Technical Feasibility of Compressed Air Energy Storage (CAES) Utilizing a Porous Rock Reservoir

Final Report Appendix — Chapter 3

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Prepared by

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Citation

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Abstract

Pacific Gas & Electric Company (PG&E) conducted a project to explore the viability of underground compressed air energy storage (CAES) technology.

CAES uses low-cost, off-peak electricity to compress air into a storage system in an underground space such as a rock formation or salt cavern. When electricity is needed, the air is withdrawn and used to drive a generator for electricity production.

The project screened potential sites in California and selected two locations: King Island, near Stockton, and East Island in San Joaquin County. All necessary rights were acquired at both sites to conduct tests and develop a CAES facility. Core drilling provided information on reservoir rock properties, caprock properties, reservoir pressure, and reservoir fluid. Results found the conditions at the King Island site to be more favorable than East Island. Air injection testing at King Island produced data on flow dynamics, rock mechanics, and other factors. Finally, the project team developed a conceptual engineering design for a CAES facility and reservoir infrastructure, and analyzed the environmental impacts and permitting requirements.

To determine the interest and qualifications of potential third parties, the project issued a Request for Offer (RFO), which required applicants to describe their technical qualifications to develop, construct, own, operate, and maintain a CAES facility at the King Island site, and to estimate their costs for participation in the project. Offers were received, but the best offer was not economically competitive with alternative storage technologies.

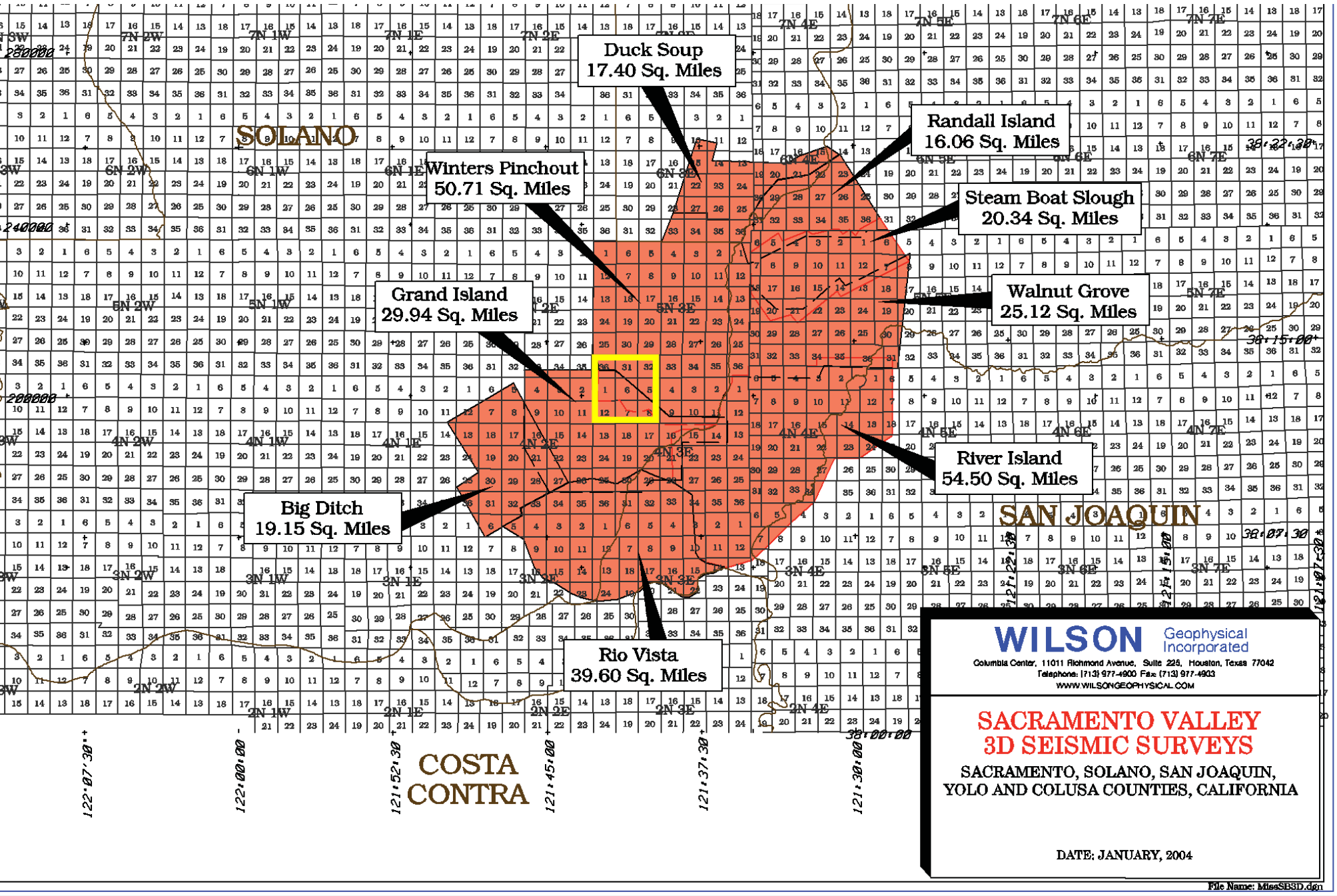
The project demonstrated the technical feasibility of using an abandoned natural gas reservoir for storing high-pressure compressed air for a 300-MW-by-10-hour CAES facility. The reservoir at the King Island site was shown to be capable of accommodating the flow rates and pressures necessary for the operation of the facility. However, the estimated high cost of a CAES facility will have to be addressed in the context of the cost of alternative energy storage technologies.

Chapter 3 Attachments

A301: Cache Slough Site Selection and Attachments
A302: Crossroads Site Selection and Attachments
A303: McMullin Ranch Site Selection and Attachments
A304: Merrill Avenue Site Selection and Attachments
A305: Perkins Lake Site Selection and Attachments
A306: Putah Sink Site Selection and Attachments
A307: Tracy Site Selection and Attachments
A308: West Thornton Site Selection and Attachments
A309: Willow Slough Site Selection and Attachments
A310: Zamora Site Selection and Attachments
A311: 111019 - Screening_CAES_Model_GIPtoWVol
A312: 120127 - Evaluation Summary Composite
A313: 120822 - Evaluation Summary Composite
A314: CAES High Level Review.docx
A315: CAES Reservoir Size Determination
A316: East Islands Cultural Final No Records
A317: East Islands_BCA_Final
A318: King_Cultural Final No Records
A319: King_Island_BCA_Final
A320: Master_List.xlsx
A321: PG&E CAES Gas Screening Model_November 2011

A301: Cache Slough Site Selection and Attachments

Cache Slough - 3D Seismic
Cache Slough - Aerial Map
Cache Slough - APN Map
Cache Slough - Biological Constraints Analysis
Cache Slough - Cultural Resources Report
Cache Slough - Detailed Geological Report
Cache Slough - DOE Environmental Questionaire
Cache Slough - Formation Tops
Cache Slough - FWS Biological Effects Assessment
Cache Slough - GIS Evaluation
Cache Slough - Preliminary Geological Report
Cache Slough - Production Data
Cache Slough - Solano County Administrative Permit
Cache Slough - Well Data
Cache Slough Site Selection Close-Out - Final_12_04



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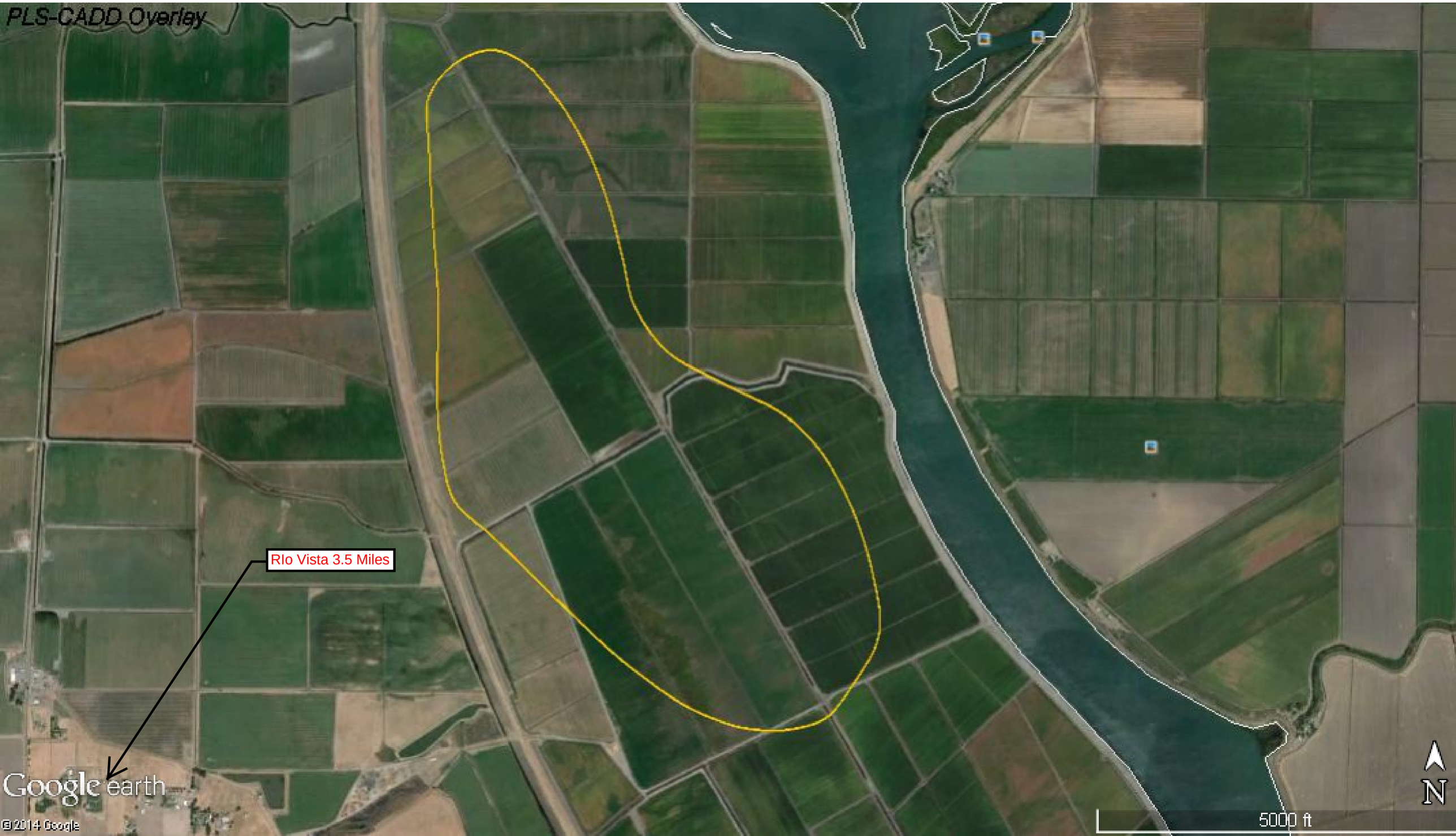
SACRAMENTO VALLEY 3D SEISMIC SURVEYS

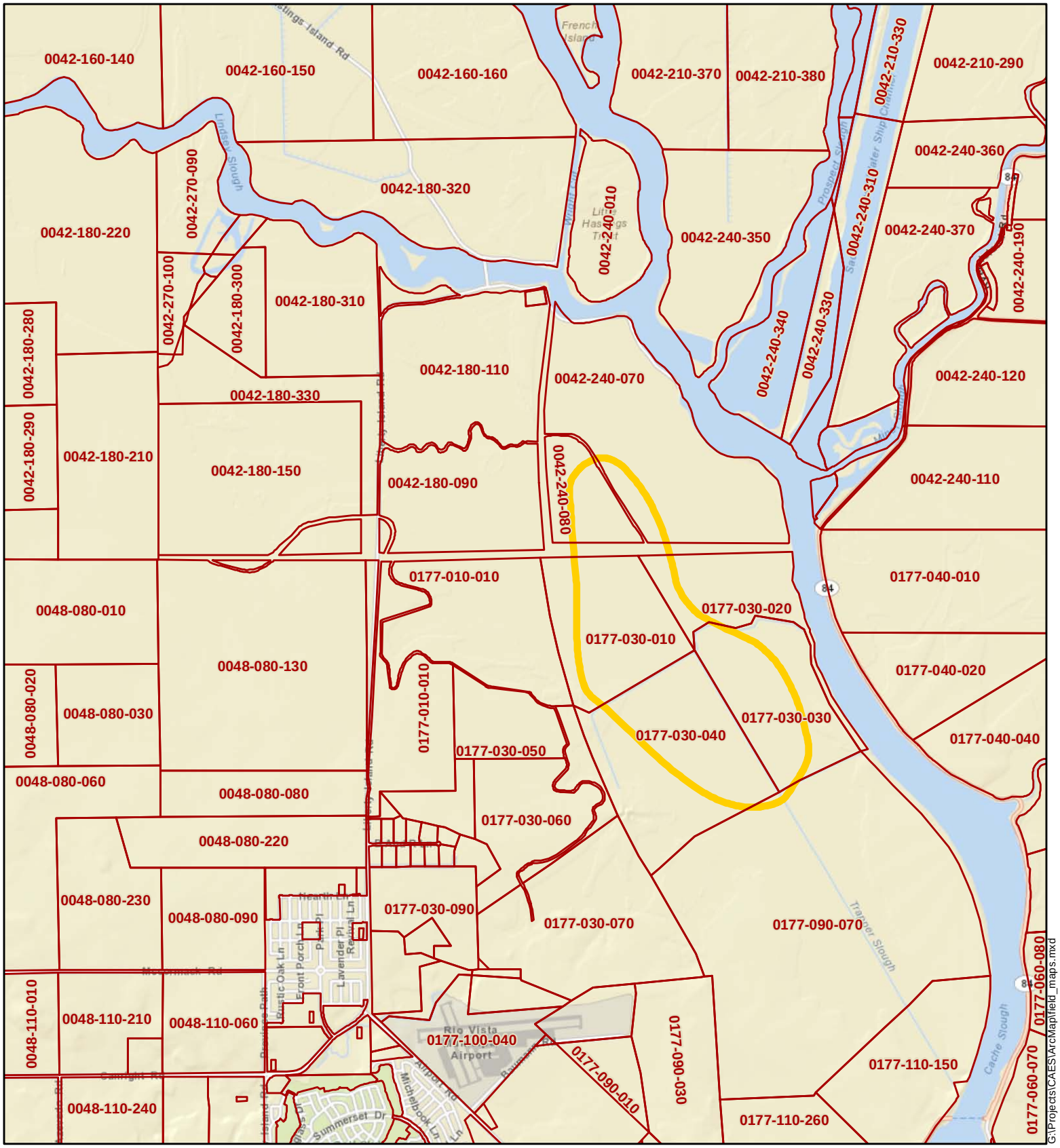
SACRAMENTO, SOLANO, SAN JOAQUIN, YOLO AND COLUSA COUNTIES, CALIFORNIA

DATE: JANUARY, 2004

File Name: MissSB3D.dgn

Cache Slough Aerial Map





Cache Slough Gas

- Approximate Structure Formation
- Station Site
- Parcels
- 1,500' Buffer
- Gas Pipeline Connection
- Gas Supply
- Gen-Tie

1:40,000

0 1,700 3,400 5,100

Feet

G:\Projects\CAESVArcMapfield_maps.mxd

North State Resources, Inc.

Date:	October 12, 2012	**PG&E Order #:**	8105484
To:	Land and Environmental Management—Catalina Reyes, Biologist		
From:	North State Resources, Inc.— John W. Hunt, Biologist		
Project:	PG&E Compressed Air Energy Storage Sites–Proposed Investigative Geologic Core Sampling at the Cache Slough		
Subject:	Final Biological Constraints Analysis of the Cache Slough Well #2, Parcel 1, and Parcel 6 Geological Core Sampling Locations, Solano County, California		

Introduction and Summary

Mr. John W. Hunt, NSR Biologist, conducted a biological constraints analysis for the proposed Geologic Core Sampling Phase of the Pacific Gas and Electric Company (PG&E) Compressed Air Energy Storage Project (project) at the proposed Cache Slough Well #2 natural gas well pad expansion area, Parcel 1 and Parcel 6 alternative sampling locations, and associated access roads (project area). The survey area consists of all areas within 20 feet of proposed access roads and all areas within 250 feet of the existing well pads and proposed well pad expansion areas (Figure 1, Appendix A). The objective of the project is to expand and utilize the existing footprint of Well #2 well pads to stage geological core sampling equipment. The Parcel 1 and Parcel 6 sampling locations have been evaluated as an alternative if land access is not granted for Well #2 well pad expansion area. The geological core sampling will be used to determine the suitability of the project vicinity for compressed air storage within depleted subterranean natural gas reservoirs.

A field reconnaissance was conducted on August 20, 2012 with Ms. Catalina Reyes, PG&E Biologist. Mr. Hunt conducted a second field review of the alternative sites on October 2, 2012. The project area includes all proposed access roads, existing well pads and staging areas, and well pad expansion areas identified by PG&E technical staff during the field reviews conducted on August 20 and October 2, 2012 (Figure 2, Appendix A).

Giant garter snake, listed as threatened under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA); Swainson's hawk, listed as threatened under CESA; loggerhead shrike and burrowing owls, designated as California species of special concern (SC); and white-tailed kite, a state fully protected (FP) species, have the potential to be adversely affected or impacted by the project This document provides Avoidance and Minimization Measures (AMMs) that would avoid effects on these species.

The irrigation canal and irrigation ditches, and drainage ditches within the project area appear to meet wetland criteria and are considered to qualify as potential waters of the United States. The existing access roads, the existing well pads, and the proposed well pad expansion areas do not appear to meet wetland criteria and are not considered to qualify as potential waters of the United States. All determinations concerning waters of the United States should be considered preliminary and tentative unless verified in writing by the U.S. Army Corps of Engineers.

The proposed project will receive federal funding from the U.S. Department of Energy (USDOE). As such, the USDOE is required under section 7 of the federal Endangered Species Act to determine whether

the proposed project may affect federally listed and proposed species or proposed or designated critical habitat. If the USDOE determines that the project may affect federally listed species or critical habitat, consultation with the U.S. Fish and Wildlife Service and/or National Marine Fisheries Services is required.

Project Description

The objective of the project is to collect approximate 10-inch diameter geological core samples from the subsurface natural gas formation at depth approximately 4,000-5,000 feet. Cores will be used determine the suitability of the subsurface formation for compressed air storage. Compressed air storage involves utilizing appropriate geological formations (e.g., depleted natural gas reservoirs) to store surplus energy in the form of compressed air during periods of low electric demand. This stored energy can then be utilized during periods of higher electric demand, improving the efficiency of energy distribution through the power grid.

The project area is located in Cache Slough approximately 2 miles northeast of Rio Vista in Solano County, California at approximately 38.218712°, -121.686601° (Figure 2, Appendix A). Site access to the well pad location and alternative sampling locations is along an unnamed dirt road northwest from River Road.

Given that there are existing access roads, no road construction is necessary for project construction. Improvements to the existing access roads will be limited to light graveling of the unnamed dirt road if determined to be necessary (e.g., work to occur during the wet season) with the assumption no additional grading will be required. If grading is required, it will be limited to the existing road and will not extend beyond the compacted surface. All vehicle traffic will be on the existing access roads and all staging will be within the existing well pads. Water trucks will be used as necessary to reduce dust during site access and other construction activities. Approximately 28 truck trips will be required to import well pad material to the site. An additional five truck trips will be required to remove drill-core samples and associated material from the site. If the well pad expansion area is restored to pre-project conditions, an additional 28 truck trips will be required to remove temporary well pad expansion materials, which will total 61 truck trips. PG&E standard Best Management Practices (BMPs) and AMMs will be implemented to avoid impacts on potential waters of the United States.

There are three proposed potential geological core sampling locations but only one will be chosen for coring. Well Pad #2 expansion area is the preferred location of geological core sampling but if the land access is not acquired for that site but is instead acquired for one of the alternatives (Parcel 1 and 6) then coring will occur at that location. One of the proposed sampling locations consists of a temporary well pad expansion area at an existing natural gas well location (Well #2). Two proposed alternative sampling locations (Parcel 1 and Parcel 6) will require establishing new temporary drilling pads within existing row crops (Figure 2). The Well #2 pad expansion will result in a 120 x 220 foot well pad built on the existing base, which may only disturb approximately 0.2 acre of vegetation. Approximately 0.2 acre of alfalfa at Well #2 will be cleared in order to accommodate each well pad expansion. The Parcel 1 alternative sampling location will consist of establishing a new pad within a corn field. This pad will be located adjacent to an existing ranch road on the west side and an existing staging area on the south side. The Parcel 1 pad will measure 220 feet along its north-south axis and extend approximately 140 feet northeast into the existing corn field (approximately 0.7 acre). Approximately 20 additional feet of corn field along the north and east side of the Parcel 1 pad may be temporarily impacted during pad construction. The Parcel 6 alternative sampling location will consist of establishing a new pad within an existing alfalfa field. This pad will be located adjacent existing ranch roads along the north and east sides. The Parcel 6 pad will measure 220 feet along its east -west axis and extend approximately 140 feet southeast into the

existing alfalfa field (approximately 0.7 acre). Approximately 20 additional feet of the alfalfa field along the western and southern side of the Parcel 6 pad may be temporarily impacted during pad construction. No more than 0.7 acre of alfalfa will be temporarily cleared in order to accommodate geological core sampling. After clearing the vegetation, approximately 1 foot of crushed rock will be placed within the cleared area and compacted with a roller.

Access to Parcel 6 utilizes an existing crossing over the canal. Parcel 1 is accessed from the canal road via an existing crossing over a ditch that drains water southeast from agricultural lands within and around the project area. No additional roads or crossings will be required to develop pads at the Parcel 1 or Parcel 6 alternatives.

After the well pad expansion or alternate pad area has been established (i.e., cleared of vegetation, rocked, and compacted), well drilling equipment will be moved onto the expansion area. The primary equipment includes the drill rig, mud and water tanks and pumps, shaker tanks, electric generators, diesel fuel tanks, and drill pipe racks. Geologic sampling will consist of drilling a 10 inch diameter well to a depth of approximately 4,000-5,000 feet and extracting a geological core sample not greater than 4 inches in diameter. All sections of the core sample will be removed offsite for analysis and storage. All peripheral material (e.g., cuttings and drilling mud) removed during the coring process will be immediately placed in proper storage receptacles and removed offsite for disposal at an authorized facility. The drilling crew, plus engineers, temporary workers and site visitors, will consist of an average of approximately 12 workers per shift, with three shifts per day. A maximum of 20 workers may be present during various operations. In addition to worker vehicles, service and delivery vehicles will access the site during the drilling phase including equipment trucks for all aspects of the effort. All drilling activities will be completed in compliance with the County Gas and Oil Well Improvement Plan approval.

Once the core samples are obtained and the remaining hole is plugged and abandoned per California Division of Oil Gas and Geothermal Resources (DOGGR) and Environmental Protection Agency (EPA) standards, the drilling equipment will be dismantled and demobilized from the site. Construction equipment similar to that used during well pad development will be used to remove the pad materials and return the site to near pre-project conditions. This includes spreading of any surface vegetation or roots stockpiled during site preparation. All removed material will be disposed of at suitable landfills or recycled consistent with county grading or other permit requirements. However, the property owner may elect to retain the pad expansion area for farm equipment staging and storage.

Well pad construction and improvements to access roads will occur over a two-week period commencing as early as October 2012. Drilling activities will occur virtually continuously for up to approximately six weeks. If elected, removal of the pad expansion area and subsequent site restoration will take up to two weeks.

Habitat and Affected Environment

The project area is situated in a landscape that currently supports active agricultural operations, existing natural gas well sites, and access roads. The project area is located below sea level in Cache Slough within the Yolo Bypass. Cache Slough was historically reclaimed for agricultural use by the construction of levees/dikes and draining to enable farming.

Habitats within the project area (Figure 3-1 through 3-3 and Figures 4-1 through 4-3, Appendix A) include flood irrigated row crops (e.g., alfalfa and corn). Some of the cornfields adjacent to the access roads in the project area were flood irrigated during the August 20, 2012 field reconnaissance. The well pad expansion area and alternative sampling locations are within regularly harvested and disked row

crops. Alfalfa crops within the project are harvested multiple times throughout the growing season and fields are disked and replanted on a 3-4 year rotation. Visual inspection of these fields revealed a notable absence of small mammal burrows. The alfalfa field adjacent to Well Pad #2 was observed as completely disked for replanting during the October 2, 2012 field visit. Corn fields within the project area are harvested annually and are disked annually. All agricultural crops within the project area are actively farmed and regularly disked, harvested and/or disturbed up to the edge of existing roads.

The access road follows a discontinuous series of irrigation ditches along most of its length prior to crossing and following a large earthen irrigation canal (canal) east to Well #2, Parcel 1, and Parcel 6. Habitat within the canal is predominantly open water. Narrow strips of vegetation bordering the banks of the canal include cattails (*Typha* sp.) and bulrush (*Schoenoplectus acutus*). Schools of black bass (*Micropterus* spp.) ranging from 8-15 inches in size were observed along the length of this canal. The banks of the canal are largely devoid of vegetation and appeared to be both mechanically and chemically managed. Ruderal herbaceous species occurring along the banks and adjacent road shoulders include bristly ox-tongue (*Helminthotheca echioides*), redroot pigweed (*Amaranthus retroflexus*), common knotweed (*Polygonum aviculare*), knotweed (*Polygonum arenastrum*), and Bermuda grass (*Cynodon dactylon*). A valve at the levee supplies water from Cache Slough for irrigation delivery to crops. The canal is gravity fed by water from Cache Slough to the west. Cache Slough is a large channel of deep open water located approximately 0.5 miles east of the project area.

A large drainage ditch is located along the access roads to both Parcel 1 and Parcel 6. Similar to the irrigation canal, the drainage ditch appears to be regularly managed and the banks are largely devoid of vegetation. Habitat in the drainage ditch was dominated by cattails, mosquito fern (*Azolla* sp.) and water hyacinth (*Eichhornia crassipes*). Characteristic of regularly cleared irrigation ditches in the area, the cattails within this ditch showed only 1-2 years growth with no reproductive stems.

The Well #2existing well pad is composed of compacted gravels. The well pad is no longer in use and no equipment is present. Ruderal herbaceous vegetation occurs along the edges of the existing pads is dominated by bristly ox-tongue and annual saltmarsh aster (*Symphyotrichum subulatum*).

No annual grasslands that would support vernal pool habitat occur within or near the project area. The project is within the Giant Garter Snake Priority Conservation Area designated by the Solano County General Plan and is not within any other Solano County designated conservation areas (Solano County 2008).

Methods

The determination of the potential for the project area to support habitat for special-status species, waters of the United States, and other sensitive biological resources was established through desktop review and a field reconnaissance. The desktop review was completed using a series of database searches and a review of pertinent resources (Attachment 1). Special-status species[1] listed in the U.S. Fish and Wildlife (USFWS) species list for Solano County and species reported in the CNDDB to occur within a 5-mile radius of the project area were considered in the evaluation (e.g., listed shrimp, valley elderberry longhorn beetle, giant garter snake) (Appendix B). Additionally, special-status species not included in the USFWS species list or CNDDB records were considered due to their known geographic range and/or the presence of potential habitat (e.g., white-tailed kite, loggerhead shrike, ringtail). Special-status species shown in

[1] Special-status species: Listed, candidate, or proposed for listing as threatened or endangered under the Endangered Species Act, or California Endangered Species Act, California Native Plant Protection Act, California Species of Special Concern, and California Fully Protected Species. Special-status plants include California rare plant rank (RPR) 1A, 1B and 2.

the USFWS and CNDDB queries (Appendix B) that are not included in Table 1 lack habitat within the project area or the project area is not within the range of the species (e.g., vernal pool species). These species are not analyzed further in this document.

Following completion of the field reconnaissance, an assessment of local, state, and federal permitting requirements was conducted to determine if the proposed project requires permits or authorizations from the local government or state and federal regulatory agencies. No local, state, or federal permits addressing biological resources are anticipated to be required. To the discretion of the Solano County Planting division staff, a biological survey may be required to confirm the absence of giant garter snake to issue a grading permit.

Special-Status Species and Potential Impacts

The project area contains potentially suitable habitat for eleven special-status plant species including: watershield (*Brasenia schreberi*), bristly sedge (*Carex comosa*), woolly rose-mallow (*Hibiscus lasiocarpus* var. *occidentalis*), Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), Mason's lilaeopsis (*Lilaeopsis masonii*), Delta mudwort (*Limosella subulata*), eel-grass pondweed (*Potamogeton zosteriformis*), Sanford's arrowhead (*Sagittaria sanfordii*), marsh skullcap (*Scutellaria galericulata*), side-flowering skullcap (*Scutellaria lateriflora*), and Suisun marsh aster (*Symphyotrichum lentum*). The potentially suitable habitat for these species is located within the canals and irrigation ditches that are present within the project area. The proposed project would not result in disturbance to the canals and irrigation ditches. Therefore, the proposed project would not result in impacts on special-status plant species.

Special-status animal species that were determined to have the potential to occur in or near the project area, and that could be adversely affected by the proposed project, include giant garter snake (*Thamnophis gigas*), Swainson's hawk (*Buteo swainsoni*), white-tailed kite (*Elanus leucurus*), western burrowing owl (*Athene cunicularia*), and loggerhead shrike (*Lanius ludovicianus*) (Table 1).

Within the project vicinity, the irrigation canal, irrigation ditches, drainage ditches and associated upland provide potentially suitable habitat for giant garter snake (GGS). Giant garter snakes are typically absent from larger rivers and other water bodies that support introduced populations of large, predatory fish and lack emergent vegetation (Hansen 1988; USFWS 1997). Because the source of irrigation water within the project area is provided by the deep water channel of Cache Slough, a high flow channel lacking appropriate aquatic habitat (i.e., emergent vegetation), it is not expected that this canal provides connectivity to potential GGS source populations. Intensively managed canals and ditches within the project area provide suitable foraging habitat for GGS, but low quality basking habitat with few potential refugia (e.g., small mammal burrows, crevices, or similar cavities). Intensively managed roadways and agricultural habitat within the project area do not provide suitable upland or basking habitat for giant garter snake. The nearest CNDDB GGS occurrence record is approximately 8-9 miles north and northwest of the project area. In the unlikely event that GGS are present within the project area, adverse impacts (e.g., injury or death) on GGS could result from vehicular traffic or ground disturbance associated with project activities.

Irrigation canals and irrigation ditches adjacent to each project area could provide dispersal habitat for juvenile GGS An irrigation canal, which provides potential aquatic habitat for GGS is located immediately south of Well #2 and the expansion area is located approximately 160 feet north of potential aquatic habitat. The Parcel 1 and Parcel 6 locations are approximately 50 feet north and south of this irrigation canal, respectively. Additionally, the Parcel 1 and Parcel 2 locations are approximately 35 feet east and west of a large drainage ditch which provides potential low quality aquatic habitat for GGS.

Both the irrigation canals and ditches are also maintained (e.g., vegetation removal and recontouring) to efficiently deliver water to crops, which reduces the amount of emergent vegetation required for GGS escape cover and foraging habitat (Miller, Hornaday et al. 1999) and devalues the quality of the habitat. Despite having some emergent vegetation, because these aquatic habitats (canals, ditches) appear to be subject to regular vegetation management using both mechanical and chemical technique, and habitat within the channels are mostly open water, these aquatic habitats offer poor to marginal habitat to GGS.

Burrows and other underground refuge are important to GGS during summer and winter to escape unfavorable winter cold temperatures or excessive summer heat. The GGS recovery plan states that wintering habitat can be up to 250 meters (820 feet) from the edge of marsh habitat (Miller, Hornaday et al. 1999). Typically, the USFWS defines upland habitat as all areas occurring within 200 feet of aquatic habitat (White 1997). Following that definition, the well pad expansion areas at Well Pad #2, Parcel 1 and Parcel 6 are all within 200 feet of potential aquatic habitat (irrigation ditches) and thus may provide upland habitat for winter burrows. In addition, GGS burrows may also exist along project access roads since they are located within 200 feet of aquatic habitat. If burrows are located under the access roads or within well pad expansion areas then burrows can collapse and snakes can become entombed.

Despite the presence of vegetated irrigation ditches that may support dispersal of GGS, these provide marginal to poor habitat. Based on landscape habitat use analyses conducted by Wylie et al (Wylie, Graham et al. 1995; Wylie, Casazza et al. 1997; Wylie, Casazza et al. 2002; Wylie, Casazza et al. 2002) provided in the Solano Multispecies Habitat Conservation Plan (Solano MHCP), low quality ditch habitat associated with rice fields provided an artificial marsh habitat that provides the essential components (e.g., appropriate cover, high food availability, and upland refuge) to support GGS. Alternatively, studies conducted in high quality marsh habitat surrounded by fallow fields did not locate GGS or found them at very low densities. Based on these results, areas supporting marginal to poor habitat or small, isolated patches of good habitat are presumed to not support GGS due to lack of surrounding aquatic habitat (Solano County Water Agency 2009). Within the project area, the surrounding aquatic habitat is of marginal to poor quality and thus, it is unlikely that GGS would use these for dispersal.

The upland habitat that the project area (i.e. upland habitat along access routes and within well pad expansion area) provides is also poor to marginal habitat for GGS. As part of existing agricultural activities, potential upland habitat for GGS within and immediately around proposed project area are extensively disked, tilled and planted with row crops to the edge of the existing well pad precludes occupation of burrowing mammals that would provide refugia for GGS. Additionally, no burrows or other refugia were observed around the existing well pad, in the pad expansion areas, or along the access road, and no ground squirrel activity was observed during the field reconnaissance on August 20, 2012 or October 2, 2012 in these areas. Furthermore, due to the high level of disturbance, the Solano MHCP does not consider cultivated or plowed uplands within the project area to be suitable wintering habitat for GGS (Solano County Water Agency 2009). Due to the level of regular disking and harvesting activity, uplands within the project area are not considered to provide suitable wintering habitat (i.e., refugia) for GGS.

Based on the observation of low quality habitat (i.e. distance from moderate to poor quality dispersal habitat) provided by the primary irrigation ditches (greater than 200 feet), documented lack of use in non-rice agricultural lands, the lack of upland habitat including burrows or other refugia, and the lack of ground squirrel activity near the well pad expansion areas, the irrigation canal, drainage ditches, irrigation ditches, and the associated farmed upland provide low quality habitat and the likelihood for GGS to occur within the pad expansion area is very low.

To minimize potential adverse effects on GGS, a survey for burrows shall be conducted 24 hours prior to any modifications to access roads (i.e., grading or addition of gravels) and within well pad expansion areas. If burrows are observed during the inactive period, they shall be flagged and grading or addition of gravel along the shoulder shall avoid all burrows. In addition, all vehicles will travel in the road center and speed limit of 10 mph will be maintained which will also minimize potential impact on this species. However, if construction occurs during the GGS active period, the likelihood of encountering a snake along or within access roads bordering GGS aquatic habitat greatly increases. Due to the aquatic habitat along the access roads, if construction activities, occurs during the active period, a biological monitor will drive in front of heavy construction vehicles (i.e. dump trucks, drill rigs, etc.) on all dirt roads during entry/exit of project site. The biologist will lead vehicles at a maximum speed of 10 mph, watch for signs of snakes, and stop and investigate the road if there are any concerns.

Potential nesting habitat (e.g., trees, power poles/towers) for Swainson's hawk occurring within 0.5 mile of the project area is limited to riparian habitat along River Road near the entrance to the project area and a few stands of isolated trees. Noise generated by expanding the pad, exploration drilling, site restoration, and other construction activities could adversely affect this species if active nests are located within 0.5 mile. Project implementation is expected to commence as early as October 2012 and extend for a total of four to six weeks, which is outside of the nesting season for these species. If project implementation is confined to this period, the proposed project would not result in adverse effects on this species. However, if work will occur during the nesting season (i.e., March 1–July 31), protocol -level surveys for Swainson's hawk will be required. If active nests are detected within 0.5 mile of project activities, construction activity will stop immediately and will not resume until PG&E Biologist or Land Planner contacts USFWS and California Department of Fish and Game (CDFG) Biologists to discuss possible AMM's, which could include avoidance buffers, reconsidering access routes, and additional surveys.

Cornfields are located within the Parcel 1 alternative location. These fields were actively growing during the August 20, 2012 field visit and were being During the October 2, 2012 field visit. California Department of Fish and Game Swainson's hawk guidelines (California Department of Fish and Game 1994) were considered in assessing impacts on the loss of foraging habitat for Swainson's hawk and, although fallow cornfields are listed as potential foraging habitat, corn fields within the project area are fallowed after most Swainson's hawks have migrated south. These fields provide limited foraging opportunities and the conversion of approximately 0.4 acre of corn would have no significant effects on Swainson's hawk foraging habitat.

Alfalfa fields bordering the Well #2 expansion area and within the Parcel 6 alternative location provide potential foraging habitat for Swainson's hawks(California Department of Fish and Game 1994). Assuming that there are no conservation easements, a loss of 0.7 acre of foraging habitat would not diminish or disrupt foraging activities in the vicinity and would not affect the success of this species, because loss of foraging habitat is small, extensive foraging habitat is available, and conversion of land is consistent with agricultural use in that development of the well does not have growth inducing effects.

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T/—	Elderberry shrubs associated with riparian forests which occur along rivers and streams.	None. No elderberry shrubs were observed within the project area.	None required
Delta smelt *Hypomesus transpacificus* **Critical habitat**	T/T	Estuarine systems in the Sacramento-San Joaquin Delta.	None. Canals and ditches occurring within the project area provide potential habitat for this species and are connected to higher quality habitat (marshes and sloughs) occurring outside of the project area. However, all potential habitat for this species occurs outside of planned activity areas (i.e., access roads, existing well pads, and temporary well pad expansions areas) and no impacts or modifications to potential habitat are expected.	None required
Sacramento splittail Pogonichthys macrolepidotus	—/SC	Shallow, dead-end sloughs with submerged vegetation.	None. Canals and ditches occurring within the project area provide potential habitat for this species and are connected to higher quality habitat (marshes and sloughs) occurring outside of the project area. However, all potential habitat for this species occurs outside of planned activity areas (i.e., access roads, existing well pads, and well pad expansions areas) and no impacts or modifications to potential habitat are expected.	None required
Longfin smelt Spirinchus thaleichthys	—/SC	Sloughs of Suisun Bay and Delta.	None. Canals and ditches occurring within the project area provide potential habitat for this species and are connected to higher quality habitat (marshes and sloughs) occurring outside of the project area. However, all potential habitat for this species occurs outside of planned activity areas (i.e., access roads, existing well pads, and well pad expansions areas) and no impacts or modifications to potential habitat are expected.	None required

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
California red-legged frog *Rana draytonii*	T/SC	Require aquatic habitat for breeding, also uses a variety of other habitat types including riparian and upland areas. Adults prefer dense, shrubby or emergent vegetation associated with deep-water pools with fringes of cattails and dense stands of overhanging vegetation. This species also breeds in ephemeral ponds that support little or no vegetation.	None. This species is outside the current known range (CWHR) and there are no occurrences within 5 miles of the project area. Additionally, the Solano Multispecies Habitat Conservation Plan (SMHCP) (Solano County Water Agency 2009) concludes that CRLF is extirpated from the valley floor. This species is not expected to occur in the project area.	None required.
Giant garter snake *Thamnophis gigas*	T/T	Freshwater marshes and low gradient streams with emergent vegetation. Adapted to drainage canals and irrigation ditches with mud substrate.	Very Low. Canals, waterways, and ditches, and associated uplands within the project area provide potential habitat. The nearest CNDDB GGS occurrence record is approximately 8-9 miles north and northeast of the project area. Ground disturbance activities that disrupt burrows within the project area could adversely affect this species.	Pre construction surveys Biological monitor Water quality BMPs
Western pond turtle *Emys marmorata*	--/SC	Slow water aquatic habitat with available basking sites. Hatchlings require shallow water with dense submergent or short emergent vegetation. Requires an upland oviposition site in the vicinity of the aquatic site.	None. Although canals in the project area are perennial, and contain fresh emergent vegetation, the banks are steep and do not contain available basking sites. Canals are actively maintained and likely preclude the occupation of pond turtles. Additionally, upland breeding sites are unavailable in the cropland habitat around the well expansion site and access roads. Due to lack of basking habitat and upland oviposition sites, the potential for pond turtles to occur in the project area is unlikely.	None required.

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
California black rail *Laterallus jamaicensis coturniculus*	—/T, FP	Coastal and inland marsh habitat.	None. Canals and ditches occurring within the project area provide poor to no potential habitat for this species and are connected to higher quality habitat (marshes and sloughs) occurring outside of the project area. However, potential habitat for this species occurs outside of planned activity areas (i.e., access roads, existing well pads, and temporary well pad expansions areas) and no impacts or modifications to potential habitat are expected.	None required
Swainson's hawk *Buteo swainsoni*	--/T	Breeds in stands with few trees in juniper-sage flats, riparian areas, and oak savannah; forages in adjacent livestock pasture, grassland or grain fields.	Moderate. Larger trees and stands of trees occurring within 0.5 mile of the project area provide potential nesting habitat for Swainson's hawk. One Swainson's hawk was observed overhead during the field visit on August 20, 2012. There are seven recorded CNDDB occurrences of nesting Swainson's hawk within 5 miles of the project area. Noise generated by project activities could disrupt nesting behavior and nest success if Swainson's hawks are nesting within 0.5 mile of the project area.	If work is expected to occur during nesting season (March 1 to July 31), Swainson's hawk nesting surveys will be performed following CDFG protocol developed by the Swainson's Hawk Technical Advisory Committee.
Burrowing owl *Athene Cunicularia hypugea*	—/SC	Grasslands and ruderal habitats.	None. No burrows or habitat is present around any of the pad areas.	None required.
White-tailed kite *Elanus leucurus*	—/FP	Nests in tall shrubs and trees, forages in grasslands, agricultural fields and marshes.	Low. Isolated trees and shrubs near proposed access roads.	Nesting bird surveys required within the breeding season (February 15-August 31).
Loggerhead shrike *Lanius ludovicianus*	—/SC	Nests in tall shrubs and dense trees, forages in grasslands, marshes, and ruderal habitats.	Low. Isolated trees and shrubs near proposed access roads provide nesting habitat for this species. One loggerhead shrike was observed perched on a wire during the field visit on August 20, 2012[2].	Nesting bird surveys required within the breeding season (February 15-August 31).

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures

[1]Status Codes: : Federal and State Codes: T = Threatened; SC = Species of Special Concern (State), FP = Fully Protected (State)
[2]Records of special-status species observed during the field visit were submitted to the California Department of Fish and Game.

Nesting habitat for loggerhead shrike and white-tailed kite within 300 feet of the project area is riparian habitat along the Sacramento River at the intersection of River Road and the unnamed access road. There is no habitat within 300 feet of either well pad. As with the Swainson's hawk, construction activities could have adverse impacts on nesting success for these species depending on the timing of the work. Because proposed disturbance to vegetation is limited to alfalfa and corn crops, no physical disturbance to potential nesting habitat for loggerhead shrike or white-tailed kite is expected. If work is to occur during the nesting season for these species (February 15–August 31), nesting bird surveys will occur 72 hours prior to the start of construction to determine if birds are nesting in the area. If nesting birds are found PG&E will halt work and consult with CDFG and USFWS to establish AMM's to protect nest (i.e. establish buffers).

Waters of the United States and Potential Impacts

An assessment for potential waters of the United States was conducted during the August 20, 2012 field reconnaissance. The irrigation canals, drainage ditches, and irrigation ditches adjacent to roadways within the project area support a prevalence of hydrophytic vegetation, and some reaches of the channels contained flowing or ponded water. The canals and ditches within the project area drain into or are adjacent (separated by a berm) to Cache Slough and the Sacramento River, which qualify as waters of the United States. Given that the irrigation canals and ditches support hydrophytic vegetation, are subject to extended inundation and/or saturation, and are tributary to waters of the United States, the features are considered as potential waters of the United States. The project will not result in any physical disturbance of canals or ditches within the project area; thus, the proposed project will not result in direct impacts on the irrigation canals and ditches. AMMs have been incorporated into the proposed project to avoid the potential for indirect impacts.

Although the USFWS National Wetlands Inventory identifies the entire project area as farmed wetlands, the existing access roads, the existing well pads, and the proposed well pad expansion areas do not appear to currently meet wetland criteria. The existing access roads and the existing well pads consist of compacted surfaces that are graded and sparsely vegetated; and do not exhibit evidence of long-duration ponding or saturation. However, most of the project area and well pad expansion sites area located at or below sea-level within a diked and leveed portion of the Yolo Bypass. Sparse vegetation within the existing well pads was dominated by bristly ox-tongue and annual saltmarsh aster, both ruderal species associated with wetter site conditions. The Parcel 1 alternate location currently support leveled and routinely disked agricultural fields planted with corn. The proposed Well #2 expansion area and Parcel 6 alternate location currently support leveled and routinely harvested agricultural fields planted with alfalfa (3-4 year planting rotation). Field inspection of row crops at the expansion area and alternate locations did not identify the presence of hydrophytic vegetation or evidence of soil inundation/saturation unrelated to routine irrigation. Based on observation of the water level in ponded portions of the irrigation canal and drainage ditch, the surface of the agricultural field appeared to be at least 3 feet above the water table. Although the ruderal vegetation within existing well pads is associated with wetter habitats, the lack of hydrologic indicators disqualifies the existing access roads, existing well pads, and proposed well pad expansion area for Well #2, Parcel 1 and Parcel 6 alternate locations as potential waters of the United States. Additionally, given the lack of hydrophytic vegetation, proposed well pad expansion areas would not be considered waters of the United States.

It is important to note that the field assessment did not involve a formal delineation using U.S. Army Corps of Engineers (USACE) methodology and no detailed investigations for wetland hydrology were conducted. The entire project area was historically Sacramento–San Joaquin Delta marshland prior to diking/draining and conversion to agricultural production. Areas of agricultural production that were formerly wetlands may still qualify as jurisdictional wetlands if hydrological characteristics remain to the

extent that hydrophytic vegetation would return if the agricultural activities ceased. The determinations provided in this document concerning wetland hydrology are based on single visual assessments conducted on August 20, 2012 and October 2, 2012. Definitive documentation of the status of wetland hydrology generally cannot be provided by a single visual assessment during the dry season. Therefore, all determinations provided in this document concerning waters of the United States should be considered preliminary and tentative unless verified in writing by the USACE.

Other Sensitive Biological Resources

Migratory birds and raptors (i.e., birds of prey) protected under the federal Migratory Bird Treaty Act and the California Department of Fish and Game Code may nest on open ground, vegetation, or structures within the project area. Construction activities could have adverse impacts on nesting success for birds nesting near the construction site. If disturbance to vegetation and removal of existing crops (i.e., corn and alfalfa) for pad construction is conducted outside of the nesting season, then no impacts to nesting birds are expected to result from pad construction activities. If work is to occur during the nesting season for these species (February 15–August 31), nesting bird surveys will be occur 72 hours prior to the start of construction required to determine if birds are nesting in the area. If nesting birds are found PG&E will halt work and consult with CDFG and USFWS to establish AMM's to protect nest (i.e. establish buffers).

Avoidance and Minimization Measures (22 total):

1. Prior to working on-site, all workers shall be provided with Environmental Awareness Training by a qualified biologist approved by UFWS and CDFG. The training shall address the identification and general ecology of GGS, Swainson's hawk, nesting birds and other special-status species that have potential to occur in the project area, and the AMMS to be implemented in order to avoid impacts on these resources. Areas to be avoided shall also be addressed in the training. Please contact project biologist, Catalina Reyes (925-808-8811) two weeks prior to construction to schedule the training.

2. Prior to construction, all work areas (e.g., vehicle access, parking, staging) needed to complete the project shall be identified in coordination with the on-site biologist. Due to the presence of sensitive resources, some work areas may need to be adjusted. All work areas shall be limited to the minimum area necessary to complete work.

3. If practicable, ground disturbing activity (e.g. vegetation removal, compaction, and placement of gravel fill) at all the well pad site shall be conducted during the active season for giant garter snake (GGS) (i.e., between May 1 and October 1). If ground-disturbing activity cannot be conducted during the GGS active season, preconstruction surveys for potential GGS wintering sites (i.e., burrows and soils crevices) shall be conducted within two weeks by a qualified biologist approved by USFWS and CDFG to determine the if potential GGS habitat is present within proposed areas of ground disturbing activity (e.g., the well pad expansion site, road work, application of gravel) and again within 24 hours prior to ground disturbing activity.

4. All burrows or potential refuge habitat shall be flagged and avoided. If work is suspended for a period of five days or greater, the project area must be resurveyed. If it is determined that potential GGS wintering habitat (e.g., burrows and crevices) is present within areas planned for ground disturbance, ground-disturbing activities shall be postponed until the GGS active season (i.e., between May 1 and October 1). If GGS is encountered at any time during the project, work will stop immediately and the USFWS and CDFG will be contacted before work proceeds.

5. A biological monitor shall be on site during all phases of construction to direct access and construction work around irrigation ditches and other sensitive habitats capable of supporting GGS. If any GGS are observed within the project area during work activities, work shall cease and the on-site project manager shall immediately contact the project biologist, Catalina Reyes (925-808-8811) prior to resuming work. The biological monitor has the authority to stop construction to resolve any biological concerns.

6. Access to well pads shall be confined to existing roads, road shoulders, and other compacted areas. Travel along roads shall be restricted to the centerline. If placement of gravel on access roads is necessary, the placement shall be limited to the existing road surface. No gravel shall be placed on canal or ditch banks or other areas that may support burrows that could be used by GGS. No grading shall occur along segments of existing roads that may support burrows that could be used by GGS.

7. Canals, irrigation ditches, and drainage ditches will be designated as environmentally sensitive areas and physical disturbance to irrigation ditches will be avoided during construction.

8. If deemed necessary, an exclusionary fence shall be erected to protect potentially sensitive habitat adjacent to the existing well pad. To ensure that GGS does not become trapped or entangled, no wattles with plastic monofilament netting are permitted. Burlap or coconut wattles are appropriate substitutes.

9. A qualified biologist approved by USFWS and CDFG shall perform a general pre-construction survey within 72 hours of the start of project construction.

10. Provide escape ramps at a 45 degree angle or less for any excavations that are greater than one foot that are left open overnight. For smaller holes, cover so that no gaps occur and inspect each morning for wildlife. Inspect prior to filling any trenches or holes. If special-status wildlife becomes entrapped, work shall stop and the PG&E project biologist, Catalina Reyes, shall be notified immediately to determine next steps.

11. All construction personnel shall visually check for snakes and other wildlife under vehicles and equipment prior to moving them.

12. Construction equipment will be maintained to prevent leaks of fuels, lubricants or other pollutants into aquatic habitats.

13. Whenever possible, refueling and maintenance of vehicles shall occur offsite. In cases when this is not possible, refueling and maintenance of vehicles and equipment will be conducted over drip pans and at least 100 feet from any waterway.

14. Open ends of pipes, conduits or other materials stored onsite will be covered to exclude wildlife and will be inspected prior to use.

15. Vehicular speed within the project area shall be limited to 10 miles per hour in order avoid impacts on wildlife that may be located on or near roadways. If construction occurs during the active period of the GGS, biological monitors will drive in front heavy construction vehicles (i.e. dump trucks, drill rigs, etc.) on all dirt roads during entry/exit of project site. Biologist will lead

vehicles at a minimum speed of 10 mph, watch for signs of snakes, and stop and investigate the road if there are any concerns.

16. Watering of roads during dry season work shall be performed as necessary (approximately 3–4 times a day) in order to reduce potential dust resulting from project associated traffic.

17. All potential nesting substrate (e.g., shrubs and trees) that requires removal to construct the project should be removed before the onset of the nesting season (i.e., prior to February 15), if feasible. This will help preclude nesting and substantially decrease the likelihood of direct impacts on nesting birds. If this is not feasible then a nesting bird survey of potential nesting substrate will be performed 72 hours prior to its removal.

18. Surveys for nesting raptors and migratory birds (including Swainson's hawk) shall be required if project construction is to occur during the nesting season (February 15–August 31; March 1-July 31 for Swainson's hawk). Surveys shall be conducted by a qualified biologist approved by FWS and CDFG.

    Surveys for Swainson's hawk shall follow the California Department of Fish and Game protocol developed by the Swainson's Hawk Technical Advisory Committee (see Appendix C).

    Surveys for other nesting birds, surveys will consist of performing an initial survey after February 15, 2013 or within a month of the start of project date if project is to begin later in the nesting bird season. A second nesting bird survey shall be performed within 72 hours of the start of construction. The surveys shall be repeated if work is suspended for five days or more. Please contact project biologist, Catalina Reyes (925-808-8811) two weeks prior to construction schedule surveys.

19. Caution shall be used when handling and/or storing chemicals (fuel, hydraulic fluid, etc.). As part of standard PG&E Best Management Practices (BMPs) crews shall have appropriate materials on site to provide secondary containment and prevent and manage spills. If groundwater is encountered, contact PG&E Environmental Specialist Bryon Nicholson (415-990-0139).

20. Crews shall implement all standard PG&E BMPs outlined in the Good Housekeeping Activity Specific Erosion and Sediment Control Plan (January 2011) as needed.

21. If the scope of work or project location changes, contact project biologist Catalina Reyes (925-808-8811) prior to commencing work. The project biologist or Land Planner (Ernie Ralston, 515-973-3215) will contact the USFWS Bay-Delta Fish & Wildlife Office ESA/Regulatory Division and the Dept. of Fish & Game-Bay Delta Region upon notice of any such changes.

22. Remove construction related trash from the site daily and upon work completion and return site to near pre-construction contours and conditions upon project completion.

Attachment 1. Desktop Review Results

Source	Results
County	Solano
USGS Quadrangle	Terminous, California (Unsectioned Wetlands of the Empire Tract)
Aerial Photographs – Google Earth 2012 & Bing Aerial Imagery 2012	Row crop region within diked and leveed portion of Yolo Bypass situated primarily at or below sea level. Majority of project vicinity extensively disked, tilled and planted with corn and alfalfa. Network of irrigation canals and ditches within and adjacent to project area. Canals and irrigated ditches regularly maintained (i.e., chemically and mechanically cleared of vegetation and contoured). Sparse intermittent emergent vegetation fringes banks of larger canals.
Land Ownership California Protected Areas Database (CPAD)	None. Private Ownership.
USFWS official list	Attached.
Federally Designated Critical Habitat (within 5-mile radius)	Within Delta Smelt Critical Habitat.
CNDDB-5-mile radius	Attached.
CNDDB owl viewer	Not within range of Spotted Owl.
CNPS-9 quad search	Attached.
PG&E Raptor Concentration Zones (RCZ)	Within RCZ.
National Audubon Society Important Bird Areas (IBA)	Within Sacramento-San Joaquin IBA.
U.S. Department of Agriculture (USDA) Web Soil Survey	No serpentine or alkaline soils were observed during the field investigation.
USFWS National Wetlands Inventory	Entire project area included within farmed wetlands (Pf) in USFWS NWI (below sea level within Yolo Bypass).
PG&E San Joaquin HCP or other HCPs, NCCPs	Within Solano Multispecies Habitat Conservation Plan (SMHCP)
Known Swainson's Hawk, golden or bald eagle nest sites	CNDDB Swainson's hawk nesting record within 5 miles of project area. Nearest CNDDB occurrence is 2 miles northeast of the project area. No golden or bald eagle occurrences within 5 miles.
PG&E VELB Conservation Program Range	Within PG&E VELB Conservation Program Range.
CWHR (California Wildlife Habitat Relations) species.	Potential giant garter snake habitat is found in association with waterways, canals, ditches, and associated uplands within the project area. Potential nesting habitat for Swainson's hawk occurs in two locations within 0.5 mile of the project area. Potential nesting habitat for loggerhead shrike and white-tailed kite at eastern entrance within 0.5 mile of the project area.

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Photograph 1. View north-northwest along canal and project area access toward project area from southeastern entrance at River Road. Photograph shows (from left to right) existing corn crops, vegetated bank of irrigation canal, irrigation canal with cleaned and graded bank adjacent access road (with no burrows or crevices in surface).



Photograph 2. View east-northeast along canal toward existing Well #2 pad. Photograph shows (from left to right) harvested alfalfa field with existing Well #2 pad in distance (hay stacks in distance), canal adjacent Well #2, harvested alfalfa.



Photograph 3. View east-northeast along northern edge of existing Well #2 pad into proposed well pad expansion area. Photograph shows (from left to right) existing alfalfa crop (previously harvested), disked edge of Well #2 pad with ruderal vegetation dominated by bristly ox-tongue and edge of gravel compacted well pad with alfalfa bales.



Photograph 4. View northeast across Parcel 6 alternate location showing existing alfalfa crops.



Photograph 5. View southwest across Parcel 1 alternate showing recently harvested and disked corn field.



Photograph 9. View west toward main irrigation canal passing between Well #2 expansion area (right of photograph) and Parcel 6 alternate location (left side of photograph).



Photograph 9. View north toward drainage ditch passing between Well #2 expansion area (to left outside of photograph) and Parcel 1 alternate location (right side of photograph).

APPENDIX A

Figures

APPENDIX B

USFWS, CNDDB, and CNPS Queries

APPENDIX C

Swainson's Hawk Survey Protocol

Cultural Resource Survey for the PG&E CAES – Cache Slough Project, Solano County, California

Prepared for

Pacific Gas and Electric Company

Prepared by

SWCA Environmental Consultants

October 2012

CONFIDENTIAL – NOT FOR PUBLIC DISTRIBUTION

CULTURAL RESOURCE SURVEY FOR THE PG&E CAES – CACHE SLOUGH PROJECT SOLANO COUNTY, CALIFORNIA

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SWCA Project No. 23910
SWCA Cultural Resources Report No. 2012-403

October 2012

Keywords: Cultural resources survey; 47.1 acres; Solano County; Rio Vista quadrangle; Township 4 North, and Range 2 East

Archaeological and other heritage resources can be damaged or destroyed through uncontrolled public disclosure of information regarding their location. This document contains sensitive information regarding the nature and location of archaeological sites which should not be disclosed to the general public or unauthorized persons.

Information regarding the location, character, or ownership of a cultural resource is exempt from the Freedom of Information Act pursuant to 16 USC 470w-3 (National Historic Preservation Act) and 16 USC Section 470(h) (Archaeological Resources Protection Act).

MANAGEMENT SUMMARY

Purpose and Scope: SWCA Environmental Consultants (SWCA) was retained by Pacific Gas and Electric (PG&E) to conduct a cultural resource study in support of the PG&E Compressed Air Energy Storage (CAES) – Cache Slough Project (project). The study area consists of 19.1 hectares (47.1 acres) of land located approximately 6.5 kilometers (4 miles) northeast of City of Rio Vista in Solano County, California. The cultural resource study consisted of a cultural resource record and literature search, Native American consultation, cultural resource survey of the study area, and preparation of a cultural resource technical report documenting the results of the inventory and providing management recommendations.

Dates of Investigation: A search of the California Historical Resources Information System (CHRIS) was conducted by the Northwest Information Center (NWIC) at Sonoma State University in Rohnert Park, California, and the results were received on August 27, 2012. Cultural resource specialists conducted an intensive-level cultural resource survey on August 29, 2012 and October 9, 2012.

Findings of the Investigation: Five prior cultural resource studies have been conducted within a 1-mile radius of the area of potential effects (APE), one of which may have included a portion of the APE. The records and literature search also indicates that four cultural resources have been previously recorded within a 1-mile radius of the APE, none of which are located in the study area. SWCA did identify one previously unrecorded cultural resource as a result of the current study; SWCA-CACHE-1 is adjacent to the APE and consists of three open, earthen canal segments of a larger irrigation system that diverts water to the surrounding agricultural fields.

Investigation Constraints: Ground visibility was generally poor throughout the study area due to obstruction by vegetative ground cover and gravel. Additionally, a small portion of the APE within the well pad site was unable to be surveyed due to haystacks and a manure pile.

Recommendations Summary: Although a small portion of the APE could not be surveyed within the well pad site due to haystacks and a manure pile, other portions of the APE exhibited poor ground visibility. The study area is significantly disturbed due to ongoing agricultural activities, which are likely to have exposed any substantial archaeological resources as a result of plowing that churns up the subsurface sediments and brings them to the surface. Additionally, only previously disturbed soil in the APE is expected to be affected during ground-disturbing activities. Therefore, there is a low potential for encountering undisturbed archaeological materials in the APE during project implementation. No additional cultural resource mitigation measures should be necessary beyond standard measures to minimize impacts to the unanticipated discovery of buried cultural resources or the unanticipated discovery of human remains. These standard measures are described below.

If cultural resources are discovered during construction grading, trenching, or excavation, project personnel should halt earthmoving activities in the immediate area and notify a qualified archaeologist to evaluate the resource. In the event of the discovery of human remains during project implementation, relevant state law shall be followed, beginning with a cessation of disturbance and immediately contacting the Solano County coroner.

Disposition of Data: This report will be filed with the NWIC located at Sonoma State University, Rohnert Park, PG&E, and SWCA. All field notes and records related to the current project are on file at SWCA's Pasadena office. All geographical information systems data created during this study are on file at SWCA's Pasadena office and PG&E.

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CONTENTS

Management Summary ..... **i**

Introduction **1**
Project Description 1
Area of Potential Effects 1

Regulatory Setting **6**
Federal 6
National Historic Preservation Act 6
State 7
California Environmental Quality Act 7

Environmental Setting **8**

Cultural Setting **9**
Prehistoric Overview 9
Windmiller Pattern (2500–500 B.C.) 10
Berkeley Pattern (500 B.C.–A.D. 500) 10
Augustine Pattern (A.D. 500–Historic Contact) 11
Ethnographic Overview 11
Historic Overview 13
Solano County 13

Background Research **14**
California Historical Resources Information System Records Search 14
Prior Cultural Resources Studies within 1 Mile of the APE 14
Previously Recorded Cultural Resources within 1 Mile of the APE 15
Historic Map Review 16
Sacred Lands File Search and Initial Native American Coordination 16

Methods **17**

Results **18**

Discussion and Recommendations **22**
Discussion 22
Recommendations 23
Inadvertent Discovery of Cultural Resources 23
Inadvertent Discovery of Human Remains 23

References Cited **24**

APPENDICES

Appendix A. Records Search Results Summary from NWIC
Appendix B. (confidential) Native American Coordination Correspondence
Appendix C. California Department of Parks and Recreation 523 Series Forms

TABLES

Table 1. Prior Cultural Resources Studies within 1 Mile of the APE 14
Table 2. Previously Recorded Cultural Resources within 1 Mile of the APE..... 16
Table 3. Record of Native American Coordination Efforts..... 17

FIGURES

Figure 1. Location of the study area. 2
Figure 2. Detailed location of the study area. 3
Figure 3. The area of potential effects. 4
Figure 4. Study area map. 5
Figure 5. Overview of study area; view to west/southwest. 8
Figure 6. Portion of the well pad and surrounding agricultural activities; view to the west. 19
Figure 7. Portion of the well pad that was unable to be surveyed; view to the southeast. 19
Figure 8. Cultural resources map. 20
Figure 9. Overview of northwest-southeast segment; view to the northwest. 21
Figure 10. Hand-operated canal gate; view to the west 21
Figure 11. Overview of the L-shaped southern segment of SWCA-CACHE-1; view to the south. 22

INTRODUCTION

SWCA Environmental Consultants (SWCA) was retained by Pacific Gas and Electric (PG&E) to conduct a cultural resource study in support of the PG&E Compressed Air Energy Storage (CAES) – Cache Slough Project (project). The study area consists of 19.1 hectares (47.1 acres) of land located approximately 6.5 kilometers (km) (4 miles) northeast of City of Rio Vista in Solano County, California (Figures 1 and 2). The cultural resource study consisted of a cultural resource record and literature search, Native American consultation, cultural resource survey of the study area, and preparation of a cultural resource technical report documenting the results of the inventory and providing management recommendations.

Project Description

The PG&E CAES project would use renewable energy from sources such as wind to inject compressed air into an underground reservoir and then use it to help power a turbine generator during peak periods when the energy is needed most. It will be implemented in three phases: site selection and feasibility analysis, licensing and permitting, and construction and operation.

Development of the Cache Slough reservoir site consists of constructing a well pad site that will support a drilling rig and other equipment for the purpose of core drilling tests to determine whether the Cache Slough reservoir is a viable candidate for the CAES project. The Cache Slough site consists of three potential well pad locations. Construction of the well pad will require importing non-native fill material (e.g., sand and gravel) to stabilize the site to support a drilling rig. Site preparation will include importing and placement of fill and its grading and compaction. Access routes may also require grading prior to construction. Site preparation will occur over a 1- to 2-week period starting as early as October 2012. Core drilling is planned to start as early as November 2012 following site preparation, and will consist of drill rig and support equipment mobilization, and conducting core drilling to approximately 1,524 m (5,000 feet) below the surface.

Area of Potential Effects

An area of potential effects (APE) is defined as the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties (36 Code of Federal Regulations 800.16(d)). The proposed project is located within unincorporated Solano County in an area primarily characterized by agricultural land use. The archaeological or direct APE boundary represents portions of the study area that will be directly affected by the proposed undertaking, and includes areas where ground disturbance may result from the proposed undertaking. Specifically, the direct APE consists of the construction footprint, or well pad sites, and the approximately 5.31-km (3.3-mile) access road (Figure 3). The vertical APE extends to approximately 1,524 m (5,000 feet) below the existing ground surface, or the depth to which core drilling will be conducted. A study area was established to include both the APE and buffer, and included an approximately 61-m (200-foot) buffer around the well pad sites, and a 7.5-m (25-foot) buffer from the edges of the potential access roads (Figure 4).

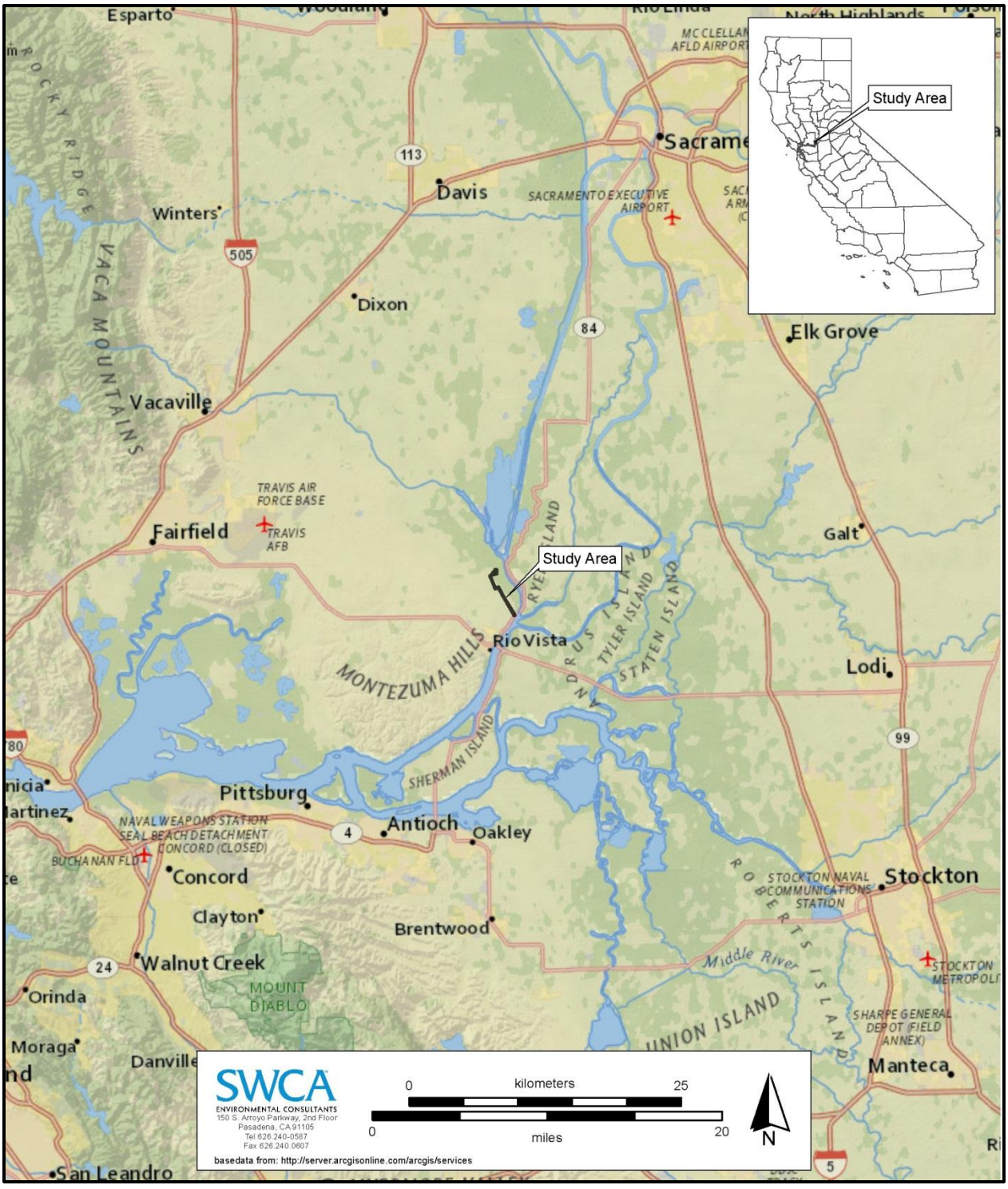


Figure 1. Location of the study area.

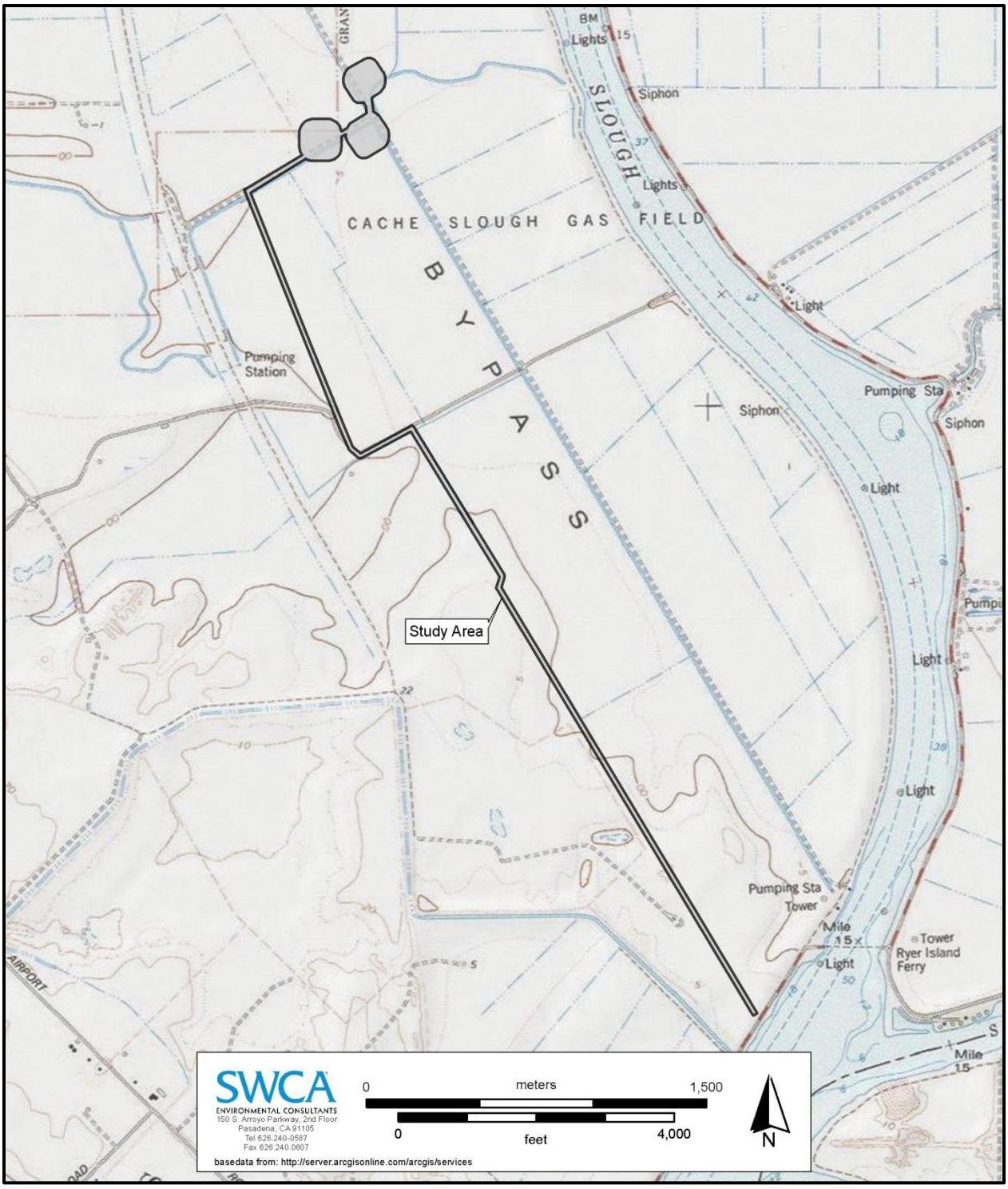


Figure 2. Detailed location of the study area.



Figure 3. The area of potential effects.



Figure 4. Study area map.

REGULATORY SETTING

This section identifies federal regulations, state legislation, and local statutes, ordinances, and guidelines that govern the identification and treatment of cultural resources and analysis of project-related effects on cultural resources. As the lead agency, the Department of Energy must consider these requirements in making decisions on projects that may affect cultural resources. The current study was conducted in compliance with both federal and state laws, particularly Section 106 of the National Historic Preservation Act (NHPA) and the California Environmental Quality Act (CEQA).

Federal

National Historic Preservation Act

The current study was completed under the provisions of the NHPA of 1966, as amended (16 United States Code 470f). Cultural resources are considered during federal undertakings chiefly under Section 106 of the NHPA through one of its implementing regulations, 36 CFR 800 (Protection of Historic Properties), as well as the National Environmental Policy Act (NEPA). Properties of traditional religious and cultural importance to Native Americans are considered under Section 101(d)(6)(A) of the NHPA. Other relevant federal laws include the Archaeological Data Preservation Act of 1974, the American Indian Religious Freedom Act of 1978, the Archaeological Resources Protection Act of 1979, and the Native American Graves Protection and Repatriation Act of 1989.

Section 106 requires federal agencies to take into account the effects of their undertakings on any district, site, building, structure, or object that is included in or eligible for the National Register of Historic Places (NRHP) and to afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings (36 CFR 800.1). Under Section 106, cultural resources must be identified and evaluated; effects on historic properties are reduced to acceptable levels through mitigation measures or agreements among consulting and interested parties. Historic properties are those resources that are listed in or are eligible for the NRHP in accordance with the criteria listed below (36 CFR 60.4) (ACHP 2010).

The quality of *significance* in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess *integrity* of location, design, setting, materials, workmanship, feeling and association and that

(A) Are associated with events that have made a significant contribution to the broad patterns of our history; or

(B) Are associated with the lives of persons significant in our past; or

(C) Embody the distinctive characteristics of a type, period, or method of installation, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(D) Have yielded, or may be likely to yield, information important in prehistory or history.

Impacts of a project to significant cultural resources that affect the characteristics of any resource that qualify it for the NRHP are considered a significant effect on the environment. Under 36 CFR 800.5(a)(2), adverse effects on historic properties include, but are not limited to

(i) Physical destruction of or damage to all or part of the property;

(ii) Alteration of a property;

(iii) Removal of the property from its historic location;

(iv) Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;

(v) Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features;

(vi) Neglect of a property which causes its deterioration;

(vii) Transfer, lease, or sale of property out of federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

State

California Environmental Quality Act

CEQA requires a lead agency to determine whether a project may have a significant effect on historical resources (Section 21084.1). If it can be demonstrated that a project will cause damage to a unique archaeological resource, the lead agency may require that reasonable efforts be made to permit any or all of these resources to be preserved in place or left in an undisturbed state. To the extent that they cannot be left undisturbed, mitigation measures are required (Section 21083.2[a], [b], and [c]).

Section 21083.2(g) defines a *unique archaeological resource* as an archaeological artifact, object, or site about which it can be clearly demonstrated that without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

(1) Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.

(2) Has a special and particular quality such as being the oldest of its type or the best available example of its type.

(3) Is directly associated with a scientifically recognized important prehistoric or historic event or person.

A *historical resource* is a resource listed in, or determined to be eligible for, the California Register of Historical Resources (CRHR) (Section 21084.1); a resource included in a local register of historical resources (Section 15064.5[a][2]); or any object, building, structure, site, area, place, record, or manuscript that a lead agency determines to be historically significant (Section 15064.5[a][3]).

Public Resources Code (PRC) Section 5024.1, Section 15064.5 of the CEQA Guidelines, and PRC Sections 21083.2 and 21084.1 were used as the basic guidelines for this cultural resource study. PRC Section 5024.1 requires an evaluation of historical resources to determine their eligibility for listing in the CRHR. The purpose of the register is to maintain listings of the state's historical resources and to indicate which properties are to be protected from substantial adverse change. The criteria for listing resources on the CRHR were expressly developed to be in accordance with previously established criteria developed for listing in the NRHP, enumerated below.

According to PRC Section 5024.1(c)(1–4), a resource is considered historically significant if it (i) retains "substantial integrity," and (ii) meets at least one of the following criteria:

(1) Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage.

(2) Is associated with the lives of persons important in our past.

(3) Embodies the distinctive characteristics of a type, period, region, or method of installation, or represents the work of an important creative individual, or possesses high artistic values.

(4) Has yielded, or may be likely to yield, information important in prehistory or history.

Impacts to significant cultural resources that affect the characteristics of any resource that qualify it for the NRHP or adversely alter the significance of a resource listed on or eligible for the CRHR are considered a significant effect on the environment. These impacts could result from "physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of an historical resource would be materially impaired" (CEQA Guidelines, Section 15064.5 [b][1], 2000). Material impairment is defined as demolition or alteration "in an adverse manner [of] those characteristics of an historical resource that convey its historical significance and that justify its inclusion in, or eligibility for inclusion in, the California Register…" (CEQA Guidelines Section 15064.5[b][2][A]).

ENVIRONMENTAL SETTING

The APE is situated within the Sacramento-San Joaquin Delta region, an area in the California Central Valley lowlands that is defined by the confluence of the Sacramento, American, Mokelumne, and San Joaquin Rivers. The topography of the study area is virtually flat, with elevations ranging from -1.5 to 1.5 meters (-5 to 5 feet) above mean sea level (Figure 5). Climate is characterized by warm, dry summers, and mild, moist winters. Summer temperatures have highs around 32 degrees Celsius (90 degrees Fahrenheit), and winter temperatures have highs around 13 degrees Celsius (55 degrees Fahrenheit).



Figure 5. Overview of study area; view to west/southwest.

Although current land uses in the APE include agricultural croplands, the greater study area is characterized by vegetation communities that include freshwater marshland near permanent water in low-

lying areas, seasonal wetlands and vernal pools within grasslands and woodlands, riparian scrub/forest along drainages, and grasslands and oak woodlands in valley foothill areas. With this mosaic of vegetation communities, and in view of the ethnographic descriptions of the Plains Miwok (Kroeber 1925; Latta 1977; Wallace 1978) who historically occupied the area, it would appear the greater study area would have provided a very productive environment for its prehistoric occupants, one well suited to a hunting-gathering economy with a variety of fish, waterbirds, small and large mammals, and edible plant species.

CULTURAL SETTING

Prehistoric Overview

California prehistory is divided into three broad temporal periods that reflect similar cultural characteristics throughout the state: Paleoindian period (ca. 9000–6000 B.C.), Archaic period (6000 B.C.–A.D. 500), and Emergent period (A.D. 500–Historic Contact) (Fredrickson 1973, 1974, 1994a). The Archaic is divided further into Lower (6000–3000 B.C.), Middle (3000–1000 B.C.), and Upper (1000 B.C.– A.D. 500) periods, generally governed by climatic and environmental variables, such as the drying of pluvial lakes at the transition from the Paleoindian to the Lower Archaic.

The APE lies in what generally is described as the Delta subregion of the Central Valley Archaeological Region, which is one of eight arbitrary organizational divisions of the state (Moratto 1984). This archaeological subregion surrounds the Sacramento-San Joaquin Delta in the middle of the Central Valley and mainly includes portions of Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties.

Occupation in the Sacramento-San Joaquin Delta region during the Prehistoric period is estimated to have occurred as early as 12,000 years ago, but only a few archaeological sites have been identified that predate 5,000 years ago. It is possible that Holocene alluvial deposits buried many prehistoric sites in this area, and Moratto (1984:214) estimates that as much as 10 m of sediment accumulated along the lower stretch of the Sacramento River drainage system during the last 5,000–6,000 years. CA-CCO-637 in eastern Contra Costa County, for example, is one of the few early Holocene-age sites in the region, with a record of human occupation as early as 8,500 years ago during the Lower Archaic (Meyer and Rosenthal 1998). The archaeological remains at that site were discovered approximately 2 m below the surface within an alluvial fan near Kellogg Creek.

Prehistoric material culture in central California subsequent to the Paleoindian and Lower Archaic periods has been categorized according to "horizons" or "patterns" that define broad technological, economic, social, and ideological elements over long periods of time and large areas. The taxonomic system historically used for central California is a tripartite classification scheme with Early, Middle, and Late Horizons. This Central California Taxonomic System (CCTS) was the result of efforts of a number of researchers (e.g., Beardsley 1954; Heizer 1949) and was developed further after the advent of radiocarbon dating (Fredrickson 1973, 1974; Heizer 1958; Ragir 1972).

Today, a series of generalized periods associated with regionally based "patterns" are typically used as part of the CCTS for the Sacramento Delta area, San Francisco Bay area, and North Coast ranges (Bennyhoff and Fredrickson 1969; Fredrickson 1973, 1974). Smaller units of patterns are referred to as "aspects" and "phases," which emphasize more local features. Revisions of the widely accepted CCTS (Bennyhoff 1994; Fredrickson 1994a, 1994b) are found in a recent volume edited by Hughes (1994).

Fredrickson (1973, 1974) defined several regionally based patterns, three of which are specific to the prehistory of the APE. Referred to as the Windmiller Pattern, Berkeley Pattern, and Augustine Pattern,

each represents a general pattern of resource exploitation, as identified between 2500 B.C. and the beginning of Euro-American contact in the early 1800s. The Windmiller Pattern was first identified at the Windmiller site (CA-SAC-107) near the Cosumnes River in Sacramento County; the Berkeley Pattern was initially identified at the West Berkeley site (CA-ALA-307) in Alameda County on the east side of San Francisco Bay; and the Augustine Pattern was identified at the Augustine site (CA-SAC-127) in the Sacramento-San Joaquin Delta. These patterns are present within the following horizon sequences: Middle Archaic period/Windmiller Pattern (formerly Early Horizon), Upper Archaic period/Berkeley Pattern (formerly Middle Horizon), and Emergent period/Augustine Pattern (formerly Late Horizon).

Windmiller Pattern (2500–500 B.C.)

Clearly documented evidence for human occupation in the general area is found at sites characteristic of the Windmiller Pattern during the Middle Archaic period. These sites date to as early as 4,500 years ago and as late as 2,500 years ago (2500–500 B.C.). Such sites often contain manos and metates (grinding stones), as well as many mortar fragments, indicating that acorns and/or various seeds formed an important part of the diet (Moratto 1984:201).

In addition to plant foods, the subsistence system included many other food resources, such as deer, elk, pronghorn, rabbits, and waterfowl. Numerous faunal remains have been documented at Windmiller Pattern sites, along with large quantities of projectile points. Also, the presence of angling hooks and baked clay artifacts possibly used as net or line sinkers, along with the remains of sturgeon, salmon, and smaller fishes, indicates that fishing was an additional source of food (Fredrickson 1973; Heizer 1949; Ragir 1972). Items made of baked clay included net sinkers, pipes, and discoids, as well as cooking "stones." Ground and polished charmstones, impressions of twined basketry, shell beads, and bone tools also have been found at Windmiller Pattern sites. Some items, such as shell beads, obsidian tools, and quartz crystals, were obtained by trade.

The archaeological record during the Windmiller Pattern indicates that people practiced a mixed procurement strategy of both game and wild plants, with the addition of acorns and/or seeds. The mixed exploitation of a wide range of natural resources ties into a seasonal foraging strategy. Populations likely occupied the lower elevations of the Sacramento Valley in the winter months and shifted to higher elevations during the summer (Moratto 1984:206). Mortuary practices included burials, accompanied by grave goods, in cemeteries that were separate from the habitation sites.

Berkeley Pattern (500 B.C.–A.D. 500)

Over a 1,000-year period, the Windmiller Pattern began to shift to the more specialized adaptive Berkeley Pattern during the Upper Archaic period. A shift to a greater reliance on acorns as a dietary staple is interpreted during the Berkeley Pattern from the increase in mortars and pestles, along with a decrease in manos and metates. Mortars and pestles are better suited to crushing and grinding acorns, whereas manos and metates were used primarily for grinding wild grass grains and seeds (Moratto 1984:209–210).

As demonstrated by the artifact assemblage, hunting remained an important aspect of food procurement during the Berkeley Pattern (Fredrickson 1973:125–126). The archaeological record, which consists of numerous large shell midden/mounds, also demonstrates that occupants at most Berkeley Pattern sites near water (both fresh and salt) made intensive use of aquatic resources.

The artifact assemblage also includes shell beads and ornaments, as well as numerous types of bone tools. Interment continues to dominate mortuary practices, but a few cremations are also found at Berkeley Pattern sites.

Artifact assemblages and radiocarbon dating of sites from this period suggest this subsistence pattern may have developed in the San Francisco Bay region and later spread to surrounding coastal locales and into central California. Moratto (1984:207–211) suggests that the pattern is related to the expansion of Eastern Miwok populations from the San Francisco Bay area to the Sacramento Valley and Sierra foothills.

Augustine Pattern (A.D. 500–Historic Contact)

The Augustine Pattern is evidenced by a number of changes in subsistence, foraging, and land-use patterns that begin to reflect the use pattern known from Historic period Native American groups in the area. A substantial increase in the intensity of subsistence exploitation (including fishing, hunting, and gathering [particularly the acorn]) evidenced in the archaeological record correlates directly with population growth (Moratto 1984:211–214).

Tools and cooking implements include shaped mortars and pestles, hopper mortars, bone awls used for producing coiled baskets, and the bow and arrow. Pottery vessels, known as Cosumnes Brownware, are found in some parts of the Central Valley and most likely developed during this period from the prior baked clay industry.

During this period, an increase in sedentism led to the development of social stratification, accompanied by a shift to elaborate ceremonial and social organization. Exchange networks, with the use of clamshell disk beads as currency, also developed during the Augustine Pattern. Mortuary practices during this pattern included flexed burials and pre-interment burning of offerings in a grave pit, as well as cremation of high-status individuals (Fredrickson 1973:127–129; Moratto 1984:211). Additional items of material culture include flanged tubular pipes, harpoons, and small Gunther barbed series projectile points. The Augustine Pattern may represent the southward expansion of Wintu populations (Moratto 1984: 211–214).

Ethnographic Overview

The northeastern corner of the segment is located in an area historically occupied by the Penutian-speaking Plains Miwok, a subgroup of the Eastern Miwok (Kroeber 1925; Levy 1978; Shipley 1978:84). The Plains Miwok historically occupied the lower Mokelumne River, Cosumnes River, and the Sacramento River from Rio Vista to Freeport (Levy 1978:398–399). Neighboring groups included the Nisenan to the north, Patwin and Bay Miwok to the west, Northern Valley Yokuts to the south, and the Washoe to the east.

Spanish mission records, diaries, and journals have provided the most comprehensive study of the Miwok, as well as some ethnographical studies done in the first half of the twentieth century (Bennyhoff 1977; Levy 1978:399). Much of the history of the Plains Miwok, however, is incomplete.

The villages of the Plains Miwok were divided into "tribelets," political units that were also structured by similarities in language and ethnicity. The tribelets averaged 300–500 persons, and each held claim to a designated portion of territory within the lands of the Plains Miwok, which also extended to the natural resources within each territory (Levy 1978:410). Each tribelet's territory contained a main village and smaller satellite villages. Within a tribelet's main village was an assembly or dance house, either a large semi-subterranean structure or a simpler circular brush structure (Kroeber 1925:447). Other structures included semi-subterranean or aboveground conical houses made with tule-matting, conical sweathouses, winter grinding houses, and acorn granaries (Levy 1978:408–409). The Plains Miwok also practiced cremation (Kroeber 1925:452).

The rich resources of the Sacramento-San Joaquin Delta and surrounding areas provided the Plains Miwok with food and material needs. The primary food staple was the acorn, supplemented by waterfowl, fish, shellfish, and large and small mammals (Bennyhoff 1977; Levy 1978). The Miwok are best described as seasonally mobile hunter-gatherers with semi-permanent villages. The delta islands were also used regularly for hunting and fishing base camps. Permanent settlements of the Plains Miwok were located on high ridges or knolls near watercourses or on the sandy islands in the delta.

The Plains Miwok collected plant greens and roots in the spring; seeds and nuts in the spring, summer, and early fall; and acorns in the late fall/early winter (Levy 1978:402–403). Acorns, particularly from the prevalent valley oak (*Quercus lobata*) could be stored for some time in the conical-shaped granaries prior to processing. Tule elk, pronghorn antelope, and mule deer, as well as smaller mammals such as jackrabbits, cottontails, beaver, squirrels, and woodrats, were regularly hunted. Game birds included many types of waterfowl, mountain and valley quail, pigeons, jays, and woodpeckers. In addition to salmon, the Plains Miwok fished for sturgeon and lamprey (Levy 1978:402–403).

A wide array of tools, implements, and enclosures were used by the Plains Miwok for hunting and gathering of natural resources. Among those used for hunting land mammals and birds were the bow and arrow, traps and snares, nets, and enclosures/blinds. Communal hunting drives were employed for both large and small mammals. Many plants were collected using wooden tools: long poles for dislodging acorns and pinecones, fire-hardened digging sticks for roots, and beaters for dislodging seeds. Once collected, seeds, roots, and nuts were placed in burden baskets and transported for processing or storage (Levy 1978:403–404).

The Plains Miwok used a variety of tools to process food resources. These included portable stone mortars and pestles, bedrock mortars, anvils, woven strainers and winnowers, leaching and boiling baskets, woven drying trays, and knives. Unprocessed acorns were stored in conical granaries. Various foods were baked in earth ovens. Exotic items such as obsidian, steatite, and shell indicate they traded with coastal groups and mountain tribes (Levy 1978).

The Native American population in the Sacramento Valley came into contact with European culture beginning in the late 1700s, as a result of increased incursions into the area by the Spanish. Traditional lifeways were drastically altered during the early to mid-1800s as Spanish colonization and proselytization, Mexican land grants, and the American takeover and settlement pushed indigenous peoples into the rugged California interior and reduced their numbers through transport to the missions, disease, and slaughter. Beginning in the early 1800s, most of the Plains Miwok converts were transported to Mission San José (Levy 1978:400–402). Many resisted and tried to return to their villages in the Delta. Plains Miwok fought the invaders in the 1820s and 1830s, and with neighboring Yokuts, they also attacked Mexican coastal settlements. The secularization of the missions followed, spurred in part by these activities. During the war with Mexico in the 1840s, the Miwoks aided the United States (Cook 1960, 1962).

The California Gold Rush of 1849 and the continuing influx of Euro-Americans into formerly remote regions of California was the final cultural blow for many California Indians, including the Miwok bands near the study area. With the loss of the majority of their traditional lands, as well as enslavement, slaughter, and disease, surviving Miwok labored for the growing lumber, ranching, farming, and mining industries (Levy 1978:401).

During the first half of the twentieth century, acquisitions of land by the federal government (from 2 acres to more than 300 acres) created a number of reservations, or *rancherias*, for the Plains Miwok, along with the Northern and Central Sierra Miwok. Between 1934 and 1972, the U.S. Bureau of Indian Affairs then terminated relations with most of these rancherias, although since 1984, the status has been restored to most of the rancherias (Slagle 2005). Today, although there is no unified California Miwok tribal

organization at a state or federal level, there are seven rancherias that have primarily or exclusively Eastern Miwok populations. These are the Buena Vista Rancheria (Plains Miwok/Amador County), the Chicken Ranch Rancheria (Central Sierra division of Eastern Miwok/Tuolumne County), the Ione Rancheria (Northern Sierra and Plains Miwok/Amador County), the Jackson Rancheria (Northern Sierra and Plains Miwok/Amador County), the Sheep Ranch Rancheria (Northern Sierra Miwok/Calaveras County), the Shingle Springs Rancheria (Plains Miwok/El Dorado County), and the Tuolumne Rancheria (Central Sierra Miwok/Tuolumne County) (Slagle 2005).

Historic Overview

Post-contact history for the state of California is generally divided into three periods: the Spanish period (1769–1822), the Mexican period (1822–1848), and the American period (1848–present). Although there were brief visits by Spanish, Russian, and British explorers from 1529 to 1769, the beginning of Spanish settlement in California occurred in 1769 with the establishment of Mission San Diego, one of the 21 missions established from 1769 to 1823. The Mexican period began when news of the successful revolution by Mexico against the Spanish crown reached California in 1822. This period is marked by an extensive era of land grants, most of which were in the interior of the state, and by exploration by American fur trappers west of the Sierra Nevada Mountains.

With the signing of the Treaty of Guadalupe Hidalgo in 1848, ending the Mexican-American War, California became a territory of the United States. The discovery of gold in 1848 at Sutter's Mill near Sacramento and the resulting Gold Rush era influenced the history of the state and the nation. The rush of tens of thousands of people to the gold fields also had a devastating impact on the lives of indigenous Californians, with the introduction and concentration of diseases; the loss of land and territory, including traditional hunting and gathering locales; violence; malnutrition; and starvation. Thousands of settlers and immigrants continued to pour into the state, particularly after the completion of the transcontinental railroad in 1869.

With continued growth, California continues to be a national leader in agriculture and poultry production, ranching (cattle and sheep), aerospace and communications industries, as well as the film and entertainment business. The wealth of California's natural resources (e.g., lumber, petroleum deposits, minerals, and fish) also continues to contribute to its growth and development.

Solano County

Established in 1850, Solano County is one of California's original 27 counties. It is an area of tidal wetlands, marshes, and rivers, and many of the county's agricultural products were shipped along its numerous waterways. The Sacramento River, Suisun and San Pablo Bays, and the Carquinez Strait border the county on its southern and eastern sides. At 34,000 hectares (84,000 acres), Suisun Marsh is the largest marsh in the United States; it is also the largest remaining coastal wetland in California.

The name Solano derives from a well-known and respected local Native American leader. The chief of the local Suisun (Patwin) people received the name Solano when he was baptized at Mission San Francisco Solano. Solano became a close friend of General Mariano Vallejo, who named the county in his honor (Gudde 1998:368; Hoover et al. 2002:491). A bronze statue of Chief Solano is located at the corner of Texas Street and Union Avenue in Fairfield, across from the county courthouse.

Beginning in the early 1850s, European American settlers began the process of transforming the Delta tidal wetlands into islands of farmland surrounded by levees (Lund et al. 2007). Early Californians redirected the natural flow of water through the construction of levees, reclaiming the "swamped and overflowed lands" and constructing irrigation canals for agricultural purposes (JRP Historical Consulting

Services and California Department of Transportation 2000). Originally part of the Rancho Los Ulpinos, the area surrounding the study area was typical of this development. This area was the initial location of the settlement of Rio Vista, then named "Brazos del Rio" (Arms of the River); however, following severe flooding in 1862, the settlement was washed away and moved to its current location approximately 8 km (5 miles) to the southwest (Hoover et al. 2002). Although wetlands in the surrounding Delta continued to be reclaimed throughout the late eighteenth century, a historic topographic map indicates little development occurred within the study area surrounding the subject property as late as 1936 (USGS 1936). By 1946, the construction of a levee system helped to reclaim the area, and the large canal system connecting Lindsey Slough to the Sacramento River was in place (Thomas Brothers 1946). The area continued to be developed over the following decade and by 1953, a large irrigation system was in place, providing water to the surrounding agricultural land.

BACKGROUND RESEARCH

California Historical Resources Information System Records Search

On August 22, 2012, a search was requested of the California Historical Resources Information System (CHRIS) at the Northwest Information Center (NWIC), located at Sonoma State University in Sonoma, California. The search included any previously recorded cultural resources and investigations within a 1.6-km (1-mile) radius of the APE. The CHRIS search also included a review of the NRHP, the CRHR, the California Points of Historical Interest list, the California Historical Landmarks list, the Archaeological Determinations of Eligibility list, and the California State Historic Resources Inventory list. Additionally, the records search included a review of historic maps covering the APE. A letter dated August 24, 2012, from the NWIC summarizing the results of the records search and providing a bibliography of prior cultural resources studies is provided in Appendix A of this report.

Prior Cultural Resources Studies within 1 Mile of the APE

The records searches identified five prior cultural resources studies within 1 mile of the APE (Table 1). Of this, one (S-005055) may have been conducted in the study area; a brief summary of this study is provided in the paragraph that follows. Additionally, eight unmapped studies (S -000848, S-005208, S-009462, S-012790, S-032596, S-033600, S-035031, and S-038635) are located in the records search area, and are classified by the NWIC as an "Other Report," with little or no fieldwork and/or missing maps or inadequate locational information. Appendix A provides a complete bibliography all studies identified by the NWIC.

Table 1. Prior Cultural Resources Studies within 1 Mile of the APE

NWIC Report No.	Title of Study	Author	Year	Proximity to the Study area
S-005055	Cultural Resources Reconnaissance: Sacramento River Deep Water Ship Canal (Collinsville to Sacramento)	Seldomridge, Jeffery S. and Connie Smith-Madsen	1976	Potentially within*
S-007295	Intensive Cultural Resource Survey and Literature Review for the Sacramento Deep Water Channel Project, Yolo and Solano Counties, California.	Werner, Robert H.	1985	Outside

Table 1. Prior Cultural Resources Studies within 1 Mile of the APE

NWIC Report No.	Title of Study	Author	Year	Proximity to the Study area
S-007448	Intensive Cultural Resource Survey and Literature Review for the Sacramento Deep Water Channel Project, Yolo and Solano Counties, California.	Werner, Robert H.	1985	Outside
S-020057	Cultural Resources Assessment Within Reclamation District 536, Solano County, California (SAC 20) For: Cultural Resource Inventory and Evaluation for the U.S. Army Corps of Engineers Sacramento District, PL 84-99 Levee Rehabilitation on the Feather…	Gerry, Robert A.	1997	Outside
S-027048	Archaeological Survey and Literature Review for the Calpine Natural Gas Company, City of Rio Vista Gas Gathering System, Solano County, California	Sterling, Deborah and John Holson	2003	Outside

*The NWIC does not have sufficient locational information on file to determine what extent of the study includes portions of the current APE.

S-005005

In 1976, Jeffery S. Seldomridge and Connie Smith-Madsen prepared *Cultural Resources Reconnaissance: Sacramento River Deep Water Ship Channel (Collinsville to Sacramento)* for the U.S. Army Corps of Engineers. The reconnaissance survey included the banks and adjoining land of 29 percent of the study area, which covered the 43.74-river mile length of the Sacramento River Deep Water Ship Channel from Collinsville to Sacramento. The cultural resource investigation also included a literature review of the archaeological site files of the California State Department of Parks and Recreation, the NRHP, and various publications. Two small artifacts and an archaeological site (Yol-42) were identified as a result of the study; however, none appear to be within the boundaries of the current APE. Although the study recommended Yol-42 be protected, it was suggested that the potential for identifying additional prehistoric cultural resources was low due to significant disturbance from the development of levees, dredging, and rip wrapping.

Previously Recorded Cultural Resources within 1 Mile of the APE

The records search identified four previously recorded cultural resources within 1 mile of the APE (Table 2). Of these, none were identified within the boundaries of the current APE.

Table 2. Previously Recorded Cultural Resources within 1 Mile of the APE

Primary No.	Trinomial	Resource Description	NRHP/CRHR Eligibility	Recorder and Year	Proximity to Study area
P-48-000117	CA-SOL-276	Large Occupation Site	Not evaluated	Parkman, E. Breck and Katherine Flynn; 1980	Outside
P-48-000911	–	US5	Not evaluated	Panamerican Consultants; 2009	Outside
P-48-000912	–	US12	Not evaluated	Panamerican Consultants; 2009	Outside
P-48-000912	–	US13	Not evaluated	Panamerican Consultants; 2009	Outside

Historic Map Review

In addition to reviewing previously conducted studies and previously recorded site records, SWCA examined the study area on historic maps provided by the NWIC. Maps of Solano County from 1872 and 1877 show the study area as completely undeveloped and remaining so through 1914, as depicted on an unnamed map by C.F. Weber and Company. A Thomas Brothers Map from 1946 shows what appears to be a road running slightly inland from the western bank of the Sacramento River. The course of the road appears to be the present western bank of the river, most likely for ongoing dredging for the development of a deep water channel.

Sacred Lands File Search and Initial Native American Coordination

Native American coordination was initiated for this project on August 24, 2012. As part of the process of identifying cultural resources in or near the APE, the Native American Heritage Commission (NAHC) was contacted to request a review of the Sacred Lands File (SLF). The NAHC faxed a response on August 28, 2012 (Appendix B), and stated that Native American cultural resources were not identified within 0.8 km (0.5 mile) of the APE, but noted that it is always possible for cultural resources to be unearthed during construction activities. The NAHC also provided a contact list of seven Native American individuals or tribal organizations that may have knowledge of cultural resources in or near the APE. Letters were prepared and mailed to each of the NAHC-listed contacts on August 31, 2012, requesting information regarding any Native American cultural resources in or immediately adjacent to the APE.

One follow-up phone call was made to each Native American contact on September 13, 2012. No additional responses have been received to date. A complete record of Native American coordination to date is provided in Table 3.

Shortly after initial Native American Coordination, the APE was expanded from one well pad location to include the current three well pad locations. New letters were prepared and mailed to each of the NAHC-listed contact on October 11, 2012 requesting information regarding any Native American cultural resources in or immediately adjacent to the expanded APE.

Table 3. Record of Native American Coordination Efforts

NAHC-Provided Contact	Coordination Efforts	Results of Coordination Efforts
Wintun/Patwin P.O. Box 1047 Wheatland, California 95692 Contact: Kesner Flores	**8/31/12:** Letter sent via U.S. Mail. **9/13/12:** Mr. Flores did not have any concerns regarding the project.	No further action required
Cortina Band of Indians P.O. Box 1630 Williams, California 95987 Contact: Charlie Wright, Chairperson	**8/31/12:** Letter sent via U.S. Mail **9/13/12:** SWCA spoke with the receptionist at the Cortina Band of Indians and was informed the letter had been received and that there were no concerns regarding the project at this time.	No further action required
Cortina Wintun Environmental Protection Agency P.O. Box 1630 Williams, California 95987	**8/31/12:** Letter sent via U.S. Mail **9/13/12:** SWCA spoke with the receptionist at the Cortina Wintun Environmental Protection Agency and was informed the letter had been received and that there were no concerns regarding the project at this time.	No further action required
Yocha Dehe Wintun Nation P.O. Box 18 Brooks, California 95606 Contact: Marshall McKay, Chairperson	**8/31/12:** Letter sent via U.S. Mail **9/13/12:** Left a voicemail	No further action required
Yocha Dehe Wintun Nation P.O. Box 18 Brooks, California 95606 Contact: Leland Kinter, Native Cultural Renewal Committee	**8/31/12:** Letter sent via U.S. Mail **9/13/12:** Left a message with receptionist	No further action required
Yocha Dehe Wintun Nation P.O. Box 18 Brooks, California 95606 Contact: Cynthia Clarke, Native Cultural Renewal Committee	**8/31/12:** Letter sent via U.S. Mail **9/13/12:** Left a message with receptionist	No further action required
Yocha Dehe Wintun Nation P.O. Box 18 Brooks, California 95606 Contact: Reno Franklin, Cultural Resources Director	**8/31/12:** Letter sent via U.S. Mail **9/13/12:** Left a voicemail	No further action required

METHODS

On August 29, 2012, SWCA Cultural Resource Specialist Katie Martin and William Kendig conducted an intensive-level pedestrian survey to identify any archaeological or historic built environment resources (i.e., buildings, structures, and objects) that may occur in the study area. SWCA Cultural Resource Specialists Sara Ferland and Ryan Glenn conducted an additional intensive-level survey on October 9, 2012 to identify any archaeological or historic built environment resources that may occur within the expanded study area. The entire APE was surveyed by walking linear transects spaced no more than 15 m (49 feet) apart. The ground surface was examined for the presence of prehistoric artifacts (e.g., flaked stone tools, tool-making debris, stone milling tools), historic artifacts (e.g., metal, glass, ceramics), sediment discoloration that might indicate the presence of a cultural midden, and depressions and other features indicative of the former presence of structures or buildings (e.g., post holes, foundations). A

Trimble global positioning system (GPS) receiver with sub-meter accuracy was used to maintain transect accuracy and to record the location of cultural resources in the study area.

SWCA Cultural Resource Specialists documented their fieldwork using a field notebook, digital camera, close-scale field maps, and aerial photographs. Copies of the field notes and digital photographs are on file at the SWCA Pasadena office.

RESULTS

During the intensive-level field survey for cultural resources, ground visibility was poor in the study area (approximately 0% in some areas) due to obstruction by vegetative ground cover. Other areas of the study area were heavily disturbed due to agricultural activities, the construction of farm access roads, and well pad construction associated with prior natural gas production (Figures 6). A portion of the study area within the well pad site was unable to be surveyed due to haystacks and a manure pile (Figure 7).

One cultural resource was identified in the APE as a result of the intensive-level survey, which was recorded on California Department of Parks and Recreation 523 Series forms and included in Appendix C of this report. SWCA-CACHE-1 intersects a portion of the APE and consists three canal segments, which are part of a larger irrigation system that diverts water from Lindsey Slough and the Sacramento River to the surrounding irrigation fields (Figure 8). Gradually developed circa 1936 to 1953, the large irrigation system features open, unlined, earthen canal varies between 40 to 60 feet in width, and appears to be regularly dredged to remove buildup (Thomas Brothers 1946; USGS 1936; USGS 1953). One of the canal segments, which was constructed circa 1936 to 1946, runs along a northwest-southeast axis for approximately 378 meters (1240 feet) and directs water from Lindsey Slough to the north, to the Sacramento the south (Figure 9). Intersecting this segment is a second canal segment, which runs along an approximate northeast-southwest axis for 815 meters (2765 feet) and directs water from the Sacramento River to the east into the agricultural fields to the west. This segment was partially in place by 1946, and later completed by 1953. A dirt road passes over the intersection of the canal segments, which are connected via underground pipes, with some featuring small, hand-operated canal gates (Figure 10). To the southwest, a third, small L-shaped segment that was developed by 1953 is approximately 804 meters (2640 feet) in total length similarly connected to the greater irrigation system via underground pipes (Figure 11). Due to the boundaries of the intensive-level survey that was undertaken of the current study, the extent of the entire irrigation system was not documented.



Figure 6. Portion of the well pad and surrounding agricultural activities; view to the west.



Figure 7. Portion of the well pad that was unable to be surveyed; view to the southeast.



Figure 8. Cultural resources map.



Figure 9. Overview of northwest-southeast segment; view to the northwest.



Figure 10. Hand-operated canal gate; view to the west



Figure 11. Overview of the L-shaped southern segment of SWCA-CACHE-1; view to the south.

DISCUSSION AND RECOMMENDATIONS

Discussion

The goal of this study is to identify cultural resources within the PG&E CAES study area and to provide management recommendations for those resources. The results of the literature and records search identified five prior cultural studies within 1 mile of the APE, one of which was potentially within a portion of the APE. No previously recorded cultural resources were identified as a result of the literature and records search. The NAHC Sacred Lands File search was also negative for cultural resources within 0.5 mile of the study area.

During the current study, one resource was identified as a result of the cultural resource survey: SWCA-CACHE-1. Although irrigation systems are significant within the agricultural development of the Sacramento-San Joaquin River Delta, SWCA-CACHE-1 is not associated with the early development of irrigated farming in the region and as a result, it does not appear eligible for the NRHP or CRHR under Criterion A/1. In addition, archival research does not indicate that the resource is directly associated with persons significant to our past, and it does not appear eligible for the NRHP or CRHR under Criterion B/2. The irrigation canal is perhaps the most common canal type in California, and SWCA-CACHE-1 does not possess any distinctive features to warrant consideration for architectural significance; therefore, it does not appear eligible for the NRHP or CRHR under Criterion C/3. No evidence was discovered to warrant consideration under Criterion D/4.

Recommendations

Although a small portion of the APE was unable to be surveyed within the well pad site due to haystacks and a manure pile, and other portions were subject to poor ground visibility, the study area is significantly disturbed due to ongoing agricultural activities, which are likely to have exposed any substantial archaeological resources. Additionally, only previously disturbed soil within the APE is expected to be impacted during ground-disturbing activities. Therefore, there is a low potential for encountering undisturbed archaeological materials in the APE during project implementation. No additional cultural resource mitigation measures should be necessary beyond standard measures to minimize impacts to the unanticipated discovery of buried cultural resources or the unanticipated discovery of human remains. These standard measures are described below.

However, ground disturbance associated with the proposed project could impact previously unrecorded cultural resources. SWCA recommends that the following measures be taken to identify additional cultural resources in the study area, to prevent or reduce the significance of project-related impacts to cultural resources, and to satisfy the requirements of Section 106 and CEQA.

Inadvertent Discovery of Cultural Resources

If cultural resources are exposed during ground-disturbing activities, construction activities (e.g., grading, grubbing, or vegetation clearing) should be halted immediate near the discovery. An archaeologist who meets the Secretary of the Interior's Professional Qualifications Standards (National Park Service 1983) should then be retained to evaluate the find's significance under CEQA. If the discovery proves to be significant, additional work, such as data recovery excavation, may be warranted and should be discussed in consultation with the lead agency.

Inadvertent Discovery of Human Remains

The discovery of human remains is always a possibility during ground disturbances; State of California Health and Safety Code Section 7050.5 addresses these findings. This code section states that no further disturbance shall occur until the county coroner has made a determination of origin and disposition pursuant to PRC Section 5097.98. The coroner must be notified of the find immediately. If the human remains are determined to be prehistoric, the coroner will notify the NAHC, which will determine and notify a most likely descendant. The most likely descendant shall complete the inspection of the site within 48 hours of notification and may recommend scientific removal and nondestructive analysis of human remains and items associated with Native American burials.

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Appendix A

Records Search Results Summary from NWIC

CALIFORNIA HISTORICAL RESOURCES INFORMATION SYSTEM

ALAMEDA
COLUSA
CONTRA COSTA
LAKE
MARIN
MENDOCINO
MONTEREY
NAPA
SAN BENITO
SAN FRANCISCO
SAN MATEO
SANTA CLARA
SANTA CRUZ
SOLANO
SONOMA
YOLO

Northwest Information Center
Sonoma State University
150 Professional Center Drive, Suite E
Rohnert Park, California 94928-3609
Tel: 707.588.8455
Email: leigh.jordan@sonoma.edu
http://www.sonoma.edu/nwic

Date: 24 August 2012 NWIC File No.: 12-0189

To: Steven Treffers, SWCA Environmental Consultants, 150 S. Arroyo Parkway, 2nd Floor, Pasadena, CA 91105

From: Lisa Hagel

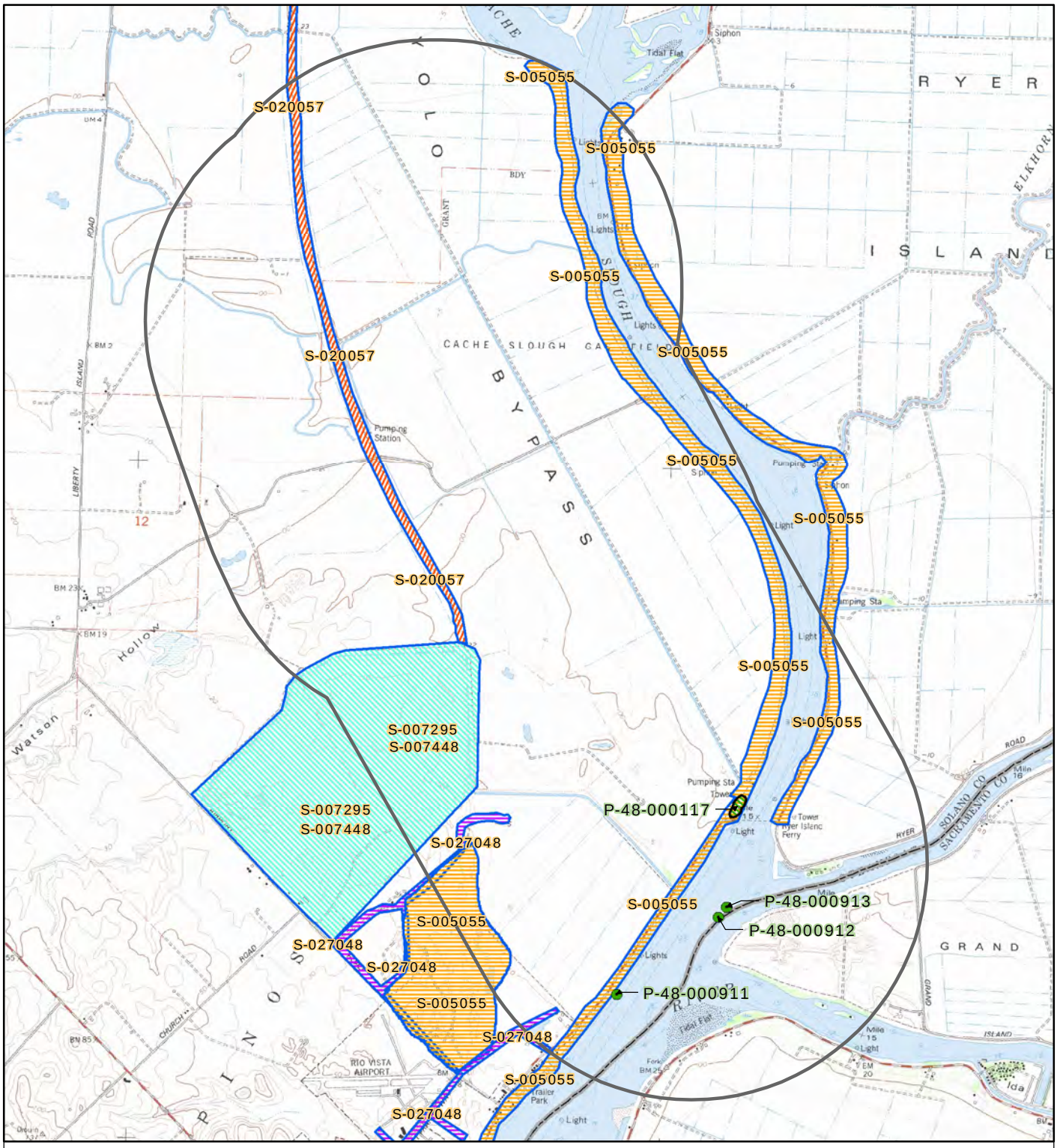
re: PG&E CAES Cache Slough Project (Project #023910.00)

Rio Vista 7.5'

Resources In	There were no recorded sites within the project area.
Resources within one-mile radius	P-48-117, 911, 912, & 913 are within one mile. Enclosed are copies of the site record forms and the database printout for the resources. The resource locations are plotted on the enclosed map.
Reports In	S-5055 may have included part of the project area. Enclosed is a copy of a section of the report (field methodology, study results, and "Contractor's Suggestions"). The study location is plotted on the enclosed map.
Reports within one-mile radius	S-20057, 7295, 7448, & 27048 are within one mile. Enclosed are bibliographic references for the reports. The study locations are plotted on the enclosed map.
Other Reports	Eight reports are classified as "Other Reports" (reports with little or no field work and/or missing maps or inadequate locational information) that include your search area: S-35031, 5208, 12790, 848, 33600, 38635, 32596, & 9462. The electronic report map for your study area does not depict study locations for these reports because their shapes are either not representable or would be shown at a very large scale (e.g. all of Solano County). In addition, you have not been charged a fee for their shapes. Enclosed are bibliographic references for the reports.
OHP HPD	Copied the indices for Rio Vista.
OHP ADOE	None of the above referenced recorded resources appeared in

	the Archaeological Determinations of Eligibility.
California Inventory	There were no properties in the Rio Vista area.
Caltrans Bridge Inventory	There were no evaluated bridges in the vicinity of the project.
Historic-period Maps	Copied the pertinent sections of the 1872 J.S. Henning, Map of Solano County, California; the 1877 Map of Solano County; the 1914 C.F. Weber & Co., un-named map; and the 1946 Thomas Bros. Map of Solano County, California.
GLO or Rancho Plat Maps	Copied the pertinent section of the 1858 Rancho Los Ulpinos Plat Map.
Other	We do not have a Soil Survey for Solano County.

PG&E CAES Cache Slough Project (Project #023910.00)



Northwest Information Center

May depict confidential cultural resource locations.
Do not distribute.

Feet
0 1,300 2,600 3,900 5,200 6,500

0 320 640 960 1,280 1,600
Meters

N

Northwest Information Center Report Detail Record: S-000848

Previous designation(s):

PDF file: \\SVR01\library\pdf-library\reports\848.pdf

Citation Information

Authors: David A. Fredrickson

Year: 1977

Title: A Summary of Knowledge of the Central and Northern California Coastal Zone and Offshore Areas, Vol. III, Socioeconomic Conditions, Chapter 7: Historical & Archaeological Resources

Originator: The Anthropology Laboratory, Sonoma State College

No. Pages: 223

Report Type(s): Management plan
Records/literature search
Regional overview

No.Resources: 0

No. Informal:

Collections:

Accession No.:

Facility:

Disclosure: Not for publication

Associated Resources

Notes

Santa Barbara and Ventura counties are also within the study area. 9880 prehistoric and historic resources were identified in the 17 counties when the report was written in 1977.

Location Info

County(ies): Alameda
Contra Costa
Del Norte
Humboldt
Marin
Mendocino
Monterey
Napa
Other
San Francisco
San Luis Obispo
San Mateo
Santa Clara
Santa Cruz
Solano
Sonoma

USGS 7.5' Quads: ~All quads - Alameda Co.
~All quads - Contra Costa Co.
~All quads - Del Norte Co.
~All quads - Humboldt Co.
~All quads - Marin Co.
~All quads - Mendocino Co.
~All quads - Monterey Co.
~All quads - San Francisco Co.
~All quads - San Mateo Co.
~All quads - Santa Clara Co.
~All quads - Solano Co.
~All quads - Sonoma Co.

Address:

Northwest Information Center Report Detail Record: S-000848

Database Record Metadata

	Date	User	
Entered:	4/7/2005	nwic-main	
Last Modified:	6/5/2012	hagell	
IC Actions:	*Date*	*User*	*Action taken*
	4/7/2005	jay	Appended records from NWICmain bibliographic database.
Record Status:			
Date Mapped:			

Northwest Information Center Report Detail Record: S-005055

Previous designation(s): ASC #52
PDF file: None

Citation Information

Authors: Jeffry Seldomridge
Connie Smith-Madsen
Year: 1976
Title: Cultural Resources Reconnaissance: Sacramento River Deep Water Ship Channel (Collinsville to Sacramento)
Originator: California State University, Sacramento
No. Pages: 36
Report Type(s): Archaeological survey
No.Resources: 1
No. Informal: 2
Collections:
Accession No.:
Facility:
Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-57-000045		CA-YOL-42	

Notes

An obsidian projectile point and possible baked clay fragment were also found. 30-40% of the project area was not included in the field survey. There were five over-sized maps in the report.

Location Info

County(ies): Solano
Yolo
USGS 7.5' Quads: Antioch North
Clarksburg
Jersey Island
Liberty Island
Rio Vista
Sacramento West
Saxon
Address:

Database Record Metadata

	Date	*User*
Entered:	4/7/2005	nwic-main
Last Modified:	8/24/2012	hagell

IC Actions:	*Date*	*User*	*Action taken*
	4/7/2005	jay	Appended records from NWICmain bibliographic database.

Record Status:
Date Mapped:

Northwest Information Center Report Detail Record: S-005208

Previous designation(s): ASC #89

PDF file: \\SVR01\library\pdf-library\reports\5208.pdf

Citation Information

Authors: Gregory Greenway
William E. Soule

Year: 1977

Title: Sacramento-San Joaquin Delta Investigations: Cultural Resources Reconnaissance.

Originator:

No. Pages: 87

Report Type(s): Records/literature search
Site specific

No.Resources: 56

No. Informal: 85

Collections:

Accession No.:

Facility:

Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-07-000021		CA-CCO-1	
P-07-000022		CA-CCO-2	
P-07-000023		CA-CCO-3	
P-07-000025		CA-CCO-5	
P-07-000036		CA-CCO-17	BATY
P-07-000037		CA-CCO-18/H	Marsh Site
P-07-000039		CA-CCO-20	
P-07-000044		CA-CCO-26	
P-07-000069		CA-CCO-127	
P-07-000070		CA-CCO-128	
P-07-000072		CA-CCO-130	
P-07-000076		CA-CCO-134	HOTCHKISS TRACT
P-07-000078		CA-CCO-136	VEALE TRACT #2
P-07-000080		CA-CCO-138	C-138
P-07-000081		CA-CCO-139	Simone Mound
P-07-000082		CA-CCO-140	BETHEL TRACT
P-07-000083		CA-CCO-141	C-141
P-07-000085		CA-CCO-143	
P-07-000086		CA-CCO-144	
P-07-000087		CA-CCO-145	BYRON TRACT
P-07-000089		CA-CCO-147	
P-07-000090		CA-CCO-148/H	ORWOOD #1
P-07-000091		CA-CCO-149	
P-07-000092		CA-CCO-150	Veale Tract #1
P-07-000179		CA-CCO-302	NELSON NO. 302
P-07-000711		CA-CCO-350	
P-48-000009		CA-SOL-1	PETERSON #1
P-48-000010		CA-SOL-2	Peterson #2
P-48-000011		CA-SOL-3	PETERSON #3
P-48-000012		CA-SOL-4	PETERSON
P-48-000013		CA-SOL-5	PETERSON #5
P-48-000041		CA-SOL-33	Hastings Adobe
P-48-000042		CA-SOL-34	
P-57-000021		CA-YOL-18	
P-57-000029		CA-YOL-26	
P-57-000030		CA-YOL-27	S-27
P-57-000032		CA-YOL-29	SCHIBIG
P-57-000033		CA-YOL-30	SLATER

Northwest Information Center Report Detail Record: S-005208

P-57-000034	CA-YOL-31	SCHRADER
P-57-000045	CA-YOL-42	
P-57-000047	CA-YOL-44	
P-57-000048	CA-YOL-45	INDIAN HEAD
P-57-000049	CA-YOL-47	KIRTLAND
P-57-000050	CA-YOL-49	ENGWALD
P-57-000051	CA-YOL-51	ELKHORN KNOLL
P-57-000052	CA-YOL-52	HOLLAND LAND
P-57-000053	CA-YOL-53	KING MOUND
P-57-000054	CA-YOL-54	FERRAN
P-57-000055	CA-YOL-55	S-55 GORTER
P-57-000056	CA-YOL-57	SSC-YOL-6
P-57-000063	CA-YOL-65	PYLMAN 1
P-57-000065	CA-YOL-67	HUDSON
P-57-000066	CA-YOL-68	PYLMAN 2
P-57-000092	CA-YOL-117	Glide site
P-57-000107	CA-YOL-132	Riverbank Protection Site No. 3
P-57-000146	CA-YOL-46	missing as of 4/2010

Notes

131 archaeological sites were also recorded in Sacramento and San Joaquin counties; 39 ethnographic village locations and 46 historic sites are within the study area.

Location Info

County(ies): Alameda
Contra Costa
Sacramento
San Joaquin
Solano
Yolo

USGS 7.5' Quads: Antioch North
Antioch South
Birds Landing
Bouldin Island
Brentwood
Clarksburg
Clayton
Clifton Court Forebay
Courtland
Davis
Dixon
Dozier
Honker Bay
Isleton
Jersey Island
Liberty Island
Rio Vista
Sacramento West
Saxon
Woodward Island

Address:

Database Record Metadata

	Date	*User*	
Entered:	4/7/2005	nwic-main	
Last Modified:	7/16/2012	hagell	
IC Actions:	*Date*	*User*	*Action taken*
	4/7/2005	jay	Appended records from NWICmain bibliographic database.

Record Status:

Date Mapped:

Northwest Information Center Report Detail Record: S-007295

Previous designation(s):
PDF file: \\SVR01\library\pdf-library\reports\7295.pdf

Citation Information

Authors: Roger H. Werner
Year: 1985
Title: Intensive Cultural Resource Survey and Literature Review for the Sacramento Deep Water Ship Channel Project, Yolo and Solano Counties, California.
Originator: Archaeological Services, Inc.
No. Pages: 71
Report Type(s): Archaeological survey
Records/literature search
No.Resources: 1
No. Informal:
Collections:
Accession No.:
Facility:
Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-57-000045		CA-YOL-42	

Notes

See also S-7448.

Location Info

County(ies): Solano
Yolo
USGS 7.5' Quads: Antioch North
Clarksburg
Liberty Island
Rio Vista
Sacramento West
Saxon
Address:

Database Record Metadata

	Date	*User*
Entered:	4/7/2005	nwic-main
Last Modified:	8/24/2012	hagell

IC Actions:

Date	*User*	*Action taken*
4/7/2005	jay	Appended records from NWICmain bibliographic database.

Record Status:
Date Mapped:

Northwest Information Center Report Detail Record: S-007448

Previous designation(s):
PDF file: \\SVR01\library\pdf-library\reports\7448.pdf

Citation Information

Authors: Roger H. Werner
Year: 1985
Title: Sacramento Deep Water Ship Channel, Cultural Resources Survey and Literature Review, Yolo and Solano Counties, California.
Originator: Archaeological Services, Inc.
No. Pages: 38
Report Type(s): Archaeological survey
Records/literature search
No.Resources: 1
No. Informal:
Collections:
Accession No.:
Facility:
Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-57-000045		CA-YOL-42	

Notes

See also S-7295.

Location Info

County(ies): Solano
Yolo
USGS 7.5' Quads: Antioch North
Clarksburg
Liberty Island
Rio Vista
Sacramento West
Saxon
Address:

Database Record Metadata

	Date	*User*
Entered:	4/7/2005	nwic-main
Last Modified:	8/24/2012	hagell

IC Actions:

Date	*User*	*Action taken*
4/7/2005	jay	Appended records from NWICmain bibliographic database.

Record Status:
Date Mapped:

Northwest Information Center Report Detail Record: S-009462

Previous designation(s):

PDF file: \\SVR01\library\pdf-library\reports\9462.pdf

Citation Information

Authors: Teresa Ann Miller

Year: 1977

Title: Identification and Recording of Prehistoric Petroglyphs in Marin and Related Bay Area Counties

Originator: San Francisco State University

No. Pages: 110

Report Type(s): Regional overview
Thesis

No.Resources: 33

No. Informal: 35

Collections:

Accession No.:

Facility:

Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-07-000323		CA-CCO-553/H	Alvarado Park, Wildcat Regional Park
P-21-000087		CA-MRN-57	NELSON NO.57
P-21-000376		CA-MRN-414	DEER ISLAND AREA #1
P-21-000378		CA-MRN-416	DEER ISLAND AREA #3
P-21-000379		CA-MRN-417	DEER ISLAND AREA #4
P-21-000380		CA-MRN-418	DEER ISLAND AREA #5
P-21-000381		CA-MRN-419	DEER ISLAND AREA #6
P-21-000382		CA-MRN-420	17 NOVATO
P-21-000383		CA-MRN-421	NOVATO #18
P-21-000384		CA-MRN-422	NOVATO #19(CONFUSED W
P-21-000386		CA-MRN-425	TIBURON 3 FIELD #3
P-21-000387		CA-MRN-426	TIBURON #4 FIELD #4
P-21-000388		CA-MRN-427	TIBURON #5 FIELD #5
P-21-000389		CA-MRN-428	TIBURON 6
P-21-000390		CA-MRN-429	TIBURON 7 FIELD #7
P-21-000391		CA-MRN-430	TIBURON #8 FIELD #8
P-21-000392		CA-MRN-431	TIBURON #9
P-21-000393		CA-MRN-432	TIBURON 12
P-21-000394		CA-MRN-433	TIBURON 13 FIELD #13
P-21-000395		CA-MRN-434	TIBURON 14 AND 15 FIELD #'S 14 AND 1
P-21-000396		CA-MRN-435	TIBURON #16 FIELD #16
P-21-000397		CA-MRN-436	TIBURON 17 FIELD #17
P-21-000398		CA-MRN-437	TIBURON 18
P-21-000399		CA-MRN-438	TIBURON 19 FIELD #19
P-21-000400		CA-MRN-439	TIBURON 20A
P-21-000401		CA-MRN-440	TIBURON 21 FIELD #21
P-21-000402		CA-MRN-442	TIBURON 1 FIELD #1
P-21-000546		CA-MRN-424	
P-23-000789		CA-MEN-854	Upper Twin Rocks
P-23-000790		CA-MEN-855	Milling Stone Basin
P-49-000629		CA-SON-682	SDA-25
P-49-000785		CA-SON-844	PETALUMA #1
P-49-000787		CA-SON-846	PETALUMA #3

Notes

Masters Thesis.

Location Info

County(ies): Alameda
Contra Costa

	Lake
	Marin
	Mendocino
	Napa
	San Francisco
	San Mateo
	Santa Clara
	Santa Cruz
	Solano
	Sonoma
USGS 7.5' Quads:	~All quads - Alameda Co.
	~All quads - Contra Costa Co.
	~All quads - Lake Co.
	~All quads - Marin Co.
	~All quads - Mendocino Co.
	~All quads - Napa Co.
	~All quads - San Francisco Co.
	~All quads - San Mateo Co.
	~All quads - Santa Clara Co.
	~All quads - Santa Cruz Co.
	~All quads - Solano Co.
	~All quads - Sonoma Co.
Address:	

Database Record Metadata

	Date	*User*	
Entered:	4/7/2005	nwic-main	
Last Modified:	3/22/2012	grahams	
IC Actions:	*Date*	*User*	*Action taken*
	4/7/2005	jay	Appended records from NWICmain bibliographic database.
	10/5/2010	muchb	updated county list as per thesis content
Record Status:			
Date Mapped:			

Northwest Information Center Report Detail Record: S-012790

Previous designation(s):
PDF file: None

Citation Information

Authors: Kenneth N. Owens
Year: 1991
Title: Sacramento-San Joaquin Delta, California: Historical Resources Overview
Originator: Public History Research Institute, California State University, Sacramento
No. Pages: 209
Report Type(s): Historic study
Records/literature search
Regional overview
No.Resources: 3
No. Informal: 1342
Collections:
Accession No.:
Facility:
Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-07-000903			IRON HOUSE SCHOOL
P-07-000910			JOHN MARSH HOUSE
P-07-000918			MCCABE HOUSE

Notes

1,358 historic resource locations are within the study area. 16 of the historic resources are recognized as being historically significant. Most of the resources do not appear to have been recorded.

Location Info

County(ies): Alameda
Contra Costa
Sacramento
San Joaquin
Solano
Yolo
USGS 7.5' Quads: Antioch North
Antioch South
Birds Landing
Bouldin Island
Brentwood
Byron Hot Springs
Clarksburg
Clifton Court Forebay
Courtland
Davis
Dixon
Dozier
Honker Bay
Isleton
Jersey Island
Liberty Island
Address:

Database Record Metadata

	Date	*User*
Entered:	4/7/2005	nwic-main
Last Modified:	6/13/2012	hagell

IC Actions:	*Date*	*User*	*Action taken*
	4/7/2005	jay	Appended records from NWICmain bibliographic database.

Northwest Information Center Report Detail Record: S-012790

Record Status:

Date Mapped:

Northwest Information Center Report Detail Record: S-020057

Previous designation(s):
PDF file: None

Citation Information

Authors: Robert A. Gerry
Year: 1997
Title: Cultural Resources Assessment Within Reclamation District 536, Solano County, California (SAC 20) For: Cultural Resource Inventory and Evaluation for the U.S Army Corps of Engineers Sacramento District, PL 84-99 Levee Rehabilitation on the Feather, …
Originator: Peak & Associates, Inc.
No. Pages: 8
Report Type(s): Archaeological survey
No.Resources: 0
No. Informal: 0
Collections:
Accession No.:
Facility:
Disclosure: Not for publication

Associated Resources

Notes

…Bear, Sacramento and San Joaquin River Systems, DACWO5-97-P-0385.

Location Info

County(ies): Solano
USGS 7.5' Quads: Liberty Island
Rio Vista
Address:

Database Record Metadata

	Date	*User*
Entered:	4/7/2005	nwic-main
Last Modified:	8/24/2012	hagell

IC Actions:	*Date*	*User*	*Action taken*
	4/7/2005	jay	Appended records from NWICmain bibliographic database.

Record Status:
Date Mapped:

Northwest Information Center Report Detail Record: S-027048

Previous designation(s):

PDF file: \\SVR01\library\pdf-library\reports\27048.pdf

Citation Information

Authors: Deborah Sterling
John Holson

Year: 2003

Title: Archaeological Survey and Literature Review for the Calpine Natural Gas Company, City of Rio Vista Gas Gathering System, Solano County, California

Originator: Pacific Legacy, Inc.

No. Pages: 22

Report Type(s): Archaeological survey

No.Resources: 0

No. Informal: 4

Collections:

Accession No.:

Facility:

Disclosure: Not for publication

Associated Resources

Notes

Two historic structures and two historic levee sections were found within the study area. The structures will not be affected by construction activities.

Location Info

County(ies): Solano

USGS 7.5' Quads: Rio Vista

Address:

Database Record Metadata

	Date	*User*	
Entered:	4/7/2005	nwic-main	
Last Modified:	8/24/2012	hagell	
IC Actions:	*Date*	*User*	*Action taken*
	4/7/2005	jay	Appended records from NWICmain bibliographic database.

Record Status:

Date Mapped:

Northwest Information Center Report Detail Record: S-032596

Previous designation(s):

PDF file: \\SVR01\library\pdf-library\reports\32596.pdf

Citation Information

Authors: Randall Milliken
Jerome King
Patricia Mikkelsen

Year: 2006

Title: The Central California Ethnographic Community Distribution Model, Version 2.0, with Special Attention to the San Francisco Bay Area, Cultural Resources Inventory of Caltrans District 4 Rural Conventional Highways

Originator: Consulting in the Past; Far Western Anthropological Research Group, Inc.

No. Pages: 69

Report Type(s): Ethnographic study
Regional overview

No.Resources: 0

No. Informal:

Collections:

Accession No.:

Facility:

Disclosure: Not for publication

Associated Resources

Notes

Not-mappable report. The study also is within Calaveras, Amador, Tuolomne, Mariposa, Madera, & Tulare counties.

Location Info

County(ies): Alameda
Contra Costa
Fresno
Kern
Kings
Marin
Merced
Monterey
Napa
Other
Sacramento
San Benito
San Francisco
San Joaquin
San Luis Obispo
San Mateo
Santa Clara
Santa Cruz
Solano
Sonoma
Stanislaus
Yolo

USGS 7.5' Quads: ~All quads - Alameda Co.
~All quads - Contra Costa Co.
~All quads - Marin Co.
~All quads - Monterey Co.
~All quads - Napa Co.
~All quads - San Benito Co.
~All quads - San Francisco Co.
~All quads - San Mateo Co.
~All quads - Santa Clara Co.
~All quads - Santa Cruz Co.

~All quads - Solano Co.
~All quads - Sonoma Co.
~All quads - Yolo Co.

Address:

Database Record Metadata

	Date	*User*
Entered:	3/1/2007	hagell
Last Modified:	6/12/2012	hagell
IC Actions:		
Record Status:		
Date Mapped:		

Northwest Information Center Report Detail Record: S-033600

Previous designation(s):

PDF file: \\SVR01\library\pdf-library\reports\33600.pdf

Citation Information

Authors: Jack Meyer
Jeff Rosenthal

Year: 2007

Title: Geoarchaeological Overview of the Nine Bay Area Counties in Caltrans District 4

Originator: Far Western Anthropological Research Group, Inc.

No. Pages: 49

Report Type(s): Geoarchaeology
Regional overview

No.Resources: 68

No. Informal: 9

Collections:

Accession No.:

Facility:

Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-01-000001		CA-ALA-554	Castlewood Site
P-01-000002		CA-ALA-555	Meadowlark Dairy Site
P-01-000014		CA-ALA-483	Site 2
P-01-000063		CA-ALA-43	De Avillo
P-01-000064		CA-ALA-44	Kaiser
P-01-000067		CA-ALA-47	
P-01-000080		CA-ALA-60	Castro Valley
P-01-000124		CA-ALA-394	Pleasanton Meadows Site
P-01-000139		CA-ALA-413	Santa Rita Village
P-01-000140		CA-ALA-414	Iverson Site
P-01-001795		CA-ALA-566	Hayward Bypass Site
P-01-002110		CA-ALA-467	H&A-HEP-1
P-01-002160		CA-ALA-574	Bernal
P-01-002162		CA-ALA-576	Curtner Site
P-01-002245		CA-ALA-586	HWY 238-1
P-07-000019		CA-CCO-696	Burial Site
P-07-000024		CA-CCO-4	SLATER SITE
P-07-000037		CA-CCO-18/H	Marsh Site
P-07-000047		CA-CCO-30	
P-07-000075		CA-CCO-133	ADER SITE
P-07-000079		CA-CCO-137	Monument
P-07-000088		CA-CCO-146	HOLLAND TRACT
P-07-000089		CA-CCO-147	
P-07-000108		CA-CCO-225	Anaclario Site
P-07-000182		CA-CCO-305	
P-07-000185		CA-CCO-308	Stone Valley Site
P-07-000186		CA-CCO-309	The Rossmoor Site
P-07-000217		CA-CCO-431	Murwood School
P-07-000239		CA-CCO-459	
P-07-000401		CA-CCO-637	
P-07-000721		CA-CCO-368	
P-21-000010		CA-MRN-249	
P-21-000048		CA-MRN-17	NELSON #17
P-21-002615		CA-MRN-674	Pelican site
P-28-000009		CA-NAP-863	
P-28-000028	790000506	CA-NAP-15/H	#15, Suscol Mound #5
P-28-000301		CA-NAP-399	B- 55- V V
P-28-000967		CA-NAP-916	Double Whoa!

Northwest Information Center Report Detail Record: S-033600

P-38-000006	CA-SFR-6	Loud's Presidio Mount
P-38-000028	CA-SFR-28	BART BURIAL
P-38-000101	CA-SFR-112	49 STEVENSON ST
P-38-000102	CA-SFR-113	5TH & MARKET
P-38-000119	CA-SFR-114	
P-41-000080	CA-SMA-77	University Village Site
P-41-000284	CA-SMA-273	
P-43-000016	CA-SCL-755	SCU/Old Alameda Burial site
P-43-000189	CA-SCL-178	MH-22
P-43-000296	CA-SCL-288	
P-43-000308	CA-SCL-300	FIRST STREET
P-43-000310	CA-SCL-302	
P-43-000423	CA-SCL-418/H	
P-43-000424	CA-SCL-419/H	441 N. 1st
P-43-000448	CA-SCL-447/H	formerly known as CA-SCL-6E
P-43-000451	CA-SCL-450	
P-43-000485	CA-SCL-484	None
P-43-000561	CA-SCL-566	
P-43-000604	CA-SCL-609	Ronald McDonald House
P-43-000608	CA-SCL-613	Stanford Man II
P-43-000614	CA-SCL-619	ELK SITE
P-43-000623	CA-SCL-675	"Coyote Creek Site"
P-43-001015	CA-SCL-553	
P-43-001058	CA-SCL-674	
P-43-001080	CA-SCL-702	Waste Management Site
P-43-001163	CA-SCL-828	Fuel Farm Site
P-43-001194	CA-SCL-832	Iowa Avenue and Sunnyvale Avenue Site
P-43-001576	CA-SCL-849	
P-48-000007	CA-SOL-391	Fairfield PEC-1
P-48-000157	CA-SOL-324	

Notes

Nine unrecorded prehistoric resources. Not-mappable report.

Location Info

County(ies): Alameda
Contra Costa
Marin
Napa
San Francisco
San Mateo
Santa Clara
Solano
Sonoma

USGS 7.5' Quads: ~All quads - Alameda Co.
~All quads - Contra Costa Co.
~All quads - Marin Co.
~All quads - Napa Co.
~All quads - San Francisco Co.
~All quads - San Mateo Co.
~All quads - Santa Clara Co.
~All quads - Solano Co.
~All quads - Sonoma Co.

Address:

Database Record Metadata

	Date	*User*
Entered:	9/24/2007	guldenj
Last Modified:	11/22/2011	muchb
IC Actions:		
Record Status:		

Date Mapped:

Northwest Information Center Report Detail Record: S-035031

Previous designation(s):

PDF file: \\SVR01\library\pdf-library\reports\35031.pdf

Citation Information

Authors: URS Corporation

Year: 2008

Title: Cultural Resources Baseline Literature Review for the Urban Levee Project

Originator: URS Corporation

No. Pages: 486

Report Type(s): Records/literature search

No.Resources: 30

No. Informal:

Collections:

Accession No.:

Facility:

Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-48-000112		CA-SOL-271/H	
P-48-000549			C-Davis-1
P-57-000022		CA-YOL-19	S-19
P-57-000023		CA-YOL-20	S-20
P-57-000024		CA-YOL-21	S-21
P-57-000025		CA-YOL-22	S-22
P-57-000026		CA-YOL-23	S-23
P-57-000027		CA-YOL-24	S-24
P-57-000028		CA-YOL-25	S-25
P-57-000030		CA-YOL-27	S-27
P-57-000039		CA-YOL-36	X-6
P-57-000048		CA-YOL-45	INDIAN HEAD
P-57-000057		CA-YOL-59	
P-57-000075		CA-YOL-82	S-82 MARTY
P-57-000076		CA-YOL-100	S-100. Schneider
P-57-000107		CA-YOL-132	Riverbank Protection Site No. 3
P-57-000110		CA-YOL-135	
P-57-000132			Valley Oak Groves & Valley Oak Trees and
P-57-000135			SMUD-ISO-1
P-57-000195		CA-YOL-179H	HB-2
P-57-000201		CA-YOL-187	O Jesus
P-57-000211			Kiewit #5
P-57-000400			C-Davis-1
P-57-000403			REF 1-H
P-57-000417			REF 17-H
P-57-000423			Navigation Obstruction 12
P-57-000424			Navigation Obstruction10
P-57-000435			Vickrey's Orchard Campsite
P-57-000521			EB-2
P-57-000530		CA-YOL-213H	LNWI-C-8

Notes

See also S-35094. The project is also in Yuba County.

Location Info

County(ies): Other
Sacramento
San Joaquin
Solano
Sutter
Yolo

Northwest Information Center Report Detail Record: S-035031

USGS 7.5' Quads:	Clarksburg Davis Grays Bend Merritt Sacramento West Taylor Monument Verona Woodland
Address:	

Database Record Metadata

	Date	*User*
Entered:	10/8/2008	hagell
Last Modified:	6/12/2012	hagell
IC Actions:		
Record Status:		
Date Mapped:		

Northwest Information Center Report Detail Record: S-038635

Previous designation(s): Contract #W91238-07-D-0015

PDF file: \\SVR01\library\pdf-library\reports\38635.pdf

Citation Information

Authors: Andrew D.W. Lydecker

Year: 2010

Title: Cultural Resources Remote Sensing Survey and Diver Investigations at Selected Target Locations, Sacramento River Bank Protection Project (SRBPP), Sacramento River and Tributaries

Originator: Panamerican Consultants,Inc.

No. Pages: 258

Report Type(s): Archaeological Eval: NRHP
Other

No.Resources: 19

No. Informal: 0

Collections: Unknown

Accession No.:

Facility:

Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-48-000911			US5
P-48-000912			US12
P-48-000913			US13
P-48-000914			US53
P-48-000915			US110
P-48-000916			US171
P-48-000917			US176
P-48-000918			US181
P-57-000651			US99
P-57-000653			US297
P-57-000654			US299
P-57-000655			US300
P-57-000656			US313
P-57-000657			US356
P-57-000658			US407
P-57-000659			US408
P-57-000660			US411
P-57-000661			US418
P-57-000662			US459

Notes

383 magnetic anomalies and 110 sidescan sonar targets were identified during the remote sensing survey. An additional 30 'targets' were noted on the riverbank. 4 historic vessels appear to meet eligibility criteria for National Register listing.

Location Info

County(ies): Sacramento
Solano
Yolo

USGS 7.5' Quads: Isleton
Knights Landing
Rio Vista
Sacramento West

Address:

Northwest Information Center Report Detail Record: S-038635

Database Record Metadata

	Date	*User*
Entered:	2/17/2012	blacke
Last Modified:	7/17/2012	hagell
IC Actions:		
Record Status:		
Date Mapped:		

CA SOL-276

FARALLONES COLLECTIVE
ARCHAEOLOGICAL SITE SURVEY RECORD

1. Site Sol-276	2. Map USGS 7.5' Rio Vista Quadrangle
3. County Solano	4. Township 4N Range 3E / ¼ of ¼ Section
5. UTM Grid or Long & Lat. 4,227,260 m North/617,240 m East, Zone 10	
6. Location Solano X is located along the levee adjacent to the Ryer Island Ferry's western approach, approx. 1 kilometer north of the confluence of Steamboat Slough	
7. Contour Elevation 0'	8. Previous site designation Solano X
9. Owner not determined	10. Address not determined
11. Present tenant The Ryer Island Ferry is situated on a large portion of the site.	
12. Description of site A large occupation site, situated along the top of a levee fronting the Sacramento River, and characterized by midden containing artifactual	
13. Area approx. 100X10 meters	14. Depth approx. 60-70 centimeters
15. Vegetation typical Delta-marsh vegetation with willow trees on site	
16. Nearest water Sacramento River	17. Soil of site dark midden - Egbert Muck
18. Surrounding soil type nonmidden - Egbert Muck	
19. Previous excavation The Dept. of Anthropology, CSU-Hayward, surface collected the	
20. Cultivation-logging Cultivated field west of levee contains some site material.	
21. Buildings, roads, etc. Ferry launch has impacted southern portion of site.	
22. Erosion wave action	23. Possibility of destruction tremendous through erosion
24. Features (burials, house pits, etc.) Numerous human burials have been observed eroding	
25. Artifacts The site was surface collected in 1966 by CSU-Hayward. The artifacts collected, which are still curated by the Dept. of Anthropology at CSUH, include	
26. Remarks In addition to the artifactual materials mentioned in #25 above, the site is characterized by various other ecofactual and nonartifactual materials.	
27. Published references In James A. Bennyhoff's ETHNOGEOGRAPHY OF THE PLAINS MIWOK,	
28. Sketch map attached	29. Photos color slides (on file at
30. Recorded by E. Breck Parkman & Katherine Flynn	31. Date Oct. 20, 1980
32. Continuation Sheet Yes ☒ No ☐	

ARCHAEOLOGICAL SITE SURVEY RECORD CA SOL-276

(Continuation Sheet)

Item No.	CONTINUATION
6	and the Sacramento River. The ferry dock is situated on the
	southern portion of the site, with the northern site boundary
	falling just south of the wooden structure crowning the small
	mound north of the ferry dock.
12	and ecofactual materials, fire hearths and other nonartifactual
	features, and human burials which are all being exposed in the
	constantly eroding levee walls.
19	site in 1966. No maps or reports appear to have been completed
	which document this investigation, although the archeological
	materials collected are still curated by CSU-Hayward.
24	out of the eastern wall of the river levee. At the time of the
	Parkman/Flynn visit to the site (4/27/79), at least 3 human
	burials were observed eroding from the wall of the levee. It
	was not possible to determine burial posture of any of the 3
	interments. In a visit to the site several weeks earlier, Ben
	Ananian of CSU-Hayward reported observing 4 additional burials
	eroding from the levee, 2 of which appeared to be flexed burials,
	one having several obsidian serrated projectile points in
	association. Several nonartifactual features, including one
	large ash lens, were observed in the levee walls.

Recorded by	Date

ARCHAEOLOGICAL SITE SURVEY RECORD CA SOL-276

(Continuation Sheet)

Item No.	CONTINUATION
25	20 obsidian projectile points, 8 obsidian blades, 3 unclassified
	obsidian tools, 2 obsidian cores, 1 obsidian flake scraper, 4
	chert flake scrapers, 1 sandstone blade-like tool, 1 pigment
	mortar, 1 mortar fragment, 1 grinding stone, 3 pestle fragments,
	3 hammerstones, 1 battered pebble tool, 1 grooved stone sinker,
	10 charmstones, 1 perforated clay sinker, 1 clay ball, 3 bone
	harpoon heads, 2 antler fishspears, 1 antler atlatl, 7 bone awls,
	2 bone needles, 2 bone "fiber-strippers," 3 bone flaking tools,
	1 serrated bone tool, 3 antler flakers, 7 unclassified bone
	tools, 1 beaver jaw fragment (burial association), 1 Haliotis
	pendant, and 4 clamshell disk beads. Numerous other artifacts,
	consisting primarily of baked clay objects and obsidian debitage,
	were collected by CSUH in 1966, but were never added to the site
	catalogue represented by the artifacts listed above. During the
	visit to Solano X by Parkman and Flynn, several artifacts were
	collected from the eroding beach area adjacent to the levee.
	These artifacts include 2 obsidian and 1 basalt projectile points,
	½ very large pestle fragment, 2 bone awl fragments, and 1
	clamshell (Saxidomus nuttalli) disk bead. These artifacts were
	added to the collection curated by CSU-Hayward.
26	A great quantity of faunal remains, most of which had been burned,
	was observed. Many large mineralized mammal bones, including elk,
	deer, and human, were noted. Also noted were small mammal and fish

Recorded by	Date

ARCHAEOLOGICAL SITE SURVEY RECORD CA SOL-276
(Continuation Sheet)

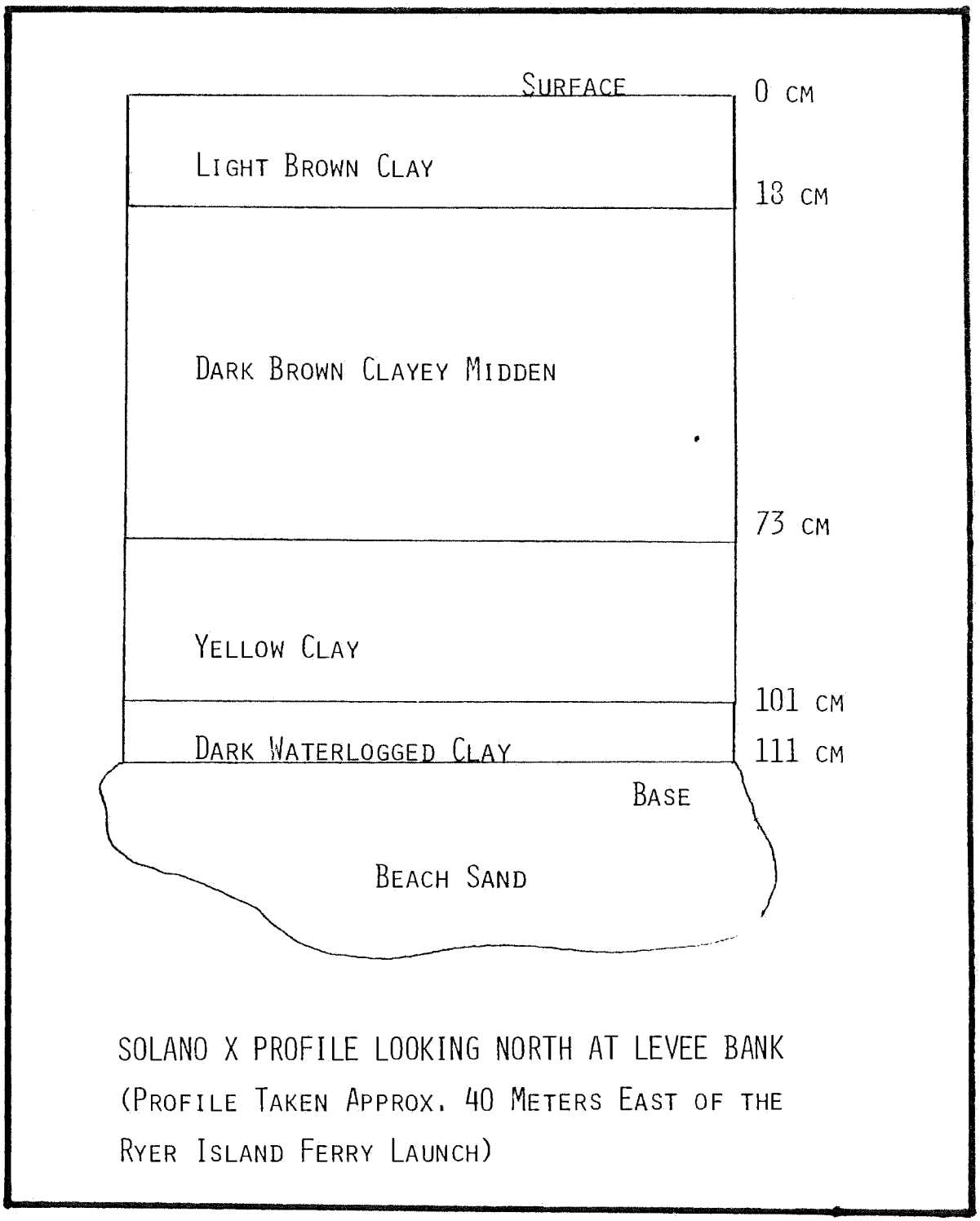
Item No.	CONTINUATION
	remains. Much of the bone appears to have been worked. In addition
	to the faunal material, a small quantity of fire-cracked rock and
	a large quantity of baked clay was observed. Little shell was
	observed in the midden. The predominant shell present appears to
	be fresh water clam (Margitifera). Shells of the California
	mussel (Mytilus edulis) were also noted, but in much less
	abundance. In addition to the artifactual material, CSU-Hayward
	also collected a fairly large quantity of faunal remains from
	the site, all of which is still curated along with the artifacts.
	A cursory inspection of these faunal remains indicates the
	presence of domestic cattle (Bos) within the collection in
	significant numbers, apparently indicating a historic occupation
	of the site.
27	Center for Archaeological Research at Davis, Publication No. 5,
	1977, a historic Plains Miwok settlement named Anizumne is
	mentioned, and appears to be a likely candidate for the Solano
	X archeological site. Bennyhoff (1977:78) locates Anizumne just
	north of Rio Vista: "On the 1824 Map the village is placed between
	the Ompin and Chucumne, west of the Quenemsia on the west bank of
	the Sacramento River. Merriam's location of the 'Hannesuk' can be
	interpreted to mean the Sacramento River. One source reported
	'Halo chemuck' as a village name placed just north of Rio Vista,
	but, as discussed under Comment below, the associations of this
	name are confused. No archaeological sites are known in this

Recorded by	Date

ARCHAEOLOGICAL SITE SURVEY RECORD CA SOL-276
(Continuation Sheet)

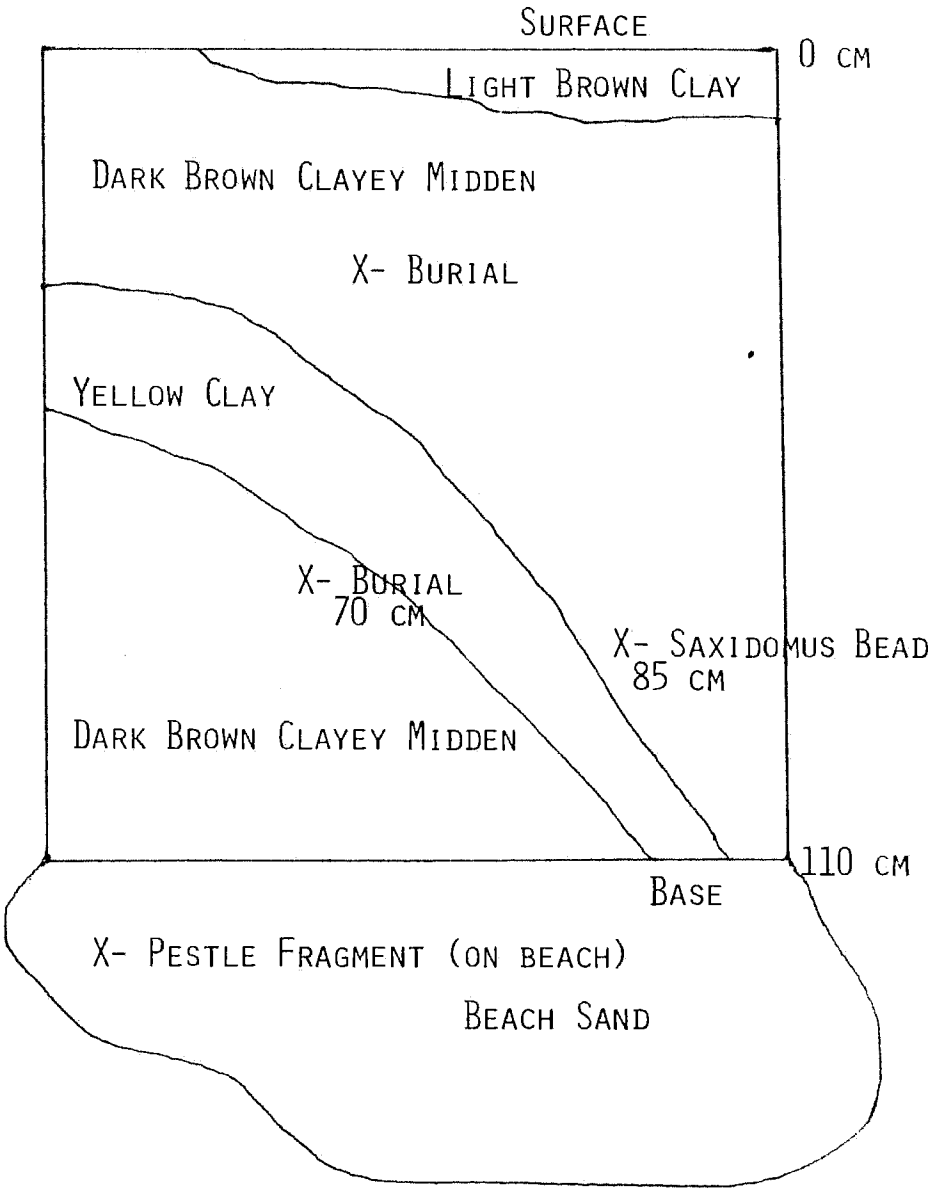
Item No.	CONTINUATION
	unsurveyed section, but the tribelet center may have been at Rio
	Vista or on the knoll one-half mile north of Rio Vista, beside the
	small marsh on the west bank of the Sacramento River." According
	to Bennyhoff (1977:79), Anizumne represented, "...a moderate
	sized tribelet which accepted missionization immediately."
29	Archaeological Resource Service, 661 Olive Avenue, Novato,
	California 94947)

Recorded by	Date



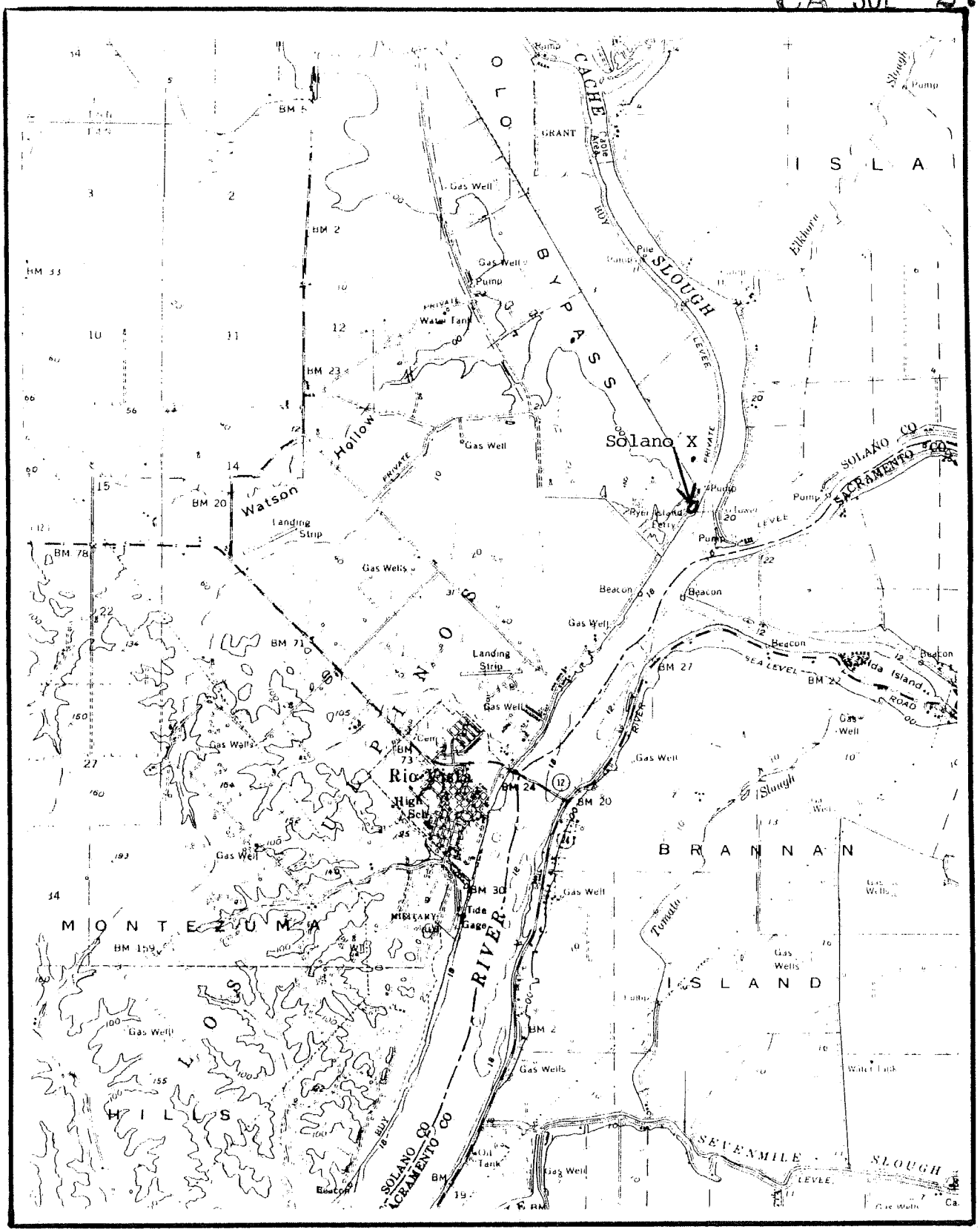
SOLANO X PROFILE LOOKING NORTH AT LEVEE BANK
(PROFILE TAKEN APPROX. 40 METERS EAST OF THE RYER ISLAND FERRY LAUNCH)

PROFILE 1



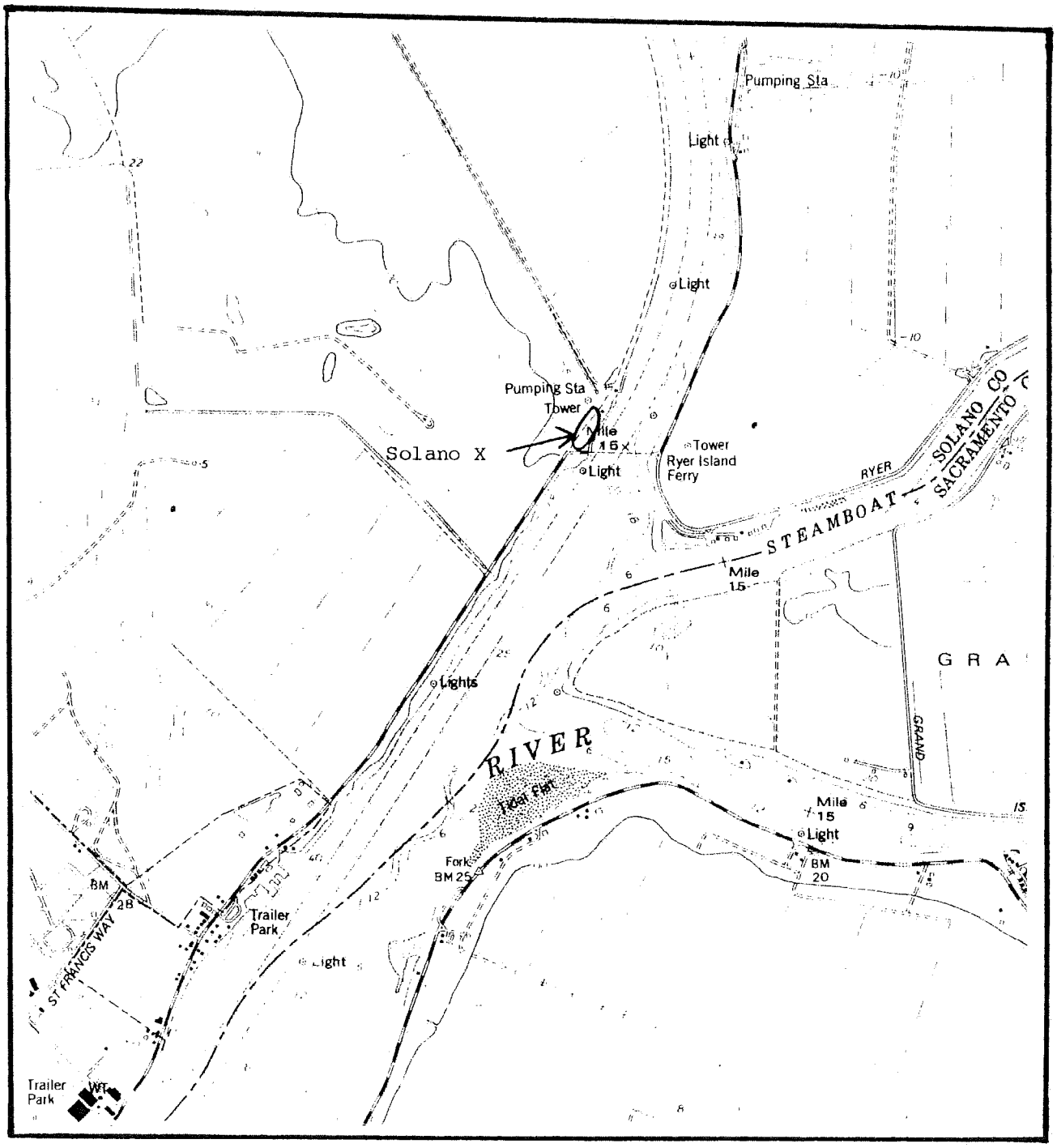
SOLANO X PROFILE LOOKING NORTH AT LEVEE BANK
(PROFILE TAKEN APPROX. 30 METERS EAST OF THE RYER ISLAND FERRY LAUNCH)

CA SOL-276



MAP 1. Location of Solano X. Compiled from USGS 15' Rio Vista Quadrangle.

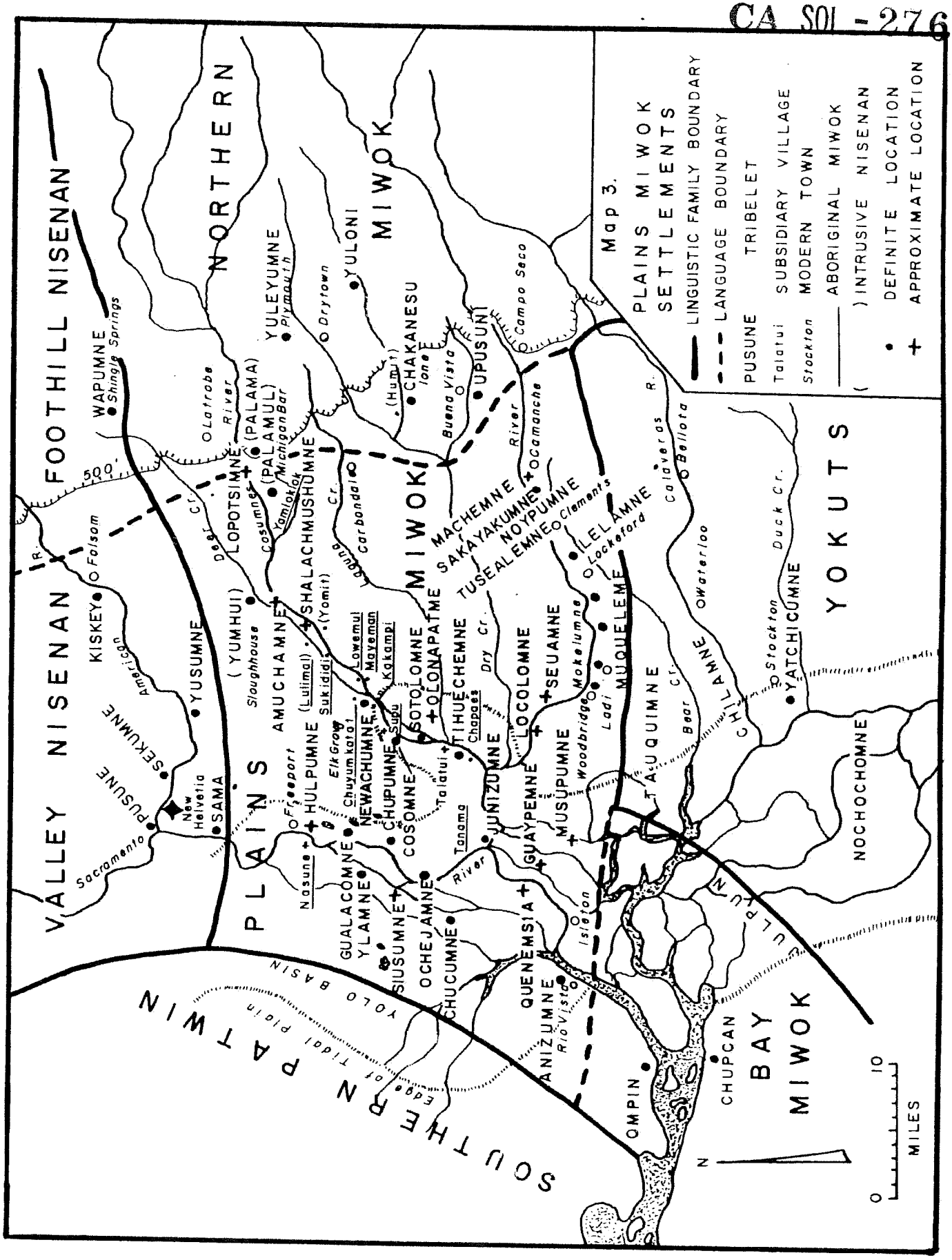
CA SOL-276



MAP 2. Location of Solano X. Compiled from USGS 7.5'

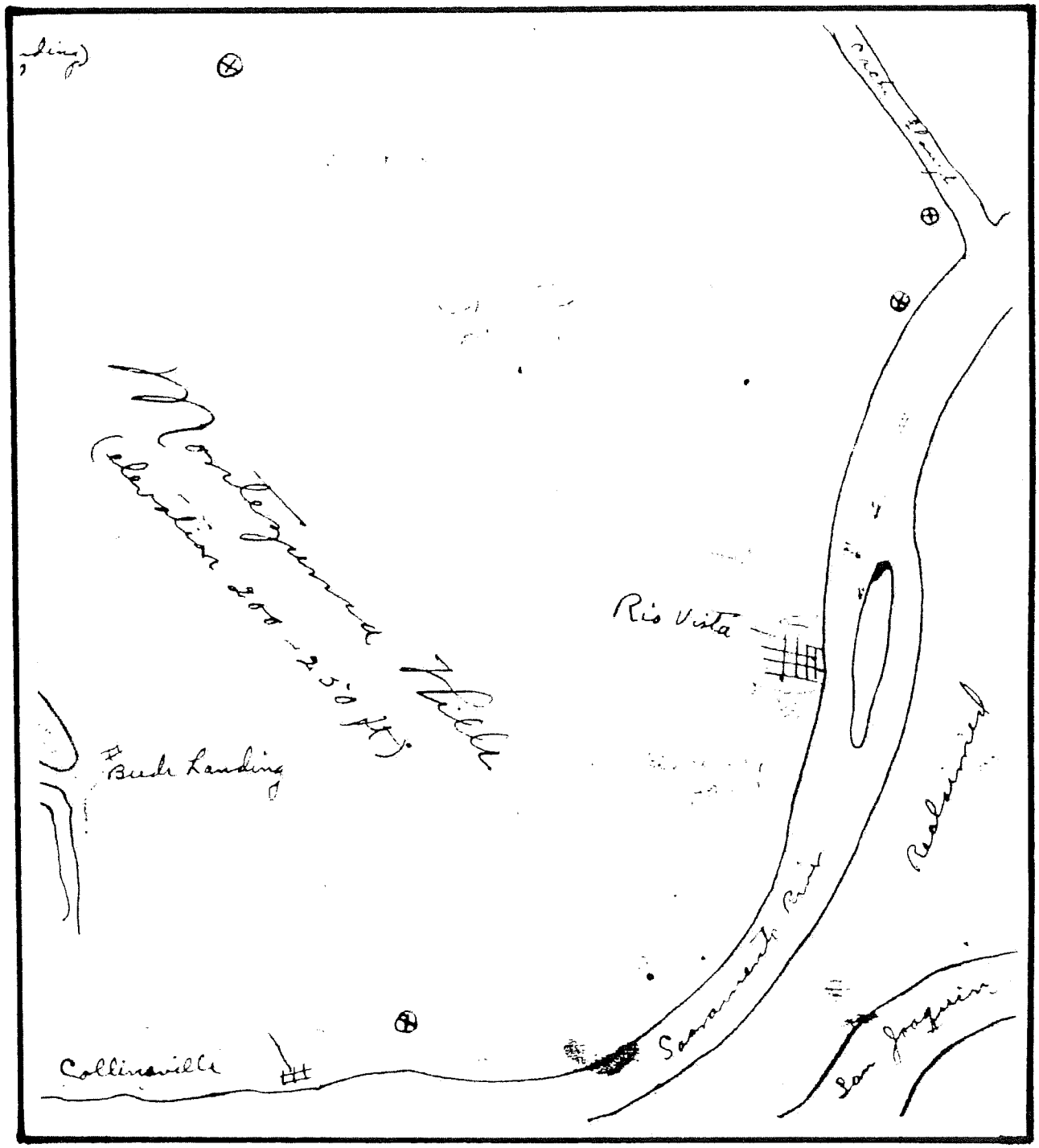
Rio Vista Quadrangle.

CA SOl - 276



MAP 3. Location of Anizumne. After Bennyhoff (1977:165).

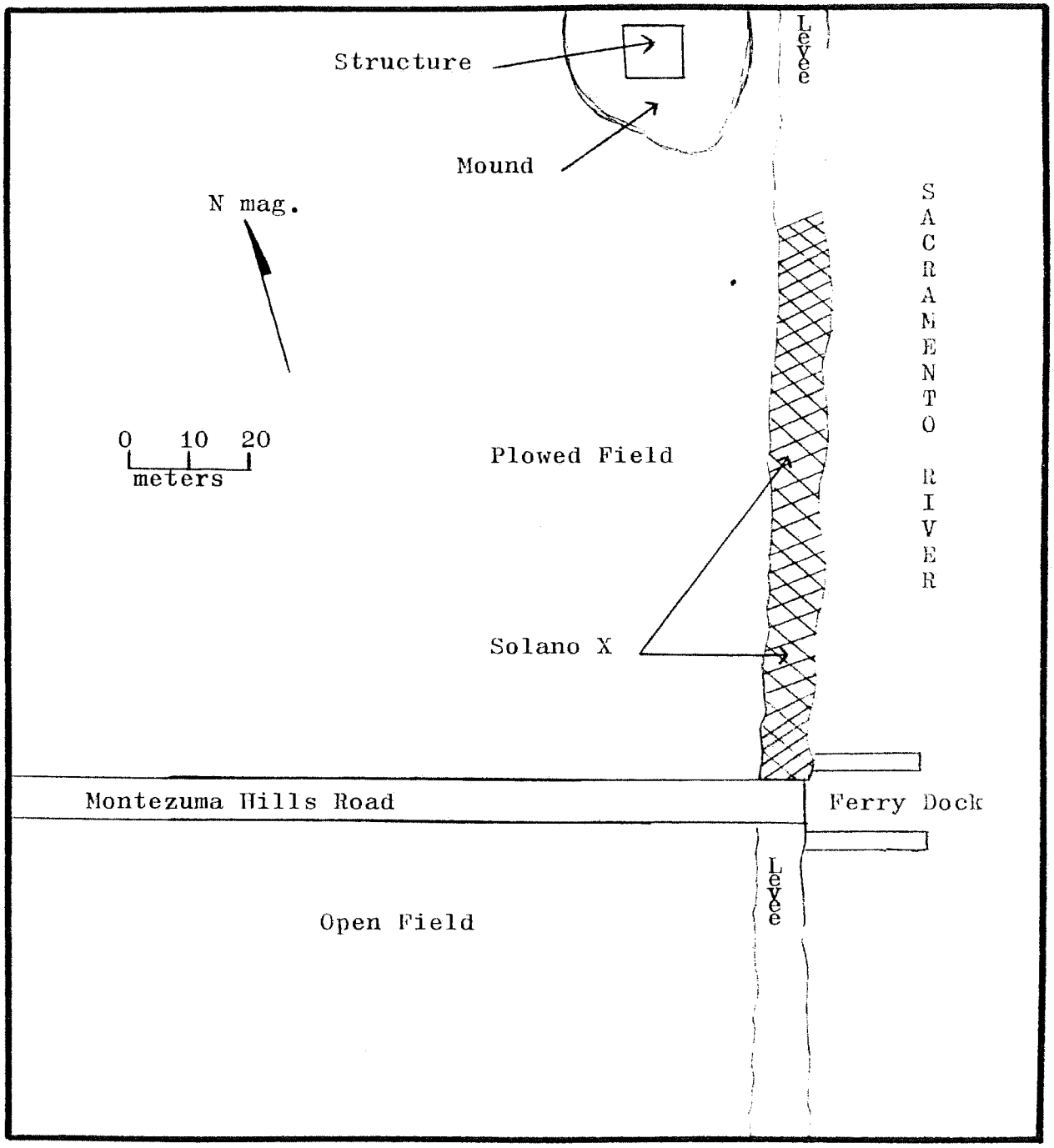
CA SOL - 276



MAP 4. Location of Archeological Sites in the Vicinity of Rio Vista. From a letter from N.C. Nelson to C. Hart Merriam (no date). Manuscript on file at Bancroft Library, Berkeley.

Nelson's scale is ½"=1 mile

CA SOL-276



MAP 5. Sketch Map of Solano X.

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # P-48-000911
HRI #
Trinomial
NRHP Status Code

Other Listings
Review Code Reviewer Date

Page 1 of 2 *Resource Name or #: US5

P1. Other Identifier: M005/C0091/RV02

***P2. Location:** ☒ **Not for Publication** ☐ **Unrestricted** ***a. County:** Solano

and (P2b and P2c or P2d. Attach a Location Map as necessary.)

***b. USGS 7.5' Quad:** Rio Vista **Date:** 1978 **T** Unplatted; **R** ; ¼ of ¼ of Sec ; M.D. **B.M.**

c. Address: City: Zip:

d. UTM: Zone: 10; 616426 mE/ 4226178 mN (G.P.S.) NAD 1983

e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate) Elevation:

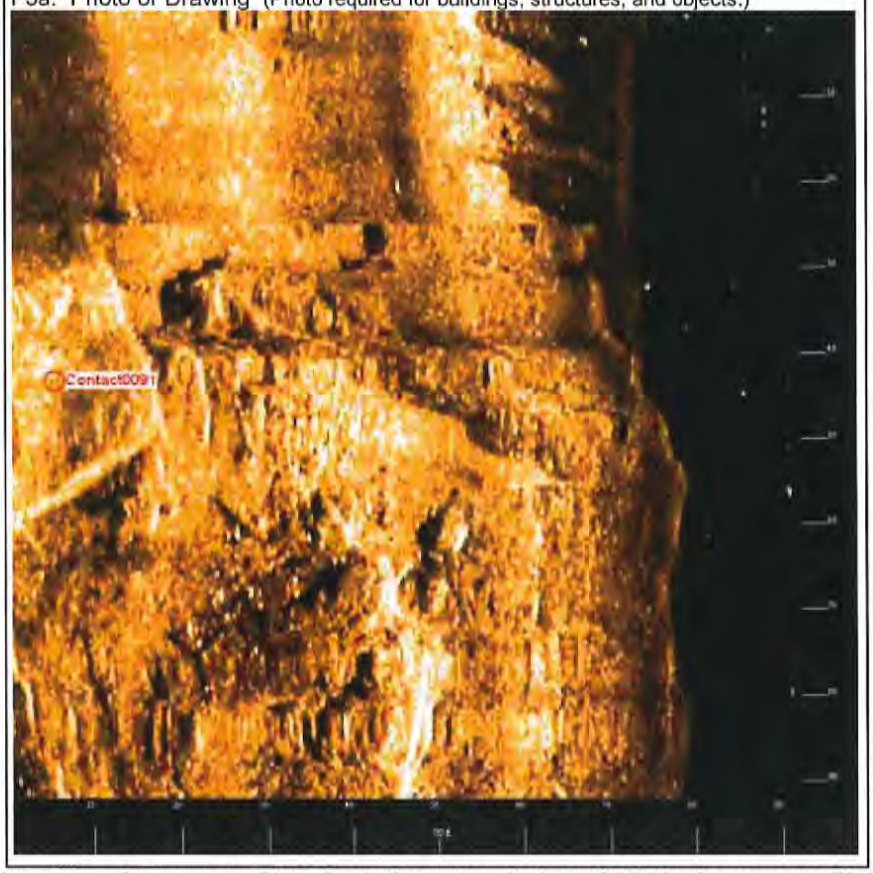
***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

US5 (sidescan sonar contact C-0091) appears to be the remains of a large barge or floating dock structure. It is located in the Sacramento River north of Rio Vista, in the vicinity of RV03, a large ocean-going vessel with a riveted steel or iron hull and RV05, a micro barge on shore. It is almost completely submerged. It is associated with magnetic anomaly M005, a large complex dipole, along with visual target RV02 which appears to be a large floating dock or barge constructed of a series of small compartments.

***P3b. Resource Attributes:** (List attributes and codes) AH14, AH16

***P4. Resources Present:** ☐Building ☐Structure ☒Object ☐Site ☐District ☐Element of District ☐Other (Isolates, etc.)

P5a. Photo or Drawing (Photo required for buildings, structures, and objects.)



*P5b. Description of Photo: (View, date, accession #)

Sidescan Sonar Photo C-0091

***P6. Date Constructed/Age and Sources:**
☒Historic
☐Prehistoric ☐Both

***P7. Owner and Address:**
Unknown

***P8. Recorded by:** (Name, affiliation, and address)

Panamerican Consultants, Inc.
Memphis, Tennessee

***P9. Date Recorded:**

September 22, 2009 to October 12, 2009

***P10. Survey Type:** (Describe)

Remote Sensing & Visual Survey with Limited Dive Investigations

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.")

Panamerican Consultants, Inc. 2010. *Cultural Resources Remote Sensing Survey and Diver Investigations at Selected Target Locations, Sacramento River Bank Protection Project (SRBPP) Sacramento River and Tributaries.* Revised Draft. A ugust. Memphis, TN. Prepared for U.S. Army Corps of Engineers, Sacramento, California.

USACE. 2012. Memorandum for Record: Results from Underwater Survey Performed by Panamerican Consultants Fall 2009.

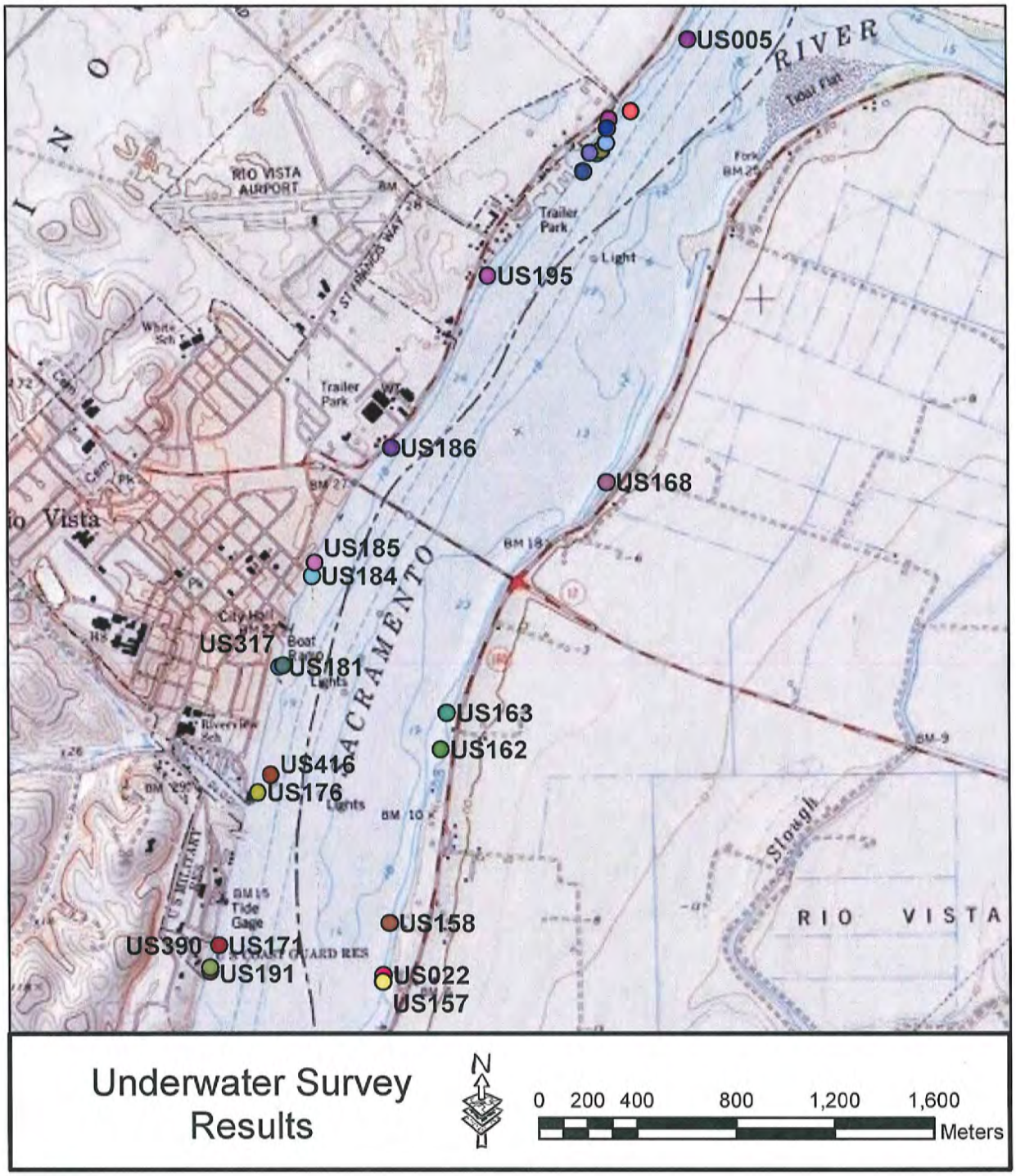
***Attachments:** ☐NONE ☒Location Map ☐Sketch Map ☐Continuation Sheet ☐Building, Structure, and O bject Record ☐Archaeological Record ☐District Record ☐Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ☐ Other (List):

State of California - The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
LOCATION MAP

Primary # P-48-000911
HRI #
Trinomial

Page 2 of 2 *Resource Name or # (Assigned by recorder) US005

*Map Name: Rio Vista, CA *Scale: 1/24000 *Date of map: 1978



State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # P-48-000912
HRI #
Trinomial
NRHP Status Code

Other Listings
Review Code Reviewer Date

Page 1 of 2 *Resource Name or #: US12

P1. Other Identifier: D055/M012

***P2. Location:** ☒ **Not for Publication** ☐ **Unrestricted** ***a. County:** Solano

and (P2b and P2c or P2d. Attach a Location Map as necessary.)

***b. USGS 7.5' Quad:** Rio Vista **Date:** 1978 **T** Unplatted; **R** ; **¼ of** **¼ of Sec** ; M.D. **B.M.**

c. Address: City: Zip:

d. UTM: Zone: 10; 617052 mE/ 4220810 mN (G.P.S.) NAD 1983

e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate) Elevation:

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

US12 (magnetic anomaly M-012) is located in the middle of the Sacramento River at Rio Vista, at the entrance to Steamboat Slough. US12 generated a complex dipole signature with a total gamma deviation of 540 over 500 feet. Located in 25 feet of water, the anomaly crosses three lines.

***P3b. Resource Attributes:** (List attributes and codes) AH1

***P4. Resources Present:** ☐Building ☐Structure ☒Object ☐Site ☐District ☐Element of District ☐Other (Isolates, etc.)

P5a. Photo or Drawing (Photo required for buildings, structures, and objects.)

No photo available, object underwater

P5b. Description of Photo: (View, date, accession #)

***P6. Date Constructed/Age and Sources:**
☒Historic
☐Prehistoric ☐Both

***P7. Owner and Address:**
Unknown

***P8. Recorded by:** (Name, affiliation, and address)

Panamerican Consultants, Inc.
Memphis, Tennessee

***P9. Date Recorded:**
September 22, 2009 to October 12, 2009

***P10. Survey Type:** (Describe)
Remote Sensing & Visual Survey with Limited Dive Investigations

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.")

Panamerican Consultants, Inc. 2010. *Cultural Resources Remote Sensing Survey and Diver Investigations at Selected Target Locations, Sacramento River Bank Protection Project (SRBPP) Sacramento River and Tributaries.* Revised Draft. A ugust. Memphis, TN. Prepared for U.S. Army Corps of Engineers, Sacramento, California.

ICF International. 2011. *Historic Properties Treatment Plan Sacramento River Bank Protection Project.* Revised Draft. March. (ICF 00627.08.) Sacramento, CA. Prepared for U.S. Army Corps of Engineers, Sacramento, California.

USACE. 2012. Memorandum for Record: Results from Underwater Survey Performed by Panamerican Consultants Fall 2009.

***Attachments:** ☐NONE ☒Location Map ☐Sketch Map ☐Continuation Sheet ☐Building, Structure, and O bject Record ☐Archaeological Record ☐District Record ☐Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ☐ Other (List):

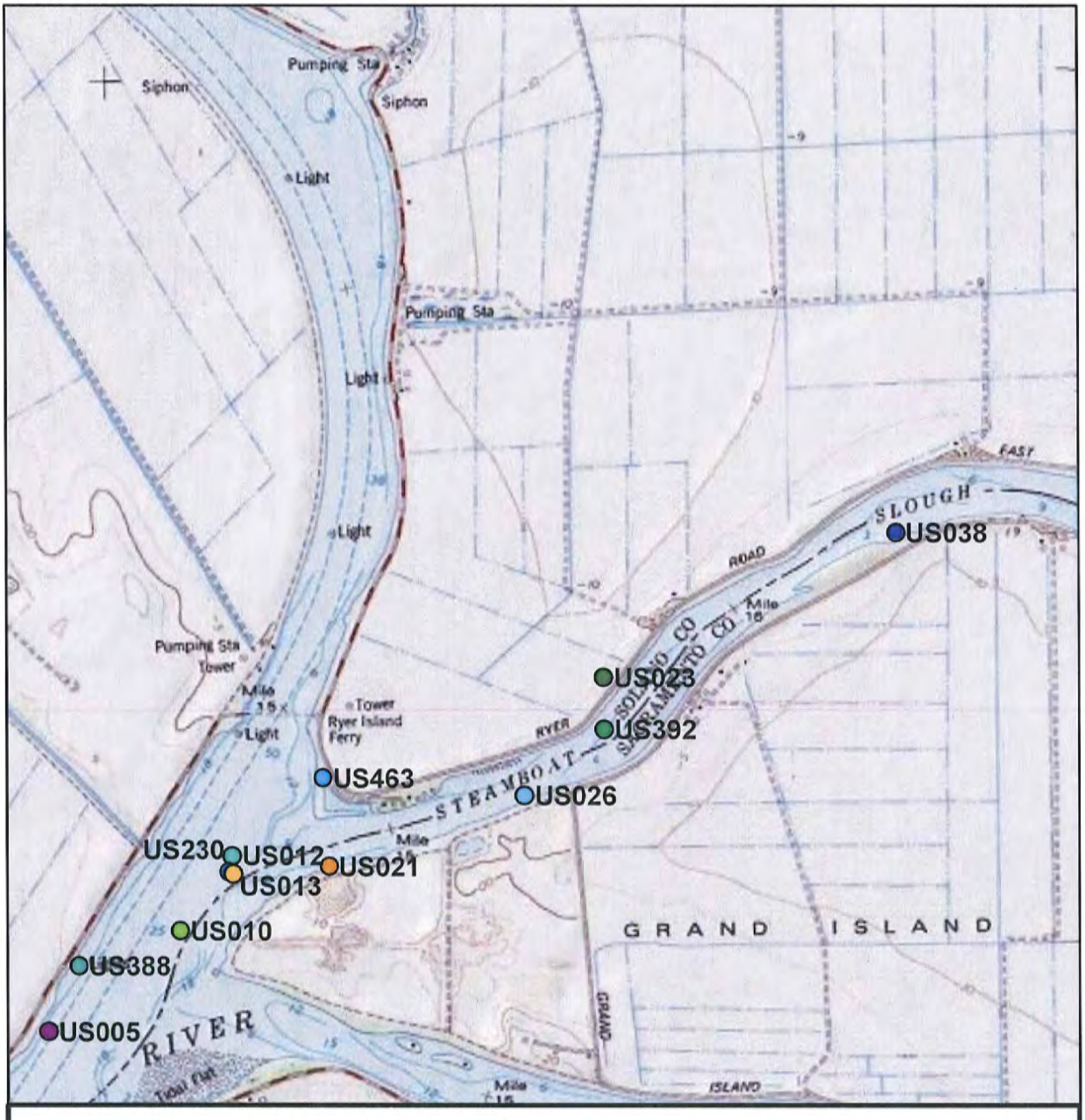
State of California - The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
LOCATION MAP

Primary # P-48-000912
HRI #
Trinomial

Page 2 of 2

Resource Name or # (Assigned by recorder) US012

*Map Name: Rio Vista, CA *Scale: 1/24000 *Date of map: 1978



Underwater Survey Results

N

0 200 400 800 1,200 1,600

Meters

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # P-48-000913
HRI #
Trinomial
NRHP Status Code

Other Listings
Review Code Reviewer Date

Page 1 of 2 *Resource Name or #: US13

P1. Other Identifier: D044/M012/C0092
*P2. Location: ☒ Not for Publication ☐ Unrestricted *a. County: Solano
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
*b. USGS 7.5' Quad: Rio Vista Date: 1978 T Unplatted; R ; ¼ of ¼ of Sec ; M.D. B.M.
c. Address: City: Zip:
d. UTM: Zone: 10; 617112 mE/ 4226781 mN (G.P.S.) NAD 1983
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate) Elevation:

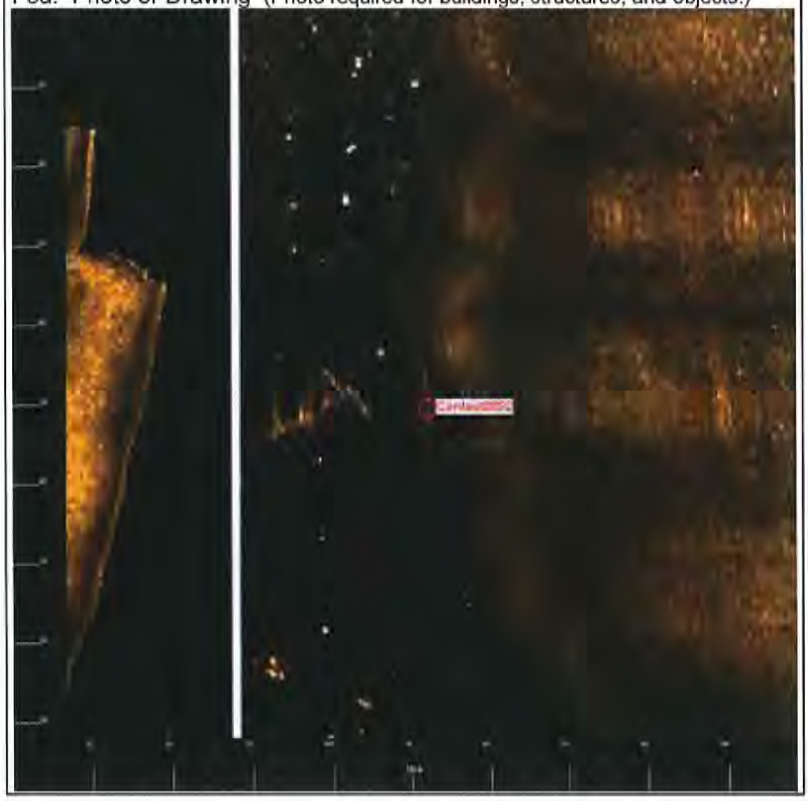
*P3a. Description: (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

US13 (sidescan sonar contact C-0092) is located in the middle of the Sacramento River at Rio Vista, at the entrance to Steamboat Slough. It is associated with magnetic anomaly M012 which generated a complex dipole signature with a total gamma deviation of 540 over 500 feet. It is small, and likely does not account for the anomaly by itself, suggesting there are other objects buried in the vicinity.

*P3b. Resource Attributes: (List attributes and codes) AH1

*P4. Resources Present: ☐Building ☐Structure ☒Object ☐Site ☐District ☐Element of District ☐Other (Isolates, etc.)

P5a. Photo or Drawing (Photo required for buildings, structures, and objects.)



P5b. Description of Photo: (View, date, accession #)

Sidescan Sonar Photo C-0092

*P6. Date Constructed/Age and Sources:
☒Historic
☐Prehistoric ☐Both

*P7. Owner and Address:
Unknown

*P8. Recorded by: (Name, affiliation, and address)

Panamerican Consultants, Inc.
Memphis, Tennessee

*P9. Date Recorded:

September 22, 2009 to October 12, 2009

*P10. Survey Type: (Describe)

Remote Sensing & Visual Survey with Limited Dive Investigations

*P11. Report Citation: (Cite survey report and other sources, or enter "none.")

Panamerican Consultants, Inc. 2010. *Cultural Resources Remote Sensing Survey and Diver Investigations at Selected Target Locations, Sacramento River Bank Protection Project (SRBPP) Sacramento River and Tributaries.* Revised Draft. August. Memphis, TN. Prepared for U.S. Army Corps of Engineers, Sacramento, California.

ICF International. 2011. *Historic Properties Treatment Plan Sacramento River Bank Protection Project.* Revised Draft. March. (ICF 00627.08.) Sacramento, CA. Prepared for U.S. Army Corps of Engineers, Sacramento, California.

USACE. 2012. Memorandum for Record: Results from Underwater Survey Performed by Panamerican Consultants Fall 2009.

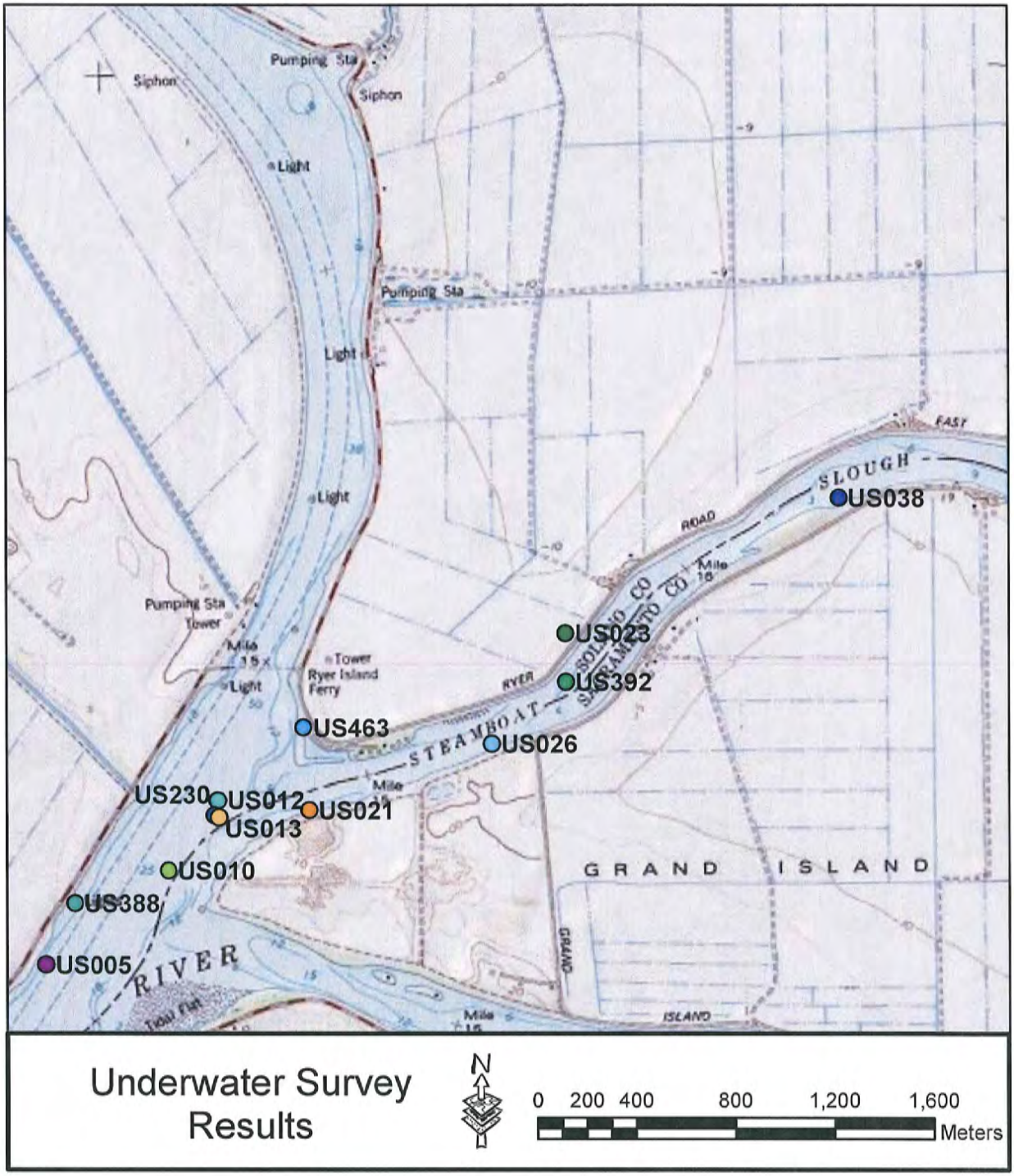
*Attachments: ☐NONE ☒Location Map ☐Sketch Map ☐Continuation Sheet ☐Building, Structure, and Object Record ☐Archaeological Record ☐District Record ☐Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ☐ Other (List):

State of California - The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
LOCATION MAP

Primary # P-48-000913
HRI #
Trinomial

Page 2 of 2 Resource Name or # (Assigned by recorder) US013

*Map Name: Rio Vista, CA *Scale: 1/24000 *Date of map: 1978



Confidential Appendix B

Native American Coordination Correspondence

STATE OF CALIFORNIA, Edmund G. Brown, Jr., Governor

NATIVE AMERICAN HERITAGE COMMISSION
915 CAPITOL MALL, ROOM 364
SACRAMENTO, CA 95814
(916) 653-6251
Fax (916) 657-5390

August 28, 2012

Steven Treffers
SWCA, Environmental Consultants
150 South Arroyo Parkway, Second Floor
Pasadena, CA 91105

Sent by Fax: 626-240-0607
Number of Pages: 2

Re: PG&E CAES—Cache Slough Project, Solano County.

Dear Mr. Treffers:

A record search of the sacred land file has failed to indicate the presence of Native American cultural resources in the immediate project area. The absence of specific site information in the sacred lands file does not indicate the absence of cultural resources in any project area. Other sources of cultural resources should also be contacted for information regarding known and recorded sites.

Enclosed is a list of Native Americans individuals/organizations who may have knowledge of cultural resources in the project area. The Commission makes no recommendation or preference of a single individual, or group over another. This list should provide a starting place in locating areas of potential adverse impact within the proposed project area. I suggest you contact all of those indicated, if they cannot supply information, they might recommend others with specific knowledge. By contacting all those listed, your organization will be better able to respond to claims of failure to consult with the appropriate tribe or group. If a response has not been received within two weeks of notification, the Commission requests that you follow-up with a telephone call to ensure that the project information has been received.

If you receive notification of change of addresses and phone numbers from any of these individuals or groups, please notify me. With your assistance we are able to assure that our lists contain current information. If you have any questions or need additional information, please contact me at (916) 653-4038.

Sincerely,

Debbie Pilas-Treadway
Environmental Specialist III

Native American Contacts
Solano County
August 28, 2012

Kesner Flores
PO Box 1047 Wintun / Patwin
Wheatland , CA 95692
calnagpra@hotmail.com
925-586-8919

Cortina Band of Indians
Charlie Wright, Chairperson
PO Box 1630 Wintun / Patwin
Williams , CA 95987
(530) 473-3274 - Voice
(530) 473-3190 - Voice
(530) 473-3301 - Fax

Cortina Wintun Environmental Protection Agency
P.O. Box 1630 Wintun (Patwin)
Williams , CA 95987
corwepa@yahoo.com
(530) 473-3318
(530) 473-3319
(530) 473-3301 - Fax

Yocha Dehe Wintun Nation
Marshall McKay, Chairperson
P.O. Box 18 Wintun (Patwin)
Brooks , CA 95606
(530) 796-3400
(530) 796-2143 Fax

Yocha Dehe Wintun Nation
Leland Kinter, Native Cultural Renewal Committee
P.O. Box 18 Wintun (Patwin)
Brooks , CA 95606
lkinter@yochadehe-nsn.gov
(530) 979-6346
(530) 796-3400 - office
(530) 796-2143 Fax

Yocha Dehe Wintun Nation
Cynthia Clarke, Native Cultural Renewal Committee
P.O. Box 18 Wintun (Patwin)
Brooks , CA 95606
(530) 796-3400 - office
(530) 796-2143 Fax

Yocha Dehe Wintun Nation
Reno Franklin, Cultural Resources Director
P.O. Box 18 Wintun (Patwin)
Brooks , CA 95606
rfranklin@yochadehe-nsn.gov
(530) 979-6346
(530) 796-3400 - office
(530) 796-2143 Fax

This list is current only as of the date of this document.

Distribution of this list does not relieve any person of statutory responsibility as defined in Section 7050.5 of the Health and Safety Code, Section 5097.94 of the Public Resources Code and Section 5097.98 of the Public Resources Code

This list is only applicable for contacting local Native Americans with regard to cultural resources for the proposed PGE CAES-Cache Slough project, Solano County

Pacific Gas and Electric Company

Christophe Descantes, PhD
Sr. Cultural Resources Specialist
Land & Environmental Management

Mailing Address
245 Market Street — N10A
San Francisco, CA 94105
Tel: (415) 973.1177
Mobile: (925) 719.2740
Email: chd8@PGE.com

August 31, 2012

Yocha Dehe Wintun Nation
Cynthia Clarke, Native Cultural Renewal Committee
P.O. Box 18
Brooks, CA 95606

RE: Cultural Resources Survey for the PG&E CAES – Cache Slough Project in Solano County, California

Dear Ms. Clarke:

Pacific Gas and Electric (PG&E) is conducting a cultural resources study for the PG&E CAES – Cache Slough Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

The project area is located in unincorporated Cache Slough County near the City of Rio Vista and falls within the USGS 7.5-minute Rio Vista quadrangle map (see enclosed project location map). The proposed project would use renewable energy from sources such as wind to inject compressed air into an underground reservoir. The Cache Slough reservoir site consists of the construction of a well pad measuring approximately 1 acre, which would support a drilling rig and other equipment for the purpose of core drilling tests to determine if the site is a viable candidate for the CAES project.

As part of the process of identifying cultural resources issues for this project, SWCA contacted the Native American Heritage Commission (NAHC) and requested a Sacred Lands File (SLF) search and a list of Native American individuals and/or tribal organizations that may have knowledge of cultural resources in or near the project area. The NAHC SLF search did not identify any Native American cultural resources within a one-half mile radius of the proposed project area. The NAHC recommended that we consult with you directly regarding your knowledge of the presence of cultural resources that may be impacted by this project.

If you have knowledge of any cultural resources that may exist within or near the project area, please contact Steven Treffers at (626) 240-0587, streffers@swca.com, at your earliest convenience.

Thank you for your attention to this matter.

Best regards,

Christophe Descantes
Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Pacific Gas and Electric Company

Christophe Descantes, PhD
Sr. Cultural Resources Specialist
Land & Environmental Management

Mailing Address
245 Market Street — N10A
San Francisco, CA 94105
Tel: (415) 973.1177
Mobile: (925) 719.2740
Email: chd8@PGE.com

August 31, 2012

Kesner Flores
P.O. Box 1047
Wheatland, CA 95692

RE: Cultural Resources Survey for the PG&E CAES – Cache Slough Project in Solano County, California

Dear Mr. Flores:

Pacific Gas and Electric (PG&E) is conducting a cultural resources study for the PG&E CAES – Cache Slough Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

The project area is located in unincorporated Cache Slough County near the City of Rio Vista and falls within the USGS 7.5-minute Rio Vista quadrangle map (see enclosed project location map). The proposed project would use renewable energy from sources such as wind to inject compressed air into an underground reservoir. The Cache Slough reservoir site consists of the construction of a well pad measuring approximately 1 acre, which would support a drilling rig and other equipment for the purpose of core drilling tests to determine if the site is a viable candidate for the CAES project.

As part of the process of identifying cultural resources issues for this project, SWCA contacted the Native American Heritage Commission (NAHC) and requested a Sacred Lands File (SLF) search and a list of Native American individuals and/or tribal organizations that may have knowledge of cultural resources in or near the project area. The NAHC SLF search did not identify any Native American cultural resources within a one-half mile radius of the proposed project area. The NAHC recommended that we consult with you directly regarding your knowledge of the presence of cultural resources that may be impacted by this project.

If you have knowledge of any cultural resources that may exist within or near the project area, please contact Steven Treffers at (626) 240-0587, streffers@swca.com, at your earliest convenience.

Thank you for your attention to this matter.

Best regards,

Christophe Descantes
Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Pacific Gas and Electric Company

Christophe Descantes, PhD
Sr. Cultural Resources Specialist
Land & Environmental Management

Mailing Address
245 Market Street — N10A
San Francisco, CA 94105
Tel: (415) 973.1177
Mobile: (925) 719.2740
Email: chd8@PGE.com

August 31, 2012

Yocha Dehe Wintun Nation
Reno Franklin, Cultural Resources Director
P.O. Box 18
Brooks, CA 95606

RE: Cultural Resources Survey for the PG&E CAES – Cache Slough Project in Solano County, California

Dear Mr. Franklin:

Pacific Gas and Electric (PG&E) is conducting a cultural resources study for the PG&E CAES – Cache Slough Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

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August 31, 2012

Yocha Dehe Wintun Nation
Leland Kinter, Native Cultural Renewal Committee
P.O. Box 18
Brooks, CA 95606

RE: Cultural Resources Survey for the PG&E CAES – Cache Slough Project in Solano County, California

Dear Mr. Kinter:

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August 31, 2012

Yocha Dehe Wintun Nation
Marshall McKay, Chairperson
P.O. Box 18
Brooks, CA 95606

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Dear Mr. McKay:

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August 31, 2012

Cotina Wintun Environmental Protection Agency
P.O. Box 1630
Williams, CA 95987

RE: Cultural Resources Survey for the PG&E CAES – Cache Slough Project in Solano County, California

To Whom It May Concern:

Pacific Gas and Electric (PG&E) is conducting a cultural resources study for the PG&E CAES – Cache Slough Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

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August 10, 2012

Cotina Band of Indians
Charlie Wright, Chairperson
P.O. Box 1630
Williams, CA 95987

RE: Cultural Resources Survey for the PG&E CAES – Cache Slough Project in Solano County, California

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Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Pacific Gas and Electric Company

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Sr. Cultural Resources Specialist
Land & Environmental Management

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245 Market Street — N10A
San Francisco, CA 94105
Tel: (415) 973.1177
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Email: chd8@PGE.com

October 11, 2012

Yocha Dehe Wintun Nation
Cynthia Clarke, Native Cultural Renewal Committee
P.O. Box 18
Brooks, CA 95606

RE: Updated Cultural Resources Survey for the PG&E CAES – Cache Slough Project in Solano County, California

Dear Ms. Clarke:

Pacific Gas and Electric (PG&E) is conducting additional cultural resources studies for the PG&E CAES – Cache Slough Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

The project area is located in unincorporated Cache Slough County near the City of Rio Vista and falls within the USGS 7.5-minute Rio Vista quadrangle map (see enclosed project location map). The proposed project would use renewable energy from sources such as wind to inject compressed air into an underground reservoir. PG&E recently conducted a cultural resources study of the Cache Slough reservoir site in September 2012, which consisted of an approximately 1 acre well pad site that would support a drilling rig. Two additional well pad sites, which are both located within several hundred meters of the originally surveyed well pad, are now being considered for the purpose of core drilling tests to determine if either site is a viable candidate for the CAES project.

As part of the process of identifying cultural resources issues for this project, SWCA previously contacted the Native American Heritage Commission (NAHC) and requested a Sacred Lands File (SLF) search and a list of Native American individuals and/or tribal organizations that may have knowledge of cultural resources in or near the project area. The NAHC SLF search did not identify any Native American cultural resources within a one-half mile radius of the proposed project area. The NAHC recommended that we consult with you directly regarding your knowledge of the presence of cultural resources that may be impacted by this project.

If you have knowledge of any cultural resources that may exist within or near the project area, please contact me at (415) 973-1177, CHD8@pge.com, at your earliest convenience.

Thank you for your attention to this matter.

Best regards,

Christophe Descantes
Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Pacific Gas and Electric Company

Christophe Descantes, PhD
Sr. Cultural Resources Specialist
Land & Environmental Management

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October 11, 2012

Kesner Flores
P.O. Box 1047
Wheatland, CA 95692

RE: Updated Cultural Resources Survey for the PG&E CAES – Cache Slough Project in Solano County, California

Dear Mr. Flores:

Pacific Gas and Electric (PG&E) is conducting additional cultural resources studies for the PG&E CAES – Cache Slough Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

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Sr. Cultural Resources Specialist
Enclosure: Project Location Map

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Land & Environmental Management

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Mobile: (925) 719.2740
Email: chd8@PGE.com

October 11, 2012

Yocha Dehe Wintun Nation
Reno Franklin, Cultural Resources Director
P.O. Box 18
Brooks, CA 95606

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Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Pacific Gas and Electric Company

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Sr. Cultural Resources Specialist
Land & Environmental Management

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October 11, 2012

Yocha Dehe Wintun Nation
Leland Kinter, Native Cultural Renewal Committee
P.O. Box 18
Brooks, CA 95606

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Dear Mr. Kinter:

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October 11, 2012

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P.O. Box 18
Brooks, CA 95606

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October 11, 2012

Cotina Wintun Environmental Protection Agency
P.O. Box 1630
Williams, CA 95987

RE: Updated Cultural Resources Survey for the PG&E CAES – Cache Slough Project in Solano County, California

To Whom It May Concern:

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Email: chd8@PGE.com

October 11, 2012

Cotina Band of Indians
Charlie Wright, Chairperson
P.O. Box 1630
Williams, CA 95987

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Best regards,

Christophe Descantes
Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Appendix C

California Department of Parks and Recreation Series 523 Forms

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary #
HRI #
Trinomial
NRHP Status Code 6Z

Other Listings
Review Code | Reviewer | Date

 *Resource Name or #: SWCA-CACHE-1

P1. Other Identifier:

***P2. Location:** ☐ **Not for Publication** ☐ **Unrestricted** ***a. County:** Solano

and (P2b and P2c or P2d. Attach a Location Map as necessary.)

***b. USGS 7.5' Quad:** Rio Vista **Date:** 2012 **T** 4 N; **R** 2 E ; **¼ of** **¼ of Sec** ; M.D. **B.M.**

c. Address: City: Zip:

d. UTM: Zone: 10 ; mE/ mN (G.P.S.)

e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate) Elevation:

APN #0177-03-0004

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

Gradually developed circa 1936 and 1953, the subject property consists of three canal segments, which are part of a larger, interconnected irrigation system that diverts water from the Lindsey Slough and the Sacramento River to the surrounding agricultural fields. The open, earthen canal varies from 40 to 60 feet in width, and appears to be regularly dredged to remove build up. One of the canal segments, which was developed circa 1936 to 1946, runs for approximately 1240 feet along a northwest-southeast axis and directs water from Lindsey Slough to the north, to the Sacramento the south. Intersecting this segment, is a second canal segment, which runs along an approximate northeast-southwest axis for approximately 2,765 feet and directs water from the Sacramento River to the east into the agricultural fields to the west. This segment was partially in place by 1946, and later completed by 1953. A dirt road passes over the intersection of the canal segments, which are connected via underground pipes that feature small, hand-operated canal gates. To the southwest, a third, small L-shaped segment that was developed by 1953 is approximately 2640 feet in total length and is similarly connected to the greater irrigation system via underground pipes. All three segments are situated on a level landscape and are surrounded by agricultural fields located within the Sacramento-San Joaquin Delta in unincorporated Solano County, approximately 4 miles northeast of the City of Rio Vista. They continue to function as irrigation ditches and retain integrity of location, design, setting, materials, workmanship, feeling and association. Due to the boundaries of the intensive-level survey that was undertaken of the current study, the extent of the entire irrigation system was not documented.

***P3b. Resource Attributes:** (List attributes and codes) HP20. Canal/aqueduct

***P4. Resources Present:** ☐Building ☒Structure ☐Object ☐Site ☐District ☐Element of District ☐Other (Isolates, etc.)

P5a. Photo or Drawing (Photo required for buildings, structures, and objects.)



P5b. Description of Photo: (View, date, accession #) View of the southern segment, view to the south, August 29, 2012, DSCN0385.jpg

***P6. Date Constructed/Age and Sources:** ☒Historic ☐Prehistoric ☐Both

Circa 1936-1953 (Thomas Bros 1946; USGS 1936; USGS 1953)

***P7. Owner and Address:**

Unknown

***P8. Recorded by:** (Name, affiliation, and address)

Steven Treffers
SWCA Environmental Consultants
150 S. Arroyo Parkway, 2nd Floor
Pasadena, CA 91105

***P9. Date Recorded:** October 9, 2012

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") Cultural Resource Survey for the PG&E CAES – Cache Slough Project, Solano County, California

***Attachments:** ☐NONE ☒Location Map ☐Sketch Map ☐Continuation Sheet ☒Building, Structure, and Object Record ☐Archaeological Record ☐District Record ☒Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ☐ Other (List):

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

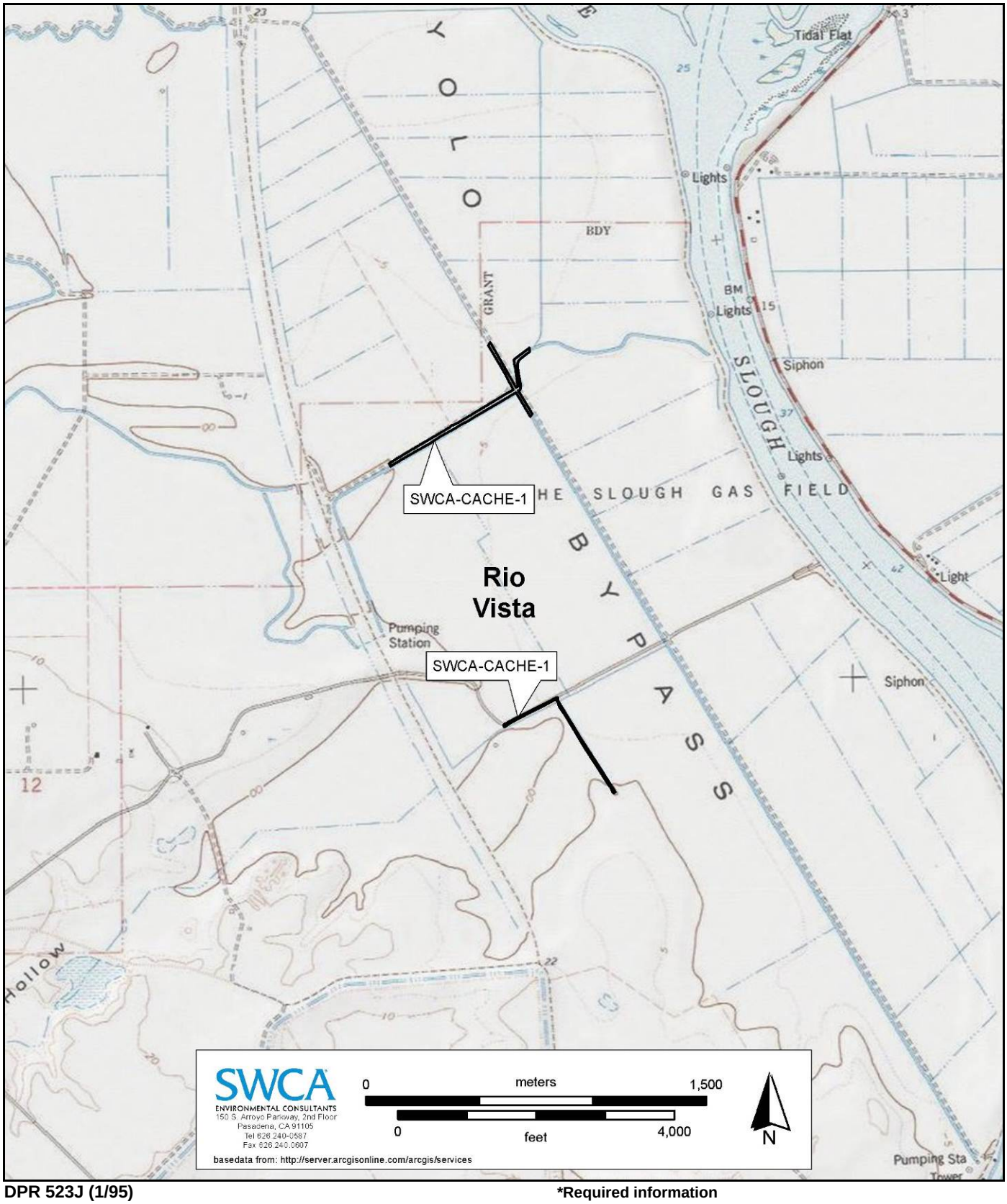
LOCATION MAP

Primary #
HRI#
Trinomial

***Resource Name or #:** SWCA-CACHE-1

***Map Name:** Rio Vista

***Scale:** 1:24,000 ***Date of Map:** 2012



***Required information**

LINEAR FEATURE RECORD

 Resource Name or #: (Assigned by recorder) SWCA-CACHE-1

L1. Historic and/or Common Name: N/A

L2a. Portion Described: ☐ Entire Resource ☒ Segment ☐ Point Observation **Designation:**

b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map)

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.) SWCA-CACHE-1 consists of three segments of a larger irrigation system that diverts water from a main canal running between Lindsey Slough to the Sacramento River to the south. The two open earthen canal systems were constructed circa 1936-1953 and vary in width and length. Both segments are connected to the larger irrigation system via underground pipes and are bounded by unpaved access roads. No associated features or artifacts were identified within the boundaries of the intensive-level survey that was undertaken during the current study.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width:

b. Bottom Width: Unknown

c. Height or Depth: Unknown

d. Length of Segment:

L5. Associated Resources:

L4e. Sketch of Cross-Section (include scale) **Facing:**

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.) Located within the Sacramento-San Joaquin Delta in unincorporated Solano County, the three segments are situated on a level landscape and surrounded by agricultural fields.

L7. Integrity Considerations: The segments continue to function as irrigation ditches and retain integrity of location, design, setting, materials, workmanship, feeling and association.

L8a. Photograph, Map or Drawing



L8b. Description of Photo, Map, or Drawing (View, scale, etc.) A section of the northeast-southwest segment, view to the northeast.

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)

Steven Treffers
SWCA Environmental Consultants
150 S. Arroyo Parkway, 2nd Floor
Pasadena, CA 9110

L11. Date: October 9, 2012

BUILDING, STRUCTURE, AND OBJECT RECORD

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) SWCA-CACHE-1

B1. Historic Name: N/A
B2. Common Name: N/A
B3. Original Use: Irrigation Ditch
B4. Present Use: Irrigation Ditch
***B5. Architectural Style:** N/A
***B6. Construction History:** (Construction date, alterations, and date of alterations)
Constructed between 1936 and 1953 (Thomas Bros 1946; USGS 1936; USGS 1953)
***B7. Moved?** ☒No ☐Yes ☐Unknown **Date:** **Original Location:**
***B8. Related Features:**
B9a. Architect: N/A
b. Builder: Unknown
***B10. Significance: Theme:** Irrigation
Area: Central Valley
Period of Significance: 1936-53
Property Type: Open Canal
Applicable Criteria: N/A
(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Gradually developed circa 1936 and 1953, the subject property consists of three segments of an irrigation ditch developed as part of a larger irrigation system to provide water to agricultural land located northeast of the City of Rio Vista. The open earthen canal is connected to a canal system that was developed earlier and connects Lindsey Slough to the Sacramento River within the Sacramento-San Joaquin River Delta.

Beginning in the early 1850s, European American settlers began the process of transforming the Delta tidal wetlands into islands of farmland surrounded by levees (Lund et al. 2007). Early Californians redirected the natural flow of water through the construction of levees, reclaiming the "swamped and overflowed lands" and constructing irrigation canals for agricultural purposes (JRP & California Department of Transportation 2000). Originally part of the Rancho Los Ulpinos, the area surrounding the subject property was typical of this development. This area was the initial location of the settlement of Rio Vista, then named "Brazos del Rio" (Arms of the River); however, following severe flooding in 1862, the town was washed away and moved to its current location approximately 5 miles to the southwest (Hoover et al. 2002). While wetlands in the surrounding Delta continued to be reclaimed throughout the late eighteenth century, an historic topographic map indicates little development occurred within the area surrounding the subject property as late as 1936 (USGS 1936). By 1946, the construction of a levee system helped to reclaim the area and the initial portion of the canal system that connects Lindsey Slough to the Sacramento was in place (Thomas Brothers 1946). The area continued to be developed over the following decade and by 1953, the larger irrigation system is in place, providing water to the surrounding agricultural land, as it continues to do today.

While irrigation systems are significant within the agricultural development of the Sacramento-San Joaquin River Delta, the subject property is not associated with the early development of irrigated farming in the region and as a result, it does not appear eligible for the National or California registers under Criteria A/1. In addition, archival research did not indicate the property is directly associated with persons significant to our past and it does not appear eligible for the National or California registers under Criteria B/2. The irrigation canal is perhaps the most common canal type in California, and the subject property does not possess any distinctive features to warrant consideration for architectural significance, therefore it does not does not appear eligible for the National or California registers under Criterion C/3. No evidence was discovered to warrant consideration under Criterion D/4.

B11. Additional Resource Attributes: (List attributes and codes)
***B12. References:**

JRP Historical Consulting and California Department of Transportation. *Water Conveyance Systems in California: Historical Context Development and Evaluation Procedures*. 2000.

Lund, Jay, Ellen Hanak, William Fleenor, Richard Howitt, Jeffrey Mount, and Peter Moyle. *Envisioning Futures for the Sacramento San Joaquin Delta*. Public Policy Institute of California, San Francisco, 2007.

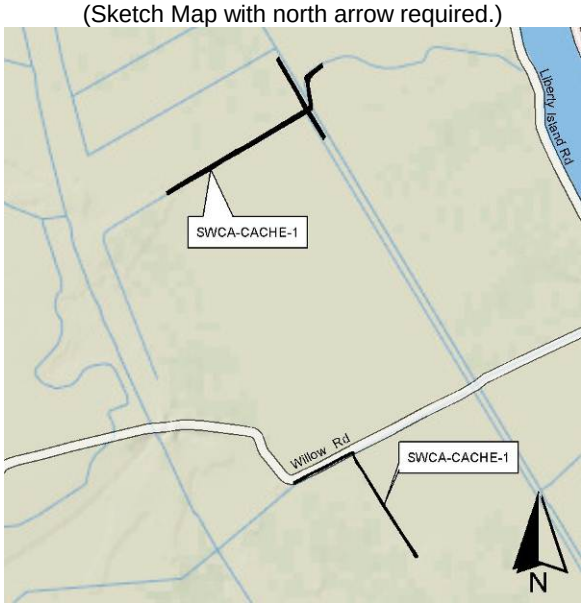
Thomas Brothers. *Map of Solano County, California*. 1946.

USGS. *Rio Vista, CA*, 7.5-minute Quadrangle, 1910, reprinted 1936.

USGS. *Rio Vista, CA*. 7.5-minute Quadrangle. 1953.

B13. Remarks:
***B14. Evaluator:** Steven Treffers
***Date of Evaluation:** September 13, 2012

(Sketch Map with north arrow required.)



(This space reserved for official comments.)

1/2/2012

GEOLOGY AND GAS PRODUCTION OF THE CACHE SLOUGH GAS FIELD, SOLANO COUNTY, CALIFORNIA

Douglas P. Imperato, Ph.D
Consulting Geologist
Santa Barbara, CA

EXECUTIVE SUMMARY

More than 12 BCF of natural gas have been produced from the Cache Slough gas field since field discovery in 1945. Nearly all of the field production is from the Upper Cretaceous Midland sand at an average depth of 4750 feet. Gas is entrapped in a northwest-striking faulted anticline. The Midland gas pool encompasses an area of more than 600 acres, and has a maximum drilled thickness is nearly 70 feet. Log-derived reservoir porosity averages 33 percent, with a water saturation of 35 percent. The reservoir exhibits a strong water-drive production mechanism, with relatively little pressure depletion of the reservoir.

INTRODUCTION

This report describes the subsurface stratigraphy, structure, rock properties, and gas production characteristics of the Cache Slough gas field in Solano County, California based on analysis of all of the available data from wells drilled in and around the field. The field is located in the southern Sacramento Valley, about 25 miles southwest of the City of Sacramento, and about 5 miles north of the City of Rio Vista and Highway 12 (Attachment 1). The study area includes approximately six square miles centered on Section 6 of Township 4 North, Range 3 East (Attachment 2). The ground surface in the study area is approximately at sea level, and most of the area is actively farmed. Cache Slough is located east and north of the field (Attachment 2). The field is located in a prolific part of the Sacramento Valley. The Lindsey Slough and Rio Vista gas fields border the Cache Slough field to the west and south, respectively, and the Liberty Island field is located approximately one mile to the north (Attachment 1).

History of Development

The Cache Slough gas field was discovered by Standard Oil Company in the California Packing Company (CALPAC) Number 2 well in March, 1945. The well flowed at a rate as high as 14,867 mcf per day with casing and tubing pressures of 1814 and 1826, respectively, through a 5/8 inch choke, and was completed in the upper Cretaceous Midland sand with perforations at depths of 4765 to 4790 feet. This discovery was quickly followed by three additional gas wells drilled in 1945, one each by Amerada Hess and Peter Cook, Jr., and another by Standard Oil Company. Four additional wells were drilled in the field by Amerada and Standard between 1948 and 1960 (Attachment 3). Field production ceased in October, 1962, after seven gas wells had produced a combined total of 11,554, mmcf.

Field production was re-established between 1978 and 1980, with completion of the CALPAC 12 by Chevron. A proprietary 3-D seismic survey was acquired across the field in the early 1990's. A total of seven wells were drilled between 1990 and 1998, with only limited success. Tonka Energy and ABA Energy completed wells that produced relatively low volumes of gas from the Starkey and Domengine Formations, respectively. In 2004, Towne Exploration Company completed the Church 6-6 which produced until 2008. There is currently no production from the field, and all wells have been abandoned. The surface location of the APC Church 1-2 well, currently shut in, is within the boundaries of the Cache Slough field but the well is directionally drilled and was productive from the Lindsey Slough gas field.

METHODS

All available data from more than 30 exploration and development wells drilled in and around the Cache Slough gas field were analyzed for this investigation (Attachment 3). Well records from the archives of the California Division of Oil, Gas and Geothermal Resources (CDOGGR) were reviewed, and a digital well database was compiled that includes API number, operator, well name, number, status, total depth, elevation, spud date, location, latitude, longitude, and survey data for directional wells. Latitude and longitude are referenced to the 1927 North

America datum. Raster well-log images were obtained from the CDOGGR archives and from commercial sources.

A summary of the history of each gas wells was prepared from the archive CDOGGR well records and is included herein in Appendix I, along with well logs for each gas well, annotated with stratigraphic and production information. Monthly gas production, water production, and pressure data from the CDOGGR archives were compiled in spreadsheet format and production-decline curves were plotted for each gas well. These are also included in Appendix I. Well completion and production information, including spud date, abandonment date, perforated intervals, initial production rate, initial shut-in pressure, and cumulative production, is summarized in Attachment 4. All digital well and production data were input into Landmark Geographix software for data manipulation, cross-section preparation, and mapping.

A series of cross sections were constructed with logs annotated with production data, and all producing intervals and pertinent stratigraphic horizons were identified and correlated in all wells. Gas zone thickness was calculated from spontaneous potential logs using a net-sandstone cutoff of 10 millivolts from the shale baseline. Reservoir rock property data were compiled from well histories and CDOG publications. Stratigraphic information from the wells was incorporated in the preparation of structure and isochore maps of the gas pools.

REGIONAL GEOLOGY

The deepest well in the field drilled east of the Midland fault is the Chevron Peter Cook 12 well in Section 6, Township 4N, Range 3E, drilled in 1960 to a total depth of 7,730 feet. The stratigraphic sequence penetrated in this well includes the age and approximate thicknesses of strata as follows:

Non-marine Undifferentiated	Recent-Miocene	3000 feet
Markley Canyon Fill	Miocene-Oligocene	1000 feet
Domengine Formation	Eocene	300 feet
Capay Formation	Eocene	500 feet

Mokelumne River Formation	Upper Cretaceous	1700 feet
H&T Shale	Upper Cretaceous	300 feet
Starkey Formation	Upper Cretaceous	800 feet

Major regional unconformities are present at the base of the undifferentiated non-marine strata, Markley Canyon fill, and Capay Formation. The Markley is one of three Tertiary submarine canyons, or gorges, that have eroded into underlying Upper Cretaceous strata in this area. The base of freshwater in the Cache Slough area is at approximately 2000 to 2300 feet in the Miocene to Recent undifferentiated non- marine strata.

The Cache Slough gas field is on the eastern margin of the Sacramento basin, east of, and adjacent to the Midland fault system (Attachment 5). This fault system represents a. major structural and stratigraphic boundary between more gently southwestward-dipping, relatively undeformed strata to the east, with complexly faulted, steeply southwest-dipping strata to the west. As a result of the complex deformation history of this fault, the stratigraphic sequence west of the fault is very different from the Cache Slough area east of the fault, and includes a much thicker sequence of Paleogene strata. The Thornton arch, a prominent west-striking anticline, is located approximately 10 miles east of Cache Slough (Attachment 5).

RESERVOIR STRATIGRAPHY

The Midland sand is the upper-most Mokelumne River Formation interval in the Cache Slough area, and is the primary reservoir in the gas field (Attachments 6 and 7). Production from eight wells completed in this sand accounts for more than 95 percent of the total field production. A relatively minor amount of gas has been produced from four wells completed in lower Mokelumne River, Starkey, and Domengine Formations (Attachment 4).

The Mokelumne River Formation represents deposition in a fluvial-deltaic environment and consists primarily of sandstone, inter-bedded with relatively thin shale and lignite layers. The thicker sandstones, including the Midland, were deposited as river-channel or delta-front

deposits, with thinner sandstone, shale and lignite beds representing inter-channel marsh and swamp deposits. The Midland sand locally includes relatively thin shale interbeds.

The Midland sand is approximately 500 feet thick and overlies a more shale-rich Mokelumne River Formation interval. The MR1 horizon, delineated herein as part of this study, represents the approximate base of the Midland sand (Attachments 6 and 7). The Midland is overlain unconformably by the Eocene Capay Formation, a 300-400 foot thick shale interval. The average depth of the Midland sand is approximately 4750 feet (Attachments 6 and 7). .

RESERVOIR ROCK PROPERTIES

Upper Cretaceous sandstones in the Sacramento basin are composed of quartzo-feldspathic detritus derived from the Sierran magmatic arc system to the east and northeast. Framework mineralogy is dominated by volcaniclastic and plutoniclastic grains, principally monocrystalline quartz, plagioclase and K-feldspar, biotite, and volcanic lithic fragments (Mertz, 1990), the Rumsey petrofacies of Ingersoll (1983).

The Midland sand is described in cores from the Amerada Church 2 well as a gray, fine to medium- grained micaceous sandstone. The upper-most two feet of the sand is described as “tight and shaley, cemented”, whereas the cored interval below is “friable”.

In the Cache Slough gas field, log-derived porosity for the Midland sand averages 33 percent, with a water saturation of 35 percent and gas saturation of 65 percent. Permeability measurements for the Midland sand in the Cache Slough gas field are not available. Reported Mokelumne River Formation sandstone permeability in the southern Sacramento basin is variable, ranging from 1500 millidarcies at the McDonald Island gas field, located approximately 15 miles southeast of Cache Slough, to 250 millidarcies at the Bunker gas field, approximately eight to ten miles northwest of Cache Slough (California Division of Oil and Gas, 1998). The relatively high initial production rates and nature of the production drive mechanism of Cache Slough gas wells (see below) suggest relatively high permeability of the Midland reservoir in the Cache Slough field.

STRUCTURE

The structure of the Cache Slough gas field is dominated by a faulted, elongate anticline that creates the trap for gas accumulation in the Midland sand (Attachment 8). The original gas-water contact of the Midland sand gas pool was at an elevation of approximately -4805 feet below sea level, and the highest Midland sand penetration in the field in the Peter Cook 8 well is at an elevation nearly 100 feet higher than this (Attachment 8).

The Cache Slough anticline strikes northwest, parallel to the Midland fault which forms the trap along the southwest flank of the anticline. The Midland sand is approximately 1000 feet lower on the southwest side of the Midland fault relative to the Cache Slough field (Attachment 8).

The Cache Slough fault, which forms the trap along the northwest flank of the anticline, has 150-350 feet of vertical separation at the top of the Midland sand. The Church 1-2 well encountered approximately 60 gross feet of gas in the Midland sand on the west (down) side of the Cache Slough fault. The elevation of the gas-water contact in this well is nearly 200 feet lower than in the Cache Slough field.

Well data clearly demonstrate the northeast dip that forms the closure along the northeast flank of the anticline. There are no wells to delineate the southeast flank of the anticline, however, so the magnitude of the dip in this area is assumed to be consistent with the northeastern flank of the anticline (Attachment 8).

GAS PRODUCTION

CDOGGR production records indicate that a total of 12,052 mmcf have been produced from the eight gas wells completed in the Midland sand, and 553 mmcf from the four wells completed in other intervals (Attachments 4 and Appendix I).. Field production began in 1945 and continued intermittently until 2008, with sustained production rates as high as more than 5,000 mcf per day. The initial reservoir pressure was approximately 2120 psi or approximately 1910 psi at the surface.

Wells were likely produced at or near their maximum capacity due to the apparent competitive nature of the initial field development between Standard Oil (Chevron) with the CALPAC lease and Amerada Hess with the Church lease. It appears that field production was limited, however, by a seasonal market. Through the late 1940's and 1950's, wells were produced only during winter months, generally November through April.

A total of 13 wells have penetrated the Midland gas pool in the Cache Slough field since its discovery in 1945. These wells help delineate the horizontal and vertical extent of the gas pool and document the rise in elevation of the gas-water contact through time.

In the 1940's, of the initial five wells completed in the Midland sand, two penetrated the gas-water contact at approximately -4805 feet subsea. The Peter Cook 8 well encountered the top of the Midland sand at the highest elevation in the field, but only produced through March, 1952. The relatively limited production from this well relative to its structural position likely resulted from the relatively low elevation of the perforations. More than 60 feet of the Midland sand was perforated, which led to early incursion of the water table and premature abandonment of the well. If the perforations in this well were limited to the upper few feet of the Midland sand, as in most of the other wells, it is likely that this well would have produced significantly longer and a larger volume of gas.

In 1978, the CALPAC 12 well encountered about 20 feet of gas with the gas-water contact at about -4760. Three wells drilled in the 1990's encountered the top of the Midland sand above the original gas-water contact, but below the elevation of the water table at that time. The original gas-water contact could be observed in these wells however, as an anomalously slow interval on the sonic-log curve. In 2004, the Towne Church 6-6 well encountered about 25 feet gross thickness of gas with the gas-water contact at -4750.

Production records indicate that the Midland gas pool has a strong water-drive reservoir production mechanism, which is typical of porous sandstones that have an efficient hydraulic connection to the water table. Gas wells typically exhibited very little pressure drop during

production, prior to incursion of saltwater into the wellbore from the rising water table. Reservoir pressure dropped very little during the history of field production, despite the relatively large volume of gas that was produced. The Towne Church 6-6 well, for example, was completed nearly 50 years after field discovery and after total field production of nearly 12 BCF, yet had a shut in pressure of 1715 psi, only about 10% lower than the original reservoir pressure.

RESERVOIR VOLUMETRICS

The Midland gas pool in the Cache Slough gas field has a maximum drilled net thickness of nearly 70 feet and encompasses an area of approximately 600 acres (Attachment 9). The Peter Cook 8 well appears to have penetrated the gas pool at, or near, the crest of the structure and maximum gas pool thickness. The reservoir volume calculated from net gas isochores is estimated at approximately 21,400 acre-feet. With a total production of 12,052 mmcf, the initial gas content, or "richness" of the reservoir is estimated at approximately 567 mcf/acre-ft. This value is significantly lower than the value of 1400 mcf/ac-ft reported by California Division of Oil and Gas (1998), but is consistent with richness values calculated in other fields in the southern Sacramento basin.

LIMITATIONS

This report is based on an evaluation of all publically available data from the wells drilled in and around the Cache Slough gas field. No seismic-reflection or other geophysical data were incorporated into the analysis. Integration of additional data into the analysis could alter the results and conclusions presented herein.

REFERENCES

California Division of Oil and Gas, 1998, California Oil and Gas Fields, Central California: California Division of Oil and Gas v 1, TR10, unpaginated.

Ingersoll, R. V., 1983, Petrofacies and provenance of late Mesozoic farearc basin, northern and central California: American Association of Petroleum Geologists Bulletin, V. 67, p. 1125-1142.

Mertz, K. A., 1990, Summary of the diagenetic history of the Upper Cretaceous Forbes, Starkey, and Winters Formations, Sacramento Basin, California, in Ingersoll, R. V. and T. H. Nilsen, eds., 1990, Sacramento Valley Symposium and Guidebook: Pacific Section S.E.P.M., Vol. 65, p. 53-67.

ATTACHMENTS

1. Regional map of the Sacramento Valley showing regional geography, oil and gas fields and the location of the Cache Slough gas field.

2. Topographic map of the Cache Slough gas field and vicinity showing wells, cumulative gas production, and outline of Midland sand gas pool.

3. Project well list, including status, total depth, elevation, spud date, and location. Latitude and longitude are in NAD 1927 coordinates.

4. Production summary showing initial production rate, shut in pressure, formation, gas production, and water production for each productive interval in each gas well.

5. Structure-contour map on top of the third Mokelumne River Formation sand showing regional structure of the Cache Slough gas field area.

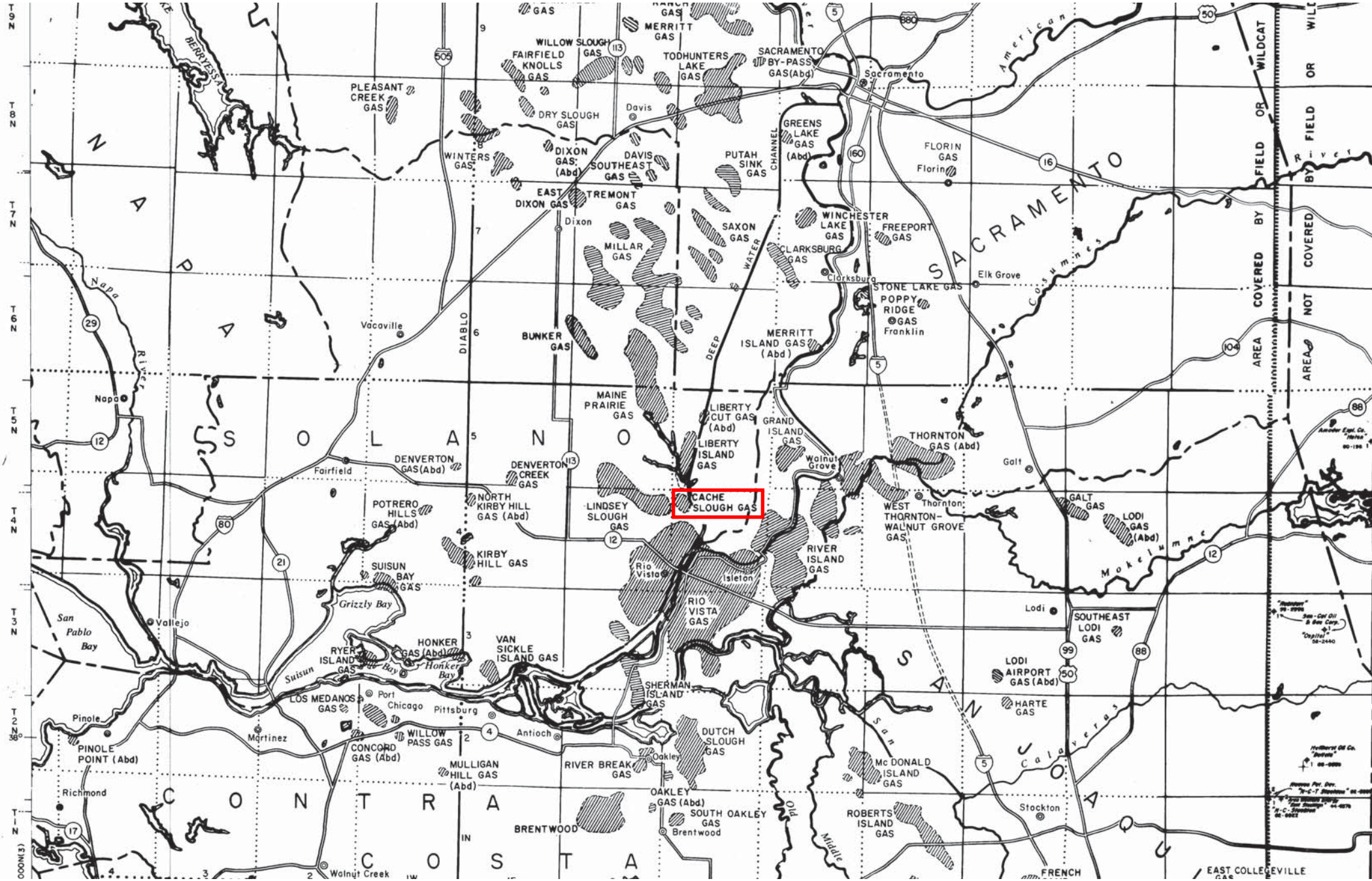
6. Structural cross section CS1 showing the stratigraphy, structure, and Midland sand gas pool of the Cache Slough gas field.

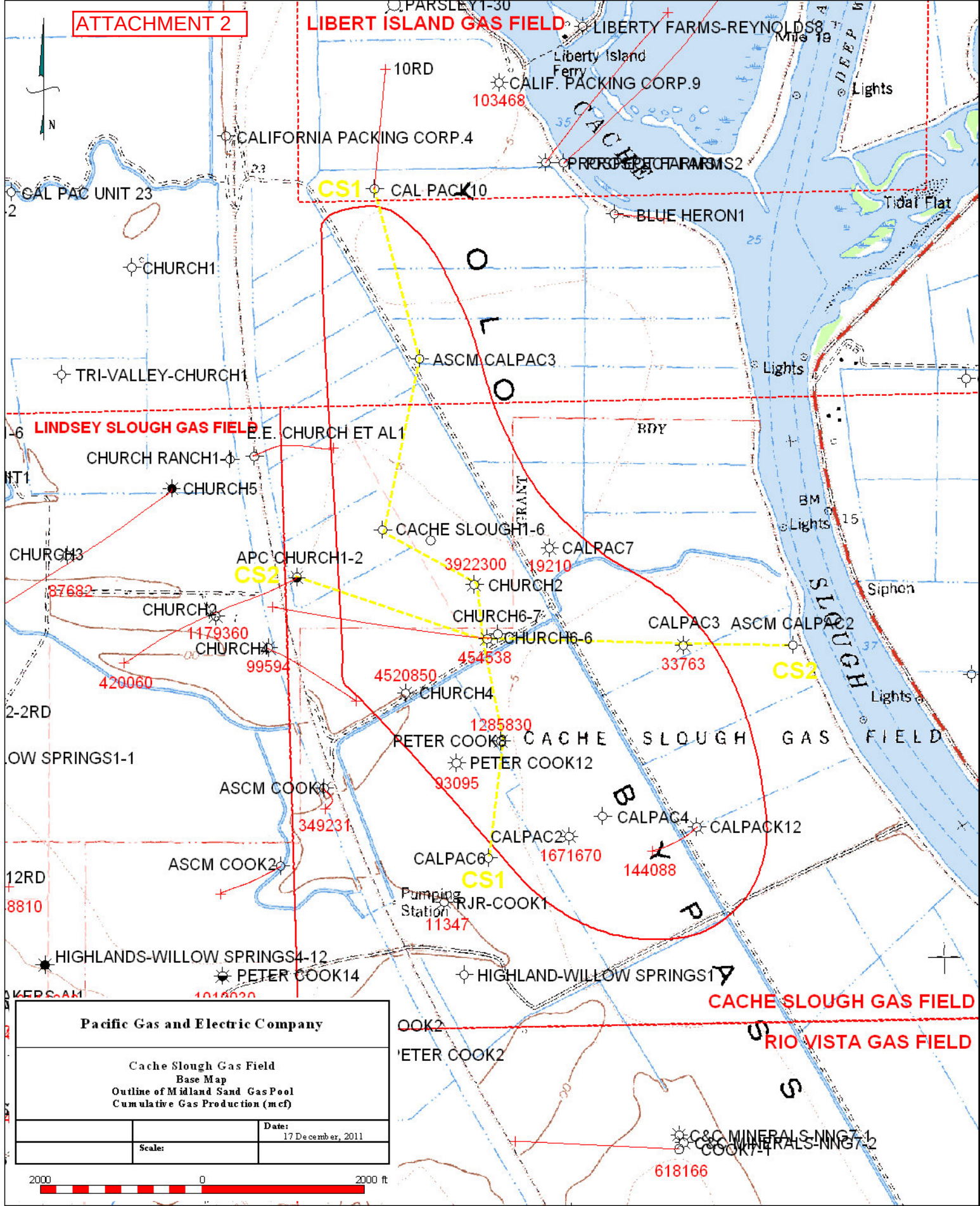
7. Structural cross section CS2 showing the stratigraphy, structure, and Midland sand gas pool of the Cache Slough gas field.

8. Structure-contour map on top of the Midland sand.

9. Net gas isochore map of the Midland sand gas pool.

ATTACHMENT 1




ATTACHMENT 2
LIBERT ISLAND GAS FIELD
PARSLEY1-30
LIBERTY FARMS-REYNOLDS8
Liberty Island Ferry
Mile 19
Lights
10RD
CALIF. PACKING CORP.9
103468
CALIFORNIA PACKING CORP.4
CACHE SLOUGH
DEEP WATER SHIP CHANNEL
CAL PAC UNIT 23
CS1
CAL PACK10
Tidal Flat
BLUE HERON1
CHURCH1
OLD RIVER
ASCM CALPAC3
TRI-VALLEY-CHURCH1
Lights
LINDSEY SLOUGH GAS FIELD
E.E. CHURCH ET AL1
BDY
CHURCH RANCH1-1
CHURCH5
GRANT
BM
Lights
15
CACHE SLOUGH1-6
CALPAC7
CHURCH3
APC CHURCH1-2
3922300
19210
CS2
87682
CHURCH2
Siphon
CHURCH6-7
CALPAC3
ASCM CALPAC2
1179360
CHURCH6-6
CHURCH4
99594
454538
33763
CS2
420060
4520850
CHURCH4
Lights
2-2RD
1285830
PETER COOK8
CACHE SLOUGH GAS FIELD
PETER COOK12
LOW SPRINGS1-1
93095
ASCM COOK1
CALPAC4
CALPACK12
349231
CALPAC2
1671670
144088
ASCM COOK2
CALPAC6
CS1
12RD
Pumping Station
RJR-COOK1
8810
11347
HIGHLANDS-WILLOW SPRINGS4-12
PETER COOK14
HIGHLAND-WILLOW SPRINGS1
CACHE SLOUGH GAS FIELD
OOK2
RIO VISTA GAS FIELD
ETER COOK2
C&C MINERALS-NNG7-1
C&C MINERALS-NNG7-2
COOK7-1
618166
Pacific Gas and Electric Company
Cache Slough Gas Field
Base Map
Outline of Midland Sand Gas Pool
Cumulative Gas Production (mcf)
Date:
17 December, 2011
Scale:
2000
0
2000 ft

ATTACHMENT 3

CACHE SLOUGH GAS FIELD
PROJECT WELLS

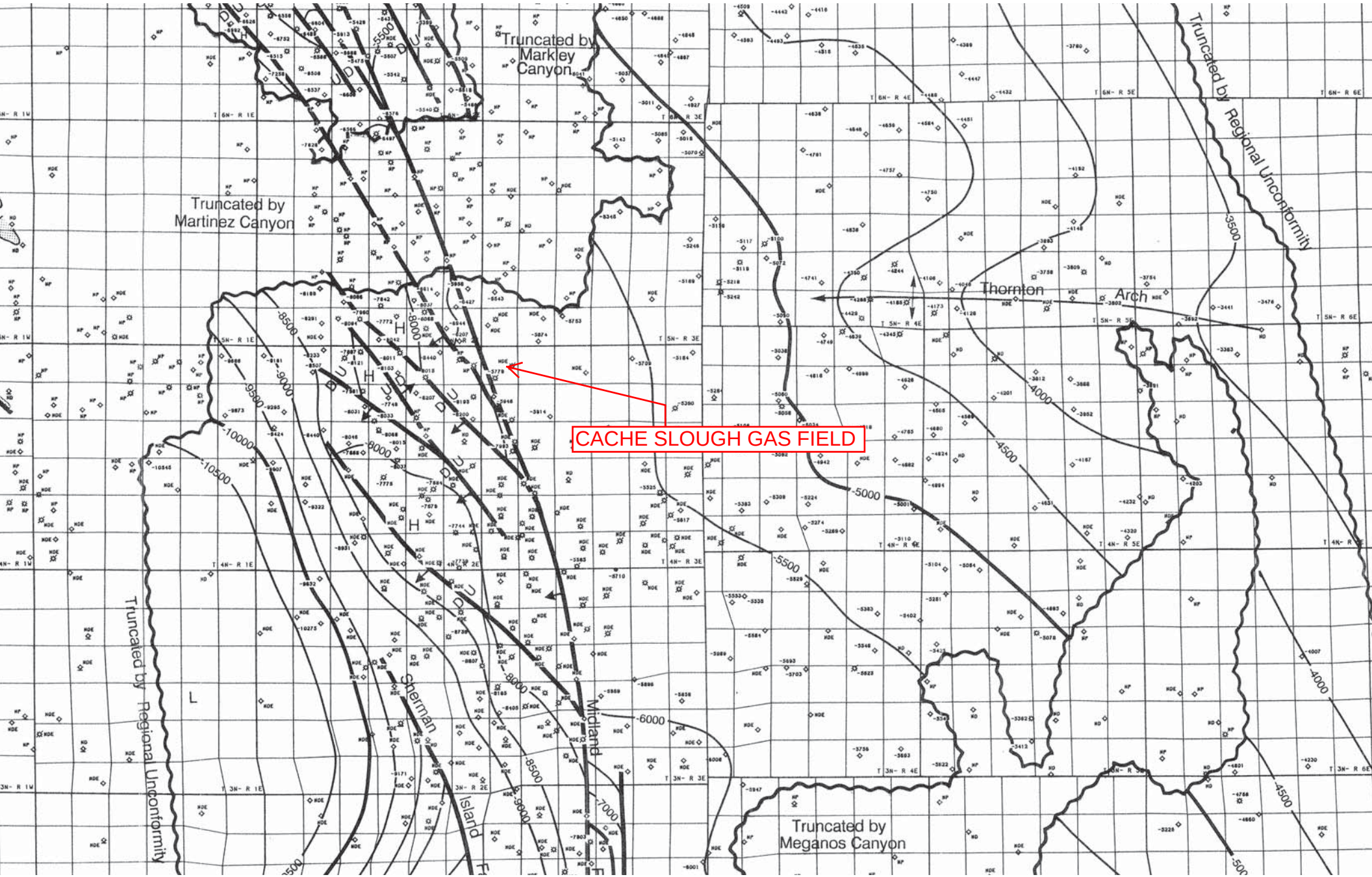
API NO.	OPERATOR	WELL NAME	NO.	LAT.	LONG.	SPUD	STATUS	TD	ELEV		FIELD
04095000360000	PETER COOK, JR.	PETER COOK	2	38.20506	-121.6909	11/6/1942	P&A	4791	10	GR	RIO VISTA GAS
04095000410000	CHEVRON U.S.A. INC.	CALPAC	2	38.2124	-121.68262	1/14/1945	AGS	4840	7	DF	CACHE SLOUGH
04095000330000	AMERADA HESS CORP.	CHURCH	2	38.22094	-121.68666	5/5/1945	AGS	4796	11	KB	CACHE SLOUGH
04095000370000	PETER COOK, JR.	PETER COOK	8	38.21563	-121.68553	7/11/1945	AGS	4790	10	GR	CACHE SLOUGH
04095000420000	CHEVRON U.S.A. INC.	CALPAC	3	38.21886	-121.6777	7/29/1945	AGS	5653	4	DF	CACHE SLOUGH
04095000350000	AMERADA HESS CORP.	CHURCH	4	38.21727	-121.68961	3/7/1948	AGS	4787	9	KB	CACHE SLOUGH
04095000430000	CHEVRON U.S.A. INC.	CALPAC	6	38.21169	-121.68609	12/1/1950	P&A	5700	6	DF	CACHE SLOUGH
04095000440000	CHEVRON U.S.A. INC.	CALPAC	7	38.22217	-121.68343	12/12/1951	AGS	4842	10	DF	CACHE SLOUGH
04095000400000	CHEVRON U.S.A. INC.	PETER COOK	12	38.2149	-121.68744	6/25/1960	AGS	7730	11	KB	CACHE SLOUGH
04095001160000	CHEVRON U.S.A. INC.	CAL PACK	10	38.23434	-121.69088	4/13/1962	P&A	5000	7	KB	LIBERTY ISLAND
04095001160001			10RD	38.23434	-121.69088	4/21/1962	P&A	5318	7	KB	
04095000380000	C & C CO-OWNERS IN C	PETER COOK	14	38.20772	-121.69748	8/8/1963	SHUTIN	15000	22	DF	LINDSEY SLOUGH
04095000390000	OCCIDENTAL PETROLEUM	E.E. CHURCH ET AL	1	38.2253	-121.69607	5/11/1966	P&A	8831	10	KB	CACHE SLOUGH-N
04095200870000	PHILLIPS PETROLEUM C	CHURCH	2	38.21989	-121.69774	5/6/1969	AGS	9828	13	KB	LINDSEY SLOUGH
04095200980000	PHILLIPS PETROLEUM C	CHURCH	3	38.22197	-121.70409	7/27/1969	AGS	9411	12	KB	LINDSEY SLOUGH
04095201020000	PHILLIPS PETROLEUM C	CHURCH	4	38.21882	-121.69549	9/16/1969	AGS	9725	14	KB	LINDSEY SLOUGH
04095202880000	TRI-VALLEY OIL & GAS	CHURCH	1	38.23171	-121.7013	9/18/1975	P&A	9550	12	KB	LINDSEY SLOUGH
04095203730000	CHEVRON U.S.A. INC.	CALPACK	12	38.21271	-121.67715	6/22/1978	AGS	5600	12	KB	CACHE SLOUGH
04095204650000	JIM GRAHAM	CHURCH	5	38.224222	-121.699601	7/15/1981	GAS	10583	27	KB	LINDSEY SLOUGH
04095205000000	HIGHLANDS ENERGY COR	COOK	2	38.20606	-121.6912	1/31/1982	P&A	7615	20	KB	RIO VISTA
04095205710000	UMC PETROLEUM CORP.	HIGHLAND-WILLOW SPRINGS	1	38.20774	-121.68715	10/3/1982	P&A	8787	14	KB	LINDSEY SLOUGH
04095206100000	ATLANTIC OIL CO.	TRI-VALLEY-CHURCH	1	38.2281	-121.70432	6/15/1983	P&A	9637	23	KB	LINDSEY SLOUGH
04095208690000	NAHAMA & WEAGANT ENE	CHURCH RANCH	1-1	38.2252	-121.69711	12/15/1989	P&A	9446	16	KB	LINDSEY SOUGH
04095208820000	NAHAMA & WEAGANT ENE	CACHE SLOUGH	1-6	38.2228	-121.69058	8/15/1990	P&A	5520	9	KB	CACHE SLOUGH
04095209790000	TONKA ENERGY, INC.	ASCM COOK	1	38.21406	-121.69312	3/30/1994	AGS	9811	15	KB	CACHE SLOUGH
04095209800000	ANACAPA OIL CORP.	ASCM CALPAC	2	38.21885	-121.673	4/21/1994	P&A	9888	13	KB	CACHE SLOUGH
04095209830000	ANACAPA OIL CORP.	ASCM COOK	2	38.21143	-121.69499	7/15/1994	P&A	9812	16	KB	CACHE SLOUGH
04095209860000	ANACAPA OIL CORP.	ASCM CALPAC	3	38.22859	-121.68897	9/2/1994	P&A	6907	15	KB	CACHE SLOUGH
04095209900000	ANACAPA OIL CORP.	CALPAC	4	38.21308	-121.6812	4/26/1995	P&A	5600	7	KB	CACHE SLOUGH
04095210500000	ABA ENERGY CORP.	RJR-COOK	1	38.21019	-121.68798	8/21/1998	AGS	7774	14	KB	CACHE SLOUGH
04095212080000	TOWNE	CHURCH	6-6	38.219094	-121.686098	7/27/2004	AGS	8746	11	KB	CACHE SLOUGH
04095211990000	CASTLE MINERALS	BLUE HERON	1	38.23346	-121.68059	8/10/2004	P&A	5129	11	KB	LIBERTY ISLAND
04095212680000	TOWNE	CHURCH	6-7	38.219255	-121.685645	12/29/2006	P&A	6883	11	KB	CACHE SLOUGH
04095212880000	ARMSTRONG	APC CHURCH	1-2	38.221212	-121.694255	11/10/2007	SHUTIN	9251	9	KB	LINDSEY SLOUGH

ATTACHMENT 4

CACHE SLOUGH GAS FIELD
PRODUCTION SUMMARY

APINUM	OPERATOR	WELL NAME/NO.		SPUD DATE	ABD	PROD INT. (FT)	FM.	INITIAL PRODUCTION RATE	SHUT IN PRESS (PSI)	CUM GAS (MCF)	CUM H2O (BBLS)
04095000410000	CHEVRON U.S.A. INC.	CALPAC	2	1/14/1945	7/12/1952	4765-4790	Midland sand	2795 mcf/d, 1885/1881 psi, 1/4 in.	1876/1893 psi	1,671,668	314
04095000330000	AMERADA HESS CORP.	CHURCH	2	5/5/1945	7/25/1963	4760-4790	Midland sand	15,049 mcf/d, 1881/1811 psi, 3/8 in.	1910/1910 psi	3,922,297	31,774
04095000370000	PETER COOK, JR.	PETER COOK	8	7/11/1945	5/26/1966	4712-4777	Midland sand	2796 mcf/d, 1836/1863 psi, 1/4 in.	1903/1903 psi	1,285,831	2,312
04095000420000	CHEVRON U.S.A. INC.	CALPAC	3	7/29/1945	11/6/1952	4790-4795	Midland sand	2590 mcf/d, 1746/1748 psi, 1/4 in.	1879 psi	33,763	2,767
04095000350000	AMERADA HESS CORP.	CHURCH	4	3/7/1948	9/4/1963	4743-4786	Midland sand	5913 mcf/d, 1529/1796 psi, 3/8 in.	1801/1801 psi	4,520,850	1,579
04095000440000	CHEVRON U.S.A. INC.	CALPAC	7	12/12/1951	11/3/1952	4790-4796	Midland sand	2940 mcf/d, 1020 psi tbg, 3/8 in.		19,210	1,258
04095203730000	CHEVRON U.S.A. INC.	CALPACK	12	6/22/1978	11/21/1980	4812-4822	Midland sand	2437 mcf/d, 1536/1608 psi	1734/1734 psi	144,088	2,738
04095212080000	TOWNE	CHURCH	6-6	7/27/2004	12/4/2008	4834-4841	Midland sand	887 mcf/d, 1600/1725 psi, 10/64 in	1710/1715 psi	454,538	
								TOTAL		**12,052,245**	**42,742**
04095000400000	CHEVRON U.S.A. INC.	PETER COOK	12	6/25/1960	1/23/1962	5329-31,	Lower MRF	3850 mcf/d, 1811/1946 psi, 5/16 in.	1972/1970 psi	93,095	9,009
04095201020000	PHILLIPS PETROLEUM	CHURCH	4	9/16/1969	4/25/1973	5483-89, 5593-98, 5604-12, 5620-27	Lower MRF	1600 mcf/d, 1837 psi, 13/64 in.	2050 psi	99,594	163
04095209790000	TONKA ENERGY, INC.	ASCM COOK	1	3/30/1994	4/9/2002	6787-95, 6800-06, 6872-92,	Starkey Fm.	1510 mcf/d, 2110 psi	2500/2325 psi	349,231	
04095210500000	ABA ENERGY CORP.	RJR-COOK	1	8/21/1998	7/7/1999	4692-4701	Domengine Fm.	389 mcf/d, 480/480 psi, 12/64 in.		11,347	
								TOTAL		**553,267**	**9,172**
								FIELD TOTAL		**12,605,512**	**51,914**

ATTACHMENT 5



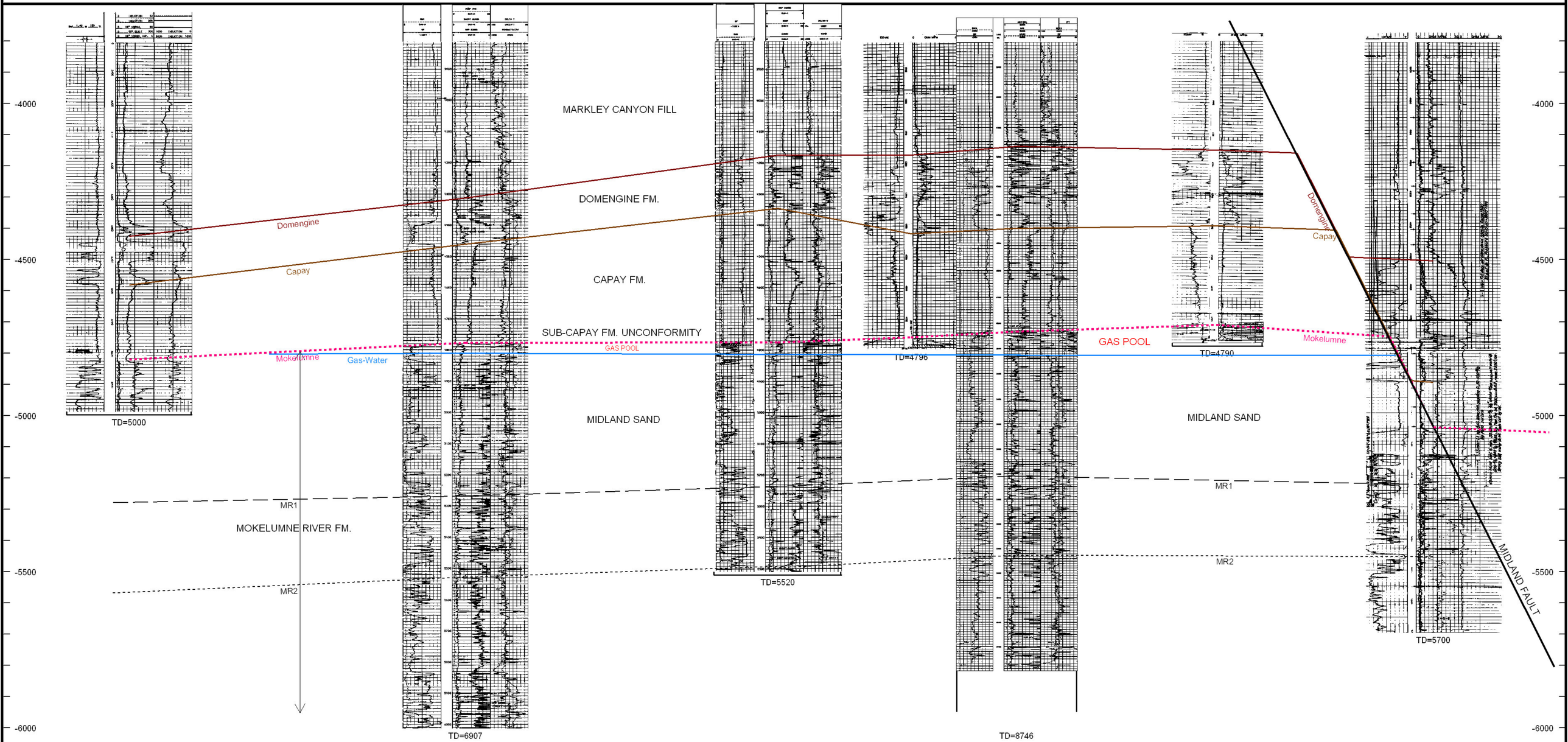
ATTACHMENT 6

PACIFIC GAS AND ELECTRIC COMPANY
CACHE SLOUGH GAS FIELD
STRUCTURAL CROSS SECTION CS1
Horizontal Scale = 1 in per 400 ft; Vertical Scale = 1 in per 200 ft
Vertical Exaggeration = 2

NORTH

SOUTH

04095001160000	2156 ft	04095209860000	2004 ft	04095208820000	853 ft	04095000330000	676 ft	04095212080000	1285 ft	04095000370000	1389 ft	04095000430000
CHEVRON U.S.A. INC. CAL PACK 10 2200 S 925 E NW TWP: 5 N - Range: 3 E - Sec. 31 Spud Date=4/13/1962		ANACAPA OIL CORP. ASCM CALPAC 3 725 N 1335 E SW TWP: 5 N - Range: 3 E - Sec. 31 Spud Date=9/2/1994		NAHAMA & WEAGANT ENE CACHE SLOUGH 1-6 1330 S 900 E NW TWP: 4 N - Range: 3 E - Sec. 6 Spud Date=8/15/1990	Cum Gas All Zones: 3922300 MCF	AMERADA HESS CORP. CHURCH 2 TWP: 4 N - Range: 3 E - Sec. Spud Date=6/5/1945	Cum Gas All Zones: 454538 MC	TOWNE CHURCH 6-6 TWP: 4 N - Range: 3 E - Sec. Spud Date=7/27/2004	Cum Gas All Zones: 1285830 MCF	PETER COOK, JR. PETER COOK 8 4000 S 2450 E NW TWP: 4 N - Range: 3 E - Sec. 6 Spud Date=7/11/1945		CHEVRON U.S.A. INC. CALPAC 6 150 S 2350 E NW TWP: 4 N - Range: 3 E - Sec. 7 Spud Date=12/1/1950



ATTACHMENT 7

PACIFIC GAS AND ELECTRIC COMPANY
CACHE SLOUGH GAS FIELD
STRUCTURAL CROSS SECTION CS2
Horizontal Scale = 1 in per 400 ft; Vertical Scale = 1 in per 200 ft
Vertical Exaggeration = 2

WEST

EAST

Cum Gas All Zones: 420060 MCF
04095212880000
ARMSTRONG
APC CHURCH 1-2
TWP: 4 N - Range: 2 E - Sec. 1
Spud Date=11/10/2007

2436 ft

Cum Gas All Zones: 454538 MCF
04095212080000
TOWNE
CHURCH 6-6
TWP: 4 N - Range: 3 E - Sec. 6
Spud Date=7/27/2004

2395 ft

Cum Gas All Zones: 33763 MCF
04095000420000
CHEVRON U.S.A. INC.
CALPAC 3
TWP: 4 N - Range: 3 E - Sec. 6
Spud Date=7/29/1945

1338 ft

04095209800000
ANACAPA OIL CORP.
ASCM CALPAC 2
2460 N 770 E SW
TWP: 4 N - Range: 3 E - Sec. 5
Spud Date=4/21/1994

-4000
-4500
-5000
-5500
-6000

CACHE SLOUGH FAULT

MARKLEY CANYON FILL

DOMENGINE FM.

CAPAY FM.

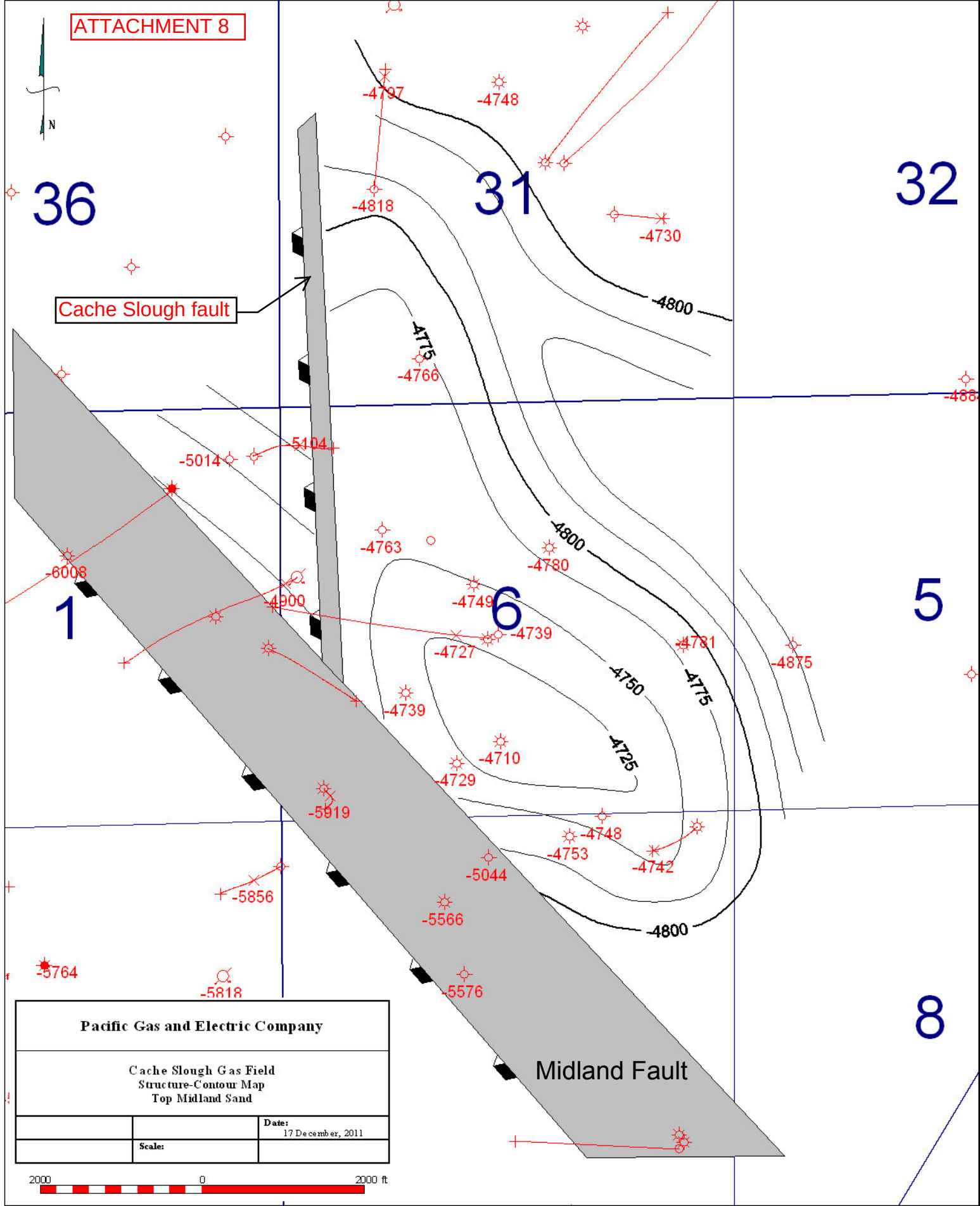
SUB-CAPAY FM. UNCONFORMITY

MIDLAND SAND

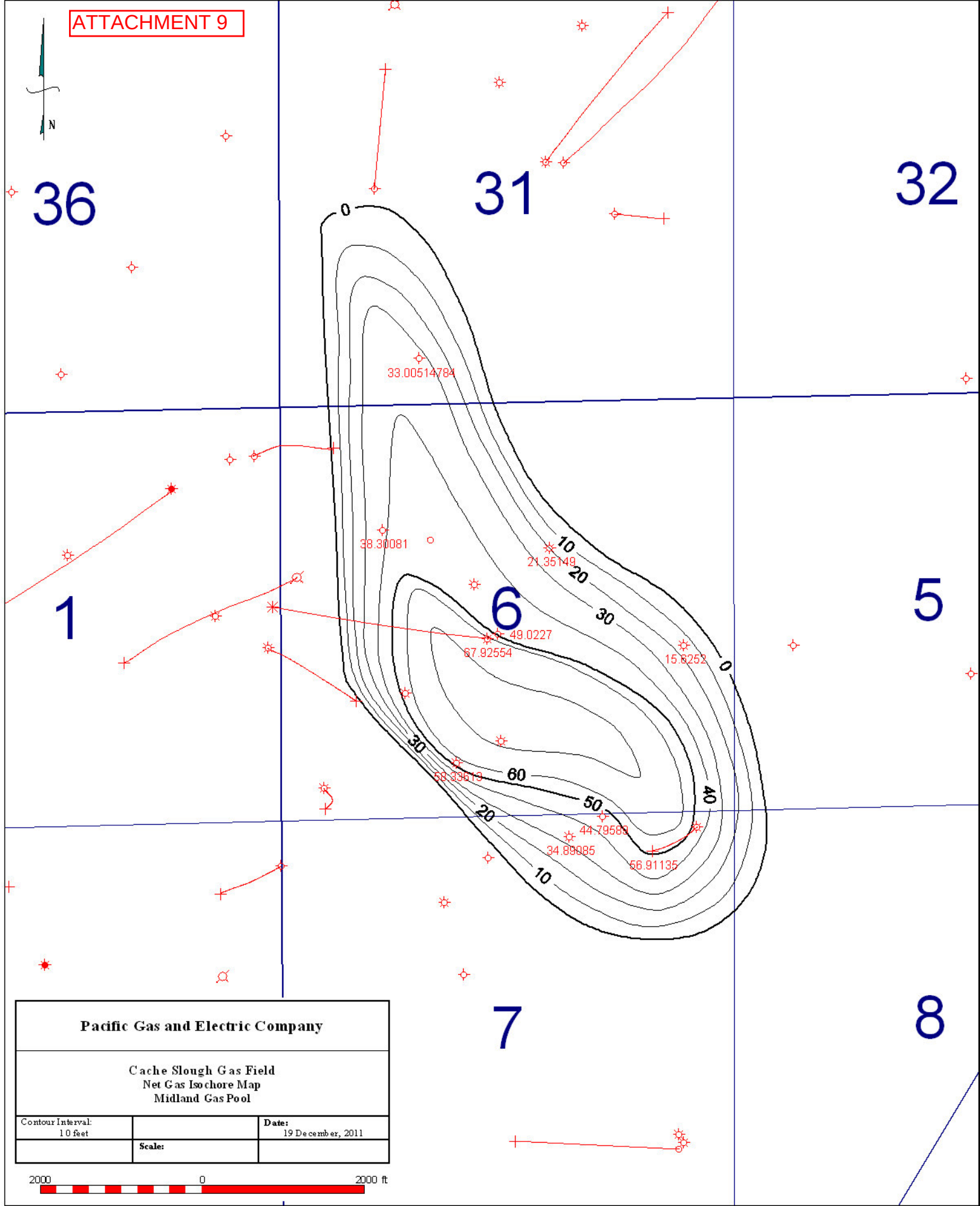
MOKELUMNE RIVER FM.

Domengine
Capay
Mokelumne
GAS POOL
Gas-Water
MR1
MR2

TD=9251
TD=8746
TD=5653
TD=9888


ATTACHMENT 8
N
36
31
32
1
6
5
8
Cache Slough fault
Midland Fault
-4797
-4748
-4818
-4730
-4800
-4775
-4766
-5104
-5014
-4763
-4780
-6008
-4900
-4749
-4739
-4727
-4781
-4875
-4750
-4739
-4710
-4729
-5819
-4748
-4753
-4742
-5044
-5856
-5566
-4800
-5764
-5818
-5576
Pacific Gas and Electric Company
Cache Slough Gas Field
Structure-Contour Map
Top Midland Sand
Date:
17 December, 2011
Scale:
2000
0
2000 ft

ATTACHMENT 9



Pacific Gas and Electric Company

Cache Slough Gas Field
Net Gas Isochore Map
Midland Gas Pool

Contour Interval: 10 feet		Date: 19 December, 2011
	Scale:	

2000 0 2000 ft

APPENDIX I

A) Chevron CALPAC 2, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

B) Amerada Church 2 annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

C) Peter Cook 8, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

D) CALPAC 3, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

E) Amerada Church 4, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

F) Chevron CALPAC 7, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

G) Chevron Peter Cook 12, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

H) Chevron CALPAC 12, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

I) Towne Church 6-6, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

J) Chevron Peter Cook 12, annotated well log and well-history summary.

K) Phillips Church 4, annotated well log and well-history summary.

L) Tonka ASCM Cook 1, annotated well log and well-history summary.

M) ABA RJR-Cook 1, annotated well log and well-history summary.

API NO.	FORMATION	MEASURED DEPTH	TRUE VERTICAL DEPTH	ELEVATION
04095000330000	Capay	4427	4427	-4416
04095000330000	CapayBase	4760	4760	-4749
04095000330000	Domengine	4176	4176	-4165
04095000330000	Gas-Water	4818	4818	-4807
04095000330000	Mokelumne	4760	4760	-4749
04095000330000	MrklyCynB	4215	4215	-4204
04095000330000	PAY1	4760	4760	-4749
04095000350000	black	4480	4480	-4471
04095000350000	CapayBase	4748	4748	-4739
04095000350000	Domengine	4416	4416	-4407
04095000350000	gray	4609	4609	-4600
04095000350000	Mokelumne	4747	4747	-4738
04095000350000	MrklyCynB	4415	4415	-4406
04095000350000	PAY1	4740	4740	-4731
04095000350000	red	4661	4661	-4652
04095000360000	Domengine	4620	4620	-4610
04095000360000	PAY1	3942	3942	-3932
04095000360000	PAY2	4538	4538	-4528
04095000370000	Capay	4402	4402	-4392
04095000370000	CapayBase	4720	4720	-4710
04095000370000	Domengine	4160	4160	-4150
04095000370000	Gas-Water	4814	4814	-4804
04095000370000	gray	4721	4721	-4711
04095000370000	Mokelumne	4720	4720	-4710
04095000370000	MrklyCynB	4160	4160	-4150
04095000370000	PAY1	4719	4719	-4709
04095000380000	Anderson	6220	6220	-6198
04095000380000	Bunker	8650	8650	-8628
04095000380000	CapayBase	5840	5840	-5818
04095000380000	CretUndiff	7155	7155	-7133
04095000380000	CretUndiff	7155	7155	-7133
04095000380000	DomBase	4990	4990	-4968
04095000380000	Domengine	4550	4550	-4528
04095000380000	Forbes	14010	14010	-13988
04095000380000	H_Tb	9250	9250	-9228
04095000380000	Hamilton	5840	5840	-5818
04095000380000	K-1	10960	10960	-10938
04095000380000	Kfm	14820	14820	-14798
04095000380000	Martinez	6365	6365	-6343
04095000380000	McSs	7015	7015	-6993
04095000380000	McSsB	7470	7470	-7448
04095000380000	MgCshlBase	6220	6220	-6198
04095000380000	MokRivBase	8955	8955	-8933
04095000380000	MR1	7620	7620	-7598
04095000380000	MR2	7925	7925	-7903
04095000380000	MR3	8215	8215	-8193
04095000380000	MR4	8590	8590	-8568
04095000380000	PAY1	8995	8995	-8973
04095000380000	PAY2	12360	12360	-12338
04095000380000	PAY3	14700	14700	-14678
04095000380000	Peterson	10140	10140	-10118
04095000380000	SacShale	12625	12625	-12603
04095000380000	SacShale	13625	13625	-13603
04095000380000	STKY2	9700	9700	-9678
04095000380000	StrkyUndiff	9250	9250	-9228
04095000380000	WNTRS3	10470	10470	-10448
04095000380000	WNTRS4	10950	10950	-10928
04095000380000	WNTRS5	11635	11635	-11613

04095000390000	Bunker	6300	6207	-6197
04095000390000	CapayBase	5180	5114	-5104
04095000390000	CretUndiff	5305	5235	-5225
04095000390000	Domengine	5030	4969	-4959
04095000390000	H_Tb	6875	6773	-6763
04095000390000	K-1	8600	8495	-8485
04095000390000	Mokelumne	5180	5114	-5104
04095000390000	MokRivBase	6645	6546	-6536
04095000390000	MrklyCynB	5030	4969	-4959
04095000390000	Peterson	7770	7665	-7655
04095000390000	STKY2	7440	7335	-7325
04095000390000	STKY3	7765	7660	-7650
04095000390000	StrkyUndiff	6880	6778	-6768
04095000400000	black	4931	4931	-4920
04095000400000	Bunker	6200	6200	-6189
04095000400000	CapayBase	4740	4740	-4729
04095000400000	DomBase	4445	4445	-4434
04095000400000	Domengine	4214	4214	-4203
04095000400000	Gas-Water	4816	4816	-4805
04095000400000	gray	4751	4751	-4740
04095000400000	green	5144	5144	-5133
04095000400000	H_Tb	6815	6815	-6804
04095000400000	Mokelumne	4737	4737	-4726
04095000400000	MokRivBase	6575	6575	-6564
04095000400000	MR1	4989	4989	-4978
04095000400000	MR2	5450	5450	-5439
04095000400000	MR3	5790	5790	-5779
04095000400000	MR4	6185	6185	-6174
04095000400000	MrklyCynB	4220	4220	-4209
04095000400000	PAY1	5329	5329	-5318
04095000400000	Peterson	7680	7680	-7669
04095000400000	red	4823	4823	-4812
04095000400000	STKY2	7165	7165	-7154
04095000400000	STKY3	7680	7680	-7669
04095000400000	StrkyUndiff	6810	6810	-6799
04095000400000	white	4751	4751	-4740
04095000410000	CapayBase	4760	4760	-4753
04095000410000	Domengine	4270	4270	-4263
04095000410000	Gas-Water	4811	4811	-4804
04095000410000	Mokelumne	4760	4760	-4753
04095000410000	MrklyCynB	4270	4270	-4263
04095000410000	PAY1	4765	4765	-4758
04095000410000	red	4808	4808	-4801
04095000420000	black	4975	4975	-4971
04095000420000	Capay	4495	4495	-4491
04095000420000	CapayBase	4785	4785	-4781
04095000420000	CretUndiff	1715	1715	-1711
04095000420000	Dobbins	4795	4795	-4791
04095000420000	DomBase	4580	4580	-4576
04095000420000	Domengine	4290	4290	-4286
04095000420000	Forbes	1715	1715	-1711
04095000420000	FR	5352	5352	-5348
04095000420000	Gas-Water	4804	4804	-4800
04095000420000	gray	4800	4800	-4796
04095000420000	green	5182	5182	-5178
04095000420000	Kfm	2330	2330	-2326
04095000420000	Mokelumne	4785	4785	-4781
04095000420000	MR1	5179	5179	-5175
04095000420000	MR2	5500	5500	-5496
04095000420000	MrklyCynB	4290	4290	-4286
04095000420000	PAY1	4784	4784	-4780

04095000430000	Capay	4900	4900	-4894
04095000430000	CapayBase	5050	5050	-5044
04095000430000	DomBase	4915	4915	-4909
04095000430000	Domengine	4510	4510	-4504
04095000430000	Mokelumne	5043	5043	-5037
04095000430000	MR1	5227	5227	-5221
04095000430000	MR2	5458	5458	-5452
04095000440000	CapayBase	4790	4790	-4780
04095000440000	Domengine	4290	4290	-4280
04095000440000	Gas-Water	4815	4815	-4805
04095000440000	Mokelumne	4790	4790	-4780
04095000440000	MrklyCynB	4290	4290	-4280
04095000440000	PAY1	4790	4790	-4780
04095001160000	Capay	4588	4588	-4581
04095001160000	CapayBase	4825	4825	-4818
04095001160000	DomBase	4595	4595	-4588
04095001160000	Domengine	4432	4432	-4425
04095001160000	Mokelumne	4826	4826	-4819
04095001160000	MrklyCynB	4430	4430	-4423
04095001160001	CapayBase	5103	4804	-4797
04095001160001	Domengine	4670	4409	-4402
04095200870000	Bunker	6343	6343	-6330
04095200870000	CretUndiff	6380	6380	-6367
04095200870000	H_Tb	6925	6925	-6912
04095200870000	MokRivBase	6710	6710	-6697
04095200870000	MR4	6320	6320	-6307
04095200870000	MrklyCynB	6265	6265	-6252
04095200870000	Nortonville	4400	4400	-4387
04095200870000	PAY1	6343	6343	-6330
04095200870000	PAY2	6955	6955	-6942
04095200870000	PAY3	9130	9130	-9117
04095200870000	Peterson	7770	7770	-7757
04095200870000	STKY2	7435	7435	-7422
04095200870000	STKY3	7770	7770	-7757
04095200870000	StrkyUndiff	6920	6920	-6907
04095200870000	Winters-Lower	9745	9745	-9732
04095200870000	Winters-Upper	9130	9130	-9117
04095200870000	WNTRS1	9130	9130	-9117
04095200870000	WNTRS2	9485	9485	-9472
04095200980000	Anderson	6480	6480	-6468
04095200980000	CapayBase	6020	6020	-6008
04095200980000	Hamilton	6020	6020	-6008
04095200980000	K-1	8400	8400	-8388
04095200980000	Martinez	6795	6795	-6783
04095200980000	MgCshlBase	6480	6480	-6468
04095200980000	MrklyCynB	5175	5175	-5163
04095200980000	PAY1	7662	7662	-7650
04095200980000	Peterson	7662	7662	-7650
04095200980000	STKY2	7325	7325	-7313
04095200980000	STKY3	7665	7665	-7653
04095200980000	SWTHsh	8950	8950	-8938
04095200980000	Winters-Upper	9372	9372	-9360
04095201020000	Bunker	6370	6223	-6209
04095201020000	CretUndiff	5436	5383	-5369
04095201020000	H_Tb	6955	6764	-6750
04095201020000	K-1	8705	8481	-8467
04095201020000	Mokelumne	5430	5378	-5364
04095201020000	MokRivBase	6715	6538	-6524
04095201020000	MrklyCynB	5435	5382	-5368
04095201020000	Nortonville	4400	4398	-4384
04095201020000	PAY1	5519	5458	-5444

04095201020000	Peterson	7850	7630	-7616
04095201020000	STKY2	7540	7327	-7313
04095201020000	STKY3	7850	7630	-7616
04095201020000	StrkyUndiff	6958	6766	-6752
04095201020000	SWTHsh	9110	8886	-8872
04095201020000	Winters-Upper	9620	9396	-9382
04095201020000	WNTRS1	9610	9386	-9372
04095202880000	H_Tb	7195	7195	-7183
04095202880000	STKY2	7695	7695	-7683
04095202880000	STKY3	8100	8100	-8088
04095202880000	WNTRS1	9200	9200	-9188
04095203730000	black	4982	4930	-4918
04095203730000	CapayBase	4805	4754	-4742
04095203730000	Domengine	4404	4354	-4342
04095203730000	Gas-Water	4870	4818	-4806
04095203730000	green	5200	5147	-5135
04095203730000	Mokelumne	4810	4758	-4746
04095203730000	MR1	5023	4971	-4959
04095203730000	MrklyCynB	4343	4294	-4282
04095203730000	PAY1	4810	4758	-4746
04095203730000	red	4867	4816	-4804
04095203730000	white	4826	4774	-4763
04095204650000	Bunker	6550	6392	-6365
04095204650000	H_Tb	7210	6889	-6862
04095204650000	K-1	9080	8352	-8325
04095204650000	Martinez	4790	4790	-4763
04095204650000	McSs	5075	5073	-5046
04095204650000	MokRivBase	6895	6656	-6629
04095204650000	MrklyCynB	4790	4790	-4763
04095204650000	PAY1	9080	8352	-8325
04095204650000	PAY2	10295	9338	-9311
04095204650000	Peterson	8230	7673	-7646
04095204650000	STKY2	7850	7371	-7344
04095204650000	STKY3	8230	7673	-7646
04095204650000	StrkyUndiff	7210	6889	-6862
04095204650000	SWTHsh	9640	8806	-8779
04095204650000	Winters-Upper	10240	9294	-9267
04095204650000	WNTRS1	10045	9136	-9109
04095205710000	Bunker	6335	6335	-6321
04095205710000	Capay	4980	4980	-4966
04095205710000	CapayBase	5590	5590	-5576
04095205710000	DomBase	4980	4980	-4966
04095205710000	Domengine	4560	4560	-4546
04095205710000	H_Tb	6810	6810	-6796
04095205710000	K-1	8500	8500	-8486
04095205710000	Mokelumne	5590	5590	-5576
04095205710000	MokRivBase	6690	6690	-6676
04095205710000	MR2	5660	5660	-5646
04095205710000	MR3	5960	5960	-5946
04095205710000	MR4	6340	6340	-6326
04095205710000	Peterson	7665	7665	-7651
04095205710000	STKY2	7160	7160	-7146
04095205710000	STKY3	7660	7660	-7646
04095205710000	StrkyUndiff	6810	6810	-6796
04095205710000	SWTHsh	8750	8750	-8736
04095206100000	H_Tb	7025	7025	-7002
04095206100000	McSs	5255	5255	-5232
04095206100000	McSsB	5510	5510	-5487
04095206100000	MokRivBase	6950	6950	-6927
04095206100000	MR1	5590	5590	-5567
04095206100000	MR2	5880	5880	-5857

04095206100000	MR3	6230	6230	-6207
04095206100000	MR4	6385	6385	-6362
04095206100000	MrklyCynB	5255	5255	-5232
04095206100000	STKY2	7470	7470	-7447
04095206100000	STKY3	7760	7760	-7737
04095206100000	SWTHsh	9115	9115	-9092
04095206100000	WNTRS1	9520	9520	-9497
04095208690000	Bunker	6510	6510	-6494
04095208690000	CapayBase	5030	5030	-5014
04095208690000	Domengine	4930	4930	-4914
04095208690000	K-1	8450	8450	-8434
04095208690000	Mokelumne	5030	5030	-5014
04095208690000	MokRivBase	6890	6890	-6874
04095208690000	Peterson	7940	7940	-7924
04095208690000	StrkyUndiff	7110	7110	-7094
04095208690000	Winters-Upper	9380	9380	-9364
04095208820000	black	4988	4988	-4979
04095208820000	Capay	4345	4345	-4336
04095208820000	CapayBase	4772	4772	-4763
04095208820000	Domengine	4175	4175	-4166
04095208820000	Gas-Water	4813	4813	-4804
04095208820000	gray	4827	4827	-4818
04095208820000	green	5176	5176	-5167
04095208820000	Mokelumne	4775	4775	-4766
04095208820000	MR1	5235	5235	-5226
04095208820000	MR2	5493	5493	-5484
04095208820000	red	4891	4891	-4882
04095209790000	Anderson	6520	6512	-6497
04095209790000	CapayBase	5940	5934	-5919
04095209790000	DomBase	5150	5149	-5134
04095209790000	Domengine	4725	4725	-4710
04095209790000	Hamilton	5940	5934	-5919
04095209790000	K-1	8485	8475	-8460
04095209790000	MgCshlBase	6520	6512	-6497
04095209790000	Peterson	7620	7611	-7596
04095209790000	StrkyUndiff	6780	6772	-6757
04095209790000	Winters-Lower	9750	9738	-9723
04095209790000	Winters-Upper	9245	9234	-9219
04095209800000	Bunker	6335	6335	-6322
04095209800000	Capay	4560	4560	-4547
04095209800000	CapayBase	4888	4888	-4875
04095209800000	Domengine	4390	4390	-4377
04095209800000	Mokelumne	4870	4870	-4857
04095209800000	MokRivBase	6520	6520	-6507
04095209800000	MR1	5297	5297	-5284
04095209800000	MR2	5594	5594	-5581
04095209800000	Peterson	7685	7685	-7672
04095209800000	StrkyUndiff	6780	6780	-6767
04095209800000	Winters-Upper	9380	9380	-9367
04095209830000	Anderson	6270	6227	-6211
04095209830000	Capay	5050	5031	-5015
04095209830000	CapayBase	5908	5872	-5856
04095209830000	DomBase	5050	5031	-5015
04095209830000	Domengine	4600	4591	-4575
04095209830000	Hamilton	5908	5872	-5856
04095209830000	K-1	8330	8259	-8243
04095209830000	Martinez	6505	6459	-6443
04095209830000	McSs	7135	7077	-7061
04095209830000	MgCshlBase	6270	6227	-6211
04095209830000	Winters-Lower	9750	9678	-9662
04095209830000	Winters-Upper	9230	9158	-9142

04095209860000	Capay	4465	4465	-4450
04095209860000	CapayBase	4781	4781	-4766
04095209860000	Domengine	4318	4318	-4303
04095209860000	Gas-Water	4815	4815	-4800
04095209860000	Mokelumne	4782	4782	-4767
04095209860000	MR1	5272	5272	-5257
04095209860000	MR2	5532	5532	-5517
04095209900000	black	4939	4939	-4932
04095209900000	CapayBase	4755	4755	-4748
04095209900000	Domengine	4280	4280	-4273
04095209900000	Gas-Water	4813	4813	-4806
04095209900000	gray	4757	4757	-4750
04095209900000	green	5155	5155	-5148
04095209900000	Mokelumne	4755	4755	-4748
04095209900000	MR1	4981	4981	-4974
04095209900000	MR2	5474	5474	-5467
04095209900000	MrklyCynB	4280	4280	-4273
04095209900000	red	4832	4832	-4825
04095209900000	white	4777	4777	-4770
04095210500000	Bunker	6353	6353	-6339
04095210500000	Capay	4955	4955	-4941
04095210500000	CapayBase	5580	5580	-5566
04095210500000	Domengine	4528	4528	-4514
04095210500000	Hamilton	5580	5580	-5566
04095210500000	Mokelumne	5870	5870	-5856
04095210500000	MokRivBase	6550	6550	-6536
04095210500000	Peterson	7675	7675	-7661
04095210500000	StrkyUndiff	6820	6820	-6806
04095212080000	black	5103	4959	-4948
04095212080000	Bunker	6688	6205	-6194
04095212080000	Capay	4448	4411	-4400
04095212080000	CapayBase	4829	4738	-4727
04095212080000	Domengine	4165	4148	-4137
04095212080000	Gas-Water	4928	4818	-4807
04095212080000	gray	4882	4780	-4769
04095212080000	green	5359	5164	-5153
04095212080000	Mokelumne	4835	4742	-4731
04095212080000	MR1	5410	5205	-5194
04095212080000	MR2	5728	5457	-5446
04095212080000	Peterson	8410	7630	-7619
04095212080000	red	4977	4857	-4846
04095212080000	StrkyUndiff	7402	6774	-6763
04095212080000	TEST1	6356	5948	-5937
04095212680000	Capay	4431	4431	-4420
04095212680000	CapayBase	4750	4750	-4739
04095212680000	Domengine	4166	4166	-4155
04095212680000	Mokelumne	4750	4750	-4739
04095212880000	Capay	4577	4572	-4563
04095212880000	CapayBase	4925	4909	-4900
04095212880000	Domengine	4392	4390	-4381
04095212880000	Mokelumne	4926	4909	-4900
04095212880000	MR1	5410	5353	-5344
04095212880000	MR2	5731	5639	-5630
04095212880000	Peterson	8188	7638	-7629
04095212880000	StrkyUndiff	7281	6902	-6893

Pacific Gas and Electric Company
Compressed Air Energy Storage Project

Cache Slough Well Pad Expansion and Core Well Drilling

Assessment of Effects on Federally Listed Species

October 12, 2012

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Cache Slough Well Pad Expansion and Core Well Drilling

Assessment of Effects on Federally Listed Species

Contents

Section 1 Introduction 1

Section 2 Consultation to Date 1

Section 3 Proposed Action 2

3.1 Location 2

3.2 Environmental Setting 2

3.3 Proposed Action 3

Section 4 Status of Federally Listed Species and Critical Habitat 5

4.1 Federally Listed Species and Critical Habitat 5

Section 5 Potential Effects 10

5.1 Direct Effects 10

5.2 Indirect Effects 11

5.3 Cumulative Effects 11

Section 6 Proposed Avoidance and Minimization Measures 12

Section 7 Determination 15

Section 8 List of Preparers 15

Section 9 References 15

Tables

Table 1. Federally Listed Species Considered for Analysis 5

Appendices

Appendix A U.S. Fish and Wildlife Service Species List
Appendix B Figures

Section 1 Introduction

The purpose of this document is to review the proposed Cache Slough Well Pad Expansion and Core Well Drilling (Proposed Action) in sufficient detail to determine to what extent the Proposed Action may affect any of threatened, endangered, and proposed species or designated critical habitat. This document is prepared in accordance with legal requirements set forth under regulations to implement section 7 of the Endangered Species Act (50 CFR 402; 16 U.S.C. 1536 (c)).

The following listed species may be affected by the Proposed Action:

- Delta smelt (*Hypomesus transpacificus*), Threatened
- Giant garter snake (*Thamnophis gigas*), Threatened

The Proposed Action area is located within designated critical habitat for Delta smelt. The Proposed Action area does not provide habitat for any federally listed or proposed plant species.

Section 2 Consultation to Date

Reconnaissance-level field surveys were conducted by North State Resources, Inc. (NSR) and Pacific Gas and Electric Company (PG&E) on August 20, 2012 and October 2, 2012 to assess the habitat suitability for federally listed plant and animal species within the Proposed Action area and vicinity. Prior to conducting the field surveys, a species list was obtained from the U. S. Fish and Wildlife Service (USFWS) (Appendix A). Following the field surveys, a Biological Constraints Report was prepared by NSR (North State Resources 2012). PG&E submitted a copy of the report via email to Kim S. Turner and Maral Kasparian of the USFWS Bay-Delta Office ESA/Regulatory Division on September 20, 2012. PG&E initiated a meeting with the USFWS on September 26, 2012 to provide background about the Compressed Air Energy Storage Project and to discuss potential impacts that the core well drilling may have on federally listed species at the King Island site and two other potential locations for the project in the San Francisco Bay-Delta area.

Section 3 Proposed Action

3.1 Location

The Proposed Action is located in Cache Slough approximately 2 miles northeast of Rio Vista in Solano County, California at approximately 38.218712°, -121.686601° (Figure 2, Appendix B). Site access to the well pad location and alternative sampling locations is along an unnamed dirt road northwest from River Road. The dirt road is graded and well-maintained.

The Proposed Action area consists of all areas within 20 feet of the proposed access road and all areas within 250 feet of the existing well pad, proposed well pad expansion area (Well #2), and alternate locations (Parcel 1 and Parcel 6) (Figure 1, Appendix B).

3.2 Environmental Setting

The Proposed Action area is situated in a landscape that currently supports active agricultural operations, existing natural gas well sites, and access roads. The Proposed Action area is located below sea level in Cache Slough within the Yolo Bypass. Cache Slough was historically reclaimed for agricultural use by the construction of levees/dikes and draining to enable farming.

Habitats within the Proposed Action area (Figure 3-1 through 3-3 and Figures 4-1 through 4-3, Appendix B) include flood irrigated row crops (e.g., alfalfa and corn). Some of the cornfields adjacent to the access roads in the Proposed Action area were flood irrigated during the August 20, 2012 field reconnaissance. The well pad expansion area and alternative sampling locations are within regularly harvested and disked row crops. Alfalfa crops within the project are harvested multiple times throughout the growing season and fields are disked and replanted on a 3-4 year rotation. Visual inspection of these fields revealed a notable absence of small mammal burrows. The alfalfa field adjacent to Well Pad #2 was observed as completely disked for replanting during the October 2, 2012 field visit. Corn fields within the Proposed Action area are harvested annually and are disked annually. All agricultural crops within the Proposed Action area are actively farmed and regularly disked, harvested and/or disturbed up to the edge of existing roads.

The access road follows a discontinuous series of irrigation ditches along most of its length prior to crossing and following a large earthen irrigation canal (canal) east to Well #2, Parcel 1, and Parcel 6. Habitat within the canal is predominantly open water. Narrow strips of vegetation bordering the banks of the canal include cattails (*Typha* sp.) and bulrush (*Schoenoplectus acutus*). Schools of black bass (*Micropterus* spp.) ranging from 8-15 inches in size were observed along the length of this canal. The banks of the canal are largely devoid of vegetation and appeared to be both mechanically and chemically managed. Ruderal herbaceous species occurring along the banks and adjacent road shoulders include bristly ox-tongue (*Helminthotheca echioides*), redroot pigweed (*Amaranthus retroflexus*), common knotweed (*Polygonum aviculare*), knotweed (*Polygonum arenastrum*), and Bermuda grass (*Cynodon dactylon*). A valve at the levee supplies water from Cache Slough for irrigation delivery to crops. The canal is gravity fed by water from Cache Slough to the west. Cache Slough is a large channel of deep open water located approximately 0.5 miles east of the Proposed Action area.

A large drainage ditch is located along the access roads to both Parcel 1 and Parcel 6. Similar to the irrigation canal, the drainage ditch appears to be regularly managed and the banks are largely devoid of vegetation. Habitat in the drainage ditch was dominated by cattails, mosquito fern (*Azolla* sp.) and water hyacinth (*Eichhornia crassipes*). Characteristic of regularly cleared irrigation ditches in the area, the cattails within this ditch showed only 1-2 years growth with no reproductive stems.

Well #2is composed of compacted gravels. Well #2 is no longer in use and no equipment is present. Ruderal herbaceous vegetation occurs along the edges of the existing pad and is dominated by bristly ox-tongue and annual saltmarsh aster (*Symphyotrichum subulatum*).

No annual grasslands that would support vernal pool habitat occur within or near the Proposed Action area. The project is within the Giant Garter Snake Priority Conservation Area designated by the Solano County General Plan and is not within any other Solano County designated conservation areas (Solano County 2008).

3.3 Proposed Action

The objective of the project is to collect approximate 4-inch diameter geological core samples from the subsurface natural gas formation at depth approximately 4,000-5,000 feet. Cores will be used determine the suitability of the subsurface formation for compressed air storage. Compressed air storage involves utilizing appropriate geological formations (e.g., depleted natural gas reservoirs) to store surplus energy in the form of compressed air during periods of low electric demand. This stored energy can then be utilized during periods of higher electric demand, improving the efficiency of energy distribution through the power grid.

Given that existing access roads are available, no road construction is necessary for project construction. Improvements to the existing access roads from the ranch yard to approximately 900 feet north will be limited to light graveling of the unnamed dirt road if determined to be necessary (e.g., work to occur during the wet season) with the assumption no additional grading will be required. If grading is required, it will be limited to the existing road and will not extend beyond the compacted surface. All vehicle traffic will be on the existing access roads and all staging will be contained within the southeast portion of the existing well pad. Water trucks will be used as necessary to reduce dust during site access and other construction activities. Approximately 28 truck trips will be required to import well pad material to the site. An additional five truck trips will be required to remove drill cuttings and associated material from the site. If well pad expansion sites are restored to pre-project conditions, an additional 28 truck trips will be required to remove temporary well pad expansion materials, which will total 61 truck trips. Standard PG&E Best Management Practices (BMPs) and Avoidance and Minimization Measures (AMMs) will be implemented to avoid impacts on potential waters of the United States.

There are three proposed potential geological core sampling locations but only one will be chosen for coring. Well Pad #2 expansion area is the preferred location of geological core sampling but if the land access is not acquired for that site but is instead acquired for one of the alternatives (Parcel 1 and 6) then coring will occur at that location. One of the proposed sampling locations consists of a temporary well pad expansion area at an existing natural gas well location (Well #2). The two proposed alternative sampling locations (Parcel 1 and Parcel 6) would require establishing new

temporary drilling pads within existing row crops. Well #2 pad expansion will result in a 120 x 220 foot well pad built on the existing base, which may only disturb approximately 0.2 acre of vegetation. Approximately 0.2 acre of alfalfa at Well #2 will be cleared in order to accommodate well pad expansion. The Parcel 1 alternative sampling location will consist of establishing a new pad within an existing corn field. This pad would be located adjacent to an existing ranch road on the west side and an existing staging area on the south side. The Parcel 1 pad will measure 220 feet along its north-south axis and extend approximately 140 feet northeast into the existing corn field (approximately 0.7 acre). Approximately 20 additional feet of corn field along the north and east side of the Parcel 1 may be temporarily impacted during pad construction. The Parcel 6 alternative sampling location will consist of establishing a new pad within an existing alfalfa field. This pad would be located adjacent existing ranch roads along the north and east sides. The Parcel 6 pad will measure 220 feet along its east -west axis and extend approximately 140 feet southeast into the existing alfalfa field (approximately 0.7 acre). Approximately 20 additional feet of the alfalfa field along the western and southern side of the Parcel 6 may be temporarily impacted during pad construction. No more than 0.7 acre of alfalfa will be temporarily cleared in order to accommodate geological core sampling. After clearing the vegetation, approximately 1 foot of crushed rock will be placed within the cleared area and compacted with a roller.

After the well pad expansion or alternate pad area has been established (i.e., cleared of vegetation, compacted and surfaced with gravel), well drilling equipment will be moved onto the expansion area. The primary equipment includes the drill rig, mud and water tanks and pumps, shaker tanks, electric generators, diesel fuel tanks, and drill pipe racks. Geologic sampling will consist of drilling a 10 inch diameter well to a depth of approximately 4,000-5,000 feet and extracting a geological core sample not greater than 4 inches in diameter. All sections of the core sample will be removed offsite for analysis and storage. All peripheral material (e.g., cuttings and drilling mud) removed during the coring process will be immediately placed in proper storage receptacles and removed offsite for disposal at an authorized facility. The drilling crew, plus engineers, temporary workers and site visitors, will consist of an average of approximately 12 workers per shift, with three shifts per day. A maximum of 20 workers may be present during various operations. In addition to worker vehicles, service and delivery vehicles will access the site during the drilling phase including equipment trucks for all aspects of the effort. All drilling activities will be completed in compliance with the County Gas and Oil Well Improvement Plan approval.

Once the core sample is obtained and the core hole is plugged and abandoned per California Division of Oil Gas and Geothermal Resources (DOGGR) and Environmental Protection Agency (EPA) requirements, the drilling equipment will be dismantled and demobilized from the site. Construction equipment similar to that used during well pad development will be used to remove the pad materials and return the site to near pre-project conditions. This includes spreading of any surface vegetation or roots stockpiled during site preparation. All removed material would be disposed of at suitable landfills or recycled consistent with county grading or other permit requirements. However, the property owner may elect to retain the pad for farm equipment staging and storage.

Well pad construction and improvements to access roads will occur over a two-week period commencing as early as October 2012. Drilling activities will occur virtually continuously for up to approximately six weeks. If elected to remove the well pad, restoration of the site will take up to two weeks.

Section 4 Status of Federally Listed Species and Critical Habitat

4.1 Federally Listed Species and Critical Habitat

The status of federally listed and proposed species and designated critical habitat in the action area was determined by: review of the USFWS species list, review of the California Natural Diversity Data Base records, and the results of the August 20, 2012 and October 2, 2012 field surveys. Based on this review, Delta smelt and giant garter snake, both federally threatened, were determined to have the potential to occur in, or in close proximity to, the Proposed Action area. Designated critical habitat for Delta smelt occurs within, or in close proximity to, the Proposed Action area. No other federally listed species or designated habitat occurs within the Proposed Action area. Table 1 summarizes the review of federally listed and proposed species and designated critical habitat. Delta smelt and giant garter snake are discussed further below.

Table 1. Review of Federally Listed Species and Designated Critical Habitat

Common Name *Scientific Name*	Status	General Habitat Description	Potential for Occurrence
Conservancy fairy shrimp *Branchinecta conservatio*	Endangered	Vernal pool crustaceans live in vernal pools, swales, and ephemeral freshwater habitats. None are known to occur in riverine waters or marine waters.	None. Vernal pool habitat is absent from the Proposed Action area.
Vernal pool fairy shrimp *Branchinecta lynchi*	Threatened	Vernal pool crustaceans live in vernal pools, swales, and ephemeral freshwater habitats. None are known to occur in riverine waters or marine waters.	None. Vernal pool habitat is absent from the Proposed Action area.
Delta green ground beetle *Elaphrus viridis*	Threatened	Associated with vernal pool habitats in the San Francisco Bay Delta region	None. Vernal pool habitat is absent from the Proposed Action area.
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	Threatened	Elderberry shrubs associated with riparian forests which occur along rivers and streams.	None. No elderberry shrubs are present within the Proposed Action area or within 100 feet of the Proposed Action area.
Vernal pool tadpole shrimp *Lepidurus packardi*	E/—	Vernal pool crustaceans live in vernal pools, swales, and ephemeral freshwater habitats. None are known to occur in riverine waters or marine waters.	None. Vernal pool habitat is absent from the Proposed Action area.

Table 1. Review of Federally Listed Species and Designated Critical Habitat

Common Name *Scientific Name*	Status	General Habitat Description	Potential for Occurrence
Green sturgeon, southern DPS *Acipenser medirostris*	Threatened	This DPS includes green sturgeon that spawn in rivers south of the Eel River. Preferred spawning substrate is large cobble, but can range from clean sand to bedrock.	None. Drainage canals and irrigation ditches do not provide habitat for this species.
Delta smelt *Hypomesus transpacificus* **Critical Habitat**	Threatened	Estuarine systems in the Sacramento-San Joaquin Delta.	**Yes**. Upper Cache Slough and Liberty Island provide habitat for this species. Valve feeding the irrigation canal is unscreened and Delta smelt may occur in the irrigation ditch. Designated critical habitat occurs within the Proposed Action area.
Central Valley steelhead DPS *Oncorhynchus mykiss*	Threatened	Spawns in cool, moderately fast flowing water with gravel bottom.	None. Drainage canals and irrigation ditches do not provide habitat for this species.
Central Valley spring-run ESU Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Freshwater rivers and streams. Sacramento River and its tributaries.	None. Drainage canals and irrigation ditches do not provide habitat for this species.
Winter-run Chinook salmon ESU *Oncorhynchus tshawytscha*	Endangered	Spawn and rear in main-stem Sacramento River. Require cool year-round water temperatures, since spawning occurs during the summer. Requires deep pools and riffles, and clean gravel and cobble substrate to spawn.	None. Drainage canals and irrigation ditches do not provide habitat for this species.
California tiger salamander *Ambystoma californiense*	Threatened	Vernal or temporary pools in annual grasslands, or open stages of woodlands.	None. Vernal pool habitat is absent from the Proposed Action area.

Table 1. Review of Federally Listed Species and Designated Critical Habitat

Common Name *Scientific Name*	Status	General Habitat Description	Potential for Occurrence
California red-legged frog *Rana draytonii*	Threatened	Requires aquatic habitat for breeding, also uses a variety of other habitat types including riparian and upland areas. Adults utilize dense, shrubby or emergent vegetation associated with deep-water pools with fringes of cattails and dense stands of overhanging vegetation. This species may also breed in ephemeral ponds that support little or no vegetation.	None. The Proposed Action area is located outside the current known range of this species and there are no reported occurrences within 5 miles of the Proposed Action area. This species is not expected to occur in the Proposed Action area.
Giant garter snake *Thamnophis gigas*	Threatened	Freshwater marshes and low gradient streams with emergent vegetation. Adapted to drainage canals and irrigation ditches with mud substrate.	**Yes.** Canals, waterways, and associated uplands within the Proposed Action area provide potential habitat. A known extant population of GGS occurs within the Coldani Marsh-White Slough area approximately 0.5 mile to the northeast of the Proposed Action area. The location of this population is hydrologically connected to irrigation canals within the Proposed Action area.
California clapper rail *Rallus longirostris obsoletus*	Endangered	Tidal salt marshes and sloughs of the San Francisco Bay.	None. Drainage canals and irrigation ditches do not provide habitat for this species. Out of the current known range.
Least Bell's vireo *Vireo bellii pusillus*	Endangered	Obligate riparian breeders inhabiting diverse riparian woodlands along water courses.	None. Riparian habitat is absent from the Proposed Action area.
Western snowy plover *Charadrius alexandrinus nivosus*	Threatened	Nests in coastal wetlands and coastal dune habitat	None. Wetland and dune habitat are absent from the Proposed Action area.
California brown pelican *Pelecanus occidentalis californicus*	Endangered	Nests on undisturbed islands near estuarine, marine, subtidal, and marine pelagic waters.	None. Island habitat is absent from the Proposed Action area.

Table 1. Review of Federally Listed Species and Designated Critical Habitat

Common Name *Scientific Name*	Status	General Habitat Description	Potential for Occurrence
California least tern *Sternula antillarum browni*	Endangered	Nests in areas relatively free of human or predatory disturbance on barren to sparsely vegetated sites near waters of coastal bays and inlets.	None. Proposed Action area is outside known range of species. Habitat relatively free of human disturbance absent from the Proposed Action area.
Northern spotted owl *Strix occidentalis caurina*	Endangered	Resides in large stands of old growth, multi-layered mixed conifer, redwood, and Douglas-fir habitats	None. Old growth, multi-layered mixed conifer, redwood, and Douglas-fir habitats are absent from the Proposed Action area.
Riparian brush rabbit *Sylvilagus bachmani riparius*	Endangered	Riparian areas with dense shrub layer, low-growing vines, some tall shrubs, and scrubby trees throughout San Joaquin Valley.	None. Riparian habitat is absent from the Proposed Action area.

Delta Smelt

The valve allowing water into the irrigation canal is unscreened and Delta smelt could occur in the irrigation canal west of Cache Slough. Cache Slough is within designated Critical Habitat for Delta smelt. Smelt are known to migrate through Cache Slough and utilize near-shore habitats of Liberty Island in the upper reach of Cache Slough for both spawning and non-spawning habitat year-round (Sommer et. al. 2011). Liberty Island is located approximately 1.0 mile north of the action area. Larval fish have been observed in Montezuma Slough (Wang 1986), Suisun Slough in Suisun Marsh (Moyle 2002), the Napa River estuary (Stillwater Sciences 2006), the Sacramento River above Rio Vista, and Cache, Lindsey, Georgiana, Prospect, Beaver, Hog, Sycamore, and Barker sloughs (U.S. Fish and Wildlife Service 1996). Spawning was also observed in the Sacramento River up to Garcia Bend (RM 50) during drought conditions because of increased saltwater intrusion that moved delta smelt spawning and rearing farther inland (Wang and Brown 1993).

Giant Garter Snake

Within the project vicinity, the irrigation canal, irrigation ditches, drainage ditches and associated upland provide potentially suitable habitat for giant garter snake (GGS). Giant garter snakes are typically absent from larger rivers and other water bodies that support introduced populations of large, predatory fish and lack emergent vegetation (Hansen 1988; USFWS 1997). Because the source of irrigation water within the Proposed Action area is provided by the deep water channel of Cache Slough, a high flow channel lacking appropriate aquatic habitat (i.e., emergent vegetation), it is not expected that this canal provides connectivity to potential GGS source populations. Intensively managed canals and ditches within the Proposed Action area provide suitable foraging habitat for GGS, but low quality basking habitat with few potential refugia (e.g., small mammal burrows, crevices, or similar cavities). Intensively managed roadways and agricultural habitat within the Proposed Action area do not provide suitable upland or basking habitat for giant garter snake. The

nearest CNDDB GGS occurrence record is approximately 8-9 miles north and northwest of the Proposed Action area. In the unlikely event that GGS are present within the Proposed Action area, adverse impacts (e.g., injury or death) on GGS could result from vehicular traffic or ground disturbance associated with project activities.

Irrigation canals and irrigation ditches adjacent to each Proposed Action area could provide dispersal habitat for juvenile GGS. An irrigation canal, which provides potential aquatic habitat for GGS is located immediately south of Well #2 and the expansion area is located approximately 160 feet north of potential aquatic habitat. The Parcel 1 and Parcel 6 locations are approximately 50 feet north and south of this irrigation canal, respectively. Additionally, the Parcel 1 and Parcel 2 locations are approximately 35 feet east and west of a large drainage ditch which provides potential low quality aquatic habitat for GGS. Both the irrigation canals and ditches are maintained (e.g., vegetation removal and recontouring) to efficiently deliver water to crops, which reduces the amount of emergent vegetation required for GGS escape cover and foraging habitat (Miller et al. 1999) and devalues the quality of the habitat. Despite having some emergent vegetation, because these aquatic habitats (canals, ditches) appear to be subject to regular vegetation management using both mechanical and chemical technique, and habitat within the channels are mostly open water, these aquatic habitats offer poor to marginal habitat to GGS. Burrows and other underground refuge are important to GGS during summer and winter to escape unfavorable winter cold temperatures or excessive summer heat. The GGS recovery plan states that wintering habitat can be up to 250 meters (820 feet) from the edge of marsh habitat (Miller et al. 1999). Typically, the USFWS defines upland habitat as all areas occurring within 200 feet of aquatic habitat (White 1997). Following that definition, well pad expansion areas at Well Pad #2, Parcel 1 and Parcel 6 are all within 200 feet of potential aquatic habitat (irrigation ditches) and thus may provide upland habitat for winter burrows. In addition, GGS burrows may also exist along project access roads since they are located within 200 feet of aquatic habitat. If burrows are located under the access roads or within well pad expansion areas then burrows can collapse and snakes can become entombed.

Despite the presence of vegetated irrigation ditches that may support dispersal of GGS, these provide marginal to poor habitat. Based on landscape habitat use analyses conducted by Wylie et al (Wylie, Casazza, and Daugherty 1997; Wylie, Casazza, and Martin 2002; Wylie et al. 2002; Wylie et al. 1995) provided in the Solano Multispecies Habitat Conservation Plan (Solano MHCP), low quality ditch habitat associated with rice fields provided an artificial marsh habitat that provides the essential components (e.g., appropriate cover, high food availability, and upland refuge) to support GGS. Alternatively, studies conducted in high quality marsh habitat surrounded by fallow fields did not locate GGS or found them at very low densities. Based on these results, areas supporting marginal to poor habitat or small, isolated patches of good habitat are presumed to not support GGS due to lack of surrounding aquatic habitat (Solano County Water Agency 2009). Within the Proposed Action area, the surrounding aquatic habitat is of marginal to poor quality and thus, it is unlikely that GGS would use these for dispersal.

The upland habitat that the Proposed Action area (i.e. upland habitat along access routes and within well pad expansion area) provides is also poor to marginal habitat for GGS. As part of existing agricultural activities, potential upland habitat for GGS within and immediately around Proposed Action area are extensively disked, tilled and planted with row crops to the edge of the existing well pad precludes occupation of burrowing mammals that would provide refugia for GGS. Additionally,

no burrows or other refugia were observed around either of the existing well pads, in the pad expansion areas, or along the access road, and no ground squirrel activity was observed during the field reconnaissance on August 20, 2012 or October 2, 2012 in these areas. Furthermore, due to the high level of disturbance, the Solano MHCP does not consider cultivated or plowed uplands within the Proposed Action area to be suitable wintering habitat for GGS (Solano County Water Agency 2009). Due to the level of regular disking and harvesting activity, uplands within the Proposed Action area are not considered to provide suitable wintering habitat (i.e., refugia) for GGS. Based on the observation of low quality habitat (i.e. distance from moderate to poor quality dispersal habitat) provided by the primary irrigation ditches (greater than 200 feet), documented lack of use in non-rice agricultural lands, the lack of upland habitat including burrows or other refugia, and the lack of ground squirrel activity near the well pad expansion areas, the irrigation canal, drainage ditches, irrigation ditches, and the associated farmed upland provide low quality habitat and the likelihood for GGS to occur within the pad expansion area is very low.

Section 5 Potential Effects

As discussed above, Delta smelt may occur within the irrigation canal and GGS has a low potential to occur within the Proposed Action area. In the unlikely event that Delta smelt or GGS is present within the Proposed Action area or nearby areas, the proposed project could result in effects on Delta smelt and GGS. These potential effects are discussed below.

5.1 Direct Effects

Direct effects are those that are caused by or will result from the proposed action at the time of the proposed action (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998).

Delta Smelt

If Delta smelt are present within the Proposed Action area during project activities, direct effects could include mortality and increased stress resulting from silting, fill, or spill of oil or other chemicals resulting in direct mortality or a reduction of prey items.

The valve allowing water into the irrigation canal is unscreened and Delta smelt could occur in the irrigation canal west of Cache Slough. The roads may be graded and augmented with gravel, which may result in direct effects from silting, fill or spills. Implementation of PG&E standard Best Management Practices will avoid effects on Delta smelt.

No work will occur within Cache Slough or aquatic habitat in the Cache Slough region and designated critical habitat will not be affected.

Giant Garter Snake

If GGS are present within the Proposed Action area during project activities, direct effects could include mortality, increased risk of predation, and increased stress resulting from:

- Crushing, dismemberment, and other injuries resulting from filling or crushing of burrows or crevices used for refuge;
- Crushing, dismemberment, and other injuries resulting from contact with vehicles and other construction equipment during construction activities;
- GGS movement into areas of unsuitable habitat where they will experience greater risk of predation or other sources of mortality;
- Silting, fill, or spill of oil or other chemicals resulting direct mortality or a reduction of prey items.

Well Pad #2, Parcel 1, Parcel 6 and the access roads are within 200 feet of aquatic habitat, and although it is marginally suitable, grading and gravel augmentation could adversely affect an individual. Implementation of the avoidance and minimization measures described in Section 6 would reduce effects to may affect by not adversely affect giant garter snake.

5.2 Indirect Effects

Potential indirect effects are those that are caused by or will result from the proposed action and occur later in time (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998). The Proposed Action is a short-term construction activity that is anticipated to be completed within eleven weeks. The expansion of the Cache Slough Well #2, Parcel 1, or Parcel 6 is not expected to significantly alter habitat suitability for GGS from existing conditions. Once the pad is installed and core sampling is complete, the pad will be returned to agricultural use or will become permanent. The Proposed Action is not anticipated to result in indirect effects on Delta smelt or GGS.

5.3 Cumulative Effects

Cumulative effects are those effects resulting from future state, local, and private actions that are reasonably certain to occur in the action area. The Proposed Action is not expected to change existing land uses that could result in cumulative effects, or otherwise contribute to cumulative effects on Delta smelt or GGS. All irrigation and drainage canals and ditches are subject to existing management related to maintaining viable agricultural land through water management to retain Cache Slough as upland and water delivery to irrigate crops. The adjacent agricultural lands are also subject to ongoing management as part of ongoing agricultural operations. Management actions in proximity to the Proposed Action area are expected to continue after implementation of the proposed project.

If core sampling determines that the geology of the site is suitable for compressed air storage and the site is selected for compression testing, then it would be subject to a separate federal action and would be subject to the consultation requirements established in Section 7 of ESA and, therefore, are not considered cumulative to the proposed action at this time. Because it is yet to be determined if this site would be selected, farming activities will continue on the site and there are no reasonably foreseeable projects planned that would affect the area.

Section 6 Proposed Avoidance and Minimization Measures

The following measures have been incorporated into the Proposed Action in order to avoid or minimize the potential for adverse effects on Delta smelt and GGS.

1. Prior to working on-site, all workers shall be provided with Environmental Awareness Training by a qualified biologist. The training shall address the identification and general ecology of Delta smelt and GGS and other species that have potential to occur in the Proposed Action area, and the AMMS to be implemented in order to avoid impacts on these resources. Areas to be avoided shall also be addressed in the training.

2. Prior to construction, all work areas (e.g., vehicle access, parking, staging) needed to complete the project shall be identified in coordination with the on-site biologist. Due to the presence of sensitive resources, some work areas may need to be adjusted. All work areas shall be limited to the minimum area necessary to complete work.

3. If practicable, ground disturbing activity (e.g. vegetation removal, compaction, and placement of gravel fill) at all the pad sites shall be conducted during the active season for giant garter snake (GGS) (i.e., between May 1 and October 1). If ground-disturbing activity cannot be conducted during the GGS active season, preconstruction surveys for potential GGS wintering sites (i.e., burrows and soils crevices) shall be conducted within two weeks by a qualified biologist to determine if potential GGS wintering sites are present within proposed areas of ground disturbing activity (e.g., the pad expansion sites, road work, application of gravel) and again within 24 hours prior to ground-disturbing activity.

4. All burrows or potential refuge habitat shall be flagged and avoided. If work is suspended for a period of five days or greater, then the Proposed Action area must be resurveyed. If it is determined that potential GGS wintering habitat (e.g., burrows and crevices) is present within areas planned for ground disturbance, ground-disturbing activities shall be postponed until the GGS active season (i.e., between May 1 and October 1). If GGS is encountered at any time during the project, work will stop immediately and the USFWS will be contacted before work proceeds.

5. A biological monitor shall be on site during all phases of construction to direct access and construction work around irrigation ditches and other sensitive habitats capable of supporting GGS. If any GGS are observed within the Proposed Action area during work activities, work shall cease and the on-site project manager shall immediately contact the project biologist, Catalina Reyes (925-808-8811) prior to resuming work. The biological monitor has the authority to stop construction to resolve any biological concerns.

6. Access to pads shall be confined to existing roads, road shoulders, and other compacted areas. Travel along roads shall be restricted to the centerline. If placement of gravel on access roads is necessary, the placement shall be limited to the existing road surface. No gravel shall be

placed on canal or ditch banks or other areas that may support burrows that could be used by GGS. No grading shall occur along segments of existing roads that may support burrows that could be used by GGS.

7. Canals and irrigation ditches will be designated as environmentally sensitive areas and physical disturbance to irrigation ditches will be avoided during construction.

8. If deemed necessary, an exclusionary fence shall be erected to protect potentially sensitive habitat adjacent to the pad expansion area. To ensure that GGS does not become trapped or entangled, no wattles with plastic monofilament netting are permitted. Burlap or coconut wattles are appropriate substitutes.

9. A qualified biologist shall perform a general pre-construction survey within 72 hours of the start of project construction.

10. Escape ramps at a 45 degree angle or less will be provided for any excavations that are greater than one foot that are left open overnight. For smaller holes, cover so that no gaps occur and inspect each morning for wildlife. Inspect prior to filling any trenches or holes. If special-status wildlife becomes entrapped, work shall stop and the PG&E project biologist, Catalina Reyes, shall be notified immediately to determine next steps.

11. All construction personnel shall visually check for snakes and other wildlife under vehicles and equipment prior to moving them.

12. Construction equipment will be maintained to prevent leaks of fuels, lubricants or other pollutants into aquatic habitats.

13. Whenever possible, refueling and maintenance of vehicles shall occur offsite. In cases when this is not possible, refueling and maintenance of vehicles and equipment will be conducted over drip pans and at least 100 feet from any waterway.

14. Open ends of pipes, conduits or other materials stored onsite will be covered to exclude wildlife and will be inspected prior to use.

15. Vehicular speed within the Proposed Action area shall be limited to 10 miles per hour in order avoid impacts on wildlife that may be located on or near roadways. If construction occurs during the active period of the GGS, biological monitors will drive in front heavy construction vehicles (i.e. dump trucks, drill rigs, etc.) on all dirt roads during entry/exit of project site. Biologist will lead vehicles at a minimum speed of 10 mph, watch for signs of snakes, and stop and investigate the road if there are any concerns.

16. Watering of roads during dry season work shall be performed as necessary (approximately 3–4 times a day) in order to reduce potential dust resulting from project associated traffic.

17. Caution shall be used when handling and/or storing chemicals (fuel, hydraulic fluid, etc.). As part of standard PG&E Best Management Practices (BMPs) crews shall have appropriate materials on site to provide secondary containment and prevent and manage spills. If groundwater is encountered, contact PG&E Environmental Specialist Bryon Nicholson (415-990-0139).

18. Crews shall implement all standard PG&E BMPs outlined in the Good Housekeeping Activity Specific Erosion and Sediment Control Plan (January 2011) as needed.

19. If the scope of work or project location changes, contact project biologist Catalina Reyes (925-808-8811) prior to commencing work. The project biologist or Land Planner (Ernie Ralston, 515-973-3215) will contact the USFWS Bay-Delta Fish & Wildlife Office ESA/Regulatory Division upon notice of any such changes.

20. Construction related trash will be removed from the site daily and upon work completion and return site to near pre-construction contours and conditions upon project completion.

Section 7 Determination

With the implementation of the avoidance and minimization measures identified in Section 6, it is determined that the Cache Slough Well Pad Expansion Project:

- *may affect, but is not likely to adversely affect,* Delta smelt and
- *may affect, but is not likely to adversely affect*, giant garter snake.
- *will have no effect* on designated critical habitat for Delta smelt.

The Cache Slough Well Pad Expansion Project will not affect any other federally listed or proposed species, and will have no effect on designated critical habitat for any federally listed species.

Section 8 List of Preparers

- Heather Kelly, Project Manager, NSR
- John Hunt, Biologist, NSR
- Catalina Reyes, Biologist, PG&E
- Mark Wuestehube, Environmental Analyst, NSR

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APPENDIX A

U.S. Fish and Wildlife Service Species List

U.S. Fish & Wildlife Service

Sacramento Fish & Wildlife Office

Federal Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 120805065452

Database Last Updated: September 18, 2011

Quad Lists

Listed Species

Invertebrates

Branchinecta conservatio
Conservancy fairy shrimp (E)

Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Elaphrus viridis
delta green ground beetle (T)

Lepidurus packardi
vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
Critical habitat, delta smelt (X)
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)

Rana draytonii
California red-legged frog (T)

Reptiles

Thamnophis gigas
giant garter snake (T)

Birds

Rallus longirostris obsoletus
California clapper rail (E)

Quads Containing Listed, Proposed or Candidate Species:

RIO VISTA (480B)

County Lists

Solano County

Listed Species

Invertebrates

Apodemia mormo langei
Lange's metalmark butterfly (E)

Branchinecta conservatio
Conservancy fairy shrimp (E)
Critical habitat, Conservancy fairy shrimp (X)

Branchinecta lynchi
Critical habitat, vernal pool fairy shrimp (X)
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Elaphrus viridis
Critical habitat, delta green ground beetle (X)
delta green ground beetle (T)

Lepidurus packardi
Critical habitat, vernal pool tadpole shrimp (X)
vernal pool tadpole shrimp (E)

Speyeria callippe callippe
callippe silverspot butterfly (E)

Speyeria zerene myrtleae
Myrtle's silverspot butterfly (E)

Syncaris pacifica
California freshwater shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Eucyclogobius newberryi
tidewater goby (E)

Hypomesus transpacificus
Critical habitat, delta smelt (X)
delta smelt (T)

Oncorhynchus kisutch
coho salmon - central CA coast (E) (NMFS)

Oncorhynchus mykiss
Central California Coastal steelhead (T) (NMFS)

Central Valley steelhead (T) (NMFS)
Critical habitat, Central California coastal steelhead (X) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
Critical habitat, winter-run chinook salmon (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)
Critical habitat, CA tiger salamander, central population (X)

Rana draytonii
California red-legged frog (T)
Critical habitat, California red-legged frog (X)

Reptiles

Masticophis lateralis euryxanthus
Alameda whipsnake [=striped racer] (T)
Critical habitat, Alameda whipsnake (X)

Thamnophis gigas
giant garter snake (T)

Birds

Charadrius alexandrinus nivosus
western snowy plover (T)

Pelecanus occidentalis californicus
California brown pelican (E)

Rallus longirostris obsoletus
California clapper rail (E)

Sternula antillarum (=Sterna, =albifrons) browni
California least tern (E)

Strix occidentalis caurina
northern spotted owl (T)

Mammals

Reithrodontomys raviventris
salt marsh harvest mouse (E)

Vulpes macrotis mutica
San Joaquin kit fox (E)

Plants

Blennosperma bakeri
Baker's stickyseed [=Sonoma Sunshine] (E)

Castilleja affinis ssp. neglecta
Tiburon paintbrush (E)

Cirsium hydrophilum var. hydrophilum
Suisun thistle (E)

Cordylanthus mollis ssp. mollis
soft bird's-beak (E)

Erysimum capitatum ssp. angustatum
Contra Costa wallflower (E)
Critical Habitat, Contra Costa wallflower (X)

Holocarpha macradenia
Santa Cruz tarplant (T)

Lasthenia conjugens
Contra Costa goldfields (E)
Critical habitat, Contra Costa goldfields (X)

Limnanthes vinculans
Sebastopol meadowfoam (E)

Navarretia leucocephala ssp. pauciflora
few-flowered navarretia (E)

Neostapfia colusana
Colusa grass (T)
Critical habitat, Colusa grass (X)

Oenothera deltoides ssp. howellii
Antioch Dunes evening-primrose (E)
Critical habitat, Antioch Dunes evening-primrose (X)

Orcuttia inaequalis
San Joaquin Valley Orcutt grass (T)

Sidalcea keckii
Keck's checker-mallow (=checkerbloom) (E)

Trifolium amoenum
showy Indian clover (E)

Tuctoria mucronata
Critical habitat, Solano grass (=Crampton's tuctoria) (X)
Solano grass (=Crampton's tuctoria) (E)

Proposed Species

Plants

Cirsium hydrophilum var. hydrophilum
Critical habitat, Suisun thistle (PX)

Cordylanthus mollis ssp. mollis
Critical habitat, soft bird's-beak (PX)

Key:

(E) *Endangered* - Listed as being in danger of extinction.
(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.
(P) *Proposed* - Officially proposed in the Federal Register for listing as endangered or threatened.
(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.
(C) *Candidate* - Candidate to become a proposed species.
(V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.
(X) *Critical Habitat* designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, **or may be affected by** projects within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list. See our Protocol and Recovery Permits pages.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

> Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.

  During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.

- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.

  Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our Map Room page.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern.

However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

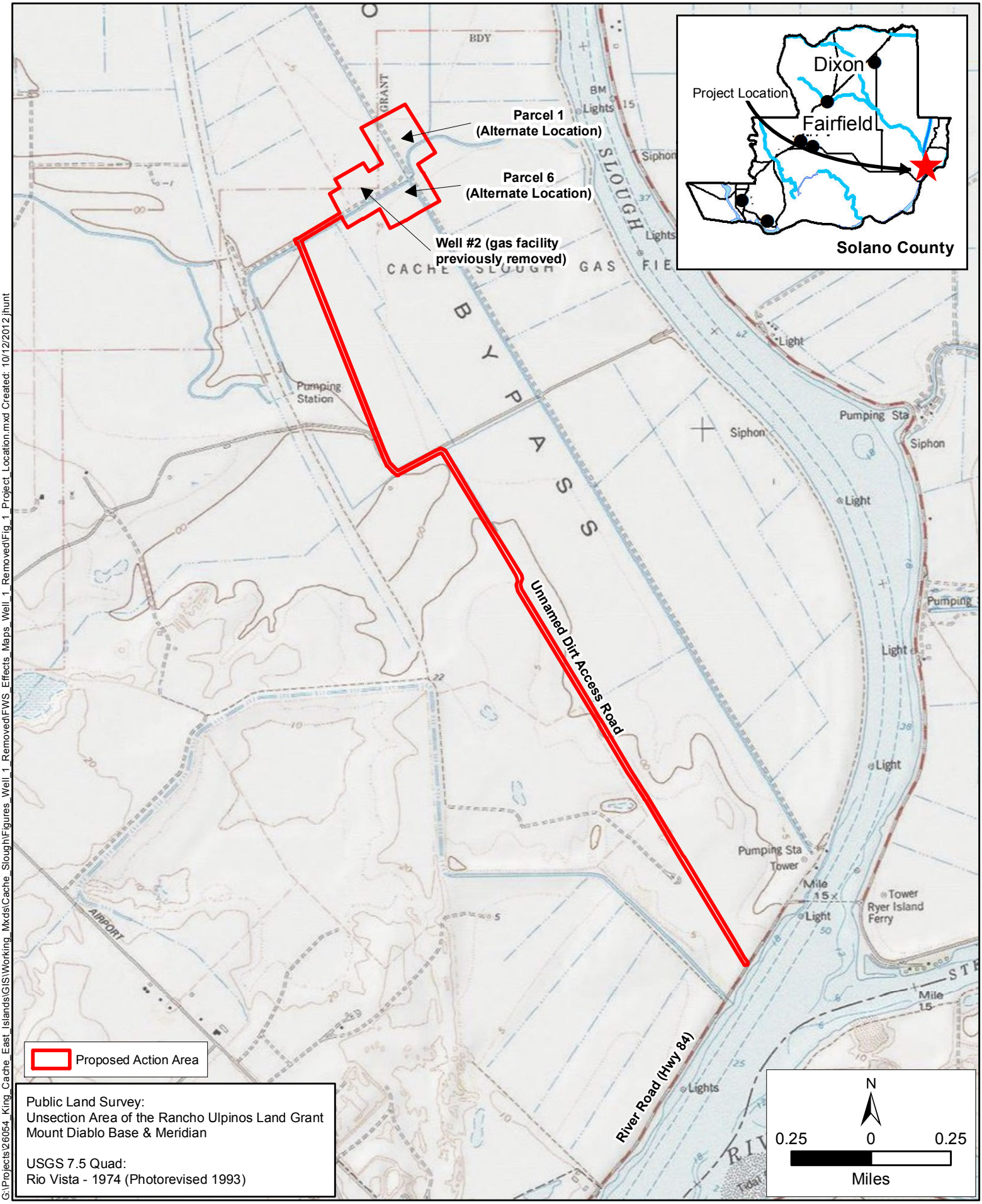
If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6520.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be November 03, 2012.

APPENDIX B

Figures

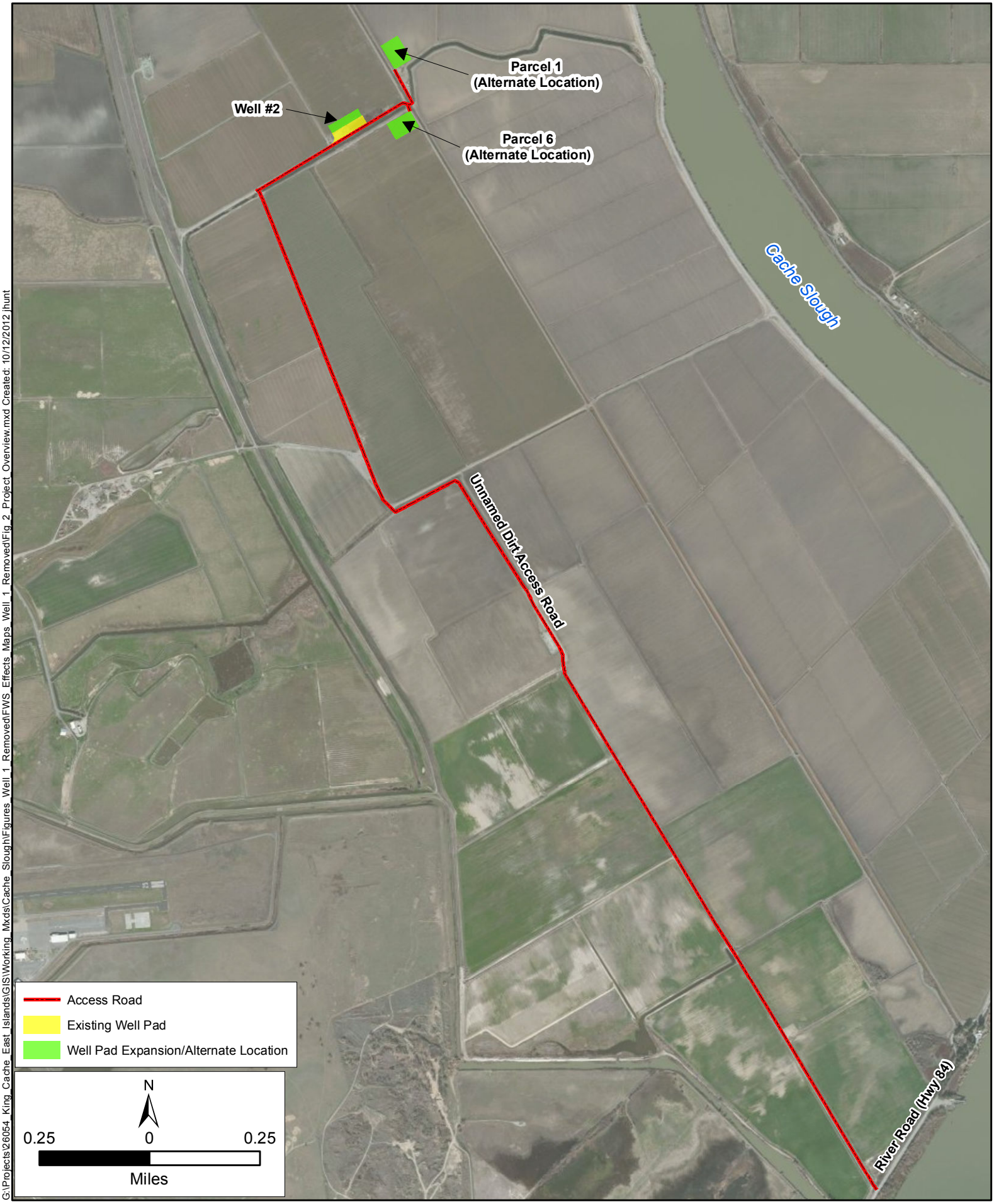


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North State Resources, Inc.

Cache Slough, Solano County, California

Figure 1. Project Location and Vicinity Map



Cache Slough, Solano County, California

North State Resources, Inc.

Figure 2. Project Area



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Cache Slough, Solano County, California

North State Resources, Inc.

Figure 3-1. Survey Results



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Cache Slough, Solano County, California

North State Resources, Inc.

Figure 3-2. Survey Results



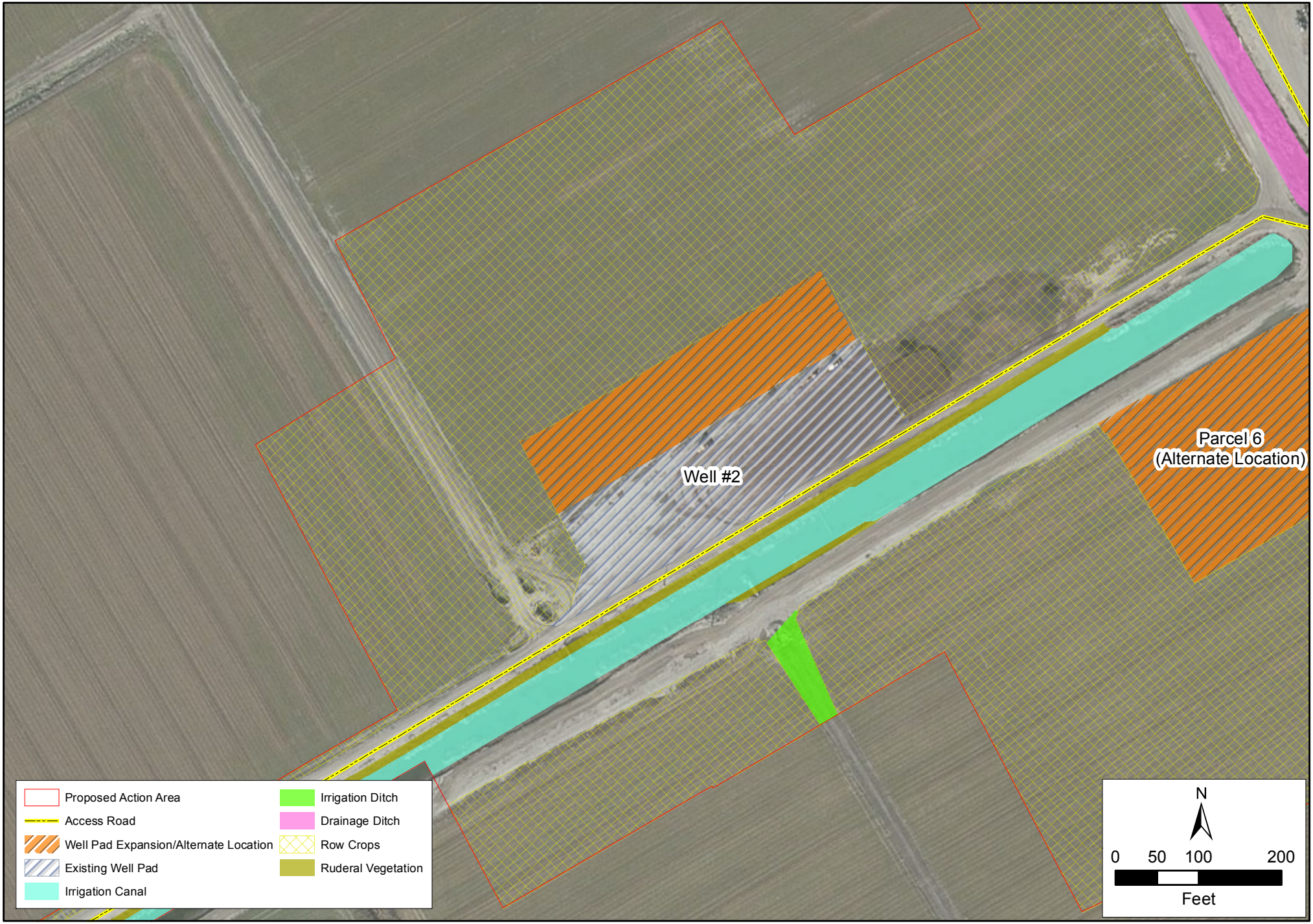
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Cache Slough, Solano County, California

North State Resources, Inc.

Figure 3-3. Survey Results

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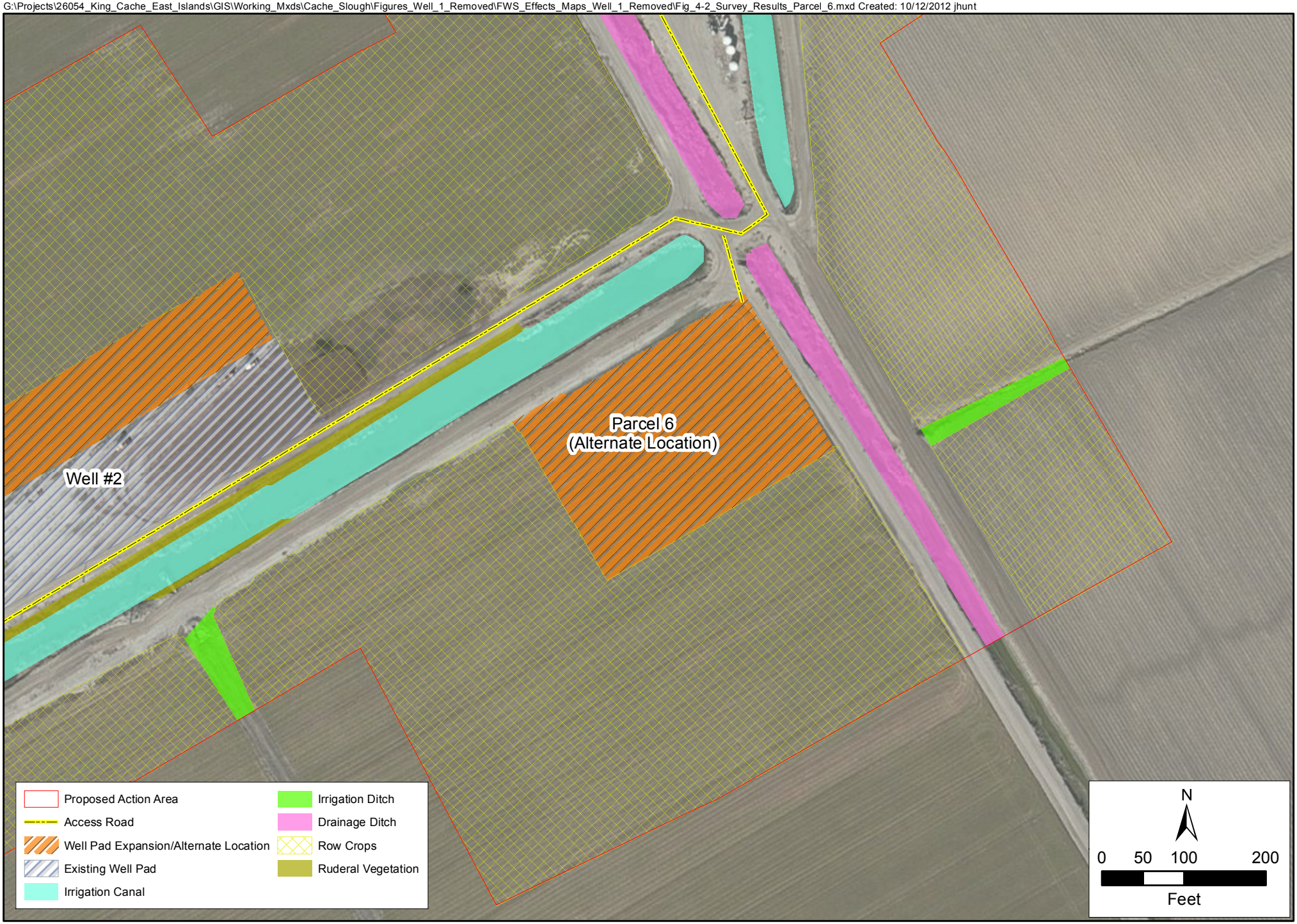


Cache Slough, Solano County, California

North State Resources, Inc.

Figure 4-1. Survey Results - Well#2 Pad Expansion Area

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Cache Slough, Solano County, California

North State Resources, Inc.

Figure 4-2. Survey Results - Parcel 6 (Alternate Location)

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Cache Slough, Solano County, California

North State Resources, Inc.

Figure 4-3. Survey Results - Parcel 1 (Alternate Location)

Gas Field GIS Environmental Evaluation

Field Name: **Cache Slough**

Resource Category	Presence/Potential Direct Effects: Station	Field	0.25mi	5mi	Vaca Gen-Tie	8Mile Gen-tie	Gas Connection	Comments & Mitigation Options	R-Y-G	Notes
Scenic Highway	N	N	N	N	N		N			
Airport/Approach Patterns	Y				N			Rio Vista Aiport ~8200' S of station		Need to review Airport Master Plan to confirm station site not infringing on control areas.
Envirostor List Site										
Federal Sensitive Species										
Suitable Habitat	N	N	N	N	N	N	N			
Critical Habitat	N	N	N	N	N	N	N			
State Sensitive Species										
Suitable Habitat	N	N	N	N	Y	Y	N	[Vaca-Dixon-SwHa], [8M-Delta tule pea, Mason's lilaeopsis, Black Rail]		SwHa & Rail require limited construction period if nesting near gen-tie. Plants can be avoided.
ACEC/Protected Lands	N	N	N	Y	N	Y	N	Along Sacramento River & White's Slough		Routing next to lands at Sac River, must obtain R/W from DWR at White's Slough xing
Kern County VFHCP Preservation Priority Ranking										
Land Use/Zoning	A80	A80						Solano County		
Public Lands	N	N	N	Y	N	Y	N	DWR White Slough Wildlife Area @ I-5		Must obtain R/W from DWR at White's Slough xing
Tribal Lands	N	N	N	N	N	N	N			
Williamson Act Contracts	Y	Y								Station site is under WA contract
Farmland Class	P	P/S	P/S	P/S	P/S/O	P/L	P/S			Station site is prime farmland
Crop Types	Row	Row	Row	Row	Row	Row	Row			
Wetlands	N	N	N	N	N	N	N			
Vernal Pools	N	N	N	Y	N	N	N			
Flood Zones	100	100	100	100	100/500/X	100	100			Will need to obtain flood elevation for station structure designs

Locational Assumptions:
Station Site: **Located on top of field, approx 1.5 mi East of Liberty Island Rd. Access over private property. ~48 ac.**
Gas: **~2.3 mi to Line 200C5-1, 8" dia, 868# MAOP, Installed 1980 Route is all private land requiring easements**
Electric Gen-Tie Alternatives:
Vaca-Dixon Sub: ~23 mi through row crop, generally following roads, property lines or field edges. Skirts edges of vernal pool areas. Segment just NW of station is Hasting Is hunting club. **17 Residence front route.**
Gold Hill - Eight Mile 230kV Line: ~20 mi through row crop, generally following roads, property lines or field edges and Highway 12. Additional 4 miles to Eight Mile Sub. **Three residences along route, plus recreation/modular residential/commercial development at Mokelumne River and Potato Slough.**
Waste water source: **None in close proximity**

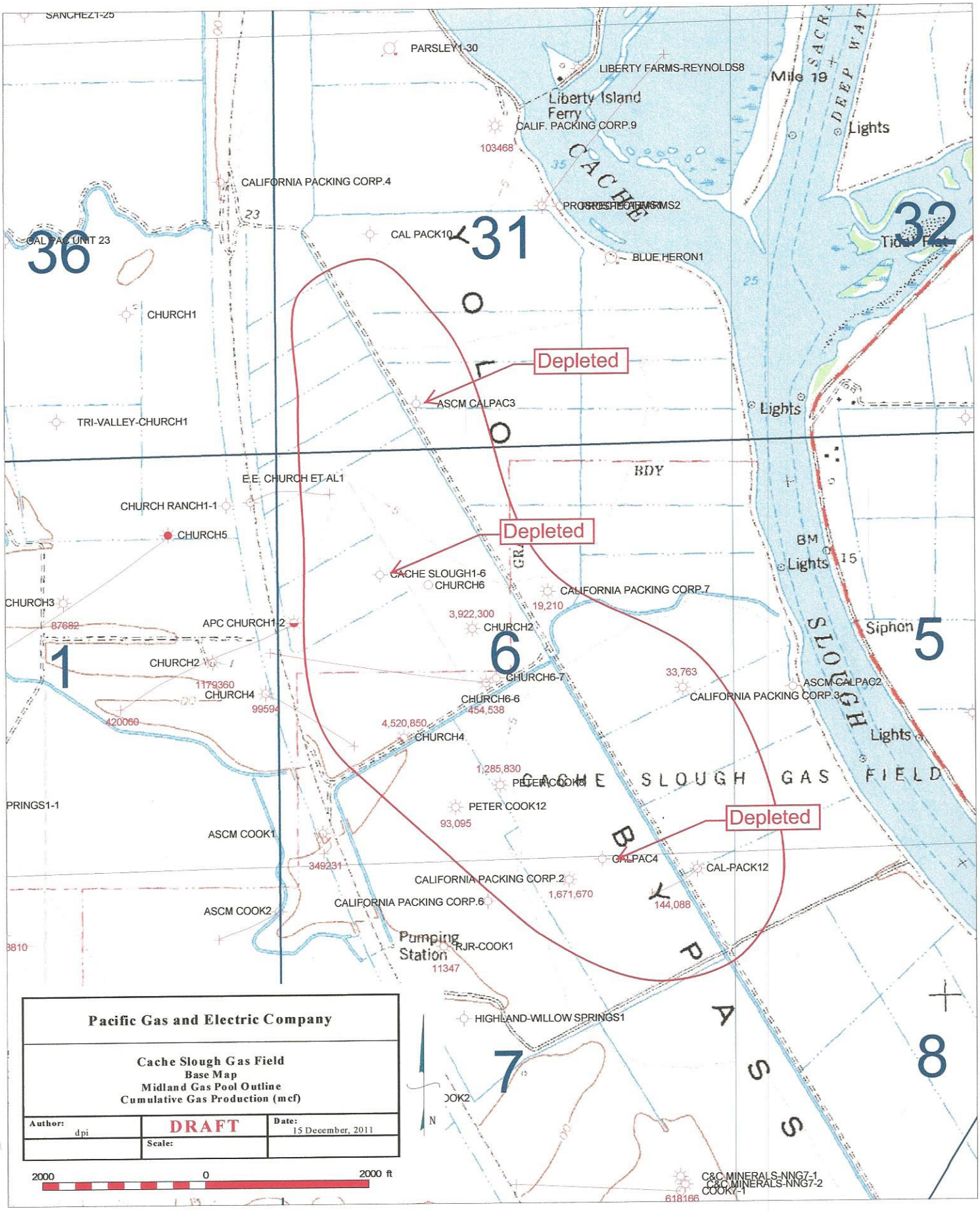
Env Policy Criteria
Sources of noise: **Farming operations only - no other transportation, commercial or industrial sources.**
Other power generational facilities and industrial areas that could be cumulatively significant: **None**
Sensitive receptors: **See gen-tie descriptions above**
Economic status of lands/EJ communities:
Water availability and source: **To be determined during subsequent screening**
Known wildlife corridors/connectivity areas, nesting areas, Audubon IBAs: **Known waterfowl migration route & potential collision w/gen-tie, otherwise subject to further review - none shown in GIS.**
Conservation Easements: **None affecting station site or buffers**
Riparian Areas: **8 Mile Gen-tie at Sacramento River Xing, Vaca Dixon Gen-tie at Cache Slough - Both short segments of riparian veg**
Areas that would be preferred for siting such as degraded or disturbed lands: **None in vicinity - surrounded by ag**

Zoning Info - Solano County - Ag Zoning District - "Utility facilities or infrastructure, outside of R.O.W." allowed with Use Permit

Cache Slough Gas Field Reconnaissance

12/19/11

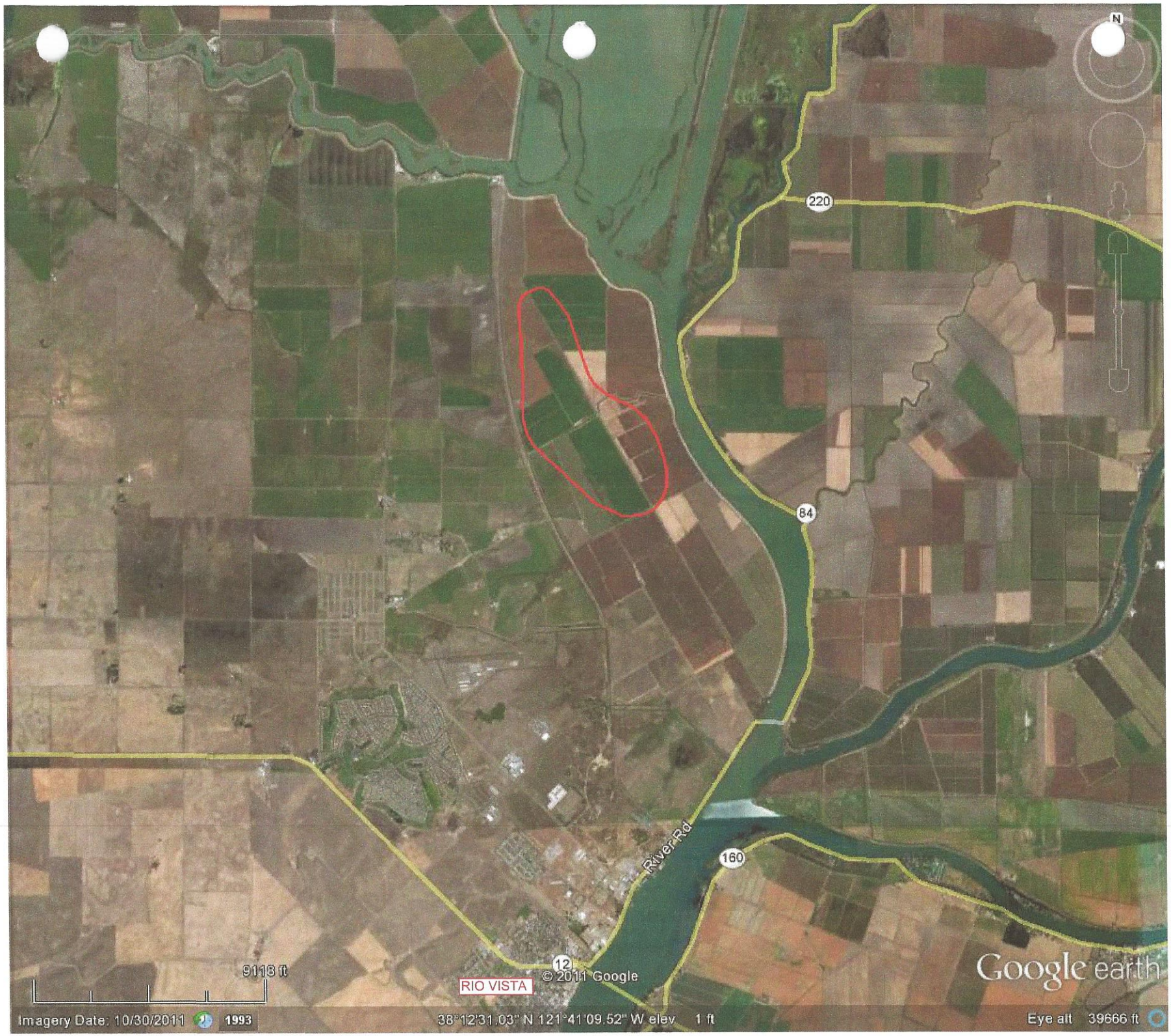
Pool Discovery Date:	January, 1945
Primary Productive Zone:	Midland Sand (Mokelumne River Formation)
2011 Field Production (thru 6/11):	No current production, last produced January, 2008
Cum Gas Production (Midland pool):	12,052,245 mcf
Reserves (CDDOGR 2009):	0
Number of gas wells (Midland pool):	8 abandoned gas wells
Average Reservoir Depth:	4750 feet
Reservoir Area:	Approximately 650 acres
Maximum Gross Pay Thickness:	70 feet
Trapping Mechanism:	Structural closure, folding and faulting
Cultural Conditions:	Field located four miles north of Rio Vista adjacent to Cache Slough. Elevation of ground surface is as much as five feet below mean sea level. Surface use is agriculture. Access from Highway 12 and 84.
Notes:	3D seismic data has been acquired over the field and may be available for purchase. Seismic data quality is poor.

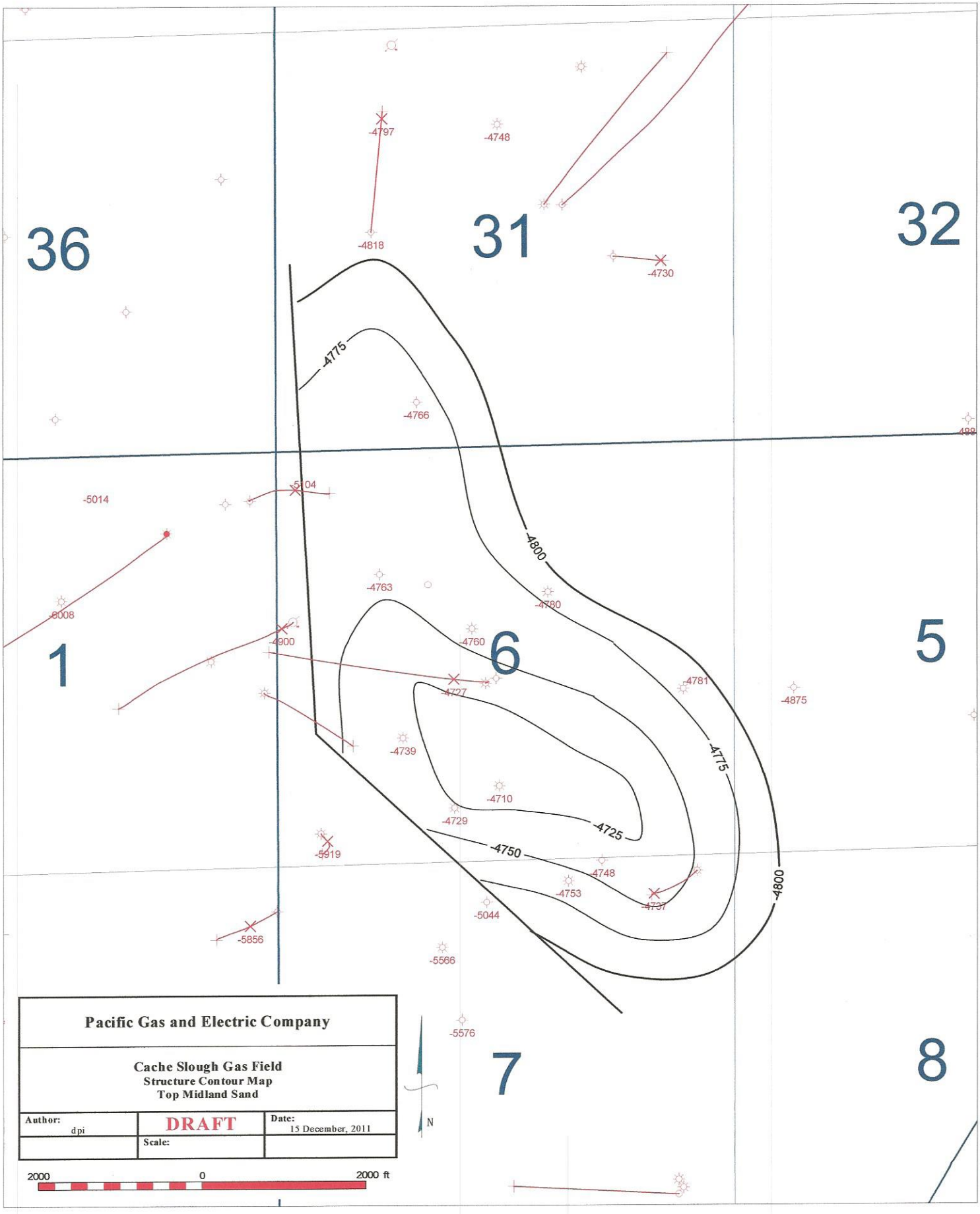


Pacific Gas and Electric Company

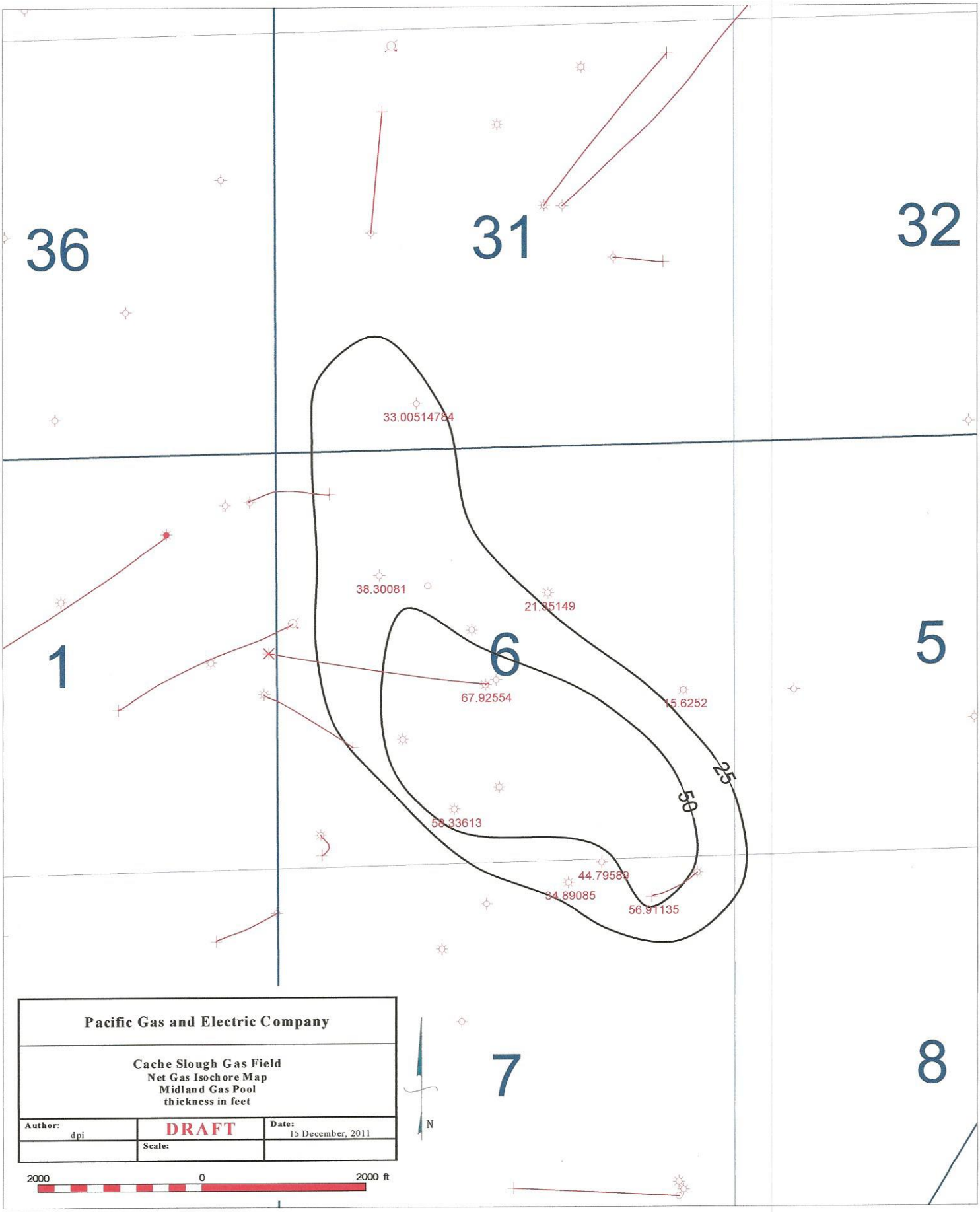
Cache Slough Gas Field
Base Map
Midland Gas Pool Outline
Cumulative Gas Production (mcf)

Author: dpi	DRAFT	Date: 15 December, 2011
	Scale:	


N
220
84
River Rd
160
12
RIO VISTA
9118 ft
© 2011 Google
Google earth
Imagery Date: 10/30/2011
1993
38°12'31.03" N 121°41'09.52" W elev 1 ft
Eye alt 39666 ft



Pacific Gas and Electric Company		
Cache Slough Gas Field Structure Contour Map Top Midland Sand		
Author: dpi	DRAFT	Date: 15 December, 2011
	Scale:	


36
31
32
1
6
5
7
8
33.00514784
38.30081
21.35149
67.92554
15.6252
58.33613
44.79589
34.89085
56.91135
25
50
N
Pacific Gas and Electric Company
Cache Slough Gas Field
Net Gas Isochore Map
Midland Gas Pool
thickness in feet
Author:
dpi
DRAFT
Date:
15 December, 2011
Scale:
2000
0
2000 ft

ATTACHMENT 4

CACHE SLOUGH GAS FIELD
PRODUCTION SUMMARY

APINUM	OPERATOR	WELL NAME/NO.		SPUD DATE	ABD	PROD INT. (FT)	FM.	INITIAL PRODUCTION RATE	SHUT IN PRESS (PSI)	CUM GAS (MCF)	CUM H2O (BBLS)
04095000410000	CHEVRON U.S.A. INC.	CALPAC	2	1/14/1945	7/12/1952	4765-4790	Midland sand	2795 mcf/d, 1885/1881 psi, 1/4 in.	1876/1893 psi	1,671,668	314
04095000330000	AMERADA HESS CORP.	CHURCH	2	5/5/1945	7/25/1963	4760-4790	Midland sand	15,049 mcf/d, 1881/1811 psi, 3/8 in.	1910/1910 psi	3,922,297	31,774
04095000370000	PETER COOK, JR.	PETER COOK	8	7/11/1945	5/26/1966	4712-4777	Midland sand	2796 mcf/d, 1836/1863 psi, 1/4 in.	1903/1903 psi	1,285,831	2,312
04095000420000	CHEVRON U.S.A. INC.	CALPAC	3	7/29/1945	11/6/1952	4790-4795	Midland sand	2590 mcf/d, 1746/1748 psi, 1/4 in.	1879 psi	33,763	2,767
04095000350000	AMERADA HESS CORP.	CHURCH	4	3/7/1948	9/4/1963	4743-4786	Midland sand	5913 mcf/d, 1529/1796 psi, 3/8 in.	1801/1801 psi	4,520,850	1,579
04095000440000	CHEVRON U.S.A. INC.	CALPAC	7	12/12/1951	11/3/1952	4790-4796	Midland sand	2940 mcf/d, 1020 psi tbg, 3/8 in.		19,210	1,258
04095203730000	CHEVRON U.S.A. INC.	CALPACK	12	6/22/1978	11/21/1980	4812-4822	Midland sand	2437 mcf/d, 1536/1608 psi	1734/1734 psi	144,088	2,738
04095212080000	TOWNE	CHURCH	6-6	7/27/2004	12/4/2008	4834-4841	Midland sand	887 mcf/d, 1600/1725 psi, 10/64 in	1710/1715 psi	454,538	
								TOTAL		**12,052,245**	**42,742**
04095000400000	CHEVRON U.S.A. INC.	PETER COOK	12	6/25/1960	1/23/1962	5329-31,	Lower MRF	3850 mcf/d, 1811/1946 psi, 5/16 in.	1972/1970 psi	93,095	9,009
04095201020000	PHILLIPS PETROLEUM	CHURCH	4	9/16/1969	4/25/1973	5483-89, 5593-98, 5604-12, 5620-27	Lower MRF	1600 mcf/d, 1837 psi, 13/64 in.	2050 psi	99,594	163
04095209790000	TONKA ENERGY, INC.	ASCM COOK	1	3/30/1994	4/9/2002	6787-95, 6800-06, 6872-92,	Starkey Fm.	1510 mcf/d, 2110 psi	2500/2325 psi	349,231	
04095210500000	ABA ENERGY CORP.	RJR-COOK	1	8/21/1998	7/7/1999	4692-4701	Domengine Fm.	389 mcf/d, 480/480 psi, 12/64 in.		11,347	
								TOTAL		**553,267**	**9,172**
								FIELD TOTAL		**12,605,512**	**51,914**

Department Of Resource Management
675 Texas Street, Suite 5500
Fairfield, CA • 94533
Planning Division
(707) 784-6765

ADMINISTRATIVE PERMIT NO. AD-12-09

PG&E
(permittee)

To construct a one acre well pad and drill for the purpose of collecting core samples of the cap rock and porous rock formations. The project is located 1.4 miles northeast of the City of Rio Vista in an "A-80" Exclusive Agricultural Zoning District, APN's: 0177-030-010, 020, and 040.
(Land use, location and zone district)

In addition to the zoning regulations, the building laws and other ordinances, the conditions of granting this permit are attached as follows: Attachment A, Permit Standards (Oil & Gas Well Drilling).

Granting or conditional granting of this permit does not release the permittee from complying with all other county, state or federal laws. Failure to comply with all the aforementioned provisions and conditions will be cause for the revocation of this Permit by the County Planning Commission.

Failure, neglect or refusal to exercise this Permit within a period of one (1) year from the date of granting thereof, shall automatically cause the same to become and remain null and void.

This permit shall not take effect unless permittee signs in the space below within thirty (30) days after the date of granting hereof.

I agree to conform fully to this use permit and all of the foregoing conditions.

Permittee's Signature — Date: 12/20/12

ERNIE RALSTON
Permittee's Name (Please Print)

PO Box 770000-N10A — SAN FRANCISCO, CA — 94177
Address — City — Zip

Date Granted December 6, 2012

SOLANO COUNTY ZONING ADMINISTRATOR

Issued by: Bill Emlen
Bill Emlen, Director, Resource Management

Date 1/8/13

PERMIT STANDARDS (Oil and Gas Well Drilling)

1. Security satisfactory to the Director of Resource Management has been or will be posted as security for payment of repairs to County roads and highways damaged by well-drilling activities, including transportation of equipment to and from the site.

2. Drilling operations will conform to the regulations of the California Division of Oil and Gas designed to prevent damage to natural resources.

3. The drilling operation will be confined to as small an area as practical and will not cause irreversible damage to unique vegetation or fish and wildlife habitats.

4. After drilling is complete, all drilling muds, soil wastes, waste water and other fluids will be removed from the site and disposed of in a manner that does not adversely affect other areas.

5. Measures will be taken to prevent any significant pollution of ground water surface water or water courses.

6. Derricks will be removed when wells are brought into production.

7. If wells are abandoned, they shall be sealed in accordance with Division of Oil and Gas regulations, and the drilling or production facilities will be removed.

8. Necessary measures will be taken to prevent dust, noise, light glare, odor and other objectionable elements from adversely affecting the surrounding area beyond acceptable limits.

9. Chain link, barbed wire, or other adequate fencing shall be installed around the construction site to prevent unauthorized access. Fencing may be scaled back if the well is brought into production.

10. The permittee shall obtain a building permit from the Building and Safety Division of the Department of Resource Management prior to erecting liquid storage tanks greater than 5000 gallons capacity.

11. The permittee shall file a Hazardous Materials Business Plan with the Division of Environmental Health of the Department of Resource Management prior to the construction of a production facility.

12. Disposal of human waste on-site is prohibited by California Health and Safety Code. Section 5411 and County Code, Chapter 25. Contents of chemical portable toilets shall be disposed of at a designated receiving station which discharge to a publicly owned sewage treatment works.

13. All liquid storage tanks shall have a method of control of spilled fluid; this may be accomplished by one or more of the following methods:

    a) Drainage system for safe disposal.
    b) Division walls to direct fluids to a preferred point.
    c) Dikes or fire walls capable of containing the volume of the largest tank.

14. Any changes of production or pipeline facilities not shown on the submitted plans shall require a new permit prior to construction.

Attachment A

ATTACHMENT 3

CACHE SLOUGH GAS FIELD
PROJECT WELLS

API NO.	OPERATOR	WELL NAME	NO.	LAT.	LONG.	SPUD	STATUS	TD	ELEV	FIELD
04095000360000	PETER COOK, JR.	PETER COOK	2	38.20506	-121.6909	11/6/1942	P&A	4791	10 GR	RIO VISTA GAS
04095000410000	CHEVRON U.S.A. INC.	CALPAC	2	38.2124	-121.68262	1/14/1945	AGS	4840	7 DF	CACHE SLOUGH
04095000330000	AMERADA HESS CORP.	CHURCH	2	38.22094	-121.68666	5/5/1945	AGS	4796	11 KB	CACHE SLOUGH
04095000370000	PETER COOK, JR.	PETER COOK	8	38.21563	-121.68553	7/11/1945	AGS	4790	10 GR	CACHE SLOUGH
04095000420000	CHEVRON U.S.A. INC.	CALPAC	3	38.21886	-121.6777	7/29/1945	AGS	5653	4 DF	CACHE SLOUGH
04095000350000	AMERADA HESS CORP.	CHURCH	4	38.21727	-121.68961	3/7/1948	AGS	4787	9 KB	CACHE SLOUGH
04095000430000	CHEVRON U.S.A. INC.	CALPAC	6	38.21169	-121.68609	12/1/1950	P&A	5700	6 DF	CACHE SLOUGH
04095000440000	CHEVRON U.S.A. INC.	CALPAC	7	38.22217	-121.68343	12/12/1951	AGS	4842	10 DF	CACHE SLOUGH
04095000400000	CHEVRON U.S.A. INC.	PETER COOK	12	38.2149	-121.68744	6/25/1960	AGS	7730	11 KB	CACHE SLOUGH
04095001160000	CHEVRON U.S.A. INC.	CAL PACK	10	38.23434	-121.69088	4/13/1962	P&A	5000	7 KB	LIBERTY ISLAND
04095001160001			10RD	38.23434	-121.69088	4/21/1962	P&A	5318	7 KB	
04095000380000	C & C CO-OWNERS IN C	PETER COOK	14	38.20772	-121.69748	8/8/1963	SHUTIN	15000	22 DF	LINDSEY SLOUGH
04095000390000	OCCIDENTAL PETROLEUM	E.E. CHURCH ET AL	1	38.2253	-121.69607	5/11/1966	P&A	8831	10 KB	CACHE SLOUGH-N
04095200870000	PHILLIPS PETROLEUM C	CHURCH	2	38.21989	-121.69774	5/6/1969	AGS	9828	13 KB	LINDSEY SLOUGH
04095200980000	PHILLIPS PETROLEUM C	CHURCH	3	38.22197	-121.70409	7/27/1969	AGS	9411	12 KB	LINDSEY SLOUGH
04095201020000	PHILLIPS PETROLEUM C	CHURCH	4	38.21882	-121.69549	9/16/1969	AGS	9725	14 KB	LINDSEY SLOUGH
04095202880000	TRI-VALLEY OIL & GAS	CHURCH	1	38.23171	-121.7013	9/18/1975	P&A	9550	12 KB	LINDSEY SLOUGH
04095203730000	CHEVRON U.S.A. INC.	CALPACK	12	38.21271	-121.67715	6/22/1978	AGS	5600	12 KB	CACHE SLOUGH
04095204650000	JIM GRAHAM	CHURCH	5	38.224222	-121.699601	7/15/1981	GAS	10583	27 KB	LINDSEY SLOUGH
04095205000000	HIGHLANDS ENERGY COR	COOK	2	38.20606	-121.6912	1/31/1982	P&A	7615	20 KB	RIO VISTA
04095205710000	UMC PETROLEUM CORP.	HIGHLAND-WILLOW SPRINGS	1	38.20774	-121.68715	10/3/1982	P&A	8787	14 KB	LINDSEY SLOUGH
04095206100000	ATLANTIC OIL CO.	TRI-VALLEY-CHURCH	1	38.2281	-121.70432	6/15/1983	P&A	9637	23 KB	LINDSEY SLOUGH
04095208690000	NAHAMA & WEAGANT ENE	CHURCH RANCH	1-1	38.2252	-121.69711	12/15/1989	P&A	9446	16 KB	LINDSEY SOUGH
04095208820000	NAHAMA & WEAGANT ENE	CACHE SLOUGH	1-6	38.2228	-121.69058	8/15/1990	P&A	5520	9 KB	CACHE SLOUGH
04095209790000	TONKA ENERGY, INC.	ASCM COOK	1	38.21406	-121.69312	3/30/1994	AGS	9811	15 KB	CACHE SLOUGH
04095209800000	ANACAPA OIL CORP.	ASCM CALPAC	2	38.21885	-121.673	4/21/1994	P&A	9888	13 KB	CACHE SLOUGH
04095209830000	ANACAPA OIL CORP.	ASCM COOK	2	38.21143	-121.69499	7/15/1994	P&A	9812	16 KB	CACHE SLOUGH
04095209860000	ANACAPA OIL CORP.	ASCM CALPAC	3	38.22859	-121.68897	9/2/1994	P&A	6907	15 KB	CACHE SLOUGH
04095209900000	ANACAPA OIL CORP.	CALPAC	4	38.21308	-121.6812	4/26/1995	P&A	5600	7 KB	CACHE SLOUGH
04095210500000	ABA ENERGY CORP.	RJR-COOK	1	38.21019	-121.68798	8/21/1998	AGS	7774	14 KB	CACHE SLOUGH
04095212080000	TOWNE	CHURCH	6-6	38.219094	-121.686098	7/27/2004	AGS	8746	11 KB	CACHE SLOUGH
04095211990000	CASTLE MINERALS	BLUE HERON	1	38.23346	-121.68059	8/10/2004	P&A	5129	11 KB	LIBERTY ISLAND
04095212680000	TOWNE	CHURCH	6-7	38.219255	-121.685645	12/29/2006	P&A	6883	11 KB	CACHE SLOUGH
04095212880000	ARMSTRONG	APC CHURCH	1-2	38.221212	-121.694255	11/10/2007	SHUTIN	9251	9 KB	LINDSEY SLOUGH

CACHE SLOUGH RESERVOIR

Summary and Decision

The Cache Slough Reservoir is located in Solano County, California, near the City of Rio Vista, and approximately 30 miles southwest of the City of Sacramento (Cache Slough—Aerial Map.pdf).

Based on the final Cost Model, Cache Slough was ranked in the top five sites and was given a "Green" rating as part of the environmental screening. Given the site's ranking as a top site, PG&E pursued the associated temporary and permanent rights/agreements that were needed to allow reservoir testing (core drilling and air injection test), and if selected, the full development of a CAES facility. However, in April 2013, the site was dropped from further consideration after the project team determined that the estimated time and resources to acquire the necessary land rights to achieve site control prior to drilling a core well did not meet the project's schedule. Conversations with holders of certain rights made it appear highly unlikely that an agreement could be reached that would provide all the land/mineral rights required to build a facility.

Subsurface/Reservoir Screening

Preliminary Screening Results

Cache Slough was identified early in the reservoir screening process through data gathered for the CAES project. The two production reservoirs at Cache Slough are located in the Mokelumne River formation and are combined for natural gas production of approximately 12.5 Bcf from depths of 4,730 and 5,335 ft. A brief preliminary geological analysis was prepared on October 3, 2011, followed by a preliminary geological report on December 19, 2011 (Cache Slough—Preliminary Geological Report.pdf). Those reports concluded that Cache Slough was a "good candidate," with a thick gas column of approximately 70 ft and a relatively small aerial footprint of 650 acres. However, the reports also noted that elevations as low as 5 ft below sea level could create a development challenge for a fully developed CAES facility.

Detailed Geological Summary

On January 3, 2012, a detailed geological report was issued (Cache Slough—Detailed Geological Report.pdf). This analysis indicated that approximately 95%t of the reported production volume came from eight wells completed in the Midland sand of the upper Mokelumne River formation, with the remainder coming from four wells completed in the lower Mokelumne River formation (Cache Slough—Formation Tops.xls, Cache Slough—Well Data.pdf). Production from the field ceased in 2008 (Cache Slough—Production Data.pdf). Log analysis indicated excellent porosity of approximately 33% and water saturation at 35%. Permeability is expected to be excellent based on the production data. 3D seismic data has been acquired over the field (Cache Slough—

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3D Seismic.pdf) and may be available for purchase from Wilson Geophysical in Houston (http://wilsongeophysical.com).

Reservoir Modeling and Evaluation

No reservoir models were constructed. Further reservoir evaluation was put on hold until the development and land acquisition challenges could be resolved (see discussion below on "Land Acquisition/Site Control").

Testing/Development Potential

In August 2012, PG&E's team ranked the top seven reservoir candidates geologically. Geologically, Cache Slough was ranked second due to its strong scoring for the total size, depth, and pressure of the reservoir, and the fact that it was a single reservoir with a relatively simple structure. The larger number of abandoned wells (12) and their age (67 years) were key concerns for potential development. Testing the reservoir would likely not have been difficult due to the short duration of the onsite activity; however, full development was judged to have significant challenges due to: 1) concern about the costs/requirements of re-entering the abandoned wells to re-plug/abandon them, and 2) concern over the possibility that the land above the reservoir may one day be flooded in conjunction with the Bay Delta Conservation Plan (BDCP) (see below) and its elevation being below the flood plain. These issues would likely require well pads to be raised significantly, or for the wells to be drilled from platforms.

Siting and Environmental Evaluation

Core Well and Temporary Site Facilities (TSF) Siting. When evaluating siting alternatives for the core well, the project team considered four semi-adjacent drilling pad sites, based on the subsurface ownership. A Biological Assessment, a Biological Constraints Analysis (BCA), and a Cultural Resources survey were conducted, all with negative results (Cache Slough—FWS Biological Effects Assessment.pdf, Cache Slough—Biological Constraints Analysis.docx, Cache Slough—Cultural Resources Report.pdf). All three documents were submitted to the Department of Energy (DOE) with the Environmental Questionnaire (EQ).

A Solano County Administrative Permit was obtained for the pad preparation and core drilling (Cache Slough—Solano County Administrative Permit.pdf). The California Division of Oil, Gas, and Geothermal Resources (DOGGR) issued a drilling permit (Cache Slough—DOGGR Drilling Permit HILARIDES 612-0402.pdf). A California Environmental Quality Act (CEQA) review was not required since DOGGR Field Rules were in effect for this reservoir and issuance of drilling permits is considered a ministerial approval. A DOE Environmental Questionnaire (Cache Slough—DOE Environmental Questionnaire.pdf) was completed, including supporting graphics and resource reports, and was filed with the DOE, leading to the issuance of an Interim

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Action Memo by the DOE on November 16, 2012, approving core drilling activities for Cache Slough (in addition to two other sites).

Permanent Facilities. In addition to evaluations for various Energy Conversion Facility (ECF) sites and linear routing scenarios, the project team conducted a geographic information system (GIS) evaluation for the permanent gas field, preferred ECF site, and interconnection linears, which did not identify any fatal flaws. However, the presence of a large vernal pool complex west of the site was determined to be problematic for a potential gen-tie connection. In addition, the preferred gen-tie scenario was 21 miles in length, which had a significant cost impact on the Cost ranking.

The regional, state, and federal wildlife agencies were briefed on the project on two occasions. In addition to the GIS evaluations, a longer-term issue was identified pertaining to the potential use of the land above the reservoir in conjunction with the Bay Delta Conservation Plan (BDCP) and related programs The BDCP is a comprehensive conservation strategy aimed at protecting certain species of fish and wildlife, while permitting the reliable operation of California's two biggest water delivery projects. As part of this plan, this site was identified for potential future flooding (see earlier discussion in the "Testing/Development Potential" section).

Land Acquisition/Site Control

Deployment

In February 2012, one landman was deployed to Cache Slough to identify the surface, mineral, and preferred ECF site owners (Cache Slough—APN Map.pdf). The results of this effort showed that the entire storage reservoir belonged to one surface owner. Title work identified three separate entities as severed mineral owners. Due to the proximity of the Rio Vista Airport, residences, and the flood plain, two other properties (other than the reservoir location) were selected as potential ECF sites.

Preliminary Title Work

In January 2012, a cursory title review of the six Assessor's Parcel Numbers (APNs) overlying the storage reservoir was approved. These cursory reports were completed in July 2012. Due to the complexity of how mineral rights had been severed over different portions of the reservoir, plotting mineral ownership proved extremely difficult and time consuming. Subsequently, in September 2012, additional title reports were completed for parcels where the project sought to acquire additional surface rights.

Reservoir Surface Ownership

In March 2012, PG&E first contacted the landowners to discuss the CAES Project. The landowners are third-generation dairy farmers and at the time, owned the largest dairy operation in California. They had purchased the ranch at Cache Slough in July 2009 for the sole purpose of growing corn and alfalfa to feed their herds. For this reason, one of their main concerns throughout negotiations was minimizing the project's footprint on all surface uses on their ranch.

DRAFT

After learning about the larger project and receiving the Compressed Air Lease and Agreement ("CALA"), they had several initial comments:

- Asked when/where any remaining attic gases will be removed and separated from the released air, and whether PG&E would analyze the released air to determine the quantity of remaining attic gases.
- Expressed concern about the potential for a catastrophic explosion due to the gas/air mixture.
- Insisted on being very specific about the location and size of future well pads and a potential ECF.
- Countered the initial offer for surface use at a higher $/acre/year rate.
- Requested an increase of general liability insurance.
- Requested clarification on what sort of cooperation would be required of the landowners as PG&E acquired all of the permits and approvals necessary for the project.

In August 2012, PG&E accepted the surface owner's request for additional compensation for surface use and liability insurance. Other concerns were addressed outside the form agreement and found acceptable. In September 2012, the landowners executed the CALA.

In October 2012, PG&E countersigned the CALA, and on December 26, 2012, the Memorandum of Agreement was recorded in Solano County.

In April 2013, Cache Slough was eliminated as a back-up reservoir for core testing due to the inability to reach agreement with the mineral owners in a timely manner. On May 5, 2013, a Quitclaim Deed of the Memorandum of Agreement was recorded in Solano County.

Reservoir Mineral Ownership

Obtaining the mineral owner consents, required to perform the initial core testing and fully develop the site in the future, proved challenging and ultimately unsuccessful in the time required to move forward.

Three mineral owners were identified as part of the initial title search: Owner A (712 net mineral acres), Owner B (352 net mineral acres), and Owner C (132 net mineral acres).

In general, the issues associated with acquiring the associated mineral rights at this specific site can be summarized as: 1) compensation and 2) ownership complexity.

Compensation. PG&E's initial offers were structured so as to pay the mineral owners an annual payment equal to the number of net mineral acres controlled and an agreed-to price per acre (i.e., # of Acres x $/Acre = Annual Payment). Typical commercial issues included:

- Amount of rate
- Request for indexing of the rate
- Ongoing payment vs. large, upfront payment
- Ensuring rate was "market"

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During negotiations, one mineral owner, despite numerous attempts and offers, continually expressed "no interest" in entering into a Mineral Consent agreement for this project. While it would have been possible to drill a core well at a location that did not involve the mineral ownership rights of this entity, full development of the site would have been impossible without their agreement.

Other negotiations regarding compensation focused on the adequacy of the compensation being offered and trying to determine if it was representative of a "market" lease. Unlike exploration for oil and natural gas where a transparent market exists to determine the value of any oil and/or natural gas extracted, the CAES development was creating a market for a depleted natural gas reservoir. CAES would "re-purpose" the reservoir for an alternate use, and unlike other markets or natural gas storage where multiple parties are vying for the commodity (natural gas, storage, etc.), the air that would be stored would be used to generate electricity by the entity that injected the air (there was not a "market" for the air). One proposed structure from a potential counterparty was for the future developer to pay a percentage of the net profits generated from the future plant.

Ownership Complexity. One of the items that made this site attractive was the limited number of parties required to reach agreement in order to allow for the core drilling and future development. As mentioned briefly above, even after multiple offers, one owner had no interest in the CAES project. Given that eminent domain was not an option, this owner's lack of interest became a fatal flaw.

With a separate owner, the project team found that the initial interest of one entity/owner, had been severed multiple times to multiple heirs (a total of approximately 25 entities). Previously, this entity had entered into a mineral management agreement whereby one person would represent the interests of the others (from a transactional basis, this would look like one owner); unfortunately, this mineral management agreement had expired. While interest was expressed in reviving the agreement, after multiple discussions, the project team realized that the amount of time and resources required would not meet the schedule requirements for the project.

Alternate ECF

While the agreement with the surface owner included the right to place an ECF on their location, because of the issues discussed above related to potential flooding of the site, proximity to the airport, and the fact that the site was below sea level, alternate ECF sites were investigated for their feasibility and whether they could be a more technically and economically viable solution.

PG&E's standard Option to Purchase structure involved an initial three-year term for an identified piece of property. It would include the ability to extend the initial Option to Purchase period by an additional three years. If the exercise to purchase the property was subsequently triggered, the agreement included an agreed to "strike" price for the purchase of the optioned property. In return for the Option to Purchase, PG&E would pay a fixed annual

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payment to keep the option in place for the first three years. If the option was extended beyond the initial period, PG&E would pay an agreed-to price for Years 4, 5, and 6.

In May 2012, PG&E contacted the owner of the first site, , to discuss the CAES Project and the possibility of a potential Option to Purchase of 20 acres on a ranch located adjacent to the Storage Reservoir. The owner's counteroffer to PG&E's basic financial terms included:

- Four-fold increase in compensation, both in option payments and strike price.
- Up-front money to cover legal costs.
- No ability for PG&E to assign its rights.
- If the ECF was not to be constructed in the future, the 20 acres to revert back to the surface owner.

In February 2013, based on an analysis by the project team, PG&E determined that better alternative ECF sites were available and should be investigated; no future negotiations were held.

The California Department of Water Resources (DWR) owns several parcels of land adjacent to the storage reservoir that had also been identified as potential alternate ECF Sites. Due to the proximity of the Rio Vista Airport, and the distance to interconnect to both gas and electric transmission lines, associated with a number of the DWR parcels, the preferred location had been the southern portion of the DWR property near the Sacramento River. In June 2012, a small group from the CAES Project Team met in Sacramento with DWR to present the project and discuss a possible long-term lease for the purpose of siting an ECF on the property. While the overall project was well received, several issues arose that would need to be addressed before discussing and negotiating a lease.

- DWR already had a tenant on the property mining gravel. Although the lease had expired, the tenant had inadvertently stored rock in critical habitat and would need to move the rock prior to the lease terminating. Further, the Army Corps of Engineers was obligated to work with the tenant to provide direction on where the rock would go, as well as to supervise and approve the tenant's construction of a ramp leading to the levee. The estimated time frame to complete both tasks was up to five years.
- Because DWR is a government agency, any lease with a total value of over $150,000.00 would need to go out for public bid. PG&E would have no guarantee that it would be the successful bidder to be awarded the lease.
- The Central Valley Flood Protection Board (CVFPB) had earmarked Cache Slough as a potential site for future flood control to convert into wetlands in perpetuity. Several engineers at DWR argued that this designation would preclude any development for a CAES Project at Cache Slough.

Discussion between PG&E, DWR and the CVFPB moved forward in good faith, and specific locations on the parcels were identified as acceptable to all parties involved.

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However, in April 2013, the CAES Project Management decided that obtaining all the agreements necessary to drill a core well into the Storage Reservoir did not meet the project's schedule. Thus any future work on an ECF was cancelled, and Cache Slough was eliminated.

References

1) Cache Slough - Aerial Map.pdf
2) Cache Slough - Preliminary Geological Report.pdf
3) Cache Slough - Detailed Geological Report.pdf
4) Cache Slough - Formation Tops.xls
5) Cache Slough - Well Data.pdf
6) Cache Slough - Production Data.pdf
7) Cache Slough - 3D Seismic.pdf
8) Cache Slough - FWS Biological Effects Assessment.pdf
9) Cache Slough - Biological Constraints Analysis.docx
10) Cache Slough - Cultural Resources Report.pdf
11) Cache Slough - Solano County Administrative Permit.pdf
12) Cache Slough - DOGGR Drilling Permit - HILARIDES 612-0402.pdf
13) Cache Slough - DOE Environmental Questionaire.pdf
14)
15) Cache Slough - APN Map.pdf

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A302: Crossroads Site Selection and Attachments

CAES - High Level Review
Crossroads - Aerial Map
Crossroads - APN Map
Crossroads - Preliminary Geological Report
Crossroads Site Selection Close-Out - Final Report

CAES – HIGH LEVEL REVIEW

Bowerbank:

- Production was from thin, lenticular Piocene San Joaquin and Etchegoin sands, 4-24 feet thick. Sands are also trapped against cross faults on anticline.
- Many small discontinuous pools.
- Land may be difficult unless shallow rights can be bought. Much of land is believed to be leased for Miocene Monterey shale resource play.

Cache Slough:

- Simple faulted anticlinal nose apparently not complicated by additional faulting.
- Shale top seal.
- Good depth – 4,800'.
- Good permeable reservoir – Paleocene Mokelumne River/1st Massive sands.
- Thick original gas column (~90'); small area (500 acres).
- About a dozen wells in pool; produced about 12.5 Bcf.

Clarksburg:

- Winters sands too deep (7,450'), produce from several small stratigraphic pools.
- Lower Starkey pool may be good candidate; 4,400' deep.
- Production (~6.7 Bcf) apparently produced from a single pool; ~ 4 wells.
- Wells had between 50 and 60 feet of Starkey pay.
- Good permeable thick reservoir in faulted, erosional trap (underlies Markley shale submarine canyon).
- May be potential surface problems; Sacramento River and ship channel cross area; many of wells were directionally drilled.

Crossroads:

- Good reserves (17.2 Bcf), but broken up into several fault blocks and pools.
- At least four main fault blocks and at least that many Starkey pools (best reservoir). Deeper Winters sands are also in fault traps but additionally are highly compartmentalized by stratigraphic complications.
- Starkey reservoir average depth 4,150 feet; I.P. = 2,050 PSI.
- DOGGR lists 11 Starkey wells. This is the best and most continuous reservoir. The Starkey Field produced 7.9 Bcf of gas. Best pool (of the 4+) estimated to have produced about 3 Bcf max.
- Field is spread out over about 9 square miles; may require a very large gathering system.

King Island:

- Good permeable reservoir (Mokelumne River).
- Good reserves, produced 10.5 Bcf.
- Thick gas column – 120 feet max; small area (~350 acres).
- Simple erosional trap by Meganos channel has truncated reservoir sands, has limited an active water drive. Lateral closure against Meganos Channel shales.
- Gas in Mokelumne River pool produced from two wells.

McMullin Ranch:

- Large 4-way anticlinal structure has produced 63.7 Bcf from Blewett, Tracy and Lathrop sandstones. Lathrop pool too deep to be considered (7,200'); Tracy too small, produced a limited amount of gas; Blewett sands (B4, B5 and B5a) produced an estimated 40 Bcf of gas and should be only reservoirs considered.
- Blewett sands are good permeable reservoirs.
- Simple anticlinal structure not complicated by faulting.
- Thick gas column (~ 70') at crest of B5a horizon; structure covers ~ 1,400 acres.
- B4 reservoir covers only about 300 acres w/maximum 20' fill-up; reserves may be too low.
- An estimated 17 idle and/or suspended wells.

Merrill Avenue:

- Thick Blewett sand in a primary stratigraphic trap that has good lateral and up-dip closure into low permeability shale.
- Thick (64') column of gas; field produced 19.7 Bcf of gas; most from one well in one pool.
- Complex Blewett sand stratigraphy, 3-D seismic data may be needed to accurately define pool limits.
- Map be too deep: 6,300'.

Merritt Island:

- Winters sand reservoirs in multiple pools.
- Main trap is stratigraphic, drained by one well that produced 4.38 Bcf of the 5.6 Bcf of field reserves; produced from an 8 foot thick sand at up dip edge.
- Later wells found a 10 to 15 foot thick depleted sand covering about 300 acres.
- Probably too deep (7,400').
- Sacramento River over trap necessitates directional wells.
- Surface culture is primarily pear orchards.

Tremont:

- Produced about 5 Bcf of gas from two separate fault closures.
- Traps are located about one mile from one another.
- Stacked reservoirs between 6,000’ and 6,500’.
- Single reservoir too small and complicated.

Trico NW:

- Thin (~10’) lenticular Pliocene sands in stratigraphic traps on broad nose; at least three reservoirs.
- Shallow depths between 2,400’ and 3,800’.
- To get enough reservoir volume, need large surface footprint.

Zamora:

- Produced ~6.5 Bcf from good Starkey sand reservoir.
- Shallow depth ~ 3,600’.
- Combination structural and truncation traps; 3 small gas pools.

Bounde Creek:

- Multiple stacked gas reservoirs on anticlinal feature.
- Significant stratigraphic component to traps.
- Depths to reservoirs appear to be Princeton Cyn/Torres sand (8.6 Bcf) and Forbes McGowan sand (~20 Bcf).
- Both sands could have stratigraphic complications.
- Seven wells produced from Torres zone; 19 from McGowan.

French Camp:

- Large active field chiefly producing from deeper Lathrop sandstones.
- Target sand for the study would be Starkey sands, good reservoir.
- Produced only 2.3 Bcf from Starkey sands from 2 structural pools.
- Too small.

Tracy:

- 1st commercial gas field in California.
- Reservoir, structure, original gas reserves are ideal.
- Tremendous liability issues; early wells through reservoir not properly abandoned and cannot be properly abandoned because of housing tracts.

Perkins Lake:

- Production from basal Eocene Markley channel sands.
- Excellent reservoir; gas reserves (38 Bcf) produced from 5 wells.
- Good depth (~3,400') and pressure (1,600 PSI).
- Reservoir may be too large?
- Sands have stratigraphic complications.

Vernalis:

- Very large field (104 Bcf) chiefly producing from Blewett sandstones.
- Good depths (3,800' to 4,200') of Blewett B-1 through B-4 sands.
- Good Blewett pressures (1,765 PSI to ~ 2,000 PSI).
- Overlying Azevedo sands may also be potential candidates; thick sands but laterally discontinuous and, in part, truncated by Miocene unconformity.
- Large Blewett anticlinal structure complicated by faulting and permeability changes; sands may be compartmentalized.
- Large number of wells; 9 producing, 24 shut-in as of 2006.
- May need 3-D seismic to accurately define reservoirs.

East Islands:

- Simple compaction anticlinal closed up dip by a fault.
- Moderate depth (4,600') and pressure (estimated at 2,000 PSI).
- Good thick permeable reservoir; Paleocene Meganos Channel sand.
- Field discovered in late 1970s; now near economic limit.
- Four productive wells; main 2-well pool produced majority of gas.
- Small reservoir (4.0 Bcf); most gas produced from a single well (3.7 Bcf) w/50' pay column.
- Main pool (2 wells) covers about 150 acres.

Liberty Island:

- Simple truncation trap of permeable Midland sand by shale-filled Markley Channel.
- Field discovered 1960, ~ 13 wells drilled within productive limits; all now abandoned.
- Moderate depth (4,725') and pressure (2,020 PSI).
- Good size (27.4 Bcf); 690 acres.
- Permeable reservoir; wells averaged 30' of pay.
- Minor faulting may compartmentalize reservoir.

Rio Jesus:

- Simple truncation trap of permeable Mokelumne River and Starkey sands by shale-filled Markley Channel.
- Field discovered 1972; four wells drilled within productive limits; all now abandoned.
- Shallow depth (2,400'), good pressure (1,275 PSI).
- Good permeable sands; 35' average pay.
- Small area (~200 acres); 3.9 Bcf.
- Erosion by Markley channel has truncated three stacked reservoirs, these most likely will act like multiple pools/compartments.
- Water encroachment only from down dip direction; sand truncated laterally and up dip.

Schohr Ranch:

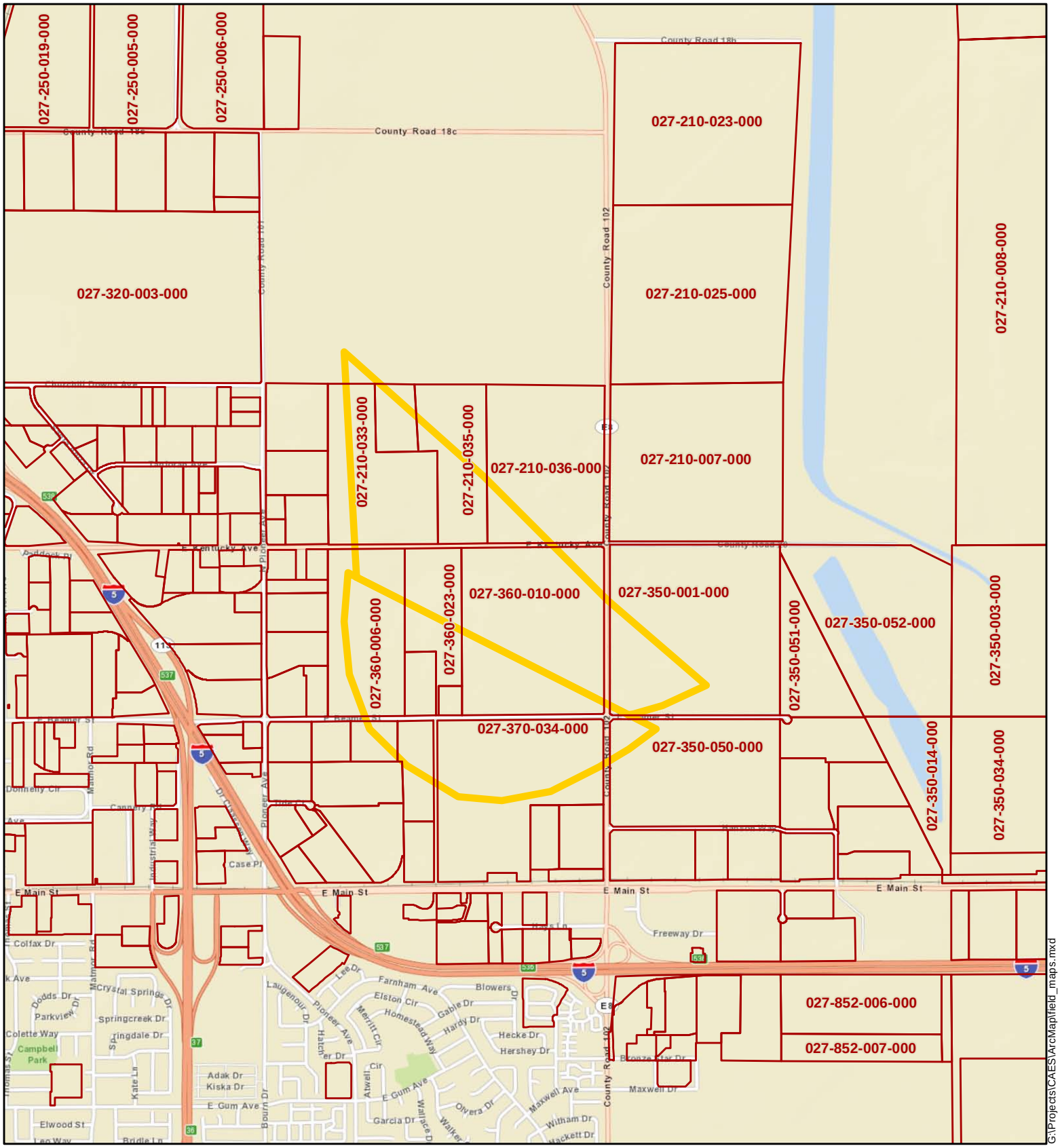
- Anticlinal structure has produced 2.1 Bcf from permeable Kione sandstone.
- Field discovered 1957; half dozen wells drilled within productive limits; now abandoned.
- Shallow depth (2,570'), good pressure (1,220 PSI).
- Simple anticlinal structure; minor faulting.
- Thin average pay (15') on top of thick sands covers 360 acres.
- Small size and compartmentalization of reservoir downgrades this field as a candidate.

West Thornton/Walnut Grove

- Approximately 20 Bcf in pool.
- Meganos Channel sands are good permeable reservoirs.
- Overlying Capay Shale drapes over channel sand forming good top on simple compaction anticline.
- Depth to reservoir (3,500') good; reservoir pressure good (1,540 PSI).
- Reservoir is believed to be uncomplicated by stratigraphy and faulting.

Crossroads Aerial Map





G:\Projects\CAESVArcMap\field_maps.mxd

Crossroads

Approximate Structure Formation

Parcels

1,500' Buffer

1:24,000

0 1,700 3,400

Feet

Crossroads

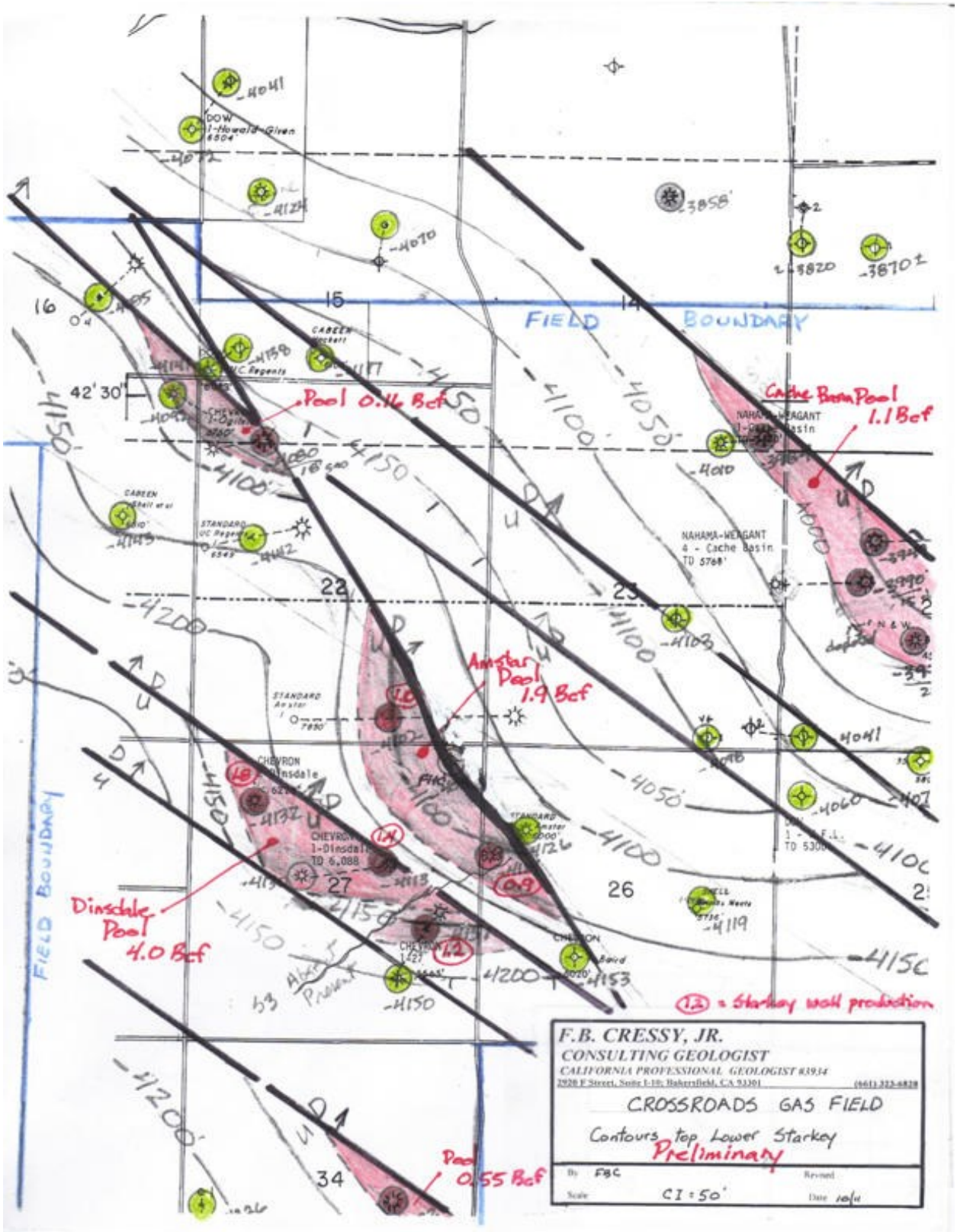
Attached is a portion of my work structure map on the Crossroads gas field contoured on the lower Starkey pay horizon. The contour horizon is a good pick and the map on it depicts the complexity of the area. I've interpreted seven faults in the area; no doubt it is much more complicated than shown. The deeper Winters horizons are even more complex due to the stratigraphic complexities in the thin pay sands. These deeper Winters sands would not lend themselves as reservoirs for a CAES facility. The map should be considered a preliminary overview using only log picks. Detailed correlations between wells to better determine faulting was not done as I considered this first look more as a reconnaissance to get the "flavor" of the area.

I've mapped five Starkey pools within the field boundary. The traps are anticlinal bowings against east-dipping normal faults that have displacements on the order of 50 feet. Altogether they've produced 8.035 Bcf of gas. The largest pool, referred here as the Dinsdale pool, produced 4.0 Bcf from three wells centered in Section 27, T10N-R2E. One of the three produced from a stratigraphically slightly higher Starkey sand and is in a different compartment than the other two wells. The second largest pool, the Amstar pool, lies about a half mile to the northeast and produced 1.9 Bcf. Together these two pools might have the minimum reservoir volume (5.9 Bcf) for a CAES candidate. There could be a potential problem with the Amstar pool in that it may not be completely depleted. In the 1990's a well was drilled to look for "attic" gas in this pool. The contour point appears to have been faulted out together with the top of pay zone. Just looking at the area of this pool and its produced gas compared to the Dinsdale pool, suggests it should have held more gas.

I believe there are better candidates than the Crossroads field to use as a CAES facility and it is recommended that this field be moved down the priority list. Should it be decided to proceed with a more detailed geologic evaluation, the study should be limited to the area around the Dinsdale and Amstar pools.

In summary:

- Pools on the small side based on most recent gas simulation modeling that shows smallest field size of 3.7 BCF.
- No potential for stacked reservoirs.
- Would probably require combined use of Dinsdale and Amstar pools.
- Amstar pool may have attic gas.
- Use of multiple pools for CAES compounds reservoir uncertainty and risk factors.
- May be more small faults within pools.


FIELD BOUNDARY
Pool 0.16 Bcf
Cache Basin Pool
1.1 Bcf
Amster Pool
1.9 Bcf
Dinsdale
Pool
4.0 Bcf
Pool
0.55 Bcf
(1.2) = Starkey well production
NAHAMA-WEAGANT
4 - Cache Basin
TD 5769'
CHEVRON
1-Dinsdale
TD 6,088
STANDARD
Amster
7850'
CABEEN
STANDARD
UC Regents
DOW
1-Howald-Given
6504'
15
14
22
23
27
26
34
16
-4150'
-4100'
-4200'
-4050'
-4000'
F.B. CRESSY, JR.
CONSULTING GEOLOGIST
CALIFORNIA PROFESSIONAL GEOLOGIST #3934
2920 F Street, Suite I-10; Bakersfield, CA 93301 (661) 323-6828
CROSSROADS GAS FIELD
Contours top Lower Starkey
Preliminary
By FBC
Revised
Scale CI = 50'
Date 10/11

CROSSROADS RESERVOIRS

Summary and Decision

The Crossroads reservoirs, located in Yolo County, California (City of Woodland), were not selected for detailed modeling and/or were not a finalist site for the CAES Feasibility Study (Crossroads—Aerial Map.pdf). In the opinion of the project team, development of the reservoirs would be challenging for the following reasons:

- Multiple pools increase development risk and operational challenges.
- The net thickness of the reservoir sands was estimated to be 15 to 20 ft, very thin for high deliverability storage development purposes.
- Due to the faulted nature of the region, additional small faults may exist within the reservoirs, increasing the development risk.
- The combined size of the two largest pools, at approximately 6 Bcf, is on the small size, and combined with the relatively thin reservoir, would create deliverability challenges.

Subsurface/Reservoir Screening

Preliminary Screening Results

A preliminary review of the Crossroads data was completed (CAES—High Level Review.docx). The review concluded that the site consisted of at least four main fault blocks, accounting for at least that many separate reservoirs in the field. Total field production was reported as 17.2 Bcf, of which approximately 8 Bcf came from the Starkey formation, which were the reservoirs of interest. Depth of 4,150 ft and initial pressures of 2,050 psi were well suited for CAES development. The field covers approximately 9 square miles, which would require a rather extensive gathering system.

Detailed Geological Summary

Based on the encouraging preliminary screening results, a preliminary geological evaluation was completed to look deeper into the field attributes without conducting a full detailed geological evaluation (Crossroads—Preliminary Geological Report.docx). That work was completed in November 2011.

The Starkey formation accounts for five reservoirs that produced from the field. The largest one, the Dinsdale pool, produced 4.0 Bcf from three wells. The second largest pool, the Amstar pool, produced about 1.9 Bcf. The project team concluded that, to have sufficient reservoir volume for a CAES project, the two largest pools would need to be developed together. The team also noted that the Amstar pool may have remaining gas at the top of the structure.

Reservoir Modeling and Evaluation

DRAFT

Based on the results of the preliminary analysis, no further work was conducted on the Crossroads reservoirs.

Testing/Developmental Potential

No testing was conducted.

Siting and Environmental Evaluation

Determination – No Fatal Flaws

Based on a review of aerial photography overlaid by property lines and the gas reservoir boundary, a ~40 acre station site was identified at the north end of an agricultural field in northeast Woodland, California. The proposed station site is zoned Industrial/Planned Development Overlay by the city of Woodland, and is located in a warehouse and trucking business area typically active 24 hours, 7 days a week. The station site is just within the 100-year flood plain. It is not under the jurisdiction of the Williamson Act, and the farmland classification is Urban. The existing Woodland Biomass Cogen (25 MW by DTE Energy Services) is located on East Kentucky Avenue, just west of the site and connects to an existing 115-kV gen-tie. Due to the industrial nature of adjacent land uses and zoning, the project would be considered a compatible use. The nearest sensitive receptors to the station site are residences located 1.3 miles to north.

From this site, gas transmission service, with an operating pressure that would work for a CAES facility, is located approximately 1 mile from the site, with a connection route in franchise. The nearest 230-kV electric transmission line is on the east side of Interstate Highway I-505. The gen-tie route would extend west approximately 13 miles from the station site along agricultural field breaks and State Route 16 to the existing line. The gen-tie runs north of the Watt-Woodland Airport approach/departure pattern, requiring a Federal Aviation Administration (FAA) airspace study. Due to the distance of the line from the airport, no marking or other design requirements would likely be required. Twenty-five residences lie along the gen-tie route. A potential wastewater source for cooling water is the Woodland Wastewater Treatment Plant located approximately 2.5 miles southeast of the station site.

No schools are located along either the gas or electric routes. This area is part of the Pacific Flyway, a known waterfowl migration route, and a potential collision with the east-west running gen-tie would need to be addressed during project permitting. No riparian or protected areas are directly affected by any project feature, but the gen-tie runs parallel to a section of Cache Creek protected by a conservation easement.

Land Acquisition/Site Control

Deployment

DRAFT

In February 2012, PG&E reviewed the proposed reservoir location and surrounding environment to identify the surface, mineral, and preferred Energy Conversion Facility (ECF) site owners/locations. None of these surface or severed mineral owners were contacted regarding the CAES Project.

Preliminary Title Work

In March 2012, PG&E proceeded with a limited Title Review of the 16 Assessor's Parcel Numbers (APNs) overlying the two storage reservoirs (Crossroads—APN Map.pdf). Title work identified 13 surface owners and 3 entities owning severed mineral rights. These reports were completed in May 2012.

References

1) Crossroads - Aerial Map.pdf
2) CAES - High Level Review.docx
3) Crossroads - Preliminary Geological Report.docx
4) Crossroads - APN Map.pdf

DRAFT

A303: McMullin Ranch Site Selection and Attachments

CAES - Evaluation Summary Composite - 1-4-12
McMullin Ranch - Aerial Map
McMullin Ranch - APN Map
McMullin Ranch - Existing Well Status Plugging Data
McMullin Ranch - Preliminary Geological Analysis
McMullin Ranch - Preliminary Reservoir Evaluation
McMullin Ranch - Well Production Plot Exhibits
McMullin Site Selection Close-Out Reports - Final Site Report

Ranking by: Composite by Reservoir Team

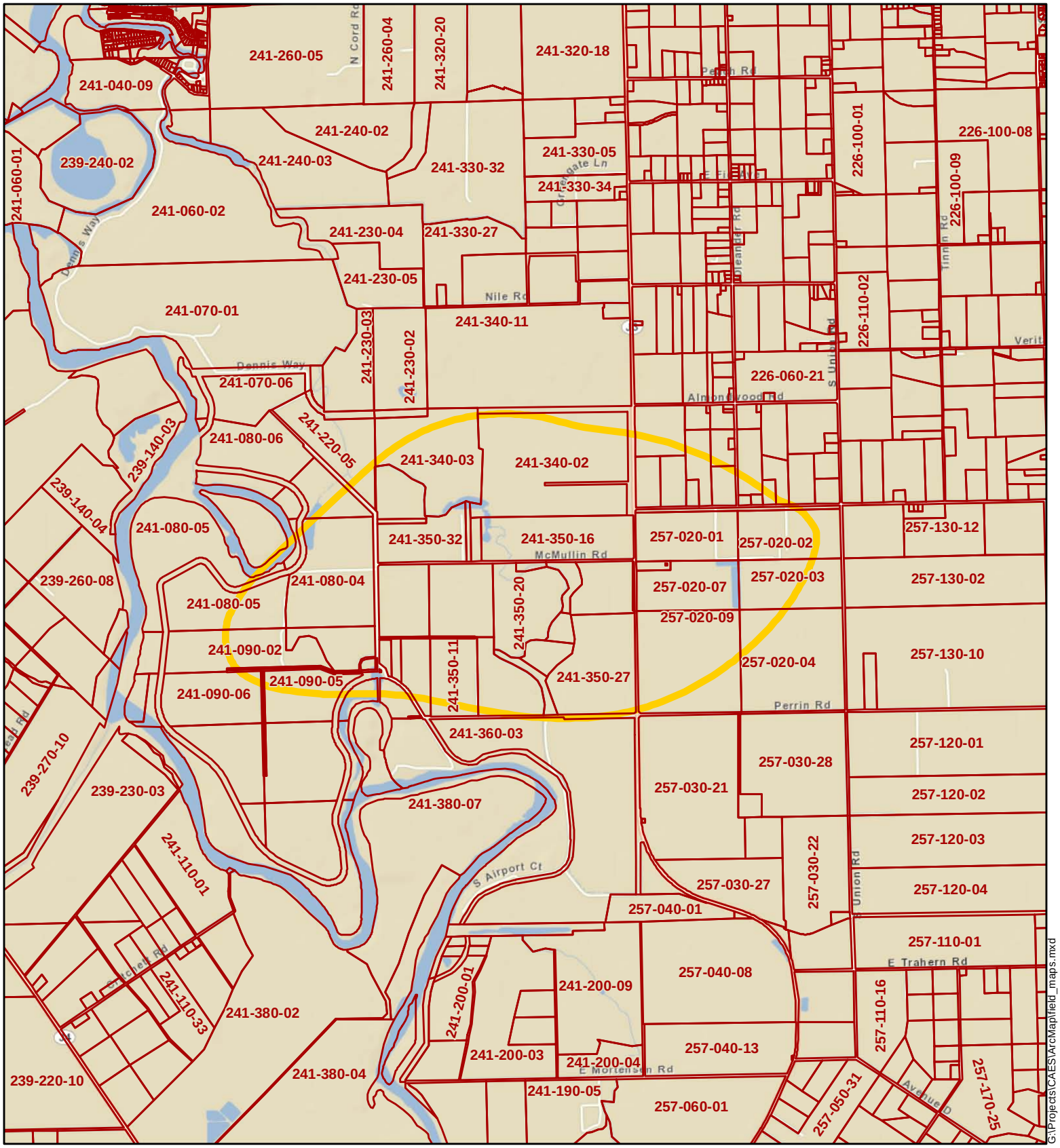
Updated 1/4/2012

	RESERVOIR CHARACTERISTICS	SCORING WEIGHT	KING ISLAND DESCR.	KING ISLAND RAW SCORE (1 TO 10)	KING ISLAND WEIGHTED SCORE	EAST ISLANDS DESCR.	EAST ISLANDS RAW SCORE (1 TO 10)	EAST ISLANDS WEIGHTED SCORE	CACHE SLOUGH (Midland Pool) DESCR.	CACHE SLOUGH (Midland Pool) RAW SCORE (1 TO 10)	CACHE SLOUGH (Midland Pool) WEIGHTED SCORE	ZAMORA DESCR.	ZAMORA RAW SCORE (1 TO 10)	ZAMORA WEIGHTED SCORE
1	OGIP Size (Bcf)	**10**	16	10	100	5-7	10	100	12.1	10	100	5	9	90
2	Net Thickness	**8**	140	10	80	85	8	64	70	9	72	50	7	56
3	Reservoir Size (Acres)	**6**	235	9	54	200	9	54	600	8	48	800	7	42
4	Original Pressure (psig)/Depth	**10**	2,150/4,700	8	80	2,000/4,600	8	80	2,120/4,750	8	80	1,460/3,500	10	100
5	Drive Mechanism	**6**	Mod WD	6	36	Strong WD	5	30	Strong WD	5	30	Combined	8	48
6	Caprock Thickness (ft)	**8**	100	8	64	90	8	64	200-400	9	72	300-400	10	80
7	# of Traps for Storage Development	**10**	1	10	100	1	10	100	1	10	100	2	8	80
8	Permeability (md)	**10**	Exc.	8	80	200-400	6	60	High	8	80	50-100	4	40
9	Porosity	**3**	28.7%	8	24	30%	9	27	33%	10	30	28-32%	10	30
10	Remaining reserves (Bcf)	**5**	.5-1.5	7	35	.025-.05	9	45	0	10	50	0	10	50
11	Water Saturation	**8**	22%	10	80	40-45%	6	48	35%	8	64	35%	8	64
12	# Abandoned Wells	**10**	1	10	100	3	10	100	12	5	50	7	7	70
13	# Producing/Idle Wells	**4**	2	10	40	1	10	40	0	8	32	0	8	32
14	# Abandoned Wells w/ Issues	**6**	0	10	60	0	10	60	0	10	60	0	10	60
15	Age of Wells (Years)	**5**	25	9	45	30	8	40	67	5	25	34	8	40
16	Trapping Mechanism	**4**	Channel	10	40	Channel	10	40	Fault	6	24	Fault	6	24
	TOTAL WEIGHTED SCORE (Maximum Possible = 1,130)				**1018**			**952**			**917**			**906**

	RESERVOIR CHARACTERISTICS	SCORING WEIGHT	MERRILL AVENUE (Southeast) DESCR.	MERRILL AVENUE (Southeast) RAW SCORE (1 TO 10)	MERRILL AVENUE (Southeast) WEIGHTED SCORE	WILLOW SLOUGH (GREINER) DESCR.	WILLOW SLOUGH (GREINER) RAW SCORE (1 TO 10)	WILLOW SLOUGH (GREINER) WEIGHTED SCORE	MCMULLIN RANCH (B-5 & B-5A) DESCR.	MCMULLIN RANCH (B-5 & B-5A) RAW SCORE (1 TO 10)	MCMULLIN RANCH (B-5 & B-5A) WEIGHTED SCORE
1	OGIP Size (Bcf)	**10**	10.5	10	100	7	10	100	35	8	80
2	Net Thickness	**8**	30' Max	5	40	200+	10	80	20	5	40
3	Reservoir Size (Acres)	**6**	2,000 est.	5	30	150	10	60	1,600	6	36
4	Original Pressure (psig)/Depth	**10**	2,700/6,300	5	50	2,200/4,850	7	70	2,415/5,300	6	60
5	Drive Mechanism	**6**	Depletion	10	60	Strong WD	5	30	Strong WD	5	30
6	Caprock Thickness (ft)	**8**	>300	10	80	>200	9	72	30-40	5	40
7	# of Traps for Storage Development	**10**	1	10	100	4+	2	20	Stacked	5	50
8	Permeability (md)	**10**	Low	4	40	50-100	4	40	597	8	80
9	Porosity	**3**	???	6	18	25-31%	8	24	28.0%	8	24
10	Remaining reserves (Bcf)	**5**	Significant	2	10	0	10	50	0.1	8	40
11	Water Saturation	**8**	???	7	56	43-50%	5	40	???	7	56
12	# Abandoned Wells	**10**	0	10	100	3	5	50	16	5	50
13	# Producing/Idle Wells	**4**	6	9	36	2	10	40	13	6	24
14	# Abandoned Wells w/ Issues	**6**	0	10	60	1	5	30	0	10	60
15	Age of Wells (Years)	**5**	22	9	45	37	7	35	51	4	20
16	Trapping Mechanism	**4**	Anticline	9	36	Fault	6	24	Anticline	9	36
17	**TOTAL WEIGHTED SCORE** (Maximum Possible = 1,130)				**861**			**765**			**726**

McMullin Ranch Aerial Map





McMullin Ranch Gas

Approximate Structure Formation

Station Site

1,500' Buffer

Parcels

1:40,000

0 1,700 3,400 5,100 Feet

G:\Projects\CAESArcMapfield_maps.mxd

List of Wells inside the Blewett B-5/B-5A Sands Closure
McMullin Gas Field

API#	Well Status	Lease Name	Well#	Operator Name	Section	Township	Range	Spud Date	Abandonment Date
7700008	P	Occidental-King	42-26	Great Basins Petroleum Co.	26	2S	6E	4/9/1962	2/7/1967
7700014	I	McMullin	2Y	Towne Exploration Co.	26	2S	6E	10/24/1963	
7700015	I	McMullin	4X	Towne Exploration Co.	25	2S	6E	9/30/1964	
7700105	P	Gulf-Bucher	27-19	Great Basins Petroleum Co.	19	2S	7E	6/16/1961	6/26/1961
7700106	P	Kromann	23X-30	Great Basins Petroleum Co.	30	2S	7E	11/19/1960	7/28/1981
7700109	I	Luck	75-25	Towne Exploration Co.	25	2S	6E	10/19/1964	
7700110	P	McMullin	2	Great Basins Petroleum Co.	26	2S	6E	7/5/1960	8/8/1977
7700111	I	McMullin	3	Towne Exploration Co.	25	2S	6E	8/22/1960	
7700112	P	McMullin	4	Triton Oil & Gas Corp.	25	2S	6E	10/5/1960	9/8/1964
7700113	I	McMullin	3X	Towne Exploration Co.	25	2S	6E	6/26/1963	
7700115	I	McMullin	5X	Towne Exploration Co.	24	2S	6E	4/26/1963	
7700116	I	Occidental-Dutra	32-25	Towne Exploration Co.	25	2S	6E	8/29/1963	
7700117	I	Occidental-Hays	67X-24	Towne Exploration Co.	24	2S	6E	7/5/1963	
7700119	P	Occidental-McMullin	2-X	Great Basins Petroleum Co.	26	2S	6E	3/28/1962	8/26/1981
7700120	P	Occidental-Whiting	66X-23	Triton Oil & Gas Corp.	23	2S	6E	5/1/1962	5/24/1962
7700121	I	Occidental-Whiting	87X-23	Towne Exploration Co.	23	2S	6E	2/9/1964	
7700124	P	Signet-Filippini	76X-26	Great Basins Petroleum Co.	26	2S	6E	9/3/1960	9/11/1964
7700125	P	Signet-Hays	67-24	Great Basins Petroleum Co.	24	2S	6E	1/5/1961	9/21/1978
7700127	P	Signet-Luck	77X-25	Triton Oil & Gas Corp.	25	2S	6E	8/2/1960	7/27/1981
7700128	I	Signet-Perrin	33-25	Towne Exploration Co.	25	2S	6E	5/12/1960	
7700129	P	Signet-Whiting	66-23	Triton Oil & Gas	23	2S	6E	4/18/1960	5/5/1960
7700130	P	Perrin Unit A	2	Chevron U.S.A. Inc.	30	2S	7E	12/8/1960	2/21/1970
7700135	P	[BLANK]	39	Paul F. McKenzie	26	2S	6E	2/15/1964	2/29/1964
7700136	P	Azevedo	1	Chevron U.S.A. Inc.	25	2S	6E	7/19/1955	9/8/1955
7700376	P	Kromann-Dutra	1	Reynolds & Carver	30	2S	7E	5/12/1965	5/18/1965
7720007	I	Perrin	22-25	Towne Exploration Co.	25	2S	6E	5/2/1967	
7720035	A	Hays	88X-23	Towne Exploration Co.	23	2S	6E	11/16/1967	
7720471	P	L.H. Hays	24-1	Amoco Prod. Co.	24	2S	6E	9/8/1985	11/4/1985
7720478	P	L.H. Hays	24-1A	Towne Exploration Co.	24	2S	6E	11/7/1985	4/4/1986

Well Status symbols:

P = plugged

U = unknown

I = idle

A = Active

STATUS OF WELLS IN THE BLEWITT B-5/B-5A POOL OF THE MCMULLIN GAS FIELD

API NUMBER	TOTAL DEPTH	PERFORATIONS	PERFS SQUEEZED?	PLUGS IN CASING	COLLAPSED INTERVAL	JUNK? Y or N	JUNK INTERVAL	FRESHWATER INTERFACE	WAS FRESHWATER INTERFACE PLUGGED (Y/N)	WELDED STEEL PLATE	REGULATORY STATUS	PROPERLY ABANDONED?	COMMENTS
7700008	6392	6102-6101, 6090-6081, 6063-6062, 6005-6004, 5950-5949, 5411-5410, 5375-5374, 6000-5991, 5974-5965, 5393-5392, 5390-5383	6063-6062, 5411-5410	6392-6131, 6098, 6094-5764, 5455-5196, 10-0	N	Y	6098	N	na	Y	Location and hardness of cement plug was witnessed and approved by DOG engineer	Y	All perfs are directly plugged or squeezed except for 6102-6101. There is a surface plug and a welded steel plate. Junk is present in the hole and plugged. The freshwater interface is not noted in the report.
7700105	6568	None	na	535-375 , 44-14, 10-0	N	N	N	above 506	Y	Y	No engineer of the DOG was available.	Y	The well contains no perfs. There is a surface plug and a welded steel plate. The freshwater interace is noted to be above 506 and it is plugged.
7700106	6600	5864-5861, 5386-5266, 5253	N	5832, 5431-4971, 500-400, 100-0	N	N	na	above 500	Y	N	Top of plug witnessed and approved by DOG	Y	The majority of perf interval is plugged. Perf 5864-5861 is not plugged. There is a surface plug, but no steel plate. The freshwater interface is noted to be above 500 and it is plugged.
7700110	6455 (OD 6410)	6414, 6413-6402, 6400-6394, 6355, 6010, 6006-6000, 5984-5972, 5822, 5412, 5411-5402, 5398-5385, 5378-5371, 5360-5344, 5336-5331, 5320-5290, 5280	N	6447-6417, 6058, 6000-5617, 5600-5104, 4050-3791, 890-744, 30-0	N	Y	5219-4055	N	na	Y	Location and hardness of cement plug was witnessed and approved by representative of the DOG	N	Well was directonally redrilled from 3750 to 6455. A significant interval of perfs below 6355 are not plugged. There is a surface plug and a welded steel plate. The freshwater interface is not noted, but there is a plug interval from 890-744.
7700112	6500	5992-5989, 5825-5821, 5385-5349, 5322-5300, 5299-5296, 5293-5289, 5284-5276, 5270-5269	5385-5349, 5349-5377,	6031, 6025-5741, 5362-5361, 5359-5124, 10-1	N	N	na	N	na	Y	Location and hardnesss of cement plug witnessed and approved by DOG	Y	All perfs are directly plugged or squeezed. There is a surface plug and a welded steel plate. The freshwater interface is not noted and there is no shallow plug.
7700119	5500	5388-5387, 5377-5362, 5342-5320, 5314-5279, 5265-5264, 450	5388-5387	5480-5404, 5352-5160, 5280-5160, 450-350, 40-0	N	Y	5353-5280	above 525	Y	Y	Location and hardness of cement plug witnessed and approved by DOG	Y	All perfs are plugged or squeezed except for 5377-5362. There is a surface plug and a welded steel plate. The freshwater interface is noted to be above 525 and it is plugged.
7700120	9988	None	na	6050-5750, 1054-775, 10-0	N	N	na	above 994	Y	Y	Witness waived by DOG	Y	The well contains no perfs. There is a surface plug and a welded steel plate. The freshwater interface is noted to be above 994 and it is plugged.
7700124	6500	5395-5388, 5384-5380, 5328-5325, 5313-5309, 5285-5284	N	5510-5465, 5386-5231, 10-0	N	Y	6500	N	na	Y	Location and hardness of cement plug witnessed and approved by DOG	Y	All perfs are plugged except for 5395-5388. There is a plug directly above this interval. There is a surface plug and a welded steel plate. The freshwater interface is not noted and there is no shallow plug.
7700125	6500	6359, 6356-6350, 6325, 5380-5367, 5325-5308, 5302-5296, 5288-5282, 5260, 5259	N	6456-6384, 6360-6180, 5450, 5380-5126, 550-0	N	Y	6363, 6336, 6327	above 500	Y	Y	Cementing operations witnessed and approved by DOG	Y	All perfs are plugged. There is a surface plug and a welded steel plate. The freshwater interface is noted to be above 500 and it is plugged.
7700127	6535	5867-5862, 5390-5380, 5372-5352, 5341, 5300-5291, 5299, 5277-5272, 5260-5256, 5239, 5129, 5109	5390-5380	5828, 5380, 5360-4840,	N	Y	5184, 5168	above 500	N	Y	top of cement plug witnessed and approved by DOG	N	Some of the perfs are plugged. Intervals 5867-5862 and 5390-5380, and 5372-5360 are open. There is no mention of a surface plug, but there is a welded steel plate. The freshwater interface is noted to be above 500. A plug was supposed to be placed at 360-260, but was not documented to have been placed.

STATUS OF WELLS IN THE BLEWITT B-5/B-5A POOL OF THE MCMULLIN GAS FIELD

API NUMBER	TOTAL DEPTH	PERFORATIONS	PERFS SQUEEZED?	PLUGS IN CASING	COLLAPSED INTERVAL	JUNK? Y or N	JUNK INTERVAL	FRESHWATER INTERFACE	WAS FRESHWATER INTERFACE PLUGGED (Y/N)	WELDED STEEL PLATE	REGULATORY STATUS	PROPERLY ABANDONED?	COMMENTS
7700130	6800	5384-5383, 5377-5373, 5329-5319, 5307-5301, 5292-5288, 5275-5272	N	5490-5423, 5335-5077, 25-0	N	N	na	N	na	Y	The location and hardness of the cement plug are approved	Y	Perfs 5384-5383 and 5377-5373 are not plugged. There is a surface plug and a welded steel plate. The freshwater interface is not noted and there is no shallow plug. There is very little pertinent information provided in this report.
7700135	7864	None	na	855-716, 10-0	N	N	na	above 500	N	Y	Plug approved by the drilling foreman, but not by DOG	?	The well contains no perfs. There is a surface plug and a welded steel plate. The freshwater interface is noted to be above 500. However, the only plug is located at greater depth and does not seal the interface.
7700136	5500	None	na	800-667, 660-585, 10-0	N	N	na	above 700	Y	Y	na	Y	The well contains no perfs. There is a surface plug and a welded steel plate. The freshwater interface is noted to be above 700 and it is plugged.
7700376	5440	None	na	5435-5190, 566-408, 10-0	N	N	na	above 516	Y	Y	Location and hardness of cement plug was witnessed and approved by DOG	Y	The well contains no perfs. There is a surface plug and a welded steel plate. The freshwater interface is noted to be above 516 and it is plugged.
7700014	8749	8567-8553, 8515, 7667-7644, 7620-7606, 7540-7519, 7493-7487, 7835, 7419, 7418, 5973-5968, 5959-5940, 5930, 5929	7835, 7418, 5973-5968, 5930	8713-8663, 8640-8318, 7675-7340, 6050-6047, 5973-5961	N	N	na	na	na	na	Idle	N	This is an idle well. Deeper perfs were plugged in order to recomplete at shallower depth. The well is not fully plugged and thus there are open perfs between 5959-5929.
7700015	5450	5372-5368, 5358-5352, 5308-5302	5372-5368	5368, 5365	N	N	na	na	na	na	Idle	N	This is an idle well. The deepest perf interval is plugged. The well is not fully plugged and thus there are open perfs between 5358-5352 and 5308-5302.
7700109	5480	5229, 5223, 5215, 5121-5116, 5109	5229, 5223, 5215, 5109	5450-5403, 5229-5220, 5224	N	N	na	na	na	na	Idle	N	This is an idle well. The well is mostly plugged, but there are open perfs between 5121 and 5116.
7700111	6510	5990, 5915, 5385, 5362-5344, 5350-5337, 5294-5289, 5282-5280, 5276-5262, 5240	N	6049, 6047-5699, 5361, 5330	N	N	na	na	na	na	Idle	N	This is an idle well. Deeper perfs were plugged in order to recomplete at shallower depth. The well is not fully plugged and thus there are open perfs from 5385-5240.
7700113	8754	8663, 8560-8547, 8516-8512, 8465	8663, 8564-8562	8561	N	N	na	na	na	na	Idle	N	This is an idle well.The well is not fully plugged and thus there are open perfs between 8560-8547, 8516-8512, and 8465.
7700115	9960	8543-8524, 8518-8501, 8426	8655, 8425	9955-9849, 9603-9485, 9374-9227, 8805-8712, 8655-8530, 8519-8319	N	N	na	na	na	na	Idle	N	This is an idle well. It appears that the perfs are plugged off, except between 8530-8524.
7700116	8728	8686-8685, 8596-8595, 8437-8436	8596-8595	8675, 8580	N	N	na	na	na	na	Idle	N	This is an idle well. The well is not fully plugged and thus there are open perfs between 8686-8685 and 8438-8437.
7700117	8800	8679, 8635, 8570, 8550-8510, 8453, 8085	8680-8679, 8636-8635	8752-8706, 8650, 8578, 8548-8331	N	N	na	na	na	na	Idle	N	This is an idle well. The well is not fully plugged and thus there are open perfs between 8570 to 8085
7700121	8743	8623-8622, 8556-8500, 8425, 8184-8001, 7950	N	8600, 8556-8315, 8200-7596	N	N	na	na	na	na	Idle	N	This is an idle well. All perfs above 8556 are plugged.

STATUS OF WELLS IN THE BLEWITT B-5/B-5A POOL OF THE MCMULLIN GAS FIELD

API NUMBER	TOTAL DEPTH	PERFORATIONS	PERFS SQUEEZED?	PLUGS IN CASING	COLLAPSED INTERVAL	JUNK? Y or N	JUNK INTERVAL	FRESHWATER INTERFACE	WAS FRESHWATER INTERFACE PLUGGED (Y/N)	WELDED STEEL PLATE	REGULATORY STATUS	PROPERLY ABANDONED?	COMMENTS
7700128	6350	5994-5993, 5993-5988, 5986-5972, 5954-5945, 5922-5910, 5783-5782, 5384-5383, 5383-5362, 5347-5346, 5350-5347, 5356-5350, 5312-5288, 5268-5266, 5246-5245	5383-5362	6075-6002, 5710, 5359	N	N	na	na	na	na	Idle	N	This is an idle well. All perfs are open except between 5383-5362.
7720007	6008	5982-5939, 5908-5907, 5910-5909, 5300-5290, 5150-5145,	5908-5907	5995-5403	N	N	na	na	na	na	Idle	N	This is an idle well. The well is not fully plugged and thus there are open perfs between 5300 and 5145.
7720035	5981	5979-5968, 5906, 5889-5888, 5870, 5373-5372, 5389-5378, 5368-5358, 5350-5345, 5334-5323, 5310-5304, 5300-5297, 5292-5282, 5272-5264, 5255-5254	N	5210-4885, 1385-1157	N	Y	5215	na	na	na	Idle	N	This is an active well. All perf intervals are open.
7700129	6425	5970-5957, 5945-5925, 5983-5981, 5899	5983-5982	6044-5655, 10-0	N	N	na	above 803	N	Y	Location and hardness of cement plug witnessed and approved by a member of the DOG	Y	All perfs are directly plugged or squeezed. There is a surface plug and a welded steel plate. The freshwater interface is noted to be above 803, but no plug is present at this depth.
7720471	10200	na	na	3055-2705, 55-30	na	Y	3800-3055	above 500	N	N	na	?	There is insufficient information in the well report to make a proper analysis of this well. No documentation is provided on perfing history and the plugging information seems unreliable.
7720478	16145	11180-11080, 10805-10720 10635-10600	N	12550-12117 11208-10365 9902-9531, 450-5	N	N	na	above 1945	Y	N	Cementing operations witnessed and approved by DOG	Y	Probable re-entry of 7720471. Plugged-back to 12117. All perfs are plugged. Freshwater interval from 450 to 5 feet depth is plugged.

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December 5, 2011

Pacific Gas and Electric
77 Beale Street, San Francisco, CA 94105

Attn: Mr. Robert Booth, Project Manager

RE: PRELIMINARY GEOLOGICAL EVALUATION
MCMULLIN RANCH GAS FIELD
COMPRESSED AIR ENERGY STORAGE (CAES) PROJECT

INTRODUCTION

This letter report presents a preliminary geological evaluation of the McMullin Ranch Gas Field and assesses the appropriateness of the field as a candidate for Pacific Gas and Electric Company's (PG&E's) Compressed Air Energy Storage (CAES) project. The report is accompanied with the following nine exhibits:

1. Location Plat
2. Stratigraphic Column
3. Type Log
4. Structure Map, Contours top Blewett B-5a sand
5. Structural/Stratigraphic Cross-Section Display
6. Blewett B-4 Net Pay Isochore Map
7. Blewett B-5 Net Pay Isochore Map
8. Blewett B-5a Net Pay Isochore Map
9. List of Wells inside Blewett B-5/B-5A Sands Closure

The McMullin Ranch Gas Field is located in the northern San Joaquin Valley Gas Province between the cities of Stockton and Modesto. It is situated under farm land primarily in Sections 23, 24, 25, and 26, T2S-R6E, in San Joaquin County, about 15 miles south of downtown Stockton (**Exhibit 1**). The field was discovered in 1960 by Great Basins Petroleum Company with their completion of the "Signet-Whiting" #66-23 well in the First Tracy sand. Less than a month later in the initial development well, "Signet-Perrin" #33-25, Great Basins discovered productive Blewett sands approximately ¾ mile to the southeast. In 1963, Occidental Petroleum discovered productive Lower Lathrop Formation sands in a deeper pool test of the field with completion of the "McMullin" #5X-24 well. To date, nearly 64 billion cubic feet (BCF) of gas have been produced from 31 productive wells in the main field area and from three wells in a small Blewett fault closure approximately 1 mile east of the field proper. The main gas reservoirs are the Lower Lathrop, which has produced over 20 BCF of gas, Upper Tracy sands, Blewett B-5/B-5a and Blewett B-4 sands. Combined production from the Tracy and Blewett is over 43 BCF. In 1986, Amoco abandoned

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their "L.H. Hayes" #1A-24, a basement test drilled to 16,145 feet in search of deeper production in the field.

STRATIGRAPHY

The general stratigraphy in the McMullin Ranch area is shown on the stratigraphic column accompanying this report (**Exhibit 2**). It depicts the formations present in the northern San Joaquin basin in a general east-west direction. The approximate spatial location of the McMullin Ranch Gas Field with respect to formation depositional facies is depicted by the vertical dashed line near the center of the figure. The deepest well in the field, the AMOCO "Hayes" #24-1A reached a total depth of 16,146 feet after penetrating nearly 190 feet of metavolcanic basement rocks. Overlying the basement rock, the well penetrated nearly 5,000 feet of Upper Cretaceous sediments of the "E", "F", "G" biostratigraphic zones, possibly including older shales, siltstones, and tight sandstones beneath "E zone" Lathrop Formation sandstones. Approximately 4,200 feet of Lathrop Formation sandstones and siltstones overlie siltstones and shales of the Sacramento Shale. The Lathrop Formation consists of inter-bedded deep-water sandstones and has informally been divided into a Lower Lathrop and an Upper Lathrop interval, separated by a distinct shale unit nearly 200 feet in thickness. The Lower Lathrop is nearly 2,700 feet thick and contains much more sand than the Upper Lathrop.

Overlying the Upper Lathrop are 400 feet of Upper Cretaceous E zone/D-2 zone basinal and slope shales of the Sawtooth Shale. Age-equivalent Starkey Formation shelf sands lie a few miles to the east of the McMullin Ranch Field. Following deposition of the Sawtooth Shale, Cretaceous D-2 zone sands of the Tracy Formation were deposited as thick, deep-water turbidites. The depocenter of these sandstones lies just west of the McMullin Ranch Field and the sands thin easterly across the field.

Overlying the Tracy Formation, approximately 300 feet of the D-2 zone Ragged Valley shale were deposited during a sea level rise and high stand. Deep-water Blewett sands conformably overlie the Ragged Valley Shale. Over 1,100 feet of sediments consisting primarily of sandstone was deposited in the Blewett sands sequence in several correlative turbidite sand packages that are shown on the Blewett sands type log that accompanies this report (**Exhibit 3**). The Blewett sands are overlain by slope shales of the Moreno Formation, which are in turn overlain by shelf sands of the Garzas Sandstone Member. Regionally, the upper Blewett sands, shale of the Moreno Formation, and Garzas Sandstone Member are part of an Upper Cretaceous basin-slope-shelf depositional system.

Unconformably overlying the Garzas Sandstone Member are approximately 3,700 feet of Tertiary non-marine sediments thought to be mostly Miocene to Pleistocene in age.

STRUCTURE

A cursory examination of the McMullin Ranch Gas Field shows the structures of the multiple stacked producing zones to consist of simple anticlinal closures. However, because of large thickness changes within and between formations, the field structure is actually more complex. The anticlinal crests of all the major producing zones are offset from one another due to large stratigraphic thickness changes across the field, and in some cases only anticlinal nosing may be present between units where four-way

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anticlinal or domal closure is present. The structure of the Blewett sands is presented in **Exhibit 4** (structure map B-5a sand) and cross-sections showing the structure and stratigraphy of the Blewett sands are presented in **Exhibit 5**.

The thick Blewett B-5a sand overlies the Ragged Valley shale and attains a maximum thickness in excess of 200 feet. The Blewett B-5a sand trends in an east-west direction and rapidly thins to the north. This rapid thinning influences the structure of the overlying Blewett sands, giving them a nearly east/west structural orientation. Blewett sands above the B-4 sand only show anticlinal nosing.

GAS RESERVOIRS

The McMullin Ranch Gas Field produced mainly from three Upper Cretaceous zones in the field. From deepest to shallowest, they are: the Lower Lathrop "8500-foot" zone, the Upper Tracy sands, and the Blewett B-5/B-5a sands. Production from thin sands in the Upper Lathrop, Lower Tracy and Ragged Valley Formations, as well as the Blewett B-4 sand, has added minor reserves to the field's total cumulative production. The deepest producing zone in the field is the Lower Lathrop, which has produced over 20 BCF of 870 Btu gas from 11 wells. Gas recovery (CA DOGGR) from this zone is estimated between 1,400 and 1,600 MCF/Ac-ft. No wells are currently producing from this zone.

Production from the Upper Tracy sands occurs primarily from two thin sand units located above the main sand in the upper Tracy Formation that are separated by 10 to 15 feet of shale. Production is trapped in these two sands where they cross the Tracy structure, but reservoir continuity from one well to another is probably lacking in most instances. It is believed that these sands are primarily a depletion-drive reservoir. CA DOGGR publications refer to these sands as the First Tracy sands.

Upper Tracy and Blewett gas production is reported together, but the Blewett sands, primarily the Blewett B-5 and B-5a sands, are believed to have produced the majority of the nearly 43 BCF of gas production reported from these commingled zones. The discovery well for the Blewett zone, the Great Basins (now Vintage) "Signet-Perrin" #33-25 well is the highest well completed in the Blewett B-5 and B-5a sands. This closure covers over 1,900 acres and appears to have been filled to the spill point at an elevation of -5370 feet below sea level. The closure has a structural relief of 70 feet and production appears to have occurred with the aid of a water drive.

Gas in the overlying Blewett B-4 sand is trapped in the top 20 to 25 feet of an anticlinal closure. It is unknown how much gas was produced from this zone, but the ~500-acre closure is estimated to have originally had recoverable gas reserves estimated at 3 BCF based on a recovery factor of 900 MCF/Ac-ft. and average net pay of 7 feet. There has been no production from higher Blewett sands due to the lack of four-way closures.

POTENTIAL CAES RESERVOIR EVALUATION

The shallow Blewett sands are the main and shallowest reservoirs in the McMullin Ranch Gas Field, and the only reservoirs that fall within the pressure range considered suitable as potential CAES reservoirs. The Blewett sands are considered to have excellent porosity and permeability. DOGGR reported

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porosities range between 26% and 30%; averaging 28%. According to the DOGGR, core permeabilities from a limited number of tests averaged 597 millidarcies (mD). The Blewett B-4 sand reservoir is not considered to be large enough for CAES use. It is expected to have a strong water drive as it has a thin column of gas (17' max.) on water in the uppermost portion of a thick sandstone (**Exhibit 6**).

The Blewett B-5a sand is a larger and thicker reservoir; however, it also is expected to have a strong water drive. Although the structure has approximately 70 feet of relief and a maximum net pay of 40 feet (**Exhibit 8**), the gas lies on water in a thick permeable sand. This characteristic may make the Blewett B-5a problematic as a CAES reservoir.

The Blewett B-5 sand reservoir may be a better CAES candidate. The reservoir consists of thin sands (up to 44' combined net pay thickness – **Exhibit 7**) within a 70-foot thick interval. There may be some degree of inter-fingering between these thin sands; however, the lower sand lens appears to be thicker and more laterally continuous. The B-5 sand interval is bounded on the top and base respectively by 40' and 20'-foot thick mudstone/shale beds (**Exhibit 5**). Over the closure the B-5 sands appear to have been fully gas saturated. As well as being bounded above and below by impermeable barriers, the B-5 sands shale-out to the west (**Exhibit 7**), leaving approximately 1,600 acres of net B-5 sands reservoir inside the B-5/B-5A closure. Thus, any aquifer pressure support could only come from the north, east, and south edges of the reservoir.

BLEWETT SANDS RESERVOIR PARAMETERS

Original Reservoir Pressure:	2,415 psi (DOGGR)
Average Depth (Blewett B-5 sand):	5,300'
Average Reservoir Thickness:	20'
Porosity (Blewett):	26% - 30%; avg. 28% (DOGGR)
Permeability (Blewett)	597 mD (DOGGR)
Reservoir Drive:	Limited water drive?
Cumulative Gas:	35 BCF total Blewett sands (est)
Remaining Reserves:	0.1 BCF
Surface area of trap (total structural closure):	1,900 acres (Blewett B-5 & B-5a sands pools)
Productive wells (Blewett/Tracy):	1 producing well and 12 suspended wells

CONCLUSIONS

If the reported pressures are acceptable, the Blewett B-5 reservoir of the McMullin Ranch Gas Field appears at be a good potential candidate for consideration of a CAES project. The field is at its economic limit, with an estimated 0.1 Bcf of remaining gas reserves. As of the end of 2006, there were 1 producing well, 12 suspended wells and 16 abandoned wells inside the Blewett B-5/B-5A sands closure (**Exibit 9**).

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There are no obvious structural complications within the reservoir, but there may be some degree of inter-fingering and pressure communication between the thin sands in the B-5 interval. The lower sand lens in the B-5 interval appears to be thicker and more laterally continuous.

Potential advantages of the McMullin Ranch Gas Field and the B-5 sand pool include:

- Superior reservoir quality (high porosity and permeability);
- Good top and bottom seals and westerly shale-out in B-5 sand may limit water drive;
- No obvious structural compartmentalization; and
- Field is near its economic limit.

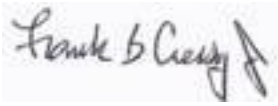
Potential drawbacks of the Blewett B-5 sand pool include:

- Depth and pressure at the upper end of the expected acceptable range for CAES; and
- Potential for inter-fingering and pressure communication between thin sands in the B-5 interval.

CLOSING

Please feel free to contact either Frank Cressy at (661) 301-7125 or Mark Ausburn at (360) 320-1029 if you wish to discuss this report.

Respectfully,
WorleyParsons



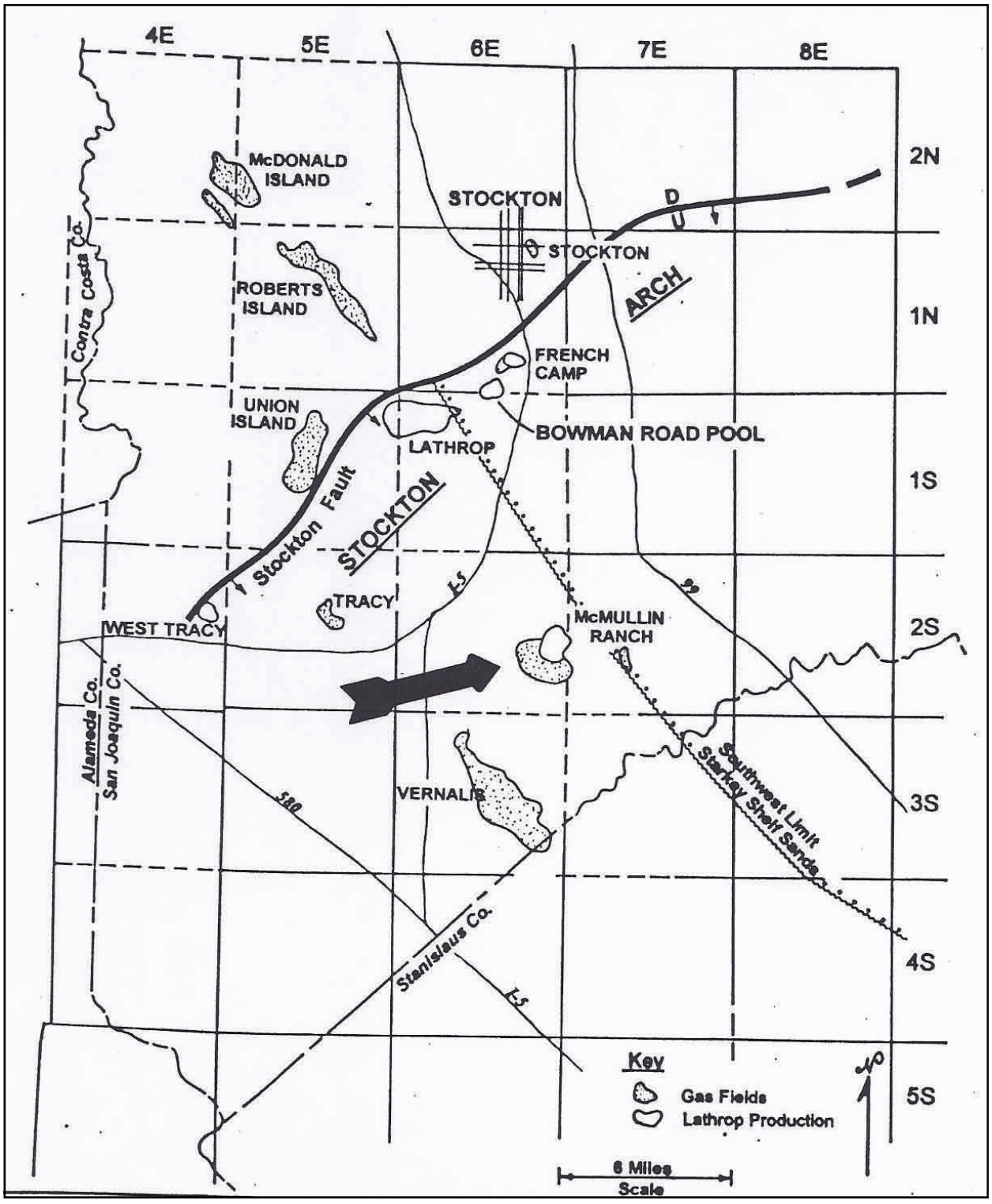


Frank Cressy, P.G. #3934
Petroleum Geologist

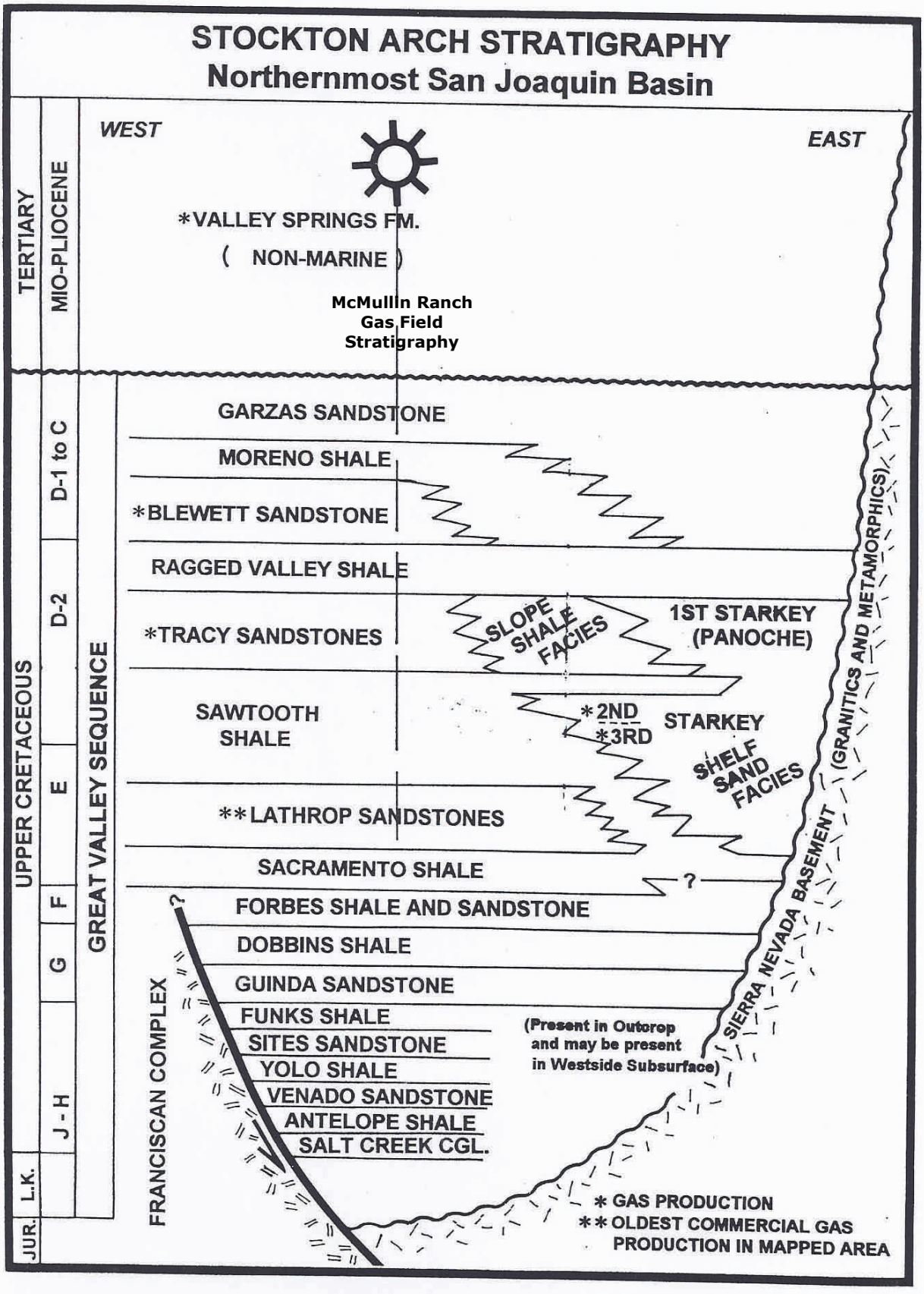
Mark Ausburn, P.G. #5212
Senior Geologist

Attached Exhibits:

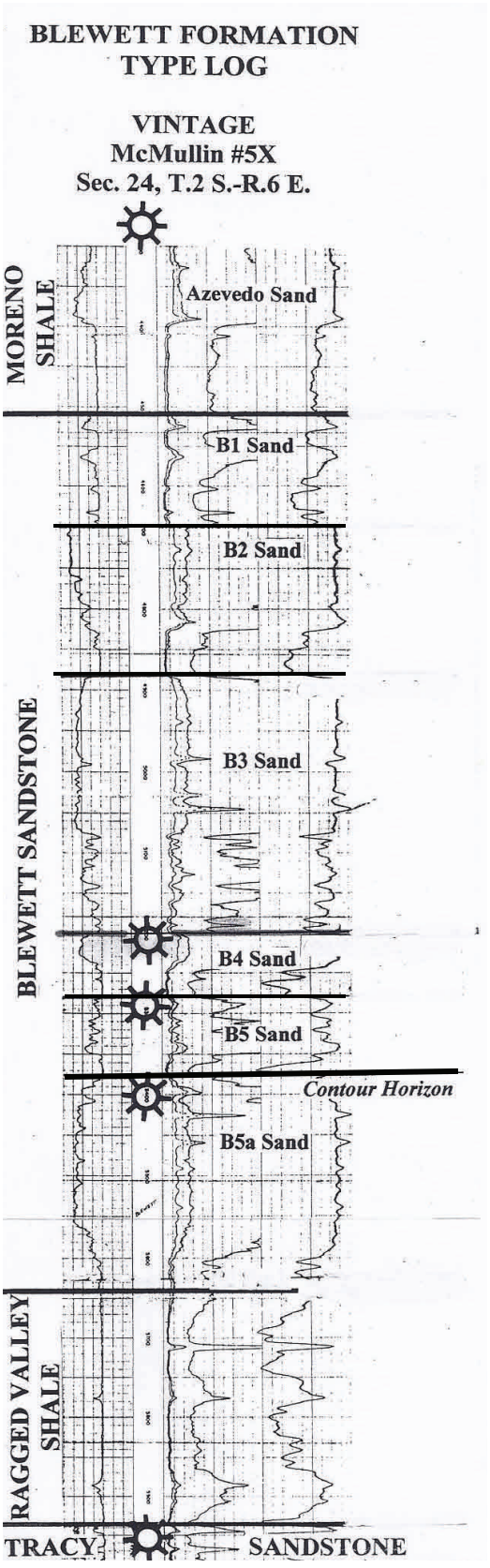
1. *Type Log*
2. *Location Plat*
3. *Stratigraphic Column*
4. *Structure Map, Contours top Blewett B-5a Sand*
5. *Structural/Stratigraphic Cross Section Display*
6. *Blewett B-4 Net Pay Isochore Map*
7. *Blewett B-5 Net Pay Isochore Map*
8. *Blewett B-5a Net Pay Isochore Map*
9. *List of Wells inside Blewett B-5/B-5A Sands Closure*



Location Plat
McMullin Ranch Gas Field


STOCKTON ARCH STRATIGRAPHY
Northernmost San Joaquin Basin
WEST
EAST
TERTIARY
MIO-PLIOCENE
*VALLEY SPRINGS FM.
(NON-MARINE)
McMullin Ranch
Gas Field
Stratigraphy
UPPER CRETACEOUS
GREAT VALLEY SEQUENCE
D-1 to C
D-2
E
F
G
J - H
L.K.
JUR.
GARZAS SANDSTONE
MORENO SHALE
*BLEWETT SANDSTONE
RAGGED VALLEY SHALE
*TRACY SANDSTONES
SLOPE SHALE FACIES
1ST STARKEY (PANOCHE)
SAWTOOTH SHALE
*2ND
*3RD
STARKEY SHELF SAND FACIES
**LATHROP SANDSTONES
SACRAMENTO SHALE
?
FORBES SHALE AND SANDSTONE
DOBBINS SHALE
GUINDA SANDSTONE
FUNKS SHALE
SITES SANDSTONE
YOLO SHALE
VENADO SANDSTONE
ANTELOPE SHALE
SALT CREEK CGL.
(Present in Outcrop and may be present in Westside Subsurface)
FRANCISCAN COMPLEX
SIERRA NEVADA BASEMENT (GRANITICS AND METAMORPHICS)
* GAS PRODUCTION
** OLDEST COMMERCIAL GAS PRODUCTION IN MAPPED AREA

McMullin Ranch Gas Field



McMullin Ranch Gas Field

Discovered 1960
Producing Zones
- Blewett B-4, B-5, B-5a Sands
- Tracy Sands
- Lower Lathrop Sand

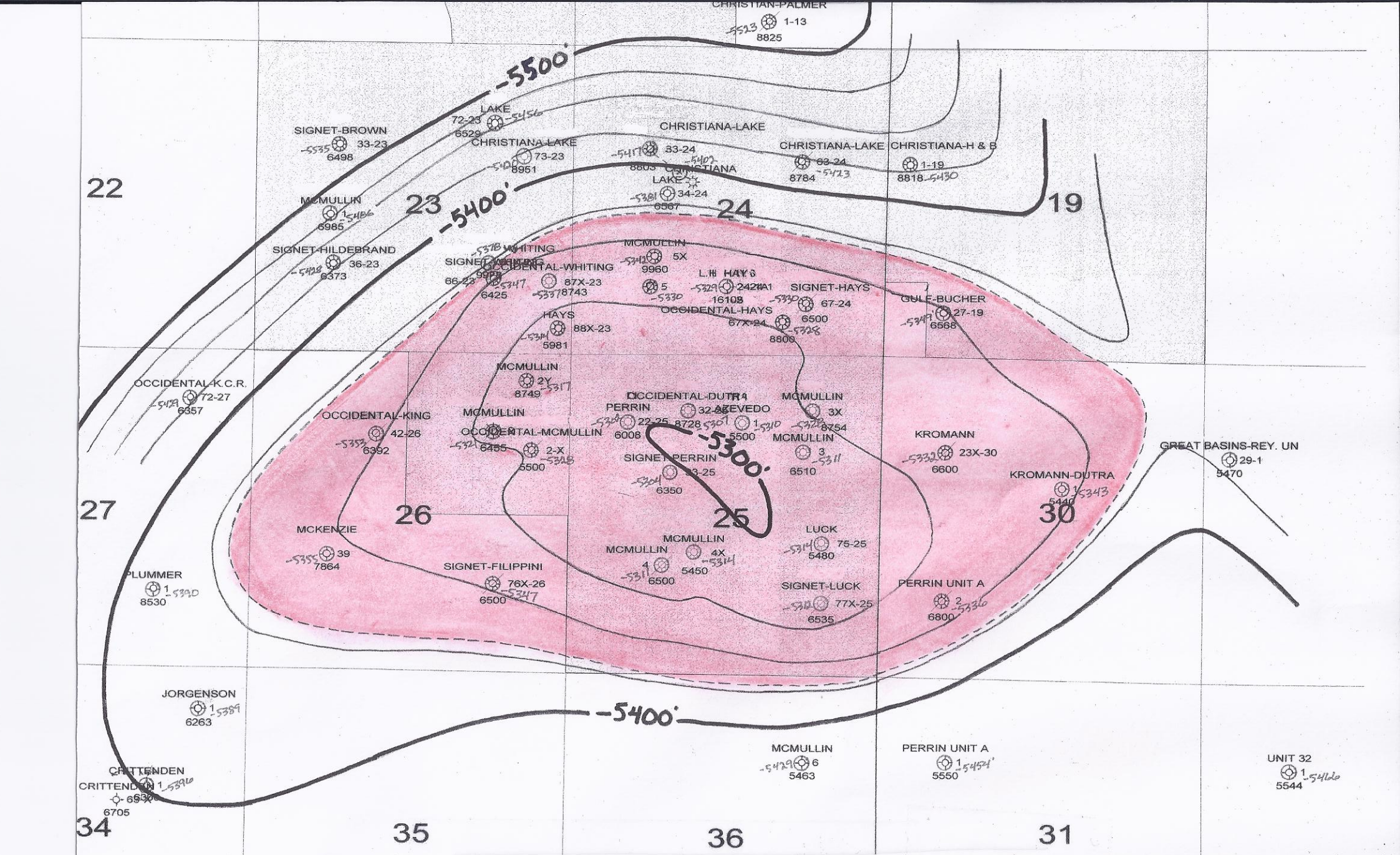
Produced 63.7 Bcf gas to 12-31-2006
- Tracy & Blewett: 43.3 Bcf
- Lower Lathrop: 20.4 Bcf

2 productive wells
14 suspended wells

Blewett Reservoir Parameters *

Porosity: 26% -30%; avg. 28%
Permeability: 597 md

* (CA DOGGR)



McMullin Ranch

Scale 1:12000.

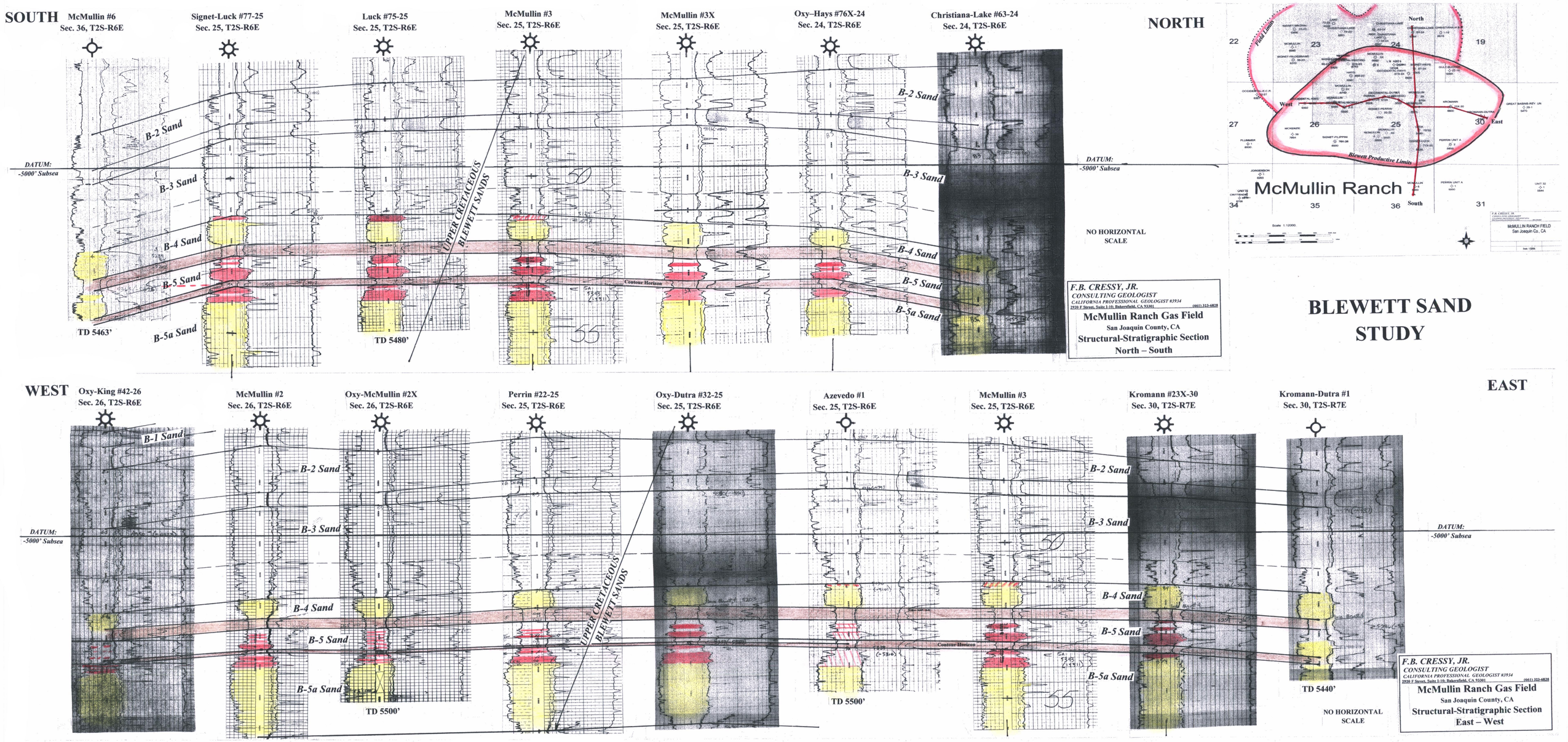
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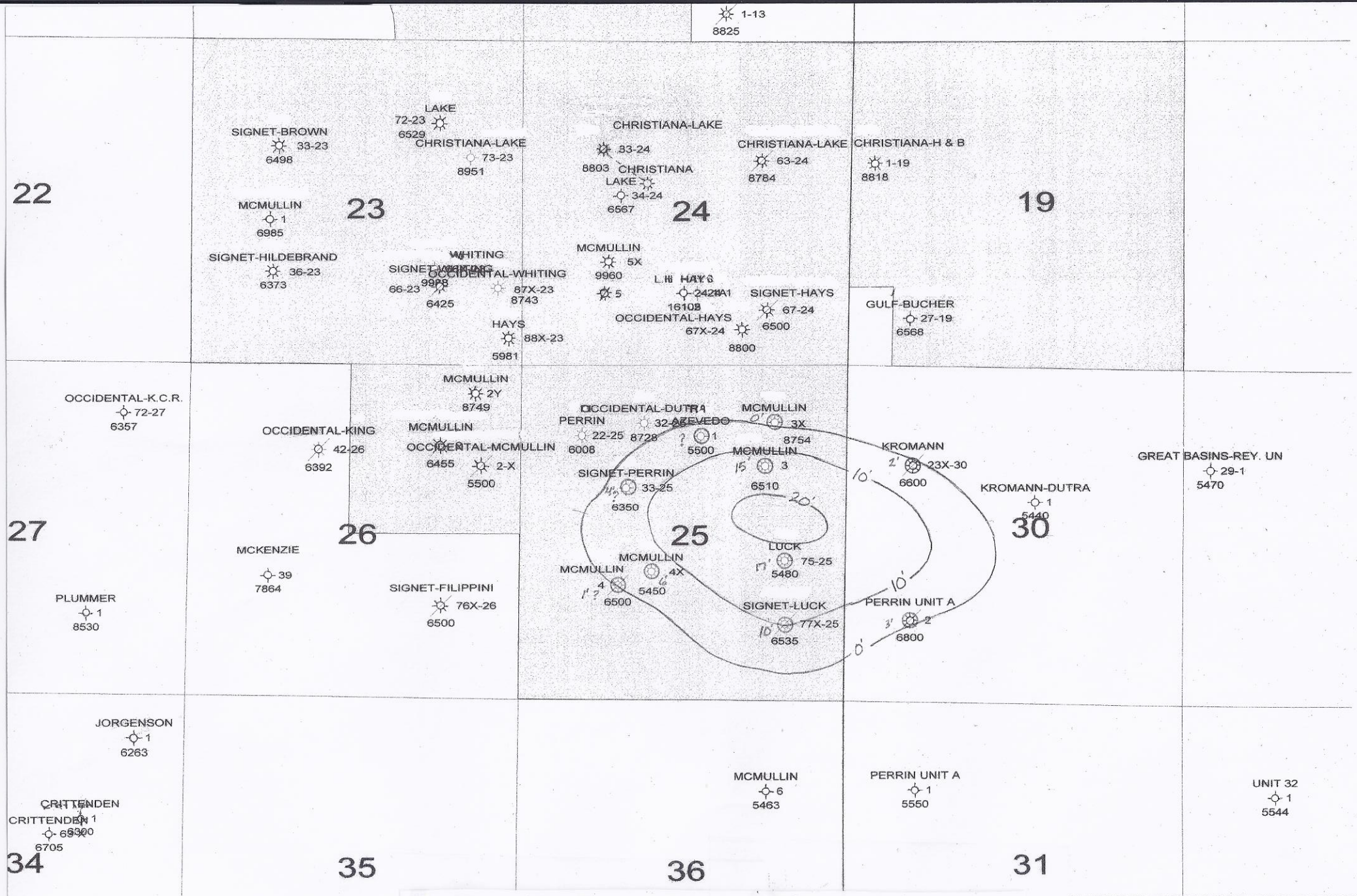
0.2 0. 0.2 0.4 0.6 0.8 1. miles

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McMULLIN RANCH FIELD
San Joaquin Co., CA
STRUCTURE MAP
Contours Top Blewett B-5a Sand

Scale 1:12000.


SOUTH
McMullin #6
Sec. 36, T2S-R6E
Signet-Luck #77-25
Sec. 25, T2S-R6E
Luck #75-25
Sec. 25, T2S-R6E
McMullin #3
Sec. 25, T2S-R6E
McMullin #3X
Sec. 25, T2S-R6E
Oxy–Hays #76X-24
Sec. 24, T2S-R6E
Christiana-Lake #63-24
Sec. 24, T2S-R6E
NORTH
DATUM:
-5000' Subsea
B-2 Sand
B-3 Sand
B-4 Sand
B-5 Sand
B-5a Sand
UPPER CRETACEOUS
BLEWETT SANDS
Contour Horizon
TD 5463'
TD 5480'
NO HORIZONTAL
SCALE
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McMullin Ranch Gas Field
San Joaquin County, CA
Structural-Stratigraphic Section
North – South
Field Limits
Blewett Productive Limits
McMullin Ranch
North
West
East
South
McMULLIN RANCH FIELD
San Joaquin Co., CA
BLEWETT SAND
STUDY
WEST
Oxy-King #42-26
Sec. 26, T2S-R6E
McMullin #2
Sec. 26, T2S-R6E
Oxy-McMullin #2X
Sec. 26, T2S-R6E
Perrin #22-25
Sec. 25, T2S-R6E
Oxy-Dutra #32-25
Sec. 25, T2S-R6E
Azevedo #1
Sec. 25, T2S-R6E
McMullin #3
Sec. 25, T2S-R6E
Kromann #23X-30
Sec. 30, T2S-R7E
Kromann-Dutra #1
Sec. 30, T2S-R7E
EAST
B-1 Sand
B-2 Sand
B-3 Sand
B-4 Sand
B-5 Sand
B-5a Sand
DATUM:
-5000' Subsea
UPPER CRETACEOUS
BLEWETT SANDS
Contour Horizon
TD 5500'
TD 5500'
TD 5440'
NO HORIZONTAL
SCALE
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McMullin Ranch Gas Field
San Joaquin County, CA
Structural-Stratigraphic Section
East – West



McMullin Ranch

Scale 1:12000.

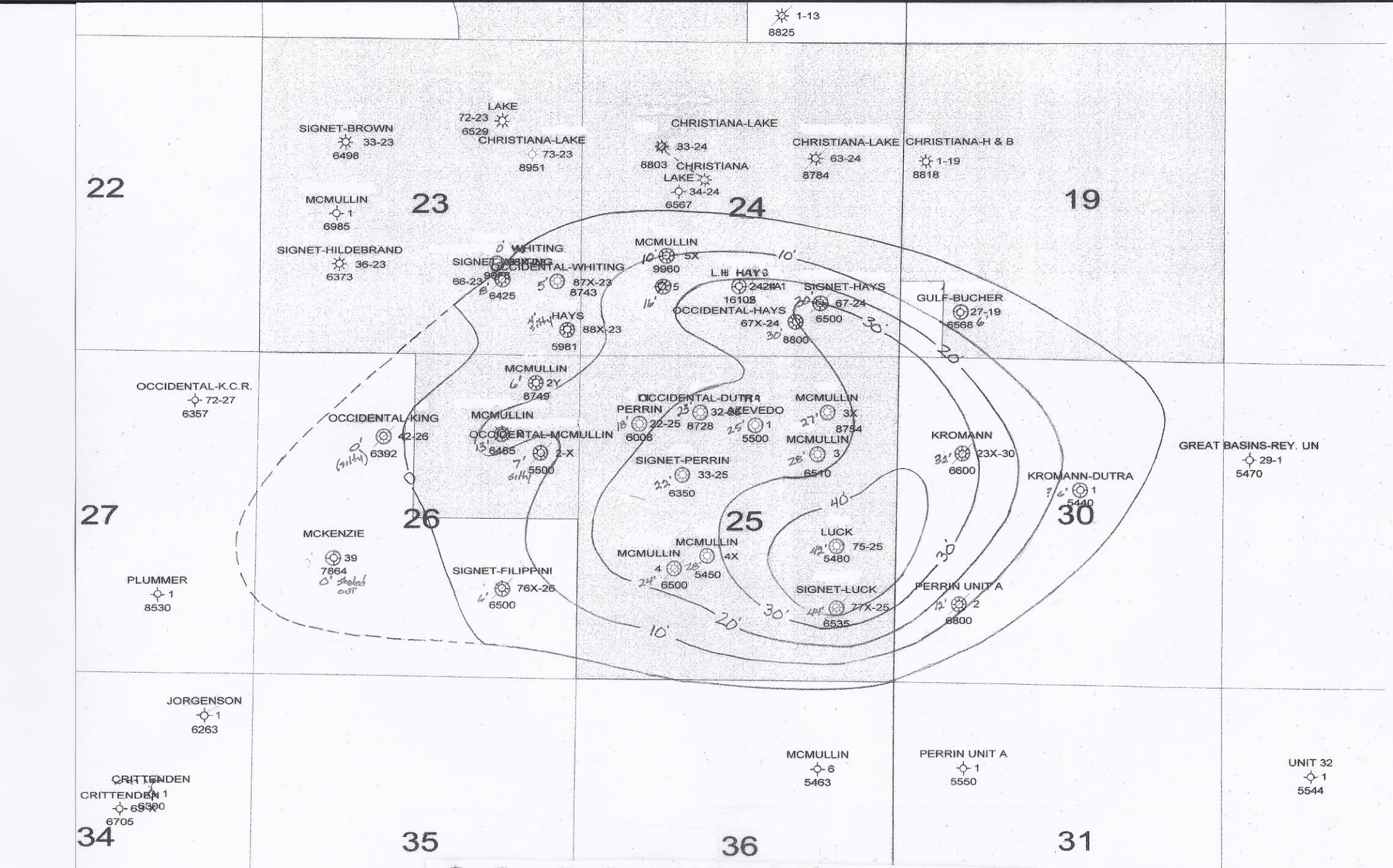
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McMULLIN RANCH FIELD
San Joaquin Co., CA
BLEWETT B-4 SAND
NET PAY ISOCHORE

Scale 1:12000.



McMullin Ranch

Scale 1:12000.

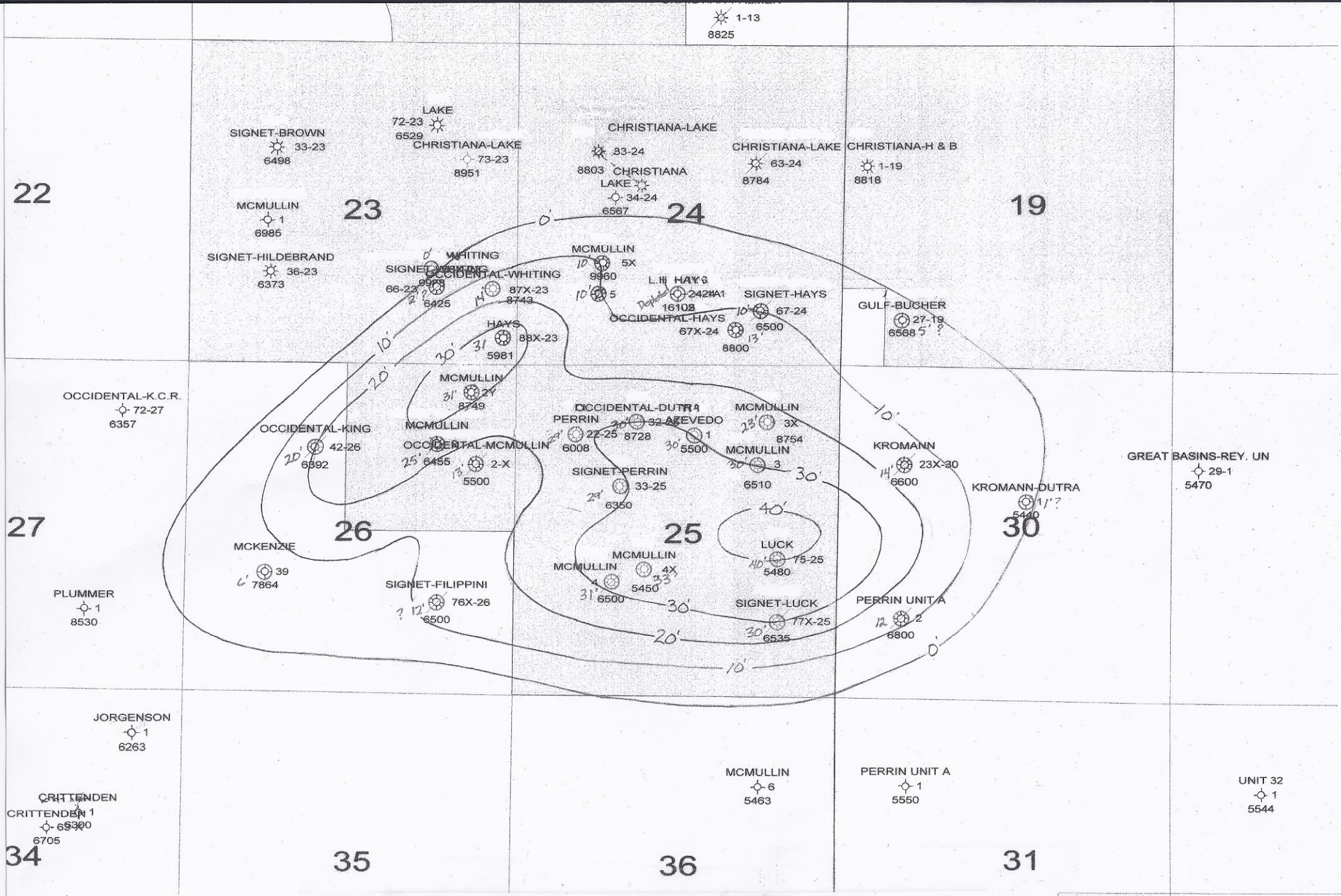
1000. 0. 1000. 2000 3000. 4000. 5000. feet

0.2 0. 0.2 0.4 0.6 0.8 1. miles

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McMULLIN RANCH FIELD
San Joaquin Co., CA
BLEWETT B-5 SAND
NET PAY ISOCHORE

Scale 1:12000.



McMullin Ranch

Scale 1:12000.

1000. 0. 1000. 2000. 3000. 4000. 5000. feet

0.2 0. 0.2 0.4 0.6 0.8 1. miles

N

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McMULLIN RANCH FIELD
San Joaquin Co., CA
BLEWETT B-5a SAND
NET PAY ISOCHORE
Scale 1:12000.

List of Wells inside the Blewett B-5/B-5A Sands Closure
McMullin Gas Field

API#	Well Status	Lease Name	Well#	Operator Name	Section	Township	Range	Spud Date	Abandonment Date
7700008	P	Occidental-King	42-26	Great Basins Petroleum Co.	26	2S	6E	4/9/1962	2/7/1967
7700014	I	McMullin	2Y	Towne Exploration Co.	26	2S	6E	10/24/1963	
7700015	I	McMullin	4X	Towne Exploration Co.	25	2S	6E	9/30/1964	
7700105	P	Gulf-Bucher	27-19	Great Basins Petroleum Co.	19	2S	7E	6/16/1961	6/26/1961
7700106	P	Kromann	23X-30	Great Basins Petroleum Co.	30	2S	7E	11/19/1960	7/28/1981
7700108	I	Lake	72-23	Towne Exploration Co.	23	2S	6E	10/10/1960	
7700109	I	Luck	75-25	Towne Exploration Co.	25	2S	6E	10/19/1964	
7700110	P	McMullin	2	Great Basins Petroleum Co.	26	2S	6E	7/5/1960	8/8/1977
7700111	I	McMullin	3	Towne Exploration Co.	25	2S	6E	8/22/1960	
7700112	P	McMullin	4	Triton Oil & Gas Corp.	25	2S	6E	10/5/1960	9/8/1964
7700113	I	McMullin	3X	Towne Exploration Co.	25	2S	6E	6/26/1963	
7700114	P	McMullin	5	Great Basins Petroleum Co.	24	2S	6E	1/25/1961	3/30/1971
7700115	I	McMullin	5X	Towne Exploration Co.	24	2S	6E	4/26/1963	
7700116	I	Occidental-Dutra	32-25	Towne Exploration Co.	25	2S	6E	8/29/1963	
7700117	I	Occidental-Hays	67X-24	Towne Exploration Co.	24	2S	6E	7/5/1963	
7700119	P	Occidental-McMullin	2-X	Great Basins Petroleum Co.	26	2S	6E	3/28/1962	8/26/1981
7700120	P	Occidental-Whiting	66X-23	Triton Oil & Gas Corp.	23	2S	6E	5/1/1962	5/24/1962
7700121	I	Occidental-Whiting	87X-23	Towne Exploration Co.	23	2S	6E	2/9/1964	
7700124	P	Signet-Filippini	76X-26	Great Basins Petroleum Co.	26	2S	6E	9/3/1960	9/11/1964
7700125	P	Signet-Hays	67-24	Great Basins Petroleum Co.	24	2S	6E	1/5/1961	9/21/1978
7700127	P	Signet-Luck	77X-25	Triton Oil & Gas Corp.	25	2S	6E	8/2/1960	7/27/1981
7700128	I	Signet-Perrin	33-25	Towne Exploration Co.	25	2S	6E	5/12/1960	
7700130	P	Perrin Unit A	2	Chevron U.S.A. Inc.	30	2S	7E	12/8/1960	2/21/1970
7700135	P	[BLANK]	39	Paul F. McKenzie	26	2S	6E	2/15/1964	2/29/1964
7700136	P	Azevedo	1	Chevron U.S.A. Inc.	25	2S	6E	7/19/1955	9/8/1955
7700376	P	Kromann-Dutra	1	Reynolds & Carver	30	2S	7E	5/12/1965	5/18/1965
7720007	I	Perrin	22-25	Towne Exploration Co.	25	2S	6E	5/2/1967	
7720035	A	Hays	88X-23	Towne Exploration Co.	23	2S	6E	11/16/1967	
7720478	N	L.H. Hays	24-1A	Towne Exploration Co.	24	2S	6E	11/7/1985	4/4/1986

Well Status symbols:

P = plugged

U = unknown

I = idle

A = Active

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January 20, 2012

Pacific Gas and Electric
77 Beale Street, San Francisco, CA 94105

Attn: Mr. Robert Booth, Project Manager

RE: PRELIMINARY GEOLOGICAL & RESERVOIR EVALUATION
MCMULLIN RANCH GAS FIELD
COMPRESSED AIR ENERGY STORAGE (CAES) PROJECT

INTRODUCTION

This report presents a preliminary geological and reservoir engineering evaluation of the McMullin Ranch Gas Field and assesses the appropriateness of the field as a candidate for Pacific Gas and Electric Company's (PG&E's) Compressed Air Energy Storage (CAES) project.

The report is accompanied by the following sets of exhibits and data contained in three separate files:

G-Exhibits (Geological Evaluation)

1. Location Plat (**G-1**)
2. Stockton Arch Stratigraphy (**G-2**)
3. Type Log (**G-3**)
4. Structure Map, Contours top Blewett B-5a sand (**G-4**)
5. Structural/Stratigraphic Cross-Section Display (**G-5**)
6. Blewett B-4 Net Pay Isochore Map (**G-6**)
7. Blewett B-5 Net Pay Isochore Map (**G-7**)
8. Blewett B-5a Net Pay Isochore Map (**G-8**)
9. List of Wells inside Blewett B-5/B-5A Sands Closure (**G-9**)

E-Exhibits (Engineering Evaluation)

1. Study Area Wellmaster (**E-1**)
2. Completion Intervals (**E-2**)
3. DOGGR Production: McMullin_Tracy / Lathrop (**E-3**)
4. DOGGR Production: McMullin_Blewett / Tracy (**E-4**)
5. DOGGR Production: McMullin_Blewett (**E-5**)
6. Production Allocation (**E-6**)
7. Pressure Data (**E-7**)
8. Engineering Appendix (well production plots)

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McMullin Ranch Prod Data_Pre_Pst_1977 (pre-1977 production data)

HISTORY

The McMullin Ranch Gas Field is located in the northern San Joaquin Valley Gas Province between the cities of Stockton and Modesto. It is situated under farm land primarily in Sections 23, 24, 25, and 26, T2S-R6E, in San Joaquin County, about 15 miles south of downtown Stockton (Exhibit **G-1**). The field was discovered in 1960 by Great Basins Petroleum Company with their completion of the "Signet-Whiting" #66-23 well in the First Tracy sand. Less than a month later in the initial development well, "Signet-Perrin" #33-25, Great Basins discovered productive Blewett sands approximately ¾ mile to the southeast. In 1963, Occidental Petroleum discovered productive Lower Lathrop Formation sands in a deeper pool test of the field with completion of the "McMullin" #5X-24 well. To date, nearly 70 billion cubic feet (BCF) of gas have been produced from 31 productive wells in the main field area and from three wells in a small Blewett fault closure approximately 1 mile east of the field proper. The main gas reservoirs are the Lower Lathrop, which has produced over 20 BCF of gas, Upper Tracy sands, Blewett B-5/B-5a and Blewett B-4 sands. Combined production from the Tracy and Blewett is 48.9 BCF (Exhibit **E-6).** In 1986, Amoco abandoned their "L.H. Hayes" #1A-24, a basement test drilled to 16,145 feet in search of deeper production in the field.

STRATIGRAPHY

The general stratigraphy in the McMullin Ranch area is shown on the stratigraphic column accompanying this report (Exhibit **G-2**). It depicts the formations present in the northern San Joaquin basin in a general east-west direction. The approximate spatial location of the McMullin Ranch Gas Field with respect to formation depositional facies is depicted by the vertical dashed line near the center of the figure. The deepest well in the field, the AMOCO "Hayes" #24-1A reached a total depth of 16,146 feet after penetrating nearly 190 feet of metavolcanic basement rocks. Overlying the basement rock, the well penetrated nearly 5,000 feet of Upper Cretaceous sediments of the "E", "F", "G" biostratigraphic zones, possibly including older shales, siltstones, and tight sandstones beneath "E zone" Lathrop Formation sandstones. Approximately 4,200 feet of Lathrop Formation sandstones and siltstones overlie siltstones and shales of the Sacramento Shale. The Lathrop Formation consists of inter-bedded deep-water sandstones and has informally been divided into a Lower Lathrop and an Upper Lathrop interval, separated by a distinct shale unit nearly 200 feet in thickness. The Lower Lathrop is nearly 2,700 feet thick and contains much more sand than the Upper Lathrop.

Overlying the Upper Lathrop are 400 feet of Upper Cretaceous E zone/D-2 zone basinal and slope shales of the Sawtooth Shale. Age-equivalent Starkey Formation shelf sands lie a few miles to the east of the McMullin Ranch Field. Following deposition of the Sawtooth Shale, Cretaceous D-2 zone sands of the Tracy Formation were deposited as thick, deep-water turbidites. The depocenter of these sandstones lies just west of the McMullin Ranch Field and the sands thin easterly across the field.

Overlying the Tracy Formation, approximately 300 feet of the D-2 zone Ragged Valley shale were deposited during a sea level rise and high stand. Deep-water Blewett sands conformably overlie the

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Ragged Valley Shale. Over 1,100 feet of sediments consisting primarily of sandstone was deposited in the Blewett sands sequence in several correlative turbidite sand packages that are shown on the Blewett sands type log that accompanies this report (Exhibit **G-3**). The Blewett sands are overlain by slope shales of the Moreno Formation, which are in turn overlain by shelf sands of the Garzas Sandstone Member. Regionally, the upper Blewett sands, shale of the Moreno Formation, and Garzas Sandstone Member are part of an Upper Cretaceous basin-slope-shelf depositional system.

Unconformably overlying the Garzas Sandstone Member are approximately 3,700 feet of Tertiary non-marine sediments thought to be mostly Miocene to Pleistocene in age.

STRUCTURE

A cursory examination of the McMullin Ranch Gas Field shows the structures of the multiple stacked producing zones to consist of simple anticlinal closures. However, because of large thickness changes within and between formations, the field structure is actually more complex. The anticlinal crests of all the major producing zones are offset from one another due to large stratigraphic thickness changes across the field, and in some cases only anticlinal nosing may be present between units where four-way anticlinal or domal closure is present. The structure of the Blewett sands is presented in Exhibit **G-4** (structure map B-5a sand) and cross-sections showing the structure and stratigraphy of the Blewett sands are presented in Exhibit **G-5**.

The thick Blewett B-5a sand overlies the Ragged Valley shale and attains a maximum thickness in excess of 200 feet. The Blewett B-5a sand trends in an east-west direction and rapidly thins to the north. This rapid thinning influences the structure of the overlying Blewett sands, giving them a nearly east/west structural orientation. Blewett sands above the B-4 sand only show anticlinal nosing.

GAS RESERVOIRS

The McMullin Ranch Gas Field produced mainly from three Upper Cretaceous zones in the field. From deepest to shallowest, they are: the Lower Lathrop “8500-foot” zone, the Upper Tracy sands, and the Blewett B-5/B-5a sands. Production from thin sands in the Upper Lathrop, Lower Tracy and Ragged Valley Formations, as well as the Blewett B-4 sand, has added minor reserves to the field’s total cumulative production. The deepest producing zone in the field is the Lower Lathrop, which has produced over 20 BCF of 870 Btu gas from 11 wells. Gas recovery (CA DOGGR) from this zone is estimated between 1,400 and 1,600 MCF/Ac-ft. No wells are currently producing from this zone.

Production from the Upper Tracy sands occurs primarily from two thin sand units located above the main sand in the upper Tracy Formation that are separated by 10 to 15 feet of shale. Production is trapped in these two sands where they cross the Tracy structure, but reservoir continuity from one well to another is probably lacking in most instances. It is believed that these sands are primarily a depletion-drive reservoir. CA DOGGR publications refer to these sands as the First Tracy sands.

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Upper Tracy and Blewett gas production is reported together, but the Blewett sands, primarily the Blewett B-5 and B-5a sands, are believed to have produced the majority of the nearly 48.9 BCF of gas production reported from these commingled zones. The discovery well for the Blewett zone, the Great Basins (now Vintage) "Signet-Perrin" #33-25 well is the highest well completed in the Blewett B-5 and B-5a sands. This closure covers over 1,900 acres and appears to have been filled to the spill point at an elevation of -5370 feet below sea level. The closure has a structural relief of 70 feet and production appears to have occurred with the aid of a water drive.

Gas in the overlying Blewett B-4 sand is trapped in the top 20 to 25 feet of an anticlinal closure. Only 514 MMcf of gas was produced from this zone (Exhibit **E-6**), but the 430-acre closure is estimated to have had initial gas-in-place (IGIP) of 5 BCF based on average net pay of 9.5 feet. There has been no production from higher Blewett sands due to the lack of four-way closures.

RESERVOIR ENGINEERING ANALYSIS

Reservoir Size

The target sands for CAES consideration are the gas-productive Blewett sands from 5,100 to 5,400 feet in depth. Reservoir size was determined using the net pay maps of the Blewett B4, B5, and B5A sands that were prepared for the Preliminary Geological Evaluation. These maps were digitized for volumetric calculations and the productive acre-feet determined for each reservoir. The results are presented in the table below.

McMullin Ranch Pool	Area, acres	Acre-Feet	Average pay, feet	Mcf/Ac-ft	IGIP, Bcf
B4	430	4,061	9.5	1,234	5.0
B5	1,654	28,392	17.2	1,272	36.1
B5A	1,826	30,276	16.6	1,297	39.3
Total		62,729			80.4
B5 (20' contour)	704	21,203	30.1	1,272	26.9
B5A (20' contour)	717	21,063	29.4	1,297	27.3

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An additional calculation is provided in the table for a reservoir area within the 20' contour for the B5 and B5A pools. The smaller area may be more representative of a CAES development area.

The reservoir size calculations were performed for the Blewett pools using the above volumetric results and general reservoir data obtained from the California Division of Oil, Gas and Geothermal Resources (DOGGR) Oil & Gas Fields, Volume 3, 1982.

Reservoir Parameters	B4 Pool	B5 Pool	B5A Pool
Productive Area, acres	430	1,654	1,826
Acre-Feet	4,061	28,392	30,276
Average Thickness, feet	9.5	17.2	16.6
Depth, MD, feet	5,100	5,250	5,350
Initial Pressure, psi	2,208	2,273	2,317
Porosity, %	28	28	28
Initial Water Saturation, %	35	35	35
Initial Gas Saturation, %	65	65	65
Temperature, °F	140	140	140
Gas Specific Gravity	0.61	0.61	0.61
Heating Content, Btu/cu-ft	895	895	895
Bgi, ft^3/scf	0.006428	0.006235	0.006114
Initial Gas in Place, MMcf	5,010	36,100	39,260

The total IGIP for the three Blewett sand gas reservoirs (B4, B5, B5A) is estimated to be 80.4 billion cubic feet (Bcf). The IGIP for the B5 and B5A pools is 36.1 and 39.3 Bcf, respectively, but only 5.0 Bcf for the smaller B4 pool. Reservoir size calculations were not made for the Upper Tracy and Lower Lathrop gas reservoirs since these pools are not considered to have CAES potential.

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Reservoir Performance

Wellmaster

The McMullin Ranch field produced natural gas from intervals in the Blewett B4, B5, B5A sands and from deeper Upper Tracy and Lower Lathrop sands. The study area of interest in this evaluation is defined as the closure limits of the Blewett B5 and B5A pools. Within this area, there are 29 wells drilled and 23 wells with gas production. These wells were evaluated for drilling, completion and production information. Exhibit **E-1** is a wellmaster of the wells in the area of interest including dates, peak rates, initial flowing tubing pressures (IFTP) and well status. Currently, there are no active producers in the field and consequently no gas reserves. There are 13 shut-in (idle) wells. Exhibit **E-2** provides the completion histories and intervals of the wells, as determined from DOGGR online well records.

Production Allocation

Of the 23 wells with production, 7 producers were completed in the Tracy zone or deeper Lathrop zone, 8 wells had commingled Blewett and Tracy (or deeper) production, and 8 wells were Blewett only producers. Production plots for these three well groups are presented by Exhibits **E-3** through **E-5**. Production commenced in 1961 with no production after 2006, although 13 wells remain idle within the area of interest. In this analysis it was determined that the B4 pool had only one effective producer, Luck 75-25. There are other wells with perforations in the B4 but an examination of the individual well histories did not support any significant gas production from the B4 completions other than the Luck 75-25.

The average cumulative gas recovery per well is 2,130 MMcf for the 23 producing wells with a maximum of 5,770 MMcf. Four wells had peak producing rates above 5 MMcf per day. The highest peak well rate was 6 MMcf per day for Blewett sand producer Occidental-McMullin 2-X with a flowing tubing pressure (FTP) of 1,600 psig.

The production plots for all producing wells in the study area are provided in the **Engineering Appendix**. It was necessary to purchase the pre-1977 gas production data from an outside vendor while the post-1976 production data were downloaded from DOGGR website. The purchased pre-1977 data are included in a digital file that accompanies this report (**McMullin Ranch Prod Data_Pre_Pst_1977**).

Recovery Factors

Gas recovery factors were derived by allocating production in commingled wells based on net pay maps where Blewett-only production was present, and using net perforated feet where Tracy or deeper production was commingled in the wells because Tracy and Lathrop net pay maps were not prepared in this preliminary study.

Details of the production allocation are provided in Exhibit **E-6** for the Blewett sands. Completion intervals were defined from available data on the DOGGR online database, which may not contain all workovers, as a few wells have unexplained rate changes without corresponding well work history. All wells within the area of interest are defined on Exhibit **E-6**.

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Recovery Factor Results	B4 Pool	B5 Pool	B5A Pool
Allocated Cumulative Prod, Bcf	0.514	15.861	14.765
Gas-in-Place, Bcf	5.01	36.10	39.26
Gas Recovery Factor, %	10.3	43.9	37.6
Gas Reserves, Bcf	0.0	0.0	0.0

The production allocation was also made using net feet of perforations only. This method resulted in gas recovery factors of 13.8% (B4), 48.7% (B5) and 32.8% (B5A). The composite gas recovery factor for the Blewett sands is 38.7% of the IGIP.

The overall Blewett gas recovery factor is about half of what might be expected for these largely depletion drive gas reservoirs. There is some uncertainty in the initial gas saturations and porosities but not enough to explain the low recovery factors. All of the gas production is believed to have been accounted for in the study area; however, the allocated Tracy zone portion of the gas production in the comingled Blewett/Tracy well completions may be less than calculated by the allocation process. Of all of the factors that impact the recovery factor calculation, net pay is probably the most significant. The lower than expected recovery factor may be an indication that net pay is overstated in some wells and any future evaluations should investigate the net pay/gas production used in this preliminary report.

Pressure Data

Reservoir pressure data as found in DOGGR online records is tabulated in Exhibit **E-7**. The available data indicate that the initial reservoir condition for both the Blewett and Tracy sands was normally pressured. Nine well points for the Blewett sands confirm this finding. For initial gas-in-place calculations, an initial reservoir pressure gradient of 0.433 psi per foot was used. Only one pressure point was found for the Blewett zone after initial conditions. This point was recorded in the McMullin 4 well in August 1964 and it showed a reservoir pressure of 1803 psi for the B5A sand. Current reservoir pressures are unknown; however, based on the last reported tubing pressure data, reservoir pressures in the Blewett sands appear to be less than 500 psig.

There are shale breaks between the Blewett sands such that no vertical reservoir communication is expected between the three Blewett pools other than that allowed through wellbores. As such, reservoir pressure in each pool is expected to vary based on the extent of depletion.

Reservoir Quality

No permeability or porosity data were located in the on-line well records. The Azevedo 1 well was cored, but the core analysis was not available. A sonic log was run in well McKenzie 39 which might be

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interpreted for porosity. A permeability of 597 millidarcies was reported by the DOGGR for the Blewett zone. The observed peak well rates are consistent with this high permeability.

Drive Mechanism

Reservoir drive appears to be predominately volumetric gas depletion despite the fact that the B5A and Tracy zones have large bottom aquifers. The reservoir drive mechanism is depletion drive in the B4 and B5 pools and weak to moderate water drive in the B5A pool. Aquifer thickness ranges from 200-250 feet for the B5A and from 100-200 feet for the Tracy zone. Nevertheless, water production has been minimal in most wells, especially for the early well years. The highest water production observed was in well Signet-Perrin 33-25 (166 BWPD); however, an April 1966 workover closed the Tracy perforations and the lower perforations in the B5A, successfully eliminating all water production in the well. Competent shale intervals near the top of the B5A appear to be limiting the water influx, especially when only the top sand is open to production.

POTENTIAL CAES RESERVOIR EVALUATION

The McMullin Ranch Blewett sands (B4, B5, B5A) contained an estimated 80.4 BCF of IGIP with a cumulative gas production of 31.1 BCF (39% of IGIP). Permeability is good for CAES operations but the low recovery factor indicates uncertainty in the geologic and reservoir characterization. The reservoir drive mechanism is depletion drive in the B4 and B5 pools and weak to moderate water drive in the B5A pool. The current reservoir pressure appears to be low (less than 500 psi); therefore, a large quantity of cushion air would need to be injected in the reservoir to achieve the desired CAES working pressure.

The shallow Blewett sands are the main and shallowest reservoirs in the McMullin Ranch Gas Field, and the only reservoirs that fall within the pressure range considered suitable as potential CAES reservoirs. The Blewett B-4 sand reservoir is not considered to be large enough for CAES use. The Blewett B-5A sand is a larger and thicker reservoir; however, it appears to have a water drive. Although the structure has approximately 70 feet of relief (Exhibit **G-4**) and a maximum net pay of 40 feet (Exhibit **G-8**), the gas lies on water in a thick permeable sand. This characteristic may make the Blewett B-5A problematic as a CAES reservoir.

The Blewett B-5 sand reservoir may be a better CAES candidate. The reservoir consists of thin sands (up to 44' combined net pay thickness – Exhibit **G-7**) within a 70-foot thick interval. There may be some degree of inter-fingering between these thin sands; however, the lower sand lens appears to be thicker and more laterally continuous. The B-5 sand interval is bounded on the top and base respectively by 40' and 20'-foot thick mudstone/shale beds (Exhibit **G-5**). Over the closure the B-5 sands appear to have been fully gas saturated. As well as being bounded above and below by impermeable barriers, the B-5 sands shale-out to the west (Exhibit **G-7**), leaving approximately 1,650 acres of net B-5 sands reservoir inside the B-5/B-5A closure. Thus, any aquifer pressure support could only come from the north, east, and south edges of the reservoir.

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CONCLUSIONS

If the reported pressures are acceptable, the Blewett B-5 reservoir of the McMullin Ranch Gas Field appears at be a good potential candidate for consideration of a CAES project. Currently, there are no active producers and there are 13 idle wells.

Potential advantages of the McMullin Ranch Gas Field and the B-5 sand pool include:

- Superior reservoir quality (high porosity and permeability);
- No obvious structural compartmentalization and no expected vertical communication between Blewett Sands;
- Water production has been minimal; and
- Reservoir drive appears to be predominately volumetric gas depletion.

Potential drawbacks of the Blewett B-5 sand pool include:

- Depth and pressure at the upper end of the expected acceptable range for CAES;
- Apparent low current reservoir pressure (less than 500 psi) might require a large quantity of cushion air to achieve desired CAES working pressure; and
- Potential for inter-fingering and pressure communication between thin sands in the B-5 interval.

CLOSING

Please feel free to contact either Frank Cressy at (661) 301-7125, Alan Burzlaff at (661) 325-0038, or Mark Ausburn at (360) 320-1029 if you wish to discuss this report.

Respectfully,
WorleyParsons





Frank Cressy, P.G. #3934

Petroleum Geologist

Mark Ausburn, P.G. #5212

Senior Geologist

McMullin Ranch Field, San Joaquin County, CA
STUDY AREA WELLMASTER

Sorted by drill date

APINUMBR	LEASE NAME	WELL	OPER NAME	SEC	TWN	RGE	DRILLED	MaxOfDATE	Last Prod Year	Peak Mcfd	FTP, psig	CumGas_Mcf	CumWater_Bbls	DOGGR Well Status
07700136	Azevedo	1	Chevron U.S.A. Inc.	25	2S	6E	19-Jul-55	08-Sep-55				-	-	Plugged
07700125	Signet-Hays	67-24	Great Basins Petroleum Co.	24	2S	6E	01-Jan-60	01-Dec-78		3,000	1,800	2,204,242	36,222	Plugged
07700128	Signet-Perrin	33-25	Towne Exploration Co.	25	2S	6E	01-May-60	01-Dec-11	1993	5,000	1,800	5,066,721	97,095	Idle
07700110	McMullin	2	Great Basins Petroleum Co.	26	2S	6E	01-Aug-60	01-Dec-77		310	2,100	169,077	212	Plugged
07700127	Signet-Luck	77X-25	Triton Oil & Gas Corp.	25	2S	6E	01-Aug-60	01-Dec-81		4,000	1,700	4,905,254	31,471	Plugged
07700111	McMullin	3	Towne Exploration Co.	25	2S	6E	01-Sep-60	01-Dec-11	1989	5,000	2,300	5,769,874	16,564	Idle
07700124	Signet-Filippini	76X-26	Great Basins Petroleum Co.	26	2S	6E	01-Sep-60	01-Sep-64		700	1,600	224,801	964	Plugged
07700108	Lake	72-23	Towne Exploration Co.	23	2S	6E	01-Oct-60	01-Dec-11	1979	1,100	1,100	1,272,566	1,098	Idle
07700112	McMullin	4	Triton Oil & Gas Corp.	25	2S	6E	01-Oct-60	01-Jan-65		3,000	2,300	1,354,328	3,050	Plugged
07700106	Kromann	23X-30	Great Basins Petroleum Co.	30	2S	7E	01-Dec-60	01-Dec-81		3,000	1,800	4,569,849	39,118	Plugged
07700130	Perrin Unit A	2	Chevron U.S.A. Inc.	30	2S	7E	01-Dec-60	01-Feb-70		2,000	2,000	1,630,459	3,034	Plugged
07700114	McMullin	5	Great Basins Petroleum Co.	24	2S	6E	01-Feb-61	01-Apr-71		2,700	2,400	1,801,625	63,167	Plugged
07700105	Gulf-Bucher	27-19	Great Basins Petroleum Co.	19	2S	7E	16-Jun-61	26-Jun-61				-	-	Plugged
07700119	Occidental-McMullin	2-X	Great Basins Petroleum Co.	26	2S	6E	01-Apr-62	01-Dec-81		6,000	1,600	2,270,205	1,193	Plugged
07700120	Occidental-Whiting	66X-23	Triton Oil & Gas Corp.	23	2S	6E	01-May-62	24-May-62				-	-	Plugged
07700008	Occidental-King	42-26	Great Basins Petroleum Co.	26	2S	6E	01-Oct-62	01-Jan-67		1,800	1,700	589,228	7,661	Plugged
07700115	McMullin	5X	Towne Exploration Co.	24	2S	6E	01-May-63	01-Dec-11	1986	5,000	3,500	3,561,716	17,543	Idle
07700113	McMullin	3X	Towne Exploration Co.	25	2S	6E	01-Jul-63	01-Dec-11	1989	1,200	3,400	1,100,716	4,645	Idle
07700117	Occidental-Hays	67X-24	Towne Exploration Co.	24	2S	6E	01-Jul-63	01-Dec-11	1985	3,200	2,800	3,515,058	5,742	Idle
07700116	Occidental-Dutra	32-25	Towne Exploration Co.	25	2S	6E	01-Sep-63	01-Dec-11	1990	1,300	1,500	1,772,003	2,840	Idle
07700014	McMullin	2Y	Towne Exploration Co.	26	2S	6E	01-Nov-63	01-Dec-11	2002	220	3,000	211,186	6,778	Idle
07700135	[BLANK]	39	Paul F. McKenzie	26	2S	6E	15-Feb-64	29-Feb-64				-	-	Plugged
07700121	Occidental-Whiting	87X-23	Towne Exploration Co.	23	2S	6E	01-Apr-64	01-Dec-11	1985	1,400	1,500	964,277	1,114	Idle
07700015	McMullin	4X	Towne Exploration Co.	25	2S	6E	01-Nov-64	01-Dec-11	1988	3,000	1,500	1,082,439	7,751	Idle
07700109	Luck	75-25	Towne Exploration Co.	25	2S	6E	01-Jan-65	01-Dec-11	2004	1,200	2,000	1,994,092	4,837	Idle
07700376	Kromann-Dutra	1	Reynolds & Carver	30	2S	7E	12-May-65	18-May-65				-	-	Plugged
07720007	Perrin	22-25	Towne Exploration Co.	25	2S	6E	01-Jul-67	01-Dec-11	2003	1,500	1,400	1,576,038	2,417	Idle
07720035	Hays	88X-23	Towne Exploration Co.	23	2S	6E	01-Nov-67	01-Dec-11	2006	900	1,000	1,334,942	2,274	Idle
07720478	L.H. Hays	24-1A	Towne Exploration Co.	24	2S	6E	07-Nov-85	04-Apr-86				-	-	Plugged
											Total	48,940,696	356,790	

McMullin Ranch Field - Completion Intervals

API#	Lease Name	Well#	Spud Date	Abandon Date	Interval	Top_MD	Btm_MD	Perfs, ft	Zone	Open	Closed	Notes
07700008	Occidental-King	42-26	4/9/1962	2/7/1967	5383-5390	5383	5390	7	5A	4/30/1962	2/6/1967	
					5965-5974	5965	5974	9	T	4/30/1962	2/6/1967	
					5991-6000	5991	6000	9	T	4/30/1962	2/6/1967	
					6081-6090	6081	6090	9	T	4/29/1962	2/6/1967	
07700014	McMullin	2Y	10/24/1963		7487-7493	7487	7493	6	T	11/16/1963	4/15/1967	
					7519-7540	7519	7540	21	T	11/16/1963	4/15/1967	
					7606-7620	7606	7620	14	T	11/16/1963	4/15/1967	
					7644-7647	7644	7647	3	T	11/16/1963	4/15/1967	
					8553-8567	8553	8567	14	T	11/16/1963	4/15/1967	
					5940-5950	5940	5950	10	T	5/13/1967		
07700015	McMullin	4X	9/30/1964		5302-5308	5302	5308	6	5	10/8/1964		
					5352-5358	5352	5358	6	5A	10/8/1964		
					5369-5372	5369	5372	3		10/8/1964	4/13/1967	Covered by plug at 5368
					5311-5321	5311	5321	10	5	5/30/1967		
07700105	Gulf-Bucher	27-19	6/16/1961	6/26/1961	None							
07700106	Kromann	23X-30	11/19/1960	7/28/1981	5266-5270	5266	5270	4	5	12/2/1960	7/27/1981	
					5284-5295	5284	5295	11	5	12/2/1960	7/27/1981	
					5304-5328	5304	5328	24	5	12/2/1960	7/27/1981	
					5372-5386	5372	5386	14	5A	12/2/1960	7/27/1981	
					5861-5864	5861	5864	3	T	12/2/1960	7/27/1981	
07700108	Lake	72-23	10/10/1960		5938-5940	5938	5940	2	T	10/26/1960		All perfs taken off WBD
					5942-5944	5942	5944	2	T	10/26/1960		
					5960-5966	5960	5966	6	T	10/26/1960		
					5968-5973	5968	5973	5	T	10/26/1960		
					6273-6277	6273	6277	4	T	10/25/1960		Not sure if open after DST; text blacked out
					6313-6320	6313	6320	7	T	10/25/1960		
					6322-6324	6322	6324	2	T	10/25/1960		
					6388-6393	6388	6393	5	T	10/25/1960		
07700109	Luck	75-25	10/19/1964		5116-5121	5116	5121	5	4	10/31/1964		
					5254-5259	5254	5259	5	5	10/13/1968		
					5262-5265	5262	5265	3	5	10/13/1968		
					5270-5274	5270	5274	4	5	10/13/1968		
					5290-5300	5290	5300	10	5	10/13/1968		
					5352-5357	5352	5357	5	5A	10/13/1968		
07700110	McMullin	2	7/5/1960	8/8/1977	5290-5320	5290	5320	30	5	8/9/1960	7/26/1977	
					5331-5336	5331	5336	5	5	8/9/1960	7/26/1977	
					5344-5360	5344	5360	16	5A	8/9/1960	7/26/1977	
					5371-5378	5371	5378	7	5A	8/9/1960	7/26/1977	
					5385-5398	5385	5398	13	5A	8/9/1960	7/26/1977	
					5402-5411	5402	5411	9	5A	8/9/1960	7/26/1977	
					5972-5984	5972	5984	12	T	8/9/1960	7/26/1977	
					6000-6006	6000	6006	6	T	8/9/1960	7/26/1977	
					6394-6400	6394	6400	6	T	8/8/1960	7/26/1977	
					6402-6413	6402	6413	11	T	8/8/1960	7/26/1977	
07700111	McMullin	3	8/22/1960		5262-5276	5262	5276	14	5	9/5/1960		
					5280-5282	5280	5282	2	5	9/5/1960		
					5289-5294	5289	5294	5	5	9/5/1960		
					5344-5362	5344	5362	18	5A	9/5/1960		
					5367-5384	5367	5384	17	5A	9/5/1960		
					5975-5988	5975	5988	13	T	9/5/1960		
					5337-5362	5337	5362	25	5A	10/29/1968		BP at 5361
07700112	McMullin	4	10/5/1960	9/8/1964	5276-5284	5276	5284	8	5	10/21/1960	9/6/1964	
					5289-5293	5289	5293	4	5	10/21/1960	9/6/1964	
					5296-5299	5296	5299	3	5	10/21/1960	9/6/1964	
					5300-5322	5300	5322	22	5	10/21/1960	9/6/1964	
					5349-5385	5349	5385	36	5A	10/21/1960	9/6/1964	

EXHIBIT 2

McMullin Ranch Field - Completion Intervals

API#	Lease Name	Well#	Spud Date	Abandon Date	Interval	Top_MD	Btm_MD	Perfs, ft	Zone	Open	Closed	Notes
					5989-5991	5989	5991	2	T	10/21/1960	9/6/1964	
07700113	McMullin	3X	6/26/1963		8512-8516	8512	8516	4	T	7/20/1963		
					8547-8558	8547	8558	11	T	7/20/1963		
07700114	McMullin	5	1/25/1961	3/30/1971	5296-5300	5296	5300	4	5	2/13/1961	3/30/1971	
					5303-5306	5303	5306	3	5	2/13/1961	3/30/1971	
					5313-5315	5313	5315	2	5	2/13/1961	3/30/1971	
					5319-5321	5319	5321	2	5	2/13/1961	3/30/1971	
					5325-5339	5325	5339	14	5	2/13/1961	3/30/1971	
					5365-5372	5365	5372	7	5A	2/13/1961	3/30/1971	
					5932-5934	5932	5934	2	T	2/12/1961	3/30/1971	
					5948-5951	5948	5951	3	T	2/12/1961	3/30/1971	
					5954-5956	5954	5956	2	T	2/12/1961	3/30/1971	
					5971-5984	5971	5984	13	T	2/12/1961	3/30/1971	
					6348-6362	6348	6362	14		2/8/1961	2/12/1961	Plugged off by BP
07700115	McMullin	5X	4/26/1963		8501-8518	8501	8518	17	T	5/30/1963		
					8524-8543	8524	8543	19	T	5/30/1963	4/12/1968	cmt plug set at 8530-8655, so partial plug off
07700116	Occidental-Dutra	32-25	8/29/1963		8482-8484	8482	8484	2	T	9/15/1963		Text blacked out on hard copy
					8506-8508	8506	8508	2	T	9/15/1963		Text blacked out on hard copy
					8534-8550	8534	8550	16	T			Text blacked out on hard copy
07700117	Occidental-Hays	67X-24	7/5/1963		8510-8532	8510	8532	22	T	7/27/1963	8/17/1979	
					8535-8540	8535	8540	5	T	7/27/1963	8/17/1979	
					8544-8550	8544	8550	6	T	7/27/1963	8/17/1979	plug @ 8331
					??					8/21/1979		Interval blacked out - 8,058-8,068 based on proposal
07700119	Occidental-McMullin	2-X	3/28/1962	8/26/1981	5279-5314	5279	5314	35	5	5/21/1962	1/16/1981	
					5320-5342	5320	5342	22	5	5/21/1962	1/16/1981	
					5362-5377	5362	5377	15	5A	5/20/1962	1/16/1981	
07700120	Occidental-Whiting	66X-23	5/1/1962	5/24/1962	No Perfs							Only DST intervals
07700121	Occidental-Whiting	87X-23	2/9/1964		8052-8062	8052	8062	10			9/19/1973	Can't find record but it's on the Cmt data sheet
					8500-8514	8500	8514	14	T	2/28/1964	9/19/1973	
					8520-8525	8520	8525	5	T	2/28/1964	9/19/1973	
					8530-8532	8530	8532	2	T	2/28/1964	9/19/1973	
					8535-8547	8535	8547	12	T	2/28/1964	9/19/1973	
					8549-8552	8549	8552	3	T	2/28/1964	9/19/1973	
					8555-8556	8555	8556	1	T	2/28/1964	9/19/1973	
					8001-8184	8001	8184	183	T	8/5/1980		
					8118-8122	8118	8122	4	T	8/5/1980		
					6413-6418	6413	6418	5	T	9/10/1980		
					6424-6429	6424	6429	5	T	9/10/1980		
07700124	Signet-Filippini	76X-26	9/3/1960	9/11/1964	5309-5313	5309	5313	4	5	10/17/1960	9/11/1964	
					5325-5328	5325	5328	3	5	10/17/1960	9/11/1964	
					5380-5384	5380	5384	4	5A	10/17/1960	9/11/1964	
					5388-5394	5388	5394	6	5A	10/17/1960	9/11/1964	
07700125	Signet-Hays	67-24	1/5/1961	9/21/1978	5282-5288	5282	5288	6	5	1/19/1961	9/21/1978	
					5296-5302	5296	5302	6	5	1/19/1961	9/21/1978	
					5308-5325	5308	5325	17	5	1/19/1961	9/21/1978	
					5367-5380	5367	5380	13	5A	1/19/1961	9/21/1978	
					6350-6356	6350	6356	6	T	6/17/1972	9/21/1978	
07700127	Signet-Luck	77X-25	8/2/1960	7/27/1981	5256-5260	5256	5260	4	5	8/17/1960	3/23/1966	
					5272-5277	5272	5277	5	5	8/17/1960	3/23/1966	
					5291-5300	5291	5300	9	5	8/17/1960	3/23/1966	
					5352-5372	5352	5372	20	5A	8/17/1960	3/23/1966	
					5380-5390	5380	5390	10	5A	8/17/1960	3/23/1966	Rtnr @ 5380'
					5862-5867	5862	5867	5		8/17/1960	3/23/1966	Below BP @ 5828
					5305-5310	5305	5310	5	5	3/28/1966	7/27/1981	
07700128	Signet-Perrin	33-25	5/12/1960		5266-5268	5266	5268	2	5	5/26/1960		
					5288-5312	5288	5312	24	5	5/26/1960		

EXHIBIT 2

McMullin Ranch Field - Completion Intervals

API#	Lease Name	Well#	Spud Date	Abandon Date	Interval	Top_MD	Btm_MD	Perfs, ft	Zone	Open	Closed	Notes
					5334-5337	5334	5337	3	5A	5/26/1960		
					5340-5342	5340	5342	2	5A	5/26/1960		
					5346-5356	5346	5356	10	5A	5/26/1960		
					5362-5383	5362	5383	21	5A	5/26/1960	4/15/1966	Sqz'd
					5782-5783	5782	5783	1		5/26/1960	4/15/1966	Closed by retainer at 5395 in 4-66
					5910-5922	5910	5922	12	T	5/26/1960	4/15/1966	Closed by retainer at 5395 in 4-66
					5945-5954	5945	5954	9	T	5/26/1960	4/15/1966	Closed by retainer at 5395 in 4-66
					5972-5986	5972	5986	14	T	5/26/1960	4/15/1966	Closed by retainer at 5395 in 4-66
					5988-5993	5988	5993	5	T	5/26/1960	4/15/1966	Closed by retainer at 5395 in 4-66
					5347-5350	5347	5350	3	5	4/17/1966		Re-perf after sqz
					5290-5295	5290	5295	5	5	4/18/1966		Re-perf
07700130	Perrin Unit A	2	12/8/1960	2/21/1970	5272-5275	5272	5275	3	4	2/18/1969	2/20/1970	
					5288-5292	5288	5292	4	4	2/18/1969	2/20/1970	
					5301-5307	5301	5307	6	4	2/18/1969	2/20/1970	
					5319-5329	5319	5329	10	5	12/27/1960	2/20/1970	
					5373-5377	5373	5377	4	5A	2/18/1969	2/20/1970	
					5383-5384	5383	5384	1	5A	12/26/1960	2/20/1970	
07700135	[Blank]	39	2/15/1964	2/29/1964	None							
07700136	Azevedo	1	7/19/1955	9/8/1955	None							
07700376	Kromann-Dutra	1	5/12/1965	5/18/1965	None							
07720007	Perrin	22-25	5/2/1967		5939-5982	5939	5982	43	T	~5/18/67		This is a re-drill well
					5290-5300	5290	5300	10	5	11/18/1999		
					5145-5150	5145	5150	5	5	11/18/1999		
					5145-5159	5145	5159	14	4	1/16/2003		Outside net pay isopach
					5248-5252	5248	5252	4	5	1/16/2003		
					5290-5300	5290	5300	10	5	1/16/2003		
					5282-5285	5282	5285	3	5	1/16/2003		
					5270-5275	5270	5275	5	5	1/16/2003		
					5359-5362	5359	5362	3	5A	1/16/2003		
					5346-5351	5346	5351	5	5A	1/16/2003		
07720035	Hays	88X-23 OH	11/16/1967		5264-5271	5264	5271	7	5	11/29/1967	5/8/1968	OH never produced
					5282-5292	5282	5292	10	5	11/29/1967	5/8/1968	OH never produced
					5297-5300	5297	5300	3	5	11/29/1967	5/8/1968	OH never produced
					5304-5310	5304	5310	6	5	11/29/1967	5/8/1968	OH never produced
					5345-5350	5345	5350	5	5A	11/29/1967	5/8/1968	OH never produced
					5358-5368	5358	5368	10	5A	11/29/1967	5/8/1968	OH never produced
07720035	Hays	88X-23 RD			5284-5287	5284	5287	3	5	5/21/1968		
					5299-5302	5299	5302	3	5	5/21/1968		
					5304-5308	5304	5308	4	5	5/21/1968		
					5323-5334	5323	5334	11	5	5/21/1968		
					5364-5368	5364	5368	4	5A	5/21/1968		
					5378-5389	5378	5389	11	5A	5/21/1968		
07720478	L.H. Hays	24-1A	11/7/1985	4/4/1986	10600-10635	10600	10635	35		4/4/1986	4/4/1986	
					10720-10805	10720	10805	85		4/4/1986	4/4/1986	
					11080-11180	11080	11180	100		4/4/1986	4/4/1986	

McMullin Ranch

DOGGR Production

Summary: McMullin_Tracy / Lathrop

Cum production thru August 2011

Cum Gas, MMcf:	**12,397.5**
Cum Water, MBbls:	**39.8**

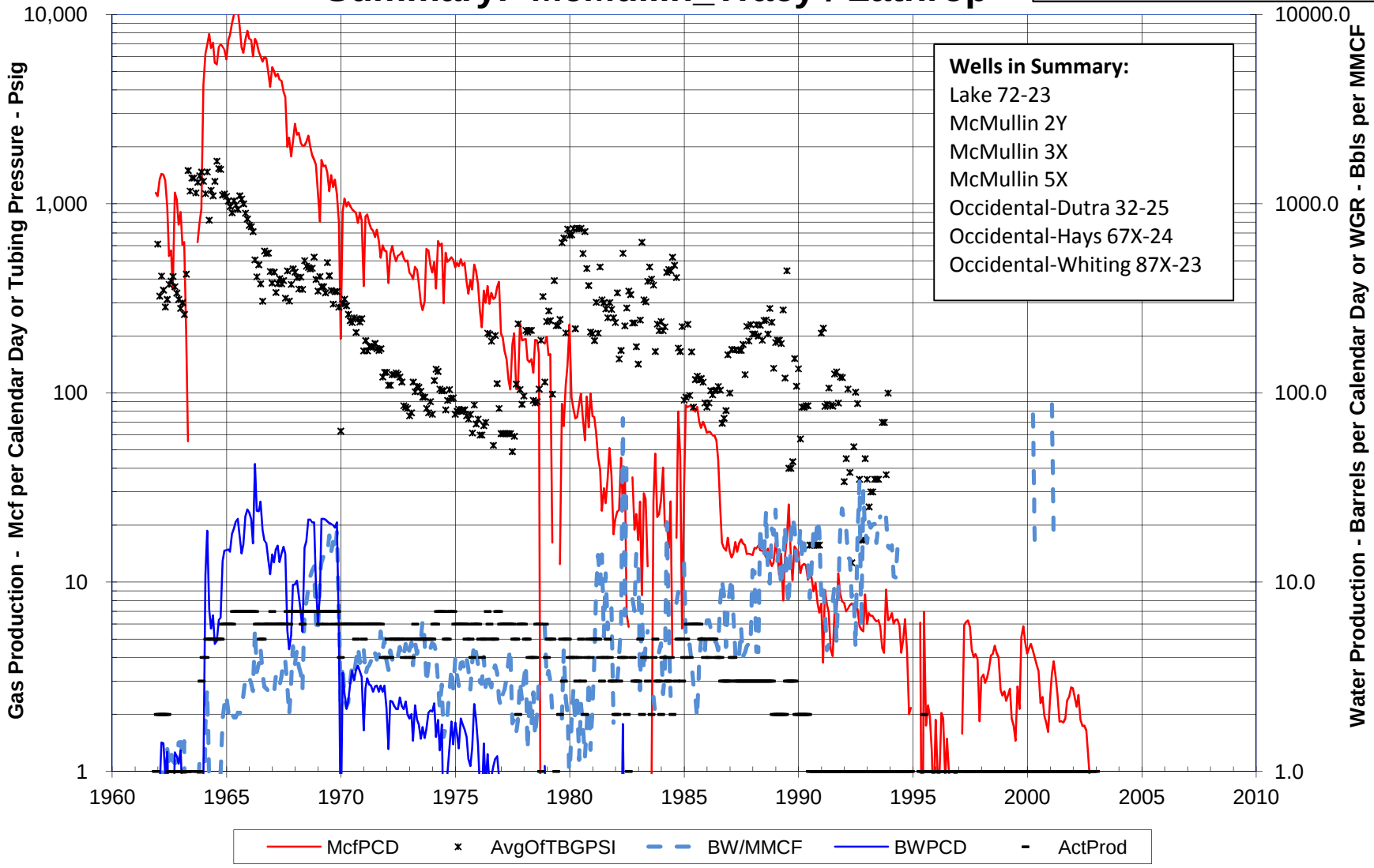


EXHIBIT 3

McMullin Ranch

DOGGR Production

Summary: McMullin_Blewett / Tracy

Cum production thru August 2011

Cum Gas, MMcf:	**20,896.7**
Cum Water, MBbls:	**229.3**

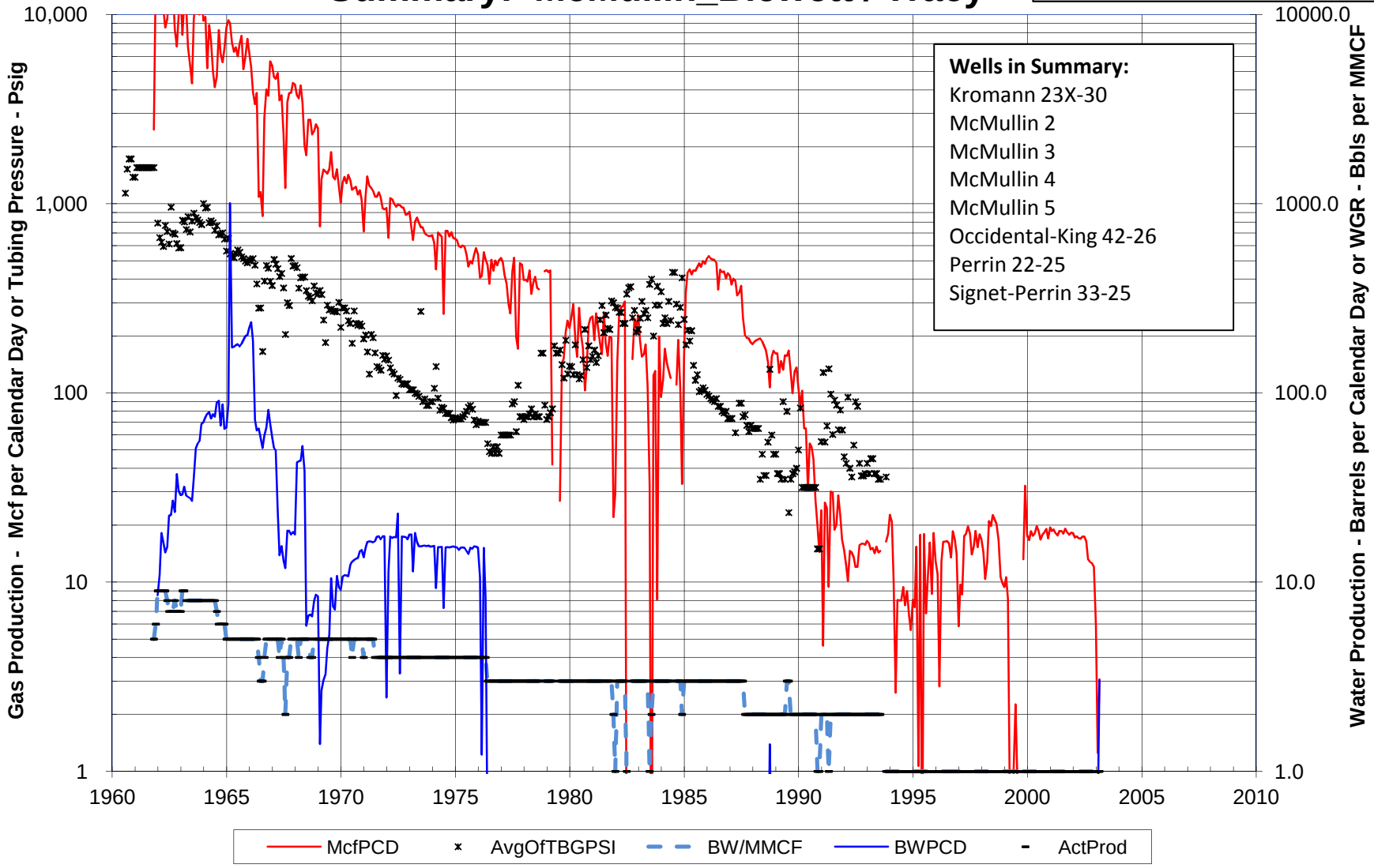


EXHIBIT 4

McMullin Ranch

DOGGR Production

Summary: McMullin_Blewett

Cum production thru August 2011

Cum Gas, MMcf:	**15,646.4**
Cum Water, MBbls:	**87.7**

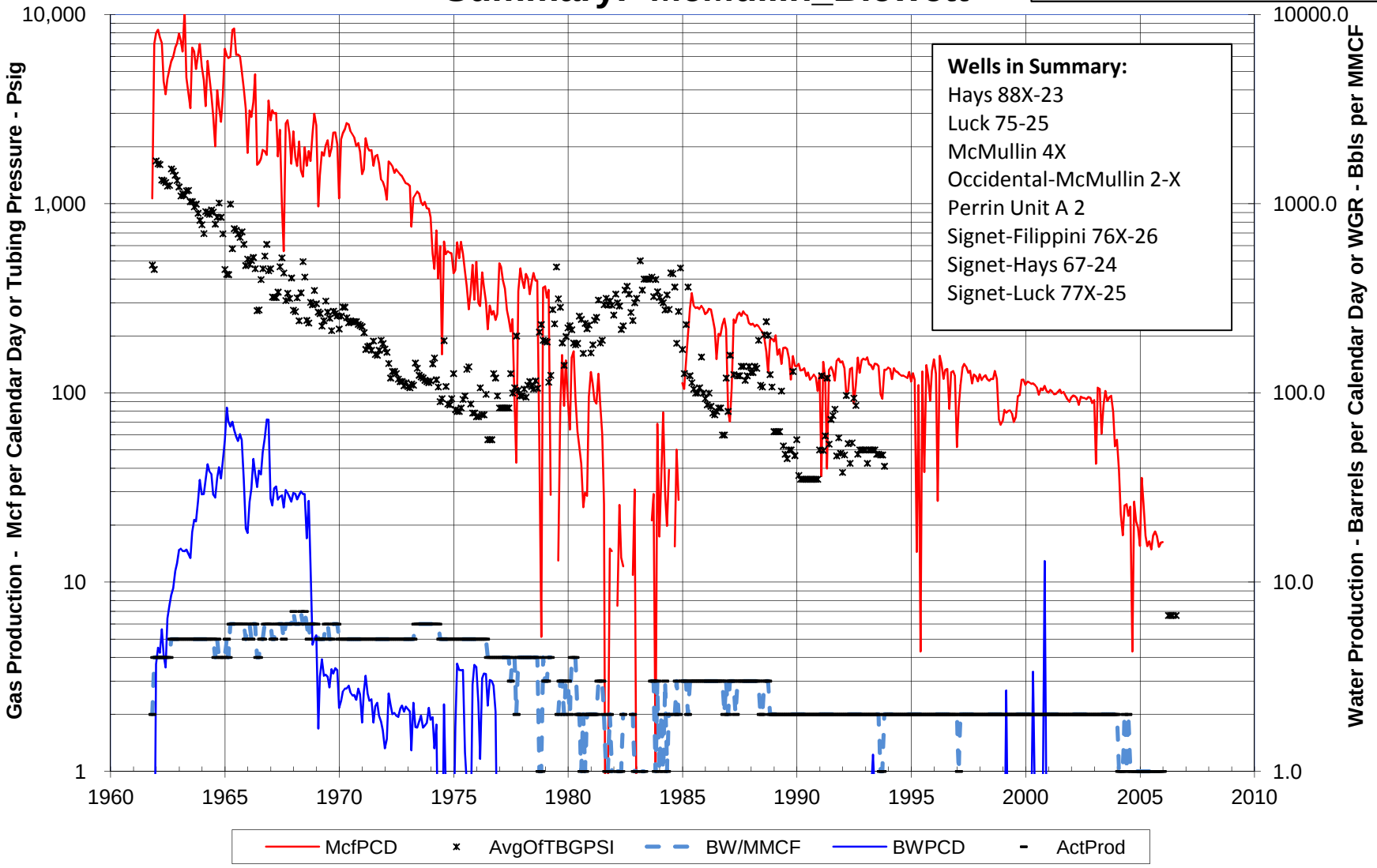


EXHIBIT 5

McMullin Ranch Gas Field
Production Allocation
Effective Perfs Used for Allocation Where Tracy+ is Open

Net Pay Used for Allocation Where Blewett Only Open

												Net Pay			Effective Perfs				Allocated Prod, MMCF				
API#	LeaseName	Well#	Sec	Twn	Rge	Top B4	Top B5	Top B5a	Top Tracy	MMCF	MBW	B4	B5	B5A	B4	B5	B5A	T+	B4	B5	B5A	Tracy+	Notes
7700135	[BLANK]	39	26	2S	6E	5,230	5,318	5,400	6,002	-	-	0	0	6	0	0	0	0	-	-	-	-	
7700136	Azevedo	1	25	2S	6E	5,130	5,250	5,339	NR	-	-	2	25	30	0	0	0	0	-	-	-	-	
7700105	Gulf-Bucher	27-19	19	2S	7E	5,186	5,297	5,390	6,033	-	-	0	6	5	0	0	0	0	-	-	-	-	
7720035	Hays OH	88X-23	23	2S	6E	5,164	5,260	5,345	5,929	-	-				0	0	0	0	-	-	-	-	
7720035	Hays RD	88X-23	23	2S	6E	5,180	5,280	5,364	5,945	1,335	2	0	4	31	0	21	15	0	-	153	1,182	-	
7700106	Kromann	23X-30	30	2S	7E	5,138	5,259	5,373	6,028	4,570	39	2	32	14	0	37	14	3	-	3,131	1,185	254	No logs available
7700376	Kromann-Dutra	1	30	2S	7E	5,163	5,286	5,400	NR	-	-	0	6	1	0	0	0	0	-	-	-	-	
7720478	L.H. Hays	24-1A	24	2S	6E	5,197	5,284	5,379	6,010	-	-	0	21	6	0	0	0	0	-	-	-	-	
7700108	Lake	72-23	23	2S	6E					1,273	1	0	0	0	0	0	0	33	-	-	-	1,273	
7700109	Luck	75-25	25	2S	6E	5,118	5,248	5,346	NR	1,994	5	17	42	40	10	22	5	0	514	758	722	-	B4 pre 10/1968 = 207 MMCF
7700110	McMullin	2	26	2S	6E	5,176	5,270	5,350	5,952	169	-	0	13	25	0	15	35	18	-	37	87	45	
7700111	McMullin	3	25	2S	6E	5,124	5,258	5,343	5,974	5,770	17	15	28	30	0	21	42	13	-	1,594	3,189	987	
7700112	McMullin	4	25	2S	6E	5,137	5,256	5,346	5,990	1,354	3	1	24	31	0	37	36	2	-	668	650	36	
7700114	McMullin	5	24	2S	6E	5,182	5,270	5,365	5,922	1,802	63	0	16	10	0	25	7	20	-	866	243	693	
7700014	McMullin	2Y	26	2S	6E	5,180	5,270	5,349	5,940	211	7	0	6	31	0	0	0	10	-	-	-	211	
7700113	McMullin	3X	25	2S	6E	5,140	5,258	5,361	5,962	1,101	5	0	27	23	0	0	0	15	-	-	-	1,101	
7700015	McMullin	4X	25	2S	6E	5,121	5,258	5,346	NR	1,082	8	6	28	33	0	14	17	0	-	497	585	-	
7700115	McMullin	5X	24	2S	6E	5,200	5,280	5,374	5,938	3,562	18	0	10	10	0	0	0	36	-	-	-	3,562	
7700116	Occidental-Dutra	32-25	25	2S	6E	5,139	5,250	5,337	5,940	1,772	3	0	23	30	0	0	0	20	-	-	-	1,772	
7700117	Occidental-Hays	67X-24	24	2S	6E	5,166	5,265	5,363	5,970	3,515	6	0	30	13	0	0	0	33	-	-	-	3,515	
7700008	Occidental-King	42-26	26	2S	6E	5,218	5,308	5,380	5,960	589	8	0	0	**20**	0	0	7	27	-	-	121	468	
7700119	Occidental-McMullin	2-X	26	2S	6E	5,176	5,273	5,358	NR	2,270	1	0	7	13	0	57	15	0	-	795	1,476	-	
7700120	Occidental-Whiting	66X-23	23	2S	6E	5,240	5,330	5,408	5,930	-	-	0	3	2	0	0	0	0	-	-	-	-	
7700121	Occidental-Whiting	87X-23	23	2S	6E	5,200	5,290	5,368	5,935	964	1	0	5	14	0	0	0	37	-	-	-	964	
7720007	Perrin	22-25	25	2S	6E	5,145	5,248	5,330	5,939	1,576	2	0	18	29	0	10	0	43	-	4	-	1,572	Tracy+ pre 11/1999 = 1555 MMCF
7700130	Perrin Unit A	2	30	2S	7E	5,140	5,319	5,371	6,102	1,630	3	3	12	12	0	10	1	0	-	815	815	-	
7700124	Signet-Filippini	76X-26	26	2S	6E	5,192	5,292	5,378	6,010	225	1	0	6	12	0	7	10	0	-	75	150	-	
7700125	Signet-Hays	67-24	24	2S	6E	5,173	5,280	5,365	5,970	2,204	36	0	30	10	0	30	13	0	-	1,653	551	-	No logs available
7700127	Signet-Luck	77X-25	25	2S	6E	5,118	5,250	5,348	6,086	4,905	31	10	44	30	0	23	30	0	-	2,916	1,989	-	
7700128	Signet-Perrin	33-25	25	2S	6E	5,133	5,248	5,335	5,948	5,067	97	2	22	29	0	26	36	39	-	1,899	1,821	1,347	Post 4/1966 w/o T+ & 21' B5A; 1578 mmcf post 4/1966
TOTAL										48,940	357								514	15,861	14,765	17,800	

Blewett Only Open

Est. Initial Gas in Place, MMCF	**5,010**	**36,100**	**39,260**	**NA**
Recovery Factor, %	**10.3%**	**43.9%**	**37.6%**	**NA**

EXHIBIT 6

McMullin Ranch Field, San Joaquin County, CA

Pressure Data

Sorted by zone and drill date

Well	Date	Interval	Zone	Avg Depth	ISIP, psi	FSIP, psi	ISIP, psi/ft	FSIP, psi/ft
Luck 75-25	10/24/1964	5116-5128	B4	5,122	2,294	2,224	0.45	0.43
Signet-Perrin 33-25	5/18/1960	5293-5313	B5	5,303	2,395	2,320	0.45	0.44
Gulf_Bucher 27-19	6/22/1961	5305-5388	B5	5,346	2,462		0.46	
McMullin 2X	5/21/1962	5279-5314	B5	5,297		2,298		0.43
McMullin 3	9/6/1960	5262-5384	B5-5A	5,323		2,400		0.45
McMullin 2X	7/14/1960	5362-5377	B5A	5,370		2,290		0.43
McMullin 2	7/14/1960	5350-5410	B5A	5,380	2,405	2,405	0.45	0.45
Signet-Fillipini 76X-26	9/9/1960	5382-5441	B5A	5,411	2,390	2,355	0.44	0.44
McMullin 2X	5/25/1962	5362-5377	B5A	5,370		2,250		0.42
McMullin 4	8/7/1964	5349-5385	B5A	5,367	1,803	1,727	0.34	0.32
McMullin 2	8/9/1960	5972-6006	Tracy	5,989		2,650		0.44
McMullin 3	9/5/1960	5922-5941	Tracy	5,932	2,650	2,500	0.45	0.42
Lake 72-23	10/19/1960	5941-5980	Tracy	5,960	2,788	2,768	0.47	0.46
Kromann 23X-30	12/1/1960	5861-5864	Tracy	5,862	2,685		0.46	
McMullin 5	2/12/1961	5932-5984	Tracy	5,958	2,720	2,705	0.46	0.45
Occidental-King 42-26	4/20/1962	6083-6084	Tracy	6,083	2,800	2,755	0.46	0.45
Occidental-King 42-26	4/29/1962	6081-6090	Tracy	6,085	2,810	2,690	0.46	0.44
McMullin 2Y	7/11/1967	5940-5950	Tracy	5,945		1,571		0.26
McMullin 2Y	7/14/1967	5940-5950	Tracy	5,945		1,775		0.30

McMullin Ranch

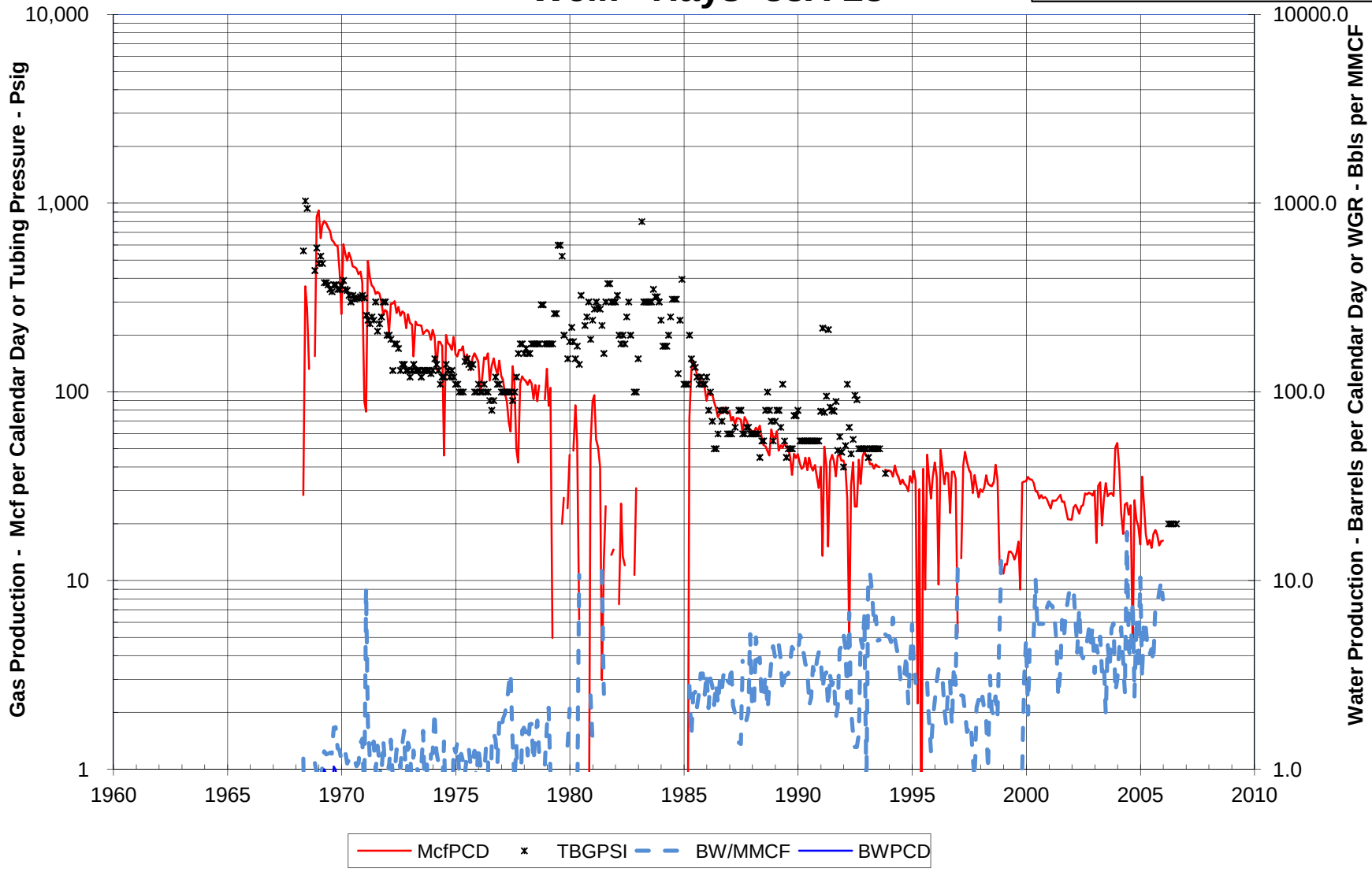
DOGGR Production

API#: 07720035

Well: Hays 88X-23

Cum production thru August 2011

Cum Gas, MMcf:	1,334.9
Cum Water, MBbls:	2.3



McMullin Ranch

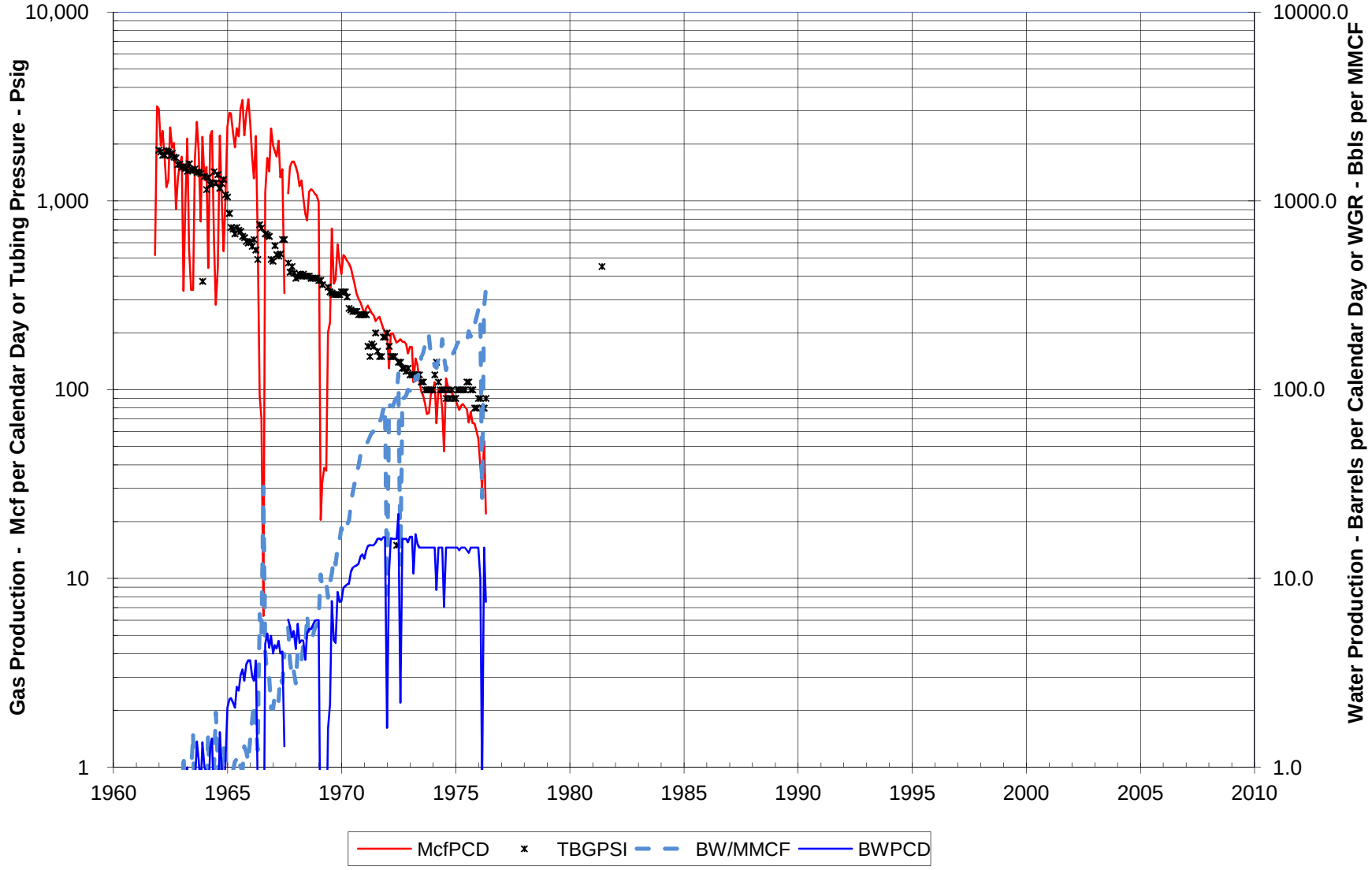
DOGGR Production

API#: 07700106

Well: Kromann 23X-30

Cum production thru August 2011

Cum Gas, MMcf:	4,569.8
Cum Water, MBbls:	39.1



McMullin Ranch

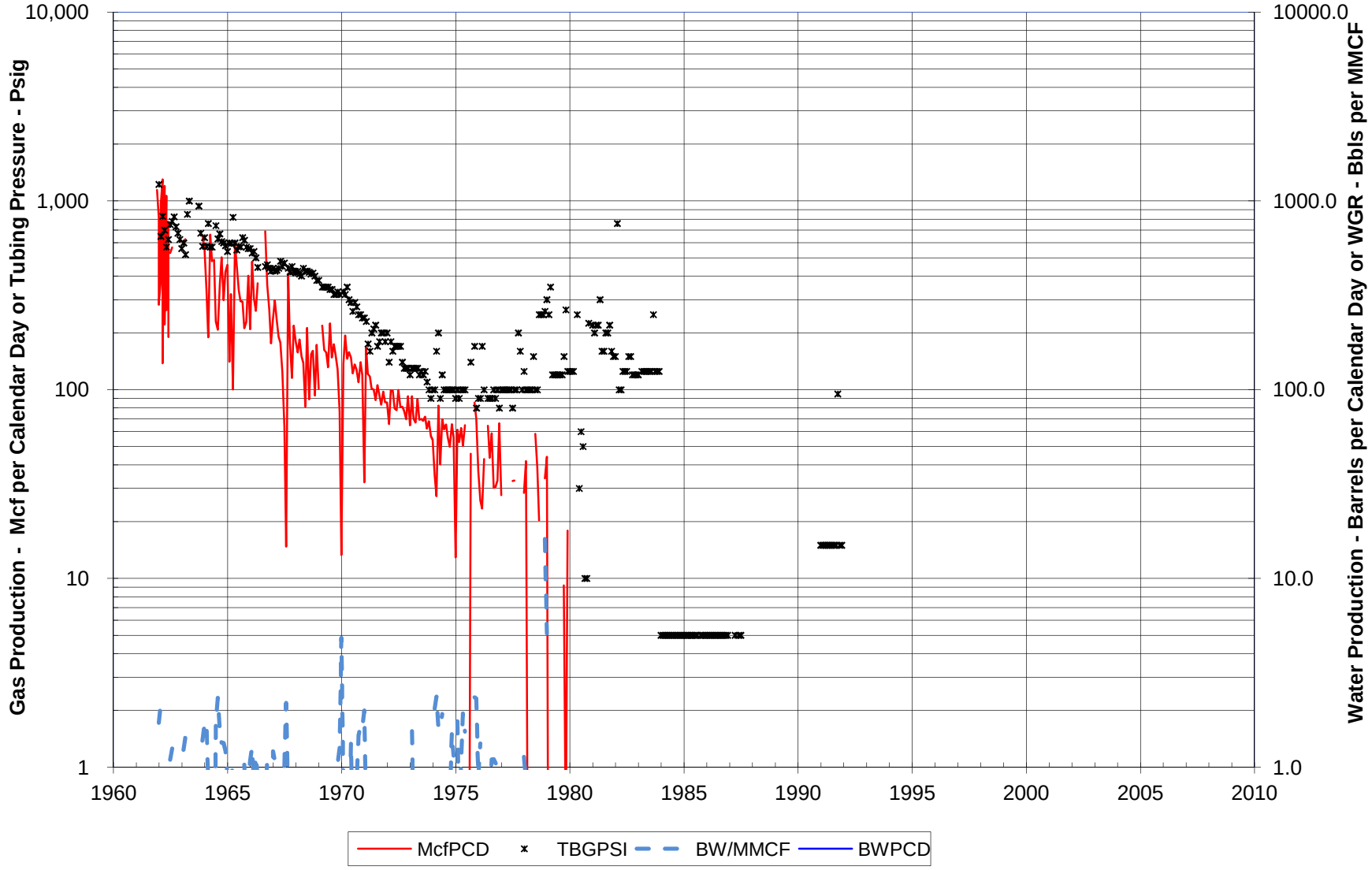
DOGGR Production

API#: 07700108

Well: Lake 72-23

Cum production thru August 2011

Cum Gas, MMcf:	1,272.6
Cum Water, MBbls:	1.1



McMullin Ranch

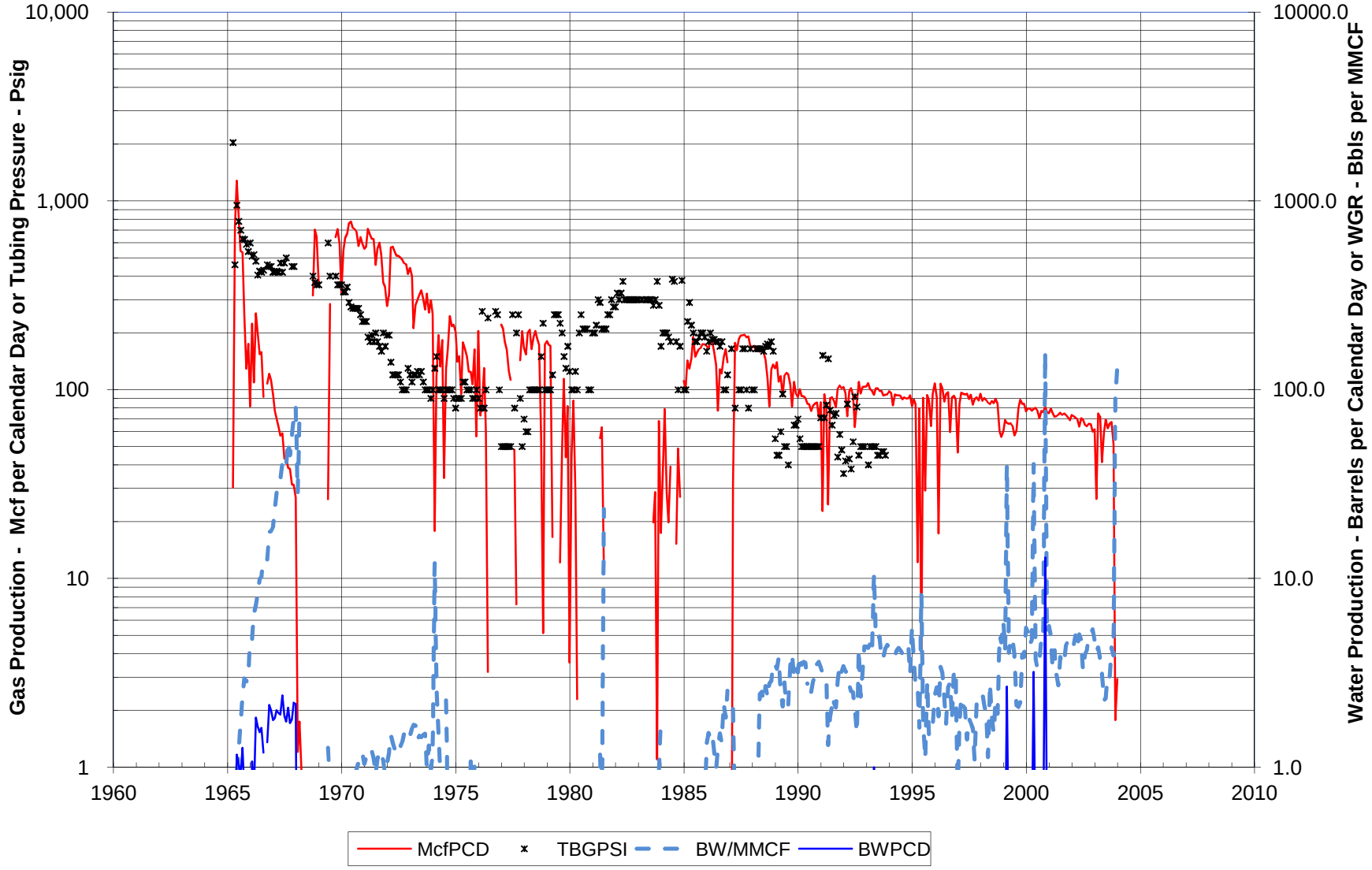
DOGGR Production

API#: 07700109

Well: Luck 75-25

Cum production thru August 2011

Cum Gas, MMcf:	1,994.1
Cum Water, MBbls:	4.8



McMullin Ranch

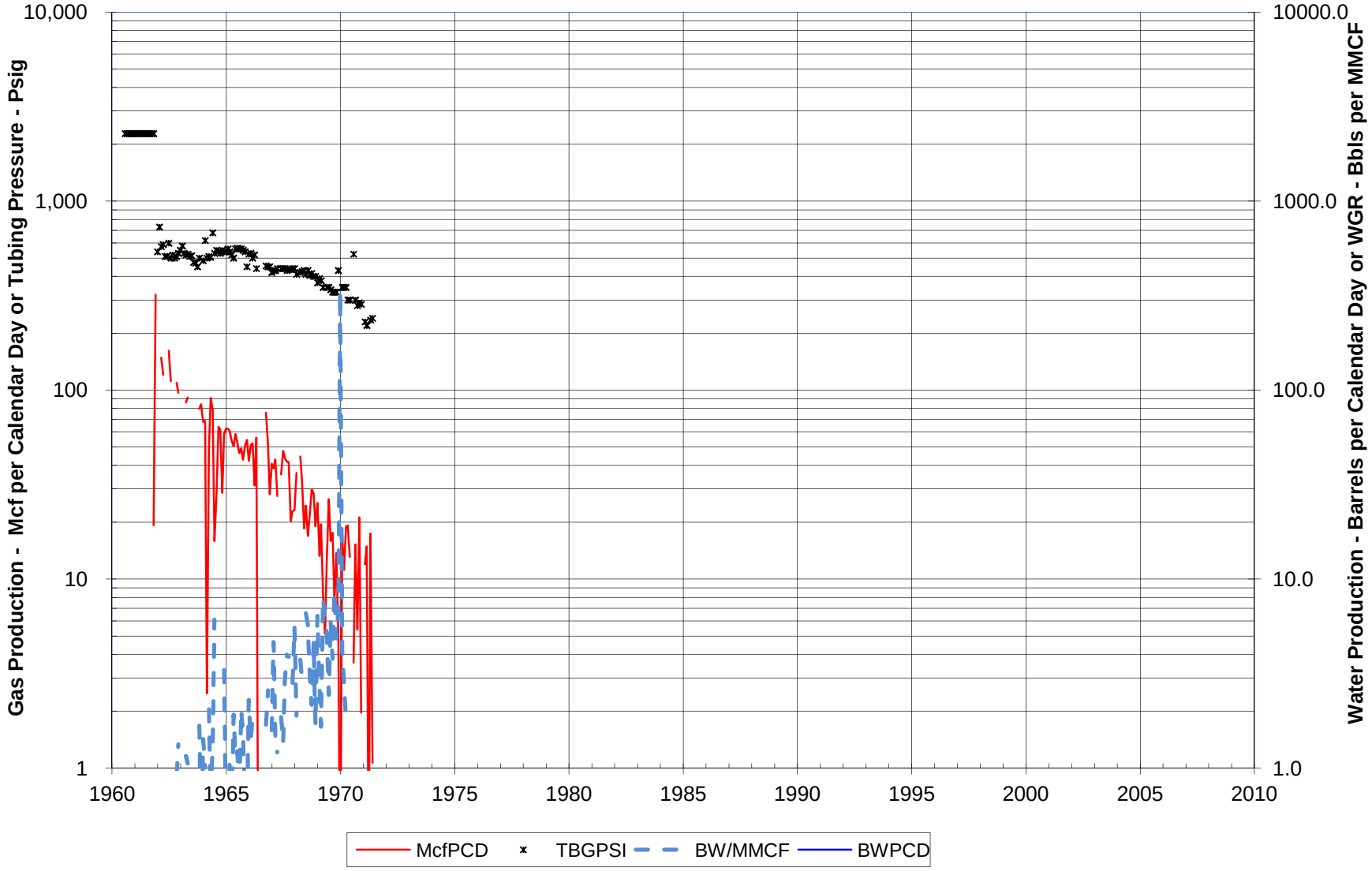
DOGGR Production

API#: 07700110

Well: McMullin 2

Cum production thru August 2011

Cum Gas, MMcf:	169.1
Cum Water, MBbls:	0.2



McMullin Ranch

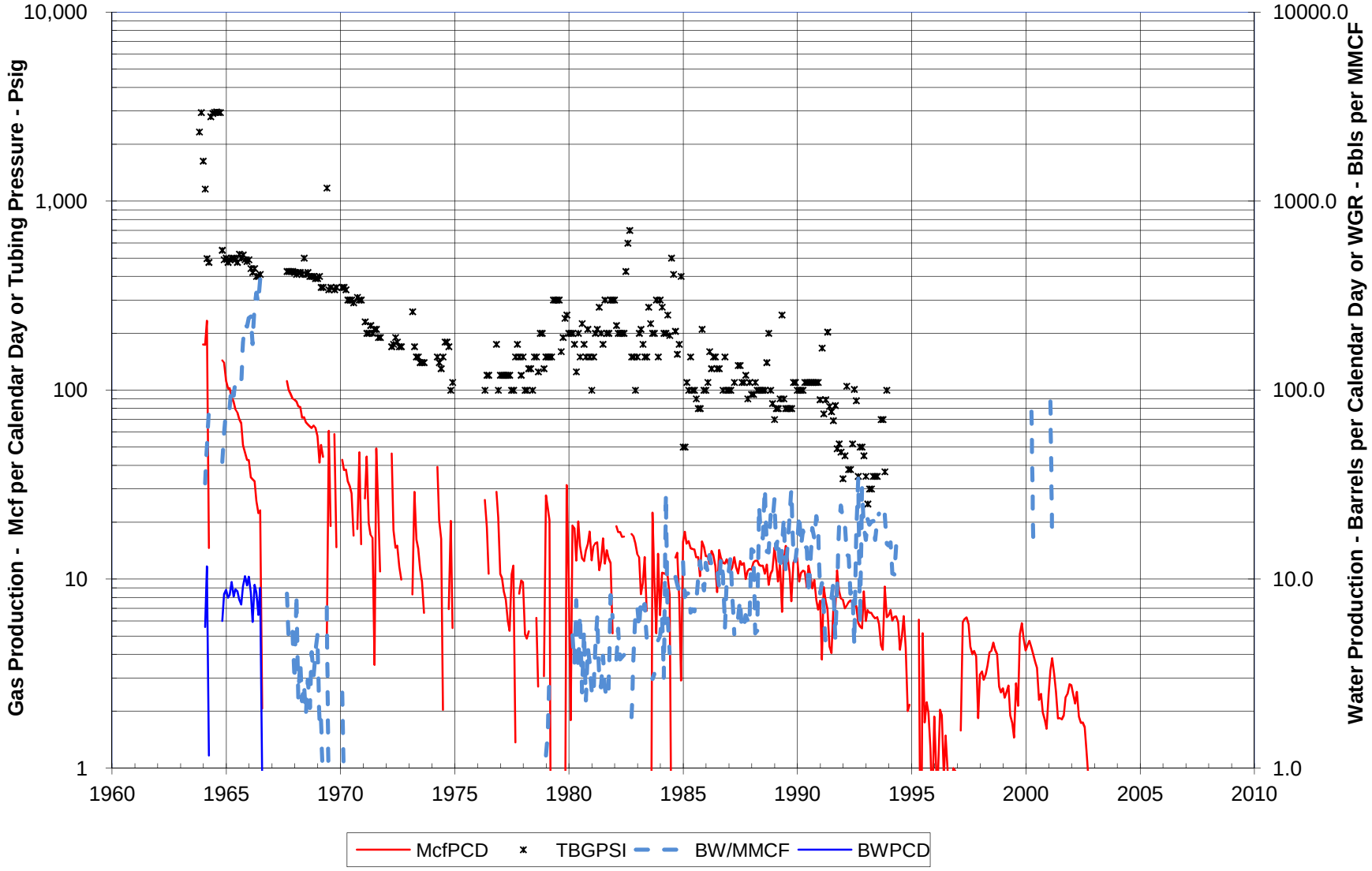
DOGGR Production

API#: 07700014

Well: McMullin 2Y

Cum production thru August 2011

Cum Gas, MMcf:	211.2
Cum Water, MBbls:	6.8



McMullin Ranch

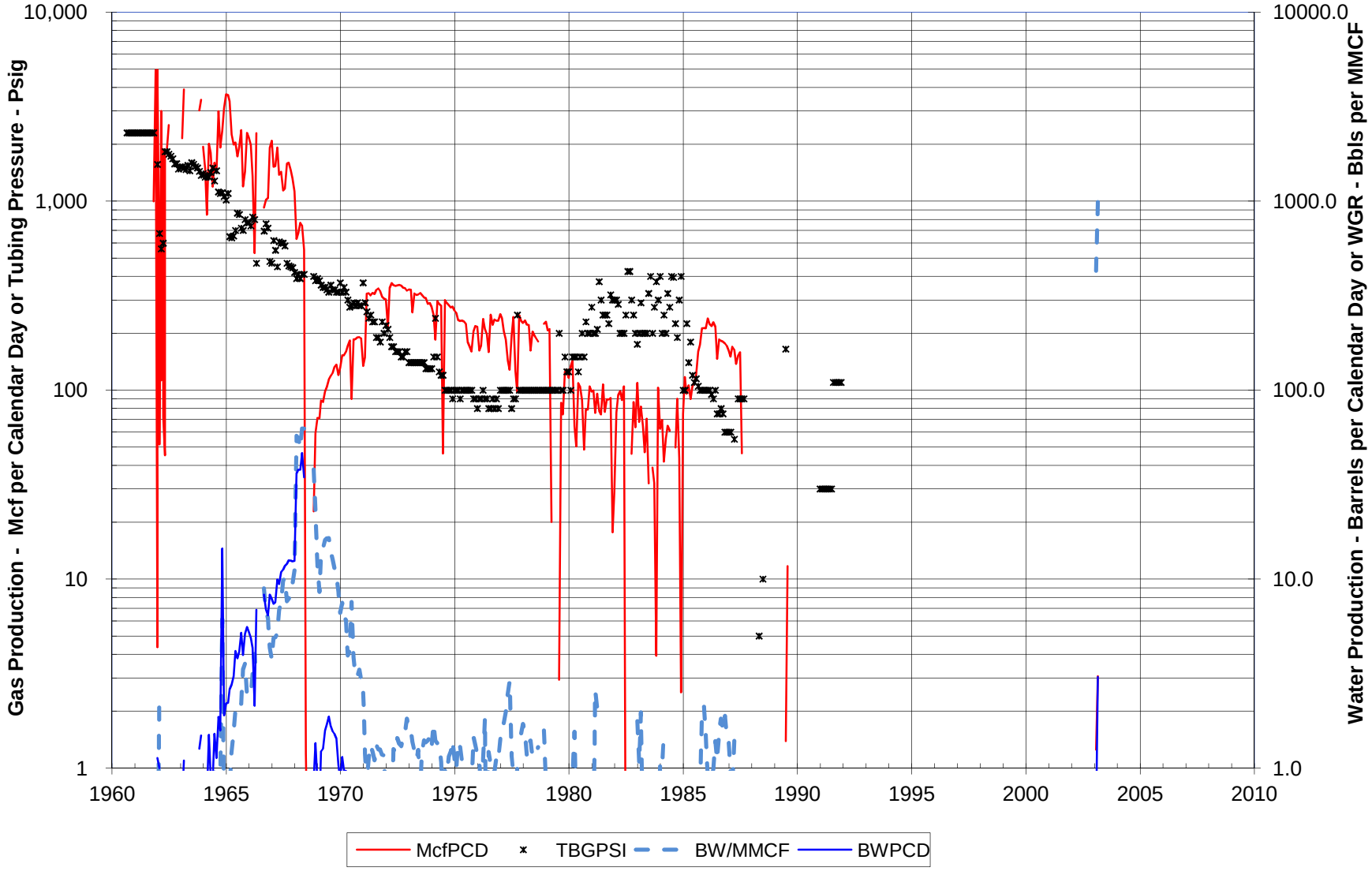
DOGGR Production

API#: 07700111

Well: McMullin 3

Cum production thru August 2011

Cum Gas, MMcf:	5,769.9
Cum Water, MBbls:	16.6



McMullin Ranch

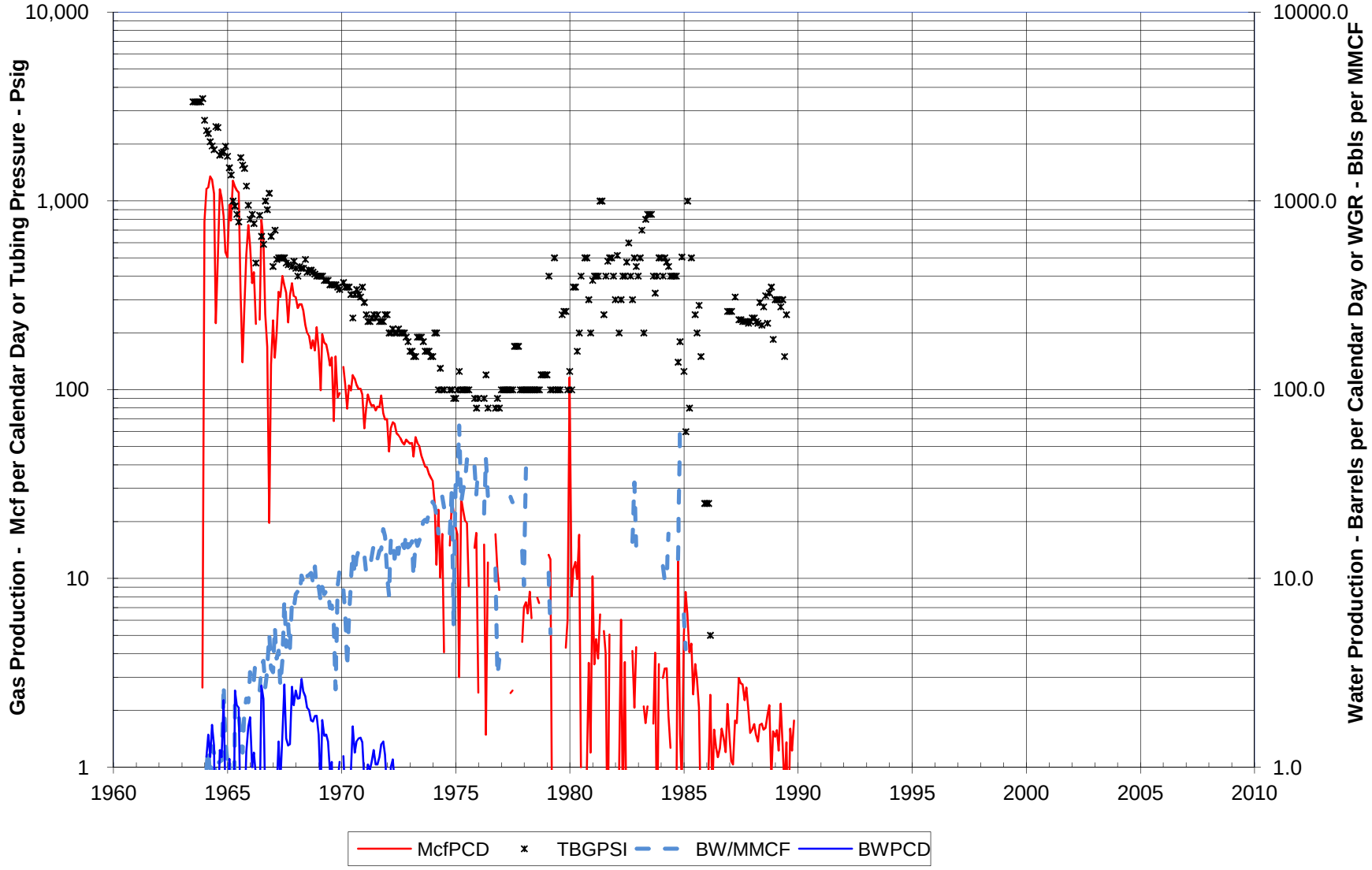
DOGGR Production

API#: 07700113

Well: McMullin 3X

Cum production thru August 2011

Cum Gas, MMcf:	1,100.7
Cum Water, MBbls:	4.6



McMullin Ranch

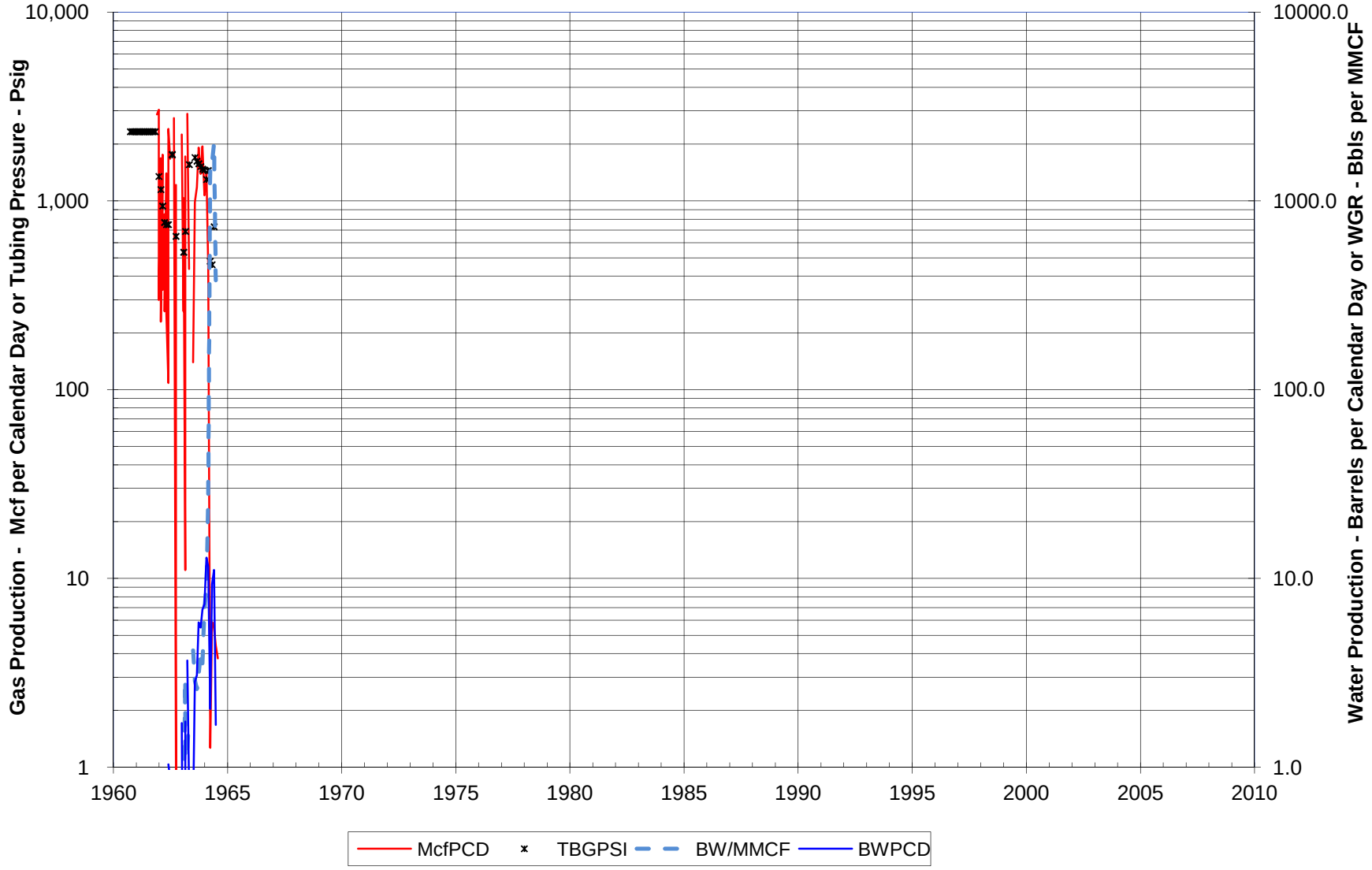
DOGGR Production

API#: 07700112

Well: McMullin 4

Cum production thru August 2011

Cum Gas, MMcf:	1,354.3
Cum Water, MBbls:	3.1



McMullin Ranch

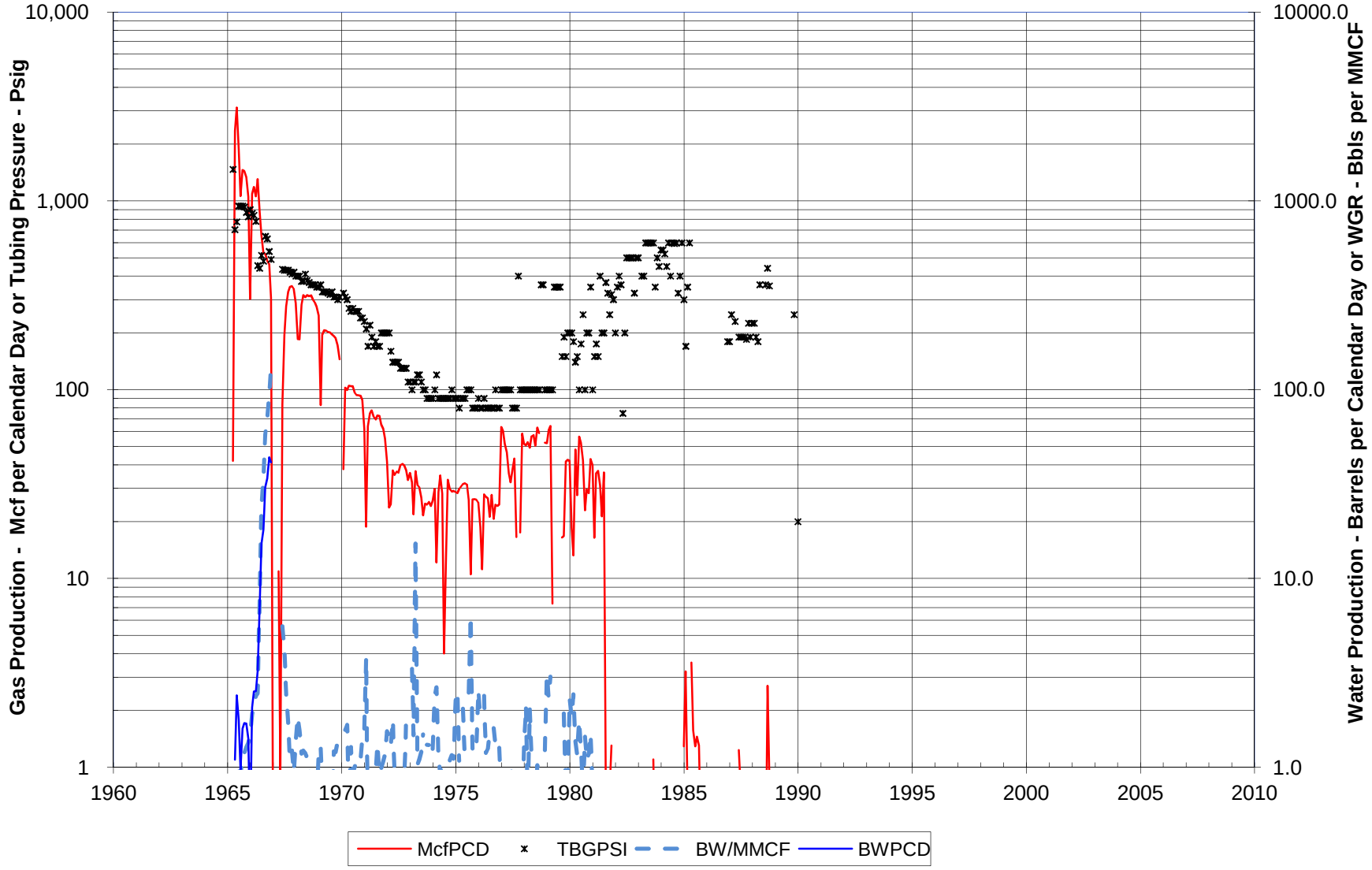
DOGGR Production

API#: 07700015

Well: McMullin 4X

Cum production thru August 2011

Cum Gas, MMcf:	1,082.4
Cum Water, MBbls:	7.8



McMullin Ranch

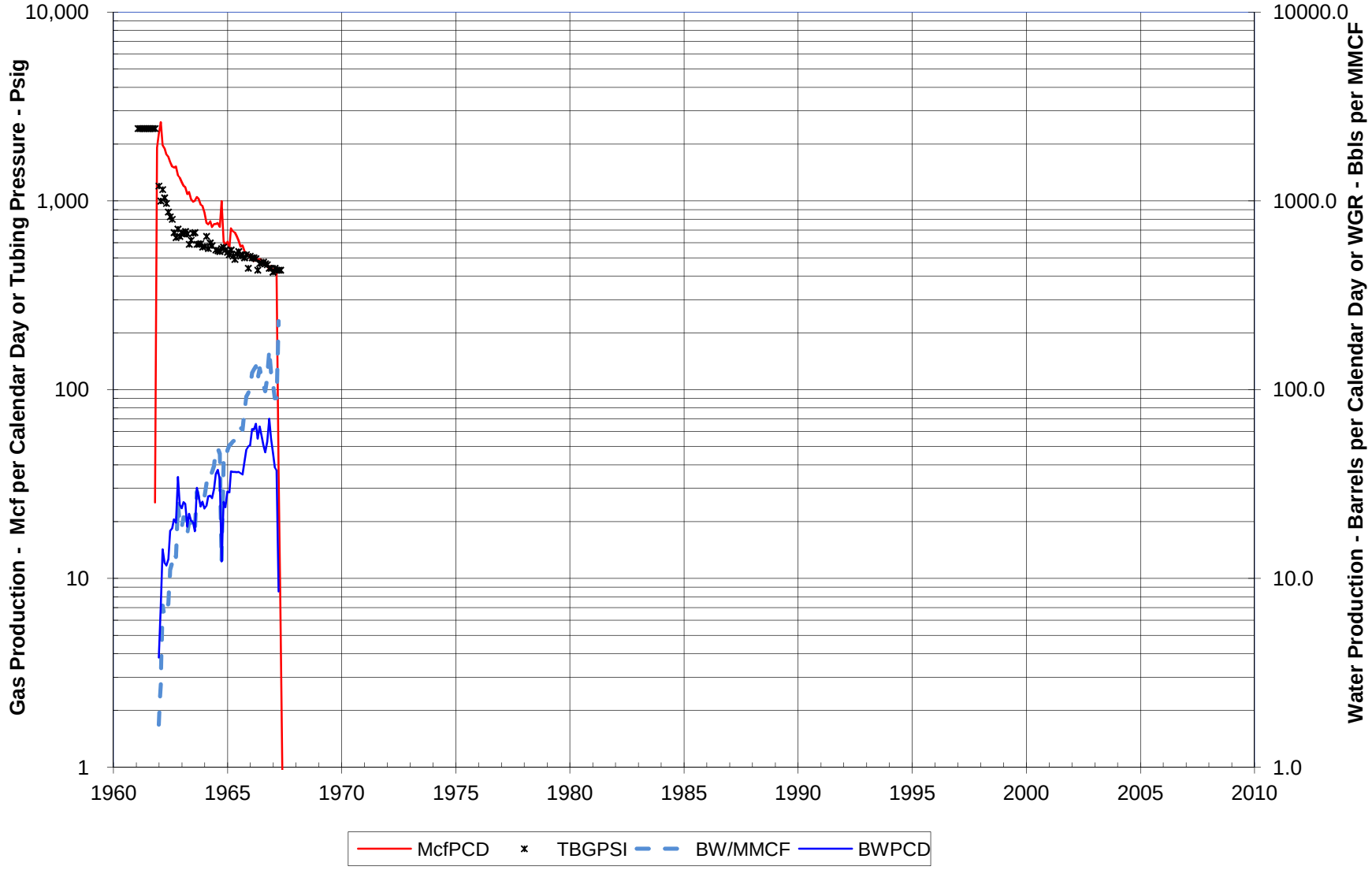
DOGGR Production

API#: 07700114

Well: McMullin 5

Cum production thru August 2011

Cum Gas, MMcf:	1,801.6
Cum Water, MBbls:	63.2



McMullin Ranch

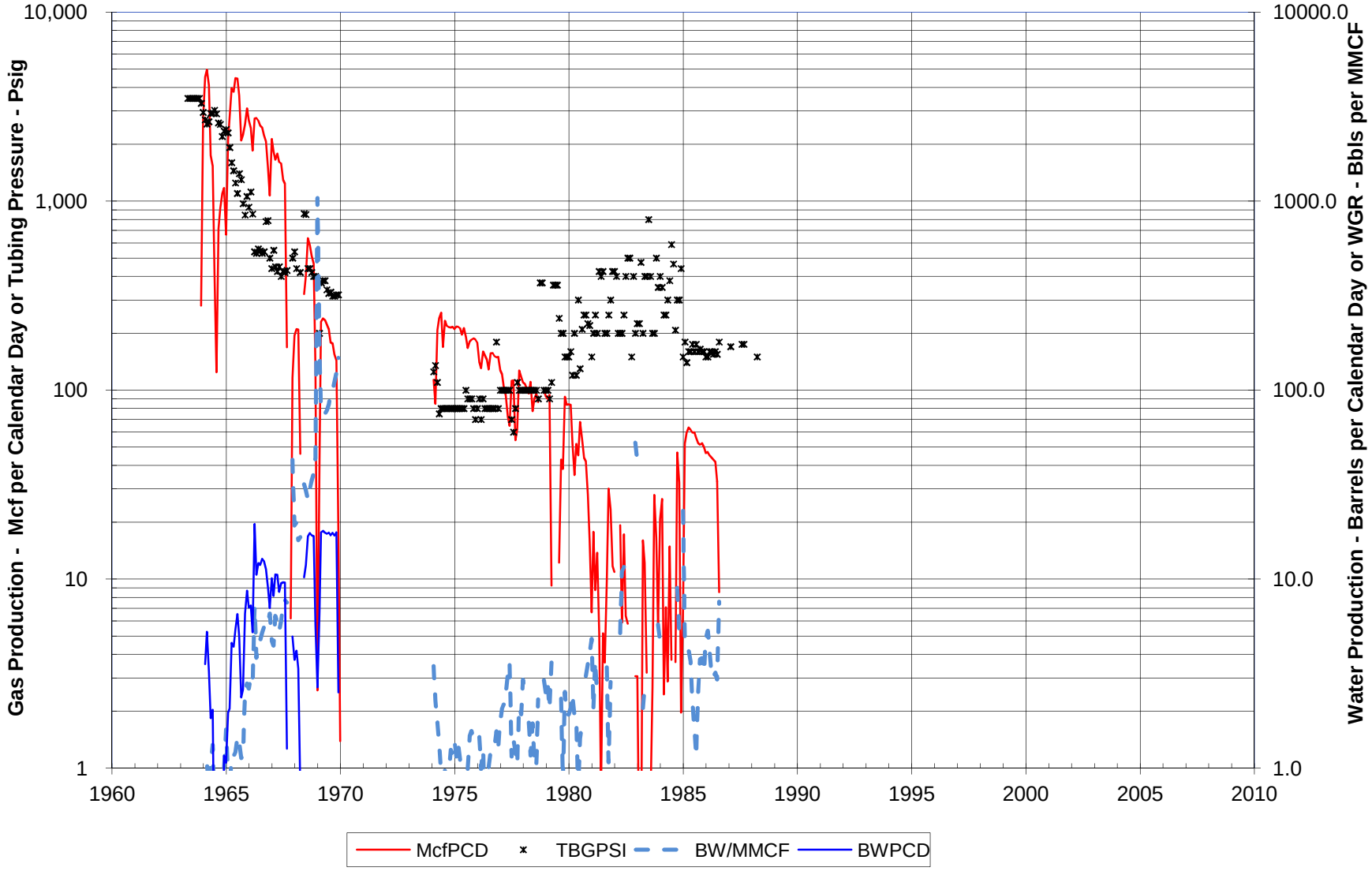
DOGGR Production

API#: 07700115

Well: McMullin 5X

Cum production thru August 2011

Cum Gas, MMcf:	3,561.7
Cum Water, MBbls:	17.5



McMullin Ranch

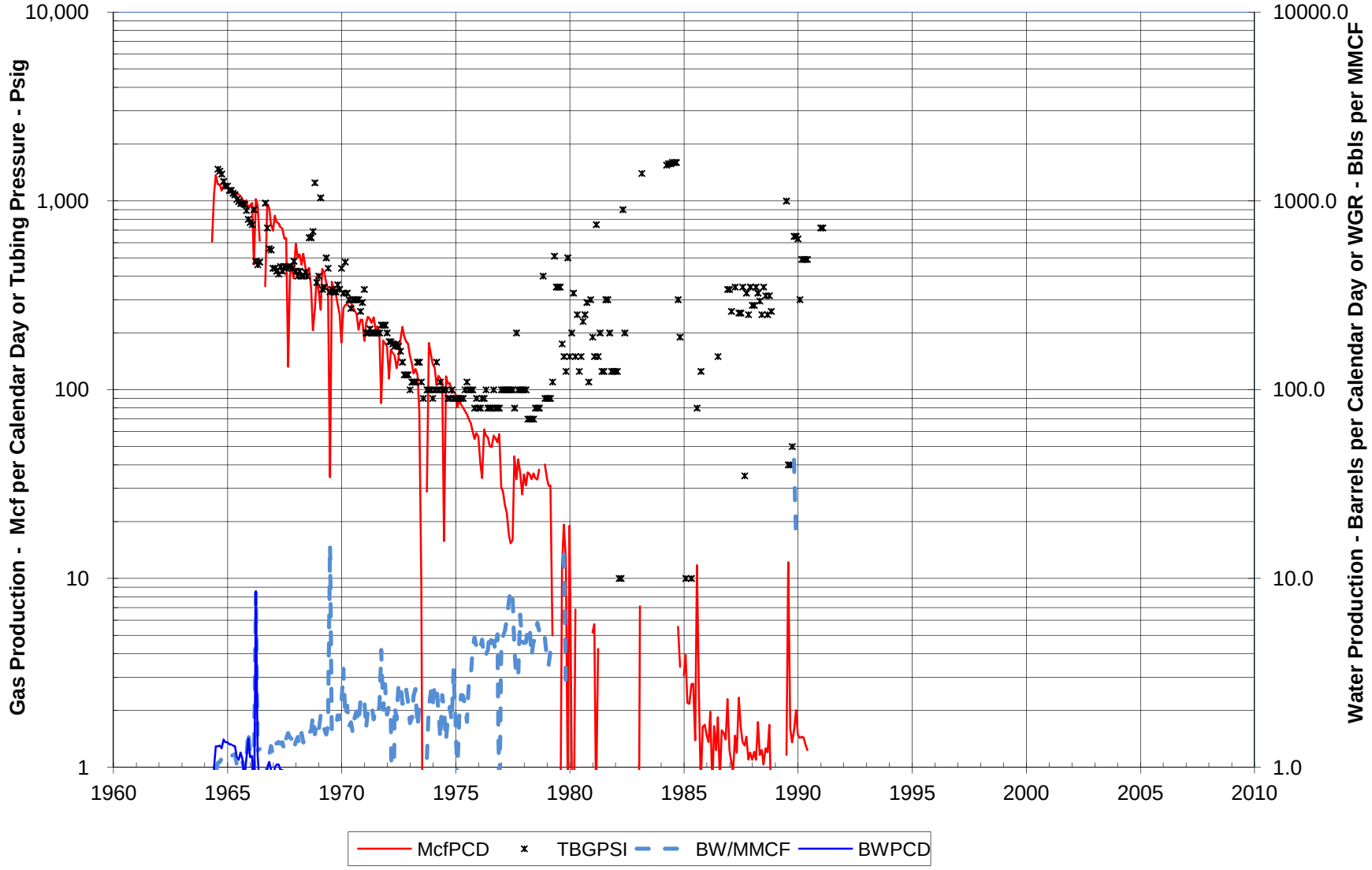
DOGGR Production

API#: 07700116

Well: Occidental-Dutra 32-25

Cum production thru August 2011

Cum Gas, MMcf:	1,772.0
Cum Water, MBbls:	2.8



McMullin Ranch

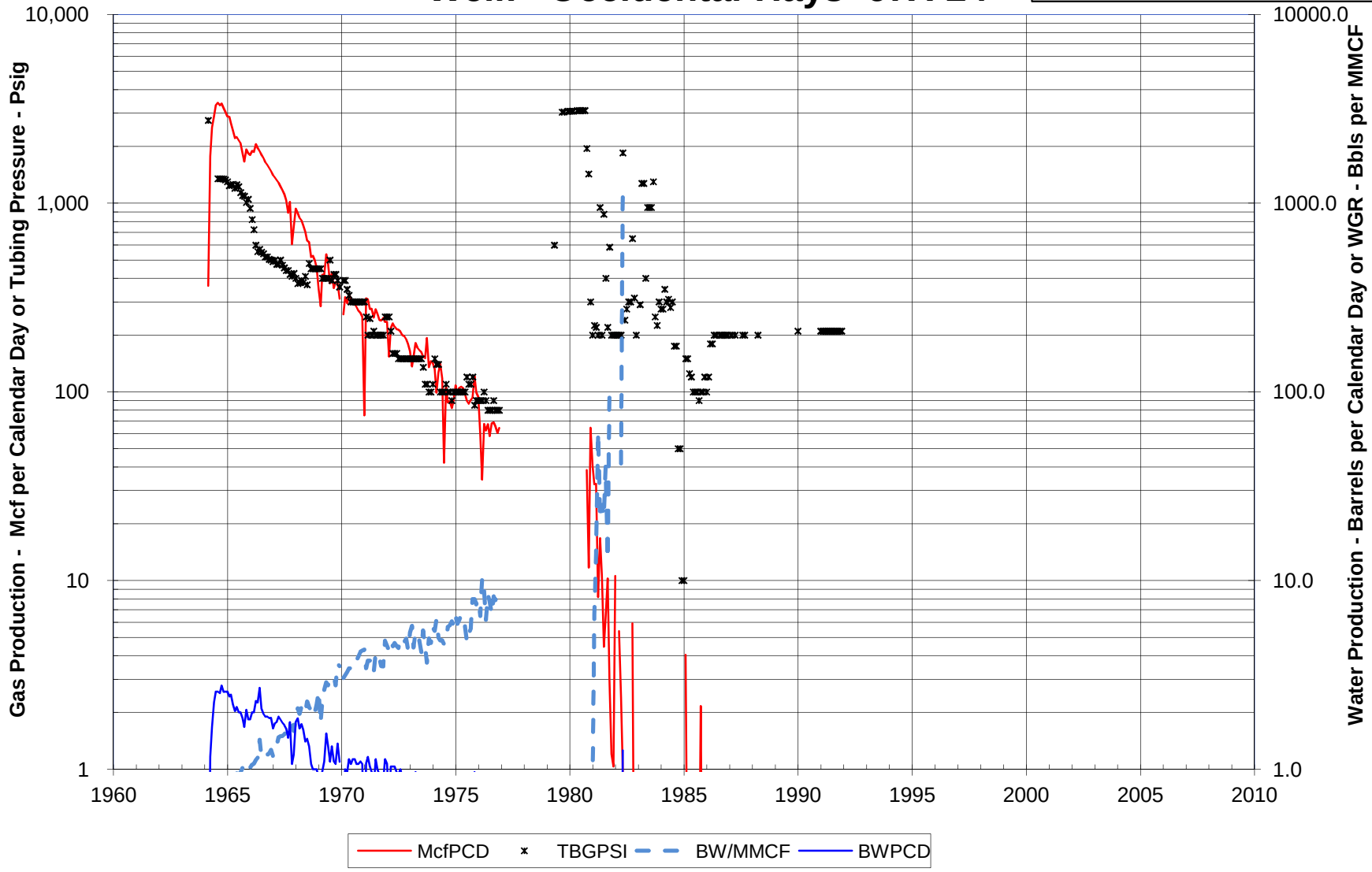
DOGGR Production

API#: 07700117

Well: Occidental-Hays 67X-24

Cum production thru August 2011

Cum Gas, MMcf:	3,515.1
Cum Water, MBbls:	5.7



McMullin Ranch

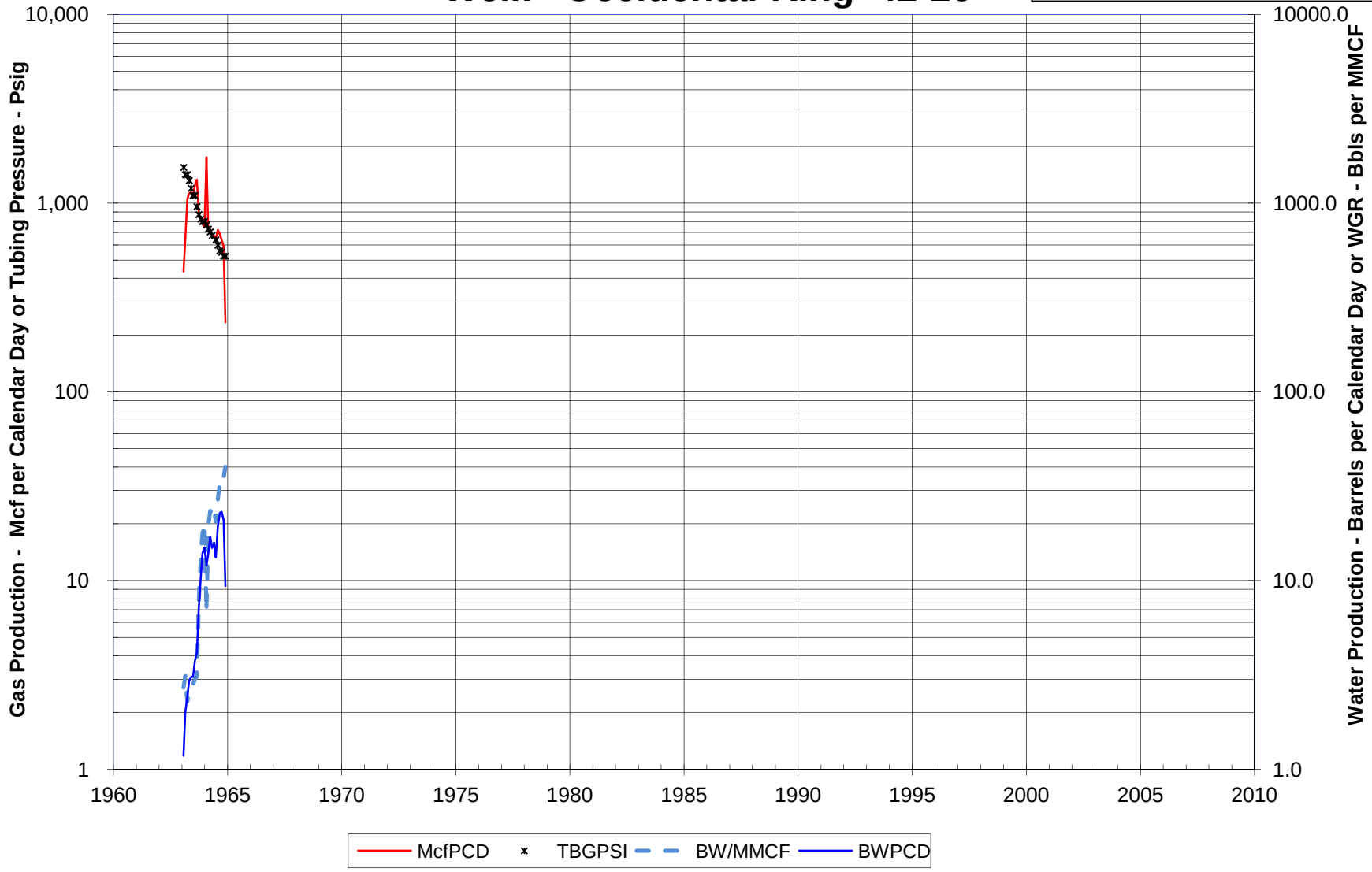
DOGGR Production

API#: 07700008

Well: Occidental-King 42-26

Cum production thru August 2011

Cum Gas, MMcf:	589.2
Cum Water, MBbls:	7.7



McMullin Ranch

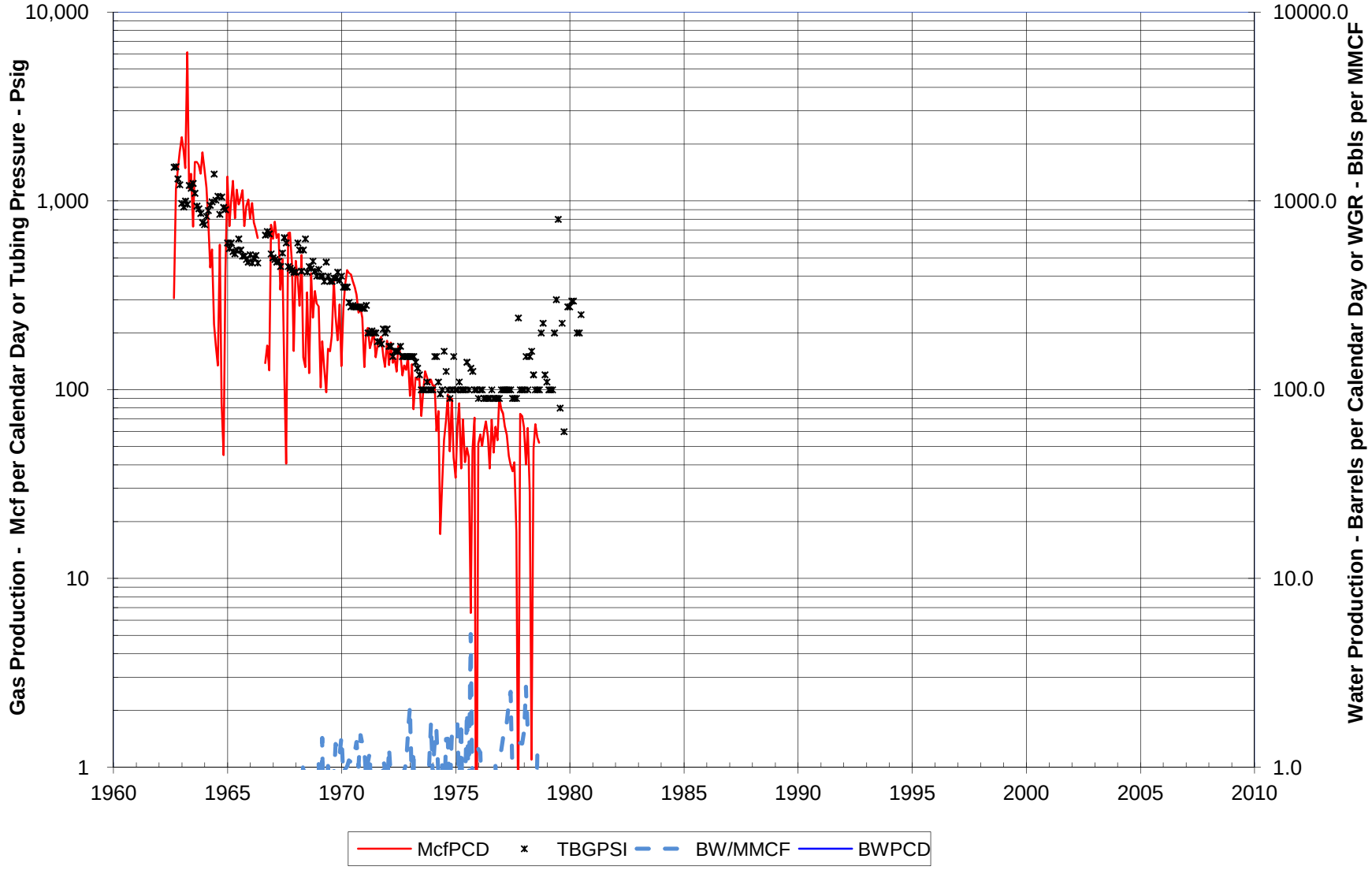
DOGGR Production

API#: 07700119

Well: Occidental-McMullin 2-X

Cum production thru August 2011

Cum Gas, MMcf:	2,270.2
Cum Water, MBbls:	1.2



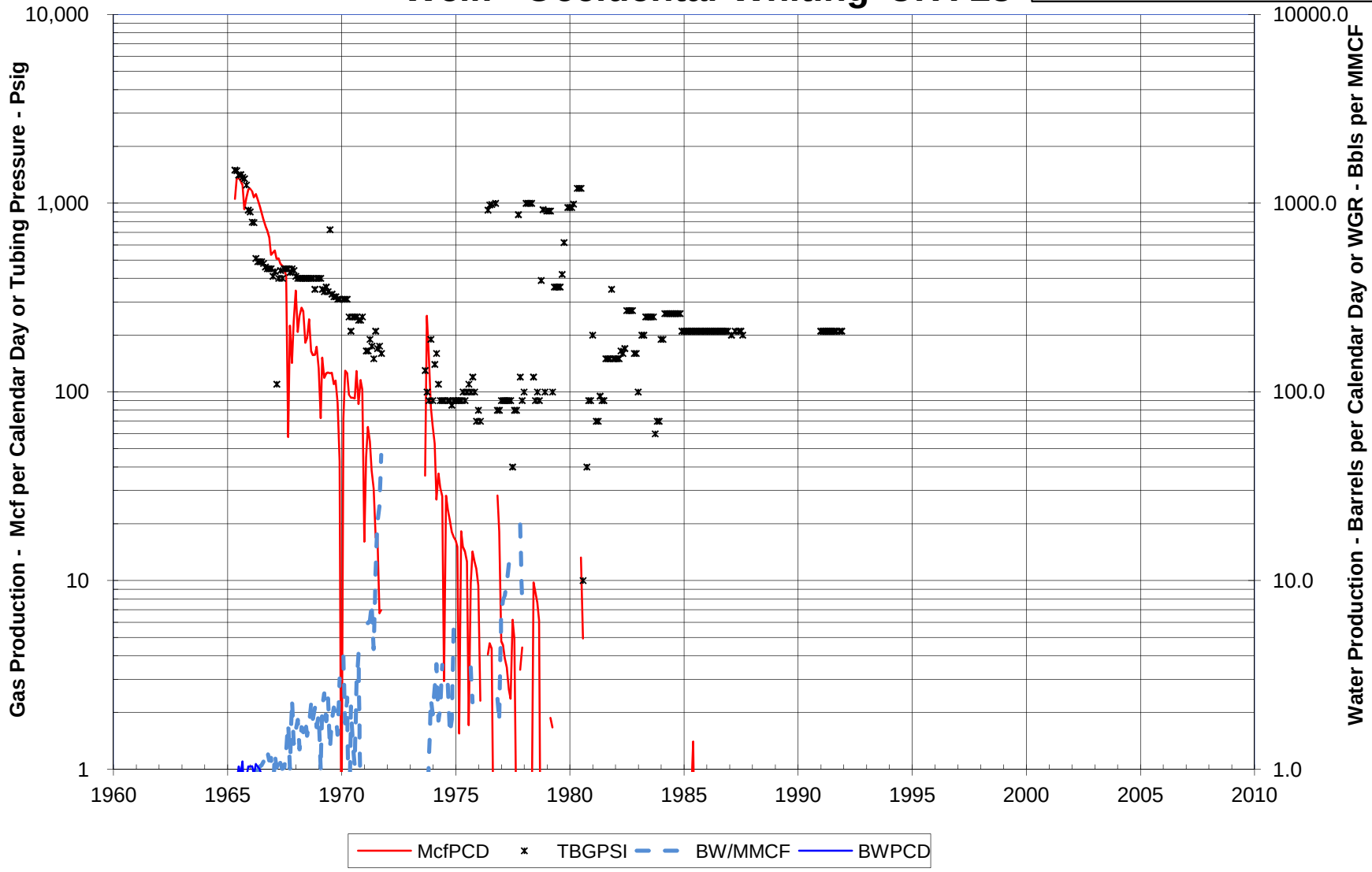
McMullin Ranch

DOGGR Production

API#: 07700121 **Well: Occidental-Whiting 87X-23**

Cum production thru August 2011

Cum Gas, MMcf:	964.3
Cum Water, MBbls:	1.1



McMullin Ranch

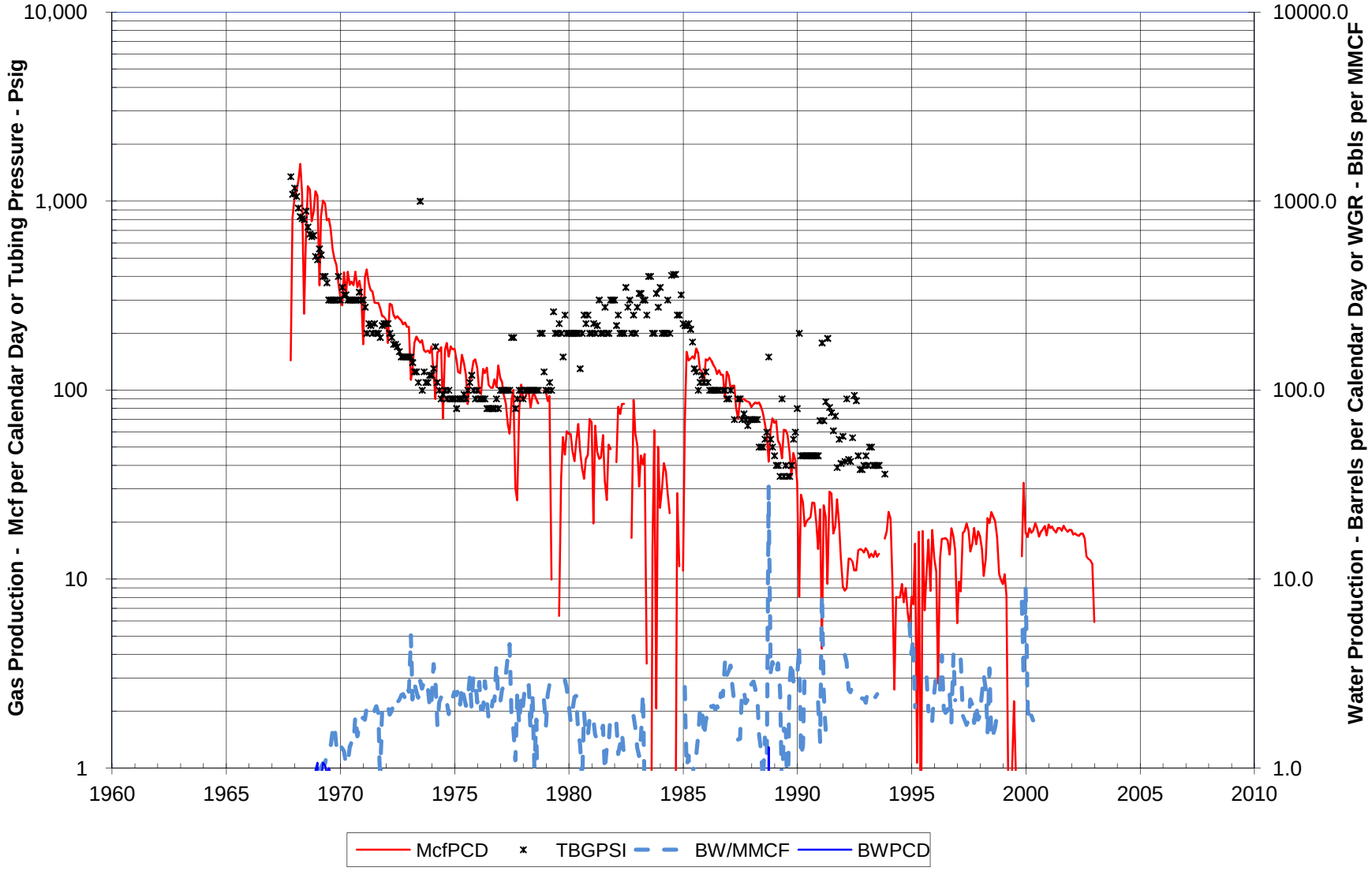
DOGGR Production

API#: 07720007

Well: Perrin 22-25

Cum production thru August 2011

Cum Gas, MMcf:	1,576.0
Cum Water, MBbls:	2.4



McMullin Ranch

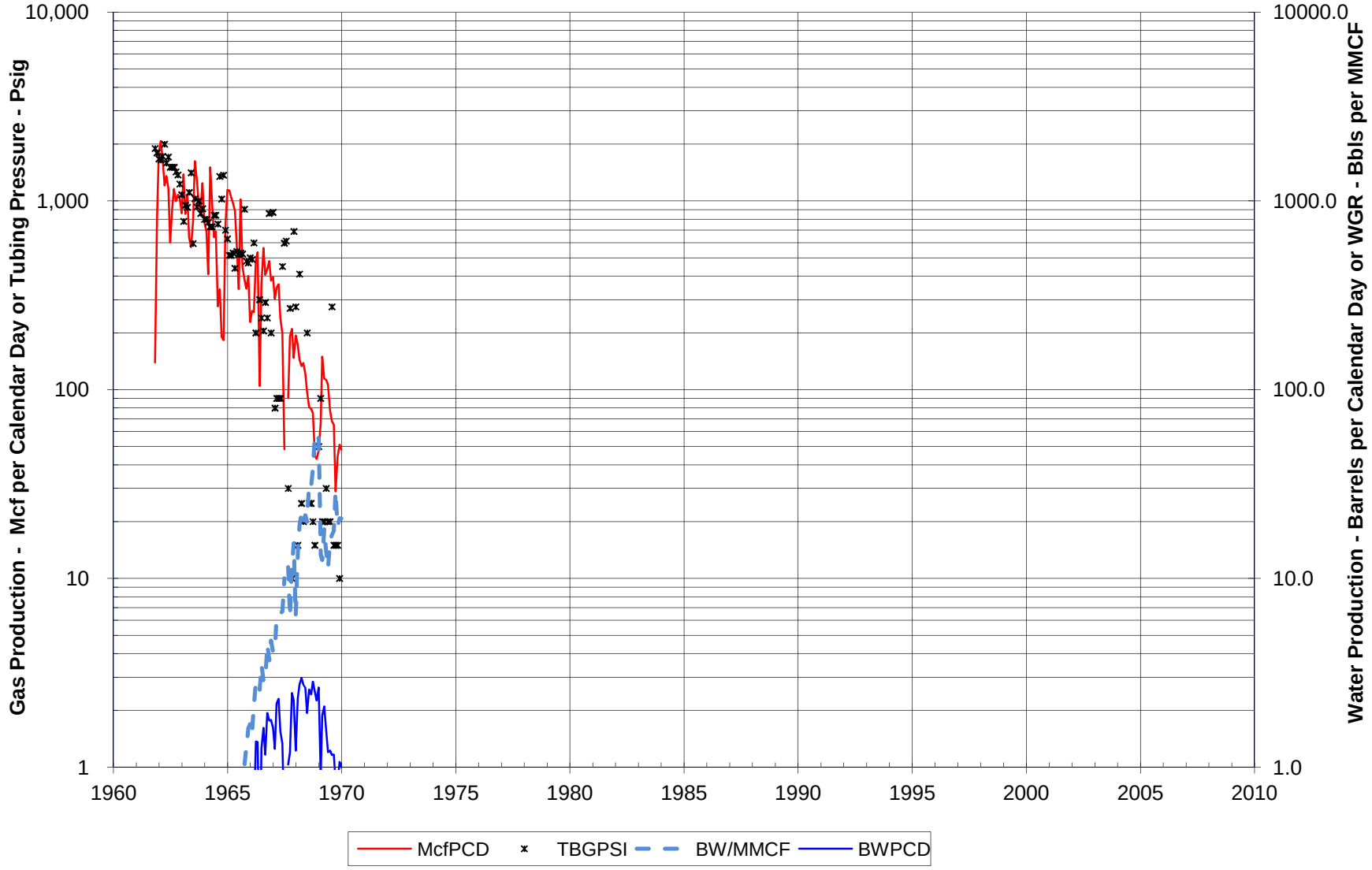
DOGGR Production

API#: 07700130

Well: Perrin Unit A 2

Cum production thru August 2011

Cum Gas, MMcf:	1,630.5
Cum Water, MBbls:	3.0



McMullin Ranch

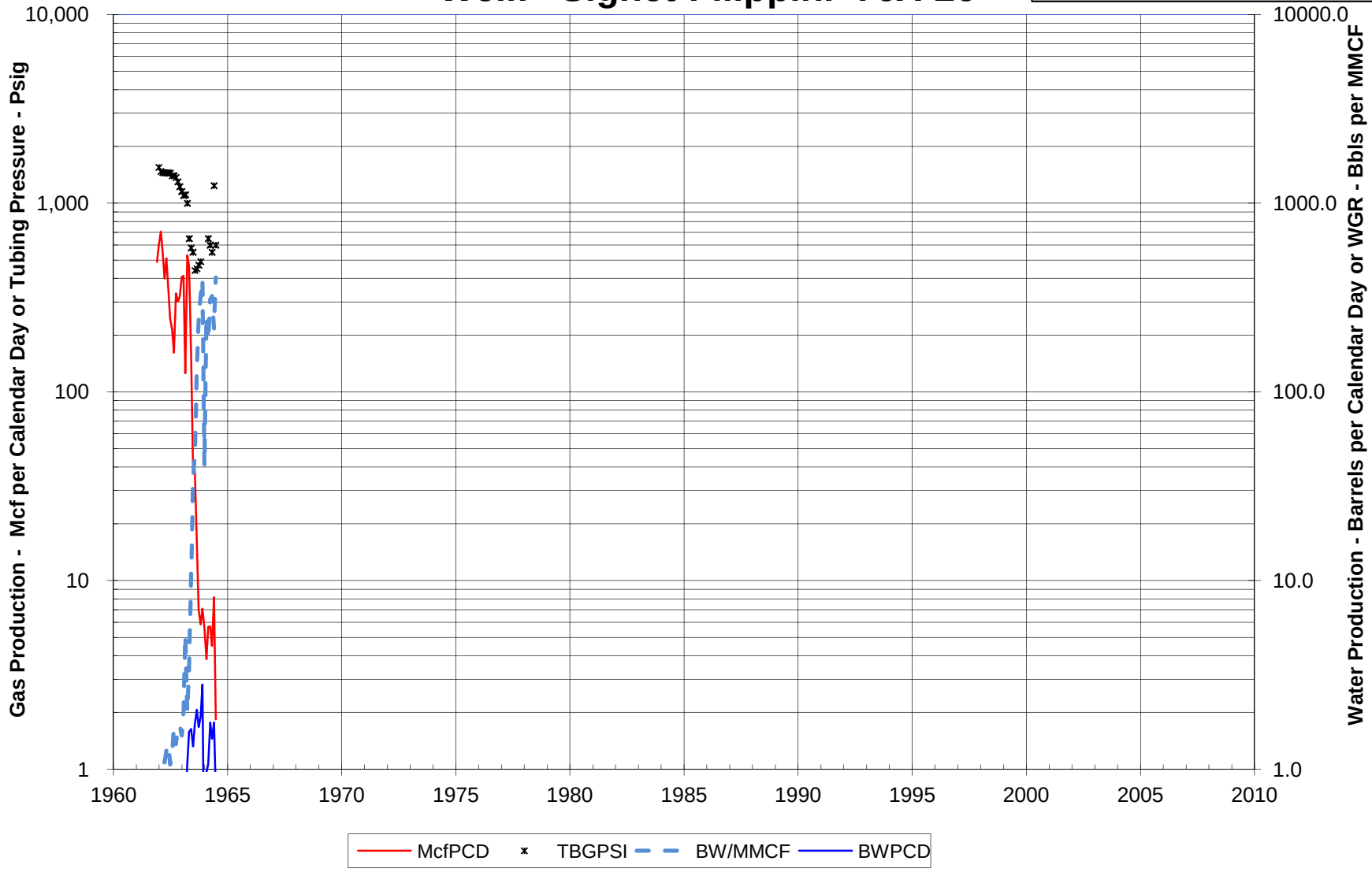
DOGGR Production

API#: 07700124

Well: Signet-Filippini 76X-26

Cum production thru August 2011

Cum Gas, MMcf:	224.8
Cum Water, MBbls:	1.0



McMullin Ranch

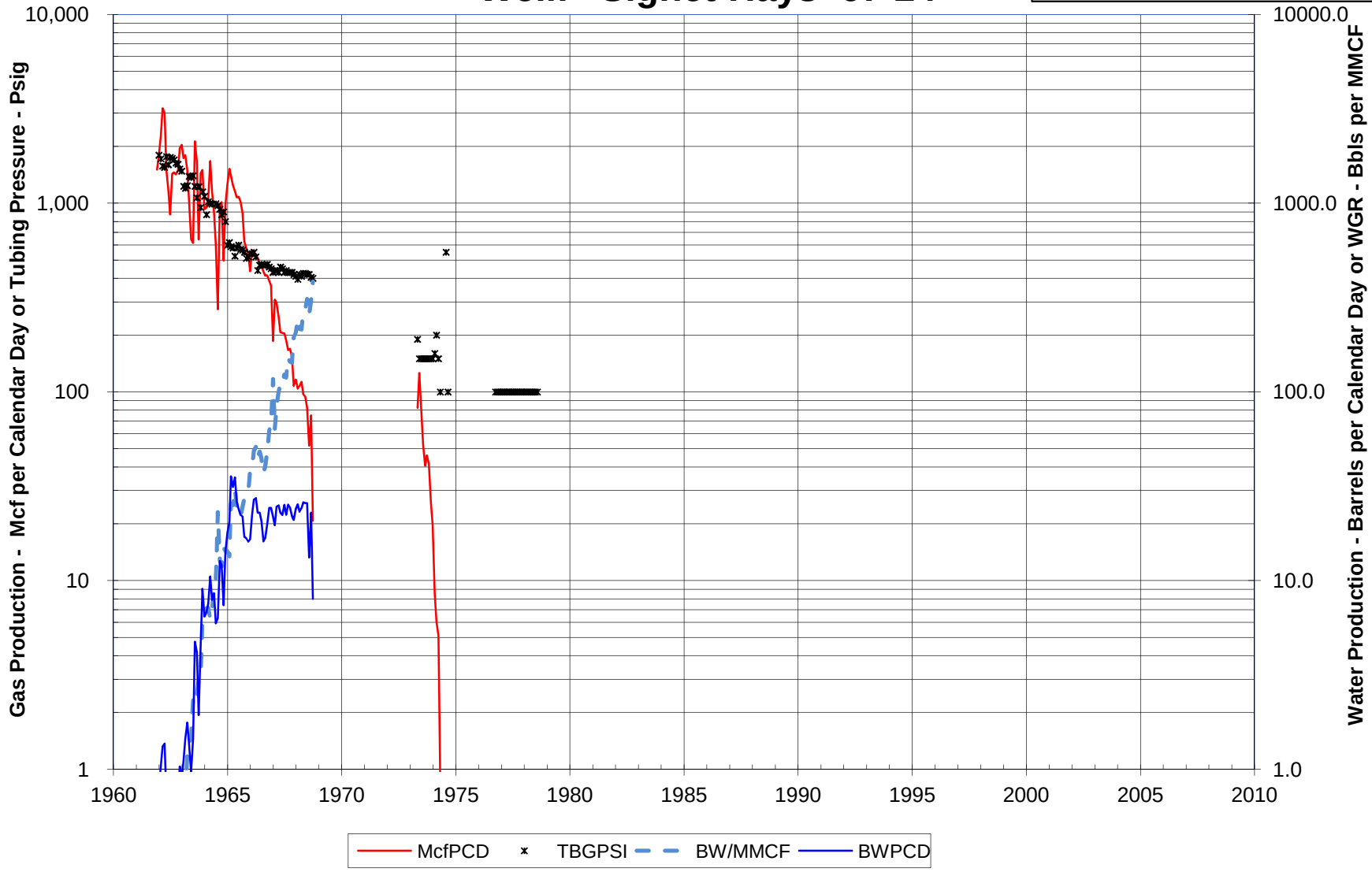
DOGGR Production

API#: 07700125

Well: Signet-Hays 67-24

Cum production thru August 2011

Cum Gas, MMcf:	2,204.2
Cum Water, MBbls:	36.2



McMullin Ranch

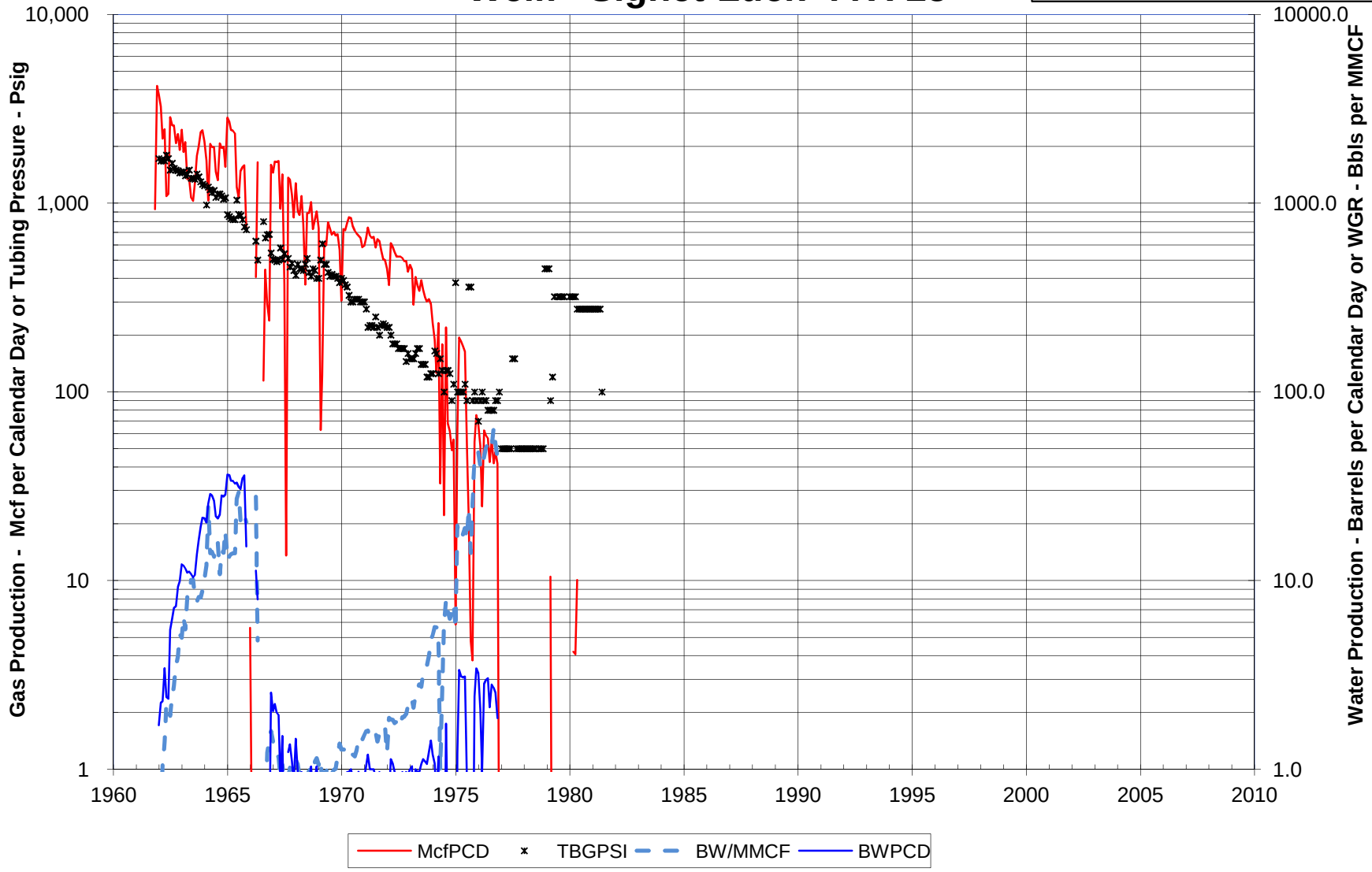
DOGGR Production

API#: 07700127

Well: Signet-Luck 77X-25

Cum production thru August 2011

Cum Gas, MMcf:	4,905.3
Cum Water, MBbls:	31.5



McMullin Ranch

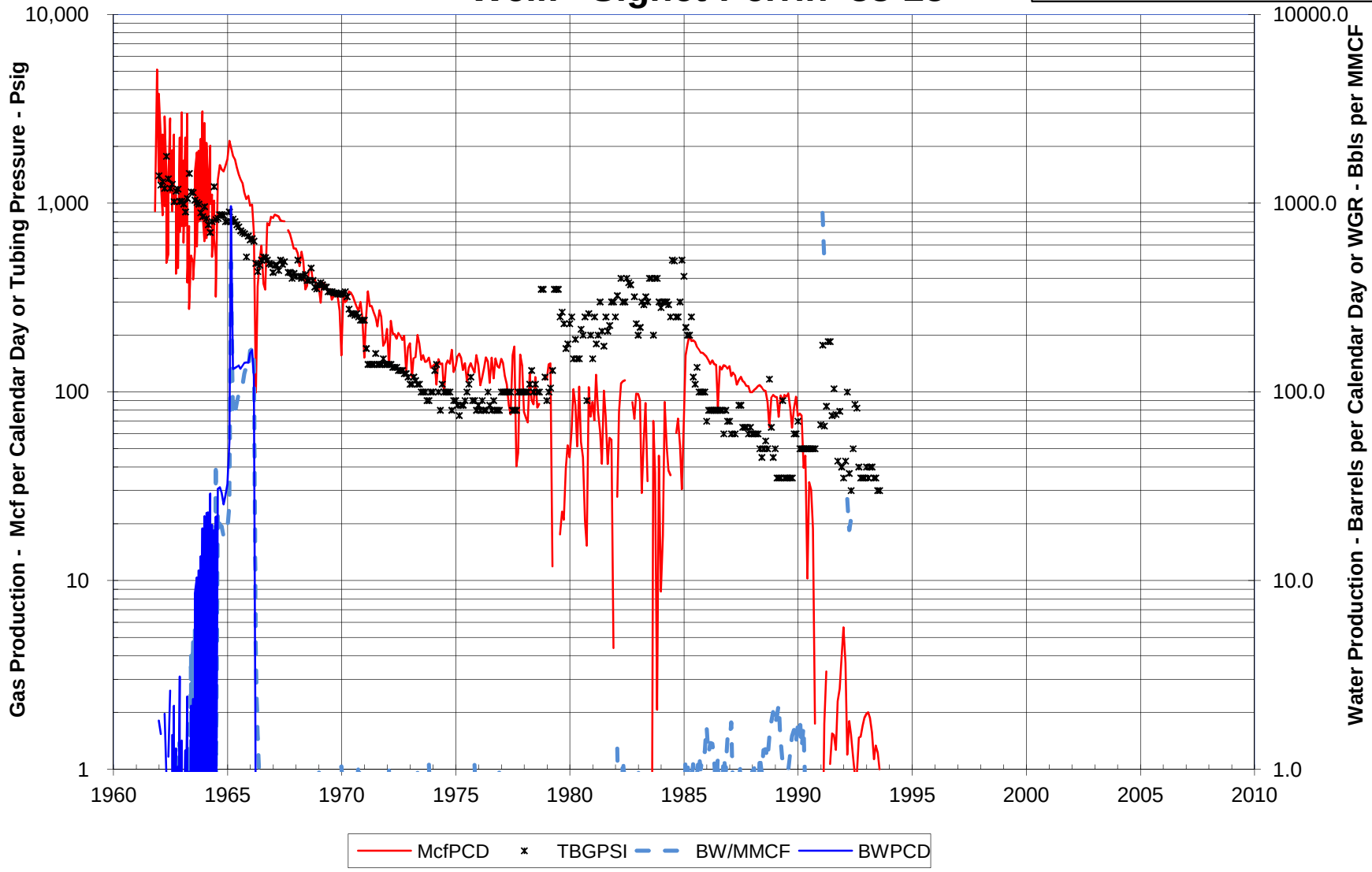
DOGGR Production

API#: 07700128

Well: Signet-Perrin 33-25

Cum production thru August 2011

Cum Gas, MMcf:	5,066.7
Cum Water, MBbls:	97.1



McMULLIN RANCH RESERVOIR

Summary and Decision

The McMullin Ranch Reservoir, located in San Joaquin County, California (east of Tracy and south of Stockton), was not selected for detailed modeling and/or was not a finalist site for the CAES Feasibility Study (McMullin Ranch—Aerial Map.pdf).

The project team concluded that a CAES development at McMullin would not be feasible based on a combination of factors, which include the following:

- A large number of idle wells would require abandonment, and improperly abandoned wells would require significant rework.
- The apparent low current reservoir pressure would require a large quantity of cushion air, which complicates testing and full field development.
- The depth and pressure are at the upper end of the acceptable range.
- Inter-fingering and pressure communication may occur between thin sands in the B-5 interval.

Subsurface/Reservoir Screening

Preliminary Screening Results

A preliminary review of the McMullin Ranch gas field was completed on December 5, 2011 (McMullin Ranch—Preliminary Geological Analysis.pdf, McMullin Ranch—Well Production Plot Exhibits.pdf). That report indicated that over 64 Bcf had been produced from multiple stacked formations (Tracy, Lathrop, and Blewett) within the field. The focus of the report was on the Blewett formation, which exhibited characteristics within acceptable reservoir parameters for a CAES project. At approximately 5,300 ft depth and an estimated pressure of 2,415 psi, the formation was judged to be at the upper limit for these parameters.

The Blewett formation has multiple productive reservoirs. The B-4 is the shallowest and smallest, with an estimated size of 3 Bcf and approximately 500 acres in aerial extent. The B-5 and B-5a are both larger, with a footprint of approximately 1,900 acres and an estimated production of 35 Bcf. The reported production volumes had been comingled with the Tracy formation production and totaled 43 Bcf. Data available from the California Division of Oil, Gas, and Geothermal Resources (DOGGR) looked promising, with porosities of 26% to 30% and excellent core permeability that averaged 597 millidarcies (mD). The project team believed that the Blewett formations all experienced strong water drive.

Due to the relatively large number of wells drilled into the field, the team prepared a summary for review on December 9, 2011 of all the wells in the field with their pertinent data and current status (McMullin Ranch—Existing Well Status Plugging Data.xls). Based on the available information, the report indicated that 14 existing wells would need to be properly abandoned, and there are possibly 2 more where the data was inconclusive. The project team also discovered that at

least 3 of those wells have downhole junk in critical intervals, which would significantly complicate remediation and proper abandonment.

Detailed Geological Summary

Based on the encouraging preliminary screening results, a preliminary geological evaluation was undertaken to look deeper into the field attributes (McMullin Ranch—Preliminary Reservoir Evaluation.pdf). That evaluation was completed in January 2012. The report built on the previous review and included numerous geological maps, along with well and production data. Based on the geological interpretation, estimates were provided for the three Blewett formation reservoirs as follows:

Formation	Size (Acres)	Average Net Pay (Ft)	Initial Gas-In-Place (Bcf)
B-4	430	9.5	5.0
B-5	1,654	17.2	36.1
B-5A	1,826	16.6	39.3

Initial reservoir pressures ranged from 2,208 psi to 2,317 psi. The heating content of the native gas was 895 Btu/ft^3.

The report also estimated recovery factors for each of the production reservoirs. These recovery factors were based on the geological interpretation of net pay where Blewett-only production was present and used net perforated feet where production volumes had been comingled with Tracy production. The resulting recovery factors were significantly lower than expected (in the range of 10.3% to 43.9%) and led to the conclusion that the net pay for some wells may have been overstated.

An evaluation was completed of the drive mechanism, and unlike the earlier assessment of a strong water-drive, this evaluation concluded that the B4 and B5 likely have depletion drives and the B5A has a weak-to-moderate water drive. The evaluation also estimated that the current reservoir pressure appears to be low (less than 500 psi); therefore, a large quantity of cushion air would need to be injected in the reservoir to achieve the desired CAES working pressure.

In January of 2012, the PG&E project team completed a detailed ranking of the top seven reservoirs being evaluated at that time (CAES—Evaluation Summary Composite—1-4-12.xls). This evaluation utilized a weighted scoring of 16 reservoir characteristics, resulting in an overall total weighted score. McMullin Ranch ranked seventh – scoring 726 as compared to scores of 906 to 1018 for the top three sites.

Reservoir Modeling and Evaluation

Based on the results of the preliminary analysis, no further work was conducted on the McMullin Ranch reservoirs.

Testing/Development Potential

No testing was conducted.

Siting and Environmental Evaluation

Determination – No Fatal Flaws

Based on a review of aerial photography overlaid by property lines and the gas reservoir boundary, the project team selected an approximate 40-acre station site approximately 0.5 mile west of Airport Road, southwest of Manteca. The reservoir area is in row crops, but is also occupied by a moderate density of farm residences, making station siting a challenge. The station site is located in the western portion of the gas reservoir to maximize distance from residences and still be on a county road. Residential density increases significantly in the field area to east. The station site is zoned Agriculture, is in an area with a 40-acre minimum parcel, is under a Williamson Act contract, is categorized as prime farmland, and is within the 100-year flood zone. The nearest sensitive receptors to the station are farm residences approximately 2,300 feet south, 4,500 feet southeast, and 3,800 feet northeast.

From this site, gas transmission service with operating pressures that would work for a CAES facility are located approximately 3 miles from the site. The route would follow the county road and field breaks/property lines. The gen-tie route, to the nearest 230-kV electric transmission line, would extend northwest approximately 9 miles, following existing linear facilities and property lines. No residences lie along this gen-tie route, and no schools are along either the gas or electric routes. No apparent wastewater sources for cooling water are in the vicinity of the station site. This area is part of the Pacific Flyway, a known waterfowl migration route, and potential collision with the northwest running gen-tie would need to be addressed during project permitting. No protected areas are directly affected by any project feature, but the gen-tie does cross riparian corridors.

Land Acquisition/Site Control

Deployment

In February 2012, PG&E reviewed the proposed reservoir location and surrounding environs to identify the surface, mineral, and preferred Energy Conversion Facility (ECF) site owners (McMullin Ranch—APN Map.pdf). None of these owners was contacted regarding the CAES Project.

Preliminary Title Work

In February 2012, PG&E proceeded with a limited Title Review of the 78 Assessor's Parcel Numbers (APNs) overlying the storage reservoir. Title work identified 38 surface owners over the storage reservoir. Full title reports were not completed.

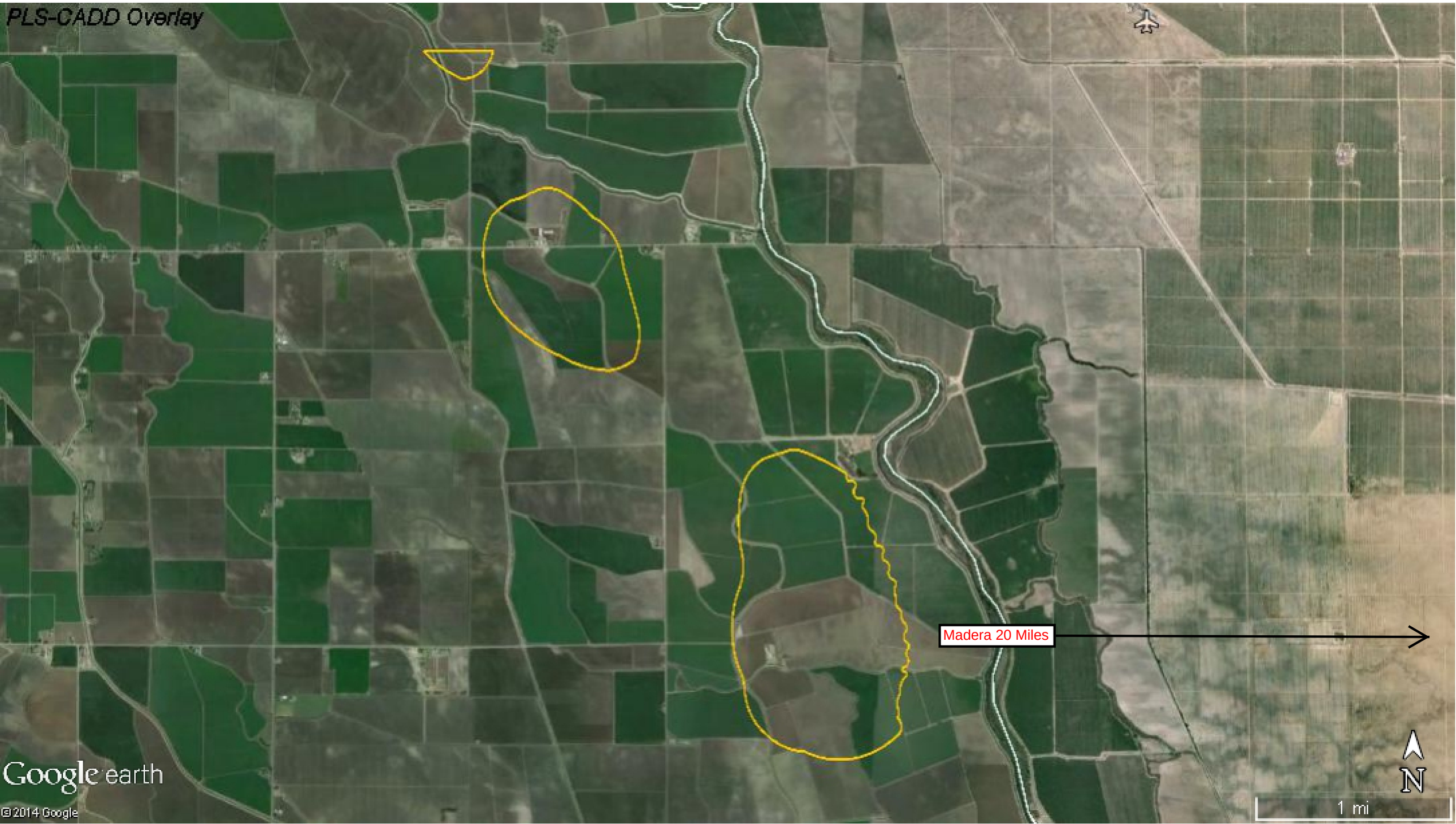
References

1) McMullin Ranch - Aerial Map.pdf
2) McMullin Ranch - Preliminary Geological Analysis.pdf
3) McMullin Ranch - Well Production Plot Exhibits.pdf
4) McMullin Ranch - Existing Well Status Plugging Data.xls
5) McMullin Ranch - Preliminary Reservoir Evaluation.pdf
6) CAES - Evaluation Summary Composite - 1-4-12.xls
7) McMullin Ranch - APN Map.pdf

A304: Merrill Avenue Site Selection and Attachments

Merrill Avenue - Aerial Map.pdf
Merrill Avenue - Preliminary Reservoir Evaluation.pdf
Merrill Site Selection Close-Out Report.pdf

Merrill Avenue Aerial Map



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December 14, 2011

Pacific Gas and Electric
77 Beale Street, San Francisco, CA 94105

Attn: Mr. Robert Booth, Project Manager

RE: PRELIMINARY RESERVOIR ENGINEERING EVALUATION REPORT MERRILL AVENUE FIELD

OVERVIEW

The Merrill Avenue Field, located about 20 miles south of Merced, California, has produced over 32.1 bcf of gas from the Blewett sands located at depths of 6,200 – 6,800 feet. Nearly 50 percent of the field production (15.7 bcf) was produced from one well, O'Banion 1, completed in October 1989. The production performance curves of the Merrill Avenue wells were reviewed for the purpose of identifying the reservoir drive mechanism and assessing the reservoir pressure conditions. If there was evidence of a strong water drive and relatively high pressures, these unfavorable CAES conditions were noted, and in these cases it may eliminate the need to perform more detailed geological and reservoir engineering evaluations. This review included wells designated by the DOGGR as being in the Merrill Avenue, Southeast field.

EXHIBIT 1 is a base map of the Merrill Avenue Field with three areas identified as the Northwest, Central and Southeast Areas. A simple structure map for the Merrill Avenue field area (from the California DOGGR) is shown in **EXHIBIT 2**. This map shows the location of two gas productive areas at local structural highs on a structure that dips to the southwest. The gas-water contact in each of these pools appears to be tilted possibly due to pinching out of the Blewett sands. The Merrill Avenue - Southeast field is an additional pool identified by the DOGGR. **EXHIBIT 3** is a list of the Merrill Avenue wells with cumulative production for each of the three areas. Finally, **EXHIBIT 4** is a tabulation of the field pressure data extracted from the well records.

NORTHWEST AREA PRODUCTION PERFORMANCE

The average depth to the top of the Blewett sands in the Northwest area is about 6,300 feet MD. The wells appear to have 150 - 350 feet of bottom aquifer present under the completion interval. Net pay ranges from 20 – 50 feet (see Dodd 1-14 well log as **EXHIBIT 5**). Maximum gas rates are 2 – 6 MMcfd which implies good permeability. Initial reservoir pressure was 2,768 pounds per square inch gauge (psig) at 6,370 feet (Dodd 1-14). A static pressure of 2,700 psig was measured by a pressure buildup in the Judgement Day 1 well in July 2004.

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The well production plots are presented by **EXHIBITS 6** through **10**. The cumulative gas production from the northwest area is only 3.1 bcf. Gas rate decline is severe in the wells and water breakthrough occurs rapidly, evidence of water coning. All wells are currently shut-in or abandoned.

The CAES potential in this area is unfavorable due to the depth, high reservoir pressure, large bottom water aquifer and small reservoir size.

CENTRAL AREA PRODUCTION PERFORMANCE

The central area wells have an average top of zone at about 6,600 feet measured depth (MD). The wells have from 0 - 300 feet of bottom aquifer. Production plots are given by **EXHIBITS 11** through **16**.

The O'Banion 1 was the discovery well and has produced the majority of gas at 15.7 bcf. **EXHIBIT 17** is the well log across the productive interval. The well's peak production rate was nearly 20 MMcfd; however, this is the only well that exhibited such production capacity. There are core data available for wells in the central area. Conventional core in the O'Banion 1 showed air permeabilities from 500 - 2,900 millidarcies (mD) for the producing interval. The high gas rate also led to water coning problems after four years of production. Attempts to reduce the water production by cementing the lower producing interval in 1994 and 1995 were unsuccessful. Initial flowing tubing pressures in these wells as with all area wells are 2,000 psi. The initial reservoir pressure measured in the O'Banion 1 was 2,920 psig. The reported 700 psi final flowing pressure in 1997 was due to the high water production which reached 1,000 barrels of water per day (bwpd).

The geology is complex in this area. The O'Banion 3 is a nearby offset well to O'Banion 1, but the O'Banion 3 has no apparent bottom water. O'Banion 3 does have water production problems, possibly from the upper half of the completion with higher water saturation. The massive Blewett section present in the O'Banion 1 does not appear to be present in O'Banion 3.

This pool may be worth a further look for CAES potential if only because it has excellent permeability, in the range necessary for the required CAES deliverability. However, the current reservoir pressure is very high (over 2,500 psig) and maintaining that pressure would be necessary to keep water out of any CAES wells.

SOUTHEAST AREA PRODUCTION PERFORMANCE

The southeast area is composed of multiple thin sand sections that do not have an associated aquifer. The producing interval is up to 30 feet in thickness (see Triangle T 1-33 well log in **EXHIBIT 18**) and is stratigraphically different from the massive Blewett sand seen in the northwest and central areas. The sands may be discontinuous between wells. There also seems to be a complete pinch-out of the Blewett between the central and southeast areas as no sand is present in O'Banion 2.

Production plots are presented by **EXHIBITS 19** through **23**. A maximum well rate of up to 3 MMcfd with a cumulative production of 4.98 bcf was observed in Triangle T 1-33. Cumulative gas production for this area is 10.5 bcf. There are three active wells producing about 550 Mcfd.

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The drive mechanism for the wells in this area is volumetric depletion. Water does not appear to be an issue. Flowing tubing pressures in most wells are about 200 psig. As a result the current reservoir pressure is estimated to be less than 500 psi.

The southeast area of the Merrill Avenue field has some favorable CAES qualities in terms of weak or no water drive and low current pressure. However, the gas deliverability rates are low (1-2 MMcfd), indicating that reservoir permeability may not be sufficient for CAES operations. In addition, there are considerable gas reserves remaining in this area that would be have to be acquired before implementation of a CAES project.

CLOSING

Please feel free to contact either Alan Burzlaf at (661) 342-6660 or Mark Ausburn at (360) 320-1029 if you wish to discuss this report.

Respectfully,
WorleyParsons



Alan Burzlaff
Reservoir Engineer

Mark Ausburn, P.G. #5212
Project Manager

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Attached Exhibits:

1. *Merrill Ave. Field Location Map*
2. *Merrill Ave. Field Structure Map, Cross-section & Type Log*
3. *Merrill Ave. Field Cumulative Production Table*
4. *Merrill Ave. Field Pressure Data Table*
5. *Dodd #1-14 Well Log Showing Blewett Sand Pay*
6. *Coderniz #1-14 Well Production Plot*
7. *Dodd #1-14 Well Production Plot*
8. *Dodd #2-14 Well Production Plot*
9. *Judgement Day #1 Well Production Plot*
10. *Wolfsen #1-10 Well Production Plot*
11. *Fourchy #1-25 Well Production Plot*
12. *Le Compte #1 Well Production Plot*
13. *O'Banion #1 Well Production Plot*
14. *O'Banion #3 Well Production Plot*
15. *O'Banion #5 Well Production Plot*
16. *B&N2 Well Production Plot*
17. *O'Banion #1 Well Log Showing Blewett Sand Pay*
18. *Triangle T #1-33 Well Log Showing Blewett Sand Pay*
19. *Red Heat #1 Well Production Plot*
20. *Triangle T #1-28 Well Production Plot*
21. *Triangle T #1-29 Well Production Plot*
22. *Triangle T #1-33 Well Production Plot*
23. *Triangle T #2-33 Well Production Plot*

EXHIBIT 1

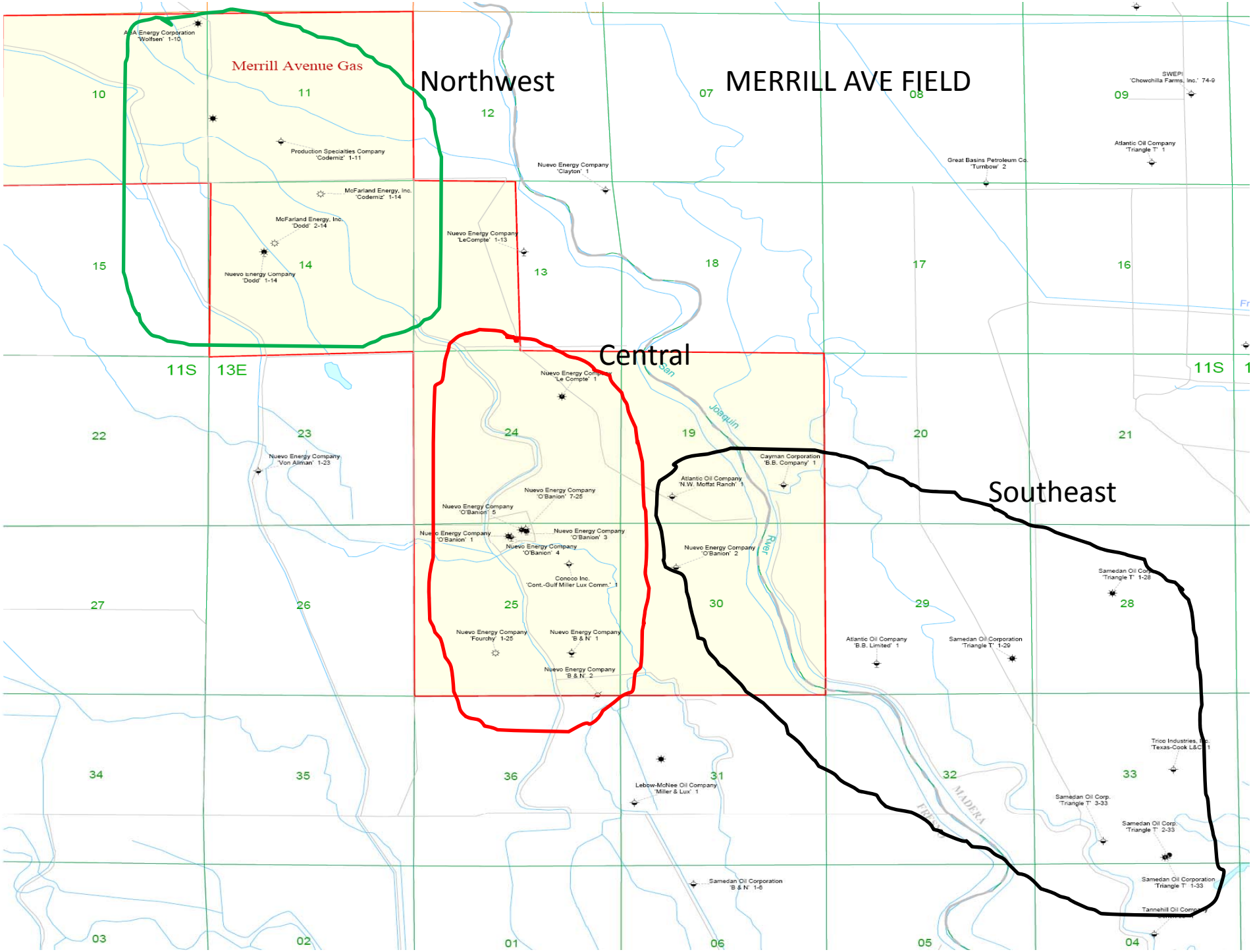
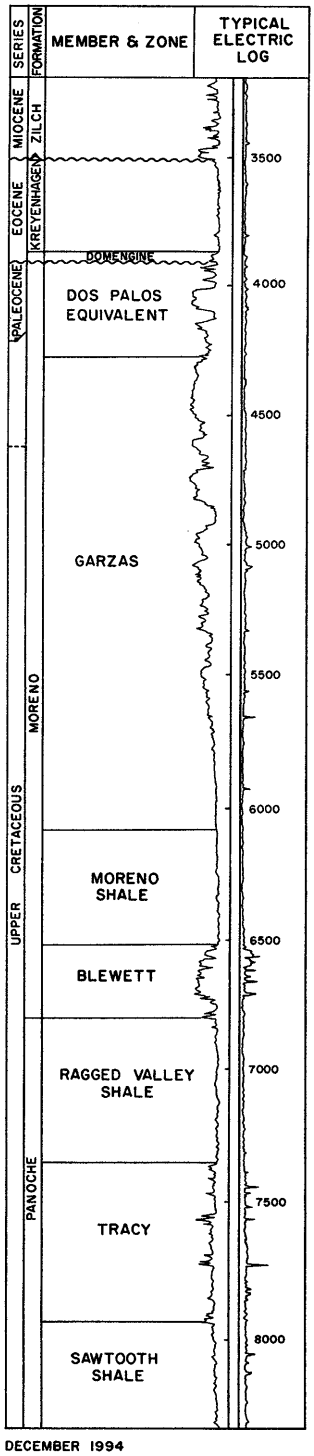
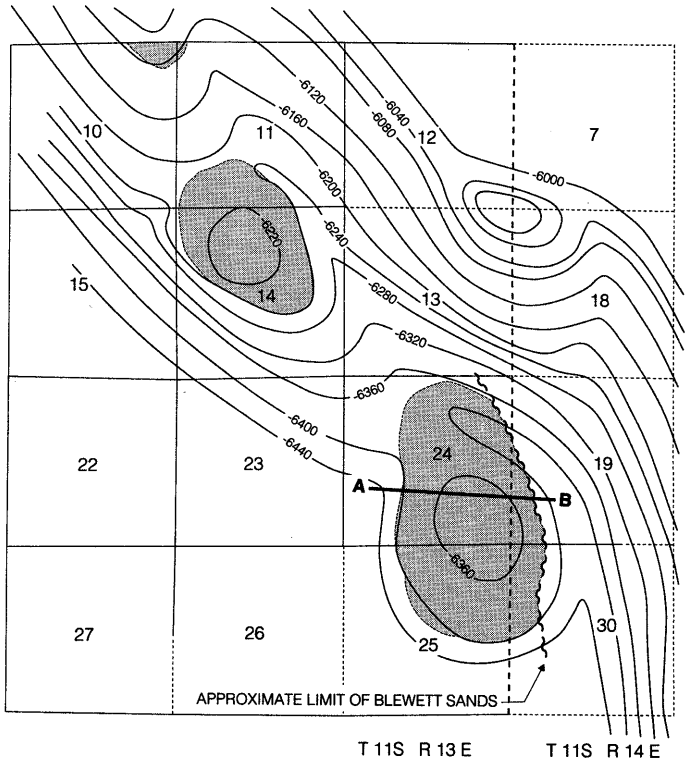

Merrill Avenue Gas
Northwest
MERRILL AVE FIELD
Central
Southeast
11S
13E
11S
Production Specialties Company 'Codemiz' 1-11
McFarland Energy, Inc. 'Codemiz' 1-14
McFarland Energy, Inc. 'Dodd' 2-14
Nuevo Energy Company 'Dodd' 1-14
Nuevo Energy Company 'Clayton' 1
Nuevo Energy Company 'LeCompte' 1-13
Great Basins Petroleum Co. 'Turnbow' 2
Atlantic Oil Company 'Triangle T' 1
Nuevo Energy Company 'Le Compte' 1
Nuevo Energy Company 'Von Allman' 1-23
Nuevo Energy Company 'O'Banion' 7-25
Nuevo Energy Company 'O'Banion' 5
Nuevo Energy Company 'O'Banion' 1
Nuevo Energy Company 'O'Banion' 3
Nuevo Energy Company 'O'Banion' 4
Conoco Inc. 'Cont.-Gulf Miller Lux Comm.' 1
Nuevo Energy Company 'Fourchy' 1-25
Nuevo Energy Company 'B & N' 1
Nuevo Energy Company 'B & N' 2
Cayman Corporation 'B.B. Company' 1
Atlantic Oil Company 'N.W. Moffat Ranch' 1
Nuevo Energy Company 'O'Banion' 2
Atlantic Oil Company 'B.B. Limited' 1
Samedan Oil Corporation 'Triangle T' 1-29
Lebow-McNee Oil Company 'Miller & Lux' 1
Samedan Oil Corporation 'B & N' 1-5
Samedan Oil Corp. 'Triangle T' 3-33
Samedan Oil Corp. 'Triangle T' 2-33
Samedan Oil Corporation 'Triangle T' 1-33
Tannehill Oil Company
Trico Industries, Inc. 'Texas-Cook L&C' 1
SWEPI 'Chowchilla Farms, Inc.' 74-9
San Joaquin
River
Fresno
Madera

EXHIBIT 2

MERRILL AVE. GAS FIELD





CONTOURS ON ELECTRIC LOG MARKER

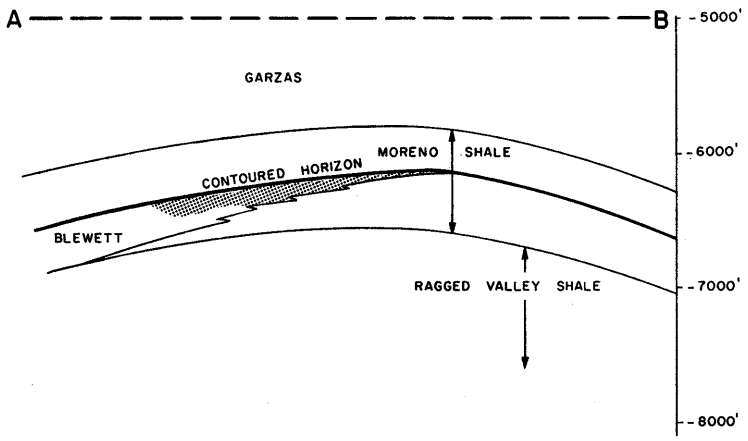


EXHIBIT 3

MERRILL AVENUE FIELD

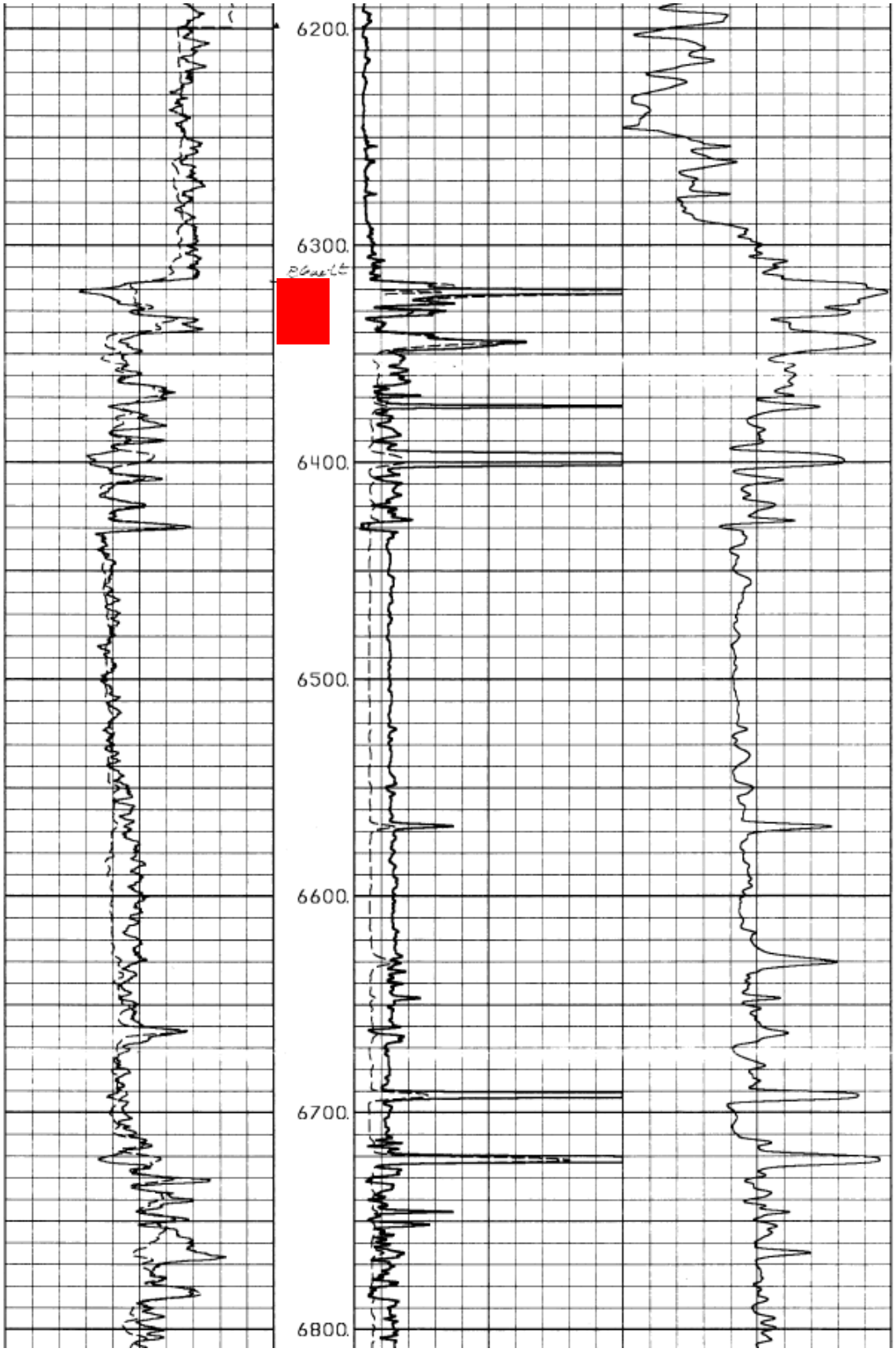
FRESNO AND MADERA COUNTIES, CALIFORNIA

WELL	API	FIELD	Lease	Operator	SEC	TWN	RGE	Start date	End Date	Aug 2011 Mcfpd	CumGas_Mcf	CumWater_Bbls	CumWI_Bbls	BBL/MMCF
Northwest Area														
1-11	01923929	Merrill Avenue	Coderniz	Production	11	11S	13E	01-Sep-97	01-Dec-97	-	-	-	-	0.0
1-14	01923432	Merrill Avenue	Coderniz	McFarland	14	11S	13E	01-Jan-94	01-Dec-97	-	531,434	456	-	0.9
1-14	01923529	Merrill Avenue	Dodd	Plains Expl. &	14	11S	13E	01-Jan-94	01-Dec-97	-	1,022,483	10,918	-	10.7
2-14	01923531	Merrill Avenue	Dodd	McFarland	14	11S	13E	01-Jan-94	01-Dec-97	-	906,039	14,890	-	16.4
1	01924286	Merrill Avenue	Judgement Day	Vintage Prod	11	11S	13E	01-Nov-03	01-Aug-11	-	147,837	1,721	-	11.6
1-10	01923420	Merrill Avenue	Wolfsen	ABA Energy	10	11S	13E	01-Jan-93	01-Dec-00	-	502,955	10,222	-	20.3
											3,110,748	38,207		12.3
Central Area														
1	01923191	Merrill Avenue	B & N	Union Oil Co. of	25	11S	13E	01-Jan-90	01-Dec-90	-	-	-	-	0.0
2	01923490	Merrill Avenue	B & N	Plains Expl. &	25	11S	13E	01-Nov-93	01-Dec-98	-	-	-	422,214	0.0
1-25	01923530	Merrill Avenue	Fourchy	Plains Expl. &	25	11S	13E	01-Aug-94	01-Dec-97	-	15,864	5,534	-	348.8
1	01923184	Merrill Avenue	Le Compte	Plains Expl. &	24	11S	13E	01-Nov-89	01-Dec-98	-	1,623,247	44,420	-	27.4
1	01923118	Merrill Avenue	O'Banion	Plains Expl. &	25	11S	13E	01-Oct-89	01-Dec-98	-	15,726,099	591,779	-	37.6
3	01923204	Merrill Avenue	O'Banion	Plains Expl. &	25	11S	13E	01-Mar-90	01-Dec-98	-	832,105	13,794	-	16.6
4	01923270	Merrill Avenue	O'Banion	Union Oil Co. of	25	11S	13E	01-May-90	01-Dec-95	-	-	-	-	0.0
5	01923533	Merrill Avenue	O'Banion	Plains Expl. &	25	11S	13E	01-Nov-94	01-Dec-98	-	351,434	118,310	-	336.6
7-25	01923650	Merrill Avenue	O'Banion	Union Oil Co. of	25	11S	13E	01-Dec-95	01-Dec-95	-	-	-	-	0.0
											18,548,749	773,837		41.7
Southeast Area														
2	01923185	Merrill Avenue	O'Banion	Union Oil Co. of	30	11S	14E	01-Nov-89	01-Dec-90	-	-	-	-	0.0
1	01924415	Any Field	Red Heat	Vintage Prod	31	11S	14E	01-Jul-05	01-Aug-11	-	499,370	186	-	0.4
1-28	03920086	Merrill Ave SE	Triangle T	Lario Oil & Gas	28	11S	14E	01-Jul-99	01-Dec-09	-	697,615	719	-	1.0
1-29	03920072	Merrill Ave SE	Triangle T	Lario Oil & Gas	29	11S	14E	01-Jan-93	01-Aug-11	90	2,077,148	20,411	-	9.8
1-33	03920075	Merrill Ave SE	Triangle T	Lario Oil & Gas	33	11S	14E	01-Jun-94	01-Aug-11	314	4,976,408	4,117	-	0.8
2-33	03920091	Merrill Ave SE	Triangle T	Lario Oil & Gas	33	11S	14E	01-Jul-01	01-Aug-11	146	2,217,797	4,889	-	2.2
										550	10,468,338	30,322		2.9

EXHIBIT 4

Merrill Avenue Pressure Data			
Northwest Area			
Well	**Date**	**Pressure, psig**	**Comments**
Wolfsen 1-10	10/2/1992	2,650	Tubing Pressure (Pt) after 72 hr PBU
	5/18/1994	1,830	Pt after perf 6246-49
	3/26/1996	2,567	FL at 300' after perf 6270-75 (Assume .43 psi/ft)
	5/9/1998	1,300	Pt after perf 6118-23
	3/14/2000	1,400	Pt at start w/o
Judgement Day 1	12/15/2003	1,850	Pt after perf 6318-31
	12/16/2003	2,400	SITP after perf 6335-41 and run 3 rate test
	4/17/2004	2,677	P at 6324'MD. .423 psi/ft w/Pt=2350. Open perfs 6318-31
	7/3/2004	1,700	Pt after perf 6322-30, FTP=1000, Q=249 MCFPD
	7/6/2004	1,400	Pt after perf 6330-34. FTP=1250, Q=645 MCFPD
	7/15/2004	2,694	Reservoir pressure from PBU. Open perfs 6318-34, 38-41
	9/28/2004	835	FTP, Q=250 MCFPD after perf 6318-32
	6/20/2011	2,000	Pt at start w/o
Dodd 2-14	11/2/1994	2,200	2 min SITP after perf 6292-95, 6300-04, 10-14, 25-28, 32-34, Q=3 MMCFPD
Dodd 1-14	7/17/1994	2,768	Press at 6370'MD sfter 40 hr SI. Open perfs 6316-20, 22-27, 29-32, 40-46
	7/19/1994	2,415	Pt after PBU, T=169^{o}F
Central Area			
Well	**Date**	**Pressure, psig**	**Comments**
O'Banion 5	1/11/1994	2,100	Pt after perf 6916-25
	1/4/1995	1,500	Pt at start w/o
O'Banion 3	?	2,943	Initial reservoir pressure from PBU
	7/13/1994	900	Pt at start w/o
	1/27/1997	350	Pt prior perf 7144-48, 58-60, 62-65
O'Banion 1	5/18/1990	2,920	Initial reservoir pressure from PBU
	6/22/1994	1,600	FTP at Q=11-12 MMCFPD
	9/29/1994	1,970	SITP after perf 6571-76
	10/2/1994	1,800	Pt w/Q=4 MMCFPD
	6/27/1995	1,780	SITP after lug back to 6562.5'
	8/28/1995	1,715	Pt at start w/o
Fourchy 1-25	9/1/1994	2,575	PBU, T=173^{o}F
LeCompte 1	1/29/1990	2,936	Press at 6650'MD after 60 hr PBU

EXHIBIT 5



Dodd 1-14

EXHIBIT 6

Merrill Avenue Gas (Northwest)

DOGGR Production

API#: 01923432

Well: Coderniz 1-14

Cum production thru August 2011

Cum Gas, MMcf:	531.4
Cum Water, MBbls:	0.5

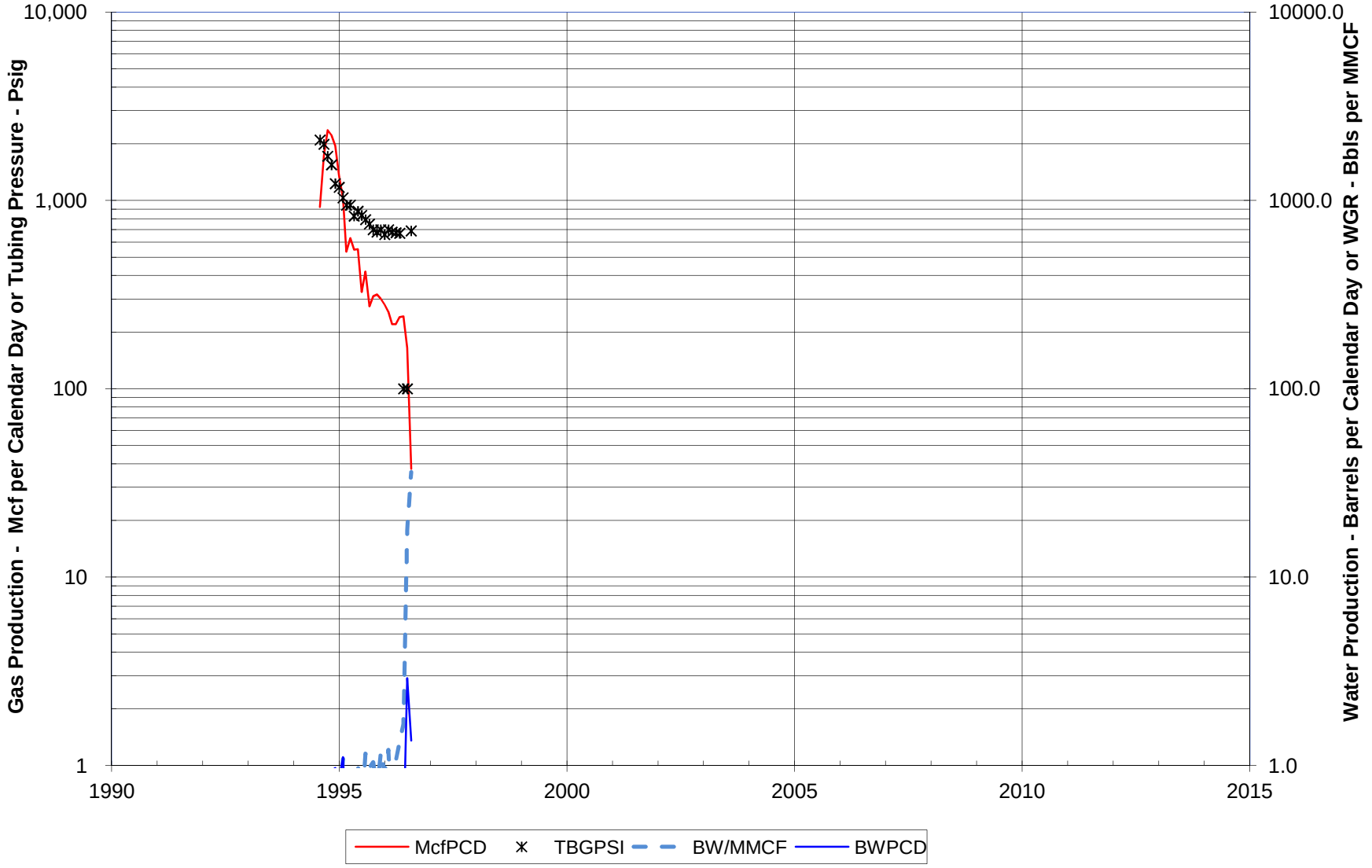


EXHIBIT 7

Merrill Avenue Gas (Northwest)

DOGGR Production

Cum production thru August 2011

Cum Gas, MMcf:	1,022.5
Cum Water, MBbls:	10.9

API#: 01923529

Well: Dodd 1-14

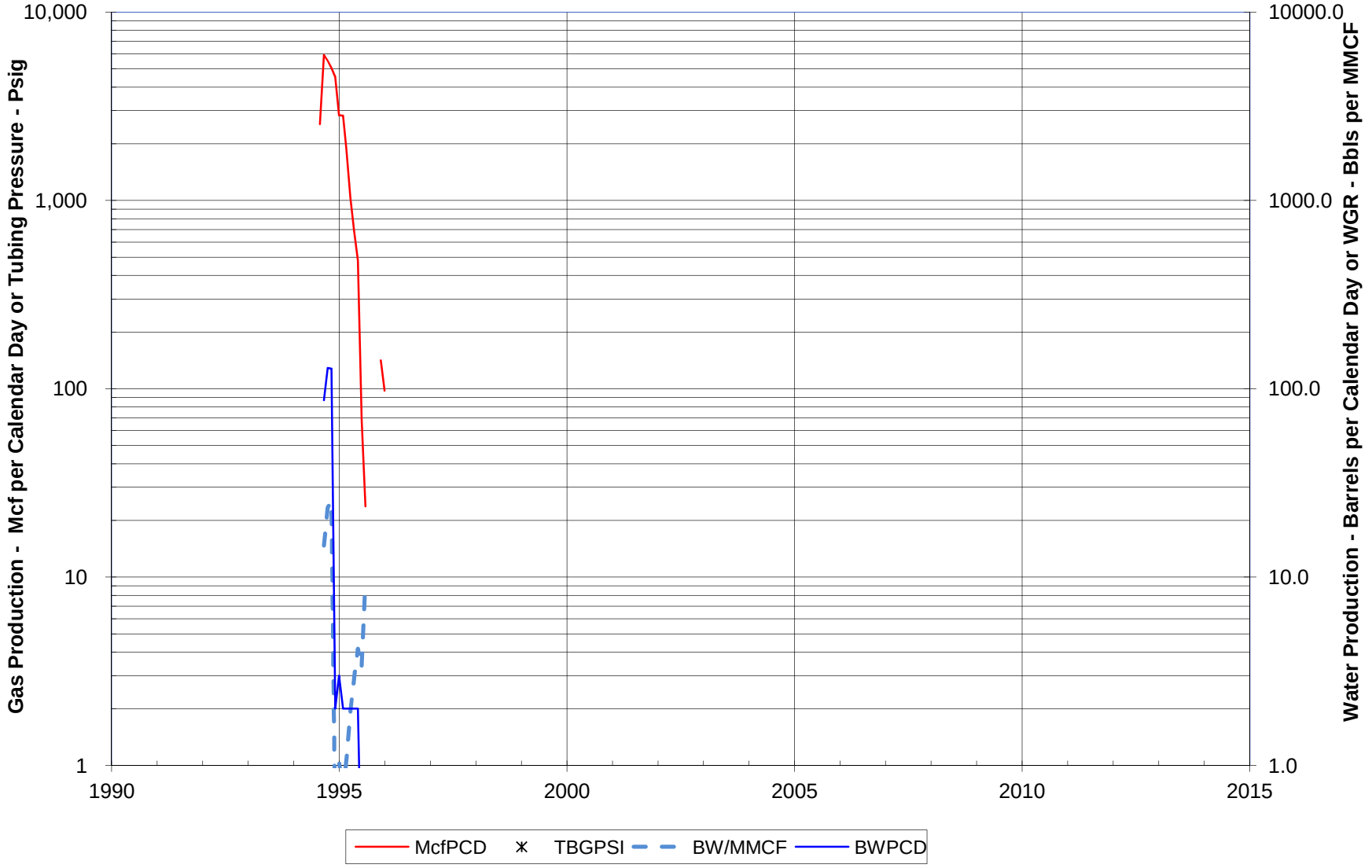


EXHIBIT 8

Merrill Avenue Gas (Northwest)

DOGGR Production

API#: 01923531

Well: Dodd 2-14

Cum production thru August 2011

Cum Gas, MMcf:	906.0
Cum Water, MBbls:	14.9

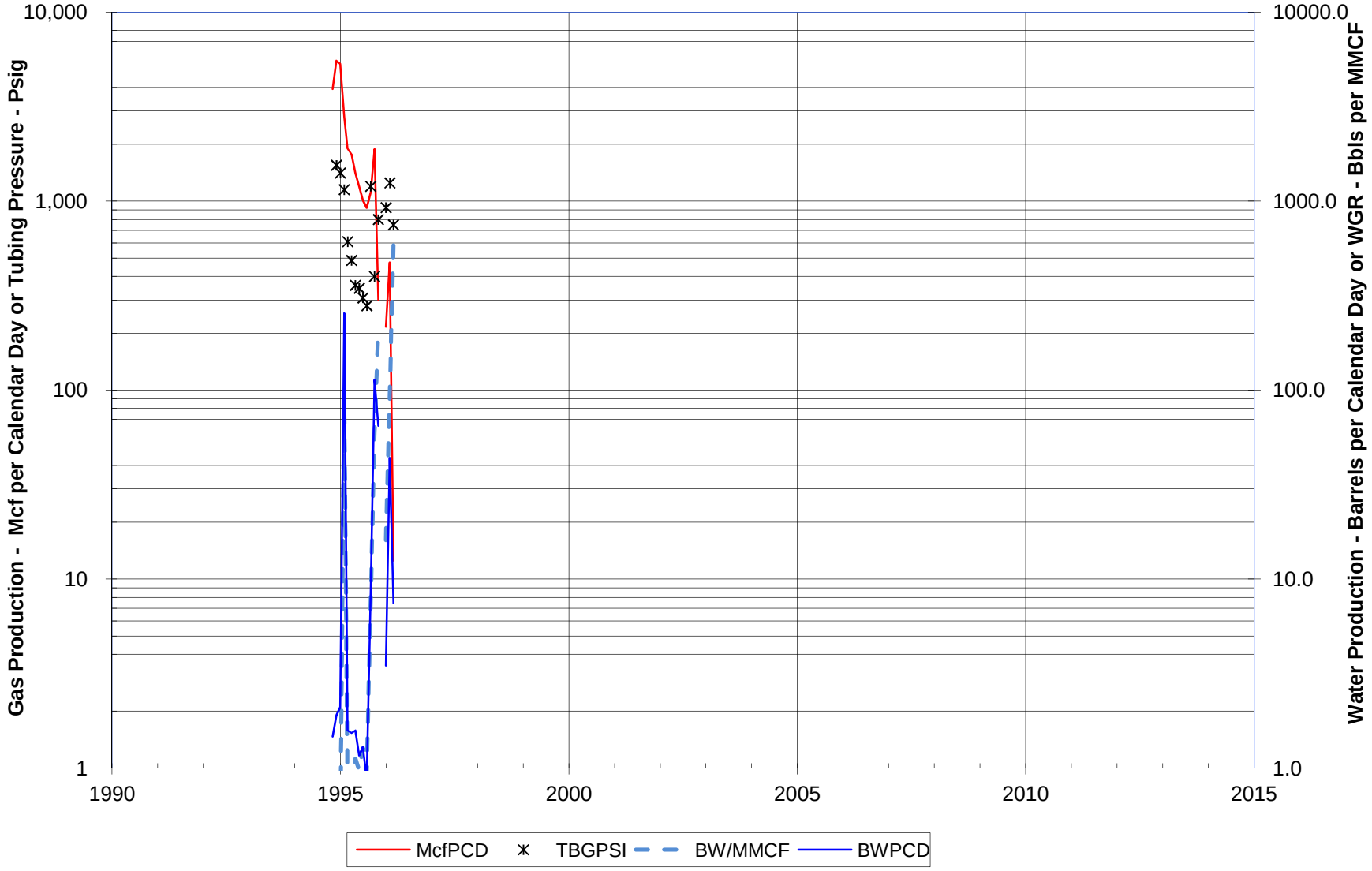


EXHIBIT 9

Merrill Avenue Gas (Northwest)

DOGGR Production

API#: 01924286

Well: Judgement Day 1

Cum production thru August 2011

Cum Gas, MMcf:	147.8
Cum Water, MBbls:	1.7

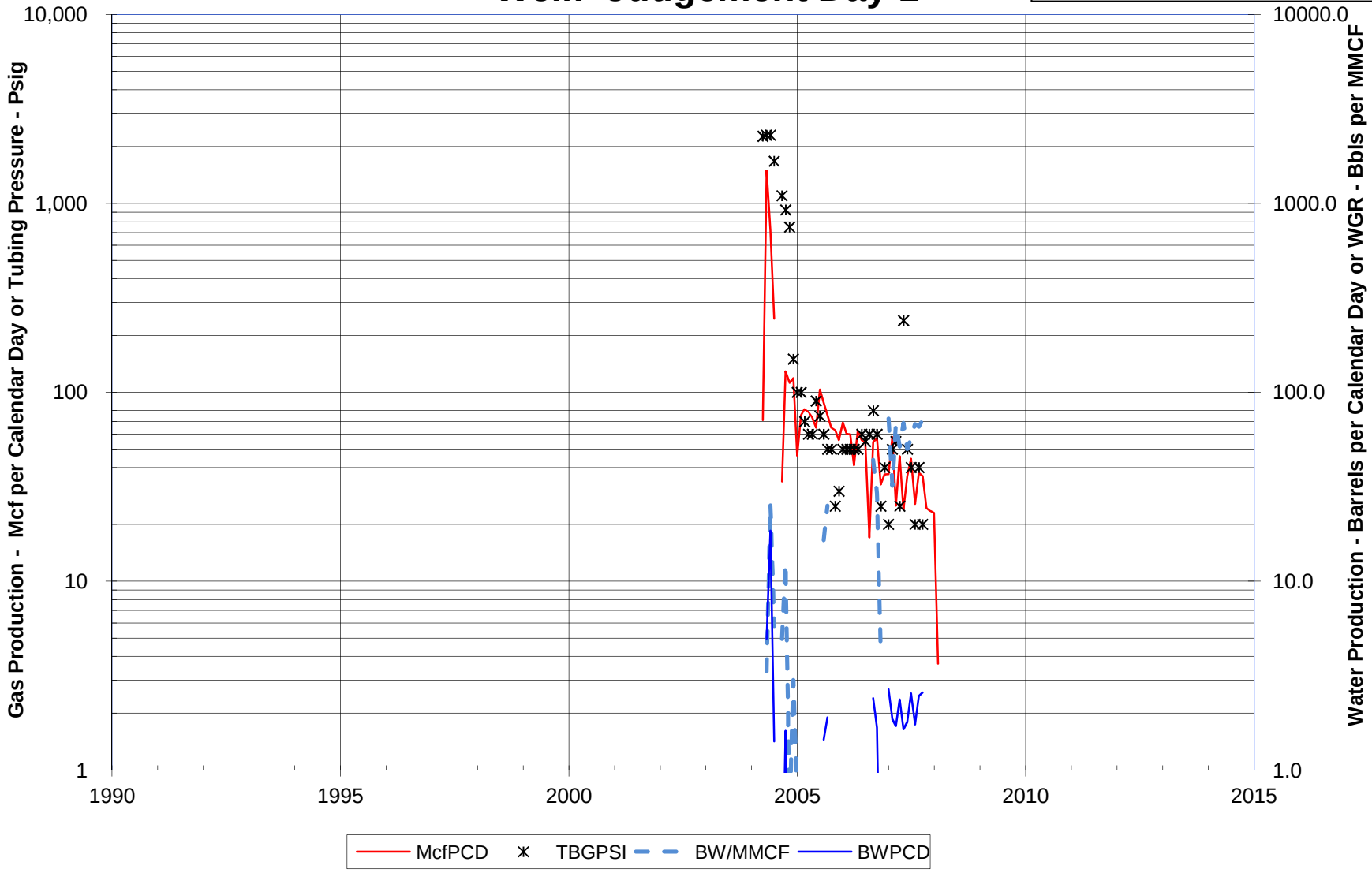


EXHIBIT 10

Merrill Avenue Gas (Northwest)

DOGGR Production

API#: 01923420

Well: Wolfsen 1-10

Cum production thru August 2011

Cum Gas, MMcf:	503.0
Cum Water, MBbls:	10.2

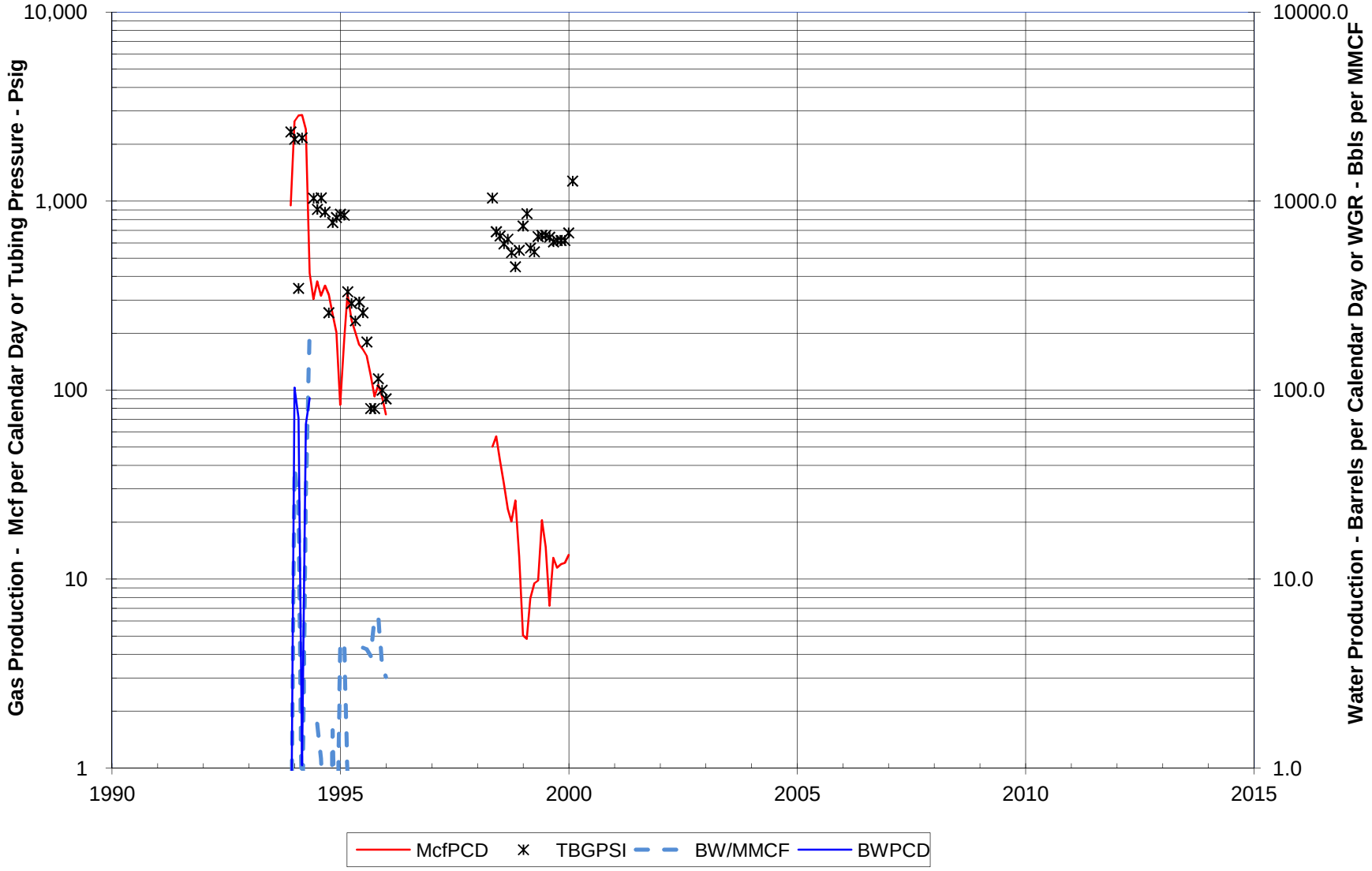


EXHIBIT 11

Merrill Avenue Gas (Central)

DOGGR Production

API#: 01923530

Well: Fourchy 1-25

Cum production thru August 2011

Cum Gas, MMcf:	15.9
Cum Water, MBbls:	5.5

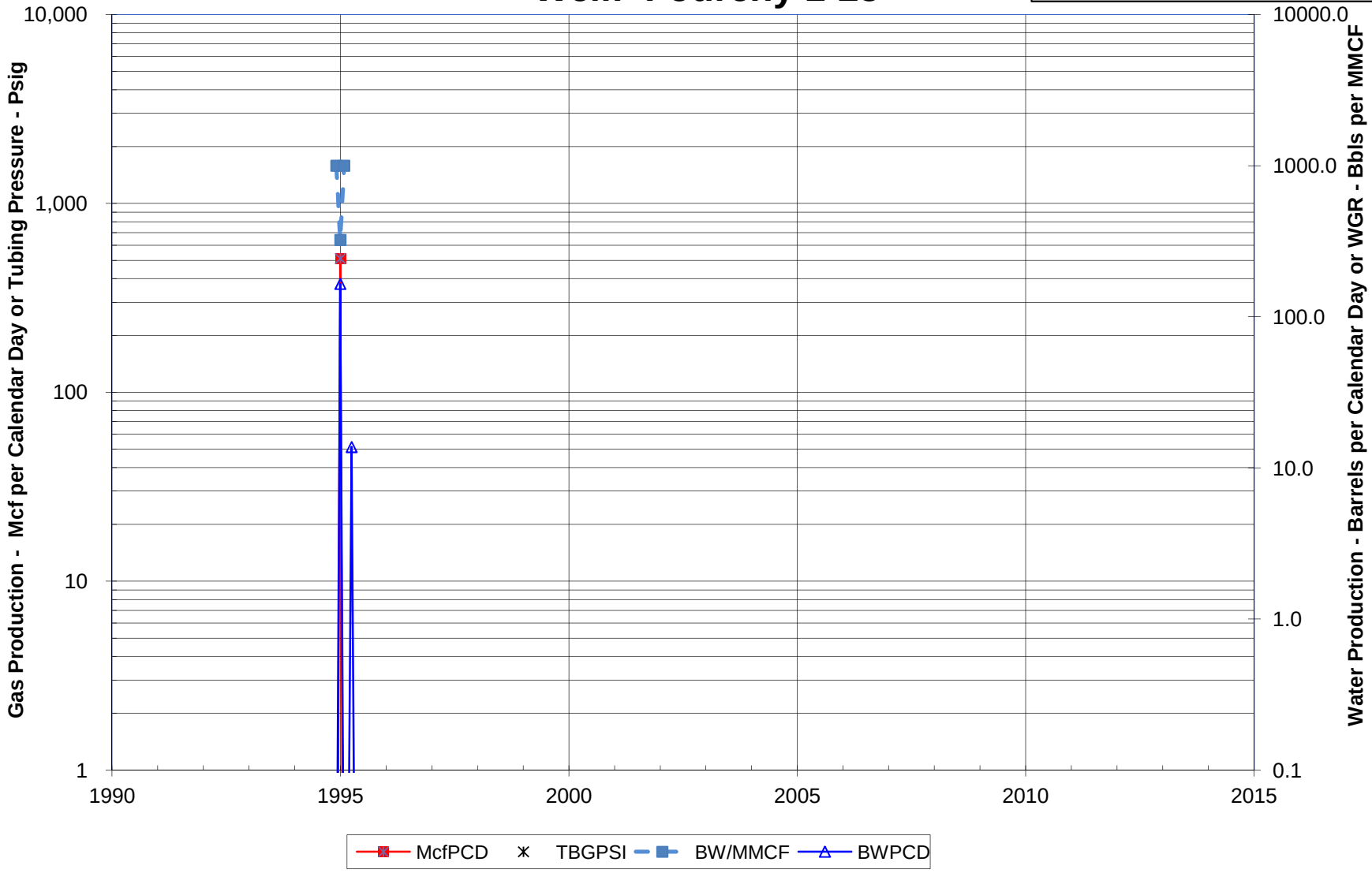


EXHIBIT 12

Merrill Avenue Gas (Central)

DOGGR Production

API#: 01923184

Well: Le Compte 1

Cum production thru August 2011

Cum Gas, MMcf:	1,623.2
Cum Water, MBbls:	44.4

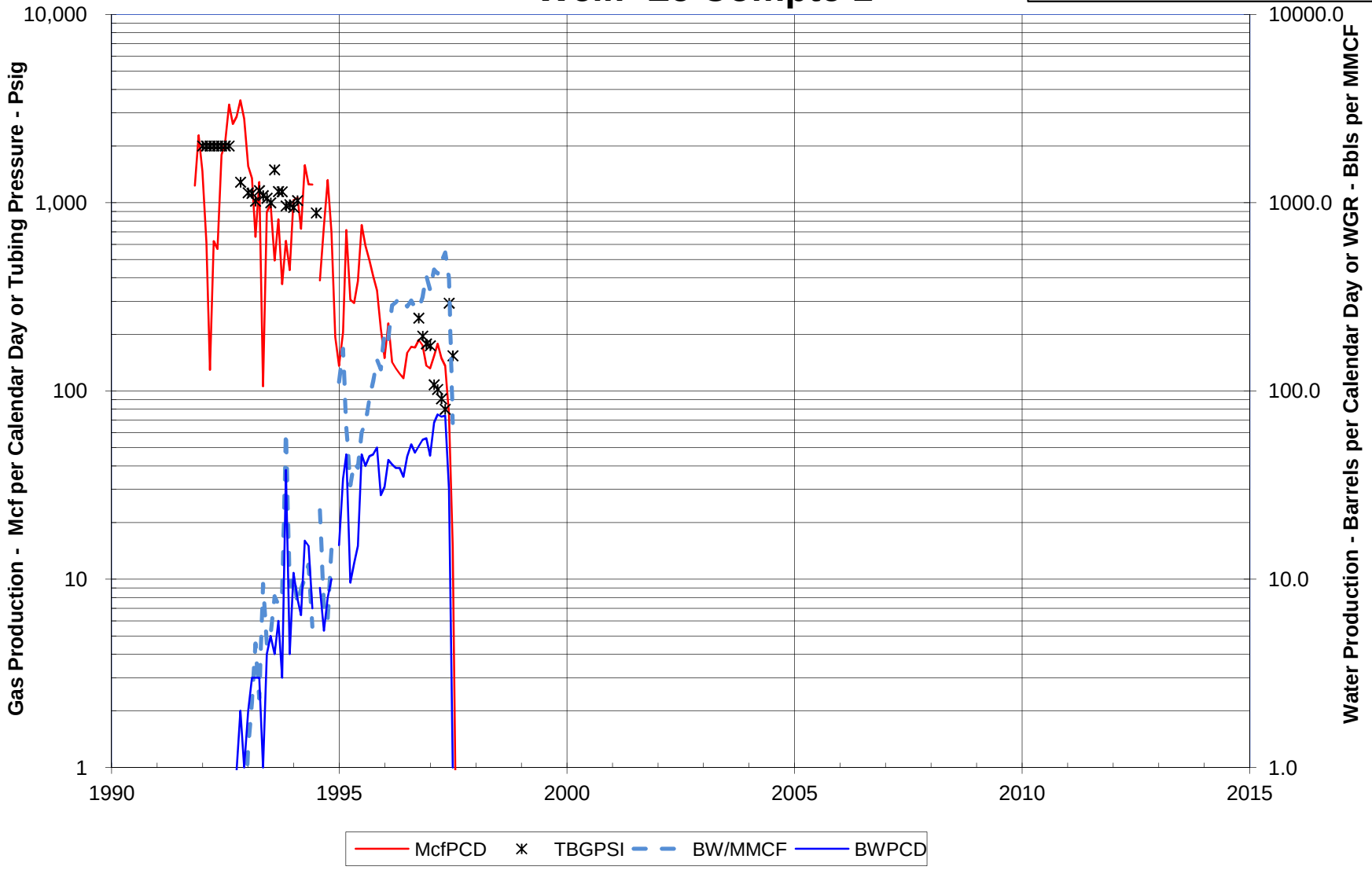


EXHIBIT 13

Merrill Avenue Gas (Central)

DOGGR Production

Cum production thru August 2011

Cum Gas, MMcf:	15,726.1
Cum Water, MBbls:	591.8

API#: 01923118

Well: O'Banion 1

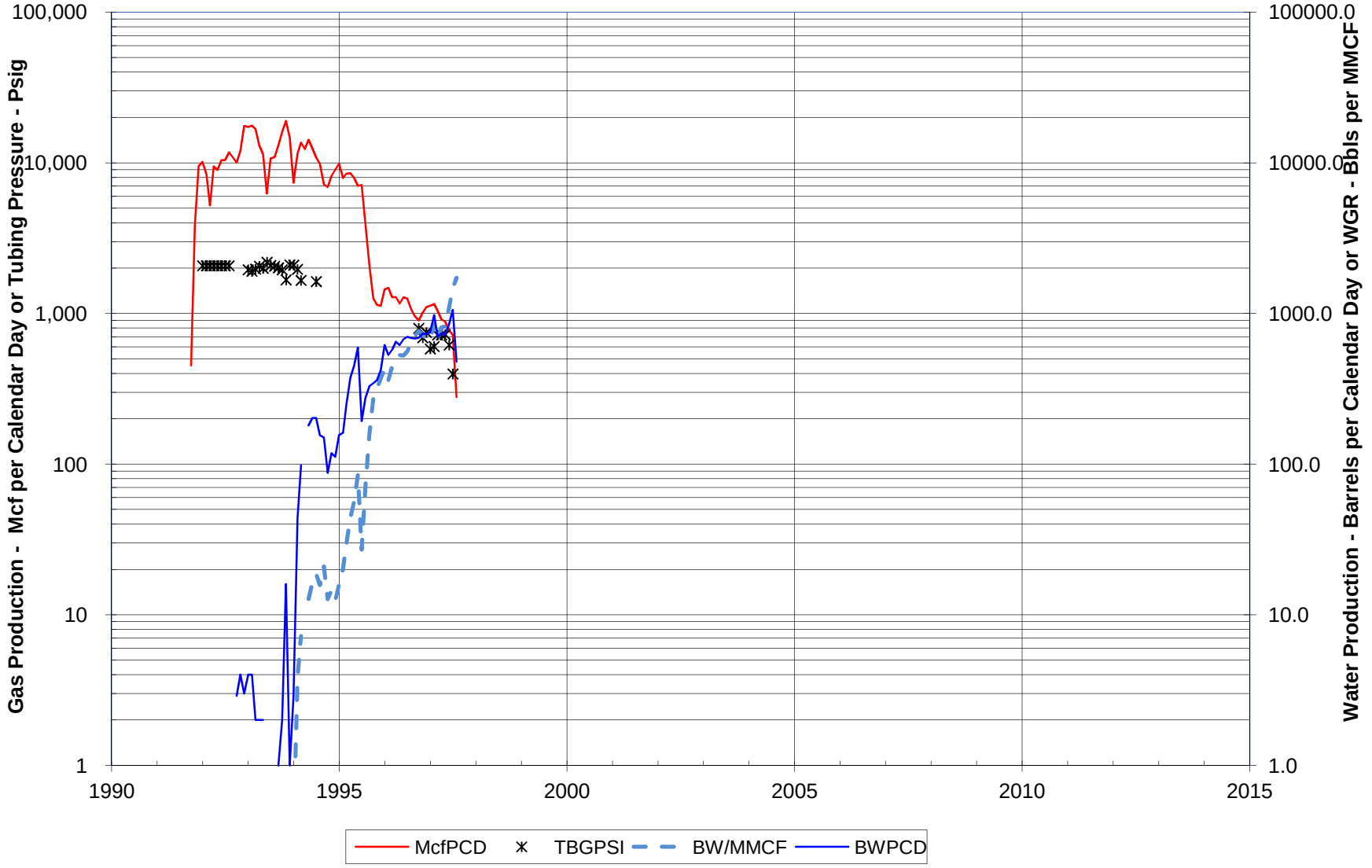


EXHIBIT 14

Merrill Avenue Gas (Central)

DOGGR Production

API#: 01923204

Well: O'Banion 3

Cum production thru August 2011

Cum Gas, MMcf:	832.1
Cum Water, MBbls:	13.8

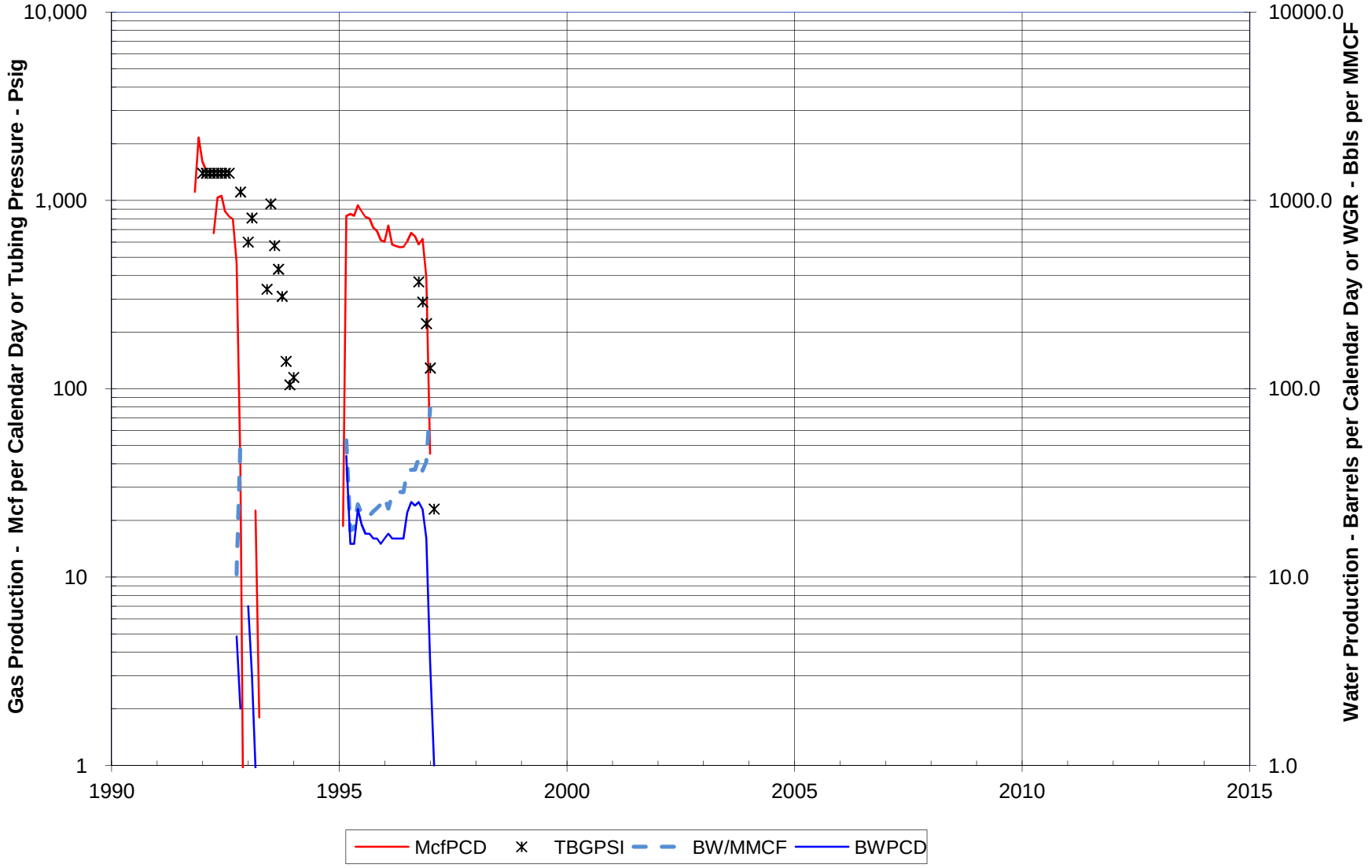


EXHIBIT 15

Merrill Avenue Gas (Central)

DOGGR Production

API#: 01923533

Well: O'Banion 5

Cum production thru August 2011

Cum Gas, MMcf:	351.4
Cum Water, MBbls:	118.3

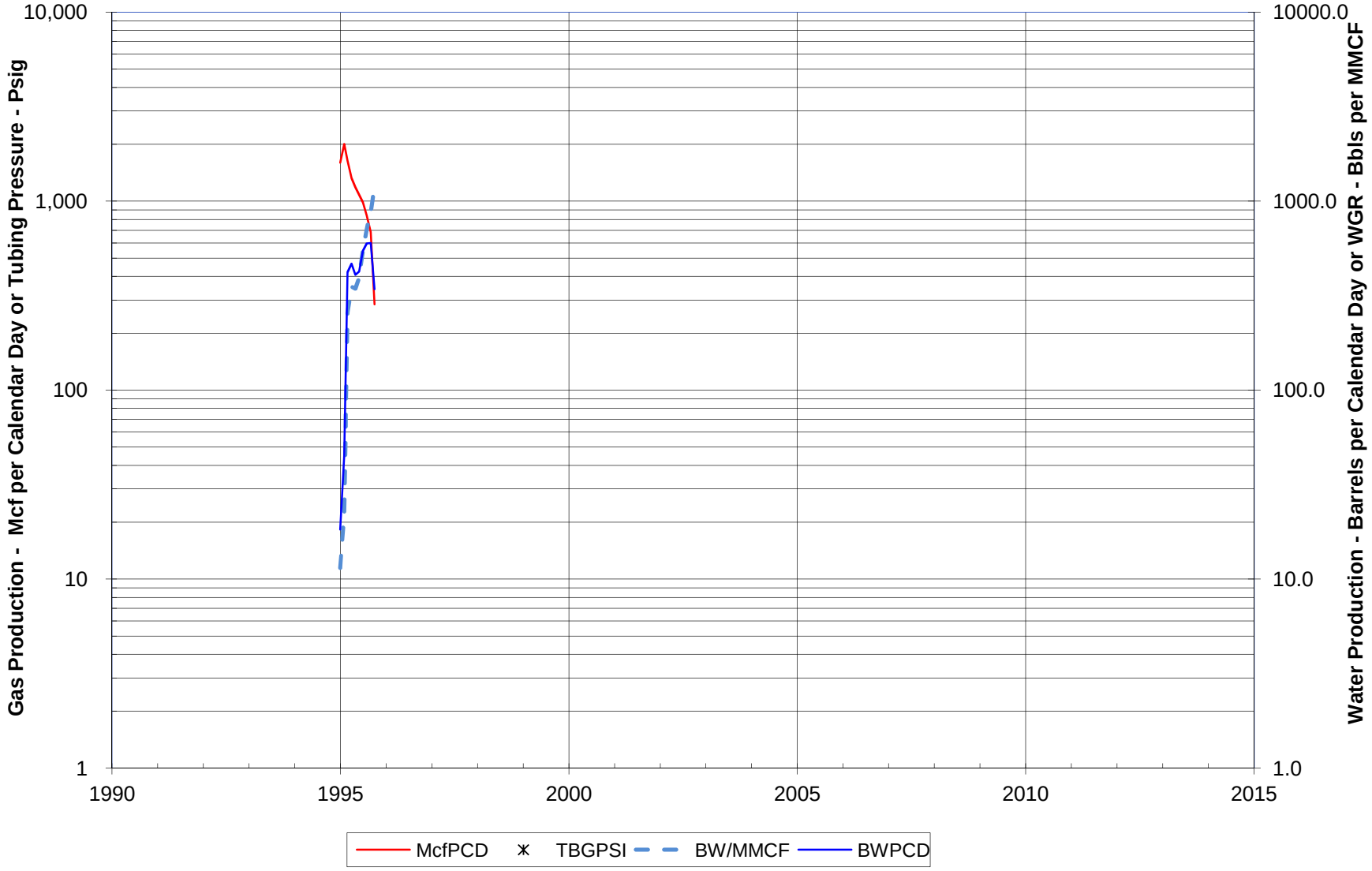


EXHIBIT 16

Merrill Avenue Gas (Central)

DOGGR Production

Cum production thru August 2011

Cum Gas, MMcf:	0.0
Cum Water Dspsl, MBbls:	422.2

API#: 01923490

Well: B & N 2

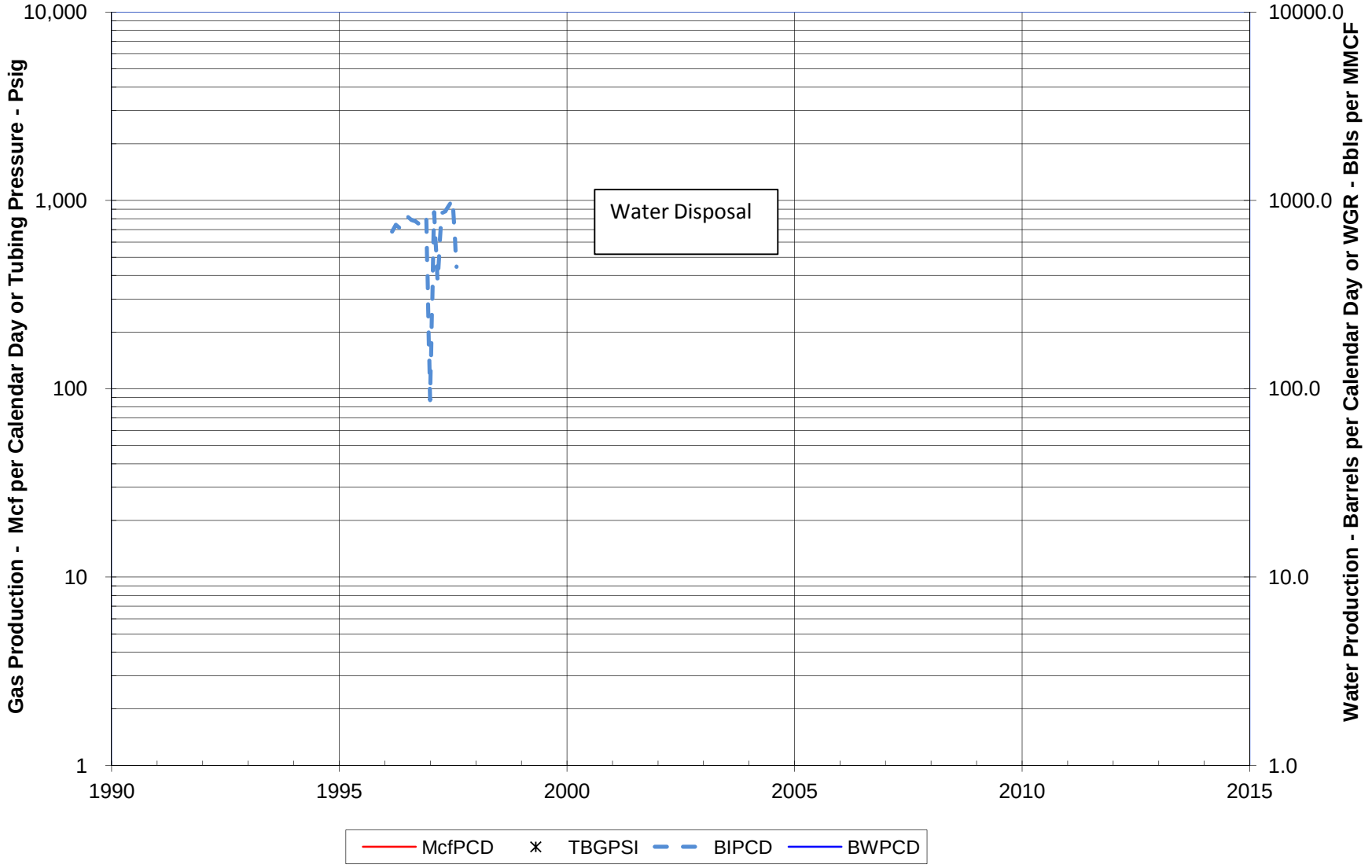
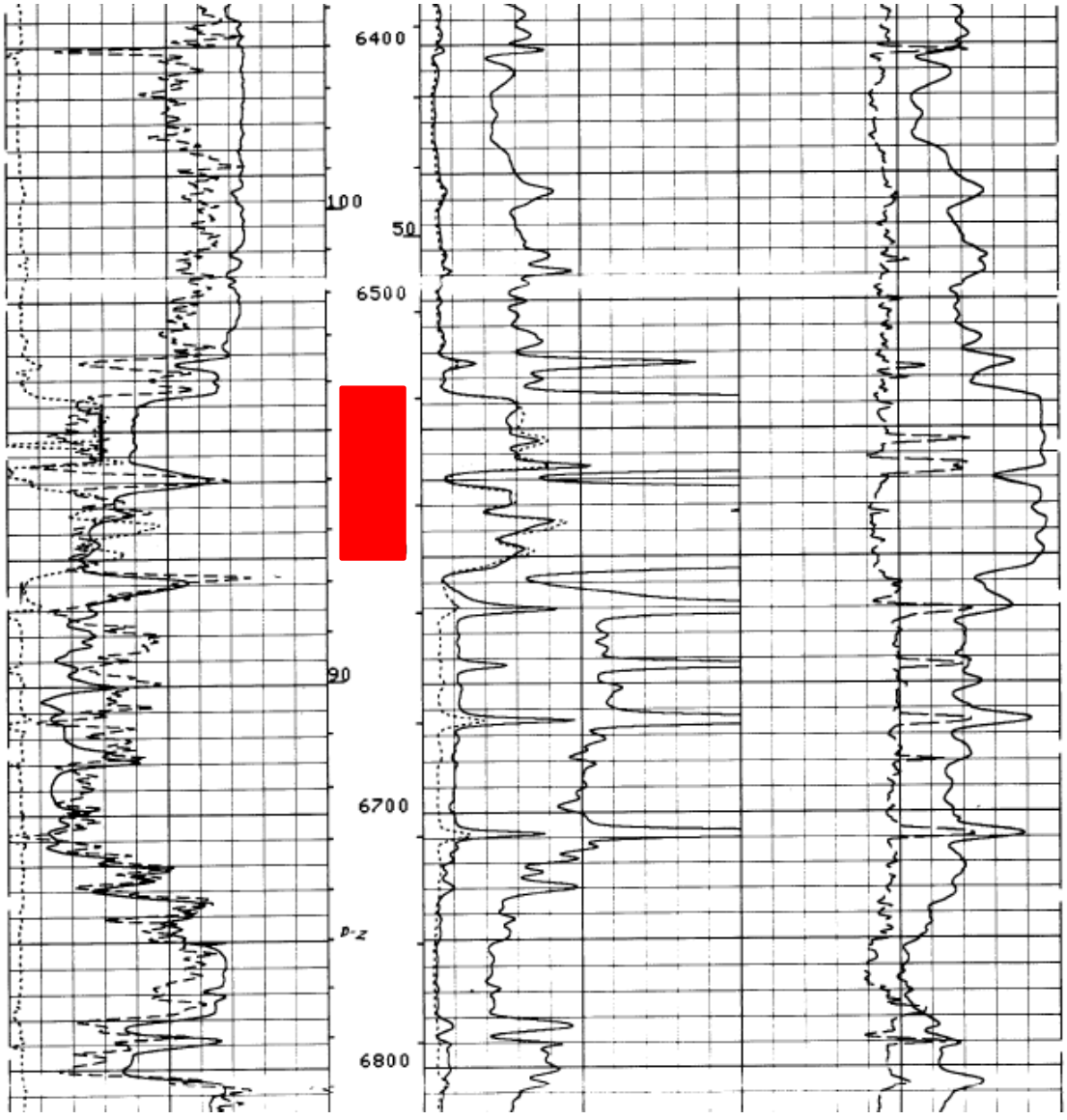
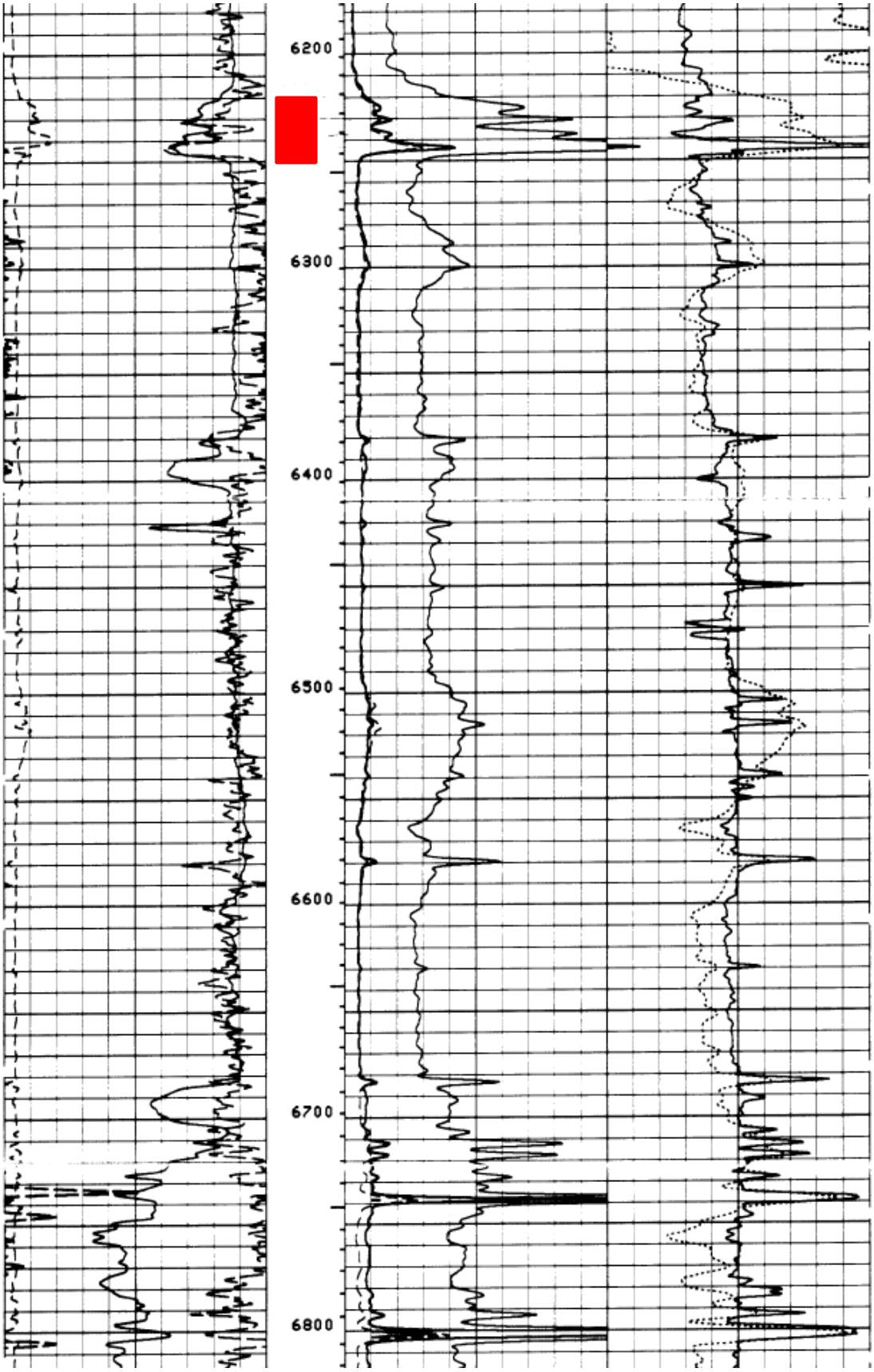


EXHIBIT 17



O'Banion 1

EXHIBIT 18



Triangle T 1-33

EXHIBIT 19

Merrill Avenue Gas (Southeast)

DOGGR Production

API#: 01924415

Well: Red Heat 1

Cum production thru August 2011

Cum Gas, MMcf:	499.4
Cum Water, MBbls:	0.2

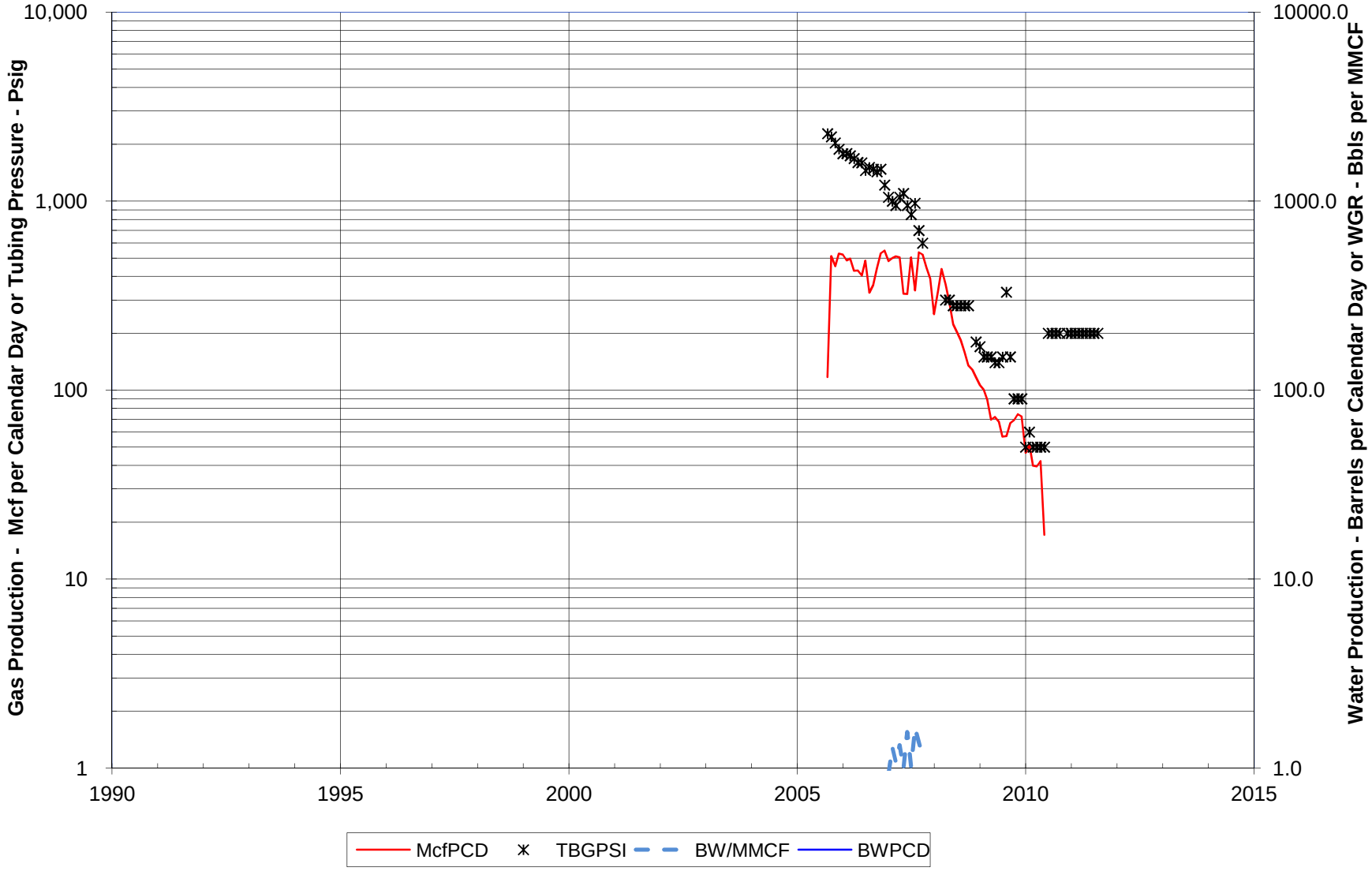


EXHIBIT 20

Merrill Avenue Gas (Southeast)

DOGGR Production

API#: 03920086

Well: Triangle T 1-28

Cum production thru August 2011

Cum Gas, MMcf:	697.6
Cum Water, MBbls:	0.7

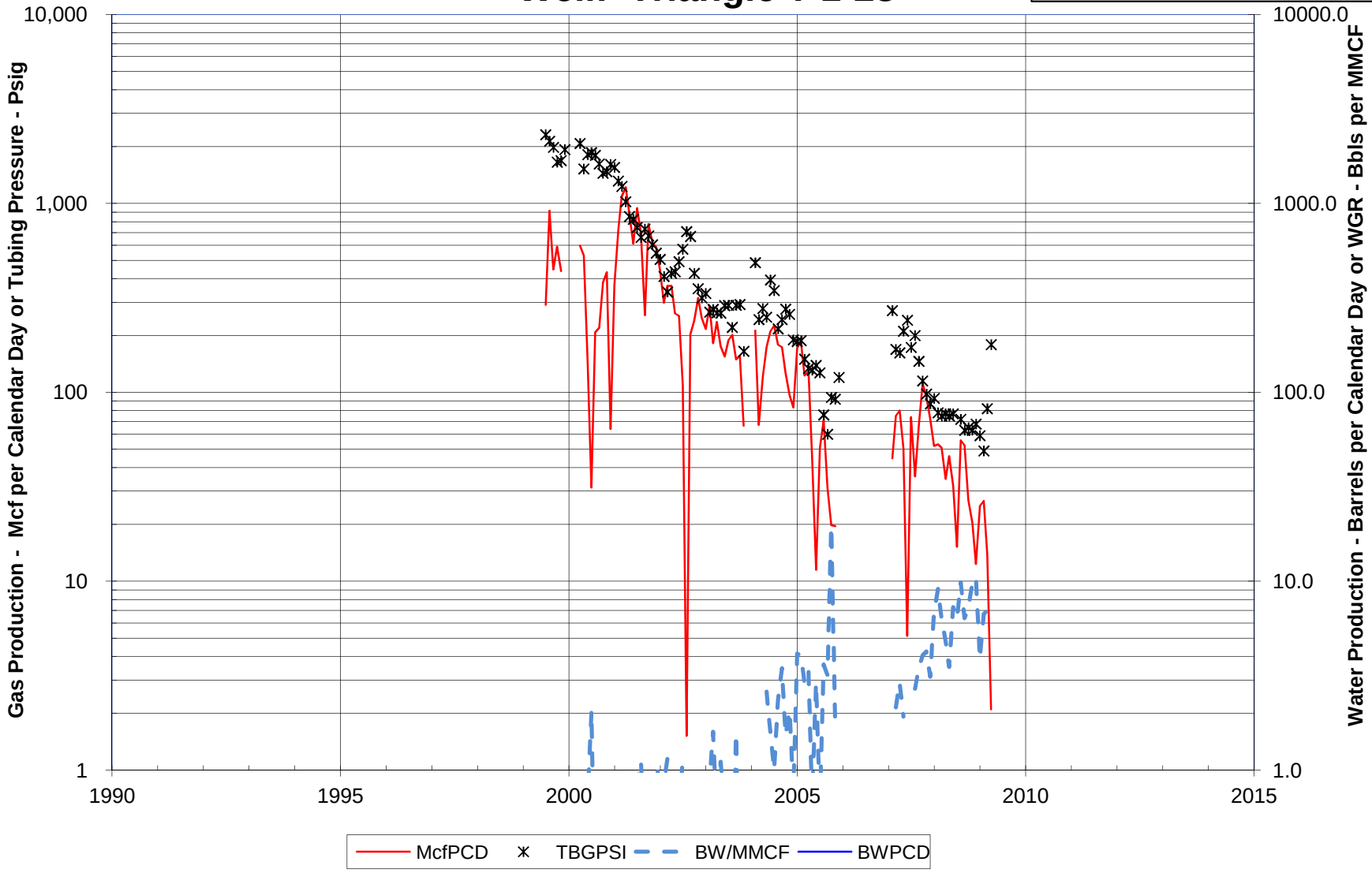


EXHIBIT 21

Merrill Avenue Gas (Southeast)

DOGGR Production

API#: 03920072

Well: Triangle T 1-29

Cum production thru August 2011

Cum Gas, MMcf:	2,077.1
Cum Water, MBbls:	20.4

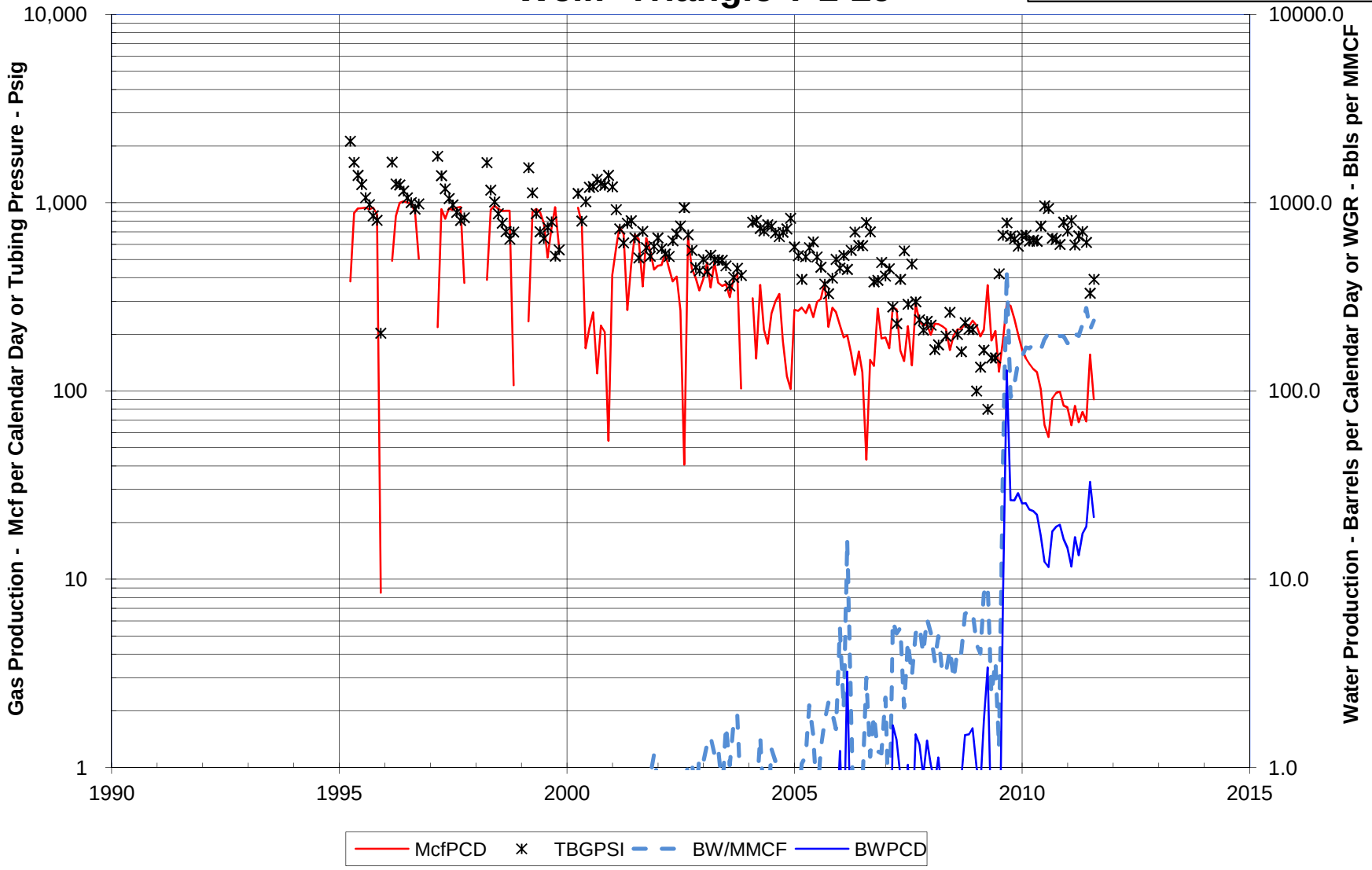


EXHIBIT 22

Merrill Avenue Gas (Southeast)

DOGGR Production

API#: 03920075

Well: Triangle T 1-33

Cum production thru August 2011

Cum Gas, MMcf:	4,976.4
Cum Water, MBbls:	4.1

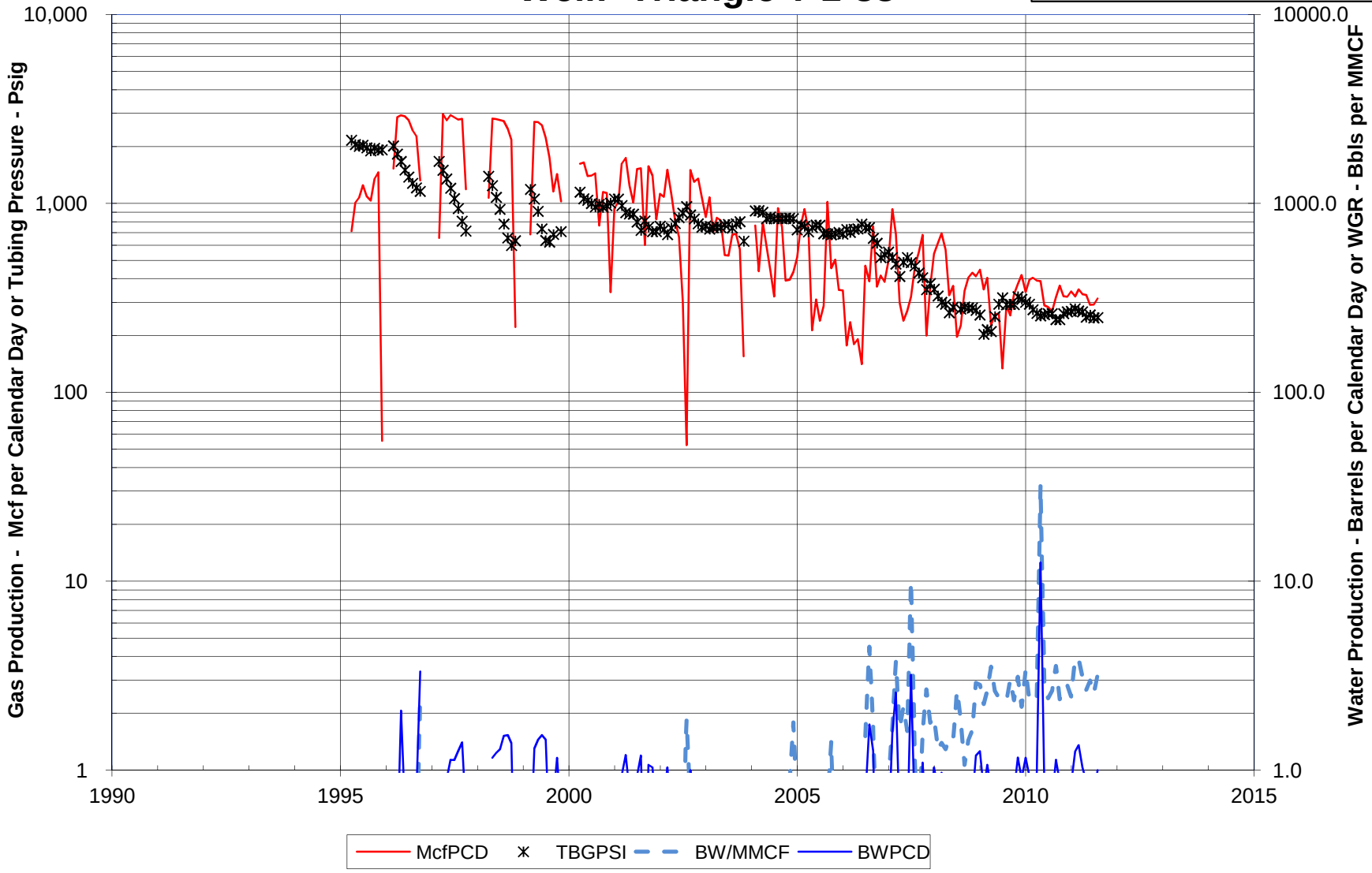


EXHIBIT 23

Merrill Avenue Gas (Southeast)

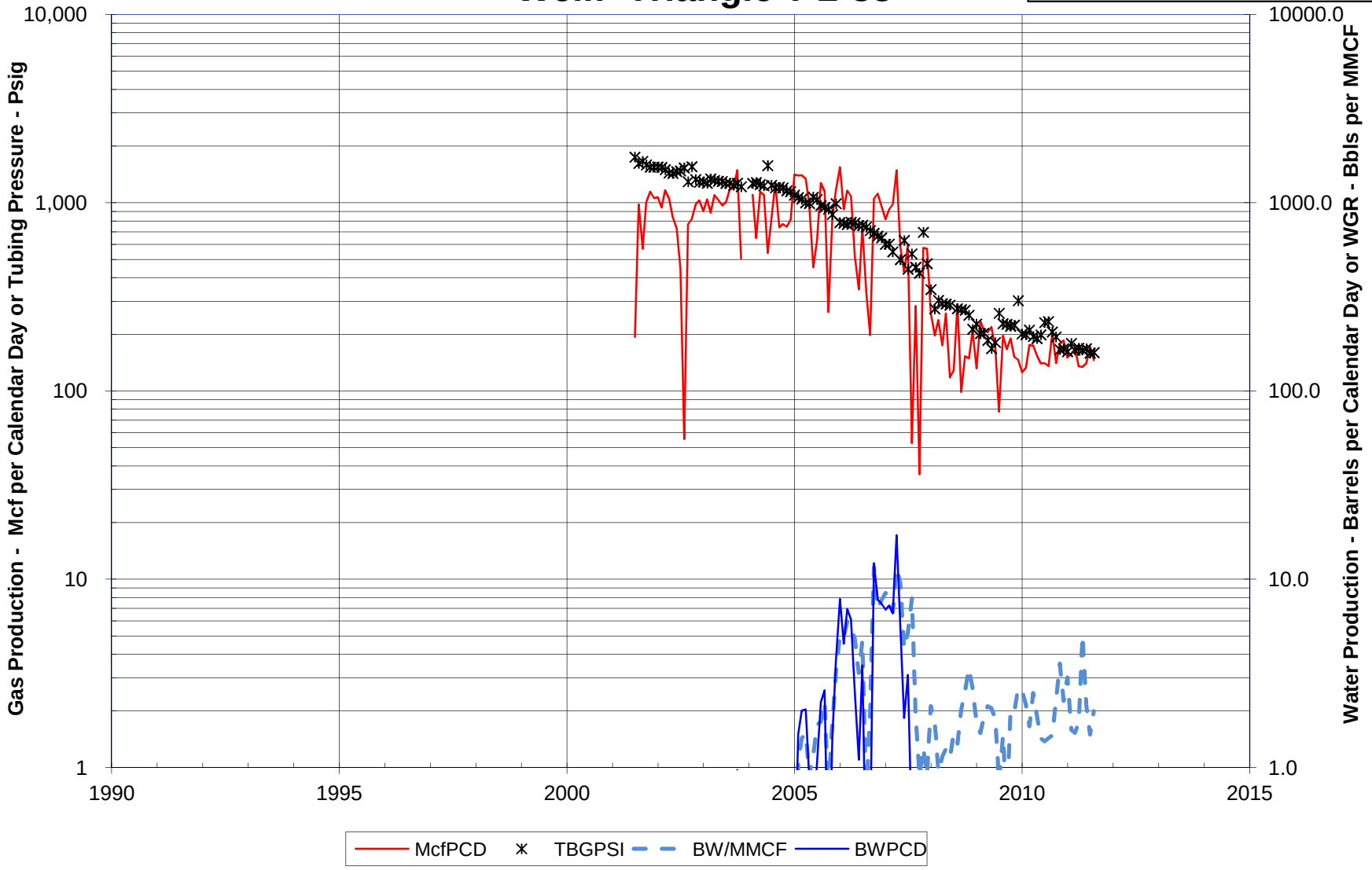
DOGGR Production

API#: 03920091

Well: Triangle T 2-33

Cum production thru August 2011

Cum Gas, MMcf:	2,217.8
Cum Water, MBbls:	4.9



MERRILL AVENUE RESERVOIR

Summary and Decision

The Merrill Avenue reservoir, located in Fresno County, California (20 miles south of Merced), was not selected for detailed modeling and/or was not a finalist site for the CAES Feasibility Study (Merrill Avenue—Aerial Map.pdf). In the opinion of the project team, development of the reservoirs would be challenging due to the subsurface reservoir complexity.

Subsurface/Reservoir Screening

Preliminary Screening Results

The Merrill Avenue gas field was identified in the very early reservoir screening process as having the potential for CAES testing and development. The available information indicated that one of the reservoirs had produced 19.7 Bcf of natural gas from a formation at about 6,300 ft. The average reservoir thickness was reported to be about 70 ft, and the water production volume was low.

Preliminary Geological Summary

Based on the earlier analysis, the project team completed a preliminary screening of the Merrill Avenue gas field data on December 14, 2011 (Merrill Avenue—Preliminary Reservoir Evaluation.pdf). In total, the field had produced 32.1 Bcf of natural gas from three separate reservoirs in the Blewett sands at depths of 6,200 to 6,800 ft. The reservoirs are:

- **Northwest Area.** At a depth of 6,300 ft, this reservoir is by far the smallest of the three, having accounted for only 3.1 Bcf of the total field production. Net pay for the five productive wells in this reservoir ranges from 20 to 50 ft. The static bottomhole pressure was measured at approximately 2,700 psig. The wells experienced high water production relatively early in their life, indicating an active water drive. All wells are currently shut-in.

- **Central Area.** Five wells produced from the Central Area from a depth of about 6,600 ft. One well accounted for the majority of the gas production, 15.7 Bcf out of a total 18.5 for the area. That same well, the O'Banion #1, also recorded peak production rates of nearly 20 MMcfd, indicating excellent permeability. This finding is confirmed by conventional core data from the well showing 500 to 2,900 mD (millidarcies) of permeability. The initial reservoir pressure was measured at 2,920 psi. Production late in the life of the field was hampered by water production with rates as high as 1,000 barrels per day, indicating a very strong water drive. All wells are currently shut-in.

- **Southeast Area.** This reservoir is characterized by multiple thin sand sections with a total net thickness of up to 30 ft in the productive interval. It is stratigraphically different from the other two productive reservoirs described above in that the individual sand

layers appear to be discontinuous between wells. Five wells produced from the reservoir, accounting for a total of 10.5 Bcf, and three of those wells continue to be productive. The disconnected nature of the productive sand layers appears to have limited the encroachment of water such that the drive mechanism is primarily through volumetric depletion. The current reservoir pressure is estimated at 500 psig, indicating the presence of a significant quantity of remaining recoverable gas reserves (no estimate provided). Permeability is expected to be relatively lower than the other areas as indicated by the deliverability rates, which are lower, ranging from 1 to 2 MMcfd.

Reservoir Modeling and Evaluation

Based on the results of the preliminary geological analysis, the project team determined that, even though the Merrill Avenue reservoir parameters are within an acceptable range for CAES development, other reservoirs appeared to have better characteristics. Specifically the Northwest area is too small, the Central area is likely too large with more complex geology, and the Southeast area productive sands are too disconnected. Collectively all of the reservoirs are somewhat deeper and at higher pressure than ideal for a CAES project. For these reasons, no further evaluation was conducted at the Merrill Avenue field.

Testing/Development Potential

No testing was conducted.

Siting and Environmental Evaluation

Determination – No Fatal Flaws

Based on a review of aerial photography overlaid by property lines and the gas reservoir boundary, the project team selected an approximate 47-acre parcel located at end of Merrill Avenue for the station site. The site is currently in row crops, as are all the surrounding properties. The site is not within the 100-year flood zone. Zoning is agriculture preserve, and the site is not under Williamson Act contract. The land is classified as farmland of statewide importance. The nearest sensitive receptor is a farm residence approximately 3000 ft west of the station.

There are two gas transmission service options with operating pressures that would work for a CAES facility. The first is located approximately 1.5 miles from the site and the gas line route would be all in county road franchise, passing one residence. Larger main transmission pipelines are located approximately 22 miles west near Interstate Highway I-5. The gas line route to this connection would mostly follow or be within county roads. However, two segments would cross private property, where new easements would be required. More than 25 residences lie along this gas line route, with several large residential complexes fronting the route. The nearest suitable electric transmission connection is located approximately 21 miles to the west. The gen-tie route would extend west from the station along field breaks. Farming patterns in this area require the

gen-tie to follow an irregular route, possibly complicating design and construction and affecting farming operations. The gen-tie route runs approximately 0.5 mi south of the runway at Dos Palos Airport and, based on the results of a Federal Aviation Administration (FAA) Airspace Study, may require a further shift in alignment to the south to avoid the flight pattern. Three residences are located within half mile along the gen-tie route, the closest at 2100 ft. No schools are located along the gen-tie or gas line routes.

No conservation easements or riparian areas are affected by project facilities, and the only sensitive species (primarily kit fox) are along the western end of the gen-tie in the foothills. This area is part of the Pacific Flyway, a known waterfowl migration route, and potential collision with the gen-tie would need to be addressed during project permitting.

Land Acquisition/Site Control

No land acquisition efforts were undertaken at the Merrill Avenue reservoir location.

References

1) Merrill Avenue - Aerial Map.pdf
2) Merrill Avenue - Preliminary Reservoir Evaluation.pdf

A305: Perkin's Lake Site Selection and Attachments

Perkin’s Lake - 3D Seismic
Perkin’s Lake - Aerial Map
Perkin’s Lake - APN Map
Perkin’s Lake - Conservation Easements Map
Perkin’s Lake - Detailed Geological Report
Perkin’s Lake - Geological Report Appendix
Perkin’s Lake - Habitat Assessment
Perkin’s Lake - Preliminary Screening Review
Perkin’s Lake - Reconnaissance Report
Perkin’s Lake Site Selection Close-Out Report

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SEISMIX CALIFORNIA PROGRAM
PROPRIETARY 3D & 2D SURVEY LEGEND
Monday, April 11th, 2005

#	Owner	3-D Title	County	State	Square Miles
1	PYR Energy	Se Maricopa	Kern	CA	50.00
2	Cimarex Energy	N. Willows	Glenn	CA	12.00
3	Cimarex Energy	N.W. Blosser	Glenn	CA	23.00
4	Cimarex Energy	N.W. Malton	Tehama	CA	12.00
5	Cimarex Energy	S.E. Malton	Glenn	CA	15.00
6	Cimarex Energy	Cameron	Sutter	CA	12.00
7	Slawson	Andromeda	Sutter	CA	18.20
8	Slawson	Fiji	Yolo	CA	33.50
9	Slawson	Bali	Yolo/Solano	CA	17.00
10	Slawson	Moonbend	Sutter	CA	12.70
11	Slawson	Orion	Sutter/Colusa	CA	15.00
12	Slawson	Yolo Bypass	Yolo	CA	45.60
13	Crest Oil & Gas	Stoney Creek	Glenn	CA	22.00
14	Crest Oil & Gas	Merlin	Glenn	CA	16.00
15	Petrogulf	Arbuckle	Colusa	CA	23.90
16	Lario Oil and Gas	Carson Pass	Tehama	CA	28.28
17	Lario Oil and Gas	Llano Seco	Butte	CA	14.33
18	Lario Oil and Gas	N. Conway Ranch	Yolo	CA	24.80
19	Lario Oil and Gas	Zamora	Yolo	CA	26.00
20	Venoco, Inc. (*)	Todhunters Lake	Yolo	CA	13.80
21	Carneros Energy, Inc. (*)	Tejon	Kern	CA	36.00
22	Royale Energy, Inc. (*)	Rice Creek	Tehama/Glenn	CA	16.00
				Total	**487.11**

Owner	Counties	States	2-D Mileage
		Total	**0.00**

***** All Square and Linear Miles Are Approximate *****
***** All Partnership Approval Must Be Received By Participants Prior To Submittal *****

NOTE: (*) = Recently Added Surveys
 # = Survey Reprocessed & Released by ECHO

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SeisMix California

Survey #1

SE MARICOPA 3D

Owner:
PYR Energy Corporation

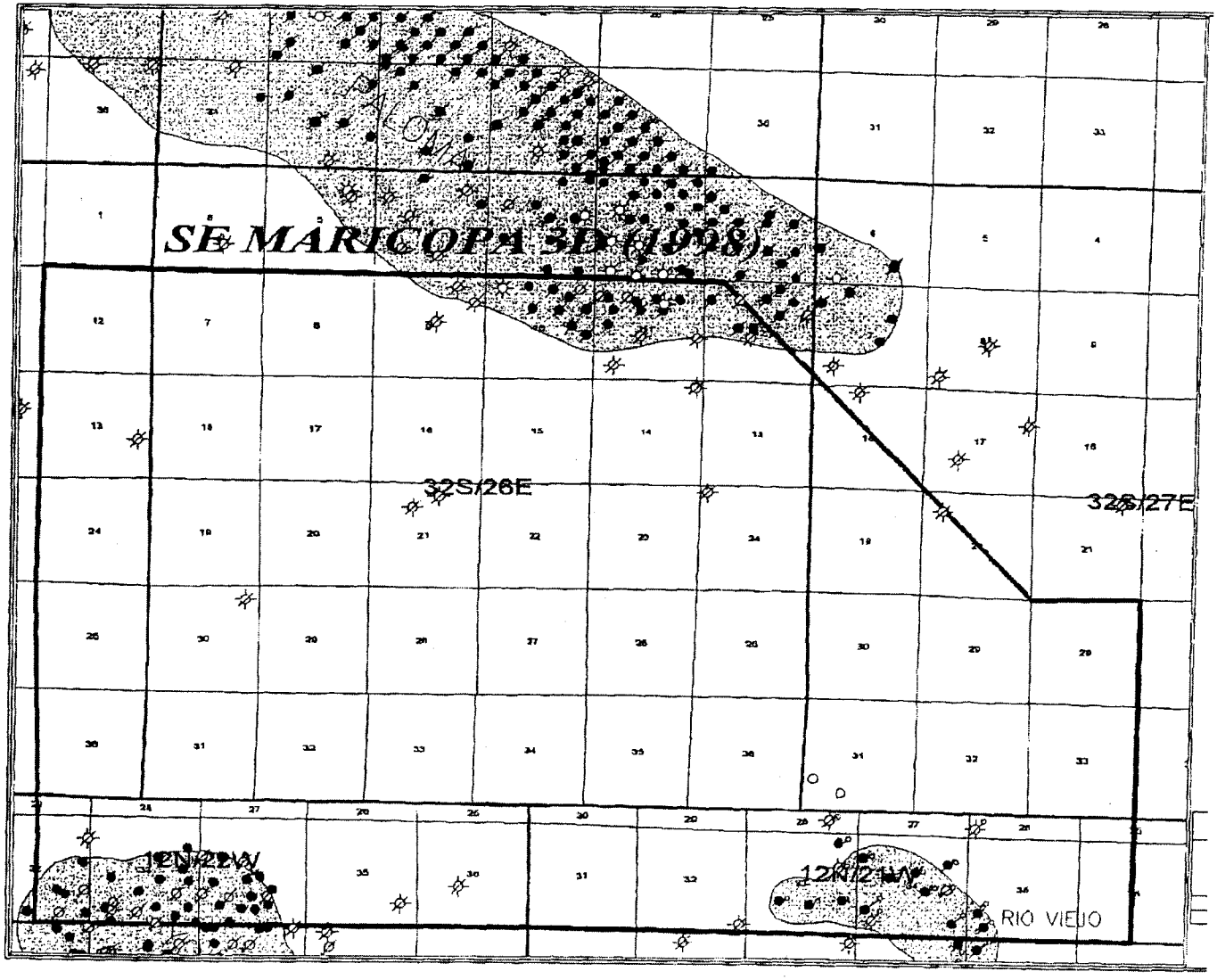
Square Miles: 50

Basin: San Joaquin
State: California
County: Kern

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Survey #2

N. WILLOWS 3D

Owner:
Cimarex Energy Company

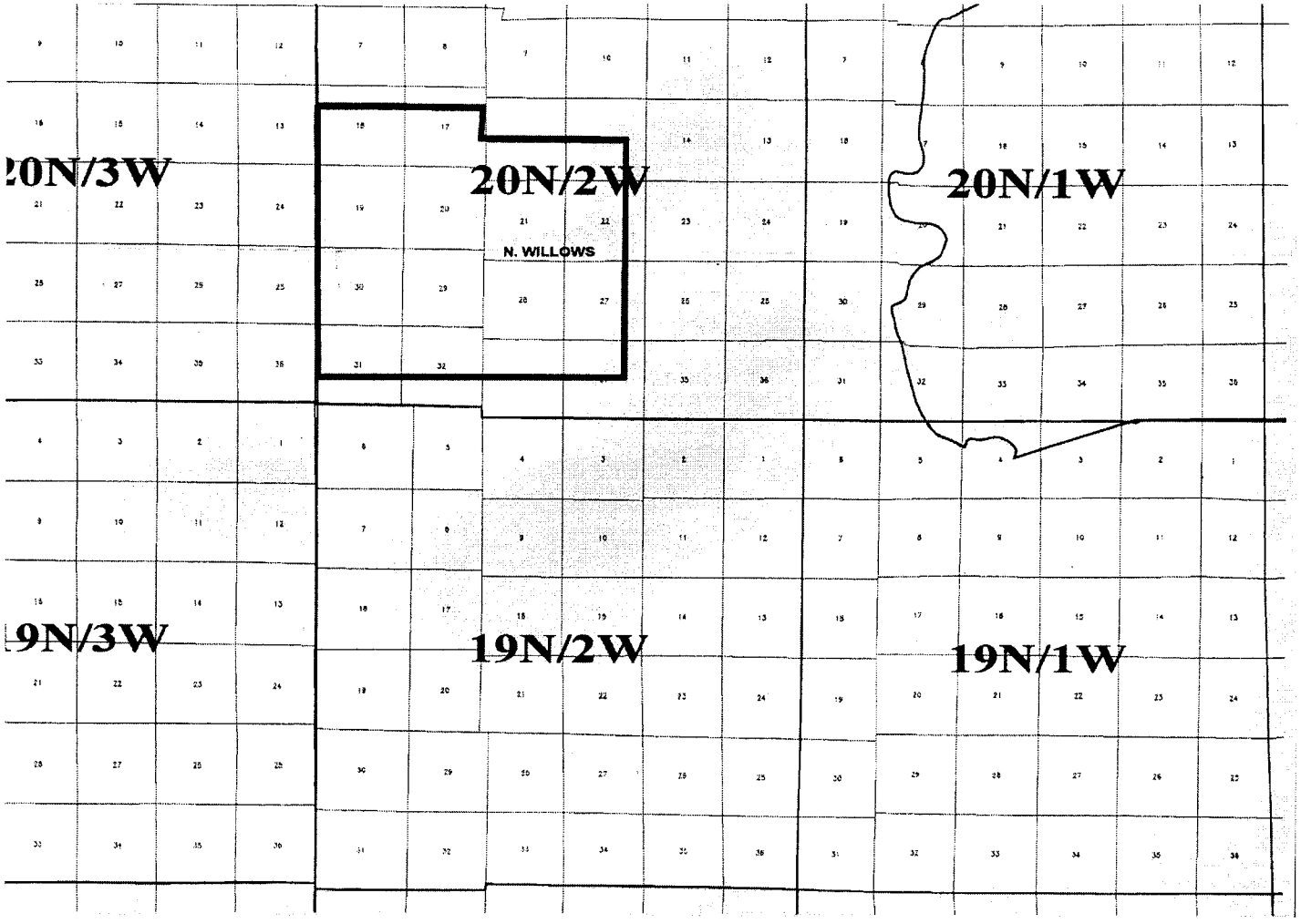
Square Miles: 12

Basin: Sacramento
State: California
County: Glenn

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Survey #3

N.W. BLOSSER 3D

Owner:
Cimarex Energy Company

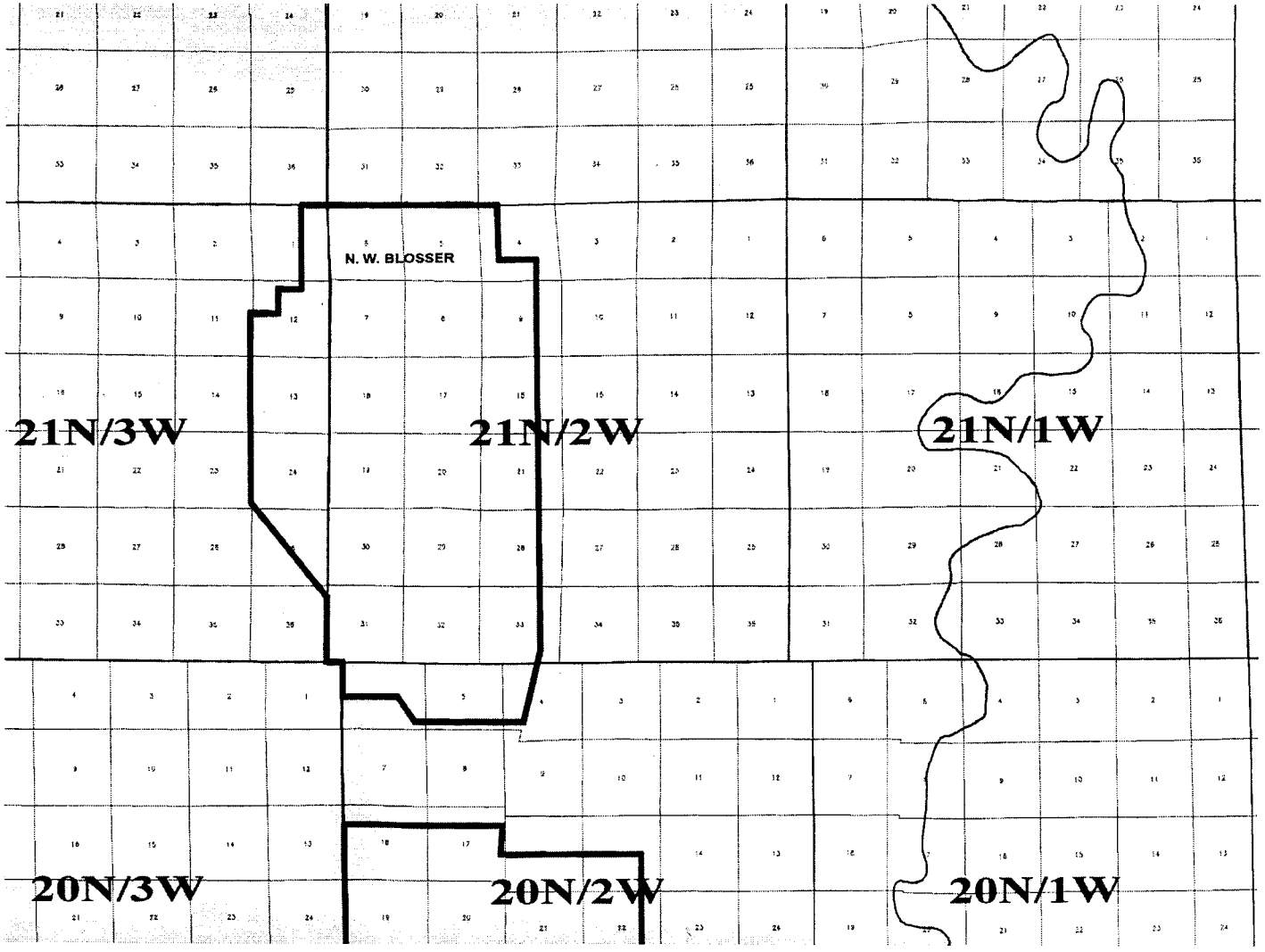
Square Miles: 23

Basin: Sacramento
State: California
County: Glenn

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Survey #4

N.W. MALTON 3D

Owner:
Cimarex Energy Company

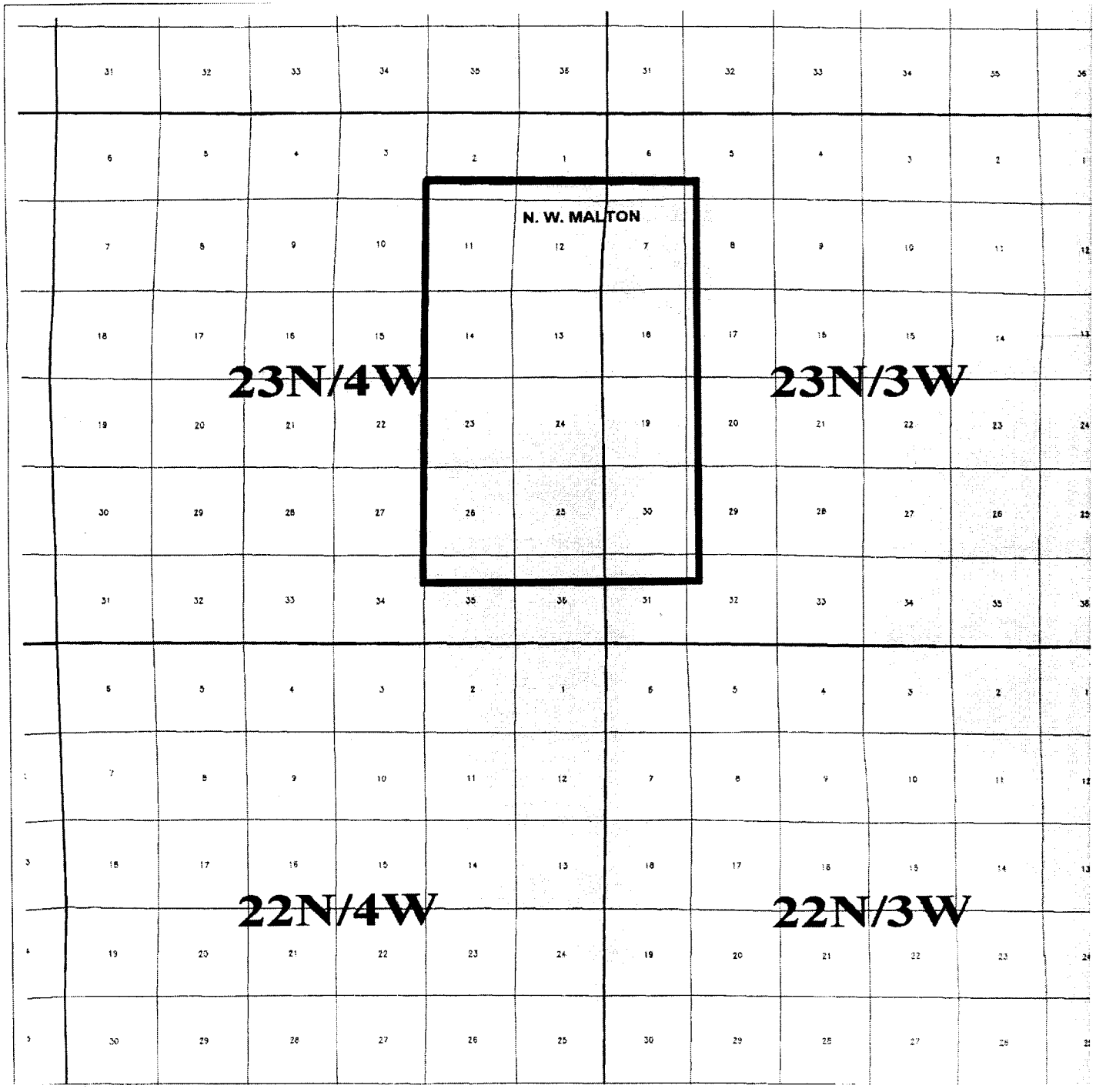
Square Miles: 12

Basin: Sacramento
State: California
County: Tehama

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Survey #5

S.E. MALTON 3D

Owner:
Cimarex Energy Company

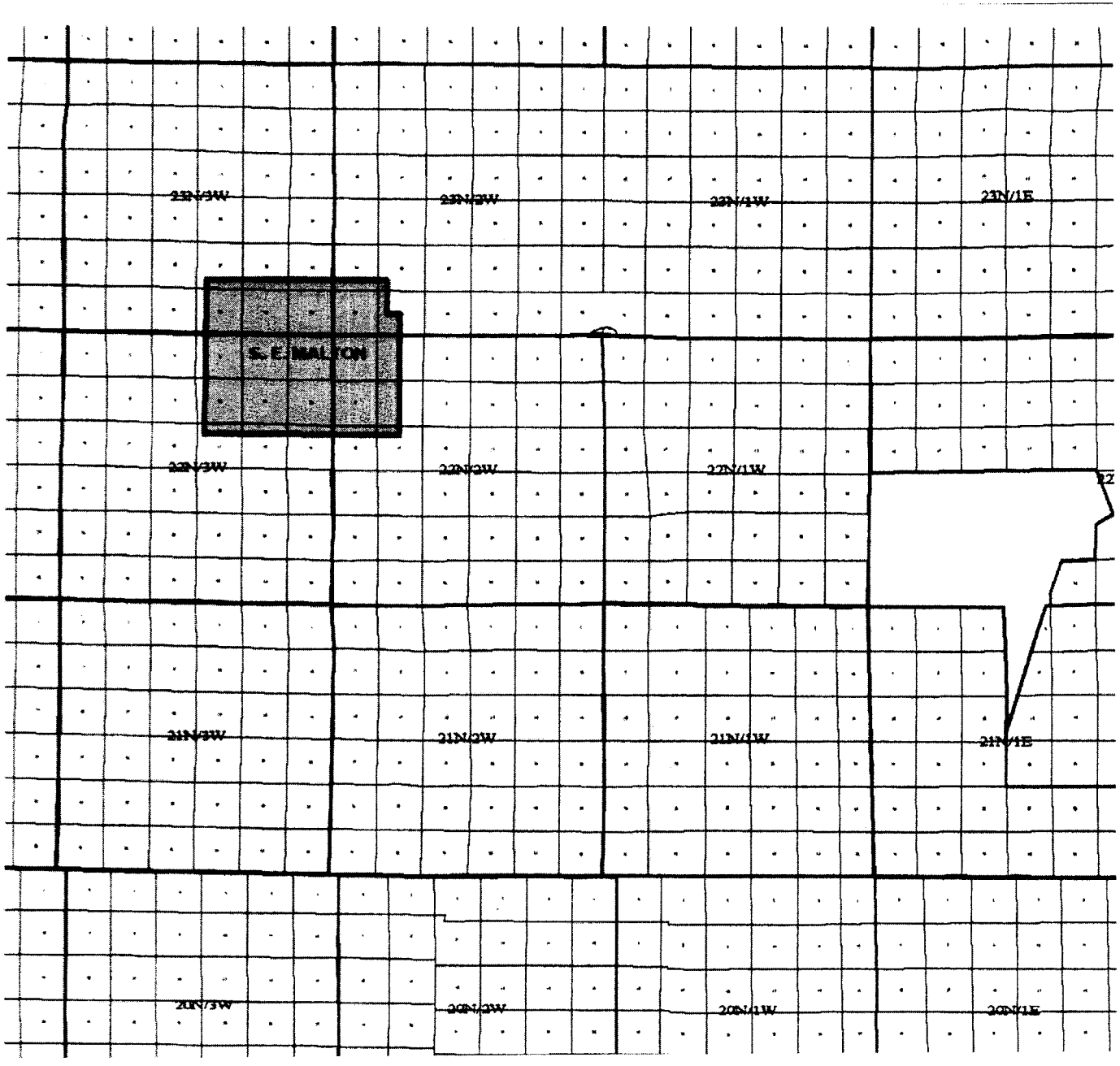
Square Miles: 15

Basin: Sacramento
State: California
County: Glenn

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Survey #6

CAMERON 3D

Owner:
Cimarex Energy Company

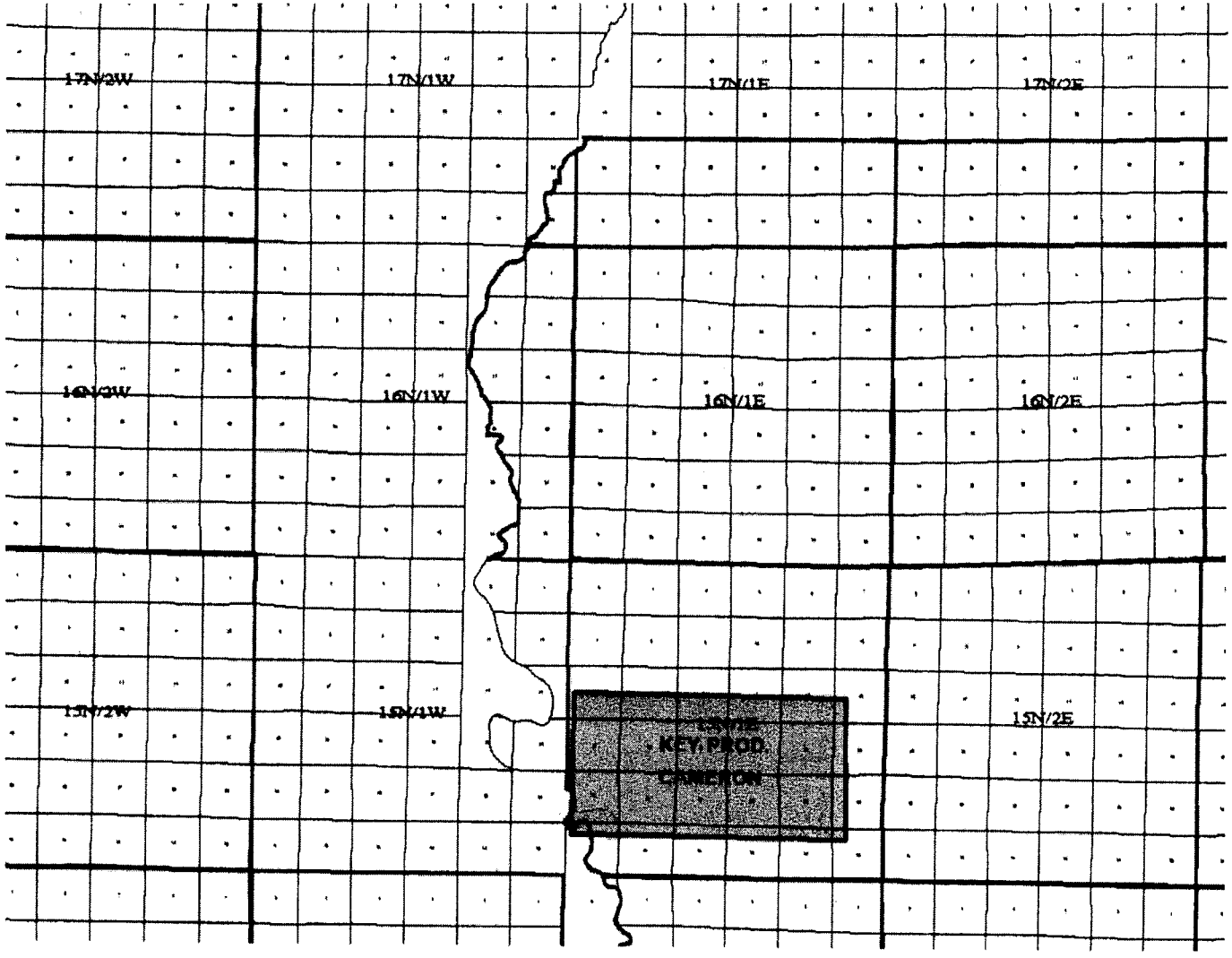
Square Miles: 12

Basin: Sacramento
State: California
County: Sutter

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Survey #7

ANDROMEDA 3D

Owner:
Slawson Exploration Company, Inc.

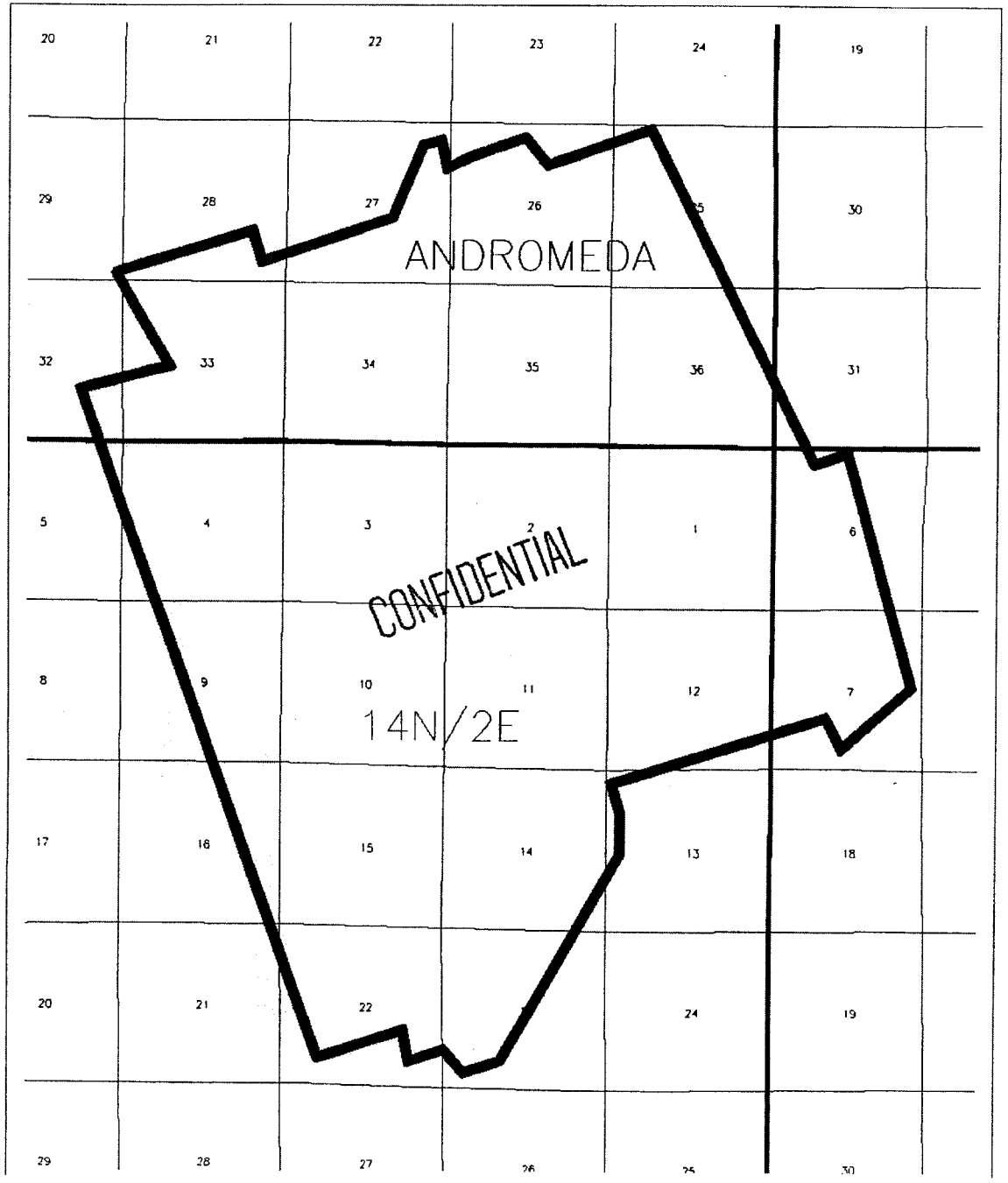
Square Miles: 18.2

Basin: Sacramento
State: California
County: Sutter

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Survey #8

FIJI 3D

Owner:
Slawson Exploration Company, Inc.

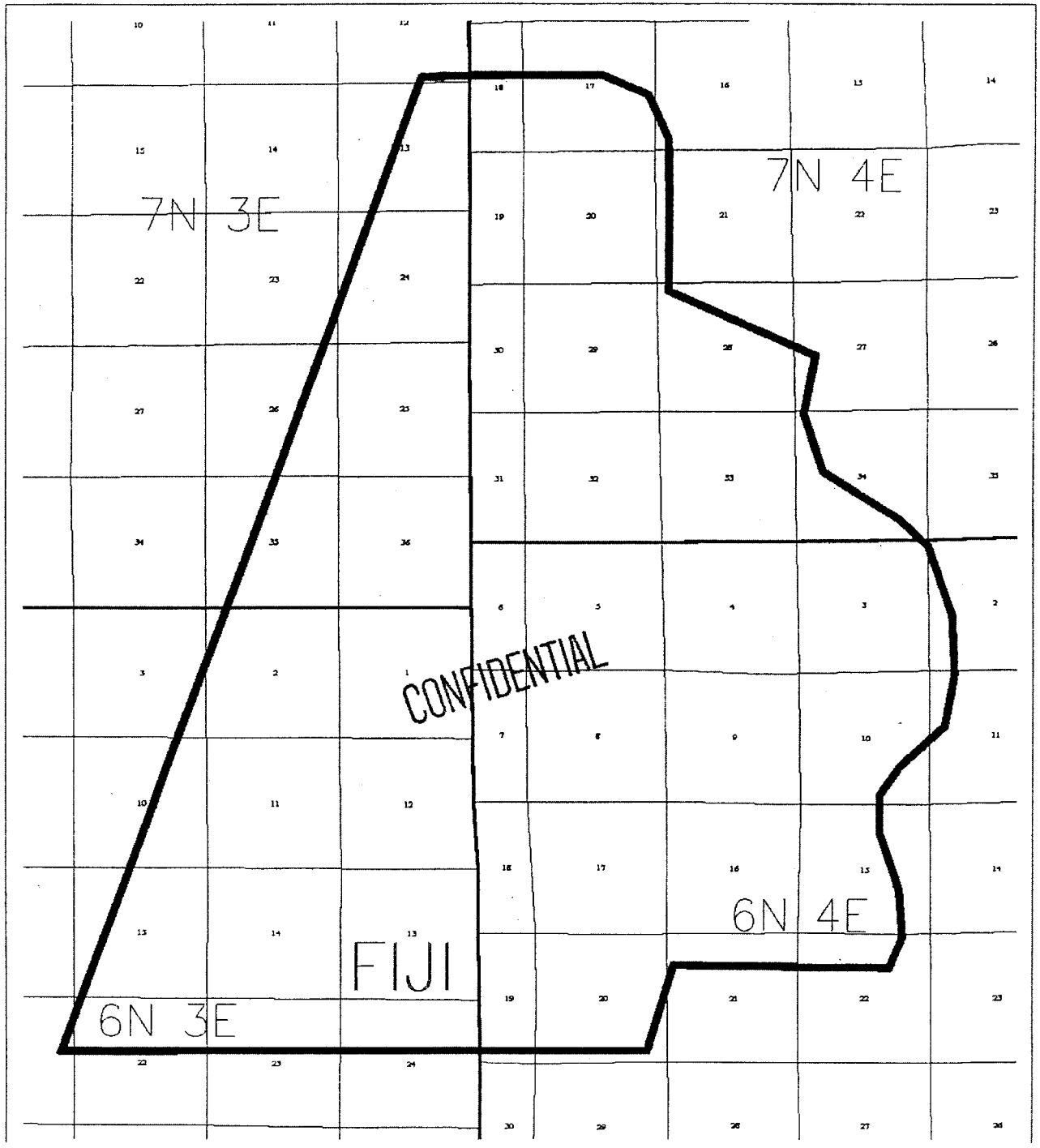
Square Miles: 33.5

Basin: Sacramento
State: California
County: Yolo

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SeisMix California

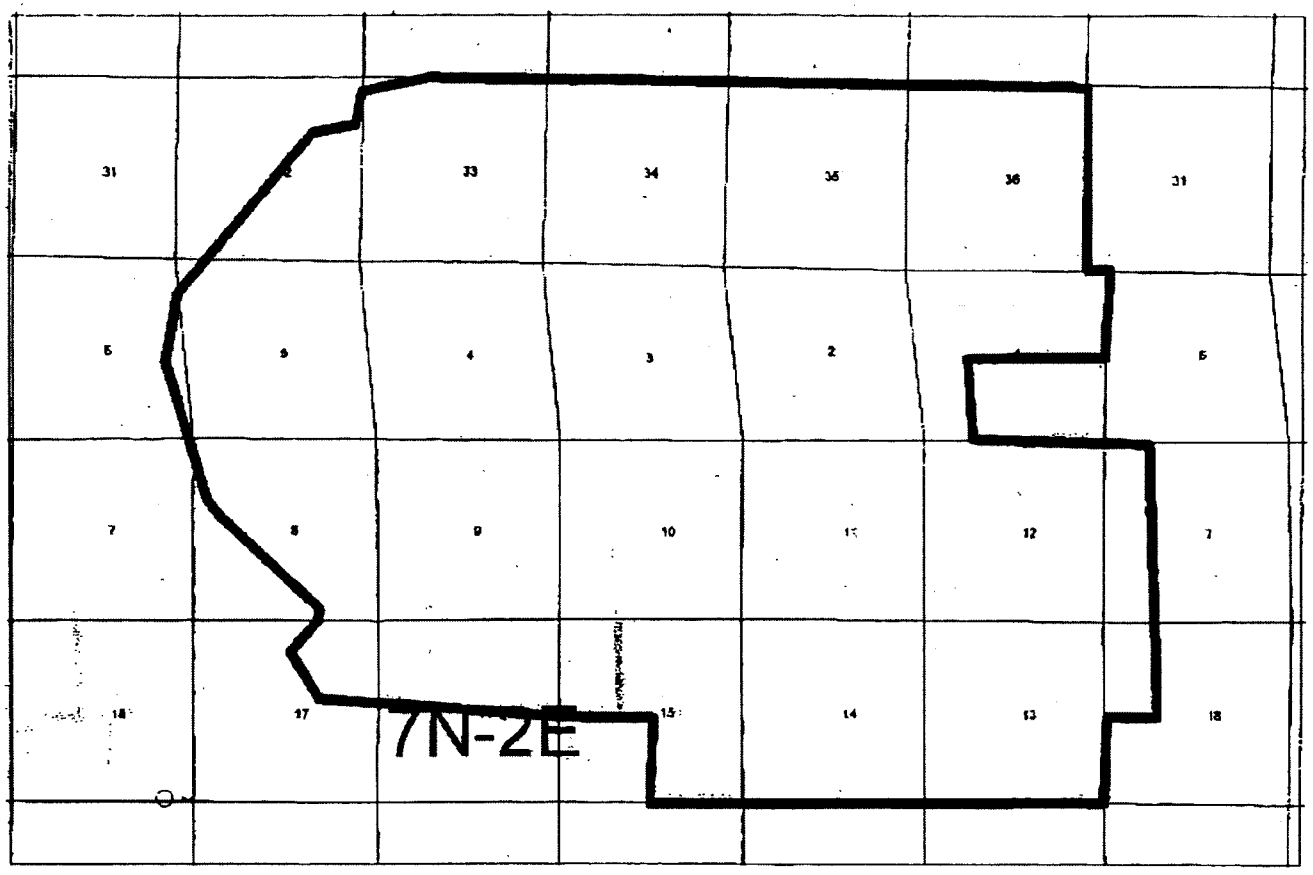
Survey #9

BALI 3D

Owner:
Slawson Exploration Company, Inc.

Square Miles: 17

Basin: Sacramento
State: California
Counties: Yolo & Solano



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houston@echogeo.com

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SeisMix California

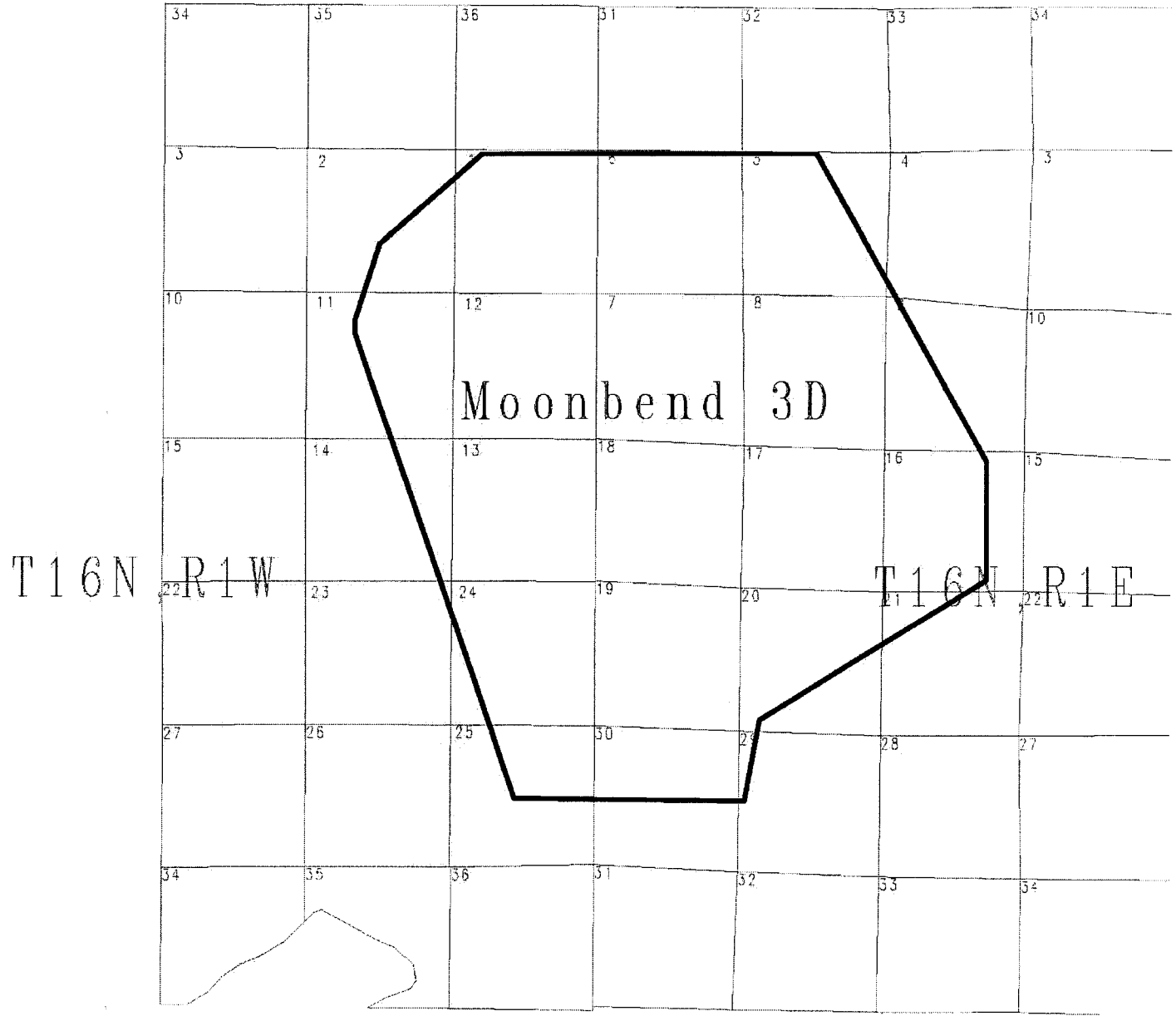
Survey #10

MOONBEND 3D

Owner:
Slawson Exploration Company, Inc.

Square Miles: 12.7

Basin: Sacramento
State: California
County: Sutter



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Survey #11

ORION 3D

Owner:
Slawson Exploration Company, Inc.

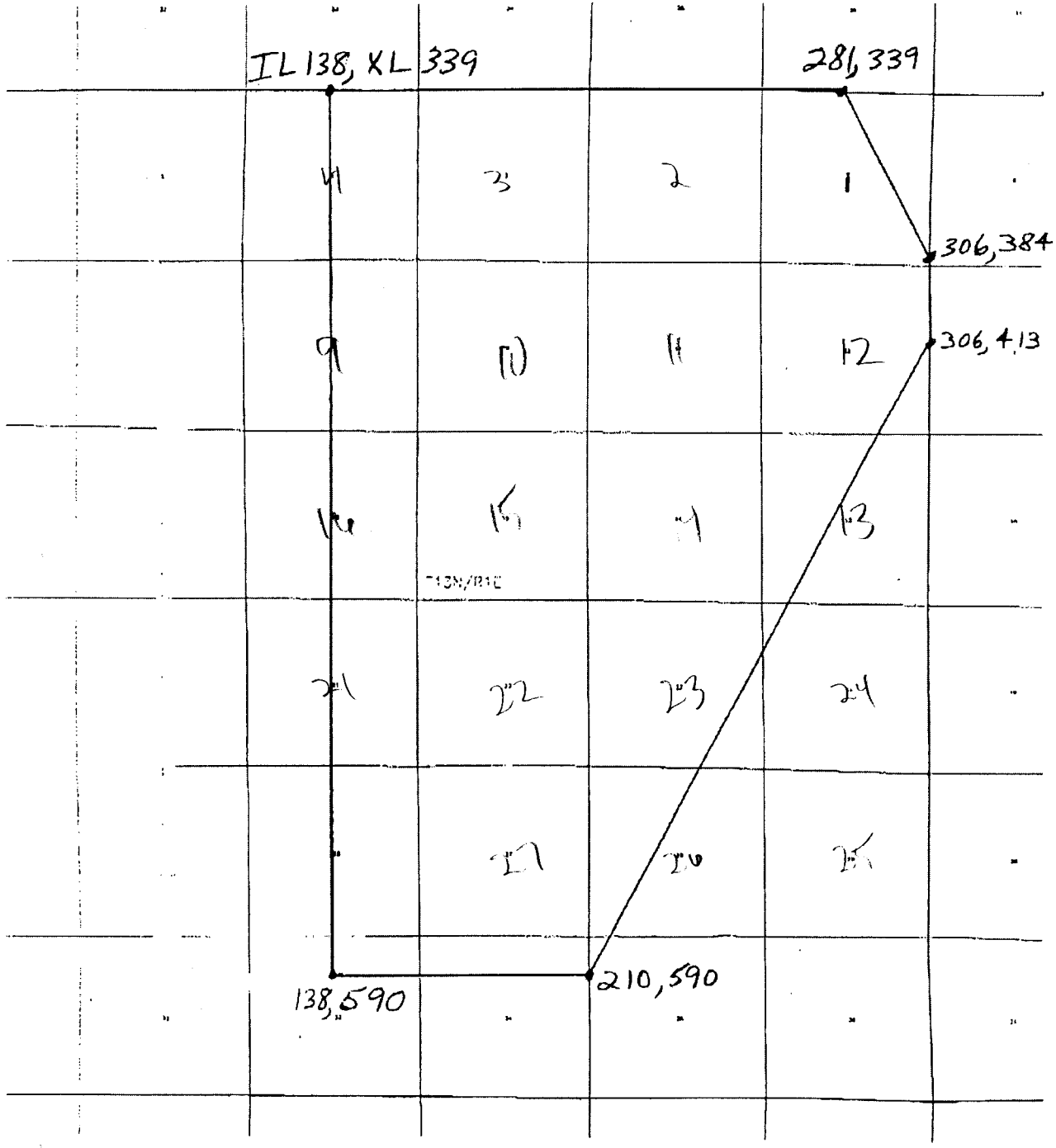
Square Miles: 15

Basin: Sacramento
State: California
Counties: Sutter & Colusa

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Survey #12

YOLO BYPASS 3D

Owner:
Slawson Exploration Company, Inc.

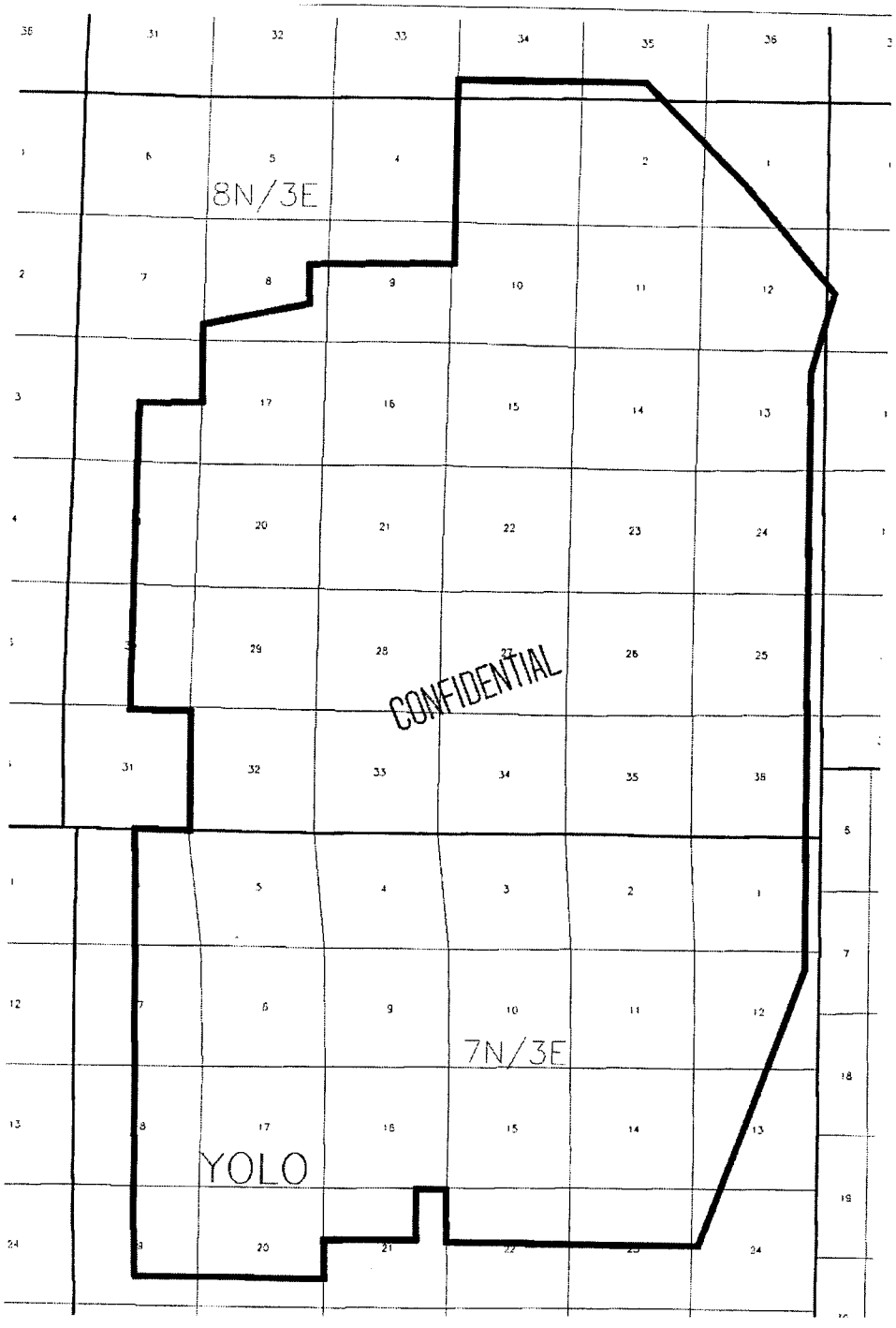
Square Miles: 45.6

Basin: Sacramento
State: California
County: Yolo

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Suite 3100
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Survey #13

STONEY CREEK 3D

Owner:
Crest Oil & Gas, Ltd.

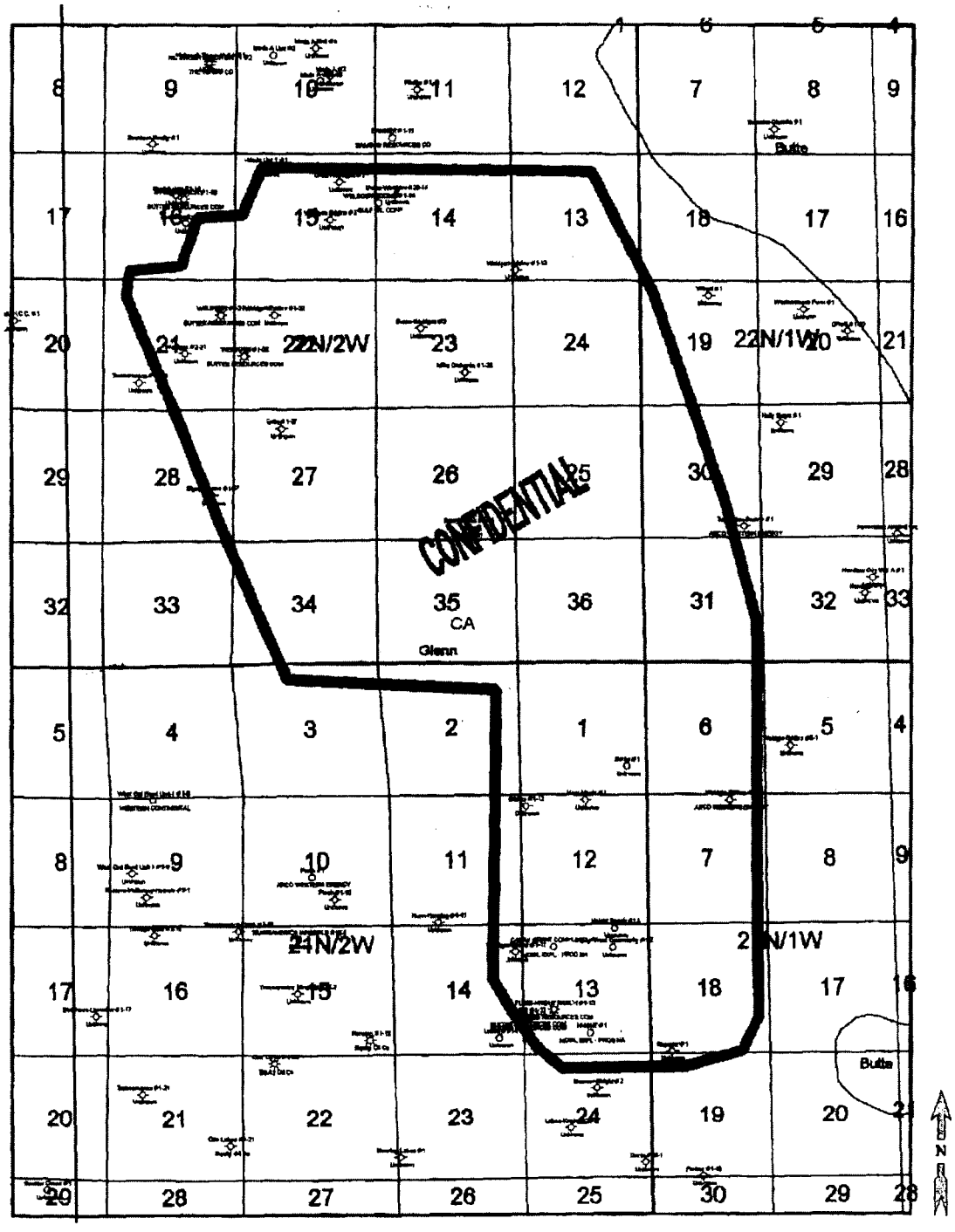
Square Miles: 22

Basin: Sacramento
State: California
County: Glenn

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Survey #14

MERLIN 3D

Owner:
Crest Oil & Gas, Ltd.

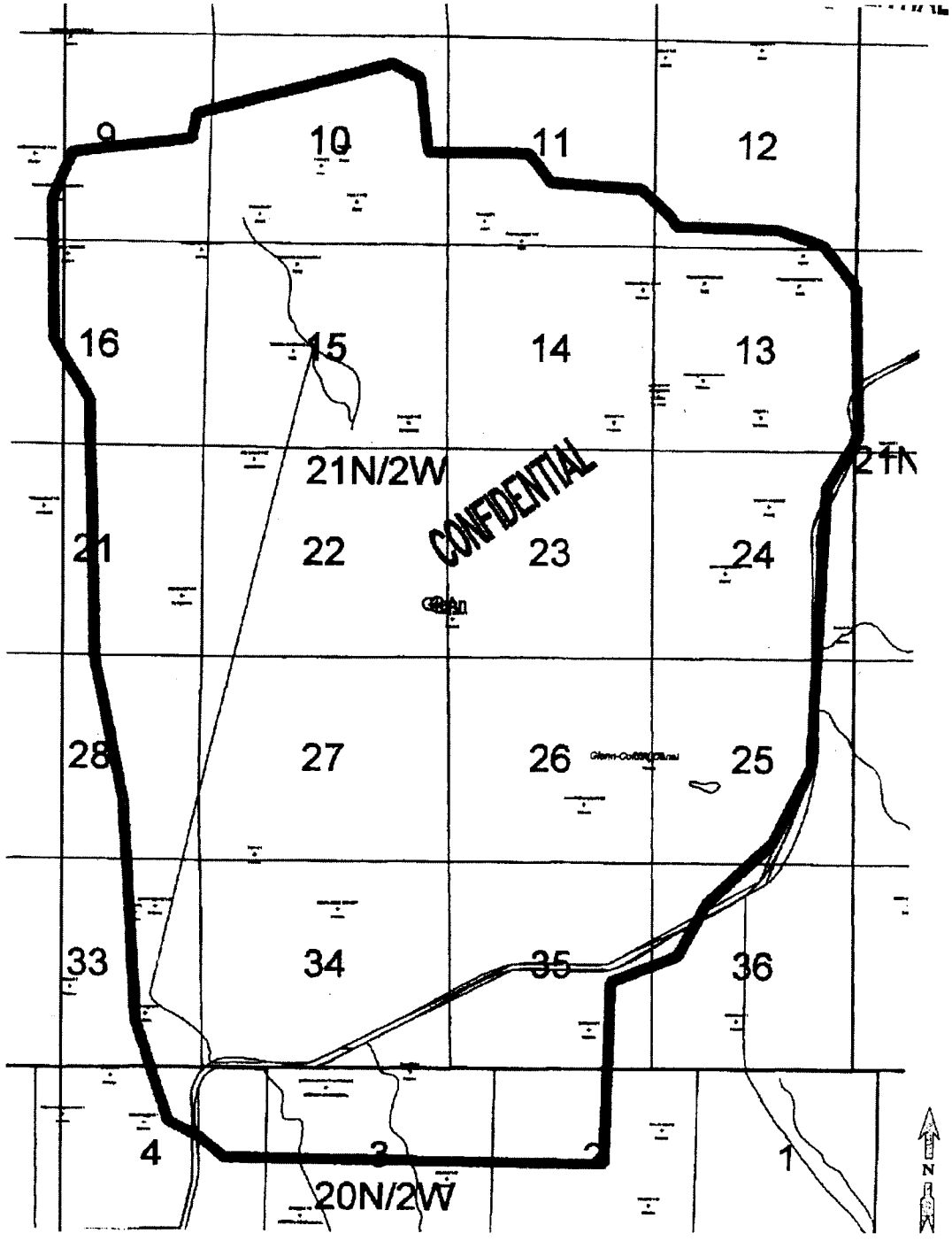
Square Miles: 16

Basin: Sacramento
State: California
County: Glenn

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Survey #15

ARBUCKLE 3D

Owner:
Petrogulf Corporation

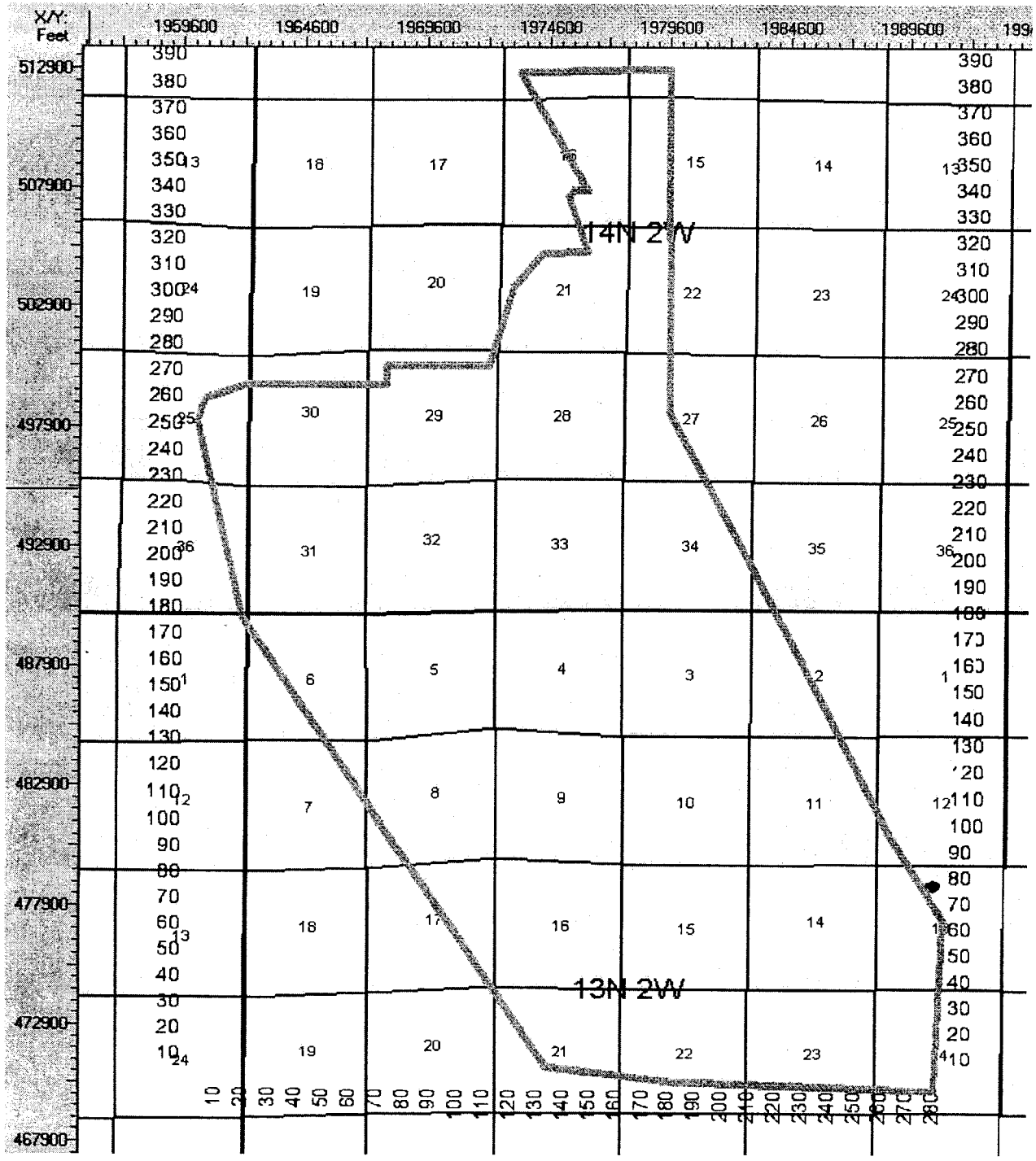
Square Miles: 23.9

Basin: Sacramento
State: California
County: Colusa

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Survey #16

CARSON PASS 3D

Owner:
Lario Oil and Gas Company

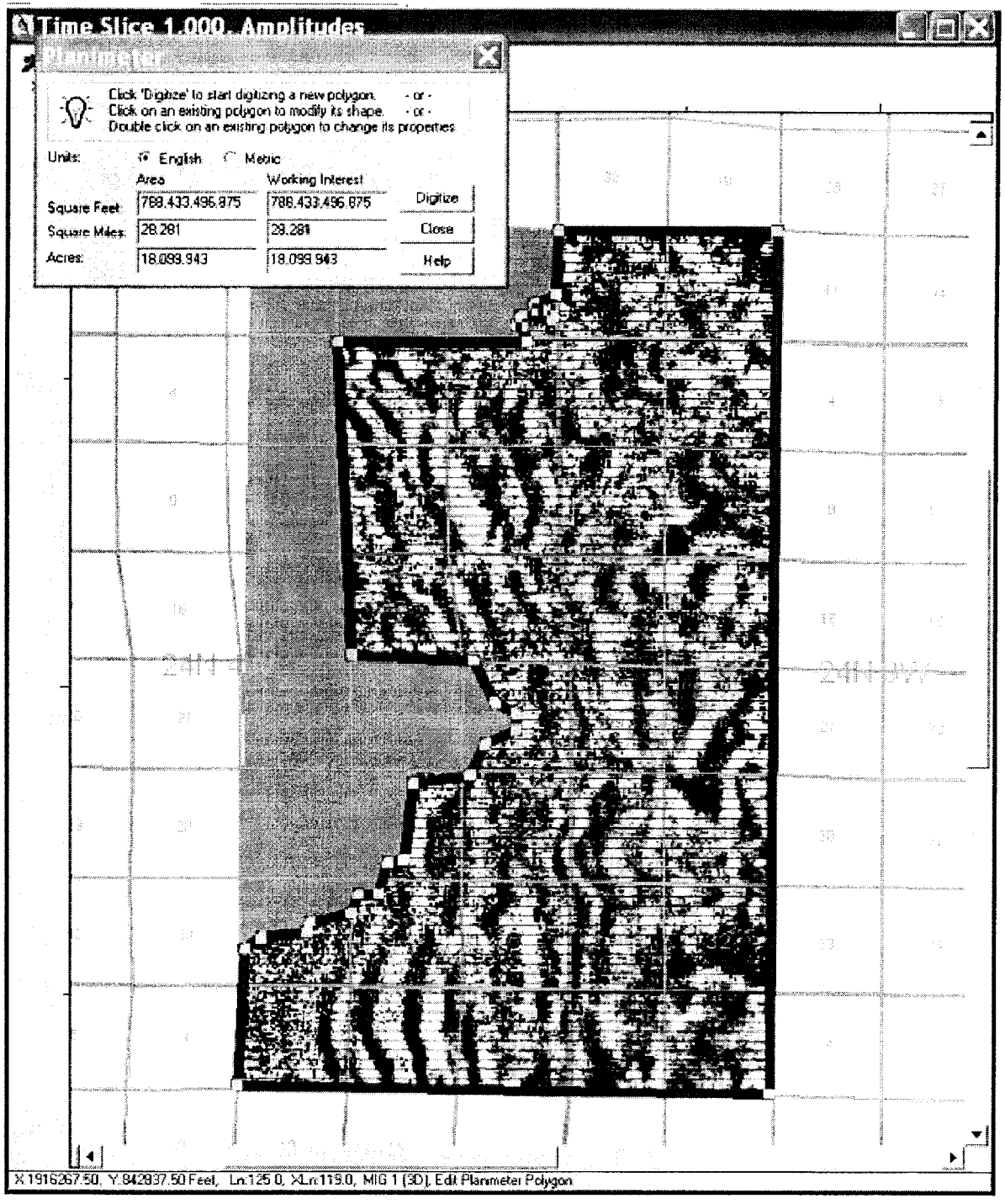
Square Miles: 28.28

Basin: Sacramento
State: California
County: Tehama

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Survey #17

LLANO SECO 3D

Owner:
Lario Oil and Gas Company

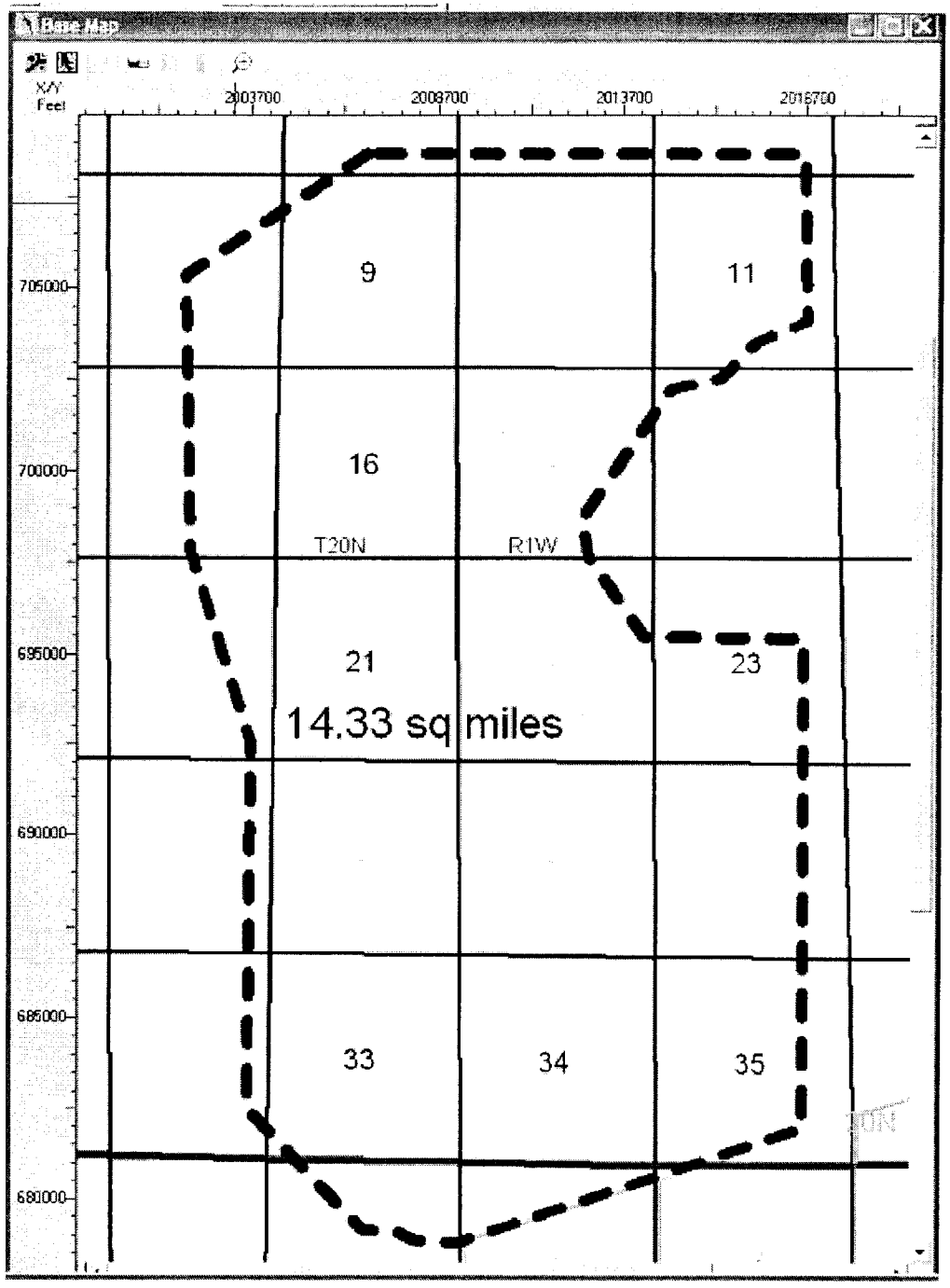
Square Miles: 14.33

Basin: Sacramento
State: California
County: Butte

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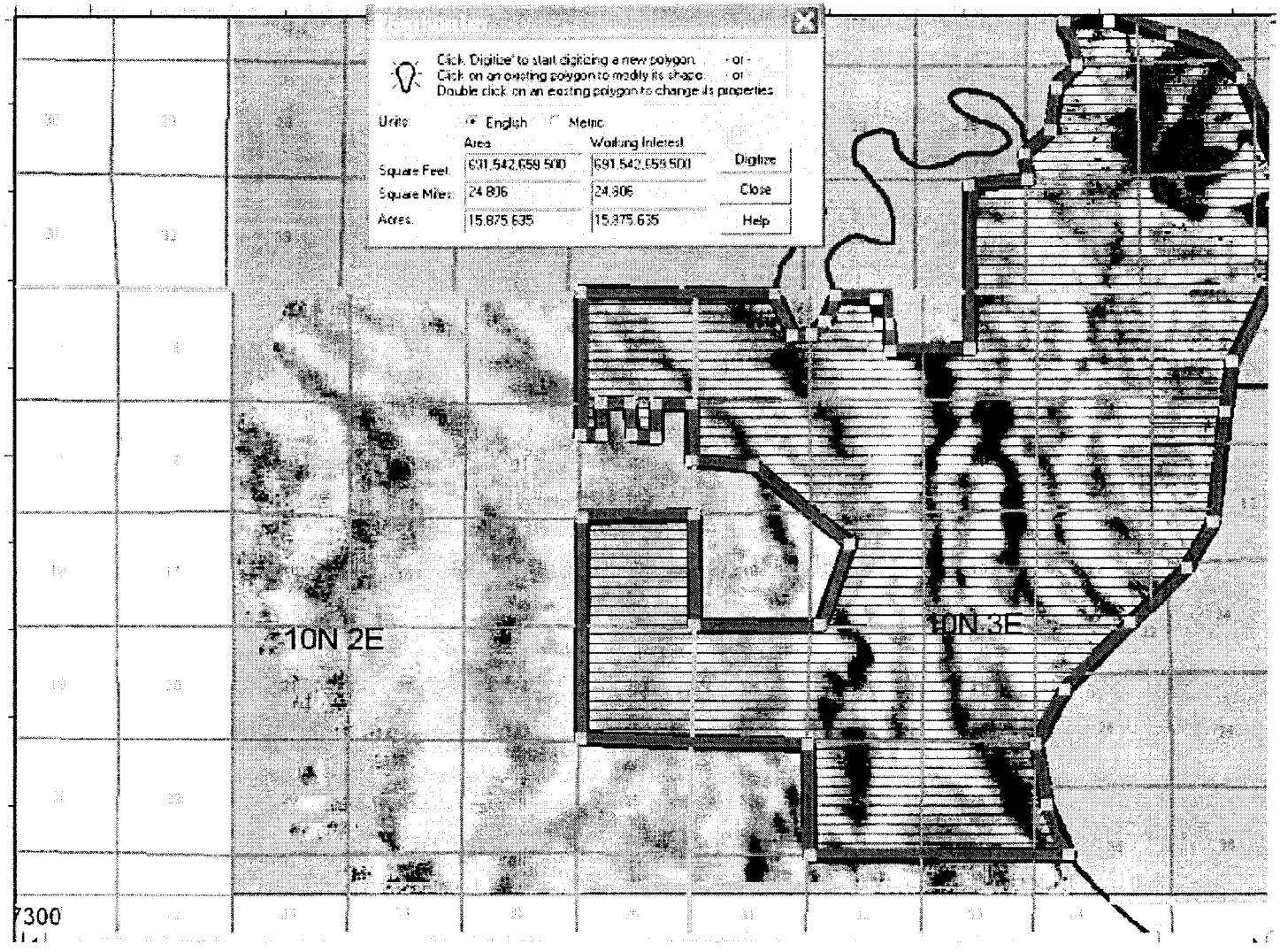
Survey #18

N. CONWAY RANCH 3D

Owner:
Lario Oil and Gas Company

Square Miles: 24.80

Basin: Sacramento
State: California
County: Yolo



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Survey #19

ZAMORA 3D

Owner:
Lario Oil and Gas Company

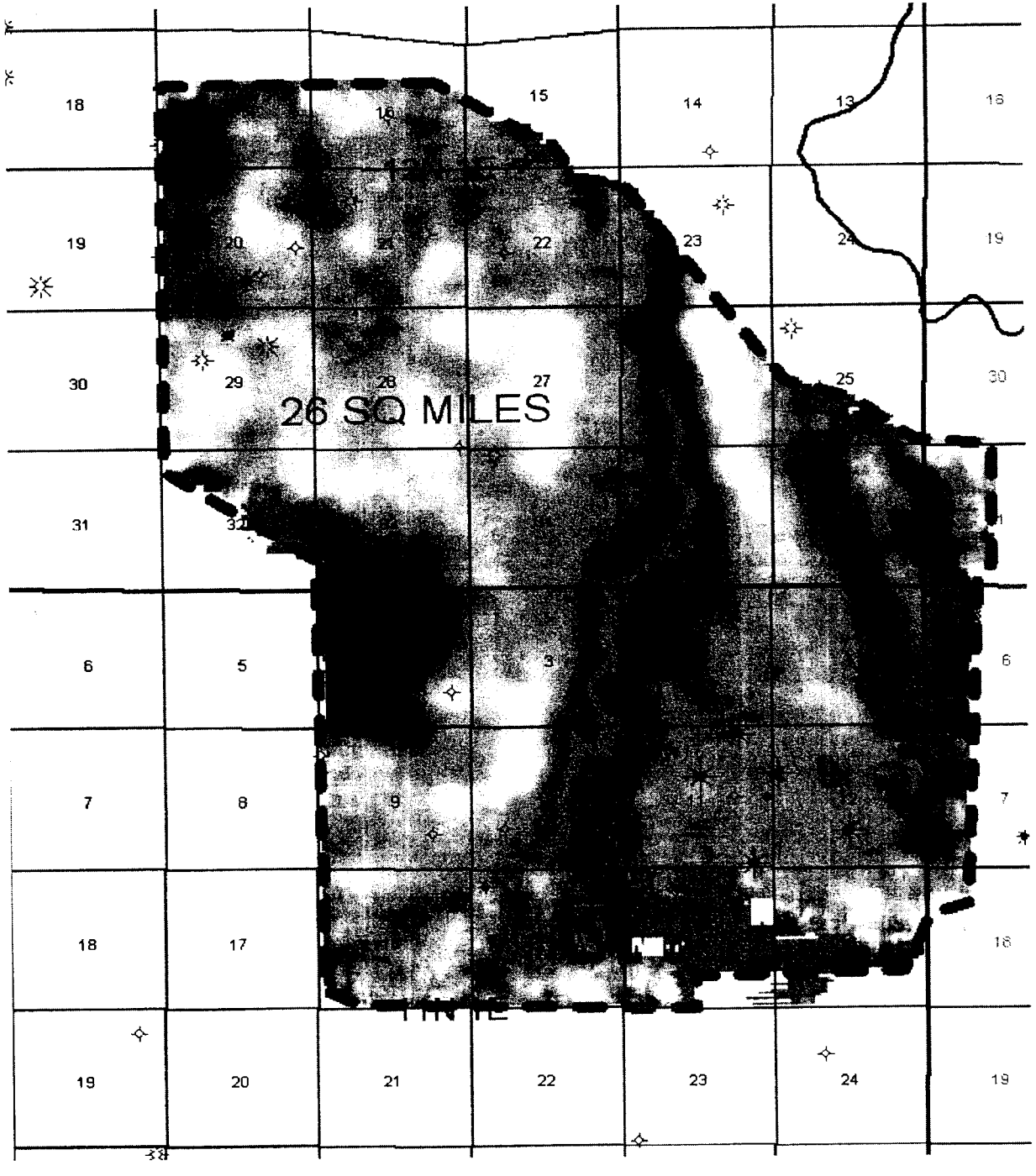
Square Miles: 26

Basin: Sacramento
State: California
County: Yolo

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Survey #20

TODHUNTERS LAKE 3D

Owner: Venoco, Inc.

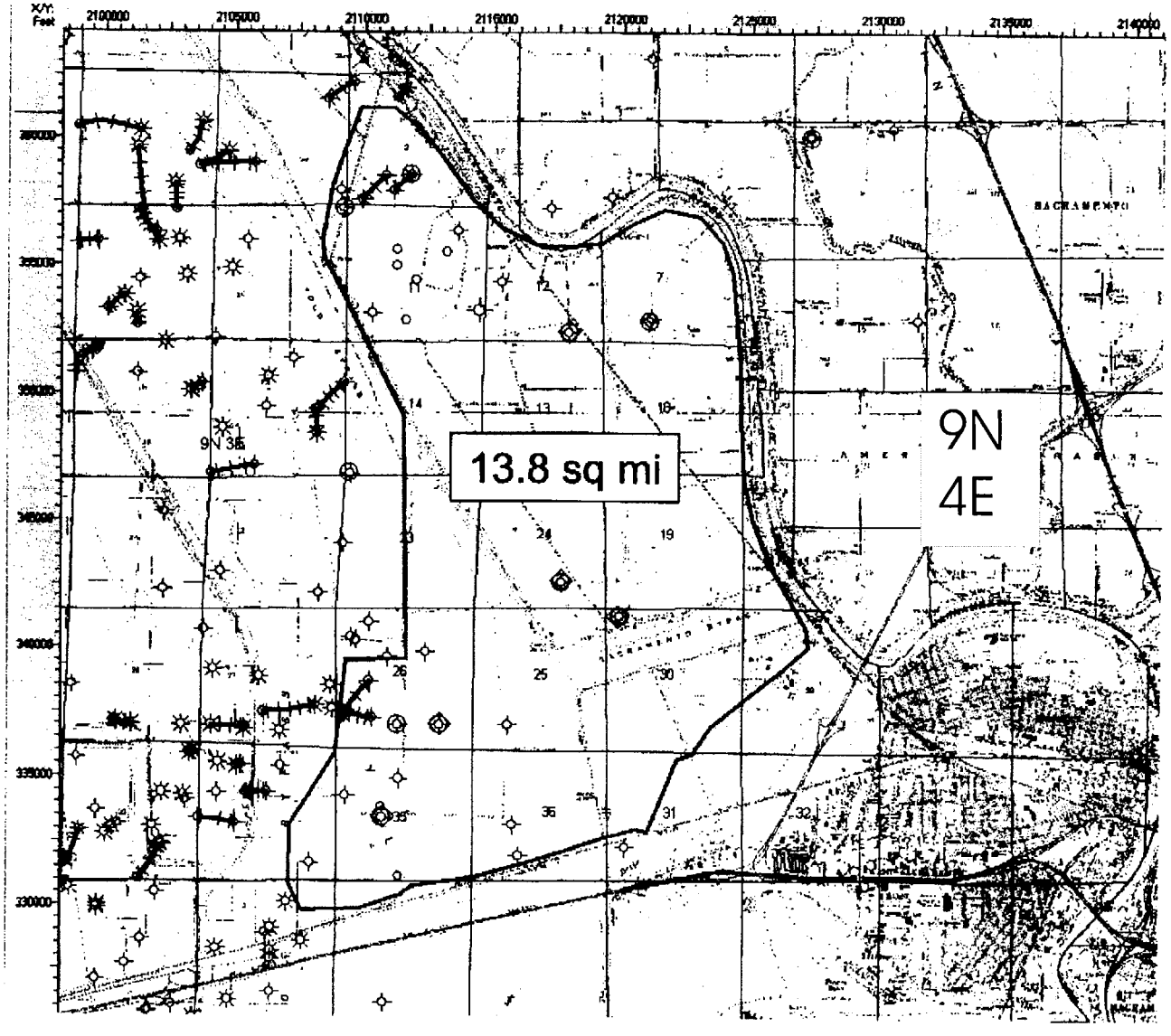
Square Miles: 13.8

Basin: Sacramento
State: California
County: Yolo

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Survey #21

TEJON 3D

Owner: Carneros Energy, Inc.

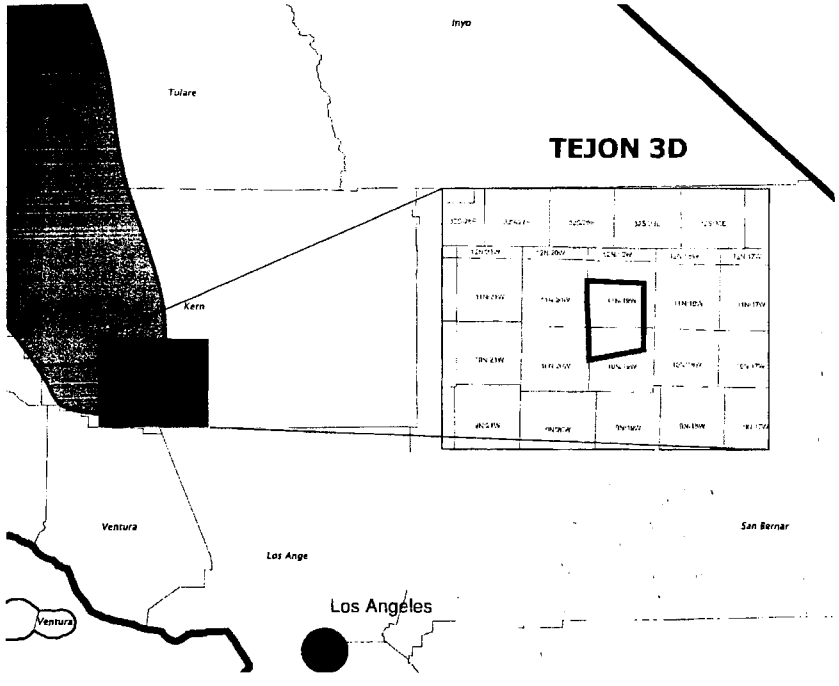
Square Miles: 36

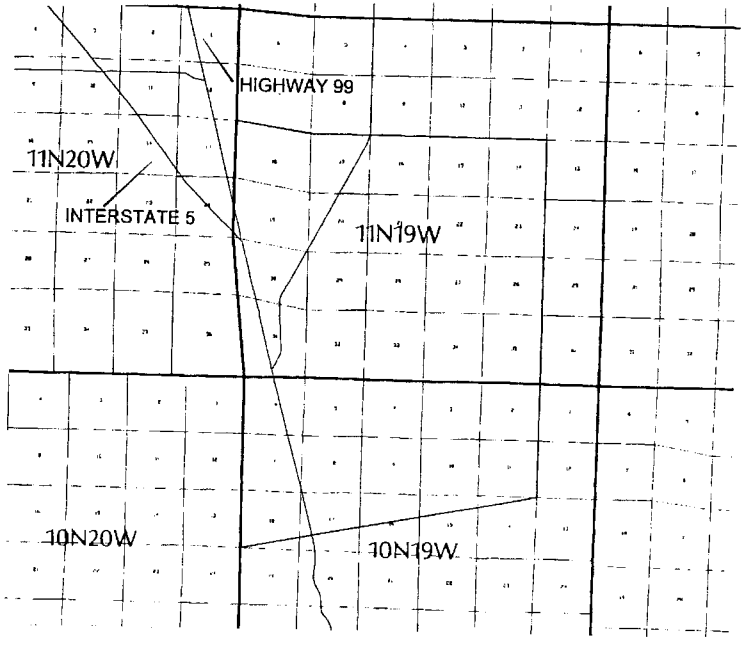
Basin: San Joaquin
State: California
County: Kern

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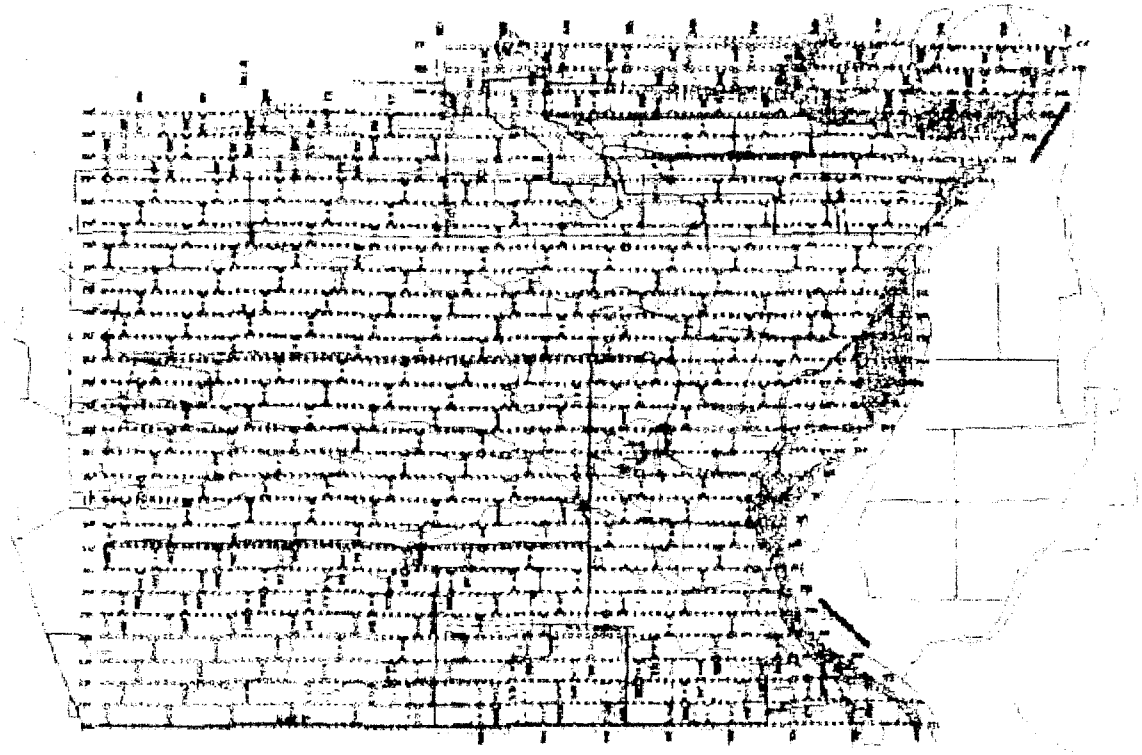
Survey #22

RICE CREEK 3D

Owner: Royale Energy, Inc.

Square Miles: 16

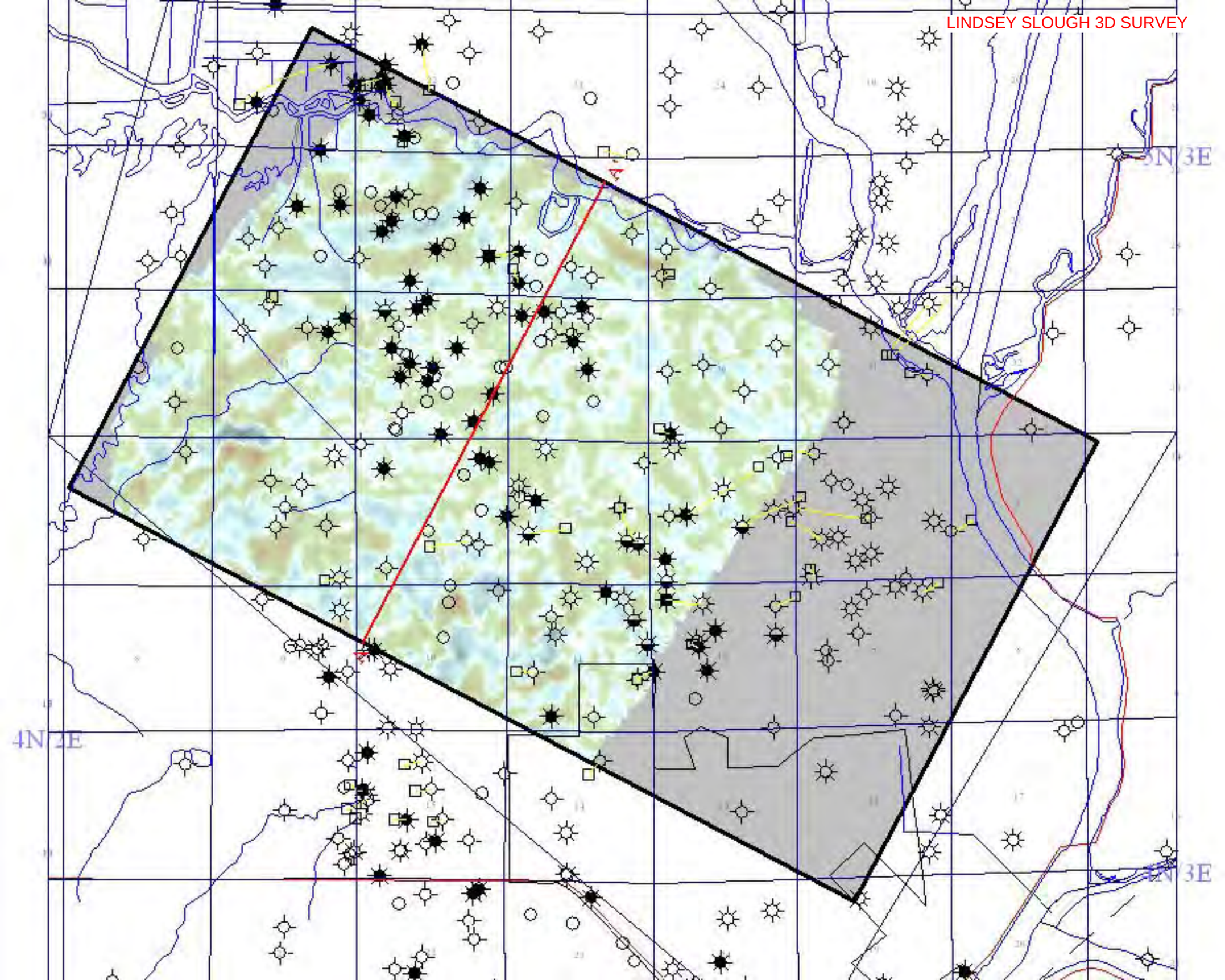
Basin: Sacramento
State: California
Counties: Tehama/Glenn



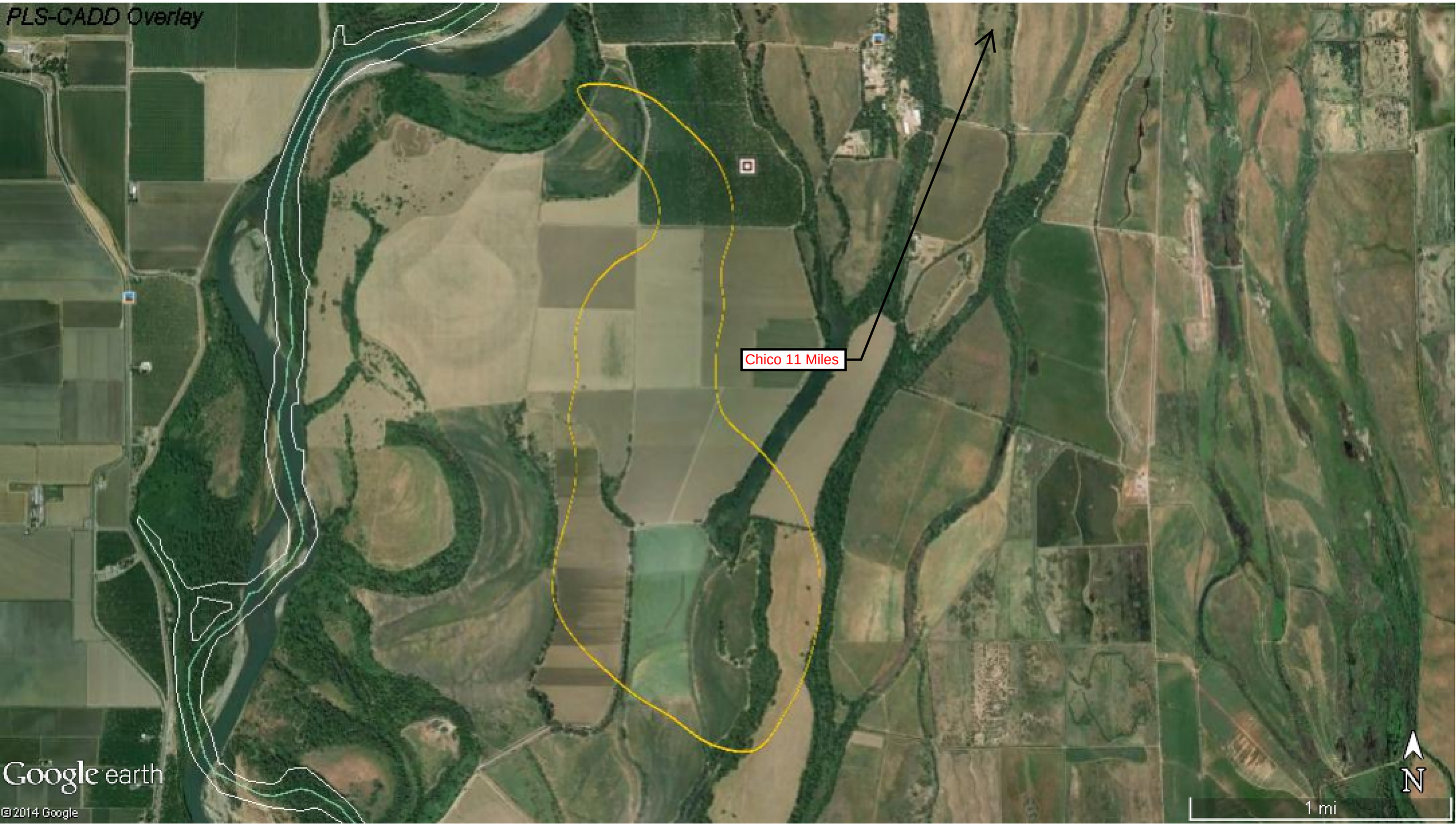
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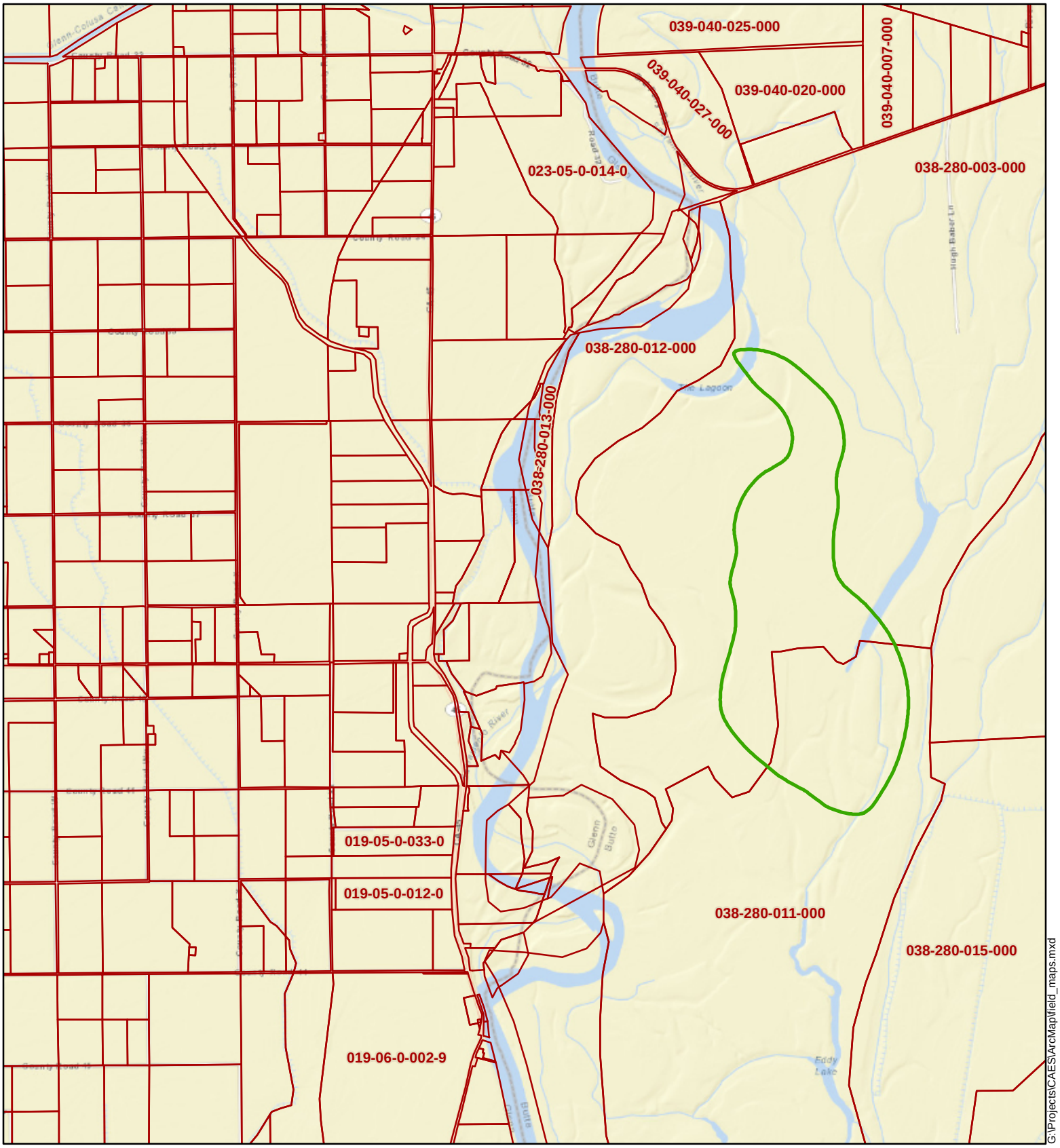
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LINDSEY SLOUGH 3D SURVEY
A
A'
5N/3E
4N/2E
4N/3E

Perkin’s Lake Aerial Map





Perkins Lake

Parcels

Perkins Lake Contour

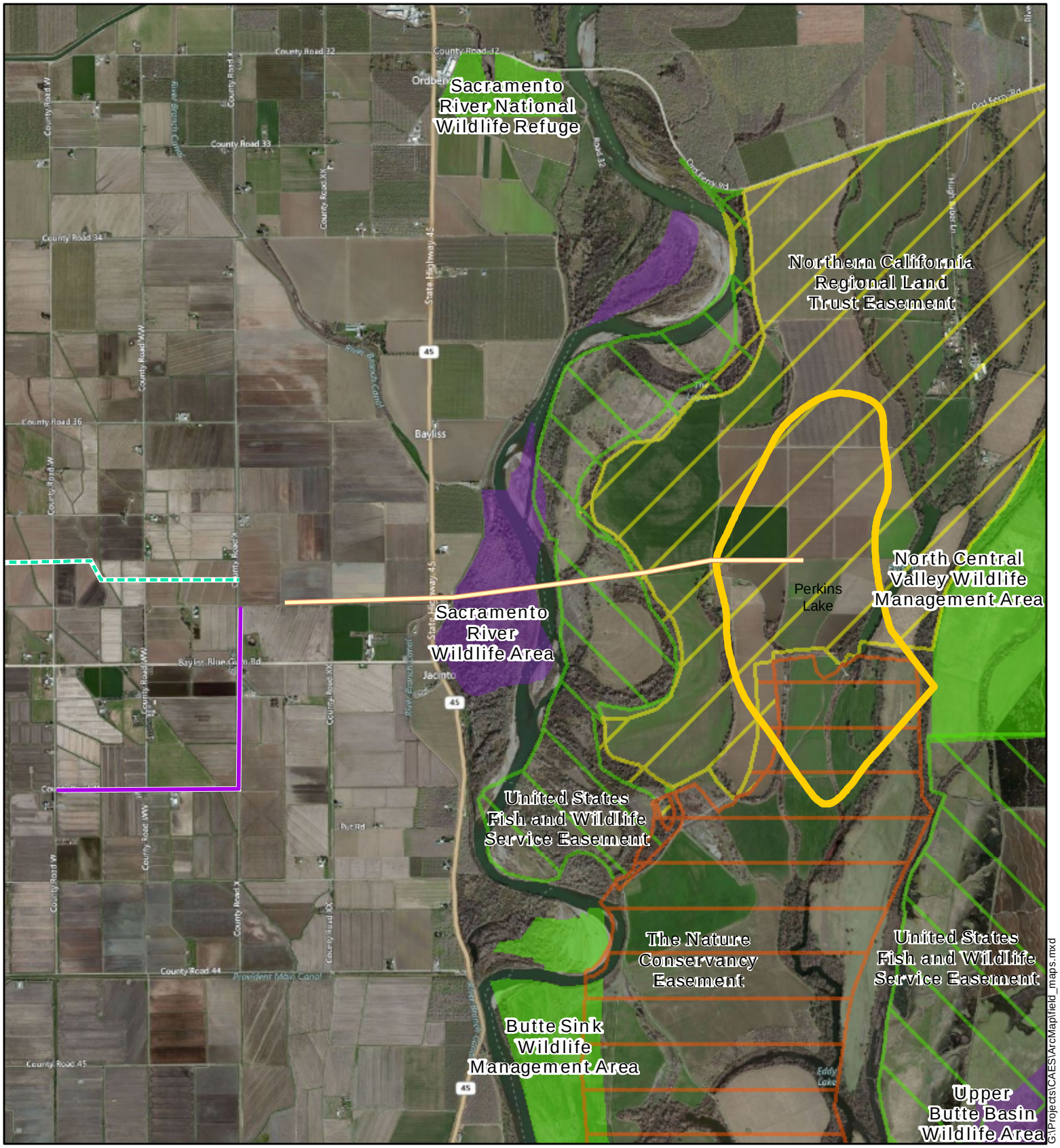
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Feet

G:\Projects\CAES\ArcMap\field_maps.mxd

7/31/2012



Perkins Lake

Approximate Structure Formation

1,500' Buffer

Protected Lands

Federal

State

Conservation Easements

Federal

Non Profit/Special District

Other

Air Pipeline

Gas Pipeline Connection

Gen-Tie

1:45,000

0 1,700 3,400 5,100 6,800

Feet

G:\Projects\CAESVArcMapfield_maps.mxd

7/22/2012

GEOLOGY AND GAS PRODUCTION OF THE PERKINS LAKE GAS FIELD, BUTTE COUNTY, CALIFORNIA

Douglas P. Imperato, Ph.D
Consulting Geologist
Santa Barbara, CA

EXECUTIVE SUMMARY

Nearly 35 BCF of natural gas have been produced from eight wells in the Perkins Lake gas field since the field was discovered in 1955. Production is from Eocene age Princeton canyon fill sandstones and conglomerates at a depth of approximately 3500 feet. The reservoir encompasses an area of 970 acres and has a maximum drilled thickness of more than 170 feet. Log-derived porosity averages 30 percent, with gas saturation of about 75 percent. Gas is entrapped primarily as a result of stratigraphic pinchout of reservoir sandstones and conglomerates into surrounding shale and siltstone. The relatively low pressure of the depleted wells and lack of significant water production indicates a dominant depletion-drive production mechanism.

INTRODUCTION

This investigation includes evaluation of the subsurface stratigraphy, structure, rock properties, and gas production characteristics of the Perkins Lake gas field in Butte County, California. The field is located in the northern Sacramento Valley, about 12 miles southwest of the City of Chico (Attachment 1). The field encompasses an area of approximately six square miles in Township 20 North, Range 1 West (Attachment 2). The field was named after Perkins Lake which is in the eastern part of the field, and the Sacramento River borders the field to the west. The flat terrain of the field surface is at an elevation of about 105 feet and is utilized for farming. Units of the Sacramento River National Wildlife Refuge are located adjacent to the field to the west and the eastern part of the field is within the Llano Seco Unit of the North Central Valley Wildlife Management area.

History of Development

The Perkins Lake gas field was discovered in 1955 by Humble Oil & Refining Company with the completion of the Parrott Investment Company B-1 well in Section 16. After drilling to a depth of 4370 feet, casing was cemented at 3558 feet and gun perforated from 3410 to 3487 feet. Initial production on September 21, 1955 was at a rate of 5741 mcf per day with a tubing pressure of 975 psi and casing pressure of 1205 psi.

Eight more wells were drilled by Humble during the next two years, four of which were completed. The deepest well in the field, the Parrott Investment Company B-6, was drilled in 1956 in Section 16 and reached a total depth of 6500 feet. Various operators drilled several unsuccessful wells in the field during the next 25 years. In the late 1990's, a 3D-seismic survey was acquired over the field, which led to the drilling of five additional wells by Lario Oil & Gas. Three of these were completed as gas wells.

Most of the wells in the field were drilled with a 9-7/8 inch hole to a depth of about 600 feet. Seven inch casing was then cemented to the surface, providing an anchorage for the blowout-prevention equipment. A 6-1/8 inch hole was then drilled through the prospective zones and their potential evaluated by open-hole tests. For productive wells, 4-1/4 inch casing was cemented through the zone and selectively jet or bullet perforated after water shut-off was demonstrated. Well abandonment includes cementing plugs across the perforated interval, at the base of fresh water, and at the surface.

At the time of this report, there were five active producing gas wells in the field, three of the wells originally drilled by Humble during the initial field development, and two of the recent wells originally drilled by Lario. All wells are currently operated by Alanmar Energy, with total field production in March, 2012 at 2392 mcf gas and 8 bbls water. CDOGGR (2010) report cumulative gas production for the Perkins Lake gas field at 34,863 mmcf and 99 bbls water through 2009.

METHODS

This evaluation includes analysis of data from 21 wells drilled in the Perkins Lake gas field and vicinity. Historical records for these wells, on file at the California Division of Oil,, Gas, and Geothermal Resources (CDOGGR), were reviewed and a digital well database was compiled for each well that includes API number, operator, well name, number, status, total depth, elevation, spud date, location, latitude, and longitude (Attachment 3). Latitude and longitude are referenced to the 1927 North America datum. Directional survey data was also compiled for each directional well. Raster well-log images were obtained from commercial sources and the CDOGGR.

Appendix I herein includes (for all eight of the commercial gas wells in the field): 1) a portion of the electric log showing the gas interval and pertinent stratigraphic and production information; 2) a well-history summary; 3) a diagram showing the current wellbore configuration; 4) a production decline curve; and 5) monthly production data in tabular form. The well history summaries were prepared from the CDOGGR well history records and the monthly gas production, water production, and pressure data were compiled from on-line and archive records of the CDOGGR. Well completion and production information, including perforated intervals, initial production rate, and cumulative production for each well, are summarized in Attachment 4. All digital well and production data were input into Landmark Geographix software for data manipulation, cross section preparation, and mapping.

A series of cross sections that included all wells in the study area were prepared and logs were annotated with available perforation information. Producing intervals and pertinent stratigraphic horizons were identified and correlated among all wells. The thicknesses of the gas zones were calculated from spontaneous potential logs, and recorded in the database. A cutoff of 10 millivolts from the shale baseline was used in the net-sandstone calculations. The stratigraphic information was incorporated in the preparation of structure and isochore maps of the gas pool. Reservoir rock property data was compiled from well histories and CDOG publications.

REGIONAL GEOLOGY

The depositional sequence in the Perkins Lake gas field ranges in age from Late Cretaceous to Holocene. Eocene and older rocks were deposited in a marine environment, whereas younger rocks represent continental deposition. A basalt flow about 200 feet thick is present near the base of the Tehama Formation in the southeastern part of the field. A generalized stratigraphic column for the field indicating age and approximate thickness of units is as follows:

Alluvium	Holocene	150 feet
Tehama Formation	Pliocene	2100 feet
Princeton canyon fill	Eocene	1100-1800 feet
Kione Formation	Upper Cretaceous	0-600 feet
Forbes Formation	Upper Cretaceous	1500 feet
Dobbins Shale	Upper Cretaceous	400 feet
Guinda Formation	Upper Cretaceous	500 feet

The crystalline basement rocks in the Perkins Lake area dip to the west at an estimated depth of approximately 8500 feet below sea level. The Perkins Lake sands that form the gas reservoir for the Perkins Lake gas field are part of the Eocene age Princeton canyon fill deposits. These Eocene sediments consist of shale, siltstone, conglomerates, and lenticular sandstones. The Princeton canyon is one of four distinct submarine canyons in the Sacramento valley that were developed during periods of uplift in Paleogene time. Redwine (1972) concluded that the Princeton canyon was cut and filled between the late Paleocene and early Eocene. These marine deposits grade northward and eastward into alluvial deposits derived from the northern Sierra Nevada. Throughout most of the Perkins Lake gas field, Princeton canyon fill deposits are 1500

to 2000 feet thick (Attachment 5). They are thinnest along the eastern and southeastern margins of the field, and thicken abruptly to the west and northwest. The thicker deposits correspond with areas of greater down-cutting of the submarine canyon.

Major unconformities in the Perkins Lake gas field depositional sequence are present at the base of the Pliocene Tehama Formation and at the base of the Eocene Princeton canyon fill. The base of fresh water in the field is at a depth of 1500 feet, which corresponds with the lower part of the Tehama Formation.

The Perkins Lake gas field is located on the gently west-dipping eastern margin of the Sacramento basin (Harwood and Helley, 1987). The Willows fault system, a major structural feature of the Sacramento valley, is located about eight miles to the west. This steeply east-dipping fault exhibits reverse separation in Late Cretaceous strata that decreases upward. The Chico monocline fault, another major structural feature, is located about 15 miles northeast of the field.

In the vicinity of the Perkins Lake gas field, the pre-Eocene unconformity surface (the base of the Princeton canyon fill) dips steeply northward and westward in the southern and eastern margins of the field, respectively (Attachment 6). This surface dips gently northward throughout most of the field. The pre-Pliocene unconformity surface (base Tehama Formation), in contrast, dips northeastward throughout most of the field, and is folded in a broad syncline with a northeast-striking axis (Attachment 7).

RESERVOIR STRATIGRAPHY

The Princeton canyon fill deposits that form the gas reservoir at Perkins Lake consist of conglomerates and sandstones locally interbedded with siltstones (Attachments 8 and 9, Appendix I). These deposits are completely encased in shale and siltstone, as the coarse-grained lithologies are not present in the correlative interval in surrounding wells. Sandstones are poorly sorted, medium grained, gray, soft and friable. Carbonate-cemented sandstone beds are present locally. Conglomerates are brownish gray, soft and poorly consolidated. Pebbles are 1/8 to 3/8-inches in diameter, angular to sub-rounded, and are composed of gray to black metamorphic rocks, brownish yellow chert, smoky quartz, and greenstone. Siltstone is medium gray, firm, with mica flakes and lignite. The shale that encases the reservoir is dark gray, firm, and fissile interbedded with very thin siltstone.

The Perkins Lake gas reservoir has a lobate geometry, elongate in the north-south direction, with a maximum gross thickness of more than 170 feet (Attachment 10). The reservoir reaches a maximum width of about 5500 feet in the south part of the field, and encompasses an area of about 970 acres. The reservoir thickness is asymmetric, with a thick trend along the western margin of the reservoir. The gross interval thickness was measured from the top of the highest reservoir sandstone to the base of the lowest reservoir sandstone.

Net-sandstone isochores of the Perkins Lake gas reservoir have a similar geometry as the gross interval isochores (Attachment 11). Net sandstone thickness is about 75 feet in the north part of the field and increases to a maximum of more than 100 feet thick in the south part of the field, although net-to-gross ratios are higher at the north end of the field and decrease southward. The thickest reservoir was encountered in the B-1 field discovery well, which has a gross and net thickness of 173 and 111 feet respectively. A marked decrease in sandstone content is present in the B-4well located on the eastern margin of the central part of the reservoir. This well has a gross and net thickness of 55 and 12 feet respectively. The net sandstone values only include those that sandstones that are above the elevation of the original gas-water content in the field (see below).

STRUCTURE

The structure of the Perkins Lake reservoir is difficult to delineate due to the absence of a well-defined horizon that can be correlated throughout the field. A structure-contour of a mid-Princeton canyon fill electric-log marker horizon, about 400 feet above the Perkins Lake sands ("blue" horizon shown on Attachments 8 and 9) shows that the Eocene strata in the vicinity of the field form a broad north-plunging anticline (Attachment 12). The regional westerly dip is not apparent. This geometry is not likely a result of tectonic folding, but more likely a result of differential compaction; compaction of the thick sandstone and conglomerate sequence that forms the reservoir is much less than the surrounding shale.

A structure-contour map of the top of the upper-most Perkins Lake sandstone similarly does not appear to reflect tectonic structure (Attachment 13). The elevation of the top of the reservoir appears to be stratigraphically controlled, with the higher elevations generally corresponding with the thicker intervals of sandstone and conglomerate. The notable exception is the structural high on the western margin of the central part of the reservoir that may reflect faulting.

The lower-most sandstones in the southern part of the field, where the reservoir is thickest, appear to define a water table at an elevation of approximately -3380 feet subsea. The B-1 discovery well tested water in the sandstone at the base of the reservoir, and this water table can be observed in later wells drilled in this part of the field (Appendix I). Throughout most of the field, the base of the Perkins Lake reservoir is above this elevation.

RESERVOIR ROCK PROPERTIES

Log-derived porosity for the Perkins Lake reservoir averages approximately 30 percent (California Division of Oil and Gas, 1998). Gas saturation is approximately 75 percent, and the gas has a heating value of 950 Btu (California Division of Oil and Gas, 1998). Eocene age Princeton canyon fill strata have consistent porosity and saturation values where they form the reservoir in the nearby Greenwood, Willows, Llano Seco, and Bounde Creek fields. Permeability measurements are not available for the Eocene strata in any of these fields.

GAS PRODUCTION

Production records from the California Division of Oil, Gas, and Geothermal Resources archives indicate that a total of 34,397 Mmcf gas and 23 Mbbls water have been produced from the eight gas wells in the Perkins Lake gas field (Attachment 4 and Appendix I). Nearly all of this gas is from the Eocene age Princeton canyon fill reservoir. A total of 118 mmcf was produced from the Late Cretaceous Forbes Formation in the Lario Volcano 1 well. Nearly all of the field production was from the original wells drilled by Humble in the 1950's. The wells drilled after 1956 produced a combined total of 819 Mmcf.

Initial production rates for most wells exceeded 4000 mcf per day, and two wells had rates above 5500 mcf per day. During the first few years of field production, average monthly production rates in most wells exceeded 3000 mcf per day, and rates of more than 2000 mcf per day were sustained for several years (Appendix I).

The history of gas and water production indicates that the Princeton canyon fill reservoir has a pressure depletion production mechanism. The initial reservoir pressure of 1450 psi has declined to near zero, and very little water has been produced in the field. This drive mechanism is consistent with reservoir geology; reservoir sandstones and conglomerates are completely encased in impermeable shale, with no connection to a significant source of water.

The more recent drilling in the field confirms that the long history of gas production from the early Humble wells has resulted in a depleted reservoir with extremely low pressure but with little to no water incursion. In 1984, the B-11 well encountered depleted Perkins Lake sands that exhibited no mud log show (depletion) but with high resistivity, indicative of an absence of significant water in the reservoir. The well appears to have been a test of deeper zones, as the Eocene sands were not tested before the well was plugged. The A-1 well drilled in 1991 similarly encountered a thick section of depleted Perkins Lake sands with no mudlog show and high resistivity. The well was plugged after formation tests were conducted (results not available). The A-2 well had similar results. Significant gas shows were recorded in this well in Princeton Canyon fill sandstones below the elevation of the original reservoir gas-water contact.

Three wells drilled by Lario in 1998 and 1999 had commercial production from Princeton canyon fill deposits correlative with Perkins Lake reservoir. The Fins well appears to have encountered a small isolated reservoir of Princeton canyon fill deposits on the margin of the main Perkins Lake reservoir, as the well encountered high reservoir pressure, had a significant mud log show, and produced a relatively high volume of gas (463 mmcf). The relatively low cumulative production volumes and lack of mud log show in the Volcano and Pirate wells indicates that these wells encountered small, partially depleted portions of the Perkins Lake reservoir. The Margaritaville well in 1999 encountered the depleted Perkins Lake reservoir depleted (no mud log show) with little to know water incursion (high resistivity), and the well was plugged with no completion attempt.

Reservoir Volumetrics

The Perkins Lake gas field reservoir has a maximum drilled gross thickness of 173 feet and encompasses an area of approximately 967 acres. The B-1 discovery well appears to have penetrated the gas pool at, or near, the area of maximum reservoir thickness.

The gross reservoir volume is estimated at 79,425 acre-feet (3.46×10^9 ft^3), and the net reservoir volume is estimated at 48,270 acre-feet (2.10×10^9 ft^3). The net reservoir volume only includes the volume of the reservoir above the elevation of the gas-water contact. The overall ratio of net-to-gross volume for the reservoir is 0.61. With a total production of 34,397 Mmcf, the recoverable "richness" (total production divided by the net reservoir volume) of this pool is calculated at 713 mcf/acre-ft.

REFERENCES

California Division of Oil and Gas, 1998, California Oil and Gas Fields, Central California: California Department of Conservation, Division of Oil, Gas, and Geothermal Resources Publication TR10.

California Division of Oil, Gas, and Geothermal Resources, 2010, 2009 Annual Report of the State Oil and Gas Supervisor: California Department of Conservation, Division of Oil, Gas, and Geothermal Resources Publication PR06.

Harwood, D.S., and Helley, E.J., 1987, Late Cenozoic tectonism of the Sacramento Valley, California: U.S., Geological Survey Professional Paper 1359, 46 p.

Redwine, L. E, 1972, The Tertiary Princeton submarine valley system beneath the Sacramento Valley, California: Los Angeles, University of California, PhD. Dissertation, 480 p.

ATTACHMENTS

1. Regional map of the Sacramento Valley showing regional geography, gas fields and the location of the Perkins Lake gas field.

2. Base map showing the gas field boundary, wells, cumulative gas production in each well, cross section locations, and the outline of the reservoir.

3. List of Perkins Lake gas field project wells including API number, operator, well name, well number, latitude and longitude (NAD 1927), well status, spud date, total depth, and elevation.

4. Perkins Lake gas field production summary including productive interval, initial production rate, shut in pressure, gas production, and water production for each gas well.

5. Isochore map of the Princeton canyon fill.

6. Structure-contour map of the pre-Eocene unconformity (base Princeton canyon fill).

7. Structure-contour map of the pre-Pliocene unconformity (base Tehama Formation).

8. Cross section X-X’ longitudinal down the axis of the Perkins Lake reservoir.

9. Cross Section Y-Y’ across the southern part of the Perkins Lake reservoir.

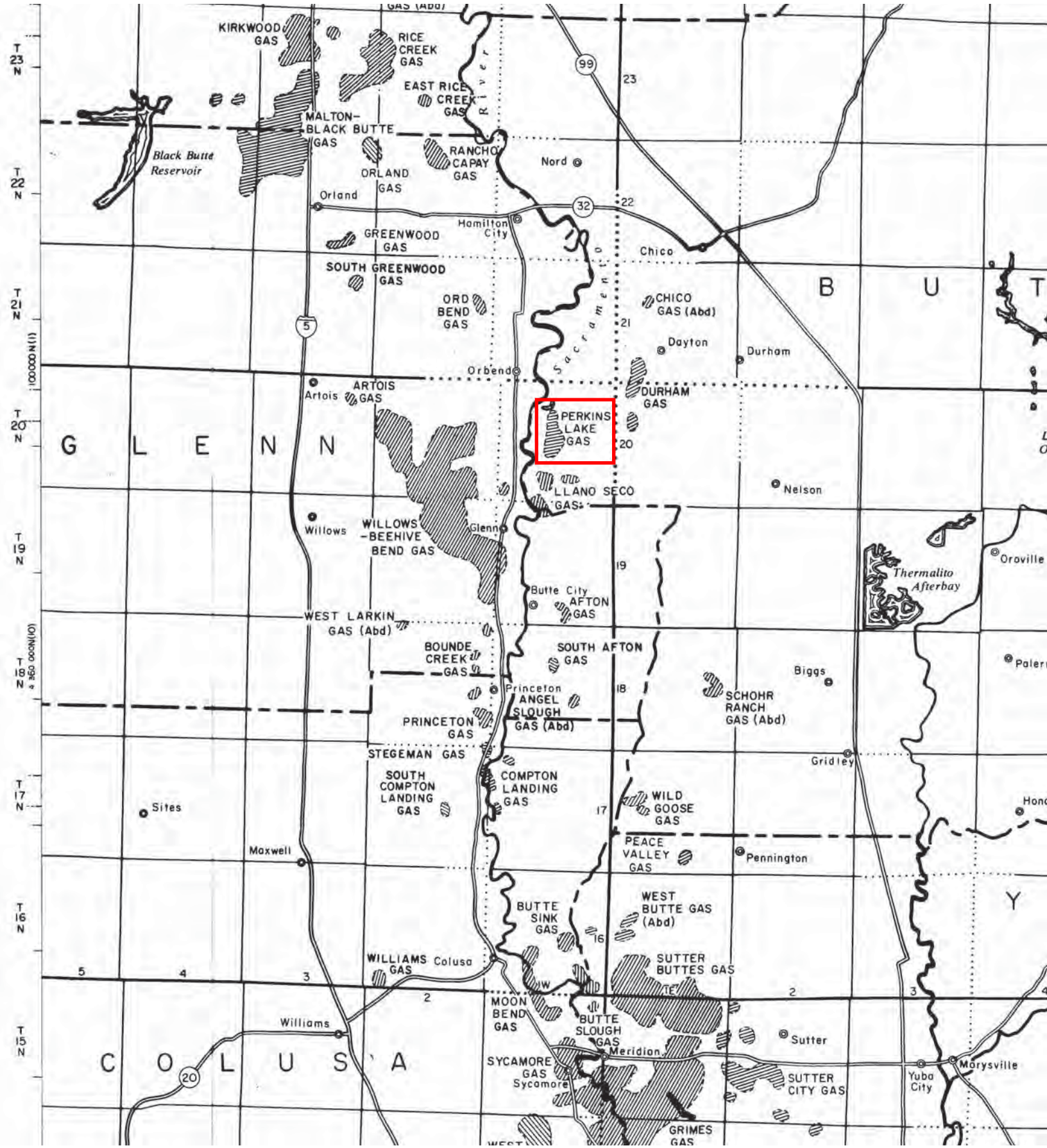
10. Gross isochore map of the Perkins Lake reservoir.

11. Net-sandstone isochore map of the Perkins Lake reservoir.

12. Structure-contour map of a mid-Princeton canyon fill horizon (“blue”).

13. Structure-contour map of the top of the Perkins Lake reservoir.

ATTACHMENT 1



ATTACHMENT 2

Pacific Gas and Electric Company
CAES PROJECT

Perkins Lake Gas Field
Base Map

Author:		Date:
dpi		8 July, 2012
	Units: Feet	

2000 0 2000 ft

N

ARNOLD1
REAGER1
ORD FERRY1-5
LAST MANGO1-3
COOPER5-1
VOLCANO1-9
234,290
CHEESEBURGER1-10
463,451
FINS2-9
PARROTT INVESTMENT CO.B-10
PARROTT INVESTMENT CO.B-2
PARROTT INVESTMENT CO.B-7
6,060,099
CAPITAL CO.D-1
121,788
PIRATE1-16
PARROTT INVESTMENT CO.B-11
PARROTT INVESTMENT CO.B-6
PARROTT2
PARROTT INVESTMENT CO.B-4
8,127,718
SECTION 31-UNIT1
PARROTT RANCHA-3
PARROTTA-1
8,294,988
PARROTT INVESTMENT CO.B-1
3,272,301
PARROTT INVESTMENT CO.B-5
PARROTT1
PARROTTA-2
MARGARITAVILLE1-21
PARROTT INVESTMENT CO.B-3
7,821,921
EXXON-PARROTT23-1
PARROTT INVESTMENT CO.B-1
PARROTT INVESTMENT CO.B-9
LLANO SECO2
NEAVES-PARROTT INV.5
BUTTE LLANO SECO2
PARROTT INV. CO.8A
NEAVES-PARROTT INV.2
NEAVES-PARROTT INV.4
PARROTT INVESTMENT CO.B-2
DELTA T.D.C.1-54
URICH OIL - PARROTT2
15577
NEAVES-PARROTT INV.6
BUTTE LLANO SECO1
BUTTE LLANO SECO3
PARROTT INV. CO.3-A

ATTACHMENT 3

PERKINS LAKE PROJECT WELLS

API NO.	OPERATOR	WELL NAME	NO.	LAT 27	LONG 27	STATUS	SPUD	TD	ELEV	
04007000370000	ALANMAR ENERGY	PARROTT INVESTMENT CO.	B-1	39.580462	-121.970044	GAS	8/30/1955	4370	109	KB
04007000390000	ALANMAR ENERGY	PARROTT INVESTMENT CO.	B-3	39.573239	-121.968281	GAS	11/11/1955	3870	114	KB
04007000400000	ALANMAR ENERGY	PARROTT INVESTMENT CO.	B-4	39.587348	-121.969002	AGS	11/28/1955	3700	120	KB
04007000410000	ALANMAR ENERGY	PARROTT INVESTMENT CO.	B-5	39.580121	-121.960236	AGS	12/15/1955	4123	119	KB
04007000420000	ALANMAR ENERGY	PARROTT INVESTMENT CO.	B-6	39.587617	-121.979933	P&A	5/9/1956	6500	122	KB
04007000430000	ALANMAR ENERGY	PARROTT INVESTMENT CO.	B-7	39.59686	-121.966472	GAS	7/10/1956	3990	121	KB
04007000380000	ALANMAR ENERGY	PARROTT INVESTMENT CO.	B-2	39.600682	-121.94718	P&A	10/1/1956	4722	121	KB
04007000440000	ALANMAR ENERGY	PARROTT INVESTMENT CO.	B-9	39.568184	-121.981313	P&A	2/27/1957	4500	118	KB
04007000450000	ALANMAR ENERGY	PARROTT INVESTMENT CO.	B-10	39.598612	-121.976491	P&A	3/16/1957	4500	124	GR
04007200220000	BOB SPREEN, OPERATOR	PARROTT INVESTMENT CO.	B-1	39.57116	-121.954096	P&A	9/30/1969	5400	121	KB
04007200680000	ALANMAR ENERGY	PARROTT INVESTMENT CO.	B-11	39.58883	-121.97513	P&A	7/20/1984	6180	130	KB
04007200690000	DEKALB ENERGY CO.	PARROTT	1	39.580518	-121.952698	P&A	5/24/1988	4538	104	KB
04007200700000	DEKALB ENERGY CO.	PARROTT	2	39.587594	-121.98383	P&A	6/1/1988	3993	105	GR
04007200800000	ALANMAR ENERGY	PARROTT	A-2	39.578894	-121.975486	P&A	10/4/1991	3800	120	KB
04007200790000	ALANMAR ENERGY	PARROTT	A-1	39.581637	-121.964635	P&A	10/11/1991	3800	120	KB
04007200810000	ALANMAR ENERGY	PARROTT RANCH	A-3	39.583475	-121.987153	P&A	11/14/1992	4000	122	KB
04007200860000	LARIO OIL & GAS CO.	VOLCANO	1-9	39.605066	-121.973847	GAS	12/18/1998	5587	122	KB
04007200880000	LARIO OIL & GAS CO.	FINS	2-9	39.599465	-121.970591	AGS	2/23/1999	4222	120	KB
04007200890000	LARIO OIL & GAS CO.	CHEESEBURGER	1-10	39.601535	-121.960946	P&A	3/6/1999	4221	115	KB
04007200900000	LARIO OIL & GAS CO.	PIRATE	1-16	39.590401	-121.973945	GAS	4/15/1999	3900	116	KB
04007200870000	LARIO OIL & GAS CO.	MARGARITAVILLE	1-21	39.575355	-121.971598	P&A	5/3/1999	3850	111	KB

ATTACHMENT 4

PERKINS LAKE GAS FIELD
PRODUCTION SUMMARY

APINUM	WELL NAME/NO.		SPUD DATE	ABD DATE	PROD INT. (FT)	INITIAL PRODUCTION RATE	SHUT IN PRESS (PSI)	CUM GAS (MCF)	CUM H2O (BBLS)
00700037	PARROTT INVESTMENT CO.	B-1	8/30/1955	NA	3365-90'	5741 mcf/d, 1/2" choke, 975/1205#	1450#	5,453,194	0
					10/69 perforated 3408-3458 dual completion with original perfs			2,841,794	7,529
00700039	PARROTT INVESTMENT CO.	B-3	11/11/1955	NA	3460-3470' and 3472-82'	5670 mcf/d, 3/8" choke, 1190/1400#	1450/1450#	7,618,953	2,082
					10/80 plugged, added 3220-26' and 3232-38'			202,968	2,135
00700040	PARROTT INVESTMENT CO.	B-4	11/28/1955	11/15/2011	3364-85' and 3395-3405'	4380 mcf/d, 3/8" choke, 1110/1325#	1350#	8,127,718	4,466
00700041	PARROTT INVESTMENT CO.	B-5	12/15/1955	8/11/1983	3285-95' and 3455-3505'	4060 mcf/d, 3/8" choke, 920/1210#	1350/1355#	3,272,301	0
00700043	PARROTT INVESTMENT CO.	B-7	7/10/1956	NA	3420-3422' and 3430-3478'	3020 mcf/d, 3/8" choke, 1300/1390#	1500#	6,060,099	6,374
00720086	VOLCANO	1-9	12/18/1998	NA	5495-5550' and 5480-90' , 5/99 added 5368-76' and 5352-64'		2135/2140#	117,878	53
					11/02 added 3456-59' and 3474-3500'		not reported	116,412	10
00720088	FINS	2-9	2/23/1999	12/19/2001	3299-3326', 3331-50', 3354-58', 3364-68'	2774 mcf/d, 16/64" choke, 1400/1420#	1440/1440#	463,451	59
00720090	PIRATE	1-16	4/15/1999	NA	3619-22' and 3628-32'	805 mcf/d, 12/64" choke, 1020/1100#	1310/1320#	95,782	610
					9/04 isolated and perforated 3336-70' and 3400-14'		75/75#	26,006	20
							TOTAL	**34,396,556**	**23,338**

Pacific Gas and Electric Company
CAES PROJECT

Perkins Lake Gas Field
Isochore Map
Princeton Canyon Fill

Author:	ATTACHMENT 5	Date:
dpi		8 July, 2012
	Units: Feet	

2000 0 2000 ft

N

05 03 02
08 08 09 10 11
17 17 16 15 14
20 20 21 22 23
29 29 28 27 26

1885.33
1947.92
1925.53
1764.57
1730
1463
2529.39
2055.23
1704
1760
1705.38
1670
1723
1612
1672
1571
1540
1620
1500
1530
937.87
1115
1490
274.79
893.14
538.86

Pacific Gas and Electric Company
CAES PROJECT

Perkins Lake Gas Field
Structure-Contour Map
Pre-Eocene Unconformity
(Base Princeton Canyon Fill)

Author:	ATTACHMENT 6	Date:
dpi		8 July, 2012
	Units: Feet	

2000 0 2000 ft

N

-3600 -3200 -4000 -3800 -3400 -3600 -4000 -3800 -3600 -3400 -3200 -3000 -2800 -2600 -2400 -2200

+4151.75 +4008.01 +3979.4 +3747 +3746 +3809 +4150 +3882 +3700 +3735 +3655.38 +3638 +3668 +3580 +3591 +3569 +3636 +3515 +3374 +3396 +2961.41 +3019 +3322 +2499.39 +2220 +2331 +2411 +2535 +2316

05 03 02 08 08 09 10 11 17 17 16 15 14 20 20 21 22 23 29 29 28 27 26

Pacific Gas and Electric Company
CAES PROJECT

Perkins Lake Gas Field
Structure-Contour Map
Pre-Pliocene Unconformity
(Base Tehama Formation)

Author:	ATTACHMENT 7	Date:
dpi		8 July, 2012
	Units: Feet	

2000 0 2000 ft

N

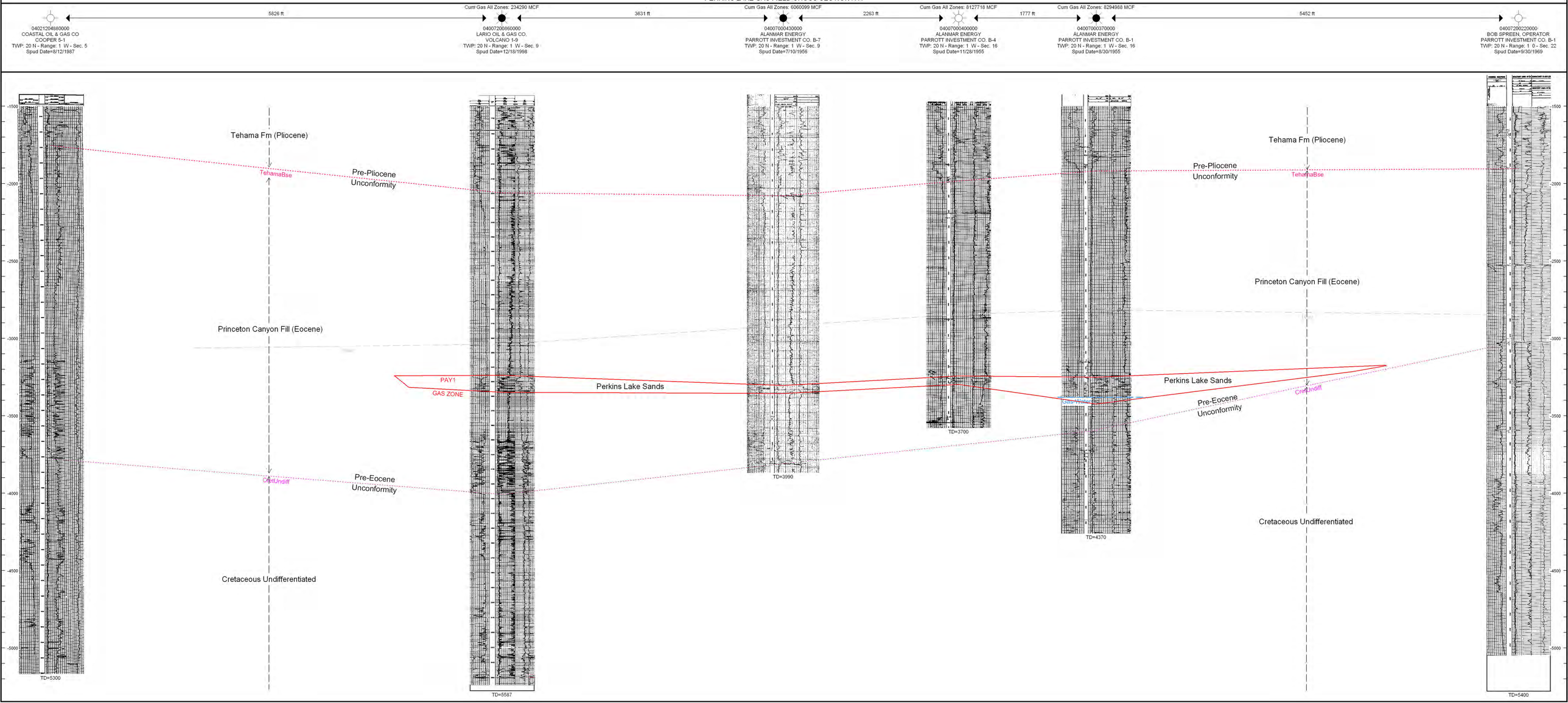
+2266.42 +2233 +2284 +2060.09 +2053.87 +2173.98 +1981.43 +2079 +1620.61 +1826.77 +1996 +1975 +1950 +1968 +1983 +1940 +1968 +2096 +1998 +1919 +1895 +1874 +2023.54 +1866 +1904 +1832 +2056.21 +1606.25 +1681.14

02 03 05 08 08 09 10 11 14 15 16 17 17 20 20 21 22 23 26 27 28 29 29

-1650 -1750 -1800 -1850 -1900 -1950 -2000 -2050 -2100 -2150 -2200 -2250 -2300 -2350

ATTACHMENT 8

PACIFIC GAS AND ELECTRIC COMPANY
CAES PROJECT
PERKINS LAKE GAS FIELD CROSS SECTION X-X'



ATTACHMENT 9

PACIFIC GAS AND ELECTRIC COMPANY
CAES PROJECT
PERKINS LAKE GAS FIELD CROSS SECTION Y-Y'

3452 ft | 1462 ft | 1468 ft | 1293 ft | 2096 ft

Cum Gas All Zones: 8294988 MCF

Cum Gas All Zones: 3272301 MCF

04007200810000
ALANMAR ENERGY
PARROTT RANCH A-3
TWP: 20 N - Range: 1 W - Sec. 17
Spud Date=11/14/1992

04007200800000
ALANMAR ENERGY
PARROTT A-2
TWP: 20 S - Range: 1 W - Sec. 21
Spud Date=10/4/1991

04007000370000
ALANMAR ENERGY
PARROTT INVESTMENT CO. B-1
TWP: 20 N - Range: 1 W - Sec. 16
Spud Date=8/30/1955

04007200790000
ALANMAR ENERGY
PARROTT A-1
TWP: 20 N - Range: 1 W - Sec. 15
Spud Date=10/11/1991

04007000410000
ALANMAR ENERGY
PARROTT INVESTMENT CO. B-5
TWP: 20 N - Range: 1 W - Sec. 15
Spud Date=12/15/1955

04007200690000
DEKALB ENERGY CO.
PARROTT 1
TWP: 20 N - Range: 1 0 - Sec. 15
Spud Date=5/24/1988

-1500
-2000
-2500
-3000
-3500
-4000

Tehama Fm. (Pliocene)

Pre-Pliocene Unconformity

TehamaBse

Princeton Canyon Fill (Eocene)

Pre-Eocene Unconformity

CretUndiff

Cretaceous Undifferentiated

PAY1

GAS ZONE

Gas-Water

Perkins Lake Sands

TD=4000

TD=3800

TD=4370

TD=3800

TD=4123

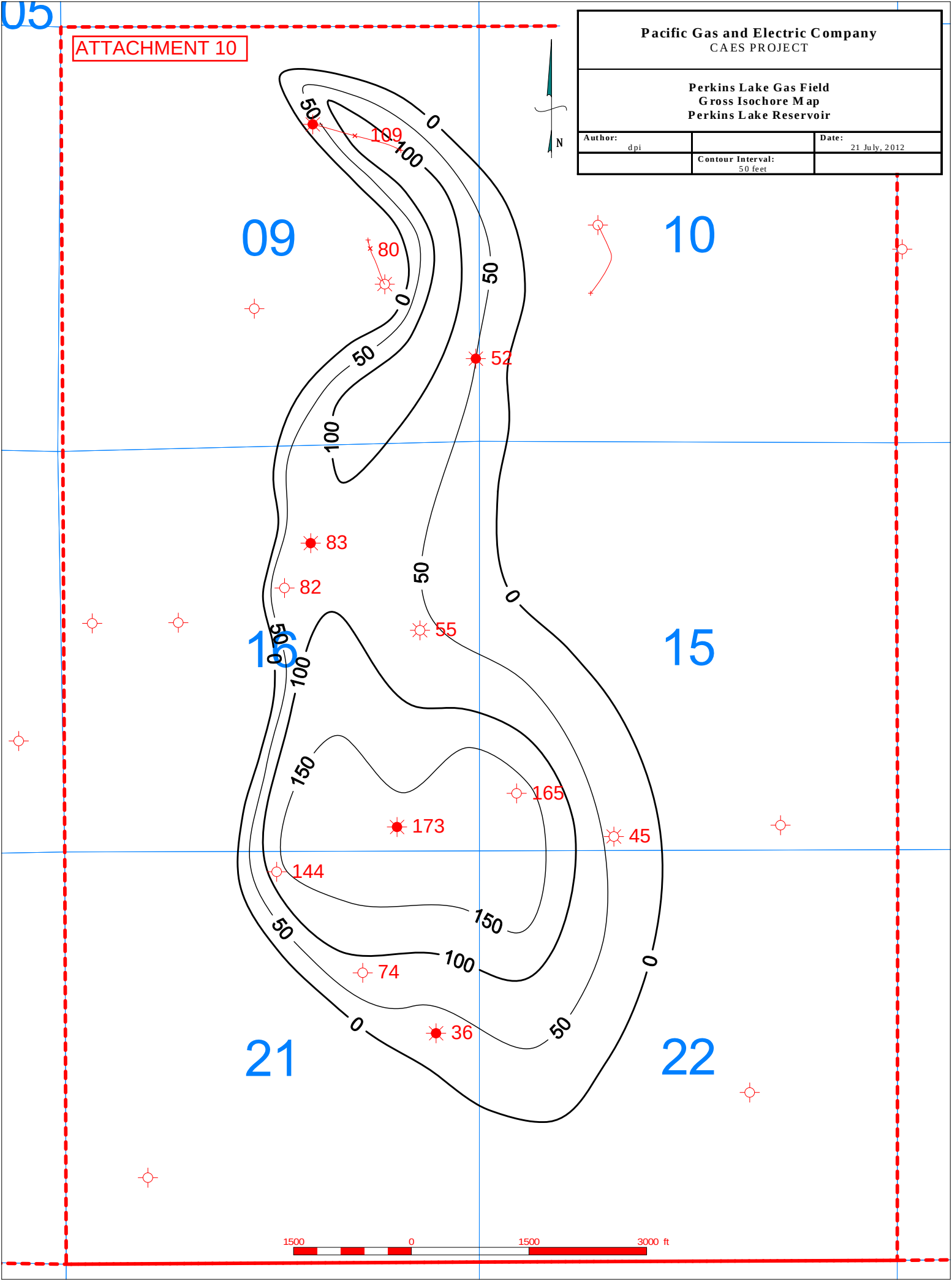
TD=4538

ATTACHMENT 10

Pacific Gas and Electric Company
CAES PROJECT

Perkins Lake Gas Field
Gross Isochore Map
Perkins Lake Reservoir

Author:		Date:
dpi		21 July, 2012
	Contour Interval: 50 feet	



ATTACHMENT 11

Pacific Gas and Electric Company
CAES PROJECT

Perkins Lake Gas Field
Net-Sandstone Isochore Map
Perkins Lake Reservoir

Author:		Date:
dpi		21 July, 2012
	Contour Interval: 25 feet	

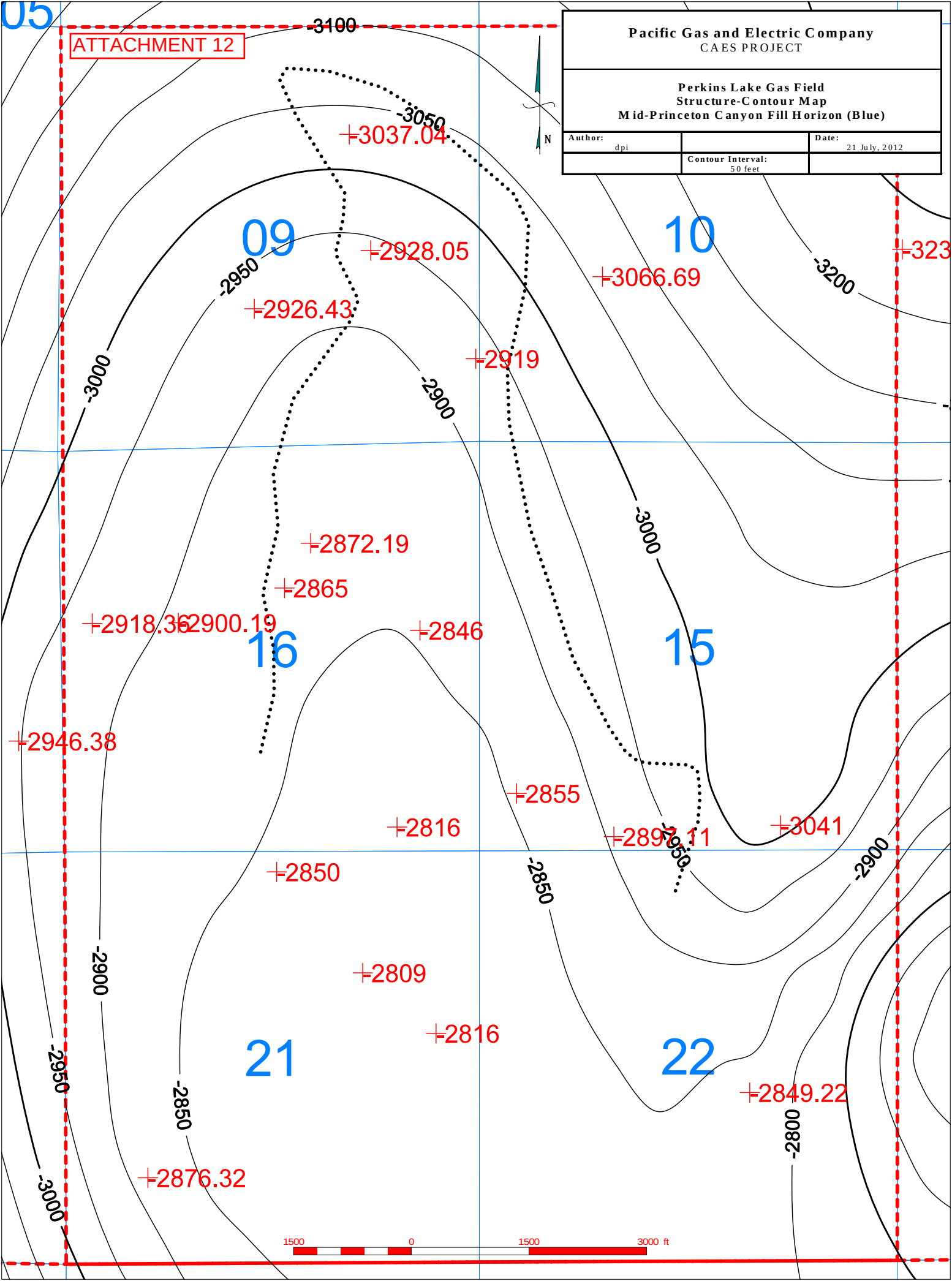
N

09 10 15 21 22

85.56705
78.82559
51.1031
36.0765
39.65587
11.72345
90.34878
111.3928
22.54263
31.42969
50.65724
31.69903

0 25 50 75 100

1500 0 1500 3000 ft

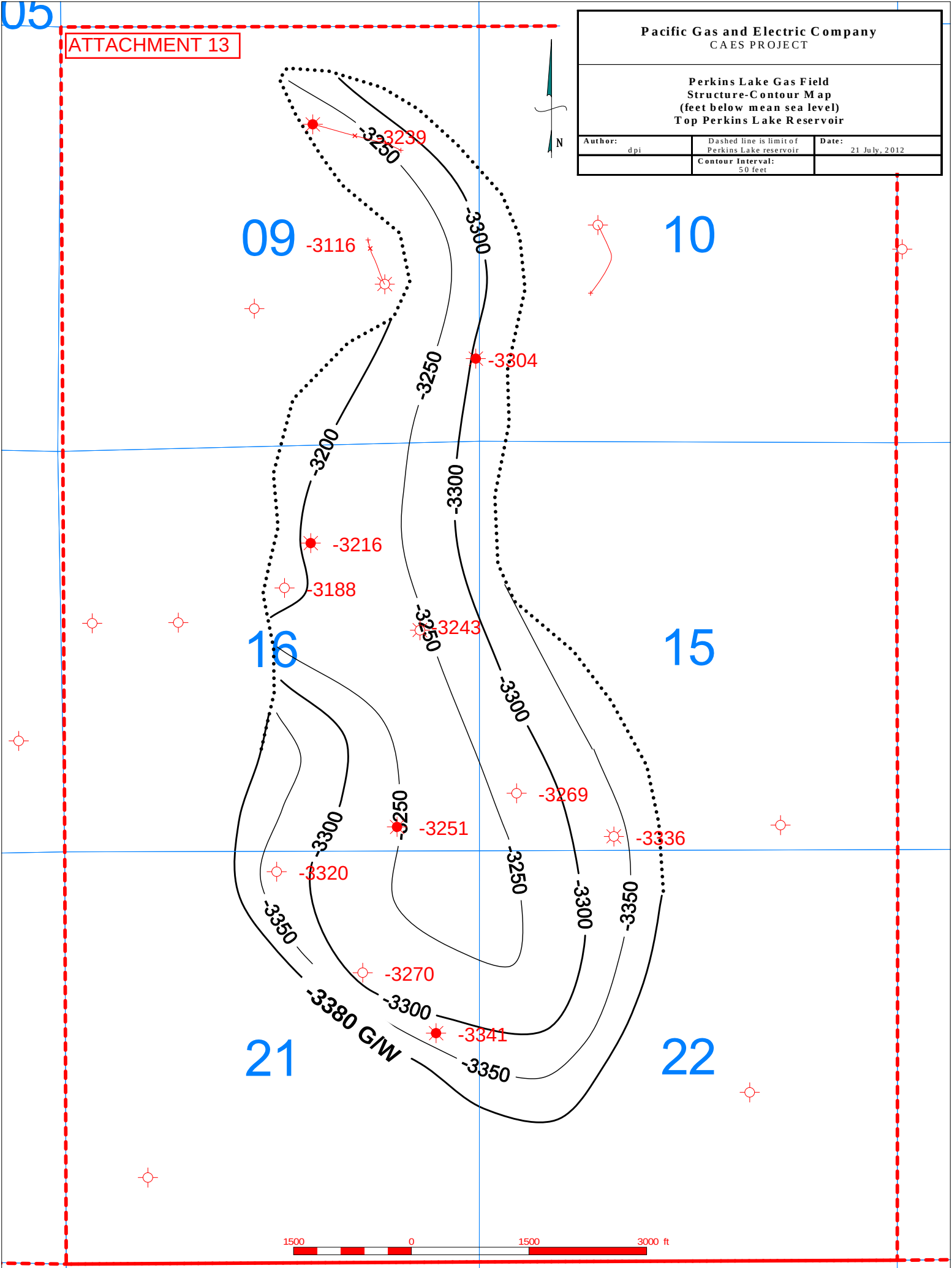

ATTACHMENT 12
Pacific Gas and Electric Company
CAES PROJECT
Perkins Lake Gas Field
Structure-Contour Map
Mid-Princeton Canyon Fill Horizon (Blue)
Author:
dpi
Date:
21 July, 2012
Contour Interval:
50 feet
N
09
10
15
16
21
22
-3100
-3050
-3000
-2950
-2900
-2850
-3200
-2800
+3037.04
+2928.05
+3066.69
+2926.43
+2919
+2872.19
+2865
+2918.36
+2900.19
+2846
+2946.38
+2855
+2816
+2850
+2809
+2816
+2849.22
+2876.32
1500
0
1500
3000 ft

ATTACHMENT 13

Pacific Gas and Electric Company
CAES PROJECT

Perkins Lake Gas Field
Structure-Contour Map
(feet below mean sea level)
Top Perkins Lake Reservoir

Author: dpi	Dashed line is limit of Perkins Lake reservoir	Date: 21 July, 2012
	Contour Interval: 50 feet	



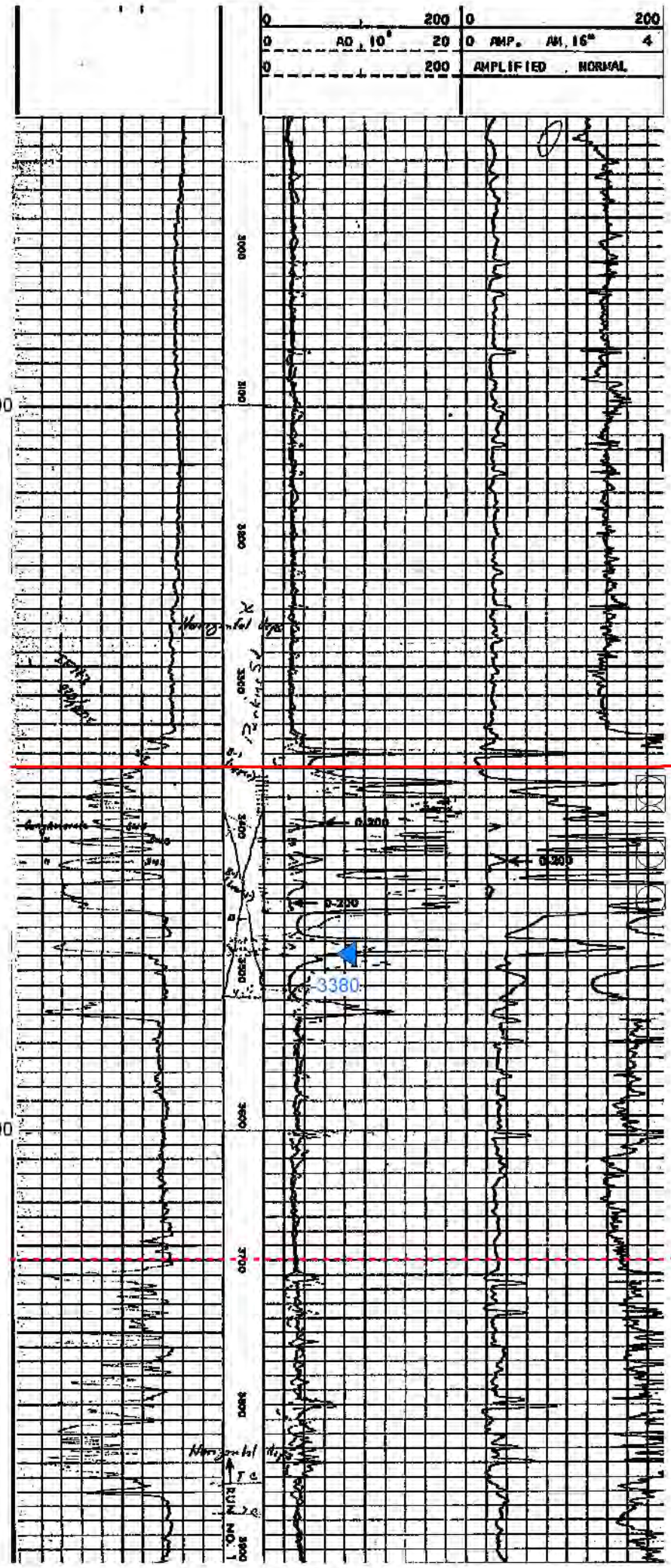
APPENDIX I

Annotated well log, well-history summary, wellbore diagram, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data for the following wells:

00700037	PARROTT INVESTMENT CO.	B-1
00700039	PARROTT INVESTMENT CO.	B-3
00700040	PARROTT INVESTMENT CO.	B-4
00700041	PARROTT INVESTMENT CO.	B-5
00700043	PARROTT INVESTMENT CO.	B-7
00720086	VOLCANO	1-9
00720088	FINS	2-9
00720090	PIRATE	1-16

Cum Gas All Zones: 8294988 MCF

04007000370000
ALANMAR ENERGY
PARROTT INVESTMENT CO. B-1
TWP: 20 N - Range: 1 W - Sec. 16
Spud Date=8/30/1955



-3000

-3500

Princeton Canyon Fill
(Eocene)

Top Perkins Lake Sands

Pre-Eocene
Unconformity

Cretaceous Undifferentiated

04-007-00037 ** 16-20N-1W MD

ALANMAR ENERGY "PARROTT INVESTMENT CO." B-1

Field: Perkins Lake Gas

County: Butte

Elev: 109 KB

TD: 4370

LOC: 21075' N, 1057' W SEC Sec 4

☐ Directional

Spud: 8/31/55

Current Status: Gas

Horizons: Base Tehama 2028'

Original Operator: Humble Oil & Refining Co.

Casing: 7" cemented at 525'; 4" cemented at 3558'

08/31/55 spudded in
09/01/55 525 ran 7" casing cemented at 525 with 150 sacks
09/09/55 3970 ran electric log, microlog, dipmeter
09/11/55 4370 ran electric log, induction log, took 18 sidewall samples
09/12/55 4370 ran 5-12" casing cemented at 3558 with 180 sacks top of plug at 3527'

09/14/55 WSO at 3310, perforated **3477-87'**
09/15/55 ran drill stem test of interval 3477' to 3487' using 1" top and 1/4" bottom choke and no water cushion. Tool open 150 minutes and shut in 45 minutes. Gas to surface in 2 minutes. Maximum surface pressure 180 lbs. Flowed at the rate of 2740 mcf /day. Recovery: dry gas. Pressures: im 1850, fm 1830, if 1430, ff 1370, si 1570.
09/16/55 Perforated **3365-90'**, and **3410-60'**, ran 2-3/8" tubing set at 3285'
09/18/55 DST indicated communication between perforations 3460 and 3477'
09/19/55 flowing 5741 mcf thru 1/2" bean, 975-1205#, thru 3/8" bean flowed 4060 mcf,1280/1295#, thru 1/4" bean 1350/1365#. Shut in 1450#. Interval: 3365-3390'
09/21/55 Cement plug 3527-3390'

09/26/69. Cleaned out to 3520' Perforated and squeezed 3511'.
09/29/69 Jet perforated 2 holes per foot 3477-87', tested, no gas. Squeezed.
100/3/69 Set packer at 3396', sleeve at 3393' Jet perforated 2 holes per foot **3440-58'**, tested 400 mcf/d.
10/07/69 Jet perforated 2 holes per foot **3408-30'** tested overall 3408-58' flowed 620 mcf/d
10/17/69 shut in
10/27/69 flowing from both zones maximum of1600 mcf/d. Intervals: 3365-3390 and 3408-58'
11/07/69 tested 1123 mcf/d, 23/64" bean 350# TP. from lower interval: 3408-3458'
12/31/69 upper zone shut in. Recompleted

01/23/73 Well transferred to Exxon Corporation
10/24/91 Well transferred to William Braun Resources
12/05/91 Well transferred to Alanmar Oil Company
07/30/93 Well transferred to Alanmar Energy

Alanmar Energy
Parrott Investment B-1

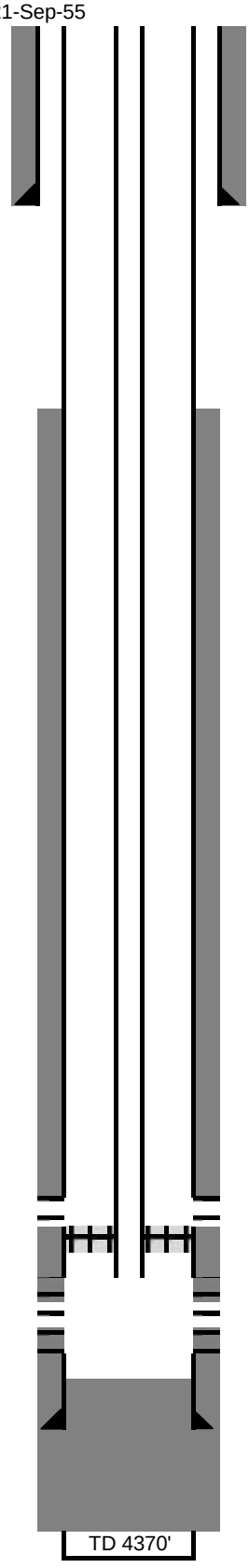
007-00037
Perkins Lake Gas Field
Butte County, CA
Sec 16, 20N, R1W MDB&M

WI/NRI:
Spud: 31-Aug-55
Comp: 21-Sep-55

KB: 109
DF:
GL: 100

Directional Data:

NOT TO SCALE



Surface Casing: 7" cemented at 525 ft
.

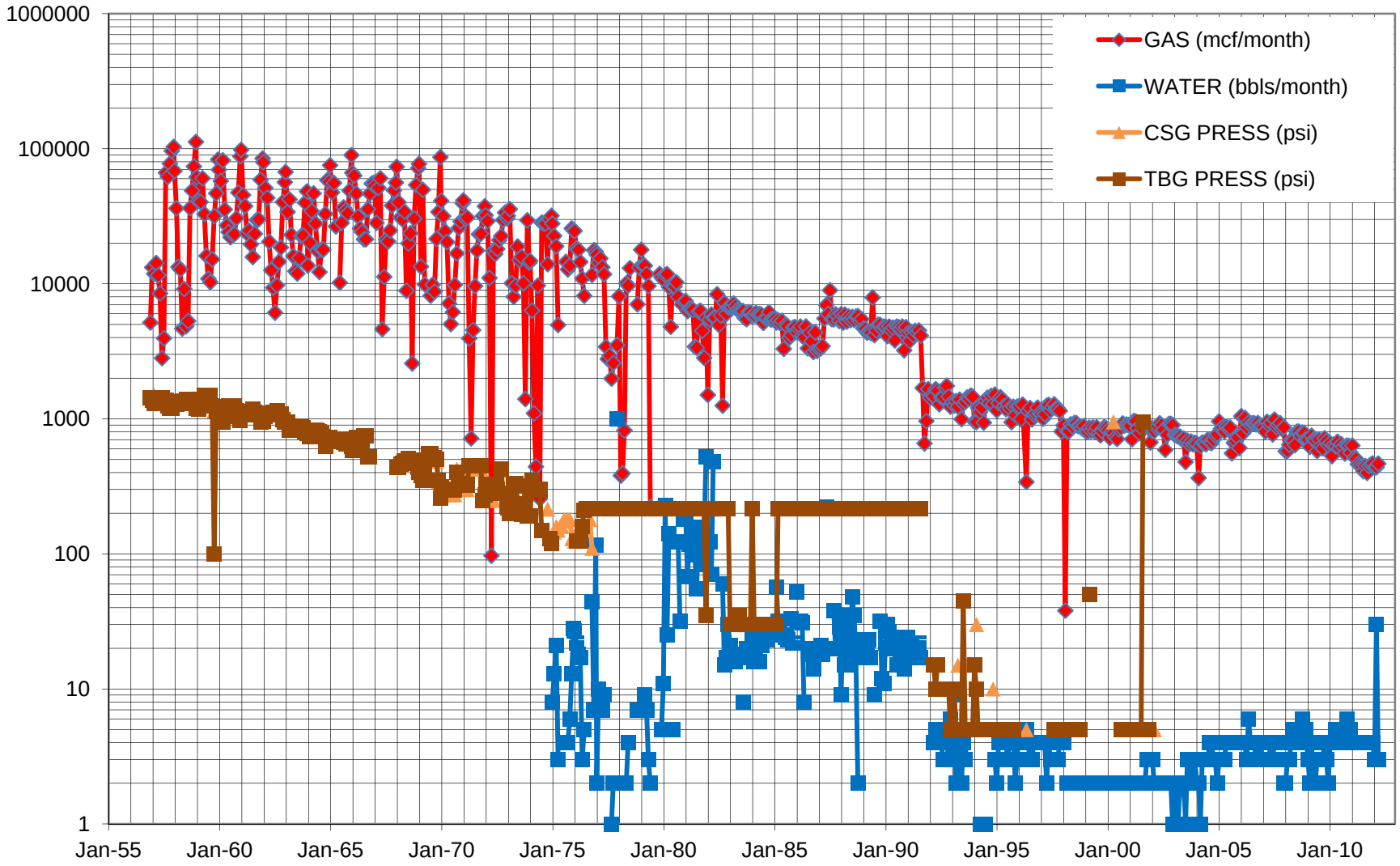
Casing Record reported on well summary report- no detail in well history:

Size	Depth of Shoe	Top
7”	525.77	8.5
5-1/2”	39.21	10.4
4-1/2”	598.94	39.21
4-1/2”	951.47	598.94
4”	3,558.22	951.47

9/14/55 WSO at 3310'
9/16/55 Perforated 3365-90'
10/3/69 Packer at 3396' sleeve at 3393'
9/21/55 Cement plug 3390-3527'
9/16/55 Perforated 3410-60'
10/3/69 Perforated 3408-30', 3440-58'
9/14/55 Perforated 3477-87, 9/29/69 Perforated, tested, squeezed 3477-87
9/26/69 Perforated and squeezed 3511
Top of cement 3527'
Production Casing: 5-1/2" cemented at 3558'

00700037 PARROTT INVESTMENT B-1

CUM PROD 8,294,988 MCF; 7529 BBLS H2O



	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-56	0	1425	5170	0	10
Jan-57	1380	1375	13238	0	22
Feb-57	1380	1300	11872	0	21
Mar-57	1420	1400	14253	0	23
Apr-57	1420	1400	11583	0	21
May-57	1440	1425	8490	0	22
Jun-57	1460	1440	2815	0	21
Jul-57	1425	1375	3957	0	13
Aug-57	1400	1375	66440	0	25
Sep-57	1275	1250	62033	0	29
Oct-57	1275	1200	77653	0	31
Nov-57	1275	1200	96499	0	30
Dec-57	1350	1300	103380	0	31
Jan-58	1332	1331	68628	0	26
Feb-58	1300	1275	36241	0	28
Mar-58	1325	1300	13325	0	31
Apr-58	1300	1300	12779	0	30
May-58	1350	1350	4673	0	31
Jun-58	1350	1350	9159	0	30
Jul-58	1400	1400	4855	0	31
Aug-58	1350	1400	5301	0	31
Sep-58	1400	1300	36372	0	30
Oct-58	1400	1350	49024	0	31
Nov-58	1400	1350	73984	0	30
Dec-58	1300	1200	112433	0	30
Jan-59	1350	1350	61661	0	31
Feb-59	1300	1175	41137	0	28
Mar-59	0	1400	40367	0	31
Apr-59	1400	1400	60438	0	28
May-59	1500	1500	32865	0	31
Jun-59	1500	1500	16115	0	30
Jul-59	1450	1450	10908	0	31
Aug-59	1500	1500	10283	0	31
Sep-59	1250	1250	15198	0	30
Oct-59	1100	100	31718	0	31
Nov-59	1150	1150	46778	0	30
Dec-59	1150	1150	83329	0	31
Jan-60	1150	1150	70018	0	31
Feb-60	1050	1050	57720	0	29
Mar-60	950	950	82079	0	31
Apr-60	1200	1200	35504	0	30
May-60	1225	1225	27049	0	31
Jun-60	1250	1250	24161	0	30
Jul-60	1250	1250	22132	0	31
Aug-60	1250	1250	23114	0	31
Sep-60	1250	1250	23351	0	30
Oct-60	1150	1150	30639	0	31
Nov-60	1050	1050	47437	0	30
Dec-60	975	975	88021	0	31
Jan-61	0	1135	98338	0	31
Feb-61	0	1075	45454	0	28
Mar-61	0	1075	37645	0	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Apr-61	1090	1090	23634	0	30
May-61	0	1075	24764	0	31
Jun-61	0	1125	19622	0	30
Jul-61	0	1175	15792	0	31
Aug-61	0	1125	23479	0	31
Sep-61	0	1075	29727	0	30
Oct-61		1100	30047	0	31
Nov-61	0	950	59029	0	30
Dec-61	0	975	84805	0	31
Jan-62	0	960	79585	0	31
Feb-62	0	1040	51275	0	28
Mar-62	0	1075	43328	0	31
Apr-62	0	1100	20520	0	30
May-62	0	1100	12598	0	24
Jun-62	0	1125	9370	0	25
Jul-62	0	1125	6116	0	31
Aug-62	0	1150	9758	0	29
Sep-62	0	0	14603	0	30
Oct-62	0	1088	18596	0	31
Nov-62	0	987	40342	0	30
Dec-62		950	56571	0	31
Jan-63	0	950	67422	0	31
Feb-63	0	950	34034	0	26
Mar-63	0	825	42206	0	31
Apr-63	0	860	23032	0	30
May-63	0	860	16029	0	31
Jun-63	0	880	12423	0	30
Jul-63	0	884	11913	0	24
Aug-63	0	878	15535	0	31
Sep-63	0	875	22618	0	30
Oct-63	0	860	22777	0	31
Nov-63	0	800	39966	0	30
Dec-63	0	775	48348	0	31
Jan-64	0	775	13665	0	31
Feb-64	0	740	20170	0	28
Mar-64	0	775	34588	0	31
Apr-64	0	800	46725	0	30
May-64	0	825	27946	0	31
Jun-64	0	815	17515	0	30
Jul-64	0	800	12228	0	31
Aug-64	0	780	17941	0	29
Sep-64	0	740	17924	0	29
Oct-64	0	625	32978	0	31
Nov-64	0	715	58593	0	30
Dec-64	0	700	56904	0	31
Jan-65	0	725	75512	0	31
Feb-65	0	680	47500	0	19
Mar-65	0	690	55811	0	31
Apr-65	0	700	26623	0	19
May-65	0	700	0	0	0
Jun-65	0	700	10206	0	7
Jul-65	0	700	28317	0	28

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS		
Aug-65	0	675	36768	0	31		
Sep-65	0	650	34964	0	30		
Oct-65	0	665	33242	0	31		
Nov-65	0	675	49076	0	30		
Dec-65	0	625	89747	0	31		
Jan-66	0	588	66517	0	28		
Feb-66	0	625	63277	0	28		
Mar-66	0	725	46639	0	31		
Apr-66	0	625	31419	0	30		
May-66	0	600	25690	0	20		
Jun-66	0	650	24159	0	28		
Jul-66	0	750	21368	0	26		
Aug-66	0	750	21371	0	28		
Sep-66	0	525	35777	0	27		
Oct-66	0	525	46628	0	28		
Nov-66	0	0	55233	0	30		
Dec-66	0	0	55974	0	31		
Jan-67	0	0	53035	0	25		
Feb-67	0	0	28311	0	21		
Mar-67	0	0	51333	0	22		
Apr-67	0	0	60477	0	28		
May-67	0	0	4622	0	6		
Jun-67	0	0	11260	0	15		
Jul-67	0	0	21241	0	16		
Aug-67	0	0	20581	0	31		
Sep-67	0	0	24862	0	29		
Oct-67	0	0	37990	0	27		
Nov-67	0	0	49291	0	28		
Dec-67	0	0	56176	0	27		
Jan-68	435	435	73591	0	31		
Feb-68	433	435	40156	0	28		
Mar-68	465	465	31124	0	17		
Apr-68	470	469	29907	0	19		
May-68	488	488	34302	0	31		
Jun-68	475	475	8890	0	21		
Jul-68	509	509	19893	0	29		
Aug-68	495	495	23690	0	29		
Sep-68	495	495	2574	0	3		
Oct-68	493	493	30386	0	31		
Nov-68	490	490	53995	0	30		
Dec-68	438	438	71891	0	31		
Jan-69	400	400	77326	0	30		
Feb-69	383	383	13413	0	28		
Mar-69	350	350	49703	0	24		
Apr-69	450	450	9912	0	9		
May-69	0	0	0	0	0		
Jun-69	550	550	0	0	0		
Jul-69	550	550	8176	0	15		
Aug-69	510	510	9854	0	18		
Sep-69	515	515	8757	0	18	5,453,194	0
Oct-69	500	500	21544	0	22		
Nov-69	350	350	34034	0	30		

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-69	325	260	86731	0	31
Jan-70	312	312	41223	0	31
Feb-70	300	300	31745	0	28
Mar-70	275	300	24517	0	23
Apr-70	275	300	20417	0	26
May-70	275	300	7154	0	11
Jun-70	275	300	5036	0	7
Jul-70	275	300	6169	0	10
Aug-70	275	300	9826	0	20
Sep-70	275	400	16801	0	16
Oct-70	220	330	25969	0	30
Nov-70	250	325	28970	0	24
Dec-70	325	325	39555	0	31
Jan-71	250	325	41567	0	31
Feb-71	175	325	30352	0	28
Mar-71	175	325	30940	0	29
Apr-71	175	450	3946	0	6
May-71	190	450	717	0	1
Jun-71	190	450	4549	0	6
Jul-71	190	450	9631	0	16
Aug-71	190	450	17643	0	28
Sep-71	190	450	23294	0	30
Oct-71	180	450	23531	0	29
Nov-71	160	250	31845	0	30
Dec-71	150	275	37520	0	31
Jan-72	150	325	32234	0	31
Feb-72	150	325	29135	0	28
Mar-72	150	325	11054	0	13
Apr-72	0	0	97	0	1
May-72	150	325	17515	0	29
Jun-72	160	300	16675	0	31
Jul-72	160	300	18124	0	31
Aug-72	160	280	21079	0	30
Sep-72	180	425	22590	0	30
Oct-72	160	280	29709	0	31
Nov-72	180	280	33660	0	30
Dec-72	180	225	30548	0	31
Jan-73	180	220	31891	0	31
Feb-73	186	200	35732	0	28
Mar-73	200	240	10106	0	11
Apr-73	220	330	8014	0	12
May-73	292	330	9670	0	12
Jun-73	200	235	18903	0	25
Jul-73	200	225	14997	0	29
Aug-73	180	195	15871	0	31
Sep-73	200	225	10115	0	20
Oct-73	305	320	1401	0	21
Nov-73	175	190	29579	0	28
Dec-73	175	190	14327	0	15
Jan-74	170	190	14808	0	18
Feb-74	325	350	6344	0	9
Mar-74	250	300	1098	0	2

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Apr-74	300	300	443	0	2
May-74	0	0	9706	0	10
Jun-74	300	300	256	0	2
Jul-74	150	150	28404	0	31
Aug-74	0	0	27983	0	31
Sep-74	0	0	28013	0	30
Oct-74	215	0	13987	0	15
Nov-74	0	130	30152	0	28
Dec-74	0	120	31922	0	31
Jan-75	115	0	27923	8	31
Feb-75	135	0	22634	13	28
Mar-75	160	0	18972	21	31
Apr-75	150	0	4954	3	7
May-75	0	0	0	0	0
Jun-75	0	0	0	0	0
Jul-75	0	0	0	0	0
Aug-75	175	0	14548	4	31
Sep-75	180	0	12781	4	30
Oct-75	180	0	13619	6	31
Nov-75	120	0	25702	13	30
Dec-75	115	0	24999	28	31
Jan-76	115	0	24615	27	31
Feb-76	0	125	18303	22	29
Mar-76	0	125	17891	18	31
Apr-76	0	125	14518	17	30
May-76	0	160	10927	3	31
Jun-76	0	210	8158	5	24
Jul-76	0	215	0	0	0
Aug-76	0	215	0	0	0
Sep-76	215	0	0	0	0
Oct-76	90	0	11652	44	17
Nov-76	0	0	17755	7	30
Dec-76	0	0	17214	116	31
Jan-77	0	215	16434	2	31
Feb-77	0	215	14352	10	28
Mar-77	0	215	15432	0	31
Apr-77	0	215	13260	7	30
May-77	0	215	11787	9	31
Jun-77	0	215	3417	0	30
Jul-77	0	215	2777	0	31
Aug-77	0	215	2938	0	31
Sep-77	0	215	1988	1	30
Oct-77	0	215	2594	2	31
Nov-77	0	215	0	0	0
Dec-77	0	215	3522	1003	31
Jan-78	0	215	8094	0	31
Feb-78	0	215	380	0	28
Mar-78	0	215	395	0	0
Apr-78	0	215	821	2	3
May-78	0	215	10095	2	29
Jun-78	0	215	9698	4	30
Jul-78	0	215	13070	0	28

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Aug-78	0	215	0	0	0
Sep-78	0	215	0	0	0
Oct-78	0	215	0	0	0
Nov-78	0	215	7050	7	13
Dec-78	0	215	13226	0	31
Jan-79	0	215	17889	0	31
Feb-79	0	215	13600	0	28
Mar-79	0	215	13629	9	31
Apr-79	0	215	11824	7	30
May-79	0	215	9642	3	31
Jun-79	0	215	223	2	1
Jul-79	0	215	0	0	0
Aug-79	0	215	0	0	0
Sep-79	0	215	0	0	0
Oct-79	0	215	0	0	0
Nov-79	0	215	11845	0	26
Dec-79	0	215	11185	5	31
Jan-80	0	215	10753	11	28
Feb-80	0	215	11592	228	29
Mar-80	0	215	11814	25	31
Apr-80	0	215	9484	141	30
May-80	0	215	4804	0	11
Jun-80	0	215	9603	5	29
Jul-80	0	215	9588	0	31
Aug-80	0	215	10267	0	31
Sep-80	0	215	7995	122	27
Oct-80	0	0	0	32	23
Nov-80	0	215	7036	0	0
Dec-80	0	215	7373	182	31
Jan-81	0	215	7470	194	31
Feb-81	0	215	6284	68	28
Mar-81	0	215	6568	118	31
Apr-81	0	215	6547	152	30
May-81	0	215	6429	153	31
Jun-81	0	215	3427	99	21
Jul-81	0	215	3365	55	14
Aug-81	0	215	6229	158	31
Sep-81	0	215	6319	129	30
Oct-81	0	215	4487	83	25
Nov-81	0	215	2828	128	17
Dec-81	0	35	5607	522	30
Jan-82	0	215	1504	0	3
Feb-82	0	215	5445	122	28
Mar-82	0	215	5932	71	31
Apr-82	0	215	5599	480	30
May-82	0	215	5631	0	30
Jun-82	0	215	8371	0	29
Jul-82	0	215	4959	0	30
Aug-82	0	215	5842	0	31
Sep-82	0	215	1254	60	5
Oct-82	0	215	7223	15	31
Nov-82	0	215	5999	17	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-82	0	215	6693	30	28
Jan-83	0	30	6704	21	28
Feb-83	0	30	6747	18	26
Mar-83	0	30	7150	0	31
Apr-83	0	30	6827	16	30
May-83	0	30	6436	18	29
Jun-83	0	35	6322	18	29
Jul-83	0	30	6247	0	29
Aug-83	0	30	6295	8	29
Sep-83	0	30	5580	0	28
Oct-83	0	30	5471	20	25
Nov-83	0	30	6175	17	30
Dec-83	0	30	6134	30	31
Jan-84	0	215	5797	23	29
Feb-84	0	30	5864	16	28
Mar-84	0	30	6102	23	31
Apr-84	0	30	5924	23	29
May-84	0	30	5982	16	31
Jun-84	0	30	5909	21	29
Jul-84	0	30	5140	0	26
Aug-84	0	30	5566	0	28
Sep-84	0	30	5590	23	28
Oct-84	0	30	6170	0	30
Nov-84	0	30	5442	0	29
Dec-84	0	30	5485	25	31
Jan-85	0	30	5447	0	30
Feb-85	0	30	5176	57	28
Mar-85	0	215	5369	32	30
Apr-85	0	215	5126	30	28
May-85	0	215	5322	25	31
Jun-85	0	215	3302	0	30
Jul-85	0	215	4982	24	31
Aug-85	0	215	4868	23	30
Sep-85	0	215	3995	0	26
Oct-85	0	215	4170	33	24
Nov-85	0	215	4745	22	30
Dec-85	0	215	4785	0	30
Jan-86	0	215	4379	52	30
Feb-86	0	215	4648	0	28
Mar-86	0	215	4823	32	30
Apr-86	0	215	4119	31	29
May-86	0	215	4024	8	31
Jun-86	0	215	4836	0	30
Jul-86	0	215	3330	0	31
Aug-86	0	215	4333	20	30
Sep-86	0	215	3754	18	30
Oct-86	0	215	3133	14	31
Nov-86	0	215	4373	19	30
Dec-86	0	215	3188	18	27
Jan-87	0	215	3289	18	31
Feb-87	0	215	3335	21	27
Mar-87	0	215	3455	18	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Apr-87	0	215	5533	0	26
May-87	0	215	6967	221	30
Jun-87	0	215	5980	0	29
Jul-87	0	215	8962	20	28
Aug-87	0	215	5476	0	29
Sep-87	0	215	5463	38	30
Oct-87	0	215	5944	20	31
Nov-87	0	215	5777	0	30
Dec-87	0	215	5314	29	31
Jan-88	0	215	5969	9	30
Feb-88	0	215	5158	35	29
Mar-88	0	215	5927	15	30
Apr-88	0	215	5253	15	28
May-88	0	215	5735	29	30
Jun-88	0	215	5390	18	28
Jul-88	0	215	5690	48	31
Aug-88	0	215	5408	35	31
Sep-88	0	215	5728	17	30
Oct-88	0	215	5769	2	31
Nov-88	0	215	5311	0	30
Dec-88	0	215	5474	18	31
Jan-89	0	215	4683	23	29
Feb-89	0	215	4636	20	28
Mar-89	0	215	4364	22	30
Apr-89	0	215	4416	23	30
May-89	0	215	4334	17	31
Jun-89	0	215	7924	0	30
Jul-89	0	215	4171	9	31
Aug-89	0	215	4521	0	31
Sep-89	0	215	4982	0	30
Oct-89	0	215	4974	32	31
Nov-89	0	215	4645	12	30
Dec-89	0	215	4823	11	31
Jan-90	0	215	4809	22	31
Feb-90	0	215	4105	30	28
Mar-90	0	215	4828	26	31
Apr-90	0	215	4541	0	30
May-90	0	215	4745	20	31
Jun-90	0	215	3810	23	30
Jul-90	0	215	4827	15	31
Aug-90	0	215	4786	24	30
Sep-90	0	215	4647	17	30
Oct-90	0	215	4824	19	31
Nov-90	0	215	3223	14	24
Dec-90	0	215	4780	17	28
Jan-91	0	215	4312	24	31
Feb-91	0	215	3789	17	28
Mar-91	0	215	4372	21	31
Apr-91	0	215	4154	22	30
May-91	0	215	4484	22	31
Jun-91	0	215	4354	19	30
Jul-91	0	215	4519	22	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Aug-91	0	215	4136	17	31
Sep-91	0	0	1696	0	30
Oct-91	0	0	658	0	31
Nov-91	0	0	964	0	30
Dec-91	0	0	1662	0	31
Jan-92	0	0	1435	0	31
Feb-92	0	0	1503	0	29
Mar-92	0	15	1473	4	31
Apr-92	0	10	1657	5	30
May-92	0	15	1617	0	31
Jun-92	0	0	1283	0	30
Jul-92	0	10	1442	4	31
Aug-92	0	10	1452	3	31
Sep-92	0	10	1701	3	30
Oct-92	0	10	1757	3	31
Nov-92	0	10	1463	4	30
Dec-92	0	5	1232	6	31
Jan-93	0	10	1335	3	31
Feb-93	0	10	1257	9	28
Mar-93	0	5	1351	2	31
Apr-93	0	5	1232	4	30
May-93	0	5	1387	4	31
Jun-93	0	5	995	2	30
Jul-93	0	45	1296	4	31
Aug-93	0	5	1341	3	31
Sep-93	5	0	1443	5	30
Oct-93	0	5	1406	0	30
Nov-93	0	5	1487	0	30
Dec-93	0	5	1460	0	30
Jan-94	0	15	957	0	31
Feb-94	0	10	946	0	28
Mar-94	0	5	1207	0	31
Apr-94	0	5	1125	1	28
May-94	0	0	1213	1	31
Jun-94	0	5	938	0	30
Jul-94	0	5	1365	1	31
Aug-94	0	5	1435	0	31
Sep-94	0	5	1316	0	30
Oct-94	0	5	1480	0	31
Nov-94	10	5	1286	0	30
Dec-94	0	5	1512	3	31
Jan-95	0	5	1157	2	31
Feb-95	0	5	1310	4	31
Mar-95	0	5	1447	0	31
Apr-95	0	5	1396	0	28
May-95	0	5	1240	5	31
Jun-95	0	0	1182	4	30
Jul-95	0	0	1280	3	31
Aug-95	0	0	1197	4	31
Sep-95	0	5	946	5	30
Oct-95	0	5	1230	5	31
Nov-95	0	0	1066	2	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-95	5	0	1229	3	31
Jan-96	0	0	1244	5	31
Feb-96	0	0	997	4	29
Mar-96	0	0	1275	5	31
May-96	5	0	341	5	31
Jun-96	0	0	1145	4	30
Jul-96	0	0	1204	3	31
Aug-96	0	0	990	3	31
Sep-96	0	0	1076	4	30
Oct-96	0	0	1102	4	31
Nov-96	0	0	1212	4	30
Dec-96	0	0	1099	4	31
Jan-97	0	0	1080	4	31
Feb-97	0	0	1005	4	29
Mar-97	0	0	1084	4	31
Apr-97	0	0	1255	2	30
May-97	0	0	1270	4	31
Jun-97	0	0	1158	3	30
Jul-97	0	0	1222	3	31
Aug-97	0	5	1282	3	31
Sep-97	0	5	1197	3	30
Oct-97	0	0	1193	3	31
Nov-97	0	0	1145	4	30
Dec-97	0	0	807	4	31
Jan-98	0	5	895	4	31
Feb-98	0	5	38	0	2
Mar-98	0	5	810	2	31
Apr-98	0	5	810	2	30
May-98	0	5	911	2	30
Jun-98	0	5	879	2	30
Jul-98	0	5	934	2	31
Aug-98	0	0	929	2	31
Sep-98	0	5	884	2	30
Oct-98	0	5	882	2	31
Nov-98	0	0	852	2	30
Dec-98	0	0	886	2	31
Jan-99	0	0	809	2	31
Feb-99	0	0	801	2	28
Mar-99	0	50	860	2	31
Apr-99	0	0	813	2	28
May-99	0	0	865	2	31
Jun-99	0	0	806	2	30
Jul-99	0	0	867	2	31
Aug-99	0	0	783	2	30
Sep-99	0	0	755	2	30
Oct-99	0	0	810	2	31
Nov-99	0	0	867	2	30
Dec-99	0	0	854	2	31
Jan-00	0	0	821	2	31
Feb-00	0	0	724	2	29
Mar-00	0	0	801	2	30
Apr-00	952	0	786	2	30

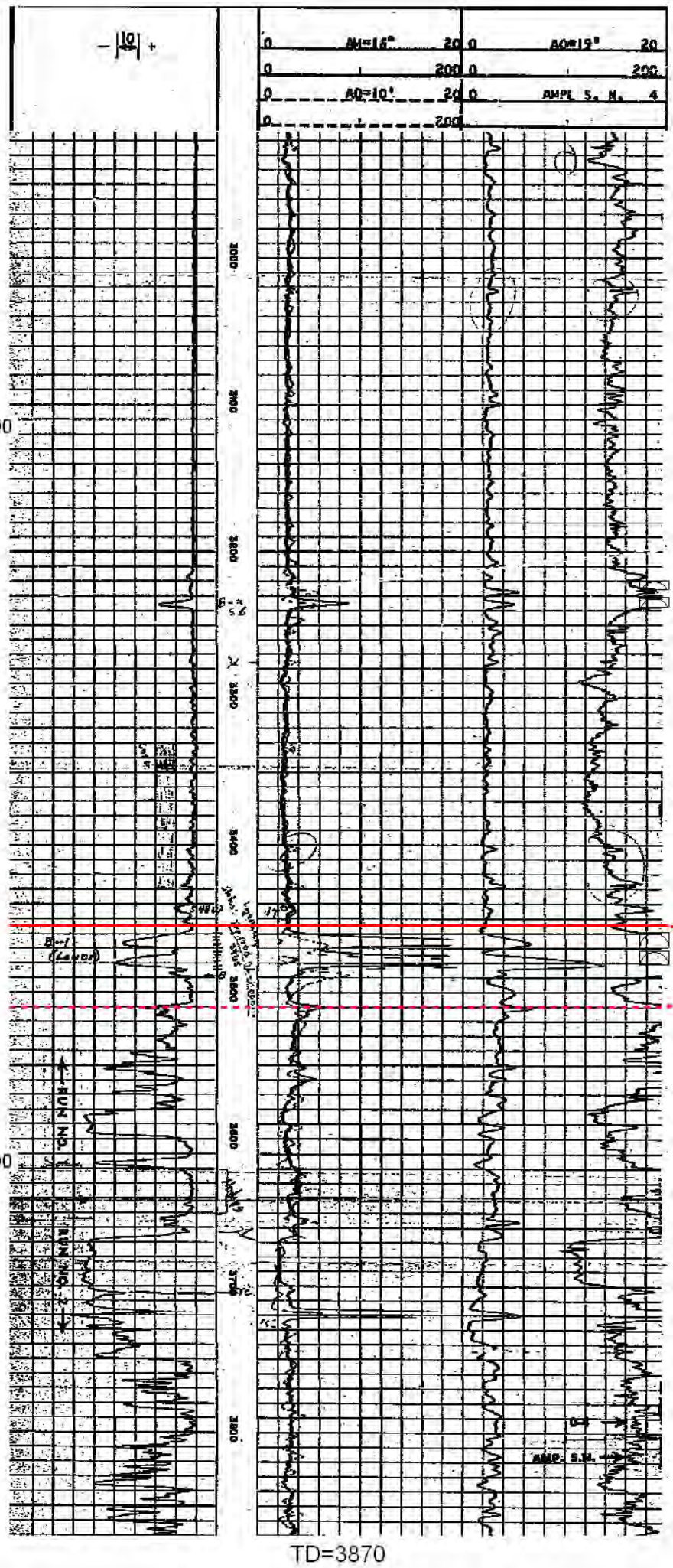
	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
May-00	0	0	731	2	31
Jun-00	0	0	710	2	30
Jul-00	0	0	837	2	31
Aug-00	0	5	861	2	31
Sep-00	0	5	925	2	30
Oct-00	0	5	894	2	31
Nov-00	0	0	908	2	30
Dec-00	0	0	902	2	31
Jan-01	0	0	888	0	31
Feb-01	0	5	707	2	28
Mar-01	0	5	964	2	31
Apr-01	0	0	959	2	30
May-01	0	0	854	2	31
Jun-01	0	0	785	2	30
Jul-01	0	5	910	2	31
Aug-01	5	952	836	2	31
Sep-01	5	0	903	2	30
Oct-01	5	0	893	3	31
Nov-01	0	5	887	3	30
Dec-01	0	0	670	3	31
Jan-02	0	0	811	3	31
Feb-02	5	0	812	2	28
Mar-02	0	0	867	2	31
Apr-02	0	0	883	2	28
May-02	0	0	927	2	30
Jun-02	0	0	898	2	30
Jul-02	0	0	826	2	30
Aug-02	0	0	590	2	26
Sep-02	0	0	762	2	30
Oct-02	0	0	918	0	31
Nov-02	0	0	918	2	30
Dec-02	0	0	899	1	31
Jan-03	0	0	763	2	27
Feb-03	0	0	753	2	28
Mar-03	0	0	742	1	30
Apr-03	0	0	739	2	29
May-03	0	0	705	2	28
Jun-03	0	0	715	2	30
Jul-03	0	0	480	1	31
Aug-03	0	0	689	3	30
Sep-03	0	0	649	2	28
Oct-03	0	0	679	2	31
Nov-03	0	0	647	3	30
Dec-03	0	0	666	3	23
Jan-04	0	0	656	2	31
Feb-04	0	0	365	2	17
Mar-04	0	0	630	1	28
Apr-04	0	0	668	3	30
May-04	0	0	664	3	31
Jun-04	0	0	649	3	28
Jul-04	0	0	702	3	30
Aug-04	0	0	672	4	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Sep-04	0	0	664	4	29
Oct-04	0	0	702	3	31
Nov-04	0	0	751	3	30
Dec-04	0	0	770	2	31
Jan-05	0	0	959	3	31
Feb-05	0	0	846	3	28
Mar-05	0	0	867	3	30
Apr-05	0	0	807	3	30
May-05	0	0	873	4	31
Jun-05	0	0	847	4	30
Jul-05	0	0	863	4	31
Aug-05	0	0	556	4	31
Sep-05	0	0	664	4	30
Oct-05	0	0	682	4	31
Nov-05	0	0	731	4	30
Dec-05	0	0	609	4	29
Jan-06	0	0	1048	4	31
Feb-06	0	0	786	4	28
Mar-06	0	0	1017	4	31
Apr-06	0	0	869	3	26
May-06	0	0	937	6	31
Jun-06	0	0	901	4	29
Jul-06	0	0	926	4	30
Aug-06	0	0	928	4	30
Sep-06	0	0	911	3	29
Oct-06	0	0	933	4	31
Nov-06	0	0	892	4	30
Dec-06	0	0	891	3	29
Jan-07	0	0	865	0	31
Feb-07	0	0	806	0	28
Mar-07	0	0	952	0	31
Apr-07	0	0	901	3	30
May-07	0	0	933	4	31
Jun-07	0	0	768	3	30
Jul-07	0	0	988	4	31
Aug-07	0	0	871	4	31
Sep-07	0	0	903	4	30
Oct-07	0	0	930	4	31
Nov-07	0	0	844	0	29
Dec-07	0	0	866	2	31
Jan-08	0	0	576	2	31
Feb-08	0	0	581	3	29
Mar-08	0	0	643	3	31
Apr-08	0	0	700	4	26
May-08	0	0	691	5	31
Jun-08	0	0	640	4	29
Jul-08	0	0	802	4	23
Aug-08	0	0	807	4	31
Sep-08	0	0	748	4	30
Oct-08	0	0	790	6	31
Nov-08	0	0	786	5	30
Dec-08	0	0	710	5	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS	
Jan-09	0	0	702	3	31	
Feb-09	0	0	622	2	28	
Mar-09	0	0	750	4	31	
Apr-09	0	0	700	2	30	
May-09	0	0	691	2	31	
Jun-09	0	0	579	3	30	
Jul-09	0	0	703	3	31	
Aug-09	0	0	627	3	29	
Sep-09	0	0	606	3	25	
Oct-09	0	0	719	4	31	
Nov-09	0	0	686	3	30	
Dec-09	0	0	638	2	30	
Jan-10	0	0	660	4	31	
Feb-10	0	0	531	4	28	
Mar-10	0	0	646	4	31	
Apr-10	0	0	626	5	30	
May-10	0	0	676	5	31	
Jun-10	0	0	607	4	30	
Jul-10	0	0	651	4	31	
Aug-10	0	0	621	5	31	
Sep-10	0	0	554	5	30	
Oct-10	0	0	634	6	31	
Nov-10	0	0	631	4	30	
Dec-10	0	0	561	5	31	
Jan-11	0	0	635	4	29	
Feb-11	0	0	519	4	26	
Mar-11	0	0	507	4	29	
Apr-11	0	0	462	4	30	
May-11	0	0	450	4	31	
Jun-11	0	0	439	4	30	
Jul-11	0	0	410	4	31	
Aug-11	0	0	447	4	31	
Sep-11	0	0	398	4	30	
Oct-11	0	0	447	4	31	
Nov-11	0	0	459	4	30	
Dec-11	0	0	468	4	31	
Jan-12	0	0	436	3	29	
Feb-12	0	0	439	30	27	
Mar-12	0	0	466	3	31	2841794
			8,294,988	7,529		

Cum Gas All Zones: 7821921 MCF

04007000390000
ALANMAR ENERGY
PARROTT INVESTMENT CO. B-3
TWP: 20 N - Range: 1 W - Sec. 21
Spud Date=11/11/1955



-3000

-3500

Princeton Canyon Fill
(Eocene)

Top Perkins Lake Sands

Pre-Eocene
Unconformity

Cretaceous Undifferentiated

04-007-00039 ** 21-20N-1W MD

ALANMAR ENERGY "PARROTT INVESTMENT CO." B-3

Field: Perkins Lake Gas
County: Butte
Elev: 114 KB
TD: 3870
LOC: 2380 S 556 w NEC
☐ Directional

Spud: 11/11/55
Current Status: Gas
Horizons: top of producing sand 3460
Original Operator: Humble Oil & Refining Co.
Casing: 7” cemented at 622’; 4-1/2” cemented at 3699’

01/01/55 loc
11/12/55 640
11/13/55 7"cmtd w/185 sacks at 623'
11/15/55 1320 d
11/16/55 2144 d s and sh
11/17/55 2730 d s and sh
11/18/55 3390 three conventional cores 3330-3390’
11/19/55 3632 two conventional cores 3390-3430’
11/20/55 3700 ran electric log
11/21/55 3870 ran electric log, 4 1/2" casing cemented at 3699' w/150 sacks
11/23/55 testing WSO 3419, Perforated **3460-70’ and 3472-82’**
11/24/55 Flowing 5670 mcf/d (3 hr. Gauge), 3/8" bn. 1190/1400#. Shut in 1450/1450#

1/23/73 Well transferred to Exxon Corporation

10/12/80 Killed well w/55 bbls water. Tagged fill at 3503'
10/13/80 plugged to 3542' w/17sx
10/14/80 plugged to 3300'. Ran neutron collar log. Swabbed to 2600'. Perf'd. W/4 spf **3220-26’ & 3232-38'**
10/15/80 blew well for 3 hrs. Will clean out on compressor 180 mcf, 50#t.p
10/16/55 shut in, 1000# t.p
10/17/80 3870 on compressor 80-160 mcf/d
10/18/80 80-100 mcf/d

10/24/91 Well transferred to William Braun Resources
12/5/91 Well transferred to Alanmar Oil Company
7/30/93 Well transferred to Alanmar Energy

Alanmar Energy
Parrott Investment B-3

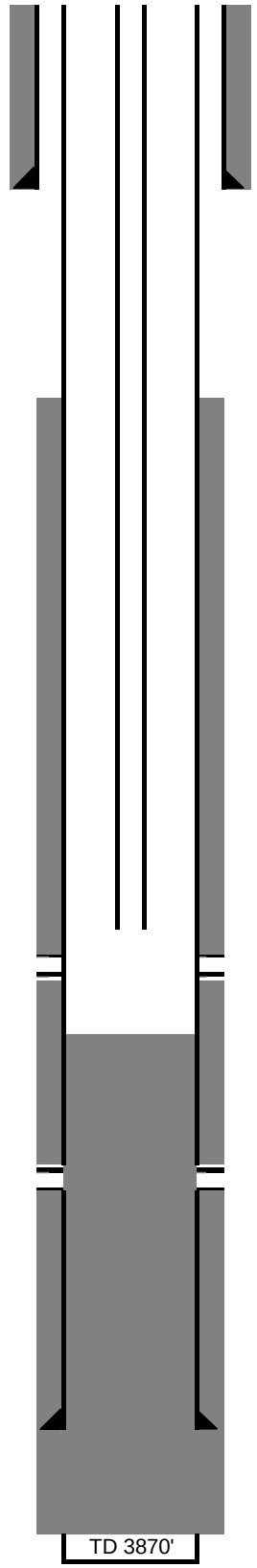
007-00039
Perkins Lake Gas Field
Butte County, CA
Sec 21, 20N, R1W MDB&M

WI/NRI:
Spud: 11-Nov-55
Comp: 24-Nov-55

KB: 117
DF:
GL: 106

Directional Data:

NOT TO SCALE



Surface Casing: 7" cemented at 622 ft
.

10/14/80 Ran tubing to 3166'

10/14/80 Perforate 3220-26' and 3232-38'

10/14/80 Plugged to 3300'

11/23/55 WSO at 3419'

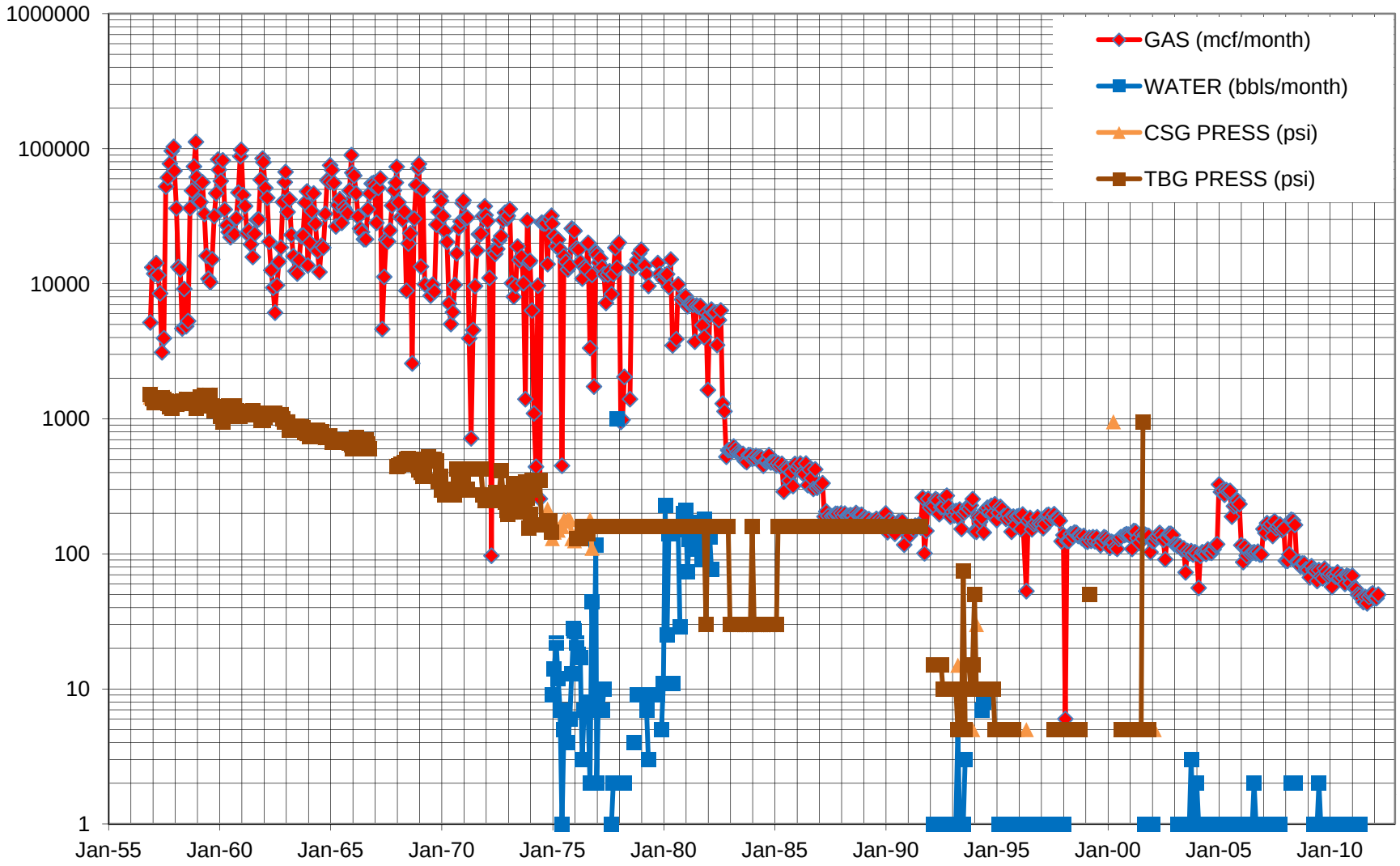
11/23/55 Perforated 3460-70' and 3472-82'

10/13/80 Plugged to 3542'

Top of cement 3665
Production Casing: 4-1/2" cemented at 3699'

00700039 PARROTT INVESTMENT B-3

CUM PROD 7,821,921 MCF; 4217 BBLS H2O



	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-56	1450	1525	5170	0	10
Jan-57	1450	1420	13239	0	22
Feb-57	1500	1320	11871	0	21
Mar-57	1425	1400	14253	0	23
Apr-57	1425	1400	11586	0	21
May-57	1425	1420	8490	0	22
Jun-57	1440	1440	3111	0	24
Jul-57	1425	1400	3958	0	13
Aug-57	1375	1350	52538	0	23
Sep-57	1350	1300	61195	0	29
Oct-57	1325	1225	77653	0	31
Nov-57	1300	1200	96499	0	30
Dec-57	1325	1300	103380	0	31
Jan-58	1335	1335	68628	0	26
Feb-58	1300	1275	36214	0	28
Mar-58	1325	1325	13324	0	31
Apr-58	1325	1300	12779	0	30
May-58	1350	1350	4672	0	31
Jun-58	1350	1350	9159	0	30
Jul-58	1400	1400	4855	0	31
Aug-58	1350	1400	5301	0	31
Sep-58	1350	1300	36372	0	30
Oct-58	1350	1350	49024	0	31
Nov-58	1350	1350	73984	0	30
Dec-58	1300	1200	112433	0	30
Jan-59	1350	1350	61661	0	31
Feb-59	1250	1250	41137	0	28
Mar-59	0	1450	40367	0	31
Apr-59	1400	1400	56431	0	28
May-59	1500	1500	32965	0	31
Jun-59	1500	1500	16115	0	30
Jul-59	1450	1450	10909	0	31
Aug-59	1500	1500	10283	0	31
Sep-59	1250	1250	15198	0	30
Oct-59	1150	1150	31718	0	31
Nov-59	1150	1150	46778	0	30
Dec-59	1150	1150	83329	0	31
Jan-60	1150	1150	70018	0	31
Feb-60	1050	1050	57720	0	29
Mar-60	950	950	82079	0	31
Apr-60	1200	1200	35505	0	30
May-60	1225	1225	27049	0	31
Jun-60	1250	1250	24161	0	30
Jul-60	1250	1250	22132	0	31
Aug-60	1250	1250	23113	0	31
Sep-60	1250	1250	23350	0	30
Oct-60	1150	1150	30640	0	31
Nov-60	1050	1050	47438	0	30
Dec-60	1045	1045	88019	0	31
Jan-61	0	1135	98338	0	31
Feb-61	0	1075	45454	0	28
Mar-61	0	1075	37645	0	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Apr-61	0	1090	23634	0	30
May-61	0	1075	24764	0	31
Jun-61	0	1100	19622	0	30
Jul-61	0	1150	15792	0	31
Aug-61	0	1100	23479	0	31
Sep-61	0	1075	29726	0	30
Oct-61	0	1100	30046	0	31
Nov-61	0	970	59028	0	30
Dec-61	0	975	84805	0	31
Jan-62	0	975	79585	0	31
Feb-62	0	1025	51275	0	28
Mar-62	0	1075	43328	0	31
Apr-62	0	1075	20519	0	30
May-62	0	1075	12598	0	24
Jun-62	0	1100	9370	0	25
Jul-62	0	1100	6116	0	31
Aug-62	0	1075	9758	0	29
Sep-62	0	0	14603	0	30
Oct-62	0	1075	18596	0	31
Nov-62	0	1005	40342	0	30
Dec-62	0	950	56570	0	31
Jan-63	0	950	67422	0	31
Feb-63	0	950	34033	0	26
Mar-63	0	830	42207	0	31
Apr-63	0	860	23032	0	30
May-63	0	860	16029	0	31
Jun-63	0	885	12423	0	30
Jul-63	0	880	11913	0	24
Aug-63	0	878	15033	0	30
Sep-63	0	875	22619	0	30
Oct-63	0	860	22777	0	31
Nov-63	0	790	39966	0	30
Dec-63	0	775	48348	0	31
Jan-64	0	775	13666	0	31
Feb-64	0	735	20170	0	28
Mar-64	0	760	34589	0	31
Apr-64	0	800	46725	0	30
May-64	0	815	27946	0	31
Jun-64	0	825	17515	0	30
Jul-64	0	800	12228	0	31
Aug-64	0	800	19183	0	31
Sep-64	0	740	18537	0	30
Oct-64	0	725	32978	0	31
Nov-64	0	725	58595	0	30
Dec-64	0	750	56902	0	31
Jan-65	0	750	75511	0	31
Feb-65	0	675	69620	0	28
Mar-65	0	675	55810	0	31
Apr-65	0	670	26623	0	19
May-65	0	700	38338	0	28
Jun-65	0	700	42314	0	29
Jul-65	0	700	28315	0	28

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Aug-65	0	685	36767	0	31
Sep-65	0	675	34964	0	30
Oct-65	0	700	33242	0	31
Nov-65	0	665	49076	0	30
Dec-65	0	640	89747	0	31
Jan-66	0	600	66517	0	28
Feb-66	0	638	63275	0	28
Mar-66	0	725	46639	0	31
Apr-66	0	625	31421	0	30
May-66	0	600	25690	0	20
Jun-66	0	650	24159	0	28
Jul-66	0	700	21368	0	26
Aug-66	0	700	21371	0	28
Sep-66	0	650	35778	0	27
Oct-66	0	600	46628	0	28
Nov-66	0	0	55233	0	30
Dec-66	0	0	55974	0	31
Jan-67	0	0	53035	0	25
Feb-67	0	0	28311	0	21
Mar-67	0	0	51333	0	22
Apr-67	0	0	60477	0	28
May-67	0	0	4622	0	6
Jun-67	0	0	11260	0	15
Jul-67	0	0	21241	0	16
Aug-67	0	0	20581	0	31
Sep-67	0	0	24862	0	29
Oct-67	0	0	37990	0	27
Nov-67	0	0	49291	0	28
Dec-67	0	0	56176	0	27
Jan-68	445	445	73592	0	31
Feb-68	449	449	40157	0	28
Mar-68	460	460	31122		17
Apr-68	463	463	29907		19
May-68	474	474	34302		31
Jun-68	500	500	8890		21
Jul-68	508	508	19893	0	29
Aug-68	500	500	23689	0	29
Sep-68	500	500	2574	0	3
Oct-68	503	503	30386	0	31
Nov-68	495	495	53995	0	30
Dec-68	451	451	71891	0	31
Jan-69	418	418	77327	0	30
Feb-69	400	400	13413	0	28
Mar-69	375	375	49704	0	24
Apr-69	450	450	9912	0	9
May-69	0	0	0	0	0
Jun-69	525	525	0	0	0
Jul-69	500	500	8176	0	15
Aug-69	500	500	9854	0	18
Sep-69	505	505	8757	0	18
Oct-69	485	485	27419	0	28
Nov-69	345	345	34034	0	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-69	0	375	44188	0	31
Jan-70	300	300	41223	0	31
Feb-70	300	300	31745	0	28
Mar-70	275	275	24518	0	23
Apr-70	275	275	20417	0	26
May-70	275	275	7154	0	11
Jun-70	275	275	5037	0	7
Jul-70	275	275	6169	0	10
Aug-70	275	275	9826	0	17
Sep-70	425	425	16802	0	16
Oct-70	350	350	25969	0	30
Nov-70	360	360	28967	0	24
Dec-70	360	360	39555	0	31
Jan-71	360	360	41568	0	31
Feb-71	300	300	30532	0	28
Mar-71	300	300	30940	0	29
Apr-71	425	425	3947	0	6
May-71	425	425	717	0	1
Jun-71	425	425	4549	0	6
Jul-71	425	425	9631	0	16
Aug-71	425	425	17643	0	28
Sep-71	425	425	23294	0	30
Oct-71	425	425	23532	0	29
Nov-71	300	275	31845	0	30
Dec-71	250	250	37520	0	31
Jan-72	250	250	32233	0	31
Feb-72	250	250	29136	0	28
Mar-72	250	250	11053	0	13
Apr-72	0	0	97	0	1
May-72	250	250	17515	0	29
Jun-72	0	285	16676	0	31
Jul-72	0	285	18124	0	31
Aug-72	0	285	21079	0	30
Sep-72	415	415	22590	0	30
Oct-72	0	285	29709	0	31
Nov-72	0	240	33661	0	30
Dec-72	0	210	30548	0	31
Jan-73	0	195	31891	0	31
Feb-73	0	204	35732	0	28
Mar-73	0	240	10106	0	11
Apr-73	220	330	8015	0	12
May-73	0	315	9669	0	12
Jun-73	0	289	18903	0	25
Jul-73	0	280	14998	0	29
Aug-73	0	204	15871	0	31
Sep-73	0	230	10114	0	20
Oct-73	0	340	1400	0	21
Nov-73	0	260	29578	0	28
Dec-73	0	155	14327	0	15
Jan-74	0	195	14808	0	18
Feb-74	0	350	6345	0	9
Mar-74	0	300	1097	0	2

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Apr-74	0	350	442	0	2
May-74	0	0	9706	0	10
Jun-74	0	350	256	0	2
Jul-74	0	165	28404	0	31
Aug-74	0	0	27980	0	31
Sep-74	0	0	28013	0	30
Oct-74	215	0	13987	0	15
Nov-74	0	175	30151	0	28
Dec-74	0	145	31922	0	31
Jan-75	130	0	27925	9	31
Feb-75	145	0	22634	14	28
Mar-75	160	0	18973	22	31
Apr-75	150	0	21229	12	30
May-75	160	0	18025	7	31
Jun-75	160	0	450	1	2
Jul-75	180	0	16032	5	31
Aug-75	175	0	14549	4	31
Sep-75	180	0	12782	4	30
Oct-75	180	0	13619	6	31
Nov-75	130	0	25702	13	30
Dec-75	135	0	25000	28	31
Jan-76	125	0	24615	27	31
Feb-76	0	130	18304	22	29
Mar-76	0	130	17892	18	31
Apr-76	0	130	14518	17	30
May-76	0	160	10927	3	31
Jun-76	0	155	13294	7	30
Jul-76	0	160	12873	8	24
Aug-76	0	140	20145	7	29
Sep-76	180	0	3347	2	5
Oct-76	110	0	11653	44	17
Nov-76	0	0	1735	7	30
Dec-76	0	0	17214	116	31
Jan-77	0	160	16435	2	31
Feb-77	0	160	14351	10	28
Mar-77	0	160	15432	0	31
Apr-77	0	160	13261	7	30
May-77	0	160	11789	10	31
Jun-77	0	160	7210	0	30
Jul-77	0	160	11718	0	31
Aug-77	0	160	12398	0	31
Sep-77	0	160	8389	1	30
Oct-77	0	160	11824	2	31
Nov-77	0	160	18496	0	30
Dec-77	0	160	13164	1003	31
Jan-78	0	160	20172	0	31
Feb-78	0	160	948	0	28
Mar-78	0	160	985	0	0
Apr-78	0	160	2046	2	3
May-78	0	160	0	0	0
Jun-78	0	160	0	0	0
Jul-78	0	160	1400	0	0

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS		
Aug-78	0	160	13047	0	31		
Sep-78	0	160	13213	4	30		
Oct-78	0	160	13684	0	31		
Nov-78	0	160	15116	9	29		
Dec-78	0	160	16868	0	31		
Jan-79	0	160	17891	0	31		
Feb-79	0	160	13601	0	28		
Mar-79	0	160	13630	9	31		
Apr-79	0	160	11825	7	30		
May-79	0	160	9642	3	31		
Jun-79	0	160	0	0	0		
Jul-79	0	160	0	0	0		
Aug-79	0	160	0	0	0		
Sep-79	0	160	0	0	0		
Oct-79	0	160	14267	9	31		
Nov-79	0	160	11844	0	30		
Dec-79	0	160	11185	5	31		
Jan-80	0	160	10753	11	28		
Feb-80	0	160	11592	228	29		
Mar-80	0	160	11813	25	31		
Apr-80	0	160	9485	141	30		
May-80	0	160	15138	0	31		
Jun-80	0	160	3495	11	10		
Jul-80	0	160	0	0	0		
Aug-80	0	160	3894	0	11		
Sep-80	0	160	9906	151	30		
Oct-80	0	0	0	29	20	7618953	2082
Nov-80	0	160	7652	0	0		
Dec-80	0	160	8018	198	31		
Jan-81	0	160	8123	211	31		
Feb-81	0	160	6833	74	28		
Mar-81	0	160	7144	128	31		
Apr-81	0	160	7120	165	30		
May-81	0	160	6992	166	31		
Jun-81	0	160	3726	108	21		
Jul-81	0	160	6907	113	26		
Aug-81	0	160	6774	172	31		
Sep-81	0	160	6872	140	30		
Oct-81	0	160	4926	91	25		
Nov-81	0	160	4031	182	17		
Dec-81	0	30	6096	0	30		
Jan-82	0	160	1635	0	3		
Feb-82	0	160	5922	133	28		
Mar-82	0	160	6451	77	31		
Apr-82	0	160	6088	0	30		
May-82	0	160	6123	0	30		
Jun-82	0	160	3521	0	29		
Jul-82	0	160	5392	0	30		
Aug-82	0	160	6355	0	31		
Sep-82	0	160	1298	0	5		
Oct-82	0	160	1136	0	31		
Nov-82	0	160	524	0	30		

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-82	0	160	586	0	28
Jan-83	0	30	587	0	28
Feb-83	0	30	589	0	26
Mar-83	0	30	625	0	31
Apr-83	0	30	597	0	30
May-83	0	30	562	0	29
Jun-83	0	30	552	0	29
Jul-83	0	30	546	0	29
Aug-83	0	30	551	0	29
Sep-83	0	30	488	0	28
Oct-83	0	30	478	0	25
Nov-83	0	30	540	0	30
Dec-83	0	30	537	0	31
Jan-84	0	160	507	0	29
Feb-84	0	30	512	0	28
Mar-84	0	30	533	0	31
Apr-84	0	30	518	0	29
May-84	0	30	523	0	31
Jun-84	0	30	516	0	29
Jul-84	0	30	450	0	26
Aug-84	0	30	487	0	24
Sep-84	0	30	489	0	28
Oct-84	0	30	540	0	30
Nov-84	0	30	475	0	29
Dec-84	0	30	479	0	31
Jan-85	0	30	476	0	30
Feb-85	0	30	453	0	28
Mar-85	0	160	470	0	30
Apr-85	0	160	447	0	28
May-85	0	160	465	0	31
Jun-85	0	160	289	0	30
Jul-85	0	160	436	0	31
Aug-85	0	160	426	0	30
Sep-85	0	160	348	0	26
Oct-85	0	160	404	0	24
Nov-85	0	160	318	0	20
Dec-85	0	160	464	0	30
Jan-86	0	160	424	0	30
Feb-86	0	160	449	0	28
Mar-86	0	160	467	0	30
Apr-86	0	160	399	0	29
May-86	0	160	389	0	31
Jun-86	0	160	467	0	30
Jul-86	0	160	323	0	31
Aug-86	0	160	420	0	30
Sep-86	0	160	364	0	30
Oct-86	0	160	303	0	31
Nov-86	0	160	423	0	30
Dec-86	0	160	309	0	26
Jan-87	0	160	318	0	31
Feb-87	0	160	323	0	27
Mar-87	0	160	334	0	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Apr-87	0	160	189	0	30
May-87	0	160	206	0	30
Jun-87	0	160	191	0	29
Jul-87	0	160	0	0	28
Aug-87	0	160	190	0	29
Sep-87	0	160	192	0	30
Oct-87	0	160	198	0	31
Nov-87	0	160	198	0	30
Dec-87	0	160	0	0	31
Jan-88	0	160	200	0	30
Feb-88	0	160	189	0	29
Mar-88	0	160	199	0	30
Apr-88	0	160	190	0	29
May-88	0	160	191	0	30
Jun-88	0	160	194	0	28
Jul-88	0	160	192	0	31
Aug-88	0	160	181	0	31
Sep-88	0	160	201	0	30
Oct-88	0	160	195	0	31
Nov-88	0	160	193	0	30
Dec-88	0	160	195	0	31
Jan-89	0	160	183	0	29
Feb-89	0	160	185	0	28
Mar-89	0	160	180	0	30
Apr-89	0	160	181	0	30
May-89	0	160	172	0	31
Jun-89	0	160	0	0	30
Jul-89	0	160	176	0	31
Aug-89	0	160	182	0	31
Sep-89	0	160	175	0	30
Oct-89	0	160	169	0	31
Nov-89	0	160	163	0	30
Dec-89	0	160	169	0	31
Jan-90	0	160	200	0	31
Feb-90	0	160	145	0	28
Mar-90	0	160	177	0	31
Apr-90	0	160	168	0	30
May-90	0	160	171	0	31
Jun-90	0	160	141	0	30
Jul-90	0	160	167	0	31
Aug-90	0	160	173	0	31
Sep-90	0	160	170	0	30
Oct-90	0	160	176	0	31
Nov-90	0	160	117	0	24
Dec-90	0	160	148	0	28
Jan-91	0	160	156	0	31
Feb-91	0	160	137	0	28
Mar-91	0	160	159	0	31
Apr-91	0	160	152	0	30
May-91	0	160	162	0	31
Jun-91	0	160	158	0	30
Jul-91	0	160	165	0	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Aug-91	0	160	157	0	31
Sep-91	0	0	261	0	30
Oct-91	0	0	101	0	31
Nov-91	0	0	148	0	30
Dec-91	0	0	256	0	31
Jan-92	0	0	221	0	31
Feb-92	0	0	232	0	29
Mar-92	0	15	227	1	31
Apr-92	0	15	255	1	30
May-92	0	15	249	0	31
Jun-92	0	0	197	0	30
Jul-92	0	15	222	1	31
Aug-92	0	10	223	1	31
Sep-92	0	10	262	1	30
Oct-92	0	10	270	1	31
Nov-92	0	10	225	1	30
Dec-92	0	10	189	1	31
Jan-93	0	10	205	1	31
Feb-93	0	10	193	1	28
Mar-93	0	10	208	1	31
Apr-93	15	5	189	5	30
May-93	0	10	213	1	31
Jun-93	0	5	153	1	30
Jul-93	0	75	199	1	31
Aug-93	0	5	206	3	31
Sep-93	15	0	222	0	30
Oct-93	0	15	216	0	30
Nov-93	0	10	229	0	30
Dec-93	5	15	255	0	30
Jan-94	0	50	147	0	31
Feb-94	30	10	146	0	28
Mar-94	0	10	186	10	31
Apr-94	0	10	173	10	28
May-94	0	0	186	7	31
Jun-94	0	10	144	8	30
Jul-94	0	10	212	10	31
Aug-94	0	10	220	9	31
Sep-94	0	10	203	0	30
Oct-94	0	10	227	0	31
Nov-94	10	10	198	0	30
Dec-94	0	5	233	0	31
Jan-95	0	5	178	0	31
Feb-95	0	5	202	1	31
Mar-95	0	5	223	0	31
Apr-95	0	5	215	0	28
May-95	0	5	191	1	31
Jun-95	0	0	182	1	30
Jul-95	0	0	197	1	31
Aug-95	0	0	184	1	31
Sep-95	0	5	146	1	30
Oct-95	0	5	189	1	31
Nov-95	0	0	164	0	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-95	5	0	189	0	31
Jan-96	0	0	191	1	31
Feb-96	0	0	153	1	29
Mar-96	0	0	196	1	31
May-96	5	0	53	1	31
Jun-96	0	0	176	1	30
Jul-96	0	0	185	0	31
Aug-96	0	0	152	0	31
Sep-96	0	0	166	1	30
Oct-96	0	0	170	1	31
Nov-96	0	0	187	1	30
Dec-96	0	0	169	1	31
Jan-97	0	0	166	1	31
Feb-97	0	0	155	1	29
Mar-97	0	0	167	1	31
Apr-97	0	0	193	0	30
May-97	0	0	195	1	31
Jun-97	0	0	178	0	30
Jul-97	0	0	188	0	31
Aug-97	0	5	197	0	31
Sep-97	0	5	184	1	30
Oct-97	0	0	184	0	31
Nov-97	0	0	176	1	30
Dec-97	0	0	124	1	31
Jan-98	0	5	138	1	31
Feb-98	0	5	6	0	2
Mar-98	0	5	125	0	31
Apr-98	0	5	125	0	30
May-98	0	5	140	0	30
Jun-98	0	5	135	0	30
Jul-98	0	5	144	0	31
Aug-98	0	0	143	0	31
Sep-98	0	5	136	0	30
Oct-98	0	5	136	0	31
Nov-98	0	0	131	0	30
Dec-98	0	0	136	0	31
Jan-99	0	0	124	0	31
Feb-99	0	0	123	0	28
Mar-99	0	50	132	0	31
Apr-99	0	0	125	0	28
May-99	0	0	133	0	31
Jun-99	0	0	124	0	30
Jul-99	0	0	133	0	31
Aug-99	0	0	121	0	30
Sep-99	0	0	116	0	30
Oct-99	0	0	125	0	31
Nov-99	0	0	133	0	30
Dec-99	0	0	131	0	31
Jan-00	0	0	126	0	31
Feb-00	0	0	111	0	29
Mar-00	0	0	123	0	30
Apr-00	952	0	121	0	30

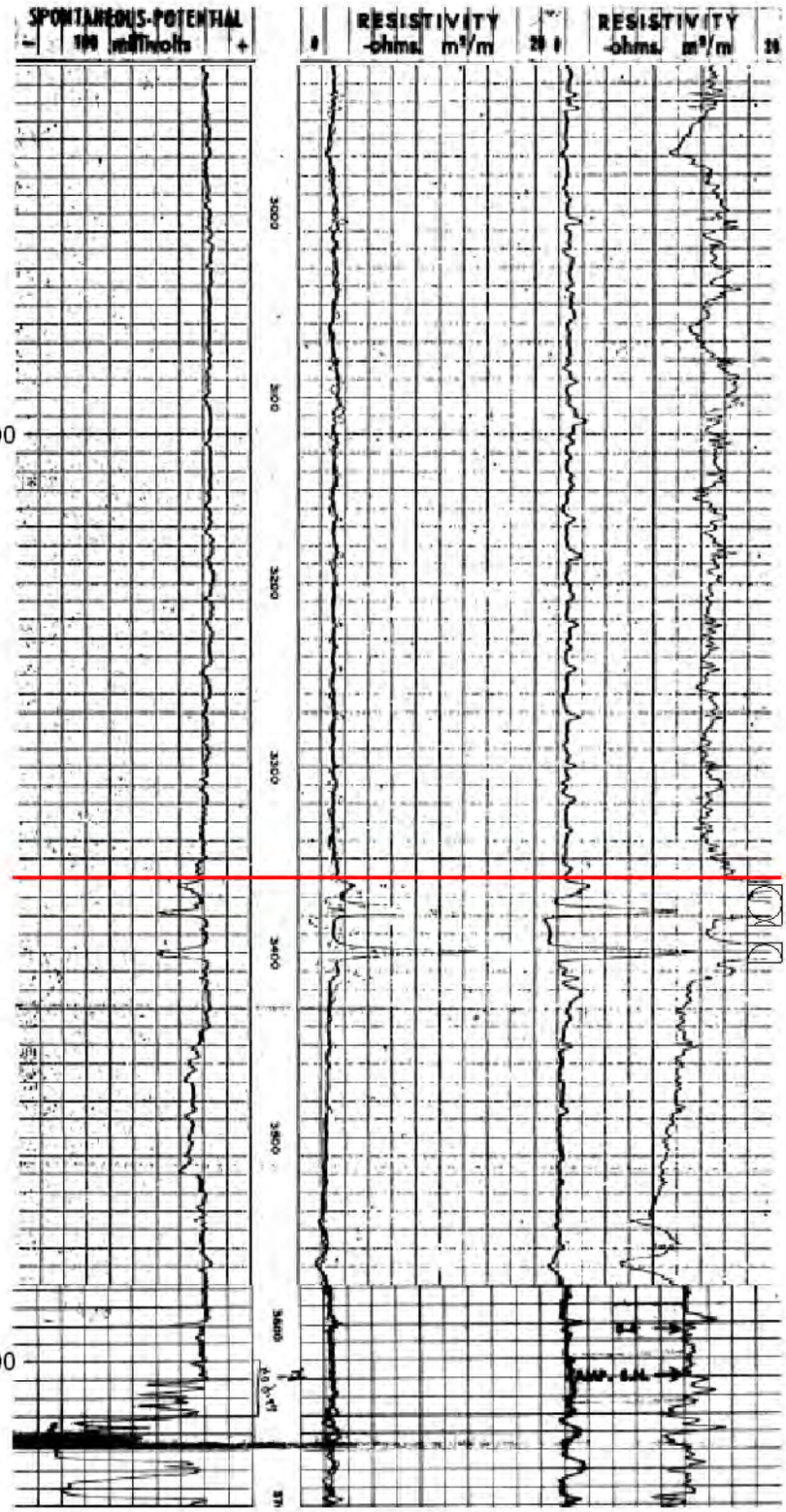
	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
May-00	0	0	112	0	31
Jun-00	0	0	109	0	30
Jul-00	0	0	129	0	31
Aug-00	0	5	133	0	31
Sep-00	0	0	0	0	0
Oct-00	0	5	138	0	31
Nov-00	0	0	140	0	30
Dec-00	0	0	139	0	31
Jan-01	0	0	137	0	31
Feb-01	0	5	109	0	28
Mar-01	0	5	148	0	31
Apr-01	0	0	147	0	30
May-01	0	0	131	0	31
Jun-01	0	0	121	0	30
Jul-01	0	5	140	0	31
Aug-01	5	952	129	0	31
Sep-01	5	0	139	1	30
Oct-01	5	0	137	1	31
Nov-01	0	5	136	1	30
Dec-01	0	0	103	1	31
Jan-02	0	0	125	1	31
Feb-02	5	0	125	0	28
Mar-02	0	0	133	0	31
Apr-02	0	0	136	0	28
May-02	0	0	143	0	30
Jun-02	0	0	138	0	30
Jul-02	0	0	127	0	30
Aug-02	0	0	91	0	26
Sep-02	0	0	132	0	30
Oct-02	0	0	141	0	31
Nov-02	0	0	141	0	30
Dec-02	0	0	138	0	31
Jan-03	0	0	118	0	27
Feb-03	0	0	117	0	28
Mar-03	0	0	114	1	30
Apr-03	0	0	114	1	29
May-03	0	0	108	1	28
Jun-03	0	0	110	1	30
Jul-03	0	0	73	1	31
Aug-03	0	0	105	1	30
Sep-03	0	0	101	1	28
Oct-03	0	0	105	3	31
Nov-03	0	0	99	1	30
Dec-03	0	0	103	1	23
Jan-04	0	0	101	2	31
Feb-04	0	0	56	1	17
Mar-04	0	0	97	1	28
Apr-04	0	0	103	1	30
May-04	0	0	102	0	31
Jun-04	0	0	100	1	28
Jul-04	0	0	108	1	30
Aug-04	0	0	103	1	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Sep-04	0	0	102	1	29
Oct-04	0	0	108	1	31
Nov-04	0	0	116	1	30
Dec-04	0	0	118	0	31
Jan-05	0	0	327	1	31
Feb-05	0	0	288	1	28
Mar-05	0	0	295	1	30
Apr-05	0	0	274	1	30
May-05	0	0	297	1	31
Jun-05	0	0	288	1	30
Jul-05	0	0	293	1	31
Aug-05	0	0	189	1	31
Sep-05	0	0	226	1	30
Oct-05	0	0	232	1	31
Nov-05	0	0	248	1	30
Dec-05	0	0	234	1	29
Jan-06	0	0	116	1	31
Feb-06	0	0	87	1	28
Mar-06	0	0	113	1	31
Apr-06	0	0	97	1	26
May-06	0	0	106	1	31
Jun-06	0	0	100	1	29
Jul-06	0	0	102	1	30
Aug-06	0	0	103	2	30
Sep-06	0	0	101	1	29
Oct-06	0	0	104	0	31
Nov-06	0	0	99	0	30
Dec-06	0	0	99	0	29
Jan-07	0	0	153	0	31
Feb-07	0	0	143	0	28
Mar-07	0	0	169	0	31
Apr-07	0	0	160	1	30
May-07	0	0	166	1	31
Jun-07	0	0	136	1	30
Jul-07	0	0	175	1	31
Aug-07	0	0	155	0	31
Sep-07	0	0	160	1	30
Oct-07	0	0	165	1	31
Nov-07	0	0	150	0	29
Dec-07	0	0	154	0	31
Jan-08	0	0	89	0	31
Feb-08	0	0	89	0	29
Mar-08	0	0	99	0	31
Apr-08	0	0	179	2	26
May-08	0	0	177	2	31
Jun-08	0	0	164	2	29
Jul-08	0	0	87	0	23
Aug-08	0	0	87	0	31
Sep-08	0	0	81	0	30
Oct-08	0	0	85	0	31
Nov-08	0	0	85	0	30
Dec-08	0	0	77	0	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS		
Jan-09	0	0	76	0	31		
Feb-09	0	0	67	0	28		
Mar-09	0	0	81	0	31		
Apr-09	0	0	76	1	30		
May-09	0	0	75	1	31		
Jun-09	0	0	63	1	30		
Jul-09	0	0	76	2	31		
Aug-09	0	0	68	1	29		
Sep-09	0	0	66	1	25		
Oct-09	0	0	78	0	31		
Nov-09	0	0	74	0	30		
Dec-09	0	0	69	0	30		
Jan-10	0	0	71	0	31		
Feb-10	0	0	57	0	28		
Mar-10	0	0	70	1	31		
Apr-10	0	0	68	0	30		
May-10	0	0	73	0	31		
Jun-10	0	0	66	0	30		
Jul-10	0	0	70	1	31		
Aug-10	0	0	67	1	31		
Sep-10	0	0	60	1	30		
Oct-10	0	0	69	1	31		
Nov-10	0	0	68	1	30		
Dec-10	0	0	61	1	31		
Jan-11	0	0	69	0	29		
Feb-11	0	0	56	0	26		
Mar-11	0	0	55	0	29		
Apr-11	0	0	50	0	30		
May-11	0	0	49	1	31		
Jun-11	0	0	47	0	30		
Jul-11	0	0	44	0	31		
Aug-11	0	0	48	0	31		
Sep-11	0	0	43	0	30		
Oct-11	0	0	48	0	31		
Nov-11	0	0	50	0	30		
Dec-11	0	0	51	0	31		
Jan-12	0	0	47	0	29		
Feb-12	0	0	47	0	27		
Mar-12	0	0	50	0	31	202968	2135
			7,821,921	4,217			

Cum Gas All Zones: 8127718 MCF

04007000400000
ALANMAR ENERGY
PARROTT INVESTMENT CO. B-4
TWP: 20 N - Range: 1 W - Sec. 16
Spud Date=11/28/1955



Princeton Canyon Fill
(Eocene)

Top Perkins Lake Sands

-3000

-3500

04-007-00040 ** 19-20N-1W MD

ALANMAR ENERGY "PARROTT INVESTMENT CO." B-4

Field: Perkins Lake Gas

County: Butte

Elev: 120 KB

TD: 3700

LOC: 2800 N 700 W SEC

☐ Directional

Spud: 11/28/55
Current Status: Abandoned Gas
Horizons: top of producing sand 3361'
Original Operator: Humble Oil & Refining Co.
Casing: 7" cemented at 611'; 4-1/2" cemented at 3462'

10/28/55 loc
11/28/55 rigging rotary, spud in
11/29/55 631 d 7" cemented at 611' with 180 sacks
12/01/55 2435 d
12/02/55 3303 d
12/03/55 3377 three conventional cores 3330-3377'
12/04/55 3425 three conventional cores 3377-3425'
12/05/55 3547 four conventional cores 3425-3505'
12/06/55 3700 ran electric, microlog, dipmeter, velocity survey, induction logs
12/07/55 3700 plugged to 3549' TOC 3419'
12/08/55 testing, drilled plug to 3465'
12/09/55 cmtd 4 1/2" casing at 3462 with 150 sax
12/10/55 gun perforated **3364-3385'** and **3395-3405'**. Hung 2 1/2" from 3356'. Completed and flowing 4380 mcf, 3/8" choke, 1110/1325#, shut-in pressure 1350/1350#

1/23/73 Well transferred to Exxon Corporation
10/24/91 Well transferred to William Braun Resources
12/5/91 Well transferred to Alanmar Oil Company
7/30/93 Well transferred to Alanmar Energy

11/15/11 Well abandoned

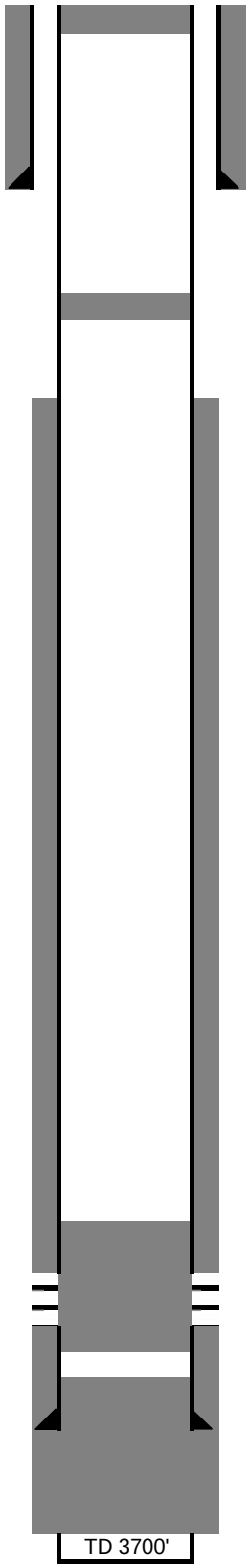
Alanmar Energy
Parrott Investment B-4

007-00040
Perkins Lake Gas Field
Butte County, CA
Sec 19, 20N, R1W MDB&M

WI/NRI:
Spud: 28-Nov-55
Comp: 10-Dec-55

KB: 120
DF:
GL: 110

Directional Data:



11/15/11 Plugged 0-35'

Surface Casing: 7" cemented at 611 ft
.

10/28/11 Plugged 1181-1460'

10/27/11 Plugged 3037-3409'

12/10/55 Perforated 3364-85', 3395-3405'

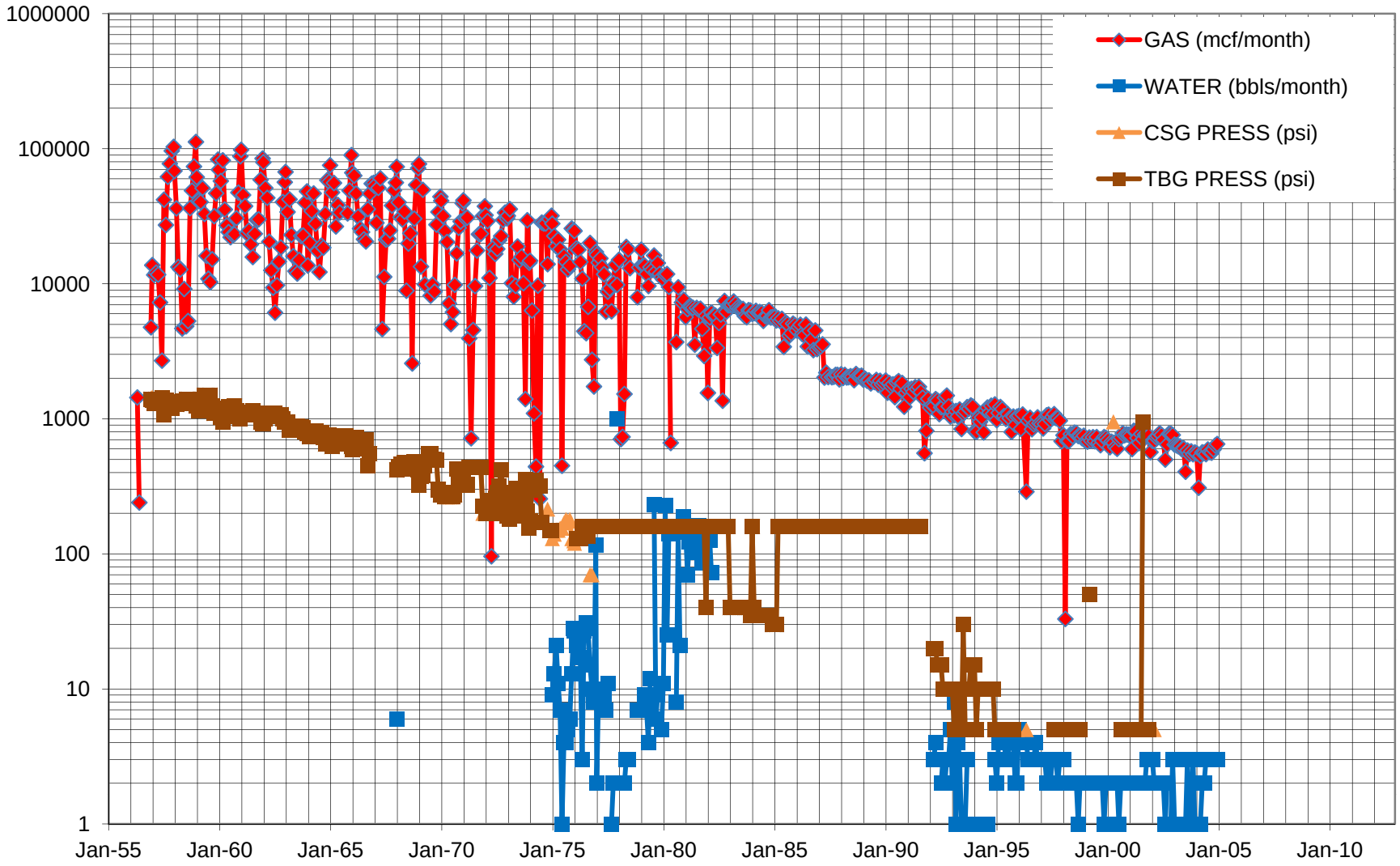
Top of cement 3430
Production Casing: 4-1/2" cemented at 3462'

TD 3700'

NOT TO SCALE

00700040 PARROTT INVESTMENT B-4

CUM PROD 8,127,718 MCF; 4466 BBLS H2O



	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
May-56	0	0	1440	0	24
Jun-56	0	0	240	0	4
Jul-56	0	0	0	0	0
Aug-56	0	0	0	0	0
Sep-56	0	0	0	0	0
Oct-56	0	0	0	0	0
Nov-56	0	0	0	0	0
Dec-56	1425	1400	4768	0	8
Jan-57	1450	1375	13756	0	22
Feb-57	1375	1300	11643	0	21
Mar-57	1425	1400	12110	0	23
Apr-57	1425	1400	11704	0	21
May-57	1425	1400	7274	0	22
Jun-57	1425	1425	2701	0	24
Jul-57	1256	1072	41968	0	23
Aug-57	1375	1375	27276	0	18
Sep-57	1325	1250	62032	0	29
Oct-57	1250	1200	77653	0	31
Nov-57	1275	1200	96500	0	30
Dec-57	1325	1300	103380	0	31
Jan-58	1333	1330	68629	0	26
Feb-58	1300	1275	36214	0	28
Mar-58	1325	1300	13324	0	31
Apr-58	1325	1300	12779	0	30
May-58	1350	1350	4672	0	31
Jun-58	1350	1350	9159	0	30
Jul-58	1400	1400	4855	0	31
Aug-58	1350	1400	5302	0	31
Sep-58	1300	1300	36373	0	30
Oct-58	1350	1350	49024	0	31
Nov-58	1350	1300	73984	0	30
Dec-58	1350	1250	112433	0	30
Jan-59	1350	1300	61661	0	31
Feb-59	1250	1150	41138	0	28
Mar-59	0	1400	40367	0	31
Apr-59	1400	1400	51178	0	28
May-59	1500	1500	32965	0	31
Jun-59	1500	1500	16115	0	30
Jul-59	1450	1450	10909	0	31
Aug-59	1500	1500	10283	0	31
Sep-59	1250	1250	15199	0	30
Oct-59	1100	1100	31718	0	31
Nov-59	1150	1150	46778	0	30
Dec-59	1150	1150	83329	0	31
Jan-60	1150	1150	70019	0	31
Feb-60	1025	1025	57719	0	29
Mar-60	950	950	82078	0	31
Apr-60	1200	1200	35505	0	30
May-60	1200	1200	27049	0	31
Jun-60	1225	1225	24161	0	30
Jul-60	1225	1225	22133	0	31
Aug-60	1250	1225	23113	0	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Sep-60	1250	1250	23350	0	30
Oct-60	1150	1150	30640	0	31
Nov-60	1050	1050	47438	0	30
Dec-60	1000	1000	88019	0	31
Jan-61	0	1125	98337	0	31
Feb-61	0	1075	45453	0	28
Mar-61	0	1075	37645	0	31
Apr-61	0	1090	23634	0	30
May-61	0	1075	24764	0	31
Jun-61	0	1100	19622	0	30
Jul-61	0	1150	15792	0	31
Aug-61	0	1100	23480	0	31
Sep-61	0	1075	29726	0	30
Oct-61	0	1100	30046	0	31
Nov-61	0	950	59028	0	30
Dec-61	0	925	84805	0	31
Jan-62	0	925	79585	0	31
Feb-62	0	1000	51274	0	28
Mar-62	0	1075	43328	0	31
Apr-62	0	1075	20519	0	30
May-62	0	1075	12598	0	24
Jun-62	0	1100	9370	0	25
Jul-62	0	1100	6117	0	31
Aug-62	0	1050	9757	0	31
Sep-62	0	0	14603	0	30
Oct-62	0	1075	18596	0	31
Nov-62	0	1000	40342	0	30
Dec-62	0	950	56571	0	31
Jan-63	0	950	67422	0	31
Feb-63	0	950	34032	0	26
Mar-63	0	825	42206	0	31
Apr-63	0	860	23031	0	30
May-63	0	860	16029	0	31
Jun-63	0	875	12423	0	30
Jul-63	0	880	11913	0	24
Aug-63	0	878	15033	0	30
Sep-63	0	875	22620	0	30
Oct-63	0	860	22777	0	31
Nov-63	0	800	39966	0	30
Dec-63	0	775	48348	0	31
Jan-64	0	775	13665	0	31
Feb-64	0	735	20169	0	28
Mar-64	0	740	34588	0	31
Apr-64	0	750	46725	0	30
May-64	0	815	27947	0	31
Jun-64	0	750	17515	0	30
Jul-64	0	750	12228	0	31
Aug-64	0	790	19183	0	31
Sep-64	0	725	18537	0	30
Oct-64	0	650	32978	0	31
Nov-64	0	750	58593	0	30
Dec-64	0	755	56904	0	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Jan-65	0	715	75512	0	31
Feb-65	0	625	47500	0	19
Mar-65	0	650	55811	0	31
Apr-65	0	665	26623	0	19
May-65	0	650	38338	0	28
Jun-65	0	650	33767	0	24
Jul-65	0	750	0	0	0
Aug-65	0	750	0	0	0
Sep-65	0	750	0	0	0
Oct-65	0	675	33242	0	31
Nov-65	0	675	49076	0	30
Dec-65	0	625	89747	0	31
Jan-66	0	590	66517	0	28
Feb-66	0	625	63277	0	28
Mar-66	0	725	46640	0	31
Apr-66	0	625	31421	0	30
May-66	0	600	25690	0	20
Jun-66	0	600	24159	0	28
Jul-66	0	700	21368	0	26
Aug-66	0	700	20607	0	27
Sep-66	0	450	35778	0	27
Oct-66	0	550	46628	0	28
Nov-66	0	0	55234	0	30
Dec-66	0	0	55974	0	31
Jan-67	0	0	53035	0	25
Feb-67	0	0	28311	0	21
Mar-67	0	0	51333	0	22
Apr-67	0	0	60477	0	28
May-67	0	0	4622	0	6
Jun-67	0	0	11260	0	15
Jul-67	0	0	21241	0	16
Aug-67	0	0	21582	0	31
Sep-67	0	0	24862	0	29
Oct-67	0	0	37991	0	27
Nov-67	0	0	49291	0	28
Dec-67	0	0	56176	0	27
Jan-68	419	419	73592	6	31
Feb-68	444	444	40157	0	28
Mar-68	463	463	31124	0	17
Apr-68	463	463	29907	0	19
May-68	474	474	34303	0	31
Jun-68	469	469	8891	0	21
Jul-68	428	428	19893	0	29
Aug-68	463	463	23691	0	29
Sep-68	463	463	2576	0	3
Oct-68	481	481	30386	0	31
Nov-68	475	475	53996	0	30
Dec-68	422	422	71892	0	31
Jan-69	325	325	77327	0	30
Feb-69	375	375	13413	0	28
Mar-69	380	380	49704	0	24
Apr-69	450	450	9912	0	9

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
May-69	0	0	0	0	0
Jun-69	550	550	0	0	0
Jul-69	550	550	8175	0	15
Aug-69	500	500	9854	0	18
Sep-69	500	500	8758	0	18
Oct-69	495	495	27421	0	28
Nov-69	300	300	34034	0	30
Dec-69	0	275	44188	0	31
Jan-70	275	275	41223	0	31
Feb-70	285	285	31747	0	28
Mar-70	265	265	24519	0	23
Apr-70	265	265	20417	0	26
May-70	265	265	7153	0	11
Jun-70	265	265	5037	0	7
Jul-70	265	265	6169	0	10
Aug-70	275	275	9825	0	17
Sep-70	425	425	16802	0	16
Oct-70	350	350	25969	0	30
Nov-70	350	350	28971	0	24
Dec-70	350	350	39556	0	31
Jan-71	350	350	41568	0	31
Feb-71	325	325	30533	0	28
Mar-71	325	325	30940	0	29
Apr-71	440	440	3947	0	6
May-71	440	440	718	0	1
Jun-71	440	440	4550	0	6
Jul-71	440	440	9631	0	16
Aug-71	440	440	17645	0	28
Sep-71	440	440	23295	0	30
Oct-71	440	440	23532	0	29
Nov-71	200	225	31845	0	30
Dec-71	225	225	37520	0	31
Jan-72	200	200	32234	0	31
Feb-72	250	250	29135	0	28
Mar-72	200	200	11054	0	13
Apr-72	0	0	96	0	1
May-72	200	200	18515	0	29
Jun-72	0	260	16675	0	31
Jul-72	0	285	18124	0	31
Aug-72	0	320	21079	0	30
Sep-72	420	420	22590	0	30
Oct-72	0	285	29709	0	31
Nov-72	0	240	33660	0	30
Dec-72	0	190	30548	0	31
Jan-73	0	195	31892	0	31
Feb-73	0	182	35733	0	28
Mar-73	0	225	10107	0	11
Apr-73	0	278	8015	0	12
May-73	0	307	9670	0	12
Jun-73	0	250	18903	0	25
Jul-73	0	230	14997	0	29
Aug-73	0	190	15872	0	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Sep-73	0	230	10115	0	20
Oct-73	0	355	1401	0	21
Nov-73	0	208	29579	0	28
Dec-73	0	155	14328	0	15
Jan-74	0	175	14808	0	18
Feb-74	0	307	6344	0	9
Mar-74	0	300	1098	0	2
Apr-74	0	350	443	0	2
May-74	0	0	9706	0	10
Jun-74	0	320	256	0	2
Jul-74	0	170	28405	0	31
Aug-74	0	0	27980	0	31
Sep-74	0	0	28013	0	30
Oct-74	215	0	13988	0	15
Nov-74	0	150	30152	0	28
Dec-74	0	150	31923	0	31
Jan-75	130	0	27925	9	31
Feb-75	140	0	22635	13	28
Mar-75	150	0	18972	21	31
Apr-75	150	0	21230	11	30
May-75	155	0	18025	7	31
Jun-75	155	0	450	1	2
Jul-75	170	0	16032	4	31
Aug-75	180	0	14548	4	31
Sep-75	175	0	12782	5	30
Oct-75	180	0	13619	6	31
Nov-75	130	0	25702	13	30
Dec-75	125	0	24999	28	31
Jan-76	120	0	24616	27	31
Feb-76	0	130	18303	21	29
Mar-76	0	130	17891	18	31
Apr-76	0	130	14519	17	30
May-76	0	160	10927	3	31
Jun-76	0	151	4457	27	30
Jul-76	0	160	4318	31	24
Aug-76	0	135	6756	28	29
Sep-76	70	0	20078	15	30
Oct-76	70	0	2741	10	4
Nov-76	0	0	1736	8	30
Dec-76	0	0	17214	116	31
Jan-77	0	160	16435	2	31
Feb-77	0	160	14350	10	28
Mar-77	0	160	15432	0	31
Apr-77	0	160	13260	8	30
May-77	0	160	11787	9	31
Jun-77	0	160	6211	7	30
Jul-77	0	160	8748	11	31
Aug-77	0	160	9255	0	31
Sep-77	0	160	6262	1	30
Oct-77	0	160	10135	2	31
Nov-77	0	160	13808	0	30
Dec-77	0	160	9827	1003	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Jan-78	0	160	15057	0	31
Feb-78	0	160	707	0	28
Mar-78	0	160	735	0	0
Apr-78	0	160	1528	2	3
May-78	0	160	18781	3	29
Jun-78	0	160	18040	3	30
Jul-78	0	160	13071	0	28
Aug-78	0	160	0	0	0
Sep-78	0	160	0	0	0
Oct-78	0	160	0	0	0
Nov-78	0	160	7960	7	16
Dec-78	0	160	13226	0	31
Jan-79	0	160	17891	0	31
Feb-79	0	160	13602	0	28
Mar-79	0	160	13629	9	31
Apr-79	0	160	11826	7	30
May-79	0	160	9642	4	31
Jun-79	0	160	13264	12	30
Jul-79	0	160	12661	0	0
Aug-79	0	160	16215	232	31
Sep-79	0	160	12322	6	30
Oct-79	0	160	14266	9	31
Nov-79	0	160	11845	0	30
Dec-79	0	160	11185	5	31
Jan-80	0	160	10753	11	28
Feb-80	0	160	11592	229	29
Mar-80	0	160	11814	25	31
Apr-80	0	160	9484	141	30
May-80	0	160	664	0	2
Jun-80	0	160	0	0	0
Jul-80	0	160	0	0	0
Aug-80	0	160	3707	8	11
Sep-80	0	160	9427	144	30
Oct-80	0	0	0	21	15
Nov-80	0	160	7282	0	0
Dec-80	0	160	7631	189	31
Jan-81	0	160	5664	147	23
Feb-81	0	160	6504	70	28
Mar-81	0	160	6798	123	31
Apr-81	0	160	6776	157	30
May-81	0	160	6653	158	31
Jun-81	0	160	3546	103	21
Jul-81	0	160	6627	108	27
Aug-81	0	160	6448	163	31
Sep-81	0	160	6540	133	30
Oct-81	0	160	4646	86	25
Nov-81	0	160	2927	132	17
Dec-81	0	40	5803	0	30
Jan-82	0	160	1557	0	3
Feb-82	0	160	5635	126	28
Mar-82	0	160	6140	73	31
Apr-82	0	160	5794	0	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
May-82	0	160	5828	0	30
Jun-82	0	160	3351	0	29
Jul-82	0	160	5133	0	30
Aug-82	0	160	5924	0	31
Sep-82	0	160	1363	0	5
Oct-82	0	160	7475	0	31
Nov-82	0	160	6210	0	30
Dec-82	0	160	6941	0	28
Jan-83	0	40	6938	0	28
Feb-83	0	40	6983	0	26
Mar-83	0	40	7401	0	31
Apr-83	0	40	7068	0	30
May-83	0	40	6660	0	29
Jun-83	0	40	6544	0	29
Jul-83	0	40	6465	0	29
Aug-83	0	40	6514	0	29
Sep-83	0	40	5775	0	28
Oct-83	0	40	5663	0	25
Nov-83	0	40	6390	0	30
Dec-83	0	35	6348	0	31
Jan-84	0	160	5998	0	29
Feb-84	0	40	6068	0	28
Mar-84	0	35	6317	0	31
Apr-84	0	35	6132	0	29
May-84	0	35	6191	0	31
Jun-84	0	35	6116	0	29
Jul-84	0	35	5319	0	28
Aug-84	0	35	5760	0	25
Sep-84	0	35	5786	0	28
Oct-84	0	35	6384	0	30
Nov-84	0	35	5633	0	29
Dec-84	0	30	5677	0	31
Jan-85	0	30	5639	0	30
Feb-85	0	30	5358	0	28
Mar-85	0	160	5556	0	30
Apr-85	0	160	5305	0	28
May-85	0	160	5508	0	31
Jun-85	0	160	3418	0	30
Jul-85	0	160	5156	0	31
Aug-85	0	160	5039	0	30
Sep-85	0	160	4134	0	26
Oct-85	0	160	4305	0	24
Nov-85	0	160	5076	0	30
Dec-85	0	160	4939	0	30
Jan-86	0	160	4521	0	30
Feb-86	0	160	4798	0	28
Mar-86	0	160	4978	0	30
Apr-86	0	160	4252	0	29
May-86	0	160	4153	0	31
Jun-86	0	160	4992	0	30
Jul-86	0	160	3437	0	31
Aug-86	0	160	4472	0	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Sep-86	0	160	3874	0	30
Oct-86	0	160	3233	0	31
Nov-86	0	160	4514	0	30
Dec-86	0	160	3290	0	26
Jan-87	0	160	3395	0	31
Feb-87	0	160	3442	0	27
Mar-87	0	160	3566	0	31
Apr-87	0	160	2025	0	30
May-87	0	160	2198	0	30
Jun-87	0	160	2039	0	29
Jul-87	0	160	0	0	28
Aug-87	0	160	2037	0	29
Sep-87	0	160	2050	0	30
Oct-87	0	160	2118	0	31
Nov-87	0	160	2116	0	30
Dec-87	0	160	1962	0	31
Jan-88	0	160	2138	0	30
Feb-88	0	160	2010	0	29
Mar-88	0	160	2119	0	30
Apr-88	0	160	2029	0	29
May-88	0	160	2037	0	30
Jun-88	0	160	2071	0	28
Jul-88	0	160	2048	0	31
Aug-88	0	160	1934	0	31
Sep-88	0	160	2150	0	30
Oct-88	0	160	2080	0	31
Nov-88	0	160	2065	0	30
Dec-88	0	160	2089	0	31
Jan-89	0	160	1949	0	29
Feb-89	0	160	1974	0	28
Mar-89	0	160	1917	0	30
Apr-89	0	160	1928	0	30
May-89	0	160	1832	0	31
Jun-89	0	160	0	0	30
Jul-89	0	160	1877	0	31
Aug-89	0	160	1944	0	31
Sep-89	0	160	1793	0	30
Oct-89	0	160	1915	0	31
Nov-89	0	160	1798	0	30
Dec-89	0	160	1855	0	31
Jan-90	0	160	1923	0	31
Feb-90	0	160	1561	0	28
Mar-90	0	160	1843	0	31
Apr-90	0	160	1740	0	30
May-90	0	160	1802	0	31
Jun-90	0	160	1450	0	30
Jul-90	0	160	1855	0	31
Aug-90	0	160	1903	0	31
Sep-90	0	160	1666	0	29
Oct-90	0	160	1842	0	31
Nov-90	0	160	1230	0	24
Dec-90	0	160	1558	0	28

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Jan-91	0	160	1646	0	31
Feb-91	0	160	1446	0	28
Mar-91	0	160	1670	0	31
Apr-91	0	160	1587	0	30
May-91	0	160	1718	0	31
Jun-91	0	160	1663	0	30
Jul-91	0	160	1728	0	31
Aug-91	0	160	1579	0	31
Sep-91	0	0	1435	0	30
Oct-91	0	0	557	0	31
Nov-91	0	0	815	0	30
Dec-91	0	0	1407	0	31
Jan-92	0	0	1214	0	31
Feb-92	0	0	1272	0	29
Mar-92	0	20	1247	3	31
Apr-92	0	20	1402	4	30
May-92	0	15	1368	0	31
Jun-92	0	0	1086	0	30
Jul-92	0	15	1220	2	31
Aug-92	0	10	1228	3	31
Sep-92	0	10	1439	2	30
Oct-92	0	10	1487	3	31
Nov-92	0	10	1237	3	30
Dec-92	0	10	1042	5	31
Jan-93	0	10	1130	2	31
Feb-93	0	5	1063	8	28
Mar-93	0	10	1144	1	31
Apr-93	0	5	1042	4	30
May-93	0	10	1174	3	31
Jun-93	0	5	842	1	30
Jul-93	0	30	1097	0	31
Aug-93	0	5	1135	1	31
Sep-93	10	0	1221	3	30
Oct-93	0	10	1190	0	30
Nov-93	0	15	1258	0	30
Dec-93	0	10	1235	0	30
Jan-94	0	15	810	0	31
Feb-94	0	5	801	0	28
Mar-94	0	10	1021	0	31
Apr-94	0	10	952	1	28
May-94	0	0	1026	0	31
Jun-94	0	10	794	1	30
Jul-94	0	10	1155	1	31
Aug-94	0	10	1214	1	31
Sep-94	0	10	1113	0	30
Oct-94	0	10	1252	0	31
Nov-94	10	10	1089	0	30
Dec-94	0	5	1279	3	31
Jan-95	0	5	979	2	31
Feb-95	0	5	1108	4	31
Mar-95	0	5	1225	0	31
Apr-95	0	5	1181	0	28

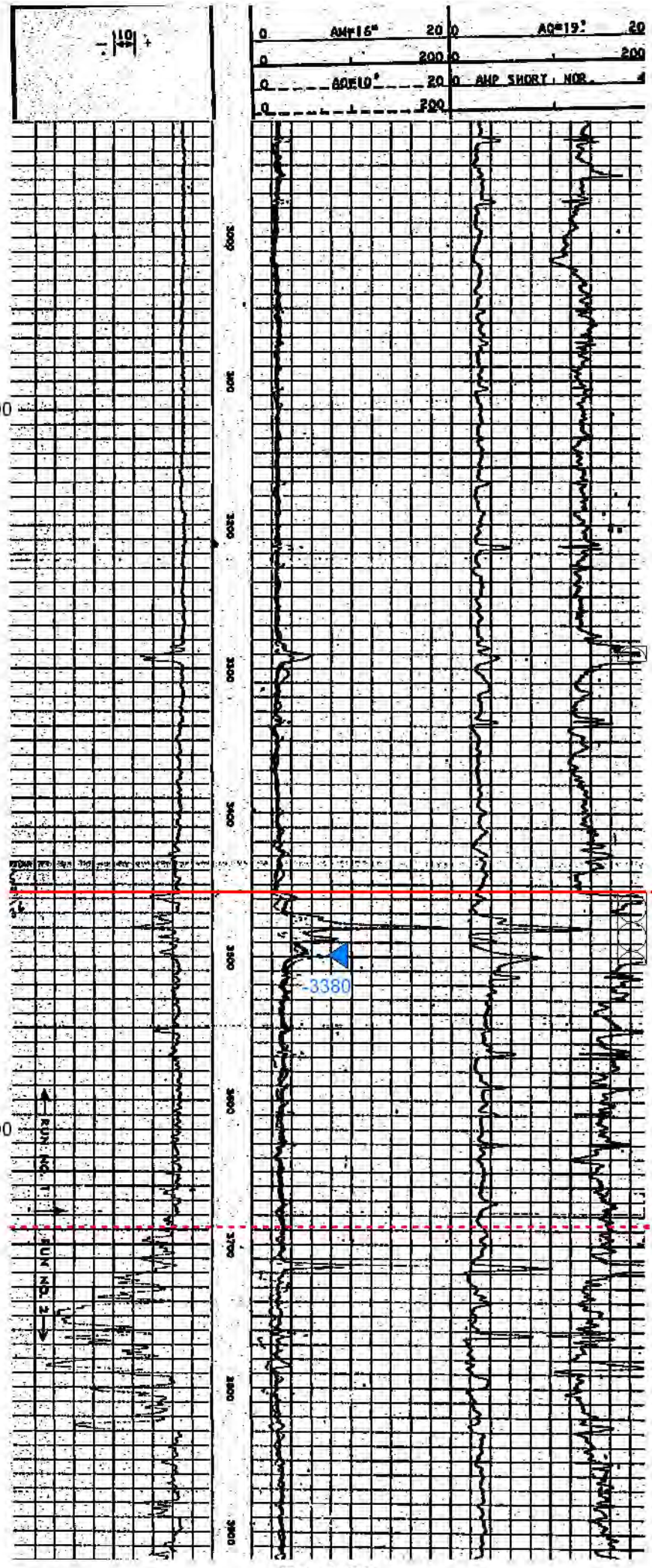
	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
May-95	0	5	1049	4	31
Jun-95	0	0	1001	3	30
Jul-95	0	0	1083	3	31
Aug-95	0	0	1013	4	31
Sep-95	0	5	800	4	30
Oct-95	0	5	1041	4	31
Nov-95	0	0	902	2	30
Dec-95	5	0	1040	2	31
Jan-96	0	0	1053	5	31
Feb-96	0	0	844	4	29
Mar-96	0	0	1078	4	31
May-96	5	0	289	4	31
Jun-96	0	0	969	3	30
Jul-96	0	0	1019	3	31
Aug-96	0	0	838	3	31
Sep-96	0	0	910	3	30
Oct-96	0	0	933	4	31
Nov-96	0	0	1026	3	30
Dec-96	0	0	930	3	31
Jan-97	0	0	914	3	31
Feb-97	0	0	850	3	29
Mar-97	0	0	917	3	31
Apr-97	0	0	1062	2	30
May-97	0	0	1074	3	31
Jun-97	0	0	980	2	30
Jul-97	0	0	1034	3	31
Aug-97	0	5	1085	3	31
Sep-97	0	5	1013	3	30
Oct-97	0	0	1010	2	31
Nov-97	0	0	969	3	30
Dec-97	0	0	683	3	31
Jan-98	0	5	757	3	31
Feb-98	0	5	33	0	2
Mar-98	0	5	685	2	31
Apr-98	0	5	685	2	30
May-98	0	5	771	2	30
Jun-98	0	5	744	2	30
Jul-98	0	5	790	2	31
Aug-98	0	0	786	2	31
Sep-98	0	5	748	1	30
Oct-98	0	5	747	2	31
Nov-98	0	0	721	2	30
Dec-98	0	0	750	2	31
Jan-99	0	0	684	2	31
Feb-99	0	0	678	2	28
Mar-99	0	50	728	2	31
Apr-99	0	0	688	2	28
May-99	0	0	732	2	31
Jun-99	0	0	682	2	30
Jul-99	0	0	734	2	31
Aug-99	0	0	663	2	30
Sep-99	0	0	639	2	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Oct-99	0	0	685	2	31
Nov-99	0	0	734	1	30
Dec-99	0	0	722	2	31
Jan-00	0	0	695	2	31
Feb-00	0	0	617	2	29
Mar-00	0	0	678	2	30
Apr-00	952	0	665	2	30
May-00	0	0	619	2	31
Jun-00	0	0	601	2	30
Jul-00	0	0	708	1	31
Aug-00	0	5	729	2	31
Sep-00	0	5	783	2	30
Oct-00	0	5	757	2	31
Nov-00	0	0	768	2	30
Dec-00	0	0	763	2	31
Jan-01	0	0	751	0	31
Feb-01	0	5	598	2	28
Mar-01	0	5	816	2	31
Apr-01	0	0	811	2	30
May-01	0	0	723	2	31
Jun-01	0	0	664	2	30
Jul-01	0	5	770	2	31
Aug-01	5	952	707	2	31
Sep-01	5	0	764	2	30
Oct-01	5	0	755	3	31
Nov-01	0	5	750	3	30
Dec-01	0	0	567	3	31
Jan-02	0	0	687	3	31
Feb-02	5	0	687	2	28
Mar-02	0	0	734	2	31
Apr-02	0	0	747	2	28
May-02	0	0	784	2	30
Jun-02	0	0	760	2	30
Jul-02	0	0	699	2	30
Aug-02	0	0	500	1	26
Sep-02	0	0	645	2	30
Oct-02	0	0	776	0	31
Nov-02	0	0	776	1	30
Dec-02	0	0	760	3	31
Jan-03	0	0	645	1	27
Feb-03	0	0	637	1	28
Mar-03	0	0	628	1	30
Apr-03	0	0	626	1	29
May-03	0	0	596	1	28
Jun-03	0	0	604	1	30
Jul-03	0	0	406	1	31
Aug-03	0	0	583	3	30
Sep-03	0	0	549	1	28
Oct-03	0	0	575	1	31
Nov-03	0	0	547	3	30
Dec-03	0	0	564	1	23
Jan-04	0	0	555	1	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Feb-04	0	0	309	1	17
Mar-04	0	0	533	1	28
Apr-04	0	0	565	2	30
May-04	0	0	562	2	31
Jun-04	0	0	549	3	28
Jul-04	0	0	594	3	30
Aug-04	0	0	568	3	30
Sep-04	0	0	562	3	29
Oct-04	0	0	594	3	31
Nov-04	0	0	635	3	30
Dec-04	0	0	651	3	31
Jan-05	0	0	0	0	0
			8,127,718	4,466	

Cum Gas All Zones: 3272301 MCF

04007000410000
ALANMAR ENERGY
PARROTT INVESTMENT CO. B-5
TWP: 20 N - Range: 1 W - Sec. 15
Spud Date=12/15/1955



Princeton Canyon Fill
(Eocene)

-3000

Top Perkins Lake Sands

-3500

Pre-Eocene
Unconformity

Cretaceous Undifferentiated

04-007-00041 ** 15-20N-1W MD

ALANMAR ENERGY "PARROTT INVESTMENT CO." B-5

Field: Perkins Lake Gas

County: Butte

Elev: 119 KB

TD: 4121'

LOC: 50 N 1613 E SWC

☐ Directional

Spud: 12/15/55

Current Status: Abandoned Gas

Horizons: top of producing sand 3455'

Original Operator: Humble Oil & Refining Co.

Casing: 7" cemented at 609'; 4-1/2" cemented at 3552'

12/15/55 spud
12/16/55 124 surface s & sh, d
12/19/55 609 cemented 7" casing w/175 sacks
12/20/55 1765 d
12/21/55 2398 d
12/22/55 2867 d
12/27/55 3472 repairing road
12/28/55 3700 ran electric log, microlog and induction log, took 17 sidewall samples 2388-3677'
12/29/55 drill stem test 3457-3486, 1" top & 1/4 bottom beans, no water cushion, open 72 minutes, gas to surface in 1 minute. Flowed estimated 3640 mcf/d. D ahead
12/30/55 4121 TD
12/31/55 ran electric log, dipmeter, and took 14 sidewall samples 3531-3706, cemented 4-1/2" casing at 3552' with 150 sacks

01/02/56 4121 td. WSOK at 3284. Gun perf. **3285-95', 3455-3505'**. 3521 hung 2" at 3272. Flowing - no estimate
01/03/56 Flowing 4060 mcf/d rate (4-hr. Test) 3/8" choke, 920/1210# shut in pressure, 1350/1355#.

11/13/64 squeezed perforations 3285-95', (report illegible)

01/23/73 Well transferred to Exxon Corporation

8/11/83 Well abandoned

10/24/91 Well transferred to William Braun Resources
12/05/91 Well transferred to Alanmar Oil Company
07/30/93 Well transferred to Alanmar Energy

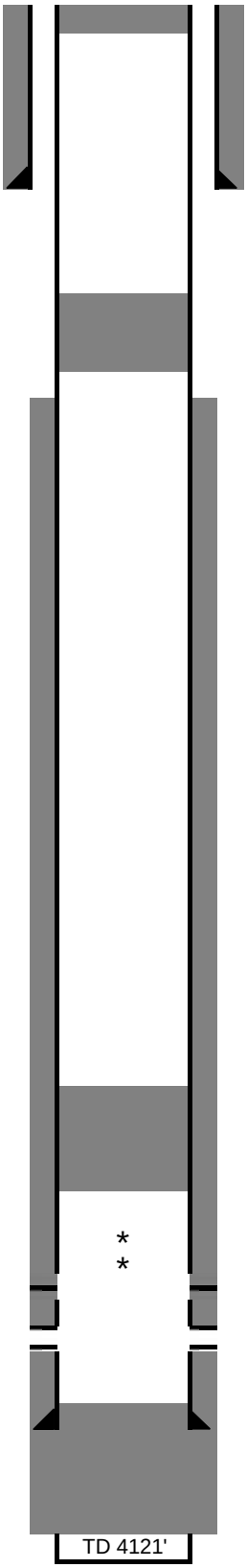
Alanmar Energy
Parrott Investment B-5

007-00041
Perkins Lake Gas Field
Butte County, CA
Sec 15, 20N, R1W MDB&M

WI/NRI:		KB:	119
Spud:	15-Dec-55	DF:	
Comp:	02-Jan-56	GL:	109

Directional Data:

NOT TO SCALE



Surface Casing: 7" cemented at 609 ft
.

8/18/83 Plugged 1340-1500'

8/18/83 Plugged 2415-3065'

* Junk in hole: packer at 3397', tubing 3065-3247' and 3278-3397'

WSO 3283-4'

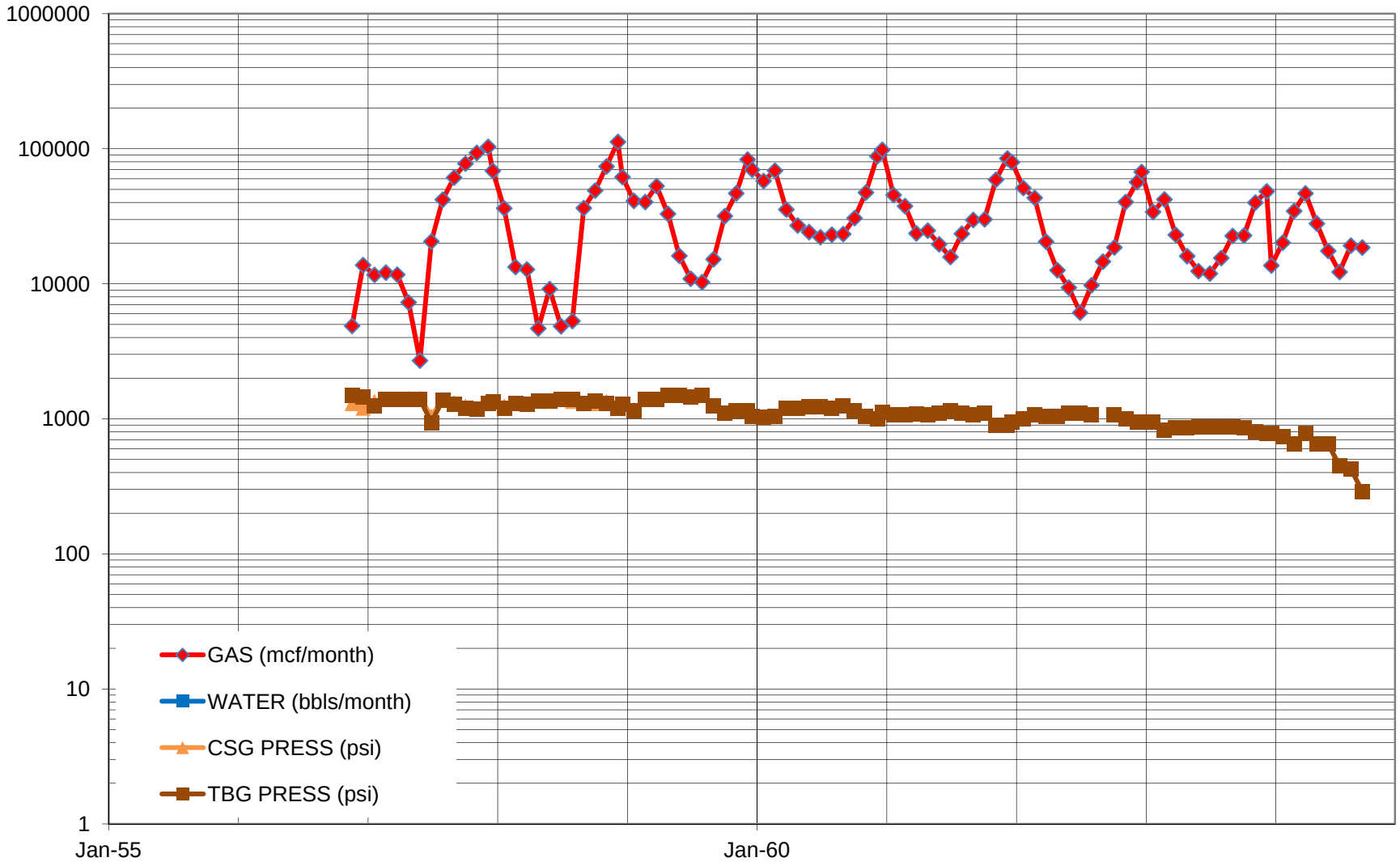
1/2/56 Perforated 3285-95', squeezed 11/64

1/2/56 Perforated 3455-3505'

Top of cement 3521'
Production Casing: 4-1/2" cemented at 3552'

00700041 PARROTT INVESTMENT B-5

CUM PROD 3,272,301 MCF; 0 BBLS H2O

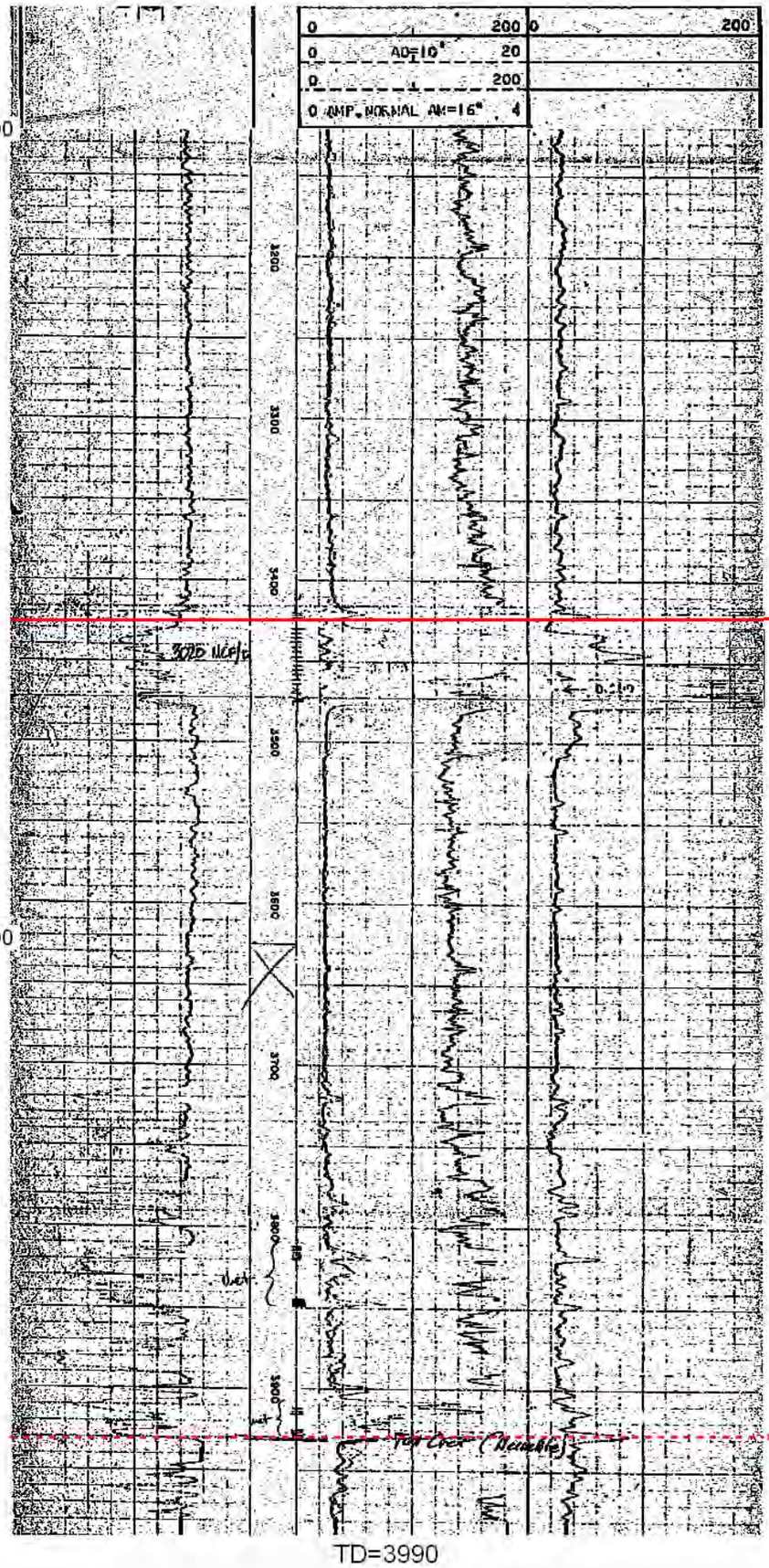


	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-56	1300	1500	4879	0	9
Jan-57	1200	1450	13759	0	22
Feb-57	1350	1250	11642	0	21
Mar-57	1400	1400	12109	0	23
Apr-57	1400	1400	11704	0	21
May-57	1425	1400	7275	0	22
Jun-57	1425	1400	2701	0	24
Jul-57	1050	940	20577	0	20
Aug-57	1375	1375	41976	0	21
Sep-57	1325	1275	61196	0	29
Oct-57	1250	1200	77653	0	31
Nov-57	1200	1175	93318	0	29
Dec-57	1300	1300	103381	0	31
Jan-58	1335	1335	68628	0	26
Feb-58	1250	1200	36214	0	28
Mar-58	1300	1300	13324	0	31
Apr-58	1300	1275	12780	0	30
May-58	1350	1350	4672	0	31
Jun-58	1350	1350	9160	0	30
Jul-58	1400	1400	4854	0	31
Aug-58	1350	1400	5302	0	31
Sep-58	1300	1300	36373	0	30
Oct-58	1300	1350	49023	0	31
Nov-58	1350	1300	73985	0	30
Dec-58	1200	1200	112434	0	30
Jan-59	1300	1275	61662	0	31
Feb-59	1175	1150	41138	0	28
Mar-59	0	1400	40368	0	31
Apr-59	1400	1400	52962	0	28
May-59	1500	1500	32965	0	31
Jun-59	1500	1500	16116	0	30
Jul-59	1450	1450	10909	0	31
Aug-59	1500	1500	10284	0	31
Sep-59	1250	1250	15199	0	30
Oct-59	1100	1100	31719	0	31
Nov-59	1150	1150	46778	0	30
Dec-59	1150	1150	83330	0	31
Jan-60	1050	1050	70019	0	31
Feb-60	1025	1025	57719	0	29
Mar-60	1050	1050	68909	0	28
Apr-60	1200	1200	35505	0	30
May-60	1200	1200	27049	0	31
Jun-60	1225	1225	24162	0	30
Jul-60	1225	1225	22133	0	31
Aug-60	1225	1200	23113	0	31
Sep-60	1250	1250	23350	0	30
Oct-60	1150	1150	30640	0	31
Nov-60	1050	1050	47438	0	30
Dec-60	1000	1000	88019	0	31
Jan-61	0	1125	98337	0	31
Feb-61	0	1075	45453	0	28
Mar-61	0	1075	37644	0	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Apr-61	0	1090	23635	0	30
May-61	0	1075	24765	0	31
Jun-61	0	1100	19623	0	30
Jul-61	0	1150	15793	0	31
Aug-61	0	1100	23480	0	31
Sep-61	0	1075	29726	0	30
Oct-61	0	1100	30046	0	31
Nov-61	0	900	59029	0	30
Dec-61	0	900	84805	0	31
Jan-62	0	950	79585	0	31
Feb-62	0	1000	51274	0	28
Mar-62	0	1075	43328	0	31
Apr-62	0	1050	20520	0	30
May-62	0	1050	12598	0	24
Jun-62	0	1100	9370	0	25
Jul-62	0	1100	6117	0	31
Aug-62	0	1075	9758	0	31
Sep-62	0	0	14603	0	30
Oct-62	0	1075	18595	0	31
Nov-62	0	1000	40341	0	30
Dec-62	0	950	56570	0	31
Jan-63	0	950	67422	0	31
Feb-63	0	950	34033	0	26
Mar-63	0	825	42206	0	31
Apr-63	0	860	23031	0	30
May-63	0	860	16030	0	31
Jun-63	0	875	12422	0	30
Jul-63	0	875	11913	0	24
Aug-63	0	878	15535	0	31
Sep-63	0	875	22619	0	30
Oct-63	0	860	22777	0	31
Nov-63	0	800	39967	0	30
Dec-63	0	775	48350	0	31
Jan-64	0	775	13665	0	31
Feb-64	0	735	20168	0	28
Mar-64	0	650	34589	0	31
Apr-64	0	780	46725	0	30
May-64	0	650	27947	0	31
Jun-64	0	650	17516	0	30
Jul-64	0	450	12228	0	31
Aug-64	0	425	19183	0	31
Sep-64	0	290	18575	0	30
			3,272,301	0	

Cum Gas All Zones: 6060099 MCF

04007000430000
ALANMAR ENERGY
PARROTT INVESTMENT CO. B-7
TWP: 20 N - Range: 1 W - Sec. 9
Spud Date=7/10/1956



-3000

-3500

Princeton Canyon Fill
(Eocene)

Top Perkins Lake Sands

Pre-Eocene
Unconformity

Cretaceous Undifferentiated

04-007-00043 ** 9-20N-1W MD

ALANMAR ENERGY "PARROTT INVESTMENT CO." B-7

Field: Perkins Lake Gas
County: Butte
Elev: 121 KB
TD: 3990’
LOC: 900 N 32 W SEC
☐ Directional

Spud: 7/10/56
Current Status: Gas
Horizons: base Tehama 2200’, top Cretaceous 3930’
Original Operator: Humble Oil & Refining Co.
Casing: 7” cemented at 513’; 4-1/2” cemented at 3983’

07/02/56 loc
07/07/56 loc d.o.g
07/11/56 656 cemented 7” casing at 513’ with 140 sacks
07/12/56 1209 d
07/13/56 2033 d
07/16/56 3990 ran electric log, microlog, and dipmeter
07/17/56 3990 24 sidewall samples 2014-3971’
07/18/56 4 1/2" cmtd at 3983’ with 350 sacks, WSO 3415’
07/19/56 perforated 3812-20’ and 3845-49’, DST recovered 1680’ SW
07/20/56 perforated 3911-15’ and 3926-30’, DST recovered 1319’ SW
07/21/56 plugged to 3622’, perforated 3420-22’ and 3430-78’
07/22/56 Well flowed 4690 mcf on 1/2" choke, t.p. 1110#, c.p. 1300#, open 1 hr. On 3/8" ck., 3020 mcf, t.p. 1300#, c.p. 1390#, open 1 hr. On 1/4" ck., 1990 mcf, t.p. 1395#, c.p. 1395#

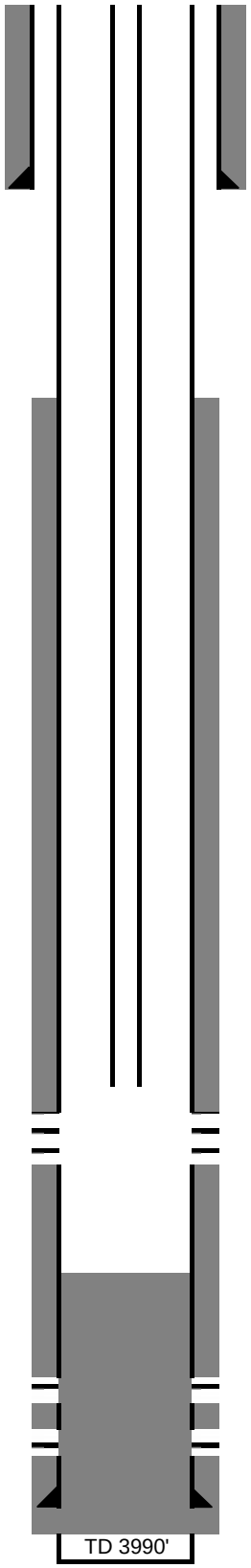
01/23/73 Well transferred to Exxon Corporation
10/24/91 Well transferred to William Braun Resources
12/05/91 Well transferred to Alanmar Oil Company
07/30/93 Well transferred to Alanmar Energy

Alanmar Energy
Parrott Investment B-7

007-00043
Perkins Lake Gas Field
Butte County, CA
Sec 9, 20N, R1W MDB&M

WI/NRI:		KB:	121	**Directional Data:**
Spud:	10-Jul-56	DF:		
Comp:	22-Jul-56	GL:	111	

NOT TO SCALE



Surface Casing: 7" cemented at 513 ft
.

7/21/56 Tubing set at 3408'
7/19/56 WSOK 3415'
7/21/56 Perforated 3420-22' and 3430-48'

7/21/56 Plugged to 3622'

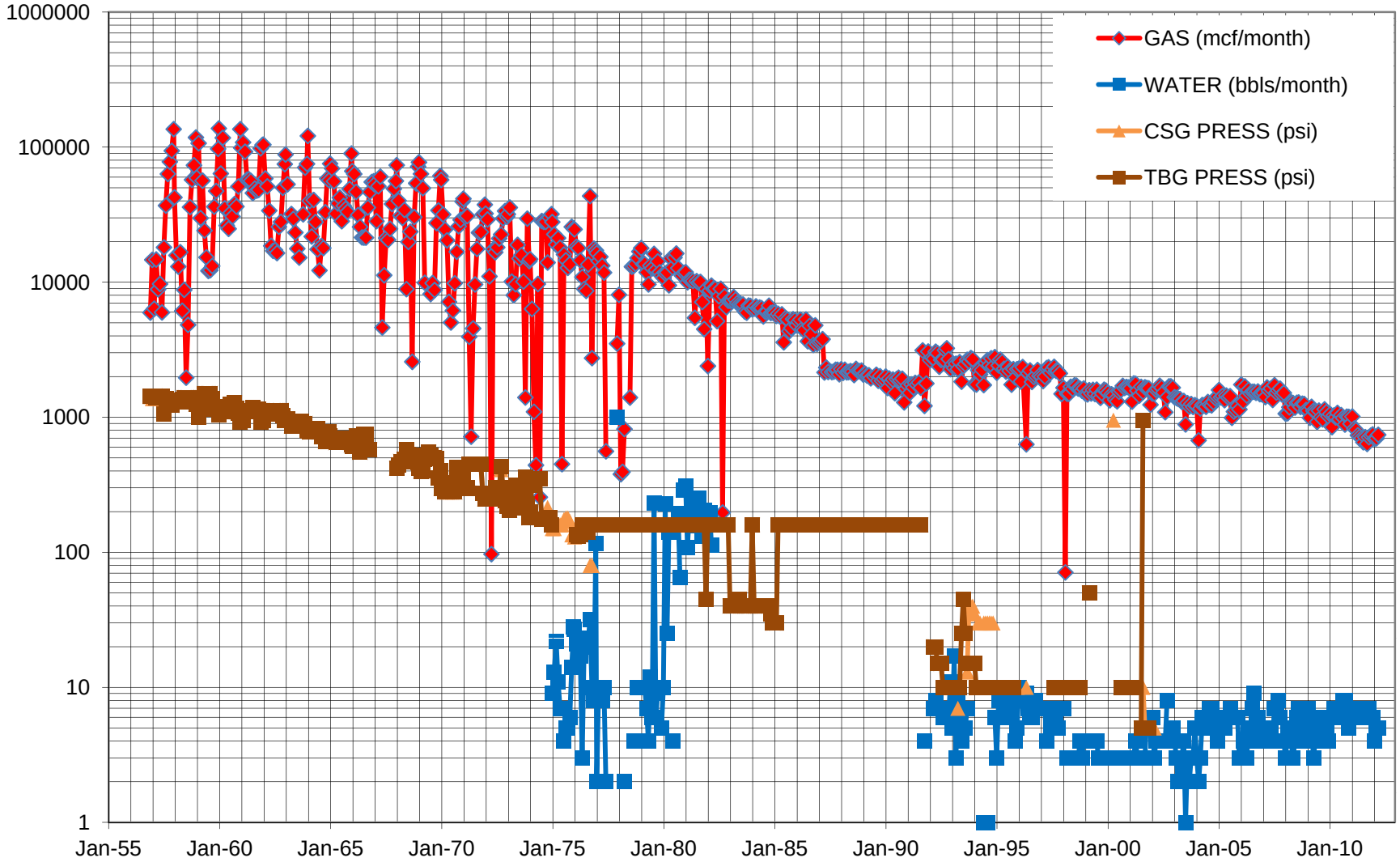
7/19/56 Perforated 3812-20' and 3845-49', wet

7/20/56 Perforated 3911-15' and 3926-30', wet

Production Casing: 4-1/2" cemented at 3983'

00700043 PARROTT INVESTMENT B-7

CUM PROD 6,060,099 MCF; 6374 BBLS H2O



	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-56	1425	1425	5960	0	13
Jan-57	1375	1425	14655	0	29
Feb-57	1375	1425	6374	0	28
Mar-57	1425	1400	14737	0	31
Apr-57	1425	1400	8863	0	29
May-57	1425	1400	9713	0	31
Jun-57	1450	1425	5979	0	30
Jul-57	1254	1061	18120	0	18
Aug-57	1375	1375	36978	0	29
Sep-57	1350	1325	63365	0	30
Oct-57	1325	1300	77982	0	31
Nov-57	1275	1225	94004	0	30
Dec-57	1350	1325	135972	0	31
Jan-58	1345	1345	42509	0	26
Feb-58	1350	1300	15815	0	27
Mar-58	1350	1325	13055	0	31
Apr-58	1325	1325	16682	0	30
May-58	1350	1350	6143	0	31
Jun-58	1400	1400	8785	0	22
Jul-58	1400	1400	1964	0	21
Aug-58	1400	1400	4835	0	31
Sep-58	1400	1300	35992	0	30
Oct-58	1400	1350	57400	0	31
Nov-58	1400	1350	73496	0	30
Dec-58	1350	1250	118025	0	31
Jan-59	1400	1350	59327	0	31
Feb-59	1200	1000	106935	0	28
Mar-59	0	1400	29843	0	31
Apr-59	1200	1200	56509	0	21
May-59	1500	1500	24124	0	27
Jun-59	1500	1500	15288	0	30
Jul-59	1500	1500	12137	0	31
Aug-59	1500	1500	12291	0	31
Sep-59	1375	1375	13190	0	30
Oct-59	1150	1150	36273	0	31
Nov-59	1200	1200	47358	0	30
Dec-59	1150	1150	97242	0	31
Jan-60	1050	1050	137650	0	31
Feb-60	1175	1175	63711	0	29
Mar-60	1100	1100	117317	0	31
Apr-60	1200	1200	35242	0	30
May-60	1175	1175	26308	0	31
Jun-60	1150	1150	24863	0	30
Jul-60	1250	1250	32566	0	31
Aug-60	1250	1175	30644	0	31
Sep-60	1275	1275	37969	0	30
Oct-60	1160	1160	36357	0	31
Nov-60	1075	1075	51174	0	30
Dec-60	925	925	135866	0	31
Jan-61	0	975	98979	0	29
Feb-61	0	950	108532	0	28
Mar-61	0	1125	92554	0	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Apr-61	0	1125	57472	0	30
May-61	0	1100	57800	0	31
Jun-61	0	1125	56224	0	30
Jul-61	0	1175	45735	0	30
Aug-61	0	1150	49322	0	31
Sep-61	0	1150	47644	0	30
Oct-61	0	1150	48292	0	31
Nov-61	0	925	98094	0	30
Dec-61	0	975	103953	0	31
Jan-62	0	950	104399	0	31
Feb-62	0	1060	58687	0	28
Mar-62	0	1080	51250	0	31
Apr-62	0	1080	33900	0	30
May-62	0	1060	18609	0	24
Jun-62	0	1125	17087	0	29
Jul-62	0	1125	17287	0	31
Aug-62	0	1125	16451	0	29
Sep-62	0	0	25722	0	30
Oct-62	0	1125	28010	0	31
Nov-62	0	1025	50074	0	30
Dec-62	0	950	74917	0	31
Jan-63	0	975	88274	0	31
Feb-63	0	975	53075	0	28
Mar-63					
Apr-63	0	860	32031	0	30
May-63	0	890	29443	0	31
Jun-63	0	870	23358	0	30
Jul-63	0	890	17724	0	24
Aug-63	0	878	15216	0	24
Sep-63	0	935	0	0	0
Oct-63	0	900	31842	0	31
Nov-63	0	900	70667	0	30
Dec-63	0	800	75270	0	31
Jan-64	0	795	121200	0	31
Feb-64	0	775	40059	0	29
Mar-64	0	795	21805	0	23
Apr-64	0	800	40666	0	22
May-64	0	815	27948	0	31
Jun-64	0	825	17517	0	30
Jul-64	0	775	12228	0	31
Aug-64	0	720	18543	0	30
Sep-64	0	760	17924	0	29
Oct-64	0	665	32978	0	31
Nov-64	0	745	58595	0	30
Dec-64	0	780	56902	0	31
Jan-65	0	730	75513	0	31
Feb-65	0	665	69620	0	28
Mar-65	0	685	55812	0	31
Apr-65	0	650	32148	0	23
May-65	0	700	38340	0	30
Jun-65	0	685	42314	0	29
Jul-65	0	700	28317	0	28

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Aug-65	0	690	36769	0	31
Sep-65	0	675	34966	0	30
Oct-65	0	700	33240	0	31
Nov-65	0	685	49076	0	30
Dec-65	0	625	89749	0	31
Jan-66	0	610	66518	0	28
Feb-66	0	642	63276	0	28
Mar-66	0	725	46641	0	31
Apr-66	0	625	31421	0	30
May-66	0	550	25691	0	20
Jun-66	0	650	21459	0	28
Jul-66	0	750	21368	0	26
Aug-66	0	750	21371	0	28
Sep-66	0	575	35778	0	27
Oct-66	0	575	46629	0	28
Nov-66	0	0	55234	0	30
Dec-66	0	0	55975	0	31
Jan-67	0	0	53036	0	25
Feb-67	0	0	28312	0	21
Mar-67	0	0	51333	0	22
Apr-67	0	0	60477	0	28
May-67	0	0	4622	0	6
Jun-67	0	0	11260	0	15
Jul-67	0	0	21240	0	16
Aug-67	0	0	20581	0	31
Sep-67	0	0	24862	0	29
Oct-67	0	0	37992	0	27
Nov-67	0	0	49291	0	28
Dec-67	0	0	56176	0	27
Jan-68	420	420	73592	0	31
Feb-68	445	445	40156	0	28
Mar-68	470	470	31122	0	17
Apr-68	469	469	29907	0	19
May-68	490	490	34303	0	31
Jun-68	575	575	8891	0	21
Jul-68	527	527	19892	0	29
Aug-68	514	514	23690	0	29
Sep-68	514	514	2576	0	3
Oct-68	523	523	30385	0	31
Nov-68	515	515	53996	0	30
Dec-68	460	460	71842	0	31
Jan-69	421	421	77327	0	30
Feb-69	398	398	63414	0	28
Mar-69	400	400	49704	0	24
Apr-69	490	490	9913	0	9
May-69	0	0	0	0	0
Jun-69	550	550	0	0	0
Jul-69	525	525	8175	0	15
Aug-69	500	500	9854	0	18
Sep-69	505	505	8757	0	18
Oct-69	495	495	27421	0	28
Nov-69	355	355	34035	0	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-69	0	400	61435	0	31
Jan-70	300	300	57306	0	31
Feb-70	325	325	31747	0	28
Mar-70	280	280	24519	0	23
Apr-70	280	280	20416	0	26
May-70	280	280	7154	0	11
Jun-70	280	280	5037	0	7
Jul-70	280	280	6166	0	10
Aug-70	280	280	9827	0	17
Sep-70	425	425	16803	0	16
Oct-70	350	350	25972	0	30
Nov-70	360	360	28967	0	24
Dec-70	370	370	39556	0	31
Jan-71	370	370	41568	0	31
Feb-71	300	300	30533	0	28
Mar-71	300	300	30941	0	29
Apr-71	450	450	3947	0	6
May-71	450	450	718	0	1
Jun-71	450	450	4550	0	6
Jul-71	450	450	9631	0	16
Aug-71	450	450	17645	0	28
Sep-71	450	450	23296	0	30
Oct-71	450	450	23532	0	29
Nov-71	275	275	31846	0	30
Dec-71	250	250	37521	0	31
Jan-72	250	250	32234	0	31
Feb-72	250	250	29137	0	28
Mar-72	250	250	11053	0	13
Apr-72	0	0	97	0	1
May-72	250	250	17515	0	29
Jun-72	0	300	16675	0	31
Jul-72	0	300	18124	0	31
Aug-72	0	300	21079	0	30
Sep-72	410	430	22590	0	30
Oct-72	0	300	29709	0	31
Nov-72	0	240	33661	0	30
Dec-72	0	220	30548	0	31
Jan-73	0	225	31891	0	31
Feb-73	0	206	35732	0	28
Mar-73	0	245	10106	0	11
Apr-73	0	288	8015	0	12
May-73	0	314	9670	0	12
Jun-73	0	250	18903	0	25
Jul-73	0	0	14998	0	29
Aug-73	0	212	15871	0	31
Sep-73	0	230	10115	0	20
Oct-73	0	360	1401	0	21
Nov-73	0	228	29579	0	28
Dec-73	0	180	14327	0	15
Jan-74	0	200	14808	0	18
Feb-74	0	315	6345	0	9
Mar-74	0	350	1098	0	2

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Apr-74	0	350	442	0	2
May-74	0	0	9706	0	10
Jun-74	0	350	256	0	2
Jul-74	0	175	28404	0	31
Aug-74	0	0	27984	0	31
Sep-74	0	0	28014	0	30
Oct-74	215	0	13989	0	15
Nov-74	0	180	30152	0	28
Dec-74	0	160	31923	0	31
Jan-75	150	0	27925	9	31
Feb-75	150	0	22635	13	28
Mar-75	165	0	18972	22	31
Apr-75	160	0	21230	11	30
May-75	160	0	18025	7	31
Jun-75	160	0	450	0	2
Jul-75	175	0	16032	4	31
Aug-75	180	0	14549	5	31
Sep-75	180	0	12782	5	30
Oct-75	170	0	13620	6	31
Nov-75	135	0	25702	14	30
Dec-75	135	0	24999	28	31
Jan-76	130	0	24615	27	31
Feb-76	0	135	18304	21	29
Mar-76	0	132	17892	19	31
Apr-76	0	135	14518	17	30
May-76	0	160	10927	3	31
Jun-76	0	153	8913	20	30
Jul-76	0	160	8635	23	24
Aug-76	0	140	13513	21	29
Sep-76	80	0	43504	32	30
Oct-76	80	0	2742	10	4
Nov-76	0	0	17735	8	30
Dec-76	0	0	17214	116	31
Jan-77	0	160	16435	2	31
Feb-77	0	160	14351	10	28
Mar-77	0	160	15433	0	31
Apr-77	0	160	13261	8	30
May-77	0	160	11789	10	31
Jun-77	0	160	560	2	30
Jul-77	0	160	0	0	0
Aug-77	0	160	0	0	0
Sep-77	0	160	0	0	0
Oct-77	0	160	0	0	0
Nov-77	0	160	0	0	0
Dec-77	0	160	3511	1002	31
Jan-78	0	160	8069	0	31
Feb-78	0	160	379	0	28
Mar-78	0	160	394	0	0
Apr-78	0	160	818	2	3
May-78	0	160	0	0	0
Jun-78	0	160	0	0	0
Jul-78	0	160	1400	0	0

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Aug-78	0	160	13047	0	31
Sep-78	0	160	13214	4	30
Oct-78	0	160	13685	0	31
Nov-78	0	160	15116	10	29
Dec-78	0	160	16868	0	31
Jan-79	0	160	17889	0	31
Feb-79	0	160	13600	0	28
Mar-79	0	160	13630	10	31
Apr-79	0	160	11824	7	30
May-79	0	160	9642	4	31
Jun-79	0	160	13264	12	30
Jul-79	0	160	12662	6	31
Aug-79	0	160	16216	233	31
Sep-79	0	160	12322	6	30
Oct-79	0	160	14268	9	31
Nov-79	0	160	11846	0	30
Dec-79	0	160	11185	5	31
Jan-80	0	160	10754	10	28
Feb-80	0	160	11593	229	29
Mar-80	0	160	11814	25	31
Apr-80	0	160	9486	140	30
May-80	0	160	15026	0	20
Jun-80	0	160	12870	4	23
Jul-80	0	160	15254	0	31
Aug-80	0	160	16334	0	31
Sep-80	0	160	12721	193	27
Oct-80	0	0	0	65	27
Nov-80	0	160	11194	0	0
Dec-80	0	160	11730	290	31
Jan-81	0	160	11884	308	31
Feb-81	0	160	9997	109	28
Mar-81	0	160	10450	188	31
Apr-81	0	160	10416	241	30
May-81	0	160	10229	243	31
Jun-81	0	160	5452	158	21
Jul-81	0	160	10187	166	27
Aug-81	0	160	9912	251	31
Sep-81	0	160	10053	205	30
Oct-81	0	160	7137	132	25
Nov-81	0	160	4501	204	17
Dec-81	0	45	8919	0	30
Jan-82	0	160	2395	0	3
Feb-82	0	160	8663	195	28
Mar-82	0	160	9437	113	31
Apr-82	0	160	8907	0	30
May-82	0	160	8958	0	30
Jun-82	0	160	5150	0	29
Jul-82	0	160	7889	0	30
Aug-82	0	160	8943	0	31
Sep-82	0	160	197	0	5
Oct-82	0	160	7854	0	31
Nov-82	0	160	6523	0	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-82	0	160	7292	0	28
Jan-83	0	40	7289	0	28
Feb-83	0	40	7337	0	26
Mar-83	0	40	7775	0	31
Apr-83	0	40	7425	0	30
May-83	0	40	6998	0	29
Jun-83	0	45	6875	0	29
Jul-83	0	40	6794	0	29
Aug-83	0	40	6846	0	29
Sep-83	0	40	6068	0	28
Oct-83	0	40	5949	0	25
Nov-83	0	40	6714	0	30
Dec-83	0	40	6671	0	31
Jan-84	0	160	6302	0	29
Feb-84	0	40	6376	0	28
Mar-84	0	40	6635	0	31
Apr-84	0	40	6443	0	29
May-84	0	40	6505	0	31
Jun-84	0	40	6426	0	29
Jul-84	0	40	5590	0	27
Aug-84	0	40	6053	0	28
Sep-84	0	40	6080	0	28
Oct-84	0	40	6709	0	30
Nov-84	0	35	5918	0	29
Dec-84	0	30	5965	0	31
Jan-85	0	30	5923	0	30
Feb-85	0	30	5630	0	28
Mar-85	0	160	5838	0	30
Apr-85	0	160	5573	0	28
May-85	0	160	5787	0	31
Jun-85	0	160	3592	0	30
Jul-85	0	160	5418	0	31
Aug-85	0	160	5295	0	30
Sep-85	0	160	4343	0	26
Oct-85	0	160	4574	0	24
Nov-85	0	160	5333	0	30
Dec-85	0	160	5247	0	30
Jan-86	0	160	4802	0	30
Feb-86	0	160	5097	0	28
Mar-86	0	160	5290	0	30
Apr-86	0	160	4518	0	29
May-86	0	160	4413	0	31
Jun-86	0	160	5303	0	30
Jul-86	0	160	3653	0	31
Aug-86	0	160	4753	0	30
Sep-86	0	160	4118	0	30
Oct-86	0	160	3436	0	31
Nov-86	0	160	4796	0	30
Dec-86	0	160	3497	0	26
Jan-87	0	160	3608	0	31
Feb-87	0	160	3658	0	27
Mar-87	0	160	3789	0	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Apr-87	0	160	2149	0	30
May-87	0	160	2334	0	30
Jun-87	0	160	2165	0	29
Jul-87	0	160	0	0	28
Aug-87	0	160	2162	0	29
Sep-87	0	160	2176	0	30
Oct-87	0	160	2249	0	31
Nov-87	0	160	2247	0	30
Dec-87	0	160	2082	0	31
Jan-88	0	160	2269	0	30
Feb-88	0	160	2135	0	29
Mar-88	0	160	2250	0	30
Apr-88	0	160	2153	0	29
May-88	0	160	2163	0	30
Jun-88	0	160	2198	0	28
Jul-88	0	160	2174	0	31
Aug-88	0	160	2054	0	31
Sep-88	0	160	2283	0	30
Oct-88	0	160	2208	0	31
Nov-88	0	160	2192	0	30
Dec-88	0	160	2218	0	31
Jan-89	0	160	2070	0	29
Feb-89	0	160	2096	0	28
Mar-89	0	160	2035	0	30
Apr-89	0	160	2048	0	30
May-89	0	160	1946	0	31
Jun-89	0	160	0	0	30
Jul-89	0	160	1994	0	31
Aug-89	0	160	2064	0	31
Sep-89	0	160	1864	0	30
Oct-89	0	160	2015	0	31
Nov-89	0	160	1864	0	30
Dec-89	0	160	1922	0	31
Jan-90	0	160	2004	0	31
Feb-90	0	160	1648	0	28
Mar-90	0	160	1937	0	31
Apr-90	0	160	1823	0	30
May-90	0	160	1904	0	31
Jun-90	0	160	1507	0	30
Jul-90	0	160	1922	0	31
Aug-90	0	160	1965	0	31
Sep-90	0	160	1874	0	30
Oct-90	0	160	1930	0	31
Nov-90	0	160	1290	0	24
Dec-90	0	160	1631	0	28
Jan-91	0	160	1724	0	31
Feb-91	0	160	1515	0	28
Mar-91	0	160	1751	0	31
Apr-91	0	160	1663	0	30
May-91	0	160	1797	0	31
Jun-91	0	160	1741	0	30
Jul-91	0	160	1809	0	31

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Aug-91	0	160	1655	0	31
Sep-91	0	0	3130	0	30
Oct-91	0	0	1215	4	31
Nov-91	0	0	1779	0	30
Dec-91	0	0	3069	0	31
Jan-92	0	0	2650	0	31
Feb-92	0	0	2775	0	29
Mar-92	0	20	2720	7	31
Apr-92	0	20	3058	8	30
May-92	0	15	2986	0	31
Jun-92	0	0	2369	0	30
Jul-92	0	15	2661	7	31
Aug-92	0	10	2680	6	31
Sep-92	0	10	3141	6	30
Oct-92	0	10	3244	6	31
Nov-92	0	10	2700	6	30
Dec-92	0	10	2274	11	31
Jan-93	0	10	2465	5	31
Feb-93	0	10	2320	17	28
Mar-93	0	10	2495	3	31
Apr-93	7	10	2274	8	30
May-93	0	10	2561	6	31
Jun-93	0	25	1837	4	30
Jul-93	0	45	2392	7	31
Aug-93	0	25	2475	5	31
Sep-93	13	0	2664	7	30
Oct-93	40	15	2596	0	30
Nov-93	40	15	2745	0	30
Dec-93	40	15	2695	0	30
Jan-94	35	15	1766	0	31
Feb-94	0	10	1747	0	28
Mar-94	30	10	2229	0	31
Apr-94	30	10	2077	0	28
May-94	0	0	2240	0	31
Jun-94	30	10	1734	1	30
Jul-94	30	10	2521	0	31
Aug-94	30	10	2649	1	31
Sep-94	30	10	2429	0	30
Oct-94	30	10	2732	0	31
Nov-94	30	10	2375	0	30
Dec-94	0	10	2792	6	31
Jan-95	0	10	2136	3	31
Feb-95	0	10	2418	8	31
Mar-95	0	10	2672	0	31
Apr-95	0	10	2577	0	28
May-95	0	10	2289	9	31
Jun-95	0	0	2183	7	30
Jul-95	0	0	2363	6	31
Aug-95	0	0	2210	8	31
Sep-95	0	10	1746	9	30
Oct-95	0	10	2272	9	31
Nov-95	0	0	1969	4	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Dec-95	10	0	2270	5	31
Jan-96	0	0	2297	10	31
Feb-96	0	0	1841	8	29
Mar-96	0	0	2353	9	31
May-96	10	0	630	9	31
Jun-96	0	0	2114	7	30
Jul-96	0	0	2223	6	31
Aug-96	0	0	1828	6	31
Sep-96	0	0	1987	7	30
Oct-96	0	0	2035	8	31
Nov-96	0	0	2238	7	30
Dec-96	0	0	2029	7	31
Jan-97	0	0	1994	7	31
Feb-97	0	0	1855	7	29
Mar-97	0	0	2002	7	31
Apr-97	0	0	2316	4	30
May-97	0	0	2344	7	31
Jun-97	0	0	2137	5	30
Jul-97	0	0	2256	6	31
Aug-97	0	10	2366	6	31
Sep-97	0	10	2210	6	30
Oct-97	0	0	2203	5	31
Nov-97	0	0	2114	7	30
Dec-97	0	0	1490	7	31
Jan-98	0	10	1653	7	31
Feb-98	0	10	71	0	2
Mar-98	0	10	1495	3	31
Apr-98	0	10	1495	3	30
May-98	0	10	1683	3	30
Jun-98	0	10	1623	3	30
Jul-98	0	10	1724	3	31
Aug-98	0	0	1715	3	31
Sep-98	0	10	1632	3	30
Oct-98	0	10	1629	4	31
Nov-98	0	0	1572	3	30
Dec-98	0	0	1636	4	31
Jan-99	0	0	1493	4	31
Feb-99	0	0	1480	4	28
Mar-99	0	50	1587	4	31
Apr-99	0	0	1501	4	28
May-99	0	0	1597	4	31
Jun-99	0	0	1489	4	30
Jul-99	0	0	1601	4	31
Aug-99	0	0	1446	3	30
Sep-99	0	0	1393	3	30
Oct-99	0	0	1495	3	31
Nov-99	0	0	1600	3	30
Dec-99	0	0	1576	3	31
Jan-00	0	0	1515	3	31
Feb-00	0	0	1337	3	29
Mar-00	0	0	1479	3	30
Apr-00	952	0	1451	3	30

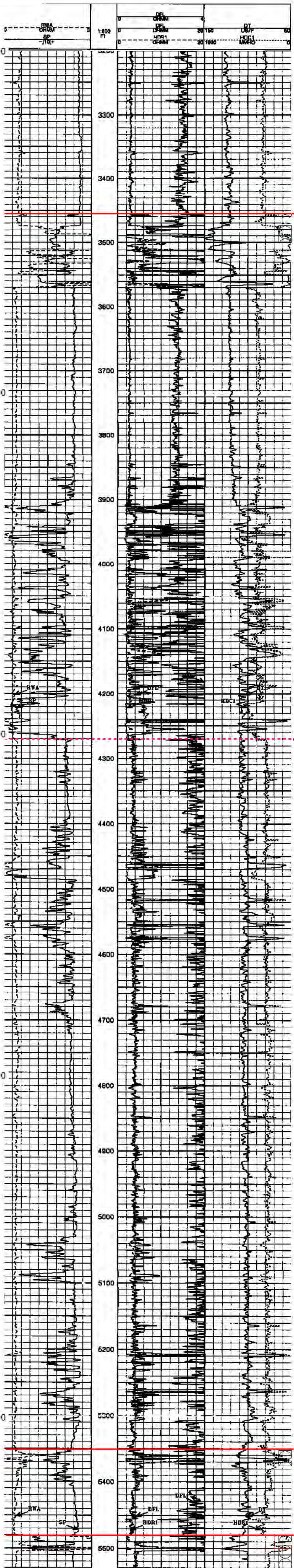
	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
May-00	0	0	1350	3	31
Jun-00	0	0	1312	3	30
Jul-00	0	0	1545	3	31
Aug-00	0	10	1590	3	31
Sep-00	0	10	1708	3	30
Oct-00	0	10	1651	3	31
Nov-00	0	0	1677	3	30
Dec-00	0	0	1665	3	31
Jan-01	0	0	1639	0	31
Feb-01	0	10	1306	3	28
Mar-01	0	10	1780	3	31
Apr-01	0	0	1770	4	30
May-01	0	0	1577	3	31
Jun-01	0	0	1448	3	30
Jul-01	0	5	1680	3	31
Aug-01	10	952	1543	3	31
Sep-01	5	0	1667	3	30
Oct-01	5	0	1648	6	31
Nov-01	0	5	1637	6	30
Dec-01	0	0	1238	6	31
Jan-02	0	0	1498	6	31
Feb-02	5	0	1500	3	28
Mar-02	0	0	1601	4	31
Apr-02	0	0	1631	4	28
May-02	0	0	1711	4	30
Jun-02	0	0	1658	4	30
Jul-02	0	0	1524	4	30
Aug-02	0	0	1090	4	26
Sep-02	0	0	1407	8	30
Oct-02	0	0	1694	0	31
Nov-02	0	0	1694	4	30
Dec-02	0	0	1659	5	31
Jan-03	0	0	1409	4	27
Feb-03	0	0	1390	3	28
Mar-03	0	0	1370	2	30
Apr-03	0	0	1365	2	29
May-03	0	0	1301	3	28
Jun-03	0	0	1319	4	30
Jul-03	0	0	885	1	31
Aug-03	0	0	1272	3	30
Sep-03	0	0	1199	2	28
Oct-03	0	0	1253	3	31
Nov-03	0	0	1194	3	30
Dec-03	0	0	1230	5	23
Jan-04	0	0	1212	3	31
Feb-04	0	0	675	2	17
Mar-04	0	0	1163	3	28
Apr-04	0	0	1233	6	30
May-04	0	0	1226	5	31
Jun-04	0	0	1197	6	28
Jul-04	0	0	1297	6	30
Aug-04	0	0	1240	7	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Sep-04	0	0	1226	7	29
Oct-04	0	0	1296	6	31
Nov-04	0	0	1386	6	30
Dec-04	0	0	1421	4	31
Jan-05	0	0	1592	5	31
Feb-05	0	0	1404	5	28
Mar-05	0	0	1438	5	30
Apr-05	0	0	1340	5	30
May-05	0	0	1448	6	31
Jun-05	0	0	1405	6	30
Jul-05	0	0	1433	7	31
Aug-05	0	0	992	6	31
Sep-05	0	0	1102	6	30
Oct-05	0	0	1132	6	31
Nov-05	0	0	1213	6	30
Dec-05	0	0	1144	3	29
Jan-06	0	0	1746	3	31
Feb-06	0	0	1310	4	28
Mar-06	0	0	1694	4	31
Apr-06	0	0	1449	3	26
May-06	0	0	1594	5	31
Jun-06	0	0	1502	4	29
Jul-06	0	0	1543	7	30
Aug-06	0	0	1547	9	30
Sep-06	0	0	1518	6	29
Oct-06	0	0	1555	6	31
Nov-06	0	0	1486	5	30
Dec-06	0	0	1485	4	29
Jan-07	0	0	1514	0	31
Feb-07	0	0	1411	0	28
Mar-07	0	0	1665	0	31
Apr-07	0	0	1576	4	30
May-07	0	0	1633	5	31
Jun-07	0	0	1344	4	30
Jul-07	0	0	1729	7	31
Aug-07	0	0	1524	7	31
Sep-07	0	0	1581	8	30
Oct-07	0	0	1628	6	31
Nov-07	0	0	1477	0	29
Dec-07	0	0	1515	4	31
Jan-08	0	0	1063	3	31
Feb-08	0	0	1072	5	29
Mar-08	0	0	1187	5	31
Apr-08	0	0	1291	4	26
May-08	0	0	1275	3	31
Jun-08	0	0	1181	4	29
Jul-08	0	0	1279	6	23
Aug-08	0	0	1287	7	31
Sep-08	0	0	1193	7	30
Oct-08	0	0	1260	5	31
Nov-08	0	0	1254	4	30
Dec-08	0	0	1132	4	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Jan-09	0	0	1119	7	31
Feb-09	0	0	992	5	28
Mar-09	0	0	1196	6	31
Apr-09	0	0	1116	3	30
May-09	0	0	1101	4	31
Jun-09	0	0	923	5	30
Jul-09	0	0	1121	5	31
Aug-09	0	0	1000	4	29
Sep-09	0	0	966	4	25
Oct-09	0	0	1146	6	31
Nov-09	0	0	1093	5	30
Dec-09	0	0	1018	4	30
Jan-10	0	0	1053	6	31
Feb-10	0	0	846	6	28
Mar-10	0	0	1030	7	31
Apr-10	0	0	999	7	30
May-10	0	0	1078	7	31
Jun-10	0	0	967	6	30
Jul-10	0	0	1038	7	31
Aug-10	0	0	990	8	31
Sep-10	0	0	884	8	30
Oct-10	0	0	1011	7	31
Nov-10	0	0	1007	5	30
Dec-10	0	0	895	7	31
Jan-11	0	0	1012	6	29
Feb-11	0	0	827	7	26
Mar-11	0	0	808	7	29
Apr-11	0	0	736	7	30
May-11	0	0	717	7	31
Jun-11	0	0	699	6	30
Jul-11	0	0	653	6	31
Aug-11	0	0	713	6	31
Sep-11	0	0	635	6	30
Oct-11	0	0	712	7	31
Nov-11	0	0	732	6	30
Dec-11	0	0	747	6	31
Jan-12	0	0	695	4	29
Feb-12	0	0	699	5	27
Mar-12	0	0	742	5	31
			6,060,099	6,374	

Cum Gas All Zones: 234290 MCF

04007200860000
LARIO OIL & GAS CO.
VOLCANO 1-9
TWP: 20 N - Range: 1 W - Sec. 9
Spud Date=12/18/1998



TD=5587

Princeton Canyon Fill
(Eocene)

Top Perkins Lake Sands

Pre-Eocene
Unconformity

Cretaceous Undifferentiated

Forbes Fm. Gas Sands

04-007-20086 ** 9-20N-1W MD

ALANMAR ENERGY "VOLCANO" 1-9

Field: Perkins Lake Gas

County: Butte

Elev: 122 KB

TD: 5587'

LOC: 1275' S 2110' W NWC

[X] Directional

Spud: 12/17/98
Current Status: Gas
Horizons: Gorge sand 3475', Forbes 4720'
Original Operator: Lario Oil & Gas
Casing: 8-5/8"" cemented at 1595'; 4-1/2" cemented at 5573'

12/17/98 Spud
12/19/98 Cement 8-5/8" casing at 1595' with 620 sacks
12/26/98 5587' TD
12/27/98 cemented 4-1/2" casing with 530 sacks

1/8/99 Ran 2-3/8" tubing to 5521'
1/9/99 Perforate 5495-550', 5480-90' Test SI 2135/2140#

5/11/99 Perforate 5368-76', no pressure increase, perforate 5352-5364', pressure increased from 1100# to 1125#, put to sales plowing 1250 mcf/d at 1055#

11/10/02 Land donut with tubing tail at 3397'
11/11/02 Perforate 3456-59', 3474-3500'

8/16/02 Well transferred to Alanmar Energy

Alanmar Energy
Volcano 1-9

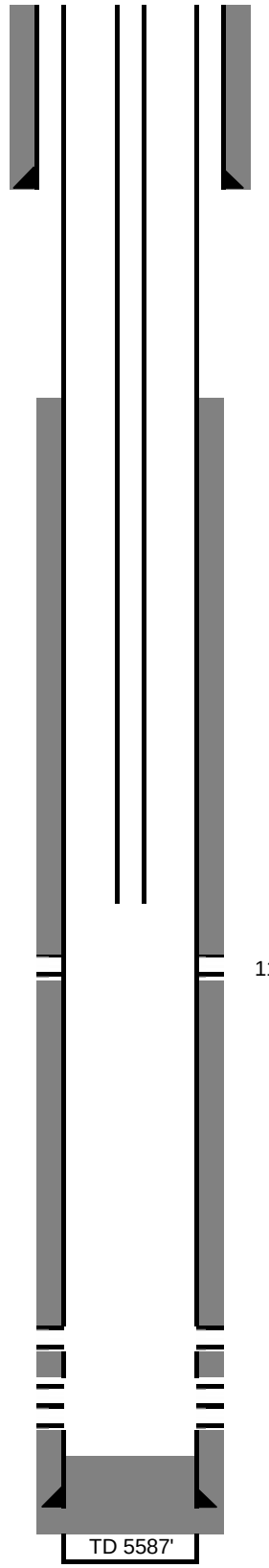
007-20086
Perkins Lake Gas Field
Butte County, CA
Sec 9, 20N, R1W MDB&M

WI/NRI:
Spud: 17-Dec-98
Comp: 27-Dec-98

KB: 122
DF:
GL: 109

Directional Data: BHL 294' south and 1168' east

NOT TO SCALE



Surface Casing: 7" cemented at 1595'
.

11/11/2002 Perforate 3456-59', 3474-3500'

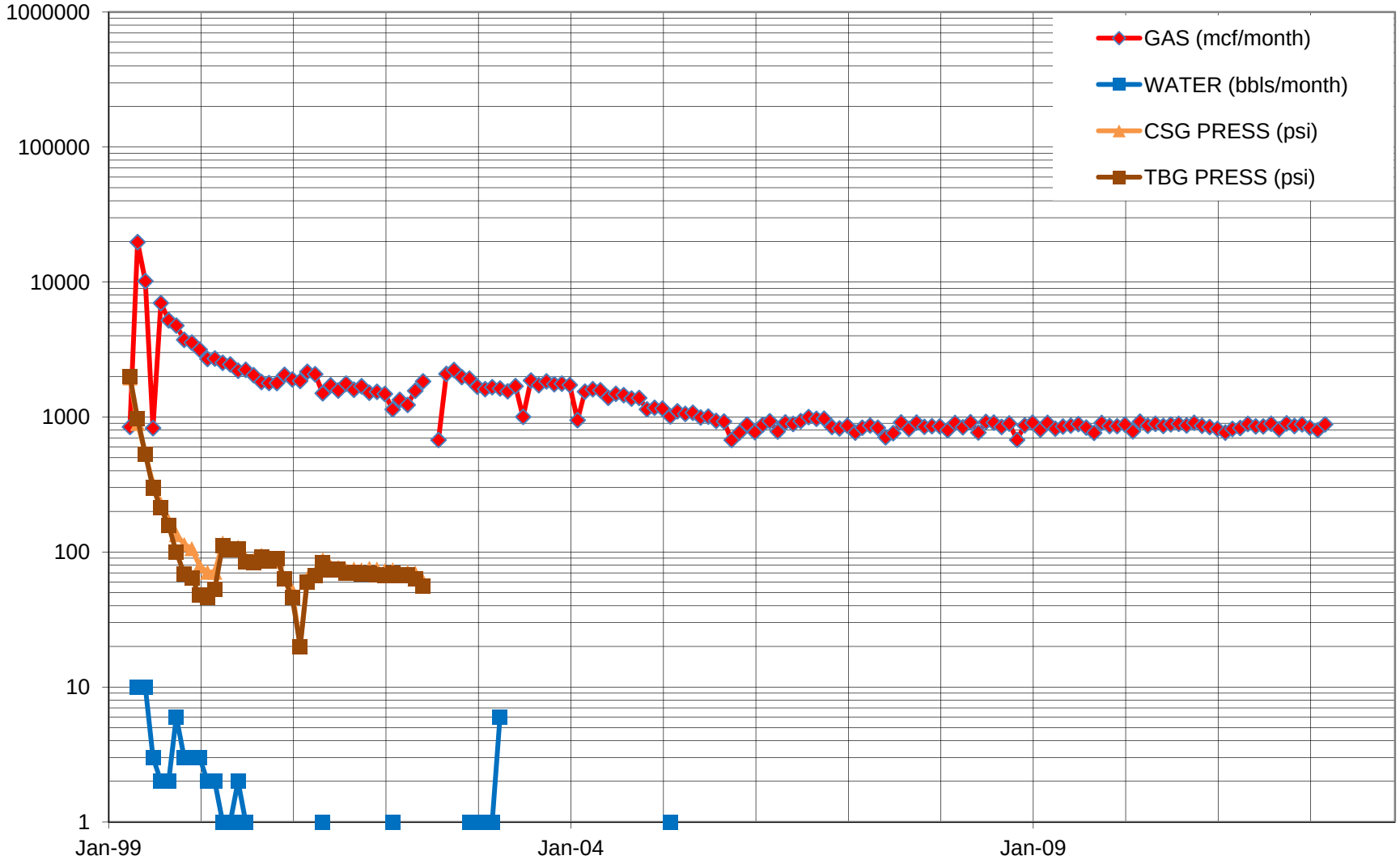
5/11/99 Perforate 5352-64' and 5368-76'

1/9/99 Perforate 5480-90', 5496-5500'

Top of cement 5516'
Production Casing: 4-1/2" cemented at 5573'

00720086 VOLCANO 1-9

CUM PROD 234,290 MCF; 63 BBLS H2O



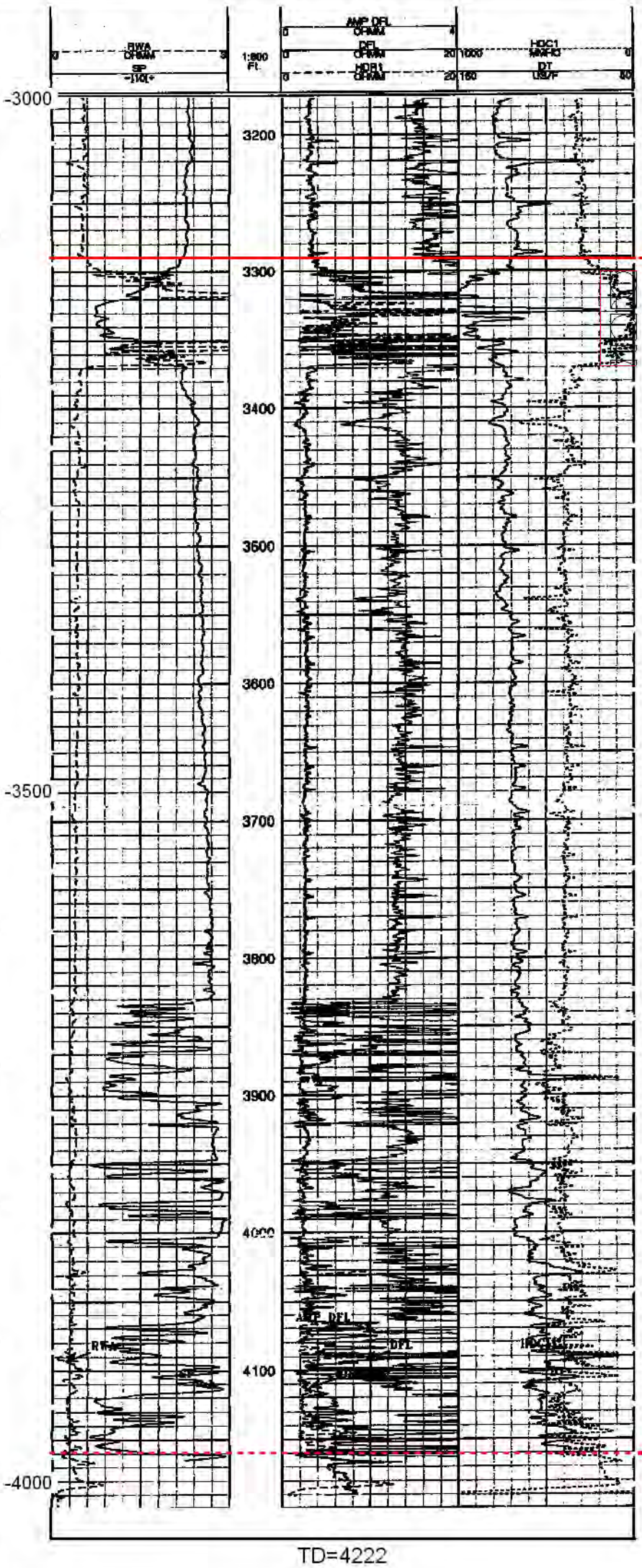
DATE	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS		
Apr-99	1950	2000	846	0	1		
May-99	897	971	19782	10	30		
Jun-99	538	532	10168	10	30		
Jul-99	320	300	828	3	31		
Aug-99	227	212	6996	2	31		
Sep-99	169	157	5210	2	30		
Oct-99	135	100	4764	6	31		
Nov-99	114	69	3739	3	30		
Dec-99	106	64	3563	3	31		
Jan-00	79	48	3161	3	31		
Feb-00	71	46	2695	2	29		
Mar-00	71	53	2714	2	31		
Apr-00	117	112	2525	1	30		
May-00	108	104	2456	1	31		
Jun-00	109	105	2204	2	30		
Jul-00	90	85	2241	1	31		
Aug-00	87	83	2044	0	31		
Sep-00	95	92	1819	0	30		
Oct-00	90	86	1786	0	28		
Nov-00	86	90	1786	0	28		
Dec-00	64	63	2055	0	31		
Jan-01	52	46	1901	0	30		
Feb-01	20	20	1852	0	28		
Mar-01	64	60	2164	0	31		
Apr-01	70	67	2078	0	29		
May-01	88	84	1501	1	27		
Jun-01	78	74	1720	0	30		
Jul-01	77	75	1573	0	31		
Aug-01	73	70	1769	0	31		
Sep-01	75	71	1594	0	30		
Oct-01	74	69	1692	0	31		
Nov-01	76	70	1514	0	30		
Dec-01	75	68	1539	0	31		
Jan-02	73	67	1485	0	31		
Feb-02	74	70	1139	1	28		
Mar-02	70	67	1342	0	31		
Apr-02	71	68	1231	0	30		
May-02	70	63	1566	0	31		
Jun-02	61	56	1838	0	30		
Jul-02	0	0	0	0	0		
Aug-02	0	0	676	0	11		
Sep-02	0	0	2088	0	30		
Oct-02	0	0	2234	0	31	117878	53
Nov-02	0	0	1977	0	30		
Dec-02	0	0	1927	1	31		
Jan-03	0	0	1681	1	27		
Feb-03	0	0	1610	0	28		
Mar-03	0	0	1665	1	30		
Apr-03	0	0	1628	6	29		
May-03	0	0	1551	0	28		
Jun-03	0	0	1696	0	30		
Jul-03	0	0	1004	0	31		
Aug-03	0	0	1866	0	30		

DATE	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Sep-03	0	0	1723	0	28
Oct-03	0	0	1839	0	31
Nov-03	0	0	1751	0	30
Dec-03	0	0	1769	0	23
Jan-04	0	0	1728	0	31
Feb-04	0	0	949	0	17
Mar-04	0	0	1543	0	28
Apr-04	0	0	1609	0	30
May-04	0	0	1580	0	31
Jun-04	0	0	1390	0	28
Jul-04	0	0	1488	0	30
Aug-04	0	0	1454	0	30
Sep-04	0	0	1373	0	29
Oct-04	0	0	1386	0	31
Nov-04	0	0	1141	0	30
Dec-04	0	0	1172	0	31
Jan-05	0	0	1156	0	31
Feb-05	0	0	1012	1	28
Mar-05	0	0	1104	0	30
Apr-05	0	0	1056	0	30
May-05	0	0	1077	0	31
Jun-05	0	0	993	0	30
Jul-05	0	0	1008	0	31
Aug-05	0	0	937	0	31
Sep-05	0	0	927	0	30
Oct-05	0	0	676	0	31
Nov-05	0	0	767	0	30
Dec-05	0	0	882	0	29
Jan-06	0	0	773	0	31
Feb-06	0	0	878	0	28
Mar-06	0	0	932	0	31
Apr-06	0	0	782	0	26
May-06	0	0	913	0	31
Jun-06	0	0	890	0	29
Jul-06	0	0	934	0	30
Aug-06	0	0	1000	0	30
Sep-06	0	0	972	0	29
Oct-06	0	0	974	0	31
Nov-06	0	0	845	0	30
Dec-06	0	0	824	0	29
Jan-07	0	0	864	0	31
Feb-07	0	0	767	0	28
Mar-07	0	0	834	0	31
Apr-07	0	0	866	0	30
May-07	0	0	833	0	31
Jun-07	0	0	708	0	30
Jul-07	0	0	761	0	31
Aug-07	0	0	913	0	31
Sep-07	0	0	817	0	30
Oct-07	0	0	910	0	31
Nov-07	0	0	847	0	29
Dec-07	0	0	857	0	31
Jan-08	0	0	854	0	31

DATE	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS		
Feb-08	0	0	799	0	29		
Mar-08	0	0	905	0	31		
Apr-08	0	0	840	0	26		
May-08	0	0	916	0	31		
Jun-08	0	0	769	0	29		
Jul-08	0	0	921	0	23		
Aug-08	0	0	910	0	31		
Sep-08	0	0	846	0	30		
Oct-08	0	0	896	0	31		
Nov-08	0	0	678	0	30		
Dec-08	0	0	868	0	30		
Jan-09	0	0	909	0	31		
Feb-09	0	0	806	0	28		
Mar-09	0	0	907	0	31		
Apr-09	0	0	820	0	30		
May-09	0	0	852	0	31		
Jun-09	0	0	864	0	30		
Jul-09	0	0	887	0	31		
Aug-09	0	0	836	0	29		
Sep-09	0	0	764	0	25		
Oct-09	0	0	905	0	31		
Nov-09	0	0	859	0	30		
Dec-09	0	0	857	0	30		
Jan-10	0	0	881	0	31		
Feb-10	0	0	784	0	28		
Mar-10	0	0	925	0	31		
Apr-10	0	0	863	0	30		
May-10	0	0	892	0	31		
Jun-10	0	0	860	0	30		
Jul-10	0	0	883	0	31		
Aug-10	0	0	891	0	31		
Sep-10	0	0	867	0	30		
Oct-10	0	0	907	0	31		
Nov-10	0	0	862	0	30		
Dec-10	0	0	844	0	31		
Jan-11	0	0	817	0	29		
Feb-11	0	0	768	0	26		
Mar-11	0	0	817	0	29		
Apr-11	0	0	830	0	30		
May-11	0	0	890	0	31		
Jun-11	0	0	854	0	30		
Jul-11	0	0	853	0	31		
Aug-11	0	0	893	0	31		
Sep-11	0	0	813	0	30		
Oct-11	0	0	898	0	31		
Nov-11	0	0	859	0	30		
Dec-11	0	0	884	0	31		
Jan-12	0	0	836	0	29		
Feb-12	0	0	800	0	27		
Mar-12	0	0	884	0	31	116412	10
			234,290	63			

Cum Gas All Zones: 463451 MCF

04007200880000
LARIO OIL & GAS CO.
FINS 2-9
TWP: 20 N - Range: 1 W - Sec. 9
Spud Date=2/23/1999



Princeton Canyon Fill
(Eocene)

-3000

Top Perkins Lake Sands

-3500

Pre-Eocene
Unconformity

-4000

Cretaceous Undifferentiated

04-007-20088 ** 9-20N-1W MD

LARIO OIL & GAS CO. "FINS" 2-9

Field: Perkins Lake Gas

County: Butte

Elev: 120 KB

TD: 4222'

LOC: 2014' N 1185'W SEC

[X] Directional

Spud: 2/23/99

Current Status: Abandoned Gas

Horizons: Princeton Canyon fill 2340'

Original Operator: Lario Oil & Gas

Casing: 8-5/8"" cemented at 645'; 4-1/2" cemented at 3515'

2/23/99 Spud
2/24/99 Cemented 8-5/8" casing at 645' with 300 sacks
2/27/99 TD 4222'
2/28/99 Ran HRI/BCS log, cemented 4-1/2" casing at 3515' with 305 sacks

3/9/99 Run in hole with 2-3/8" tubing to 3472'
3/10/99 Perforate 3299-3326', 3331-50', 3354-58', 3364-68'
3/12/99 Test 2774 mcf/d, 16/64" choke, 1400/1420#, SI 1440/1440#

12/19/01 Well abandoned

Lario Oil & Gas Company
Fins 2-9

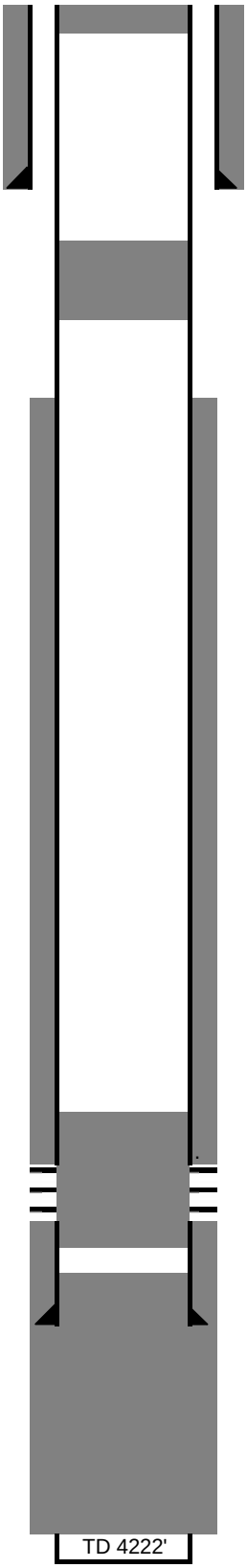
007-20088
Perkins Lake Gas Field
Butte County, CA
Sec 9, 20N, R1W MDB&M

WI/NRI:
Spud: 23-Feb-99
Comp: 27-Feb-99

KB: 120
DF:
GL: 108

Directional Data: BHL 294' south and 1168' east

NOT TO SCALE



Surface Casing: 8-5/8" cemented at 645'
.

12/18/01 Plugged 1159-1514'

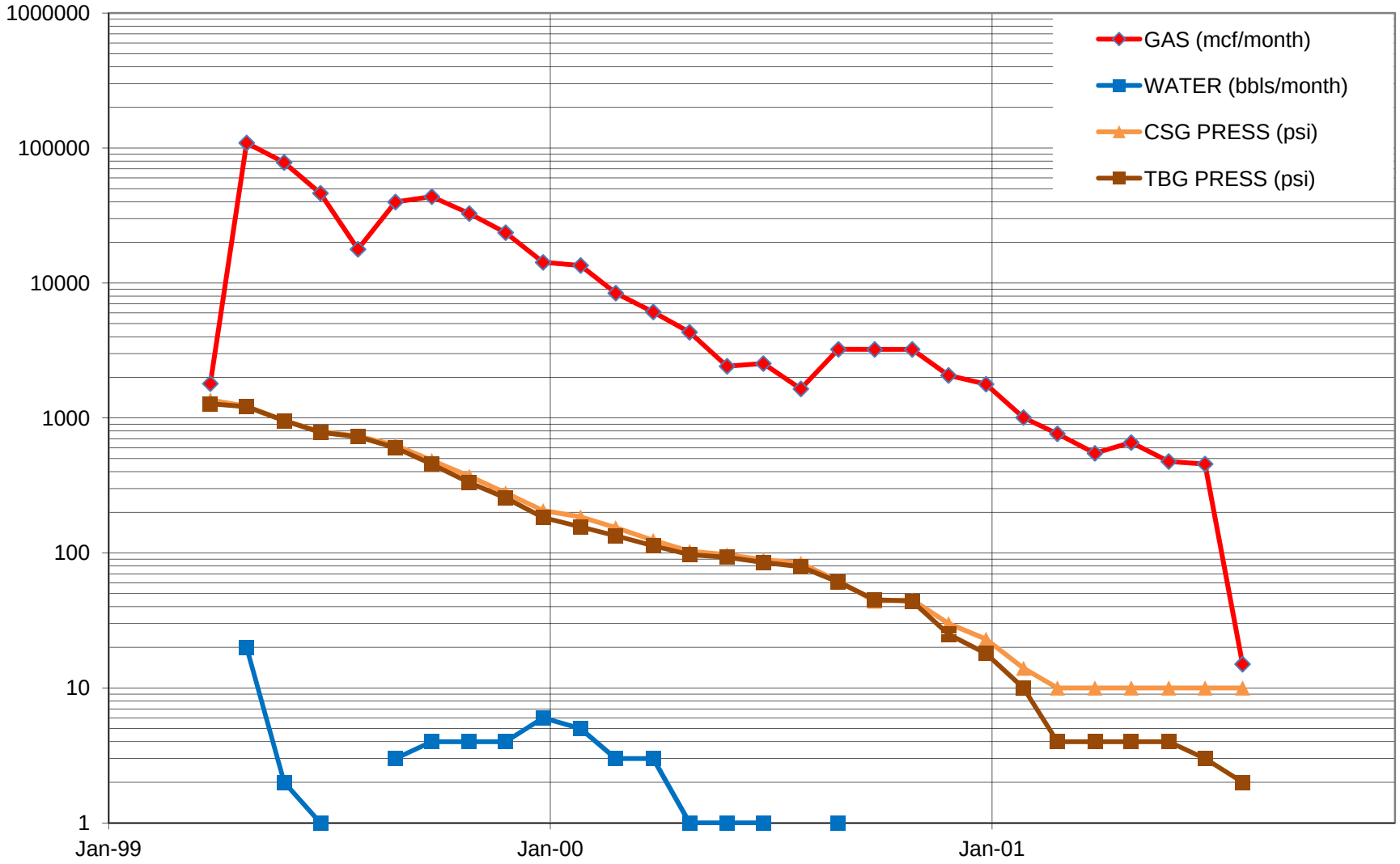
12/17/01 Plugged 3055-3375'

3/10/99 Perforate 3299-3326', 3331-50', 3354-58', 3364-68'

Top of cement 3472'
Production Casing: 4-1/2" cemented at 3515'

00720088 FINS 2-9

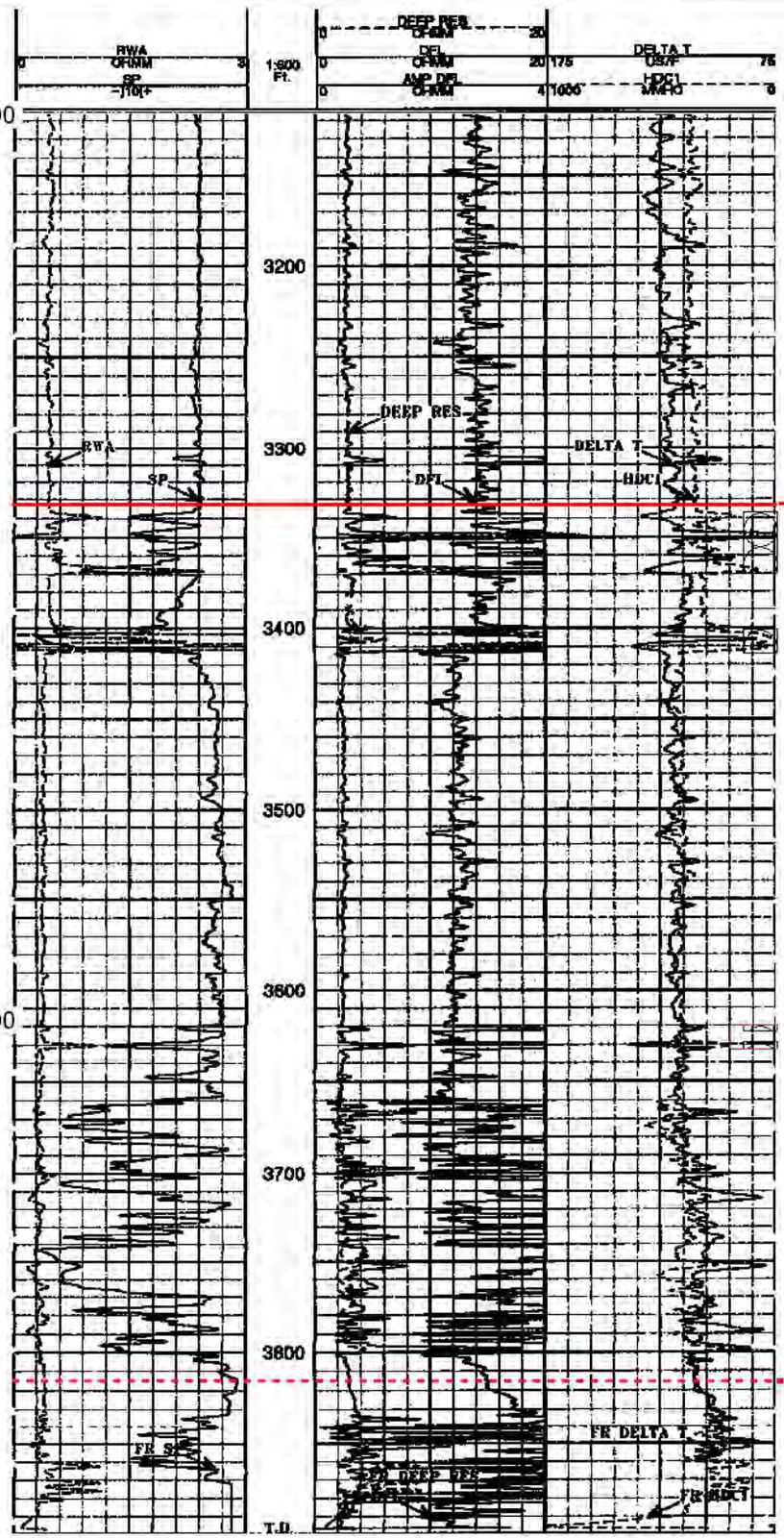
CUM PROD 463,451 MCF; 59 BBLS H2O



	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
Apr-99	1360	1275	1798	0	1
May-99	1219	1212	109126	20	31
Jun-99	957	956	78166	2	30
Jul-99	794	783	46241	1	31
Aug-99	734	726	17790	0	31
Sep-99	628	601	39825	3	30
Oct-99	485	454	43609	4	31
Nov-99	370	332	32702	4	30
Dec-99	279	256	23619	4	31
Jan-00	206	183	14223	6	31
Feb-00	185	156	13483	5	29
Mar-00	154	134	8414	3	31
Apr-00	124	113	6104	3	30
May-00	103	97	4317	1	31
Jun-00	97	93	2417	1	30
Jul-00	89	85	2531	1	31
Aug-00	84	79	1643	0	31
Sep-00	62	61	3227	1	30
Oct-00	44	45	3222	0	31
Nov-00	45	44	3222	0	30
Dec-00	30	25	2068	0	31
Jan-01	23	18	1780	0	31
Feb-01	14	10	1007	0	24
Mar-01	10	4	764	0	31
Apr-01	10	4	548	0	30
May-01	10	4	658	0	31
Jun-01	10	4	476	0	28
Jul-01	10	3	456	0	30
Aug-01	10	2	15	0	1
Sep-01	0	0	0	0	0
Oct-01	0	0	0	0	0
Nov-01	0	0	0	0	0
Dec-01	0	0	0	0	0
			463,451	59	

Cum Gas All Zones: 121788 MCF

04007200900000
LARIO OIL & GAS CO.
PIRATE 1-16
TWP: 20 N - Range: 1 W - Sec. 16
Spud Date=4/15/1999



-3000

-3500

Princeton Canyon Fill
(Eocene)

Top Perkins Lake Sands

Pre-Eocene
Unconformity

Cretaceous Undifferentiated

TD=3900

04-007-20090 ** 16-20N-1W MD

ALANMAR ENERGY "PIRATE" 1-16

Field: Perkins Lake Gas

County: Butte

Elev: 116 KB

TD: 3900'

LOC: 1313' S 2160' W NEC

☐ Directional

Spud: 4/15/99
Current Status: Gas
Horizons: Princeton Canyon fill 2215'
Original Operator: Lario Oil & Gas
Casing: 8-5/8"" cemented at 681'; 4-1/2" cemented at 3746'

4/15/99 Spud well, drill, cement 8-5/8" casing at 681' with 350 sacks
4/18/99 TD 3900, ran HRI/BCS logs
4/19/99 Cemented 4-1/2" casing at 3746' with 345 sacks

4/26/99 Perforate 3619-22' and 3628-32', tested 805 mcf/d thru 12/64" choke with 1020/1100#, SI 1310/1320#

8/16/02 Well transferred to Alanmar Energy

9/11/04 Set retainer at 3605'
9/13/04 Perforate 3336-70' and 3400-14'

Alanmar Energy
Pirate 1-16

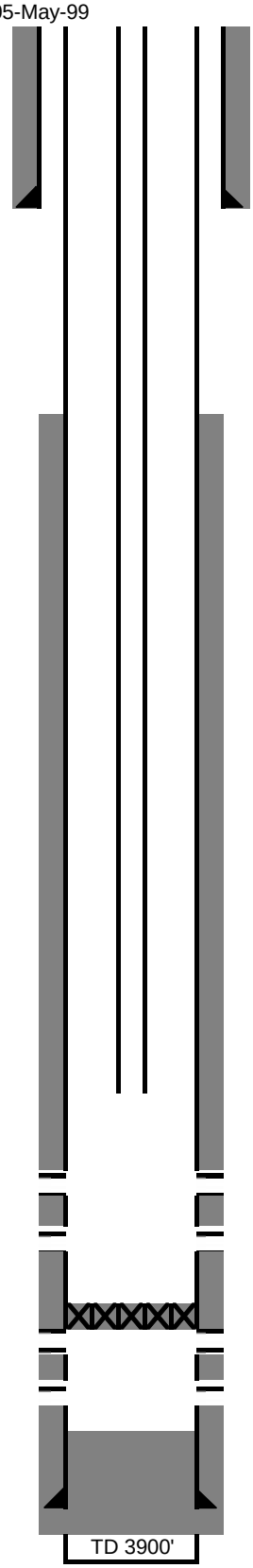
007-20090
Perkins Lake Gas Field
Butte County, CA
Sec 16, 20N, R1W MDB&M

WI/NRI:
Spud: 15-Apr-99
Comp: 05-May-99

KB: 116
DF:
GL: 104

Directional Data: BHL 294' south and 1168' east

NOT TO SCALE



Surface Casing: 8-5/8" cemented at 681'
.

9/13/04 Perforate 3336-70

9/13/04 Perforate 3400-14

9/11/04 Set retainer at 3605'
4/26/99 Perforate 3619-22'

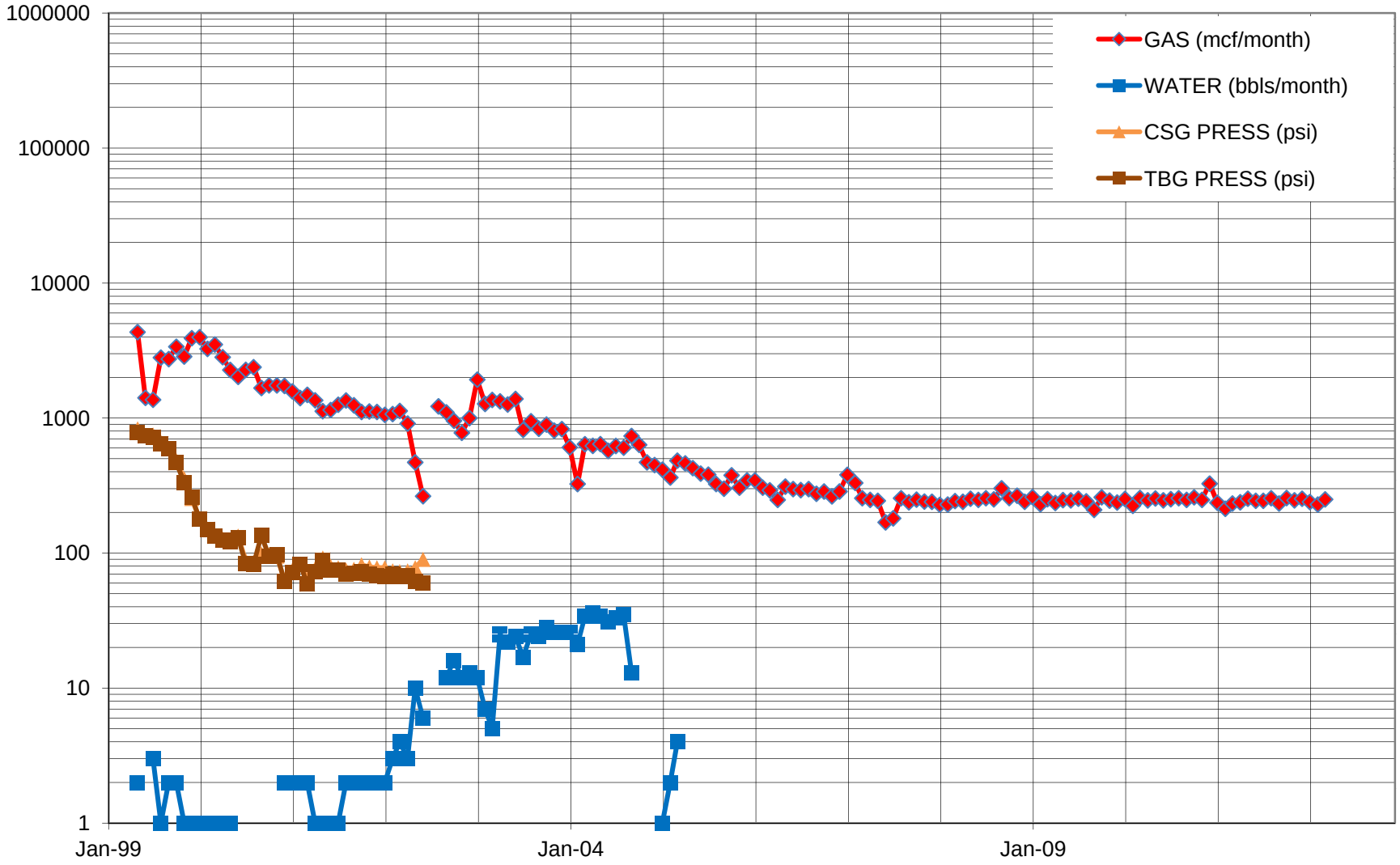
4/26/99 Perforate 3628-32'

Top of cement 3682'

Production Casing: 4-1/2" cemented at 3746'

00720090 PIRATE 1-16

CUM PROD 121,788 MCF; 630 BBLS H2O



	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS
May-99	834	787	4333	2	27
Jun-99	743	738	1413	0	21
Jul-99	751	725	1367	3	31
Aug-99	662	646	2807	1	31
Sep-99	594	593	2736	2	30
Oct-99	485	468	3379	2	31
Nov-99	356	333	2859	1	30
Dec-99	254	261	3907	1	31
Jan-00	179	178	3974	0	31
Feb-00	151	150	3257	1	29
Mar-00	134	133	3509	1	31
Apr-00	127	125	2824	1	30
May-00	124	122	2273	1	31
Jun-00	134	130	2021	0	30
Jul-00	88	84	2278	0	31
Aug-00	85	83	2384	0	31
Sep-00	99	135	1671	0	30
Oct-00	97	95	1747	0	31
Nov-00	95	97	1747	0	30
Dec-00	63	62	1732	2	31
Jan-01	75	72	1577	2	30
Feb-01	83	83	1408	2	28
Mar-01	64	59	1487	2	31
Apr-01	77	73	1355	1	29
May-01	92	89	1126	1	30
Jun-01	80	75	1147	1	30
Jul-01	78	75	1256	1	31
Aug-01	75	70	1351	2	31
Sep-01	76	71	1244	2	30
Oct-01	82	73	1110	2	31
Nov-01	79	70	1120	2	30
Dec-01	78	68	1110	2	31
Jan-02	78	67	1057	2	31
Feb-02	74	70	1072	3	28
Mar-02	73	67	1130	4	31
Apr-02	74	68	911	3	28
May-02	78	62	470	10	27
Jun-02	90	60	264	6	20
Jul-02	0	0	0	0	0
Aug-02	0	0	1222	0	11
Sep-02	0	0	1103	12	30
Oct-02	0	0	955	16	31
Nov-02	0	0	778	12	30
Dec-02	0	0	1000	13	31
Jan-03	0	0	1927	12	27
Feb-03	0	0	1275	7	28
Mar-03	0	0	1363	5	30
Apr-03	0	0	1331	25	29
May-03	0	0	1261	22	28
Jun-03	0	0	1387	24	30
Jul-03	0	0	817	17	31
Aug-03	0	0	948	25	30

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS		
Sep-03	0	0	834	24	28		
Oct-03	0	0	896	28	31		
Nov-03	0	0	807	26	30		
Dec-03	0	0	829	26	23		
Jan-04	0	0	607	26	31		
Feb-04	0	0	325	21	17		
Mar-04	0	0	641	34	28		
Apr-04	0	0	623	36	30		
May-04	0	0	642	34	31		
Jun-04	0	0	572	31	28		
Jul-04	0	0	622	33	30		
Aug-04	0	0	604	35	30	95782	610
Sep-04	0	0	737	13	29		
Oct-04	0	0	634	0	31		
Nov-04	0	0	470	0	30		
Dec-04	0	0	449	0	31		
Jan-05	0	0	415	1	31		
Feb-05	0	0	363	2	28		
Mar-05	0	0	484	4	30		
Apr-05	0	0	462	0	30		
May-05	0	0	426	0	30		
Jun-05	0	0	388	0	30		
Jul-05	0	0	381	0	31		
Aug-05	0	0	325	0	31		
Sep-05	0	0	300	0	30		
Oct-05	0	0	377	0	31		
Nov-05	0	0	305	0	30		
Dec-05	0	0	346	0	29		
Jan-06	0	0	346	0	31		
Feb-06	0	0	305	0	28		
Mar-06	0	0	292	0	31		
Apr-06	0	0	248	0	26		
May-06	0	0	311	0	31		
Jun-06	0	0	298	0	29		
Jul-06	0	0	293	0	30		
Aug-06	0	0	298	0	30		
Sep-06	0	0	275	0	29		
Oct-06	0	0	286	0	31		
Nov-06	0	0	263	0	30		
Dec-06	0	0	286	0	29		
Jan-07	0	0	380	0	31		
Feb-07	0	0	331	0	28		
Mar-07	0	0	255	0	31		
Apr-07	0	0	248	0	30		
May-07	0	0	244	0	31		
Jun-07	0	0	169	0	30		
Jul-07	0	0	181	0	31		
Aug-07	0	0	255	0	31		
Sep-07	0	0	238	0	30		
Oct-07	0	0	249	0	31		
Nov-07	0	0	241	0	29		
Dec-07	0	0	240	0	31		

	CSG PRESS (psi)	TBG PRESS (psi)	GAS (mcf/month)	WATER (bbls/month)	DAYS		
Jan-08	0	0	228	0	31		
Feb-08	0	0	229	0	29		
Mar-08	0	0	243	0	31		
Apr-08	0	0	240	0	26		
May-08	0	0	253	0	31		
Jun-08	0	0	248	0	29		
Jul-08	0	0	255	0	23		
Aug-08	0	0	250	0	31		
Sep-08	0	0	302	0	30		
Oct-08	0	0	256	0	31		
Nov-08	0	0	266	0	30		
Dec-08	0	0	240	0	30		
Jan-09	0	0	260	0	31		
Feb-09	0	0	230	0	28		
Mar-09	0	0	251	0	31		
Apr-09	0	0	235	0	30		
May-09	0	0	247	0	31		
Jun-09	0	0	246	0	30		
Jul-09	0	0	253	0	31		
Aug-09	0	0	242	0	29		
Sep-09	0	0	209	0	25		
Oct-09	0	0	259	0	31		
Nov-09	0	0	245	0	30		
Dec-09	0	0	237	0	30		
Jan-10	0	0	252	0	31		
Feb-10	0	0	224	0	28		
Mar-10	0	0	256	0	31		
Apr-10	0	0	246	0	30		
May-10	0	0	254	0	31		
Jun-10	0	0	246	0	30		
Jul-10	0	0	251	0	31		
Aug-10	0	0	255	0	31		
Sep-10	0	0	248	0	30		
Oct-10	0	0	259	0	31		
Nov-10	0	0	248	0	29		
Dec-10	0	0	327	0	31		
Jan-11	0	0	236	0	29		
Feb-11	0	0	213	0	26		
Mar-11	0	0	233	0	29		
Apr-11	0	0	238	0	30		
May-11	0	0	253	0	31		
Jun-11	0	0	244	0	30		
Jul-11	0	0	244	0	31		
Aug-11	0	0	255	0	31		
Sep-11	0	0	233	0	30		
Oct-11	0	0	256	0	31		
Nov-11	0	0	246	0	30		
Dec-11	0	0	253	0	31		
Jan-12	0	0	239	0	29		
Feb-12	0	0	229	0	27		
Mar-12	0	0	250	0	31	26006	20
			121,788	630			

Memorandum

Pacific Gas and Electric Company

Date: November 19, 2012

To: Ernie Ralston, PG&E Land Planner

From: Catalina Reyes, PG&E Project Biologist, Aquatic and Natural Resources (Power Supply Support)

Subject: Summary of Biological Constraints at Perkins Lake

Hi Mr. Ralston,

This memo communicates a summary of an initial biological desktop review and biological resources observed during a site visit of three potential well pad locations located at Perkins Lake Site on the Llano Seco Ranch on November 14, 2012. This information is presented to aid in Project construction planning and monitoring in order to minimize risk potential of adversely affecting special-status plant and wildlife species in the Project area. The first section of the document discusses general biological resources around Llano Seco Ranch/Perkins Lake Sites (Well Pad No.1, Well Pad No. 2, and Well Pad No. 3). The following sections discuss resources at each potential well pad location. Each well pad is numbered in the order of preference for the core drilling phase. Well Pad No. 1, the southern-most site, is the most desirable from an engineering preference and Well Pad No. 3 is the least.

In order to prepare an assessment for this project, a list of special-status species that could potentially be affected by the project was compiled using the California Natural Diversity Database (CNDDB) for a 5 mile radius around the approximate center location of the well pads located at 39.5815 N and -121.9752 W (accessed November 9, 2012). A review of US Fish and Wildlife Service (USFWS) Special Status Species review was also performed for the Project quadrangle (Llano Seco) and the eight adjacent quadrangles (Wet of Biggs, Butte City, Princeton, Chico, Ord Ferry, Nelson, Hamilton City, and Glenn; accessed on November 9, 2012). All well pads are located in the Township 20N, Range 1 W, and Section 21, in Butte County.

General Biological Constraints around Perkins Lake Site

Giant garter snake (GGS) has been reported to the west and east of Llano Seco Ranch. Wetland and aquatic habitat within the Project vicinity is limited to Perkins Lake, vegetated ditches, riparian wetlands, and seasonal swales within intensively farmed and tilled row crops. These features are not directly connected to wetland or aquatic habitat where GGS have been observed. Furthermore, vegetation along the banks of both Perkins Lake and vegetated ditches within the project area are dominated by riparian woodlands with dense understories of Himalayan blackberry berry (*Rubus armeniacus*), California grape (*Vitis californica*), and narrow-leaved willow (*Salix exigua*) and, thus, lack suitable cover and basking sites for GGS. Because uplands

within the Project area are intensively farmed, tilled and lacking in potential hibernacula (e.g., burrows and crevices), these areas provide poor to unsuitable upland habitat for GGS.

Along access roads and adjacent to potential well pad locations areas of riparian habitat exist that have high potential of providing nesting bird habitat. Access roads currently experience traffic associated with farming but during this project, the amount of traffic will increase. Access roads are close to riparian areas and movement of heavy machinery and increased traffic has the potential to affect nesting bird species. In addition, proposed well pad locations are adjacent to grasslands and farmlands which have the potential to provide habitat for ground nesters such as burrowing owls and waterfowl. To avoid impacts to nesting birds (listed and non-listed) it is highly recommended that work occur outside of the nesting period (February 15 to August 31). If work is to occur within the nesting period it is recommended that all low hanging vegetation near roads and any vegetation removal at well pads be cleared outside of the nesting bird period. In addition, nesting bird surveys should be performed within 2 weeks prior and again 72 hours prior to the start of construction. If nesting birds are found, the project will be stopped immediately and the biologist and/or land planner will need to contact USFWS and California Department of Fish and Game (CDFG) to propose suitable avoidance measures
The open fields and riparian and aquatic habitat of Perkins Lake on the Llano Seco Ranch provide over wintering habitat for many bird species. Based on a conversation with Joe Silvera of the USFWS who has several decades of experience on the Ranch, some species that were not listed on CNDDB and USFWS special status list but are known to utilize these habitats include but are not limited to many species of waterfowl, greater sandhill crane, American bald eagle, golden eagle, and peregrine falcon. The nesting and wintering life cycles of three of these species (greater sandhill crane, American bald eagle, and golden eagle) are State Fully Protected, thus a permit can never be issued to take these species. The impacts that this project will have on these species include temporary disturbance from traffic, well pad construction and drilling, and potential take by vehicles on access roads. By maintaining a speed limit of 15 mph and providing an awareness training tailboard, impacts to these species during wintering can be avoided. It is also recommended that the CAES group identify potential measures to reduce the noise generated by the drilling equipment. If such measures are feasible it may be in the best interest of the resources.

A number of elderberry shrubs (*Sambucus mexicanus*) were identified throughout the property and around proposed well pad locations. Elderberry shrubs are protected by USFWS because they are habitat for the valley elderberry longhorn beetle (VELB) (*Desmocerus californicus dimorphus*) which is federally listed as threatened. If these shrub stems have a diameter 1 inch or greater they are considered habitat for VELB and should be avoided. The USFWS considers working within 100 feet of an elderberry shrub during construction potential disturbance so consultation is required. It is possible that during informal consultation, PG&E can propose establishing a 25 foot buffer around the drip line and avoiding plants but this would have to be approved by USFWS. During site visit some elderberry shurbs were gps'd and their locations are mapped Figures 1-3 but it is important to note that not every individual was mapped and a thorough survey for elderberry shrubs does need to be performed.

Many of these sites are on Conservation Easements held with the Northern California Regional Land Trust (NCRLT) or The Nature Conservancy (TNC) and it is advised to communicate with

these groups once there is a preliminary plan that includes pad location, access routes and schedule.

Potential Well Pad No. 1

Well pad number 1 is approximately at 39.5803N, -121.9711W and is the location of an existing well pad which sits in between a gas compressor located to the west on the main access road and an open field that is currently being farmed on the east (Figure 1). Core drilling will require the expansion of the well pad to the east into the farmland and west towards the access road.

At the time of the site visit, the farmland directly to the east of the well pad was barren of vegetation and had just been seeded. The farmland is within the TNC Easement, and according to the ranch manager, that easement requires maintenance of the current topography, which exhibits a natural undulation that is characteristic of a former river channel swale. Evaluation of the swale was not possible at the time of the site visit because of ongoing farming activity, however surface soil color and historic aerial imagery indicate all or part of this feature may be a farmed wetland. Though no wetland plants were present due to farming activities, there is a possibility that wetland soils and hydrology may still exist. If the well pad extends east into this swale the project will not be allowed to permanently change the topography of this land per the TNC Easement. With the use of temporary fill on a geotextile fabric, the project is not expected to have any lasting negative impacts on the topography of this land. It is advised that the Land Planner consider what regulations apply if this is a farmed wetland.

Between the road and the existing well pad there is a vegetated irrigation ditch that has distinct levees and a low point. At the time of the site visit this feature was dry and there was no clear indicator if water is fed into the feature or if the feature delivers water elsewhere. The feature has distinct levee banks dominated by blackberry riparian habitat. To avoid needing to consult with the Army Corp of Engineers and CDFG, which could claim jurisdiction over this feature, it is advised that all work occur outside of the levee banks; this includes avoiding removal of vegetation from the toes of the levees and avoiding expansion of the well pad into the toe of the levee.

Species concerns at Well Pad No. 1 include elderberry shrubs along the ditch levees and access road, nesting birds, and burrowing owls that could utilize the farmed land. An elderberry shrub is located along the east side of the levee immediately north of the existing well pad and any surface disturbance within 100 feet of the shrub would require consultation with the USFWS. The riparian habitat adjacent to the site provides potential habitat for nesting birds. The majority of birds and their nest are protected under the Migratory Bird Treating Act. To avoid any impacts to nesting birds at this site, it is advised that work occur outside of the nesting phase which can run from February 15 to August 31. If work is to occur in this phase it is advised that any vegetation clearing occur before the nesting season and a nesting bird survey be performed within 72 hours prior to construction. If nesting birds are found, the project will be stopped immediately and the biologist and/or land planner will need to contact USFWS and CDFG to propose suitable avoidance measures.

Well Pad No. 2

Well pad number 2 is located at approximately 39.5864N, -121.9775W (Figure 2). There is no existing well pad at this location, only a disturbed farm equipment staging area, so its placement can occur anywhere between an existing staging area and adjacent ruderal vegetation to an existing silo. For creation of the well pad in this location crews would need to remove existing vegetation which includes black walnut (*Juglans hindsii*), olives (*Olea europea*), and smaller valley oaks (*Quercus lobata*). Understory vegetation at this site is dominated by nonnative herbs such as poison hemlock (*Conium maculatum*) and milk thistle (*Psyllibum marianum*). Removal of any native trees should be avoided and, if feasible, removal should be limited to trimming. Elderberry shrubs were observed at the locations shown on Figure 2 and will require PG&E to consult with the USFWS if pad construction will occur within 100 feet of the shrubs. During the removal of vegetation and while working within this site, appropriate measures to prevent the spread of invasive species need to implemented.

Trees and other vegetation from the staging area to the silo and the open farmland to the north and east of the site provide potential nesting bird habitat. To avoid any impacts to nesting birds, at this site it is advised that work shall occur outside of the nesting phase from February 15 to August 31. If work is to occur in this phase it is advised that any vegetation clearing occur before the nesting season and a nesting bird survey shall be performed within 72 hours prior to construction. If nesting birds are found, the project will be stopped immediately and the biologist and/or land planner will need to contact USFWS and CDFG to propose suitable avoidance measures.

There are no water ways or wetlands in close proximity of Well Pad No. 2.

Well Pad No. 3

Well pad number 3 is approximately at 39.5902N, -121.9750W and is the location of an existing gas well pad (Figure 3). The existing well pad would be expanded to the west and to the north into existing agricultural field. At the time of the field visit it was barren of vegetation.

Species concerns at this location include a single elderberry shrub in the north east corner of the pad. A constructed ditch which drains irrigation water flows through an 18-inch culvert passing under the access to Well Pad No. 3. This appears to be a constructed non-jurisdictional feature.

Open farmland that could potential provide nesting habitat for the burrowing owl exist all around the well pad. The culvert at this site also provides potential wintering and nesting habitat for burrowing owl. Though farming activities may decrease the chance that nesting burrowing owls may occur here it is advised that a survey for nesting burrowing owls be performed 2 weeks prior to the start of construction and again within 72 hours.

Attachments:
Figure 1. Potential Well Pad No. 1 – DRAFT
Figure 2. Potential Well Pad No. 2 – DRAFT
Figure 3. Potential Well Pad No. 3 – DRAFT



G:\Projects\26054 King Cache East Islands\GIS\Working Mxds\Perkins Lake\Fig 4-1 Draft Well 1.mxd Created: 11/20/2012 jhunt

North State Resources, Inc.

Perkins Lake, Butte County, California

DRAFT: Figure 1. Potential Well Pad No. 1



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North State Resources, Inc.

Perkins Lake, Butte County, California

DRAFT: Figure 2. Potential Well Pad No. 2



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North State Resources, Inc.

Perkins Lake, Butte County, California

DRAFT: Figure 3. Potential Well Pad No. 3

CAES GAS FIELD REVIEW
Perkins Lake

Perkins Lake **Good Candidate**

- Production from basal Eocene Markley channel sands.
- Excellent reservoir, gas reserves (38 Bcf.) produced from 5 wells.
- Good depth (~3400') and pressure (~1600#).
- Reservoir may be too large?
- Sands have stratigraphic complications.

COUNTY: BUTTE

PERKINS LAKE GAS FIELD

DISCOVERY WELL AND DEEPEST WELL

	Present operator and well designation	Original operator and well designation	Sec. T. & R.	B.&M.	Total depth (feet)	Pool (zone)	Strata & age at total depth
Discovery well	Exxon Corp. "Parrott Investment Company" B-1	Humble Oil & Refining Co. "Parrott Investment Company" B-1	16 20N 1W	MD	4,370	Perkins Lake	
Deepest well	Exxon Corp. "Parrott Investment Company" B-6	Humble Oil & Refining Co. "Parrott Investment Company" B-6	16 20N 1W	MD	6,500		Guinda Late Cretaceous

POOL DATA

ITEM	PERKINS LAKE					FIELD OR AREA DATA
Discovery date	September 1955					
Initial production rates						
Oil (bbl/day)						
Gas (Mcf/day)	4,060					
Flow pressure (psi)	975					
Bean size (in.)	3/8					
Initial reservoir pressure (psi)	1,575-1,600					
Reservoir temperature (°F)	106					
Initial oil content (STB/ac.-ft.)						
Initial gas content (MSCF/ac.-ft.)	1,200					
Formation	Princeton Cyn. fill					
Geologic age	Eocene					
Average depth (ft.)	3,400					
Average net thickness (ft.)	10-130					
Maximum productive area (acres)	440					
RESERVOIR ROCK PROPERTIES						
Porosity (%)	31					
S_{oi} (%)						
S_{wi} (%)	25					
S_{gi} (%)	75					
Permeability to air (md)						
RESERVOIR FLUID PROPERTIES						
Oil:						
Oil gravity (°API)						
Sulfur content (% by wt.)						
Initial solution GOR (SCF/STB)						
Initial oil FVF (RB/STB)						
Bubble point press. (psia)						
Viscosity (cp) @ °F						
Gas:						
Specific gravity (air = 1.0)	.580					
Heating value (Btu/cu. ft.)	950					
Water:						
Salinity, NaCl (ppm)	4,300					
T.D.S. (ppm)						
R_w (ohm/m) (77°F)						
ENHANCED RECOVERY PROJECTS						
Enhanced recovery projects						
Date started						
Date discontinued						
Peak oil production (bbl) Year						
Peak gas production, net (Mcf)	2,841,396					
Year	1960					

Base of fresh water (ft.): 1,500

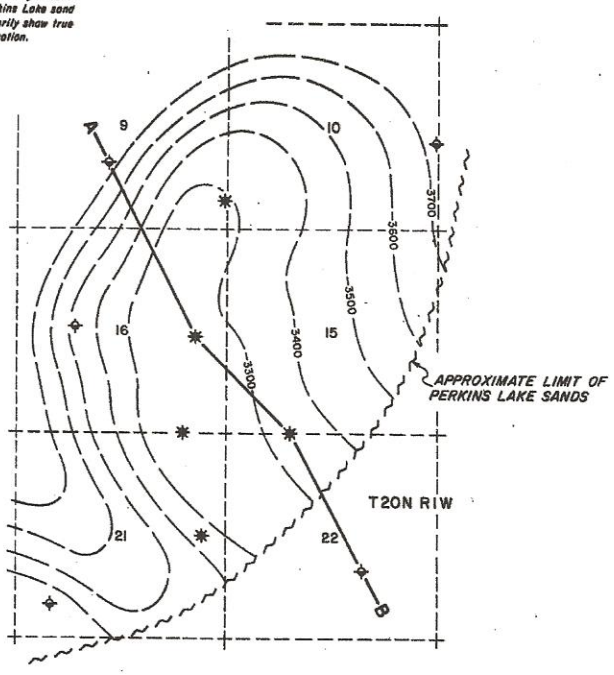
Remarks: Commercial gas deliveries began in December 1965.

Selected References: Harding, T. P., 1962, Perkins Lake Gas Field, Calif. : Calif. Div. of Mines Bull. 181. p. 103-105.
Lorshbough, A. L., 1971, Perkins Lake Gas Field: Calif. Div. of Oil and Gas, Summary of Operations -- Calif. Oil Fields, Vol. 57, No. 1.

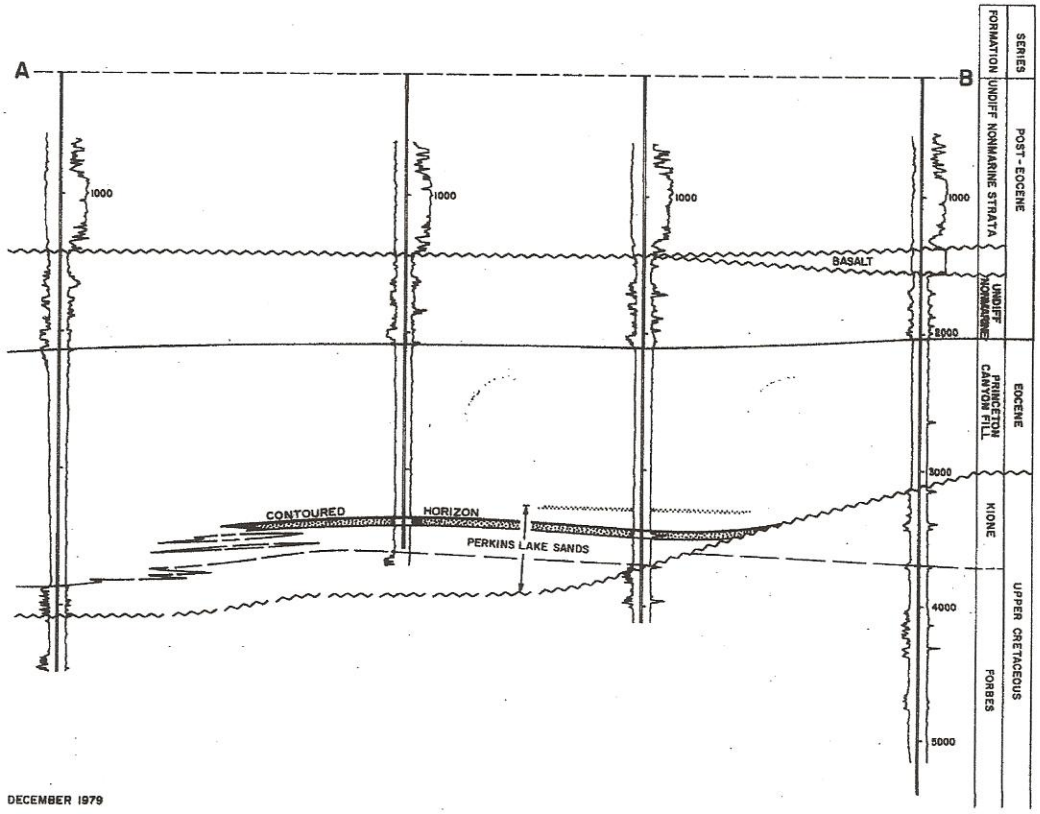
DATE: December 1980

PERKINS LAKE GAS FIELD

NOTE: Contours are on first significant occurrence of Perkins Lake sand and do not necessarily show true structural configuration.



CONTOURS ON TOP OF PERKINS LAKE SANDS

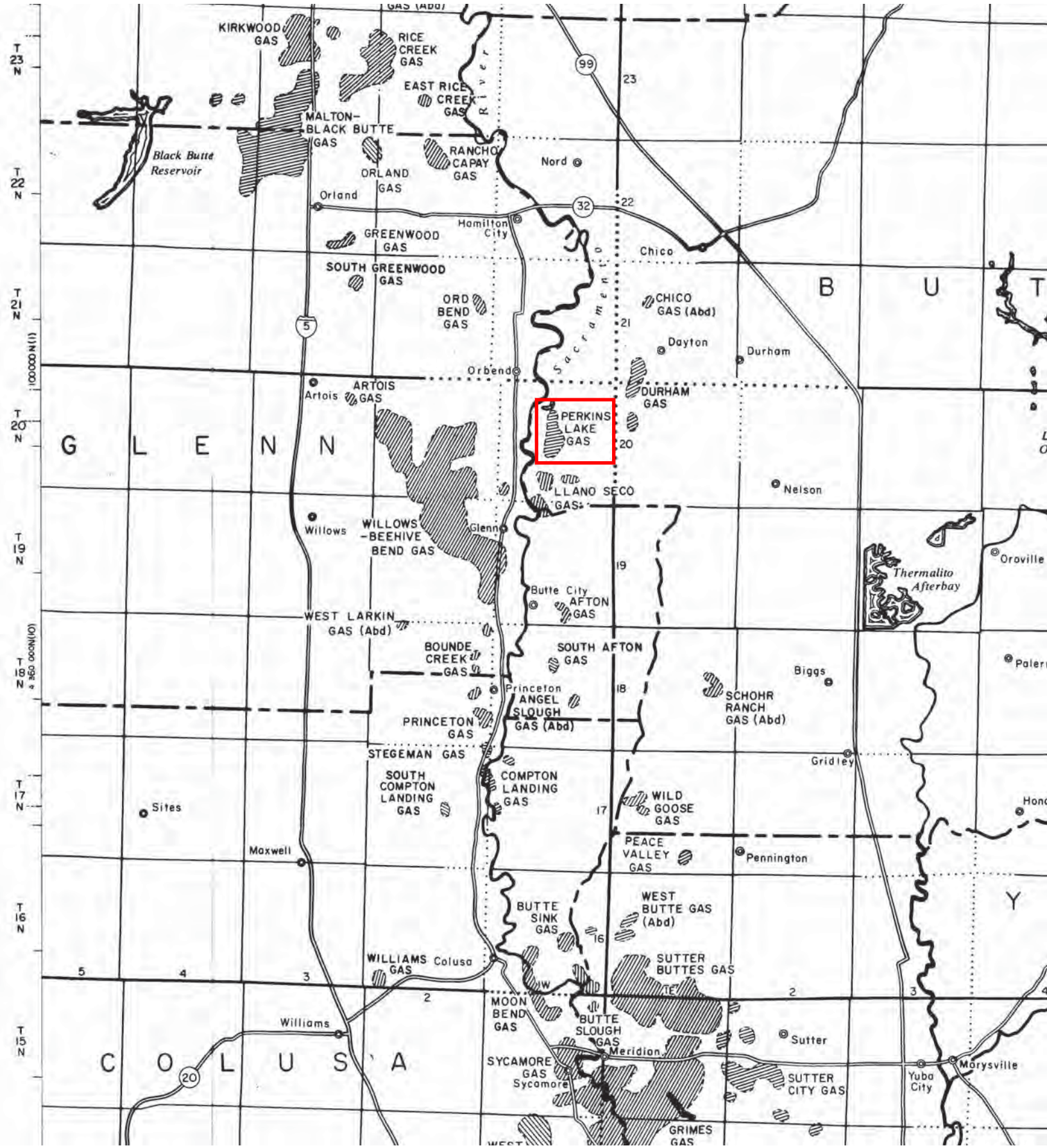


DECEMBER 1979

Perkins Lake Gas Field Reconnaissance

6/22/12

Field Discovery Date:	September, 1955
Cum Gas Prod (thru 2009):	Princeton Canyon Fill 38,032 mmcf Forbes Fm 104 mmcf
Current Field Production:	2012 Q1 average 2286 mcf/month All wells completed in Princeton Canyon Fill
Number of gas wells:	5 active producing, 3 abandoned gas wells
Average Reservoir Depth:	3400 feet (Princeton Canyon Fill)
Initial Reservoir Pressure:	1575-1600 psi (Princeton Canyon Fill)
Reservoir Area:	440 acres
Maximum Net Pay Thickness:	175 feet, lenticular sandstones and conglomerates interbedded with siltstones
Trapping Mechanism:	combination structure-stratigraphy; reservoir sandstones draped across anticlinal nose and truncated at post-Eocene unconformity
Surface Conditions:	The elevation of the ground surface ranges from 100 to 110 feet. Most of the gas field appears to be in agriculture. Units of the Sacramento River National Wildlife Refuge are located adjacent to the field to the west and the eastern part of the field is within the Llano Seco Unit of the North Central Valley Wildlife Management area. The Sacramento River National Wildlife Refuge is composed of twenty-nine units along a 77-mile stretch of the Sacramento River from Red Bluff to Princeton. The North Central Valley Wildlife Management Area includes conservation easements on 11,811 acres from willing landowners to protect wildlife habitat. In exchange for payment, the landowners agree to maintain wetlands and other habitats on their property in perpetuity. **These WMA lands are privately owned and not open for public access**
Notes:	3D seismic data has been acquired over the field and may be available for purchase.


KIRKWOOD GAS
RICE CREEK GAS
EAST RICE CREEK GAS
MALTON-BLACK BUTTE GAS
Black Butte Reservoir
ORLAND GAS
RANCHO CAPAY GAS
Nord
Orland
Hamilton City
GREENWOOD GAS
SOUTH GREENWOOD GAS
ORD BEND GAS
Chico
CHICO GAS (Abd)
Dayton
Durham
Orbend
Sacramento River
ARTOIS GAS
Artois
DURHAM GAS
PERKINS LAKE GAS
LLANO SECO GAS
Nelson
GLENN
Willows
WILLOWS-BEEHIVE BEND GAS
Glenn
Oroville
Thermalito Afterbay
Butte City
AFTON GAS
WEST LARKIN GAS (Abd)
BOUNDE CREEK GAS
SOUTH AFTON GAS
Biggs
Princeton
ANGEL SLOUGH GAS (Abd)
SCHOHR RANCH GAS (Abd)
PRINCETON GAS
STEGEMAN GAS
Gridley
SOUTH COMPTON LANDING GAS
COMPTON LANDING GAS
WILD GOOSE GAS
Sites
Maxwell
PEACE VALLEY GAS
Pennington
BUTTE SINK GAS
WEST BUTTE GAS (Abd)
WILLIAMS Colusa GAS
SUTTER BUTTES GAS
MOON BEND GAS
BUTTE SLOUGH GAS
Williams
Meridian
Sutter
COLUSA
SYCAMORE GAS
Sycamore
SUTTER CITY GAS
Yuba City
Marysville
GRIMES GAS
T 23 N
T 22 N
T 21 N
T 20 N
T 19 N
T 18 N
T 17 N
T 16 N
T 15 N

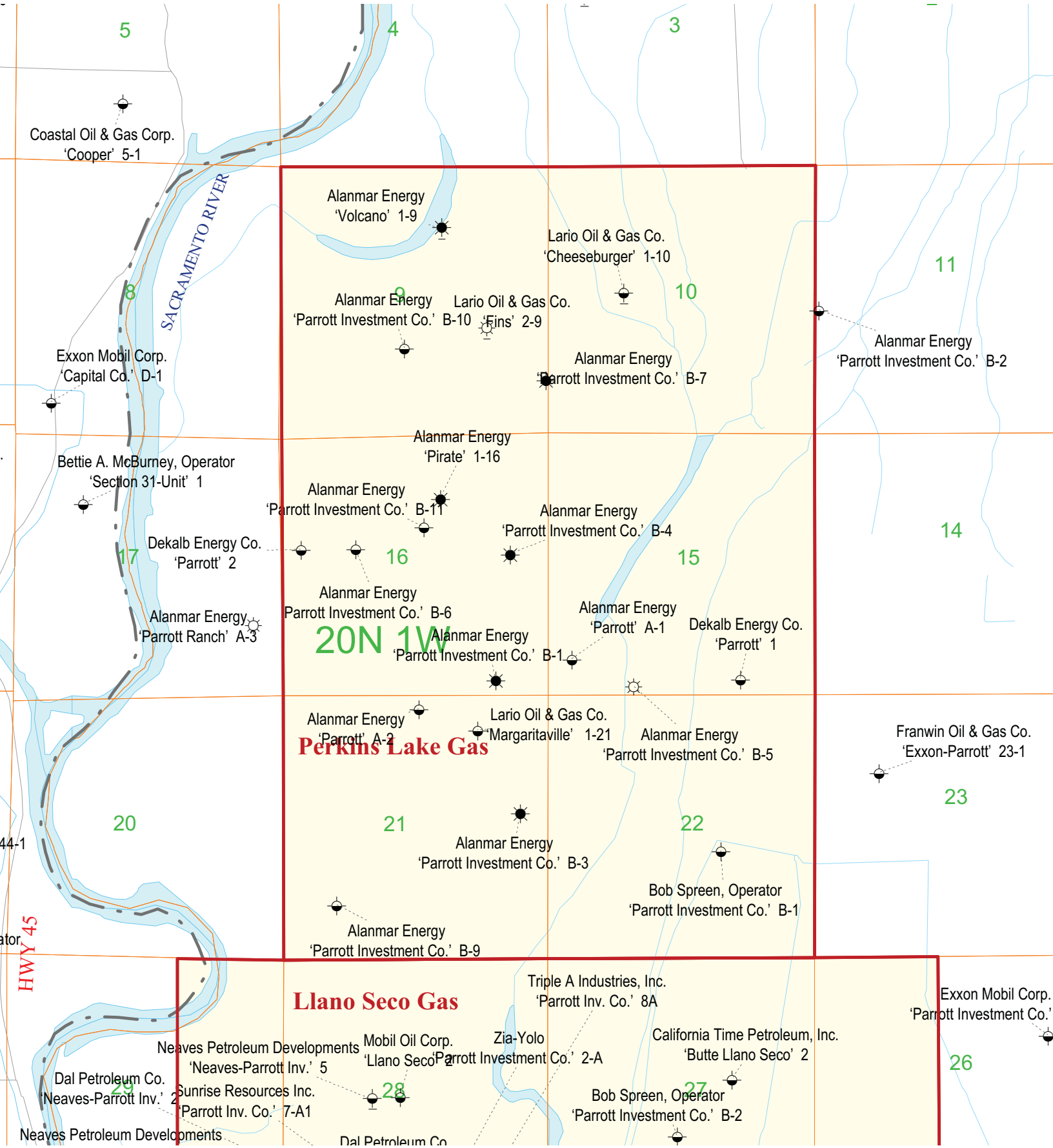

5
4
3
Coastal Oil & Gas Corp.
'Cooper' 5-1
SACRAMENTO RIVER
Alanmar Energy
'Volcano' 1-9
Lario Oil & Gas Co.
'Cheeseburger' 1-10
11
8
9
10
Alanmar Energy
'Parrott Investment Co.' B-10
Lario Oil & Gas Co.
'Fins' 2-9
Alanmar Energy
'Parrott Investment Co.' B-2
Exxon Mobil Corp.
'Capital Co.' D-1
Alanmar Energy
'Parrott Investment Co.' B-7
Alanmar Energy
'Pirate' 1-16
Bettie A. McBurney, Operator
'Section 31-Unit' 1
Alanmar Energy
'Parrott Investment Co.' B-11
Alanmar Energy
'Parrott Investment Co.' B-4
14
Dekalb Energy Co.
'Parrott' 2
17
16
15
Alanmar Energy
Parrott Investment Co.' B-6
Alanmar Energy
'Parrott' A-1
Dekalb Energy Co.
'Parrott' 1
Alanmar Energy
'Parrott Ranch' A-3
20N 1W
Alanmar Energy
'Parrott Investment Co.' B-1
Alanmar Energy
'Parrott' A-2
Lario Oil & Gas Co.
'Margaritaville' 1-21
Alanmar Energy
'Parrott Investment Co.' B-5
Franwin Oil & Gas Co.
'Exxon-Parrott' 23-1
Perkins Lake Gas
23
20
21
22
Alanmar Energy
'Parrott Investment Co.' B-3
Bob Spreen, Operator
'Parrott Investment Co.' B-1
Alanmar Energy
'Parrott Investment Co.' B-9
HWY 45
Llano Seco Gas
Triple A Industries, Inc.
'Parrott Inv. Co.' 8A
Exxon Mobil Corp.
'Parrott Investment Co.'
Neaves Petroleum Developments
'Neaves-Parrott Inv.' 5
Mobil Oil Corp.
'Llano Seco' 2
Zia-Yolo
'Parrott Investment Co.' 2-A
California Time Petroleum, Inc.
'Butte Llano Seco' 2
26
Dal Petroleum Co.
'Neaves-Parrott Inv.' 2
29
28
27
Sunrise Resources Inc.
'Parrott Inv. Co.' 7-A1
Bob Spreen, Operator
'Parrott Investment Co.' B-2
Neaves Petroleum Developments
Dal Petroleum Co

PLATE II

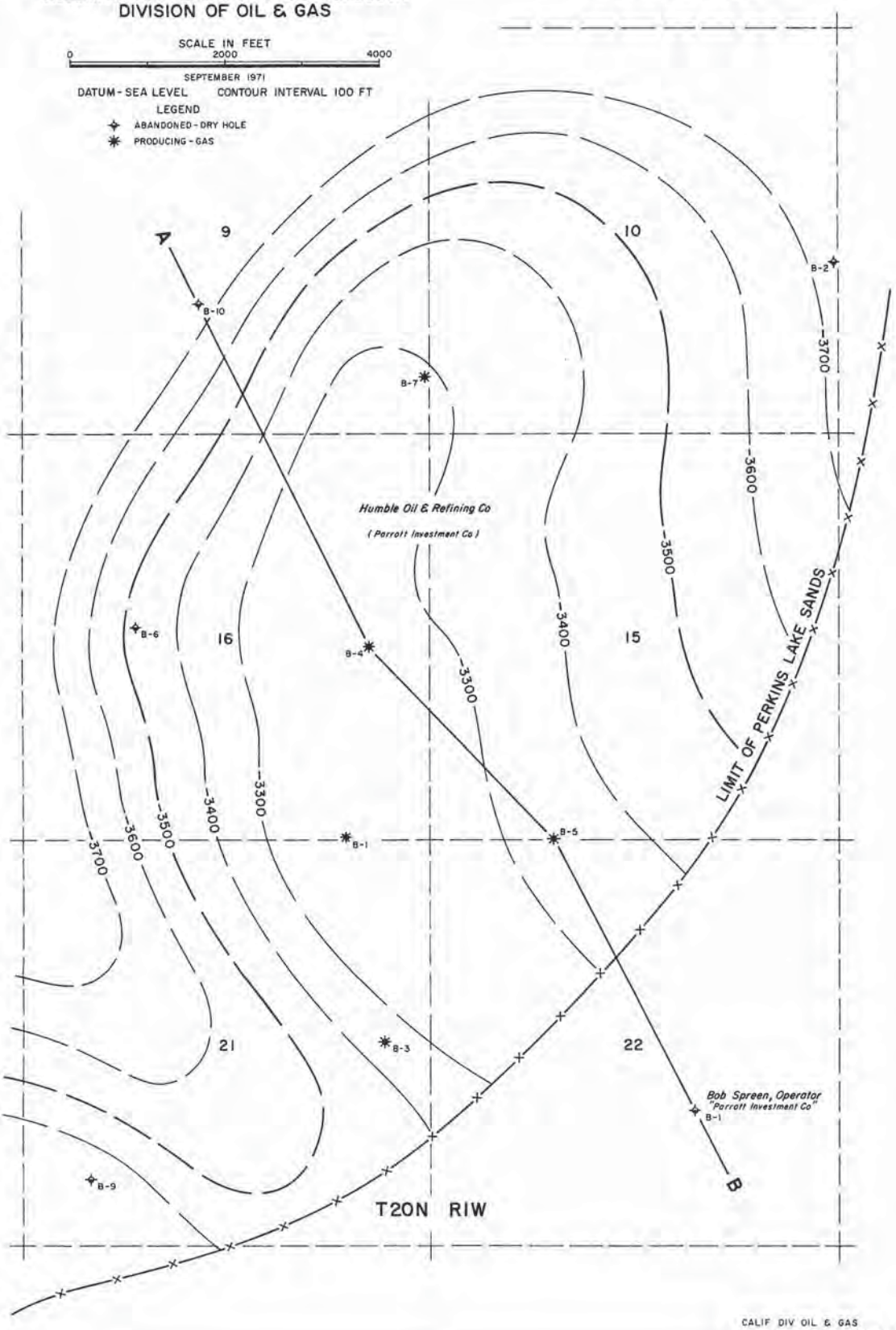
PERKINS LAKE GAS FIELD

BUTTE COUNTY, CALIFORNIA

CONTOURS ON TOP OF PERKINS LAKE SANDS

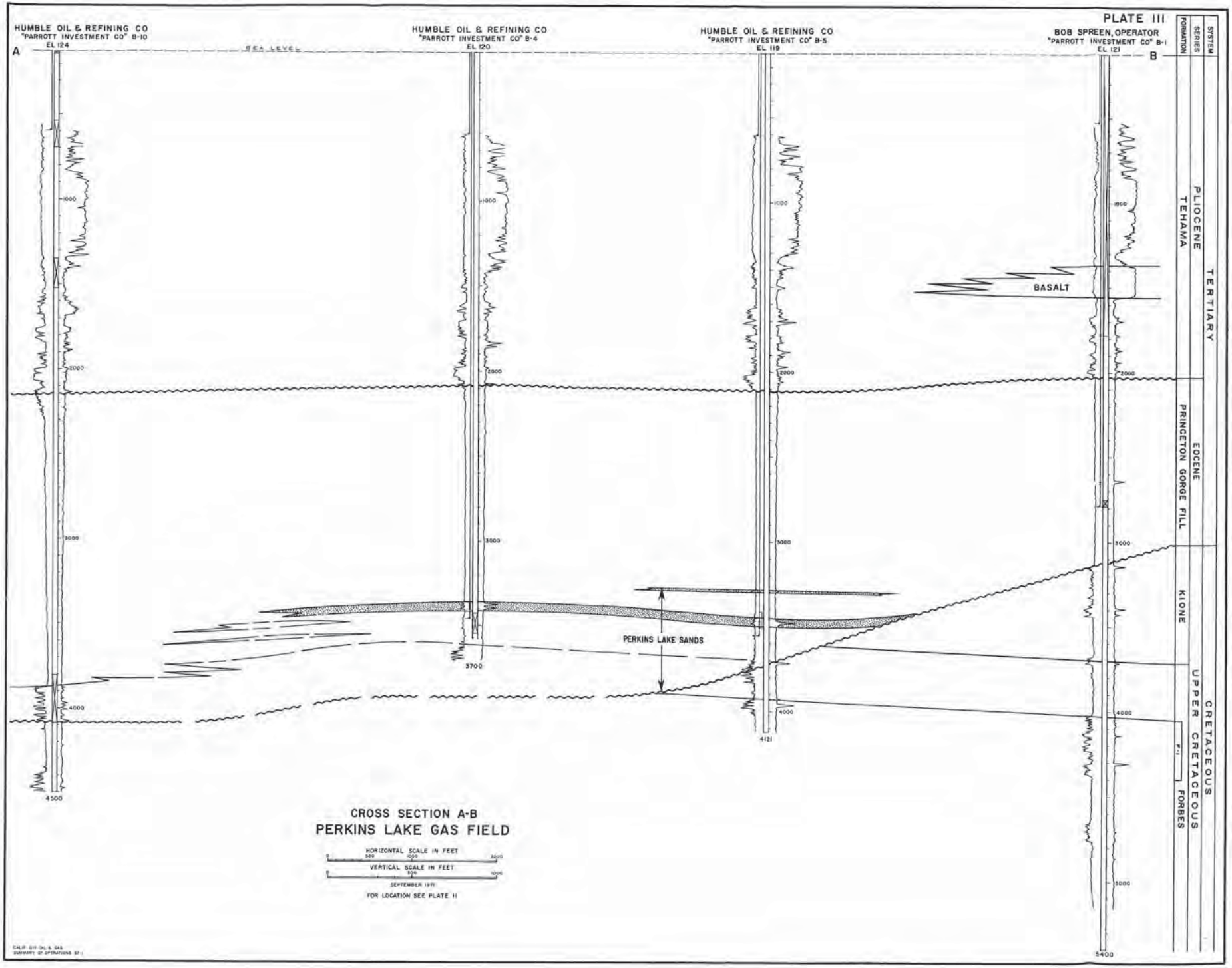
ACCOMPANYING REPORT BY A L LORSHBOUGH
DIVISION OF OIL & GAS

NOTE: Contours are on first significant occurrence of Perkins Lake sand and do not necessarily show true structural configuration.



CALIF DIV OIL & GAS
SUMMARY OF OPERATIONS 57-1

PLATE III



CROSS SECTION A-B
PERKINS LAKE GAS FIELD

HORIZONTAL SCALE IN FEET
0 500 1000 2000

VERTICAL SCALE IN FEET
0 500 1000

SEPTEMBER 1971

FOR LOCATION SEE PLATE II

CALIF. DIV. OIL & GAS
SUMMARY OF OPERATIONS 57-1

COUNTY: **BUTTE**

PERKINS LAKE GAS FIELD

DISCOVERY WELL AND DEEPEST WELL

	Present operator and well designation	Original operator and well designation	Sec. T. & R.	B.&M.	Total depth (feet)	Pool (zone)	Strata & age at total depth
Discovery well	Exxon Corp. "Parrott Investment Company" B-1	Humble Oil & Refining Co. "Parrott Investment Company" B-1	16 20N 1W	MD	4,370	Perkins Lake	
Deepest well	Exxon Corp. "Parrott Investment Company" B-6	Humble Oil & Refining Co. "Parrott Investment Company" B-6	16 20N 1W	MD	6,500		Guinda Late Cretaceous

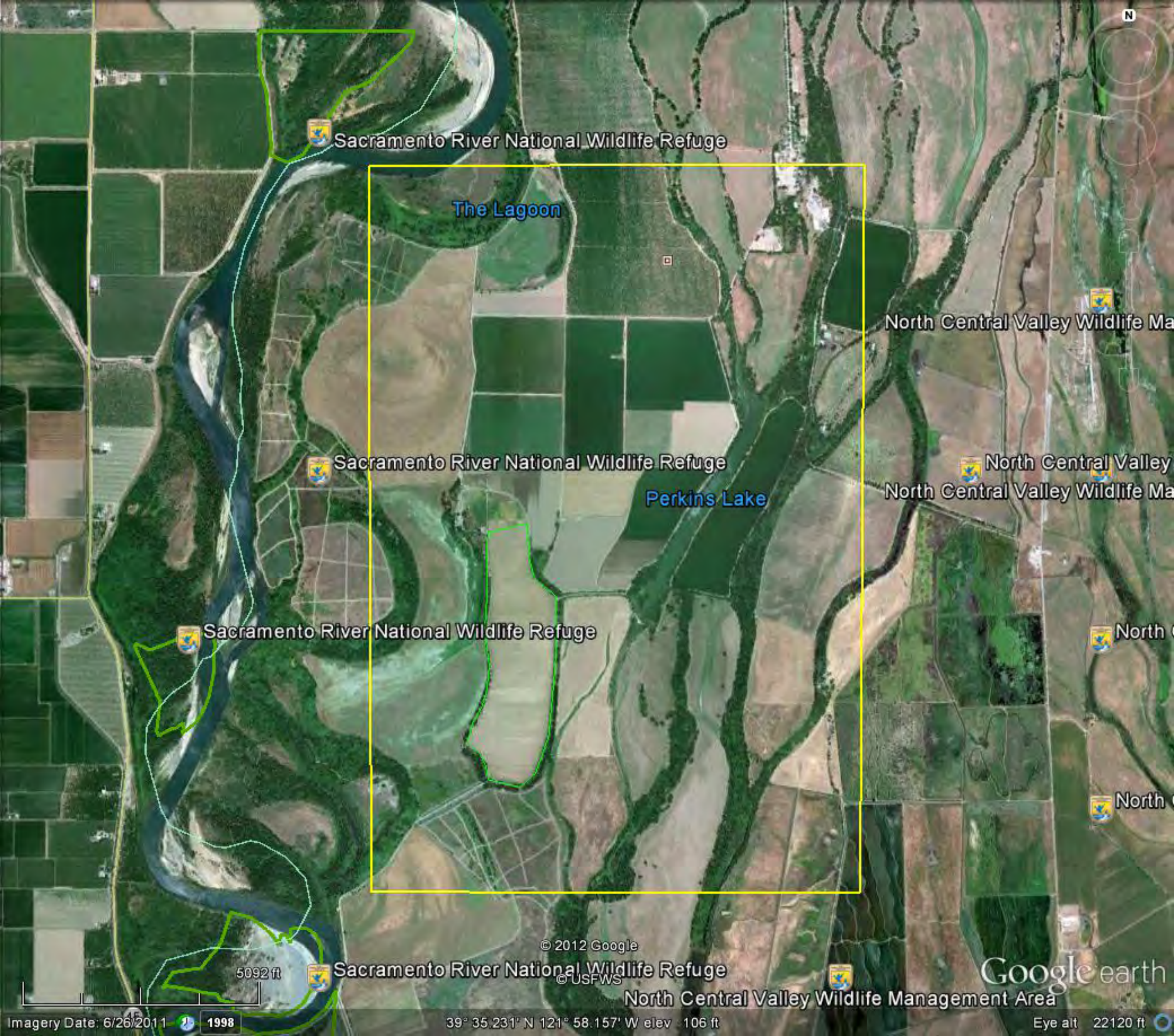
POOL DATA

ITEM	PERKINS LAKE					FIELD OR AREA DATA
Discovery date	September 1955					
Initial production rates						
Oil (bbl/day)						
Gas (Mcf/day)	4,060					
Flow pressure (psi)	975					
Bean size (in.)	3/8					
Initial reservoir pressure (psi)	1,575-1,600					
Reservoir temperature (°F)	106					
Initial oil content (STB/ac.-ft.)						
Initial gas content (MSCF/ac.-ft.)	1,200					
Formation	Princeton Cyn. fill					
Geologic age	Eocene					
Average depth (ft.)	3,400					
Average net thickness (ft.)	10-130					
Maximum productive area (acres)	440					
RESERVOIR ROCK PROPERTIES						
Porosity (%)	31					
So_i (%)						
Sw_i (%)	25					
Sg_i (%)	75					
Permeability to air (md)						
RESERVOIR FLUID PROPERTIES						
Oil:						
Oil gravity (°API)						
Sulfur content (% by wt.)						
Initial solution GOR (SCF/STB)						
Initial oil FVF (RB/STB)						
Bubble point press. (psia)						
Viscosity (cp) @ °F						
Gas:						
Specific gravity (air = 1.0)	.580					
Heating value (Btu/cu. ft.)	950					
Water:						
Salinity, NaCl (ppm)	4,300					
T.D.S. (ppm)						
R_w (ohm/m) (77°F)						
ENHANCED RECOVERY PROJECTS						
Enhanced recovery projects						
Date started						
Date discontinued						
Peak oil production (bbl) Year						
Peak gas production, net (Mcf) Year	2,841,396 1960					

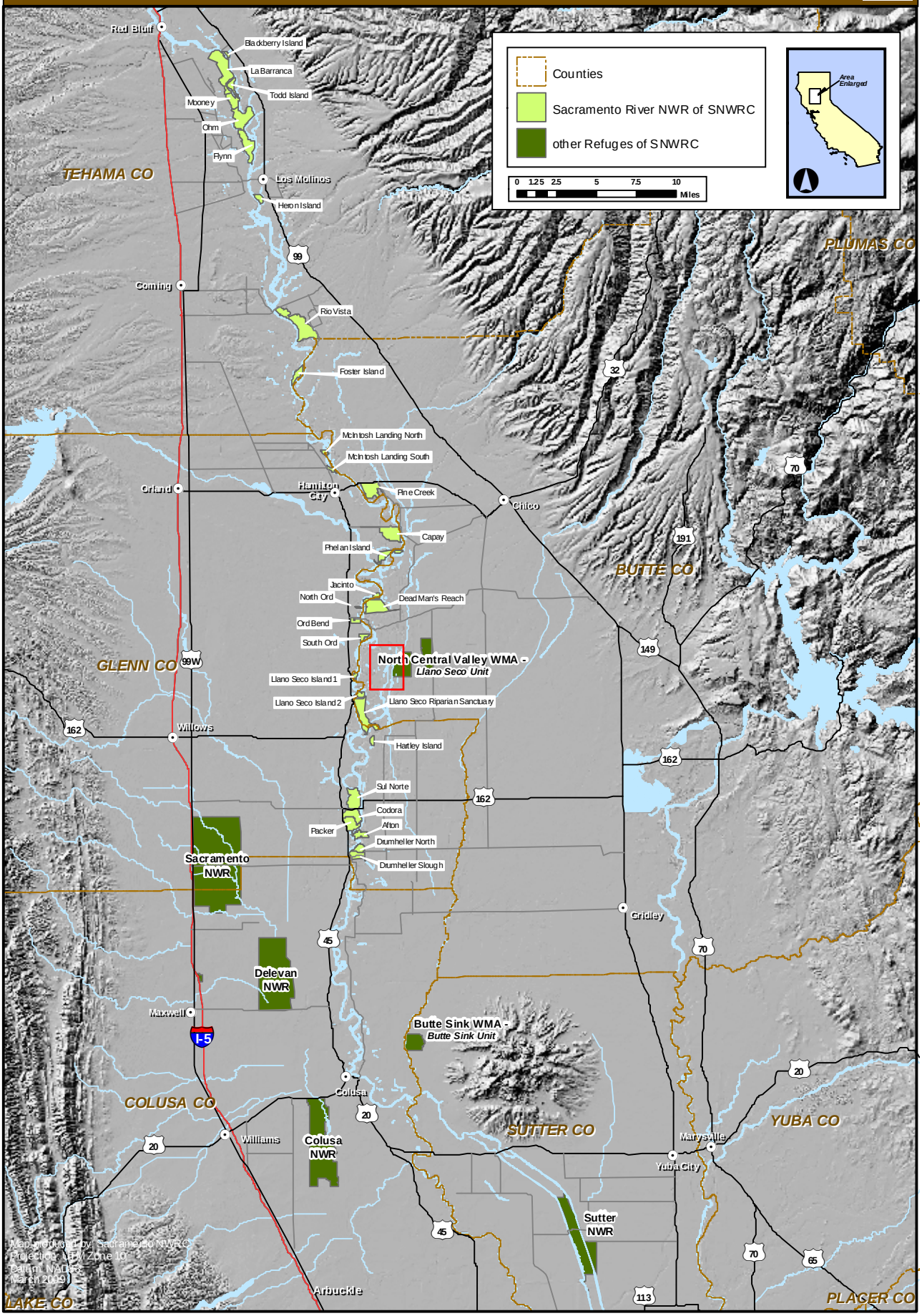
Base of fresh water (ft.): 1,500

Remarks: Commercial gas deliveries began in December 1965.

Selected References: Harding, T. P., 1962, Perkins Lake Gas Field, Calif. : Calif. Div. of Mines Bull. 181. p. 103-105.
Lorshbough, A. L., 1971, Perkins Lake Gas Field: Calif. Div. of Oil and Gas, Summary of Operations -- Calif. Oil Fields, Vol. 57, No. 1.


Sacramento River National Wildlife Refuge
The Lagoon
North Central Valley Wildlife Ma
Sacramento River National Wildlife Refuge
North Central Valley
North Central Valley Wildlife Ma
Perkins Lake
Sacramento River National Wildlife Refuge
North
North
© 2012 Google
5092 ft
Sacramento River National Wildlife Refuge
© USFWS
North Central Valley Wildlife Management Area
Google earth
Imagery Date: 6/26/2011
1998
39° 35.231' N 121° 58.157' W elev 106 ft
Eye alt 22120 ft

Sacramento National Wildlife Refuge Complex



PERKINS LAKE RESERVOIR

Summary and Decision

The Perkins Lake reservoir (Perkins Lake—Aerial Map.pdf), located in Glenn County, California (south of Chico), was not selected for detailed modeling and was not a finalist candidate for the following reasons:

- Surface area is in the Sacramento River floodway.
- Surface area is encumbered by numerous conservation easements.
- Energy Conversion Facility (ECF) siting and transmission upgrades would be difficult.
- Due to low reservoir pressure, testing of the reservoir would require more time and compression power; upgrades to power lines to power the compression equipment may be difficult due to large expanses of rice fields, which are habitat for the giant garter snake (GGS).

Subsurface/Reservoir Screening

Preliminary Screening Results

The project team completed a preliminary screening of the Perkins Lake gas field on April 26, 2012 (Perkins Lake—Preliminary Screening Review.pdf). Based on the results of that preliminary screening, the team followed up with a more detailed reconnaissance report completed on June 22, 2012 (Perkins Lake—Reconnaissance Report.pdf). That report indicated that an estimated 38 Bcf had been produced from eight wells completed within the Princeton Canyon Fill and the deeper Forbes formations. At the time of the report, five of the wells were listed as active producers. The focus of the report was on the Princeton Canyon Fill sandstones, which produced most of the gas from the field and exhibited characteristics that were acceptable reservoir parameters for a CAES project. At approximately 3,400 ft depth and an estimated 1,600 psi pressure, the field was judged to be acceptable and appeared to be a good candidate to test the CAES concept.

The field was discovered in 1955 and is currently producing limited quantities of natural gas. A total of eight wells penetrated the Eocene age Princeton Canyon gas pool. Log-derived porosities were determined to average 30%. Permeability measurements are not available. The reservoir achieves a maximum gross thickness of more than 170 ft, with maximum net thicknesses of more than 100 ft. The aerial footprint of the productive reservoir was estimated at approximately 440 acres. Based on the production history, with a very limited volume of water production reported, the team concluded that a depletion drive mechanism likely existed.

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Detailed Geological Summary

Based on the encouraging preliminary screening results, a detailed geological evaluation was completed to look deeper into the field attributes. That work was completed on July 22, 2012, building on the previous analysis (Perkins Lake—Detailed Geological Report.pdf, Perkins

Lake—Geological Report Appendix.pdf). The productive gas reservoir aerial extent was adjusted to 967 acres, and the maximum drilled gross thickness was determined to be 173 ft. A total of 21 wells have been drilled into the reservoir, only 8 of which actually produced natural gas.

The Princeton Canyon Fill deposits that form the gas reservoir at Perkins Lake consist of conglomerates and sandstones locally interbedded with siltstones. The interbedded nature of the reservoir, with no well-defined horizon that can be correlated throughout the field, creates challenges in mapping the geology. The structural geometry is lobate, elongated in the north-south direction with generally gentle dips. A well-defined water table appears to be at the elevation of -3,380 ft subsea. The history of gas and water production indicates that the reservoir has a pressure-depletion production drive mechanism. No estimates of permeability were provided; however, based on the production rates (two wells reported rates in excess of 5,500 Mcfd), the reservoir appears to have very good permeability. A 3D seismic survey was completed in the late 1990s (titled: "Llano Seco" survey) and may be available for purchase from ECHO Geophysical Corp (Perkins Lake—3D Seismic.pdf).

Reservoir Modeling and Evaluation

Based on the results of the preliminary and detailed geological analysis, the project team determined that the Perkins Lake reservoir parameters were within an acceptable range for CAES development. However, when the reservoir was evaluated against other potential reservoirs, it ranked lower than the top choices to meet the CAES program's short- and long-term objectives. Specifically, the relatively large reservoir currently at very low pressure due to the absence of an active water drive creates a significant challenge in conducting an injection test. A very large quantity of air would need to be injected to achieve pressures high enough to conduct the test procedure. For this reason, no further evaluation was conducted at Perkins Lake.

Testing/Development Potential

No testing was conducted.

Siting and Environmental Evaluation

Determination – Fatal Flaws

The entire gas reservoir surface area is in the Sacramento River floodway and encumbered by conservation easements (Perkins Lake—Conservation Easements Map.pdf), although development of a well field was not precluded by the easements. A habitat assessment was completed for three potential well pads located generally in active agricultural row crop fields over the reservoir (Perkins Lake—Habitat Assessment.pdf). Species concerns were mainly avian

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nesting and foraging, with the elderberry bushes as the only terrestrial species. However, the conservation easement would not allow development of an ECF. The width of the floodway pushes potential ECF locations at least three miles east or west of the center of the reservoir. No suitable locations for an ECF were subsequently found due to moderate density farm residential to the west and large expanses of rice fields (giant garter snake habitat) with few public roads to the east. Another key issue associated with this site was the excessive distance to the nearest 230-kV power lines, which are 13 miles to the west through moderate density farm residences and 17 miles to the east, both directions crossing perpendicular to a waterfowl migration route/pattern. Based on these constraints, this site was dropped from further consideration.

Land Acquisition/Site Control

Deployment

In May 2012, a landman deployed to the Perkins Lake reservoir to identify the surface, mineral, and preferred ECF site owners (Perkin's Lake—APN Map.pdf). The landman determined that the entirety of Perkins Lake fell within the Llano Seco ranch. The project's environmental team conducted several site visits to determine the suitability of Llano Seco for a CAES project.

Preliminary Title Work

In May 2012, PG&E proceeded with a limited title review of the parcels overlying the storage reservoir. Title work identified one surface owner, who owned all of the pore space and mineral rights over the storage reservoir. To expedite reporting to the mineral rights, PG&E requested a copy of a preliminary title report that the owner had produced in 2006. This request was acceptable to the owner, who then signed a letter authorizing the title company to release the report.

This title report identified several conservation easements that restricted allowable surface uses. While exploring for oil and natural gas were considered in these easements, drilling was limited to specific locations and months during the year. After further review and discussion regarding these easements, the project team determined that although the surface impacts involved in drilling a core or even Injection/Withdrawal (I/W) well at several locations were allowable, obtaining the required permits necessary for the project may be difficult.

In addition to these conservation easements, several unreleased oil and gas leases were identified. PG&E was unable to locate a copy of the leases for review.

In August 2012, Project Management approved First American Title Company to produce a preliminary title report for a potential ECF site west of the Sacramento River in Glenn County. The title report was completed that month.

In October 2012, Project Management approved First American Title Company to produce an additional preliminary title report for the Llano Seco ranch. That report was completed in December 2012.

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Ownership

Perkins Lake was attractive from an acquisition perspective due to the fact that the owner had site control over the entire storage reservoir including all necessary mineral rights. The initial point of contact for the owner was the Llano Seco ranch manager. In June 2012, a representative of the project team met with the ranch manager, who was able to provide some insight into the various conservation easements over the Llano Seco ranch and identify the location of six existing natural gas well pads and wells on the property, one of which was still producing. The ranch manager did not know if a copy of the oil and gas lease was available for our review. Upon receiving a presentation on the larger CAES project, the ranch manager asked a recurring question of whether compensation would include free electricity from PG&E. The ranch manager shared the results of this meeting with the landowner, who expressed a great deal of interest in the project. Further, since the landowner had personally negotiated the conservation easements with the various agencies, he felt that his relationship and the language included would allow for future development of a CAES project.

In July 2012, a meeting was held with PG&E's project team and the landowner. Being the principal negotiator of the conservation easements, the landowner was able to provide specific locations on the Llano Seco ranch where development of well pads would be allowable. He also informed PG&E that three wells were producing natural gas on the property.

In November 2012, the ranch manager conducted another site visit with the project's biologists, engineers, and planner. During this visit, the project team examined the condition and location of roads, existing well pads, and proposed well pads as they related to the location of potential environmental habitat. Several sites were identified as locations that could possibly allow for successful core wells and work within the restrictions of the conservation easements.

The major concerns raised in conversations with the landowner can be summarized as follows:

- Siting of the ECF in relation to the property
  - Noise, visual, and traffic concerns
- Impacts to ranch operation and previous restoration efforts
  - Owner had committed significant resources to restore the historical wildlife and natural aesthetics of the ranch/general area and was concerned about how the project would affect the environs and community.
- Location of any electric transmission towers required

A form agreement was never presented to the landowner. In May 2013, the project team decided that the timing of entering into an agreement to drill a core well into the storage reservoir did not meet the project's schedule, and Perkins Lake was eliminated.

ECF Sites

The owner of one potential parcel west of the Sacramento River in Glenn County was approached regarding entering into an Option to Purchase for a potential ECF. This owner had

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no interest in selling his property. No other property owner was approached regarding the CAES project.

References

1) Perkins Lake - Aerial Map.pdf
2) Perkins Lake - Preliminary Screening Review.pdf
3) Perkins Lake - Reconnaissance Report.pdf
4) Perkins Lake - Detailed Geological Report.pdf
5) Perkins Lake - Geological Report Appendix.pdf
6) Perkins Lake - 3D Seismic.pdf
7) Perkins Lake - Conservation Easements Map.pdf
8) Perkins Lake - Habitat Assessment.pdf
9) Perkins Lake - APN Map.pdf

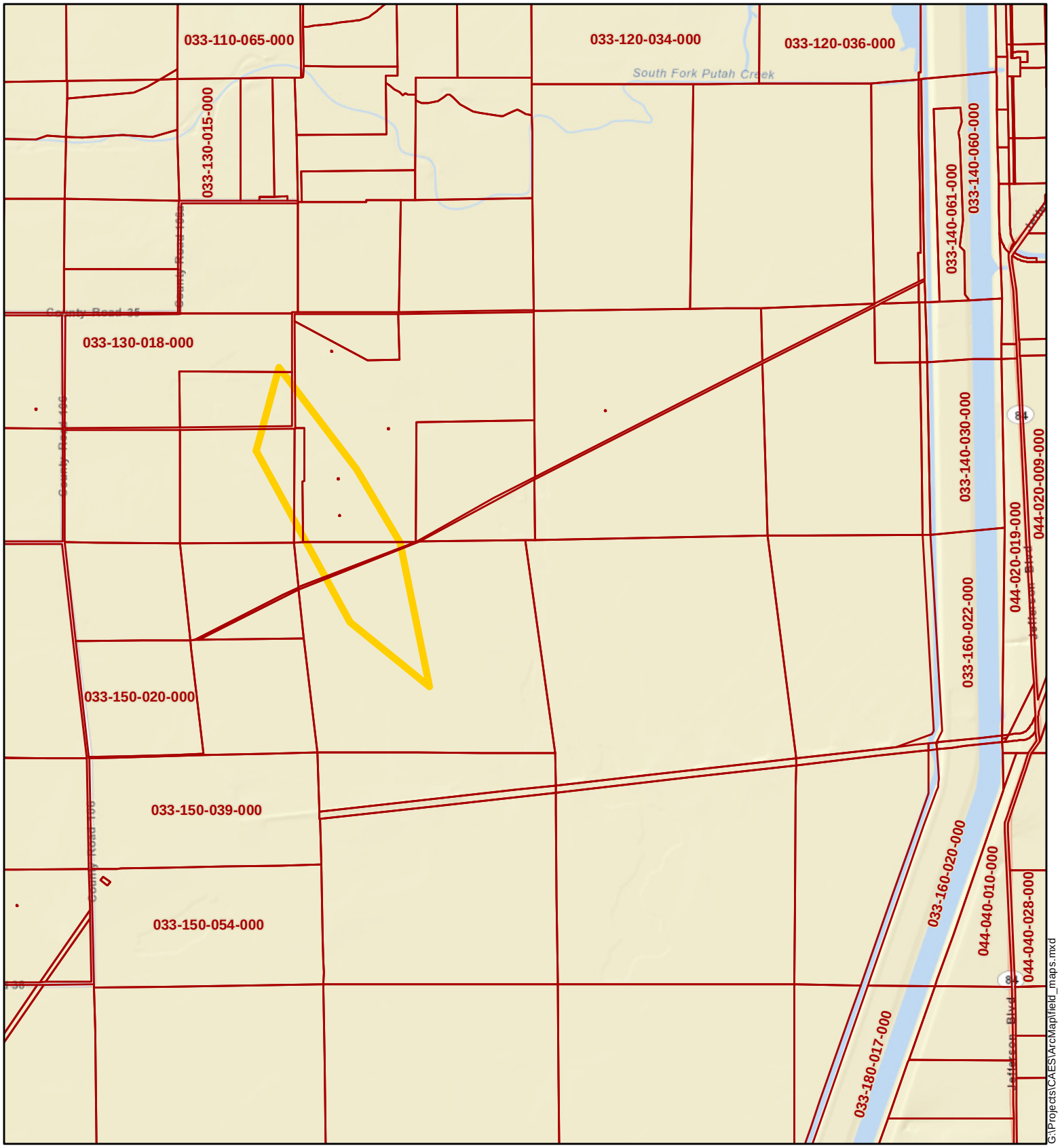
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A306: Putah Sink Site Selection and Attachments

Putah Sink - Aerial Map
Putah Sink - APN Map
Putah Sink - Detailed Geological Report
Putah Sink - Reconnaissance Report
Putah Sink Reservior Site Selection Close-Out - Final Report

Putah Sink Aerial Map





Putah Sink

Approximate Structure Formation | Parcels | 1,500' Buffer

1:36,000

0 1,700 3,400 5,100

Feet

G:\Projects\CAES\ArcMap\field_maps.mxd

5/20/2012

GEOLOGY AND GAS PRODUCTION OF THE PUTAH SINK GAS FIELD, YOLO COUNTY, CALIFORNIA

Douglas P. Imperato, Ph.D
Consulting Geologist
Santa Barbara, CA

EXECUTIVE SUMMARY

More than 6 BCF of natural gas have been produced from the Starkey Formation in three wells in the Putah Sink gas field since the pool was discovered in 1973. Production is from the fifth Starkey Formation sand at a depth of approximately 5600 feet. The gas pool encompasses an area of approximately 150 acres with a maximum thickness of more than 60 feet. Log-derived reservoir porosity averages 29 to 33 percent, with gas saturation of 70 to 78 percent. Gas is entrapped as a result of structural closure along a northwest-striking normal fault. The relatively high pressure of the depleted wells indicates a strong water-drive production mechanism.

INTRODUCTION

This investigation includes evaluation of the subsurface stratigraphy, structure, rock properties, and gas production characteristics of the Starkey Formation natural-gas reservoir of the Putah Sink gas field in Yolo County, California. The field is located in the southern Sacramento Valley, about 10 miles southwest of the City of Sacramento (Attachment 1). The study area includes approximately three square miles in Townships 7 and 8 North, Range 3 East (Attachment 2). The area is relatively flat with a surface elevation that ranges from 25 to 30 feet. Surface use is primarily agriculture. The study area is adjacent to the Yolo Bypass, one of two flood bypasses in the Sacramento Valley that protects Sacramento and other riverside communities from flooding through a system of weirs. The Yolo Bypass contains the Yolo Wildlife Area, the largest restoration project west of the Florida Everglades (Attachment 2).

History of Development

The Putah Sink gas field was discovered in May, 1973 by Shell Oil Company in the Cowell Unit 1 well completed in the Winters Formation with perforations at 6500 to 6520 feet. The well had an open flow potential of 15,700 mcf per day with a shut in pressure of 2620 psi. Shell subsequently completed the Cowell 2-34 well in November, 1973 in the Winters Formation with a production test of 2,156 mcf per day with a flowing pressure of 2575 psi.

The Starkey Formation gas pool was discovered by Shell in their Glide 1-3 well (the name was later changed to Glide 4), also competed in November, 1973. The well was perforated at 5582 to 5588 feet and 5594 to 5600 feet, although production test data was not reported. Conoco became operator of this well in 1986.

The Cowell 3-34 was drilled in August, 1974 by Shell as the second development well in the Starkey gas pool, completed as a dual producer in both the Starkey and Winters Formations. The Starkey Formation had an open flow potential of 8400 mcf per day with a shut in pressure of 2160 psi. The Winters Formation had an open flow potential of 14,600 mcf per day with a shut in pressure of 2615 psi.

The Glide 3-1 well was drilled in August, 1989 by Arkoma Production Company as the third and final development well in the Starkey gas pool. The well was initially completed in the Winters Formation. In August, 1993, the Winters Formation reservoir was plugged and the Starkey Formation was completed with a test of 640 mcf per day with 760 psi flowing tubing pressure through a 12/64-inch choke. Shut in pressure was 2000 psi. Starkey Formation production in both prior wells had been shut in prior to completion of the Starkey Formation in this well.

A summary of the perforated intervals, test data, and production data from wells completed in the Starkey Formation are included as Attachment 3. CDOGGR (2010) report total Putah Sink gas field production as 52,868 mmcf through 2009. A total of 6,346 mmcf is from the Starkey Formation and 46,522 mmcf is from the Winters Formation.

METHODS

This evaluation includes analysis of data from more than 20 exploration and development wells drilled in and around the Starkey Formation gas pool at the Putah Sink gas field (Appendix I). Well history records for these wells were reviewed, and a digital well database was compiled that includes API number, operator, well name, number, status, total depth, elevation, spud date, location, latitude, longitude, and survey data for directional wells (Appendix I). Latitude and longitude are referenced to the 1927 North America datum. Raster well-log images were obtained from commercial sources and on-line files of the California Division of Oil Gas and Geothermal Resources.

A well-history summary was prepared for each gas well from well history records (Appendix I). Monthly gas production, water production, and pressure data were compiled from on-line records of the California Division of Oil, Gas and Geothermal Resources. Production data were compiled in spreadsheet format and production-decline curves were prepared (Appendix I). Well logs for each gas well, annotated with stratigraphic information and production information, is also included in Appendix I. Well completion and production information, including perforated intervals, initial production rate, and cumulative production for each interval, is included in Attachment 3. All digital well and production data were input into Landmark Geographix software for data manipulation, cross section preparation, and mapping.

A series of cross sections that included all wells in the study area were prepared and logs were annotated with available perforation information. Producing intervals and pertinent stratigraphic horizons were identified and correlated in all available wells. The thicknesses of the gas zones were calculated from spontaneous potential logs, and recorded in the database. A cutoff of 10 millivolts from the shale baseline was used in the net-sandstone calculations. The stratigraphic information was incorporated in the preparation of structure and isochore maps of the gas pool. Reservoir rock property data was compiled from well histories and CDOG publications.

REGIONAL GEOLOGY

The stratigraphic sequence in the Putah Sink gas field includes Upper Cretaceous through Recent strata with approximate thicknesses as follows:

Nonmarine Undifferentiated	Recent-Miocene	2700 feet
Markley Canyon Fill	Oligocene-Miocene	500 feet
Nortonville Formation	Eocene	200 feet
Domengine Formation	Eocene	100 feet
Capay Formation	Eocene	200 feet
Mokelumne River Formation	Upper Cretaceous	600 feet
Starkey Formation	Upper Cretaceous	1500 feet
Winters Formation	Upper Cretaceous	2000 feet
Sacramento Shale	Upper Cretaceous	400 feet
Forbes Formation	Upper Cretaceous	3500 feet

The deepest well in the field is the Occidental Glide 1 well in Section 34, T. 8N., R. 3E., drilled in 1963 to the Winters Formation with a total depth of 8123 feet. The Glide Court 65-10 encountered crystalline gabbro, norite, and diorite basement rocks at a depth of 15,080 feet in Section 10, T. 7N., R. 3E, adjacent to the southern field boundary.

Major unconformities in the Putah Sink gas field stratigraphic sequence are present at the base of the Miocene nonmarine undifferentiated strata and at the base of the Eocene Capay Formation. The Starkey Formation gas pool is in the fifth Starkey sand, in the lower part of the formation. The base of fresh water in the field is at a depth of 2000 to 2500 feet.

The Putah Sink gas field is located on the eastern margin of the Sacramento basin, near the axial basin syncline (Harwood and Helley, 1987). Regional dip in this area is to the southwest. The structure of this area is dominated by northwest- and northeast-striking normal faults.

RESERVOIR STRATIGRAPHY

The Starkey Formation consists primarily of sandstone inter-bedded with relatively thin shale and lignite layers and was deposited in a fluvial-deltaic setting. Sandstones were deposited as river-channels or delta-fronts, with shale beds and lignite beds representing inter-channel marsh and swamp deposits, respectively.

Some of the laterally continuous and regionally correlative shale beds subdivide the Starkey Formation into first through fifth sandstone members, in order of penetration by the drill bit, from top to bottom (Attachments 4 and 5). Some of the more regionally correlative shale beds may be related to brief periods of sea-level rise. In the Putah Sink area, the five informal members of the Starkey Formation range in thickness from 200 to 400 feet (Attachment 4).

Gas production in the Putah Sink gas field is from the fifth (lowest) Starkey sandstone that is approximately 400 to 500 feet thick. The base of this sandstone coarsens upward indicative of a prograding delta-front sequence. The upper part of the fifth Starkey sandstone that includes the gas reservoir is a thick, laterally continuous “clean” sandstone with a “blocky” electric-log signature that likely represents high-energy shoreface or river channel deposition in a lower delta-plain environment (Attachment 4).

RESERVOIR ROCK PROPERTIES

Upper Cretaceous sandstones in the Sacramento basin are composed of quartzo-feldspathic detritus derived from the Sierran magmatic arc system to the east and northeast. Framework mineralogy is dominated by volcaniclastic and plutoniclastic grains, principally monocrystalline quartz, plagioclase and K-feldspar, biotite, and volcanic lithic fragments (Mertz, 1990), the Rumsey petrofacies of Ingersoll (1983). Drummond and others (1976) report similar mineralogy and “remarkable uniformity of texture and petrography” in thirty-eight thin sections from Starkey Formation sandstone that they analyzed.

Descriptions of side wall cores from the Starkey Formation reservoir in the Shell Glide 4 well are as follows:

5694 ft- Sand, gray, very friable, very good porosity and permeability, mostly clear quartz, some grains rounded, mostly subangular, fair to good sorting, medium grained.

5666 ft- Sand as above

5646 ft- Sand as above except slightly more fine grained, good sorting

5622 ft- Sand, very soft, as above, medium grained, abundant fines

5610 ft- Sand as above, except finer grained, more uniform sorting, soft, grey, subangular

5608 ft- Sand as above, very well sorted, abundant fines

5597 ft- Sand, unconsolidated, fine grained, abundant fines

5585 ft- Sand, very fine, good sorting, very soft

5578 ft- Sand, firm, becoming slightly shaley, fair sorting, fine grained

Log-derived porosity for the Starkey Formation reservoir ranges from 29 to 33 percent (California Division of Oil and Gas, 1998). Gas saturation is 70 to 78 percent, and Starkey Formation gas has a heating value of 900 Btu (California Division of Oil and Gas, 1998). Permeability measurements for Starkey Formation reservoirs in the Sacramento valley are not available.

STRUCTURE

The gentle regional southwest dip of the Starkey Formation in the vicinity of the Putah Sink gas field is disrupted by at least two northwest-striking normal faults (Attachment 5). One of these, herein called the Glide fault, is critical for gas entrapment in the Starkey Formation. The Glide fault dips northeastward and has a vertical separation of approximately 150 feet. Structure contours in the up-thrown (western) fault block close against this fault. Structural relief of the closed contours results in a gas column of about 70 feet, with an original gas-water contact at an

elevation of about -5605 feet subsea and the highest fifth Starkey penetration in the Glide 3-1 well at -5535 feet subsea.

The Glide fault was penetrated in all three wells that were completed in the Starkey Formation, as indicated by reduced thickness of Starkey Formation intervals in these wells. The Glide 4 well intersects that fault at the first Starkey sand and the Glide 3-1 well intersects the fault directly above the gas pool in the fourth Starkey sand (Attachment 6). The Cowell 3-34 intersects the fault in the first Starkey sand (Attachment 4).

The southwest-dipping normal fault located north of the Glide fault appears to be critical in gas entrapment in the Winters Formation. This fault has vertical separation of approximately 100 feet, with structure contours closing against the fault on the down-dropped (western) fault block.

GAS PRODUCTION

Production records from the California Division of Oil, Gas, and Geothermal Resources archives indicate that a total of 6,346 mmcf have been produced from the three gas wells completed in the Starkey Formation in the Putah Sink gas field (Attachment 3 and Appendix I).. Note that the cumulative gas production total reported for the Starkey Formation by CDOGGR (2010) is incorrect as this apparently does not include the Starkey Formation production in the Glide 3-1 well.

Average monthly production rates were as high as 2100 mcf per day, and rates of more than 1000 mcf per day were sustained for many months in the Glide 4 and Cowell 3-34 wells (Appendix I). Dates of first and last Starkey Formation production for each well are as follows:

Well	**First Prod**	**Last Prod**	**Highest Avg Initial Rate**
Glide 4	May, 1975	Mar, 1986	2100 mcf/d
Cowell 3-34	Jan, 1975	Nov, 1981	1630 mcf/d
Glide 3-1	Oct, 1989	Aug, 1993	930 mcf/d

The history of gas production at the Putah Sink gas field indicates that the Starkey Formation gas pool has a relatively strong water-drive production mechanism. The shut in pressure of the reservoir reported in 1989 in the Glide 3-1 well, for example, was still 2000 psi, after nearly 6 BCF had been produced in the Glide 4 and Cowell 3-34 wells. The initial reservoir pressure was 2160 psi.

Flowing tubing pressure in the Glide 3-1 well was above 1000 psi during most of the Starkey Formation production, with pressure gradually declining with increasing water production. During the last month of production, the well averaged 95 barrels water per day with flowing tubing pressure of 800 psi.

Reservoir Volumetrics

The Starkey Formation gas pool at the Putah Sink gas field has a maximum drilled net thickness of 64 feet and encompasses an area of more than 150 acres (Attachment 7). The Glide 3-1 well appears to have penetrated the gas pool at, or near, the crest of the structure and maximum gas pool thickness. The reservoir volume estimated from net gas isochores is 4480 acre-feet. With a total production of 6,346,356 mcf, the gas recovery factor, or richness (total production divided by the reservoir volume) of this pool is calculated at about 1400 mcf/acre-ft.

REFERENCES

California Division of Oil and Gas, 1998, California Oil and Gas Fields, Central California: California Department of Conservation, Division of Oil, Gas, and Geothermal Resources Publication TR10.

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Harwood, D.S., and Helley, E.J., 1987, Late Cenozoic tectonism of the Sacramento Valley, California: U.S., Geological Survey Professional Paper 1359, 46 p.

Ingersoll, R. V., 1983, Petrofacies and provenance of late Mesozoic farearc basin, northern and central California: American Association of Petroleum Geologists Bulletin, V. 67, p. 1125-1142.

Mertz, K. A., 1990, Summary of the diagenetic history of the Upper Cretaceous Forbes, Starkey, and Winters Formations, Sacramento Basin, California, in Ingersoll, R. V. and T. H. Nilsen, eds., 1990, Sacramento Valley Symposium and Guidebook: Pacific Section S.E.P.M., Vol. 65, p. 53-67.

ATTACHMENTS

1. Regional map of the Sacramento Valley showing regional geography, oil and gas fields and the location of the Putah Sink gas field.

2. Regional map of the Putah Sink gas field and vicinity showing wells, the study area, and Yolo Wildlife Area.

3. Production summary of the Starkey Formation gas pool showing productive interval, initial production rate, shut in pressure, gas production, and water production for each gas well.

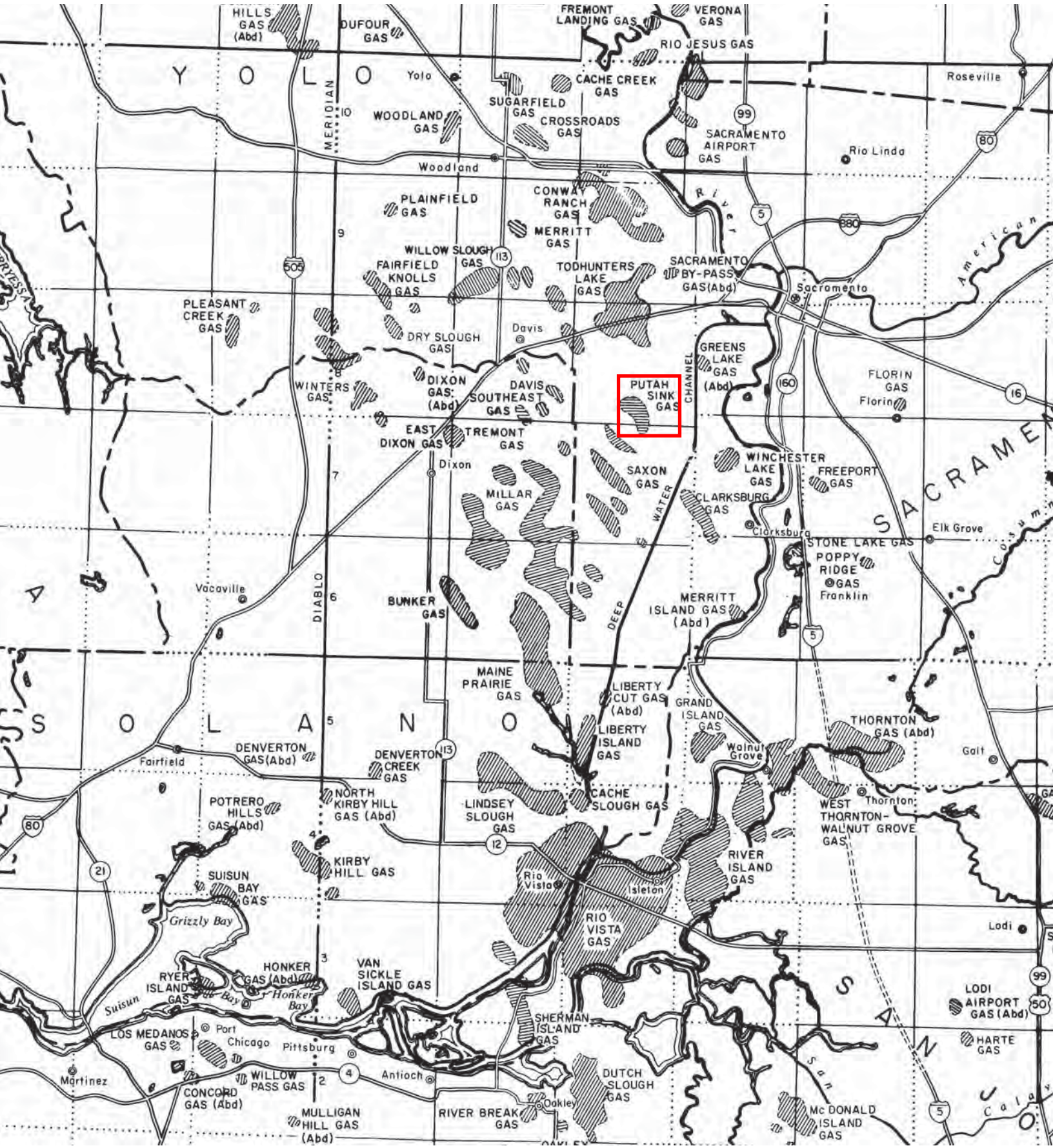
4. Structural strike cross section Y (location of cross section shown in Figure 5).

5. Structure-contour map on top of the fifth sand of the Starkey Formation.

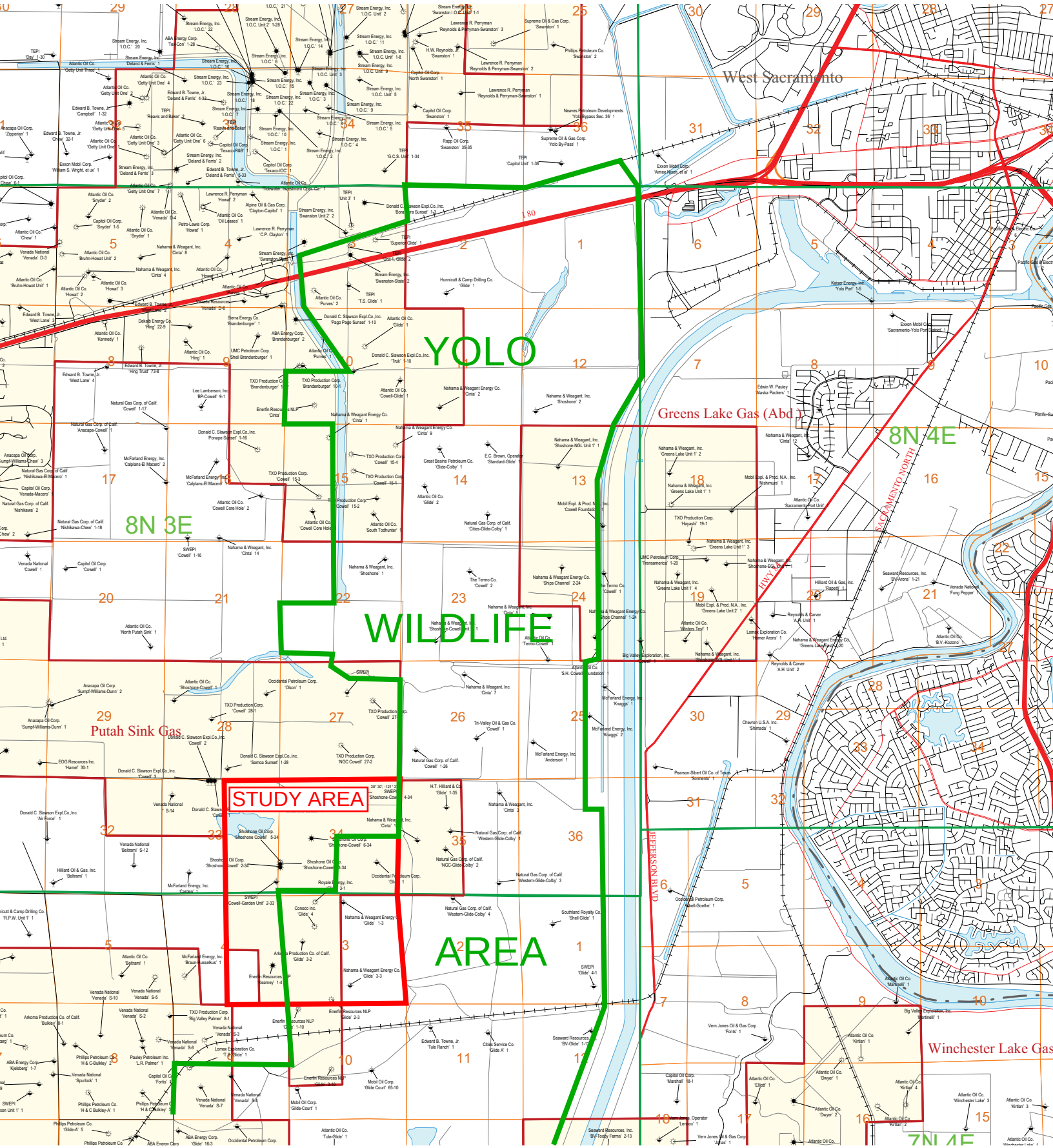
6. Structural dip cross section X (location of cross section shown in Figure 5). Glide 3-1 well is projected into the plane of the cross section.

7. Net gas isochore map of the Starkey Formation gas pool.

ATTACHMENT 1



ATTACHMENT 2



ATTACHMENT 3

PUTAH SINK GAS FIELD
STARKEY FORMATION GAS POOL
PRODUCTION SUMMARY

APINUM	WELL	DATE	PROD INT. (FT)	INITIAL PRODUCTION RATE	SHUT IN PRESS (PSI)	CUM GAS (MCF)	CUM H2O (BBLS)
11320222	CONOCO GLIDE 4	10/27/73	5582-88, 5594-5600			3,338,883	105,226
11320237	SHOSHONE COWELL 3-34*	8/23/74	5602-38	8400 mcf/d potential	2160	2,473,085	105
11320930	ROYALE GLIDE 3-1**	8/15/89	5560-64	640 mcf/d w/760 psi thru 12/64" choke	2000	534,388	49,507
						6,346,356	154,838
* Dual completion in Winters Fm							
** Initial completion in Winters Fm., recompleted in Starkey Fm. 8/5/93							

5/20/2012

PUTAH SINK CROSS SECTION Y

PACIFIC GAS AND ELECTRIC COMPANY CAES PROJECT
PUTAH SINK GAS FIELD
Datum = 0 ft Subsea
Horizontal Scale = 1 in per 200 ft; Vertical Scale = 1 in per 200 ft
Vertical Exaggeration = 1

ATTACHMENT 4

Cum Gas All Zones: 1644473 MCF
04113209150000
Spud Date=12/31/1988
SHOSHONE OIL CORP.
SHOSHONE COWELL 5-34
TWP: - Range: - Sec.

1234 ft

Cum Gas All Zones: 6632099 MCF
04113202370000
Spud Date=8/23/1974
SHOSHONE OIL CORP.
SHOSHONE-COWELL 3-34
1350 N 100 E SW
TWP: 8 0 - Range: 3 3 - Sec. 4

1353 ft

Cum Gas All Zones: 948014 MCF
04113209300000
Spud Date=8/15/1989
ROYALE ENERGY, INC.
GLIDE 3-1
200 S 1700 E NW
TWP: 7 N - Range: 3 E - Sec. 3

1008 ft

Cum Gas All Zones: 3338883 MCF
04113202220000
Spud Date=10/27/1973
CONOCO INC.
GLIDE 4
1557 S 1530 E NW
TWP: 7 N - Range: 3 E - Sec. 3

3458 ft

Cum Gas All Zones: 474229 MCF
04113209500000
Spud Date=6/16/1990
ENERFIN RESOURCES NL
GLIDE 2-3
220 N 1900 E SW
TWP: 7 N - Range: 3 E - Sec. 3

-3500
-4000
-4500
-5000
-5500
-6000
-6500
-7000

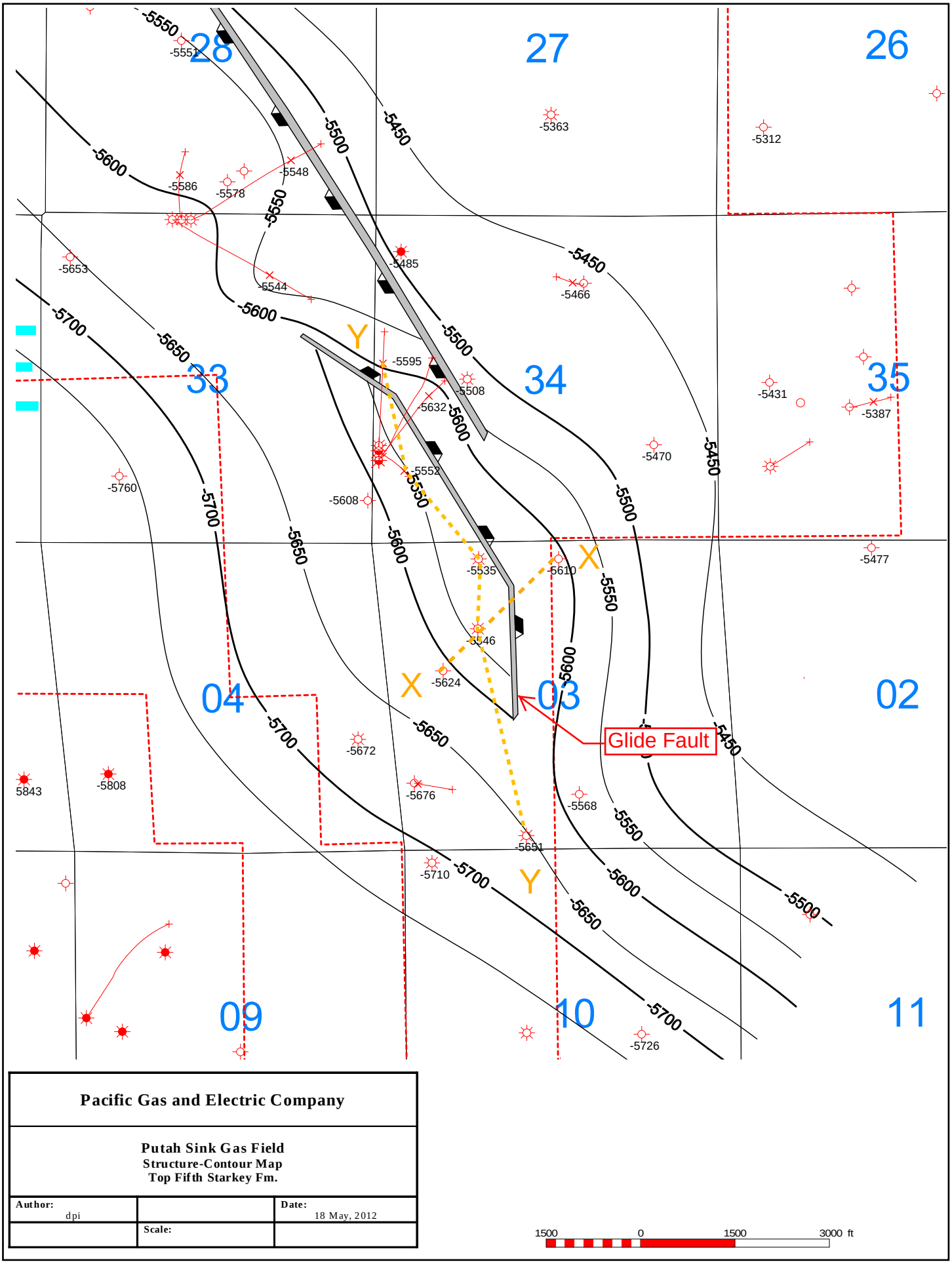
CretUndiff
STKY1
STKY2
STKY3
STKY4
STKY5
Gas-Water
WNTRS2
WNTRS3
STARKEY FM.
GAS
POOL

WELL INTERSECTS FAULT
WELL INTERSECTS FAULT
WELL INTERSECTS FAULT

-5605
-5598
-5608

TD=7247
TD=7037
TD=6945
TD=7000
TD=7040

ATTACHMENT 5



Pacific Gas and Electric Company		
Putah Sink Gas Field Structure-Contour Map Top Fifth Starkey Fm.		
Author: dpi		Date: 18 May, 2012
	Scale:	

PUTAH SINK CROSS SECTION X

PACIFIC GAS AND ELECTRIC COMPANY CAES PROJECT
PUTAH SINK GAS FIELD
Datum = 0 ft Subsea
Horizontal Scale = 1 in per 200 ft; Vertical Scale = 1 in per 200 ft
Vertical Exaggeration = 1

ATTACHMENT 6

04113209510000
Spud Date=8/11/1990
ARKOMA PRODUCTION CO
GLIDE 3-2
2200 S 900 E NW
TWP: 7 N - Range: 3 E - Sec. 3

862 ft

Cum Gas All Zones: 3338883 MCF
04113202220000
Spud Date=10/27/1973
CONOCO INC.
GLIDE 4
1557 S 1530 E NW
TWP: 7 N - Range: 3 E - Sec. 3

415 ft

Cum Gas All Zones: 948014 MCF
04113209300000
Spud Date=8/15/1989
ROYALE ENERGY, INC.
GLIDE 3-1
200 S 1700 E NW
TWP: 7 N - Range: 3 E - Sec. 3

1278 ft

04113209490000
Spud Date=6/7/1990
NAHAMA & WEAGANT ENE
GLIDE 1-3
400 S 2400 W NE
TWP: 7 N - Range: 3 E - Sec. 3

-3500
-4000
-4500
-5000
-5500
-6000
-6500

CretUndiff
CretUndiff

STKY1
STKY2
STKY3
STKY4
STKY5
WNTRS2
WNTRS3

WELL INTERSECTS FAULT
WELL INTERSECTS FAULT

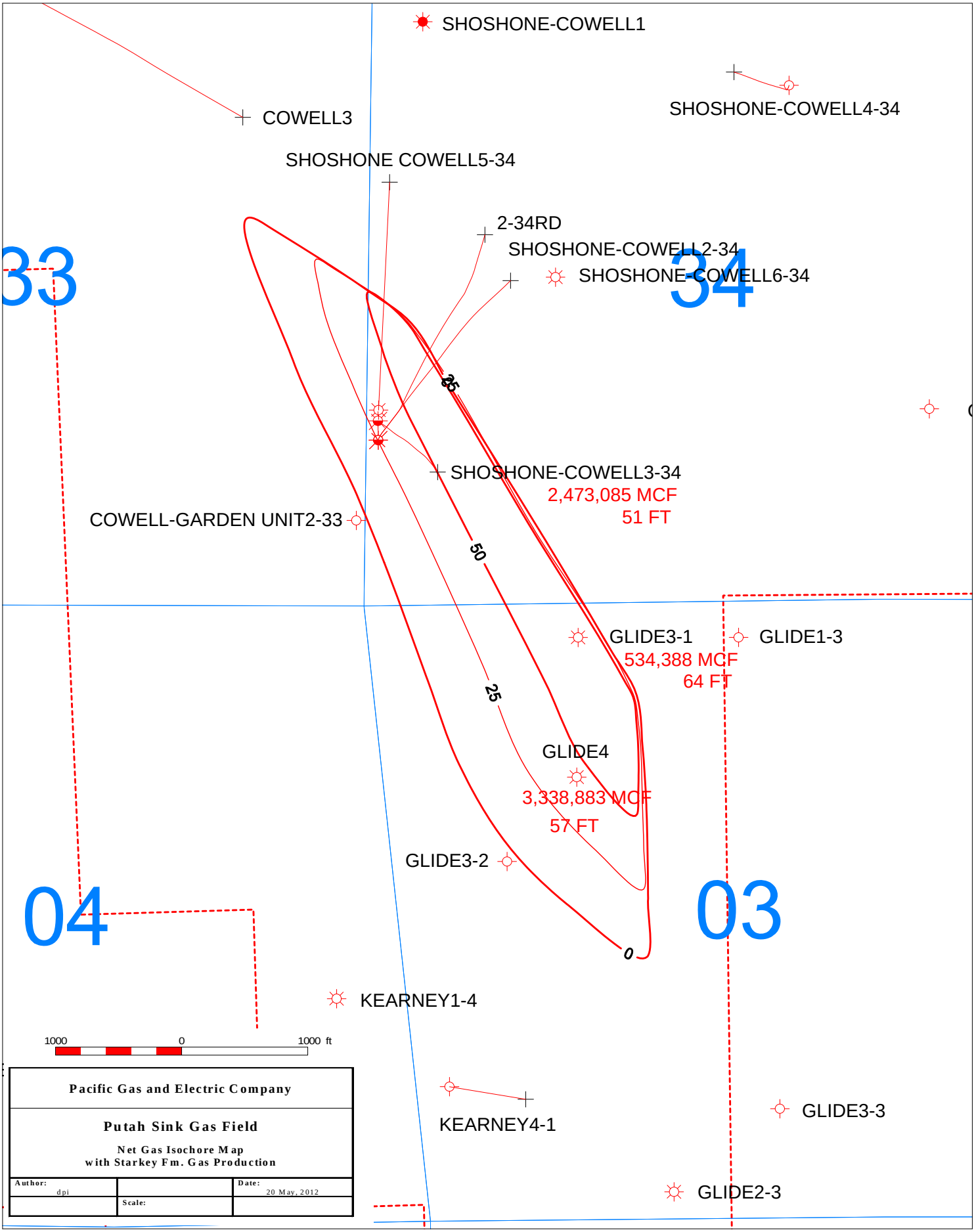
STARKEY FM GAS POOL

Gas-Water
Gas-Water
5608
5598

Glide Fault

TD=6960
TD=7000
TD=6945
TD=6960

ATTACHMENT 7



APPENDIX I

A). List of Putah Sink gas field wells that were analyzed as part of this investigation. Latitude and longitude are referenced to North American Datum 1927.

B). Glide 4 well data, including annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

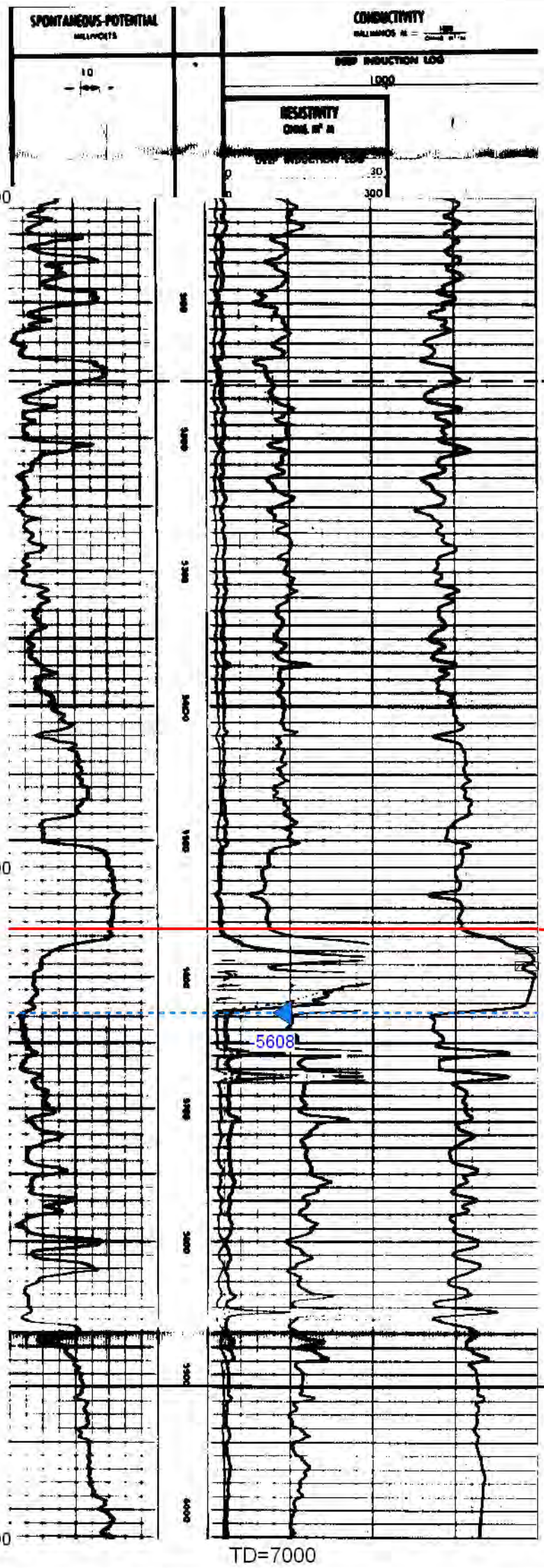
C). Cowell 3-34 well data, including annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

B). Glide 3-1 well data, including annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

API NO.	OPERATOR	WELL NAME	NO.	LAT 27	LONG 27	SPUD	STATU	TD	ELEV	
04113002090000	MOBIL OIL CORP.	GLIDE-COURT	1	38.46324	-121.6361	12/24/1953	P&A	13321	31	KB
04113002100000	MOBIL OIL CORP.	GLIDE COURT	65-10	38.46571	-121.62436	4/17/1955	P&A	15299	24	KB
04113002350000	OCCIDENTAL PETROLEUM	OLSON	1	38.51222	-121.641	9/28/1963	P&A	8100	33	KB
04113002360000	OCCIDENTAL PETROLEUM	GLIDE	1	38.49142	-121.62355	10/16/1963	P&A	8123	25	KB
04113201650000	NAHAMA & WEAGANT, IN	SHOSHONE-COWELL UNIT 1	1	38.51878	-121.61422	10/5/1972	P&A	6700	24	KB
04113201750000	SHOSHONE OIL CORP.	SHOSHONE-COWELL	1	38.499895	-121.637542	5/15/1973	GAS	6975	25	DF
04113202150000	SHOSHONE OIL CORP.	SHOSHONE-COWELL	2-34	38.490786	-121.638821	10/1/1973	SI	7260	24	DF
04113202150100	SHOSHONE OIL CORP.	SHOSHONE-COWELL	2-34RD	38.490786	-121.638821	10/1/1973	SI	7000	24	DF
04113202220000	CONOCO INC.	GLIDE	4	38.48343	-121.63336	10/27/1973	AGS	7000	24	KB
04113202240000	DONALD C. SLAWSON EX	COWELL	1	38.501316	-121.649196	11/26/1973	AGS	7500	37	DF
04113202310000	ANACAPA OIL CORP.	SUMPF-WILLIAMS-DUNN	1	38.51086	-121.67539	12/7/1973	AGS	7071	36	KB
04113202290000	DONALD C. SLAWSON EX	COWELL	3	38.501333	-121.65023	1/4/1974	AGS	7545	28	DF
04113202550000	DONALD C. SLAWSON EX	COWELL	2	38.50133	-121.649706	5/28/1974	AGS	6971	28	DF
04113202570000	SWEPI	SHOSHONE-COWELL	4-34	38.49848	-121.6274	6/14/1974	P&A	7035	23	KB
04113202370000	SHOSHONE OIL CORP.	SHOSHONE-COWELL	3-34	38.491207	-121.638825	8/23/1974	SI	7037	25	DF
04113202890000	SWEPI	COWELL-GARDEN UNIT	2-33	38.48904	-121.63944	10/11/1974	P&A	7000	22	KB
04113202910000	NAHAMA & WEAGANT, IN	CINTA	7	38.51461	-121.60968	10/11/1974	P&A	7472	23	KB
04113202650000	ANACAPA OIL CORP.	SUMPF-WILLIAMS-DUNN	2	38.51082	-121.67491	11/10/1974	P&A	7445	39	KB
04113203720000	NAHAMA & WEAGANT, IN	CINTA	11	38.49412	-121.61711	10/13/1975	P&A	7000	9	GR
04113204030000	ATLANTIC OIL CO.	SHOSHONE-COWELL	1	38.51143	-121.65561	6/5/1976	P&A	7200	37	KB
04113204470000	GRAHAM ROYALTY, LTD.	CAMPBELL UNIT	1	38.52054	-121.68632	5/11/1977	AGS	7090	42	KB
04113204540000	ATLANTIC OIL CO.	NORTH PUTAH SINK	1	38.51806	-121.65931	6/7/1977	P&A	7001	36	KB
04113204550000	SWEPI	COWELL	1-27	38.5123	-121.62822	6/24/1977	P&A	7211	33	KB
04113205680000	MCFARLAND ENERGY, IN	CARDEN	1	38.49015	-121.65323	10/26/1979	P&A	7335	30	KB
04113205830000	HILLIARD OIL & GAS,	BELTRAMI	1	38.4888	-121.67472	5/2/1980	P&A	7348	36	KB
04113205950000	NATURAL GAS CORP. OF	WESTERN GLIDE-COLBY	1	38.49522	-121.61189	10/6/1980	P&A	6811		
04113206180000	NATURAL GAS CORP. OF	NGC-GLIDE-COLBY	2	38.49303	-121.61268	11/5/1980	P&A	6877	23	KB
04113206560000	NATURAL GAS CORP. OF	WESTERN-GLIDE-COLBY	4	38.48689	-121.61149	9/20/1981	P&A	7030	18	KB
04113206120000	TXO PRODUCTION CORP.	COWELL	28-1	38.50914	-121.64969	10/17/1981	P&A	6981	29	KB
04113206600000	TXO PRODUCTION CORP.	COWELL	27-1	38.51134	-121.62415	10/27/1981	AGS	6600	22	KB
04113206930000	VENADA NATIONAL	BELTRAMI	S-12	38.49104	-121.66196	5/6/1982	P&A	7300	32	KB
04113207170000	TXO PRODUCTION CORP.	NGC COWELL	27-2	38.50584	-121.62918	8/24/1982	AGS	6820	27	KB
04113207260000	NATURAL GAS CORP. OF	COWELL	1-26	38.50526	-121.61738	10/13/1982	P&A	6800	28	KB
04113207840000	VENADA NATIONAL		S-14	38.49972	-121.65591	4/27/1984	P&A	6974	32	KB
04113209150000	SHOSHONE OIL CORP.	SHOSHONE COWELL	5-34	38.491442	-121.63881	12/31/1988	AGS	7247	30	DF
04113209300000	ROYALE ENERGY, INC.	GLIDE	3-1	38.486472	-121.633306	8/15/1989	AGS	6945	24	KB
04113209380000	ENERFIN RESOURCES NL	GLIDE	1-10	38.47322	-121.63596	12/20/1989	AGS	7078	26	KB
04113209490000	NAHAMA & WEAGANT ENE	GLIDE	1-3	38.48646	-121.62886	6/7/1990	P&A	2030	22	KB
04113209500000	ENERFIN RESOURCES NL	GLIDE	2-3	38.47439	-121.63071	6/16/1990	AGS	7040	25	KB
04113209540000	NAHAMA & WEAGANT ENE	GLIDE	3-3	38.47619	-121.62777	7/10/1990	P&A	6965	25	KB
04113209510000	ARKOMA PRODUCTION CO	GLIDE	3-2	38.4816	-121.6353	8/11/1990	P&A	6960	24	KB
04113209620000	H.T. HILLIARD & CO.	GLIDE	1-35	38.49822	-121.61253	9/13/1990	P&A	6800	22	KB
04113209670000	ENERFIN RESOURCES NL	GLIDE	3-10	38.46579	-121.63073	11/10/1990	AGS	7159	20	KB
04113209990000	EOG RESOURCES INC.	HAMEL	30-1	38.50372	-121.67683	8/13/1991	P&A	7200	12	KB
04113210010000	ENERFIN RESOURCES NL	KEARNEY	1-4	38.478626	-121.640036	10/1/1991	AGS	7127	25	KB
04113210080000	CNGC	HAMEL	30-2	38.505247	-121.682191	4/12/1992	GAS	7285	41	KB
04113211210000	DONALD C. SLAWSON EX	SAMOA SUNSET	1-28	38.502969	-121.647164	8/5/1998	P&A	6793	33	KB
04113211600000	SHOSHONE OIL CORP.	SHOSHONE-COWELL	6-34	38.494322	-121.633893	11/5/1999	AGS	6930	23.8	KB
04113211710000	DONALD C. SLAWSON EX	AIR FORCE	1	38.494191	-121.67568	10/25/2000	P&A	8426	27	GR
04113212240000	ABA ENERGY CORP	COWELL	1-28	38.51064	-121.65475	12/8/2003	P&A	7905	40	KB
04113212250000	ABA ENERGY CORP	GLIDE	1-35	38.49046	-121.61709	4/16/2004	AGS	7000	11	GR
04113212270000	ABA ENERGY CORP	KEARNEY	4-1	38.4767	-121.63692	5/8/2004	P&A	8250	26	KB
04113212480000	ABA ENERGY CORP.	HAMEL	29-1	38.51002	-121.66931	12/17/2005	P&A	6575	46	KB
04113210080001	CNGC	HAMEL	30-2RD	38.505247	-121.682191	12/3/2006	P&A	7900	41	KB
04113212710000	ABA ENERGY CORP.	COWELL	500	38.503438	-121.646237	12/22/2007	P&A			
04113212320000	ABA ENERGY CORP.	GLIDE	2-35	38.49323	-121.61539		LOC			

Cum Gas All Zones: 3338883 MCF

04113202220000
CONOCO INC.
GLIDE 4
TWP: 7 N - Range: 3 E - Sec. 3
Spud Date=10/27/1973
Datum=24



TOP FOURTH STARKEY FM.

TOP FIFTH STARKEY FM.
GAS RESERVOIR
3,338,883 MCF

BASE STARKEY FM.

04-113-20222 ** 03-7N-3E MD

CONOCO, INC. GLIDE NO. 4

Field: Putah Sink Gas

County: Yolo

Elev: 12 GL

TD: 7000

LOC: 1550’ SOUTH 1530’ EAST NWC

☐ Directional

Spud: 10/27/73

Current Status: Abandoned Gas

Horizons: Top Gorge 3174, Top Capay 4328, Top Starkey 4438, Top Winters 6919

Original Operator: Shell Oil Company

Casing: 8-5-/8” cemented at 1502; 5-1/2” cemented at 5751

09/24/73 LOC
09/27/73 LOC, D.O.G
10/29/73 MOVING IN EQUIPMENT
10/30/73 1502 CMTD 8 5/8" AT 1502'
10/31/73 3102 D
11/01/73 4378 D
11/02/73 5530 D
11/05/73 6090 DRILLED
11/06/73 7000 TD. DRILLED. RAN ELECTRIC LOC
11/07/73 5 1/2" CMTD AT 5751'
11/09/73 STANDING

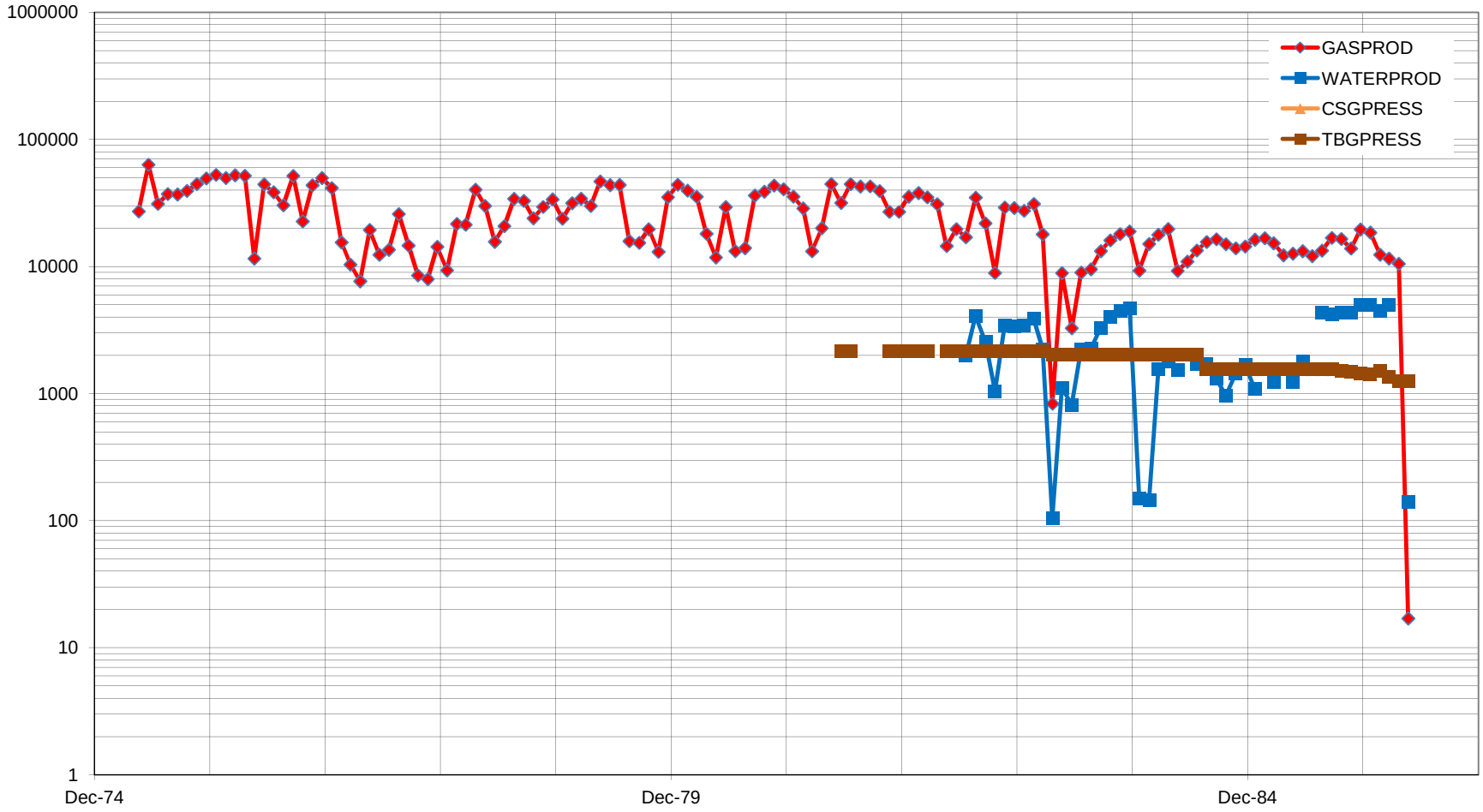
11/21/73 PERFORATED 5582-5588, 5594-5600

11/03/86 WELL TRANSFERRED TO CONOCO, INC.

09/18/90 WELL ABANDONED

04-113-20222 CONOCO GLIDE 4

CUM PROD 3,338,883 MCF; 105,226 BBLS H2O



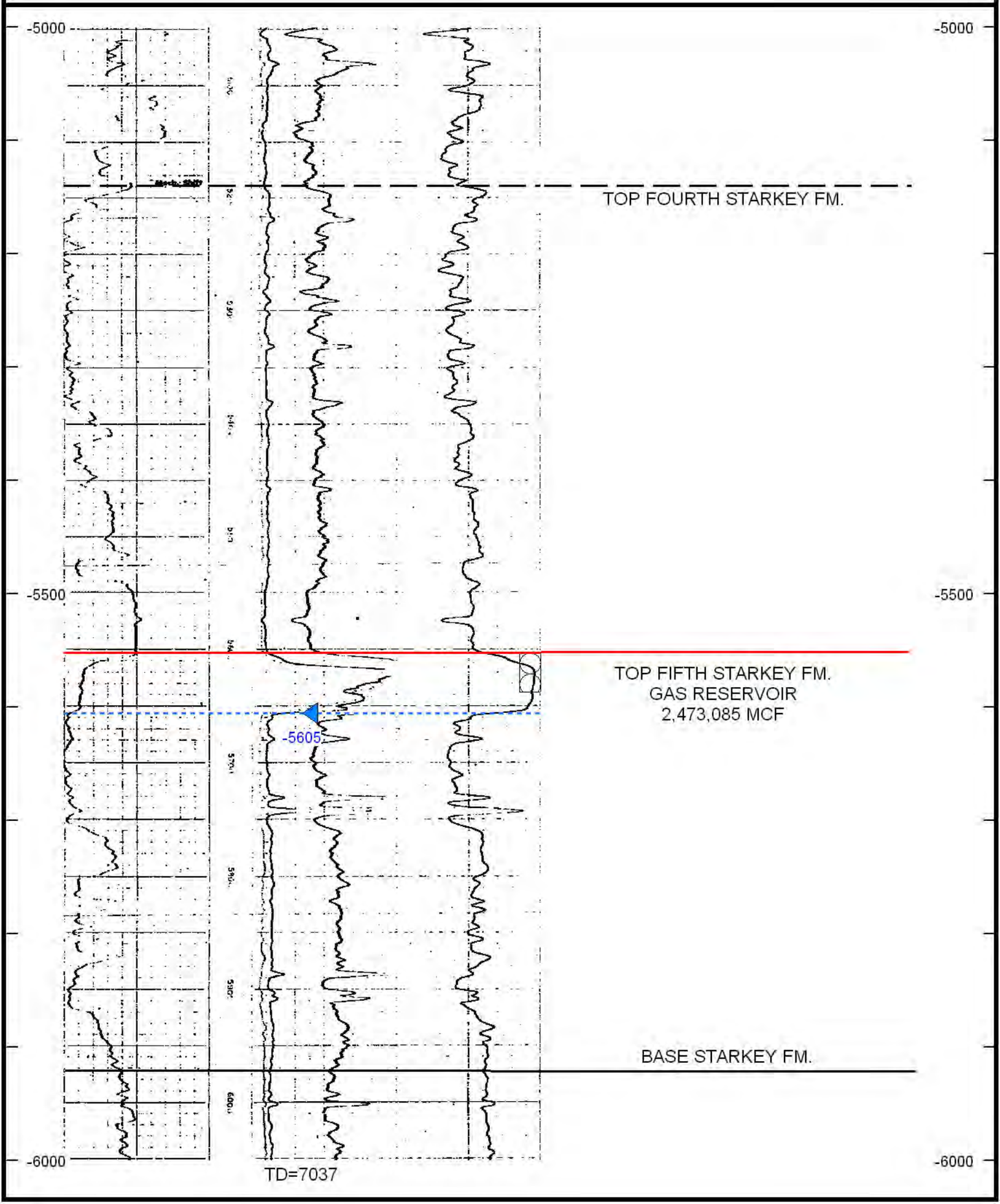
DATE	WATERPR	DAYSPRO	GASPROD	CSGPRES	TBGPRES	BTU
Jan-75	0	0	0		0	
Feb-75	0	0	0		0	
Mar-75	0	0	0		0	
Apr-75	0	0	0		0	
May-75	0	31	27178		0	
Jun-75	0	30	63280		0	
Jul-75	0	31	31164		0	
Aug-75	0	31	37191		0	
Sep-75	0	30	36904		0	
Oct-75	0	31	39397		0	
Nov-75	0	30	44628		0	
Dec-75	0	31	49441		0	
Jan-76	0	31	52693		0	
Feb-76	0	28	49769		0	
Mar-76	0	31	52258		0	
Apr-76	0	30	51787		0	
May-76	0	31	11569		0	
Jun-76	0	30	44369		0	
Jul-76	0	31	38430		0	
Aug-76	0	31	30347		0	
Sep-76	0	30	51663		0	
Oct-76	0	31	22680		0	
Nov-76	0	30	43610		0	
Dec-76	0	31	49762		0	
Jan-77	0	31	41515		0	
Feb-77	0	28	15508		0	
Mar-77	0	22	10368		0	
Apr-77	0	12	7663		0	
May-77	0	22	19426		0	
Jun-77	0	29	12375		0	
Jul-77	0	19	13565		0	
Aug-77	0	31	25897		0	
Sep-77	0	22	14627		0	
Oct-77	0	10	8524		0	
Nov-77	0	30	7969		0	
Dec-77	0	20	14316		0	
Jan-78	0	16	9339		0	
Feb-78	0	27	21653		0	
Mar-78	0	25	21357		0	
Apr-78	0	30	40267		0	
May-78	0	30	30022		0	
Jun-78	0	13	15671		0	
Jul-78	0	18	20825		0	
Aug-78	0	31	34159		0	
Sep-78	0	29	32910		0	
Oct-78	0	23	24007		0	
Nov-78	0	24	29463		0	
Dec-78	0	30	33751		0	
Jan-79	0	24	23828		0	
Feb-79	0	27	31562		0	
Mar-79	0	31	34250		0	
Apr-79	0	30	30009		0	
May-79	0	31	46750		0	
Jun-79	0	30	43706		0	

DATE	WATERPR	DAYSPRO	GASPROD	CSGPRES	TBGPRES	BTU
Jul-79	0	31	43908		0	
Aug-79	0	31	15861		0	
Sep-79	0	30	15364		0	
Oct-79	0	27	19667		0	
Nov-79	0	18	13056		0	
Dec-79	0	31	35143		0	
Jan-80	0	31	44046		0	
Feb-80	0	29	39573		0	
Mar-80	0	31	35404		0	
Apr-80	0	30	18103		0	
May-80	0	31	11783		0	
Jun-80	0	29	29384		0	
Jul-80	0	17	13212		0	
Aug-80	0	11	13979		0	
Sep-80	0	25	36257		0	
Oct-80	0	29	38807		0	
Nov-80	0	30	43382		0	
Dec-80	0	28	40637		0	
Jan-81	0	31	35514		0	
Feb-81	0	25	28710		0	
Mar-81	0	20	13195		0	
Apr-81	0	15	20059		0	
May-81	0	31	44606		0	
Jun-81	0	27	31652		2160	
Jul-81	0	31	44490		2160	
Aug-81	0	30	42648		0	
Sep-81	0	30	42812		0	
Oct-81	0	28	39329		0	
Nov-81	0	25	26939		2160	
Dec-81	0	27	26939		2160	
Jan-82	0	30	35514		2160	
Feb-82	0	28	37851		2160	
Mar-82	0	31	35073		2160	
Apr-82	0	30	31008		0	
May-82	0	19	14479		2160	
Jun-82	0	18	19723		2160	
Jul-82	2000	19	17009		2160	
Aug-82	4104	31	34900		2160	
Sep-82	2573	30	21883		2160	
Oct-82	1047	11	8901		2160	
Nov-82	3435	28	29210		2160	
Dec-82	3396	31	28874		2160	
Jan-83	3438	31	27501		2160	
Feb-83	3887	28	31095		2160	
Mar-83	2244	31	17955		2160	
Apr-83	104	5	834		2025	
May-83	1111	22	8885		2025	
Jun-83	818	15	3273		2025	
Jul-83	2242	26	8966		2025	
Aug-83	2261	26	9531		2025	
Sep-83	3308	27	13233		2025	
Oct-83	4019	29	16076		2025	
Nov-83	4505	30	18020		2025	
Dec-83	4729	31	18916		2025	

DATE	WATERPR	DAYSPRO	GASPROD	CSGPRES	TBGPRES	BTU
Jan-84	150	14	9299		2025	
Feb-84	145	29	15057		2025	
Mar-84	1550	31	17785		2025	
Apr-84	1800	30	19742		2025	
May-84	1540	31	9240		2025	
Jun-84	0	26	10939		2025	
Jul-84	1705	31	13388		2025	
Aug-84	1705	31	15617		1550	
Sep-84	1305	29	16388		1550	
Oct-84	960	16	14990		1550	
Nov-84	1440	24	13913		1550	
Dec-84	1680	24	14382		1550	
Jan-85	1085	31	16297		1550	
Feb-85	0	22	16717		1550	
Mar-85	1240	31	15273		1550	
Apr-85	0	29	12269		1550	
May-85	1240	30	12636		1550	
Jun-85	1800	30	13208		1550	
Jul-85	0	30	12093		1550	
Aug-85	4340	31	13342		1550	
Sep-85	4200	30	16825		1550	
Oct-85	4340	31	16470		1500	
Nov-85	4320	30	13871		1490	
Dec-85	4960	31	19593		1450	
Jan-86	4960	31	18506		1425	
Feb-86	4480	28	12388		1500	
Mar-86	4960	31	11553		1350	
Apr-86	0	30	10514		1250	
May-86	140	1	17		1250	
Jun-86	0	0	0		0	
Jul-86	0	0	0		0	
Aug-86	0	0	0		0	
Sep-86	0	0	0		0	
Oct-86	0	0	0		0	
Nov-86	0	0	0		0	
Dec-86	0	0	0		0	
	105,266		3,338,883			

Cum Gas All Zones: 6632099 MCF

04113202370000
SHOSHONE OIL CORP.
SHOSHONE-COWELL 3-34
TWP: 8 0 - Range: 3 3 - Sec. 4
Spud Date=8/23/1974
Datum=25



04-113-20237 ** 34-8N-3E MD

SHOSHONE COWELL 3-34

Field: Putah Sink Gas

County: Yolo

Elev: 24 KB

TD: 7037

LOC: 1350’ NORTH 100’ EAST SWC

[X] Directional

Spud: 08/23/74

Current Status: Idle Gas

Horizons: Moreno 3663, H&T 4378, Top Starkey 4487, Top Winters 6611

Original Operator: Shell Oil Company

Casing: 8-5-/8” cemented at 1542; 5-1/2” cemented at 6874

01/28/74 LOC
03/09/74 LOC, D.O.G
08/27/74 1611 D
08/28/74 2750 D
08/29/74 3565 D
08/30/74 4295 D
09/03/74 4992 D
09/04/74 6672 D
09/05/74 6930 D
09/06/74 7037 TD.
09/09/74 LOGGED
09/10/74 5 1/2" CMTD AT 6874

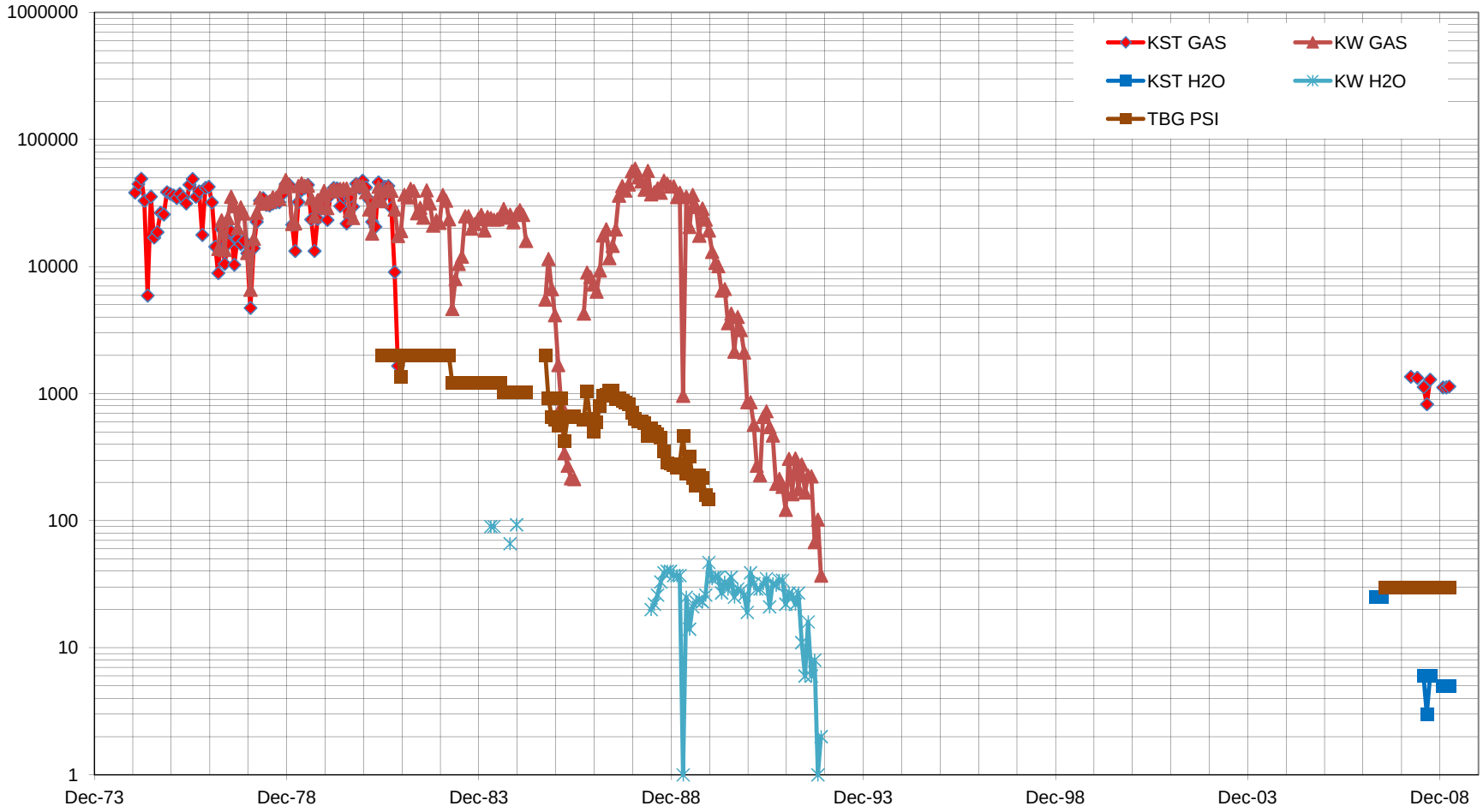
11/12/74 COMPLETED AS A DUAL PRODUCER INTHE STARKEY AND WINTERS.
4TH STARKEY 5602-5638 OPEN FLOW POTENTIAL 8400MCF/D, SIP 2160#
1ST WINTERS 6683-6703 - 14600 MCF/D, SIP 2615#

08/01/86 WELL TRANSFERRED TO CINTA OIL CO.

01/01/96 WELL TRANSFERRED TO SHOSHONE OIL CORP.

04-113-20237 SHOSHONE COWELL 3-34

STARKEY FM CUM PROD 2,473,085 MCF; 105 BBLS H2O
WINTERS FM CUM PROD 4,159,014 MCF; 1755 BBLS H2O



DATE	KST H2O	KST DAYS	KST GAS	MO	WATER DISP	KW H2O	KW DAYS	KW GAS	CSG PSI	TBG PSI
Jan-75	0	30	38207						0	0
Feb-75	0	28	44611						0	0
Mar-75	0	30	49128						0	0
Apr-75	0	30	33000						0	0
May-75	0	30	5917						0	0
Jun-75	0	30	35520						0	0
Jul-75	0	30	16898						0	0
Aug-75	0	30	18662						0	0
Sep-75	0	30	26512						0	0
Oct-75	0	30	25746						0	0
Nov-75	0	30	38570						0	0
Dec-75	0	30	37381						0	0
Jan-76	0	30	36288						0	0
Feb-76	0	28	34561						0	0
Mar-76	0	30	37316						0	0
Apr-76	0	30	34930						0	0
May-76	0	30	31370						0	0
Jun-76	0	30	44049						0	0
Jul-76	0	30	48903						0	0
Aug-76	0	30	35389						0	0
Sep-76	0	30	39096						0	0
Oct-76	0	30	17742						0	0
Nov-76	0	30	41748						0	0
Dec-76	0	30	42464						0	0
Jan-77	0	30	31986						0	0
Feb-77	0	28	14328						0	0
Mar-77	0	17	8883			0	17	13798	0	0
Apr-77	0	27	19689			0	27	23135	0	0
May-77	0	18	10502			0	18	13524	0	0
Jun-77	0	30	15163			0	30	24102	0	0
Jul-77	0	30	18963			0	30	35460	0	0
Aug-77	0	31	10341			0	31	29894	0	0
Sep-77	0	25	16494			0	25	20086	0	0
Oct-77	0	23	15025			0	23	29286	0	0
Nov-77	0	30	15983			0	30	26129	0	0
Dec-77	0	19	12736			0	19	12824	0	0
Jan-78	0	6	4728			0	6	6580	0	0
Feb-78	0	26	13965			0	26	16577	0	0
Mar-78	0	30	22517			0	30	26607	0	0
Apr-78	0	30	33035			0	30	34804	0	0
May-78	0	29	34545			0	29	31336	0	0
Jun-78	0	30	30631			0	30	32414	0	0
Jul-78	0	31	30205			0	31	32604	0	0
Aug-78	0	31	31352			0	31	35110	0	0
Sep-78	0	30	31908			0	30	34717	0	0
Oct-78	0	31	32152			0	31	34063	0	0
Nov-78	0	30	37193			0	30	42149	0	0
Dec-78	0	31	44462			0	31	48024	0	0
Jan-79	0	31	44166			0	31	44487	0	0
Feb-79	0	17	21348			0	17	21675	0	0
Mar-79	0	25	13251			0	25	21925	0	0
Apr-79	0	30	32216			0	30	43069	0	0
May-79	0	31	40060			0	31	45184	0	0
Jun-79	0	30	41567			0	30	43260	0	0

DATE	KST H2O	KST DAYS	KST GAS	MO	WATER DISP	KW H2O	KW DAYS	KW GAS	CSG PSI	TBG PSI
Jul-79	0	31	43996			0	31	43526	0	0
Aug-79	0	31	23474			0	31	34615	0	0
Sep-79	0	30	13260			0	30	24927	0	0
Oct-79	0	30	23725			0	30	33425	0	0
Nov-79	0	21	30886			0	21	29618	0	0
Dec-79	0	31	32361			0	31	39397	0	0
Jan-80	0	30	23256			0	30	28834	0	0
Feb-80	0	29	36529			0	29	39116	0	0
Mar-80	0	31	41662			0	31	40675	0	0
Apr-80	0	30	41282			0	30	39667	0	0
May-80	0	31	29896			0	31	40950	0	0
Jun-80	0	30	35454			0	30	41098	0	0
Jul-80	0	31	21808			0	31	41160	0	0
Aug-80	0	31	34363			0	31	27542	0	0
Sep-80	0	25	29651			0	25	24136	0	0
Oct-80	0	31	45008			0	31	44092	0	0
Nov-80	0	29	41523			0	29	43294	0	0
Dec-80	0	31	47482			0	31	43483	0	0
Jan-81	0	22	41954			0	22	38508	0	0
Feb-81	0	28	33534			0	28	28208	0	0
Mar-81	0	25	22483			0	25	18199	0	0
Apr-81	0	28	20584			0	28	33170	0	0
May-81	0	31	46073			0	31	42474	0	0
Jun-81	0	29	34750			0	29	32729	0	2000
Jul-81	0	31	42613			0	31	39271	0	2000
Aug-81	0	31	43107			0	31	41167	0	0
Sep-81	0	30	28943			0	30	39447	0	0
Oct-81	0	28	9056			0	28	28171	0	0
Nov-81	0	5	1653			0	5	17428	0	2000
Dec-81	0	0	0			0	28	19081	0	1360
Jan-82	0	0	0			0	31	36826	0	2000
Feb-82	0	0	0			0	28	35058	0	2000
Mar-82	0	0	0			0	31	40926	0	2000
Apr-82	0	0	0			0	30	39445	0	2000
May-82	0	0	0			0	27	26336	0	2000
Jun-82	0	0	0			0	30	29046	0	2000
Jul-82	0	0	0			0	28	24322	0	2000
Aug-82	0	0	0			0	31	39824	0	2000
Sep-82	0	0	0			0	30	31523	0	2000
Oct-82	0	0	0			0	27	21028	0	2000
Nov-82	0	0	0			0	21	23169	0	2000
Dec-82	0	0	0			0	31	22094	0	2000
Jan-83	0	0	0			0	31	36606	0	2000
Feb-83	0	0	0			0	28	32992	0	2000
Mar-83	0	0	0			0	24	23624	0	2000
Apr-83	0	0	0			0	8	4636	0	1220
May-83	0	0	0			0	17	7967	0	1220
Jun-83	0	0	0			0	23	10500	0	1220
Jul-83	0	0	0			0	15	11978	0	1220
Aug-83	0	0	0			0	31	24894	0	1220
Sep-83	0	0	0			0	30	24996	0	1220
Oct-83	0	0	0			0	31	19870	0	1220
Nov-83	0	0	0			0	30	21686	0	1220
Dec-83	0	0	0			0	31	23651	0	1220

DATE	KST H2O	KST DAYS	KST GAS	MO	WATER DISP	KW H2O	KW DAYS	KW GAS	CSG PSI	TBG PSI
Jan-84	0	0	0			0	29	25550	0	1220
Feb-84	0	0	0			0	24	19276	0	1220
Mar-84	0	0	0			0	31	24589	0	1220
Apr-84	0	0	0			90	30	24100	0	1220
May-84	0	0	0			90	30	23425	0	1220
Jun-84	0	0	0			0	29	23578	0	1220
Jul-84	0	0	0			0	31	24857	0	1220
Aug-84	0	0	0			0	31	28359	0	1030
Sep-84	0	0	0			0	29	24259	0	1030
Oct-84	0	0	0			66	22	25641	0	1030
Nov-84	0	0	0			0	28	22367	0	1030
Dec-84	0	0	0			93	31	25801	0	1030
Jan-85	0	0	0			0	31	27786	0	1030
Feb-85	0	0	0			0	28	25527	0	1030
Mar-85	0	0	0			0	20	15924	0	1030
Apr-85	0	0	0			0	0	0	0	0
May-85	0	0	0			0	0	0	0	0
Jun-85	0	0	0			0	0	0	0	0
Jul-85	0	0	0			0	0	0	0	0
Aug-85	0	0	0			0	0	0	0	0
Sep-85	0	0	0			0	11	5512	0	2000
Oct-85	0	0	0			0	31	11470	0	925
Nov-85	0	0	0			0	30	6646	0	650
Dec-85	0	0	0			0	31	4145	0	625
Jan-86	0	0	0			0	20	1682	0	560
Feb-86	0	0	0			0	28	810	0	925
Mar-86	0	0	0			0	31	340	0	425
Apr-86	0	0	0			0	30	271	0	650
May-86	0	0	0			0	16	216	0	650
Jun-86	0	0	0			0	16	213	0	660
Jul-86	0	0	0			0	0	0	0	0
Aug-86	0	0	0			0	0	0	0	0
Sep-86	0	0	0			0	30	4274	0	625
Oct-86	0	0	0			0	31	8975	0	1050
Nov-86	0	0	0			0	30	8275	0	630
Dec-86	0	0	0			0	31	7240	0	500
Jan-87	0	0	0			0	31	6361	0	600
Feb-87	0	0	0			0	28	9326	0	800
Mar-87	0	0	0			0	31	17547	0	970
Apr-87	0	0	0			0	30	19640	0	980
May-87	0	0	0			0	15	11657	0	1060
Jun-87	0	0	0			0	20	14553	0	1060
Jul-87	0	0	0			0	25	19600	0	910
Aug-87	0	0	0			0	31	36172	0	920
Sep-87	0	0	0			0	30	43003	0	880
Oct-87	0	0	0			0	31	39687	0	850
Nov-87	0	0	0			0	30	44296	0	824
Dec-87	0	0	0			0	31	56279	0	710
Jan-88	0	0	0			0	31	59148	0	636
Feb-88	0	0	0			0	29	50432	0	604
Mar-88	0	0	0			0	31	46847	0	601
Apr-88	0	0	0			0	30	40341	0	590
May-88	0	0	0			0	31	56673	0	463
Jun-88	0	0	0			20	30	37087	0	535

DATE	KST H2O	KST DAYS	KST GAS	MO	WATER DISP	KW H2O	KW DAYS	KW GAS	CSG PSI	TBG PSI
Jul-88	0	0	0			22	31	38553	0	505
Aug-88	0	0	0			26	31	41490	0	482
Sep-88	0	0	0			33	30	38096	0	452
Oct-88	0	0	0			39	31	47546	0	351
Nov-88	0	0	0			40	30	45091	0	285
Dec-88	0	0	0			40	31	42712	0	280
Jan-89	0	0	0			37	31	42833	0	273
Feb-89	0	0	0			37	27	35321	0	260
Mar-89	0	0	0			37	29	38146	0	282
Apr-89	0	0	0			1	1	964	0	467
May-89	0	0	0			25	31	35447	0	234
Jun-89	0	0	0			14	19	20501	0	320
Jul-89	0	0	0			21	28	36692	0	216
Aug-89	0	0	0			23	31	29530	0	188
Sep-89	0	0	0			24	30	17500	0	228
Oct-89	0	0	0			23	29	28621	0	218
Nov-89	0	0	0			26	30	23492	0	160
Dec-89	0	0	0			47	31	19265	0	148
Jan-90	0	0	0			35	31	13083	0	0
Feb-90	0	0	0			36	28	10683	0	0
Mar-90	0	0	0			36	31	10076	0	0
Apr-90	0	0	0			27	22	6475	0	0
May-90	0	0	0			33	31	6666	0	0
Jun-90	0	0	0			29	30	3593	0	0
Jul-90	0	0	0			36	31	4261	0	0
Aug-90	0	0	0			25	25	2143	0	0
Sep-90	0	0	0			29	30	4018	0	0
Oct-90	0	0	0			28	31	3166	0	0
Nov-90	0	0	0			26	30	2111	0	0
Dec-90	0	0	0			19	18	857	0	0
Jan-91	0	0	0			39	18	857	0	0
Feb-91	0	0	0			32	28	570	0	0
Mar-91	0	0	0			29	25	271	0	0
Apr-91	0	0	0			29	30	228	0	0
May-91	0	0	0			32	31	656	0	0
Jun-91	0	0	0			35	30	728	0	0
Jul-91	0	0	0			21	18	545	0	0
Aug-91	0	0	0			32	29	469	0	0
Sep-91	0	0	0			31	27	195	0	0
Oct-91	0	0	0			34	31	214	0	0
Nov-91	0	0	0			34	29	185	0	0
Dec-91	0	0	0			22	23	122	0	0
Jan-92	0	0	0			27	24	307	0	0
Feb-92	0	0	0			26	26	162	0	0
Mar-92	0	0	0			22	29	309	0	0
Apr-92	0	0	0			27	25	177	0	0
May-92	0	0	0			11	31	277	0	0
Jun-92	0	0	0			6	30	167	0	0
Jul-92	0	0	0			16	31	227	0	0
Aug-92	0	0	0			6	28	224	0	0
Sep-92	0	0	0			8	19	68	0	0
Oct-92	0	0	0			1	23	102	0	0
Nov-92	0	0	0			2	5	37	0	0
Dec-92	0	0	0			0	0	0	0	0

DATE	KST H2O	KST DAYS	KST GAS	MO	WATER DISP	KW H2O	KW DAYS	KW GAS	CSG PSI	TBG PSI
Jan-93	0	0	0						0	0
Feb-93	0	0	0						0	0
Mar-93	0	0	0						0	0
Apr-93	0	0	0						0	0
May-93	0	0	0						0	0
Jun-93	0	0	0						0	0
Jul-93	0	0	0						0	0
Aug-93	0	0	0						0	0
Sep-93	0	0	0						0	0
Oct-93	0	0	0						0	0
Nov-93	0	0	0						0	0
Dec-93	0	0	0						0	0
Jan-94	0	0	0						0	0
Feb-94	0	0	0						0	0
Mar-94	0	0	0						0	0
Apr-94	0	0	0						0	0
May-94	0	0	0						0	0
Jun-94	0	0	0						0	0
Jul-94	0	0	0						0	0
Aug-94	0	0	0						0	0
Sep-94	0	0	0						0	0
Oct-94	0	0	0						0	0
Nov-94	0	0	0						0	0
Dec-94	0	0	0						0	0
Jan-95	0	0	0						0	0
Feb-95	0	0	0						0	0
Mar-95	0	0	0						0	0
Apr-95	0	0	0						0	0
May-95	0	0	0						0	0
Jun-95	0	0	0						0	0
Jul-95	0	0	0						0	0
Aug-95	0	0	0						0	0
Sep-95	0	0	0						0	0
Oct-95	0	0	0						0	0
Nov-95	0	0	0						0	0
Dec-95	0	0	0						0	0
Jan-96	0	0	0						0	0
Feb-96	0	0	0						0	0
Mar-96	0	0	0						0	0
Apr-96	0	0	0						0	0
May-96	0	0	0						0	0
Jun-96	0	0	0						0	0
Jul-96	0	0	0						0	0
Aug-96	0	0	0						0	0
Sep-96	0	0	0						0	0
Oct-96	0	0	0						0	0
Nov-96	0	0	0						0	0
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Feb-97	0	0	0						0	0
Mar-97	0	0	0						0	0
Apr-97	0	0	0						0	0
May-97	0	0	0						0	0
Jun-97	0	0	0						0	0

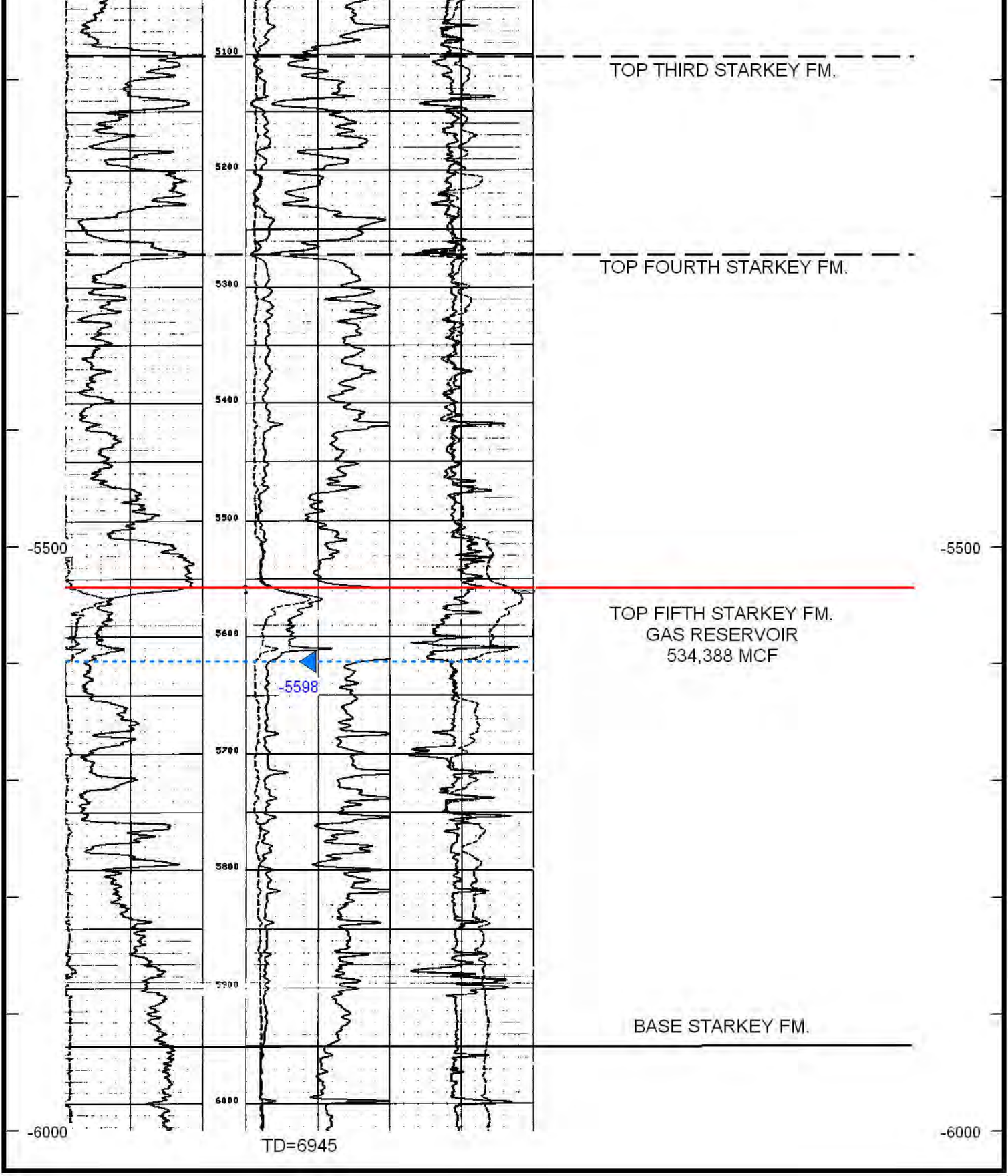
DATE	KST H2O	KST DAYS	KST GAS	MO	WATER DISP	KW H2O	KW DAYS	KW GAS	CSG PSI	TBG PSI
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Aug-97	0	0	0						0	0
Sep-97	0	0	0						0	0
Oct-97	0	0	0						0	0
Nov-97	0	0	0						0	0
Dec-97	0	0	0						0	0
Jan-98	0	0	0						0	0
Feb-98	0	0	0						0	0
Mar-98	0	0	0						0	0
Apr-98	0	0	0						0	0
May-98	0	0	0						0	0
Jun-98	0	0	0						0	0
Jul-98	0	0	0						0	0
Aug-98	0	0	0						0	0
Sep-98	0	0	0						0	0
Oct-98	0	0	0						0	0
Nov-98	0	0	0						0	0
Dec-98	0	0	0						0	0
Jan-99	0	0	0						0	0
Feb-99	0	0	0						0	0
Mar-99	0	0	0						0	0
Apr-99	0	0	0						0	0
May-99	0	0	0						0	0
Jun-99	0	0	0						0	0
Jul-99	0	0	0						0	0
Aug-99	0	0	0						0	0
Sep-99	0	0	0						0	0
Oct-99	0	0	0						0	0
Nov-99	0	0	0						0	0
Dec-99	0	0	0						0	0
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Feb-00	0	0	0						0	0
Mar-00	0	0	0						0	0
Apr-00	0	0	0						0	0
May-00	0	0	0						0	0
Jun-00	0	0	0						0	0
Jul-00	0	0	0						0	0
Aug-00	0	0	0						0	0
Sep-00	0	0	0						0	0
Oct-00	0	0	0						0	0
Nov-00	0	0	0						0	0
Dec-00	0	0	0						0	0
Jan-01	0	0	0						0	0
Feb-01	0	0	0						0	0
Mar-01	0	0	0						0	0
Apr-01	0	0	0						0	0
May-01	0	0	0						0	0
Jun-01	0	0	0						0	0
Jul-01	0	0	0						0	0
Aug-01	0	0	0						0	0
Sep-01	0	0	0						0	0
Oct-01	0	0	0						0	0
Nov-01	0	0	0						0	0
Dec-01	0	0	0						0	0

DATE	KST H2O	KST DAYS	KST GAS	MO	WATER DISP	KW H2O	KW DAYS	KW GAS	CSG PSI	TBG PSI
Jan-02	0	0	0						0	0
Feb-02	0	0	0						0	0
Mar-02	0	0	0						0	0
Apr-02	0	0	0						0	0
May-02	0	0	0						0	0
Jun-02	0	0	0						0	0
Jul-02	0	0	0						0	0
Aug-02	0	0	0						0	0
Sep-02	0	0	0						0	0
Oct-02	0	0	0						0	0
Nov-02	0	0	0						0	0
Dec-02	0	0	0						0	0
Jan-03	0	0	0						0	0
Feb-03	0	0	0						0	0
Mar-03	0	0	0						0	0
Apr-03	0	0	0						0	0
May-03	0	0	0						0	0
Jun-03	0	0	0						0	0
Jul-03	0	0	0						0	0
Aug-03	0	0	0						0	0
Sep-03	0	0	0						0	0
Oct-03	0	0	0						0	0
Nov-03	0	0	0						0	0
Dec-03	0	0	0						0	0
Jan-04	0	0	0						0	0
Feb-04	0	0	0						0	0
Mar-04	0	0	0						0	0
Apr-04	0	0	0						0	0
May-04	0	0	0						0	0
Jun-04	0	0	0						0	0
Jul-04	0	0	0						0	0
Aug-04	0	0	0						0	0
Sep-04	0	0	0						0	0
Oct-04	0	0	0						0	0
Nov-04	0	0	0						0	0
Dec-04	0	0	0						0	0
Jan-05	0	0	0						0	0
Feb-05	0	0	0						0	0
Mar-05	0	0	0						0	0
Apr-05	0	0	0						0	0
May-05	0	0	0						0	0
Jun-05	0	0	0						0	0
Jul-05	0	0	0						0	0
Aug-05	0	0	0						0	0
Sep-05	0	0	0						0	0
Oct-05	0	0	0						0	0
Nov-05	0	0	0						0	0
Dec-05	0	0	0						0	0
Jan-06	0	0	0						0	0
Feb-06	0	0	0						0	0
Mar-06	0	0	0						0	0
Apr-06	0	0	0						0	0
May-06	0	0	0						0	0
Jun-06	0	0	0						0	0

DATE	KST H2O	KST DAYS	KST GAS	MO	WATER DISP	KW H2O	KW DAYS	KW GAS	CSG PSI	TBG PSI
Jul-06	0	0	0						0	0
Aug-06	0	0	0						0	0
Sep-06	0	0	0						0	0
Oct-06	0	0	0						0	0
Nov-06	0	0	0						0	0
Dec-06	0	0	0						0	0
Jan-07	0	0	0						0	0
Feb-07	0	0	0						0	0
Mar-07	0	0	0						0	0
Apr-07	25	1	0						5	0
May-07	25	1	0						5	0
Jun-07	25	1	0						5	0
Jul-07	0	0	0						30	30
Aug-07	0	0	0						30	30
Sep-07	0	0	0						30	30
Oct-07	0	0	0						30	30
Nov-07	0	0	0						30	30
Dec-07	0	0	0						30	30
Jan-08	0	0	0						0	30
Feb-08	0	0	0						0	30
Mar-08	0	30	1359						0	30
Apr-08	0	0	0						0	0
May-08	0	31	1333						0	0
Jun-08	0	0	0						0	0
Jul-08	6	24	1129						0	30
Aug-08	3	25	825						0	30
Sep-08	6	30	1291						0	30
Oct-08	0	0	0						0	0
Nov-08	0	0	0						0	0
Dec-08	0	0	0						0	0
Jan-09	5	31	1120						0	30
Feb-09	5	26	1120						0	30
Mar-09	5	25	1140						0	30
Apr-09	0	0	0						0	0
May-09	0	0	0						0	0
Jun-09	0	0	0						0	0
	105		2,473,085			1,755		4,159,014		

Cum Gas All Zones: 948014 MCF

04113209300000
ROYALE ENERGY, INC.
GLIDE 3-1
TWP: 7 N - Range: 3 E - Sec. 3
Spud Date=8/15/1989
Datum=24



04-113-20930 ** 03-7N-3E MD

ROYALE OPERATING COMPANY GLIDE NO. 3-1

Field: Putah Sink Gas

County: Yolo

Elev: 24 DF

TD: 6945

LOC: 1700’ East 200’ South NWC

☐ Directional

Spud: 08/15/1989

Current Status: Abandoned Gas

Horizons: Top Mokelumne 3963, Top Starkey 4408, Top Main Winters Sand 6881

Original Operator: Arkoma Production Company

Casing: 8-5-/8” cemented at 786’; 4-1/2” cemented at 6940’

07/21/89 LOCATION.
07/22/89 LOCATION, D.O.G.
07/25/89 CONTRACT ASSIGNED.
08/14/89 MOVING IN EQUIPMENT.
08/16/89 DRLG "NO DOPE".
08/22/89 7000 +/-; LOGGING.
08/23/89 RUNNING CSG.
08/24/89 RAN CSG; REL RIG.

08/26/89 PERFORATED 6600-6634’
08/27/89 TESTED 995 MCF/D W/ 275 PSI THRU ½” CHOKE, SI 352 PSI

08/04/93 SET RETAINER AT 6550
08/05/93 PERFORATE 5560-5564
08/06/93 TESTED 640 MCF/D W/ 760 PSI FTP THRU 12/64” CHOKE, SI 2000 PSI

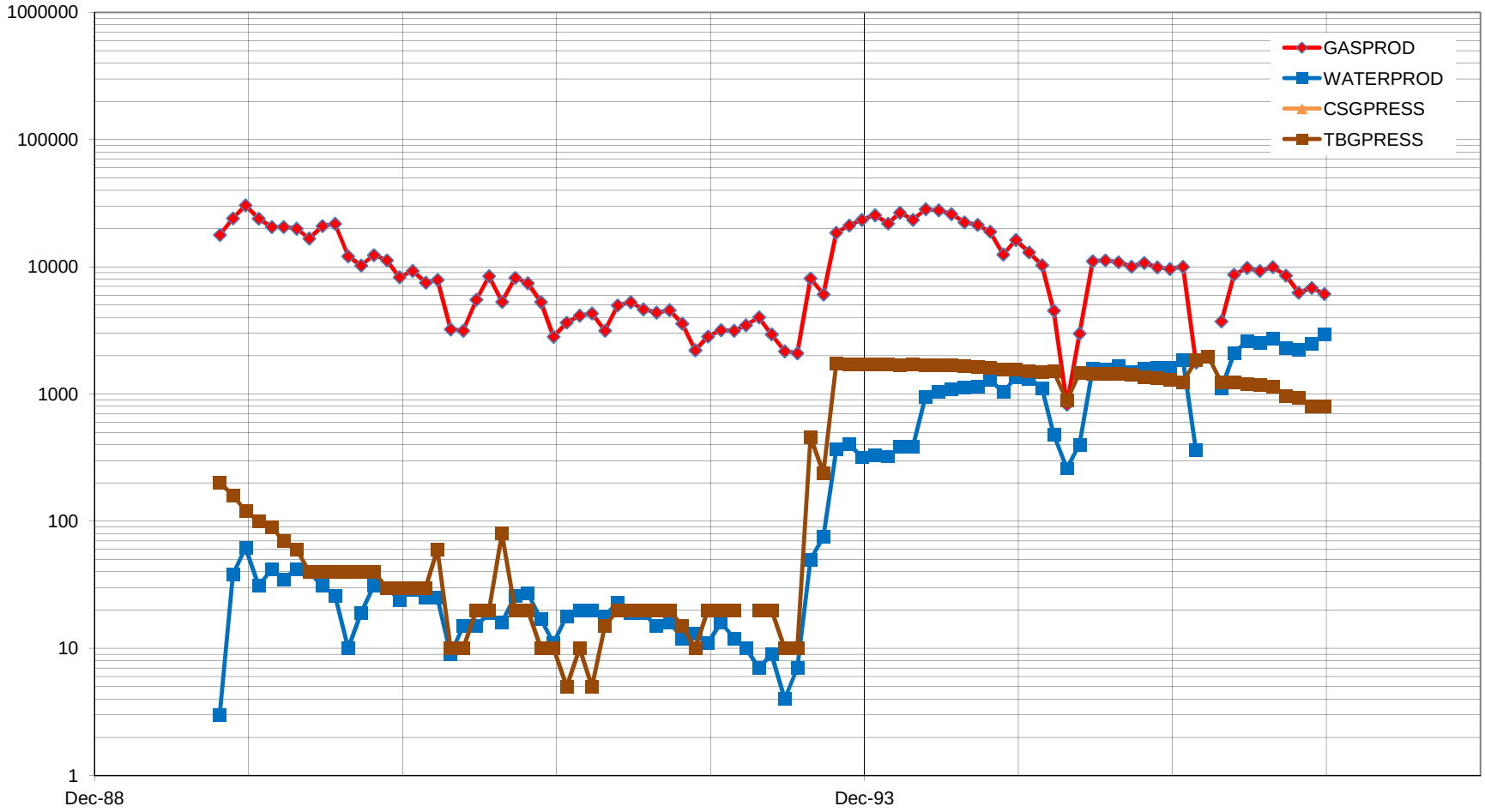
08/23/94 WELL TRANSFERRED TO ROYALE OPERATING COMPANY.

06/03/98 WELL ABANDONED

04-113-20930 ROYALE OPERATING COMPANY GLIDE NO. 3-1

STARKEY FM CUM PROD 534,388 MCF; 49,507 BBLS H2O

WINTERS FM CUM PROD 413,626 MCF; 967 BBLS H2O



DATE	WATERPR	DAYSPRO	GASPROD	CSGPRES	TBGPRES	BTU
Oct-89	3	18	17794		200	
Nov-89	38	30	24033		160	
Dec-89	62	31	30429		120	
Jan-90	31	31	23909		100	
Feb-90	42	28	20565		90	
Mar-90	35	31	20574		70	
Apr-90	42	30	19969		60	
May-90	40	31	16677		40	
Jun-90	31	30	20933		40	
Jul-90	26	29	21798		40	
Aug-90	10	29	12095		40	
Sep-90	19	25	10233		40	
Oct-90	31	31	12350		40	
Nov-90	30	30	11245		30	
Dec-90	24	25	8283		30	
Jan-91	29	31	9294		30	
Feb-91	25	26	7506		30	
Mar-91	25	26	7907		60	
Apr-91	9	26	3227		10	
May-91	15	27	3149		10	
Jun-91	15	20	5514		20	
Jul-91	19	22	8449		20	
Aug-91	16	17	5301		80	
Sep-91	26	27	8179		20	
Oct-91	27	29	7431		20	
Nov-91	17	28	5280		10	
Dec-91	11	31	2818		10	
Jan-92	18	29	3644		5	
Feb-92	20	28	4131		10	
Mar-92	20	30	4305		5	
Apr-92	18	28	3147		15	
May-92	23	30	4982		20	
Jun-92	19	30	5271		20	
Jul-92	19	30	4638		20	
Aug-92	15	30	4370		20	
Sep-92	16	30	4561		20	
Oct-92	12	29	3575		15	
Nov-92	13	26	2208		10	
Dec-92	11	28	2831		20	
Jan-93	16	29	3180		20	
Feb-93	12	28	3145		20	
Mar-93	10	29	3475			
Apr-93	7	30	4012		20	
May-93	9	29	2946		20	
Jun-93	4	29	2169		10	
Jul-93	7	30	2094		10	
Aug-93	50	28	8099		460	
Sep-93	75	30	6067		240	
Oct-93	368	31	18544		1740	
Nov-93	406	30	21118		1720	
Dec-93	317	31	23429		1720	

DATE	WATERPR	DAYSPRO	GASPROD	CSGPRES	TBGPRES	BTU
Jan-94	329	31	25470		1720	
Feb-94	324	28	21900		1720	
Mar-94	383	31	26646		1695	
Apr-94	386	30	23414		1720	
May-94	956	31	28381		1695	
Jun-94	1,048	30	27836		1695	
Jul-94	1,093	31	25987		1680	
Aug-94	1,128	31	22388		1660	
Sep-94	1,148	30	21373		1640	
Oct-94	1,289	31	18888		1620	
Nov-94	1,036	30	12499		1555	
Dec-94	1,351	31	16276		1555	
Jan-95	1,322	31	12982		1520	
Feb-95	1,116	28	10298		1494	
Mar-95	479	31	4518		1499	
Apr-95	260	8	825		890	
May-95	401	10	2990		1470	
Jun-95	1,578	30	11068		1445	
Jul-95	1,566	31	11247		1450	
Aug-95	1,664	31	10869		1440	
Sep-95	1,476	30	10042		1425	
Oct-95	1,590	31	10742		1355	
Nov-95	1,612	30	9904		1330	
Dec-95	1,597	31	9620		1300	
Jan-96	1,839	31	10015		1240	
Feb-96	362	5	1768		1840	
Mar-96	0	0	0		1970	
Apr-96	1,102	12	3721		1230	
May-96	2,094	31	8677		1240	
Jun-96	2,599	30	9804		1205	
Jul-96	2,522	29	9278		1170	
Aug-96	2,717	31	9950		1150	
Sep-96	2,284	30	8544		970	
Oct-96	2,222	31	6262		930	
Nov-96	2,478	30	6824		800	
Dec-96	2,940	31	6125		800	
TOTAL	50,474		948,014			
TOTAL STARKEY			534,388			
TOTAL WINTERS			413,626			

Starkey Formation Gas Pool of the Putah Sink Gas Field

Reconnaissance Investigation

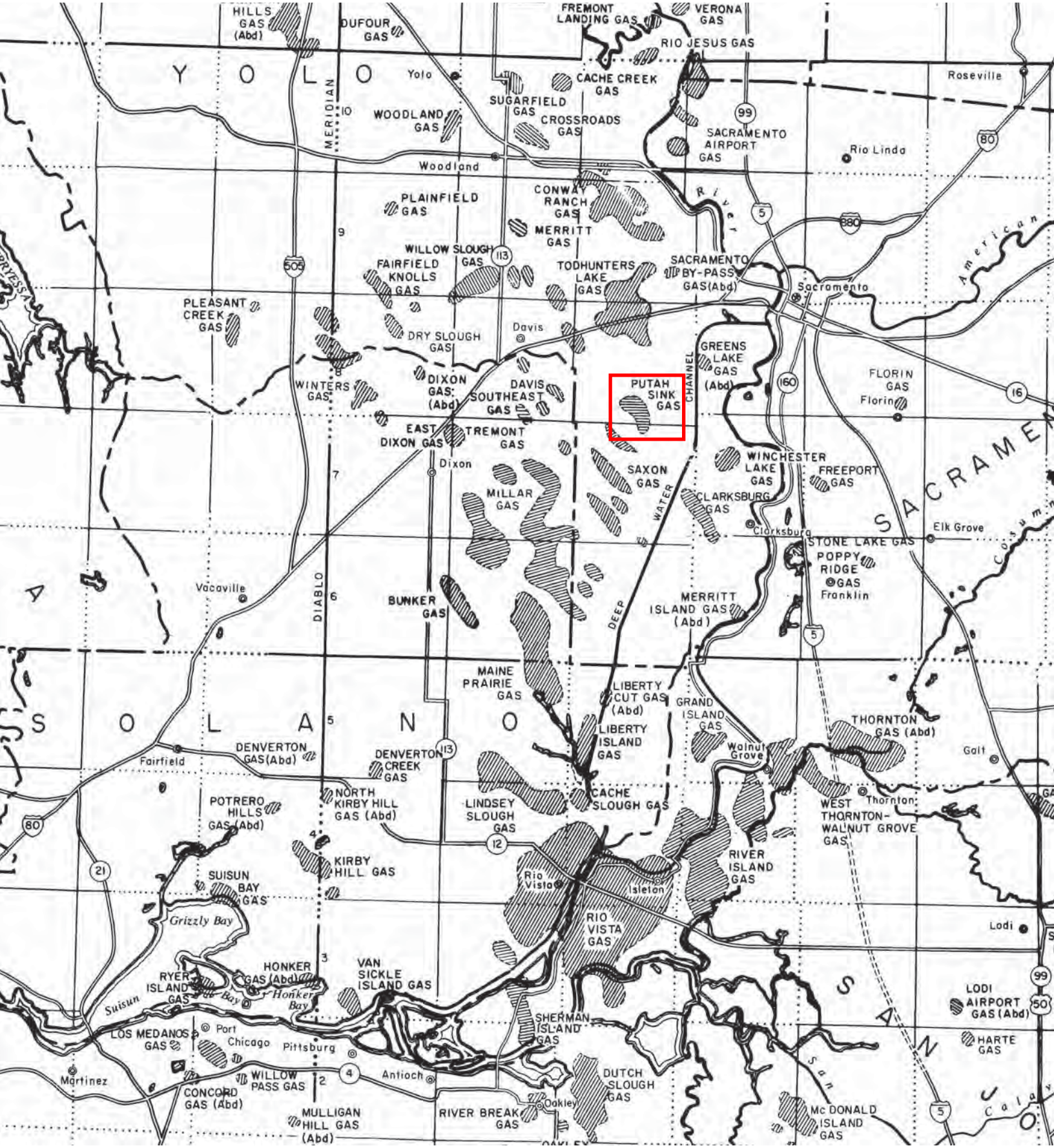
May 2, 2012

Pool Discovery Date:	November, 1973
Cum Gas Production*:	5,812 mmcf
2011-12 Pool Production*:	0
Reserves:	0
Number of gas wells*:	1 idle, 1 plugged
Reservoir Depth:	5600 feet
Reservoir Area:	175 acres+-
Maximum Drilled Thickness:	55 feet +-
Trapping Mechanism:	Structural closure, faulting
Surface Conditions**:	Undeveloped agriculture lands, 10 miles SW of downtown Sacramento, gas pool partly in the Yolo Bypass Wildlife Area (imagery dated 10/30/11)
Notes:	3D seismic data has been acquired over the field and is available for purchase.

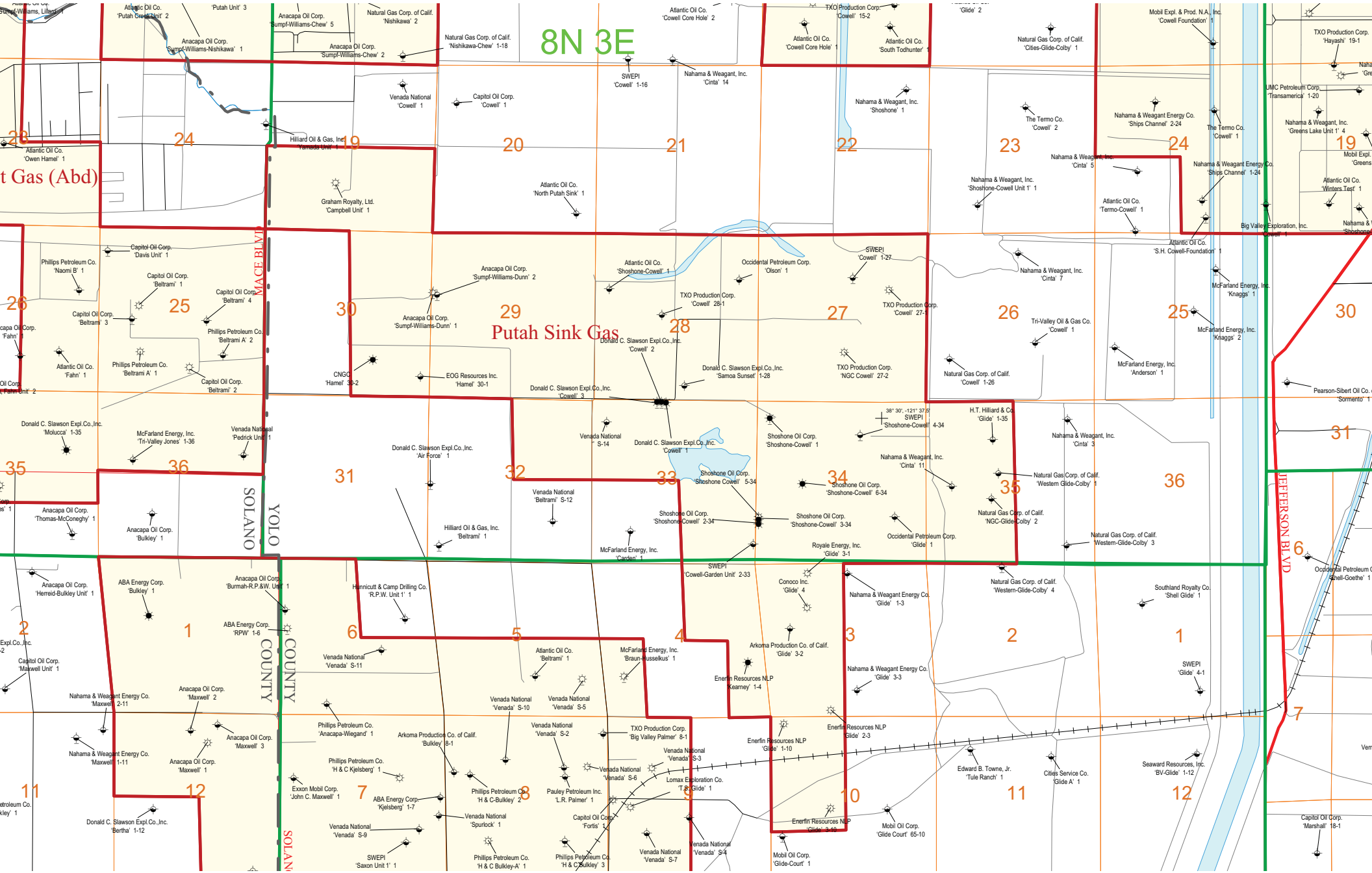
* source is CDOGGR online production database

** Google Earth image dated 10/30/11

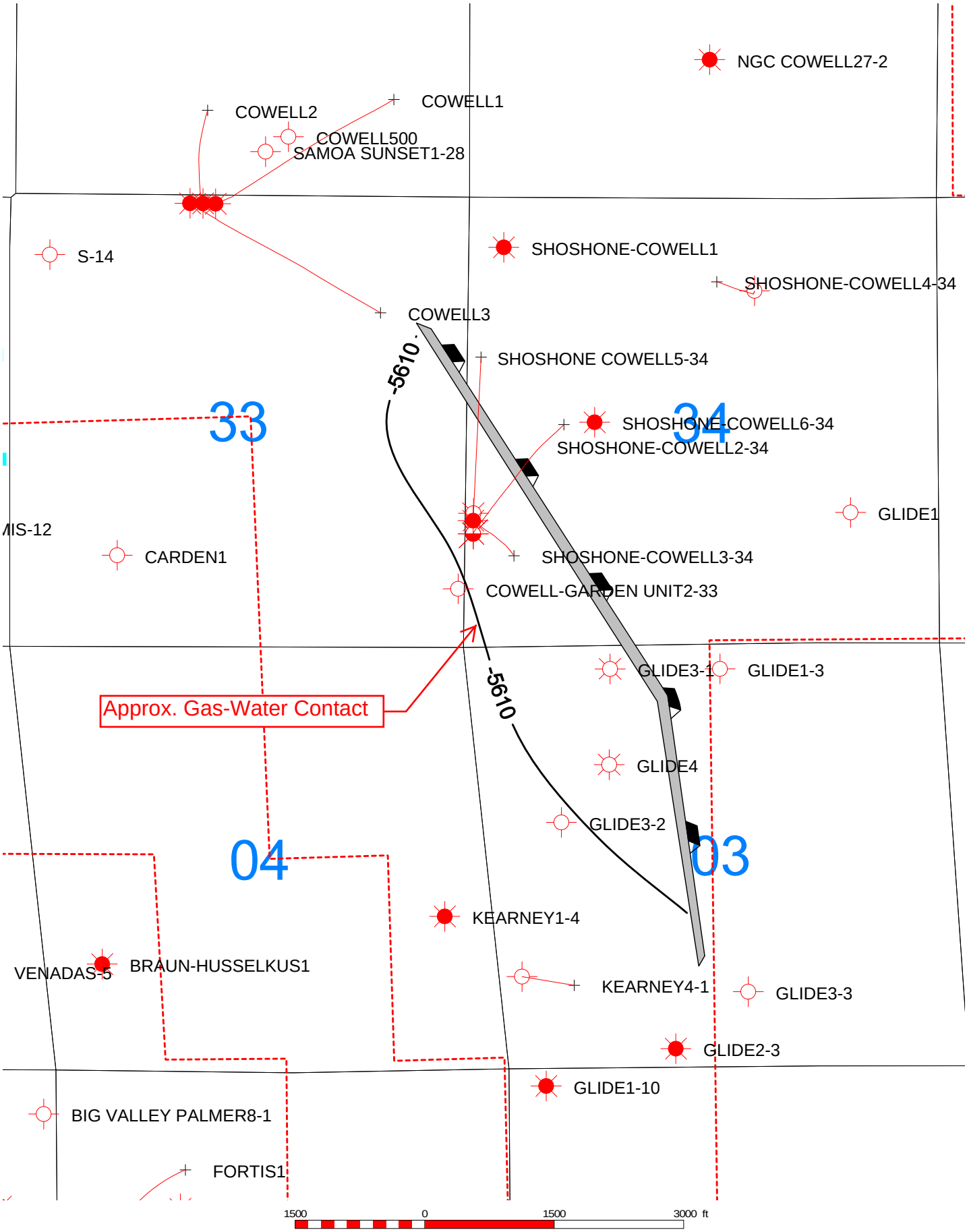
Putah Sink Gas Field Regional Location Map



Putah Sink Gas Field Base Map



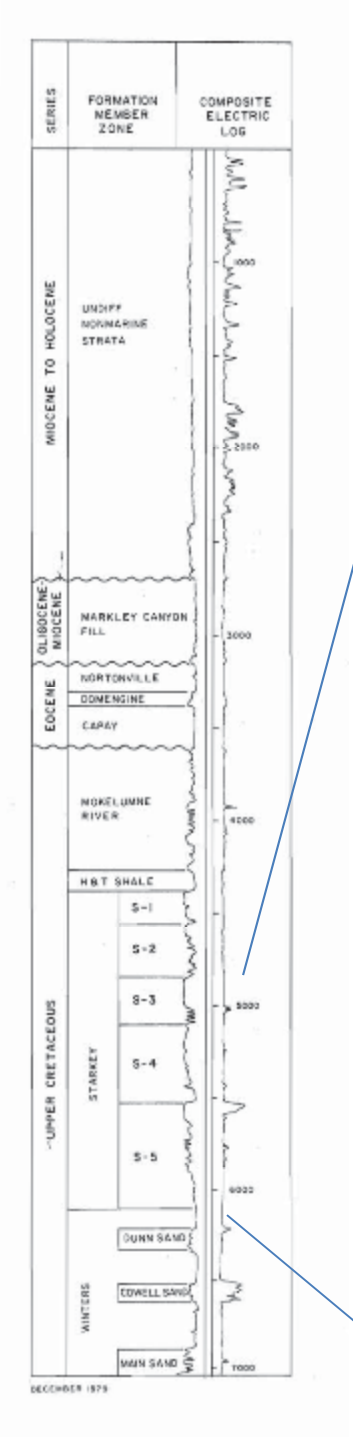
Generalized Structure-Contour Map, Top Starkey Fm. Gas Pool, Putah Sink Gas Field

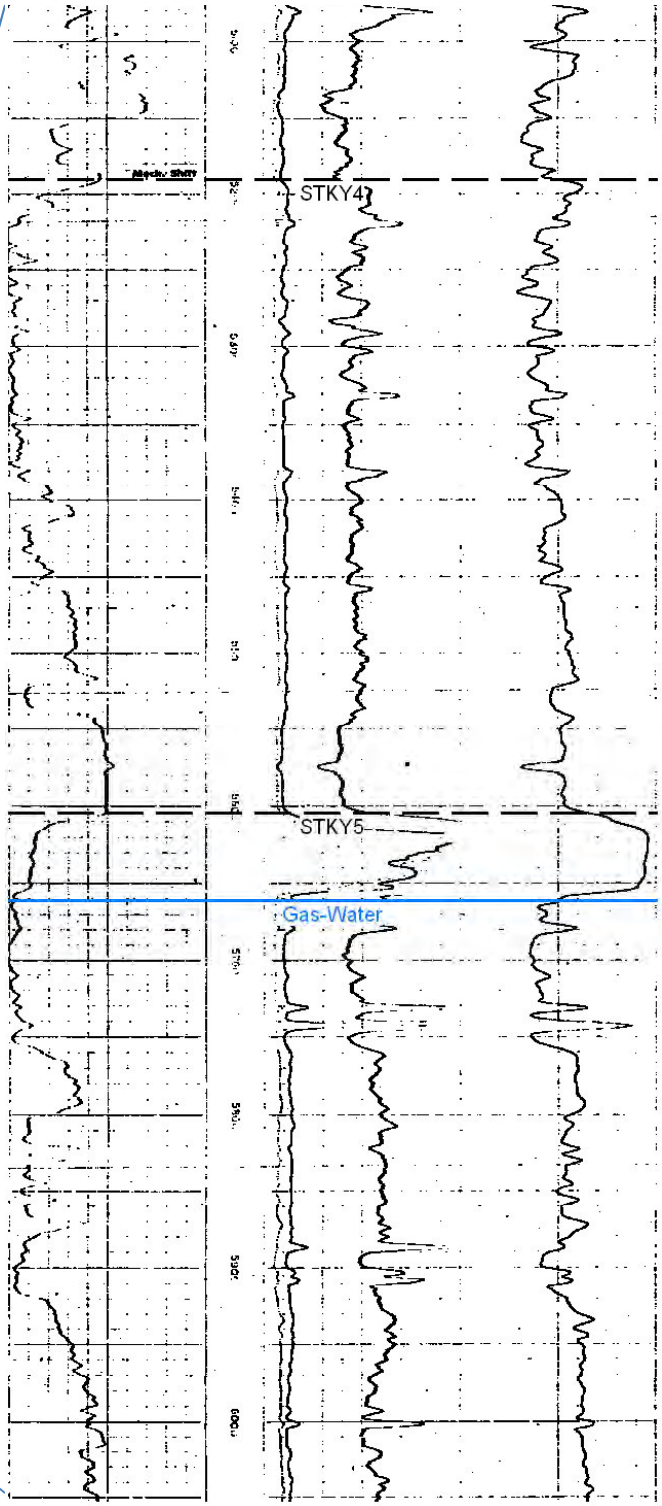


IDLE GAS WELL

Shoshone Cowell 3-34

Starkey Fm. Prod. 2,473,085 mcf





Approx. Outline of Gas Pool

34

Shoshone Cowell 3-34

Outline of Yolo Bypass Wildlife Area

3

© 2012 Google

2845 ft

2011 1993

38°29'16.41" N 121°37'39.93" W elev 12 ft

Sacramento
Davis
Yolo Bypass Wildlife Area
Shoshone Cowell 3-34
Babel Slough
Winchester Lake
West Side Hwy
16
50
5
84
160
80
© 2012 Google
3.72 mi
te: 10/30/2011
38°29'50.04" N 121°35'45.02" W elev 9 ft

COUNTY: YOLO

PUTAH SINK GAS FIELD

DISCOVERY WELL AND DEEPEST WELL

	Present operator and well designation	Original operator and well designation	Sec. T. & R.	B.&M.	Total depth (feet)	Pool (zone)	Strata & age at total depth
Discovery well	Shell Oil Co. "Shoshone-Cowell" 1	Same as present	34 8N 3E	MD	6,975	Cowell	
Deepest well	Occidental Petroleum Corp. "Glide" 1	Same as present	34 8N 3E	MD	8,123		Winters Late Cretaceous

POOL DATA

ITEM	S-4	DUNN	COWELL			FIELD OR AREA DATA
Discovery date	November 1973	April 1974	June 1973			
Initial production rates						
Oil (bbl/day)	2,080	1,600	970			
Gas (Mcf/day)	2,050	2,050	2,550			
Flow pressure (psi)		1/2	28/64			
Bean size (in.)						
Initial reservoir pressure (psi)	2,420	2,710	2,995			
Reservoir temperature (°F)	110	118	122			
Initial oil content (STB/ac.-ft.)						
Initial gas content (MSCF/ac.-ft.)	1,500-1,900	1,100-1,600	1,200-1,700			
Formation	Starkey	Winters	Winters			
Geologic age	Late Cretaceous	Late Cretaceous	Late Cretaceous			
Average depth (ft.)	5,550	6,210	6,500			
Average net thickness (ft.)	50	20	60			
Maximum productive area (acres)						720
RESERVOIR ROCK PROPERTIES						
Porosity (%)	29-33†	25-28†	25-28†			
S_{oi} (%)	22-30†	30-45†	30-45†			
S_{wi} (%)	70-78†	55-70†	55-70†			
S_{gi} (%)						
Permeability to air (md)						
RESERVOIR FLUID PROPERTIES						
Oil:						
Oil gravity (°API)						
Sulfur content (% by wt.)						
Initial solution GOR (SCF/STB)						
Initial oil FVF (RB/STB)						
Bubble point press. (psia)						
Viscosity (cp) @ °F						
Gas:						
Specific gravity (air = 1.0)	.607	.610	.605			
Heating value (Btu/cu. ft.)	900	890	910			
Water:						
Salinity, NaCl (ppm)						
T.D.S. (ppm)						
R_w (ohm/m) (77°F)						
ENHANCED RECOVERY PROJECTS						
Enhanced recovery projects						
Date started						
Date discontinued						
Peak oil production (bbl)						
Year						
Peak gas production, net (Mcf)						3,875,386
Year						1976

Base of fresh water (ft.): 2,000-2,500

Remarks: Commercial gas deliveries began in December 1974.

Selected References:

DATE: January 1981

† Log derived value.

CALIFORNIA DIVISION OF OIL AND GAS

PUTAH SINK RESERVOIR

Summary and Decision

Putah Sink Reservoir (Putah Sink—Aerial Map.pdf), located in Yolo and Sacramento County, California (10 miles southwest of downtown Sacramento), was not selected for detailed modeling and/or was not a finalist site for the CAES Feasibility Study. In the opinion of the project team, development of the reservoir would be difficult for the following reason:

- Reservoir was located in area currently managed to protect and enhance aquatic and terrestrial habitats for plant, wildlife, and fish species.

Subsurface/Reservoir Screening

Preliminary Screening Results

A preliminary reconnaissance investigation of the Putah Sink reservoir data was completed on May 2, 2012 (Putah Sink—Reconnaissance Report.pdf). That review concluded that the Starkey formation is approximately 5,600 ft deep and had a cumulative production of 5.8 Bcf. Only two wells penetrate the reservoir; one had been plugged, and the other is listed as idle. The surface is undeveloped agricultural lands, and the gas pool is partially located within the Yolo Bypass Wildlife Area. 3D seismic data has been acquired over the field and is available for purchase from ECHO Geophysical Corp (titled: "Yolo Bypass" survey).

Detailed Geological Summary

Based on the information acquired in the preliminary investigation, the project team determined that a more formal geological evaluation should be completed; that report was delivered on May 20, 2012 (Putah Sink—Detailed Geological Report.pdf). Updated information indicated that actually three wells penetrated the reservoir, the fifth Starkey, at a depth of approximately 5,600 ft. The gas pool is estimated to have an aerial extent of 150 acres and a maximum thickness of more than 60 ft. Log-derived porosities averaged 29% to 33%. Based on the latest reported pressures in the depleted wells of approximately 2,000 psi, the reservoir is suspected to have a strong water drive. The initial discovery pressure was 2,160 psi.

Further investigation into the production history revealed that a total of 6,346 MMcf had been produced from the Starkey formation. Average production rates of as much as 2,100 Mcf/d were reported from the Glide 4 well, indicating good permeability.

Reservoir Modeling and Evaluation

DRAFT

Based on the results of the preliminary and detailed geological analysis, the project team determined that the Putah Sink reservoir parameters were within an acceptable range for CAES development. However, when the reservoir was evaluated against other potential reservoirs, it ranked lower than the top choices to meet the CAES program's short- and long-term objectives. For this reason, as well as other land-related issues, no further evaluation was conducted at Putah Sink.

Testing/Development Potential

No testing was conducted.

Siting and Environmental Evaluation

Determination – Fatal Flaws

The majority of the gas field is located in the Tule Ranch unit of the Yolo Bypass State Wildlife Area, owned and managed by the California Department of Fish and Wildlife (CDFW) to protect and enhance aquatic and terrestrial habitats for plant, wildlife, and fish species. Development of a CAES project would likely be considered an incompatible use by the CDFW, and this site was dropped from further consideration.

Land Acquisition/Site Control

Deployment

In May 2012, a landman was deployed to Putah Sink reservoir to identify the surface, mineral, and preferred Energy Conversion Facility (ECF) site owners (Putah Sink—APN Map.pdf). None of these owners was contacted regarding the CAES Project.

Preliminary Title Work

In May 2012, PG&E proceeded with a limited Title Review of the 14 Assessor's Parcel Numbers (APNs) overlying the storage reservoir. Title work identified three surface owners and three severed mineral owners over the storage reservoir. Full title reports were not completed.

References

1) Putah Sink - Aerial Map.pdf
2) Putah Sink - Reconnaissance Report.pdf
3) Putah Sink - Detailed Geological Report.pdf
4) Putah Sink - APN Map.pdf

DRAFT

A307: Tracy Site Selection and Attachments

Tracy - Amerada FDL No. 2 Core Description 10-31-11
Tracy - Geological Report Appendix
Tracy - Geological Report
Tracy - GIS Evaluation
Tracy Site Selection Close-Out - Final Report

October 31, 2011

AMERADA PETROLEUM CORP. F.D.L. NO. 2
CORE DESCRIPTION AND SAMPLE ANALYSIS
SEC 15, T2S, R5E
TRACY GAS FIELD,
SAN JOAQUIN COUNTY, CA

Douglas P. Imperato, Ph.D.
Consulting Geologist

SYNOPSIS

A sample from the top of the Tracy Formation in the Amerada Petroleum Corporation's F.D.L. 2 well was obtained from the archives of the Well Sample Repository in Bakersfield, California. The sample consisted of very silty, very fine to fine-grained sandstone with a light gray color, and was analyzed for total porosity and permeability to air. X-ray diffraction analysis was performed to determine bulk mineral and clay content. The results indicate a porosity of 25.7% and permeability to air of 43.2 millidarcies. The sample consists primarily of quartz, with minor amounts of plagioclase and potassium feldspar. The clay content of the sample is nearly 20%.

METHODS

The catalog of cores from the Well Sample Repository in Bakersfield, California includes three wells in the Tracy Gas Field, including the field discovery well for the field, from which more than 1000 feet of cores were cut when the well was drilled in 1935. Upon inspection of these cores, it was found that the actual remaining cores of the Tracy Formation reservoir sand was limited to only one small sample from one well, the Amerada F.D.L. 2 well. The remaining sample was from a reported depth of 4005 feet. Core Laboratories personnel took a plug from the sample for laboratory analysis, and prepared the sample as described in the Core Analysis Procedures and Conditions (Attachment 1). The sample was analyzed for porosity, permeability to air, and grain density. X-ray diffraction analysis was also performed to determine bulk mineral and clay content;

RESULTS

Descriptions of Core 3 in the history of the Amerada F.D.L. 2 well, from depths of 3996 to 4006 feet, indicate that the depth of the sample analyzed herein is 4005 feet. The well history includes the following description:

Bottom	Thickness	Recovery	Formation
3996 ft	2 ft	0 ft (drilled)	
4004 ft	8 ft	O ft (loss)	Sand
4005 ft	**1 ft**	**1 ft**	**Sand, greenish, friable, medium grained**
4006 ft	1 ft	1 ft	Shale, dark brown, organic, abundant forams, fish scales

Correlation of this interval with surrounding wells indicates that this depth corresponds with the top of the Tracy Formation reservoir sand. The electric log for this interval is shown in Attachment 2.

The sample can be described as a gray, very fine to fine-grained sandstone. Conventional core analysis results indicate the sample has a permeability to air of 43.2 millidarcies, porosity of 25.7%, and a grain density of 2.65 g/cc (Attachment 3).

The results of the X-Ray diffraction analysis indicate that the sample is dominated by quartz grains (49.7%), plagioclase (21.8%), and potassium feldspar (8.3%) with a minor amount of pyrite (0.4%). Total clay content is 19.9%, predominantly smectite, with smaller amounts of illit/mica, and chlorite (Attachment 4).

DISCUSSION

The results obtained herein are consistent with the porosity of 28% reported by the California Division of Oil and Gas. The log-derived estimates of porosity and permeability are significantly higher than the results obtained herein, likely due to the unconsolidated "friable" nature of the sandstone.

The Tracy Formation sandstone sample can be classified as an arkose according to the sandstone classification of Folk and others (1970). This mineral composition is typical of the Late Cretaceous Rumsey petrofacies of Dickinson and Rich (1972).

The preservation of locally abundant illite/smectite with a relatively large proportion of smectite suggests that this sandstone sample did not reach burial temperatures in excess of 100-120 degrees C. This is consistent with the generally low-temperature assemblage of minerals.

The effect of clay minerals on permeability is related to their abundance, mineralogy, and salinity of the water transmitted through the pore system (Blatt and others, 1980). Clays can become dislodged and float through the pore channels, greatly reducing the permeability of the sandstones.

The Tracy Formation sandstone sample contains a relatively high ratio of smectite to other clays. This could explain the relatively low permeability of the sample, because of the relatively high expandability of smectites. This allows these clays to be easily dislodged and to occupy a greater volume per unit of clay mineral.

Pore fluids with high salinities and significant proportions of polyvalent cations are desirable in preventing clogging of pore throats by clay. Introduction of low salinity fluids into the reservoir could increase the potential for clogging of pore throats by the smectite and illite clays.

Since only one sample of the reservoir sandstone was available for analysis, and the sample corresponds with the uppermost part of the reservoir, it is not clear if the results of the core analysis from this one sample are representative of the entire reservoir, which is more than 150 feet thick. Laboratory analysis of additional Tracy Formation sandstone samples should be performed to verify the porosity, permeability, and mineralogy of the entire Tracy Formation reservoir, and to evaluate the potential effects of clay mineralogy and reservoir fluid composition on reservoir permeability.

REFERENCES CITED

Blatt, H., Middleton, G, and Murray, R, 1980, Origin of Sedimentary Rocks, Prentice-Hall, Inc. 782 p.

Folk, R.L., Andrews, P.B., and Lewis, D.W., 1970, Detrital sedimentary rock classification and nomenclature for use in New Zealand: New Zealand Journal of Geology and Geophysics, v. 13, p.937-968.

Dickinson, W. R. and Rich, E. I., 1972, Petrologic intervals and petrofacies in the Great Valley sequence, Sacramento Valley, California: Geological Society of America Bulletin, v. 83, p. 3004-3024.

ATTACHME 1

Company: Douglas Imperato
Well: F.D.L. #2
Field: Tracy Gas

File No.: 57111-511221DI
API No.: 04-077-00240
Date: 9/15/2011
Core Type: Conventional

Core Analysis Procedures and Conditions

	Procedure (1)	Procedure (2)	Procedure (3)	Procedure (4)
Sampling Method	Percussion	Percussion	Percussion	Rotary
Drill Coolant	N/A	N/A	N/A	N/A
Jacket Material	Nickel	None	N/A	None
Saturation Method	Dean Stark (Toluene)	Dean Stark (Toluene)	Retort	Dean Stark (Toluene)
Porosity Method				
Grain Volume	Boyle's Law (Helium)	Boyle's Law (Helium)	Bulk Vol-Pore Vol	Boyle's Law (Helium)
Pore Volume	Boyle's Law (Helium)	Bulk Vol-Grain Vol	Summation Of Fluids	Bulk Vol-Grain Vol
Bulk Volume	Pore Vol + Grain Vol	Mercury Displacement	Mercury Displacement	Mercury Displacement
Permeability Method	Air	Empirical	Empirical	Air

Common Conditions

Sleeved Sample Seating Pressure: N/A

Confining Pressure Pore Vol & Permeability: 400 psig

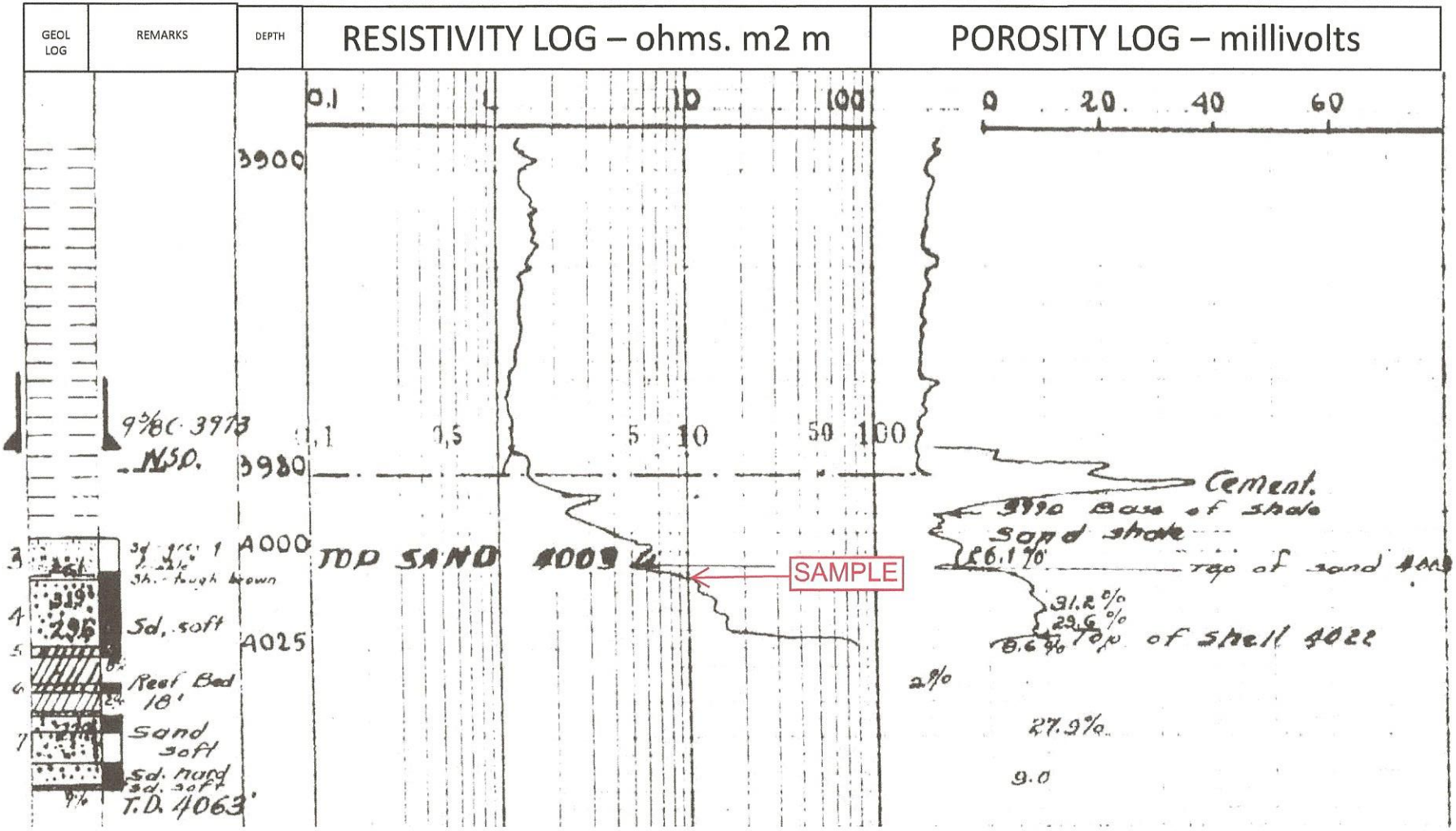
Samples Dried At 235 Degrees Fahrenheit

Additional Extraction by Soxhlet with Methylene Chloride/Methanol

Oil Density used in Calculation: 0.97g/cc

ATTACHMENT 2

AMERADA F.D.L. 2



ATTACHMENT 3

Company : Douglas Imperato
Well : F.D.L. #2
Field : Tracy Gas

Location : Sec. 15-02S-05E
Elevation :
Drlng Fluid :

CL File No. : 57111-511221DI
API No. : 04-077-00240
Date : 9/15/2011

Conventional Core Analysis Results

Sample Number	Depth ft	Perm. Kair md	Porosity %	Grain Den g/cc	Sample Wt. g	Method	Description
1	3996-06	43.2	25.7	2.65	21.6	1	Sst gy vf-fgr vslty no stn no flor

For Method Definitions See Procedures Page

ATTACHMENT 4

Company: Douglas Imperato
Well: F.D.L. #2
Field: Tracy Gas

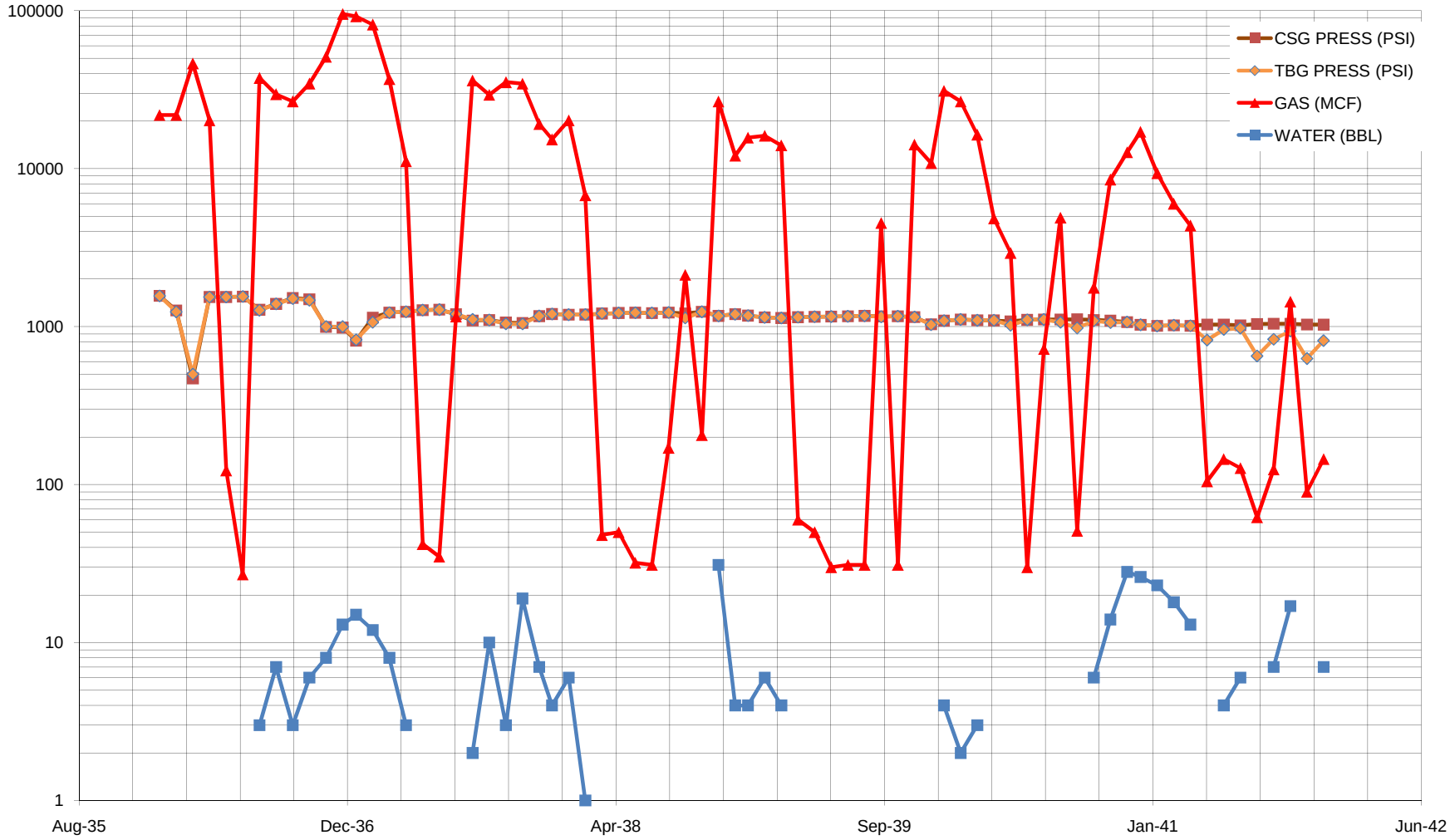
CL Bakersfield: 511221
CL Houston: 111125
Date: 11/20/2011

Conventional Core X-Ray Diffraction Data

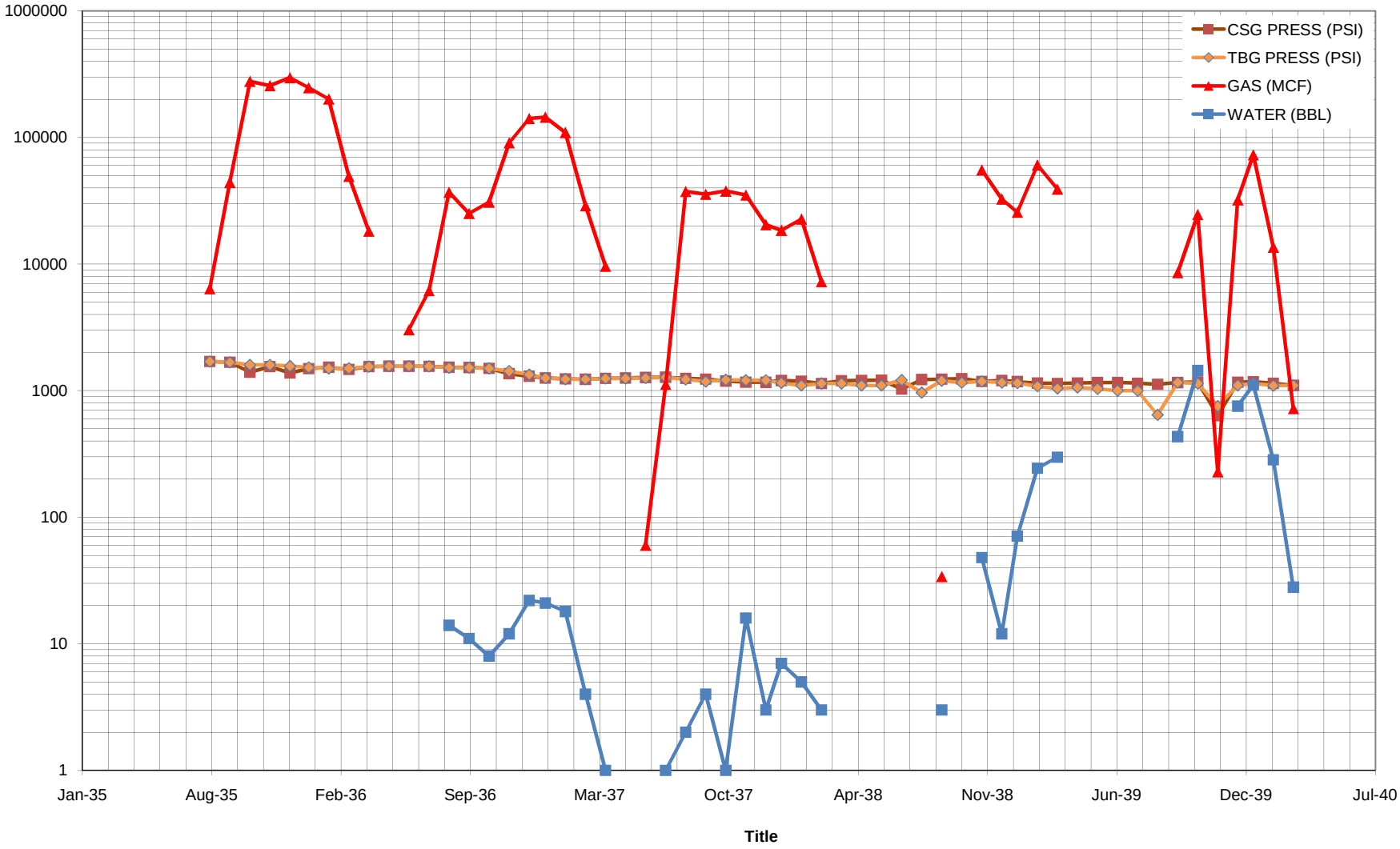
		Bulk Mineralogy (weight %)																Clay Mineralogy (weight %)					
Depth (ft)	QCI[1]	Quartz	Plagioclase	K-Feldspar	Calcite	Mg/Fe-Dolomite	Laumontite	Siderite	Apatite	Clinoptilolite	Analcime	Marcasite	Gypsum	Anhydrite	Halite	Pyrite	Total Clay	Kaolinite	Chlorite	Illite & Mica	Smectite	MXL I/S[2]	% Smectite in MXL I/S[2]
3996-4006	6.80	49.7	21.8	8.3	0	0	0	0	0	0	0	0	0	0	0	0.4	19.9	0	3.9	4.6	11.4	0	n/a

1 - QCI = Quartz crystallinity Index
2 - MXL I/S = Mixed-layer illite-smectite

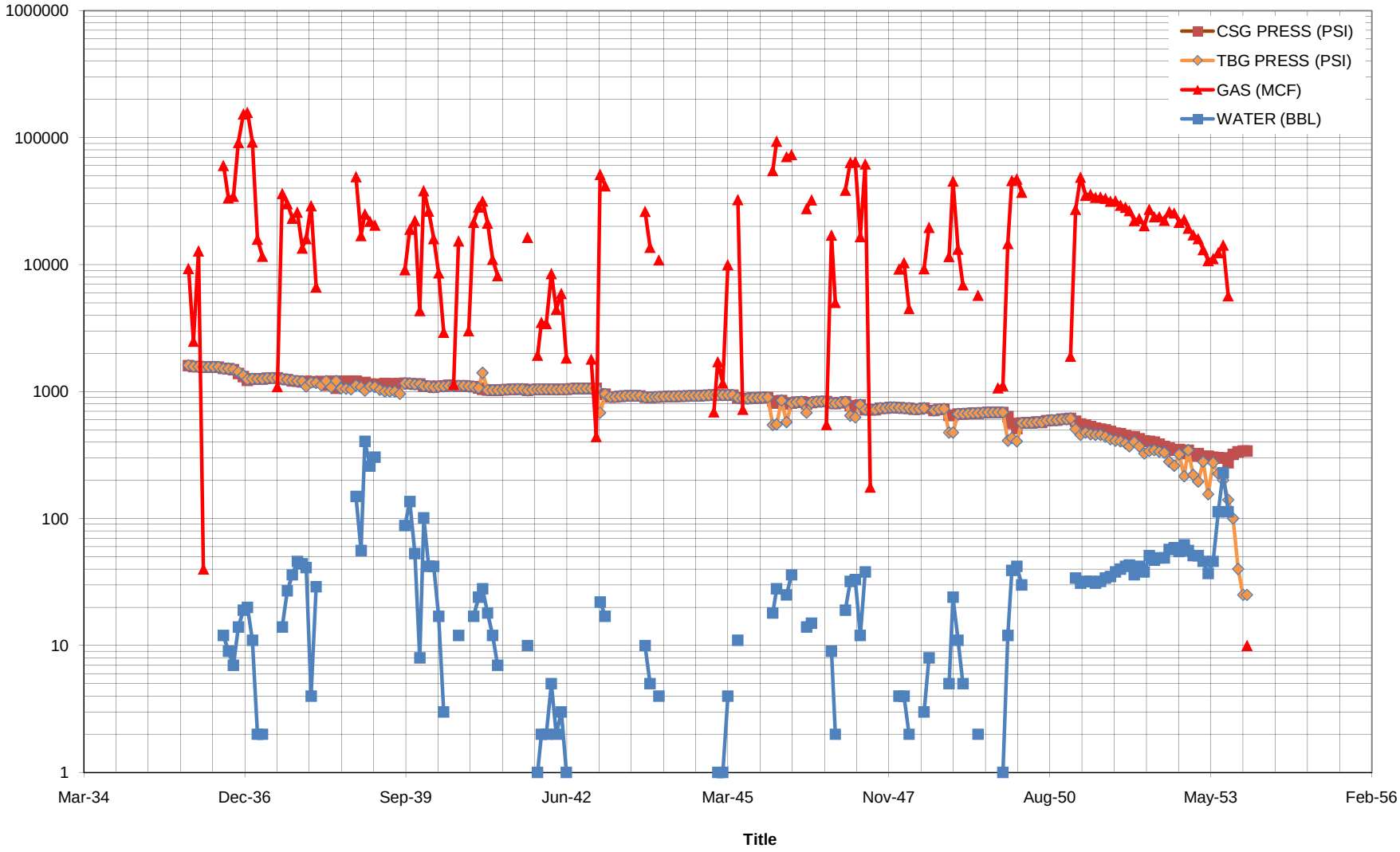
04077002380000 AMERADA HESS CORP. F.D.L. 1 CUM 1,071,807 MCF GAS 357 BBLS WATER



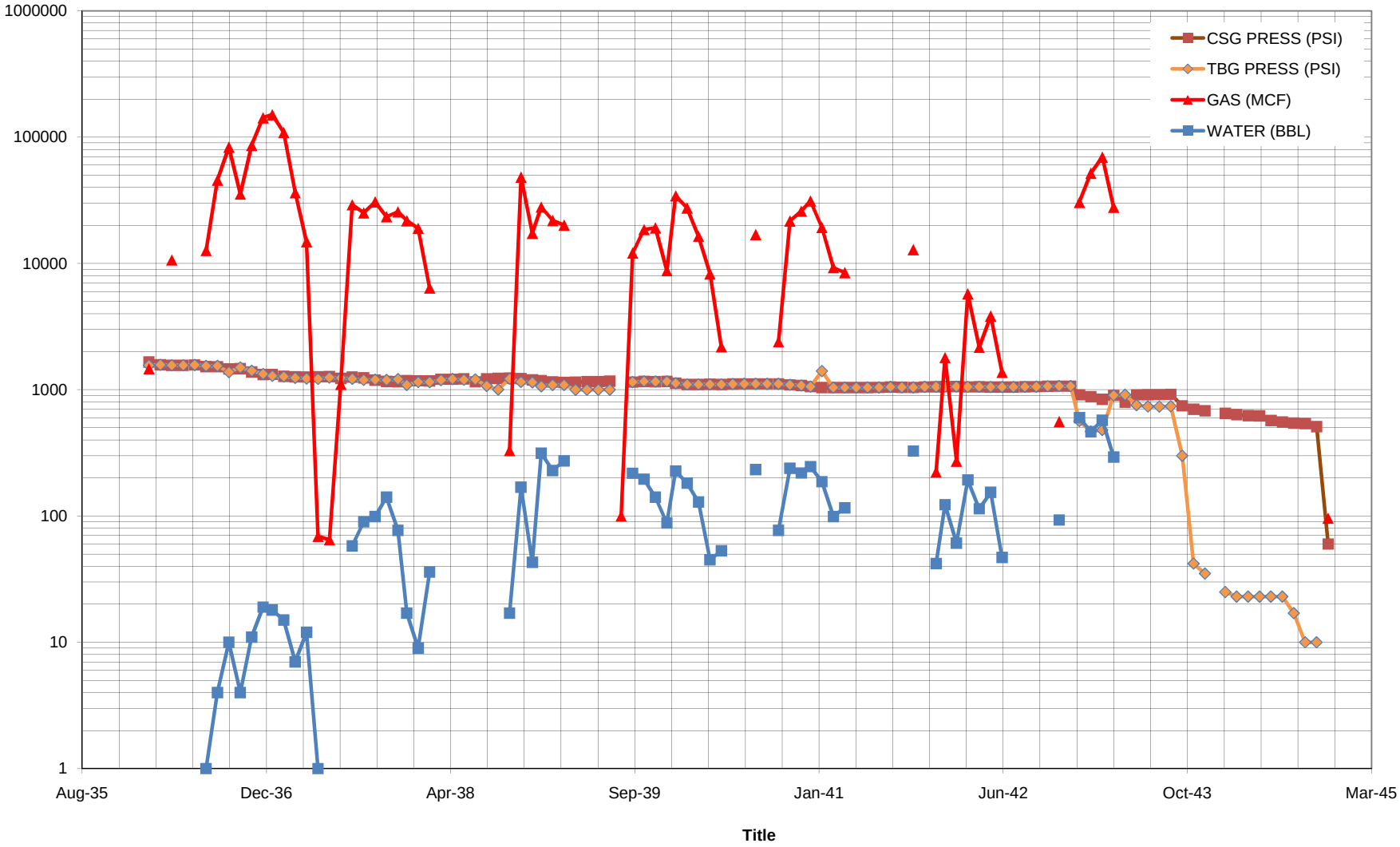
04077002400000 AMERADA HESS CORP. F.D.L. 2 CUM 2,606,550 MCF GAS 4,877 BBLS WATER



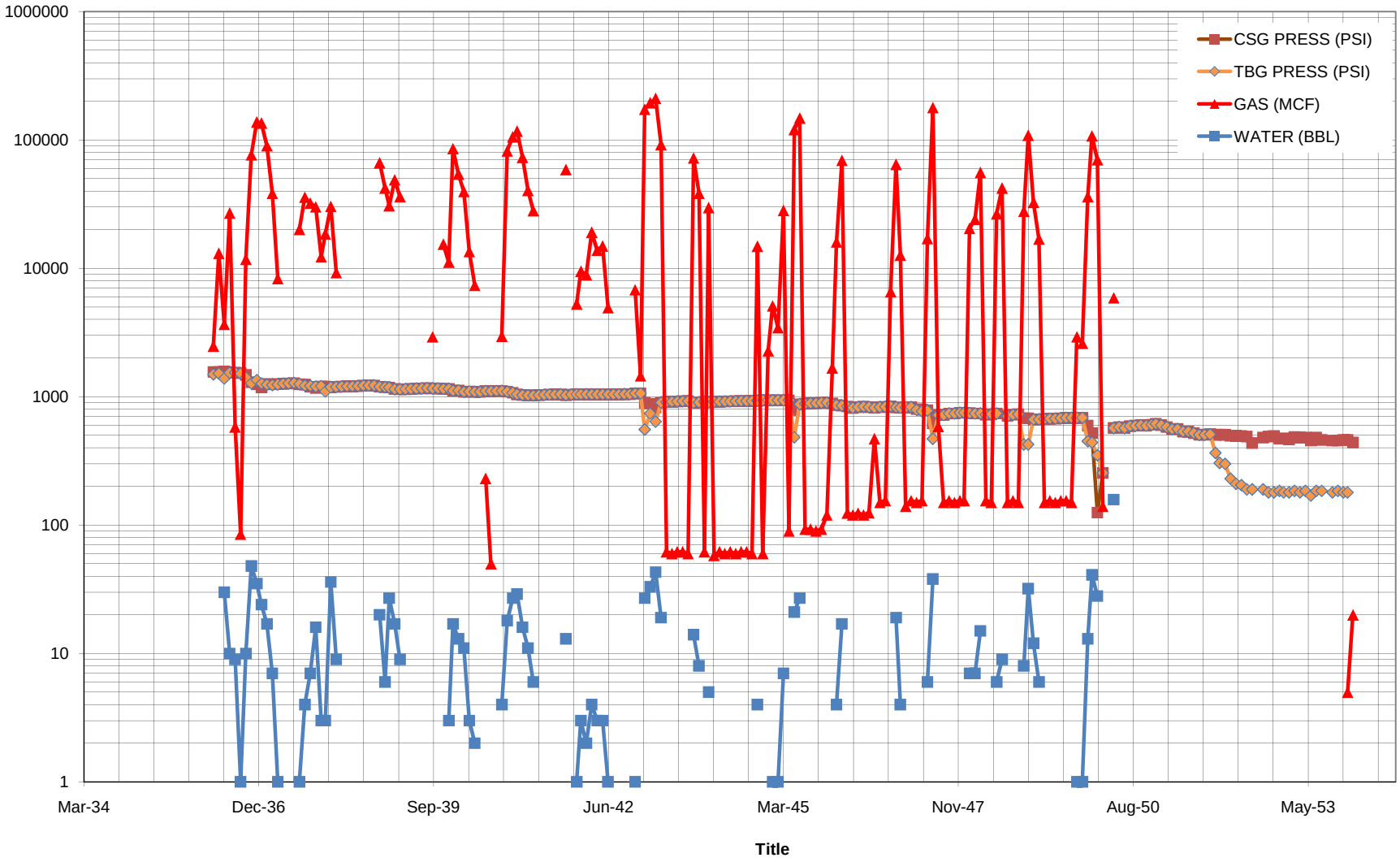
04077002390000 AMERADA HESS CORP. F.D.L. 3 CUM 3,205,095 MCF GAS 4,404 BBLS WATER



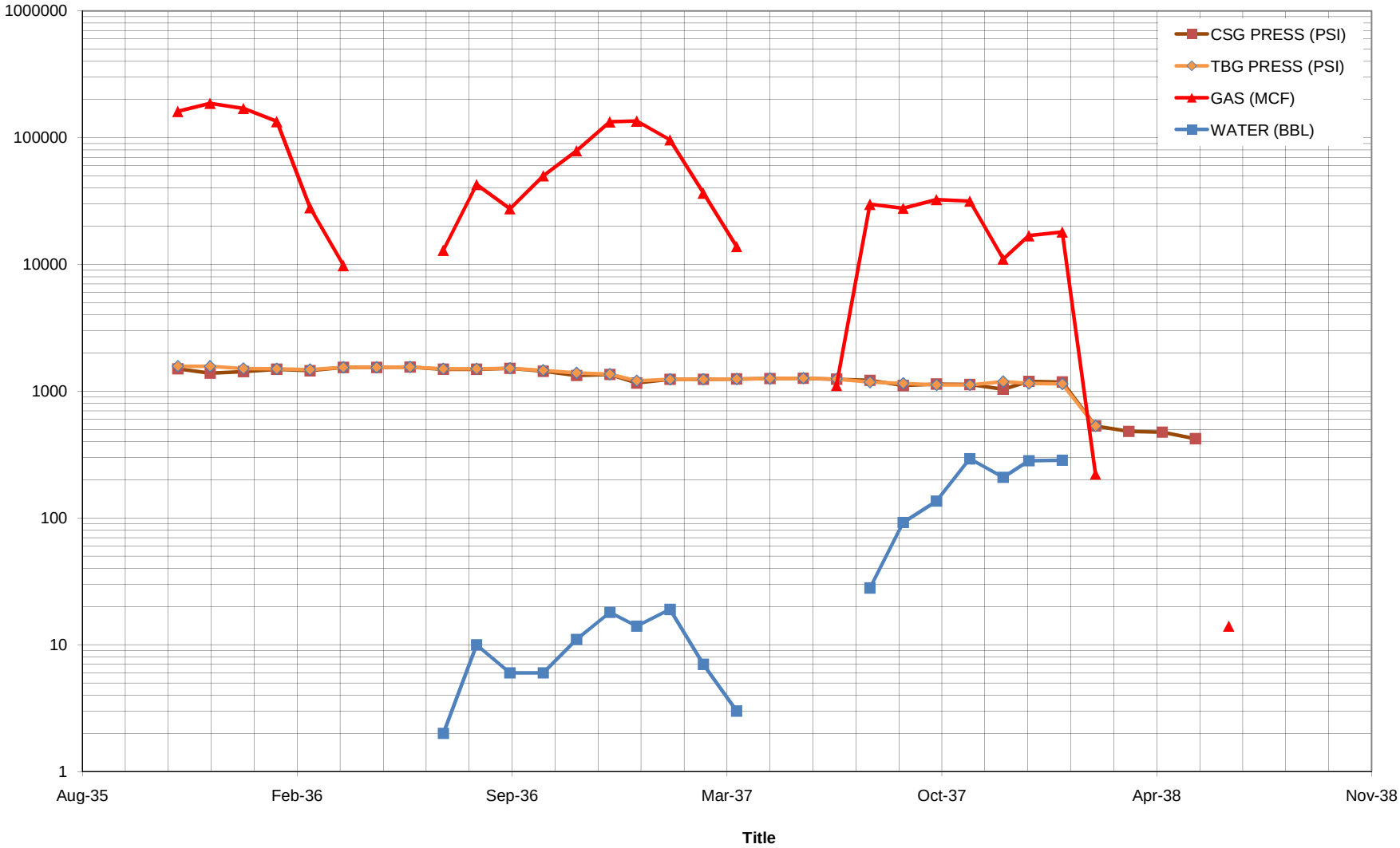
04077002410000 AMERADA HESS CORP. F.D.L. 4 CUM 1,538,048 MCF GAS 7,454 BBLS WATER



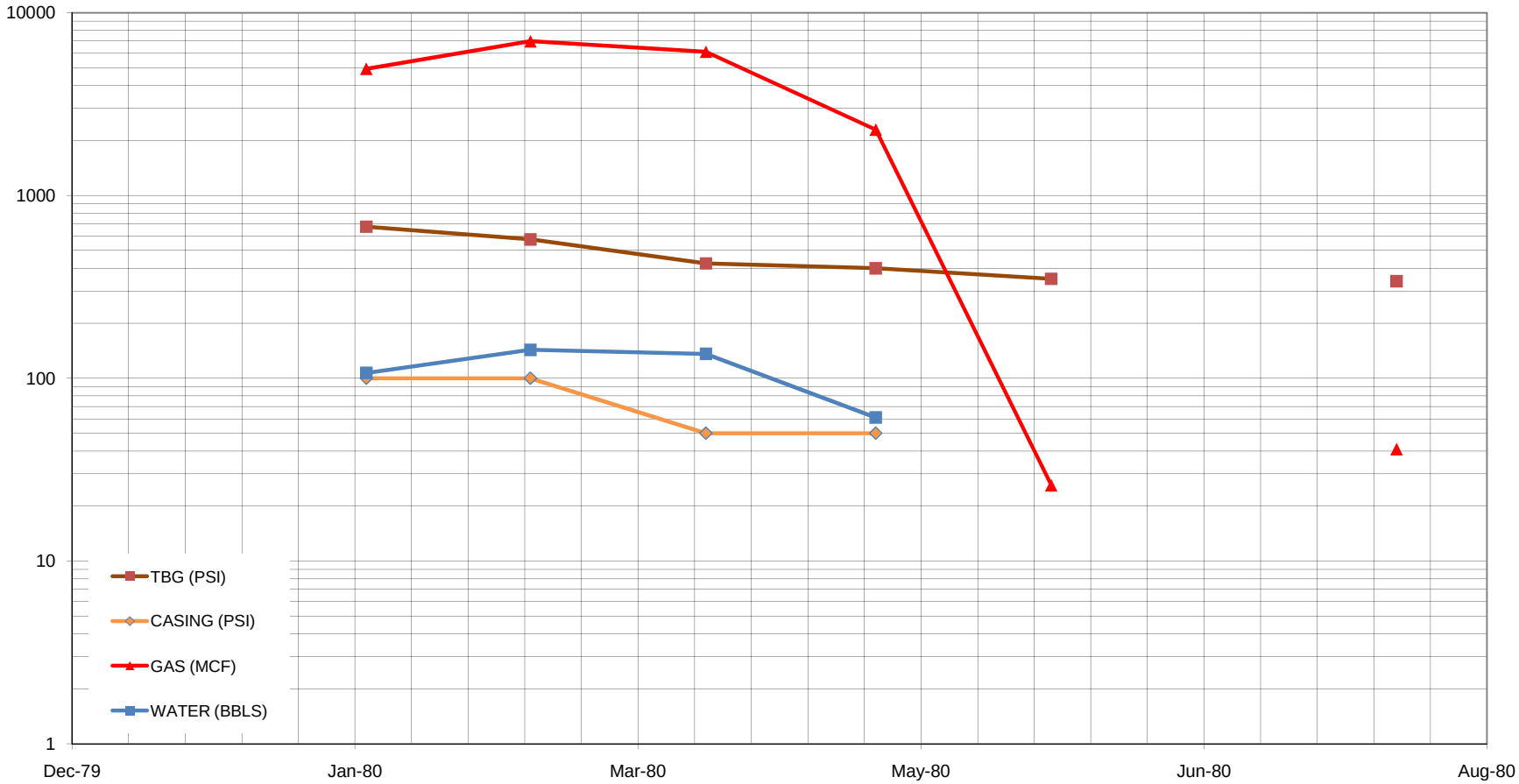
04077002420000 AMERADA HESS CORP. F.D.L. 5 CUM 3,867,990 MCF GAS 1,183 BBLS WATER



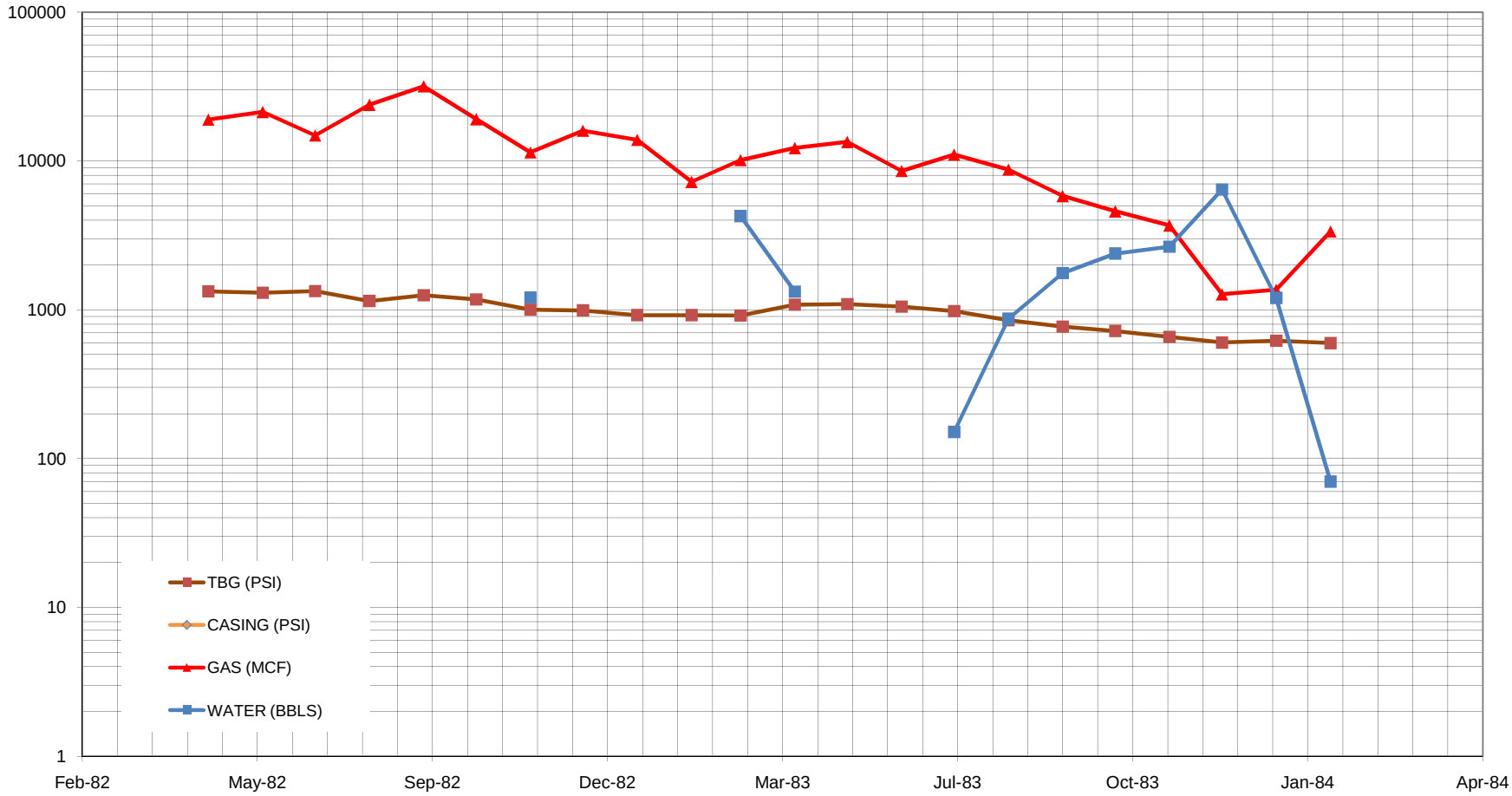
04077002440000 AMERADA HESS CORP. 31-22 CUM 1,485,624 MCF GAS 1,422 BBLS WATER



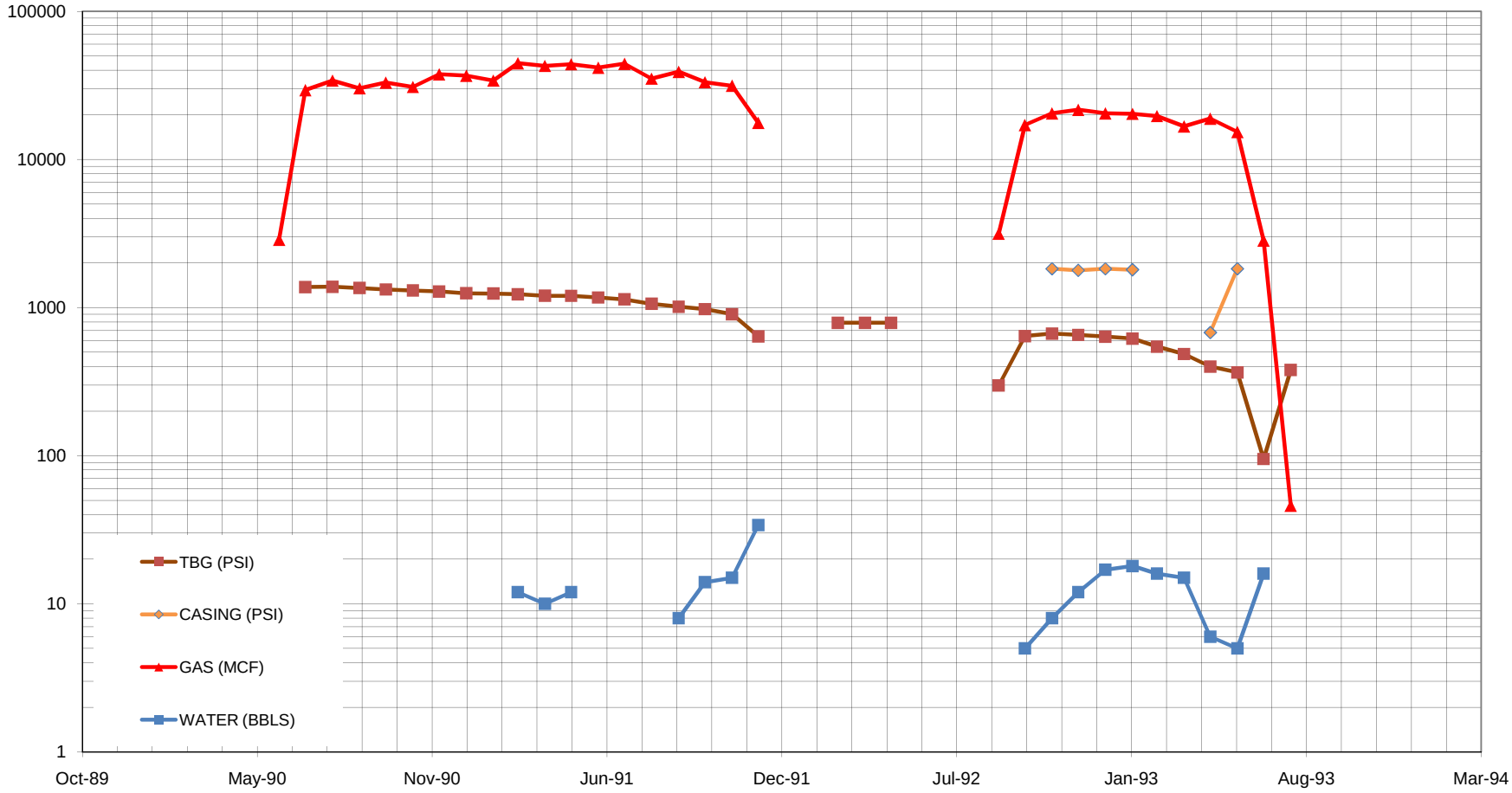
04077203060000 G.R. NANCE CO., INC. ROSSI-STEWART 1 CUM 20,386 MCF GAS 447 BBLS WATER



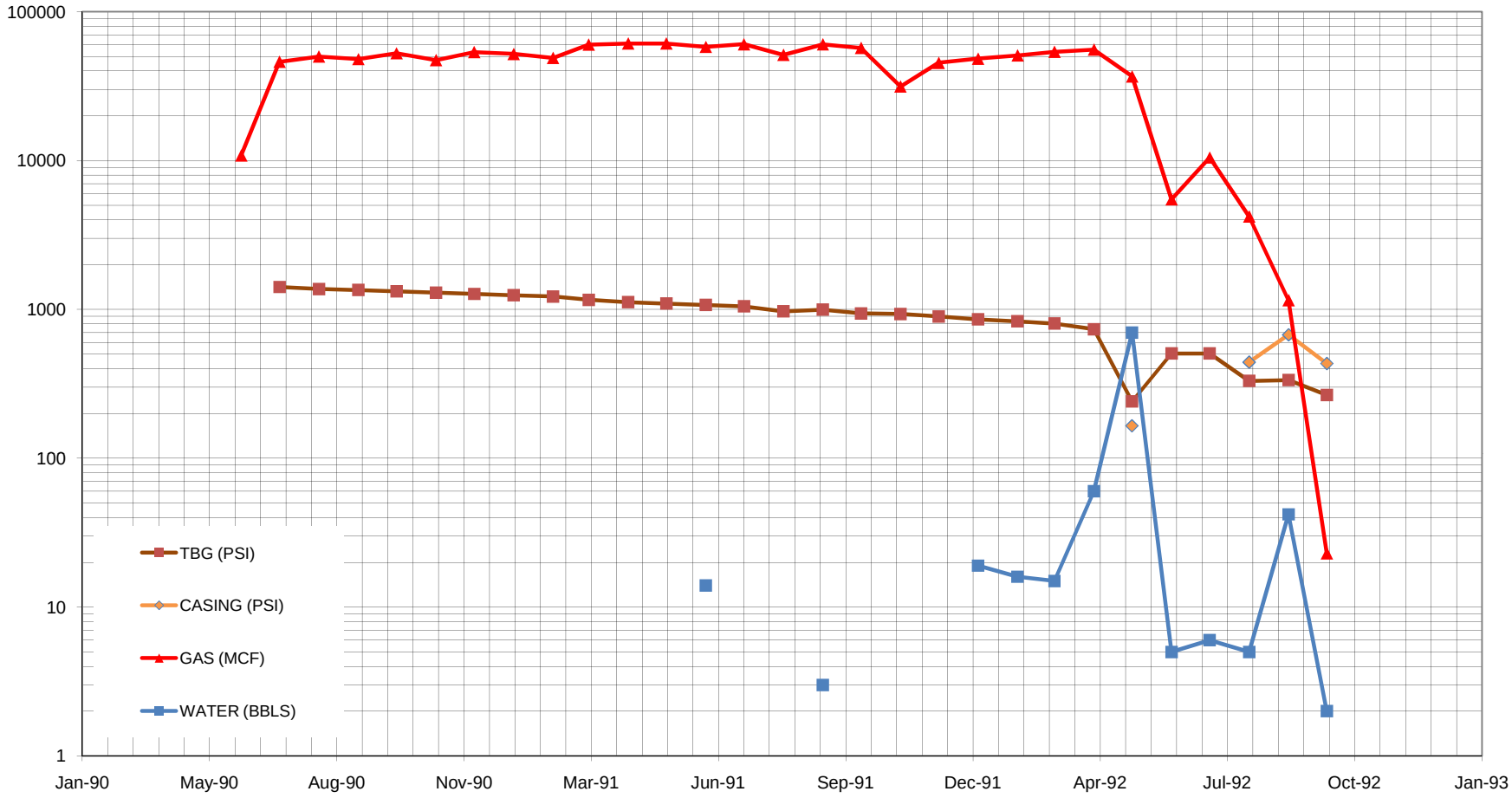
04077203840000 MARATHON OIL CO. ROSSI 1 CUM 262,470 MCF GAS 15,527 BBLS WATER



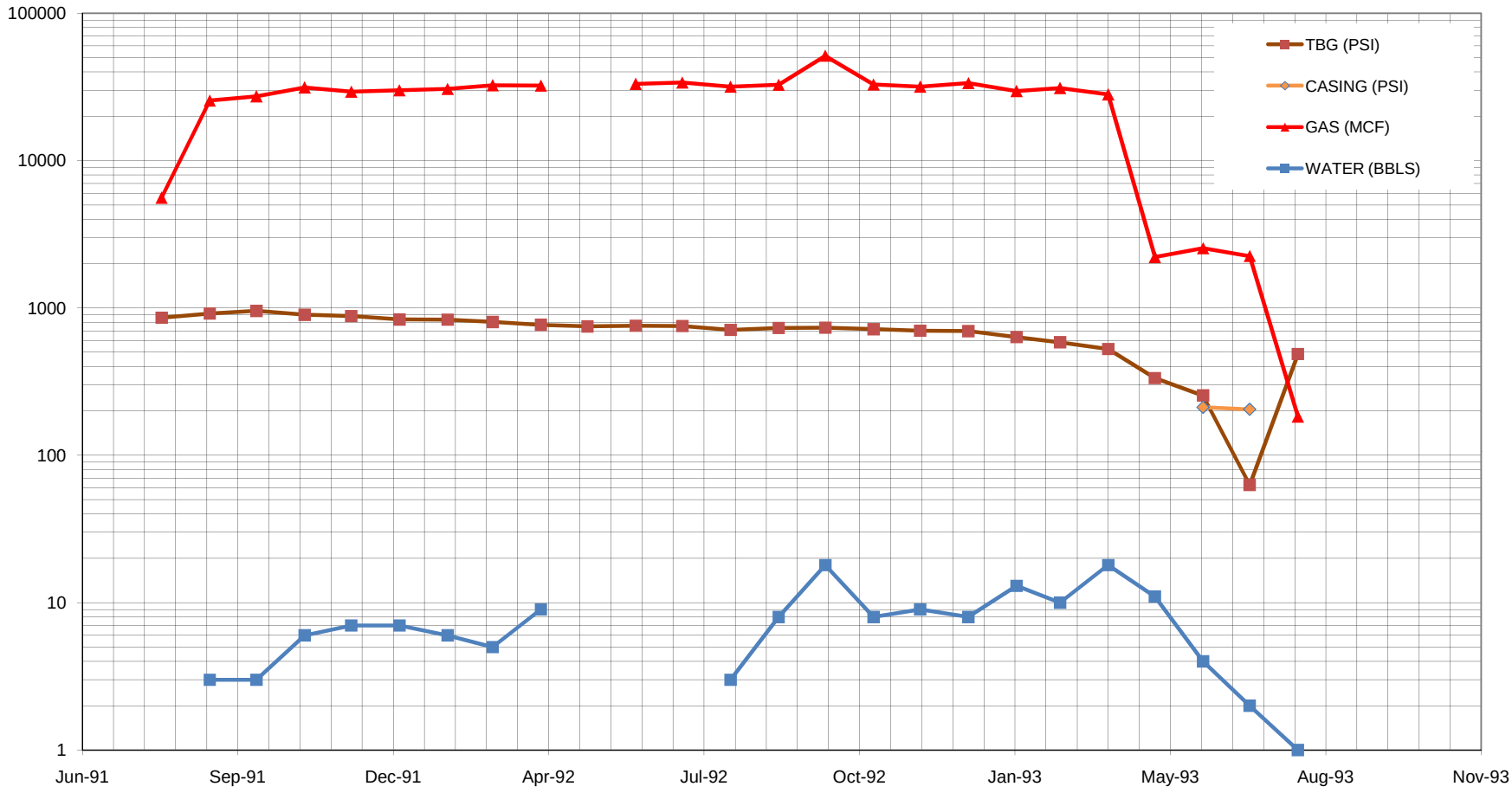
04077205310000 NAHAMA & WEAGANT TRACY 1-15 CUM 820,249 MCF GAS 227 BBLS WATER



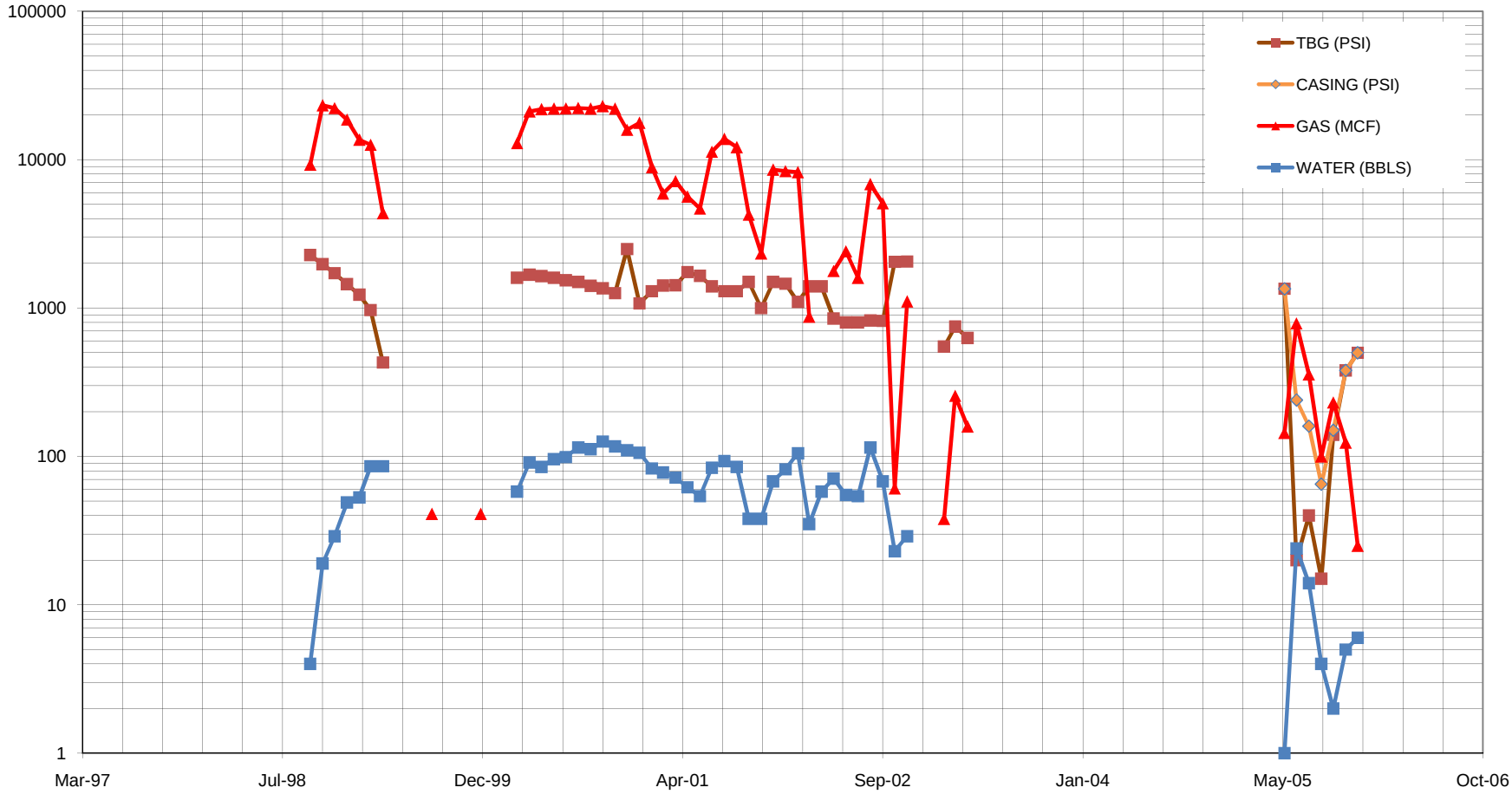
04077205320000 NAHAMA & WEAGANT TRACY 2-15 CUM 1,223,652 MCF GAS 886 BBLS WATER



04077205400000 NAHAMA & WEAGANT TRACY 3-15 CUM 621,560 MCF GAS 159 BBLS WATER



04077205880000 TRI-VALLEY OIL & GAS PIMENTAL 1-15 CUM 450,501 MCF GAS 2,947 BBLS WATER



YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Jan-36	1568	1565	21840	
Feb-36	1265	1240	21867	
Mar-36	470	500	46352	
Apr-36	1540	1540	20266	
May-36	1540	1540	123	
Jun-36	1550	1550	27	
Jul-36	1278	1270	37525	3
Aug-36	1391	1391	29611	7
Sep-36	1518	1505	26675	3
Oct-36	1490	1468	34572	6
Nov-36	995	1000	51093	8
Dec-36	986	999	95228	13
Jan-37	813	825	92060	15
Feb-37	1140	1064	81757	12
Mar-37	1226	1226	36835	8
Apr-37	1241	1241	11149	3
May-37	1272	1272	42	
Jun-37	1280	1280	35	
Jul-37	1200	1200	1157	
Aug-37	1092	1111	36147	2
Sep-37	1100	1101	29321	10
Oct-37	1061	1043	35287	3
Nov-37	1054	1040	34512	19
Dec-37	1165	1167	19178	7
Jan-38	1202	1202	15333	4
Feb-38	1190	1190	20205	6
Mar-38	1192	1192	6772	1
Apr-38	1210	1210	48	
May-38	1220	1220	50	
Jun-38	1224	1224	32	
Jul-38	1219	1219	31	
Aug-38	1228	1228	171	
Sep-38	1212	1133	2129	
Oct-38	1241	1241	206	
Nov-38	1170	1170	26599	31
Dec-38	1198	1198	12100	4
Jan-39	1173	1173	15725	4
Feb-39	1144	1144	16141	6
Mar-39	1134	1134	14056	4
Apr-39	1146	1146	60	
May-39	1154	1154	50	
Jun-39	1158	1158	30	
Jul-39	1162	1162	31	
Aug-39	1170	1170	31	
Sep-39	1160	1153	4530	
Oct-39	1163	1163	31	
Nov-39	1150	1150	14199	
Dec-39	1035	1028	10833	
Jan-40	1090	1090	31106	4
Feb-40	1110	1110	26639	2
Mar-40	1097	1097	16434	3

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Apr-40	1094	1097	4836	
May-40	1080	1020	2923	
Jun-40	1104	1104	30	
Jul-40	1110	1110	721	
Aug-40	1110	1065	4899	
Sep-40	1113	980	51	
Oct-40	1100	1089	1763	6
Nov-40	1091	1060	8536	14
Dec-40	1068	1068	12703	28
Jan-41	1027	1027	17134	26
Feb-41	1010	1010	9372	23
Mar-41	1020	1020	6003	18
Apr-41	1012	1012	4366	13
May-41	1030	822	105	
Jun-41	1030	959	145	4
Jul-41	1020	978	127	6
Aug-41	1039	652	62	0
Sep-41	1044	832	125	7
Oct-41	1042	937	1440	17
Nov-41	1030	628	90	
Dec-41	1029	816	145	7
			1,071,807	357

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Aug-35	1700	1700	6390	
Sep-35	1675	1675	44211	
Oct-35	1400	1600	277514	
Nov-35	1550	1600	257001	
Dec-35	1378	1564	296060	
Jan-36	1492	1527	247152	
Feb-36	1530	1500	201354	
Mar-36	1470	1500	49378	
Apr-36	1550	1550	18185	
May-36	1560	1560		
Jun-36	1560	1560	3025	
Jul-36	1558	1558	6175	
Aug-36	1531	1518	36932	14
Sep-36	1525	1523	25103	11
Oct-36	1500	1500	30845	8
Nov-36	1362	1425	90648	12
Dec-36	1300	1338	141193	22
Jan-37	1260	1258	144856	21
Feb-37	1240	1234	109622	18
Mar-37	1230	1230	28901	4
Apr-37	1251	1247	9608	1
May-37	1259	1250		
Jun-37	1272	1258	60	
Jul-37	1276	1276	1124	1
Aug-37	1252	1227	37418	2
Sep-37	1232	1180	35611	4
Oct-37	1192	1218	37746	1
Nov-37	1165	1208	35101	16
Dec-37	1164	1207	20490	3
Jan-38	1202	1152	18491	7
Feb-38	1189	1100	22709	5
Mar-38	1138	1140	7273	3
Apr-38	1200	1140		
May-38	1205	1100		
Jun-38	1210	1100		
Jul-38	1028	1211		
Aug-38	1224	965		
Sep-38	1232	1198	34	3
Oct-38	1242	1157		
Nov-38	1182	1182	55381	48
Dec-38	1203	1159	32665	12
Jan-39	1179	1148	25684	71
Feb-39	1148	1084	60603	244
Mar-39	1139	1040	39015	298
Apr-39	1151	1062		
May-39	1158	1033		
Jun-39	1157	1000		
Jul-39	1142	1000		
Aug-39	1122	643		
Sep-39	1159	1159	8579	433
Oct-39	1170	1140	24663	1441

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Nov-39	635	755	228	
Dec-39	1165	1103	32226	755
Jan-40	1177	1140	72984	1107
Feb-40	1142	1097	13591	284
Mar-40	1100	1100	721	28
			2,606,550	4,877

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Jan-36	1600	1607	9349	
Feb-36	1570	1570	2491	
Mar-36	1570	1570	12847	
Apr-36	1560	1560	40	
May-36	1560	1560		
Jun-36	1560	1560		
Jul-36	1560	1560		
Aug-36	1520	1515	60582	12
Sep-36	1515	1515	33612	9
Oct-36	1485	1495	34507	7
Nov-36	1385	1425	91623	14
Dec-36	1310	1340	154313	19
Jan-37	1225	1245	158418	20
Feb-37	1260	1260	92522	11
Mar-37	1255	1255	15871	2
Apr-37	1255	1255	11645	2
May-37	1275	1275		
Jun-37	1275	1275		
Jul-37	1280	1280	1096	
Aug-37	1255	1255	36358	14
Sep-37	1240	1240	30248	27
Oct-37	1215	1225	23177	36
Nov-37	1205	1210	25976	46
Dec-37	1190	1204	13534	44
Jan-38	1202	1094	16036	41
Feb-38	1195	1178	29123	4
Mar-38	1190	1170	6700	29
Apr-38	1200	1120		
May-38	1120	1210		
Jun-38	1210	1081		
Jul-38	1060	1210		
Aug-38	1210	1058		
Sep-38	1209	1052		
Oct-38	1206	1040		
Nov-38	1206	1118	49268	149
Dec-38	1162	1080	16978	56
Jan-39	1180	1015	25149	406
Feb-39	1145	1095	21972	259
Mar-39	1125	1088	20471	304
Apr-39	1140	1033		
May-39	1156	1000		
Jun-39	1148	1000		
Jul-39	1148	1000		
Aug-39	1150	958		
Sep-39	1162	1162	9128	88
Oct-39	1155	1155	18981	136
Nov-39	1140	1140	22263	53
Dec-39	1145	1145	4351	8
Jan-40	1100	1100	38308	101
Feb-40	1100	1100	26417	42
Mar-40	1080	1080	16055	42

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Apr-40	1100	1095	8605	17
May-40	1100	1095	2940	3
Jun-40	1120	1105		
Jul-40	1111	1111	1144	
Aug-40	1105	1105	15384	12
Sep-40	1110	1110		
Oct-40	1100	1100	3010	
Nov-40	1090	1090	21573	17
Dec-40	1065	1065	28456	24
Jan-41	1040	1404	31717	28
Feb-41	1025	1025	21242	18
Mar-41	1025	1025	11011	12
Apr-41	1025	1025	8204	7
May-41	1030	1030		
Jun-41	1035	1035		
Jul-41	1040	1040		
Aug-41	1045	1045		
Sep-41	1044	1044		
Oct-41	1020	1020	16410	10
Nov-41	1035	1035		
Dec-41	1040	1040	1937	1
Jan-42	1040	1040	3520	2
Feb-42	1040	1040	3437	2
Mar-42	1040	1040	8520	5
Apr-42	1035	1035	4454	2
May-42	1040	1040	5927	3
Jun-42	1040	1040	1836	1
Jul-42	1050	1050		
Aug-42	1055	1055		
Sep-42	1055	1055		
Oct-42	1055	1055		
Nov-42	1055	1055	1801	
Dec-42	1060	1060	443	
Jan-43	955	680	51375	22
Feb-43	955	955	41757	17
Mar-43	905	905		
Apr-43	905	905		
May-43	915	915		
Jun-43	925	925		
Jul-43	925	925		
Aug-43	925	925		
Sep-43	925	925		
Oct-43	900	900	26297	10
Nov-43	900	900	13702	5
Dec-43	905	905		
Jan-44	905	905	10893	4
Feb-44	910	910		
Mar-44	915	915		
Apr-44	915	915		
May-44	920	920		
Jun-44	920	920		

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Jul-44	925	925		
Aug-44	925	925		
Sep-44	925	925		
Oct-44	930	930		
Nov-44	937	937		
Dec-44	937	937	693	
Jan-45	937	937	1720	1
Feb-45	938	938	1170	1
Mar-45	938	938	10004	4
Apr-45	938	938		
May-45	890	890	32604	11
Jun-45	880	880	725	
Jul-45	880	880		
Aug-45	890	890		
Sep-45	890	890		
Oct-45	897	897		
Nov-45	900	900		
Dec-45	840	545	55079	18
Jan-46	810	550	93849	28
Feb-46	850	850		
Mar-46	795	575	70969	25
Apr-46	810	810	73648	36
May-46	825	825		
Jun-46	830	830		
Jul-46	795	680	27716	14
Aug-46	820	820	32355	15
Sep-46	830	830		
Oct-46	835	835		
Nov-46	835	835	549	
Dec-46	810	810	17078	9
Jan-47	805	805	5032	2
Feb-47	815	815		
Mar-47	830	830	38530	19
Apr-47	775	645	64073	32
May-47	765	625	64410	33
Jun-47	785	785	16660	12
Jul-47	720	720	62271	38
Aug-47	720	720	177	
Sep-47	720	720		
Oct-47	740	740		
Nov-47	740	740		
Dec-47	750	750		
Jan-48	750	750		
Feb-48	745	745	9251	4
Mar-48	740	740	10397	4
Apr-48	740	740	4507	2
May-48	725	725		
Jun-48	730	730		
Jul-48	740	740	9291	3
Aug-48	0	0	19667	8
Sep-48	710	710		

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Oct-48	725	725		
Nov-48	730	730		
Dec-48	650	475	11589	5
Jan-49	650	475	45551	24
Feb-49	665	665	13251	11
Mar-49	665	665	6930	5
Apr-49	670	670		
May-49	675	675		
Jun-49	675	675	5729	2
Jul-49	680	680		
Aug-49	685	685		
Sep-49	685	685		
Oct-49	685	685	1072	
Nov-49	685	685	1117	1
Dec-49	635	410	14652	12
Jan-50	560	430	45985	39
Feb-50	510	405	47382	42
Mar-50	565	565	37252	30
Apr-50	565	565		
May-50	565	565		
Jun-50	575	575		
Jul-50	570	570		
Aug-50	590	590		
Sep-50	595	595		
Oct-50	595	595		
Nov-50	605	605		
Dec-50	605	605		
Jan-51	615	615	1902	
Feb-51	585	505	27267	34
Mar-51	555	455	48861	31
Apr-51	545	475	35201	32
May-51	530	460	35854	32
Jun-51	515	455	33886	31
Jul-51	505	455	34039	32
Aug-51	500	440	33275	34
Sep-51	485	420	31610	35
Oct-51	470	410	31774	38
Nov-51	465	405	29358	40
Dec-51	450	390	28338	42
Jan-52	440	370	26676	43
Feb-52	440	400	22227	36
Mar-52	425	370	23140	42
Apr-52	410	325	20266	38
May-52	405	340	27304	51
Jun-52	400	345	23882	47
Jul-52	385	335	23922	49
Aug-52	370	330	22340	49
Sep-52	360	280	26164	57
Oct-52	345	260	25527	59
Nov-52	350	320	21588	55
Dec-52	325	215	22676	62

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Jan-53	345	345	19402	56
Feb-53	310	220	17175	51
Mar-53	325	195	16016	51
Apr-53	310	280	13135	46
May-53	310	155	10767	37
Jun-53	305	275	11176	46
Jul-53	300	225	12423	113
Aug-53	300	200	14302	229
Sep-53	275	140	5673	113
Oct-53	320	100		
Nov-53	335	40		
Dec-53	340	25		
Jan-54	340	25	10	
			3,205,095	4,404

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Feb-36	1656	1560	1465	
Mar-36	1575	1575		
Apr-36	1560	1560	10663	
May-36	1560	1560		
Jun-36	1570	1570		
Jul-36	1522	1542	12681	1
Aug-36	1520	1542	45645	4
Sep-36	1462	1378	83423	10
Oct-36	1470	1498	35409	4
Nov-36	1380	1410	85942	11
Dec-36	1320	1332	142328	19
Jan-37	1322	1287	150714	18
Feb-37	1275	1270	108963	15
Mar-37	1263	1241	36373	7
Apr-37	1261	1226	14856	12
May-37	1267	1217	69	1
Jun-37	1270	1250	65	
Jul-37	1230	1240	1104	
Aug-37	1260	1219	29161	58
Sep-37	1243	1195	25175	90
Oct-37	1190	1200	30708	99
Nov-37	1164	1192	23452	141
Dec-37	1157	1210	25658	77
Jan-38	1181	1091	21790	17
Feb-38	1176	1151	18976	9
Mar-38	1175	1150	6392	36
Apr-38	1210	1193		
May-38	1210	1216		
Jun-38	1218	1200		
Jul-38	1155	1207		
Aug-38	1221	1072		
Sep-38	1229	1003		
Oct-38	1236	1220	331	17
Nov-38	1225	1152	48328	169
Dec-38	1195	1143	17344	43
Jan-39	1182	1065	27935	314
Feb-39	1153	1092	21863	229
Mar-39	1140	1090	20111	273
Apr-39	1150	1000		
May-39	1157	1000		
Jun-39	1160	1000		
Jul-39	1168	1000		
Aug-39			100	
Sep-39	1150	1149	12099	218
Oct-39	1163	1163	18564	196
Nov-39	1159	1159	19116	141
Dec-39	1163	1163	8757	88
Jan-40	1125	1125	34293	227
Feb-40	1100	1100	27525	182
Mar-40	1100	1100	16426	129
Apr-40	1105	1102	8277	45

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
May-40	1100	1100	2188	53
Jun-40	1110	1109		
Jul-40	1112	1112		
Aug-40	1112	1112	16920	233
Sep-40	1113	1113		
Oct-40	1112	1112	2400	77
Nov-40	1093	1093	21686	239
Dec-40	1080	1080	25933	219
Jan-41	1058	1058	31257	246
Feb-41	1040	1404	19271	187
Mar-41	1040	1040	9259	99
Apr-41	1040	1040	8457	116
May-41	1040	1040		
Jun-41	1041	1041		
Jul-41	1043	1043		
Aug-41	1051	1051		
Sep-41	1045	1045		
Oct-41	1042	1042	12870	327
Nov-41	1052	1052		
Dec-41	1056	1056	223	42
Jan-42	1058	1058	1799	123
Feb-42	1059	1059	272	61
Mar-42	1053	1053	5746	193
Apr-42	1055	1055	2164	114
May-42	1050	1050	3836	154
Jun-42	1050	1050	1373	47
Jul-42	1050	1050		
Aug-42	1055	1055		
Sep-42	1057	1057		
Oct-42	1065	1065		
Nov-42	1068	1068	559	93
Dec-42	1068	1068		
Jan-43	910	565	30489	600
Feb-43	880	467	51861	465
Mar-43	840	480	69450	573
Apr-43	903	903	27858	293
May-43	795	912		
Jun-43	910	755		
Jul-43	912	736		
Aug-43	915	735		
Sep-43	919	739		
Oct-43	745	300		
Nov-43	700	42		
Dec-43	680	35		
Jan-44				
Feb-44	650	25		
Mar-44	635	23		
Apr-44	623	23		
May-44	620	23		
Jun-44	570	23		
Jul-44	555	23		

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Aug-44	545	17		
Sep-44	540	10		
Oct-44	510	10		
Nov-44	60		96	
			1,538,048	7,454

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Apr-36	1560	1490	2480	
May-36	1560	1515	13094	
Jun-36	1570	1385	3656	30
Jul-36	1555	1535	26995	10
Aug-36	1540	1540	581	9
Sep-36	1526	1512	85	1
Oct-36	1477	1405	11776	10
Nov-36	1298	1270	76461	48
Dec-36	1247	1345	137672	35
Jan-37	1181	1265	135170	24
Feb-37	1255	1242	90057	17
Mar-37	1246	1232	38361	7
Apr-37	1256	1243	8336	1
May-37	1262	1262		
Jun-37	1268	1268		
Jul-37	1277	1277		
Aug-37	1250	1255	20089	1
Sep-37	1242	1220	35749	4
Oct-37	1195	1215	32148	7
Nov-37	1170	1200	30067	16
Dec-37	1201	1207	12300	3
Jan-38	1201	1098	18588	3
Feb-38	1185	1185	30389	36
Mar-38	1190	1190	9249	9
Apr-38	1200	1200		
May-38	1202	1202		
Jun-38	1205	1205		
Jul-38	1210	1210		
Aug-38	1221	1221		
Sep-38	1220	1220		
Oct-38	1223	1223		
Nov-38	1195	1195	66376	20
Dec-38	1187	1187	42159	6
Jan-39	1178	1178	30713	27
Feb-39	1149	1143	48832	17
Mar-39	1141	1141	36211	9
Apr-39	1145	1145		
May-39	1150	1150		
Jun-39	1156	1156		
Jul-39	1160	1160		
Aug-39	1165	1165		
Sep-39	1161	1160	2923	
Oct-39	1159	1159		
Nov-39	1152	1152	15421	
Dec-39	1152	1152	11181	3
Jan-40	1112	1112	85411	17
Feb-40	1117	1117	54248	13
Mar-40	1090	1090	39684	11
Apr-40	1096	1096	13527	3
May-40	1090	1090	7375	2
Jun-40	1090	1090		

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Jul-40	1106	1106	231	
Aug-40	1104	1104	50	
Sep-40	1106	1106		
Oct-40	1110	1110	2962	4
Nov-40	1093	1093	81983	18
Dec-40	1073	1073	105740	27
Jan-41	1043	1043	116958	29
Feb-41	1030	1030	73155	16
Mar-41	1025	1025	40425	11
Apr-41	1022	1022	28156	6
May-41	1026	1026		
Jun-41	1035	1035		
Jul-41	1038	1038		
Aug-41	1041	1041		
Sep-41	1045	1045		
Oct-41	1028	1028	58802	13
Nov-41	1040	1040		
Dec-41	1043	1043	5270	1
Jan-42	1043	1043	9486	3
Feb-42	1045	1045	8903	2
Mar-42	1042	1042	19079	4
Apr-42	1042	1042	13814	3
May-42	1042	1042	14911	3
Jun-42	1041	1041	4926	1
Jul-42	1043	1043		
Aug-42	1043	1043		
Sep-42	1047	1047		
Oct-42	1045	1045		
Nov-42	1060	1060	6797	1
Dec-42	1061	1061	1452	
Jan-43	898	555	173467	27
Feb-43	882	740	194779	33
Mar-43	825	640	210931	43
Apr-43	900	900	91936	19
May-43	909	909	62	
Jun-43	914	914	60	
Jul-43	917	917	62	
Aug-43	922	922	62	
Sep-43	925	925	60	
Oct-43	900	900	72267	14
Nov-43	902	902	38482	8
Dec-43	912	912	62	
Jan-44	905	905	29718	5
Feb-44	912	912	58	
Mar-44	915	915	62	
Apr-44	918	918	60	
May-44	920	920	62	
Jun-44	922	922	60	
Jul-44	925	925	62	
Aug-44	925	925	62	
Sep-44	927	927	60	

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Oct-44	930	930	14831	4
Nov-44	937	937	60	
Dec-44	937	937	2275	
Jan-45	937	937	5097	1
Feb-45	938	938	3450	1
Mar-45	938	938	28269	7
Apr-45	938	938	90	
May-45	785	483	120330	21
Jun-45	873	873	147925	27
Jul-45	880	880	93	
Aug-45	890	890	93	
Sep-45	890	890	90	
Oct-45	897	897	93	
Nov-45	900	900	120	
Dec-45	887	881	1675	
Jan-46	861	861	16047	4
Feb-46	853	853	69338	17
Mar-46	838	838	124	
Apr-46	818	820	120	
May-46	830	830	124	
Jun-46	837	837	120	
Jul-46	830	830	125	
Aug-46	820	820	472	
Sep-46	830	830	150	
Oct-46	835	835	155	
Nov-46	840	840	6561	
Dec-46	825	825	64479	19
Jan-47	820	820	12654	4
Feb-47	825	825	140	
Mar-47	830	830	155	
Apr-47	800	790	150	
May-47	790	770	155	
Jun-47	785	780	17095	6
Jul-47	620	470	178641	38
Aug-47	720	720	587	
Sep-47	720	720	150	
Oct-47	740	740	155	
Nov-47	740	740	150	
Dec-47	750	750	155	
Jan-48	750	750	155	
Feb-48	745	745	20496	7
Mar-48	740	740	24135	7
Apr-48	740	740	55841	15
May-48	725	725	155	
Jun-48	730	730	150	
Jul-48	740	740	26573	6
Aug-48			42218	9
Sep-48	710	705	150	
Oct-48	725	725	155	
Nov-48	730	730	150	
Dec-48	680	425	27844	8

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Jan-49	680	425	108839	32
Feb-49	665	665	32565	12
Mar-49	665	665	16928	6
Apr-49	670	670	150	
May-49	675	675	155	
Jun-49	675	675	150	
Jul-49	680	680	155	
Aug-49	685	685	155	
Sep-49	685	685	150	
Oct-49	685	685	2924	1
Nov-49	685	685	2602	1
Dec-49	595	450	36180	13
Jan-50	520	440	107381	41
Feb-50	125	350	70188	28
Mar-50	255	255	140	
Apr-50				
May-50	570	570	5890	158
Jun-50	580	580		
Jul-50	570	570		
Aug-50	590	590		
Sep-50	595	595		
Oct-50	600	600		
Nov-50	595	595		
Dec-50	605	605		
Jan-51	615	615		
Feb-51	600	600		
Mar-51	580	580		
Apr-51	560	560		
May-51	560	560		
Jun-51	535	535		
Jul-51	535	535		
Aug-51	520	520		
Sep-51	505	505		
Oct-51	505	505		
Nov-51	510	510		
Dec-51	505	365		
Jan-52	505	305		
Feb-52	505	300		
Mar-52	495	230		
Apr-52	495	210		
May-52	495	205		
Jun-52	490	190		
Jul-52	435	190		
Aug-52				
Sep-52	480	190		
Oct-52	490	180		
Nov-52	495	180		
Dec-52	470	185		
Jan-53	475	180		
Feb-53	465	180		
Mar-53	485	185		

YEAR	CSG PRESS (	TBG PRESS (	GAS (MCF)	WATER (BBL)
Apr-53	480	180		
May-53	480	185		
Jun-53	455	170		
Jul-53	480	185		
Aug-53	460	185		
Sep-53				
Oct-53	455	180		
Nov-53	455	185		
Dec-53	460	180		
Jan-54	460	180	5	
Feb-54	440		20	
			3,867,990	1,183

YEAR	CSG PRES	TBG PRES	GAS (MCF	WATER (B
Nov-35	1500	1575	161303	
Dec-35	1387	1570	186485	
Jan-36	1428	1510	170130	
Feb-36	1490	1500	134073	
Mar-36	1450	1480	28043	
Apr-36	1540	1540	9798	
May-36	1540	1540		
Jun-36	1550	1550		
Jul-36	1490	1500	12934	2
Aug-36	1490	1501	42670	10
Sep-36	1514	1514	27479	6
Oct-36	1436	1461	49940	6
Nov-36	1329	1392	78741	11
Dec-36	1355	1361	133386	18
Jan-37	1161	1209	135355	14
Feb-37	1240	1239	96061	19
Mar-37	1241	1240	36595	7
Apr-37	1249	1246	13838	3
May-37	1258	1258		
Jun-37	1265	1265		
Jul-37	1243	1248	1112	
Aug-37	1219	1178	29814	28
Sep-37	1108	1152	27715	92
Oct-37	1138	1120	32444	136
Nov-37	1129	1122	31570	293
Dec-37	1035	1189	11024	209
Jan-38	1196	1151	16854	283
Feb-38	1181	1141	18024	285
Mar-38	532	532	222	
Apr-38	482			
May-38	475			
Jun-38	422			
Jul-38			14	
TOTAL			1,485,624	1,422

DATE	TBG (PSI)	CASING (PSI)	GAS (MCF)	WATER (BBLS)
Feb-80	675	100	4935	107
Mar-80	575	100	6981	143
Apr-80	425	50	6110	136
May-80	400	50	2293	61
Jun-80	350		26	
Jul-80				
Aug-80	340		41	
Sep-80				
Oct-80				
Nov-80				
Dec-80				
TOTAL			20,386	447

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DATE	TBG (PSI)	CASING (PSI)	GAS (MCF)	WATER (BBLS)
May-82	1330		18955	
Jun-82	1300		21323	
Jul-82	1335		14849	
Aug-82	1145		23847	
Sep-82	1251		31704	
Oct-82	1172		19100	
Nov-82	1000		11418	1209
Dec-82	990		15953	
Jan-83	920		13867	
Feb-83	920		7228	
Mar-83	915		10144	4265
Apr-83	1080		12218	1322
May-83	1090		13417	
Jun-83	1050		8569	
Jul-83	980		11038	151
Aug-83	850		8761	870
Sep-83	770		5808	1764
Oct-83	720		4586	2387
Nov-83	657		3688	2655
Dec-83	602		1271	6429
Jan-84	619		1363	1201
Feb-84	597		3363	70
			262,470	15,527

DATE	TBG (PSI)	CASING (PSI)	GAS (MCF)	WATER (BBLS)
Jun-90			2878	
Jul-90	1375		29431	4
Aug-90	1383		34138	
Sep-90	1356		30258	
Oct-90	1325		33078	
Nov-90	1305		30905	
Dec-90	1284		37574	
Jan-91	1250		36791	
Feb-91	1245		34118	
Mar-91	1230		44691	12
Apr-91	1203		42884	10
May-91	1200		43998	12
Jun-91	1170		41701	
Jul-91	1137		44347	
Aug-91	1061		35160	
Sep-91	1013		39090	8
Oct-91	976		33239	14
Nov-91	902		31464	15
Dec-91	639		17719	34
Jan-92				
Feb-92				
Mar-92	790			
Apr-92	790			
May-92	790			
Jun-92				
Jul-92				
Aug-92				
Sep-92	298		3154	
Oct-92	642		17082	5
Nov-92	667	1828	20495	8
Dec-92	654	1784	21681	12
Jan-93	637	1828	20497	17
Feb-93	618	1801	20359	18
Mar-93	545		19672	16
Apr-93	486		16718	15
May-93	400	677	18885	6
Jun-93	365	1828	15361	5
Jul-93	95		2835	16
Aug-93	379		46	
			820,249	227

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DATE	TBG (PSI)	CASING (PSI)	GAS (MCF)	WATER (BBLS)
Jun-90			10828	
Jul-90	1415		46119	
Aug-90	1371		50068	
Sep-90	1352		48063	
Oct-90	1324		52592	
Nov-90	1298		47260	
Dec-90	1271		53561	
Jan-91	1246		52081	
Feb-91	1221		49000	
Mar-91	1160		60167	
Apr-91	1120		61258	
May-91	1095		61200	
Jun-91	1072		58049	14
Jul-91	1050		60566	
Aug-91	972		51337	
Sep-91	996		60445	3
Oct-91	940		57138	
Nov-91	932		31464	
Dec-91	897		45414	
Jan-92	858		48402	19
Feb-92	833		50871	16
Mar-92	804		53855	15
Apr-92	737		55740	60
May-92	241	165	36810	699
Jun-92	506		5488	5
Jul-92	506		10485	6
Aug-92	331	442	4214	5
Sep-92	335	676	1154	42
Oct-92	266	433	23	2
			1,223,652	886

04077205400000 NAHAMA WEAGANT TRACY 3-15

DATE	TBG (PSI)	CASING (PSI)	GAS (MCF)	WATER (BBLS)
Aug-91	859		5594	
Sep-91	916		25536	3
Oct-91	956		27320	3
Nov-91	899		31351	6
Dec-91	882		29329	7
Jan-92	836		29985	7
Feb-92	833		30613	6
Mar-92	804		32446	5
Apr-92	769		32255	9
May-92	750			
Jun-92	758		33213	
Jul-92	754		33818	
Aug-92	710		31692	3
Sep-92	732		32683	8
Oct-92	735		51440	18
Nov-92	718		32858	8
Dec-92	701		31808	9
Jan-93	697		33541	8
Feb-93	634		29641	13
Mar-93	585		31068	10
Apr-93	527		28178	18
May-93	334		2218	11
Jun-93	255	212	2541	4
Jul-93	63	205	2249	2
Aug-93	487		183	1
			621,560	159

DATE	TBG (PSI)	CASING (PSI)	GAS (MCF)	WATER (BBLS)
Oct-98	2278		9229	4
Nov-98	1975		23271	19
Dec-98	1720		22227	29
Jan-99	1450		18614	49
Feb-99	1230		13620	53
Mar-99	970		12599	86
Apr-99	430		4363	86
May-99				
Jun-99				
Jul-99				
Aug-99			41	
Sep-99				
Oct-99				
Nov-99				
Dec-99			41	
Jan-00				
Feb-00				
Mar-00	1600		12923	58
Apr-00	1680		21130	91
May-00	1645		21906	85
Jun-00	1600		22073	96
Jul-00	1540		22132	99
Aug-00	1500		22276	115
Sep-00	1415		22075	112
Oct-00	1360		22940	126
Nov-00	1260		22102	117
Dec-00	2500		15890	110
Jan-01	1075		17743	106
Feb-01	1300		8889	83
Mar-01	1420		5917	78
Apr-01	1425		7169	72
May-01	1750		5636	62
Jun-01	1650		4677	54
Jul-01	1400		11309	84
Aug-01	1300		13825	93
Sep-01	1300		12145	85
Oct-01	1500		4257	38
Nov-01	1000		2331	38
Dec-01	1500		8560	68
Jan-02	1460		8371	82
Feb-02	1100		8247	105
Mar-02	1400		876	35
Apr-02	1400			58
May-02	850		1776	71
Jun-02	800		2411	55
Jul-02	800		1599	54
Aug-02	825		6842	115

DATE	TBG (PSI)	CASING (PSI)	GAS (MCF)	WATER (BBLS)
Sep-02	820		5078	68
Oct-02	2050		61	23
Nov-02	2060		1108	29
Dec-02				
Jan-03				
Feb-03	550		38	
Mar-03	750		256	
Apr-03	630		159	
May-03				
Jun-03				
Jul-03				
Aug-03				
Sep-03				
Oct-03				
Nov-03				
Dec-03				
Jan-04				
Feb-04				
Mar-04				
Apr-04				
May-04				
Jun-04				
Jul-04				
Aug-04				
Sep-04				
Oct-04				
Nov-04				
Dec-04				
Jan-05				
Feb-05				
Mar-05				
Apr-05				
May-05				
Jun-05	1350	1350	144	1
Jul-05	20	240	788	24
Aug-05	40	160	357	14
Sep-05	15	65	100	4
Oct-05	140	150	231	2
Nov-05	380	380	124	5
Dec-05	500	500	25	6
			450,501	2,947

5/12/2011

GEOLOGY AND GAS PRODUCTION OF THE TRACY GAS FIELD, SAN JOAQUIN COUNTY, CALIFORNIA

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EXECUTIVE SUMMARY

More than 17 BCF of gas have been produced from the Tracy Gas Field since its discovery in 1935. Production from the Tracy Formation gas pool accounts for nearly 14 BCF of field production. This medium-grained sandstone reservoir at a depth of approximately 4000 feet has a maximum thickness of approximately 150 feet and encompasses an area of approximately 650 acres. The trap is formed by a circular-shaped structural "dome" overlain by a thick shale sequence. The production exhibits a depletion drive, with a water-drive component. High porosity and permeability of the reservoir have yielded very high production rates. Other gas pools of the Tracy Gas Field have a more limited aerial distribution, and have yielded lower rates and volumes of production.

INTRODUCTION

This report summarizes the results of an analysis of the stratigraphy, structure, reservoir geometry, gas production and reservoir rock properties of the Tracy Gas Field in San Joaquin County, California. The Tracy Gas Field is located near the small town of Tracy in the southern Sacramento Valley, about 35 miles east of San Francisco, California (Attachment 1). The study area includes approximately 10 square miles in Township 2 South, Range 5 East (Attachment 2). This analysis is based on data from approximately 50 exploration and development wells drilled in and around the field (Attachment 3). A summary of the productive intervals, cumulative production, and initial production rates of gas wells in the Tracy Gas Field is included in Attachment 4.

History of Field Development

The Tracy Gas Field is the first commercial gas field in northern California, discovered by Amerada Petroleum Corporation in 1935. Their well F.D.L. 2 in Sec 15, T. 2 S., R. 5 E. was completed in August, 1935 flowing gas from Tracy Formation intervals between 3973 and 4063 feet at an average rate of 35,000 mcf/d through 1-3/4-inch choke with a flowing pressure of 1400 psi. Amerada followed the discovery with five field-development wells during the next two years. A total of 13,775 MMcf was produced from the Tracy Formation gas pool between 1935 and 1953.

The initial phase of field development was followed by numerous unsuccessful wells in the vicinity of the field, mostly during the 1960's. The field was reactivated in 1977 with a

successful northern field extension drilled by G. R. Nance Company. A minor amount of gas was produced from the Blewett Formation in the Nance Rossi-Stewart 1 well during 1980.

In 1981, Marathon Oil Company made a new pool discovery and established production from a Miocene-age sandstone in their Rossi 1 well at depths between 3495 and 3508 feet. The Rossi well tested 2935 mcf/d through a 22/64-inch choke with a flowing pressure of 1368 psi. Nehama and Weagant Energy Company followed with three additional gas wells in this pool in 1990. A total of 2,928 MMcf was produced from the Miocene gas pool between 1982 and 1993.

In 1997, Tri-Valley Oil and Gas Company drilled two deep tests in the field and established production from the Lathrop Formation in their Pimental well at depths between 7569 and 7621 feet. A total of 451 MMcf was produced from this one-well gas pool between 1998 and 2005. The Tri-Valley Holly Sugar well was completed but commercial production has not been established.

The Tracy Gas Field has thus produced a combined total of more than 17 BCF between 1935 and 2005, primarily from the Tracy gas pool. All wells in the field have been abandoned except for the Tri-Valley Holly Sugar 1 well, which remains shut in.

METHODS

The California Division of Oil and Gas (CDOG) records identify a total of approximately 50 wells drilled in the Tracy area. Well history records for these wells were reviewed, and a digital well database was compiled that includes API number, operator, well name, well number, status, total depth, elevation, spud date, abandonment date, location, and latitude/longitude. Well completion information, including perforated intervals and dates, was also compiled. Raster images of well logs were obtained from commercial sources and CDOG files. Monthly gas production, water production, and flowing pressure data reported to the CDOG was obtained from commercial sources. Production data was compiled in spreadsheet format and production-decline curves were prepared. The digital well and production data were input into Landmark Geographix software for data manipulation, cross section preparation, and mapping.

A series of cross sections that included all wells in the study area was prepared and logs were annotated with available perforation information. The Tracy gas pool discovery and development wells were drilled prior to the widespread use of modern logging techniques, so the logs from the more recently drilled wells (drilled after the reservoir was depleted) provide more detailed information with regards to the reservoir characteristics.

Producing intervals and pertinent stratigraphic horizons were identified and correlated in all available wells. The thicknesses of the gas zones were calculated from Spontaneous Potential logs, and recorded in the database. A cutoff of 10 millivolts from the shale baseline was used in the net-sandstone calculations. The stratigraphic information was incorporated in the preparation of structure and isopach maps of the Tracy and Miocene gas pools. Reservoir rock property data was compiled from well histories and CDOG publications. Porosity was also estimated from wireline logs calculations.

REGIONAL GEOLOGY

The Tracy Gas Field is located on the west side of the southern Sacramento basin, where the thickness of Cretaceous and Tertiary age sedimentary strata exceeds 14,000 feet. The deepest well in the field, the Amerada Tracy Community 1-1, encountered the Cretaceous Forbes Formation at total depth of 13,832 feet (Attachment 5). The stratigraphic sequence at the Tracy Gas Field includes the age and approximate thicknesses of strata as follows:

Undifferentiated Nonmarine	Miocene-Pliocene	3500 feet
Blewett Formation	Late Cretaceous	200 feet
Ragged Valley Shale	Late Cretaceous	350 feet
Tracy Formation	Late Cretaceous	1500 feet
Sawtooth Shale	Late Cretaceous	300 feet
Winters Formation	Late Cretaceous	700 feet
Lathrop Formation	Late Cretaceous	5500 feet
Sacramento Shale	Late Cretaceous	600 feet
Forbes Formation	Late Cretaceous	1200 feet +
	TOTAL	13,850 feet+

The Tracy gas pool, which accounts for most of the field production, is at the top of the Tracy Formation, directly below the Ragged Valley Shale. The Miocene gas pool is at the base of the undifferentiated nonmarine strata, directly above the unconformity between Miocene-Pliocene and Late Cretaceous age strata. The one-well Blewett Formation gas pool is directly below the unconformity, and the one-well Lathrop Formation gas pool is in the middle of the Lathrop Formation.

The regional structure of the southern Sacramento basin is dominated by three major faults: the Stockton, Vernalis, and West Tracy faults (Attachment 6). These faults exhibit reverse separation of Late Cretaceous through Pliocene strata and are the result of compression during Neogene time. The Tracy Gas Field is located near the juncture of the Stockton and Vernalis faults, and east of the West Tracy fault. Regional dip in this part of the basin is to the east.

TRACY GAS POOL

Reservoir Stratigraphy and Rock Properties

The Tracy formation is approximately 1500 feet thick in the vicinity of the Tracy Gas Field, and the upper sandstone body, which forms the Tracy gas pool reservoir, has an average gross thickness of approximately 450 feet (Attachments 7 and 8). Cuttings and cores describe the Tracy gas pool reservoir as a soft, porous, gray, medium-grained sand with pebbles at the base, interbedded with streaks of dark, blackish-gray silty shale. The lower part of the Tracy Formation consists of alternating beds of sandstone and shale. The Tracy gas pool reservoir has a sheet-like geometry in the vicinity of the field.

The Tri-Valley Pimental 1-15 well, which was drilled in 1997 near the top of the Tracy gas pool long after the Tracy gas pool was depleted, provides a modern log of the entire reservoir interval

(Attachment 9). The sonic curve clearly shows the thickness of the depleted gas pool of approximately 150 feet, and the original gas-water contact at -4050 feet subsea. The "deep" resistivity of 4-6 ohms indicates low gas saturation of the depleted reservoir. This was confirmed by a production test at the top of the reservoir by Tri-Valley, during which the interval flowed salt water.

Relatively thin shale beds, less than 10 feet in thickness, are present locally in the reservoir (Attachment 9). These generally are not correlative between wells and therefore have a limited areal extent (Attachment 10). Most of the recent well penetrations of the Tracy gas pool have reservoir sandstone-to-shale ratios between 72% and 92% sandstone, however the reservoir in the Cardoza 1 well on the west side of the gas pool is only 37% sandstone (Attachment 10). The average reservoir sandstone-to-shale ratio for the five wells is 75% sandstone.

The Tracy gas pool reservoir also includes some localized "bone" or "reef" beds of tightly calcite cemented sandstone. These beds of little to no porosity are characterized on wireline logs by high resistivity and fast sonic times. They are generally less than 10 feet in thickness and have limited areal extent.

The average porosity of the Tracy gas pool reservoir is reported to be 28% by the CDOG (1998). Initial gas saturation is reported at 70%, with a water saturation of 30%. Porosity calculations from sonic logs of the Tracy gas pool reservoir, however, predict much higher porosities than reported by the CDOG. Sonic travel times in the Tracy gas pool reservoir range from 140 to 165 microseconds per foot. This slow velocity indicates that the reservoir is relatively uncompacted, consistent with the core description of "soft" sandstone. The standard Wyllie Time Average method yields unrealistic porosities for such rocks, even with the integration of standard compaction factors. The Raymer-Hunt Formula, which is based on empirical data, yields sonic porosities of 37 to 40%, which are also considered unrealistically high values.

Standard relationships of porosity and permeability for medium-grained sands with 28% porosity predict a Tracy gas pool reservoir permeability of 10,000-12,000 md. Permeability measurements for the Tracy gas pool reservoir are not available.

The well sample repository in Bakersfield, California reports that they have cores from the following intervals in the following Tracy Gas Field wells:

WELL	TOP	BASE	COMMENT
ROSSI-STEWART UNIT 1	2704	9308	Blewett Fm producer
F.D.L. 2	3700	4937	Tracy gas pool discovery well
TRACY COMMUNITY 1-1	11710	13390	Deepest field well
TRACY COMMUNITY 1-1	3200	6070	"
TRACY COMMUNITY 1-1	6160	8680	"
TRACY COMMUNITY 1-1	7930	13832	"

Analysis of these cores could provide much additional information with regards to the stratigraphy and reservoir rock properties of the Tracy Gas Field, including direct measurements of porosity and permeability that would be much more reliable than estimates included herein.

Structure

The Tracy gas pool is a structural "dome" with structure contours that close in all directions with a roughly circular shape (Attachment 11). With the seal provided by the overlying Ragged Valley Shale, this structure provides the closure for gas entrapment in the field. On the east side of the structure, the top of the Tracy Formation dips steeply with the regional dip to the east and northeast. A structurally low depression west and south of the field provides the critical anti-regional westerly dip that creates the trap. Farther west, the Tracy Formation rises abruptly to the west.

With the top of the Tracy Formation at approximately -3900 feet subsea at the crest of the structure, and a lowest closed contour at approximately -4250 feet subsea, the total relief of the structural closure at the top of the Tracy Formation is approximately 350 feet. The original gas column had a thickness of only 150 feet, so it appears that the Tracy structure was not filled with gas to the spill point- there is an additional 200 feet of relief on the structural closure that was not filled with gas (the original gas-water contact in the field was at an elevation of approximately -4050 feet subsea).

The northern part of the Tracy structure is cut by the Tracy-Vernalis fault, across which the Tracy reservoir sand is juxtaposed with the lower Tracy Formation. Structure contours below an elevation of approximately -4150 feet subsea terminate into the fault (Attachment 11). It is possible that at elevations below -4150 feet subsea, the Tracy reservoir is in hydraulic communication with lower Tracy Formation sandstones on the north side of the Tracy fault, and that the reservoir is thus not sealed below the -4150 foot elevation.

Gas Production

As described by Hunter (1957), Tracy gas pool wells were typically drilled and cored to the top of the Tracy Formation, and either 8 5/8- or 9 7/8-inch casing was cemented over the sand. The hole was cleaned out five feet below the casing shoe and a test of water shut-off made. The well was then cored or drilled to the total depth and a 6 5/8-inch liner with 80-mesh perforations was landed on bottom. The initial pressure of the Tracy Gas pool was 1850 psi, with initial production rates that ranged from 35,000 to 65,000 mcf per day at flowing pressures of 1400 and 1170 psi, respectively, through a 1 1/2- inch choke (Attachment 4).

The average duration of production for the six productive Tracy gas pool wells was 5-8 years (see Appendix I). Two wells produced more than 15 years, and one well produced only two years. Throughout most of their production history, wells were regularly either shut in, or production sharply curtailed, for periods of one to five months each year. This presumably was due to deliverability/gas market issues. Rates during times of "normal" production were quite variable, generally ranging from 20,000 to 200,000 mcf per month. There does not appear to be any general decline in rate during the life of the wells.

Production records indicate that the Tracy gas pool reservoir pressure declined during the history of production, but that production was ultimately terminated due to water encroachment into the

reservoir; it is a depletion-drive reservoir with a water-drive component. The initial flowing casing pressure of approximately 1400 psi, declines in most wells to a final flowing casing pressure of 300 to 500 psi (Appendix I). Tubing pressures declined to significantly lower levels. This is probably not reflective of reservoir conditions but presumably due to water entry into the tubing as formation pressures declined. Water production was generally low in all wells, averaging less than 3500 barrels per well, but the rate of water production increased steadily during the life of the well.

The Tracy gas pool encompasses a maximum area of 650 acres, as defined by the -4050 structure contour at the top of the Tracy Formation, and reaches a maximum gross thickness of approximately 150 feet at the crest of the structure (Attachment 12). Average gross thickness is estimated at approximately 60 feet. Assuming a net to gross ratio of 75%, due to the presence of thin shale layers as described above, the average net thickness is estimated at approximately 45 feet. The volume of the Tracy gas pool can thus be estimated at 39,000 gross acre-feet and approximately 30,000 net acre-feet. With a total cumulative gas production of 13,775 MMcf, the recoverable richness of the Tracy gas pool can be estimated at approximately 460 mcf/acre-foot.

The estimated recoverable richness for this field is low compared with other Sacramento Valley gas pools, which are typically 500-700 mcf/acre-foot at this depth. A higher richness would necessitate a lower gas-pool volume which would not be consistent with the abundance of available data for the Tracy Gas Field. The low recovery could perhaps be explained by the regular periods of low, or no production during the life of the field (as described above), which allowed for premature encroachment of the water table.

MIOCENE GAS POOL

Undifferentiated Miocene-Pliocene nonmarine strata are approximately 3500 feet thick in the vicinity of the Tracy Gas Field, and the lower-most sandstone body, which forms the Miocene gas pool reservoir, has an average gross thickness of approximately 75 feet (Attachment 13). The reservoir is a moderately sorted, fine to medium-grained sandstone composed of a predominance of quartz grains, with abundant altered feldspar. Grain size increases downward to a coarse-grained sandstone. The upper part of the undifferentiated Miocene-Pliocene nonmarine strata consists primarily of shale, interbedded with thin sandstone beds. The Miocene gas pool reservoir has a widespread distribution as it is present in most wells in the Tracy Gas Field. The original gas-water contact of the Miocene gas pool is at an elevation of -4050 feet subsea (Attachment 13).

The average porosity of the Miocene gas pool reservoir is reported to be 20% by the CDOG (1998). Initial gas saturation is reported at 55% with a water saturation of 45%. Porosity calculations from sonic logs of the Miocene gas pool reservoir, however, predict much higher porosities than reported by the CDOG. These calculations yield unrealistically high porosity values, indicating that the Miocene gas pool reservoir is uncompacted and unconsolidated.

Standard relationships of porosity and permeability for medium-grained sands with 20% porosity predict a Miocene gas pool reservoir permeability of 4000 md. Permeability measurements for the Miocene gas pool reservoir are not available.

The Miocene gas pool is located on the northwestern margin of a northwest-striking plunging anticline that is bounded on the north by the Tracy-Vernalis fault (Attachment 14). Northerly and westerly dip form the northern and western trap, respectively, for the Miocene gas pool. The southeastern gas pool trap, however, cannot conclusively be determined with the available data. Sterling (1997) indicates that stratigraphic pinch out of the Miocene gas pool reservoir forms this trap, however, the reservoir is present with a high water saturation in several wells located southeast of the gas pool (ie. Young-Amerada Community 1 well shown in Attachment 13). It is possible that an unidentified fault forms the southeast trap for this pool. The fault offset may be sufficient to provide the trap for Miocene strata, but is too low to affect the thicker Tracy gas pool.

The four wells that produced from the Miocene gas pool had an average duration of approximately three years (see Appendix I). Two wells produced more than 15 years, and one well produced only two years. Production rates ranges from 30,000 to 60,000 mcf per month, with little decline in rate during the life of the wells. Miocene gas pool reservoir pressure declined during the history of production, but production was ultimately terminated due to water encroachment into the reservoir. The initial flowing pressure of approximately 1400 psi, declined steadily to final flowing pressures of 200 to 300 psi (Appendix I).

The Miocene gas pool encompasses a maximum area of 325 acres, and reaches a maximum gross thickness of approximately 75 feet at the crest of the structure (Attachment 15). Assuming an average net thickness of 30 feet, the Miocene gas pool has a volume of approximately 10,000 acre-feet. With a total cumulative gas production of 2928 MMcf, the recoverable richness of the Miocene gas pool can be estimated at approximately 300 mcf/acre-foot.

OTHER GAS POOLS

The Lathrop gas pool, with a cumulative production of only 450 MMcf and limited size, has been tested and produced by a single well, the Tri-Valley Pimental 1-15. As such, our understanding of this gas pool is based entirely on the information from this well. The well had an initial production rate of 1400 mcf per day with a flowing pressure of 1750 psi through a 12/64-inch choke. The gas pool consists of three sandstones beds, each less than 10-feet thick, with a gross thickness of less than 40 feet. The top of the pool is at an elevation of -7480 feet subsea. The gas pool is estimated to encompass an area of approximately 15 acres, assuming a recoverable richness of 1000 mcf/acre-foot and an average net thickness of 30 feet.

An insignificant volume of gas has been produced from the Blewett gas pool in the Nance Rossi-Stewart 1 well. This gas pool is at the top of the Blewett Formation at a depth of approximately 5200 feet.

REFERENCES

Sterling, R. S., 1997, Geology of the Miocene Pool, Tracy Gas Field, San Joaquin County, California, *in* Geology of the Northern San Joaquin Basin Gas Province, AAPG Pacific Section.

California Division of Oil and Gas, 1998, California Oil and Gas Fields, Central California, Volume I

Hunter, G. W., 1957, Tracy Gas Field: California Division of Oil and Gas, Summary of Operations, Volume 43, No. 1.

ATTACHMENTS

1. Regional map of the southern Sacramento Valley showing oil and gas fields and the location of the Tracy Gas Field.

2. Map of Tracy Gas Field and vicinity showing wells, cumulative gas production, the outline of the Tracy gas pool, and cross section locations. Wells productive from the Tracy gas pool are circled in red.

3. List of study wells, including status, total depth, elevation, spud date, and location (latitude and longitude in NAD 1927 coordinates).

4. Summary of productive wells that lists productive interval, cumulative gas and water production, and initial production rates.

5. Tracy Gas Field type log showing gas-field stratigraphy.

6. Generalized regional structure of the southern Sacramento valley showing major faults and location of gas fields (from Sterling, 1997).

7. Well-log cross section (X-X') of the Tracy gas pool.

8. Well-log cross section (Y-Y') of the Tracy gas pool.

9. Tracy gas pool type log. This well was drilled after the gas pool was depleted, and shows the current wet reservoir conditions. The sonic curve shows the residual gas in solution. Due to the early age of the discovery and development of this gas pool (1935-6), the logs from the original wells do not adequately depict the reservoir.

10. Cross section of logs from recent Tracy gas pool reservoir penetrations.

11. Structure-contour map on the top of the Tracy Formation showing the Tracy gas pool.

12. Tracy gas pool gross isopach map. Wells productive from this gas pool are circled in red. Other wells were drilled after the gas pool was depleted. Abbreviations: NDE, not deep enough; + well did not reach the gas/water contact at the base of the gas pool.

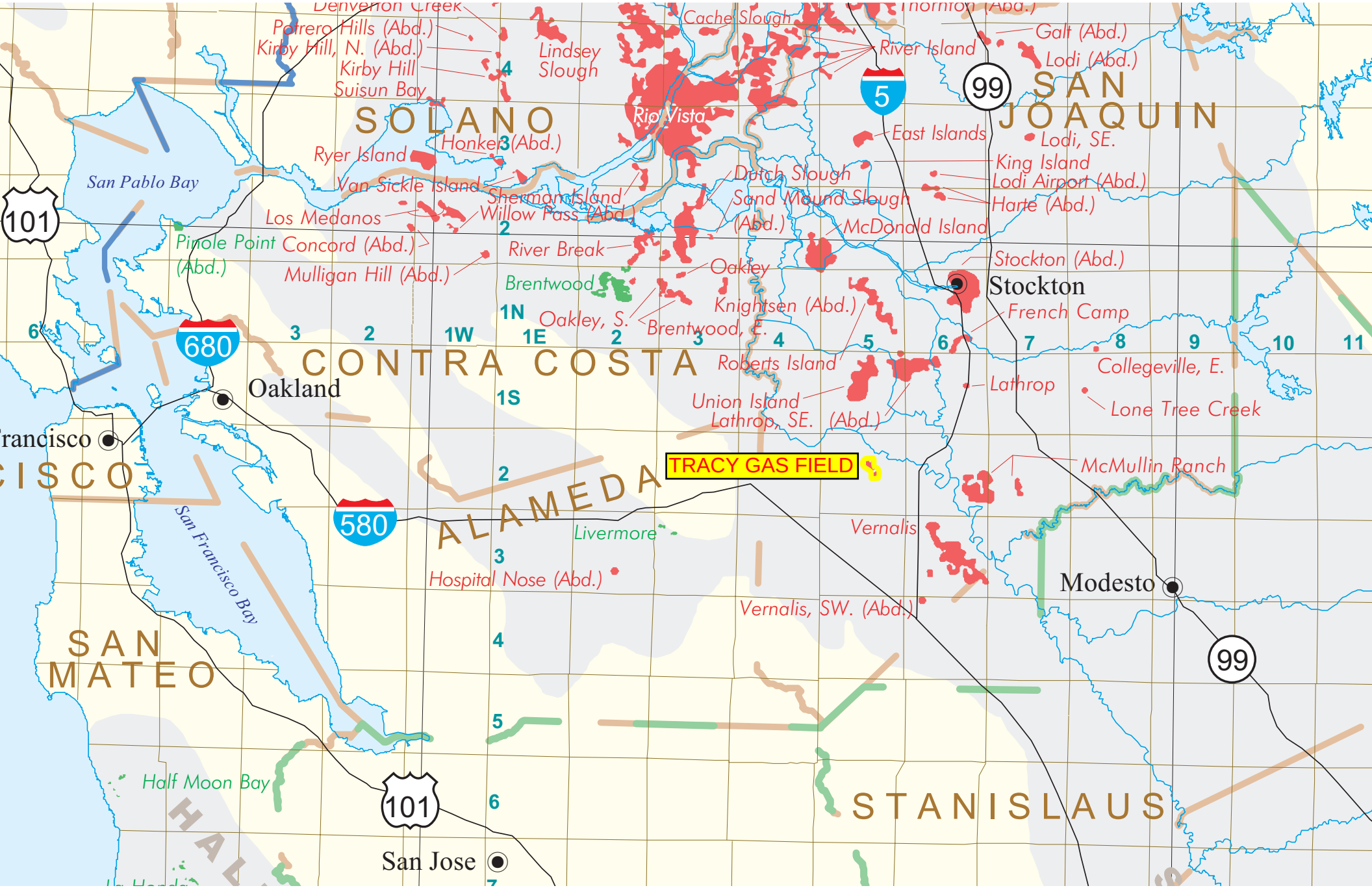
13. Well-log cross section (A-A') of the Miocene gas pool.

14. Structure-contour map on the top of the Beepee Horizon showing the Miocene gas pool.

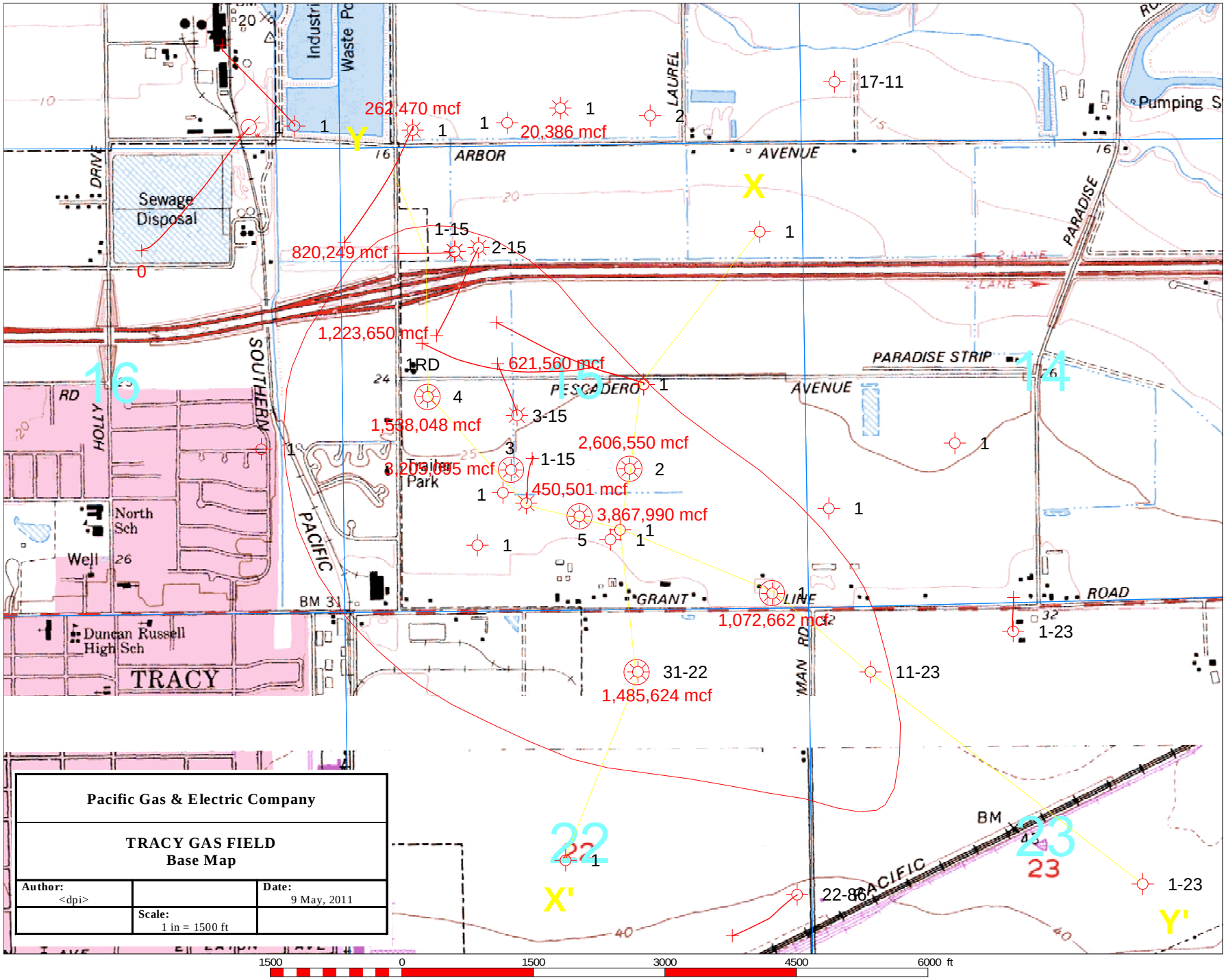
15. Miocene gas pool gross isopach map. Wells productive from this gas pool are circled in red.

Appendix I. Gas-production database that includes production-decline curves and monthly reported casing pressure, tubing pressure, gas production and water production, in tabular form.

ATTACHMENT 1



ATTACHMENT 2



ATTACHMENT 3

TRACY GAS FIELD STUDY WELLS

API NUMBER	OPERATOR	WELL NAME	NO.	LOCATION	STATI	CLASSIFICATION	TD	ELEV		SPUD	LATITUDE	LONGITUDE
04077002380000	AMERADA HESS CORP.	F.D.L.	1	TWP: 2 S - Range: 5 E - Sec. 15	AGS	VELOCITY SURVEY	9690	40	GR	4/17/35	37.75484	-121.39884
04077002400000	AMERADA HESS CORP.	F.D.L.	2	TWP: 2 S - Range: 5 E - Sec. 15	AGS	DISCOVERY	4063	36	GR	7/18/35	37.75877	-121.40443
04077002440000	AMERADA HESS CORP.		31-22	TWP: 2 S - Range: 5 E - Sec. 22	AGS	DEVELOPMENT	4087	43	GR	9/24/35	37.75241	-121.40416
04077002450000	AMERADA HESS CORP.	TRACY	11-23	TWP: 2 S - Range: 5 E - Sec. 23	P&A	DEVELOPMENT	5107	41	GR	11/10/35	37.75236	-121.39499
04077002390000	AMERADA HESS CORP.	F.D.L.	3	TWP: 2 S - Range: 5 E - Sec. 15	AGS	DEVELOPMENT	4029	31	GR	12/19/35	37.75876	-121.40911
04077002410000	AMERADA HESS CORP.	F.D.L.	4	TWP: 2 S - Range: 5 E - Sec. 15	AGS	DEVELOPMENT	4050	30	GR	1/20/36	37.76107	-121.41238
04077002420000	AMERADA HESS CORP.	F.D.L.	5	TWP: 2 S - Range: 5 E - Sec. 15	AGS	DEVELOPMENT	6160	41	KB	2/21/36	37.75729	-121.40643
04077002460000	HOLLY DEVELOPMENT CO	PADDON	1	TWP: 2 S - Range: 5 E - Sec. 16	P&A	DEVELOPMENT	4121	31	DF	4/23/36	37.75946	-121.41896
04077003460000	CHEVRON U.S.A. INC.	GERHART COMMUNITY	1	TWP: 2 S - Range: 5 E - Sec. 24	P&A	VELOCITY SURVEY	5900	35	GR	4/6/44	37.74505	-121.37625
04077003420000	TEPI	MARY SIMOS	1	TWP: 2 S - Range: 5 E - Sec. 8	P&A	WILDCAT	4692	15	KB	12/15/51	37.782197	-121.448647
04077003470000	MOBIL EXPL. & PROD.	MARTI ET AL	73-25	TWP: 2 S - Range: 5 E - Sec. 25	P&A	WILDCAT	4746	65	KB	9/22/54	37.7351	-121.36401
04077003480000	D.D. DUNLAP & DOROTH	GERHART	1	TWP: 2 S - Range: 5 E - Sec. 25	P&A	WILDCAT	4601	70	KB	1/17/57	37.72941	-121.37438
04077003430000	GREAT BASINS PETROLE	INTEX-BETTINZOLI	17-11	TWP: 2 S - Range: 5 E - Sec. 11	P&A	WILDCAT	6272	22	KB	5/27/60	37.770854	-121.396257
04077003530000	GREAT BASINS PETROLE	PETZ	72X-36	TWP: 2 S - Range: 5 E - Sec. 36	P&A	WILDCAT	4707	65	KB	11/9/60	37.72284	-121.36328
04077003410000	EXXON CORP.	HOLLY SUGAR CORP.	B-1	TWP: 2 S - Range: 5 E - Sec. 8	P&A	WILDCAT	5707	6	GR	6/17/61	37.775577	-121.437377
04077003490000	OCCIDENTAL PETROLEUM	BRICHETTO	1	TWP: 2 S - Range: 5 E - Sec. 26	P&A	WILDCAT	5020	65	KB	11/30/61	37.73224	-121.38592
04077003390000	SUN OIL CO.	F. BASTIAN	1	TWP: 2 S - Range: 5 E - Sec. 3	P&A	WILDCAT	11000	18	KB	11/17/62	37.78202	-121.40522
04077003450000	SUN OIL CO.	JOHN BERTOLOTTI UNIT	1	TWP: 2 S - Range: 5 E - Sec. 20	P&A	WILDCAT	9500	47	KB	10/11/63	37.75097	-121.439
04077002430000	AMERADA HESS CORP.	TRACY COMMUNITY 1	1	TWP: 2 S - Range: 5 E - Sec. 15	P&A	DEEPEST FIELD	13832	48	KB	2/8/64	37.75686	-121.40483
04077002490000	JOHN M. YOUNG	YOUNG NO. TRACY	1	TWP: 2 S - Range: 5 E - Sec. 14	P&A	SEMI-WILDCAT	5000	40	KB	9/1/64	37.75749	-121.39659
04077002480000	JOHN M. YOUNG	CARDOZA	1	TWP: 2 S - Range: 5 E - Sec. 15	P&A	WILDCAT	4137	40	KB	10/23/64	37.75641	-121.41046
04077002470000	JOHN M. YOUNG	YOUNG-AMERADA COMM	1	TWP: 2 S - Range: 5 E - Sec. 15	P&A	WILDCAT	4300	38	KB	2/11/65	37.75805	-121.40944
04077200810000	OIL SECURITIES & MET	AMERADA-ENDER	1	TWP: 2 S - Range: 5 E - Sec. 14	P&A	WILDCAT	6064	35	KB	4/4/65	37.75951	-121.3916
04077200170000	PALISADES PETROLEUM	TRACY	1	TWP: 2 S - Range: 5 E - Sec. 22	P&A	WILDCAT	10500	43	KB	8/9/67	37.74652	-121.40706
04077200480000	AMERADA HESS CORP.,	ROSSI-STEWART UNIT	1	TWP: 2 S - Range: 5 E - Sec. 10	P&A	WILDCAT	9308	27	KB	5/3/68	37.769633	-121.409177
04077200600000	AMERADA HESS CORP.,	ROSSI-STEWART UNIT	2	TWP: 1 S - Range: 4 E - Sec. 26	P&A	WILDCAT	6005	24	KB	8/20/68	37.769833	-121.403537
04077200710000	EDWARD B. TOWNE, JR.	GERHART	1	TWP: 2 S - Range: 5 E - Sec. 25	P&A	WILDCAT	7608	67	KB	12/18/68	37.72767	-121.37679
04077200750000	TRI-UNION DEVELOPMEN	GEORGE LAKE	1	TWP: 2 S - Range: 5 E - Sec. 9	P&A	WILDCAT	6505	6	KB	12/19/68	37.780218	-121.421886
04077201400000	REYNOLDS & CARVER	PYRAMID-TRACY UNIT	1	TWP: 2 S - Range: 5 E - Sec. 29	P&A	WILDCAT	7459	64	GR	6/24/71	37.73033	-121.44336
04077202320000	QUINTANA PETROLEUM C	HOLLY SUGAR CORP.	1	TWP: 2 S - Range: 5 E - Sec. 8	P&A	WILDCAT	11400	16	KB	5/7/74	37.7786	-121.44858
04077202600000	LAWRENCE BARKER, JR.	NORTH TRACY	1	TWP: 2 S - Range: 5 E - Sec. 15	P&A	WILDCAT	5918	19	GR	6/14/75	37.76617	-121.399243
04077202950000	RESOURCES INVESTMENT	TRACY COMMUNITY	1	TWP: 2 S - Range: 5 E - Sec. 15	P&A	SEMI-WILDCAT	4211	29	GR	5/24/77	37.75656	-121.40521
04077203060000	G.R. NANCE CO., INC.	ROSSI-STEWART	1	TWP: 2 S - Range: 5 E - Sec. 10	AGS	WILDCAT	5525	27	KB	10/29/77	37.770082	-121.407077
04077203090000	DAVIS OIL CO.	CITY OF TRACY	1	TWP: 2 S - Range: 5 E - Sec. 28	P&A	WILDCAT	6743	73	KB	11/5/77	37.73367	-121.42753
04077203260000	ARGOSY OIL CO.	ALVAREZ	1	TWP: 2 S - Range: 5 E - Sec. 27	P&A	WILDCAT	4600	85	KB	1/29/79	37.73813	-121.40847
04077203270000	ARGOSY OIL CO.	ALVAREZ	2	TWP: 2 S - Range: 5 E - Sec. 27	P&A	WILDCAT	5500	85	KB	4/23/79	37.73067	-121.40225
04077203370000	THE DOW CHEMICAL CO.	BANTA UNIT WELL	1	TWP: 2 S - Range: 5 E - Sec. 24	P&A	WILDCAT	1982	37	KB	10/19/79	37.75018	-121.37021
04077203440000	THE DOW CHEMICAL CO.	BANTA UNIT WELL	1A	TWP: 2 S - Range: 5 E - Sec. 24	P&A	WILDCAT	11091	39	KB	10/24/79	37.75013	-121.37048
04077203620000	SWEPI	EDWARDS	1-23	TWP: 2 S - Range: 5 E - Sec. 23	P&A	WILDCAT	12331	50	KB	11/8/80	37.74566	-121.38431
04077203840000	MARATHON OIL CO.	ROSSI	1	TWP: 2 S - Range: 5 E - Sec. 10	AGS	SEMI-WILDCAT	7000	21	KB	11/20/81	37.769424	-121.412907
04077203910000	MARATHON OIL CO.	HOLLY SUGAR	1	TWP: 2 S - Range: 5 E - Sec. 9	P&A	SEMI-WILDCAT	5089	28	KB	4/8/82	37.769575	-121.417569
04077204030000	MARATHON OIL CO.	BACCHETTI	1	TWP: 2 S - Range: 5 E - Sec. 5	P&A	SEMI-WILDCAT	9219	49	KB	8/28/82	37.76141	-121.40386
04077204030001	MARATHON OIL CO.		1RD	TWP: 2 S - Range: 5 E - Sec. 5	P&A	SEMI-WILDCAT	12215	49	KB	9/27/82	37.76141	-121.40386
04077205310000	NAHAMA & WEAGANT	TRACY	1-15	TWP: 2 S - Range: 5 E - Sec. 15	AGS	WILDCAT	3964	34	KB	1/27/90	37.765613	-121.411281
04077205320000	NAHAMA & WEAGANT	TRACY	2-15	TWP: 2 S - Range: 5 E - Sec. 15	AGS	DEVELOPMENT	3757	33	KB	3/3/90	37.765731	-121.410342
04077205400000	NAHAMA & WEAGANT	TRACY	3-15	TWP: 2 S - Range: 5 E - Sec. 15	AGS	DEVELOPMENT	3875	37	KB	12/22/90	37.76047	-121.40886
04077205530000	NAHAMA & WEAGANT	EAST TRACY	1-23	TWP: 2 S - Range: 5 E - Sec. 23	P&A	WILDCAT	3655	44	KB	8/12/91	37.7536	-121.38935
04077205310001	NAHAMA & WEAGANT		1-15RD	TWP: 2 S - Range: 5 E - Sec. 15	AGS	WILDCAT	3608	34	KB	8/3/92	37.765613	-121.411281
04077205690000	NAHAMA & WEAGANT	SOUTH TRACY	22-86	TWP: 2 S - Range: 5 E - Sec. 22	P&A	WILDCAT	4294	33	KB	5/20/93	37.7454	-121.39794
04077205880000	TRI-VALLEY OIL & GAS	PIMENTAL	1-15	TWP: 2 S - Range: 5 E - Sec. 15	AGS	WILDCAT	9350	41	KB	1/13/97	37.757714	-121.408521
04077206010000	TRI-VALLEY OIL & GAS	HOLLY SUGAR	1	TWP: 2 S - Range: 5 E - Sec. 9	SI	WILDCAT	11907	33	KB	12/22/97	37.769551	-121.419366

ATTACHMENT 4

TRACY GAS FIELD
SUMMARY OF PRODUCTION

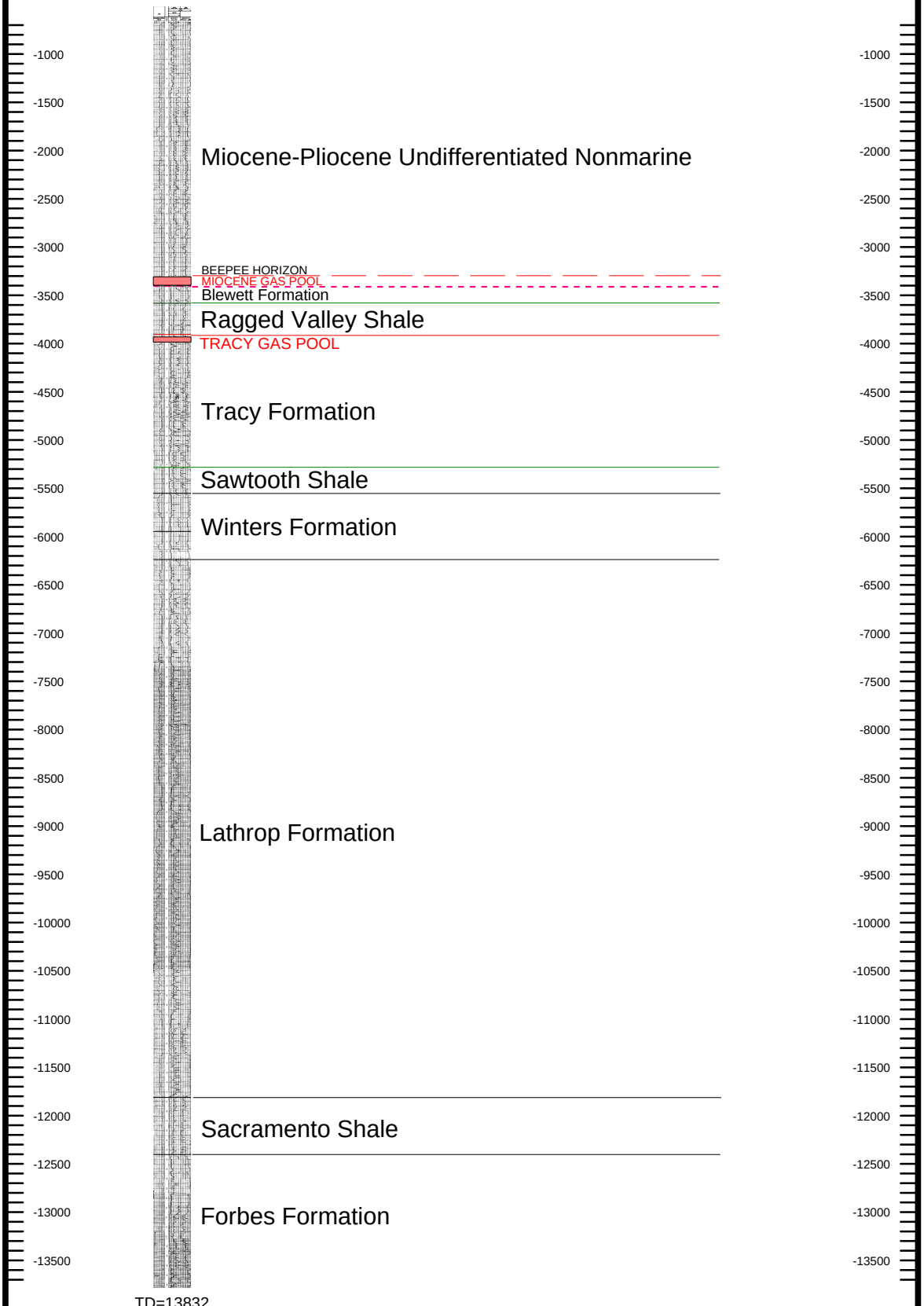
OPERATOR	LEASE	NO.	SPUD	PROD INT.	POOL	CUM MCF	CUM H2O	INITIAL PRODUCTION RATE
AMERADA HESS CORP.	F.D.L.	1	4/17/1935	4005-4055	Tracy	1,071,807	357	7840 mcf/d, 154/520 psi , 87/64 inch choke
AMERADA HESS CORP.	F.D.L.	2	7/18/1935	3973-4063	Tracy	2,606,550	4,877	35,000 mcf/d, 1400 psi, 1.75 inch choke
AMERADA HESS CORP.	F.D.L.	3	12/19/1935	3920-4029	Tracy	3,205,095	4,404	65,000 mcf/d, 1070/1170 psi, 1.5 inch choke
AMERADA HESS CORP.	F.D.L.	4	1/20/1936	3968-4050	Tracy	1,538,048	7,454	30,000 mcf/d, 1065/1040 psi, 124/64 inch choke
AMERADA HESS CORP.	F.D.L.	5	2/21/1936	3876-3994	Tracy	3,867,990	1,183	826 mcf/d, 370/490 psi
AMERADA HESS CORP.		31-22	9/24/1935	3995-4060	Tracy	1,485,624	1,422	34,000 mcf/d, 1308/1218 psi, 68/64 inch choke
TOTAL						**13,775,114**	**19,697**	
MARATHON OIL CO.	ROSSI	1	11/20/1981	3495-3508	Miocene	262,470	15,527	2935 mcf/d, 1368 psi, 22/64 inch choke
NAHAMA & WEAGANT	TRACY	1-15	1/27/1990	3408-3430	Miocene	820,249	227	1530 mcf/d, 1335 psi, 12/64 inch choke
NAHAMA & WEAGANT	TRACY	2-15	3/3/1990	3599-3630	Miocene	1,223,652	886	3000 mcf/d, 1346 psi, 12/64 inch choke
NAHAMA & WEAGANT	TRACY	3-15	12/22/1990	3452-3494	Miocene	621,560	159	1166 mcf/d, 1088 psi, 15/64 inch choke
TOTAL						**2,927,931**	**16,799**	
G.R. NANCE CO., INC.	ROSSI-STEWART	1	10/29/1977	5197-5198	Blewett	20,386	447	698 mcf/d, 500 psi, 1/4 inch choke
TRI-VALLEY OIL & GAS	PIMENTAL	1-15	1/13/1997	7569-7621	Lathrop	450,501	2,947	1404 mcf/d, 1750 psi, 12/64 inch choke
FIELD TOTAL						**17,173,932**	**39,890**	

TRACY GAS FIELD TYPE LOG

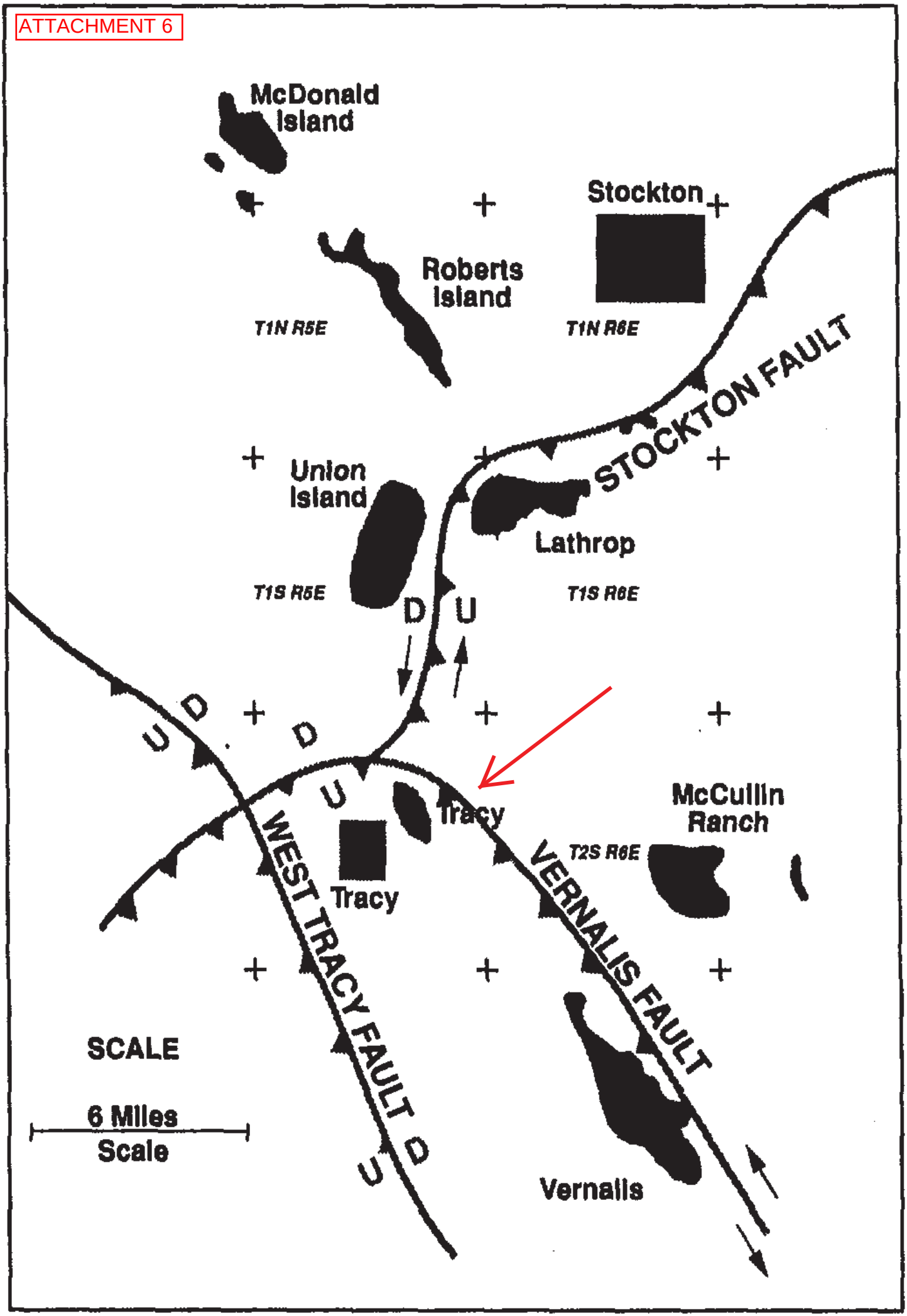
ATTACHMENT 5

04077002430000

AMERADA HESS CORP.
TRACY COMMUNITY 1 1
1185 N 2200 W SE
TWP: 2 S - Range: 5 E - Sec. 15
Spud Date=2/8/1964



ATTACHMENT 6

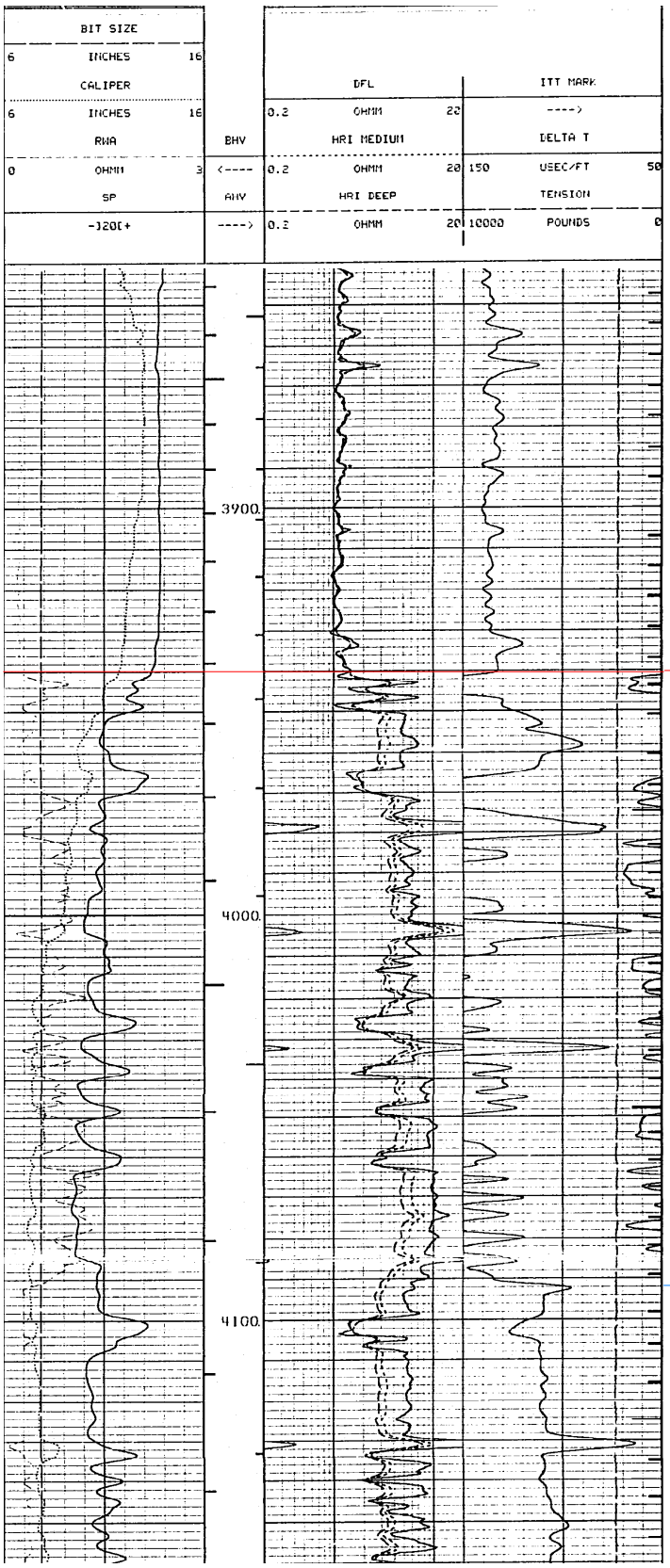


ATTACHMENT 9

TRACY GAS POOL TYPE LOG

Cum Gas All Zones: 448279 MCF
04077205880000

TRI-VALLEY OIL & GAS
PIMENTAL 1-15
1234 FSL 2055 FWL
TWP: 2 S - Range: 5 E - Sec. 15
Spud Date=1/13/1997



-3800
-3900
-4000
-4100

TOP TRACY FORMATION -3900 FT SUBSEA

LOW RESISTIVITY DUE TO DEPLETION

GAS/WATER CONTACT -4050 FT SUBSEA

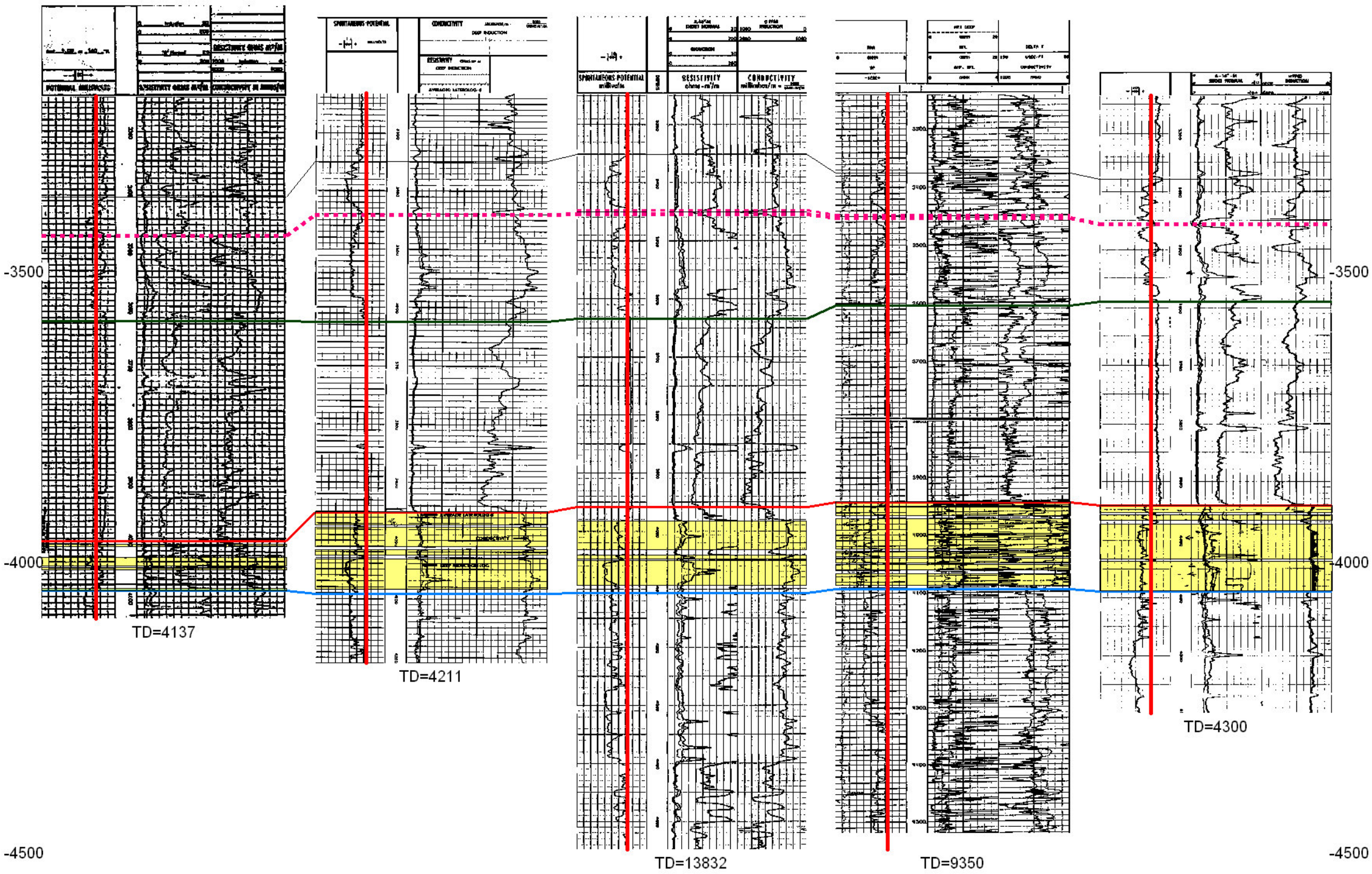
TD=9350

ATTACHMENT 10

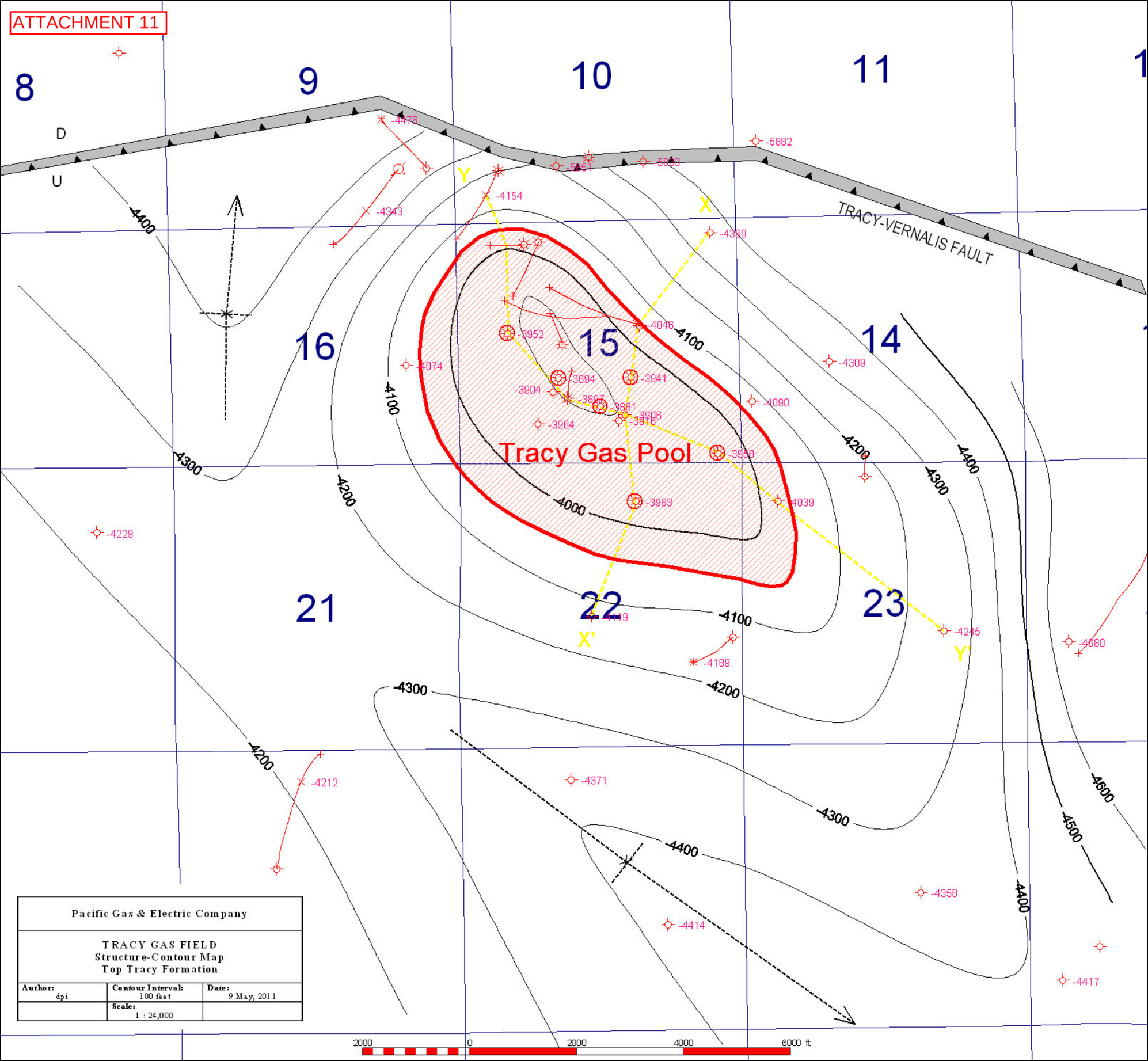
PACIFIC GAS & ELECTRIC COMPANY
TRACY GAS FIELD
Recent Tracy Gas Pool Reservoir Penetrations

Cum Gas All Zones: 448279 MCF

04077002480000	1519 ft	04077202950000	155 ft	04077002430000	1112 ft	04077205880000	293 ft	04077002470000
JOHN M. YOUNG CARDOZA 1 900 N 1400 E SW TWP: 2 S - Range: 5 E - Sec. 15 Spud Date=10/23/1964		RESOURCES INVESTMENT TRACY COMMUNITY 1 1100 N 2300 W SE TWP: 2 S - Range: 5 E - Sec. 15 Spud Date=5/24/1977		AMERADA HESS CORP. TRACY COMMUNITY 1 1 1185 N 2200 W SE TWP: 2 S - Range: 5 E - Sec. 15 Spud Date=2/8/1964		TRI-VALLEY OIL & GAS PIMENTAL 1-15 1234 FSL 2055 FWL TWP: 2 S - Range: 5 E - Sec. 15 Spud Date=1/13/1997		JOHN M. YOUNG YOUNG-AMERADA COMM 1 1700 N 1700 E SW TWP: 2 S - Range: 5 E - Sec. 15 Spud Date=2/11/1965

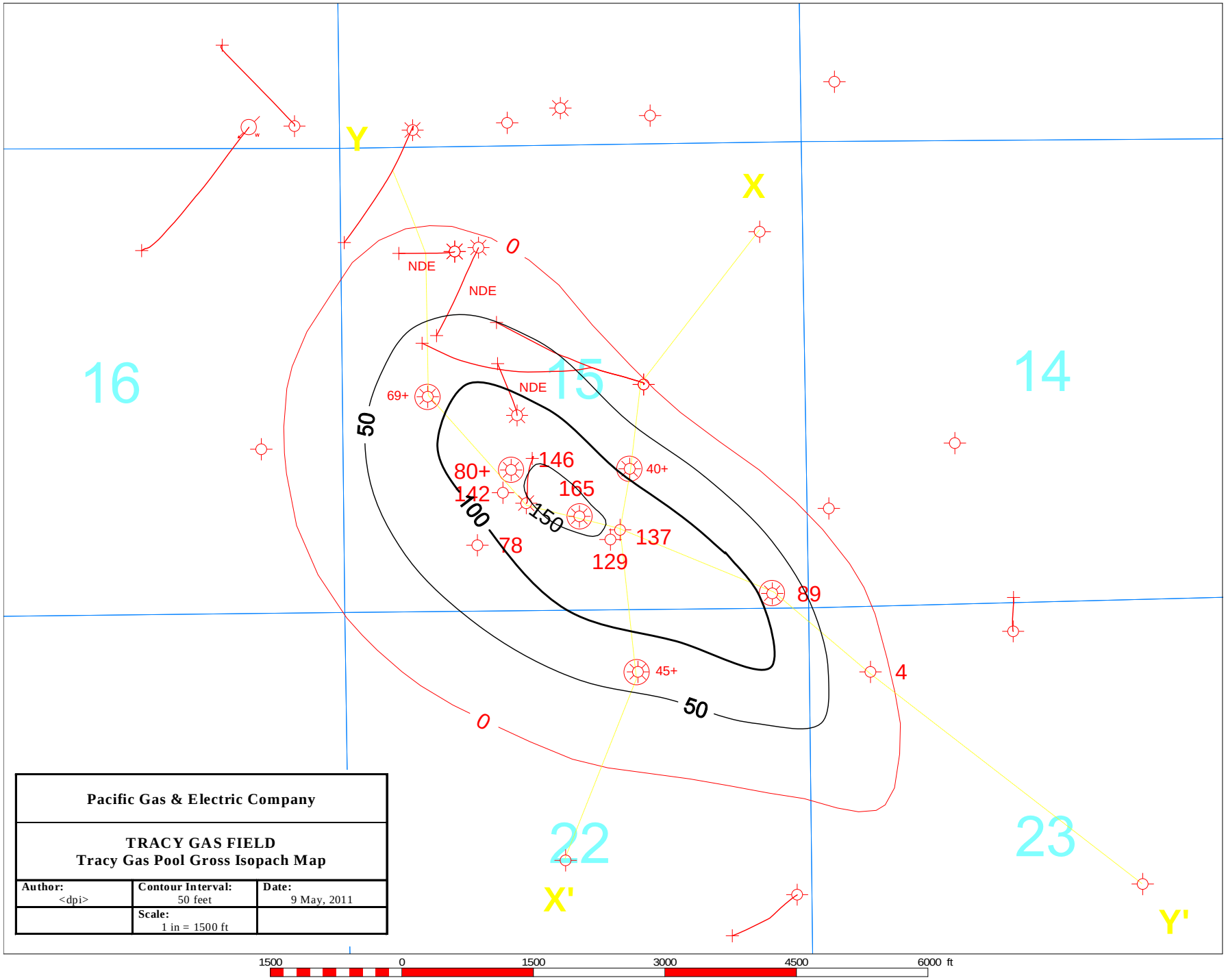


ATTACHMENT 11



Pacific Gas & Electric Company		
TRACY GAS FIELD Structure-Contour Map Top Tracy Formation		
Author: dpi	**Contour Interval:** 100 feet	**Date:** 9 May, 2011
	Scale: 1 : 24,000	

ATTACHMENT 12



Pacific Gas & Electric Company		
TRACY GAS FIELD Tracy Gas Pool Gross Isopach Map		
Author: <dpi>	**Contour Interval:** 50 feet	**Date:** 9 May, 2011
	Scale: 1 in = 1500 ft	

ATTACHMENT 13

PACIFIC GAS & ELECTRIC COMPANY
TRACY GAS FIELD CROSS SECTION A-A'
Structural Cross Section Datum = 0 ft Subsea
Horizontal Scale = 1 in per 400 ft; Vertical Scale = 1 in per 200 ft
Vertical Exaggeration = 2X

Cum Gas All Zones: 262470 MCF
04077203840000

1502 ft

MARATHON OIL CO.
ROSSI 1
TWP: 2 S - Range: 5 E - Sec. 10
Spud Date=11/20/1981

Cum Gas All Zones: 820249 MCF
04077205310001

479 ft

NAHAMA & WEAGANT
1-15RD
TWP: 2 S - Range: 5 E - Sec. 15
Spud Date=8/3/1992

Cum Gas All Zones: 122365
04077205320000

1220 ft

NAHAMA & WEAGANT
TRACY 2-15
1735 S 1187 E NW
2 S - Range: 5 E - S
Spud Date=3/3/1990

Cum Gas All Zones: 621560 MCF
04077205400000

1103 ft

NAHAMA & WEAGANT
TRACY 3-15
2525 N 1850 E SW
TWP: 2 S - Range: 5 E - Sec. 15
Spud Date=12/22/1990

04077002470000

JOHN M. YOUNG
YOUNG-AMERADA COMM 1
1700 N 1700 E SW
TWP: 2 S - Range: 5 E - Sec. 15
Spud Date=2/11/1965

-2500
-3000
-3500
-4000
-4500
-5000

Miocene-Pliocene Undifferentiated

Miocene Gas Pool

G/W -3445 ft subsea

BeePee Horizon

?

TD=3757

Blewett Formation

TD=3608

TD=3875

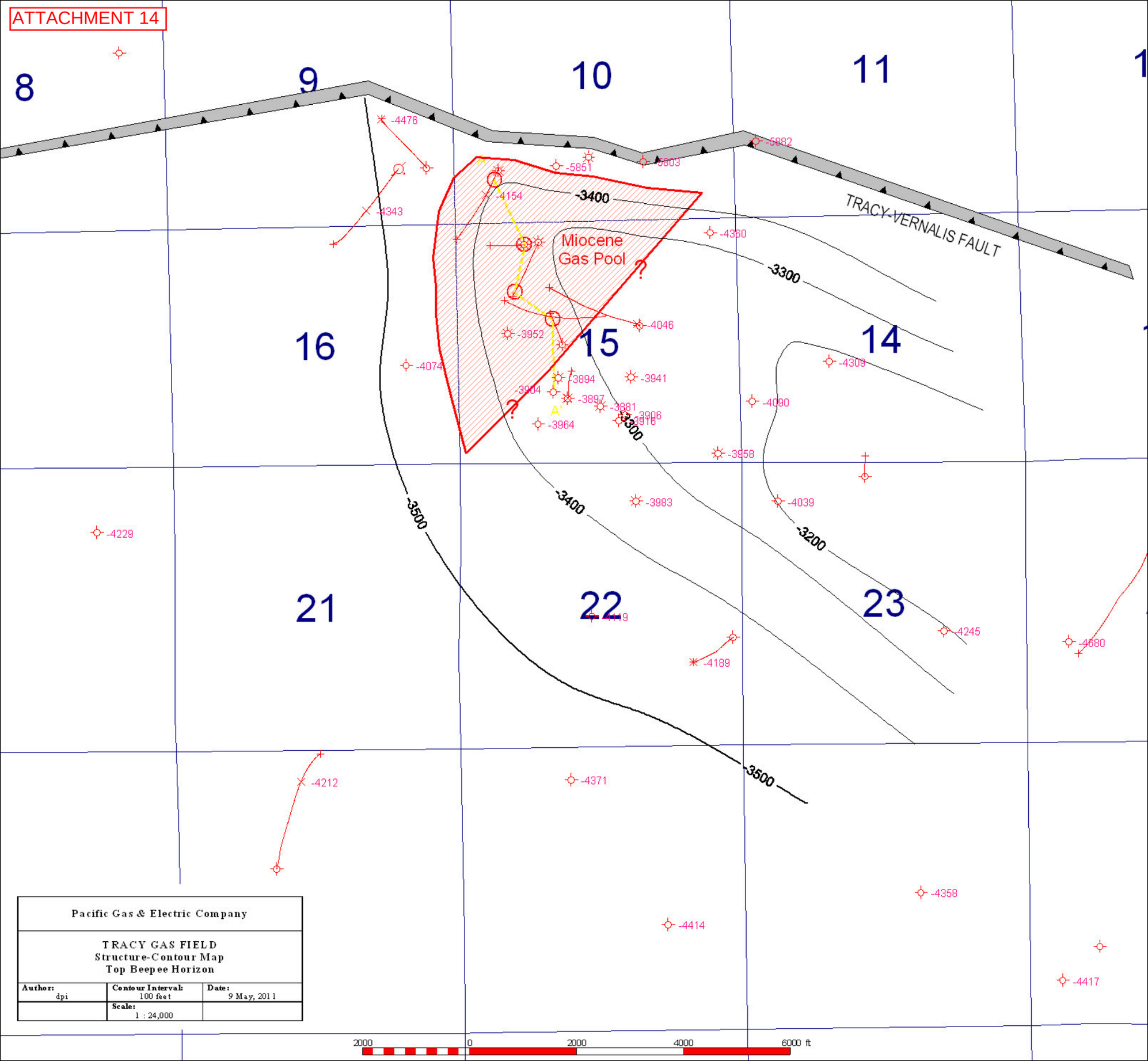
Ragged Valley Shale

Tracy Formation

TD=4300

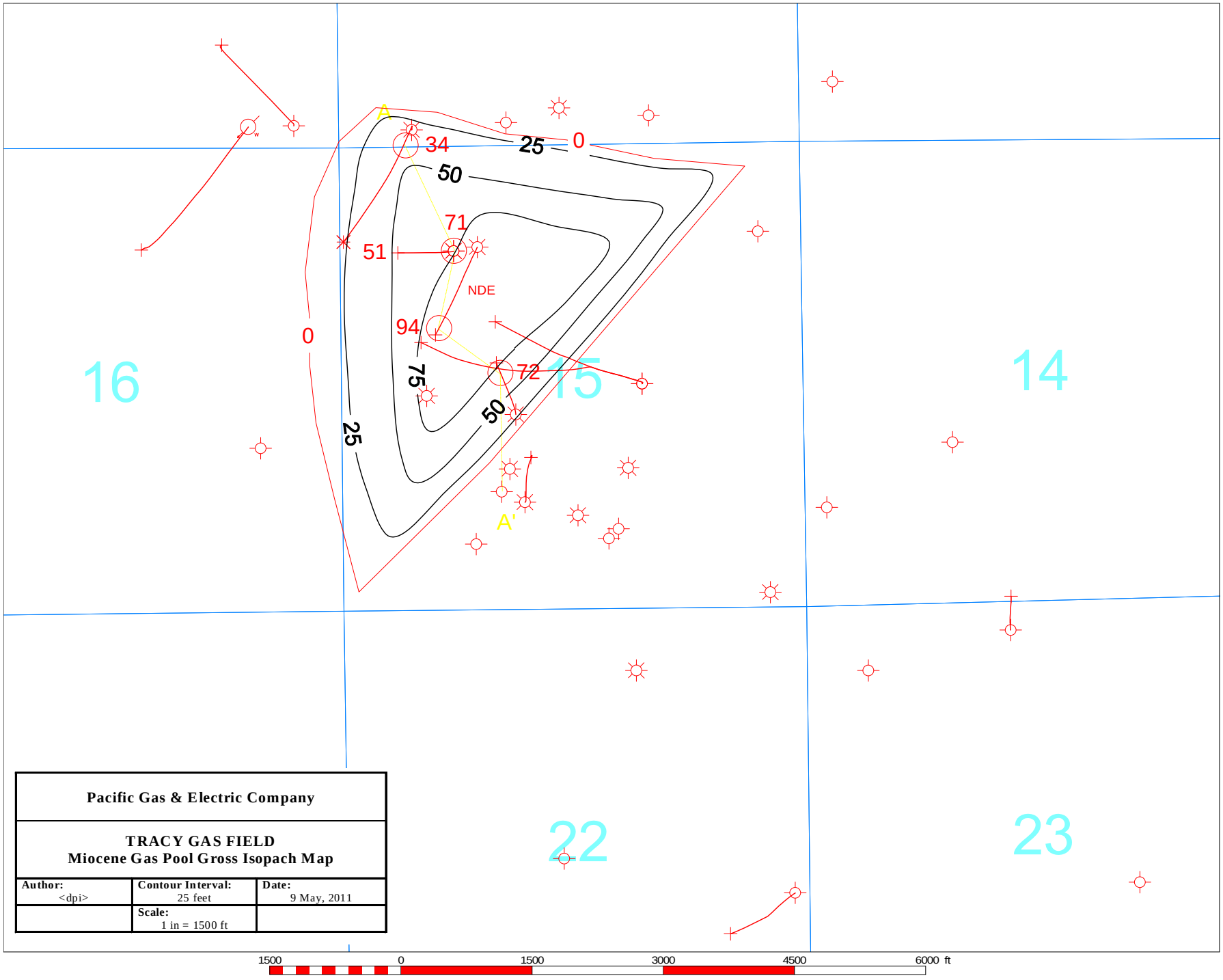
TD=7000

ATTACHMENT 14



Pacific Gas & Electric Company		
TRACY GAS FIELD Structure-Contour Map Top Beepee Horizon		
Author: dpi	**Contour Interval:** 100 feet	**Date:** 9 May, 2011
	Scale: 1 : 24,000	

ATTACHMENT 15



Pacific Gas & Electric Company		
TRACY GAS FIELD Miocene Gas Pool Gross Isopach Map		
Author: <dpi>	**Contour Interval:** 25 feet	**Date:** 9 May, 2011
	Scale: 1 in = 1500 ft	

Gas Field GIS Environmental Evaluation

Field Name: Tracy

Resource Category	Presence/Potential Direct Effects: Station	Field	0.25mi	5mi	Linears	Indirect Effects	Comments & Mitigation Options	R-Y-G
Scenic Highway	No	No	No	No	No	No	State Scenic I-580 6.5 mi from station site	
Airport/Approach Patterns	No	No	No	No	No	No	Tracy Municipal Airport located 5.4 miles to SW. Runway patterns are E-W and NW-SE, not toward site	
Envirostor List Site	No	No	No	No	No	No	Nearest sites are voluntary cleanups at the PG&E MGP site ~1 mi S and Haley Flying Service ~1.5 mi E.	
Federal Sensitive Species								
Suitable Habitat	No	No	No	No	No	No	Valley elderberry in sloughs ~0.5 N of GT/ET Interconnect site.	
Critical Habitat	No	No	No	No	No	Delta Smelt	Avoid impacts on waterways. Extremely difficult to obtain take permit for smelt - need to avoid impacts to waterways	
State Sensitive Species								
Suitable Habitat	Yes	Yes	Yes	Yes	Yes	Swainsons Hawk & Tri-colored blackbird	Swainsons Hawk nests primarily to N along sloughs. Ag lands in project area are foraging habitat. Blackbird nesting habitat along sloughs only - no project effects. Hawk foraging habitat mitigation generally available.	
ACEC/Protected Lands	No	No	No	No	No	No	Farmland trust and CDFG conservation easements on ag lands to SW	
Urban Lands	No	Yes	Yes	Yes	Yes	No	Station site is currently ag, but zoned industrial & commercial. Field area is primarily industrial w/some commercial.	
Rural Residential (aerial photo) & Potential EJ Issues	No	No	Yes	Yes	Yes	No	Single-family farm-based residential to N & E -- station proximity to existing industrial land uses and industrial zoning should preclude EJ issues.	
Public Lands	No	No	No	Yes	Yes	No	State Lands Commission, DOD, City of Tracy properties	
Tribal Lands	No	No	No	No	No	No	No tribal lands	
Williamson Act Contracts	No	N/A	N/A	N/A	N/A	N/A	Contract issue only applies to Station	
Farmland Class	Prime	P/L/U	P/L/U	P/L/U/O	P/L/U/O		P-Prime; L-Local, U-Unique, O-Other - May need to mitigate for loss of prime farmland via conservation easement	
Crop Types	Alfalfa	Row	Row	Row	Row	N/A	No orchards, vineyards or other permanent crops.	
Wetlands	No	No	Yes	Yes	No	N/A	Waste water ponds and sloughs to north show as wetlands.	
Vernal Pools	No	No	No	No	No	No	No vernal pools present in project area	
Flood Zones	Yes	Yes	Yes	Yes	Yes	N/A	Except for narrow strip along I-205, 100-yr flood extends north toward delta. Since station site is on margin, building pad elevations will need to be above flood level.	

TRACY RESERVOIR

Summary and Decision

The Tracy Reservoir, located in San Joaquin County, California (City of Tracy), approximately 60 miles southeast from San Francisco, was not selected for detailed modeling and was not a finalist candidate for the following reasons:

- Presence of clays indicated low permeability; this factor would affect deliverability for a full-scale CAES facility.
- Numerous plugged/abandoned wells penetrated the reservoir of interest, leading to concerns about reservoir integrity and/or requirements to re-enter those wells to re-plug/abandon them.

Subsurface/Reservoir Screening

Preliminary Screening Results

The Tracy Gas Field was identified in the very early reservoir screening process as having potential for CAES testing and potential development. The Tracy Gas Field was the first commercial gas field in northern California, discovered by Amerada Petroleum Corporation in 1935 and having accounted for production of over 17 Bcf. Based on the potential fit with desired characteristics for a CAES project, the project team commissioned a more complete analysis of the field.

Detailed Geological Summary

On May 12, 2011, a geological assessment of the field was compiled, entitled "Geology and Gas Production of the Tracy Gas Field" (Tracy—Geological Report.pdf, Tracy—Geological Appendix.pdf). That report identified the Tracy Formation within the Tracy Gas Field as having the potential for a CAES project. The Tracy Formation had accounted for production of 14 Bcf from a single reservoir at a depth of approximately 4,000 ft, a thickness of up to 150 ft, and an aerial extent of approximately 650 acres. Very high production rates were attributed to high porosity and permeability. Six productive wells were drilled into the Tracy Formation with very high initial production rates, ranging from 35,000 to 65,000 Mcfd. These wells were typically drilled and cored to the top of the Tracy Formation, cased, and then cored to total depth through the gas pool. The initial reservoir pressure of 1,850 psi declined over the period of production to a final flowing casing pressure of 300 to 500 psi. Based on this performance, the project team assumed that the reservoir is primarily depletion driven with a water-drive component.

The Tracy Formation is 1,500 ft thick in the vicinity of the Tracy Gas Field and exhibits excellent reservoir characteristics. Porosity reported by the California Division of Oil, Gas and Geothermal Resources (DOGGR) is 28%, and the initial water saturation is 30%. Log-derived porosities are in the high 30% range. Permeabilities are assumed to be high based on the

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production history, but none of the core data reviewed confirmed this. The core from the Amerada Petroleum Corp. F.D.L. No. 2 well yielded only one sample analyzed by CoreLab. This sample had a porosity of 25.7% and a permeability in air of 43.2 mD (Tracy—Amerada FDL No. 2 Core Description 10-31-11.pdf). The team determined that the low permeability results were likely due to a relatively high concentration of smectite and other clays, which can easily dislodge and clog the pore throats in the sandstone. Since only one sample was analyzed, the team recommended that analysis of additional core samples be conducted if Tracy was to be considered further.

Due to the early discovery of gas at Tracy and the subsequent exploration and production from deeper horizons, the reservoir of interest was reported to have 29 well penetrations. This high number of well penetrations raised concerns about the integrity of the reservoir and the ability to ensure that the reservoir will not leak through one of the old wells when filled with air.

Reservoir Modeling and Evaluation

Based on the results of the preliminary geological analysis and environmental concerns, the team determined that the Tracy Formation did not meet the requirements for a potential CAES project. In particular, concerns arose over the clay content in the reservoir, which could have a detrimental effect on reservoir performance, and the large number of old wells penetrating the reservoir, which could affect reservoir integrity. For these reasons, no further evaluation was conducted at the Tracy Gas Field.

Testing/Development Potential

No testing was conducted.

Siting and Environmental Evaluation

Determination – No Fatal Flaws

Based on a review of aerial photography overlaid by property lines and the gas reservoir boundary, the team selected a 40-acre parcel for the Energy Conversion Facility (ECF) site. The site is bounded on the south by Interstate Highway I-205 and on the west by a railroad track and the Tracy wastewater treatment plant. To the east of the station site is active agriculture. I-205 is elevated at this location, providing a significant barrier from the residential areas south of the freeway. The majority of the parcel is zoned industrial, with the southeast corner adjacent to the freeway on-ramp zoned commercial. The station site is prime farmland currently in alfalfa production, but is not under Williamson Act contract. The site is on the very edge of the 100-year flood zone. The nearest sensitive receptors to the station site are residences located approximately 2,200 ft to the north, and a residential subdivision approximately 800 ft to the south on the opposite side of the elevated freeway.

Gas transmission service at pressures that would work for a CAES facility are located approximately 2 miles west. The pipeline route would extend west and then follow existing

DRAFT

public roads through adjacent industrial and agricultural row crop land use to the connection point. The electric transmission gen-tie would connect with a 230-kV line, which parallels the gas pipeline route approximately 2 miles to the west. The gen-tie route would require approximately 0.5 mile of private rights to avoid two additional angle poles. No residences or schools lie along the gas or electric connection routes.

Although this area is part of the Pacific Flyway, a known waterfowl migration route, potential collision with the gen-tie would likely be reduced due to the primarily north-south orientation of the transmission line and location in the Tracy urban area. No conservation easements or riparian areas are in the vicinity.

Land Acquisition/Site Control

No land acquisition efforts were undertaken for the Tracy reservoir.

References

1) Tracy - Geological Report.pdf

2) Tracy - Geological Report Appendix.pdf

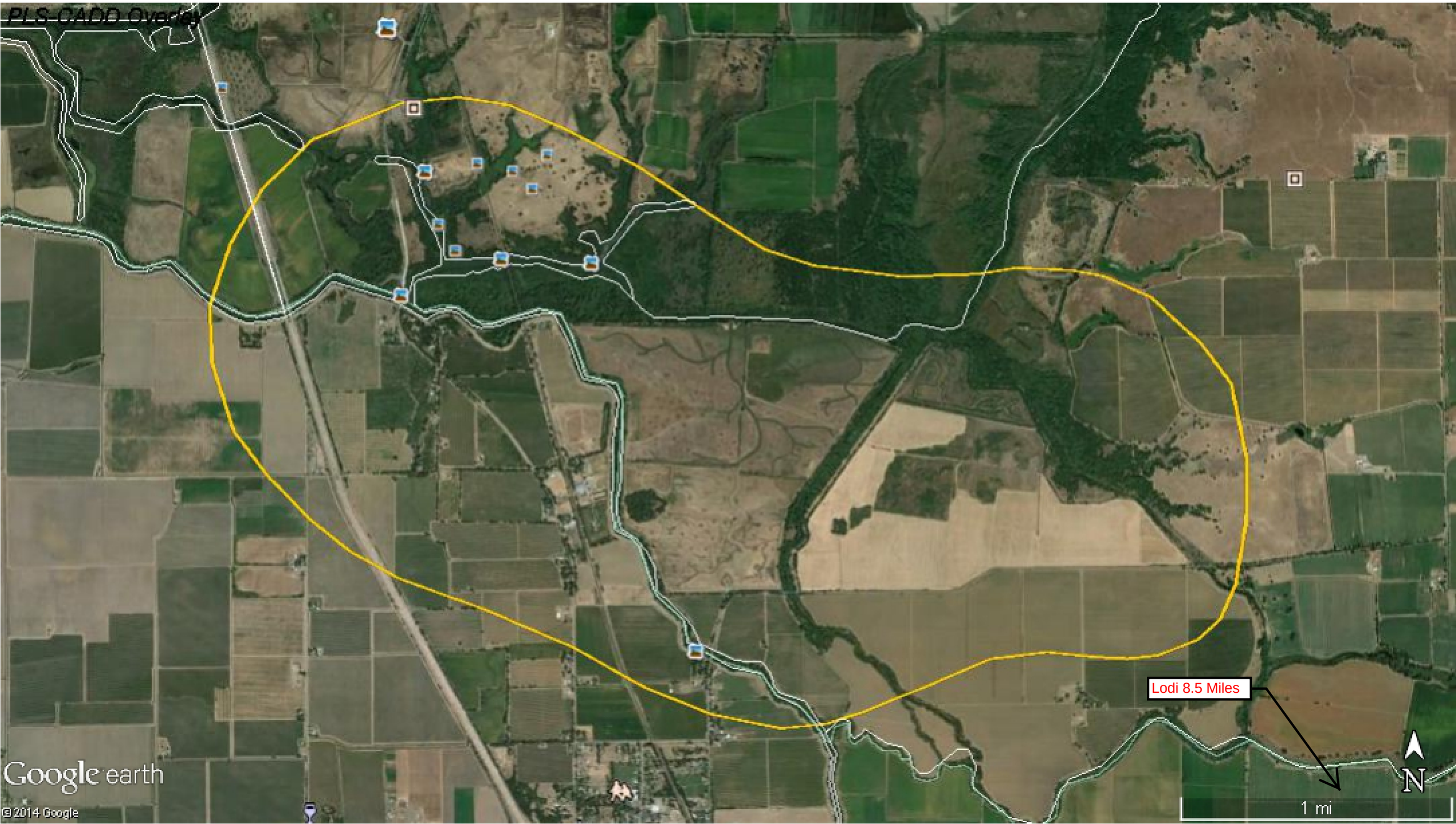
3) Tracy - Amerada FDL No. 2 Core Description 10-31-11.pdf

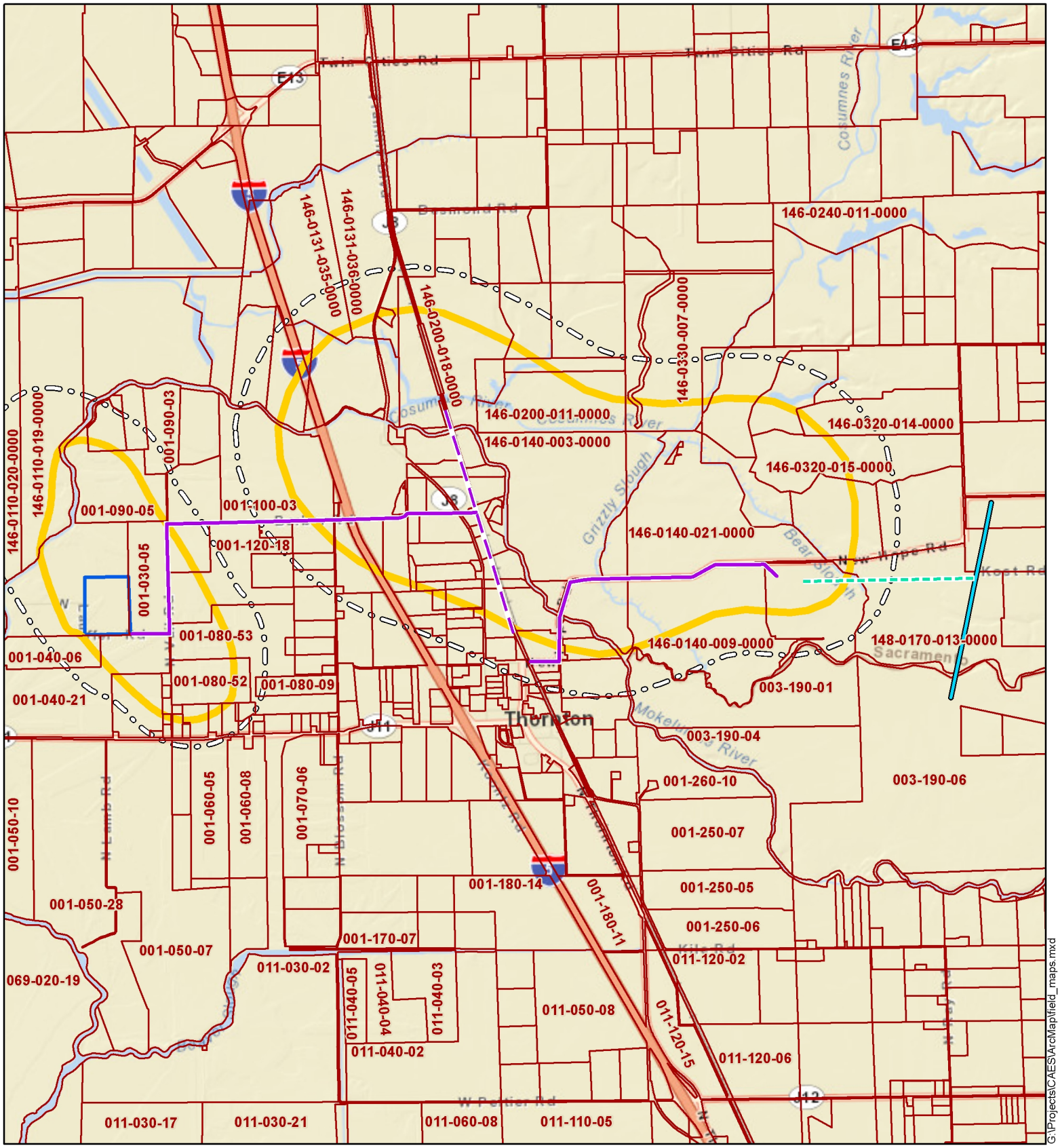
DRAFT

A308: West Thornton Site Selection and Attachments

West Thornton - Aerial Map.pdf
West Thornton - APN Map.pdf
West Thornton - Conservancy Map.pdf
West Thornton - Historic Permeability Data.pdf
West Thornton - Preliminary Geological Report.pdf
West Thornton Site Selection Close-Out - Final Report.pdf

West Thornton Aerial Map





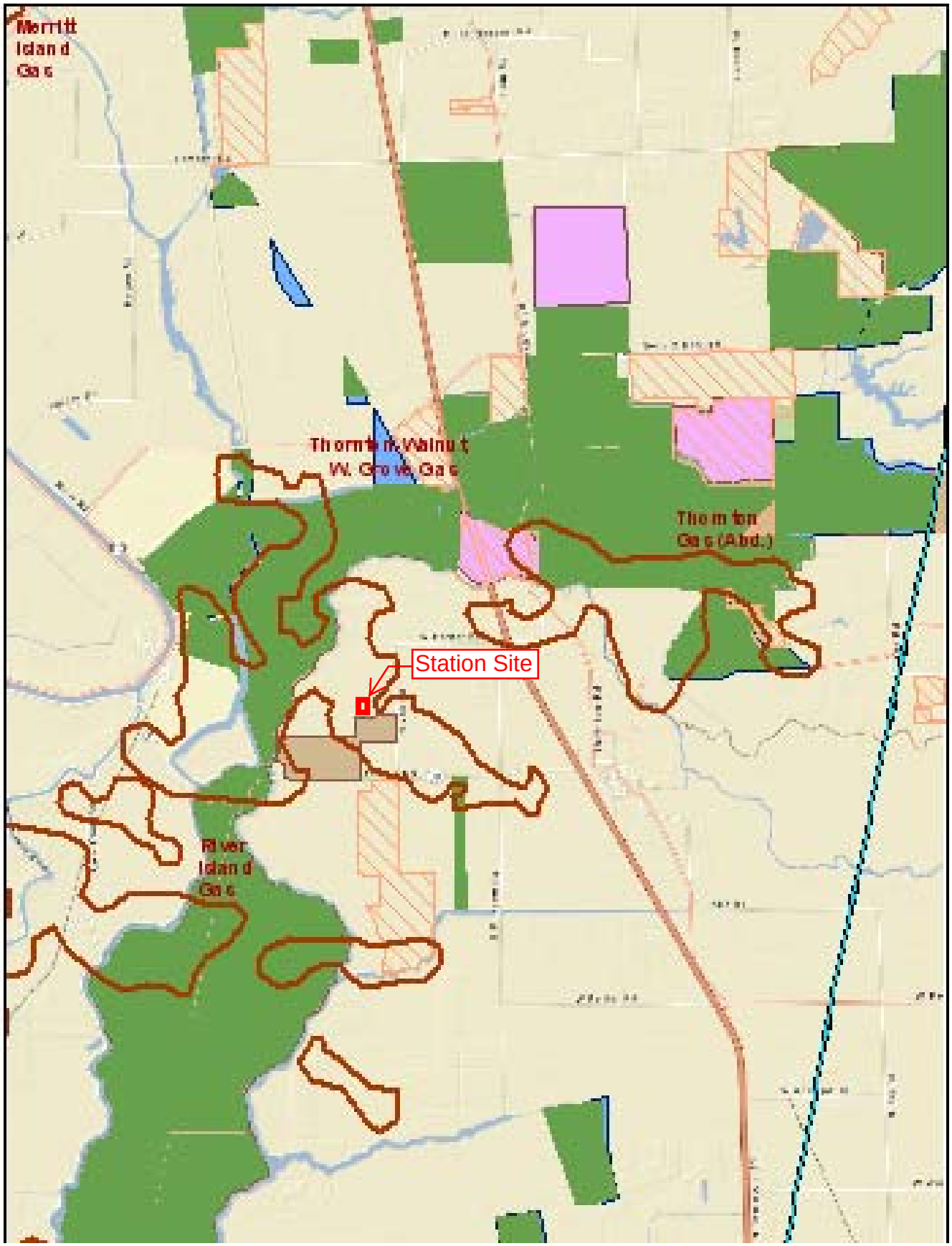
Thorton

- Approximate Structure Formation
- Parcels
- Air Pipeline
- Gas Supply
- Station Site
- 1,500' Buffer
- Existing 230 kV
- Gen-Tie
- Gas Line
- Water Supply Line
- Gas Pipeline Connection

1:55,000

0 1,700 3,400 5,100 6,800 8,500

Feet


Merritt Island Gas
Thornton/Walnut W. Grove Gas
Thornton Gas (Abd.)
Station Site
River Island Gas

RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL, GAS AND GEOTHERMAL RESOURCES

REPORT OF WELL PLUGGING AND ABANDONMENT

District 6, (916) 322-1110

Sacramento, California
January 30, 1996

Leslie H. Everett, Agent
PACIFIC GAS & ELECTRIC CO.
77 Beale Street, B32
San Francisco, CA 94177

Your report of abandonment of well "Bender" 1
API No. 077-20562, Sec. 28, T. 05N, R. 05E, M.D. B. & M.,
Thornton Gas field, San Joaquin County,
dated 12/05/95, received 12/14/95, has been examined in conjunction with records filed in this office. We have determined that all of the requirements of this Division have been fulfilled relative to removal of well equipment and junk, and the filing of well records.

NOTES: 1. Surface plugging completed on 10/11/95.

2. Site inspection made and approved 1/25/96.

Blanket Bond
MFC:sr

cc: Joe Chan, Walnut Creek Off.

WILLIAM F. GUERARD, JR.
State Oil and Gas Supervisor

By Robert A. Reid
Deputy Supervisor
ROBERT A. REID

OG159 (3/94/GSR1/2M)

DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES

CHECK LIST - RECORDS RECEIVED AND WELL STATUS

Company _____ Well No. _____

API No. 037-20562 Sec. _____, T. _____, R. _____, _____ B. & M.

County _____ Field _____

RECORDS RECEIVED	DATE
Well Summary (Form OG100)	12/14/95
History (Form OG103)	
Core Record (Form OG101)	
Directional Survey	
Sidewall Samples	
Other	
Date final records received	
Electric logs:	

STATUS		STATUS	
Producing - Oil	____	Water Disposal	____
Idle - Oil	____	Waterflood	____
Abandoned - Oil	____	Steamflood	____
Drilling - Idle	____	Fire Flood	____
Abandoned - Dry Hole	____	Air Injection	____
Producing - Gas	____	Gas Injection	____
Idle - Gas	____	CO_2 Injection	____
Abandoned - Gas	____	LPG Injection	____
Gas-Open to Oil Zone	____	Observation	____
Gas Storage	____	Waterflood Source	____

DATE 10/11/95 "E" well Yes ☐ No ☐

RECOMPLETED _____

REMARKS _____

ENGINEER'S CHECK LIST

1. Summary, History, & Core Record (dupl.) _____
2. Electric Log _____
3. Operator's Name _____
4. Signature _____
5. Well Designation _____
6. Location _____
7. Elevation _____
8. Notices _____
9. "T" Reports _____
10. Casing Record _____
11. Plugs _____
12. Surface Inspection _____
13. Production _____
14. E Well on Prod., enter EDP _____
15. Directional Survey _____

ENVIRONMENTAL INSPECTION

DATE 1-25-96

APPROVED _____

CLERICAL CHECK LIST

1. Location change _____ (F-OGD165) _____
2. Elevation change _____ (F-OGD165) _____
3. Form OGD121 _____
4. Form OG159 (Final Letter) _____
5. Form OGD150b (Release of Bond) _____
6. Duplicate logs to archives _____
7. Notice of Records Due (F-OGD170) _____
8. EDP (F-OGD42A-1, 2) _____

FINAL

RECORDS NOT APPROVED

Reason: _____

RECORDS APPROVED MFC

RELEASE BOND _____

Date Eligible _____

(Use date last needed records were received.)

MAP AND MAP BOOK 6/0 92-3581

LONG BEACH OFFICE - USE REVERSE SIDE

SUBMIT IN DUPLICATE
RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL AND GAS

Div. of Oil & Gas - Dist. 6
RECEIVED
DEC 14 1995
Sacramento, California

History of Oil or Gas Well

Operator Pacific Gas and Electric Company Field Thorton Field

Well No. Bender #1 (Abandonment) Sec. 28,T. 5N,R. 5E,M.D. B. & M.

Date: December 5, 1995 Signature: Thomas A. Wilson

Address: 375 N. Wiget Ln., Suite 130, Rm 101, Walnut Creek, CA. 94598

10/9/95 Moved in Rig and Killed Well.

Moved in rig and set up on well. Bled pressure from 500 psi to 0 psi in one hour. Pumped 240 bbls. water down tubing to try and kill well. Unable to kill well. Shut in and let stand over night.

10/10/95 Kill Well and Pump Cement Plug

Checked pressure on well, had no pressure. Changed well over with 225 bbls. 72# mud. Nippled down tree and nippled up class III BOP. Lowered tubing from 3494 to 3505. Equalized 81 sacks cement with 2% cal. (slurry wt. 15.1 ppg.). Displaced drill pipe with 18 bbls. mud. Called DOG to witness testing of plug. Plug soft after 4 hours, waited 3 more hours per DOG. Tagged plug at 3324'. Laid down excess 2-7/8" tubing to 650'. Mixed and equalized 60 sacks cement to 450'. Shut down rig.

10/11/95 Cut off Well Head and Moved Out Rig

Ran in and tagged top of cement plug at 480', DOG witnessed everything was OK. Cut off well head. Mixed 30 sacks cement. Placed 30' plug in 8-5/8" casing at surface and 30' plug in 13-3/8" x 8-5/8" annulus at surface. Loaded equipment and moved out.

RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION

DIVISION OF OIL AND GAS

No. T 695-168

REPORT ON OPERATIONS

District 6, (916) 322-1110

Leslie H. Everett, Agent
PACIFIC GAS & ELECTRIC CO.
77 Beale Street, B32
San Francisco, CA 94177

Sacramento, California
October 16, 1995

Your operations at well "Bender" 1, API No. 077-20562,
Sec. 28, T. 05N, R. 05E, M.D. B. & M. Thornton Gas
Field, in San Joaquin County,
were witnessed on 10/11/95. K. Lundy, representative of
the supervisor, was present from 0645 to 0720.
There were also present M. Cassel, drilling foreman
Present condition of well: 13 3/8" cem. 534', 8 5/8" cem. 3424', 5 1/2" ld. 3505'- 3390', perf. 3390-3505', T.D. 3581'. Plugged w/cem. 3505'- 3324', & 650'- 480'.

The operations were performed for the purpose of abandonment.

DECISION:

The plugging operations as witnessed by the Division of Oil, Gas and Geothermal Resources were not performed in accordance with the plugging and abandonment permit (No. 695-176, dated August 8, 1995) issued by the Division. If a problem should develop with this well in the future, Pacific Gas & Electric Co. will be responsible to alleviate the problem according to the Division's instructions.

Blanket Bond
KL:sr

10-25-96
KL

William F. Guerard Jr., State Oil and Gas Supervisor

By Robert A. Reid
Deputy Supervisor
Robert A. Reid

OG109 (9/89/GSR1/5M)

DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES

CEMENTING/PLUGGING MEMO

Operator PACIFIC GAS & ELECTRIC CO. Well No. "BENDER" 1

API No. 077-20562 Sec. ____, T. ____, R. ____, ____ B&M

Field THORNTON GAS, County SAN JOAQUIN. On 10-11-95,

Mr./Ms. K. KUNDY, representative of the supervisor, was present from 0540 to 0730.

There were also present MR. M. CASSEL, DF.

Casing record of well: 13 3/8" CEM. 534'; 8 5/8" CEM. 3424'; 5 1/2 Hd. 3505'-3390', PERF 3390-3505'. T.D. 3581'. PLUGGED W/CEM 3505'-3324' & 450'-480'.

The operations were performed for the purpose of ABD

☐ The plugging/cementing operations as witnessed and reported are approved.

☐ The location and hardness of the cement plug @ _____' are approved.

Hole size: _____" fr. _____' to _____', _____" to _____' & _____" to _____'

Casing				Cemented			Top of Fill		Squeezed Away	Final Press.	Perfs.
Size	Wt.	Top	Bottom	Date	MO-Depth	Volume	Annulus	Casing			

Casing/tubing recovered: _____" shot/cut at _____', _____', _____' pulled fr. _____';

_____" shot/cut at _____', _____', _____' pulled fr. _____'.

Junk (in hole): _____

Hole fluid (bailed to) at _____'. Witnessed by _____

Mudding	Date	bbls.	Displaced	Poured	Fill	Engr.
72#	10/10		—			KL

Cement Plugs		Placing	Placing Witnessed		Top Witnessed			
Date	Sx./cf	MO & Depth	Time	Engr.	Depth	Wt/Sample	Date & Time	Engr.
10/10	81 SXS	TOC 3505	—	—	—	NO TAG	10/10 NO TAG	KL
10/10	✓	✓	—	—	3324	10M	10/10 1400	KL
10/10	60 SXS	TOC @ 650			480	✓	10/11 0700	KL

OGD10 (11/93/GSR1/5M)

STATE OF CALIFORNIA—THE RESOURCES AGENCY

PETE WILSON, *Governor*

DEPARTMENT OF CONSERVATION

DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES - DISTRICT 6

801 K Street, MS 20 - 22
SACRAMENTO, CALIFORNIA 95814-3530
(916) 322-1110
TDD (916) 324-2555
TELEFAX (916) 323-0424

October 13, 1995

Leslie H. Everett, Agent
PACIFIC GAS & ELECTRIC COMPANY
77 Beale Street, B32
San Francisco, CA 94177

Dear Ms. Everett:

On August 4, 1995, the Division of Oil, Gas, and Geothermal Resources received an Notice of Intention to plug and abandon P.G.&E.'s well "Bender" 1 (077-20562). The abandonment program was modified to meet state standards, and a note was added (please see attachment) to read the program carefully because of the changes to the original program.

On October 11, 1995, a division engineer witnessed the plugging operations as specified in the permit. No permit was on site, and the engineer did not realize the well was plugged following the original program until he returned to the office. It is very important to read and evaluate all permits issued by the Division. If there are questions, or concerns, regarding the permit, they should be brought to the Division's attention before the work begins. Please take the necessary steps to ensure that all permits are read and followed when conducting well operations.

If you have any questions, or if you would like to discuss this matter further, please contact me at (916) 322-1110.

Sincerely,

Robert S. Habel

Robert S. Habel
Associate Engineer

Enclosure

cc: Joe Chan - P.G.&E.

RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES

PERMIT TO CONDUCT WELL OPERATIONS

No. P 695-176
770 (field code)
00 (area code)
-- (new pool code)
00 (old pool Code)

Leslie H. Everett, Agent
PACIFIC GAS & ELECTRIC CO.
77 Beale St., B32
San Francisco, CA 94177

Sacramento, California
August 8, 1995

Your proposal to abandon well "Bender" 1,
A.P.I. No. 077-20562, Section 28, T. 5N, R. 5E, M.D.B.& M.,
Thornton Gas field, Any area, No Pool Breakdown pool,
San Joaquin County, dated 8/2/95, received 8/4/95 has examined in conjunction with records filed in this office.

THE PROPOSAL IS APPROVED PROVIDED THAT:

1. Blowout prevention equipment conforming to Class "II" 2M requirements is installed on the 8-5/8" casing and maintained in operating condition at all times. See Manual M07 and attached sheet.
2. Wire line operations are conducted through at least a 2M lubricator.
3. All portions of the hole not plugged with cement are filled with inert mud fluid having a minimum density of 70 lbs./cu. ft and a minimum gel-strength (10 min.) of 20 lbs./100 sq. ft.
4. The hole is plugged with cement from 3505' to 3290'.
5. The hole is plugged from 740 ' to 640 ', and from 30' to 5'.
6. All annuluses between casings are filled with cement from 30' to 5'.
7. **THIS DIVISION IS NOTIFIED:**
   a. To witness the location and hardness of the cement plug at 3290 '.
   b. To witness the location and hardness of the cement plug at 640 '.
   c. To witness the placing of the surface plug.

NOTE:
1. All casing must be removed from at least 5 feet below ground level.
2. The cleanup of the wellsite must be approved by the Division before the Report of Final Well Abandonment (Form OG159) can be issued. ***Please contact this office for site inspection after the wellsite cleanup work has been completed.***
3. PLEASE READ THIS PROGRAM CAREFULLY, THERE HAVE BEEN SOME CHANGES FROM YOUR ORIGINAL PROGRAM!

Blanket Bond
RSH:sr

attachment

Engineer Robert S. Habel

Phone (916) 322-1110

WILLIAM F. GUERARD, JR., State Oil and Gas Supervisor

By Robert A. Reid

Robert A. Reid, *Deputy Supervisor*

cc: Joe Chan

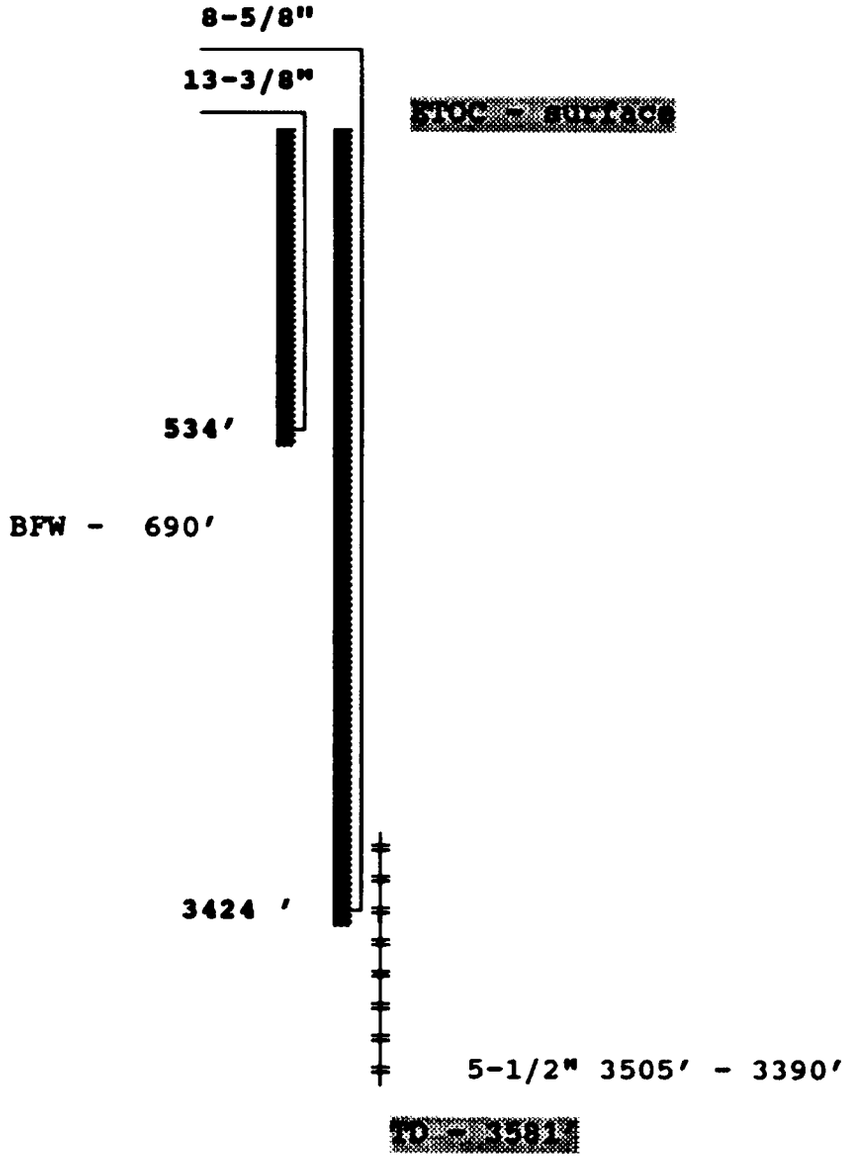
A copy of this permit and the proposal must be posted at the well site prior to commencing operations.

Records for work done under this permit are due within 60 days after the work has been completed or the operations have been suspended.

OG111 (2/95/GSR1/5M)

"Bender" 1

Spud Date: 6/24/92
RSH - August 7, 1995
Well Class - Development (OG)



KEY

|	Casing	▬	Cement
+	WSO Hole	⊕	Fish
‡	Perf.	▬	Bridge plug/Retainer

Div. of Oil & Gas - Dist. 6
RECEIVED
AUG 0 4 1995
Sacramento, California

STATE OF CALIFORNIA
DEPARTMENT OF CONSERVATION

DIVISION OF OIL AND GAS

Notice of Intention to Abandon Well

FOR DIVISION USE ONLY			
CARDS	BOND	FORMS	
		OGD114	OGD121
✓	BB	✓	✓

DIVISION OF OIL AND GAS

In compliance with Section 3229, Division 3, Public Resources Code, notice is hereby given that it is our intention to abandon well BENDER # 1, API No. 077-20562, Sec. 28, T. 5N, R. 5E, MD B. & M., THORNTON Field, SAN JOAQUIN County.

commencing work on SEPTEMBER 11, 1995.

The present condition of the well is:

1. Total depth - 3581' MD (3435' TVD)

2. Complete casing record, including plugs and perforations (present hole)
13 3/8" K-55, 8RD, CEMENTED FROM SURFACE TO 534'
8 5/8" K-55, 8RD. CEMENTED FROM SURFACE TO 3424'
5 1/2" LINER, K-55, 8RD, HUNG FROM 3390' TO 3505'
CEMENT PLUG FROM 3505' TO 3581'.

3. Last produced N/A (Date) (Oil, B D) (Gas, Mcf D) (Water, B D)

NOTE: THIS WELL WAS A RESEARCH PROJECT FOR COMPRESSED AIR ENERGY STORAGE.

4. Last injected N/A (Date) (Water, B D) (Gas, Mcf D) (Surface pressure)

Additional data for dry hole (show depths):

5. Oil or gas shows

6. Stratigraphic markers

7. Formation and age at total depth

8. Base of fresh water sands ~715'

9. Is this a critical well according to the definition on the reverse side of this form? ☐ Yes ☑ No

The proposed work is as follows:

1. MOVE IN RIG AND KILL WELL.
2. PULL TUBING AND LAY DOWN BOTTOM PERFORATED JOINT.
3. MIX, PUMP CEMENT WITH TUBING, AND SET CEMENT PLUG FROM 3324' TO 3505'.
4. PULL TUBING TO 650' AND SET CEMENT PLUG FROM 600' TO 700'.
5. PULL TUBING AND SET 30' SURFACE PLUG.
6. CUT CASING 6' BELOW SURFACE AND WELD STEEL PLATE.
7. MOVE OFF RIG.
8. RESTORE WELL PAD TO ORIGINAL CONDITIONS.

It is understood that if changes in this plan become necessary, we are to notify you immediately.

Address 375 N. WIGET LANE, STE. 170 (Street)
WALNUT CREEK, CA 94598 (City) (State) (Zip)
Telephone Number (510) 746-4223 (Area Code) (Number)

PACIFIC GAS & ELECTRIC CO. (Name of Operator)
By JOSEPH C. CHAN (Print Name)
(Signature) 8/2/95 (Date)

OG108 (11/88/DWRR/5M)

DIVISION OF OIL AND GAS

CHECK SHEET - RECORDS RECEIVED AND WELL STATUS

Company _____ Well No. _____

API No. 077-20562 Sec. _____, T. _____, R. _____, _____ B.&M.

County _____ Field _____

RECORDS RECEIVED	DATE
Well Summary (Form OG100)	9/24/92
History (Form OG103)	
Core Record (Form OG101)	
Directional Survey	9/22/92
Sidewall Samples	
Other	
Date final records received	
Electric logs:	
MUD	9/22/92
DIL	
GAMMA	
CNL	
CBL	
CYBERLOOK	

STATUS		STATUS	
Producing - Oil	___	Water Disposal	___
Idle - Oil	___	Waterflood	___
Abandoned - Oil	___	Steamflood	___
Drilling - Idle	___	Fire Flood	___
Abandoned - Dry Hole	___	Air Injection	___
Producing - Gas	___	Gas Injection	___
Idle - Gas	___	CO_2 Injection	___
Abandoned - Gas	___	LPG Injection	___
Gas-Open to Oil Zone	___	Observation	___
Gas Storage	___	Waterflood Source	___

DATE _____ "E" well Yes ☐ No ☐

RECOMPLETED _____

REMARKS _____

ENGINEER'S CHECK LIST

1. Summary, History, & Core record (dupl.) ✓
2. Electric Log ✓
3. Operator's Name ✓
4. Signature ✓
5. Well Designation ✓
6. Location ✓
7. Elevation ✓
8. Notices ✓
9. "T" Reports ✓
10. Casing Record ✓
11. Plugs ✓
12. Surface Inspection ✓
13. Production ✓
14. E Well on Prod., enter EDP _____
15. Directional Survey _____

CLERICAL CHECK LIST

1. Location change ____ (F-OGD165) _____
2. Elevation change ____ (F-OGD165) _____
3. Form OGD121 ✓
4. Form OG159 (Final Letter) _____
5. Form OGD150b (Release of Bond) _____
6. Duplicate logs to archives _____
7. Notice of Records due (F-OGD170) _____
8. EDP (F-OGD42A-1, 2) _____

RECORDS NOT APPROVED

Reason: Good

RECORDS APPROVED MFC

RELEASE BOND _____

Date Eligible _____

(Use date last needed records were received.)

MAP AND MAP BOOK 9 6/0

LONG BEACH OFFICE - USE REVERSE SIDE

OGD2 (5/89/GSR1/5M)

RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION

DIVISION OF OIL AND GAS

Div. of Oil & Gas - Dist. 6
RECEIVED
SEP 22 1992
Sacramento, California

WELL SUMMARY REPORT

SUBMIT IN DUPLICATE

Operator Pacific Gas & Electric, Well No. Bender #1, API No. 077-20562,

Sec. 28, T. 5N, R. 5E, MDB. & M., Thornton Gas Field, San Joaquin County.

Location 1310'N & 100'W from SE corner
(Give surface location from property or section corner, or street center line and/or lambert coordinates)

. Elevation of ground above sea level 5.0 feet.

All depth measurements taken from top of Kelly Bushing which is 18.0 feet above ground.
(Derrick Floor, Rotary Table or Kelly Bushing)

In compliance with Sec. 3215, Division 3 of the Public Resources Code, the information given herewith is a complete and correct record of the present condition of the well and all work done thereon, so far as can be determined from all available records.

Date September 15, 1992 Signed Charlie J. Bond

Charlie J. Bond (Engineer or Geologist) Title Supervising Engineer

Commenced drilling June 24, 1992

Completed drilling July 14, 1992

Total depth (1st hole) 3581' (2nd) (3rd)

Present effective depth 3505'

Junk

GEOLOGICAL MARKERS	DEPTH
CAPAY	3140MD(-2995TVSS)
CAPITAL SAND	3424MD(-3264TVSS)
MOKELUMNE RIVER	3534MD(-3368TVSS)

Formation and age at total depth Mokelumne-Cretaceous

Commenced producing 7/17/92 (Date) Flowing/gas lift/pumping (Cross out unnecessary words)

Name of producing zone Capital Sand

	Clean Oil bbl. per day	Gravity Clean Oil	Per Cent Water including emulsion	Gas Mcf. per day	Tubing Pressure	Casing Pressure
Initial production						
Production after 30 days						

CASING RECORD (Present Hole)

Size of Casing (A. P. I.)	Depth of Shoe	Top of Casing	Weight of Casing	Grade and Type of Casing	New or Second Hand	Size of Hole Drilled	Numbers of Sacks or Cubic Feet of Cement	Depth of Cementing if through perforations
13 3/8	534'	Surface	54.5	K-55, 8Rd	New	17 1/2"	590 cu.ft.	
8 5/8	3424'	Surface	32	K-55, 8Rd	New	12 1/4"	1492 cu.ft.	

PERFORATED CASING
(Size, top, bottom, perforated intervals, size and spacing of perforation and method.)

Was the well directionally drilled? Yes If yes, show coordinates at total depth 876.5'E and 26.5'S

Electrical log depths 3575' to 534' Other surveys LDT-CNL-GR, GST

OG 100 ATTACH ONE COPY OF EACH LOG AND SURVEY

27807-705 10-74 6M ⓢ OSP

Div. of Oil & Gas - Dist. 6
RECEIVED
SEP 2 2 1992
Sacramento, California

SUBMIT IN DUPLICATE
RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL AND GAS

History of Oil or Gas Well

Operator: Pacific Gas and Electric Co. Field: Thornton
Well: Bender #1 Location: 1310'N & 100'W from SE Corner
API No.: 20562 SEC. 28, T.5N, R. 5E, MDB&M
Date: September 15, 1992
Telephone: (510) 746-4234 Signature: Charlie J. Bond

Name: Charlie J. Bond, Supervising Engineer Gas Production and Storage Department
Address: 375 N. Wiget Lane, Suite 170, Walnut Creek, Ca 94598

BENDER #1

DRILLING HISTORY

06/24/92 Rig rigged up on well; hauled water. Mixed Spud Mud and picked up 17-1/2" bit and collar. Drilled to 160', pulled out of hole and changed bit. Made up and ran in hole with 17-1/2" bit #2. Drilled from 160' to 534' T.D. Circulated hole clean.

06/25/92 Wiped hole and circulated clean. Surveyed @ 534' 1 deg. 15 min. Pulled out of hole. Rigged up to run casing. Ran 13 joints of 13-3/8" casing as follows:
Casing shoe tack welded on first joint.
Insert float valve in second coupling from bottom.
Tack welded first two collars.
Baker locked first two thread connection above shoe.
Used 7 centralizers--placed centralizers across bottom four collars and placed remaining centralizers on every other collar after.
Landed casing shoe @ 534'. Ran cement job as follows: Rigged up cement equipment. Circulated and conditioned mud. Tested lines to 2000 psi. Pumped 18 bbls of fresh water ahead. Mixed and pumped 390 cu.ft. lead slurry of class "G" cement with 3% calcium chloride, 6% gel and 10 lbs. per sack gypseal. Mixed and pumped 200 cu.ft. tail slurry of class "G" cement with 3% calcium chloride. Released wiper plug and displaced with 76 bbls. of water. Bumped plug with 750 psi., cement in place @ 05:40 hrs. Rigged down cement trucks and cleaned out sump & flow line. Waited on cement. Cut off 20" conductor pipe @ bottom of cellar. Got cement to surface. Landed Shaffer 13-3/8" casing head 3" below ground level. Tested casing head with 3000 psi.

oil pressure. Nippled up BOPE and tested Blind Rams to 2000 psi. for 15 minutes, O.K.. Wait on cement.

06/26/92 Made up BHA and RIH. Attempted BOPE test for DOG. Closed pipe rams and pressured up to 2000 psig. Drill pipe was forced out of hole by hydraulic pressure and the kelly was jammed into the blocks. Received test plug from Shaffer Oil Tool Co. Pipe rams were damaged so they were replaced. Called DOG for retest. Pam Ceccarelli witnessed and approved all tests. RIH w/ used Hexadyne 12-1/4" bit. Tagged top of cement @ 478'. Found very hard cement all the way to the shoe @ 534'. Drilled to 647'. Circulated and surveyed @ 627' 0-30' S81W. POOH. Made up directional drilling assembly and RIH at time of report.

06/27/92 Started directional drilling from kick off point at 647'. Drilled, circulated, and surveyed @ 627'-0 deg. 30'-S81W @ 687'-2 deg.N86E @ 748'-4 deg. 15'-N82E @ 839'-6 deg. 45' N82E @ 928'-9 deg.-S88E @ 1025'-11 deg.15'-S88E. Drilled to 1166'. Wiped hole to shoe. Ran back to bottom. Surveyed @ 1116'-14 deg. 45'-N86E. Drilled ahead to 1252'. Circulated & surveyed @ 1210'-16 deg.-N88E. POOH. Picked up new mud motor. RIH. Oriented tool. Drilled to 1313' circulated & surveyed @ 1273' 17 deg.-N87E. Drilled to 1354 at time of report.

06/28/92 Drilled, circulated and surveyed @ 1334'-18 deg.15'-N89E @ 1395'-20 deg.-S89E. Drilled to 1425'. Circulated and pulled out of hole. Laid down mud motor and made up lock-in drilling assembly. Ran in hole with drilling assembly and reamed tight spots. Drilled, circulated, and surveyed @ 1493'-19 deg.45'-S84E. Drilled to 1650'; surveyed @ 1615'-19 deg.45'-S85E. Drilled to 1773'; surveyed @ 1738'-20 deg.S86E. Wiped hole to the shoe. Drilled to 1958' surveyed @ 1923'-20 deg.30'-S86E. Drilled to 2110' surveyed @ 2105'-20 deg.45'-S86E. Wiped hole to shoe. Laid down top stabilizer.

06/29/92 Drilled from 2110' to 2340'. Ran survey @ 2317'-21 deg.S86E. Wiped hole 10 stands. Drilled ahead from 2349' to 2569'. Circulated and surveyed at 2534' 20 deg. 45 min. S84E. Drilled ahead to 2661'; circulated hole clean. Pulled out of the hole and laid down lock-in assembly tools. Made up rerun 12 1/4" bit #4, mud motor & tools. Drilling ahead from 2661' to 2693' at report time.

1992 DRILLING HISTORY BENDER #1

06/30/92 Drilled ahead from 2693' to 2745' with mud motor, and made course correction. Ran surveys @ 2684' MD 20 deg. S89E and @ 2745' MD 19 deg. N88E. Pulled out of hole with mud motor and laid down. Made up and ran in hole with locked up assembly and drilled ahead from 2785' to 2905', surveyed at 2870' MD 18 deg. 15 min. N90E. Drilled to 2967' MD, circulated hole clean. Made a 10 stand wiper run, no problems. Drilled from 2967' to 3120', surveyed at 3085' 18 deg. 15 min. N88E. Drilled from 3120' to 3180' at report time.

07/01/92 Drilled ahead from 3180' to 3389' and ran surveys @ 3273' MD 19 deg. N89E and @ 3389' MD 19 deg. N90E. Wipe hole to casing shoe. Ran back in hole and circulated hole clean, and conditioned the mud system. Made a 10 stand wiper run, no problems. Circulated hole clean. Strapped out of hole with 12-1/4" locked up BHA. Made up and RIH with 9-7/8" core head, 8-1/4" core barrel with 5-1/4" fiberglass inner tube. Circulated to clean out inside the core barrel at report time.

07/02/92 Ran core from 3389' to 3391' and was unable to make any more hole. Pulled out of hole and found core head plugged with clay. Changed out core head and ran back to bottom at 3391'. Ran core from 3391' to 3418'. Circulated hole clean. POOH with core head #2, found core barrel empty, inner tube catch fingers and basket damaged and core head balled up. Changed out inner tube subs and made up core head #3. RIH to the shoe with core head #3, core barrel and inner tube #1. Stopped RIH and slipped the drill line. Continued to RIH with core barrel. Circulated hole to clean out inside of inner tube at report time.

07/03/92 Tagged bottom at 3390' and circulated core barrel clean. Worked over core from 3390' to 3417'. POOH and laid down core barrel. Recovered 7-1/2' of Capay shale. Top of recovery at 3390' to 3397.5'. MU & RIH with #2 core barrel to 3417' and cored to 3431'. Circulated hole and POOH with inner core tube #2. Laid down core barrel. Homco and Core Lab recovered approx. 15' of core from core tube #2. Reloaded core barrel with inner core tube #3 and new catcher subs. Made up core barrel run #5 with core head #3 and inner core barrel #3. On bottom, circulated hole to clean out inner core tube. Tagged bottom at 3429': Found 2' of fill. Started coring. Got back down to 3431' immediately. Cored from 3431' to 3433'. Circulated and POOH with inner core barrel #3 at report time.

1992 DRILLING HISTORY BENDER #1

07/04/92 POOH with core tube #3, no recovery. MU and reran core tube #3. Cored from 3433' to 3434'. Started torquing up; POOH to check tools. LD core tube, no recovery. PU,MU, & RIH with 9-7/8" bit to get through shale stringer. Tagged bottom at 3434', drilled to 3439'. Circulated bottoms up; got back mostly clay, some shale and little sand. Drilled another 5' to 3444'. Circulated bottoms up; got back some sand, some clay and little shale. POOH with 9-7/8" bit. Made up and RIH with core barrel run #7, core head #3, and inner core #3. Circulated to clear inner core tube. Tagged tight spot at 3437' to 3444', circulated bottoms up. Cored from 3445' at report time.

07/05/92 Cored from 3445' to 3448'. POOH & LD core tube, recovered 3' sand. Dropped off stabilizers and RIH. Tagged bottom at 3448' and circulated tube clean. Dropped ball and cored ahead to 3477'. Circulated and POOH. Recovered 30' of core sample. Found some gas trapped on top of core barrel, 30' of core sample taken was dry. Reloaded core barrel, with inner core tube #4 RIH with core head #3 and core barrel run #9. Circulated hole and tagged bottom at 3477'. Cored from 3477' to 3505'. Circulated hole, POOH with inner core tube #4. Recovered 29' of core sample. Drilled holes to relieve air/gas pressure from inside the core tube, where Homco technician will cut the core tube. Core sample seems to be a little damp and sandy. Reloaded core barrel with inner core tube #5. RIH with core head #3 and core barrel run #10, at time of report.

07/06/92 Continued to run in hole with core head #3 and core barrel run #10. Cored from 3506' to 3530'. Pulled out of hole with core barrel run #10. Recovered 24' of core sample, all sand & dry. Reloaded core barrel with core tube #6. Ran in hole with core barrel run #11. Cored from 3530' to 3546'. Pulled out of hole with run #11. Recovered 13' of sand which was becoming very ratty toward the bottom. Picked up 9-7/8" bit. Ran in hole. Drilled from 3546' to 3581'. Wiped hole. Ran back to bottom. Circulated hole clean for logs. Pulling out of hole at time of report.

07/07/92 Continued to pull out of hole and rigged up loggers. Ran logs as follows:

1. CNL-LDT-GR-CAL
2. Phasor Ind-SP
3. GST (Gamma Ray Spectrometry)

LOG TOPS
CAPITAL SANDSTONE
3424 MD, 3287 TVD (-3264 TVSS)
MOKELUMNE RIVER
3534 MD, 3391 TVD (-3368 TVSS)

Logs supervised by Jack Lentz ANR. Water saturation 80% + for entirety of reservoir except top 5-6 feet in 20-40% range. This interval shaley. Ran in hole open ended to plug back. Rigged up BJ for cement job. Pumped 10 bbls. water ahead, 16 bbls. class "G" neat slurry, 2 bbls. water behind, displaced with 37 bbls. of mud. Cement in place @ 1540 hrs. POOH. Made up 12-1/4" drilling assembly. RIH to surface casing shoe. Waited on cement.

07/08/92 Waited on cement. Ran in hole and reamed hole to 3389'. Drilled from 3389' to 3424' casing point. Circulated hole clean. Wiped hole to shoe. Ran back to bottom. Circulated hole clean and conditioned mud. Laid down drill pipe. Rigged up to run 8-5/8" casing.

07/09/92 Held safety meeting with rig crew and pick up machine crew. Picked up and ran in hole with 8-5/8" 32#, K-55, LT&C casing with shoe at 3424'. Rigged up BJ Services and installed cementing head and circulated hole clean. Held safety meeting with rig crew, BJ Services crew and Delta Vacuum truck drivers. Tested lines @ 2500 psi. Cemented 8-5/8" casing as follows: Mixed and pumped 36 bbls. of mud flush ahead. Mixed and pumped lead slurry which consisted of 219 bbls. (1232 cu.ft.-800 sacks)BJ Light Cement. Mixed and pumped tail slurry which consisted of 46 bbls. (260 cu.ft. 230 sacks)BJ Gas Check Cement. Displaced with 204 bbls. (1146 cu.ft.) of mud and ending with 10 bbls. of water. Bumped plug with 1000 psi. Had good circulation throughout cement job. CIP @ 08:30 hrs. Set slips with entire casing weight on slips-100,000#. Rigged down BJ Services. Removed BOPE. Trimmed 8-5/8" casing and landed tubing head. Tested seals with 2000 psig nitrogen and 3000 psig oil for 15 minutes each. Nippled up 8" BOPE.

07/10/92 Tested blind rams @ 2000 psi. for 15 minutes, O.K. Tested 3-1/2" pipe rams @ 1500 psi. for 15 minutes, O.K. Hydril bag leaking, replaced bag. Tested Hydril at 1500 psi. for 15 minutes, test good. Removed Shaffer's 2-7/8" back pressure valve and tubing hanger. Picked up Smith 7-5/8" bit , 6 joints 4-3/4" drill collars, drilling jars and 3-1/2" drill pipe. Reached depth at 3332'. Circulated up contaminated drilling mud. Tagged and drilled cement from 3337' to 3419'. Found float collar @ 3343'. Drilling ahead @ time of report.

1992 DRILLING HISTORY BENDER #1

07/11/92 Continued to drill ahead from 3419' to T.D. @ 3505'. Circulated hole clean. Pulled out of hole with 7-5/8" bit. Made up and ran in hole with open ended drill pipe with 8-5/8" casing scraper four joints up. Scraped 8-5/8" casing to 3390'. Circulated hole clean and pulled up into casing. Cleaned out rig pits and fluid surface system. Shipped Cypan Mud to Frac Tank and rigged up to change over mud system to clean filtered HEC/NaCl Brine. Pulled out of the hole with scraper, changed B.H.A. and RIH with 8-5/8" scraper to the shoe at 3424'. POOH and laid down casing scraper. Rigged up Schlumberger and run cement bond log from 3424' to 534'. Rigged down logging tools.

07/12/92 Made up and ran in hole with Tri-State 11" hole opener. Found casing shoe @ 3424'. Opened hole to 11" from 3424' to 3505'. Reamed hole, no tight spots, and circulated hole clean. Pulled up into casing and waited. Ran back to bottom and tagged for fill, no fill. Pulled out of hole and laid down hole opener. Ran in hole with open ended drill pipe. Cleaned out rig pits and changed over mud system from HEC/NaCl Brine to 2% KCL with GREEN dye. POOH with open ended drill pipe. PU & RIH with 5-1/2" liner. Tagged 17' of fill at 3488' and pulled up. Rechecking pipe and liner measurements at time of report.

LINER DETAIL

DESCRIPTION	O.D.	I.D.	LENGTH
Baker SC-1L Packer 86AB-47	7.640	4.750	4.82'
Mill Out Extension	6.671	4.950	4.05'
Blank Pipe	5.500	4.950	30.39'
Baker Weld Screen Liner, .012" slots	6.187	4.950	15.20'
Baker Weld Screen Liner, .012" slots	6.187	4.950	30.17'
Baker Weld Screen Liner, .012" slots	6.187	4.950	30.50'
TOTAL SCREEN LENGTH			115.13'

Liner Top at 3390 Liner Bottom at 3505

07/13/92 Continued rechecking pipe and liner measurement. Went back down. Tagged 20' of fill at 3485'. Pulled up into the shoe and waited 45 minutes. Went back down and tagged 31' of fill at 3474'. POOH with the 5-1/2" liner, chaining out of the hole. Laid down the 5-1/2" liner (liner in good condition). Made up and RIH with rerun 7-5/8" bit and drilling jars. Tagged 52' of fill at 3453'. Rigged up and changed over to Hec/NaCl Brine. Cleaned out hole to 3505' and circulated hole clean. Pulled up into the shoe and continued to circulate. Ran back to bottom and tagged 18' of fill. Cleaned out hole again and pulled into casing shoe. Continued to circulate hole clean. Ran back to bottom at 3502' had 3' of fill. Cleaned out to 3505' and drilled ahead to 3511'. POOH and laid down 7-5/8" bit. MU and RIH with 5-1/2" liner to 3505'. Tagged no fill at time of report.

TUBING DETAIL

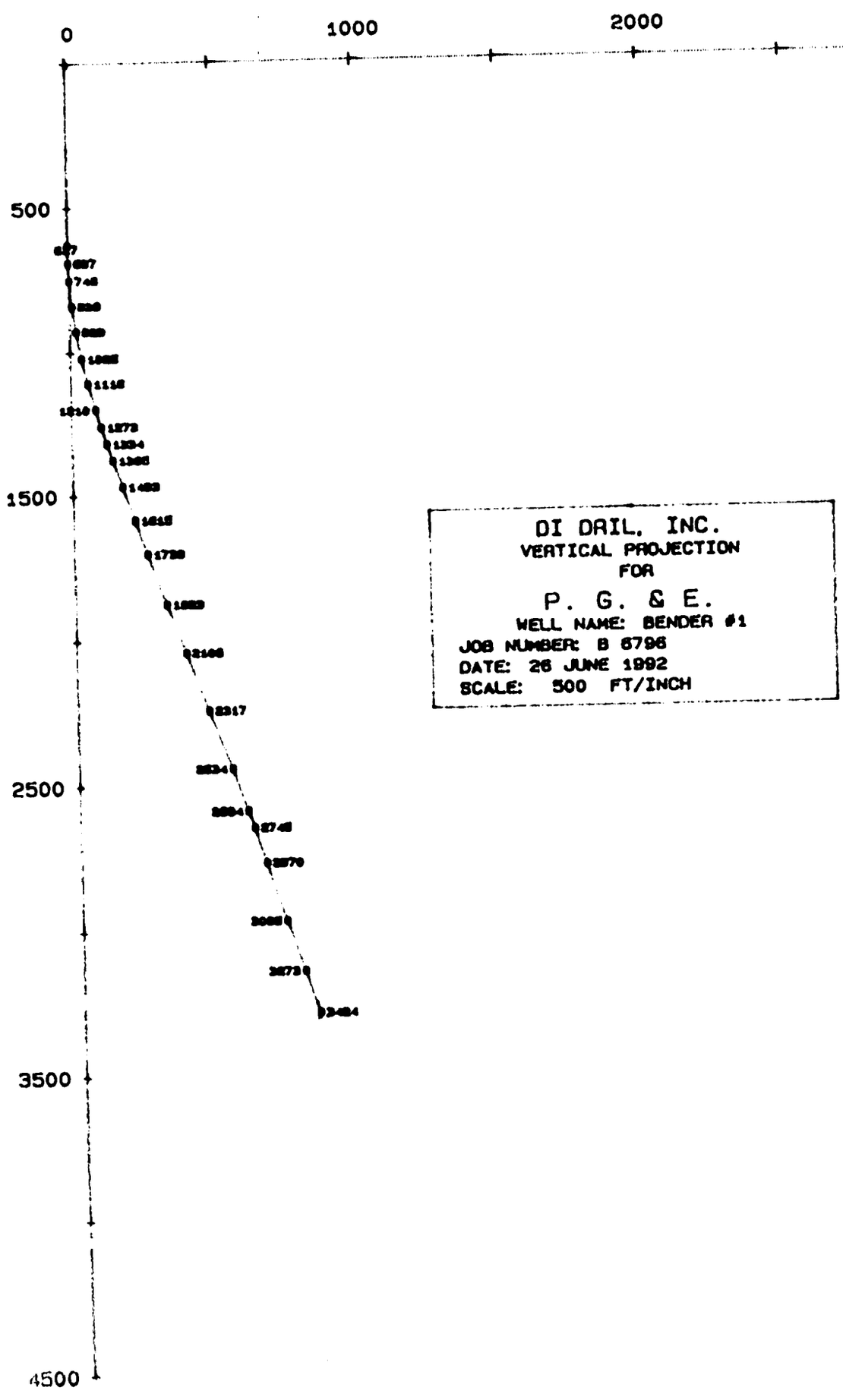
DESCRIPTION	LENGTH
Kelly Bushing to Tubing Hanger	16.43'
Tubing Hanger 9"x2-7/8" TYPE 79-AJ Ser# A420399	.31'
2-7/8", 6.5# 8rd EUE Tubing, 108 Joints	3368.69'
2-7/8", EUE 8rd BOX x 2-3/8" EUE 8rd PIN CROSS OVER	1.14'
2-3/8", 4.7# 8rd EUE Tubing, 3 Joints	96.80'
2-3/8",1Jt. perf.w/114 holes, tapernosed	10.99'
TOTAL TUBING LENGTH	3494.36'

Tubing hung 10.64' off bottom

07/14/92 Filled with fluid. Tested Baker Sand Control's 2" piping with 3500 psi., test good. Dropped setting ball. Held safety tail board on procedures in installing the SC-1L packer. Pressured up on the setting ball in 2 minute stages at 1350, 1800, & 2200 psi. Set down and pulled up 10,000# wt. on the packer. Packer set in place. Pressured up on the annulus to 1000 psi. for 10 minutes, test good. Sheared setting ball at 3200 psi., Baker's SC-1L packer installed and tested; released running tools. POOH and laid tools down. RIH with open ended drill pipe and circulated on bottom at 3386'. Rigged up Bill's tongs laydown machine and cleaned the 2-7/8" tubing string. Pulled out laying down drill pipe. Rigged up and pick up 2-3/8" tubing tail with a perforated pup joint and 2-7/8" 6.5# tubing. (See tubing detail). Removed BOPE and installed tree. Changed over from HEC/NaCl to KCL 2%. Released rig. Left hole full of KCL 2%.

1992 DRILLING HISTORY BENDER #1

07/17/92 Rigged up Halliburton and injected Nitrogen down casing to clean out KCL water. Recovered 240 bbls of KCL water (hole capacity is 180 bbls). Well started flowing on uncalibrated adjustable choke. Well stabilized, flowing gas with heavy mist. Flowing tubing pressure 380 psi., flowing casing pressure 735 psi., and shut-in casing pressure after 0 minutes--735 psi. Took 2 samples of KCL water before starting cleaning out.


0
1000
2000
3000
500
1500
2500
3500
4500
DI DRIL, INC.
VERTICAL PROJECTION
FOR
P. G. & E.
WELL NAME: BENDER #1
JOB NUMBER: B 6796
DATE: 26 JUNE 1992
SCALE: 500 FT/INCH

Div. of Oil & Gas - Dist. 6
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Sacramento, California

SUMMARY OF BASIC PROPERTIES MEASUREMENTS

Pacific Gas and Electric Company
Bender No. 1 Well

Thornton Field
San Joaquin County, California

Sample I.D.	Depth, feet	Permeability to Air, millidarcies	Porosity, percent	Grain Density, g/cc	Lithological Descriptions
					Vertical Samples
1V	3396.0	0.140	26.9	2.69	Cly, gry, vf-f gr, sdy, slty, no stn, no flu
3418.5V	3418.5	6.06	29.4	2.67	Sltst; med gry, shly, w/tr f gr qtz
2V	3422.0	0.980	39.0	2.84	Cly; gr, vf-f gr, sdy, slty, no stn, no flu
3427.0V	3427.0	22.7	27.8	2.65	Ss; lt gry, vf-fg qtz, f srt, slty-sh mtrx, tr mica
4V	3430.5	94.0	25.6	2.65	Ss; gry-wh, vf-f gr , slty, sl cly, no sn, no flu
3445.0V	3445.0	85.5	26.0	2.81	Ss; lt gry, f-slt size qtz, slty mtrx, fri
6V	3460.0	371	27.6	2.63	Ss; gry-wh, vf-c gr, slty, no stn, no flu
7V	3464.0	70.0	26.2	2.63	Ss; gry-wh, vf-vc gr, v slty, no stn, no flu
3473.0V	3473.0	662	17.9	2.64	Ss; lt gry, crs-f gr qtz, p-f srt, slty mtrx, fri, tr mica
9V	3480.0	632	27.4	2.64	Ss; gry-wh, vf-vc gr, slty, no stn, no flu
13V	3488.0	17.0	28.0	2.63	Ss; gry-wh, vf-vc gr, v slty, cly, no stn, no flu
15V	3496.0	297	26.7	2.63	Ss; gry-wh, vf-m gr, slty, cly inc, no stn, no flu
3504.8V	3504.8	388	27.4	2.59	Ss; lt-m gry, f-slt size qtz, slty mtrx, fri, tr mica
18V	3512.5	1.90	33.7	2.63	Cly; gry, vf-m gr, sdy, slty, no stn, no f[illegible]
3521.0V	3521.0	3860	29.7	2.62	Ss; wht-lt gry, crs-vf gr qtz, f srt, slty mtrx, fri
21V	3528.0	74.0	25.6	2.64	Ss; gry-wh, vf-vc gr, slty, cly, no stn, no flu
3535.0V	3535.0	23.3	26.6	2.61	Sltst; med gry, shly, w/tr f gr qtz, tr mica
23V	3538.0	1.60	29.8	2.65	Ss; gry, vf-f gr, v slty, v cly, no stn, no flu

File DRES-92207

SUMMARY OF BASIC PROPERTIES MEASUREMENTS

Pacific Gas and Electric Company
Bender No. 1 Well

Thornton Field
San Joaquin County, California

Sample I.D.	Depth, feet	Permeability to Air, millidarcies	Porosity, percent	Grain Density, g/cc	Lithological Descriptions
			Horizontal Samples		
1	3396.0	0.730	28.5	2.72	Cly; gr, vf-f gr, sdy, slty, no stn, no flu
3418.5H	3418.5	6.32	31.7	2.67	Sltst; med gry, shly, w/tr f gr qtz
2	3422.0	0.960	40.5	2.85	Cly; gry, vf-f gr, sdy, slty, no stn, no flu
3	3424.5	63.8	37.1	2.78	Cly; gry, vf-f gr, sdy, slty, no stn, no flu/Frac
3427.0H	3427.0	202	27.0	2.80	Ss; med grn-gry, f-vf gr qtz, f srt, slty sh mtrx, tr mica
3428.5H	3428.5	73.8	27.2	2.63	Ss; med gry, m-f gr qtz, f srt, slty-sh mtrx, fri, tr mica
4	3430.5	48.0	26.5	2.65	Ss; gry-wh, vf-f gr, slty, sl cly inc, no stn, no flu
3444.8H	3444.8	208	27.4	2.62	Ss; gry, f-m gr qtz, f srt, slty mtrx, mica
3446.5H	3446.5	376	28.7	2.59	Sltst; lt gry, slt-vf gr qtz, tr lam, fri
5	3458.0	29.1	21.1	2.58	Sst; tn, vf gr, v slty, carb inc, m stn, no flu
6	3460.0	400	27.7	2.63	Ss; gry-wh, vf-c gr, slty, no stn, no flu
7	3464.0	687	27.4	2.63	Ss; gry-wh, vf-vc gr, slty, no stn, no flu
8	3468.0	820	28.1	2.63	Ss; gry-wh, vf-vc gr, slty, no stn, no flu
3473.8H	3473.8	8.82	22.4	2.56	Ss; lt gry, f-vf gr qtz, f srt, slty mtrx, tr mica
10	3478.0	225	25.2	2.63	Ss; gry-wh, vf-vc gr, v slty, sl calc, no stn, no flu
11	3482.0	704	29.5	2.63	Ss; gry-wh, vf-m gr, slty, no stn, no flu
12	3487.0	1170	27.7	2.63	Ss; gry-wh, vf-vc gr, slty no stn, no flu

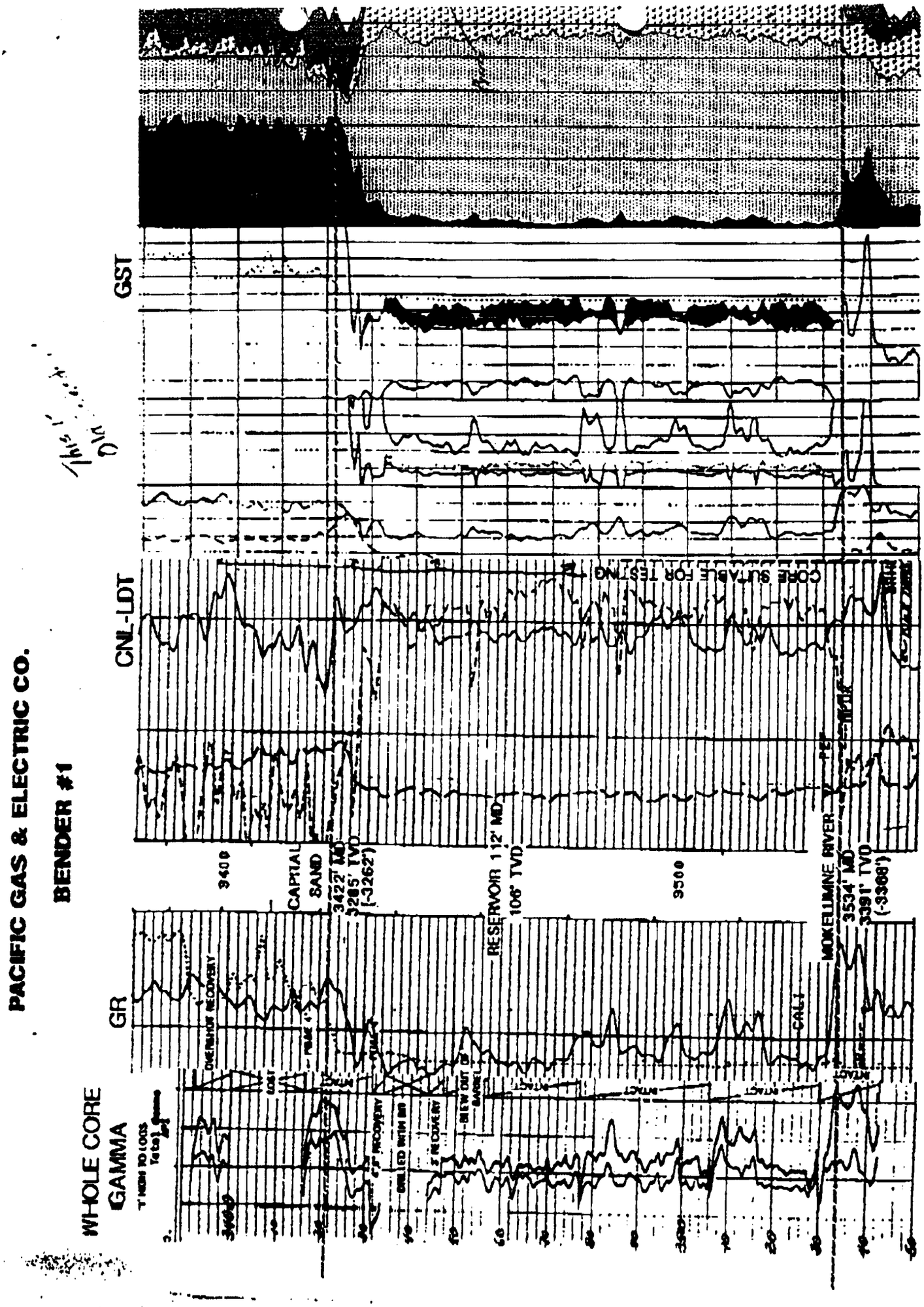
File DRES-92207

SUMMARY OF BASIC PROPERTIES MEASUREMENTS

Pacific Gas and Electric Company
Bender No. 1 Well

Thornton Field
San Joaquin County, California

Sample I.D.	Depth, feet	Permeability to Air, millidarcies	Porosity, percent	Grain Density, g/cc	Lithological Descriptions
					Horizontal Samples (continued)
3491.0H	3491.0	392	24.7	2.57	Ss; lt gry, f-crs gr qtz, p srt, slty trx, fri, tr mica
14	3492.0	1120	27.8	2.63	Ss; gry-wh, vf-vc gr, sl slty, no stn, no flu
15	3496.0	572	27.5	2.63	Ss; gry-wh, vf-m gr, slty, cly inc, no stn, no flu
16	3500.0	285	27.8	2.63	Ss; gry-wh, vf-c gr;, slty, mica lam, no stn, no flu
3504.9H	3504.9	836	29.6	2.57	Ss; lt gry, crs-f gr qtz, f srt, slty mtrx, fri, tr mica
17	3508.0	354	25.9	2.63	Ss; gry-wh, vf-vc gr, slty mica lam, no stn, no flu
18	3512.5	2.25	35.9	2.64	Cly; gry, vf-m gr; sdy strk, slty, no stn, no flu
19	3516.5	1090	28.5	2.63	Ss; gry-wh, vf-c gr, slty, no stn, no flu
3521.0H	3521.0	3570	30.0	2.73	Ss; wht-lt gry; crs-vf gr qtz, f srt, slty mtrx, fri
20	3524.0	1450	29.0	2.63	Ss; gry-wh, vf-c gr, sl slty, no stn, no flu
21	3528.0	1670	29.6	2.63	Ss; gry-wh, vf-vc gr, sl slty, no stn, no flu
22	3532.0	63.3	27.2	2.63	Ss; gry-wh, vf-vc gr, v slty, no stn, no flu
3535.0H	3535.0	8.62	31.6	2.64	Sltst; med gr, shly w/tr f gr qtz
23	3538.0	1.85	28.9	2.65	Ss; gry, vf-f gr, v slty, v cly, no stn, no .lu


PACIFIC GAS & ELECTRIC CO.
BENDER #1
WHOLE CORE GAMMA
GR
CNL-LDT
GST
CAPTIAL SAND
3422' MD
3285' TVD
(-3262')
RESERVOIR 112' MD
106' TVD
MOKELUMNE RIVER
3534' MD
3391' TVD
(-3368')
CORE SUITABLE FOR TESTING
LOG SCALINGS NOT SHOWN, FOR CORRELATIVE PURPOSE

PAGE.003

DEC 28 '92 14:33 FROM ANR STORAGE

DEC-28-1992 11:12 FROM PG&E GAS PROD & STORAGE TO 9-1-9163230424 P.05/06

CORE LABORATORIES

Company : PACIFIC GAS & ELECTRIC COMPANY
Well : BENDER #1

Field : THORNTON FIELD
Formation :

File No.: 92096
Date : 13-OCT-92

CORE ANALYSIS RESULTS

SAMPLE NUMBER	DEPTH ft	PERMEABILITY (HORIZONTAL) Kair md	PERMEABILITY (VERTICAL) Kair md	POROSITY (HELIUM) %	Helium Porosity (Part. Comp.) %	SATURATION (PORE VOLUME) OIL %	SATURATION (PORE VOLUME) WATER %	GRAIN DENSITY gm/cc	DESCRIPTION
21	3528.0	3670.		29.8		0.0	84.4	2.63	Sd gry-wh vf-vcgr sl silty no stn no flu
21V	3528.0		74.0		25.60	0.0	99.4	2.64	Sd gry-wh vf-vcgr silty cly no stn no flu
22	3532.0	83.3		27.2		0.0	99.3	2.63	Sd gry-wh vf-vcgr v silty no stn no flu
23	3538.0	1.85		28.9		0.0	99.6	2.65	Sd gry vf-fgr v silty v cly no stn no flu
23V	3538.0		1.80		28.00	0.1	99.9	2.65	Sd gry vf-fgr v silty v cly no stn no flu

Div. of Oil & Gas - Dist. 6
RECEIVED
DEC 28 1992
Sacramento, California

DEC-28-1992 11:15 FROM PG&E GAS PROD & STORAGE TO 9-1-916323042 P.04/06

DEC 28 '92 14:32 FROM ANR STORAGE PAGE.002

CORE LABORATORIES

Company : PACIFIC GAS & ELECTRIC COMPANY
Well : BENDER #1
Location : SEC.28-T5N/R5E
Co,State : SAN JOAQUIN COUNTY, CA

Field : THORNTON FIELD
Formation :
Coring Fluid : WATER BASE
Elevation :

File No.: 92096
Date : 13-OCT-92
API No. : 04-077-20562
Analysts:

CORE ANALYSIS RESULTS

SAMPLE NUMBER	DEPTH ft	PERMEABILITY (HORIZONTAL) Kair md	PERMEABILITY (VERTICAL) Kair md	POROSITY (HELIUM) %	Helium Porosity (Vert. Samp.) %	SATURATION (PORE VOLUME) OIL %	SATURATION (PORE VOLUME) WATER %	GRAIN DENSITY gm/cc	DESCRIPTION
1	3395.0	0.73		28.5		0.0	99.4	2.72	Cly gry vf-fgr sdy slty no stn no flu
1V	3395.0		0.14		26.90	0.0	99.6	2.68	Cly gry vf-fgr sdy slty no stn no flu
2	3422.0	0.98		40.5		0.0	99.4	2.86	Cly gry vf-fgr sdy slty no stn no flu
2V	3422.0		0.98		39.00	0.0	98.1	2.84	Cly gry vf-fgr sdy slty no stn no flu
3	3424.5	63.8		37.1		0.0	97.3	2.78	Cly gry vf-fgr sdy slty no stn no flu/Frac
4	3430.5	48.0		26.5		0.0	98.5	2.65	Sd gry-wh vf-fgr slty lg cly inc no stn no flu
4V	3430.5		94.0		25.60	0.0	87.2	2.65	Sd gry-wh vf-fgr slty sl cly no stn no flu
5	3458.0	28.1		21.1		0.0	94.1	2.58	Sst tn vfgr v slty carb inc m stn no flu
6	3460.0	400.		27.7		0.0	81.6	2.63	Sd gry-wh vf-cgr slty no stn no flu
6V	3460.0		371.		27.68	0.0	83.3	2.63	Sd gry-wh vf-cgr slty no stn no flu
7	3464.0	687.		27.4		0.0	87.0	2.63	Sd gry-wh vf-vcgr slty no stn no flu
7V	3464.0		79.0		26.20	0.0	90.9	2.63	Sd gry-wh vf-vcgr v slty no stn no flu
8	3468.0	820.		28.1		0.0	84.3	2.63	Sd gry-wh vf-vcgr slty no stn no flu
9V	3480.0		632.		27.46	0.0	88.5	2.64	Sd gry-wh vf-vcgr slty no stn no flu
10	3478.0	225.		26.2		0.0	95.5	2.63	Sd gry-wh vf-vcgr v slty sl calc no stn no flu
11	3482.0	704.		29.5		0.0	84.1	2.63	Sd gry-wh vf-mgr slty no stn no flu
12	3487.0	1169.		27.7		0.0	83.9	2.63	Sd gry-wh vf-vcgr slty no stn no flu
13V	3488.0		17.0		28.00	0.0	98.6	2.63	Sd gry-wh vf-vcgr v slty cly no stn no flu
14	3492.5	1117.		27.8		0.0	84.6	2.63	Sd gry-wh vf-vcgr sl slty no stn no flu
15	3496.0	572.		27.5		0.0	82.4	2.63	Sd gry-wh vf-mgr slty cly inc no stn no flu
15V	3496.0		297.	28.7	26.70	0.0	91.7	2.63	Sd gry-wh vf-mgr slty cly inc no stn no flu
16	3500.0	285.		27.8		0.0	82.9	2.63	Sd gry-wh vf-cgr slty mica lam no stn no flu
17	3508.0	356.		25.9		0.0	93.8	2.63	Sd gry-wh vf-vcgr slty mica lam no stn no flu
18	3512.5	2.25		35.9		0.0	99.8	2.64	Cly gry vf-mgr sdy strk slty no stn no flu
18V	3512.5		1.90		33.70	0.0	99.9	2.63	Cly gry vf-mgr sdy slty no stn no flu
19	3516.5	1093.		28.5		0.0	91.0	2.83	Sd gry-wh vf-cgr slty no stn no flu
20	3524.0	1448.		29.0		0.0	83.6	2.63	Sd gry-wh vf-cgr sl slty no stn no flu

DI DRIL, INC.
BAKERSFIELD,CALIFORNIA

MAGNETIC DIRECTIONAL SURVEY
BY ANGLE AVERAGE METHOD

FOR

****
* P. G. & E. *
****

Div. of Oil & Gas - Dist. 6
RECEIVED
SEP 22 1992
Sacramento, California

JOB NUMBER: B 6796

WELL NAME: BENDER #1

LOCATION: THORNTON

SURVEY DATE: 26 JUNE 1992

SURVEY ENGINEER: RED ALCOCK

MAGNETIC DECLINATION: 16.00E

TIE-ON COORDINATES AT: 0 M.D.

****
****** DEPTH MEASURED IN FEET *******
****

COMMENTS:

****
****
*** THIS DIRECTIONAL SURVEY REPORT IS ***
** CORRECT TO THE BEST OF MY KNOWLEDGE ***
* AND IS SUPPORTED BY ACTUAL FIELD DATA! *
**
**
**
**
**
****
****

DI DRIL, INC.
BAKERSFIELD, CALIFORNIA

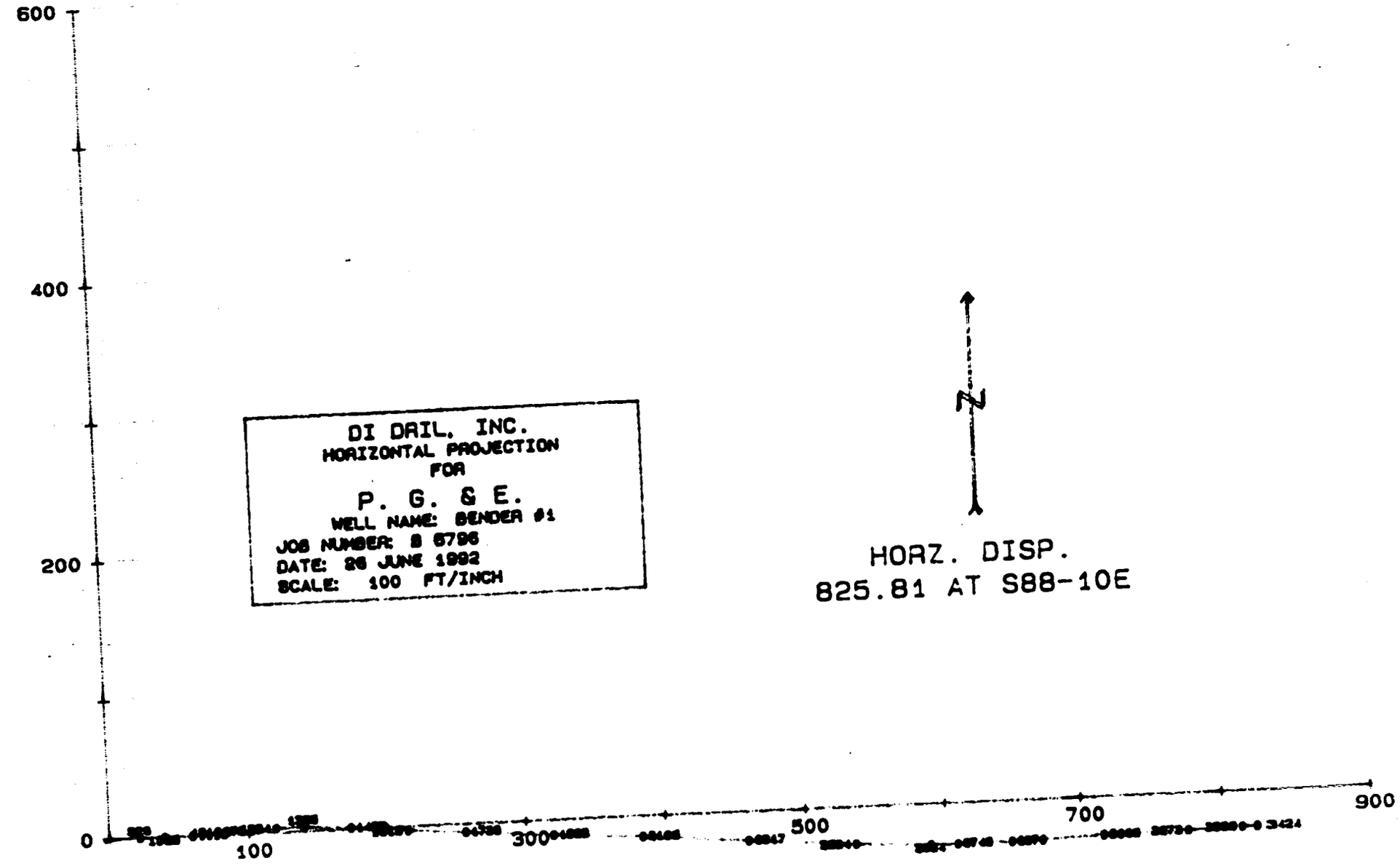
JOB NUMBER: B 6796

WELL NAME: BENDER #1

INRUN SURVEY
BY ANGLE AVERAGE METHOD

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	INCL	BEARING	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG /100	D-LEG /CL	STATION DISP.	DISPLACEMENT DIRECTION
0.0	0.00	0.00	00-00	S81-00W	0.00 N	0.00 E	0.00		0.00	AT N00-00E
627.0	626.99	-2.69	00-30	S81-00W	0.43 S	2.70 W	0.08	0.50	2.74	AT S81-00W
687.0	686.98	-2.50	02-00	N86-00E	1.73 S	2.55 W	4.16	2.50	3.08	AT S55-55W
748.0	747.89	0.80	04-15	N82-00E	1.38 S	0.75 E	3.70	2.26	1.57	AT S28-37E
9.0	838.47	9.39	06-45	N82-00E	0.17 S	9.39 E	2.75	2.50	9.39	AT S88-59E
928.0	926.63	21.54	09-00	S88-00E	0.47 N	21.57 E	2.95	2.63	21.57	AT N88-45E
1025.0	1022.12	38.59	11-15	S88-00E	0.12 S	38.61 E	2.32	2.25	38.61	AT S 89-49E
1116.0	1110.79	59.04	14-45	N86-00E	0.23 N	59.08 E	4.12	3.75	59.08	AT N 89-46E
1210.0	1201.42	83.87	16-00	N88-00E	1.54 N	83.97 E	1.44	1.36	83.98	AT N 88-57E
1273.0	1261.83	101.72	17-00	N87-00E	2.32 N	101.84 E	1.65	1.04	101.87	AT N 88-42E
1334.0	1319.97	120.14	18-15	N89-00E	2.96 N	120.30 E	2.28	1.39	120.34	AT N 88-35E
1395.0	1377.60	140.12	20-00	S89-00E	2.96 N	140.29 E	3.06	1.87	140.32	AT N 88-47E
1493.0	1469.76	173.42	19-45	S84-00E	0.93 N	173.54 E	1.75	1.72	173.54	AT N 89-42E
1615.0	1584.59	214.56	19-45	S85-00E	3.02 S	214.58 E	0.28	0.34	214.60	AT S 89-12E
1738.0	1700.26	256.33	20-00	S86-00E	6.30 S	256.26 E	0.34	0.42	256.34	AT S 88-35E
1923.0	1873.82	320.32	20-30	S86-00E	10.77 S	320.14 E	0.27	0.50	320.32	AT S 88-04E
2105.0	2044.16	384.38	20-45	S86-00E	15.24 S	384.09 E	0.14	0.25	384.40	AT S 87-44E
2317.0	2242.24	459.87	21-00	S86-00E	20.51 S	459.45 E	0.12	0.25	459.91	AT S 87-27E
4.0	2445.00	537.08	20-45	S84-00E	27.25 S	536.48 E	0.35	0.76	537.17	AT S 87-06E
2684.0	2585.62	589.28	20-00	S89-00E	30.44 S	588.61 E	1.26	1.89	589.40	AT S 87-02E
2745.0	2643.12	609.63	19-00	N88-00E	30.26 S	608.97 E	2.32	1.41	609.72	AT S 87-09E
2870.0	2761.57	649.50	18-15	N90-00E	29.56 S	648.88 E	0.79	0.99	649.56	AT S 87-23E
3085.0	2965.76	716.75	18-15	N88-00E	28.39 S	716.20 E	0.29	0.63	716.77	AT S 87-44E
3273.0	3143.91	776.69	19-00	N89-00E	26.82 S	776.23 E	0.43	0.82	776.69	AT S 88-01E
3389.0	3253.59	814.42	19-00	N90-00E	26.49 S	813.99 E	0.28	0.33	814.42	AT S 88-08E
3424.0	3286.68	825.81	19-00	N90-00E	26.49 S	825.39 E	0.00	0.00	825.81	AT S 88-10E

****
* ******** *
* THE HORIZONTAL DISPLACEMENT AT THE DEPTH OF *
* ******** *
* 3424.0 FEET EQUALS 825.81 FEET AT S88-10E *
* ******** *
****


600
400
200
0
100
300
500
700
900
DI DRIL. INC.
HORIZONTAL PROJECTION
FOR
P. G. & E.
WELL NAME: BENDER #1
JOB NUMBER: B 6796
DATE: 26 JUNE 1992
SCALE: 100 FT/INCH
N
HORZ. DISP.
825.81 AT S88-10E

RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL AND GAS

No. P 692-181

770 (field code)
00 (area code)
No Pool BD (new pool code)
(old pool code)

PERMIT TO CONDUCT WELL OPERATIONS

WELL CLASSIFICATION:
DEVELOPMENT

Thomas W. High, Agent
PACIFIC GAS & ELECTRIC CO.
77 Beale St., Room H-905
San Francisco, CA 94106

Sacramento, California
June 9, 1992

Your _____ proposal to drill well "Bender" 1,
A.P.I. No. 077-20562, Section 28, T. 5N, R. 5E, M.D. B. & M.,
Thornton Gas field, ----- area, ----- pool,
San Joaquin County, dated 5-28-92, received 6-4-92 has been examined in conjunction with records filed in this office.

THE PROPOSAL IS APPROVED PROVIDED THAT:

1. The 13 3/8" casing is cemented with sufficient cement to fill behind this casing from the shoe to the ground surface.
2. The 8 5/8 " casing is cemented with sufficient cement to fill behind this casing from the shoe to at least 500 feet above the uppermost oil or gas zone.
3. Drilling fluid of a quality and in sufficient quantity is used to control all subsurface conditions to prevent blowouts.
4. Blowout prevention equipment conforming to Class III B 2M requirements is installed on the 13 3/8" casing and maintained in operating condition at all times. See Manual M07 and attached sheet.
5. Blowout prevention equipment conforming to Class"III" 2 M requirements is installed on the 8 5/8 " casing and maintained in operating condition at all times. See Manual M07 and attached sheet.
6. Water with any beneficial use is protected from contamination at all times.
7. The Division is furnished copies of any draw down or back pressure tests performed. In addition, the Division will monitor the production for a period of six months and if anomalous water production is indicated, remedial action will be ordered.
8. THIS DIVISION IS NOTIFIED:
   a. Before deviating from the proposed casing programs and/or placing any plugs in the hole. Additional requirements shall be outlined at that time.
   b. To witness a test of the installed blowout prevention equipment prior to drilling out the shoe of the 13 3/8 " casing. The blind/blank rams shall be tested by the operator prior to calling the Division inspector. Test information of the blind/blank ram test shall be entered on the tour sheet along with the signature of the person in charge.

NOTE:
1. Information on file in this office indicates that the base of the useable fresh water deposits should be encountered at a depth of approximately 650 '.
2. The actual surface location of this well must be at least 100 feet from the outer boundary of the parcel(s) of land on which the well is situated.
3. The producing interval of this well shall be not less than 75 feet from the lease line. It will be necessary for PACIFIC GAS & ELECTRIC CO. to be able to prove that the location of the wellbore, at the producing interval, is greater than 75 feet from the lease line.

K. P. HENDERSON
Acting State Oil and Gas Supervisor

By Robert A. Reid
Deputy Supervisor
ROBERT A. REID

Engineer _____
cc: Charlie Bond
Phone _____
Blanket Bond
RSH: jhs

A copy of this permit and the proposal must be posted at the well site prior to commencing operations.

Records for work done under this permit are due within 60 days after the work has been completed or the operations have been suspended.

OG111 (11/88/DWRR/5M)

(916) 764-0821 12CH

RNR

API No. 077-20562 DIVISION OF OIL AND GAS T_____

BLOWOUT PREVENTION EQUIPMENT MEMO

Operator PACIFIC GAS & ELECTRIC CO. Well BENDER "A" 1
Field THORNTON GAS County SAN JOAQUIN Spud Date 6-24-92

VISITS: Date / Engineer / Time / Operator's Rep. / Title
1st 6-26-92 Pam Ceccarelli (1400 to 1600) MR. R. SMITH CO. REP.
2nd _____ (_____ to _____) _____

Contractor HEXADYNE Rig # 1 Contractor's Rep. & Title MR. R. WILDER, D.F
Casing record of well: 13 3/8" CEM. 534'. T.D. 534' (STANDING CEMENTED)

OPERATION: Testing (inspecting) the blowout prevention equipment and installation.
DECISION: The blowout prevention equipment and its installation on the 13 3/8 " casing are approved.

Proposed Well Opns: DRILLING . MACP: 6 psi
Hole size: 17 1/2" fr. 0 ' to ____ ' , ____ " to ____ ' & ____ " to ____ '
REQUIRED BOPE CLASS: III 2M R

CASING RECORD OF BOPE ANCHOR STRING					Cement Details	Top of Cement	
Size	Weight(s)	Grade(s)	Shoe at	~~CP at~~		Casing	Annulus
13 3/8	61#	K-55	534		LEAD: 200 SKS G W/ 2% GEL, 2% CC	494	GOOD
					TAIL: 175 SKS G W/ 3% CaCl2		

BOP STACK

API Symb.	Ram Size (in.)	Manufacturer	Model or Type	Vert. Bore Size (in.)	Press. Rtg.	Date Last Overhaul
A	—	HYD	GK		5M	
Rd		SCH	B			
Rd						
S		/	S		/	

TEST DATA

Gal. to Close	Recovery Time (Min.)	Calc. GPM Output	psi Drop to Close	Secs. to Close	Test Date	Test Press.
					6/26	1000
						1500
						1500
						1500

ACTUATING SYSTEM

Accumulator Unit(s) Working Pressure 3000 psi
Total Rated Pump Output — gpm
Distance From Well Bore 50 ft.

	Accum. Manufacturer	Capacity	Precharge
1	HYDRIL	80 gal.	750 psi
2		gal.	psi

CONTROL STATIONS	Elec.	Hyd.	Pneu.
Manifold at accumulator unit		/	
Remote at Driller's station		/	
Other:			

EMERG. BACKUP SYSTEM			Press.	Wkg. Fluid
N_2 Cylinders 3	1	L= 54	2200	8 gal.
Other:	2	L= "	2300	8 gal.
	3	L= "	2300	8 gal.
	4	L= "		gal.
	5	L= "		gal.
	6	L= "		gal.
	TOTAL:			24 gal.

HOLE FLUID MONITORING EQUIPMENT

	Alarm Type: Audible	Visual	Class
Calibrated Mud Pit			A
Pit Level Indicator			B
Pump Stroke Counter			
Pit Level Recorder			
Flow Sensor			C
Mud Totalizer			
Calibrated Trip Tank			
Other:			

TOTAL:

AUXILIARY EQUIPMENT

	No.	Size (in.)	Rated Press.	Connections: Weld	Flange	Thread	Test Press.
Fill-up Line							
Kill Line			3M				1500
Control Valve(s)							
Check Valve(s)							
Aux. Pump Connect.							
Choke Line							
Control Valve(s)							
Pressure Gauge							
Adjustable Choke(s)			5M				1500
Bleed Line							
Upper Kelly Cock							1500
Lower Kelly Cock	—	—	—	—	—	—	—
Standpipe Valve							1500
Standpipe Press. Gauge							
Pipe Safety Valve		4	3M				/
Internal Preventer							

Hole Fluid Type	Weight	Storage Pits (Type & Size)
SPUD	70	

REMARKS AND DEFICIENCIES:

OGD9 (12/90/GSR1/2M)

e. Install Shafco 13-5/8" x 8-5/8" Double studded Seal Flange for 8-5/8" casing.

f. Test packing to 2000 psi with nitrogen and 3000 psi with oil.

g. Install Shafco 12"- 3M x 9" Type 75 L-1 Tubing Head with 73 S-Seal. Orient tubing head as directed by Tom Wilson.

h. Test tubing head seals to 2000 psi with nitrogen and 3000 psi with oil.

COMPLETION PHASE

29. Install Blowout Prevention Equipment (BOPE)

a. Install kill and choke manifold and line.

b. Install an 8" 900 Series hydraulic double ram BOP's (with rams for 2-7/ tubing) and an 8" Series 900 Hydril GK bag type BOP on 8" Series 900 tubing head.

c. Check that nitrogen bottles for the BOPE are fully charged at 2500-3000 psi and keep standby nitrogen bottles on hand for the BOPE.

30. Test BOPE

a. Call the D.O.G. office in Woodland at (916) 662-4683 to witness testing the BOP's four hours in advance of time when ready to conduct test, as required by the permit.

b. Test blind rams with rig pumps at 1500 psi for 15 minutes.

c. Test pipe rams and Hydril bag at 1500 psi for 15 minutes each.

d. Test kill and choke lines and valves; test use of remote control button close BOP and accumulator valves to open BOP.

31. Check BOPE On Each Trip

a. Check BOPE on every trip by closing blind rams with pipe out of hole an pipe rams with pipe in hole on each trip.

b. Conduct BOP drills as specified in Blowout Prevention Program.

c. On each tour, record BOPE accumulator pressure, and pump pressure and strokes per minute at reduced circulating rate.

32. Pick up 2-7/8" Tubing and Run Casing Scraper.

a. Pick up string of 2-7/8", 6.5 #/ft, 8 rd thread tubing with 7-5/8" bit and a casing scraper for 8-5/8" casing.

b. Scrape casing to 3570' Measured Depth (top of float collar); circulate clean.

RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION

DIVISION OF OIL AND GAS **No. T** 692-138

Report on Operations

Thomas W. High, Agent
PACIFIC GAS AND ELECTRIC CO.
77 Beale Street, Room H-905
San Francisco, CA 94106

Sacramento **Calif.**
July 3, 1992

Your operations at well "Bender" 1, **API No.** 077-20562,
Sec. 28, **T.** 5N, **R.** 5E, **M.D. B. & M.** Thornton Gas
Field, in San Joaquin **County,**
were witnessed on 6-26-92. P. Ceccarelli, **representative of**
the supervisor, was present from 1400 **to** 1600.
There were also present R. Smith, Company Representative
Present condition of well: 13 3/8" cem. 534'. T.D. 534' (Standing Cemented).

The operations were performed for the purpose of testing the blowout prevention equipment and installation.

DECISION:

The blowout prevention equipment and its installation on the 13 3/8" casing are approved.

Blanket Bond
PMC:jhs

K. P. HENDERSON
Acting ~~State Oil and Gas Supervisor~~
By Robert S Hodel
Deputy Supervisor
for ROBERT A. REID

OG109 (9/89/GSR1/5M)

RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION

DIVISION OF OIL AND GAS

Notice of Intention to Drill New Well

Div. of Oil & Gas - Dist. 6
RECEIVED
JUN 4 1992
Sacramento, California

C.E.Q.A. INFORMATION			
EXEMPT ☐ CLASS____	NEG. DEC. ☐ S.C.H. NO.____	E.I.R. ☐ S.C.H. NO.____	DOCUMENT NOT REQUIRED BY LOCAL JURISDICTION ☑
See Reverse Side			

FOR DIVISION USE ONLY					
MAP	MAP BOOK	CARDS	BOND	114	121
	FSH	✓	BB	✓	✓

In compliance with Section 3203, Division 3, Public Resources Code, notice is hereby given that it is our intention to commence drilling well Bender No. 1, well type Core Test Well for Compressed Air Energy Storage 077-20562

Sec. 28, T. 5N, R. 5E, MD B. & M., Thornton Gas Field, San Joaquin County.

Legal description of mineral-right lease, consisting of 33.41 acres, is as follows: (Attach map or plat to scale)

See Attached Map.

Do mineral and surface leases coincide? Yes X No____. If answer is no, attach legal description of both surface and mineral leases, and map or plat to scale.

Location of well 2588.6 feet East (Direction) along ~~section~~ / property line and 70 feet South (Direction)

at right angles to said line from the____ corner of section / property ____ (Cross out one) or

NW Cor. SW/4, SE/4 of Sec. 28

Is this a critical well according to the definition on the reverse side of this form? Yes ☐ No ☒

If well is to be directionally drilled, show proposed coordinates (from surface location) and TVD at total depth:
865 feet East (Direction) and 50 feet South (Direction)

Estimated true vertical depth 3450 Feet. Elevation of ground above sea level 8 feet.

All depth measurements taken from top of Derrick Floor (Derrick Floor, Rotary Table, or Kelly Bushing) that is 15 feet above ground.

PROPOSED CASING PROGRAM

SIZE OF CASING INCHES API	WEIGHT	GRADE AND TYPE	TOP	BOTTOM	CEMENTING DEPTHS	CALCULATED FILL BEHIND CASING (Linear Feet)
13-3/8"	61#	K-55, 8-Rd	Surf.	520'	to Surf.	361 Cu. Ft.
8-5/8"	32#	K-55, 8-Rd	Surf.	3450'TVD	To Surf.	Gas Program

(A complete drilling program is preferred and may be submitted in lieu of the above program.)

Intended zone(s) of completion Capital Sand 3285 Ft. (Name, depth, and expected pressure) Estimated total depth 3450 Ft.

It is understood that if changes in this plan become necessary we are to notify you immediately.

Name of Operator	Type of Organization (Corporation, Partnership, Individual, etc.)	
Pacific Gas & Electric	Corporation	
Address	**City**	**Zip Code**
375 N. Wiget Ln. Ste. 170	Walnut Creek, CA	94598
Telephone Number / **Name of Person Filing Notice**	**Signature**	**Date**
(510)746-4234 / Charlie J. Bond	Charlie J. Bond	5/28/92

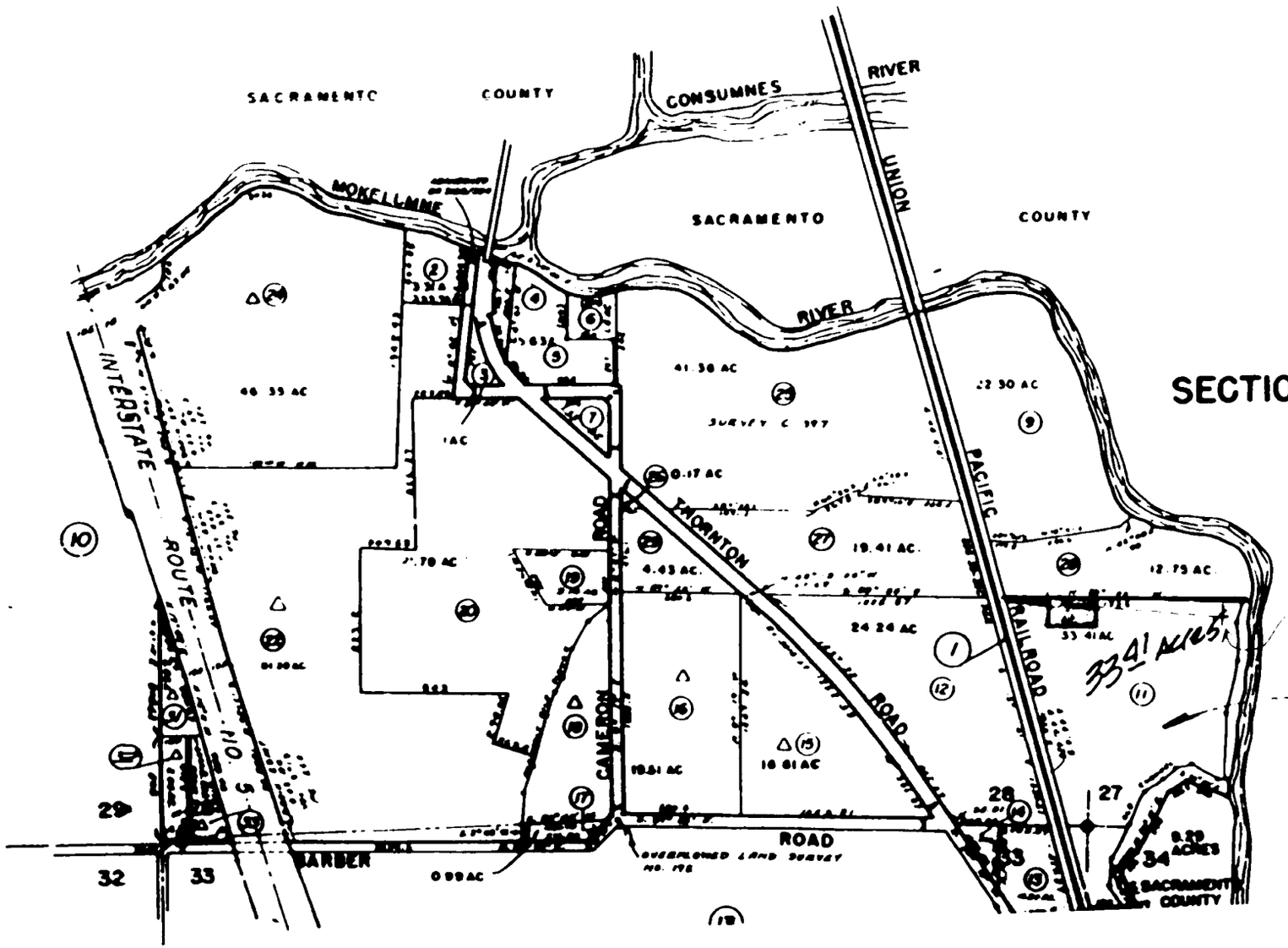
This notice and indemnity or cash bond shall be filed, and approval given, before drilling begins. If operations have not commenced within one year of receipt of the notice, this notice will be considered cancelled.

OG105 (4/88/DWRR/2M)

al Estate Information 1 2 3 4 5 6 1.800.527.9663

THIS MAP FOR ASSESSMENT USE ONLY

001-11





T. 5N. R. 5E.
SECTION 28 & POR. SEC. 27

SCALE 1" = 600'
SAN JOAQUIN COUNTY
ASSESSORS MAPS

△ WILLIAMSON ACT PARCELS

Button Hole Loc.

SACRAMENTO

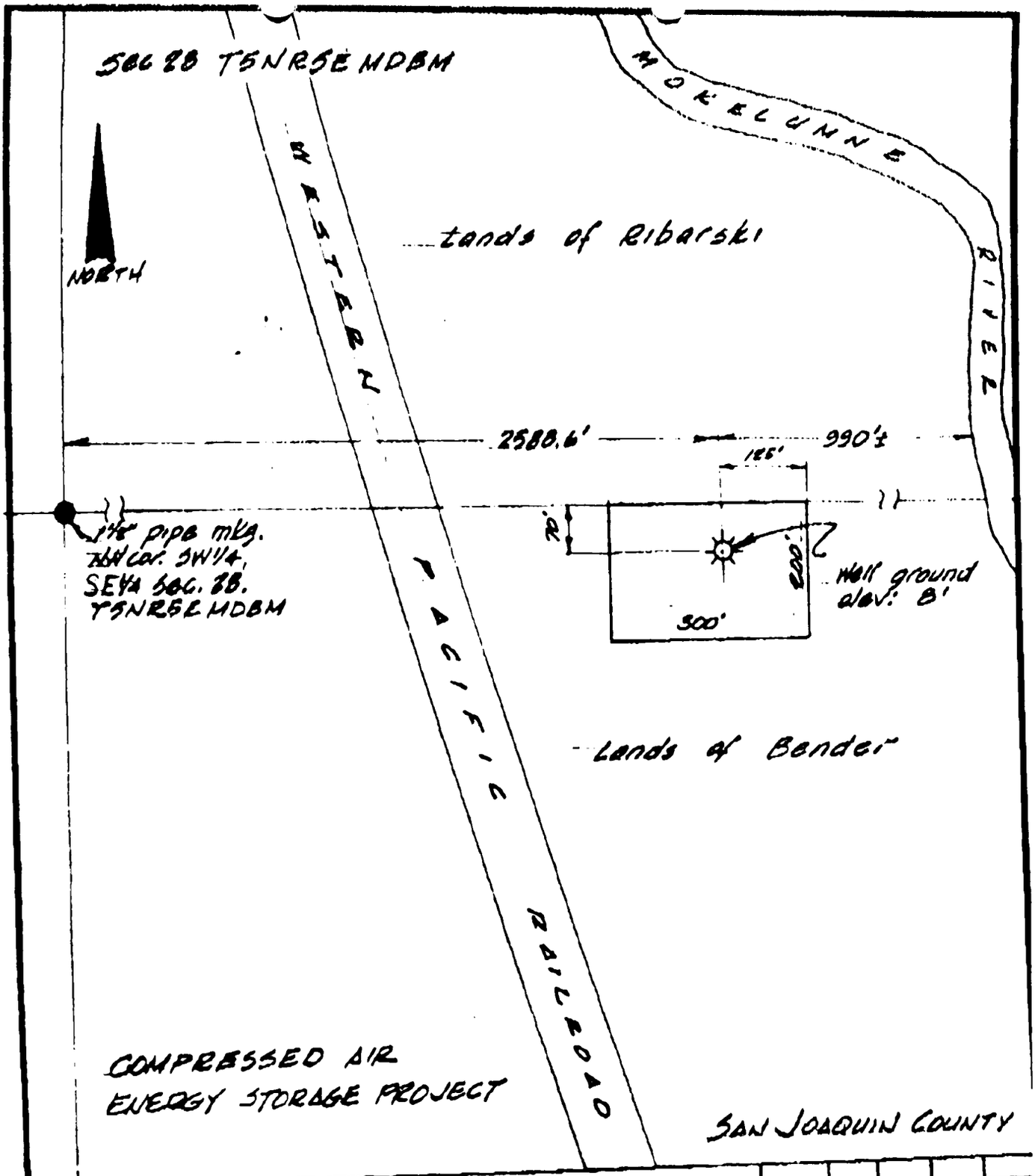
Lands of Bender

COUNTY

A - P. M. Bk. 14 Pg. 47

33.41 Acres

3 A 3



APPROVED BY	REV.	DATE	DESCRIPTION	GM	DWN.	CHKD.	SUPV.	APVD

GM 3-4630-22-3	
SUPV.	
DSGN.	
DWN. R. Jewett	
CHKD.	
O.K.	
DATE 5-6-92	SCALE 1"=200'

PGE/BENDER No. 1
TEST WELL
LEASE FROM JOHN & CAROL BENDER

PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

B/M	
DWG. LIST	
SUPS0$	
SUPS0 BY	
SHEET NO.	SHEETS
DRAWING NUMBER	REV.
001	
MICROFILM	

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WELL DRILLING AND COMPLETION SUMMARY

May 15, 1992

Thornton Field CAES Project

Bender #1

Div. of Oil & Gas - Dist. 6
RECEIVED
JUN 4 1992
Sacramento, California

Step # Operation

1. Construct cellar and install conductor pipe.
2. Move in, rig up.
3. Get 200 bbls. of mud.
4. Drill 17-1/2" hole to 520'.
5. Wipe hole, pull bit.
6. Prepare 13-3/8" casing.
7. Run 13-3/8" casing.
8. Cement 13-3/8" casing.
9. Wait on cement.
10. Cut 20" pipe.
11. Weld on casing head.
12. Install BOP.
13. Call DOG.
14. Test BOPE.
15. Check BOPE on each trip.
16. Follow safety procedures.
17. Drill out cement.
18. Drill 12-1/4" hole to K.O.P.
19. Run drilling motor until hole angle is reached.
20. Drill 12-1/4" hole to depth 50'± above top of Capital sand.
21. Core with 9-5/8" x 5" core head to base of Capital sand.
22. Lower 12-1/4" x 9-5/8" shoulder to casing point.
23. Run DIL\CNL\FDC triple combo log, and GST tool.
24. Condition hole and lay down 4-1/2" drill pipe.
25. Run 8-5/8" casing to casing point below Capital sand.
26. Rig up for cementing.
27. Cement 8-5/8" casing in one stage.
28. Install well head components.

COMPLETION PHASE.

29. Install BOPE.
30. Test BOPE.
31. Check BOPE on each trip.
32. Pick-up 2-7/8" tubing and run casing scraper.
33. Run cement bond log.
34. Run 2-7/8" tubing.
35. Displace drilling mud with water.
36. Remove BOPE and install wellhead assembly.
37. Perforate Capital Sand with Through Tubing Gun.
38. Swab well in.
39. Secure well and release rig.

WELL DRILLING PROGRAM OUTLINE

Elevation: Ground Level: 8' above Sea Level

Location: 2588.6' East and 70' South of NW corner of the South West 1/4 of the SE/4 of section 28, T5NR5E.

Note: All vertical measurements will be with respect to a Kelly Bushing (K.B. that is 18 feet above ground level.

1. Preliminary steps

   a. Construct 8' x 8' x 4' cellar.

   b. Cement 40' of 20" conductor pipe.

2. Move in, rig up

   a. Move in and rig up Hexadyne Rig #2

   b. Weld extension to 20" conductor pipe.

   c. Install 2" collar and bull plug on conductor pipe at bottom cellar.

   d. Construct drainage ditch and berm around fuel oil tank. Drain to sump comply with Federal Oil Spill Prevention and Counter Measure requiremen

3. Haul in water and mud materials

   a. Haul in fresh water and drilling mud materials to spud hole.

4. Drill 17-1/2" hole to 520'

   a. Spud with 17-1/2" bit on 4-1/2" 16.60# drill pipe, with a non-magnetic drill collar installed above bit.

   b. Install 17-1/2" stabilizers above second and fifth collars.

   c. Keep pump pressure at minimum while drilling out of conductor pipe.

   d. Drill 17-1/2" hole to about 520' ± to match casing on racks, so that th cementing head will be 5' to 6' above rig floor.

   e. Make directional surveys at 250'± and at 13-3/8" casing point with equipment supplied by Directional Drilling, Inc. Company; keep hole as nearly vertical as possible.

5. Wipe hole, pull bit

   a. Wipe hole with bit and stabilizers.

   b. Run back to bottom. Circulate and condition mud.

   c. Pull bit and stabilizers. Strap out of hole.

6. Prepare 13-3/8" casing.

   a. Tally casing before reaching casing point. Determine final depth of 17-1/2" hole for item 4.d. above.

   b. Weld 13-3/8" casing shoe to 13-3/8" shoe joint.

   c. Tack weld first three 13-3/8" casing collars to 13-3/8" casing joints a clean all 13-3/8" casing threads while casing is on racks.

   d. Rig up power tongs for 13-3/8" casing.

7. Run 13-3/8" casing

   a. Run 13 joints (approx. 520') of 13-3/8", 61.0#, K55, Range III, 8-round thread ST&C casing.

   b. Run with cement guide shoe on bottom and install an insert float valve with self fill-up assembly in second coupling from bottom.

   c. Place centralizers across the bottom four collars.

   d. Baker-Lock the first two thread connections above shoe.

   e. Apply thread dope to all other thread connections.

   f. Drop setting ball when casing is on bottom.

8. Cement 13-3/8" Casing (cement volumes for 520' of casing)

   a. Rig up cementing head for type 5W (or equivalent) top plug.

   b. Circulate for 30 minutes, and rig up cementing trucks.

   c. Preflush with 18 bbls. of water.

   d. Cement with 200 sacks (390 cu. ft.) of class "G" cement with 3% calcium chloride, 6% gel and 10 lbs/sack gypseal (106 lbs/cu. ft, 1.95 cu. ft./sack), with green dye mixed in first 100 sacks.

   e. Follow above with 175 sacks (200 cu. ft.) of class "G" cement with 3% calcium chloride (118 lbs/cu. ft., 1.14 cu. ft./sack).

   f. Note that theoretical pipe formation volume is 361 cu. ft. Specified quantities give 60% slurry volume excess excluding cement inside casing

   g. Displace cement with a top plug, 50 cu. ft. of water, and necessary mud

   h. Reciprocate casing until last 100 cu. ft. of cement remains to be displaced.

   i. Bump top plug (but if plug doesn't bump, displace no more than 20 cu. ft of mud past float valve).

8. (continued)

j. Put full weight of casing on bottom of hole, and block casing in center of rotary table.

9. Wait On Cement

a. Bleed off any excess cement through bull plug collar welded to conductor pipe. Wash out conductor pipe with water.

b. Haul cement returns away within 24 hours (cementer should supply retarder to prevent cement returns from hardening in sump).

c. Wait on cement for 24 hours before drilling out shoe.

10. Cut 20" pipe

a. Cut off 20" conductor pipe close to bottom of cellar.

b. Center 13-3/8" casing in 20" conductor pipe.

c. Do a top cement job if level of cement is not up to base of cellar.

11. Weld on casing head

a. Cut off 13-3/8" casing to a height which will allow the casing head to be 1" to 3" below ground level.

b. Weld a Shafco 12" Series 900, 3000 psi casing head bored for 8-5/8" casing to the 13-3/8" casing.

c. Check that the casing head has two 2" outlets equipped with a hydraulic 6" nipple and a Nordstrom 2" 3000 psi plug valve in one, and a 2" bull plug in the other.

d. Align casing head as directed by Tom Wilson.

e. Test casing head weld with 3000 psi oil pressure.

12. Install BOPE

a. Install 12" spool for kill and choke lines.

b. Install a 12" series 900 shaffer hydraulic double ram blowout preventer with rams for 4-1/2" drill pipe and a Hydril 12" series 900 GK bag type blowout preventer.

c. Install kill and choke manifold and lines.

d. Keep standby nitrogen bottles on hand and install mud pit level indicator with audible alarm.

13. Call D.O.G.

a. Call Division of Oil and Gas (D.O.G.) four hours before drilling out sh of the 13-3/8" casing.

b. Test blind rams before calling the D.O.G.

c. Request that the D.O.G. representative witness the test of Hydril Bag a BOP pipe rams.

14. Test BOPE

a. Test blind rams in BOP with rig pumps at 2000 psi for 15 minutes and record results on tour sheet.

b. Run a 12-1/4" bit and tag top of cement and record depth.

c. Test drill pipe rams and Hydril GK bag each with 1500 psi for 15 minute

d. Use remote control buttons to close BOP and accumulator valves to open BOP, and record test on tour sheet.

e. Record all tests on tour sheet. Have the D.O.G. representative sign to sheet.

15. Check BOPE on each trip.

a. Check BOPE on every trip by closing blind rams with pipe out of hole an pipe rams with pipe in hole.

b. Record the BOPE accumulator pressure, pump pressure and SPM at reduced circulating rate on the tour sheet on each tour.

16. Follow safety procedures.

a. Pull first five stands of pipe slowly when starting out of hole on trip

b. Stop and fill hole at least every five stands. KEEP HOLE FULL AT ALL TIMES. Record actual hole fill-up volume and/or strokes. Check agains theoretical volume/strokes.

c. Maintain pit level at all times.

17. Drill out cement

a. Increase mud weight as directed by mud engineer.

b. Drill out cement in casing, float valve, and shoe. Record depth of fill-up valve and shoe.

18. Drill 12-1/4" Hole to Kick-Off Point of 683'

a. Drill a 12-1/4" hole on 4-1/2" drill pipe to a kick-off point (K.O.P.) approximately 683', as indicated by the directional drilling plan.

18. (continued)

b. Run directional survey at K.O.P.

19. Set Up Directional Drilling Inc. to Run Drilling Motor

a. Run drilling motor in conjunction with an MWD system with a 12-1/4" bi from K.O.P. as directed by directional engineer to reach a bottom hole location (at 3400' TVD) of 865' East and 50' South OR 866' S87 deg E su face location.

b. Run surveys at least every 120'; target has a 50' radius.

c. Note that there are no other wellbores or obstructions for hole to cro it is not necessary for well to follow theoretical wellbore path to re target.

20. Drill 12-1/4" Hole to 50' above top of Capital Sand.

a. Drill a 12-1/4" hole toward bottom hole target.

b. Stop 12-1/4" hole at 3235' TVD. This should be 50' above the top of Capital Sand. Pull 12-1/4" bit and drilling assembly.

21. Core with 9-5/8" core head through Capital Sand to 3400' TVD.

a. Run 9-5/8" x 5" with 5" PVC inner tube.

b. Core 9-5/8" hole through Capital Sand to 3400' TVD. Circulate hole clean. NOTE: During coring and shoulder-lowering, the low expected rese voir pressure could cause fluid loss and drilling tool sticking pro- blems. Extra attention must be paid to mud properties.

c. Pull 9-5/8" core head. Strap out of hole.

22. Lower 12-1/4" x 9-5/8" shoulder to casing point.

a. Run 12-1/4" bit and drilling assembly on 4-1/2" drill pipe.

b. Drill 12-1/4" hole to casing point 100' below base of Capital sand (abo 3500' TVD).

Special note: Exercise extreme care to avoid sidetracking hole.

23. Run Schlumberger DIL-CNL-FDC combination logs.

a. Run DIL-CNL-FDC combination logging tool from bottom up to shoe of 13-3/8" casing.

1) Record logs on a 0 to 30 ohm linear scale on 2" and 1" scale; use l scale on 5" log.

2) Record DIL log corrected to true vertical depth (TVD) basis on 5", 2 and 1" scales

b. Run Gamma Ray Spectrometry (GST) tool from TD to above Capital Sand top

c. FAX bottom 400' of 5" scale combination log to Walnut Creek Office (510) 746-4214.

d. Make 4 field copies of each log; make certain log headings are complete

e. Check that drillers and loggers depths are within 4' of one another.

24. Lay Down 4-1/2" Drill Pipe

a. Rig up a casing/drill pipe pick-up and lay-down machine.

b. Circulate bottoms up at least twice. Make sure hole is clean and stabl

c. Pull out of hole laying down 4-1/2" drill pipe.

25. Run 8-5/8" Casing to casing point

a. Place 87± joints of 8-5/8" 32# 8Rd casing on racks, and tally each row. Casing should have been inspected by a contract firm.

b. Thoroughly clean pin and box threads and inspect for shipping damage. Thoroughly clean thread protectors and reinstall on joints dry and hand tight. Visually inspect inside of casing.

d. Weld Baker Super Seal Float Shoe on to bottom joint.

e. Use a casing pick-up machine, and casing tongs with torque gauge for 8-5/8" casing. Maximum torque for 8-5/8" 32 #, J-55 8rd casing is 4520 ft-lbs.

f. Install the following equipment on casing string:

1) Run centralizers on bottom five joints.

2) Run centralizers, above the fifth collar, on every other collar up t 100' below where hole reaches maximum angle.

3) Run centralizers next on every collar to 100' above the K.O.P. (78 centralizers total required).

4) Run centralizers on last three collars below ground level to keep 8-5/8" casing centralized in surface casing.

5) Install Super Seal Float Collar in second collar from bottom.

g. Note details as follows:

1) Bakerlock first collar and connections to float collar.

2) Apply Seal Lube to all other connections.

3) Visually inspect and air hose each set of casing threads immediately before making a connection.

26. Rig up BJ for cementing the 8-5/8" casing

a. Rig up cementing head, circulating lines, and cementing pump trucks.

b. Circulate until mud is clean.

c. Reciprocate pipe while circulating and during displacement of cement.

27. Cement 8-5/8" casing.

a. Pump out bottom wiper Plug.

b. Pump 200 cu ft of mud clean.

c. Pump lead slurry of 845 sacks (1301 cu ft) of BJ light cement +1% FL-6: +.5% CD-32, +.2% R-3, +2 GHS FP-6L, (102 pcf, 1.54 cu ft/sack, 7.7 gal water/sack).

d. Pump tail slurry of 230 sacks (260 cu ft) of Premium Cement with G:0:0 +3% KCL +.6%FL-62 +.3% CD-32 +.9%BA-61 +2 GHS FP-6L (119 PCF, 1.13 cu ft/sack, 4.82 gal water/sack).

e. Displace top wiper plug with drilling fluid.

f. Reciprocate casing until last 100 cu. ft. of cement remains to be displaced.

g. Bump top wiper plug (but if plug doesn't bump, displace no more than 2(cu. ft. of mud past float valve).

h. NOTE: cement volumes should be recalculated to bring cement to surface cas ing shoe plus contain a 25% excess.

NOTE: Have cementers make sure that excess dry cement is in the hoppers so that it is not necessary to stop to shake down the hoppers to mix t last of the slurry. Observe and make certain that the last of the slur is well mixed. This cement will seal the shoe. The special tail slurr is to be carefully mixed in a recirculating mixer.

i. Set slips. Stand cemented for 24 hours.

j. Dump cement retarder in sump to prevent any cement returns from hardening, and haul cement returns away within 24 hours.

28. Install well head components while standing cemented

a. Drop slips for 8-5/8" casing in place.

b. Hang entire casing weight on slips as directed, and record tension on weight indicator.

c. Remove BOPE.

d. Trim 8-5/8" casing to a proper height for a new tubing head.

33. Run Cement Bond Log

a. Rig up a Schlumberger logging unit and run a cement bond log from PBTD bottom of surface casing at 520'.

b. Run neutron correlation log from PBTD to 2000'±.

34. Run 2-7/8" Tubing

a. Make sure that tubing is clean before running in hole; remove any exce. or contaminated thread dope from inside and outside of tubing ends.

b. Tally tubing as it is placed on the racks; rig monitor and tool pusher should measure and keep separate tallies.

c. When making up tubing, apply a thorough coat of thread dope to the pin end only and wipe the connection clean after makeup, and DO NOT OVER-TORQUE connections.

d. Hang 2-7/8" tubing just above Capitol Sand as directed by rig monitor.

35. Displace Drilling Mud With Water

a. Displace mud in hole with 2% KCL water.

b. Haul off contaminated mud. Clean out mud system.

36. Remove BOPE and Install Wellhead Assembly

a. Install a backpressure valve in tubing hanger, and remove BOPE.

b. Install wellhead assembly.

c. Remove backpressure valve from tubing hanger.

37. Perforate Capital Sand with Through Tubing Gun

a. Swab down tubing and casing to 2500'±.

b. Rig up Schlumberger perforating unit.

c. Perforate Capital sand with 4 shots/foot as directed by rig monitor.

38. Bring in Well with Swab.

a. Rig up clean-up separator, flow lines, and flare stack.

b. flow well to separators for 3 to 5 hours to clean up.

39. Secure Well and release rig

a. Check all valves and fittings on Christmas tree to make sure they are closed.

b. Release rig.

STATE OF CALIFORNIA--THE RESOURCES AGENCY PETE WILSON, Governor

DEPARTMENT OF CONSERVATION
DIVISION OIL AND GAS--DISTRICT 6
20th FLOOR, MS-22
801 K STREET
SACRAMENTO, CALIFORNIA 95814-3530
(916) 322-1110
(916) 323-0424 (FAX)

June 8, 1992

Thomas W. High, Agent
PACIFIC GAS & ELECTRIC CO.
77 Beale St., Room H-905
San Francisco, CA 94106

Subject: Denial of Confidential Status
"Bender" 1
Sec. 28, T. 5N., R. 5E.,
Thornton Gas

Dear Mr. High:

This office is in receipt of your request dated May 28, 1992, regarding confidential status for the above well. The request is denied as the well is classified as a "Development" well. Assembly Bill 3002, which became effective January 2, 1985, restricts confidential status to "Exploratory" wells or "Development" wells where there are extenuating circumstances.

Sincerely,

Robert A. Reid

ROBERT A. REID
Deputy Supervisor

cc: Charlie Bond

WorleyParsons
resources & energy

Infrastructure and Environment
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Folsom, CA 95630, USA
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worleyparsons.com

November 1, 2011

Pacific Gas and Electric
77 Beale Street, San Francisco, CA 94105

Attn: Mr. Robert Booth, Project Manager

RE: PRELIMINARY GEOLOGICAL EVALUATION
MEGANOS CHANNEL GAS POOL OF THE WEST THORNTON / WALNUT GROVE GAS FIELD
COMPRESSED AIR ENERGY STORAGE (CAES) PROJECT

INTRODUCTION

This letter report presents a preliminary geological evaluation of the Meganos Channel gas pool of the West Thornton / Walnut Grove Gas Field and assesses its appropriateness as a candidate for Pacific Gas and Electric's (PG&E) Compressed Air Energy Storage (CAES) project. The report is accompanied by the following five exhibits:

- Type Log;
- Contours Base Eocene Capay Shale;
- W-E Cross-Section through the West Thornton/Walnut Grove Gas Field;
- Net Meganos Pay Isochore; and
- Meganos Channel Pool Wells.

The Meganos Channel gas pool of the West Thornton / Walnut Grove Gas Field is located in the Sacramento Valley gas province between the Cities of Stockton and Sacramento. It is situated under farm land in Sections 30, 31 and 32, T5N-R5E, in Sacramento County about nineteen miles northwest of downtown Stockton. The Meganos Channel gas pool, which was discovered in 1956 but developed during the early 1960s, is abandoned, having produced an estimated 25 billion cubic feet (Bcf) of gas from 16 wells.

TRAP

Meganos Channel sandstones are trapped in a large Paleocene submarine canyon where it crosses the west-dipping limb of the large Thornton anticline. Thick Meganos channel sands are overlain and capped by thick (300') impermeable Eocene Capay shales that drape over thick sandstones near the center of the channel. Meganos Channel shales also provide a lateral impermeable seal to reservoir sands. The trap covers approximately 700 acres and had a maximum fill-up of over 90 feet.

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RESERVOIR

The Meganos Channel gas pool produced over 14 Bcf of gas from eight wells from the time the pool was discovered in 1956 to November 1966. It was still producing nearly 19,000 thousand cubic feet per day (Mcf/d) in November 1966. It is estimated that 25 Bcf of gas was produced from the Meganos Channel reservoir. Meganos Channel sandstones were deposited as second-cycle sandstones and generally have excellent porosity and permeability. The original eroded sandstones were deposited in shallow marine and deltaic environments. Log porosities average about 28.7%. Core permeabilities are lacking, but can be considered excellent.

CAES CANDIDATE PROS AND CONS

The Meganos Channel gas pool appears to be an excellent candidate to test the CAES concept. All wells in this pool are abandoned. There are no obvious structural or stratigraphic complications within the reservoir, but potential stratigraphic compartmentalization may exist in these channel sands. The reservoir channel sands are of excellent quality, are sealed on the top by the thick Capay shales and on the sides by the Meganos Channel shales, and occur within the optimal depth and pressure range. The area falls within an area of projected section corners and several of the wells were found to be mis-located. This situation may exist for other wells.

MEGANOS CHANNEL SAND RESERVOIR PARAMETERS

Original Reservoir Pressure:	1,600 psi
Average Depth:	3,470’
Average Reservoir Thickness:	30’
Porosity:	25% - 30% (avg. 28.7% in logs)
Permeability:	Excellent
Reservoir Drive:	Water drive
Cumulative Gas:	estimated 25 Bcf
Remaining Reserves:	none
Surface area of trap:	~700 acres
Productive wells (Meganos):	16 producing, 22 within pool limits; all abandoned

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MEGANOS CHANNEL POOL CUMULATIVE PRODUCTION (1956-1966)

Well	Year Completed	Cum. Production	Nov. 1966 Rate
Section 30, T5N-R5E			
CHEVRON McCormack-Williamson #1	1956 OH		
	1964 R/D	989,633 Mcf*	2,037 Mcf/d
CHEVRON McCormack-Williamson #6	1960	2,060,235 Mcf	1,227 Mcf/d
CHEVRON Patterson Unit #2	1960	1,914,877 Mcf	2,624 Mcf/d
CHEVRON Patterson Unit #3	1962	1,446,519 Mcf	630 Mcf/d
Section 31, T5N-R5E			
CHEVRON Towne Unit #2	1960	2,006,476 Mcf	2,691 Mcf/d
CHEVRON Towne Unit #3	1962	2,045,572 Mcf	2,958 Mcf/d
CHEVRON Towne Unit #4	1960	1,784,111 Mcf	3,661 Mcf/d
CHEVRON Towne Unit #5	1961	1,833,212 Mcf	3,030 Mcf/d
		14,080,635 Mcf	**18,858 Mcf/d**

**Combined OH and R/D?*

In November 1966, most of the wells were producing only minor quantities of water (0.1 to 0.14 bbls/day). From March to November 1996, the rate of water production was increasing rapidly in the Patterson Unit #3 (from 52 to 155 bbls/day) and the McCormack-Williamson #6 (from 23 to 69 bbls/day).

CONCLUSIONS

The Meganos Channel gas pool of the West Thornton / Walnut Grove Field is considered an excellent candidate for CAES based on the following pool characteristics:

- Excellent reservoir quality (high porosity and permeability);
- Excellent top and lateral seals;
- No obvious structural or stratigraphic compartmentalization;
- Optimal depth and pressure range; and
- All wells are abandoned.

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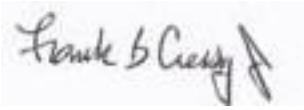
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There are discrepancies in well locations that will need to be resolved.

CLOSING

Please feel free to contact either Frank Cressy at (661) 301-7125 or Mark Ausburn at (360) 320-1029 if you wish to discuss this report.

Respectfully,
WorleyParsons





Frank Cressy, P.G. #3934
Petroleum Geologist

Mark Ausburn, P.G. #5212
Project Manager

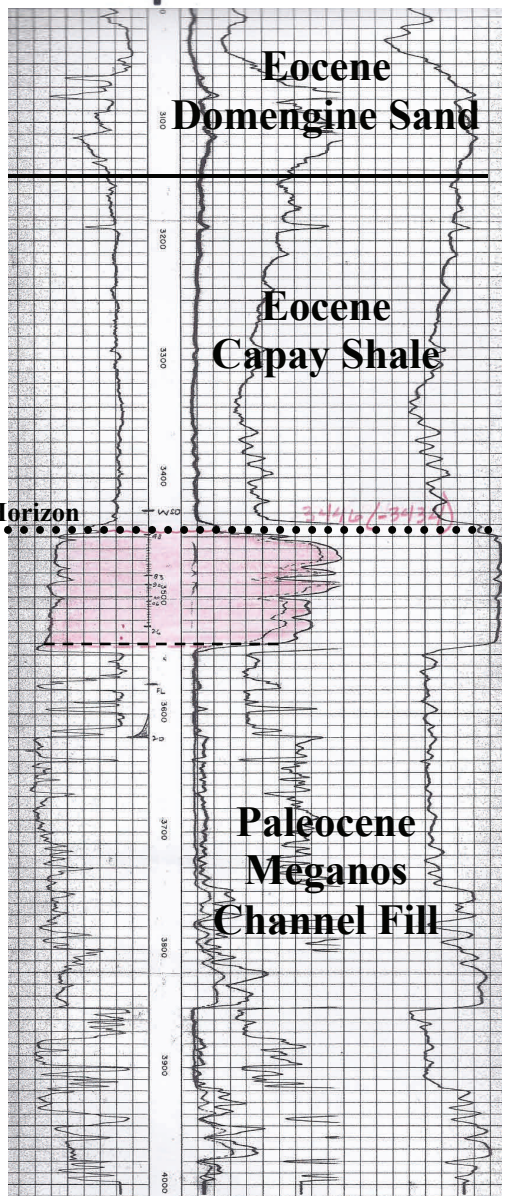
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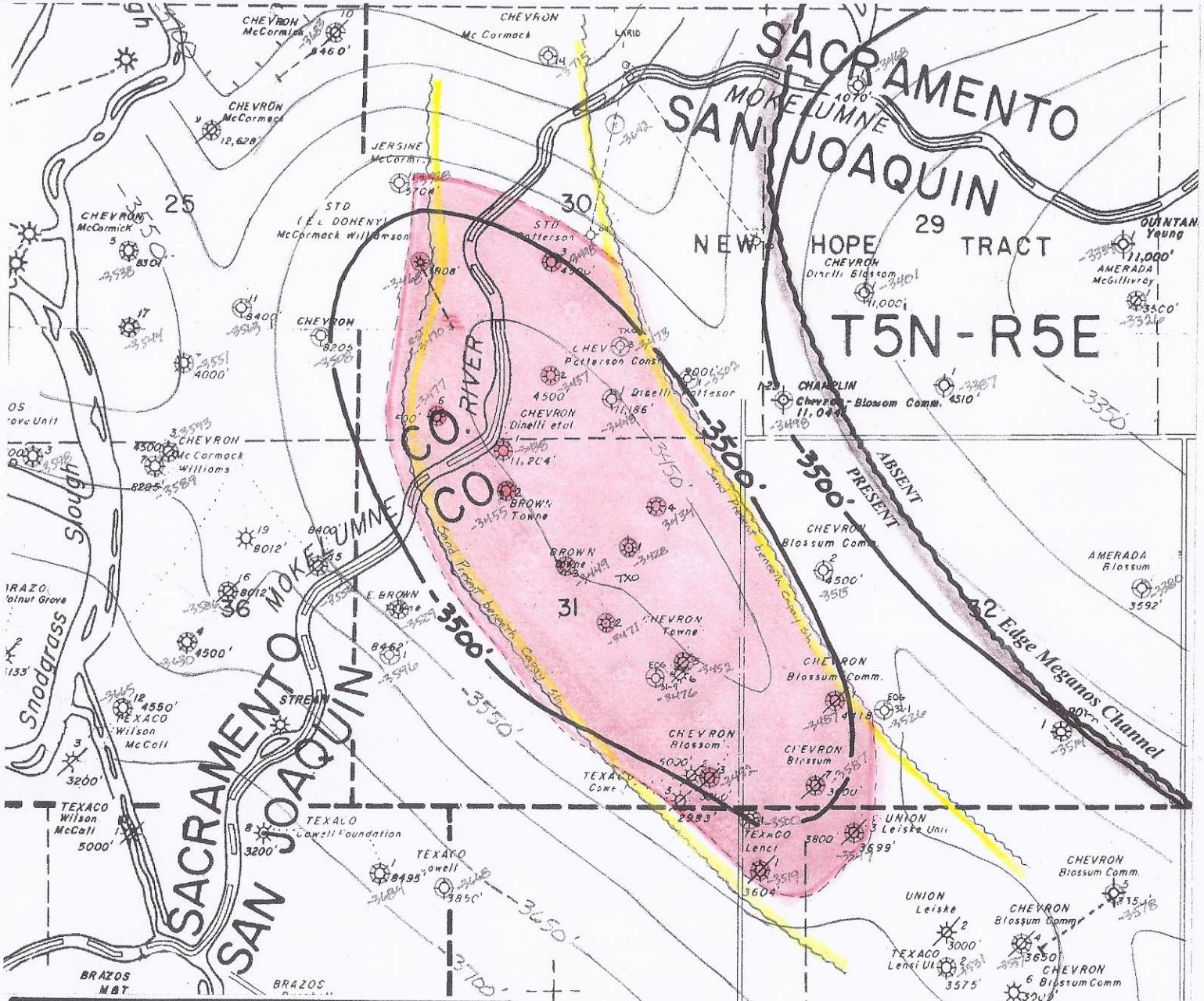
Type Log
Contours Base Eocene Capay Shale
W-E Cross-Section through the West Thornton/Walnut Grove Gas Field
Net Meganos Pay Isochore
Meganos Channel Pool Wells

TYPE LOG

West Thornton/Walnut Grove Gas Field
Meganos Channel Sand Pool
San Joaquin County, CA

CHEVRON
H.D. Towne Unit #4
Section 31, T5N-R5E





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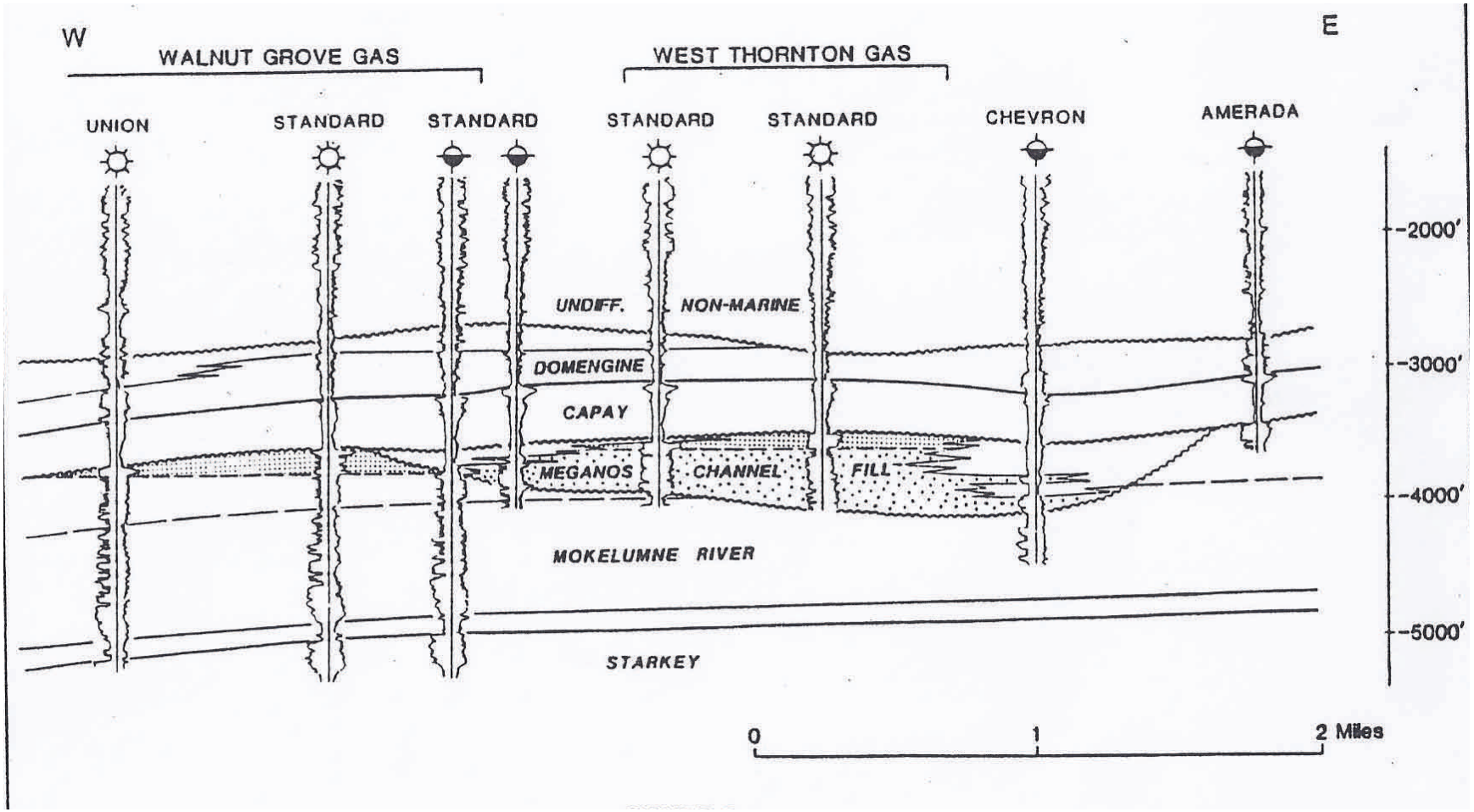
WEST THORNTON GAS POOL

Sacramento County, CA

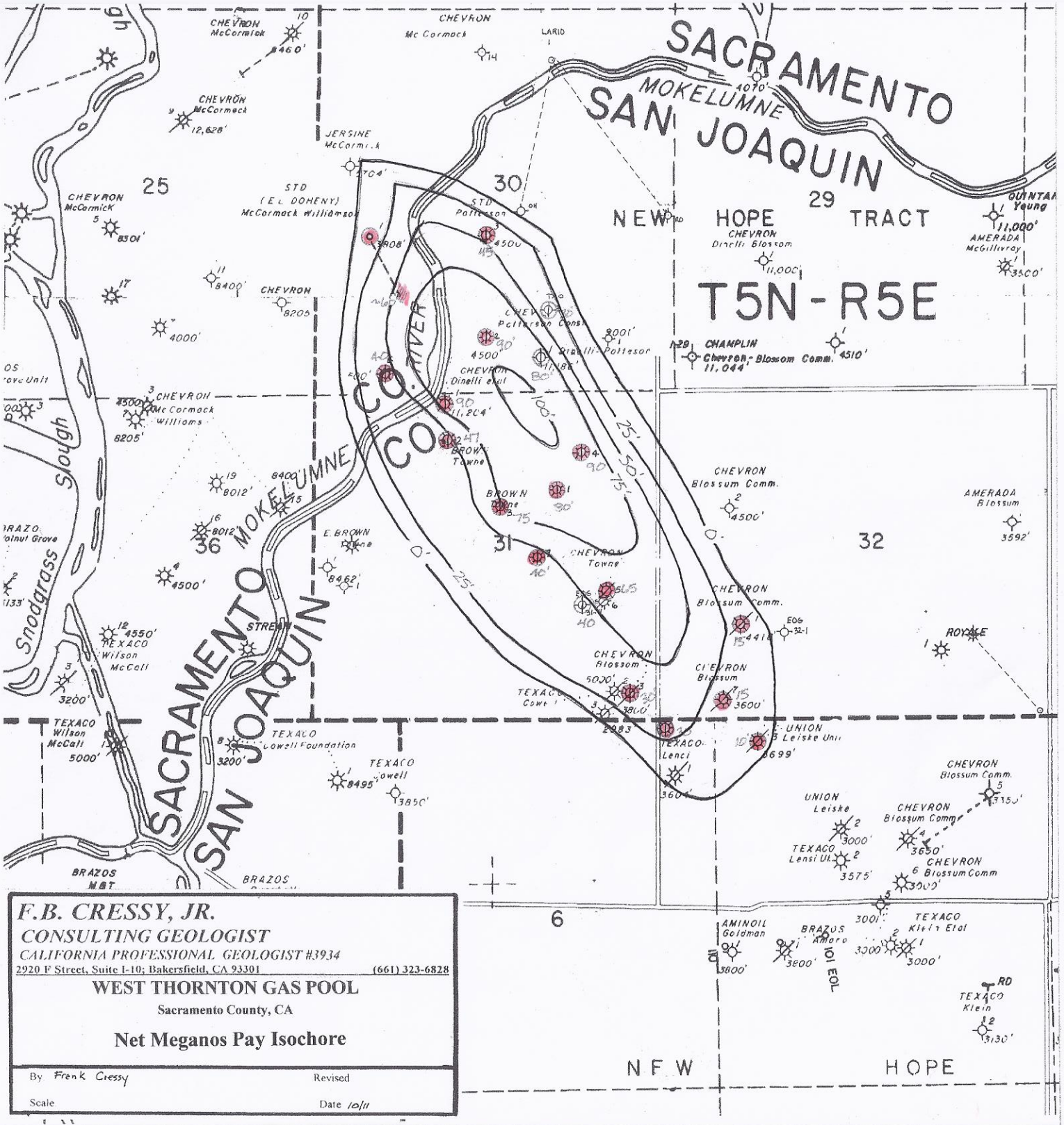
Contours base Eocene Capay Shale

By F. Cressy Revised 10/11

Scale Date



West-East cross section through the West Thornton/Walnut Grove gas field. Thick channel sands in the Paleocene Meganos Channel shale-out laterally toward the channel edges. The overlying Capay shale drapes over the underlying sand forming closed anticline trapping gas. Section from published data, Boyd, 1984.



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WEST THORNTON GAS POOL

Sacramento County, CA

Net Meganos Pay Isochore

By Frank Cressy Revised

Scale Date 10/11

WEST THORNTON GAS FIELD
Meganos Channel Pool Wells

API#	LeaseName	Well#	Operator Name	Section	Township	Spud Date	Abandon Date
6700286	McCormack-Williamson	1	Chevron U.S.A. Inc.	30	5N-5E	6/16/1956	3/12/1975
6700280	McCormack-Williamson	6	Chevron U.S.A. Inc.	30	5N-5E	6/10/1960	3/27/1975
7700214	Patterson Unit	3	Chevron U.S.A. Inc.	30	5N-5E	9/16/1960	2/16/1968
7700215	Patterson Unit	2	Chevron U.S.A. Inc.	30	5N-5E	7/12/1960	6/2/1983
7700216	Patterson Construction Co.	1	Chevron U.S.A. Inc.	30	5N-5E	3/10/1954	4/10/1954
7720432	TP Unit	3	TXO Production Corp.	30	5N-5E	4/30/1984	5/3/1984
7700207	Cowell Foundation	2	Chevron U.S.A. Inc.	31	5N-5E	2/24/1961	3/8/1961
7700213	H.D. Towne Unit	2	Chevron U.S.A. Inc.	31	5N-5E	3/23/1960	6/6/1975
7700210	H.D. Towne Unit	5	Chevron U.S.A. Inc.	31	5N-5E	3/9/1961	6/5/1975
7700211	H.D. Towne Unit	4	Chevron U.S.A. Inc.	31	5N-5E	9/3/1960	6/13/1975
7700212	H.D. Towne Unit	3	Chevron U.S.A. Inc.	31	5N-5E	6/18/1960	6/10/1975
7700223	Blossom Community	3	Chevron U.S.A. Inc.	31	5N-5E	12/19/1961	3/1/1971
7720161	Dinelli-Patterson-Towne	1	Chevron U.S.A. Inc.	31	5N-5E	2/15/1972	5/15/1979
7720422	T.P. Unit	1	TXO Production Corp.	31	5N-5E	10/15/1983	9/12/1988
7720431	T.P. Unit	2	TXO Production Corp.	31	5N-5E	4/21/1984	9/14/1988
7720555	Patterson	31-4	EOG Resources Inc.	31	5N-5E	10/8/1991	10/17/1991
7700219	Blossom Community	7	Chevron U.S.A. Inc.	32	5N-5E	3/20/1966	3/3/1971
7700225	Blossom Community	1	Chevron U.S.A. Inc.	32	5N-5E	10/27/1960	2/28/1974
7700010	Leiske	3	Union Oil Co. of Calif.	5	5N-4E	2/10/1967	5/14/1971
7700199	Lenci Unit	2	Chevron U.S.A. Inc.	5	5N-4E	1/19/1963	8/13/1971
7700006	Leiske	1	Union Oil Co. of Calif.	6	5N-4E	9/22/1961	5/12/1971
7700201	Lenci Unit	1	Chevron U.S.A. Inc.	6	5N-4E	5/3/1962	3/28/1968
7700206	Cowell Foundation	3	Chevron U.S.A. Inc.	6	5N-4E	10/21/1962	3/27/1968

WEST THORNTON RESERVOIR

Summary and Decision

The West Thornton Reservoir (West Thornton—Aerial Map.pdf), located in Sacramento County, California (approximately 19 miles northwest of Stockton), was not selected for detailed modeling and/or was not a finalist site for the CAES Feasibility Study. In the opinion of the project team, development of the reservoir would be challenging for the following reason:

- The majority of the surface land, overlaying the reservoir, is part of the Consumnes River Preserve (http://www.cosumnes.org/about-the-preserve/). The attached link provides a map of the preserve (http://cosumnes.org/documents/parcelmap.pdf).
- Development of the reservoir and/or an Energy Conversion Facility (ECF) would be incompatible with the land use.

Subsurface/Reservoir Screening

Preliminary Screening Results

A preliminary review (West Thornton—Preliminary Geological Report.pdf) of the West Thornton gas field was completed on November 1, 2011. That report indicated that an estimated 25 Bcf had been produced from 16 wells completed within the field. The focus of the report was on the Meganos Channel sandstones, which exhibited characteristics that were acceptable reservoir parameters for a CAES project. At approximately 3,470 ft deep and with an estimated 1,600 psi pressure, the gas field was judged to be acceptable and "appears to be an excellent candidate to test the CAES concept."

The field was discovered in 1956 and is currently fully depleted and abandoned. A total of 22 wells penetrated the Meganos Channel gas pool. Log-derived porosities were determined to be in the range of 25% to 30%, with an average of 28.7%. Core permeabilities are not available, but based on an assessment of available data, permeabilities were considered to be excellent. The average reservoir thickness was estimated to be 30 ft, and the aerial footprint of the productive reservoir was approximately 700 acres. Based on the production history, the project team concluded that a water drive mechanism likely existed.

Detailed Geological Summary

Based on the encouraging preliminary screening results, the project team completed a detailed geological evaluation to look deeper into the field attributes (West Thornton—Detailed Geological Analysis with Appendix.pdf). That work was completed on November 21, 2011, building on the previous analysis. The productive gas reservoir aerial extent was adjusted to 780 acres, the total well count was increased to 23, and the maximum thickness was determined to be over 90 ft (average net pay was adjusted to 45 ft). Permeabilities were calculated based on

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flowing and shut-in surface tubing pressure differentials and average gas production rates (West Thornton—Historic Permeability Data.pdf), resulting in estimates of 100 to 200 mD.

The detailed report concluded that the West Thornton Meganos Channel gas pool "is a potential, but not ideal, candidate for CAES." The study found "no obvious structural or stratigraphic complications within the reservoir, but potential stratigraphic compartmentalization may exist in these channel sands." The reservoir permeability is judged to be "moderate (100 – 200 millidarcies)" with a strong water drive.

Reservoir Modeling and Evaluation

Based on the results of the preliminary and detailed geological analysis, the project team determined that the West Thornton reservoir parameters were within an acceptable range for CAES development. However, when the reservoir was evaluated against other potential reservoirs, it ranked lower than the top choices to meet the CAES program's short- and long-term objectives. For this reason, as well as other land and environmental-related issues, no further evaluation was conducted at West Thornton.

Testing/Development Potential

No testing was conducted.

Siting and Environmental Evaluation

Determination – Fatal Flaws

The majority of this geographically large gas field is located under lands owned by The Nature Conservancy (TNC) as part of the Consumnes River Preserve (West Thornton—Conservancy Map.pdf). In addition, additional TNC parcels and conservation easements are adjacent to the potential power plant site. Further, it appears TNC is actively expanding its land rights in the area to protect additional adjacent properties. Due to the adjacency of these protected parcels, development of a CAES project was considered an incompatible use, and this site was dropped from further consideration.

Land Acquisition/Site Control

Deployment

In May 2012, a landman was deployed to the West Thornton reservoir (West Thornton—APN Map.pdf) to identify the surface, mineral, and preferred ECF site owners. None of these owners was contacted regarding the CAES Project.

Preliminary Title Work

In May 2012, PG&E proceeded with a limited Title Review of the 88 Assessor's Parcel Numbers (APNs) overlying the storage reservoir. Title work identified 44 surface owners over the first 72

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APNs researched. Given the scope of completing this volume of reporting, additional title work was put on hold. Full title reports were not completed.

References

1) West Thornton - Aerial Map.pdf
2) West Thornton - Preliminary Geological Report.pdf
3) West Thornton - Detailed Geological Analysis w Appendix.pdf
4) West Thornton - Historic Permeability Data.pdf
5) West Thornton - Conservancy Map.pdf
6) West Thornton - APN Map.pdf

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A309: Willow Slough Site Selection and Attachments

Willow Slough - Aerial Map
Willow Slough - APN Map
Willow Slough - Detailed Geological Report
Willow Slough - Reconnaissance Report
Willow Slough Site Selection Close-Out - Final Report



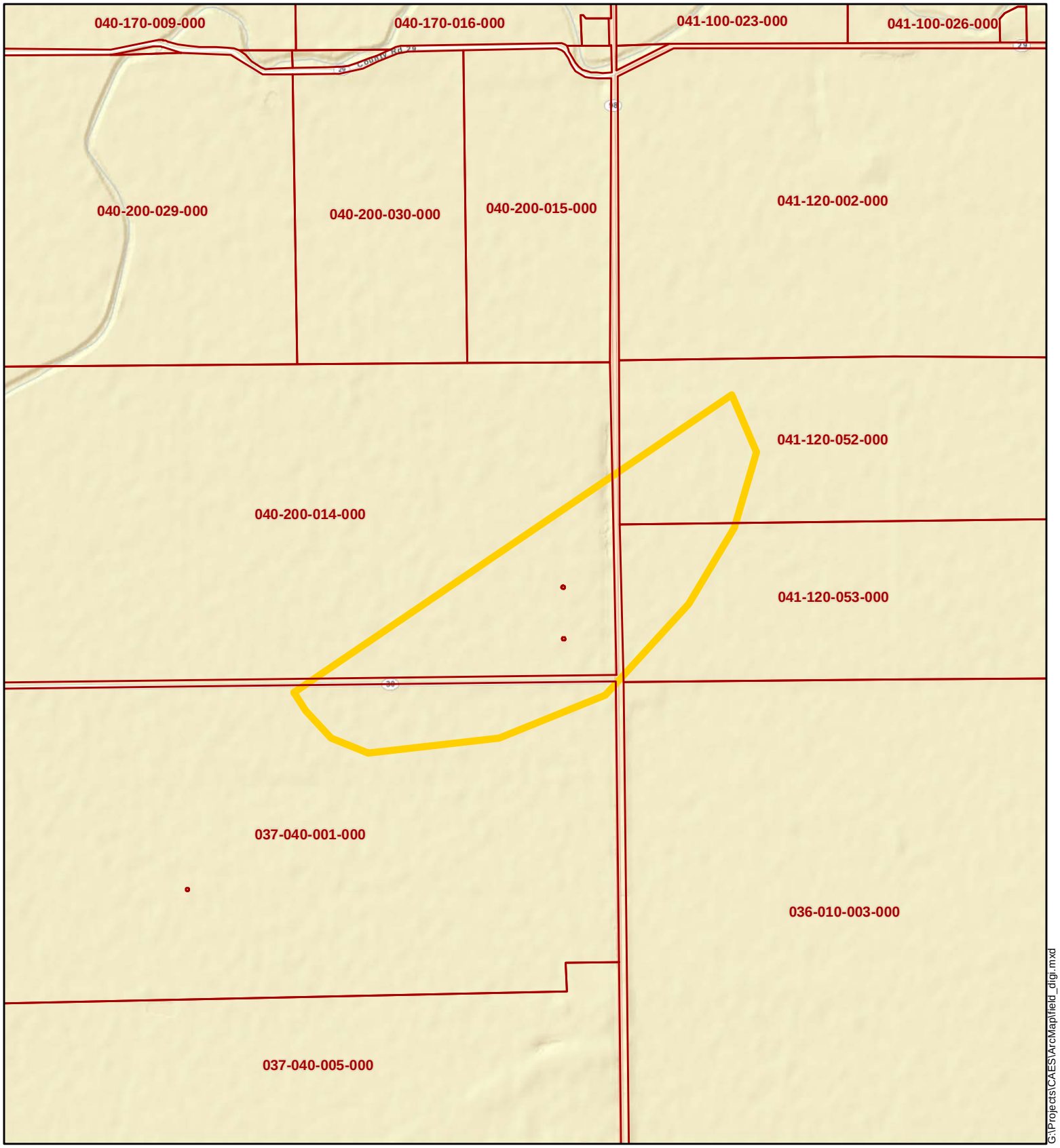
Willow Slough Gas

- Approximate Structure Formation
- Station Site
- 1,500' Buffer
- Parcels
- Existing 230 kV
- Gas Line
- Gas Pipeline Connection
- Gas Supply
- Gen-Tie
- Water Supply Line

1:13,000

0 1,700 3,400 5,100 Feet

G:\Projects\CAES\ArcMap\field_digi.mxd



Willow Slough Gas

- Approximate Structure Formation
- Station Site
- 1,500' Buffer
- Parcels
- Existing 230 kV
- Gas Line
- Gas Pipeline Connection
- Gas Supply
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- Water Supply Line

1:13,000

0 1,700 3,400 5,100 Feet

11/21/2011

GEOLOGY AND GAS PRODUCTION OF THE GREINER AREA OF THE WILLOW SLOUGH GAS FIELD, YOLO COUNTY, CALIFORNIA

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EXECUTIVE SUMMARY

More than 7.5 BCF of natural gas have been produced from three wells in the Greiner Area of the Willow Slough gas field since its discovery in 1976. Production is from at least 12 separate sandstone reservoirs of the Mokelumne River, Starkey, and Winters Formation between depths of 4000 and 5700 feet. Gas pools range in thickness from 10 to 90 feet, with areas ranging from 5 to 65 acres. Log-derived reservoir porosity averages 25 to 31 percent, with water saturations of 43 to 50 percent. Gas is entrapped in reservoirs by folding along a northeast-striking normal fault. Most reservoirs exhibit a strong water-drive production mechanism with reservoir depletion and the onset of significant water production occurring with relatively high reservoir pressure.

INTRODUCTION

This investigation includes evaluation of the subsurface stratigraphy, rock properties, structure, and gas production characteristics of the natural-gas reservoirs of the Greiner Area of the Willow Slough Gas Field in Yolo County, California. The Greiner area is the western-most part of the Willow Slough Field, and includes three directional gas wells that have produced from 12 different gas pools. The field is located in the central part of the southern Sacramento Valley, about 18 miles due west of the City of Sacramento and about 2-3 miles northwest of the City of Davis (Attachment 1). The study area includes approximately two square miles at the junction of Townships 8 and 9 North and Ranges 1 to 3 East (Attachment 2).

History of Development

The Greiner Area of the Willow Slough Gas Field was discovered by Shell Oil Company in 1976 in the Arco-Greiner 1-36 well. The well was completed in three zones, with a combined open-flow potential of 26 MMCF per day. Production began in 1977, and in 1992, operation of the well was transferred Stream Energy, Inc. The well was abandoned in 1995.

Stream continued the development of the area with the Greiner 2-36 in 1994. They acquired a 3D-seismic survey across the Greiner Area in the late 1990's, and subsequently drilled the Greiner 3-36 in 2000. These wells were purchased by Equity Oil Company, then Whiting Oil and Gas Corporation. The wells are currently idle with Maranatha Petroleum, Inc. listed as operator.

METHODS

This evaluation includes analysis of data from 16 exploration and development wells drilled in and around the Greiner Area. Well history records for all of these wells were reviewed, and a digital well database was compiled that includes API number, operator, well name, well number, status, total depth, elevation, spud date, location, latitude, longitude, and survey data for directional wells (Attachment 3). . Latitude and longitude are referenced to the 1927 North America datum. Raster images of well logs were obtained from commercial sources and CDOG files.

A well history summary was prepared for each gas well from well history records (Appendix I). Monthly gas production, water production, and pressure data were compiled from on-line records of the California Division of Oil, Gas and Geothermal Resources. Production data was compiled in spreadsheet format and production-decline curves were prepared (Appendix I). Well logs for each gas well, annotated with stratigraphic information and production information, is also included in Appendix I. Well completion and production information, including perforated intervals, initial production rate, and cumulative production for each interval, is included in

Attachment 4. A summary of gas-pool data, which includes cumulative production, elevation of the gas-water contact, maximum gross isochore thickness, and estimated are is included as Attachment 5. All of the digital well and production data were input into Landmark Geographix software for data manipulation, cross section preparation, and mapping.

A series of cross sections that includeD all wells in the study area were prepared and logs were annotated with available perforation information. Producing intervals and pertinent stratigraphic horizons were identified and correlated in all available wells. The thicknesses of the gas zones were calculated from Spontaneous Potential logs, and recorded in the database. A cutoff of 10 millivolts from the shale baseline was used in the net-sandstone calculations. The stratigraphic information was incorporated in the preparation of structure and isochore maps of the gas pools. Reservoir rock property data was compiled from well histories and CDOG publications.

REGIONAL GEOLOGY

The drilled thickness of Cretaceous and Tertiary age sedimentary strata in the Greiner area exceeds 6000 feet. The stratigraphic sequence includes the age and approximate thicknesses of strata as follows:

Nonmarine Undifferentiated	Recent-Miocene	3000 feet
Nortonville Formation	Eocene	500 feet
Domengine Formation	Eocene	100 feet
Capay Formation	Eocene	500 feet
Mokelumne River Formation	Late Cretaceous	100 feet
Starkey Formation	Late Cretaceous	1500 feet
Winters Formation	Late Cretaceous	800 feet

Major unconformities are present at the base of the Nonmarine Undifferentiated stata and at the base of the Capay Formation. At the Willow Slough field, gas reservoirs are formed by the Mokelumne River Formation, ten different horizons in the Starkey Formation, and the Winters Formation.

The Willow Slough Gas Field is located near the axial basin syncline at the northern termination of the Midland fault system, where regional dip is to the southeast (Attachment 6). The area is dominated by normal faults, which form the primary trapping mechanism for several fields in the area including Willow Slough, Toddhunters Lake, Conaway Ranch, and Crossroads. Unlike many of these fields, however, the predominant trapping fault at the Willow Slough Gas Field strikes northeast. In contrast, the major trapping faults in the nearby fields generally strike northwest. The orientation of the faults appears to parallel the direction of the regional dip in these areas.

STRUCTURE

The primary trapping fault in the Greiner area dips northwest and offsets Upper Cretaceous strata as much as 100 feet. Strata dip uniformly to the southeast, normal to the fault plane, and gas wells were drilled directionally to parallel the fault plain, in order to penetrate each gas pool in the most structurally favorable position adjacent to the fault. The Greiner 3-36 well, which was drilled based on 3D-seismic data, was drilled at an angle of 33 degrees from the vertical, which indicates a dip on the fault of 57 degrees from the horizontal.

Folding along an axis oriented normal to the primary trapping fault appears to form the critical lateral closure for the numerous Mokelumne River, Starkey, and Winters Formation gas pools (Attachments 7 to 11). This closure, or vertical distance between the structure's highest point and its lowest closed structure contour, is as much as 90 feet at the Fourth Starkey horizon.

California Division of Oil and Gas (1998) depict lateral closure in the Willow Slough Gas Field formed by a series of normal faults that strike northwest, normal to the strike of the primary trapping fault. This is in contrast to the mapping presented herein that shows the closure formed by folding, which is more consistent with the nature of the lateral closure of other, more well-documented fields in the area. With the available data, however, there is no way to determine with confidence whether the lateral closure for the Greiner Area gas pools is a result of folding (as presented herein), or faulting, as depicted by California Division of Oil and Gas (1998).

As the nature of the lateral closure is not well constrained, neither is the location of the lateral closure. There are very few wells to delineate the margins of the gas pools along the flanks of the structure, and the maps presented herein were contoured based on a reasonable gas pool size estimated from gas production volume and reservoir thickness. Integration of the well data with available seismic-reflection data would allow for a much more reliable understanding of the reservoir structure.

RESERVOIR STRATIGRAPHY AND ROCK PROPERTIES

The Mokelumne River and Starkey Formations represent deposition in a fluvial-deltaic environment. The 1500-foot thick sequence, at depths between 4000 and 5500 feet, consists primarily of sandstone, with relatively thin shale and lignite interbeds (Attachment 7). The lower part of the sequence is more sandstone-rich, with shale beds more abundant in the upper part. Sandstones were deposited as river-channel or delta-front deposits, with shale beds and lignites representing inter-channel marsh and swamp deposits, respectively. Shale beds are as thick as 50 feet, and appear to contribute to gas entrapment. Shale beds are generally laterally continuous, suggesting that they may represent periods of rising sea level.

The Starkey Formation has been informally subdivided into First through Fifth members (in order of penetration by the drill bit from top to bottom) that are bounded by regional shale beds (Attachment 7). These five informal members of the Starkey Formation can be correlated regionally throughout the central Sacramento basin. Sandstone bodies of the Starkey Formation are as thick as 150 to 200 feet and reservoir gross isochore thicknesses range from 10 to 90 feet. Most of the reservoirs are perched atop water tables, with well defined gas-water contacts.

The Winters Formation was deposited as deep-sea fan turbidites, and includes alternating beds of sandstone and shale. Sandstone bodies of the Winters Formation have also been subdivided into informal members, however, in contrast to the Starkey Formation, Winters Formation sandstone beds are much more laterally discontinuous. Shale beds that separate the sandstone bodies represent continental slope deposition. In the Greiner area, the First Winters sandstone is as

thick as 250 feet in the Greiner 3-36 well and thins to less than 50 feet in the nearby 2-36 well (Attachment 7). Lateral thinning of this sandstone body and differential compaction of sandstone compared to shale, may enhance the structural closure at the top of the First Winters Formation sandstone (Attachment 11).

Upper Cretaceous sandstones in the Sacramento basin are composed of quartzo-feldspathic detritus derived from the Sierran magmatic arc system to the east and northeast. Framework mineralogy is dominated by volcaniclastic and plutoniclastic grains, principally monocrystalline quartz, plagioclase and K-feldspar, biotite, and volcanic lithic fragments (Mertz, 1990), the Rumsey petrofacies of Ingersoll (1983). In the Willow Slough area, Upper Cretaceous sandstones are very fine to medium-grained.

Log-derived porosity for Starkey Formation sandstones average 27 to 31 percent, with a water saturation of 43 to 48 percent. For the Winters Formation, log-derived porosity is 25 to 29 percent, with water saturation of 45 to 50 percent. Btu for both the Starkey and Winters Formations are reported as 900-910. Permeability measurements of for the Willow Slough Gas Field reservoirs are not available, but permeability of 50 to 100 md is reported by the California Division of Oil and Gas (1998) for other Starkey Formation reservoirs in the Willow Slough area.

GAS PRODUCTION

Production records from the California Division of Oil, Gas, and Geothermal Resources archives indicate that a total of 7,503 mmcf have been produced from the three wells in Greiner Area of the Willow Slough gas field, with more than 5,500 mmcf from the Arco-Greiner 1-36 well. Production rates of more than 2000 mcf per day were sustained from this well for the first four to five years of production (Attachment 5 and Appendix I).

The total gas volume produced from each of the 12 gas pools was determined by integrating the stratigraphic analysis with the history of completions and production (Attachments 4 and 5, AppendixI). Wells were generally first completed in the deeper gas zones, which were then

isolated after depletion, with progressively higher zones subsequently completed, produced and isolated.

Gas production from two or more gas pools was sometimes co-mingled, making it impossible to accurately determine production volumes for each gas pool. In these cases, the relative contribution from each of the comingled zones was estimated based on the gross isochore thickness of the intervals.

The Fourth Starkey and Winters gas pools account for nearly half of the Greiner area production, and the combined total of these two pools with the Fifth Starkey and Mokelumne River Formation gas pools accounts for two-thirds of the total production. The First Starkey gas pools are notable for the relatively large volume of production relative to gas pool thickness (Attachment 5).

The history of gas production, water production, and flowing gas pressure indicates that most of the Greiner Area gas pools exhibit a relatively strong water-drive production mechanism. For most Starkey Formation gas pools, significant water production resulted in zone abandonment when flowing tubing pressures declined to about 1000 psi. Significant water production began in the Winters Formation pool in the 1-36 well at flowing tubing pressure of 1180 psi (Appendix I).

A few of the thinner gas "stringers" of the Starkey Formation exhibited a larger component of depletion-drive production mechanism. These relatively thin intervals, no more than 10-15 feet thick had relatively high production volume relative to their thickness. These sandstone bodies appear to have a widespread distribution with no water table or efficient hydraulic connection to formation water. The gas sand at 4730 feet in the 2-36 well is an example of a depletion-drive reservoir. With a thickness of only 8 feet, this reservoir produced more than 375 mmcf and had a flowing pressure of about 600 psi at the time of abandonment.

RESERVOIR VOLUMETRICS

Gross isochore thickness of Greiner Area gas pools range from 10 to 90 feet, and encompass areas of 4 to 60 acres. The reservoir volume of gas pools estimated from gross gas pool isochores and recoverable gas richness calculated from the gas pool volumes, are as follows:

Mokelumne River Fm gas pool	925 acre-ft	960 mcf/acre-ft
Fourth Starkey gas pool	2236 acre-ft	752 mcf/acre-ft
Fifth Starkey gas pool	1245 acre-ft	620 mcf/acre-ft
First Winters gas pool	1545 acre-ft	1085 mcf/acre-ft

These recoverable gas richness values (the total gas pool production divided by the reservoir volume) are generally consistent with expected values, and serve as a check on reservoir volume estimates. The higher value for the First Winters gas pool is likely die to its greater depth and higher reservoir pressure.

REFERENCES

California Division of Oil and Gas, 1998, California Oil and Gas Fields, Central California: California Division of Oil and Gas v 1, TR10, unpaginated.

Ingersoll, R. V., 1983, Petrofacies and provenance of late Mesozoic farearc basin, northern and central California: American Association of Petroleum Geologists Bulletin, V. 67, p. 1125-1142.

Jennings, C.W., compiler, 1977, Geologic map of California: California Division of Mines and Geology, scale 1:750,000.

Mertz, K. A., 1990, Summary of the diagenetic history of the Upper Cretaceous Forbes, Starkey, and Winters Formations, Sacramento Basin, California, in Ingersoll, R. V. and T. H. Nilsen, eds., 1990, Sacramento Valley Symposium and Guidebook: Pacific Section S.E.P.M., Vol. 65, p. 53-67.

ATTACHMENTS

1. Regional map of the Sacramento Valley showing oil and gas fields and the location of the Willow Slough Gas Field.

2. Topographic map of the Greiner Area of the Willow Slough Gas Field and vicinity showing wells, cumulative gas production, and outline of the major Greiner gas pools.

3. Project well list, including status, total depth, elevation, spud date, and location. Latitude and longitude are in NAD 1927 coordinates.

4. Production summary showing initial production rate, shut in pressure, formation, gas production, and water production for each productive interval in each gas well.

5. Gas pool summary showing gas production, elevation of gas-water contact, maximum gross isochore thickness, and area.

6. Generalized structure map of the southern Sacramento valley (modified from Jennings, 1977).

7. Structural cross section WS1 showing gas wells and gas-water contacts of the major gas pools of the Greiner Area of the Willow Slough Gas Field.

8. Structure-contour map on top of the Mokelumne River Formation.

9. Structure-contour map on top of the Fourth Starkey Formation.

10. Structure-contour map on top of the Fifth Starkey Formation.

11. Structure-contour map on top of the First Winters Formation.

12. Gross gas isochore map of the Mokelumne River Formation gas pool.

13. Gross gas isochore map of the Fourth Starkey Formation gas pool.

14. Gross gas isochore map of the Fifth Starkey Formation gas pool.

15. Gross gas isochore map of the First Winters Formation gas pool.

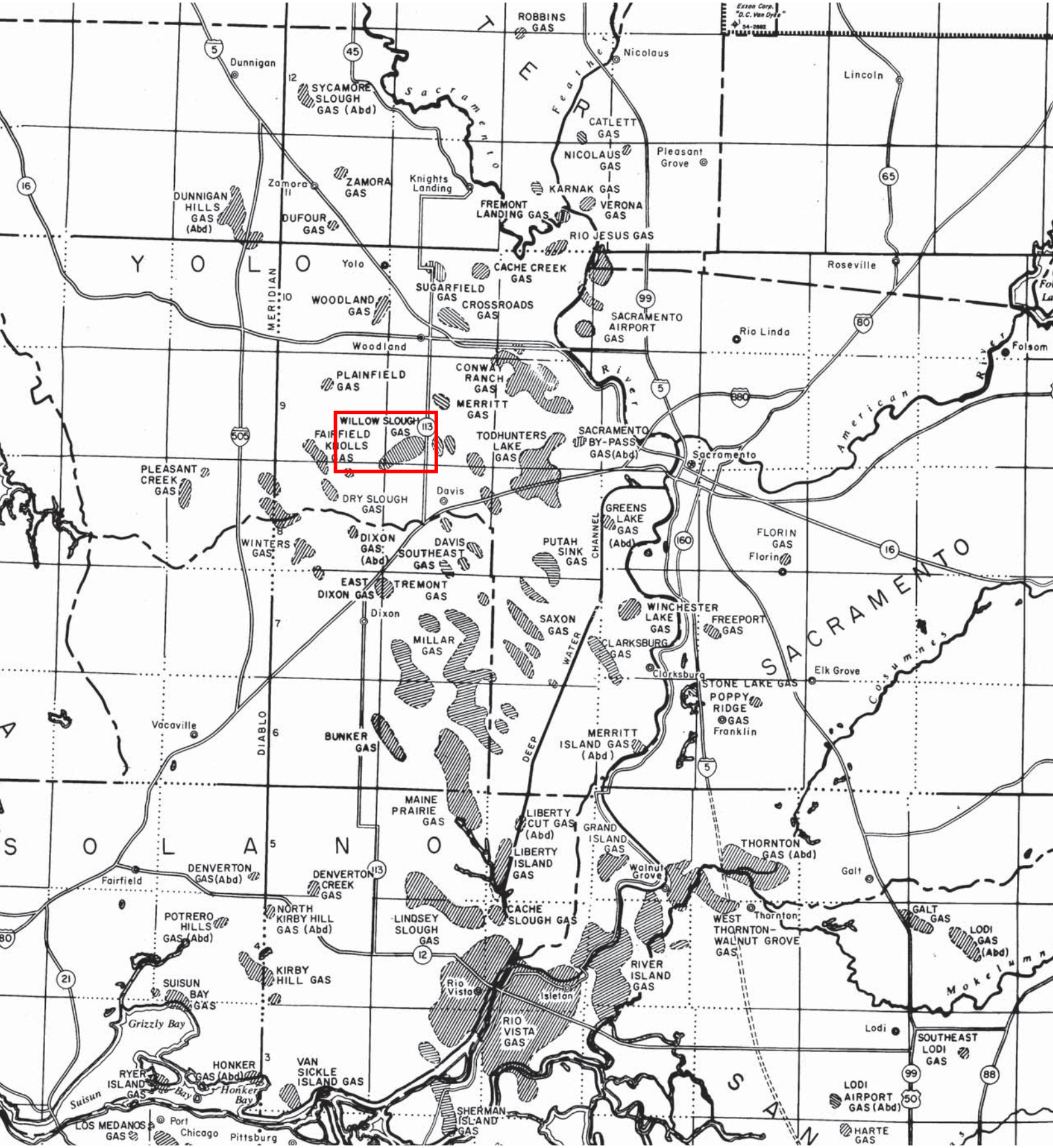
APPENDIX I

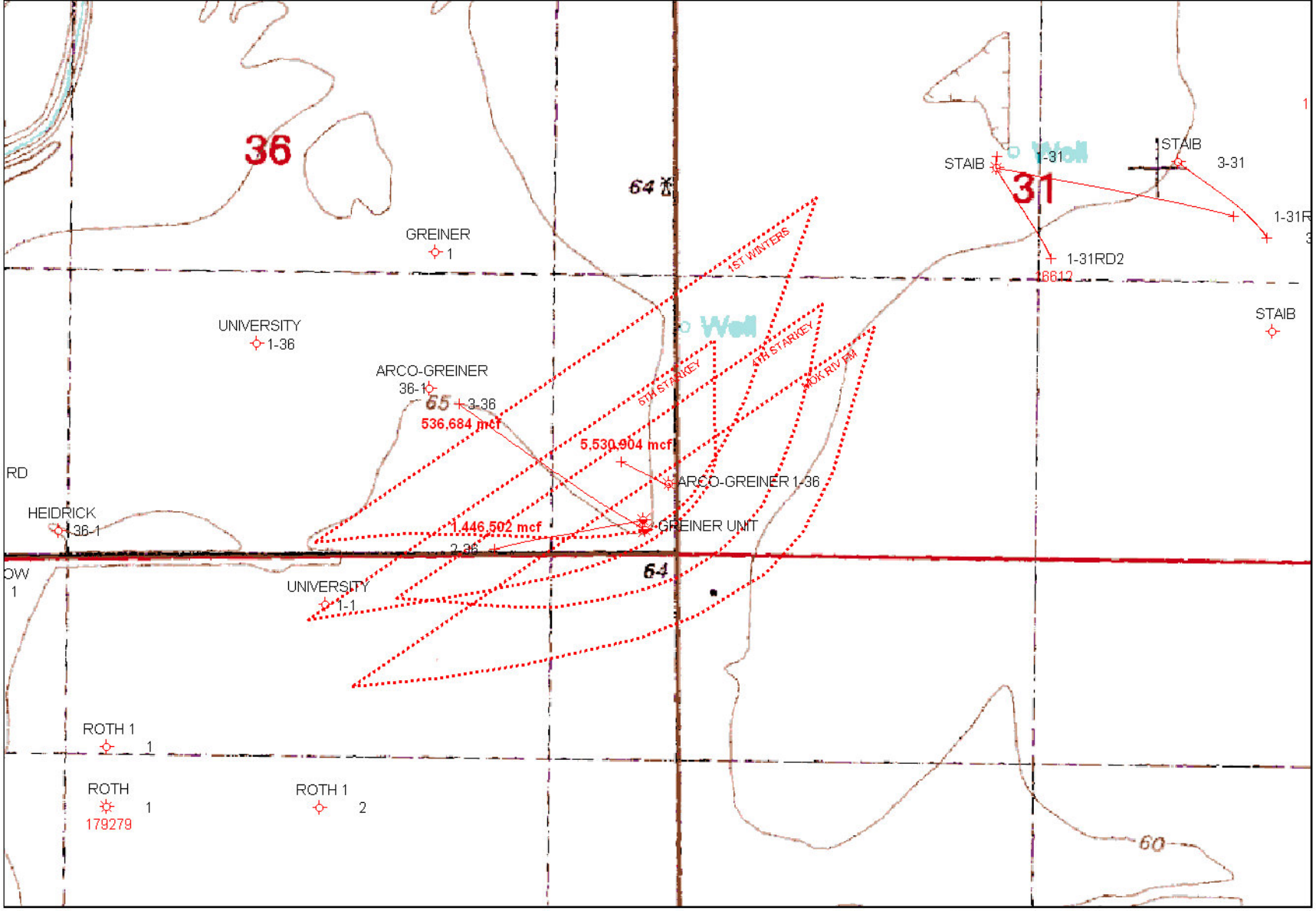
A). Arco Greiner 1-36, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

B). Greiner Unit 2-36, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

c). Greiner Unit 3-36, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

ATTACHMENT 1





Pacific Gas and Electric Company		
Willow Slough Gas Field Greiner Area Base Map		
Author: dpi		Date: 18 November, 2011
	Scale: <scale>	

ATTACHMENT 2

GREINER AREA OF THE WILLOWS SLOUGH GAS FIELD- PROJECT WELLS

API NO.	OPERATOR	WELL NAME	NO.	LOCATION	LAT 27	LONG 27	STATUS	SPUD	TD	ELEV
04113203560000	SWEPI	STAIB	1-31	TWP: 9 N - Range: 2 E - Sec. 31	38.58334	-121.79449	P&A	07/03/75	4752	72 KB
04113203560001	SHELL OIL CO.	STAIB	1-31RD	TWP: 9 N - Range: 2 E - Sec. 31	38.58334	-121.79449	P&A	07/10/75	5246	72 KB
04113203560002			1-31RD2	TWP: 9 N - Range: 2 E - Sec. 31	38.58334	-121.79449	AGS	08/12/76	5272	72 KB
04113203820000	UMC PETROLEUM CORP.	ROTH 1	1	TWP: 8 N - Range: 1 E - Sec. 1	38.5726	-121.81564	P&A	12/09/75	6085	74 KB
04113203870000	STREAM ENERGY, INC.	ARCO-GREINER	1-36	TWP: 9 N - Range: 1 E - Sec. 36	38.57748	-121.80229	AGS	02/02/76	5982	72 KB
04113203950000	UMC PETROLEUM CORP.	ROTH 1	2	TWP: 8 N - Range: 1 E - Sec. 1	38.57146	-121.8106	P&A	04/28/76	6011	74 KB
04113207210000	TRI-VALLEY OIL & GAS	GREINER	1	TWP: 9 N - Range: 1 E - Sec. 36	38.58179	-121.80782	P&A	09/27/82	6000	82 KB
04113207450000	TXO PRODUCTION CORP.	ARCO-GREINER	36-1	TWP: 9 N - Range: 1 E - Sec. 36	38.57925	-121.80797	P&A	06/16/83	5839	72 KB
04113208920000	HARTLEY NATURAL RESO	STAIB	2-31	TWP: 9 N - Range: 2 E - Sec. 31	38.58028	-121.78795	P&A	08/01/88	6100	70 KB
04113209140000	BAKER OIL & GAS CO.	STAIB	3-31	TWP: 9 N - Range: 2 E - Sec. 31	38.58345	-121.79017	P&A	12/02/88	6063	70 KB
04113209140001	BAKER OIL & GAS	STAIB	3-31RD	TWP: 9 N - Range: 2 E - Sec. 31	38.58345	-121.79017	P&A	12/19/88	5053	70 KB
04113209170000	BLACK MOUNTAIN OIL C	UNIVERSITY	1-1	TWP: 8 N - Range: 1 E - Sec. 1	38.57524	-121.81044	P&A	04/21/89	6400	85 KB
04113209560000	BLACK MOUNTAIN OIL C	UNIVERSITY	1-36	TWP: 9 N - Range: 1 E - Sec. 36	38.58011	-121.81207	P&A	01/05/91	6400	82 KB
04113210170000	EOG RESOURCES INC.	HEIDRICK	36-1	TWP: 9 N - Range: 1 E - Sec. 36	38.57661	-121.81677	P&A	10/01/92	6900	82 KB
04113210630000	STREAM ENERGY, INC.	GREINER UNIT	2-36	TWP: 9 N - Range: 1 E - Sec. 36	38.576789	-121.802883	GAS SI	10/25/94	6025	74 KB
04113211630000	STREAM ENERGY, INC.	GREINER UNIT	3-36	TWP: 9 N - Range: 1 E - Sec. 36	38.576606	-121.802848	GAS SI	03/08/00	6590	75 KB

ATTACHMENT 3

GREINER AREA OF THE WILLOW SLOUGH GAS FIELD
PRODUCTION SUMMARY

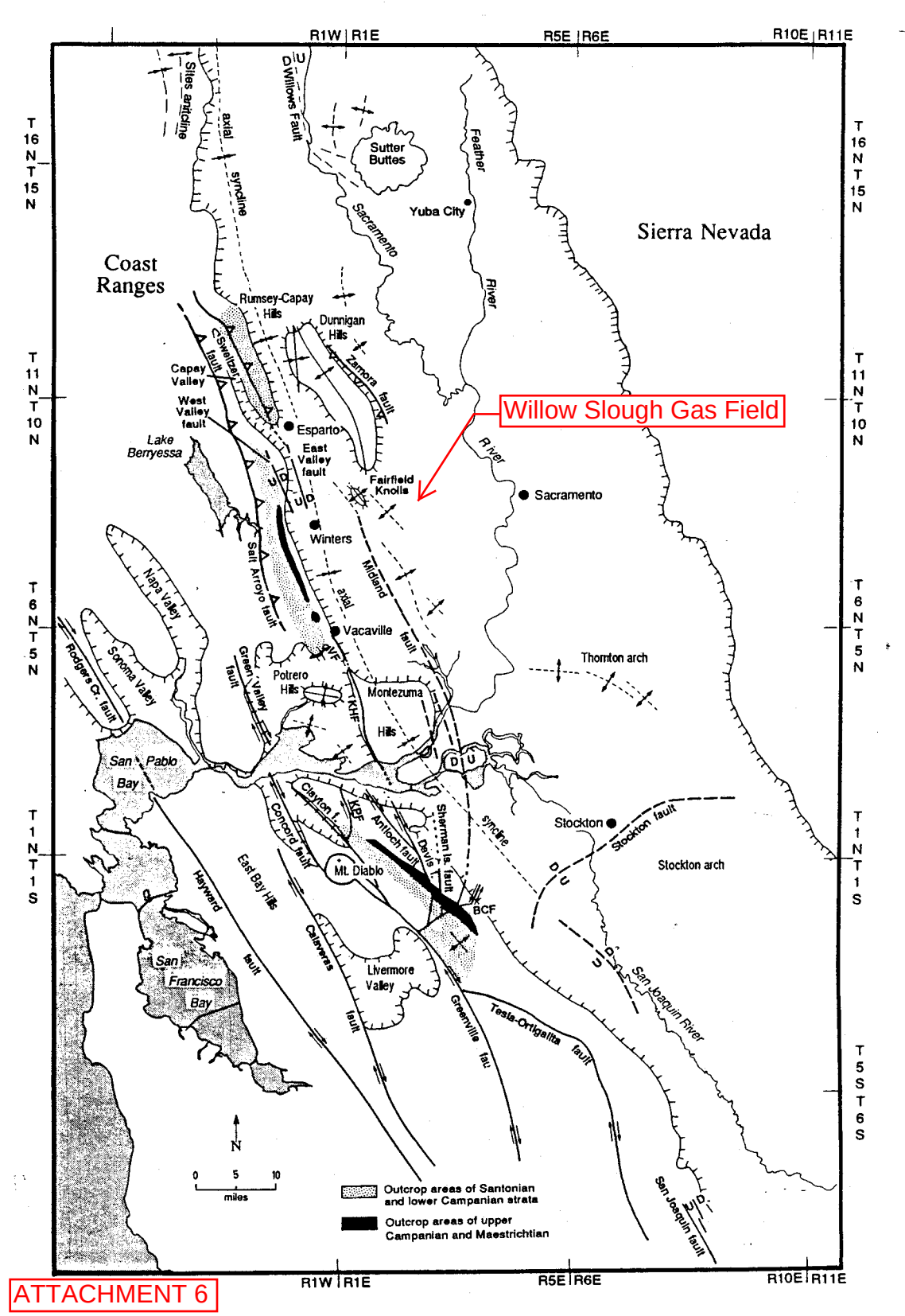
APINUM	OPERATOR	LEASE	NO.	DATE	PROD INT. (FT)	INITIAL PRODUCTION RATE	SHUT IN PRESS (PSI)	FORMATION	CUM GAS (MCF)	CUM H2O (BBLS)
11320387	SHELL OIL COMPANY	ARCO-GREINER	1-36	2/2/1976						
				12/20/76	4650-4700	open flow pot 9.3 mmcfd	1830	Fourth Starkey		
				12/20/76	5087-5098	open flow pot 7.0 mmcfd	1950	Fifth Starkey		
								Subtotal	2,021,755	-
				12/20/76	5740-5750	open flow pot 9.8 mmcfd	2240	First Winters	1,382,962	53420
				8/16/85	4603-4607			Third Starkey		
				8/16/85	4176-4181			First Starkey		
				8/16/85	4163-4167			First Starkey		
				8/16/85	4130-4135			First Starkey		
				8/16/85	4085-4094			First Starkey		
								Subtotal	1,236,518	0
				12/21/89	3980-4000			Mok Riv Fm.	889,667	182
								TOTAL	**5,530,902**	**53,602**
11321063	STREAM ENERGY, INC.	GREINER UNIT	2-36	10/25/94						
				11/16/94	5202-5212	1562 mcfd @ 1735 psi	1895	Fifth Starkey	161,635	5497
				2/27/95	4746-4748	1000 mcfd @ 1550 psi	1750	Fourth Starkey		
				2/27/95	5121-5123	2000 mcfd @ 1650 psi	1940	Fourth Starkey		
								Subtotal	321,378	2134
				1/6/96	4214-4217	2002 mcfd @ 1580 psi		First Starkey	257,002	4014
				6/5/96	4176-4180	977 mcfd @ 1480 psi	1600	First Starkey	197,359	25
				1/9/97	4180-4184			First Starkey		
				1/9/97	4198-4202	3043 mcfd @ 1270 psi	1560	First Starkey		
								Subtotal	54,204	6
				3/28/97	4118-4122	1000 mcfd @ 1490 psi	1500	First Starkey	48,013	493
				5/30/97	4515-4516	500 mcfd	1680	Third Starkey	31,554	3,422
				8/21/97	4731-4733	340 mcfd @ 1140 psi	1280	Third Starkey	375,357	253
								TOTAL	**1,446,502**	**15,844**
11321163	STREAM ENERGY, INC.	GREINER UNIT	3-36	3/8/00						
				4/5/00	5248-5260	2100 mcfd @ 1400 psi	1880	Fifth Starkey	111,365	29
				4/5/00	5967-5969		2200	First Winters	279,790	442
				9/9/00	5913-5916			First Winters		
				9/9/00	5924-27			First Winters		
				9/9/00	5914-16			First Winters		
				9/9/00	5926-28		1670	First Winters		
								Subtotal	3,577	0
				9/21/00	5158-60			Fourth Starkey	20,222	
				10/24/00	4704-06			Third Starkey		
				10/24/00	4732-35			Third Starkey		
								Subtotal	25,919	538
				5/4/01	4252-54			Second Starkey	30,492	16
				8/19/01	5967-69			Winters	3,117	122
				1/30/02	5924-27			Winters	9,060	0
				12/31/02	4756-62	600 mcfd @ 1700 psi		Fourth Starkey	6,054	97
				3/10/03	4496-98			Third Starkey	5,901	159
				5/6/03	4154-57			First Starkey	22,159	60
				5/10/04	4088-92		1550	First Starkey	19,028	85
								TOTAL	**536,684**	**1,548**

ATTACHMENT 4

GREINER AREA OF THE WILLOW SLOUGH GAS FIELD
GAS POOL SUMMARY

GAS	GAS PRODUCTION (MMCF)				GAS-WATER	MAX GROSS	AREA
POOL	Greiner 1-36	Greiner 2-36	Greiner 3-36	Total	CONTACT (FT)	THICKNESS (FT)	(ACRES)
Mokelumne River Fm	**890**			**890**	**-3930**	**35**	**60**
First Starkey A	*309*	48	19	376	-4030	37	*27*
First Starkey B	*309*	197	22	528		12	*59*
First Starkey C	*309*	54		363		10	*48*
First Starkey D	*309*	257		566	-4120	40	*38*
Second Starkey			30	30	-4160	22	*4*
Third Starkey A		32	6	38	-4375	27	*4*
Third Starkey B		375	26	401	-4550	20	*53*
Fourth Starkey A	***1516***	***161***	**6**	**1683**	**-4650**	**90**	**50**
Fourth Starkey B		*161*	20	181	-4935	20	*24*
Fifth Starkey	***505***	**162**	**104**	**771**	**-5030**	**55**	**40**
Winters	**1383**		**292**	**1675**	**-5635**	**60**	**65**
TOTAL	5531	1446	525	7502			
Structure and isochore maps of the four largest gas pools have been provided (shown in BOLD)							
Numbers shown in ITALICS represent estimated values							

ATTACHMENT 5

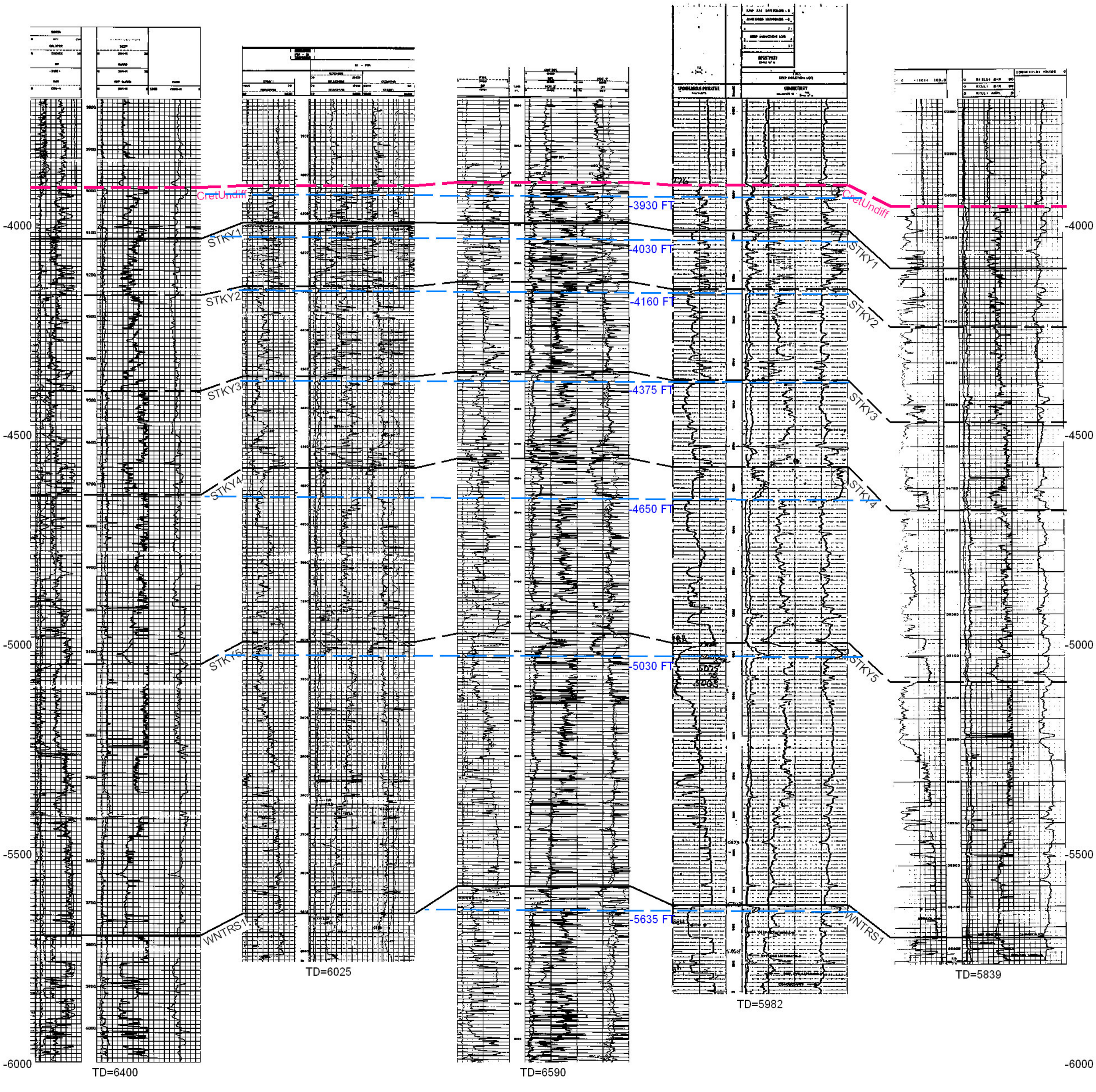


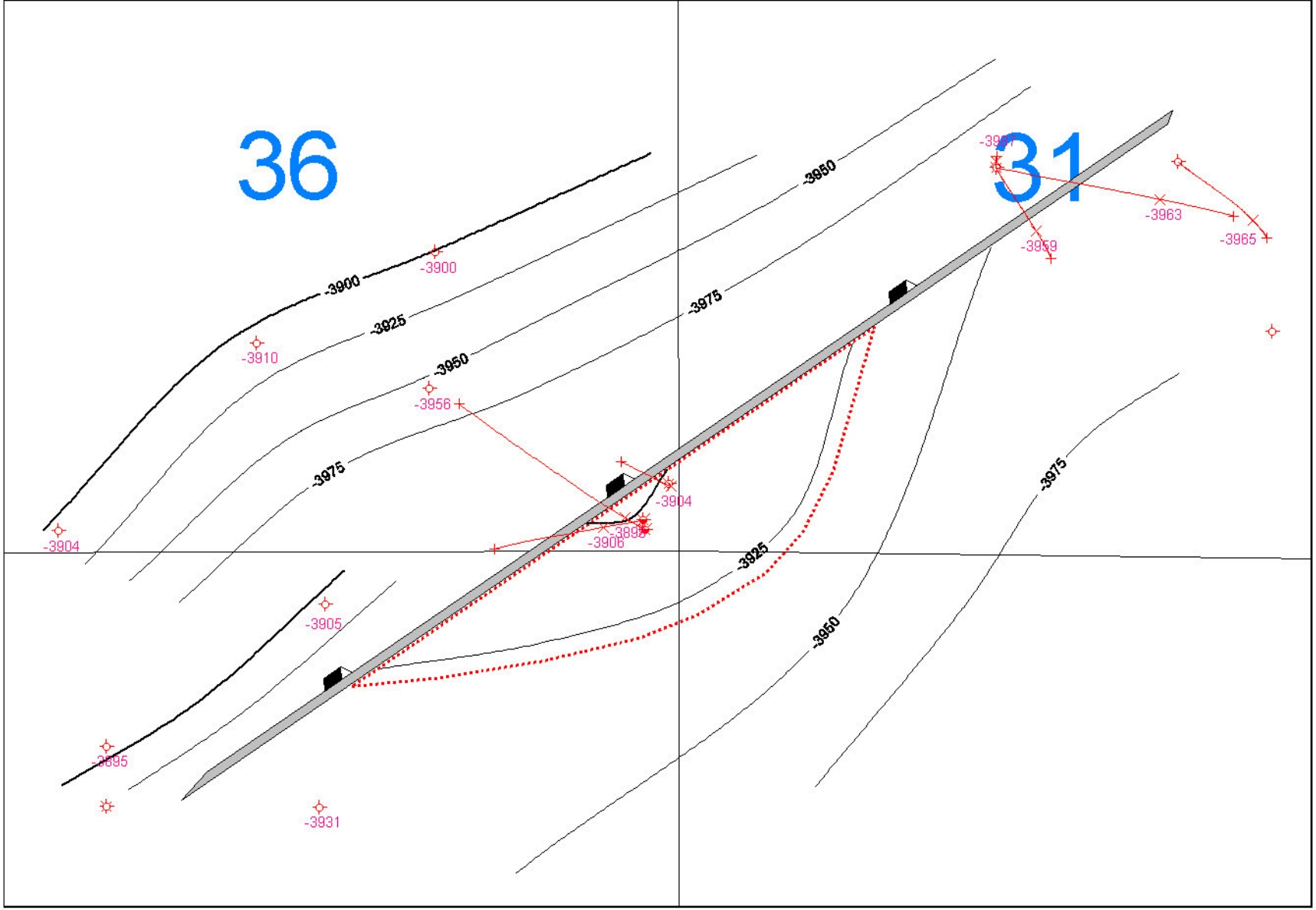
ATTACHMENT 6

ATTACHMENT 7

PACIFIC GAS AND ELECTRIC COMPANY
GREINER AREA OF THE WILLOW SLOUGH GAS FIELD
Structural Cross Section WS1
Vertical Scale = 1 in per 200 ft

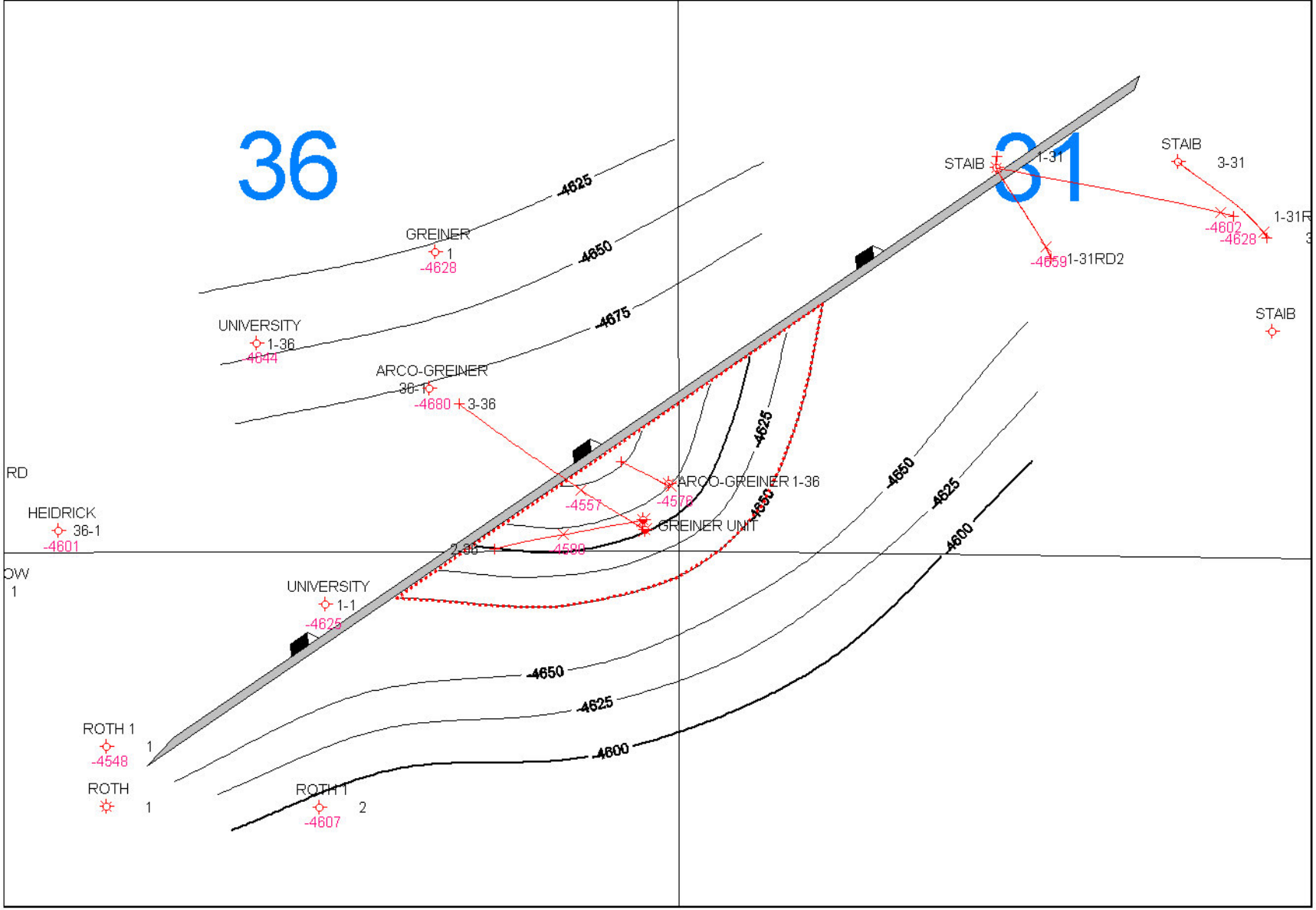
04113209560000		Cum Gas All Zones: 1446502 MCF		Cum Gas All Zones: 536684 MCF		Cum Gas All Zones: 5530904 MCF		04113207450000
Spud Date=1/5/1991	2733 ft	04113210630000	119 ft	04113211630000	358 ft	04113203870000	1767 ft	Spud Date=6/16/1983
		Spud Date=10/25/1994		Spud Date=3/8/2000		Spud Date=2/2/1976		
BLACK MOUNTAIN OIL C		STREAM ENERGY, INC.		STREAM ENERGY, INC.		STREAM ENERGY, INC.		TXO PRODUCTION CORP.
UNIVERSITY 1-36		GREINER UNIT 2-36		GREINER UNIT 3-36		ARCO-GREINER 1-36		ARCO-GREINER 36-1
1400 N 2850 W SE		250 N 200 W SE		150 N 200 W SEC		350 N 150 W SE		1060 N 1720 W SE
TWP: 9 N - Range: 1 E - Sec. 36		TWP: 9 N - Range: 1 E - Sec. 36		TWP: 9 N - Range: 1 E - Sec. 36		TWP: 9 N - Range: 1 E - Sec. 36		TWP: 9 N - Range: 1 E - Sec. 36





Pacific Gas and Electric Company		
Willow Slough Gas Field Structure- Contour Map Top Cretaceous (Mokelumne River Fm.)		
Author: dpi		Date: 20 November, 2011
	Scale: <scale>	

ATTACHMENT 8



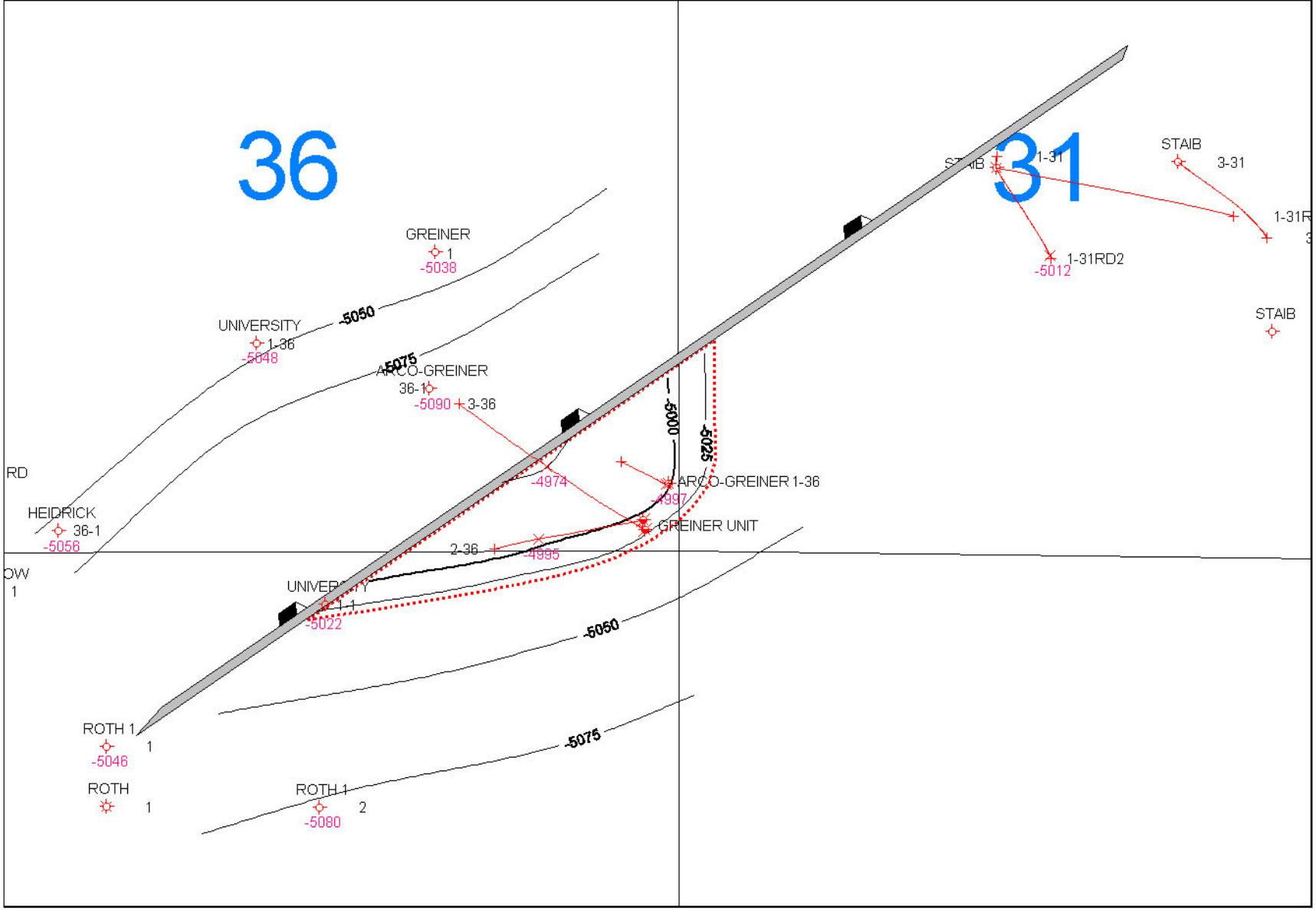
2000 0 2000 ft

Pacific Gas and Electric Company

Willow Slough Gas Field
Structure- Contour Map
Fourth Starkey Fm.

Author:		Date:
dpi		19 November, 2011
	Scale: <scale>	

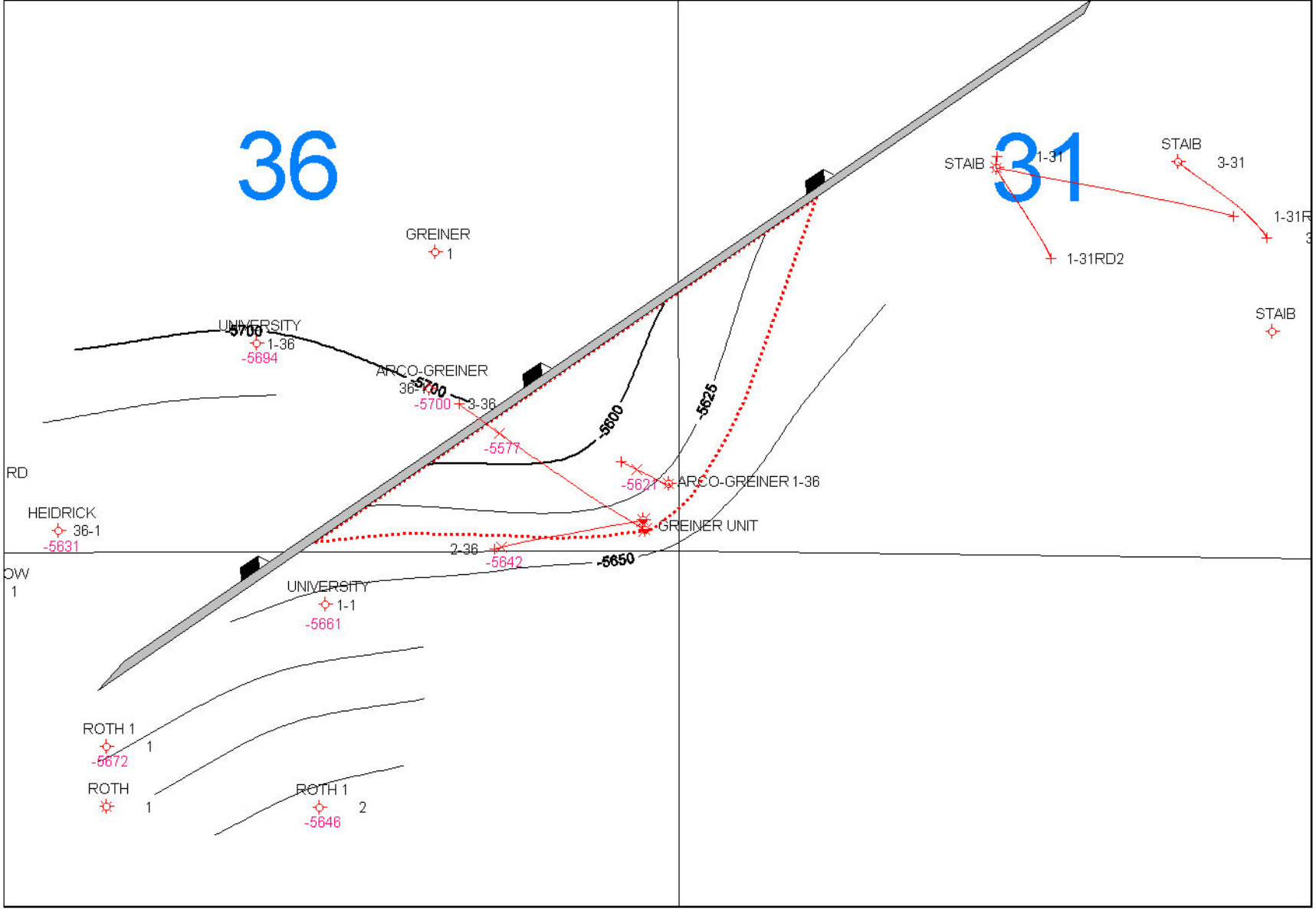
ATTACHMENT 9



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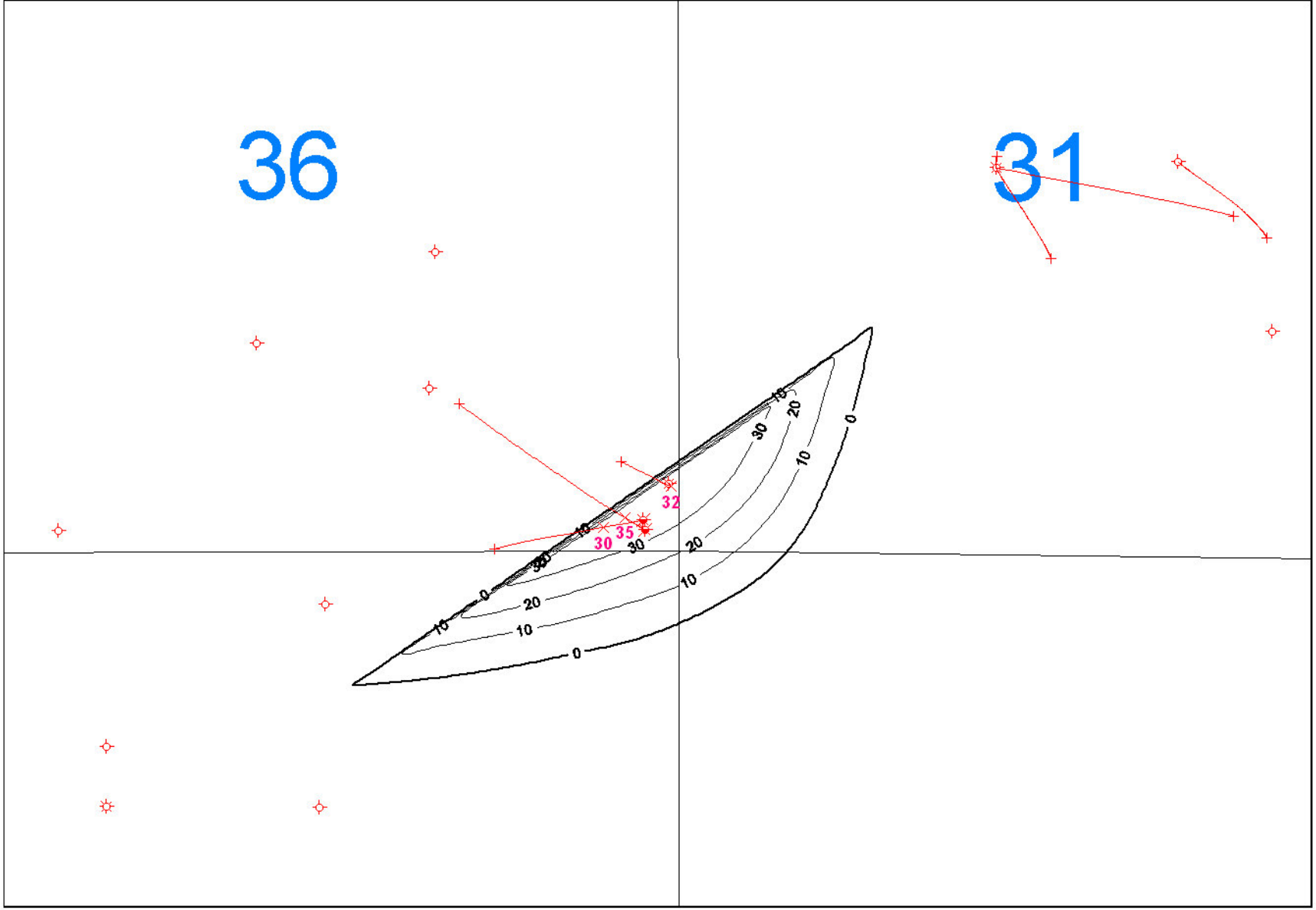
Pacific Gas and Electric Company		
Willow Slough Gas Field Structure-Contour Map Fifth Starkey Fm.		
Author: dpi		Date: 21 November, 2011
	Scale: <scale>	

ATTACHMENT 10



Pacific Gas and Electric Company		
Willow Slough Gas Field Structure-Contour Map Top First Winters Fm.		
Author: dpi		Date: 20 November, 2011
	Scale: <scale>	

ATTACHMENT 11



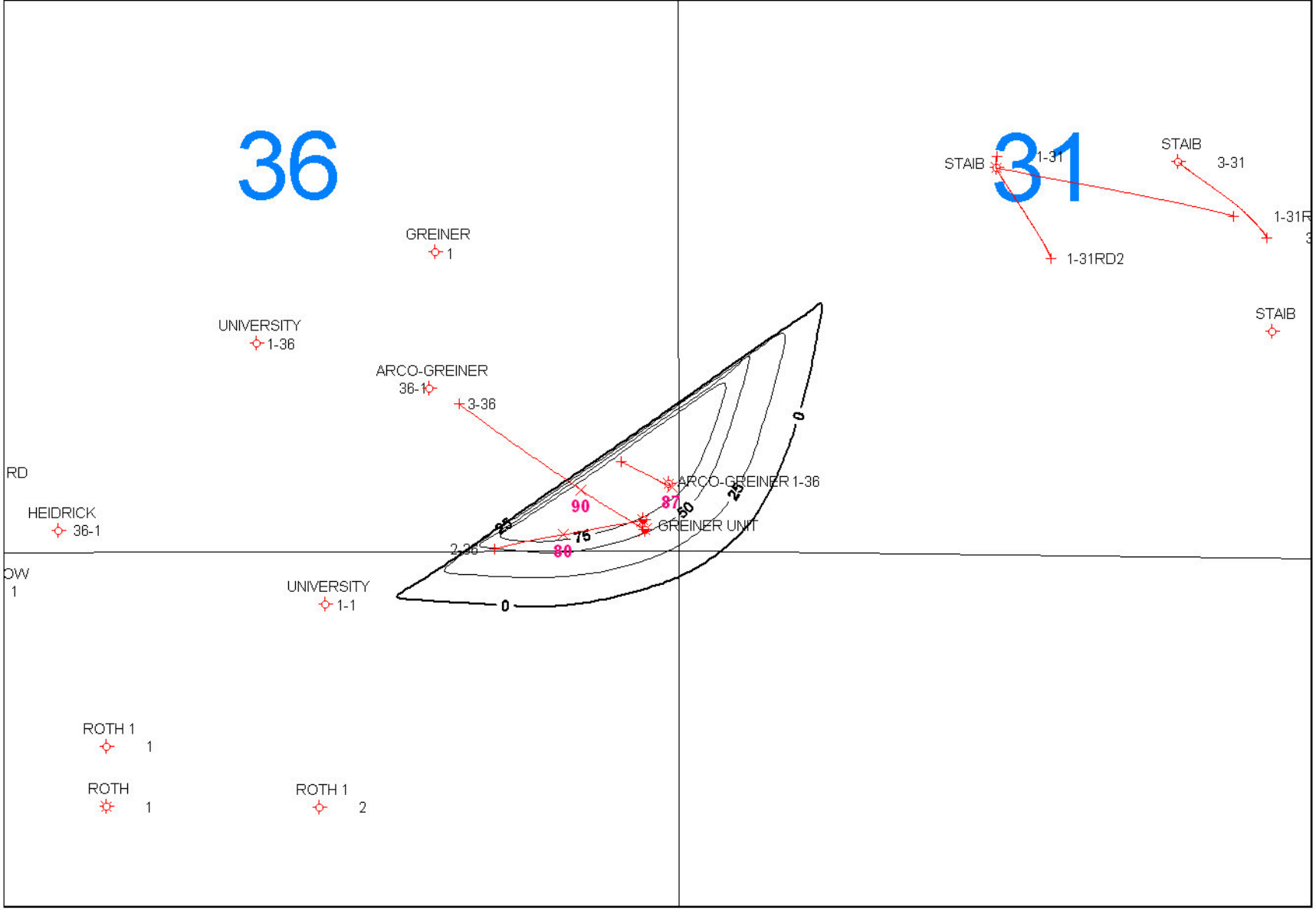
2000 0 2000 ft

Pacific Gas and Electric Company

Willow Slough Gas Field
Gross Gas Isochore Map
Mokelumne River Fm. Gas Pool

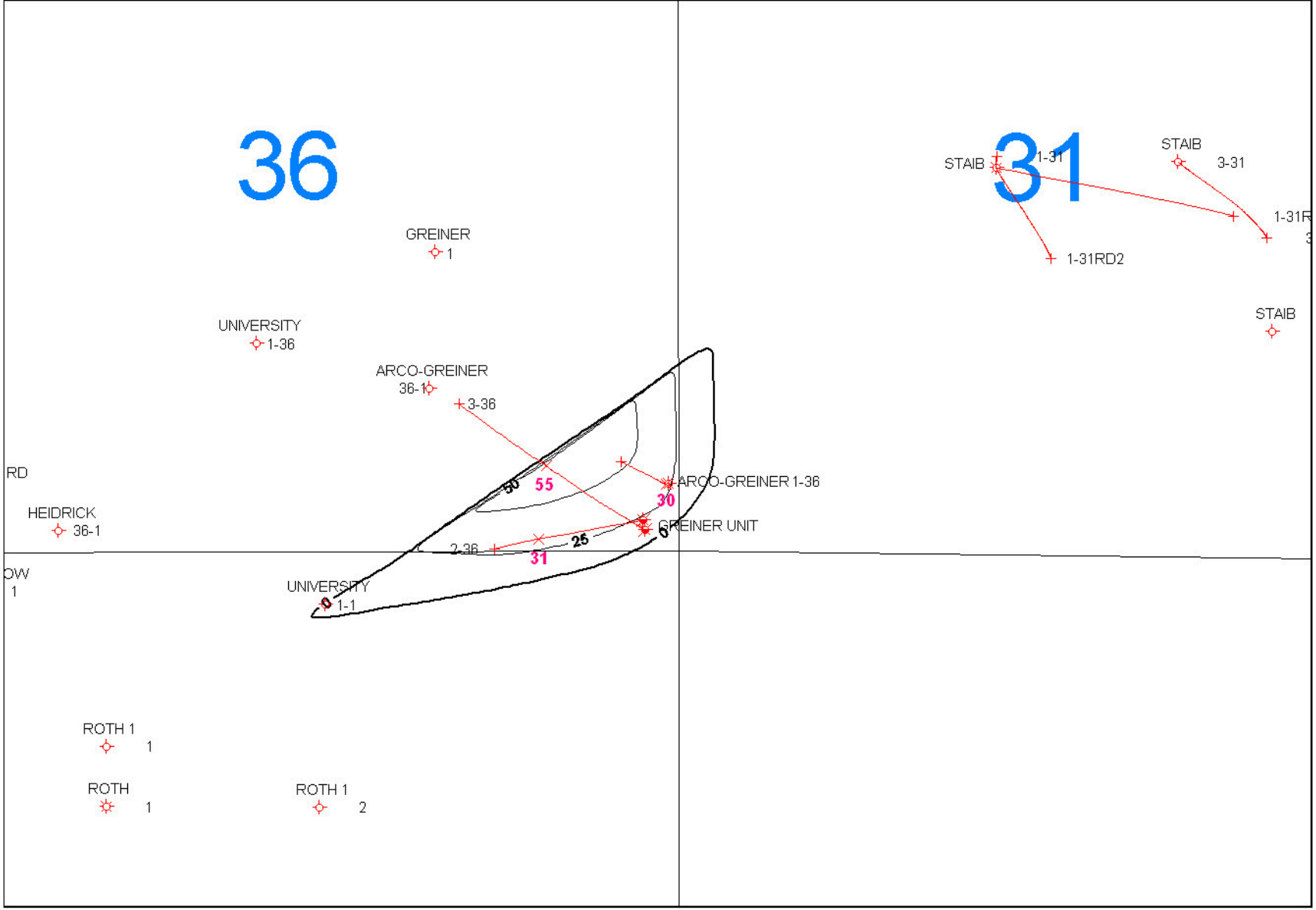
Author: dpi		Date: 20 November, 2011
	Scale: <scale>	

ATTACHMENT 12



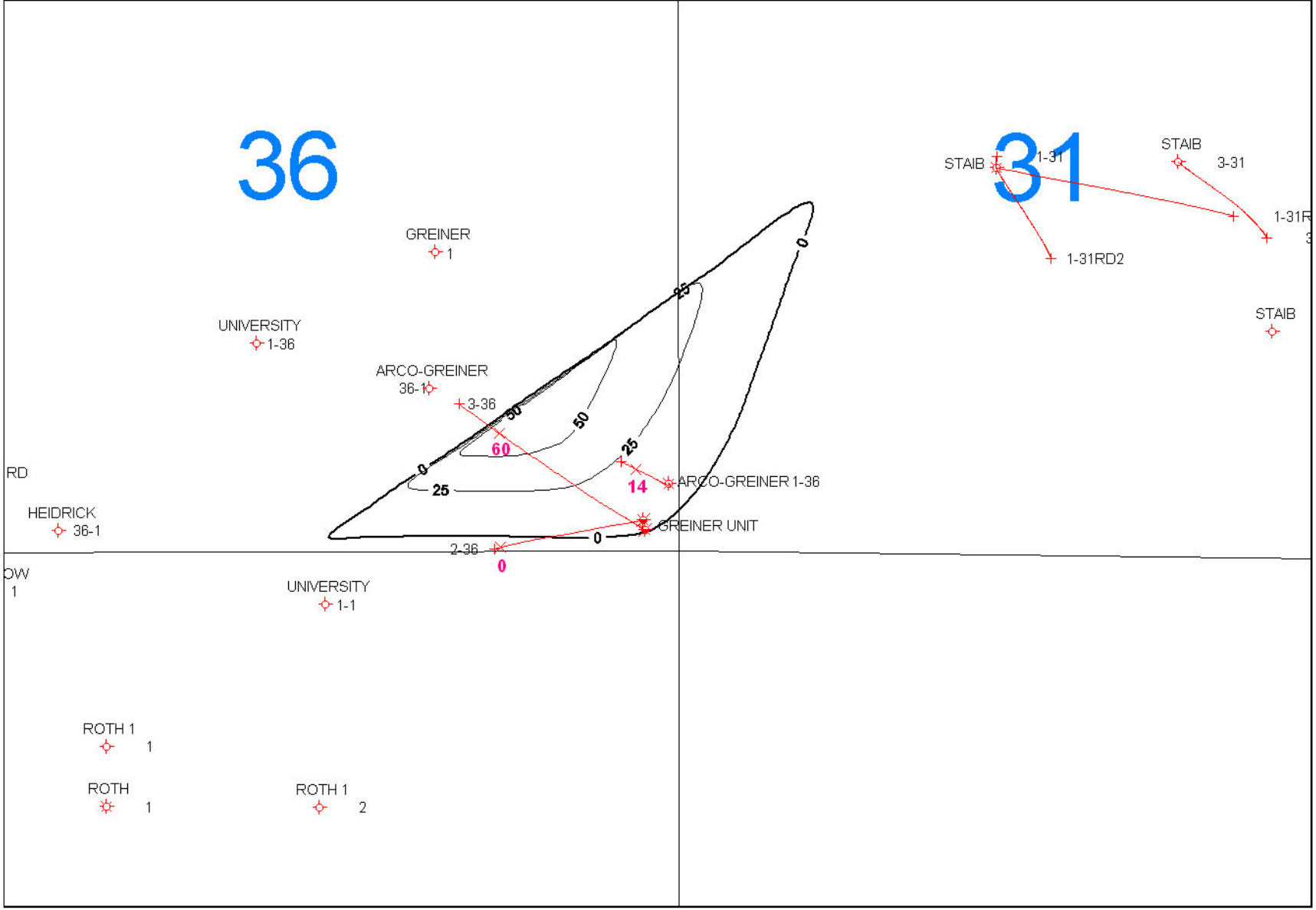
Pacific Gas and Electric Company		
Willow Slough Gas Field Gross Gas Isochore Map Fourth Starkey Gas Pool		
Author: dpi		Date: 19 November, 2011
	Scale: <scale>	

ATTACHMENT 13



Pacific Gas and Electric Company		
Willow Slough Gas Field Gross Gas Isochore Map Fifth Starkey Fm.		
Author: dpi		Date: 21 November, 2011
	Scale: <scale>	

ATTACHMENT 14



2000 0 2000 ft

Pacific Gas and Electric Company

Willow Slough Gas Field
Gross Gas Isochore Map
First Winters Gas Pool

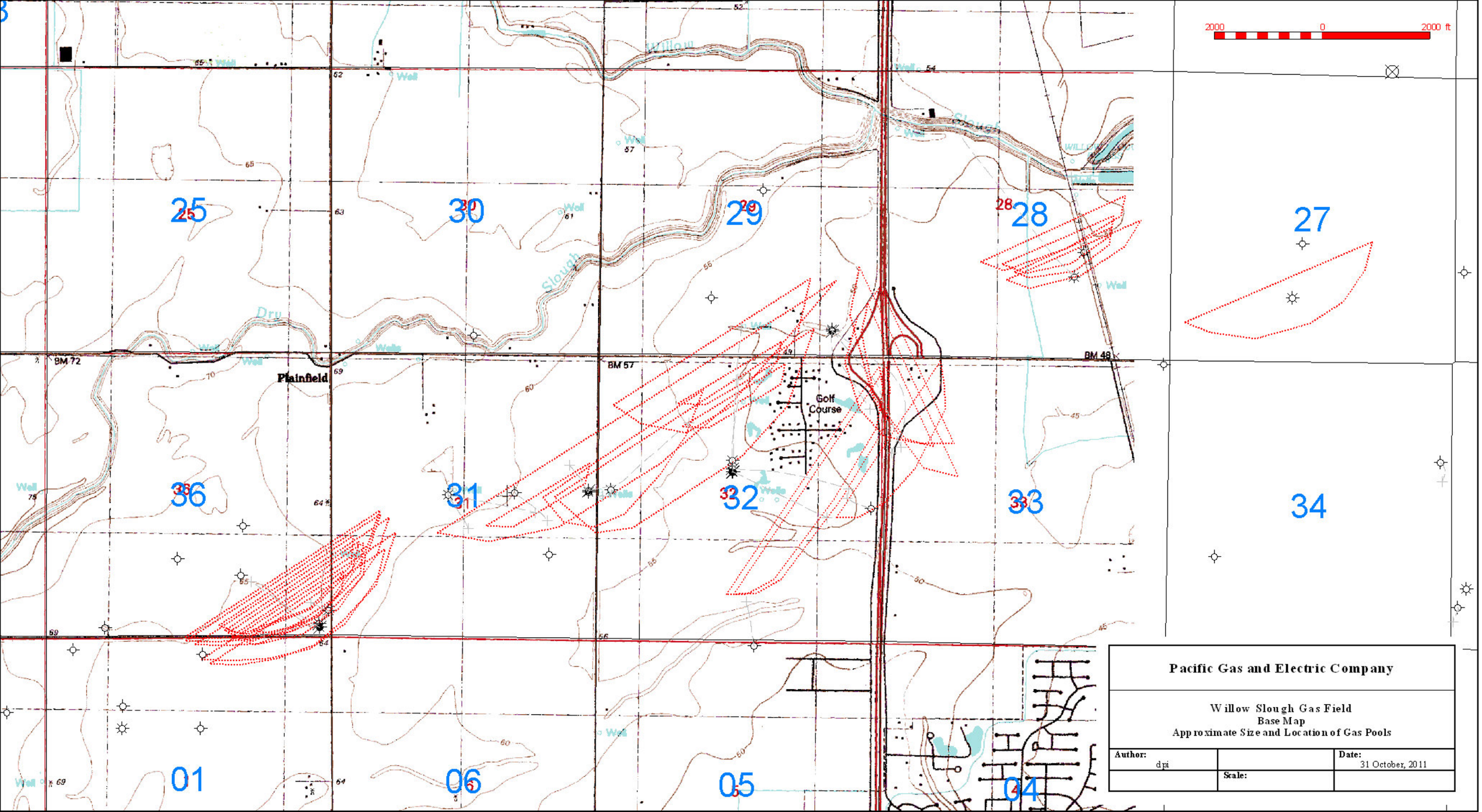
Author:		Date:
dpi		20 November, 2011
	Scale: <scale>	

ATTACHMENT 15

Willow Slough Gas Field Reconnaissance

10/28/11

Field Discovery Date:	October, 1974
Area/Production/Pools :	Greiner Area, 6988 mmcf, 10 gas pools
	Schuder Area, 5895 mmcf, 8 gas pools
	Davis-Schuder Area, 1668 mmcf, 2 gas pools
	Hess Area, 157 mmcf, 4 gas pools
	Stephens Area, 433 mmcf, 4 gas pools
	Hess Area, 369 mmcg. 1 gas pool
	Total 18,138 mmcf, 29 gas pools
Production by Formation:	Starkey Formation gas pools 14,522 mmcf,
	Winters Formation gas pools 3,616 mmcf
Number of gas wells:	8 idle, 9 abandoned
2011 Field Production:	0
Reserves (CDDOGR 2009):	0
Average Reservoir Depth:	Starkey Formation reservoirs- 4850 ft
	Winters Formation reservoirs- 6,000 ft
Reservoir Area:	15-110 acres
Maximum Net Pay Thickness:	see attached
Trapping Mechanism:	Structural closure associated with (primarily) northwest-dipping normal faults
Surface Conditions:	Field located north of City of Davis, primarily agriculture, Highway 113 through eastern part of field, golf course development N/2 Section 32, Willow Slough located north of field
Notes:	1. 3D seismic data has been acquired over the field and may be available for purchase.

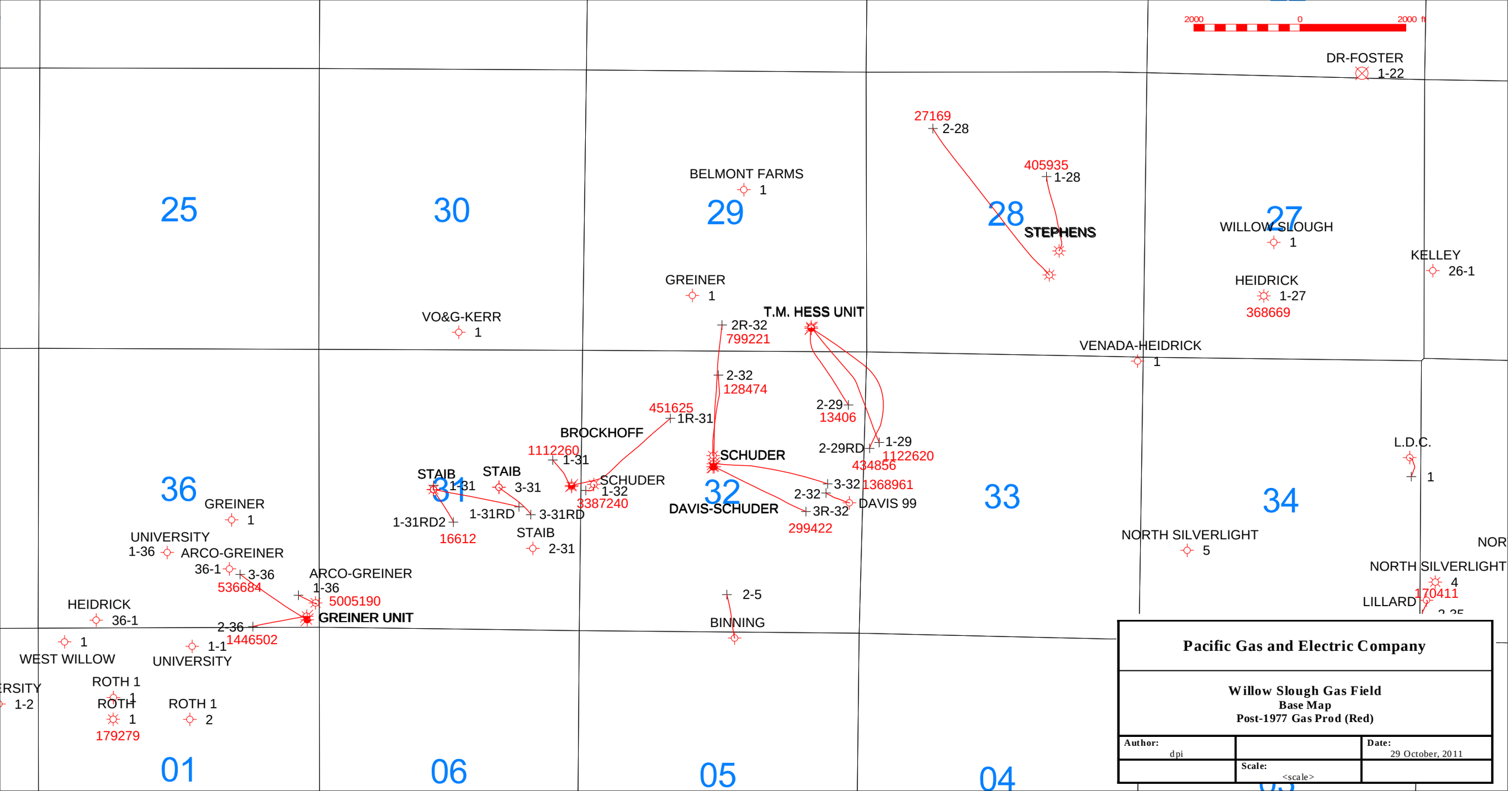


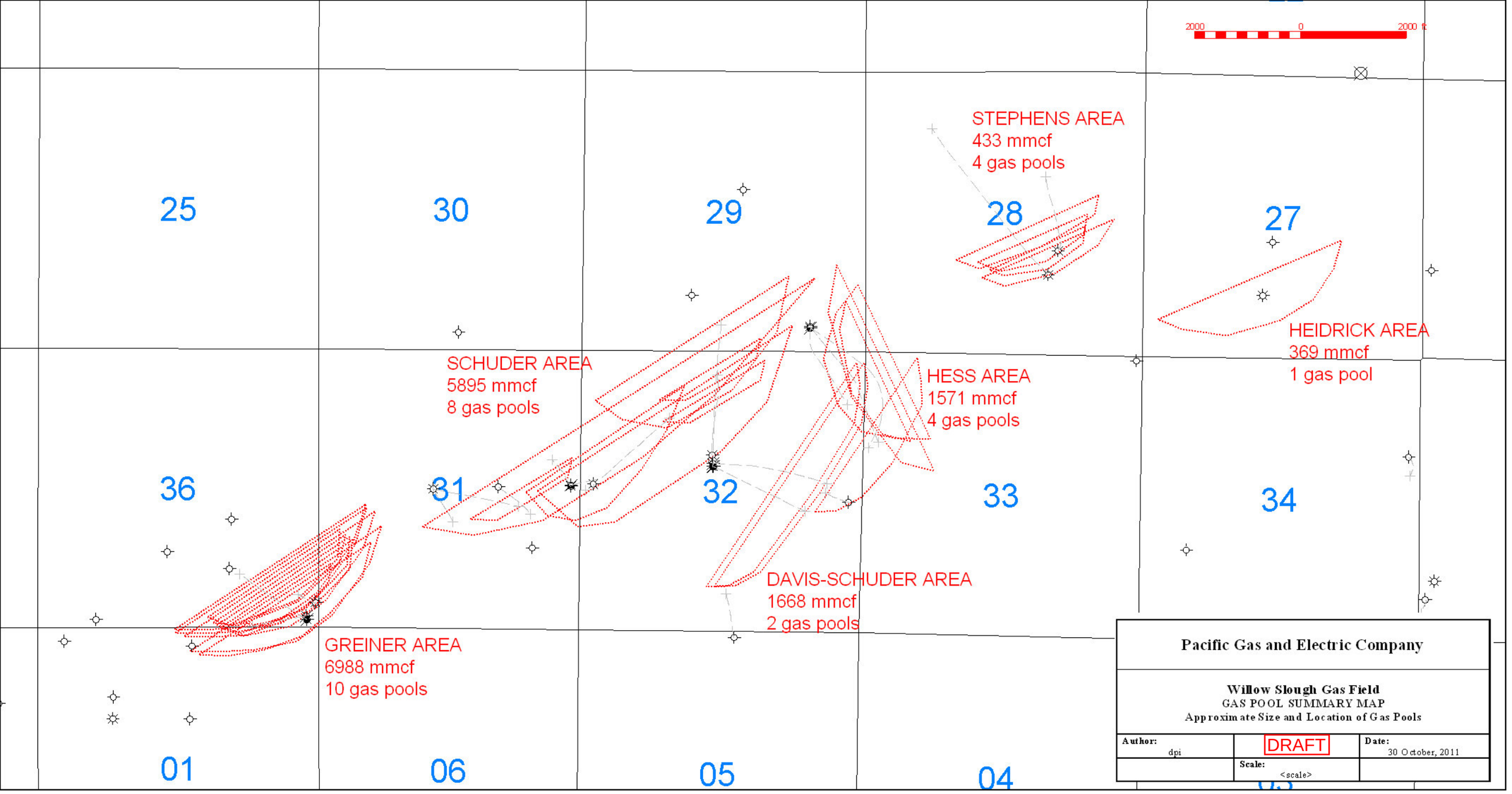
Pacific Gas and Electric Company

Willow Slough Gas Field
Base Map
Approximate Size and Location of Gas Pools

Author:		Date:
dpi		31 October, 2011
	Scale:	


38.6084, -121.8238
N
©2010 Google
Imagery Date: 6/13/2011
1993
lat 38.587605° lon -121.774508° elev 56 ft
Eye alt 25967 ft


2000 0 2000 ft
DR-FOSTER 1-22
27169 2-28
405935 1-28
STEPHENS
BELMONT FARMS 1
25
30
29
28
27
WILLOW SLOUGH 1
KELLEY 26-1
HEIDRICK 1-27
368669
GREINER 1
VO&G-KERR 1
T.M. HESS UNIT
2R-32 799221
VENADA-HEIDRICK 1
2-32 128474
451625 1R-31
2-29 13406
BROCKHOFF 1112260
1-31
SCHUDER
2-29RD
1-29 1122620
434856
L.D.C. 1
STAIB 1-31
STAIB 3-31
SCHUDER 1-32 3387240
3-32 1368961
2-32
DAVIS 99
3R-32 299422
1-31RD2 16612
1-31RD
3-31RD
DAVIS-SCHUDER
STAIB 2-31
36
31
32
33
34
GREINER 1
UNIVERSITY 1-36
ARCO-GREINER 36-1
3-36 536684
ARCO-GREINER 1-36 5005190
GREINER UNIT
NORTH SILVERLIGHT 5
NOR
NORTH SILVERLIGHT 4 170411
LILLARD
HEIDRICK 36-1
2-36 1446502
1
WEST WILLOW
1-1 UNIVERSITY
2-5
BINNING
ROTH 1 1
ROTH 1 2
ROTH 1 179279
1-2
01
06
05
04
Pacific Gas and Electric Company
Willow Slough Gas Field
Base Map
Post-1977 Gas Prod (Red)
Author: dpi
Date: 29 October, 2011
Scale: <scale>


2000 0 2000 ft
25
30
29
28
27
36
31
32
33
34
01
06
05
04
STEPHENS AREA
433 mmcf
4 gas pools
HEIDRICK AREA
369 mmcf
1 gas pool
SCHUDER AREA
5895 mmcf
8 gas pools
HESS AREA
1571 mmcf
4 gas pools
DAVIS-SCHUDER AREA
1668 mmcf
2 gas pools
GREINER AREA
6988 mmcf
10 gas pools
Pacific Gas and Electric Company
Willow Slough Gas Field
GAS POOL SUMMARY MAP
Approximate Size and Location of Gas Pools
Author:
dpi
DRAFT
Date:
30 October, 2011
Scale:
<scale>

WILLOW SLOUGH GAS FIELD GAS POOL SUMMARY

					PRODUCTIVE INTERVAL GROSS THICKNESS										
API	**NAME**	**NO.**	**SPUD**	**CUM PROD**	**S1A**	**S1B**	**S1C**	**S2**	**S3A**	**S3B**	**S4A**	**S4B**	**S5**	**KwA**	**KwB**
GREINER AREA															
04113210630000	GREINER UNIT	2-36	10/25/1994	1,446,502	25	**10**	**40**	18	12	10	24	20	37	-	-
04113211630000	GREINER UNIT	3-36	3/8/2000	536,684	**35**	**10**	37	**22**	**22**	15	**90**	**22**	**50**	**58**	-
04113203870000	ARCO-GREINER	1-36	2/2/1976	5,005,190	25	**10**	**40**	5	10	**17**	55	10	30	17	-
			Total (mcf)	6,988,376											
SCHUDER AREA															
04113211700000	SCHUDER	2R-32	12/2/2000	799,221	**12**	**8**	-	28	-	-	12	-	-	20	-
04113208240000	BROCKHOFF	1-31	8/5/1985	1,112,260	-	-	-	8	-	26	**34**	-	**36**	-	-
04113202510000	SCHUDER	1-32	7/19/1974	3,387,240	-	-	-	**37**	-	**37**	-	-	21	-	-
04113211690000	BROCKHOFF	1R-31	1/10/2001	451,625	-	-	-	**37**	**8**	8	-	-	26	12	-
04113203540000	SCHUDER	2-32	6/15/1977	128,474	-	-	-	30	-	-	-	-	-	**42**	-
04113203560002	STAIB	1-31RD2	8/12/1976	16,612	-	-	-	-	-	-	-	-	20	-	-
			Total (mcf)	5,895,432											
DAVIS-SCHUDER AREA															
04113211680000	DAVIS-SCHUDER	3R-32	12/16/2000	299,422	-	-	-	-	-	-	-	-	-	**44**	-
04113203800000	DAVIS-SCHUDER	3-32	12/4/1975	1,368,961	-	-	-	-	-	-	-	-	-	20	**12**
			Total (mcf)	1,668,383											
HESS AREA															
04113211670000	T.M. HESS UNIT	2-29	11/15/2000	13,406	-	-	-	-	-	-	12	-	-	-	
04113203850000	T.M. HESS UNIT	1-29	12/7/1976	1,122,620	-	26	-	-	-	-	**24**	-	-	**25**	-
04113211670001		2-29RD	3/5/2001	434,856	**17**	**31**	-	-	-	-	14	-	-	25	-
			Total (mcf)	1,570,882											
STEPHENS AREA															
04113203070000	STEPHENS	1-28	11/5/1974	405,935	**17**	-	-	-	-	-	**18**	-	-	-	-
04113211100000	STEPHENS	2-28	5/1/1998	27,169	16	**10**	-	-	**12**	-	8	-	-	-	-
			Total (mcf)	433,104											
04113203880000	HEIDRICK	1-27	8/23/1976	368,669	-	-	-	-	-	-	-	-	-	**18**	-
	FIELD TOTAL (POST-1977)			16,924,846											
Abbreviations: S1, First Starkey Formation gas pool; S2, Second Starkey Formation gas pool; S3, Third Starkey Formation gas pool; S4, Fourth Starkey Formation gas pool; S5, Fifth Starkey Formation gas pool; Kw, Winters Formation gas pool;															
Maximum Gross Thickness Underlined															

WILLOW SLOUGH RESERVOIR

Summary and Decision

The Willow Slough Reservoir (Willow Slough—Aerial Map.pdf), located in Yolo County, California (approximately 2-3 miles northwest of the City of Davis), was not selected for detailed modeling and was not a finalist candidate. Based on the results of the preliminary geological analysis, in the opinion of the project team, it was determined that, even though the parameters for the Willow Slough Greiner Area reservoirs were within an acceptable range for CAES development, other reservoirs appeared to have better characteristics. In comparison to other top candidates, Willow Slough was ranked sixth overall due primarily to the disconnected nature of the multiple reservoirs, the relatively low estimated permeability, and the total number of wells in the field potentially requiring attention. For these reasons, no further evaluation was conducted at the Willow Slough field.

Subsurface/Reservoir Screening

Preliminary Screening Results

The Willow Slough Gas Field was identified in the very early reservoir screening process as having potential for CAES testing and potential development. On October 28, 2011, a preliminary field assessment was compiled (Willow Slough—Reconnaissance Report.pdf). The assessment identified as many as 29 discrete gas pools within the producing field with total gas production of 18.1 Bcf. Individual pools ranged in size from 0.013 Bcf to over 5.0 Bcf. The field contains at least two productive formations: the Starkey formation at an average reservoir depth of 4,850 ft and the Winters formation at an average depth of 6,000 ft. A total of 17 wells penetrated the field, 8 of which are currently listed as "idle," and 9 have been abandoned. 3D seismic data has been acquired over the field and may be available for purchase.

The Greiner Area was determined to have the greatest potential for a CAES project. That area produced over 7.0 Bcf total and had the thickest gross productive interval in multiple stacked sand intervals, accounting for nine separate gas pools. Most of the production was from reservoirs within the Starkey formation, although two of the wells also produced gas from the deeper Winters formation, and one produced from the shallower Mokolumne River formation.

Detailed Geological Summary

Based on the preliminary screening analysis, the project team completed a more detailed geological screening of the Willow Slough Gas Field data on November 21, 2011, focusing on the Greiner Area reservoirs (Willow Slough—Detailed Geological Report.pdf). In total, this area of the field had produced 7.5 Bcf (updated from 7.0 Bcf in the earlier screening report) of natural gas from three wells, with completions in at least 12 separate sandstone reservoirs of the Mokolumne River, Starkey, and Winters formations between depths of 4,000 and 5,700 ft. Individual gas pools are very small, ranging in size from 5 to 65 acres and from 0.03 to 1.76 Bcf

DRAFT

of gas production. Thicknesses were estimated at 10 to 90 ft, and log-derived porosity averages 25 to 31%, with water saturations of 43 to 50%.

The geology of the Willow Slough area is complicated by the multiple productive horizons and numerous discrete gas pools. Based on depth and the well production history, the Starkey formation in the Greiner Area appears to have the characteristics best suited for a potential CAES development. In the Greiner Area, the trapping mechanism for each of the productive reservoirs is created by a northeast trending fault with vertical offsets of up to 100 ft. The down dip edges of the gas pools are not well defined due to the lack of well data, although it is believed that integration of the 3D seismic data into the geological interpretation would help define these boundaries.

Even though permeability measurements are not available for the Starkey formation within the Willow Slough field, permeabilities of 50 to 100 mD (millidarcies) "is reported by the California Division of Oil and Gas (1998) for other Starkey Formation reservoirs in the Willow Slough area". Of the total 7.5 Bcf produced from the Greiner Area, 5.5 Bcf was produced from a single well, the Arco-Greiner 1-36, which sustained production rates in excess of 2,000 Mcfd for the first four to five years of production, indicating reasonably good permeability.

Some of the gas reservoirs in the Greiner Area Starkey Formation, although not all, exhibited a relatively strong water-drive depletion mechanism. A few of the thinner gas zones exhibited more of a depletion-drive mechanism. Those thinner intervals (no more than 10 to 15 ft thick) had relatively higher production recovery relative to their overall thickness when compared with other thicker zones.

Reservoir Modeling and Evaluation

Based on the results of the preliminary analysis, no further work was conducted on the Willow Slough Reservoir.

Testing/Development Potential

No testing was conducted.

Siting and Environmental Evaluation

Determination – No Fatal Flaws

Based on a review of aerial photography overlaid by property lines and the gas reservoir boundary, the project team selected a 40-acre parcel for the station site. The site is currently in row crops, as are all the surrounding properties. The site is not within the 100-year flood zone. Yolo County zoning is agriculture preserve, which could complicate the permitting process due to the typical development restrictions associated with this designation. The site is under Williamson Act contract and is classified as prime farmland. The nearest sensitive receptor is a residence approximately 1,500 ft north of the station.

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Gas transmission service capable of the providing the type of pressures required for a CAES facility is located approximately 4 miles to the east. A larger gas transmission pipeline is located an additional 3 miles further east, for a total length of approximately 7 miles. The connection point would be adjacent to the City of Davis Waste Water Treatment Plant, which may be provide cooling water to the power plant.

The electric transmission gen-tie would extend approximately 7 miles west to existing 230-kV lines, following existing property lines. Two residences lie along the route – the alignment would be 100 ft from one residence and 200 ft from the second residence. Since the Yolo County Airport is due west of the station site, the route necessarily shifts approximately 2 miles north to provide a 1.25 mile separation from the end of the runway. A Federal Aviation Administration (FAA) Airspace Study would need to be conducted. Although not likely, this study may require a further shift in alignment to the north to avoid the flight pattern. No schools are located along the gas or electric routes.

No conservation easements or riparian areas are directly affecting the station or linears, and conservation easements adjacent to the gen-tie can be avoided during detailed siting. The only sensitive species potentially directly affected (giant garter snake) is along the eastern end of the pipeline route. Swainson's hawk is found throughout the area, and is the only other sensitive species potentially affected. This area is part of the Pacific Flyway, a known waterfowl migration route, and potential collision with the gen-tie would need to be addressed during project permitting.

Land Acquisition/Site Control

Preliminary Title Work

In December 2011, PG&E proceeded with Full Title Reports of the nine Assessor's Parcel Numbers (APNs) overlying the storage reservoir (Willow Slough—APN Map.pdf). These reports were never completed.

References

1) Willow Slough - Aerial Map.pdf

2) Willow Slough - Reconnaissance Report.pdf

2) Willow Slough - Detailed Geological Report.pdf

4) Willow Slough - APN Map.pdf

DRAFT

A310: Zamora Site Selection and Attachments

CAES - Reservoir Modeling Summary
Zamora - 3D Seismic - First Interpretation
Zamora - 3D Seismic - 2nd Interpretation
Zamora - Aerial Map
Zamora - APN Map
Zamora - Biological Constraints Analysis
Zamora - Conservation Easement Map
Zamora - Cultural Resources Report
Zamora - Detailed Geological Report
Zamora - Drilling Operation Site Plan
Zamora - FWS Biological Effects Assessment
Zamora - GIS Evaluation
Zamora - Noise Study
Zamora - Notice of Exemption - Roosevelt Ranch 10-1
Zamora - Permeability Review
Zamora - Reconnaissance Report
Zamora - Roosevelt Ranch ECF Corridor Map
Zamora - S3 Reservoir Modeling and History Match
Zamora - Static Model
Zamora Site Selection Close-Out - Final Report

CAES RESERVOIR SIZE DETERMINATION
Gas Simulation Model Results - SW = 20%, Sg = 80% (air only)

Case	Reservoir Properties								Rates and Cum Gas per well				Results for 10 hour withdrawal					Approximate Field Size	
	K	H	KH	Temp	Pi	Pwf	Drainage Area/well		Air In Place	Well Rate	10 hr Cum	Target 10 hr	# Wells	Working	Air-in-Place	Ratio	Depth		
Run ID	md	ft	md-ft	degF	psi	psi	Rad., Ft	Acres	MMCF	MMCFD	MMCF	MMCF	1.1 bcfd	Vol, MMCF	BCF	IAIP/WV	MD	Acres	BCF Gas
1a20gd	500	30	15,000	112	1,200	1,050	450	18.6	416.03	32.0	13.33	13.33	34	453.2	14.1	31.2	2,771	632	16.2
1b20gd	300	30	9,000	112	1,200	1,050	450	18.6	416.03	21.5	8.96	8.96	51	457.0	21.2	46.4	2,771	948	24.3
1c20gd	100	30	3,000	112	1,200	1,050	450	18.6	416.03	8.2	3.42	3.42	134	458.3	55.7	121.6	2,771	2,492	63.9
2a20gd	500	30	15,000	123	1,500	1,050	150	2.1	57.15	32.0	13.33	13.33	34	453.2	1.9	4.3	3,464	70	2.2
2c20gd	300	30	9,000	123	1,500	1,050	170	2.7	72.41	32.0	13.33	13.33	34	453.2	2.5	5.4	3,464	90	2.9
2e20gd	100	30	3,000	123	1,500	1,050	450	18.6	508.70	27.3	11.37	11.38	40	454.8	20.3	44.7	3,464	744	23.9
2hz20gd*	100	30	3,000	123	1,500	1,050	502*1100	12.7	344.88	64.0	26.67	26.67	17	453.4	5.9	12.9	3,464	216	6.9
3a20gd	500	30	15,000	134	1,800	1,050	115	1.2	38.87	32.0	13.33	13.33	34	453.2	1.3	2.9	4,157	41	1.6
3c20gd	300	30	9,000	134	1,800	1,050	120	1.3	42.32	32.0	13.33	13.33	34	453.2	1.4	3.2	4,157	45	1.7
3e20gd	100	30	3,000	134	1,800	1,050	150	2.1	66.95	32.0	13.31	13.33	34	452.5	2.3	5.0	4,157	70	2.7

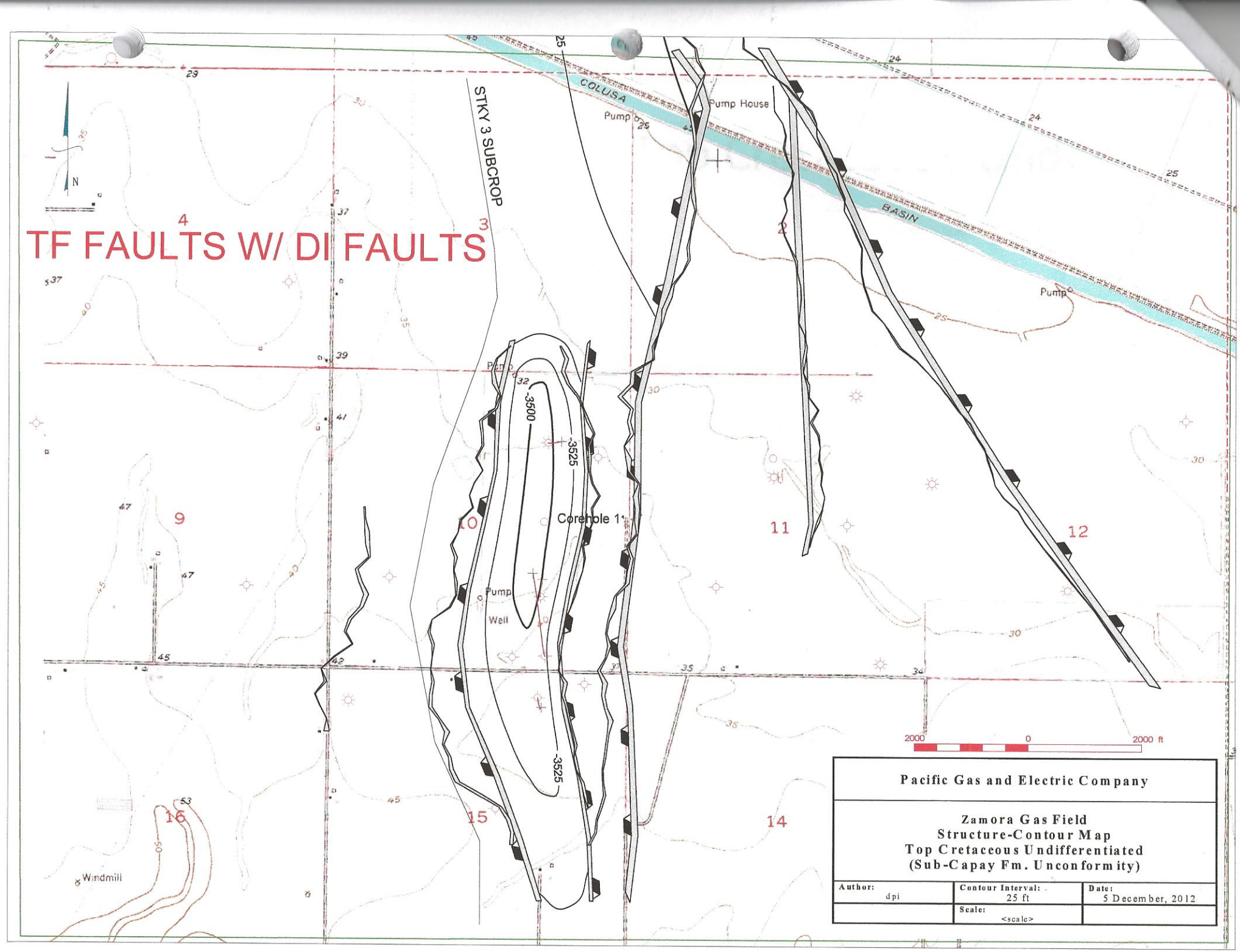
CAES RESERVOIR SIZE DETERMINATION
Gas Simulation Model Results - SW = 35%, Sg = 65% (air only)

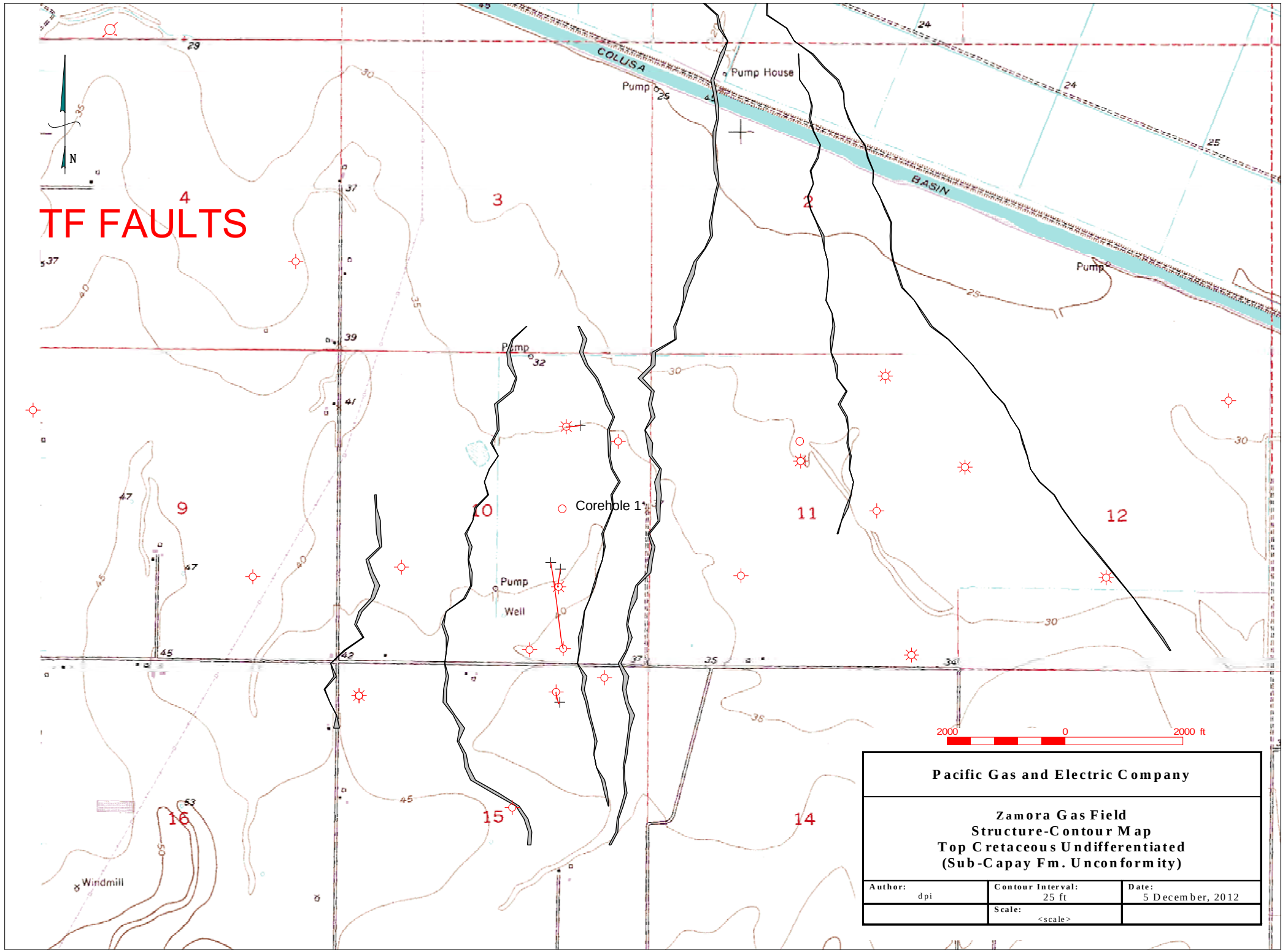
Case	Reservoir Properties								Rates and Cum Gas per well				Results for 10 hour withdrawal					Approximate Field Size	
	K	H	KH	Temp	Pi	Pwf	Drainage Area/well		Air In Place	Well Rate	10 hr Cum	Target 10 hr	# Wells	Working	Air-in-Place	Ratio	Depth		
Run ID	md	ft	md-ft	degF	psi	psi	Rad., Ft	Acres	MMCF	MMCFD	MMCF	MMCF	1.1 bcfd	Vol, MMCF	BCF	IAIP/WV	MD	Acres	BCF Gas
1a35gd	500	30	15,000	112	1,200	1,050	450	18.6	338.02	20.5	8.54	8.54	54	461.2	18.3	39.6	2,771	1,004	20.9
1b35gd	300	30	9,000	112	1,200	1,050	450	18.6	338.02	13.5	5.63	5.63	81	456.0	27.4	60.0	2,771	1,506	31.4
1c35gd	100	30	3,000	112	1,200	1,050	450	18.6	338.02	5.1	2.10	2.10	218	457.8	73.7	161.0	2,771	4,054	84.5
2a35gd	500	30	15,000	123	1,500	1,050	180	3.0	65.95	32.0	13.31	13.33	34	452.5	2.2	5.0	3,464	101	2.6
2b35gd	300	30	9,000	123	1,500	1,050	225	4.6	103.91	32.0	13.33	13.33	34	453.2	3.5	7.8	3,464	158	4.1
2c35gd	100	30	3,000	123	1,500	1,050	450	16.8	413.33	16.8	7.00	7.00	65	455.0	26.9	59.0	3,464	1,092	28.4
2hz35gd*	100	30	3,000	123	1,500	1,050	502*1100	12.7	280.22	42.0	17.50	17.50	26	455.0	7.3	16.0	3,464	330	8.6
3a35gd	500	30	15,000	134	1,800	1,050	130	1.6	40.96	32.0	13.33	13.33	34	453.2	1.4	3.1	4,157	53	1.6
3b35gd	300	30	9,000	134	1,800	1,050	140	1.8	47.44	32.0	13.33	13.33	34	453.2	1.6	3.6	4,157	61	1.9
3c35gd	100	30	3,000	134	1,800	1,050	450	18.6	484.18	30.5	12.70	12.71	36	457.2	17.4	38.1	4,157	669	20.7

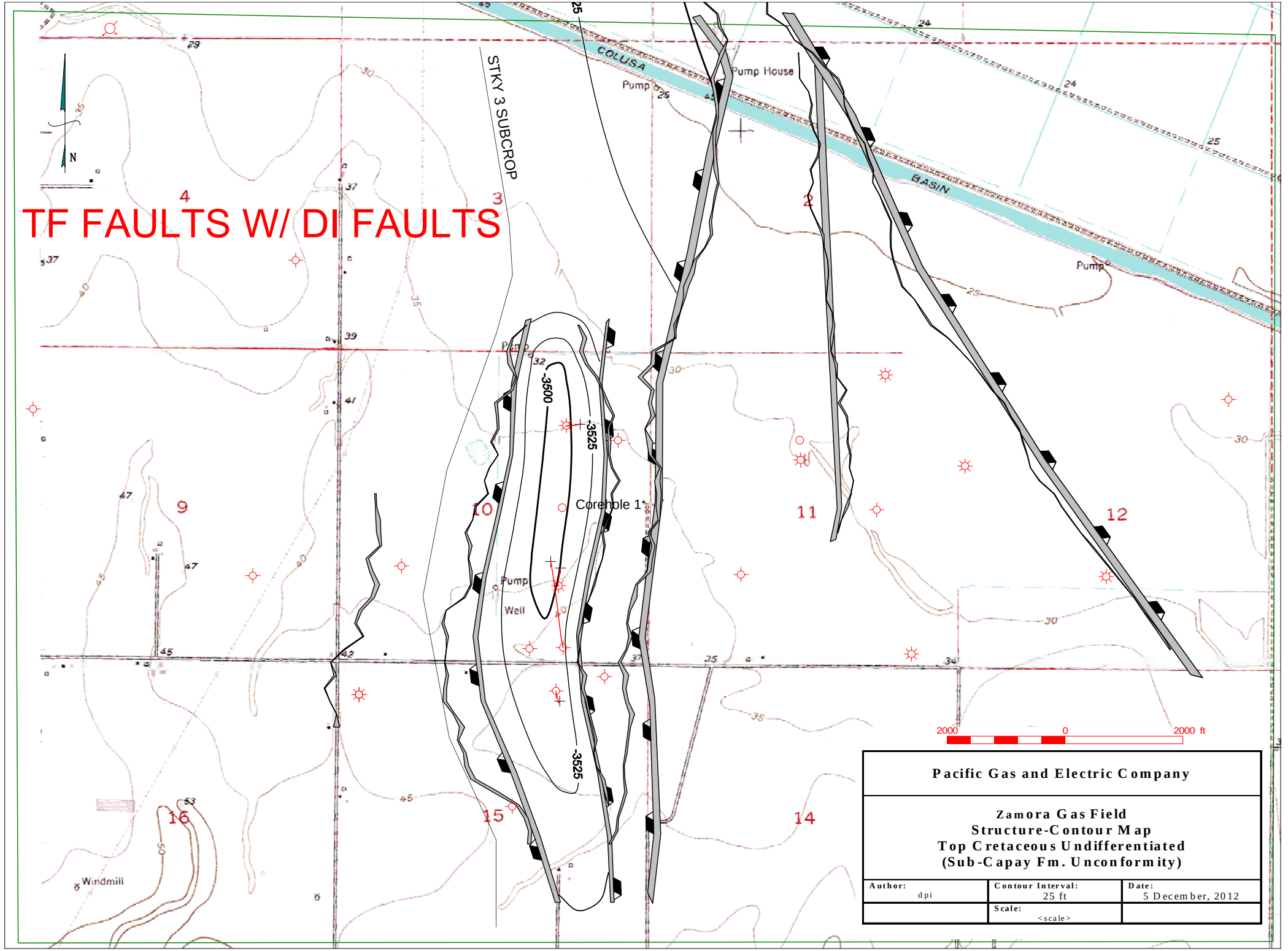
*Horizontal well length = 1000 ft

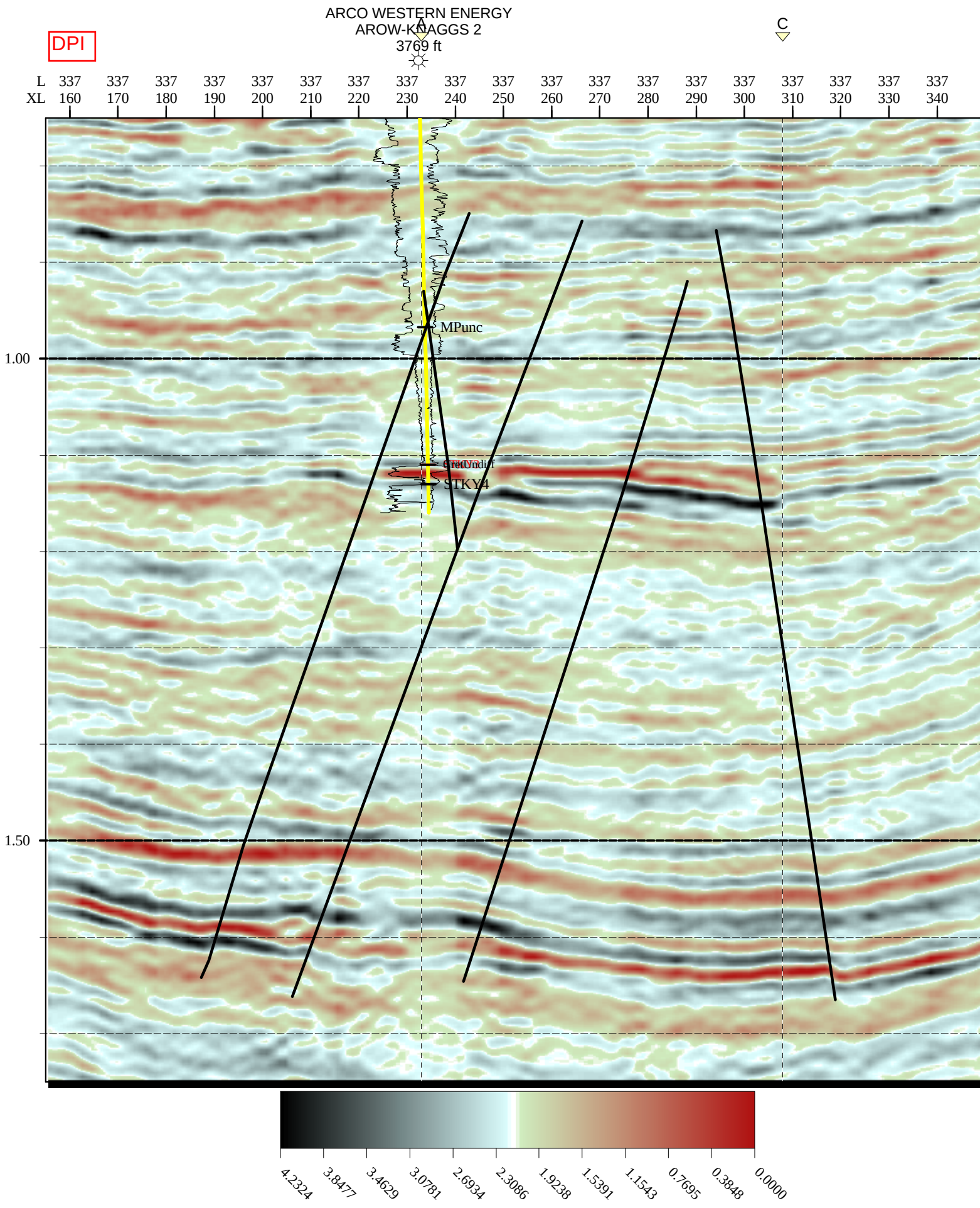
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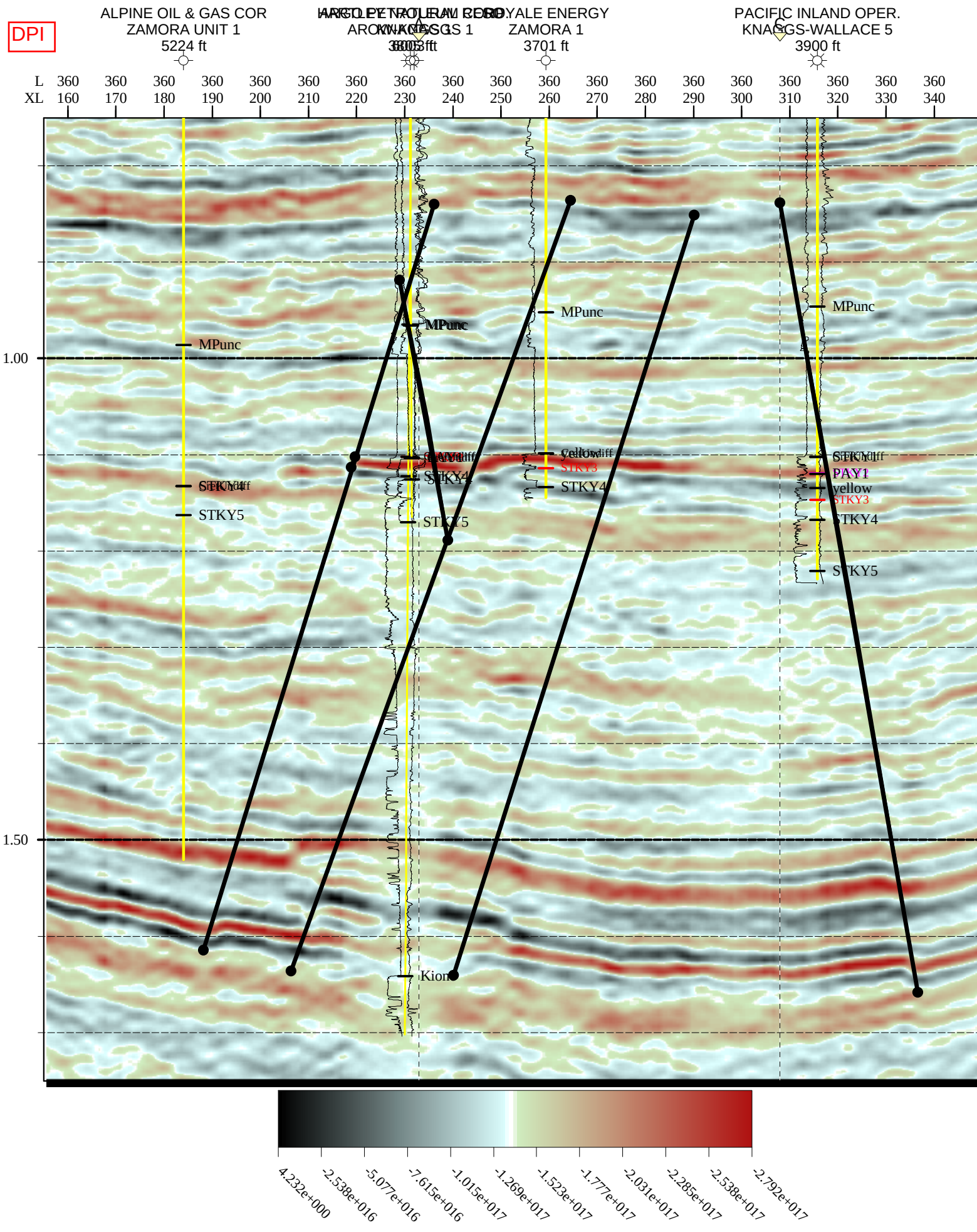
- Porosity = 28 percent
- Wellbore radius = 0.5 feet
- No aquifer
- No standoff from GWC
- No wellbore friction

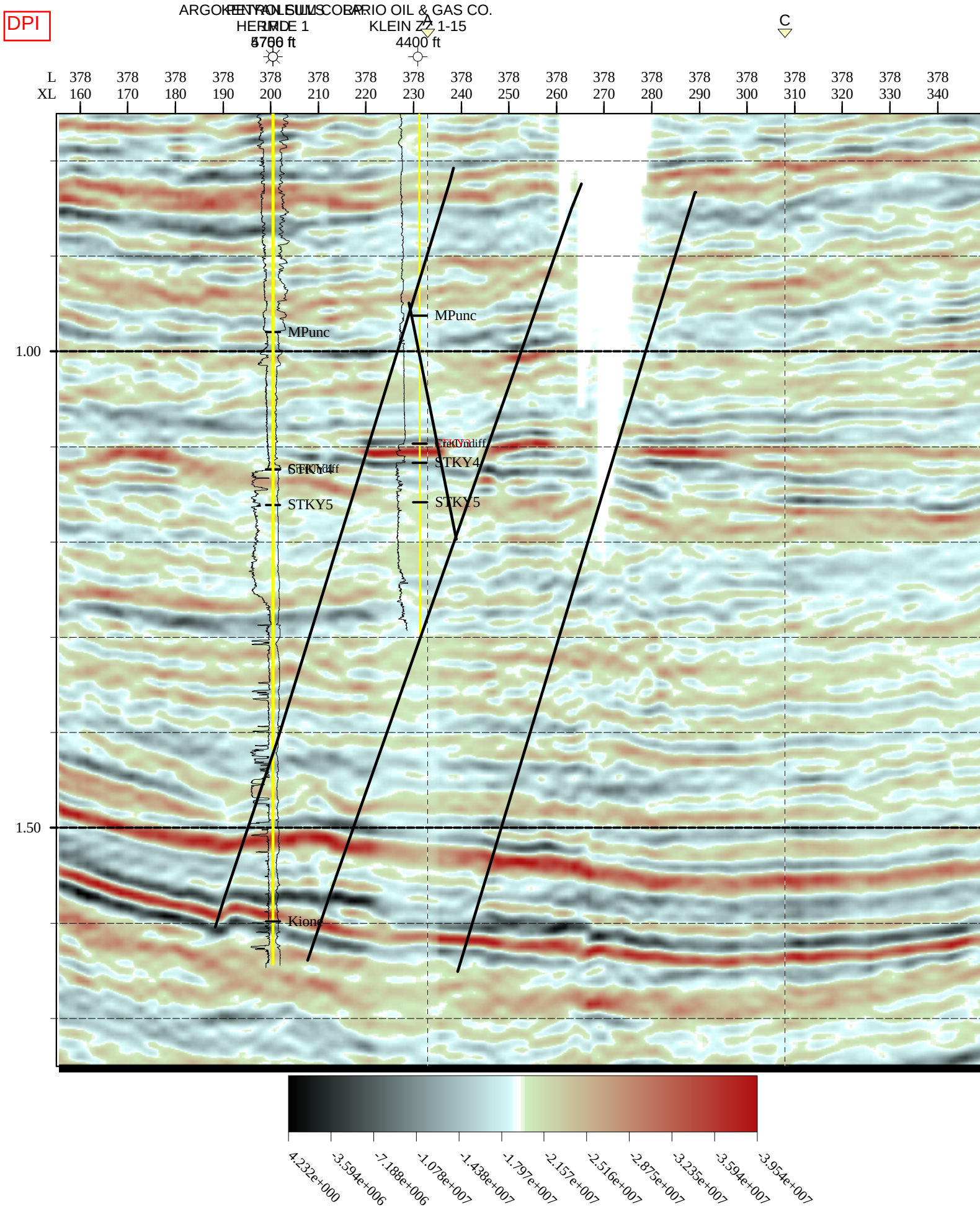

TF FAULTS W/ DI FAULTS
STKY 3 SUBCROP
COLUSA
BASIN
Pump House
Pump
Corehole 1
Pump Well
Windmill
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-3525
-3525
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0
2000 ft
Pacific Gas and Electric Company
Zamora Gas Field
Structure-Contour Map
Top Cretaceous Undifferentiated
(Sub-Capay Fm. Unconformity)
Author: dpi
Contour Interval: 25 ft
Date: 5 December, 2012
Scale: <scale>

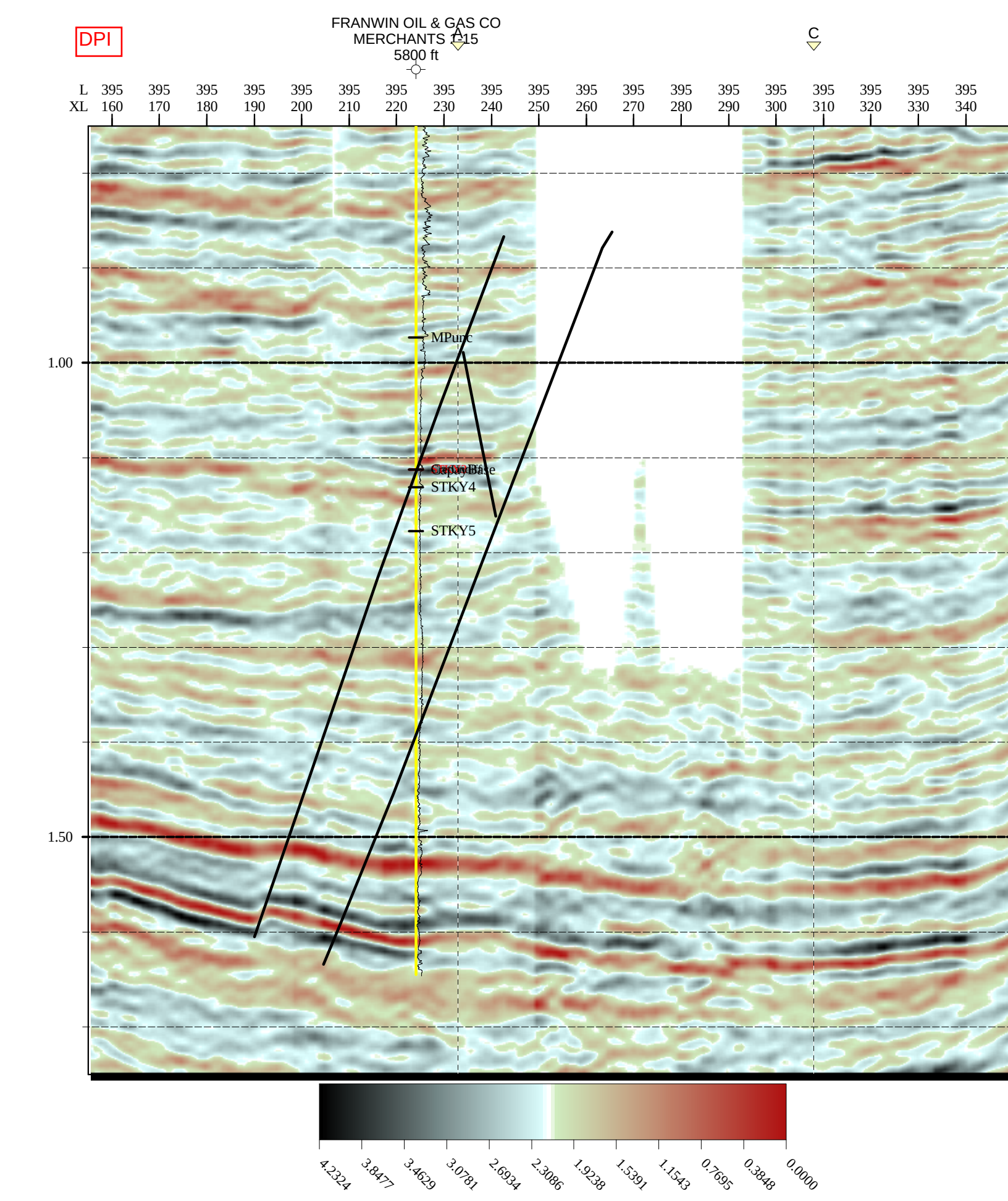

TF FAULTS
COLUSA
BASIN
Pump House
Pump
Corehole 1
Well
Windmill
2000
0
2000 ft
Pacific Gas and Electric Company
Zamora Gas Field
Structure-Contour Map
Top Cretaceous Undifferentiated
(Sub-Capay Fm. Unconformity)
Author: dpi
Contour Interval: 25 ft
Date: 5 December, 2012
Scale: <scale>


TF FAULTS W/ DI FAULTS
STKY 3 SUBCROP
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Pump House
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Corehole 1
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Pacific Gas and Electric Company
Zamora Gas Field
Structure-Contour Map
Top Cretaceous Undifferentiated
(Sub-Capay Fm. Unconformity)
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Date:
5 December, 2012
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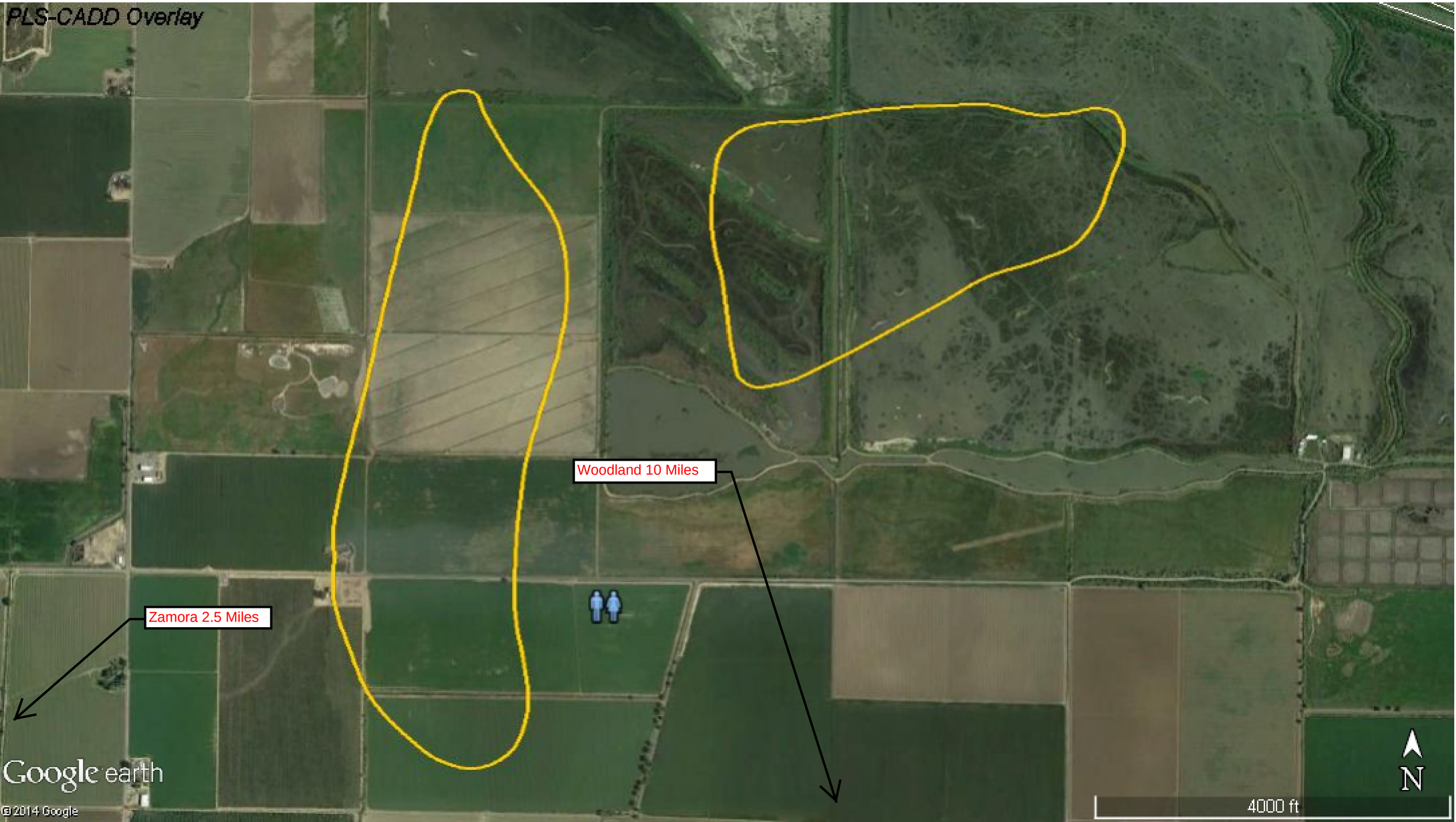

ARCO WESTERN ENERGY
AROW-KNAGGS 2
3769 ft
A
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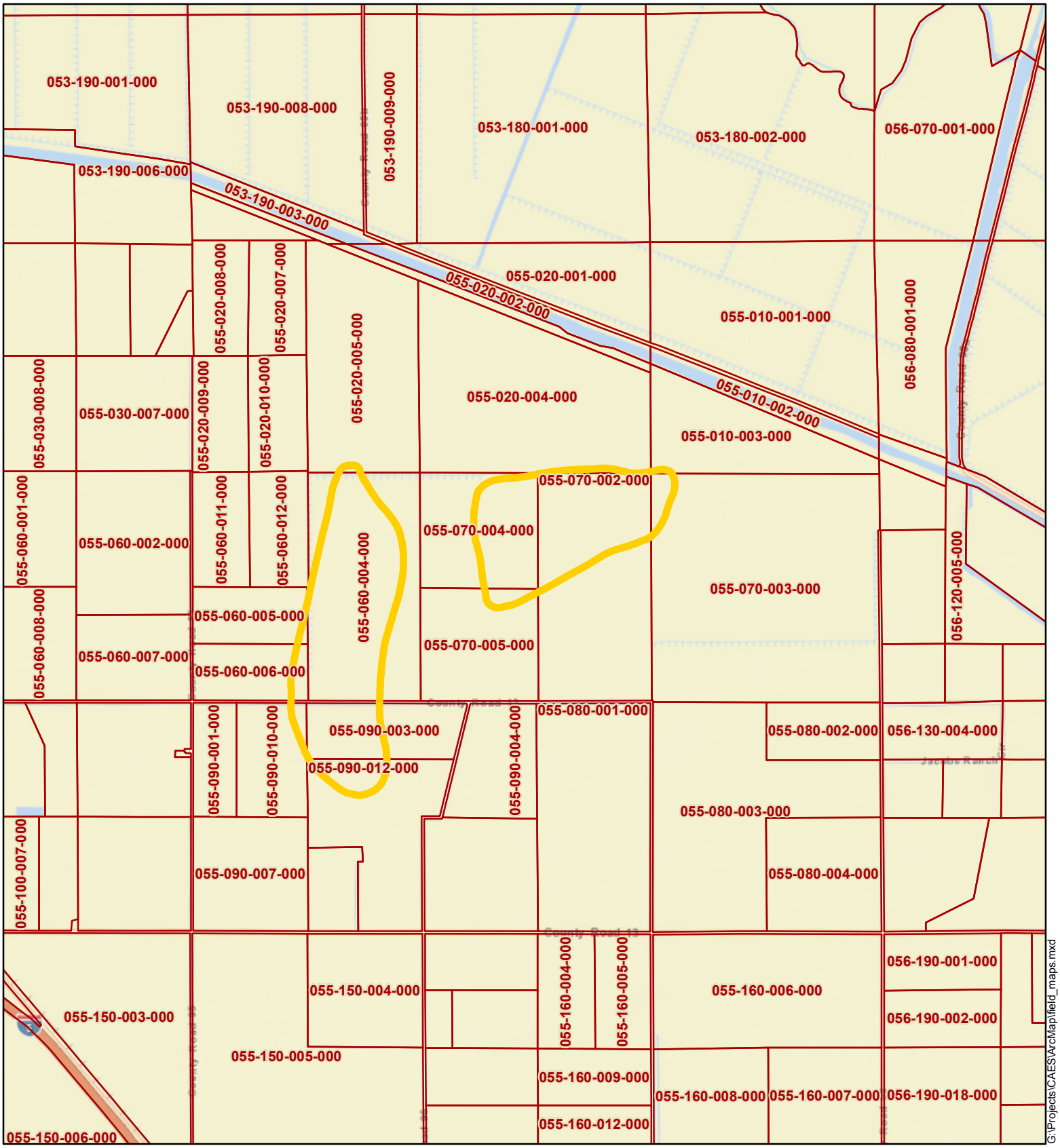

DPI
ALPINE OIL & GAS COR
ZAMORA UNIT 1
5224 ft
ARCO EXPLORATION & PRO
ARCO-KNAGGS 1
3803 ft
ROYALE ENERGY
ZAMORA 1
3701 ft
PACIFIC INLAND OPER.
KNAGGS-WALLACE 5
3900 ft
L 360 360 360 360 360 360 360 360 360 360 360 360 360 360 360 360 360 360 360 360 360
XL 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340
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STKY5
yellow
STKY3
PAY1
Kion
4.232e+000
-2.538e+016
-5.077e+016
-7.615e+016
-1.015e+017
-1.269e+017
-1.523e+017
-1.777e+017
-2.031e+017
-2.285e+017
-2.538e+017
-2.792e+017


DPI
ARGO PETROLEUM CORP.
HERMIDE 1
4700 ft
CENTRAL SULPHUR OIL & GAS CO.
KLEIN ZZ 1-15
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XL 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340
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-3.594e+006
-7.188e+006
-1.078e+007
-1.438e+007
-1.797e+007
-2.157e+007
-2.516e+007
-2.875e+007
-3.235e+007
-3.594e+007
-3.954e+007


DPI
FRANWIN OIL & GAS CO
MERCHANTS 1-15
5800 ft
A
C
L 395 395 395 395 395 395 395 395 395 395 395 395 395 395 395 395 395 395 395 395
XL 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340
1.00
1.50
MPunc
STKY4
STKY5
4.2324
3.8477
3.4629
3.0781
2.6934
2.3086
1.9238
1.5391
1.1543
0.7695
0.3848
0.0000

Zamora Aerial Map





Zamora Gas (Abd.)

Refined Zamora Boundary

Parcels

1:36,000

0 1,700 3,400 5,100

Feet

8/22/2012

Biological Constraints Analysis for the PG&E Compressed Air Energy Storage Project, Zamora Well Pad B Yolo County, California

Prepared for:

Pacific Gas and Electric Company

Prepared by:

SWCA Environmental Consultants

December 2012

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BIOLOGICAL CONSTRAINTS ANALYSIS FOR THE PG&E COMPRESSED AIR ENERGY STORAGE PROJECT ZAMORA WELL PAD B

Prepared for

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December 20, 2012

SWCA Project No. 23910

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CONTENTS

1. Introduction 1
1.1. Biological Constraints Analysis Summary 1
1.2. Project Description 1
2. Environmental Setting 3
3. Methods 3
3.1. Desktop Review and Literature Search 3
4. Results 4
4.1. Special-status Species and Potential Impacts 15
4.1.1. Giant Garter Snake 15
4.1.2. Tricolored Blackbird 16
4.1.3. Burrowing Owl 16
4.1.4. Swainson's Hawk 17
4.1.5. Mountain Plover 17
4.1.6. White-tailed Kite 18
4.1.7. Loggerhead Shrike 18
4.1.8. Nesting Migratory Passerine Birds and Raptors 19
4.1.9. Wetlands and Waters 19
5. Avoidance and Minimization Measures 19
6. References 22

TABLES

Table 1. Special-status Species and Sensitive Habitat Potential for Occurrence in the Project Area 5

APPENDICES

APPENDIX A: Figures
APPENDIX B: Species Lists
APPENDIX C: Giant Garter Snake Habitat Assessment
APPENDIX D: Swainson's Hawk Survey Protocol

1. INTRODUCTION

1.1. Biological Constraints Analysis Summary

This Biological Constraints Analysis (BCA) has been prepared by SWCA Environmental Consultants (SWCA) for the proposed Geologic Core Sampling Phase of the Pacific Gas and Electric Company (PG&E) Compressed Air Energy Storage (CAES) Project at the Zamora Well Pad B location (project) (Figure 1, Appendix A). The objective of the project is to develop a well pad and access road to support staging and operation of geological core sampling equipment. Geological core sampling will be conducted to determine the suitability of the project area for compressed air storage within depleted subterranean natural gas reservoirs. The purpose of this BCA is to determine the potential for presence of special-status species and sensitive resources that may constrain access or construction activities, and to provide recommended avoidance and minimization measures (AMMs) that may reduce constraints to access and construction activities and minimize potential for impacts to special-status species and sensitive biological resources.

Swainson's hawk (*Buteo swainsoni*), listed as threatened under the California Endangered Species Act (CESA); western yellow-billed cuckoo (*Coccyzus americanus*), a federal candidate for listing and listed as endangered under CESA; tricolored blackbird (*Agelaius tricolor*), burrowing owl (*Athene cunicularia*) and loggerhead shrike (*Lanius ludovicianus*), designated as California species of special concern (SSC); mountain plover (*Charadrius montanus*), proposed federally threatened and SSC; and white-tailed kite (*Elanus leucurus*), a state fully protected (FP) species, have the potential to be adversely affected or impacted by the project. AMMs are provided in Section 5 below that would aid in minimizing or avoiding effects on these species.

No wetland or water features are present in the access road or well pad development area that could be considered jurisdictional by the U.S. Army Corps of Engineers (USACE) or the State of California. As such, consultation with the USACE for impacts to wetlands or Waters of the U.S. and consultation with the California Department of Fish and Game (CDFG) or Regional Water Quality Control Board (RWQCB) for impacts to Waters of the State would not be required. The proposed project will receive federal funding from the U.S. Department of Energy (USDOE). Because the project will be federally funded, the USDOE is required under Section 7 of the federal Endangered Species Act (ESA) to determine whether the proposed project may affect federally listed and proposed species or proposed or designated critical habitat. If the USDOE determines that the project may affect federally listed species or critical habitat, consultation with the U.S. Fish and Wildlife Service (USFWS) would be required.

1.2. Project Description

The project area is within the U.S. Geologic Survey (USGS) California Eldorado Bend 7.5-minute topographic quadrangle (quad) in Township 11 North, Range 01 East, Section 10, and is centered at approximately 38.808858 º, -121.845417 º. The site is located on the Roosevelt Ranch, approximately 2 miles east of the town of Zamora, immediately north of County Road (CR) 12 in Yolo County, California (Appendix A, Figure 1). The elevation range at the site is between approximately 40 and 45 feet above mean sea level.

The objective of the project is to collect approximate 4-inch diameter geological core samples from the subsurface natural gas formation at depth of approximately 4,000-5,000 feet. Cores will be used to determine the suitability of the subsurface formation for compressed air storage. Compressed air storage involves utilizing appropriate geological formations (e.g., depleted natural gas reservoirs) to store surplus energy in the form of compressed air during periods of low electric demand. This stored energy can then

be utilized during periods of higher electric demand, improving the efficiency of energy distribution through the power grid.

New access road construction will be necessary between CR 12 and the proposed well pad site north of CR 12 in an agricultural field. The access road will be built perpendicular from CR 12 to the location of the well pad. Access road construction will require minimal grading but will largely consist of compaction of the subgrade, delivery of approximately 23 truckloads of aggregate, placing aggregate road base, and compaction of the final road grade to establish an approximately 14-foot-wide and 100-foot-long (approximately 0.03 acre) roadway. Once the access road has been established, a well pad with the dimensions of approximately 220 feet by 120 feet (approximately 0.6 acre) will be constructed. Construction of the well pad will consist of minimal grading, compaction of the subgrade, delivery of 70 truckloads of sand and crushed rock, placement of sand base and then crushed rock to approximately 1 foot thick, and compaction with a roller. The proposed project footprint (Appendix A, Figure 2) may shift up to 150 feet to the west, north, or east, based on the final engineering layout and site-specific conditions.

All vehicle traffic to the well pad will be via the gravel access road and all staging will be contained to the new well pad workspace. During any dry periods, water trucks will be used as necessary to reduce dust during site access and other construction activities. Approximately 110 truck trips will be required to import well pad material to the site. An additional five truck trips will be required to remove drill cuttings and associated material from the site. If the well pad site is restored to pre-project conditions, an additional 110 truck trips will be required to remove temporary well pad materials, which will total approximately 318 truck trips for the entire scope of this activity. Standard PG&E Best Management Practices (BMPs) and AMMs will be implemented to avoid impacts to sensitive resources in the vicinity of the project.

After the well pad has been established, well drilling equipment will be moved onto the pad. The primary equipment includes the drill rig, mud and water tanks and pumps, shaker tanks, electric generators, diesel fuel tanks, and drill pipe racks. Geologic sampling will consist of drilling a 10-inch diameter well to a depth of approximately 4,000-5,000 feet and extracting a geological core sample not greater than 4 inches in diameter. All sections of the core sample will be removed offsite for analysis and storage. All peripheral material (e.g., cuttings and drilling mud) removed during the coring process will be immediately placed in proper storage receptacles and removed offsite for disposal at an authorized facility. The drilling crew, plus engineers, temporary workers and site visitors, will consist of an average of approximately 12 workers per shift, with three shifts per day. A maximum of 20 workers may be present during various operations. In addition to worker vehicles, service and delivery vehicles will access the site during the drilling phase including equipment trucks for all aspects of the effort. All drilling activities will be completed in compliance with the Yolo County Gas and Oil Well Site Plan approval.

Once the core sample is obtained and the core hole is plugged and abandoned per California Division of Oil Gas and Geothermal Resources (DOGGR) requirements, the drilling equipment will be dismantled and demobilized from the site. Construction equipment similar to that used during well pad development will be used to remove the pad materials and return the site to near pre-project conditions. All removed material will be disposed of at suitable landfills or recycled consistent with county grading or other permit requirements. However, the property owner may elect to retain the pad for farm equipment staging and storage.

Access road and well pad construction will occur over a two-week period commencing as early as January 2013. Drilling activities will occur virtually continuously for up to approximately three weeks. If the well pad is elected to be removed, restoration of the site will take up to two weeks.

2. ENVIRONMENTAL SETTING

The project is located in agricultural lands west of the Sacramento River and east of the Dunnigan Hills in the southwestern corner of Roosevelt Ranch. Roosevelt Ranch contains a mixture of active row and rice crops and an extensive network of wetlands and wetland conservation easements that are managed for waterfowl and other wildlife. The Colusa Basin Drainage Canal is located approximately 1.8-mile north of the site.

Well Pad B is proposed in the southern portion of an approximately 75-acre fallow agricultural field that was previously farmed in row crops. At the time of surveys the field was disked and devoid of vegetation. This field is bordered by thin bands of ruderal vegetation along its southern margins near CR 12, and along a dirt road west of the site that runs north from CR 12 (photos in Appendix C). An irrigation canal is located approximately 400 feet north of the study area (photo in Appendix C). This canal conveys water from a large man-made lake located approximately 1200 feet east of the study area to active rice (*Oryza sativa*) fields immediately north of the canal. Plant species such as cattail (*Typha latifolia*), curly dock (*Rumex crispus*), wild radish (*Raphanus raphanistrum*), and an unidentified species of rush (*Juncus* spp.) were observed in wet areas and along the banks of the canal. Approximately 1000 feet east of the study area, a dirt road with ruderal vegetation along its margins runs north from CR 12 and separates the fallow field from the lake. A large field of non-native grassland borders the southern edge of the man-made lake just east of this dirt road. Species observed in ruderal and non-native grassland areas include Bermuda grass (*Cynodon dactylon*), ripgut brome (*Bromus diandrus*), yellow star thistle (*Centaurea solstitialis*), hoary cress (*Lepidium draba*), Russian thistle (*Salsola* spp.), common tarweed (*Centromadia pungens*), and field bindweed (*Convolvulus arvensis*). Row crops and fields planted in alfalfa (*Medicago sativa*) are present to the south of CR 12. Figure 3 in Appendix A shows the location of these habitat types in relation to the project area.

According to representatives of the Roosevelt Ranch, the fallow field surrounding the project area will be planted in winter wheat for the 2013 growing season, and the rice fields north of the project will remain in rice production.

3. METHODS

3.1. Desktop Review and Literature Search

A desktop review was performed to compile a list of potential special-status species and sensitive habitats within a 5-mile radius of the project using the current version of the CDFG California Natural Diversity Database (CNDDB), the CNDDB Spotted Owl Data Viewer, and the USFWS Sacramento Office's species list generator (including the Eldorado Bend USGS quad and Yolo County). PG&E's geographic information system (GIS) program was queried to determine if the project is within the PG&E Raptor Concentration Zone (RCZ). The California Native Plant Society (CNPS) Online Inventory of Rare and Endangered Vascular Plants of California was reviewed to identify special-status plants that have been documented within 5 miles of the project (Appendix A, Figure 4). Additional special-status species not included in the USFWS species list or CNDDB records were considered if the project is within their known geographic range and/or suitable habitat is potentially present (e.g., white-tailed kite, loggerhead shrike).

The USFWS Critical Habitat Mapper was queried to identify critical habitat for terrestrial and aquatic species within 5 miles of the project. Wetland features recorded in the National Wetlands Inventory (NWI) near the project were identified using the USFWS's online Wetlands Mapper. Soil types were assessed by reviewing the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Web Soil Survey and referencing aerial imagery of the project vicinity in Google Earth.

The special-status species list was further refined during field reconnaissance and habitat assessment surveys performed by PG&E and SWCA Biologists and by SBI giant garter snake Biologist Karen Swaim. Surveys were performed on July 14, August 2, September 14, and October 1, 2012. Surveys included the proposed location of well pad and access routes and an approximate 900-foot by 900-foot square study area centered at approximately 38.809888º, -121.845332º. The project area was surveyed for signs of special-status species (e.g., footprints, scat, feathers, snake skin sheds, signs of nesting and roosting) and potential habitat. Global Positioning System (GPS) data points were collected and photos were taken to document the proposed project workspaces and surrounding habitats (photos are included in Appendix C).

For the purposes of this report, special-status species were defined as those listed, candidate, or proposed for listing as threatened or endangered under the ESA or CESA, California species of special concern, species that are Fully Protected in California, birds protected by the Migratory Bird Treaty Act (MBTA), and those plant species considered Rare under the California Native Plant Protection Act or that have CNPS Rank 1A, 1B, or 2.

4. RESULTS

Desktop research returned records for 37 potential special-status species for the vicinity of the project area, including 13 plants, 3 invertebrates, 6 fish, 2 amphibians, 1 reptile, 9 birds, and 3 mammals. Table 1 includes the complete list of these species and describes their habitat requirements, their listing status, potential for project-related impacts, and any recommended measures that may minimize potential for impacts to these species. Three sensitive habitats were also identified during the desktop review and are described in Table 1. Special-status species that were determined to lack habitat within the project area or surrounding vicinity (e.g., vernal pool species, fish), or those with known ranges that do not include the project area are not analyzed further in this document.

Critical habitat is not present in the project area or in the surrounding vicinity. The project is within the PG&E RCZ, and as such, there is high potential for raptors to nest and forage in suitable habitat within the project area. Two Wetlands Reserve Program conservation easements managed by the Natural Resources Conservation Service are present on the Roosevelt Ranch property just east and northwest of the project (Appendix A, Figure 4), but these easements do not include the fallow field where the well pad and access road are proposed, and no NWI records of wetlands or waterways exist in the proposed well pad or access road workspaces. It is important to note that the field surveys did not involve a formal delineation using U.S. Army Corps of Engineers (USACE) methodology and no detailed investigations for wetland hydrology were conducted. However, given the lack of hydrophytic vegetation, the proposed project area is not likely to be considered waters of the United States.

Table 1. Special-status Species and Sensitive Habitat Potential for Occurrence in the Project Area

Species Name	Listing Status*	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Plants				
Ferris's milk-vetch (*Astragalus tener* var. *ferrisiae*)	1B.1	Annual herb; occurs in meadows and seeps (vernally mesic) and valley and foothill grassland (subalkaline flats). Flowers April-May. 2-75 meters (m).	**None.** Suitable habitat (vernally mesic meadows and seeps, subalkaline flats in valley and foothill grassland) is not present in the project area.	No AMMs required.
Alkali milk-vetch (*Astragalus tener* var. *tener*)	1B.2	Annual herb; occurs in alkali sinks and vernal pools. Flowers March-June. 1-60 m.	**None.** Suitable habitat (alkali sinks or vernal pools) is not present in the project area.	No AMMs required.
Brittlescale (*Atriplex depressa*)	1B.2	Annual herb; occurs in chenopod scrub, meadows and seeps, playa, valley and foothill grassland, and vernal pools (alkaline clay). Flowers April-October. 1-320 m.	**None.** Suitable habitat (chenopod scrub, meadows and seeps, playa, valley and foothill grassland, and alkaline clay vernal pools) is not present in the project area.	No AMMs required.
San Joaquin spearscale (*Atriplex joaquinana*)	1B.2	Annual herb; occurs in alkali grassland and alkali meadow, or on the margins of alkali scrub on clay soils, often in areas of high alkalinity. Flowers April-October. 1-835 m.	**None.** Suitable habitat (alkali grasslands, alkali meadows, or alkali scrub) is not present in the project area.	No AMMs required.
Round-leaved fillaree (*California macrophylla*)	1B.1	Annual herb; occurs in cismontane woodland and valley and foothill grassland (clay). Flowers March-May. 15-1200 m.	**None.** Suitable habitat (clay soils, cismontane woodland, and valley and foothill grassland) is not present in the project area.	No AMMs required.
Palmate-bracted bird's beak (*Chloropyron palmatum*)	FE / SE / 1B.1	Annual herb (hemiparasitic); occurs in chenopod scrub, valley and foothill grassland (alkaline). Flowers May-October. 5-155 m.	**None.** Suitable habitat (alkaline chenopod scrub or valley and foothill grassland) is not present in the project area.	No AMMs required.
Wooly rose mallow (*Hibiscus lasiocarpos* var. *occidentalis*)	1B.2	Perennial rhizomatous herb; occurs in freshwater marshes and swamps. Blooms June-September. 0-120 m.	**None.** Suitable habitat (freshwater marsh or swamp) is not present in the project area.	No AMMs required.

Species Name	Listing Status*	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Coulter's goldfields (*Lasthenia glabrata* ssp. *coulteri*)	1B.1	Annual herb; occurs in marshes and swamps (coastal salt), playas and vernal pools. Flowers February-June. 1-1220 m.	**None.** Suitable habitat (coastal salt marsh and swamp, playas, or vernal pools) is not present in the project area.	No AMMs required.
Colusa layia (*Layia septentrionalis*)	1B.2	Annual herb; occurs in chaparral, cismontane woodland, and valley and foothill grassland (sandy, serpentinite). Flowers April-May. 100-1095 m.	**None.** Suitable habitat (sandy, serpentine chaparral, cismontane woodland, or valley and foothill grassland) is not present in the project area.	No AMMs required.
Heckard's pepper-grass (*Lepidium latipes var. heckardii*)	1B.2	Annual herb; occurs in valley and foothill grassland (alkaline flats). Flowers March-May. 2-200 m.	**None.** Suitable habitat (alkaline flats in valley and foothill grassland) is not present in the project area.	No AMMs required.
Baker's navarretia (*Navarretia leucocephala* ssp. *Bakeri*)	1B.1	Annual herb; occurs in cismontane woodland, lower montane coniferous forest, meadows and seeps, valley and foothill grassland, and vernal pools. Flowers April-July. 5-1740 m.	**None.** Suitable habitat (cismontane woodland, lower montane coniferous forest, meadows, seeps, valley and foothill grassland, or vernal pools) is not present in the project area.	No AMMs required.
Wright's trichocoronis (*Trichocoronis wrightii* var. *wrightii*)	2.1	Annual herb; occurs in meadows and seeps, marshes and swamps, riparian forest, and vernal pools (alkaline). Flowers May-September. 5-435 m.	**None.** Suitable habitat (meadows, seeps, marshes, swamps, riparian forest, or vernal pools) is not present in the project area.	No AMMs required.
Saline clover (*Tripholium hydrophilum*)	1B.2	Annual herb; occurs in marshes and swamps, valley and foothill grassland (mesic, alkaline), and vernal pools. Flowers April-June. 0-300 m.	**None.** Suitable habitat (marshes, swamps, mesic or alkaline valley and foothill grassland, or vernal pools) is not present in the project area.	No AMMs required.
Sensitive Plant Communities				
Coastal and Valley Freshwater Marsh	Habitat is typically flooded with freshwater and dominated by perennial and emergent monocots (4-5 meters tall). Often forms closed canopies of bulrush and cattails.		**None.** Coastal and valley freshwater marsh is not present in the project area. The nearest freshwater marsh habitat is located in the irrigation canal approximately 1100 feet north of the project area.	No AMMs required.

Species Name	Listing Status*	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Great Valley mixed riparian forest	Riparian forest with an overstory dominated by Fremont cottonwood, black walnut, western sycamore, valley oak, and Gooding's willow. Understory is typically dominated by box elder, wild grape, poison oak, California blackberry, and perennial grasses.		**None.** Great Valley mixed riparian forest does not occur in the project area or vicinity.	No AMMs required.
Valley oak woodland	A savannah to forest like community that grows in valley soils, along natural drainages, and is dominated primarily by valley oak. Associated tree species in this community include box elder, black walnut, blue oak, and interior live oak. The understory consists of poison oak, wild grape, California blackberry, toyon, blue elderberry, and annual grasses.		**None.** Valley oak woodland does not occur in the project area or vicinity.	No AMMs required.
Invertebrates				
Vernal pool fairy shrimp *Branchinecta lynchi*	FT	Occurs in vernal pool habitats including depressions in sandstone, to small swale, earth slump, or basalt-flow depressions with a grassy or, occasionally, muddy bottom in grassland.	**None.** Suitable habitat (vernal pools) is not present in the project area.	No AMMs required.
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)	FT	Occurs in the Central Valley of California in association with elderberry (*Sambucus* spp.) shrubs.	**None.** Suitable habitat (elderberry shrubs) was surveyed for during field survey and was not identified within project area.	No AMMs required.
Vernal pool tadpole shrimp *Lepiderus packardi*	FE	Occurs in a wide variety of seasonal aquatic habitats, including vernal pools, alkaline pools, clay flats, stock tanks, ditches, and road ruts.	**None.** Suitable habitat (seasonal aquatic habitats) is not present in the project area.	No AMMs required.
Fish				
Green sturgeon (southern DPS) (*Acipenser medirostris*)	FT	Occurs in nearshore oceanic waters, bays, and estuaries. Spawns in cold, clean, deep, turbulent freshwater mainstems of rivers.	**None.** Aquatic habitat is not present in the project area.	No AMMs required.

Species Name	Listing Status*	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Delta smelt (*Hypomesus transpacificus*)	FT / SE	Euryhaline species (tolerant of a wide salinity range) that occurs in estuarine waters up to 14 ppt salinity. Found only from the Suisun Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano and Yolo counties.	**None.** Aquatic habitat is not present in the project area.	No AMMs required.
Central valley steelhead ESU (*Oncorhynchus mykiss*)	FT, CH	Occurs in clear, cool water with abundant in-stream cover, well-vegetated stream margins, relatively stable water flow, and a 1:1 pool-to-riffle ratio.	**None.** Aquatic habitat is not present in the project area.	No AMMs required.
Central valley spring-run chinook salmon ESU (*Oncorhynchus tshawytscha*)	FT, CH / ST	Occurs in cool, clean water with appropriate depth, quantity and flow velocities; upland and riparian vegetation to stabilize soil and provide shade; clean gravel for spawning and egg-rearing; large woody debris to provide resting and hiding places; varied channel forms; and adequate food.	**None.** Aquatic habitat is not present in the project area.	No AMMs required.
Winter-run chinook salmon, Sacramento River ESU (*Oncorhynchus tshawytscha*)	FE / SE	Occurs in cool, clean water with appropriate depth, quantity and flow velocities; upland and riparian vegetation to stabilize soil and provide shade; clean gravel for spawning and egg-rearing; large woody debris to provide resting and hiding places; varied channel forms; and adequate food.	**None.** Aquatic habitat is not present in the project area.	No AMMs required.
Sacramento splittail (*Pogonichthys macrolepidotus*)	SSC	Occurs in Suisun bay, the Sacramento River delta, and associated marshes.	**None.** Aquatic habitat is not present in the project area.	No AMMs required.

Species Name	Listing Status*	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Amphibians				
California tiger salamander (*Ambystoma californiense*)	FT / ST / SSC	Occurs in vernal pools within grassland or oak woodlands; require seasonal water, ground squirrel burrows or other underground refuges.	**None.** Suitable habitat (vernal pools in grassland or oak woodlands) is not present in the project area.	No AMMs required.
California red-legged frog (*Rana draytonii*)	FT / SSC	Occurs in permanent and sometimes temporary water features such as streams, ponds, freshwater seeps, and marshes in lowlands and foothills between sea level and approximately 6,500 feet. Adjacent upland habitat consisting of extensive vegetation is preferred for foraging and cover. The species may make longer overland movements during migration to breeding ponds.	**None.** Suitable aquatic habitat is not present in the project area, and the project area is out of the known range of the species.	No AMMs required.
Reptiles				
Giant garter snake (*Thamnophis gigas*)	FT / ST, ECCHCP	Occurs in canals, creeks, ponds, and other areas that support permanent water with vegetative cover. The snake uses grasses, weeds, cattails, tule, and other vegetation for basking, foraging and cover. Species requires sufficient water during the active season (May 1 to October 1) to support a prey base. Species also requires upland refuge and hibernacula.	**None.** No suitable aquatic or upland habitat is present within 200 feet of the project area. Burrows and other suitable upland habitat features that could provide wintering habitat were not present in the fallow field that surrounds the project area at the time of survey. This field extends approximately 1100 feet north from the project toward the nearest suitable aquatic habitat for the species, which consists of an irrigation canal.	-To the extent possible, project should be conducted during the active season (May 1 to October 1), and environmental training should be provided to crews. -Project activity will occur at least 820 feet away from any suitable aquatic habitat to remain outside of potential wintering habitat.

Species Name	Listing Status*	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Birds				
Tricolored blackbird (Nesting colony) (*Agelaius tricolor*)	SSC	Tricolored blackbirds require open water, protected nesting substrate such as cattails or tall rushes, and foraging area with insect prey.	**Low.** Suitable foraging and nesting habitat is absent from the project area but is present around irrigation canals, wetlands, and the lake within the vicinity of the project area. Though no impacts or modifications to potential habitat will occur, there is a potential that project may impact the species through temporary disturbance from project-associated noise or potential collisions with motor vehicles.	-Information on the ecology and laws regarding nesting birds will be provided in Environmental Awareness Training to work crews. -Nesting bird surveys are required if work is to occur within the breeding season (February 15 to August 31). -If nesting birds are detected then work will stop immediately and PG&E project biologist is contacted. Work will resume when appropriate buffers are in place. -To avoid collisions with motor vehicles a speed limit of 15 mph will be maintained on project access roads.
Burrowing owl (*Athene cunicularia*)	SSC	The burrowing owl is a subterranean nester dependent on burrowing mammals that occupy open, dry grasslands, deserts, and scrublands.	**Low.** Grassland habitat is present east of the project site, and small mammals were observed in this area. Small mammal burrows were not observed in the project area. Nearest known occurrence is approximately 7 miles to the southwest, near Willow Springs Creek. No sign of the species was observed during the August 2012 survey. Though no impacts or modifications to potential habitat will occur, there is a potential that project may impact the species through temporary disturbance from project-associated noise or potential collisions with motor vehicles.	-Information on the ecology and laws regarding nesting birds will be provided in Environmental Awareness Training to work crews. -Nesting bird surveys are required if work is to occur within the breeding season (February 15 to August 31). -If nesting birds are detected then work will stop immediately and PG&E project biologist is contacted. Work will resume when appropriate buffers are in place. -To avoid collisions with motor vehicles a speed limit of 15 mph will be maintained on project access roads.

Species Name	Listing Status*	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Swainson's hawk (*Buteo swainsoni*)	ST	Swainson's hawks occur in open desert, grassland, or cropland containing scattered, large trees or small groves. Roost in large trees, but will roost on ground if none available. Breed in stands with few trees in juniper-sage flats, riparian areas, and in oak savannah in the Central Valley.	**Moderate.** Suitable foraging habitat is present in the project area, and CNDDB records exist within 0.5-mile of the project. A Swainson's hawk was observed in a willow tree approximately -0.65-mile northeast of the project during the August 2012 survey. Project construction noise could disrupt nesting behavior and nest success if active nests are within 0.5-mile of the project, and there is potential for impacts related to collisions with motor vehicles.	-Information on the ecology and laws regarding nesting birds will be provided in Environmental Awareness Training to work crews. -Protocol nesting surveys following the CDFG protocol (Appendix D) should be conducted if construction is expected to occur during nesting season (March 1 to July 31). -If nesting birds are detected then work will stop immediately and PG&E project biologist is contacted. Work will resume when appropriate buffers are in place. -To avoid collisions with motor vehicles a speed limit of 15 mph will be maintained on project access roads.
Western snowy plover *Charadrius alexandrinus nivosus*	FT / SSC	Occurs on sandy beaches, salt pond levees, and shores of large alkali lakes. Needs sandy, gravelly or friable soils for nesting.	**None.** Suitable habitat (sandy beaches, salt pond levees, alkali lakes) is not present in the project area.	No AMMs required.
Mountain plover *Charadrius montanus*	PT / SSC	Winter migrant only (September-mid-March) - does not breed in California. Prefers grazed and farmed areas such as short grasslands, plowed fields, newly sprouting grain fields and sod farms.	**Low.** Suitable foraging and roosting habitat is present in the project area and CNDDB records exist within approximately 2 miles of the project. Though no impacts or modifications to potential nesting habitat will occur, there is a potential that project may impact the species through temporary disturbance from project-associated noise or potential collisions with motor vehicles.	-Information on the ecology and laws regarding migratory birds will be provided in Environmental Awareness Training to workers. -To avoid collisions with motor vehicles a speed limit of 15 mph will be maintained on project access roads.
Western yellow-billed cuckoo *Coccyzus americanus*	FC / SE	Occurs in riparian forests and woodlands with thick understories.	**None.** Suitable foraging and nesting habitat is absent from the project area. This species is associated with extreme dense thickets of willows along the Sacramento River corridor.	No AMMs required.

Species Name	Listing Status*	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
White-tailed kite (*Elanus leucurus*)	FP	White-tailed kites occur in open grasslands with scattered trees for nesting and perching. Often found along tree-lined river valleys with adjacent open areas.	**Low.** Suitable foraging habitat is present in the vicinity of the project. However, suitable nesting substrate is limited in the vicinity of the project and may therefore limit the potential for nesting in proximity of the project. Though no impacts or modifications to potential habitat will occur, there is a potential that project may impact the species through temporary disturbance from project-associated noise or potential collisions with motor vehicles.	-Information on the ecology and laws regarding nesting birds will be provided in Environmental Awareness Training to work crews. -Nesting bird surveys are required if work is to occur within the breeding season (February 15 to August 31). -If nesting birds are detected then work will stop immediately and PG&E project biologist is contacted. Work will resume when appropriate buffers are in place. -To avoid collisions with motor vehicles a speed limit of 15 mph will be maintained on project access roads.
Loggerhead shrike (*Lanius ludovicianus*)	SSC	Loggerhead shrikes occur in grasslands and open areas with scattered trees, tall shrubs, fence posts, utility wires, or other perches from which they hunt. They nest in dense, thorny trees, shrubs, or brush piles in areas that are well-hidden.	**Low.** Suitable foraging habitat is present in the project area. However, suitable nesting substrate is limited in the vicinity of the project and may therefore limit the potential for nesting in proximity of the project. Though no impacts or modifications to potential habitat will occur, there is a potential that project may impact the species through temporary disturbance from project-associated noise or potential collisions with motor vehicles.	-Information on the ecology and laws regarding nesting birds will be provided in Environmental Awareness Training to work crews. -Nesting bird surveys are required if work is to occur within the breeding season (February 15 to August 31). -If nesting birds are detected then work will stop immediately and PG&E project biologist is contacted. Work will resume when appropriate buffers are in place. -To avoid collisions with motor vehicles a speed limit of 15 mph will be maintained on project access roads.
Bank swallow (*Riparia riparia*)	ST	Nests in colonies in vertical banks with friable soils. Forages over meadows and water.	**None.** Suitable nesting habitat (vertical banks with friable soils) is not present in the project area. Open water and meadows are limited in the vicinity of the project.	No AMMs required.

Species Name	Listing Status*	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Class Aves Other migratory bird species (nesting)	MBTA	Nests in a variety of habitats. Almost all nesting bird are covered under the Migratory Bird Treaty Act.	**Low.** Suitable foraging habitat is present in the vicinity of the project. However, suitable nesting habitat is limited in the vicinity of the project and may therefore limit the potential for nesting in proximity of the project. Though no impacts or modifications to potential habitat will occur, there is a potential that project may impact the species through temporary disturbance from project-associated noise or potential collisions with motor vehicles.	-Information on the ecology and laws regarding nesting birds will be provided in Environmental Awareness Training to work crews. -Nesting bird surveys are required if work is to occur within the breeding season (February 15 to August 31). -If nesting birds are detected then work will stop immediately and PG&E project biologist is contacted. Work will resume when appropriate buffers are in place. -To avoid collisions with motor vehicles a speed limit of 15 mph will be maintained on project access roads.
Mammals				
Pallid bat (*Antrozous pallidus*)	SSC	Occurs in a wide variety of habitats, including grasslands, shrublands, woodlands, and forests from sea level through mixed conifer forests. Most common in open, dry habitats with rocky areas for roosting. Day roosts are in caves, crevices, mines, and occasionally in hollow trees and buildings. Forages in flight or on the ground.	**None.** Suitable habitat (open, dry, and rocky with caves, crevices, mines, or hollow trees) is not present in the project area.	No AMMs required.
Western red bat (*Lasiurus blossevellii*)	SSC	Roosts in forests and woodlands near streams, fields, and urban areas. Winters in western lowlands and coastal regions south of San Francisco Bay. Feeds over grasslands, shrublands, open woodlands and forests, and croplands.	**None.** Suitable foraging habitat is present in the project area. However, suitable roosting substrate is limited in the vicinity of the project. No impacts or modifications to potential habitat are anticipated to result from the project.	No AMMs required.

Species Name	Listing Status*	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
American badger (*Taxidea taxus*)	SSC	Occurs in open stages of shrub, forest, and herbaceous habitats; needs uncultivated ground with friable soils.	**None.** Suitable habitat (uncultivated ground with friable soils) is not present in the project area.	No AMMs required.

***Listing Status**

Federal:

FE: Federally Endangered

FT: Federally Threatened

PT: Proposed Threatened

CH: Critical Habitat Designated

FC: Federal Candidate for Listing

California:

SE: State Endangered

ST: State Threatened

CDFG:

SSC: Species of Special Concern

FP: Fully-protected

CNPS:

1B.1: Seriously rare, threatened, or endangered in CA and elsewhere

1B.2: Fairly rare, threatened, or endangered in CA and elsewhere

2.1: Rare, threatened, or endangered in CA, but more common elsewhere

4.1. Special-status Species and Potential Impacts

Of the 37special-status species identified during the desktop review, based on habitat suitability and conditions of the project area and surrounding vicinity, seven were determined to have potential to occur in the project area. These include tricolored blackbird, burrowing owl, Swainson's hawk, mountain plover, white-tailed kite, and loggerhead shrike. Habitat requirements and potential for these species to occur in the project area are discussed below.

Though it was determined that the project is not likely to impact giant garter snake (GGS) (*Thamnophis gigas*), there are occurrence records of the species in the Colusa Basin Drainage Canal approximately 1.8 mile north of the project area and suitable aquatic habitat is present approximately 1100 feet north of the project. Further discussion of the species' habitat requirements and rationale for its lack of occurrence and project-related impacts are provided below.

4.1.1. Giant Garter Snake

The GGS is a highly aquatic snake found in sloughs, marshes, ponds, low-gradient streams, rice fields, irrigation canals, drainages and surrounding uplands (USFWS 1993). Basic habitat requirements include the following:

1. Sufficient water during the active summer season to supply cover and prey items such as small fish and amphibians;

2. Emergent, herbaceous aquatic vegetation accompanied by vegetated banks to provide basking and foraging habitat;

3. Bankside burrows, holes and crevices to provide short-term aestivation sites;

4. High ground or upland habitat above the annual high water mark to provide cover and refuges from floodwaters during the dormant winter season.

Burrows and other underground refuge are important to GGS during summer and winter to escape unfavorable winter cold temperatures or excessive summer heat. The GGS recovery plan states that wintering habitat can be up to 250 meters (820 feet) from the edge of marsh habitat (Miller et al. 1999). Typically, the USFWS defines upland as 218 linear feet of bankside habitat, which incorporates adjacent uplands to a width of 200 feet from the edge of bank (White 1997). Based on these habitat descriptions, the highest potential for adverse impacts on GGS exists within 200 feet of aquatic habitat, with decreasing likelihood of adverse impacts to wintering habitat out to 820 feet from suitable aquatic habitat.

The irrigation canal, rice fields, and associated uplands north of the project area provide suitable habitat for GGS (Swaim 2012). The nearest known GGS population is located in the Colusa Basin Drainage Canal, approximately 1.8-mile north of the project. The rice fields and irrigation canal near the project area are directly connected to the Colusa Basin Drainage Canal through a series of wetlands, ditches, and canals within the Roosevelt Ranch property. During field visits, bullfrogs and other small prey items that would provide a suitable prey base for GGS were observed in the irrigation canal and adjacent rice fields (Swaim 2012). Therefore, there is potential for the species to occur in these aquatic habitats, the nearest of which is approximately 1100 feet north of the project.

Upland habitat for GGS in the project area is poor due to agricultural activities including disking, tilling, and cultivation of crops. Additionally, no burrows, other refugia, or ground squirrel activity were observed in the project area during field surveys. Based on the distance from suitable aquatic habitat (greater than 820 feet), the lack of burrows or other refugia, and the lack of ground squirrel or other small

mammal activity near the project, there is no suitable habitat for GGS in the project area and all construction activities would take place outside of any potential wintering habitat (refer to Appendix C, Giant Garter Snake Habitat Assessment, for further discussion).

4.1.2. Tricolored Blackbird

The tricolored blackbird breeds in colonies near fresh water, preferably in emergent wetland with tall, dense cattails or tules, but also in thickets of willow, blackberry, wild rose, or tall herbs. Typical nesting colonies support 50 or more nesting pairs. Nests are usually located a few feet above or near fresh water, but may also be hidden on the ground among low vegetation, and are typically built of mud and plant materials. Tricolored blackbirds forage over grasslands and in cropland habitats.

Emergent wetland vegetation is not present in the project area, and thus nesting of the species is not likely to occur, though croplands and grasslands in and adjacent to the project may provide suitable foraging habitat. Emergent wetland vegetation in irrigation canals and the lake near the project may support nesting colonies, though no records of nesting colonies are present in the CNDDB within 5 miles of the project. Construction activities could have adverse impacts on nesting success for this species if nesting occurs during construction, which could constitute 'take' under the CESA and MBTA. Because project construction will take place in an agricultural field, no physical disturbance to potential nesting habitat for tricolored blackbird is expected. The project could result in temporary loss of foraging habitat for the species, though the presence of extensive high-quality foraging habitat in the vicinity of the project makes it unlikely that construction activities would have any impact on foraging success. If work occurs during the nesting season (February 15–August 31), nesting bird surveys are recommended 72 hours prior to the start of construction to determine if active nests are present in the area. If nesting activity or active nests are observed anytime during project activities, work will be halted until the PG&E Biologist or Land Planner contacts the USFWS and CDFG biologists to discuss suitable AMMs, which could include avoidance buffers, monitoring of the nest until young have fledged, or additional surveys.

4.1.3. Burrowing Owl

The burrowing owl is primarily a grassland species, but occurs in areas that are frequently disturbed by human activity such as agriculture and urban development. In agricultural areas, burrowing owls typically utilize burrows along roadsides and along water conveyances near areas of sparse, short vegetation (Shuford, et al. 2008). Burrows utilized by the species are typically dug by the California ground squirrel (*Otospermophilus beecheyi*), though dens of other species (e.g., badger, fox) may also be occupied. Burrowing owls forage on insects, small rodents, birds, amphibians, reptiles, and carrion.

Small mammal burrows were not observed in the project area, though weeds and grasses between CR 12 and the fallow field limited visibility in this area. Small mammal burrows were observed along dirt roads and in canal levees on the Roosevelt Ranch north and east of the project area that may support burrowing owl, though no sign of the species was observed (white wash, pellets, feathers, etc.). Further, the field where the project will be constructed is regularly disked, plowed, planted, and harvested during agricultural operations and therefore is unlikely to provide suitable burrow habitat for the species. Foraging opportunities in the vicinity of the project are also limited due to intensive agricultural operations. There is low potential for the burrowing owl to occur in the project area and low potential for the project to impact the species. AMMs such as environmental training, following speed limits of 15 miles per hour (mph), nesting bird surveys, and pre-construction surveys to determine if owls are present in the project vicinity will reduce potential for impacts to burrowing owl. If nesting activity or active nests are observed any time during the project, construction activities will be halted until the PG&E Biologist or Land Planner contacts USFWS and CDFG biologists to discuss suitable AMMs, which could include avoidance buffers, monitoring of the nest until young have fledged, or additional surveys.

4.1.4. Swainson's Hawk

The Swainson's hawk inhabits a wide range of open habitats that include suitable nest trees in proximity of high-quality foraging opportunities. Nest trees are often in riparian forest adjacent to agricultural lands, and include willow (*Salix* spp.), Fremont cottonwood (*Populus fremontia*), valley oak (*Quercus lobata*), sycamore (*Plantanus racemosa*), walnut (*Juglans* spp.), eucalyptus (*Eucalyptus* spp.), and pine (*Pinus* spp.). Nests are large, are typically made of sticks and vegetation, and are usually constructed in the upper portions of the tree canopy. Foraging habitat includes ruderal fields, fallow fields, or low-growing grain crops, alfalfa, or safflower fields that support populations of prey including small mammals, birds, toads, crayfish, and insects.

Nesting trees are limited in the immediate vicinity of the project due to vast expanses of agricultural and fallow fields. Suitable nesting habitat in the vicinity of the project includes landscaped trees at farm residences, isolated oak trees at the margins of agricultural fields along CR 12, and riparian trees along irrigation ditches and bordering the man-made lake on Roosevelt Ranch. A Swainson's hawk was observed in a willow tree near an irrigation ditch approximately 0.65-mile northeast of the project during the field surveys, and two CNDDB records exist approximately 0.7-mile south and southwest of the project area. No remnant stick nests were observed within 0.5-mile of the project during the surveys. High-quality foraging habitat is present in the project vicinity in the form of ruderal, fallow, and row crop fields.

Noise generated by construction of the access road and well pad, exploration drilling, site restoration, and other construction activities could adversely affect this species if active nests are located within 0.5 mile, which could constitute 'take' under the CESA and MBTA. To avoid delays in the project it is recommended that work start outside of the nesting season (March 1-July 31) of Swainson's hawk. If work during nesting season cannot be avoided, protocol-level surveys for Swainson's hawk are recommended. If active nests are detected within 0.5 mile of project activities, construction activity should halt until the PG&E Biologist or Land Planner contacts the USFWS and CDFG to discuss suitable AMMs, which could include avoidance buffers, monitoring of the nest until young have fledged, or additional surveys.

4.1.5. Mountain Plover

The mountain plover is a winter migrant in California (typically September through mid-March), and is not known to nest in the project area. Wintering habitat consists of short-grass prairies or fallow, grazed, or burned fields that are flat and nearly devoid of vegetation.

The project area was within a fallow field that had been recently disked, was flat, and was nearly devoid of vegetation during the surveys. This habitat provides suitable roosting and foraging habitat for the mountain plover. Because the species is a winter migrant to the project area and does not breed in California, project activities will not impact the species' nesting phase. Construction of the well pad and access road will result in a loss of approximately 0.8-acre of wintering habitat. If the landowner elects to keep the well pad for agricultural storage or other use, this impact would be permanent. AMMs such as environmental training, maintaining speed limits of 15 mph on access roads, and pre-construction surveys will reduce potential for impacts to mountain plover. If nesting activity or active nests are observed any time during the project, construction activities will be halted until the PG&E Biologist or Land Planner contacts USFWS and CDFG biologists to discuss suitable AMMs, which could include avoidance buffers, monitoring of the nest until young have fledged, or additional surveys.

4.1.6. White-tailed Kite

The white-tailed kite is a yearlong resident of coastal and valley lowlands, often near agricultural areas where a suitable prey base (small mammals, birds, insects, reptiles, and amphibians) is present. White-tailed kites forage in open grasslands, meadows, agricultural lands and emergent wetlands, and breed in nearby trees in nests made of loosely piled sticks, twigs, and grasses.

Nesting trees are limited in the immediate vicinity of the project due to vast expanses of agricultural and fallow fields. Suitable nesting habitat in the vicinity of the project includes landscaped trees at farm residences, isolated oak trees at the margins of agricultural fields along CR 12, and riparian trees along irrigation ditches and near the man-made lake on Roosevelt Ranch. No remnant stick nests were observed in proximity of the project during surveys. High-quality foraging habitat is present in the project vicinity in the form of ruderal, fallow, and row crop fields and grasslands.

Construction activities could have adverse impacts on nesting success for this species depending on project timing which could constitute 'take' under the CESA and MBTA. Because project construction will take place in an agricultural field, no physical disturbance to potential nesting habitat for white-tailed kite is expected. The project could result in temporary loss of foraging habitat for the species, though the presence of extensive high-quality foraging habitat in the vicinity of the project makes it unlikely that construction activities would have any impact on foraging success. AMMs such as environmental training, following speed limits of 15 mph, and pre-construction nesting bird surveys will reduce potential for impacts to white-tailed kite. If nesting activity or active nests are observed any time during the project, construction activities will be halted until the PG&E Biologist or Land Planner contacts USFWS and CDFG biologists to discuss suitable AMMs, which could include avoidance buffers, monitoring of the nest until young have fledged, or additional surveys.

4.1.7. Loggerhead Shrike

The loggerhead shrike is a common resident and winter visitor in foothills and lowlands throughout California. The species frequents open habitats with scattered posts, fences, trees, shrubs, utility lines, or other perches from which they hunt. Prey consists predominantly of large insects, though small birds, mammals, amphibians, reptiles, fish, carrion, and various other invertebrates are also taken. While the species lacks talons, they are considered birds of prey that often utilize thorns, sharp twigs, or barbed wire to impale food items. Nests are constructed on stable branches in densely-foliaged shrubs or trees that are usually well-concealed.

Suitable nesting substrate is limited in the vicinity of the project due to vast expanses of open agricultural and fallow fields, and consists mainly of landscaped shrubs at area residences and dense vegetation near the irrigation ditches and man-made lake on Roosevelt Ranch. High-quality foraging habitat with adjacent fence posts, barbed wire, and utility lines is present in the project area and in the vicinity of the project. Therefore, the loggerhead shrike is unlikely to nest but may forage in the project area.

Construction activities could have adverse impacts similar to those described above for the white-tailed kite, including disturbance of nesting activities and temporary loss of foraging habitat. AMMs such as environmental training, following speed limits of 15 mph, and pre-construction nesting bird surveys will reduce potential for impacts to loggerhead shrike. If nesting activity or active nests are observed any time during the project, construction activities will be halted until the PG&E Biologist or Land Planner contacts USFWS and CDFG biologists to discuss suitable AMMs, which could include avoidance buffers, monitoring of the nest until young have fledged, or additional surveys.

4.1.8. Nesting Migratory Passerine Birds and Raptors

Nests of migratory birds are protected under the MBTA and California Fish and Game Code. Emergent wetland vegetation and trees along irrigation canals and the man-made lake north and east of the project, landscaped trees and shrubs at area residences, isolated oak trees along CR 12, and electric distribution line poles in the vicinity of the project have the potential to provide nesting substrates, though no nests were observed within 0.5 mile of the project during habitat assessment surveys. Avian species may nest in the vicinity of the project during the nesting season (February 15–August 31), though most of the suitable nesting habitat is outside of typical construction nesting buffers (0.5 mile for Swainson's hawk, 300 feet for other raptor species, and 50 feet for passerine species). Nesting activity is unlikely to occur outside of the nesting season, though some avian species may forage year-round in the vicinity of the project.

Construction activities could have adverse impacts on nesting success for bird species depending on project timing which could constitute 'take' under the MBTA. The project could result in temporary loss of foraging habitat for the species, though the presence of extensive high-quality foraging habitat in the vicinity of the project makes it unlikely that construction activities would have any impact on foraging success. If work occurs during the nesting season (February 15–August 31), nesting bird surveys are recommended 72 hours prior to the start of construction to determine if active nests are present in the area. If nesting activity or active nests are observed any time during the project, construction activities will be halted until the PG&E Biologist or Land Planner contacts USFWS and CDFG biologists to discuss suitable AMMs, which could include avoidance buffers, monitoring of the nest until young have fledged, or additional surveys.

4.1.9. Wetlands and Waters

The project will not require dredge or fill of any wetland or water features that could be considered jurisdictional by the USACE, the CDFG, or the California Regional Water Quality Control Board. As such, no permitting for impacts to jurisdictional wetland features is anticipated to be required for construction of the project.

5. AVOIDANCE AND MINIMIZATION MEASURES

The following AMMs are recommended to minimize potential impacts to special-status species or sensitive biological resources, to ensure compliance with applicable natural resource regulations, and to demonstrate PG&E's commitment to environmental stewardship.

1. Prior to working on-site, all workers shall be provided with Environmental Awareness Training by a qualified biologist approved by USFWS and CDFG. The training shall address the identification and general ecology of GGS, Swainson's hawk, nesting birds and other special-status species that have potential to occur in the project area, and the AMMs to be implemented in order to avoid impacts on these resources. Areas to be avoided shall also be addressed in the training. Please contact project biologist, Catalina Reyes (925-808-8811) two weeks prior to construction to schedule the training.

2. Prior to construction, all work areas (e.g., vehicle access, parking, staging) needed to complete the project shall be identified in coordination with the on-site biologist. All work areas shall be limited to the minimum area necessary to complete work.

3. If practicable, ground disturbing activity (e.g. vegetation removal, compaction, and placement of gravel fill) at the well pad site shall be conducted during the active season for GGS (i.e., between May 1 and October 1). Additionally, all work shall be conducted at least 250 meters (820 feet) from GGS aquatic habitat to minimize potential impacts to GGS wintering habitat.

4. A qualified biologist shall perform a general pre-construction survey within 72 hours of the start of project construction. Please contact PG&E Biologist Catalina Reyes (925-808-8811) two weeks prior to construction to schedule surveys.

5. Any and all potential nesting substrate (e.g., shrubs and trees) that requires removal to construct the project should be removed before the onset of the nesting season (i.e., prior to February 15), if feasible. This will help preclude nesting and substantially decrease the likelihood of direct impacts on nesting birds. If this is not feasible then a nesting bird survey of potential nesting substrate will be performed 72 hours prior to its removal.

6. Surveys for nesting raptors and migratory birds (including Swainson's hawk) shall be required if project construction is to occur during the nesting season (February 15–August 31; March 1-July 31 for Swainson's hawk).

   Surveys for Swainson's hawk shall follow the California Department of Fish and Game protocol developed by the Swainson's Hawk Technical Advisory Committee (see Appendix D).

   Surveys for other nesting birds shall consist of performing an initial survey after February 15 or 1 month prior to the start of construction if the project is to begin later in the nesting bird season. A second nesting bird survey shall be performed within 72 hours of the start of construction. The surveys shall be repeated if work is suspended for five (5) or more consecutive days. Please contact PG&E Biologist Catalina Reyes (925-808-8811) two weeks prior to construction to schedule surveys.

   If active nesting activity or active nests are observed in the vicinity of the project anytime during project activities, construction activities will be halted until the PG&E Biologist or Land Planner contacts the USFWS and CDFG biologists to discuss suitable AMMs, which could include avoidance buffers, monitoring of the nest until young have fledged, or additional surveys.

7. Access to the well pad shall be confined to existing roads, road shoulders, and other compacted areas such as access roads included in the project. Travel along access roads shall be restricted to the centerline.

8. To ensure that wildlife does not become trapped or entangled, no wattles with plastic monofilament netting are permitted. Burlap or coconut wattles are appropriate substitutes.

9. Escape ramps at a 45 degree angle or less shall be provided for any excavations that are greater than one foot deep that are left open overnight. Smaller holes shall be covered so that no gaps occur and shall be inspected each morning and prior to backfilling for wildlife. If special-status wildlife becomes entrapped, work shall stop and PG&E Project Biologist Catalina Reyes (925-808-8811) shall be notified immediately to determine next steps.

10. All construction personnel shall visually check for wildlife under vehicles and equipment prior to moving them.

11. Construction equipment shall be maintained to prevent leaks of fuels, lubricants or other pollutants.

12. Whenever possible, refueling and maintenance of vehicles shall occur offsite. In cases when this is not possible refueling and maintenance of vehicles and equipment shall be conducted over drip pans and at least 100 feet from any waterway.

13. Open ends of pipes, conduits or other materials stored onsite shall be covered to exclude wildlife and shall be inspected prior to use.

14. Vehicular speed within the project area shall be limited to 15 miles per hour (mph) in order avoid impacts to wildlife that may be located on or near roadways.

15. Watering of roads during dry season work shall be performed as necessary (approximately 3– 4 times per day) in order to reduce potential dust resulting from project-associated traffic.

16. Caution shall be used when handling and/or storing chemicals (fuel, hydraulic fluid, etc.). As part of standard PG&E Best Management Practices (BMPs), crews shall have appropriate materials on site to provide secondary containment and prevent and manage spills. If groundwater is encountered, crews shall contact PG&E Environmental Specialist Bryon Nicholson (415-990-0139).

17. Crews shall implement all standard PG&E BMPs outlined in the Good Housekeeping Activity Specific Erosion and Sediment Control Plan (January 2011) as needed.

18. If the scope of work or project location changes, crews shall contact project biologist Catalina Reyes (925-808-8811) as soon as possible and prior to commencing work. The project biologist or Land Planner (Ernie Ralston, 415-973-3215) shall contact the USFWS and CDFG upon notice of any such changes.

19. Construction-related trash shall be removed from the site daily and upon work completion and the project area shall be returned to near pre-construction contours and conditions upon project completion.

6. REFERENCES

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Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo Counties, California, edited by A. Champ. Sacramento, California: Sacramento Fish and Wildlife Office.

APPENDIX A:
Figures

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Figure 1: Project Location and Vicinity

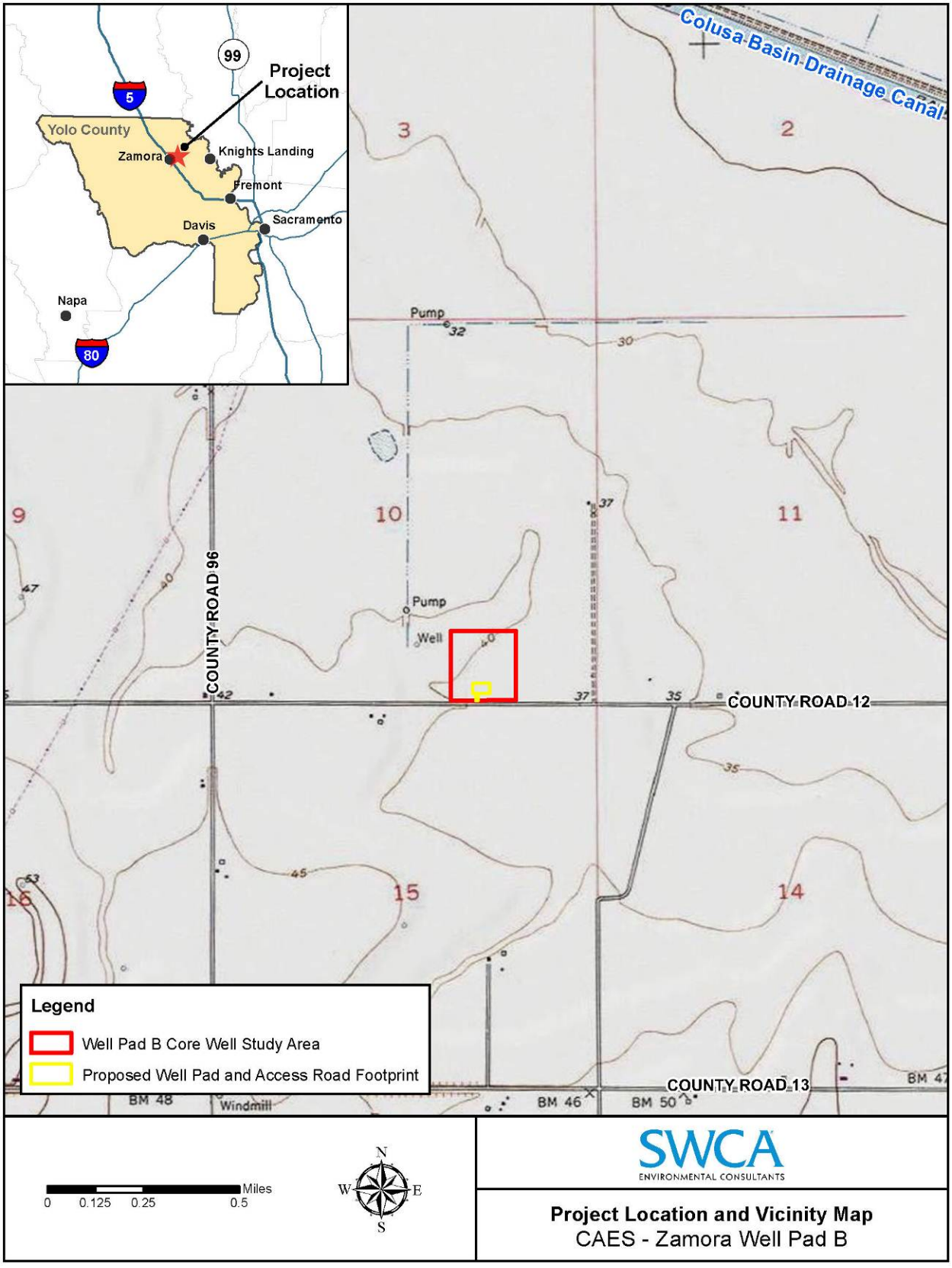


Figure 2: Project Area



Figure 3: Habitat Types

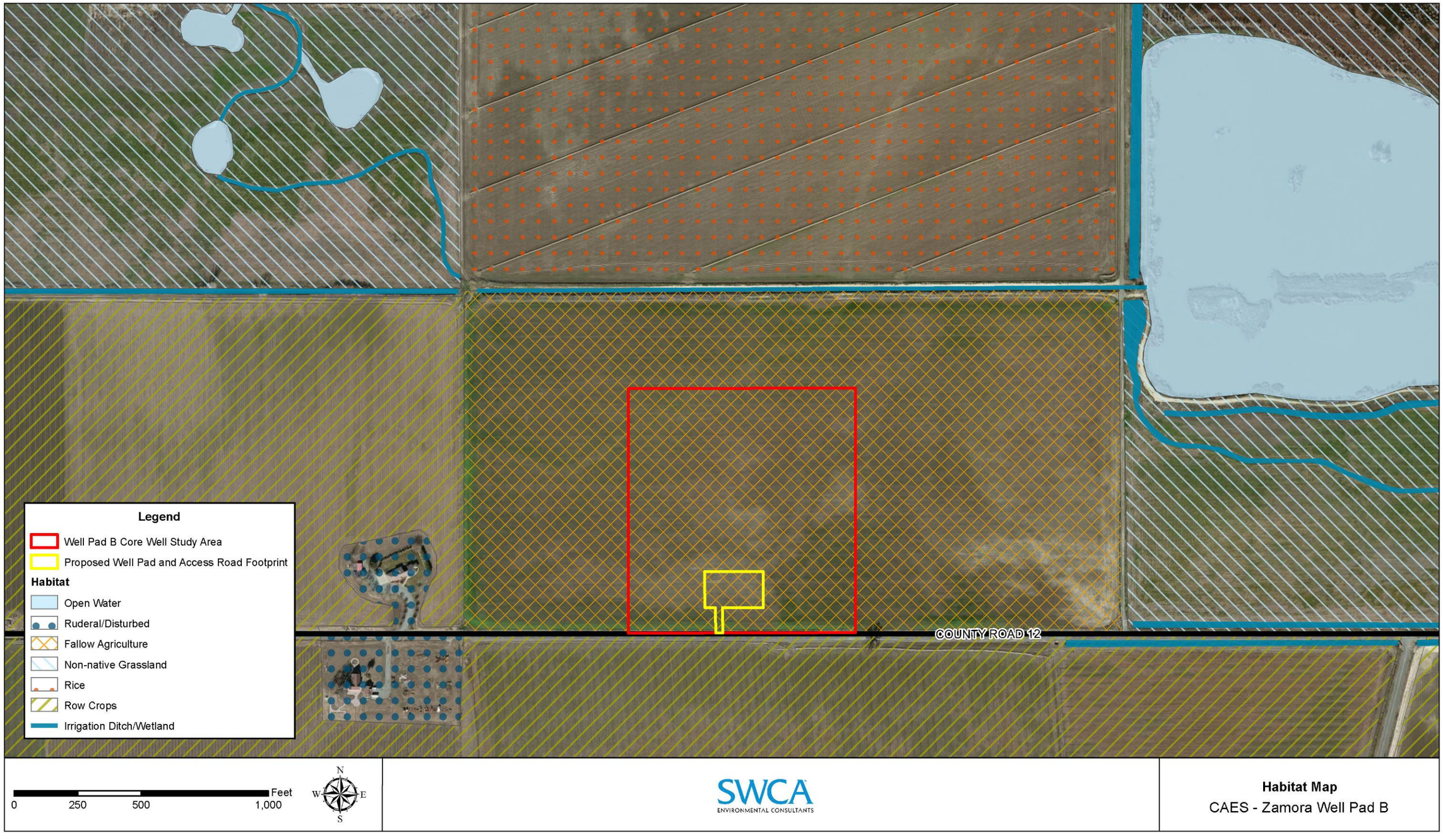
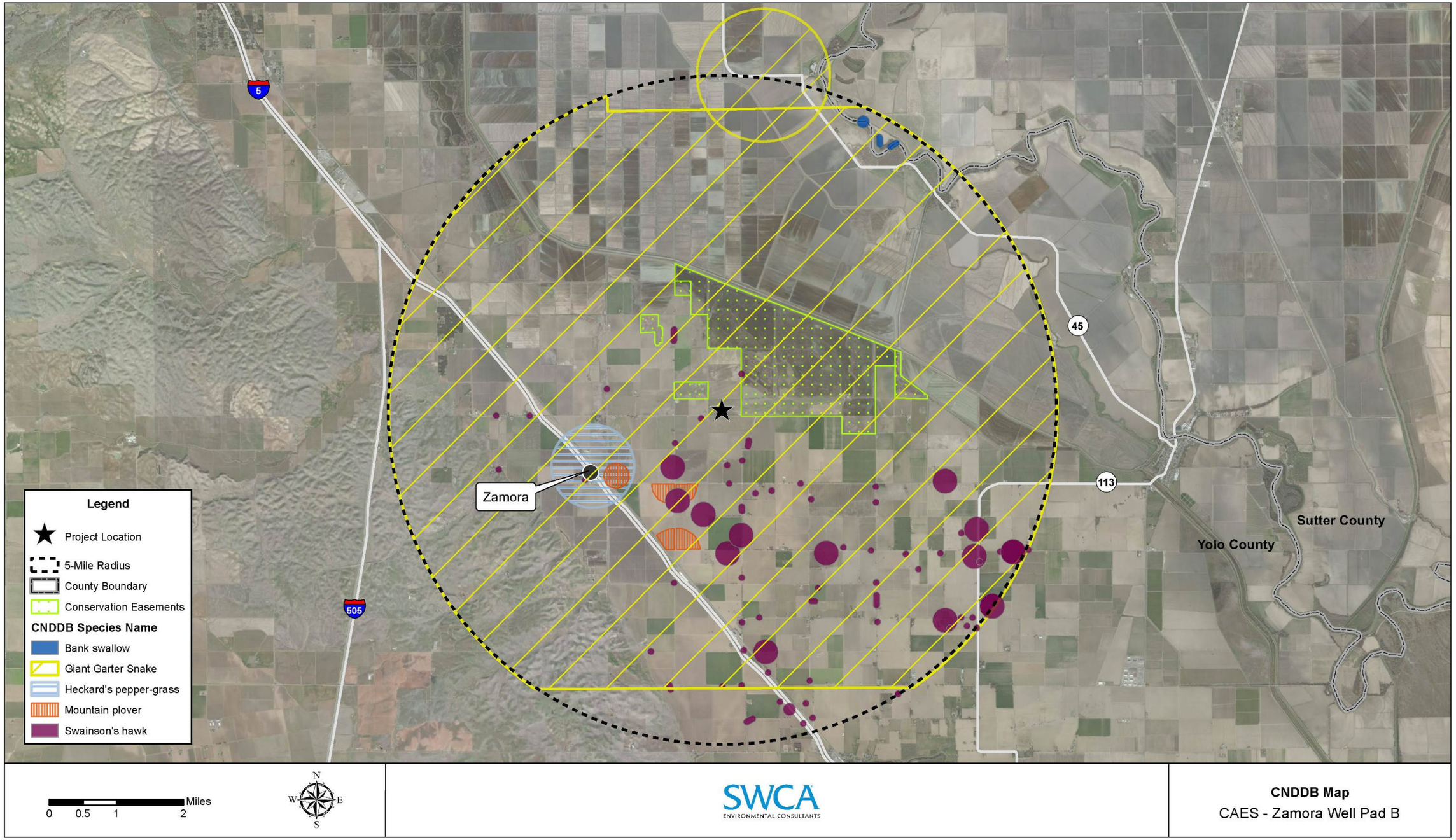


Figure 4: CNDDB Map



APPENDIX B:
Species Lists

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CDFG Zamora
Natural Diversity Database
CNDDB Wide Tabular Report

Name (Scientific/Common)	CNDDB Ranks	Other Lists	Listing Status	Total EO's	Element Occ Ranks						Population Status		Presence		
					A	B	C	D	X	U	Historic >20 yr	Recent <=20 yr	Pres. Extant	Poss. Extirp.	Extirp.
Agelaius tricolor tricolored blackbird	G2G3 S2	CDFG: SC	Fed: None Cal None	428 S:13	1	0	0	0	8	4	11	2	5	3	5
Ambystoma californiense California tiger salamander	G2G3 S2S3	CDFG: SC	Fed: Threatened Cal Threatened	1057 S:1	0	0	0	0	1	0	1	0	0	0	1
Antrozous pallidus pallid bat	G5 S3	CDFG: SC	Fed: None Cal None	402 S:1	0	0	0	0	0	1	1	0	1	0	0
Ardea alba great egret	G5 S4	CDFG:	Fed: None Cal None	35 S:1	1	0	0	0	0	0	1	0	1	0	0
Ardea herodias great blue heron	G5 S4	CDFG:	Fed: None Cal None	132 S:1	1	0	0	0	0	0	1	0	1	0	0
Astragalus tener var. ferrisiae Ferris' milk-vetch	G1T1 S1	CNPS: 1B.1	Fed: None Cal None	16 S:2	0	0	0	0	2	0	2	0	0	2	0
Astragalus tener var. tener alkali milk-vetch	G2T2 S2	CNPS: 1B.2	Fed: None Cal None	65 S:2	0	0	1	1	0	0	0	2	2	0	0
Athene cunicularia burrowing owl	G4 S2	CDFG: SC	Fed: None Cal None	1808 S:3	0	3	0	0	0	0	0	3	3	0	0
Atriplex depressa brittlescale	G2Q S2.2	CNPS: 1B.2	Fed: None Cal None	59 S:4	0	1	0	0	0	3	2	2	4	0	0
Atriplex joaquinana San Joaquin spearscale	G2 S2	CNPS: 1B.2	Fed: None Cal None	107 S:5	0	1	2	0	0	2	2	3	5	0	0
Buteo swainsoni Swainson's hawk	G5 S2	CDFG:	Fed: None Cal Threatened	1747 S:232	18	95	25	4	4	86	76	156	227	4	1
California macrophylla round-leaved filaree	G2 S2	CNPS: 1B.1	Fed: None Cal None	141 S:1	0	0	0	0	0	1	1	0	1	0	0
Charadrius alexandrinus nivosus western snowy plover	G4T3 S2	CDFG: SC	Fed: Threatened Cal None	116 S:1	0	0	0	0	0	1	1	0	1	0	0
Charadrius montanus mountain plover	G2 S2?	CDFG: SC	Fed: Proposed Threatened Cal None	88 S:11	2	4	1	0	1	3	1	10	10	1	0
Chloropyron palmatum palmate-bracted bird's-beak	G1 S1	CNPS: 1B.1	Fed: Endangered Cal Endangered	26 S:4	0	0	1	0	2	1	2	2	2	1	1

Name (Scientific/Common)	CNDDB Ranks	Other Lists	Listing Status	Total EO's	Element Occ Ranks A	B	C	D	X	U	Population Status Historic >20 yr	Recent <=20 yr	Presence Pres. Extant	Poss. Extirp.	Extirp.
Cicindela hirticollis abrupta Sacramento Valley tiger beetle	G5TH SH	CDFG:	Fed: None Cal None	5 S:1	0	0	0	0	1	0	1	0	0	1	0
Coastal and Valley Freshwater Marsh	G3 S2.1		Fed: None Cal None	60 S:1	0	0	0	0	0	1	1	0	1	0	0
Desmocerus californicus dimorphus valley elderberry longhorn beetle	G3T2 S2	CDFG:	Fed: Threatened Cal None	201 S:2	0	0	1	0	0	1	2	0	2	0	0
Falco columbarius merlin	G5 S3	CDFG:	Fed: None Cal None	31 S:1	0	1	0	0	0	0	0	1	1	0	0
Great Valley Mixed Riparian Forest	G2 S2.2		Fed: None Cal None	68 S:5	3	1	1	0	0	0	5	0	5	0	0
Hibiscus lasiocarpos var. occidentalis woolly rose-mallow	G4 S2.2	CNPS: 1B.2	Fed: None Cal None	170 S:2	0	0	0	0	0	2	2	0	2	0	0
Lasionycteris noctivagans silver-haired bat	G5 S3S4	CDFG:	Fed: None Cal None	138 S:1	0	0	0	0	0	1	1	0	1	0	0
Lasiurus blossevillii western red bat	G5 S3?	CDFG: SC	Fed: None Cal None	119 S:1	0	0	0	0	0	1	0	1	1	0	0
Lasiurus cinereus hoary bat	G5 S4?	CDFG:	Fed: None Cal None	235 S:2	0	0	0	0	0	2	1	1	2	0	0
Lasthenia glabrata ssp. coulteri Coulter's goldfields	G4T3 S2.1	CNPS: 1B.1	Fed: None Cal None	87 S:1	0	0	0	0	1	0	1	0	0	1	0
Layia septentrionalis Colusa layia	G2 S2.2	CNPS: 1B.2	Fed: None Cal None	46 S:1	0	0	0	0	0	1	1	0	1	0	0
Lepidium latipes var. heckardii Heckard's pepper-grass	G4T1 S1.2	CNPS: 1B.2	Fed: None Cal None	14 S:4	0	3	0	0	0	1	1	3	4	0	0
Navarretia leucocephala ssp. bakeri Baker's navarretia	G4T2 S2	CNPS: 1B.1	Fed: None Cal None	49 S:1	0	0	0	0	0	1	1	0	1	0	0
Nycticorax nycticorax black-crowned night heron	G5 S3	CDFG:	Fed: None Cal None	25 S:1	0	0	1	0	0	0	0	1	1	0	0
Plegadis chihi white-faced ibis	G5 S1	CDFG:	Fed: None Cal None	20 S:1	0	1	0	0	0	0	1	0	1	0	0

Name (Scientific/Common)	CNDDB Ranks	Other Lists	Listing Status	Total EO's	Element Occ Ranks						Population Status		Presence		
					A	B	C	D	X	U	Historic >20 yr	Recent <=20 yr	Pres. Extant	Poss. Extirp.	Extirp.
Pogonichthys macrolepidotus Sacramento splittail	G2 S2	CDFG: SC	Fed: None Cal:None	15 S:1	0	1	0	0	0	0	0	1	1	0	0
Riparia riparia bank swallow	G5 S2S3	CDFG:	Fed: None Cal:Threatened	268 S:16	0	2	0	0	0	14	6	10	16	0	0
Taxidea taxus American badger	G5 S4	CDFG: SC	Fed: None Cal:None	454 S:1	0	0	0	0	0	1	1	0	1	0	0
Thamnophis gigas giant garter snake	G2G3 S2S3	CDFG:	Fed: Threatened Cal:Threatened	268 S:34	0	23	0	0	0	11	7	27	34	0	0
Trichocoronis wrightii var. wrightii Wright's trichocoronis	G4T3 S1.1	CNPS: 2.1	Fed: None Cal:None	9 S:2	0	0	0	0	1	1	2	0	1	1	0
Trifolium hydrophilum saline clover	G2 S2	CNPS: 1B.2	Fed: None Cal:None	44 S:1	0	0	1	0	0	0	0	1	1	0	0
Valley Oak Woodland	G3 S2.1		Fed: None Cal:None	91 S:1	0	0	0	0	0	1	1	0	1	0	0

U.S. Fish & Wildlife Service
Sacramento Fish & Wildlife Office
Federal Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 121016114039

Database Last Updated: September 18, 2011

Quad Lists

Listed Species

Invertebrates

Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Lepidurus packardi
vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
Critical habitat, winter-run chinook salmon (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)

Rana draytonii
California red-legged frog (T)

Reptiles

Thamnophis gigas
giant garter snake (T)

Candidate Species

Birds

Coccyzus americanus occidentalis
Western yellow-billed cuckoo (C)

Quads Containing Listed, Proposed or Candidate Species:

ELDORADO BEND (530D)

County Lists

Yolo County

Listed Species

Invertebrates

Branchinecta conservatio
Conservancy fairy shrimp (E)

Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Elaphrus viridis
delta green ground beetle (T)

Lepidurus packardi
Critical habitat, vernal pool tadpole shrimp (X)
vernal pool tadpole shrimp (E)

Syncaris pacifica
California freshwater shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
Critical habitat, delta smelt (X)
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
Critical habitat, winter-run chinook salmon (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)
Critical habitat, CA tiger salamander, central population (X)

Rana draytonii
California red-legged frog (T)

Reptiles

Thamnophis gigas
giant garter snake (T)

Birds

Charadrius alexandrinus nivosus
western snowy plover (T)

Strix occidentalis caurina
northern spotted owl (T)

Vireo bellii pusillus
Least Bell's vireo (E)

Plants

Cordylanthus palmatus
palmate-bracted bird's-beak (E)

Neostapfia colusana
Colusa grass (T)
Critical habitat, Colusa grass (X)

Sidalcea keckii
Keck's checker-mallow (=checkerbloom) (E)

Tuctoria mucronata
Critical habitat, Solano grass (=Crampton's tuctoria) (X)
Solano grass (=Crampton's tuctoria) (E)

Candidate Species

Birds

Coccyzus americanus occidentalis
Western yellow-billed cuckoo (C)

Key:

(E) *Endangered* - Listed as being in danger of extinction.
(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.
(P) *Proposed* - Officially proposed in the Federal Register for listing as endangered or threatened.
(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.
(C) *Candidate* - Candidate to become a proposed species.
(V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.
(X) *Critical Habitat* designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, **or may be affected by** projects within the quads covered by the list.

within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list. See our Protocol and Recovery Permits pages.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

> Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.

  During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.

- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.

  Should your survey determine that federally listed or proposed species occur in the area and are

  likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our Map Room page.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6520.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be January 14, 2013.

CNPS Inventory of Rare and Endangered Plants

Status: Plant Press Manager window with 11 items - Mon, Jul. 30, 2012 13:19 c

Reformat list as: Standard List - with Plant Press controls

ECOLOGICAL REPORT

scientific	family	life form	blooming	communities	elevation	CNPS
Astragalus tener var. ferrisiae	Fabaceae	annual herb	Apr-May	•Meadows and seeps (Medws) (vernally mesic) •Valley and foothill grassland (VFGrs)(subalkaline flats)	2 - 75 meters	List 1B.1
Astragalus tener var. tener	Fabaceae	annual herb	Mar-Jun	•Playas (Plyas) •Valley and foothill grassland (VFGrs)(adobe clay) •Vernal pools (VnPls)/alkaline	1 - 60 meters	List 1B.2
Atriplex depressa	Chenopodiaceae	annual herb	Apr-Oct	•Chenopod scrub (ChScr) •Meadows and seeps (Medws) •Playas (Plyas) •Valley and foothill grassland (VFGrs) •Vernal pools (VnPls)/alkaline, clay	1 - 320 meters	List 1B.2
Atriplex joaquinana	Chenopodiaceae	annual herb	Apr-Oct	•Chenopod scrub (ChScr) •Meadows and seeps (Medws) •Playas (Plyas) •Valley and foothill grassland (VFGrs)/alkaline	1 - 835 meters	List 1B.2
Chloropyron palmatum	Orobanchaceae	annual herb hemiparasitic	May-Oct	•Chenopod scrub (ChScr) •Valley and foothill grassland (VFGrs)/alkaline	5 - 155 meters	List 1B.1
Hibiscus lasiocarpos var. occidentalis	Malvaceae	perennial rhizomatous herb emergent	Jun-Sep	•Marshes and swamps (MshSw)(freshwater)	0 - 120 meters	List 1B.2
Lasthenia glabrata ssp. coulteri	Asteraceae	annual herb	Feb-Jun	•Marshes and swamps (MshSw)(coastal salt) •Playas (Plyas) •Vernal pools (VnPls)	1 - 1220 meters	List 1B.1
Lepidium latipes var. heckardii	Brassicaceae	annual herb	Mar-May	•Valley and foothill grassland (VFGrs)(alkaline flats)	2 - 200 meters	List 1B.2
Lessingia hololeuca	Asteraceae	annual herb	Jun-Oct	•Broadleafed upland forest (BUFrs)	15 - 305 meters	List 3

				•Coastal scrub (CoScr) •Lower montane coniferous forest (LCFrs) •Valley and foothill grassland (VFGrs)/clay, serpentinite		
Trichocoronis wrightii var. wrightii	Asteraceae	annual herb	May-Sep	•Meadows and seeps (Medws) •Marshes and swamps (MshSw) •Riparian forest (RpFrs) •Vernal pools (VnPls)/alkaline	5 - 435 meters	List 2.1
Trifolium hydrophilum	Fabaceae	annual herb	Apr-Jun	•Marshes and swamps (MshSw) •Valley and foothill grassland (VFGrs)(mesic, alkaline) •Vernal pools (VnPls)	0 - 300 meters	List 1B.2

APPENDIX C:
Giant Garter Snake Habitat Assessment

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Swaim Biological Incorporated
4435 First Street PMB #312
Livermore, CA 94551

To: Pacific Gas and Electric Company
From: Karen Swaim
Date: November 18, 2012
Re: Giant Garter Snake Habitat Assessment for the Zamora Well Pad B Construction and Core Drilling Project

This memo provides a reconnaissance level constraints analysis for construction and operation of proposed Well Pad B, for Pacific Gas and Electric Company's Compressed Air Energy Storage Project (Project), located near Zamora in Yolo County, California (Attachment A). The proposed well pad, Well Pad B, is located in the southwest corner of the Roosevelt Ranch Preserve.

The Project is located within the current range of the giant garter snake (GGS) and suitable GGS habitat is present in portions of the Roosevelt Ranch. GGS have been documented on the Roosevelt Ranch during USGS trapping and telemetry study in the vicinity of the Colusa Basin Drainage Canal (Wylie and Amarillo 2006). These observations are approximately 1.8 miles north of the proposed well pad.

Methods

Prior to visiting the site, SBI reviewed available locality data for GGS within a 10 mile radius of the project site. Data reviewed included the California Natural Diversity Data Base and consulting/research reports currently or previously available on-line. Aerial images both current and past available through Google Earth were also reviewed to determine the distribution of aquatic habitats in the vicinity over time. The assessment for GGS was conducted by SBI Biologist Karen Swaim.

Site visits were conducted on July 14, August 2, September 14, and October 1, 2012. During site visits, aquatic habitats were visually surveyed to assess their suitability to provide habitat for GGS. Site visits included driving and walking ranch roads in the study area from County Road 12 north to the Roosevelt Ranch Boundary (Attachment A).

The GGS is a highly aquatic snake found in sloughs, marshes, ponds, low-gradient streams, as well as in rice fields, irrigation canals, and drainages and surrounding uplands (USFWS 1993). Basic habitat requirements include the following:

1. Sufficient water during the active summer season to supply cover and prey items such as small fish and amphibians;
2. Emergent, herbaceous aquatic vegetation accompanied by vegetated banks to provide basking and foraging habitat;
3. Bankside burrows, holes and crevices to provide short-term aestivation sites;
4. High ground or upland habitat above the annual high water mark to provide cover and refuges from floodwaters during the dormant winter season.

Results

No suitable aquatic habitat for GGS was found within 200 feet of the proposed Well Pad B Study area or access route. The area proposed for Well Pad B is located within an approximately 71 acre fallow field that is virtually devoid of vegetation and rodent burrows (Appendix C-Site Photos).

The closest potential aquatic habitat for GGS is located approximately 1100 feet north of the proposed well pad (Attachments B and C). This aquatic habitat consists of an agricultural ditch/canal that has well-established emergent aquatic vegetation, abundant potential prey (fish and breeding bullfrog population), and adjacent upland grassland habitat with abundant rodent burrows.

Conclusions

Well Pad B construction, including access is not expected to have any adverse impact on GGS or their habitat. The well pad workspace, as currently proposed, is approximately 1100 feet south of the drainage ditch that may provide aquatic habitat for the GGS. Although GGS may move more than 200 feet from aquatic habitat to seek upland burrows in winter, it is likely a rare occurrence. The lack of burrows and cover in the study area due to continuous agricultural use virtually precludes the potential for use by GGS to be expected. Further, while the GGS recovery plan states that wintering habitat can be up to 250 meters (820 feet) from the edge of marsh habitat (Miller et al. 1999), even if the project was shifted up to 150 feet to the north (closer to suitable aquatic habitat present in the drainage ditch), project workspaces would still remain more than 820 feet from any suitable aquatic habitat.

Recommendations

The project should maximize the distance between Well Pad B and the drainage ditch to the north. This would provide the highest degree of avoidance of GGS possible for the project.

Literature Cited

California Department of Fish and Game (CDFG). 2012. California Natural Diversity Database (CNDDB). Database query for the Willows, Chico, Portola, Lakeport, Yuba City, Truckee, Healdsburg, Sacramento, and Placerville 7 ½ - minute quadrangles. May 2012.

Miller, K. J., Kelly Hornaday, U. S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, and The Giant Garter Snake Recovery Team. 1999. Draft recovery plan for the giant garter snake (*Thamnophis gigas*): U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). 1993. Determination of threatened status for the giant garter snake / RIN 1018-AB73. Federal Register. 58: 1654 lines.

Wylie, M. and M. Amerello. 2006. Results of 2006 Monitoring for Giant Garter Snakes (*Thamnophis gigas*) For the Bank Protection Project on the Left Bank of the Colusa Basin Drainage Canal in Reclamation District 108, Sacramento River Bank Protection Project, Phase II Administrative Report Prepared for Environmental Planning

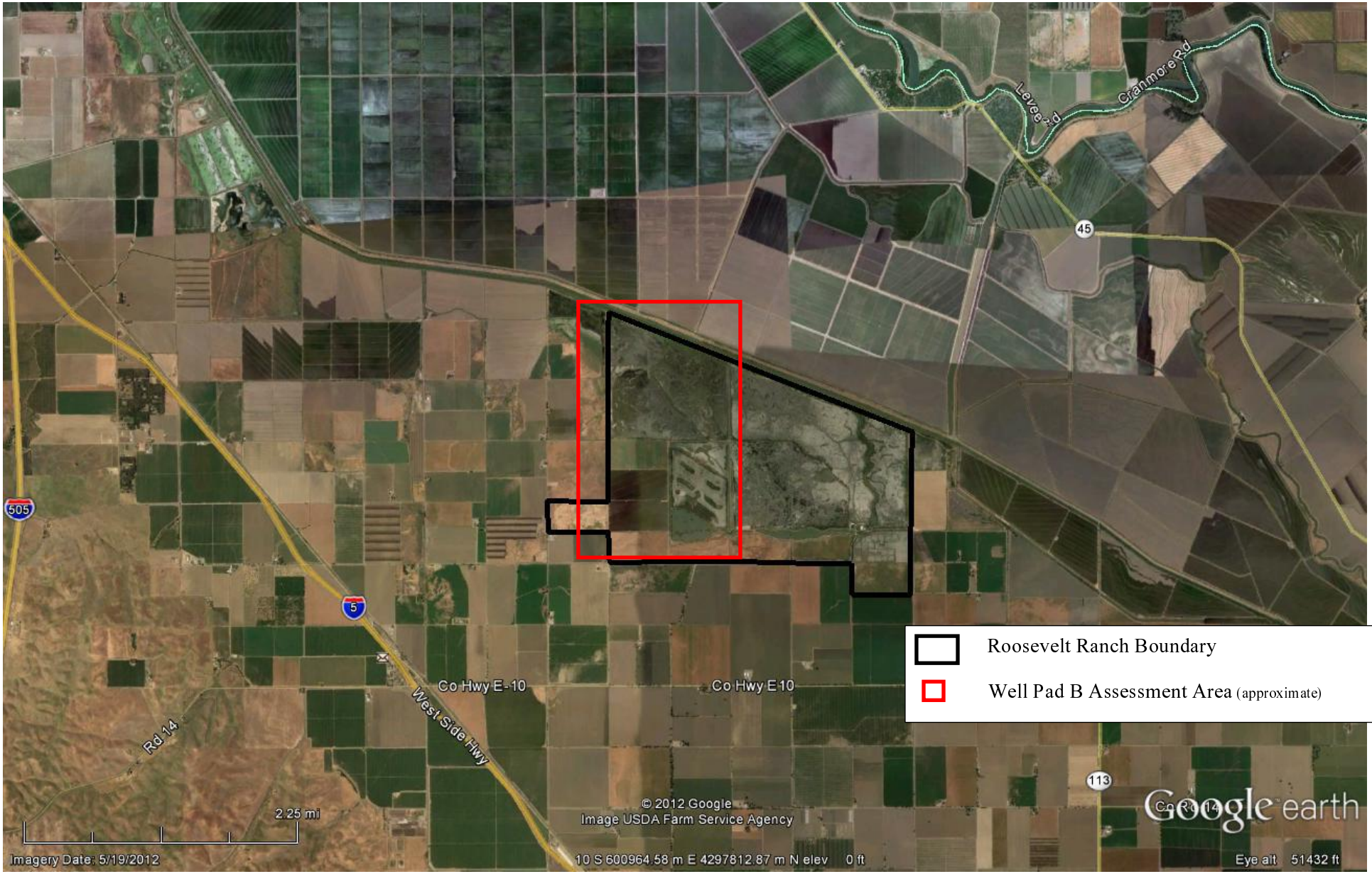
If you have any questions regarding this memo or need further information feel free to contact me.

Sincerely,

Karen E. Swain

A- PROJECT SITE LOCATION
B- AQUATIC HABITAT IN THE VICINITY OF WELL PAD B STUDY AREA
C- PROJECT AND VICINITY PHOTOS

ATTACHMENT A- PROJECT SITE LOCATION



ATTACHMENT B: AQUATIC HABITAT IN THE VICINITY OF THE WELL PAD B


Early Harvest Rice Crop
Rd 12
Potential GGS Aquatic Habitat
Well Pad B and Access Area
Roosevelt Ranch Boundary
801 ft
Imagery Date: 5/19/2012
10 S 600295.48 m E 4296381.66 m N elev 0 ft
Eye alt 3465 ft
Google earth

ATTACHMENT C- SITE AND VICINITY PHOTOS



Photo 1. View east along County Road (CR) 12 with fallow field to the north, where Well Pad B is proposed. The crop south of CR 12 is alfalfa.



Photo 2. View northeast across the fallow field from the southwest corner of Rooosevelt Ranch toward the proposed Well Pad B location.



Photo 3. View north from CR 12 toward the irrigation ditch that parallels the north edge of the fallow field. Vegetation bordering the ditch is visible along the horizon.



Photo 4. View west toward the proposed location of Well Pad B from the Roosevelt Ranch access road that parallels the eastern edge of the fallow field.



Photo 5. View south from the irrigation ditch that parallels the northern edge of the fallow field. This is the closest aquatic feature to the study area that provides potential aquatic habitat for the giant garter snake.



Photo 6. Close up of typical condition of the fallow field, which has virtually no burrows or vegetation.

APPENDIX D:
Swainson's Hawk Survey Protocol

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RECOMMENDED TIMING AND METHODOLOGY FOR SWAINSON'S HAWK NESTING SURVEYS IN CALIFORNIA'S CENTRAL VALLEY

Swainson's Hawk Technical Advisory Committee

May 31, 2000

This set of survey recommendations was developed by the Swainson's Hawk Technical Advisory Committee (TAC) to maximize the potential for locating nesting Swainson's hawks, and thus reducing the potential for nest failures as a result of project activities/disturbances. The combination of appropriate surveys, risk analysis, and monitoring has been determined to be very effective in reducing the potential for project-induced nest failures. As with most species, when the surveyor is in the right place at the right time, Swainson's hawks may be easy to observe; but some nest sites may be very difficult to locate, and even the most experienced surveyors have missed nests, nesting pairs, mis-identified a hawk in a nest, or believed incorrectly that a nest had failed. There is no substitute for specific Swainson's hawk survey experience and acquiring the correct search image.

METHODOLOGY

Surveys should be conducted in a manner that maximizes the potential to observe the adult Swainson's hawks, as well as the nest/chicks second. To meet the California Department of Fish and Game's (CDFG) recommendations for mitigation and protection of Swainson's hawks, surveys should be conducted for a ½ mile radius around all project activities, and if active nesting is identified within the ½ mile radius, consultation is required. In general, the TAC recommends this approach as well.

Minimum Equipment

Minimum survey equipment includes a high-quality pair of binoculars and a high quality spotting scope. Surveying even the smallest project area will take hours, and poor optics often result in eye-strain and difficulty distinguishing details in vegetation and subject birds. Other equipment includes good maps, GPS units, flagging, and notebooks.

Walking vs Driving

Driving (car or boat) or "windshield surveys" are usually preferred to walking if an adequate roadway is available through or around the project site. While driving, the observer can typically approach much closer to a hawk without causing it to fly. Although it might appear that a flying bird is more visible, they often fly away from the observer using trees as screens; and it is difficult to determine from where a flying bird came. Walking surveys are useful in locating a nest after a nest territory is identified, or when driving is not an option.

Angle and Distance to the Tree

Surveying subject trees from multiple angles will greatly increase the observer's chance of detecting a nest or hawk, especially after trees are fully leafed and when surveying multiple trees

in close proximity. When surveying from an access road, survey in both directions. Maintaining a distance of 50 meters to 200 meters from subject trees is optimal for observing perched and flying hawks without greatly reducing the chance of detecting a nest/young: Once a nesting territory is identified, a closer inspection may be required to locate the nest.

Speed
Travel at a speed that allows for a thorough inspection of a potential nest site. Survey speeds should not exceed 5 miles per hour to the greatest extent possible. If the surveyor must travel faster than 5 miles per hour, stop frequently to scan subject trees.

Visual and Aural Ques
Surveys will be focused on both observations and vocalizations. Observations of nests, perched adults, displaying adults, and chicks during the nesting season are all indicators of nesting Swainson's hawks. In addition, vocalizations are extremely helpful in locating nesting territories. Vocal communication between. hawks is frequent during territorial displays; during courtship and mating; through the nesting period as mates notify each other that food is available or that a threat exists; and as older chicks and fledglings beg for food.

Distractions
Minimize distractions while surveying. Although two pairs of eyes may be better than one pair at times, conversation may limit focus. Radios should be off, not only are they distracting, they may cover a hawk's call.

Notes and Species Observed
Take thorough field notes. Detailed notes and maps of the location of observed Swainson's hawk nests are essential for filling gaps in the Natural Diversity Data Base; please report all observed nest sites. Also document the occurrence of nesting great homed owls, red-tailed hawks, red-shouldered hawks and other potentially competitive species. These species will infrequently nest within 100 yards of each other, so the presence of one species will not necessarily exclude another.

TIMING

To meet **the minimum level** of protection for the species, surveys should be completed for **at least** the two survey periods immediately prior to a project's initiation. For example, if a project is scheduled to begin on June 20, you should complete 3 surveys in Period III and 3 surveys in Period V. However, it is always recommended that surveys be completed in Periods II, III and V. **Surveys should not be conducted in Period IV.**

The survey periods are defined by the timing of migration, courtship, and nesting in a "typical" year for the majority of Swainson's hawks from San Joaquin County to Northern Yolo County. Dates should be adjusted in consideration of early and late nesting seasons, and geographic differences (northern nesters tend to nest slightly later, etc). If you are not sure, contact a TAC member or CDFG biologist.

Survey dates **Justification and search image**	**Survey time**	**Number of Surveys**
I. *January-March 20 (recommended optional)*	*All day*	*1*

Prior to Swainson's hawks returning, it may be helpful to survey the project site to determine potential nest locations. Most nests are easily observed from relatively long distances, giving the surveyor the opportunity to identify potential nest sites, as well as becoming familiar with the project area. It also gives the surveyor the opportunity to locate and map competing species nest sites such as great homed owls from February on, and red-tailed hawks from March on. After March 1, surveyors are likely to observe Swainson's hawks staging in traditional nest territories.

II. *March 20 to April 5*	*Sunrise to 1000* *1600 to sunset*	*3*

Most Central Valley Swainson's hawks return by April 1, and immediately begin occupying their traditional nest territories. For those few that do not return by April 1, there are often hawks ("floaters") that act as place-holders in traditional nest sites; they are birds that do not have mates, but temporarily attach themselves to traditional territories and/or one of the site's "owners." Floaters are usually displaced by the territories' owner(s) if the owner returns.

Most trees are leafless and are relatively transparent; it is easy to observe old nests, staging birds, and competing species. The hawks are usually in their territories during the survey hours, but typically soaring and foraging in the mid-day hours. Swainson's hawks may often be observed involved in territorial and courtship displays, and circling the nest territory. Potential nest sites identified by the observation of staging Swainson's hawks will usually be active territories during that season, although the pair may not successfully nest/reproduce that year.

III. *April 5 to April 20*	*Sunrise to 1200* *1630 to Sunset*	***3***

Although trees are much less transparent at this time, 'activity at the nest site increases significantly. Both males and females are actively nest building, visiting their selected site frequently. Territorial and courtship displays are increased, as is copulation. The birds tend to vocalize often, and nest locations are most easily identified. This period may require a great deal of "sit and watch" surveying.

IV. *April 21 to June 10*	*Monitoring known nest sites only* ***Initiating Surveys is not recommended***	

Nests are extremely difficult to locate this time of year, and even the most experienced surveyor will miss them, especially if the previous surveys have not been done. During this phase of nesting, the female Swainson's hawk is in brood position, very low in the nest, laying eggs, incubating, or protecting the newly hatched and vulnerable chicks; her head may or may not be visible. Nests are often well-hidden, built into heavily vegetated sections of trees or in clumps of mistletoe, making them all but invisible. Trees are usually not viewable from all angles, which may make nest observation impossible.

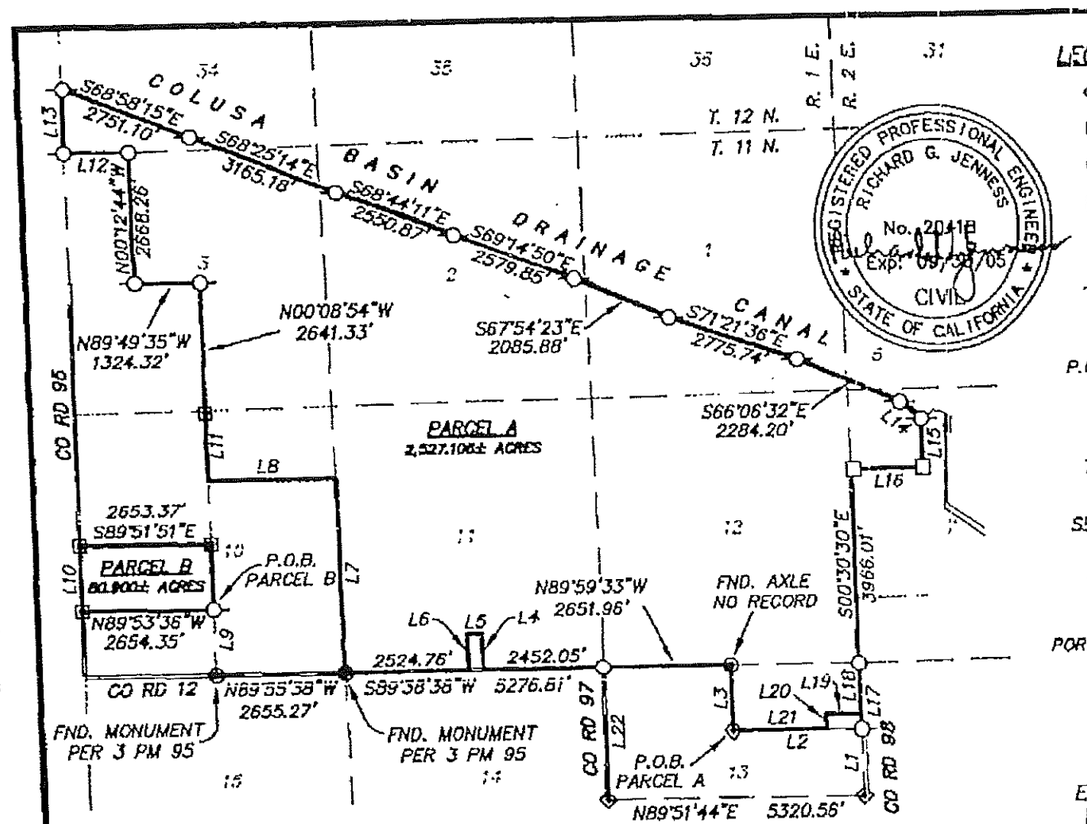
Following the male to the nest may be the only method to locate it, and the male will spend hours away from the nest foraging, soaring, and will generally avoid drawing attention to the nest site. Even if the observer is fortunate enough to see a male returning with food for the female, if the female determines it is not safe she will not call the male in, and he will not approach the nest; this may happen if the observer, or others, are too close to the nest or if other threats, such as rival hawks, are apparent to the female or male.

V. ***June 10 to JuIy 30 (post-fledging)*** ***Sunrise to 1200*** ***3***
1600 to sunset

Young are active and visible, and relatively safe without parental protection. Both adults make numerous trips to the nest and are often soaring above, or perched near or on the nest tree. The location and construction of the nest may still limit visibility of the nest, young, ‘and adults.

DETERMINING A PROJECT'S POTENTIAL
FOR IMPACTING SWAINSON'S HAWKS

LEVEL OF RISK	REPRODUCTIVE SUCCESS (Individuals)	LONGTERM SURVIVABILITY (Population)	NORMAL SITE CHARACTERISTICS (Daily Average)	NEST MONI-TORING
HIGH	Direct physical contact with the nest tree while the birds are on eggs or protecting young. (Helicopters in close proximity)	Loss of available foraging area.	Little human-created noise, little human use: nest is well away from dwellings, equipment yards, human access areas, etc. *Do not include general cultivation practices in evaluation.*	**MORE**
		Loss of nest trees.		
	Loss of nest tree after nest building is begun prior to laying eggs.	Loss of potential nest trees.		
	Personnel within 50 yards of nest tree (out of vehicles) for extended periods while birds are on eggs or protecting young that are < 10 days old.	Cumulative: Multi-year, multi-site projects with substantial noise/personnel disturbance.		
	Initiating construction activities (machinery and personnel) within 200 yards of the nest after eggs are laid and before young are > 10 days old.	Cumulative: Single-season projects with substantial noise/personnel disturbance that is greater than or significantly different from the daily norm.		
	Heavy machinery only working within 50 yards of nest.		Substantial human-created noise and occurrence: nest is near roadways, well-used waterways, active airstrips, areas that have high human use. *Do not include general cultivation practices in evaluation.*	
	Initiating construction activities within 200 yards of nest before nest building begins or after young > 10 days old.	Cumulative: Single-season projects with activities that "blend" well with site's "normal' activities.		
LOW	All project activities (personnel and machinery) greater than 200 yards from nest.			**LESS**



LEGEND:

- ⊗ = FOUND MONUMENT PER 11 M&S 43
- ⊡ = FOUND MONUMENT PER 12 M&S 98
- ⊛ = FOUND MONUMENT AS NOTED
- □ = 10" X 10" WOOD POST WITH 1 1/4" BRASS TAG STAMPED "COR ESMT" R.C.E. 20418
- ○– = 3/4" X 24" REBAR WITH 1 1/2" ALUMINUM CAP STAMPED "COR ESMT" R.C.E. 20418

P.O.B. = POINT OF BEGINNING

LOCATED IN:
A PORTION OF SECTION 34, TOWNSHIP 12 NORTH, RANGE 1 EAST MOUNT DIABLO BASE & MERIDIAN.

SECTIONS 11 AND 12 AND PORTIONS OF PROJECTED SECTIONS 1 AND 2 AND SECTIONS 3, 10, 13 TOWNSHIP 11 NORTH, RANGE 1 EAST MOUNT DIABLO BASE & MERIDIAN.

PORTIONS OF PROJECTED SECTIONS 6 AND 7, TOWNSHIP 11 NORTH, RANGE 2 EAST, MOUNT DIABLO BASE & MERIDIAN.

LINE TABLE

LINE	LENGTH	BEARING	LINE	LENGTH	BEARING
L1	1332.02	N00°34'57"W	L12	1319.09	S89°35'27"W
L2	2657.85	N89°51'06"W	L13	1289.09	N00°07'51"W
L3	1308.78	N00°26'11"W	L14	546.09	S53°05'22"E
L4	726.00	N00°21'22"W	L15	964.24	S00°26'15"W
L5	300.00	S89°38'38"W	L16	1483.33	S89°02'30"W
L6	726.00	S00°21'22"E	L17	1318.36	S00°30'31"E
L7	3971.06	N00°57'53"W	L18	1018.36	S00°30'31"E
L8	2611.07	N89°55'38"W	L19	726.05	N89°51'06"W
L9	1327.25	N00°19'23"W	L20	300.00	S00°30'31"E
L10	1328.59	N00°16'49"W	L21	1931.80	N89°51'06"W
L11	1338.34	N00°20'04"W	L22	2660.75	N00°16'30"W

SCALE 1" = 3000'

EXHIBIT TO ACCOMPANY DESCRIPTION
WETLAND RESERVE EASEMENT
FOR
CALIFORNIA WATERFOWL ASSOCIATION
KNAGGS FARMING COMPANY, L.P.
"KNAGGS–DWYER RANCH"

LM CIVIL ENGINEERING LAND SURVEYING PLANNING
LAUGENOUR AND MEIKLE
608 COURT STREET, WOODLAND, CA 95695
PHONE: (530) 662-1755
FAX: (530) 662-4302

YOLO COUNTY, CALIFORNIA
SHEET 1 OF 1 JUNE 30, 2003

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Cultural Resources Survey for the PG&E CAES – Zamora Project, Yolo County, California

Prepared for

Pacific Gas and Electric Company

Prepared by

SWCA Environmental Consultants

December 2012

CONFIDENTIAL – NOT FOR PUBLIC DISTRIBUTION

CULTURAL RESOURCES SURVEY FOR THE PG&E CAES - ZAMORA PROJECT YOLO COUNTY, CALIFORNIA

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SWCA Project No. 23910

SWCA Cultural Resources Report No. 12-354

December 2012

Keywords: Cultural resources survey; Negative survey; 31.5 acres; Yolo County; Eldorado Bend quadrangle; Township 11 North, and Range 1 East

Archaeological and other heritage resources can be damaged or destroyed through uncontrolled public disclosure of information regarding their location. This document contains sensitive information regarding the nature and location of archaeological sites which should not be disclosed to the general public or unauthorized persons.

Information regarding the location, character, or ownership of a cultural resource is exempt from the Freedom of Information Act pursuant to 16 USC 470w-3 (National Historic Preservation Act) and 16 USC Section 470(h) (Archaeological Resources Protection Act).

MANAGEMENT SUMMARY

Purpose and Scope: SWCA Environmental Consultants (SWCA) was retained by Pacific Gas and Electric (PG&E) to conduct a cultural resources study in support of the PG&E Compressed Air Energy Storage (CAES) Zamora project (project). The study area consists of 12.75 hectares (31.5 acres) of land located approximately 4 km (2.5 miles) northeast of the unincorporated community of Zamora and 16.25 km (10.1 miles) northwest of the city of Woodland in Yolo County, California. The cultural resources study consisted of a cultural resources record and literature search, Native American consultation, cultural resources survey of the study area, and preparation of a cultural resources technical report documenting the results of the inventory and providing management recommendations.

Dates of Investigation: The California Historical Resources Information System (CHRIS) was conducted by the Northwest Information Center (NWIC) at Sonoma State University in Rohnert Park, California, and received on July 31, 2012 and November 28, 2012. Cultural resources specialists conducted intensive-level cultural resources surveys on August 3, 2012 and November 29, 2012.

Findings of the Investigation: Two prior cultural resources studies have been conducted within a 0.5-mile radius of the study area. The records and literature search also indicates that two cultural resources have been previously recorded within a 0.5-mile radius of the study area, one of which is located within the boundaries of the current study area. Archaeological isolate P-57-000518, a chert biface, was recorded in 2005, but it was not located again during the present cultural resources survey. SWCA did identify one previously unrecorded archaeological isolate as a result of the current study; SWCA-CAES-01 is a unifacial chert flake that was found at the north end of the survey area in the middle of a dirt access road. SWCA archaeologists did not identify any other cultural resources within the study area.

Investigation Constraints: Ground surface visibility varied from poor to very good throughout the study area due to obstruction by vegetative ground cover and gravel. Additionally, a portion of the study area was unable to be surveyed because it is currently used for rice cultivation and was flooded with water during the cultural resources survey.

Recommendations Summary: While a portion of the study area was unable to be surveyed due to standing water and other portions were subject to poor ground visibility, the project area is significantly disturbed due to ongoing agricultural activities, which are likely to have exposed any substantial archaeological resources. Additionally, although the current study and a study from 2005 each identified an archaeological isolate, neither appears to have been part of an intact cultural deposit. Consequently, the likelihood of discovering additional archaeological resources is low, and SWCA recommends no further cultural resources work.

However, in the event that cultural resources are discovered during construction grading, trenching, or excavation, project personnel should halt earth-moving activities in the immediate area and notify a qualified archaeologist to evaluate the resource. In the event of the discovery of human remains during project implementation, relevant state law shall be followed, beginning with a cessation of disturbance and the placing of a call to the county coroner.

Disposition of Data: This report will be on file with the following entities: the NWIC located at Sonoma State University, Rohnert Park; PG&E; and SWCA. All field notes and records related to the current project are on file at SWCA's Pasadena office. All geographical information systems data created during this study are on file at SWCA's Pasadena office and PG&E.

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CONTENTS

Management Summary ..... **i**
Introduction **1**
Project Description 1
Area of Potential Effects 1
Regulatory Setting **6**
Federal 6
National Historic Preservation Act 6
State 7
California Environmental Quality Act 7
Environmental Setting **8**
Cultural Setting **9**
Prehistoric Overview 9
Windmiller Pattern (2500–500 B.C.) 10
Berkeley Pattern (500 B.C.–A.D. 500) 11
Augustine Pattern (A.D. 500–Historic Contact) 11
Ethnographic Overview 12
Historic Overview 14
Yolo County 14
Zamora 14
Background Research **15**
California Historical Resources Information System Records Search 15
Prior Cultural Resources Studies within 1 Mile of the APE 15
Previously Recorded Cultural Resources within 1-mile of the APE 16
Historic Map Review 16
Sacred Lands File Search and Initial Native American Coordination 17
Methods **18**
Results **18**
Discussion and Recommendations **24**
Discussion 24
Recommendations 25
Inadvertent Discovery of Cultural Resources 25
Inadvertent Discovery of Human Remains 25
References Cited **26**

Appendices

A. Records Search Results Summary from SBAIC
B. Native American Coordination Correspondence
C. California Department of Parks and Recreation Series 523 Forms

Tables

1. Prior Cultural Resources Studies within 1 Mile of the APE 15
2. Previously Recorded Cultural Resources within 1 Mile of the APE 16
3. Record of Native American Coordination Efforts 16

Figures

1. Location of the study area. 2
2. Detailed location of the study area. 3
3. The area of potential effects. 4
4. Study area map. 5
5. Overview of project area; view to south. 8
6. Overview of vegetation within the study area; view to the west. 9
7. Survey coverage map. 20
8. Portion of the study area that was unable to be surveyed; view to the southeast. 21
9. Heavy vegetation within the study area; view to the west. 21
10. Vegetation and disturbed areas within the study area; view to the northeast. 22
11. Portion of the study area disturbed due to agricultural activities; view to the west. 22
12. Cultural resources map. 23
13. Detail of SWCA-CAES-01. 24

INTRODUCTION

SWCA Environmental Consultants (SWCA) was retained by Pacific Gas and Electric (PG&E) to conduct a cultural resources study in support of the PG&E Compressed Air Energy Storage (CAES) Zamora project (project). The study area consists of approximately 12.75 hectares (31.5 acres) of land located approximately 4 km (2.5 miles) northeast of the unincorporated community of Zamora and 16.25 km (10.1 miles) northwest of the city of Woodland in Yolo County, California (Figures 1 and 2). The cultural resources study consisted of a cultural resources record and literature search, Native American consultation, cultural resources survey of the study area, and preparation of a cultural resources technical report documenting the results of the study and providing management recommendations.

Project Description

The PG&E CAES Zamora project would use renewable energy from sources such as wind to inject compressed air into an underground reservoir and then use it to help power a turbine generator during peak periods when the energy is needed most. It will be implemented in three phases: site selection and feasibility analysis; licensing and permitting; and construction and operation.

The Zamora reservoir site consists of the construction of a well pad measuring approximately 1 acre. The well pad will support a drilling rig and other equipment for the purpose of core drilling tests to determine whether the Zamora reservoir is a viable candidate for the CAES project. The Zamora site consists of three potential well pad locations. Construction of the well pad will require importing non-native fill material (e.g., sand and gravel) to stabilize the site so that it can support a drilling rig. Site preparation includes importing gravel and sand and performing grading and compaction. Access routes may also require grading prior to construction. Both well pad construction and access route grading are tentatively scheduled in February 2013. Core drilling consists of mobilizing a drill rig with supporting equipment, conducting core drilling to approximately 2,000 feet below the surface. Core drilling is tentatively scheduled for March 2013.

Well pad construction will completed in approximately two weeks. Core drilling, which is scheduled for March 2013, will take approximately five to six weeks.

Area of Potential Effects

An area of potential effects (APE) is defined as the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties (36 Code of Federal Regulations 800.16(d)). The proposed project is located within unincorporated Yolo County in an area primarily characterized by agricultural land use. The archaeological or direct APE boundary represents portions of the project area that will be directly affected by the proposed undertaking, and includes where ground disturbance may result from the proposed undertaking. Specifically, the direct APE consists of the construction footprint, or well pad sites, and the approximately 1,219-m (4,000-foot) access road (Figure 3). The vertical APE extends to approximately 2,000 feet below the existing ground surface, or the depth to which core drilling will be conducted. A study area was established to include both direct and indirect effects, and consisting of 61-m (200-foot) buffer around each of the potential well pad sites, and a 7.6-m (25-foot) buffer from the edges of the access road (Figure 4). Because the isolated well pad site to the west may be moved up to 46 m (150 feet) to the west, north, or east prior to construction, the previously-established 61-m (200-foot) buffer was increased an additional 46 m (150 feet) in these directions to accommodate this potential shift.



Figure 1. Location of the study area.

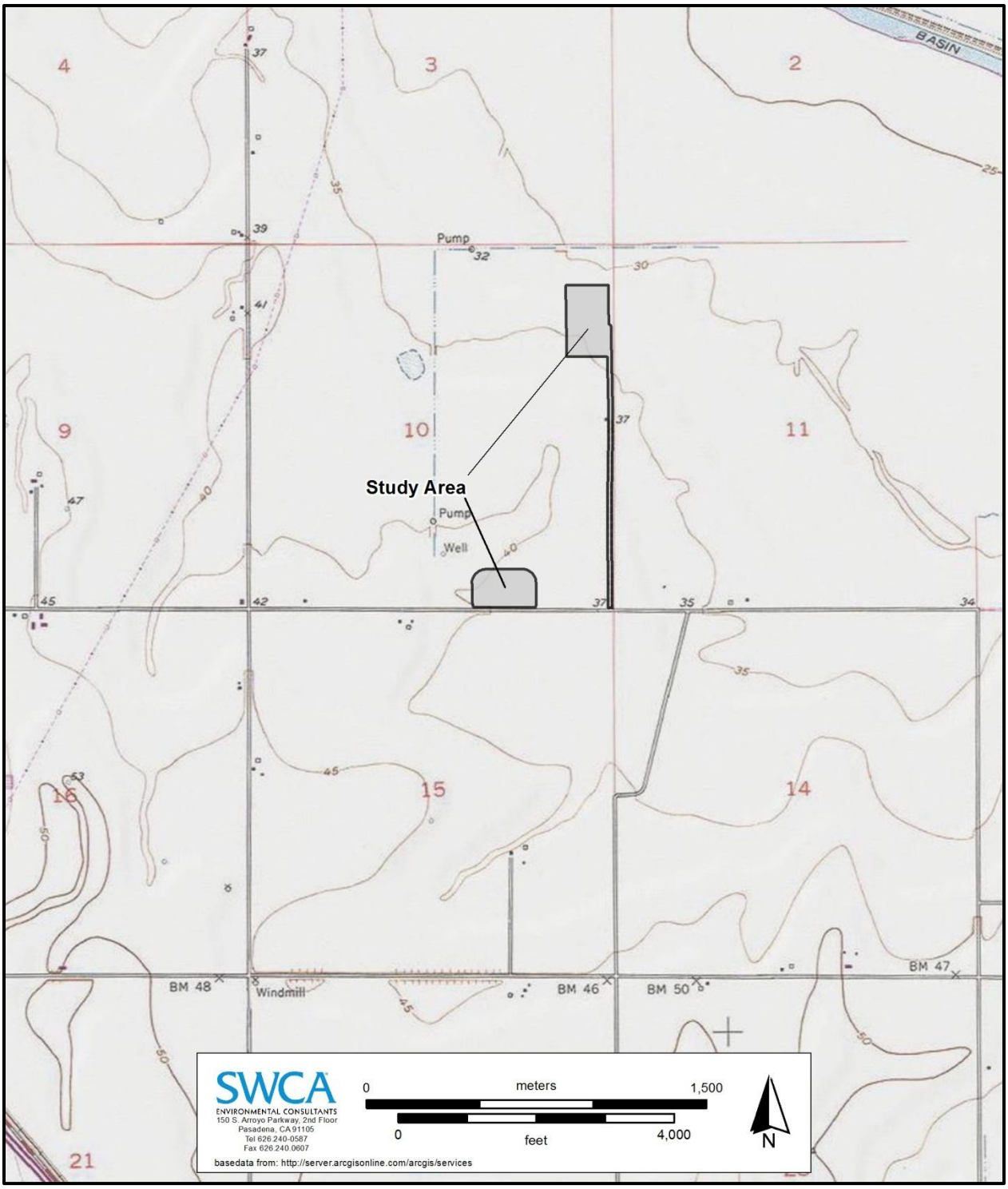


Figure 2. Detailed location of the study area.



Figure 3. The area of potential effects.



Figure 4. Study area map.

REGULATORY SETTING

This section identifies federal regulations, state legislation, and local statutes, ordinances, and guidelines that govern the identification and treatment of cultural resources and analysis of project-related effects on cultural resources. The lead agency must consider these requirements in making decisions on projects that may affect cultural resources. The current study was conducted in compliance with both federal and state laws, particularly Section 106 of the National Historic Preservation Act (NHPA) and the California Environmental Quality Act (CEQA).

Federal

National Historic Preservation Act

The current study was completed under the provisions of the NHPA of 1966, as amended (16 United States Code [USC] 470f). Cultural resources are considered during federal undertakings chiefly under Section 106 of the NHPA through one of its implementing regulations, 36 CFR 800 (Protection of Historic Properties), as well as the National Environmental Policy Act (NEPA). Properties of traditional religious and cultural importance to Native Americans are considered under Section 101(d)(6)(A) of the NHPA. Other relevant federal laws include the Archaeological Data Preservation Act of 1974, the American Indian Religious Freedom Act (AIRFA) of 1978, the Archaeological Resources Protection Act (ARPA) of 1979, and the Native American Graves Protection and Repatriation Act (NAGPRA) of 1989.

Section 106 requires federal agencies to take into account the effects of their undertakings on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places (NRHP) and to afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings (36 CFR 800.1). Under Section 106, cultural resources must be identified and evaluated; effects on historic properties are reduced to acceptable levels through mitigation measures or agreements among consulting and interested parties. Historic properties are those resources that are listed in or are eligible for listing in the NRHP in accordance with the criteria listed below (36 CFR 60.4) (Advisory Council on Historic Preservation 2000).

The quality of *significance* in American history, architecture, archaeology, engineering and culture is present in districts, sites, buildings, structures, and objects that possess *integrity* of location, design, setting, materials, workmanship, feeling and association and that

(A) Are associated with events that have made a significant contribution to the broad patterns of our history; or

(B) Are associated with the lives of persons significant in our past; or

(C) Embody the distinctive characteristics of a type, period, or method of installation, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(D) Have yielded, or may be likely to yield, information important in prehistory or history.

Impacts of a project to significant cultural resources that affect the characteristics of any resource that qualify it for the NRHP are considered a significant effect on the environment. Under 36 CFR 800.5(a)(2), adverse effects on historic properties include, but are not limited to

(i) Physical destruction of or damage to all or part of the property;

(ii) Alteration of a property;

(iii) Removal of the property from its historic location;

(iv) Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;

(v) Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features;

(vi) Neglect of a property which causes its deterioration;

(vii) Transfer, lease, or sale of property out of federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

State

California Environmental Quality Act

CEQA requires a lead agency to determine whether a project may have a significant effect on historical resources (Section 21084.1). If it can be demonstrated that a project will cause damage to a unique archaeological resource, the lead agency may require reasonable efforts be made to permit any or all of these resources to be preserved in place or left in an undisturbed state. To the extent that they cannot be left undisturbed, mitigation measures are required (Section 21083.2[a], [b], and [c]).

Section 21083.2(g) defines a *unique archaeological resource* as an archaeological artifact, object, or site about which it can be clearly demonstrated that without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

(1) Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information;

(2) Has a special and particular quality such as being the oldest of its type or the best available example of its type; or

(3) Is directly associated with a scientifically recognized important prehistoric or historic event or person.

A *historical resource* is a resource listed in, or determined to be eligible for listing in, the California Register of Historical Resources (CRHR) (Section 21084.1), a resource included in a local register of historical resources (Section 15064.5[a][2]), or any object, building, structure, site, area, place, record, or manuscript that a lead agency determines to be historically significant (Section 15064.5[a][3]).

Public Resources Code (PRC) Section 5024.1, Section 15064.5 of the CEQA Guidelines, and PRC Sections 21083.2 and 21084.1 were used as the basic guidelines for this cultural resources study. PRC Section 5024.1 requires an evaluation of historical resources to determine their eligibility for listing in the CRHR. The purpose of the register is to maintain listings of the state's historical resources and to indicate which properties are to be protected from substantial adverse change. The criteria for listing resources on the CRHR were expressly developed to be in accordance with previously established criteria developed for listing in the NRHP, enumerated below.

According to PRC Section 5024.1(c)(1–4), a resource is considered historically significant if it (i) retains "substantial integrity," and (ii) meets at least one of the following criteria:

(1) Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;

(2) Is associated with the lives of persons important in our past;

(3) Embodies the distinctive characteristics of a type, period, region or method of installation, or represents the work of an important creative individual, or possesses high artistic values; or

(4) Has yielded, or may be likely to yield, information important in prehistory or history.

Impacts to significant cultural resources that affect the characteristics of any resource that qualify it for the NRHP or adversely alter the significance of a resource listed on or eligible for listing in the CRHR are considered a significant effect on the environment. These impacts could result from "physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of an historical resource would be materially impaired" (CEQA Guidelines, Section 15064.5 [b][1], 2000). Material impairment is defined as demolition or alteration "in an adverse manner [of] those characteristics of an historical resource that convey its historical significance and that justify its inclusion in, or eligibility for inclusion in, the California Register…" (CEQA Guidelines Section 15064.5[b][2][A]).

ENVIRONMENTAL SETTING

Located in Yolo County, the study area is approximately 5.1 km (3 miles) northeast of the town of Zamora, California, and 20 km (12.5 miles) northwest of the city of Woodland, California. The topography of the project area is virtually flat, with elevations ranging from 10.7 to 12.2 m (35–40 feet) above mean sea level (amsl) (Figure 5). Characteristic of a Mediterranean climate, the area experiences warm summers and mild wet winters, receiving approximately 23 inches of annual rainfall primarily between the months of November and March.



Figure 5. Overview of study area area; view to south.

Agricultural land use of the study area and surrounding areas has resulted in standing water in irrigated fields, with vegetation, including native and non-native species such as alfalfa fields, wheat, wild grasses, and wetland vegetation (Figure 6). Habitat types present within the study area include fish, reptile, amphibian, and mammal species, such as deer, rabbit, ground squirrel, coyote, raccoon, and skunk. Bird species present in the area are western kingbird, great and snowy egret, great blue and green heron, turkey vulture, and mallard.



Figure 6. Overview of vegetation within the study area; view to the west.

CULTURAL SETTING

Prehistoric Overview

California prehistory is divided into three broad temporal periods that reflect similar cultural characteristics throughout the state: Paleoindian period (ca. 9000–6000 B.C.), Archaic period (6000 B.C.–A.D. 500), and Emergent period (A.D. 500–Historic Contact) (Fredrickson 1973, 1974, 1994a).
The Archaic is divided further into Lower (6000–3000 B.C.), Middle (3000–1000 B.C.), and Upper (1000 B.C.– A.D. 500) periods, generally governed by climatic and environmental variables, such as the drying of pluvial lakes at the transition from the Paleoindian to the Lower Archaic.

The APE lies in what generally is described as the Delta subregion of the Central Valley Archaeological Region, which is one of eight arbitrary organizational divisions of the state (Moratto 1984:Figure 1). This archaeological subregion surrounds the Sacramento–San Joaquin Delta in the middle of the Central Valley and mainly includes portions of Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties.

Occupation in the Sacramento–San Joaquin Delta region during the Prehistoric period is estimated to have occurred as early as 12,000 years ago, but only a few archaeological sites have been identified that predate 5,000 years ago. It is possible that Holocene alluvial deposits buried many prehistoric sites in this area, and Moratto (1984:214) estimates that as much as 10 m of sediment accumulated along the lower stretch of the Sacramento River drainage system during the last 5,000 to 6,000 years. CA-CCO-637 in eastern Contra Costa County, for example, is one of the few Early Holocene age sites in the region, with a record of human occupation as early as 8,500 years ago during the Lower Archaic (Meyer and Rosenthal 1998). The archaeological remains at that site were discovered approximately 2 m below the surface within an alluvial fan near Kellogg Creek.

Prehistoric material culture in central California subsequent to the Paleoindian and Lower Archaic periods has been categorized according to "horizons" or "patterns" that define broad technological, economic, social, and ideological elements over long periods of time and large areas. The taxonomic system historically used for central California is a tripartite classification scheme with Early, Middle, and Late Horizons. This Central California Taxonomic System (CCTS) was the result of efforts of a number of researchers (e.g., Beardsley 1954; Heizer 1949) and was developed further after the advent of radiocarbon dating (Fredrickson 1973, 1974; Heizer 1958; Ragir 1972).

Today, a series of generalized periods associated with regionally based "patterns" typically are used as part of the CCTS for the Sacramento Delta area, San Francisco Bay area, and North Coast ranges (Bennyhoff and Fredrickson 1969; Fredrickson 1973, 1974). Smaller units of patterns are referred to as "aspects" and "phases," which emphasize more local features. Revisions of the widely accepted CCTS (Bennyhoff 1994; Fredrickson 1994a, 1994b) are found in a recent volume edited by Hughes (1994).

Fredrickson (1973, 1974) defined several regionally based patterns, three of which are specific to the prehistory of the APE. Referred to as the Windmiller Pattern, Berkeley Pattern, and Augustine Pattern, each represents a general pattern of resource exploitation, as identified between 2500 B.C. and the beginning of Euro-American contact in the early 1800s. The Windmiller Pattern was first identified at the Windmiller site (CA-SAC-107) near the Cosumnes River in Sacramento County; the Berkeley Pattern was initially identified at the West Berkeley site (CA-ALA-307) in Alameda County on the east side of the Bay; and the Augustine Pattern was identified at the Augustine site (CA-SAC-127) in the Sacramento–San Joaquin Delta. These patterns are present within the following horizon sequences: Middle Archaic period/Windmiller Pattern (formerly Early Horizon), Upper Archaic period/Berkeley Pattern (formerly Middle Horizon), and Emergent period/Augustine Pattern (formerly Late Horizon).

Windmiller Pattern (2500–500 B.C.)

Clearly documented evidence for human occupation in the general area is found at sites characteristic of the Windmiller Pattern during the Middle Archaic period. These sites date to as early as 4,500 years ago and as late as 2,500 years ago (2500–500 B.C.). Such sites often contain manos and metates (grinding stones), as well as many mortar fragments, indicating that acorns and/or various seeds formed an important part of the diet (Moratto 1984:201).

In addition to plant foods, the subsistence system included many other food resources, such as deer, elk, pronghorn, rabbits, and waterfowl. Numerous faunal remains have been documented at Windmiller Pattern sites, along with large quantities of projectile points. Also, the presence of angling hooks and baked clay artifacts possibly used as net or line sinkers, along with the remains of sturgeon, salmon, and smaller fishes, indicates that fishing was an additional source of food (Fredrickson 1973; Heizer 1949; Ragir 1972). Items made of baked clay included net sinkers, pipes, and discoids, as well as cooking "stones." Ground and polished charmstones, impressions of twined basketry, shell beads, and bone tools,

also have been found at Windmiller Pattern sites. Some items, such as shell beads, obsidian tools, and quartz crystals, were obtained by trade.

The archaeological record during the Windmiller period indicates that people practiced a mixed procurement strategy of both game and wild plants, with the addition of acorns and/or seeds. The mixed exploitation of a wide range of natural resources ties into a seasonal foraging strategy. Populations likely occupied the lower elevations of the Sacramento Valley in the winter months and shifted to higher elevations during the summer (Moratto 1984:206). Mortuary practices included burials, accompanied by grave goods, in cemeteries that were separate from the habitation sites.

Berkeley Pattern (500 B.C.–A.D. 500)

Over a 1,000-year period, the Windmiller Pattern began to shift to the more specialized adaptive Berkeley Pattern during the Upper Archaic period. A shift to a greater reliance on acorns as a dietary staple is interpreted during the Berkeley Pattern from the increase in mortars and pestles, along with a decrease in manos and metates. Mortars and pestles are better suited to crushing and grinding acorns, while manos and metates were used primarily for grinding wild grass grains and seeds (Moratto 1984:209–210).

As demonstrated by the artifact assemblage, hunting remained an important aspect of food procurement during the Berkeley Pattern (Fredrickson 1973:125–126). The archaeological record, which consists of numerous large shell midden/mounds, also demonstrates that the majority of Berkeley Pattern sites located near, or in the vicinity of, water (both fresh and salt) made intensive use of aquatic resources. The artifact assemblage also includes shell beads and ornaments, as well as numerous types of bone tools. Interment continues to dominate mortuary practices, but a few cremations are also found at Berkeley Pattern sites.

Artifact assemblages and radiocarbon dating of sites from this period suggest this subsistence pattern may have developed in the San Francisco Bay region and later spread to surrounding coastal locales and into central California. Moratto (1984:207–211) suggests that the pattern is related to the expansion of Eastern Miwok populations from the San Francisco Bay area to the Sacramento Valley and Sierra foothills.

Augustine Pattern (A.D. 500–Historic Contact)

The Augustine Pattern is evidenced by a number of changes in subsistence, foraging, and land use patterns that begin to reflect the use pattern known from Historic period Native American groups in the area. A substantial increase in the intensity of subsistence exploitation, including fishing, hunting, and gathering (particularly the acorn), evidenced in the archaeological record correlates directly with population growth (Moratto 1984:211–214).

Tools and cooking implements included shaped mortars and pestles, hopper mortars, bone awls used for producing coiled baskets, and the bow and arrow. Pottery vessels, known as Cosumnes Brownware, are found in some parts of the Central Valley and most likely developed during this period from the prior baked clay industry.

During this period, an increase in sedentism led to the development of social stratification, accompanied by a shift to elaborate ceremonial and social organization. Exchange networks, with the use of clamshell disk beads as currency, also developed during the Augustine Pattern. Mortuary practices during this period included flexed burials and pre-interment burning of offerings in a grave pit, as well as cremation of high-status individuals (Fredrickson 1973:127–129; Moratto 1984:211). Additional items of material culture included flanged tubular pipes, harpoons, and small Gunther barbed series projectile points.

The Augustine Pattern may represent the southward expansion of Wintu populations (Moratto 1984: 211–214).

Ethnographic Overview

The APE is located in an area historically occupied by the Patwin, a northern California group whose language was of the Wintuan family (Johnson 1978; Kroeber 1925). Wintuan may be part of a larger Penutian linguistic stock that encompasses most of central California (Kroeber 1925:347–390; Shipley 1978:82), but, if Penutian, may be part of an Oregon Penutian grouping instead of a Californian subgroup (Mithun 2001). Two Patwin languages constitute the Southern Wintu branch, consisting of Patwin proper with the major dialect groups Hill, Southern Hill, and River; and Southern Patwin with its three dialects, Knight's Landing, Dixon, and Suisun (Mithun 2001:560). The "tribal" name was derived from *patwin*, for "people" (Johnson 1978:350), and was used by several tribelets to designate themselves but had no suggestion of political unity.

Patwin territory extended from Suisun Bay north past the Sutter Buttes, between the foothills of the Coastal Range on the west and the Sacramento River on the east, excluding the banks of the Sacramento River until north of its fork with the Feather River. Neighboring groups were the Nomlaki and Konkow to the north, the Nisenan and Plains Miwok to the east, the Bay Miwok and Costonoan south across Suisun Bay, and the Coast Miwok, Wappo, Lake Miwok, and Pomo to the west.

Spanish mission records, diaries, and journals provide the most comprehensive study of the Patwin; other information comes from studies completed in the first half of the twentieth century by ethnographers such as Merriam, Powers, and Gifford, and in the latter half by Bennyhoff and others (Johnson 1978:359–360). Much of the history of the Patwin, however, is incomplete.

Patwin villages were generally established in the river valleys. Families lived in elliptical earth-covered, semisubterranean structures. A dance house also was built on the north or south edge of each village, in the same form as the house but larger. The same structural pattern also was used for sweat lodges and menstrual huts; the menstrual hut was constructed on the opposite side of the village from the dance house, while the sweat lodge was placed to the east or west of the dance house (Johnson 1978:357–358). Granaries are not mentioned, but acorns were a major staple of the diet, so it is likely that there were household or community granaries constructed and located around the village. The dead were buried, usually in a cemetery at one end of the village.

The nature of religious ceremonies and organization was structured around the Kuksu Cult, a region-wide religious system. The cult was centered on one or more secret societies into which young men were initiated. Once instructed in the religious practices, members were able to achieve greater status within the community. The Kuksu religion was particularly elaborate among the Patwin, who shared basic aspects with their neighbors but also recognized the 'ghost' and *Hesi* forms, each with emphasis on different characteristics of ceremonialism and spirit helpers (Johnson 1978:353). Among the Patwin, there was also a rich body of sacred stories and beliefs stemming from a time prior to adopting the Kuksu religion. Shamans, who conducted cures for various physical and spiritual ailments, predominantly handled matters of ceremonial and religious practice. These included healings and searches for personal power through various means. Individuals, primarily women, received callings to become healers, and novice practitioners would dance in the assembly halls. The healers provided cures for both natural and spiritual sickness, including witchcraft.

The fundamental economy of the Patwin was one of subsistence fishing, hunting, and collecting plant foods (Johnson 1978:355–357). Like the majority of native Californians, the Patwin relied on acorns, collected in the fall, as the staple food. The Patwin preferred the hill and mountain oak species, but live

oak was used in a pinch. Oak groves were owned communally by the tribelet. Buckeye was second in importance to acorns. Additional dietary plants included manzanita, juniper berries, pine nuts, black berries, wild grapes, brodiaea bulbs, tule roots, and a variety of greens. Seeds were harvested from sunflower, alfalfa, clover, bunchgrass, and wild oat. Their traditional homelands included villages along the Sacramento River; Cache, Putah, and Ulas Creeks; and Suisun and San Pablo Bays. This proximity to fresh and saltwater provided many resources, including fish, waterfowl, turtle, and shellfish. Two designs of pole nets were used to land salmon, perch, chub, sucker, hardhead, pike, trout, and probably steelhead. Waterfowl, including ducks and geese, and land birds, such as quail and mud hen, also were taken. Large game included tule elk, deer, pronghorn, and bear. Grasshoppers, quail, and rabbits were hunted communally by burning grassland and encircling the prey with large nets.

To gather, collect, and process food resource, the Patwin used a wide variety of tools, implements, and enclosures (Johnson 1978:356–357). These included (1) bows and arrows, spears, traps, nets, slings, and blinds for hunting land mammals and birds, and (2) bone harpoons, hooks, nets, and weirs, for fish. Pole-propelled rafts were used to traverse rivers and bays. Woven tools—seed beaters, burden baskets, rope, and carrying nets—and sharpened digging sticks were used to collect plant resources. For processing food, a variety of tools were used, including bedrock mortars, portable mortars (predominantly basket hopper mortars) and pestles, stone knives, mussel shell knives, stone scrapers, and a variety of bone tools. The Patwin produced both closework and openwork twined baskets.

The Patwin had extensive contacts with Franciscan missionaries starting in the late 1700s, since many Patwin were brought to the San Francisco, San Jose, and Sonoma missions around San Francisco Bay. While mission life did give the Patwin some skills needed to survive in a rapidly changing world, considerable amounts of traditional cultural knowledge were lost during this era, largely due to population decimation brought on by introduced diseases for which the people had no immunity.

Around the San Francisco Bay region, retired soldiers were given vast tracts of land by the Spanish authorities, partitioned from the Native Americans' traditional hunting and gathering territories. The colonists enlisted the labor of the indigenous population to work their fields and cattle herds. Over time, the Spanish *ranchos* were operated as virtually self-contained economic units. The Native Americans (both neophytes from the disintegrating missions and *cimarrones*, or gentile Indians) became the new generation of workers, soldiers, artisans, peons, and *vaqueros*, the laborers who maintained the rancheros and their ranchos. After a period of neglect resulting from the loss of Spanish control following the Mexican revolution in 1812, government control of California shifted to Mexico in 1821. In 1834, the missions formally were secularized, and in subsequent years, the formerly extensive mission lands were divided into private land grants claimed by the growing ranchero class. With the coming of Euro-Americans after the Mexican–American War of 1846, there was a vast migration of farmers to California. Still used as laborers in new communities through the 1870s, the local native population was soon a tiny minority often lumped together with the Mexican-American community.

Pre-contact estimates of Patwin population are in the several thousands. After the ravages of disease, war, and displacement, by 1906 the number of Patwin was placed at a mere 185 (Johnson 1978:353). By 1972, the Bureau of Indian Affairs recorded only 11 tribal members. Surviving families most likely joined and married into other surviving native groups. Today, there are over 2,500 people of Wintun descent (White 2005), which includes the Patwin, Nomlaki, and Wintu. Many live on the Colusa, Cortina, Grindstone, Redding, and Rumsey *rancherias* in Colusa, Glenn, Shasta and Yolo Counties, as well as the Round Valley Reservation in Mendocino County.

Historic Overview

Post-contact history for the state of California generally is divided into three periods: the Spanish period (1769–1822), the Mexican period (1822–1848), and the American period (1848–present). Although there were brief visits by Spanish, Russian, and British explorers from 1529–1769, the beginning of Spanish settlement in California occurred in 1769 with the establishment of Mission San Diego, one of the 21 missions established from 1769–1823. Beginning when news of the successful revolution by Mexico against the Spanish crown reached California in 1822, the Mexican period is marked by an extensive era of land grants, most of which were in the interior of the state, and by exploration by American fur trappers west of the Sierra Nevada Mountains.

With the signing of the Treaty of Guadalupe Hidalgo in 1848, ending the Mexican–American War, California became a territory of the United States. The discovery of gold in 1848 at Sutter's Mill near Sacramento and the resulting Gold Rush era influenced the history of the state and the nation. The rush of tens of thousands of people to the gold fields also had a devastating impact on the lives of indigenous Californians, with the introduction and concentration of diseases, the loss of land and territory, including traditional hunting and gathering locales, violence, malnutrition, and starvation. Thousands of settlers and immigrants continued to pour into the state, particularly after the completion of the transcontinental railroad in 1869.

With continued growth, California continues to be a national leader in agriculture and poultry production, ranching (cattle and sheep), aerospace and communications industries, as well as the film and entertainment business. The wealth of California's natural resources (e.g., lumber, petroleum deposits, minerals, fish) also continues to contribute to its growth and development.

Yolo County

Yolo County is one of the original 27 California counties created in 1850 (Gudde 1998:430; Hoover et al. 2002:567). The county encompasses approximately 1,014 square miles and is located in the southwestern extent of the Sacramento Valley. The name *yolo* is said to be a derivation of a Patwin term for "a place abounding in rushes." The county seat is in Woodland. The area is the traditional homeland of the Patwin or Southern Wintun people, whose first encounter with the Spanish was with an 1808 expedition led by Gabriel Moraga up the Sacramento River. In 1817, Luis Arguello led another Spanish expedition up the Sacramento River in 1817, and in 1821, he led the last official Spanish overland expedition through areas that are now Colusa, Solano, and Yolo Counties. Between 1842 and 1846, the Mexican government deeded nine land grants in present-day Yolo County. Though originally settled during the gold rush, agriculture soon became the principal economic pursuit of the area and remains so today.

Zamora

Located approximately 2.5 miles southwest of the study area, Zamora was founded in 1875 by Illinois farmer James Black. The settlement was initially known as Blacks Station, and when the Northern Railroad was extended through the area the following year, Black filed the plat for a seven-block town site. With access to rail service, farmers were able to ship their products greater distances, and by 1890, a number of warehouses had been built along the railroad to process and store grain (Pacific Legacy, Inc. 2005:6). The town was renamed to Zamora following Black's death 1906, although maps from as late as 1941 still refer to the post office as Blacks Station (U.S. Army Corps of Engineers 1941). While the population of the Zamora was never large, the development of the four-lane Interstate 5 through the center of the commercial district in 1969 would significantly affect the community (Pacific Legacy, Inc. 2005:6).

BACKGROUND RESEARCH

California Historical Resources Information System Records Search

On July 24, 2012, a search was requested of the California Historical Resources Information System (CHRIS) at the Northwest Information Center (NWIC), located at Sonoma State University in Sonoma, California. The search included any previously recorded cultural resources and investigations within a 1-mile radius of the APE. The CHRIS search also included a review of the NRHP, the CRHR, the California Points of Historical Interest (CPHI) list, the California Historical Landmarks (CHL) list, the Archaeological Determinations of Eligibility (ADOE) list, and the California State Historic Resources Inventory (HRI) list. Additionally, the records search included a review of historic maps covering the study area. A letter dated July 30, 2012, from the NWIC summarizing the results of the records search and providing a bibliography of prior cultural resources studies is provided in Appendix A of this report.

The APE was expanded to include the western, isolated well pad site shortly after the initial CHRIS search. Because the expanded study area is situated near the southwestern boundary of the initial search, an additional records search was requested to identify any previously recorded cultural resources and investigations within a 1-mile radius of the enlarged study area. A letter dated November 27, 2012, from the NWIC summarizing these results is also included in Appendix A of this report.

Prior Cultural Resources Studies within 1 Mile of the APE

The records searches identified two prior cultural resources studies within 1 mile of the APE (Table 1). Of this total, one (S-30411) was conducted within the project area; a brief summary of this study is provided in the paragraph that follows. Additionally, an unmapped study (S-9795) is located within the records search area, but it was classified by the NWIC as an "Other Report," with little or no fieldwork and/or missing maps or inadequate locational information.

Table 1. Prior Cultural Resources Studies within 1 Mile of the APE

NWIC Report No.	Title of Study	Author	Year	Proximity to the Project Area
S-017949	Cultural Resources Inventory for the Colusa Basin/Knights Landing Ridge Cut Levees Project, Colusa and Yolo Counties California, Contract No. DACWO59P1469	Shapiro, Lisa A.	1992	Outside
S-030411	Cultural Resources Survey for Natural Resources Conservation Services, Knagg Farms	Pacific Legacy, Inc.	2005	**Within**

S-03411

In 2005, Pacific Legacy, Inc. prepared *Cultural Resources Survey for Natural Resources Conservation Services Knagg Farms* for the United States Department of Agricultural (USDA), Natural Resources Conservation Service. Covering approximately 2,896 acres through the privately owned Knagg Farms, the cultural resources assessment included a literature and records search at the NWIC, a search of the Native American Heritage Commission's (NAHC's) Sacred Lands File (SLF) and consultation with local Native American contacts, and an intensive pedestrian survey. As a result of the survey, a single isolated chert biface was discovered (P-57-000518) within the boundaries of the current APE and is described in the paragraphs that follow. The study determined it unlikely, however, that cultural deposits exist within

the project boundaries, which includes the current study area in its entirety, and found the potential for uncovering archaeological artifacts of cultural soil deposits to be low.

Previously Recorded Cultural Resources within 1-mile of the APE

The records searches identified two previously recorded cultural resources within 1 mile of the APE (Table 2). Of these, one (P-57-000518) was identified within the APE.

Table 2. Previously Recorded Cultural Resources within 1 Mile of the APE

Primary No.	Trinomial	Resource Description	California Historical Resource Status Codes	Recorder and Year	Proximity to Project Area
P-57-000143	CA-YOL-186H	Colusa drainage canal	7N	N/A (linear feature)*	Outside
P-57-000518	–	Chert biface	6Z	O'day, Sharyn J., 2005	**Within**

6Z = Found ineligible for NRHP, CRHR, or local designation through survey evaluation.
7N = Needs to be revaluated.
*Segments of the resource have been recorded at various times by a number or recorders.

P-57-000518

Recorded within the current APE on the access road, P-57-000518 is an opaque red chert biface measuring 5.5 × 3.2 × 1.2 cm that was identified during the 2005 study titled *Cultural Resources Survey for Natural Resources Conservation Services Knagg Farms* (S-030411). The biface was discovered in the middle of the dirt access road located north of County Road (CR) 12 and between CR 95 and CR 96 and was described as featuring milky white and black angled striations and a thin cortex/patina covering the sides. No other cultural materials were found in association with the artifact and after it was recorded and photographed, it was returned to the exact place where it was discovered.

Historic Map Review

A review of historic maps reveal two built cultural resources were once located within the current study area. An 1864 General Land Office (GLO) Plat Map of Township 11 North, Range 1 East depicts a store situated at the corner of present-day CR 12 and the dirt access road between CA 95 and CA 96, and a board fence a short distance to the north. By 1907, these resources were no longer extant, as seen in a 1907 U.S. Geological Survey map of the Dunnigan quadrangle. A U.S. Army Corps of Engineers map from 1931 confirms that the area remained rural through the twentieth century.

Sacred Lands File Search and Initial Native American Coordination

Native American coordination was initiated for this project on August 2, 2012. As part of the process of identifying cultural resources in or near the study area, the NAHC was contacted to request a review of the Sacred Lands File (SLF). The NAHC faxed a response on August 9, 2012 (Appendix B), and stated that Native American cultural resources were not identified within 0.5 mile of the study area, but noted that it is always possible for cultural resources to be unearthed during construction activities. The NAHC also provided a contact list of seven Native American individuals or tribal organizations that may have knowledge of cultural resources in or near the APE. SWCA prepared and mailed letters to each of the NAHC-listed contacts on August 10, 2012, requesting information regarding any Native American cultural resources in or immediately adjacent to the study area.

One follow-up phone call was made to each Native American contact on August 24, 2012. No additional responses have been received to date. A complete record of Native American coordination to date is provided in Table 3.

After initial Native American Coordination, the APE was expanded from two well pad locations to include a third well pad location. SWCA contacted the NAHC to determine if an additional review of the SLF was necessary. While the NAHC confirmed a new search of the SLF was not needed, they recommend that letters be sent to the previously-identified seven Native American individuals or tribal organizations. SWCA prepared letters and mailed them to each of the NAHC-listed contacts on November 26, 2012 to request information regarding any Native American cultural resources in or immediately adjacent to the expanded study area. Because the study area did not change significantly and a limited amount of time had passed since initial coordination efforts were completed, SWCA did not make follow-up phone calls.

Table 3. Record of Native American Coordination Efforts

NAHC-provided Contact	Coordination Efforts	Results of Coordination Efforts
Wintun/Patwin P.O. Box 1047 Wheatland, California 95692 Contact: Kesner Flores	**8/10/12:** Letter sent via U.S. Mail. **8/24/12:** Mr. Flores stated that he had no concerns with the project, but requested he be contacted should any artifacts be discovered during construction activities. **11/26/12:** Letter sent via U.S. Mail.	No further action required.
Cortina Band of Indians P.O. Box 1630 Williams, California 95987 Contact: Charlie Wright, Chairperson	**8/10/12:** Letter sent via U.S. Mail. **8/24/12:** Mr. Wright's assistant stated that he had no concerns regarding the project. **11/26/12:** Letter sent via U.S. Mail.	No further action required.
Cortina Wintun Environmental Protection Agency P.O. Box 1630 Williams, California 95987	**8/10/12:** Letter sent via U.S. Mail. **8/24/12:** An assistant to Chairperson Charlie Wright stated that the Cortina Band of Mission Indians had no concerns regarding the project. **11/26/12:** Letter sent via U.S. Mail.	No further action required.
Yocha Dehe Wintun Nation P.O. Box 18 Brooks, California 95606 Contact: Marshall McKay, Chairperson	**8/10/12:** Letter sent via U.S. Mail. **8/24/12:** Left a voicemail. **11/26/12:** Letter sent via U.S. Mail.	No further action required.

Table 3. Record of Native American Coordination Efforts

NAHC-provided Contact	Coordination Efforts	Results of Coordination Efforts
Yocha Dehe Wintun Nation P.O. Box 18 Brooks, California 95606 Contact: Leland Kinter, Native Cultural Renewal Committee	**8/10/12:** Letter sent via U.S. Mail. **8/24/12:** Left a message with the receptionist at the Yocha Dehe Wintun Nation. **11/26/12:** Letter sent via U.S. Mail.	No further action required.
Yocha Dehe Wintun Nation P.O. Box 18 Brooks, California 95606 Contact: Cynthia Clarke, Native Cultural Renewal Committee	**8/10/12:** Letter sent via U.S. Mail. **8/24/12:** Left a message with the receptionist at the Yocha Dehe Wintun Nation. **11/26/12:** Letter sent via U.S. Mail.	No further action required.
Yocha Dehe Wintun Nation P.O. Box 18 Brooks, California 95606 Contact: Reno Franklin, Cultural Resources Director	**8/10/12:** Letter sent via U.S. Mail. **8/24/12:** Left a voicemail. **11/26/12:** Letter sent via U.S. Mail.	No further action required.

METHODS

SWCA Cultural Resources Specialist Kristin Rugroden, M.A., accompanied by Project Manager Anna Kopitov, conducted an intensive-level pedestrian survey on August 3, 2012, in order to identify any archaeological or historic built environment resources (i.e., buildings, structures, and objects) that may occur within the study area. SWCA Cultural Resource Specialists Sara Ferland and Ryan Glenn conducted an additional intensive-level survey on November 29, 2012 to identify any archaeological or historic built environment resources that may occur within the expanded study area.

The entire study area was surveyed by walking linear transects spaced no more than 15 m (49 feet) apart. The ground surface was examined for the presence of prehistoric artifacts (e.g., flaked stone tools, tool-making debris, stone milling tools), historic artifacts (e.g., metal, glass, ceramics), sediment discoloration that might indicate the presence of a cultural midden, and depressions and other features indicative of the former presence of structures or buildings (e.g., post holes, foundations). A Trimble global positioning system (GPS) receiver with sub-meter accuracy was used to maintain transect accuracy and to record the location of cultural resources in the project area.

SWCA cultural resource specialists documented their fieldwork using a field notebook, digital camera, close-scale field maps, and aerial photographs. Copies of the field notes and digital photographs are on file at the SWCA Pasadena office.

RESULTS

During the intensive-level field surveys for cultural resources, ground visibility varied from poor to very good (between 0% and 90%). In addition to heavy vegetation, one portion of the study area, approximately 2.3 hectares (5.7 acres), was being used for rice cultivation at the time of the survey and could not be surveyed due to standing water (Figures 7–9). Ground visibility was improved in other areas of the study area; however they were often heavily disturbed due the construction of the access road and agricultural activities (Figures 9 and 10).

SWCA did not relocate the two resources identified during the literature and records search as being present within the APE. Archaeological isolate P-57-000518, a chert biface that was recorded in 2005 was not relocated, as was any evidence of a store and fence that appear on a GLO map from 1864.

One potential resource, a utility line, was identified within the APE. Running an east-west course, a wood pole utility line with inspection tags dating to the 1990s was identified along the north side of County Road 12. Archival research, including review of historic aerial photographs and topographic maps, failed to indicate that the line is old enough to warrant recordation. This line is therefore exempt from further consideration.

One archaeological resource was identified within the APE as a result of the intensive-level survey. Located on the access road, isolate SWCA-CAES-01 is a tertiary flake of chert measuring approximately 2 × 2.5 × 0.75 cm (Figures 12 and 13). The flake exhibits unifacial retouch along one edge. The chert is mostly black with a thin strip of green across the short axis. Two flake scars are present on the dorsal side, and no evidence of cortex was observed. Possibly due to its location on an access road, the flake displays battering. No additional artifacts or other cultural materials were found in association with SWCA-CAES-01, which may have been deposited in the road during construction of the road or in the course of adjacent farming activities. This flake is located more than 1,000 m (3,280 feet) north of the recorded location of isolated biface P-57-00518. There is no evidence that these isolates are a part of an archaeological site. After it was recorded and photographed, the object was returned to the location where it was discovered.



Figure 7. Survey coverage map.



Figure 8. Portion of the study area that was unable to be surveyed; view to the southeast.



Figure 9. Heavy vegetation within the study area; view to the west.



Figure 10. Vegetation and disturbed areas within the study area; view to the northeast.



Figure 11. Portion of the study area disturbed due to agricultural activities; view to the west.

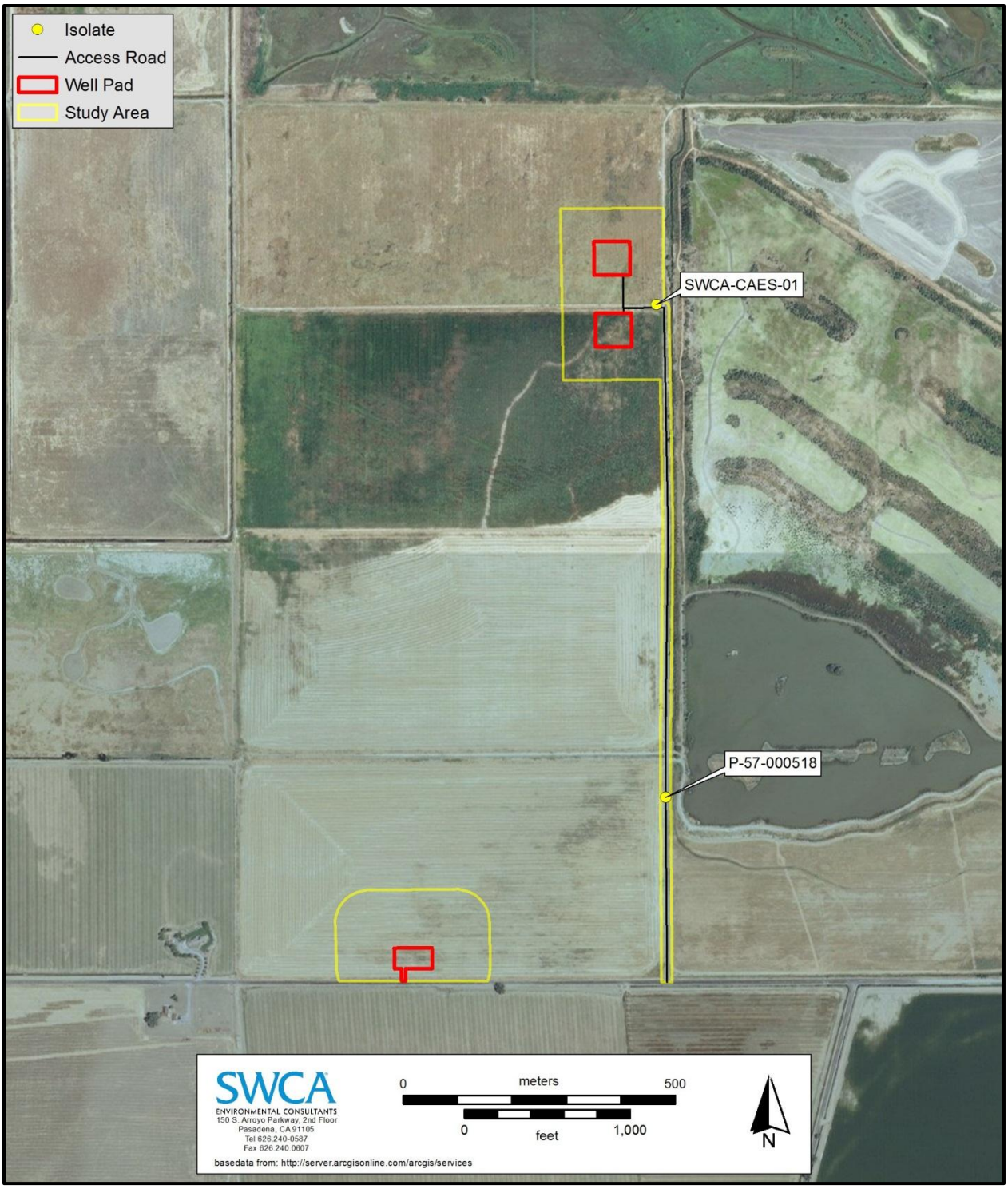


Figure 12. Cultural resources map.



Figure 13. Detail of SWCA-CAES-01.

DISCUSSION AND RECOMMENDATIONS

Discussion

The goal of this study is to identify cultural resources within the PG&E CAES - Zamora project area and provide management recommendations for those resources. The results of the literature and records search indicated that the study area had been surveyed by qualified archaeologists in 2005; and while the survey identified and recorded a single isolated chert biface (P-57-00518), the area was found unlikely to possess intact cultural deposits. Additionally, the 2005 study suggests the area surrounding the current study area has always been subject to flooding and was likely too wet and swampy for any permanent habitation by the Patwin (Pacific Legacy, Inc. 2005) during the later prehistoric and early historic periods. As a result of these considerations, no further archaeological work was recommended by Pacific Legacy, Inc.

During the course of the current study, one isolate, SWCA-CAES-01, was identified as a result of the cultural resources survey. The origin of this unifacial chert flake is unknown, and it could have been imported with fill for construction of the access road or through agricultural activities. A single isolate does not inherently indicate an increased potential for buried archaeological sites. Furthermore, SWCA-CAES-01was discovered approximately 1,000 m (3,280 feet) to the north of P-57-00518 (which could not be located during the current study), suggesting that the isolates are not elements of a single intact cultural deposit. While a wood pole utility line was also identified during the course of the cultural resources survey, archival research, including review of historic aerial photographs and topographic maps, and dated inspection tags, failed to indicate that it was old enough to warrant recordation.

Recommendations

While a portion of the study area was unable to be surveyed due to standing water and other portions were characterized by poor ground visibility, the project area is significantly disturbed due to ongoing agricultural activities, which are likely to have exposed any substantial archaeological resources. Additionally, although the current study and a study from 2005 each identified an archaeological isolate, neither appears to have been part of an intact cultural deposit. Consequently, the likelihood of discovering additional archaeological resources is low, and SWCA recommends no further cultural resources work.

However, ground disturbance associated with the proposed project does have some potential to impact previously unrecorded cultural resources. SWCA recommends that the following measures be taken to identify additional cultural resources within the project area, to prevent or reduce the significance of project-related impacts to cultural resources and to satisfy the requirements of Section 106 and CEQA.

Inadvertent Discovery of Cultural Resources

In the event that cultural resources are exposed during ground-disturbing activities, construction activities (e.g., grading, grubbing, or vegetation clearing) should be halted immediate near the discovery. An archaeologist who meets the Secretary of the Interior's Professional Qualifications Standards (National Park Service 1983) should then be retained to evaluate the find's significance under CEQA. If the discovery proves to be significant, additional work, such as data recovery excavation, may be warranted and should be discussed in consultation with the lead agency.

Inadvertent Discovery of Human Remains

The discovery of human remains is always a possibility during ground disturbances; State of California Health and Safety Code Section 7050.5 addresses these findings. This code section states that no further disturbance shall occur until the Yolo County Coroner has made a determination of origin and disposition pursuant to PRC Section 5097.98. The Coroner must be notified of the find immediately. If the human remains are determined to be prehistoric, the Coroner will notify the NAHC, which will determine and notify a Most Likely Descendant (MLD). The MLD shall complete the inspection of the site within 48 hours of notification and may recommend scientific removal and nondestructive analysis of human remains and items associated with Native American burials.

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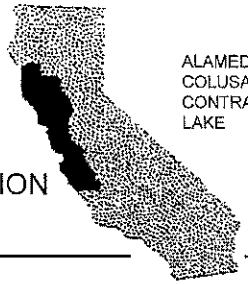
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Appendix A

Records Search Results Summary from NWIC

CALIFORNIA
HISTORICAL
RESOURCES
INFORMATION
SYSTEM



ALAMEDA
COLUSA
CONTRA COSTA
LAKE
MARIN
MENDOCINO
MONTEREY
NAPA
SAN BENITO
SAN FRANCISCO
SAN MATEO
SANTA CLARA
SANTA CRUZ
SOLANO
SONOMA
YOLO

Northwest Information Center
Sonoma State University
150 Professional Center Drive, Suite E
Rohnert Park, California 94928-3609
Tel: 707.588.8455
Email: leigh.jordan@sonoma.edu
http://www.sonoma.edu/nwic

Date: 30 July 2012 NWIC File No.: 12-0083

To: Steven Treffers, SWCA Environmental Consultants, 150 S. Arroyo Parkway, 2nd Floor, Pasadena, CA 91105

From: Lisa Hagel

re: PG&E CAES Project (Project #023910.00)

Eldorado Bend 7.5'

Resources In	There were no recorded sites within the project area.
Resources within one-mile radius	P-57-143 & 518 are within one mile. Enclosed are copies of the site record forms. The resource locations are plotted on your map.
Reports In	S-30411 included the project location. Enclosed is a copy of the report. The study location is plotted on your map.
Reports within one-mile radius	S-17949 is within one mile. Enclosed is a bibliographic reference for the report. The study location is plotted on your map.
Other Reports	One report is classified as an "Other Report" (reports with little or no field work and/or missing maps or inadequate locational information) that includes your search area: S-9795. Enclosed is a bibliographic reference for the report.
OHP HPD	Copied the indices for Zamora and the index page that includes the Colusa Drainage Canal.
OHP ADOE	The above referenced recorded sites did not appear in the Archaeological Determinations of Eligibility.

CA Inventory	There were no properties in the vicinity of the project.
Caltrans Bridge Inventory	n/a
Historic Maps	Copied the pertinent sections of the 1907 USGS Dunnigan Quadrangle and the 1941 US Army Corps of Engineers, Dunnigan Quadrangle.
GLO or Rancho Plat Maps	Copied the pertinent section of the 1864 GLO Plat Map for T11N, R1E.

Northwest Information Center Report Detail Record: S-009795

Previous designation(s):

PDF file: \\SVR01\library\pdf-library\reports\9795.pdf

Citation Information

Authors: Thomas Lynn Jackson

Year: 1986

Title: Late Prehistoric Obsidian Exchange in Central California

Originator: Stanford University

No. Pages: 279

Report Type(s): Dissertation
Regional overview

No.Resources: 36

No. Informal:

Collections:

Accession No.:

Facility:

Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-06-000025		CA-COL-1	S-1 Miller
P-07-000047		CA-CCO-30	
P-07-000080		CA-CCO-138	C-138
P-07-000188		CA-CCO-312	
P-07-000440		CA-CCO-259	BARKER'S RODEO
P-17-000320		CA-LAK-305	
P-17-000601		CA-LAK-702	1
P-21-000163		CA-MRN-138/H	NELSON NO. 138
P-21-000218		CA-MRN-193/H	Nelson No. 193
P-21-000235		CA-MRN-216/H	DNG-1
P-21-000242		CA-MRN-232/H	PB 232B
P-21-000283		CA-MRN-298/H	DNG-2
P-21-000290		CA-MRN-307/H	PROBABLY 232 C
P-21-000368		CA-MRN-402	
P-21-000423		CA-MRN-471	SAN JOSE VILLAGE
P-21-000628		CA-MRN-201	
P-23-001589		CA-MEN-1704	TCIYA
P-23-001659		CA-MEN-1844	MEN X
P-23-003068		CA-MEN-1809	Men-1704S
P-23-003119		CA-MEN-1929	
P-28-000015		CA-NAP-1	#1; Goddard; Oakville
P-28-000068		CA-NAP-65	#65
P-28-000199		CA-NAP-234	ROY PRIDMORE #3
P-28-000205		CA-NAP-240	BIG BASIN NO. 1
P-28-000828		CA-NAP-32	#32; Kolb; Rutherford; Pistorias
P-49-000135		CA-SON-159	
P-49-000360		CA-SON-389	
P-49-000423		CA-SON-455/H	Gables Site
P-49-000424		CA-SON-456	
P-49-000518		CA-SON-553	
P-49-000521		CA-SON-556	H-41
P-49-000533		CA-SON-568	
P-49-000536		CA-SON-571	
P-49-000558		CA-SON-593/H	SON-3 (SFSC)
P-49-000801		CA-SON-860/H	
P-57-000114		CA-YOL-139	ELATION HILL

Notes

PhD dissertation. Not-mappable report.

Northwest Information Center Report Detail Record: S-009795

Location Info

County(ies): Colusa
Contra Costa
Lake
Marin
Mendocino
Napa
Solano
Sonoma
Yolo

USGS 7.5' Quads: Albion
Benicia
Big Foot Mtn
Brentwood
Capell Valley
Clayton
Cloverdale
Cotati
Drakes Bay
Glen Ellen
Jericho Valley
Kirkville
Knoxville
Las Trampas Ridge
Mt George
Navarro
Novato
Petaluma River
Rutherford
San Geronimo
Santa Rosa
Sebastopol
Tomales
Upper Lake
Warm Springs Dam
Wilbur Springs

Address:

Database Record Metadata

	Date	*User*
Entered:	4/7/2005	nwic-main
Last Modified:	6/8/2012	hagell

IC Actions:	*Date*	*User*	*Action taken*
	4/7/2005	jay	Appended records from NWICmain bibliographic database.

Record Status:
Date Mapped:

Northwest Information Center Report Detail Record: S-017949

Previous designation(s):
PDF file: None

Citation Information

Authors: Lisa A. Shapiro
Year: 1992
Title: Cultural Resources Inventory for the Colusa Basin/Knights Landing Ridge Cut Levees Project, Colusa and Yolo Counties, California, Contract No. DACWO591P1469.
Originator: PAR Environmental Services, Inc.
No. Pages: 103
Report Type(s): Archaeological survey
No.Resources: 5
No. Informal: 0
Collections:
Accession No.:
Facility:
Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-06-000203		CA-COL-219H	AC-S-5
P-06-000586		CA-COL-298H	Southern Pacific Railroad
P-57-000141		CA-YOL-184H	AC-S-2
P-57-000142		CA-YOL-185H	AC-S-4
P-57-000143	5645-0002-0000	CA-YOL-186H	Colusa Drainage Canal and Knights Landin

Notes

The Colusa Drainage Canal runs through Colusa and Yolo counties, so it received two primary numbers (P-06-203 & P-57-143).

Location Info

County(ies): Colusa
Yolo
USGS 7.5' Quads: Arbuckle
Colusa
Dunnigan
Eldorado Bend
Grays Bend
Grimes
Knights Landing
Zamora
Address:

Database Record Metadata

	Date	*User*
Entered:	4/7/2005	nwic-main
Last Modified:	7/27/2012	hagell

IC Actions:	*Date*	*User*	*Action taken*
	4/7/2005	jay	Appended records from NWICmain bibliographic database.

Record Status:
Date Mapped:

Northwest Information Center Report Detail Record: S-030411

Previous designation(s):
PDF file: None

Citation Information

Authors: Pacific Legacy, Inc.
Year: 2005
Title: Cultural Resources Survey for Natural Resources Conservation Services, Knagg Farms.
Originator: Pacific Legacy, Inc
No. Pages: 33
Report Type(s): Archaeological survey
No.Resources: 1
No. Informal:
Collections:
Accession No.:
Facility:
Disclosure: Not for publication

Associated Resources

Primary No.	*HRI No.*	*Trinomial*	*Name*
P-57-000518			KF-ISO-1

Notes

P-57-143 (the Colusa Basin Drainage Canal) is adjacent to the project boundaries.

Location Info

County(ies): Yolo
USGS 7.5' Quads: Eldorado Bend
Address:

Database Record Metadata

	Date	*User*
Entered:	9/13/2005	kellyn
Last Modified:	7/27/2012	hagell
IC Actions:		
Record Status:		
Date Mapped:		

CALIFORNIA HISTORICAL RESOURCES INFORMATION SYSTEM

ALAMEDA
COLUSA
CONTRA COSTA
LAKE
MARIN
MENDOCINO
MONTEREY
NAPA
SAN BENITO
SAN FRANCISCO
SAN MATEO
SANTA CLARA
SANTA CRUZ
SOLANO
SONOMA
YOLO

Northwest Information Center
Sonoma State University
150 Professional Center Drive, Suite E
Rohnert Park, California 94928-3609
Tel: 707.588.8455
nwic@sonoma.edu
http://www.sonoma.edu/nwic

Date: 27 November 2012 NWIC File No.: 12-0509

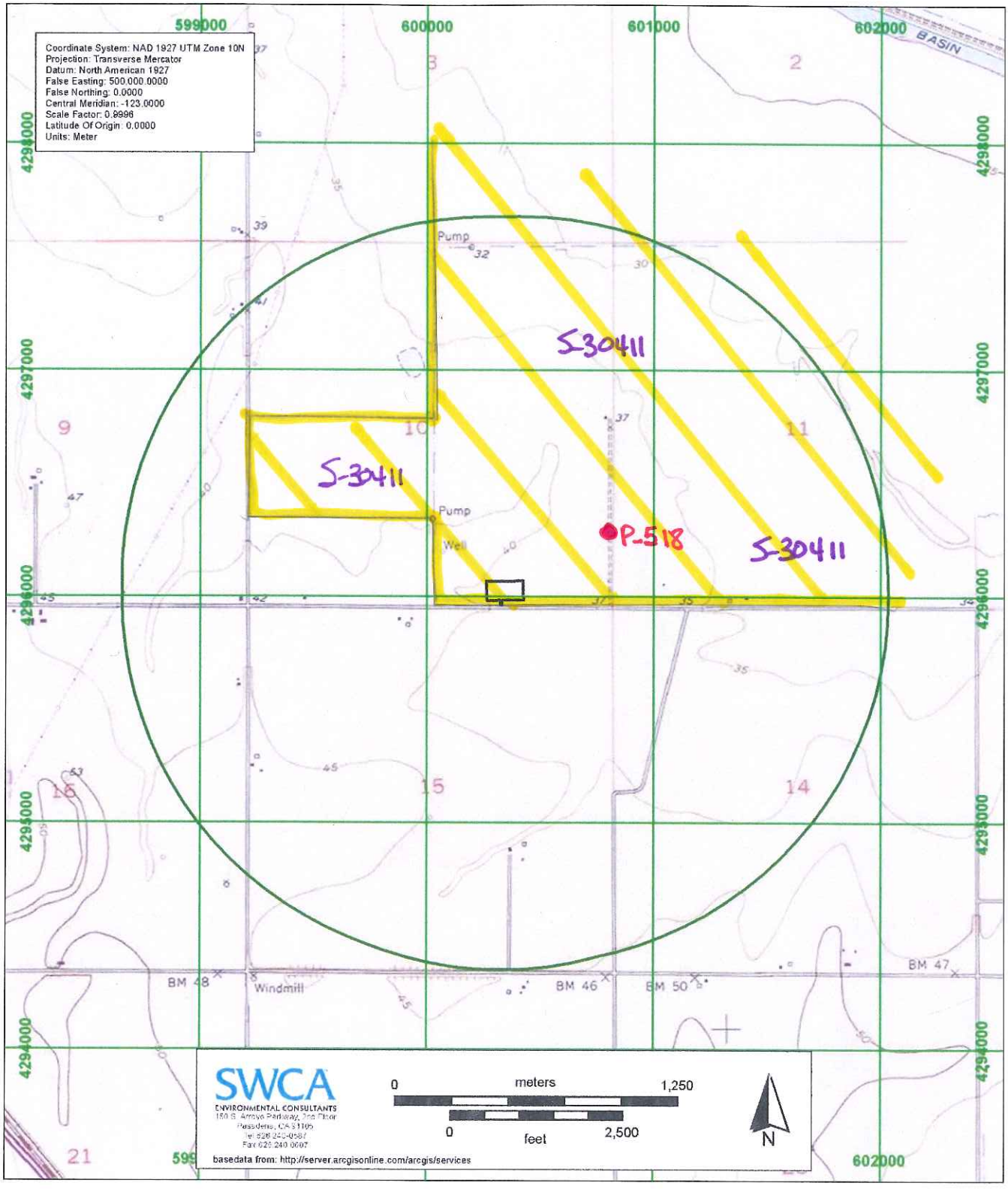
To: Steven Treffers, SWCA Environmental Consultants, 150 S. Arroyo Parkway, 2nd Floor, Pasadena, CA 91105

From: Lisa Hagel

re: PG&E CAES Project (Project #023910.00)

Eldorado Bend 7.5'

Resources In	There were no recorded sites within the project area.
Resources within one-mile radius	P-57-518 is within one mile. The site location is plotted on your map. A copy of the site record form was sent to you as part of the previous records search (12-0083).
Reports In	S-30411 includes the project area. The study location is plotted on your map. A copy of the report was sent to you as part of the previous records search.
Reports within one-mile radius	There were no additional studies within one mile.
Other Reports	One report is classified as an "Other Reports" (reports with little or no field work, missing maps, or inadequate locational information) that includes your search area: S-9795. A bibliographic reference for the report was sent to you as part of the previous records search.
OHP HPD	Copied for the previous records search.
OHP ADOE	n/a
California Inventory	n/a
Historic Maps, GLO & Rancho Plat Maps	Copied for the previous records search.


Coordinate System: NAD 1927 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1927
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -123.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
599000
600000
601000
602000
4298000
4297000
4296000
4295000
4294000
BASIN
Pump
Well
Windmill
BM 48
BM 46
BM 50
BM 47
S-30411
S-30411
S-30411
P-518
SWCA
ENVIRONMENTAL CONSULTANTS
0 meters 1,250
0 feet 2,500
N
basedata from: http://server.arcgisonline.com/arcgis/services

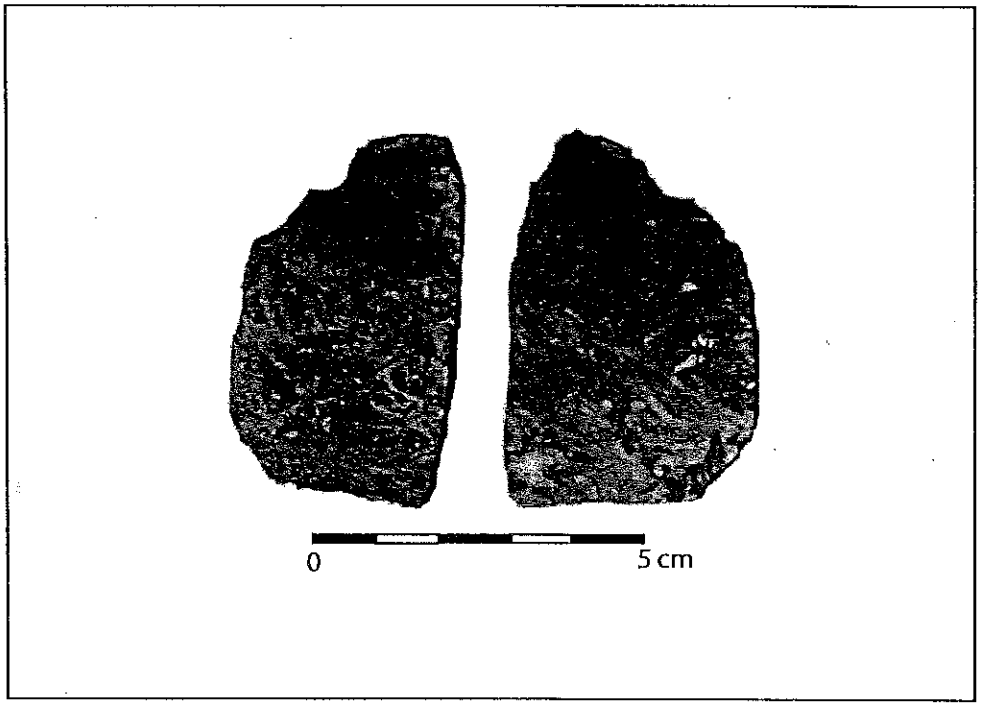
State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary #P-57-000518
HRI #
Trinomial
NRHP Status Code
Other Listings
Review Code Reviewer Date

Page 1 of 2 *Resource Name or #: (Assigned by recorder) KF - ISO-1
P1. Other Identifier:
*P2...Location: ☒ Not for Publication ☐ Unrestricted *a. County Yolo
and (P2c, P2e, and P2b or P2d. Attach a Location Map as necessary.)
*b. USGS 7.5' Quad Eldorado Bend Date 1952, PR 1973 T 11N ; R 1E; SE ¼ of SE ¼ of Sec 10 ; MD B.M
c. Address (#5304) City Zip
d. UTM: Zone 10 , 600809 mE/ 4296298 mN (Terrain Navigator Pro 2005; National Geodetic Vertical Datum 1929 and the North American Datum 1927)
e. Other Locational Data: From Sacramento follow Interstate 5 north to the Zamora exit. Veer right and take a right onto frontage road E10. Follow County Road E10 east to Rd. 96. Take County Road 96 to Rd, 12. Follow Rd. 12 west and go right onto the first access dirt road, pass a gate. Follow dirt road approximately 150 meters north. The isolate is located in the middle of the access road.

*P3a. Description: This is a red chert opaque biface measuring 5.5 cm x 3.2 cm x 1.2 cm. The chert has natural milky white and black colored random angled striations fanning through it with a thin cortex/patina covers the sides. Overall the piece is flattened and long. The edges exhibit bifacial flaking along its margins. The object displays no obvious recent fractures or battering caused by agricultural activities, despite its location in the middle of the dirt access road. This isolate was not found in association with any other material culture or artifacts.

*P3b. Resource Attributes: (List attributes and codes) AP16—other/isolate
*P4. Resources Present: ☐Building ☐Structure ☐Object ☐Site ☐District ☐Element of District ☒Other: Isolate



P5b. Description of Photo: Photo of biface. Records kept at PLI.

*P6. Date Constructed/Age and Source:
☒ Prehistoric ☐ Historic ☐ Both

*P7. Owner and Address:
Denton Kelly. Sacramento, CA

*P8. Recorded by:
Sharyn Jones O'Day
Pacific Legacy, Inc
3801 Alhambra Drive
Cameron Park, CA 95682

*P9. Date Recorded: 5/23/05

*P10. Survey Type:
Intensive Inventory

*P11. Report Citation: Cultural Resources Survey for Knagg Farms Wetlands Reserve Program Easement in Yolo County, California

*Attachments: ☐NONE ☒Location Map ☐Sketch Map ☐Continuation Sheet ☐Building, Structure, and Object Record ☐Archaeological Record ☐District Record ☐Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ☐ Other (List):

AUG - 1 2006

State of California - The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

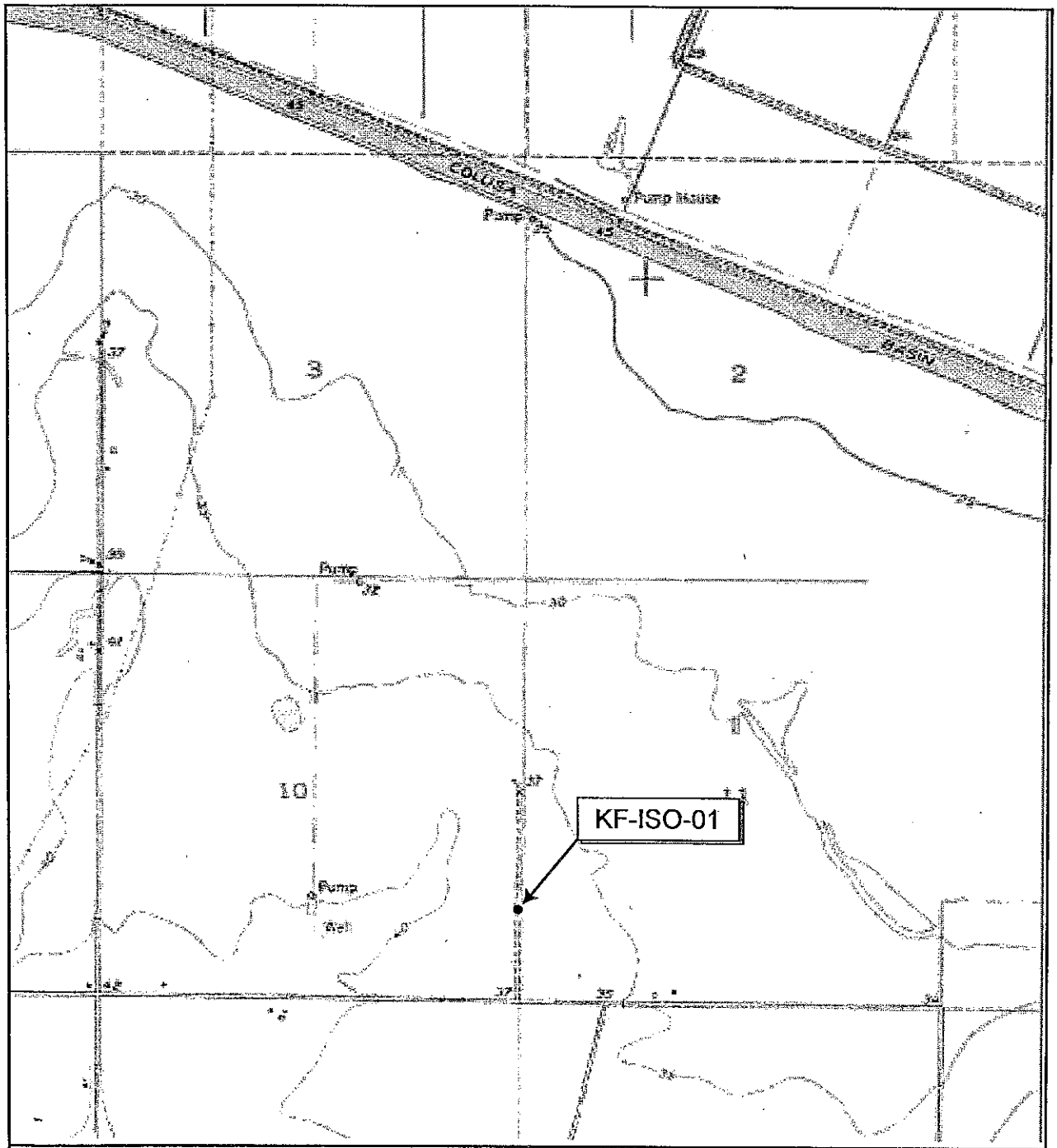
LOCATION MAP

Primary #: P-57-000518
HRI #:
Trinomial:

Page 2 of 2

*Resource Name or # (Assigned by recorder) KF-ISO-01

*Map Name: USGS 7.5' Eldorado Bend, CA *Scale: 1:24,000 *Date of Map: 1952 (PR 1973)



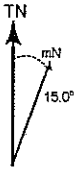
SOURCE: TOPO! National Geographic Holdings, USGS 7.5' Eldorado Bend, CA 1952 (PR 1973), SCALE: 1:24,000.



QUADRANGLE LOCATION

MILES
0 0.5 1

0 0.5 1
KILOMETERS



DPR 523J (1/95)

*Required Information

Confidential Appendix B

Native American Coordination Correspondence

STATE OF CALIFORNIA Edmund G. Brown, Jr., Governor

NATIVE AMERICAN HERITAGE COMMISSION
915 CAPITOL MALL, ROOM 364
SACRAMENTO, CA 95814
(916) 653-6251
Fax (916) 657-5390

August 9, 2012

Steven Treffers
SWCA Environmental Consultants
150 South Arroyo Parkway, Second Floor
Pasadena, CA 91105

Sent by Fax: 626-240-0607
Number of Pages: 2

Re: PG&E CAES, Yolo County.

Dear Mr. Treffers:

A record search of the sacred land file has failed to indicate the presence of Native American cultural resources in the immediate project area. The absence of specific site information in the sacred lands file does not indicate the absence of cultural resources in any project area. Other sources of cultural resources should also be contacted for information regarding known and recorded sites.

Enclosed is a list of Native Americans individuals/organizations who may have knowledge of cultural resources in the project area. The Commission makes no recommendation or preference of a single individual, or group over another. This list should provide a starting place in locating areas of potential adverse impact within the proposed project area. I suggest you contact all of those indicated, if they cannot supply information, they might recommend others with specific knowledge. By contacting all those listed, your organization will be better able to respond to claims of failure to consult with the appropriate tribe or group. If a response has not been received within two weeks of notification, the Commission requests that you follow-up with a telephone call to ensure that the project information has been received.

If you receive notification of change of addresses and phone numbers from any of these individuals or groups, please notify me. With your assistance we are able to assure that our lists contain current information. If you have any questions or need additional information, please contact me at (916) 653-4038.

Sincerely,

Debbie Pilas-Treadway
Environmental Specialist III

Native American Contacts
Yolo County
August 7, 2012

Kesner Flores
PO Box 1047 Wintun / Patwin
Wheatland , CA 95692
calnagpra@hotmail.com
925-586-8919

Cortina Band of Indians
Charlie Wright, Chairperson
PO Box 1630 Wintun / Patwin
Williams , CA 95987
(530) 473-3274 - Voice
(530) 473-3190 - Voice
(530) 473-3301 - Fax

Cortina Wintun Environmental Protection Agency
P.O. Box 1630 Wintun (Patwin)
Williams , CA 95987
corwepa@yahoo.com
(530) 473-3318
(530) 473-3319
(530) 473-3301 - Fax

Yocha Dehe Wintun Nation
Marshall McKay, Chairperson
P.O. Box 18 Wintun (Patwin)
Brooks , CA 95606
(530) 796-3400
(530) 796-2143 Fax

Yocha Dehe Wintun Nation
Leland Kinter, Native Cultural Renewal Committee
P.O. Box 18 Wintun (Patwin)
Brooks , CA 95606
lkinter@yochadehe-nsn.gov
(530) 979-6346
(530) 796-3400 - office
(530) 796-2143 Fax

Yocha Dehe Wintun Nation
Cynthia Clarke, Native Cultural Renewal Committee
P.O. Box 18 Wintun (Patwin)
Brooks , CA 95606
(530) 796-3400 - office
(530) 796-2143 Fax

Yocha Dehe Wintun Nation
Reno Franklin, Cultural Resources Director
P.O. Box 18 Wintun (Patwin)
Brooks , CA 95606
rfranklin@yochadehe-nsn.gov
(530) 979-6346
(530) 796-3400 - office
(530) 796-2143 Fax

This list is current only as of the date of this document.

Distribution of this list does not relieve any person of statutory responsibility as defined in Section 7050.5 of the Health and Safety Code, Section 5097.94 of the Public Resources Code and Section 5097.98 of the Public Resources Code

This list is only applicable for contacting local Native Americans with regard to cultural resources for the proposed PGE CAES, Yolo County

Pacific Gas and Electric Company

Christophe Descantes, PhD
Sr. Cultural Resources Specialist
Land & Environmental Management

Mailing Address
245 Market Street — N10A
San Francisco, CA 94105
Tel: (415) 973.1177
Mobile: (925) 719.2740
Email: chd8@PGE.com

August 10, 2012

Yocha Dehe Wintun Nation
Cynthia Clarke, Native Cultural Renewal Committee
P.O. Box 18
Brooks, CA 95606

RE: Cultural Resources Survey for the PG&E CAES Project in Yolo County, California

Dear Ms. Clarke:

Pacific Gas and Electric (PG&E) is conducting a cultural resources study for the PG&E CAES Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

The project area is located in unincorporated Yolo County near the community of Zamora and falls within the USGS 7.5-minute Eldorado Bend quadrangle map (see enclosed project location map). The proposed project would use renewable energy from sources such as wind to inject compressed air into an underground reservoir. The Zamora reservoir site consists of the construction of a well pad measuring approximately 1 acre, which would support a drilling rig and other equipment for the purpose of core drilling tests to determine if the site is a viable candidate for the CAES project.

As part of the process of identifying cultural resources issues for this project, SWCA contacted the Native American Heritage Commission (NAHC) and requested a Sacred Lands File (SLF) search and a list of Native American individuals and/or tribal organizations that may have knowledge of cultural resources in or near the project area. The NAHC SLF search did not identify any Native American cultural resources within a one-half mile radius of the proposed project area. The NAHC recommended that we consult with you directly regarding your knowledge of the presence of cultural resources that may be impacted by this project.

If you have knowledge of any cultural resources that may exist within or near the project area, please contact me at (415) 973-1177, chd8@pge.com, or Steven Treffers at (626) 240-0587, streffers@swca.com, at your earliest convenience.

Thank you for your attention to this matter.

Best regards,

Christophe Descantes
Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Pacific Gas and Electric Company

Christophe Descantes, PhD
Sr. Cultural Resources Specialist
Land & Environmental Management

Mailing Address
245 Market Street — N10A
San Francisco, CA 94105
Tel: (415) 973.1177
Mobile: (925) 719.2740
Email: chd8@PGE.com

August 10, 2012

Kesner Flores
P.O. Box 1047
Wheatland, CA 95692

RE: Cultural Resources Survey for the PG&E CAES Project in Yolo County, California

Dear Mr. Flores:

Pacific Gas and Electric (PG&E) is conducting a cultural resources study for the PG&E CAES Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

The project area is located in unincorporated Yolo County near the community of Zamora and falls within the USGS 7.5-minute Eldorado Bend quadrangle map (see enclosed project location map). The proposed project would use renewable energy from sources such as wind to inject compressed air into an underground reservoir. The Zamora reservoir site consists of the construction of a well pad measuring approximately 1 acre, which would support a drilling rig and other equipment for the purpose of core drilling tests to determine if the site is a viable candidate for the CAES project.

As part of the process of identifying cultural resources issues for this project, SWCA contacted the Native American Heritage Commission (NAHC) and requested a Sacred Lands File (SLF) search and a list of Native American individuals and/or tribal organizations that may have knowledge of cultural resources in or near the project area. The NAHC SLF search did not identify any Native American cultural resources within a one-half mile radius of the proposed project area. The NAHC recommended that we consult with you directly regarding your knowledge of the presence of cultural resources that may be impacted by this project.

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Thank you for your attention to this matter.

Best regards,

Christophe Descantes
Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Pacific Gas and Electric Company

Christophe Descantes, PhD
Sr. Cultural Resources Specialist
Land & Environmental Management

Mailing Address
245 Market Street — N10A
San Francisco, CA 94105
Tel: (415) 973.1177
Mobile: (925) 719.2740
Email: chd8@PGE.com

August 10, 2012

Yocha Dehe Wintun Nation
Reno Franklin, Cultural Resources Director
P.O. Box 18
Brooks, CA 95606

RE: Cultural Resources Survey for the PG&E CAES Project in Yolo County, California

Dear Mr. Franklin:

Pacific Gas and Electric (PG&E) is conducting a cultural resources study for the PG&E CAES Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

The project area is located in unincorporated Yolo County near the community of Zamora and falls within the USGS 7.5-minute Eldorado Bend quadrangle map (see enclosed project location map). The proposed project would use renewable energy from sources such as wind to inject compressed air into an underground reservoir. The Zamora reservoir site consists of the construction of a well pad measuring approximately 1 acre, which would support a drilling rig and other equipment for the purpose of core drilling tests to determine if the site is a viable candidate for the CAES project.

As part of the process of identifying cultural resources issues for this project, SWCA contacted the Native American Heritage Commission (NAHC) and requested a Sacred Lands File (SLF) search and a list of Native American individuals and/or tribal organizations that may have knowledge of cultural resources in or near the project area. The NAHC SLF search did not identify any Native American cultural resources within a one-half mile radius of the proposed project area. The NAHC recommended that we consult with you directly regarding your knowledge of the presence of cultural resources that may be impacted by this project.

If you have knowledge of any cultural resources that may exist within or near the project area, please contact me at (415) 973-1177, chd8@pge.com, or Steven Treffers at (626) 240-0587, streffers@swca.com, at your earliest convenience.

Thank you for your attention to this matter.

Best regards,

Christophe Descantes
Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Pacific Gas and Electric Company

Christophe Descantes, PhD
Sr. Cultural Resources Specialist
Land & Environmental Management

Mailing Address
245 Market Street — N10A
San Francisco, CA 94105
Tel: (415) 973.1177
Mobile: (925) 719.2740
Email: chd8@PGE.com

August 10, 2012

Yocha Dehe Wintun Nation
Leland Kinter, Native Cultural Renewal Committee
P.O. Box 18
Brooks, CA 95606

RE: Cultural Resources Survey for the PG&E CAES Project in Yolo County, California

Dear Mr. Kinter:

Pacific Gas and Electric (PG&E) is conducting a cultural resources study for the PG&E CAES Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

The project area is located in unincorporated Yolo County near the community of Zamora and falls within the USGS 7.5-minute Eldorado Bend quadrangle map (see enclosed project location map). The proposed project would use renewable energy from sources such as wind to inject compressed air into an underground reservoir. The Zamora reservoir site consists of the construction of a well pad measuring approximately 1 acre, which would support a drilling rig and other equipment for the purpose of core drilling tests to determine if the site is a viable candidate for the CAES project.

As part of the process of identifying cultural resources issues for this project, SWCA contacted the Native American Heritage Commission (NAHC) and requested a Sacred Lands File (SLF) search and a list of Native American individuals and/or tribal organizations that may have knowledge of cultural resources in or near the project area. The NAHC SLF search did not identify any Native American cultural resources within a one-half mile radius of the proposed project area. The NAHC recommended that we consult with you directly regarding your knowledge of the presence of cultural resources that may be impacted by this project.

If you have knowledge of any cultural resources that may exist within or near the project area, please contact me at (415) 973-1177, chd8@pge.com, or Steven Treffers at (626) 240-0587, streffers@swca.com, at your earliest convenience.

Thank you for your attention to this matter.

Best regards,

Christophe Descantes
Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Pacific Gas and Electric Company

Christophe Descantes, PhD
Sr. Cultural Resources Specialist
Land & Environmental Management

Mailing Address
245 Market Street — N10A
San Francisco, CA 94105
Tel: (415) 973.1177
Mobile: (925) 719.2740
Email: chd8@PGE.com

August 10, 2012

Yocha Dehe Wintun Nation
Marshall McKay, Chairperson
P.O. Box 18
Brooks, CA 95606

RE: Cultural Resources Survey for the PG&E CAES Project in Yolo County, California

Dear Mr. McKay:

Pacific Gas and Electric (PG&E) is conducting a cultural resources study for the PG&E CAES Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

The project area is located in unincorporated Yolo County near the community of Zamora and falls within the USGS 7.5-minute Eldorado Bend quadrangle map (see enclosed project location map). The proposed project would use renewable energy from sources such as wind to inject compressed air into an underground reservoir. The Zamora reservoir site consists of the construction of a well pad measuring approximately 1 acre, which would support a drilling rig and other equipment for the purpose of core drilling tests to determine if the site is a viable candidate for the CAES project.

As part of the process of identifying cultural resources issues for this project, SWCA contacted the Native American Heritage Commission (NAHC) and requested a Sacred Lands File (SLF) search and a list of Native American individuals and/or tribal organizations that may have knowledge of cultural resources in or near the project area. The NAHC SLF search did not identify any Native American cultural resources within a one-half mile radius of the proposed project area. The NAHC recommended that we consult with you directly regarding your knowledge of the presence of cultural resources that may be impacted by this project.

If you have knowledge of any cultural resources that may exist within or near the project area, please contact me at (415) 973-1177, chd8@pge.com, or Steven Treffers at (626) 240-0587, streffers@swca.com, at your earliest convenience.

Thank you for your attention to this matter.

Best regards,

Christophe Descantes
Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Pacific Gas and Electric Company

Christophe Descantes, PhD
Sr. Cultural Resources Specialist
Land & Environmental Management

Mailing Address
245 Market Street — N10A
San Francisco, CA 94105
Tel: (415) 973.1177
Mobile: (925) 719.2740
Email: chd8@PGE.com

August 10, 2012

Cotina Wintun Environmental Protection Agency
P.O. Box 1630
Willaims, CA 95987

RE: Cultural Resources Survey for the PG&E CAES Project in Yolo County, California

To Whom it May Concern:

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August 10, 2012

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Charlie Wright, Chairperson
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Willaims, CA 95987

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Email: chd8@PGE.com

November 26, 2012

Yocha Dehe Wintun Nation
Cynthia Clarke, Native Cultural Renewal Committee
P.O. Box 18
Brooks, CA 95606

RE: Revised Cultural Resources Survey for the PG&E CAES - Zamora Project in Yolo County, California

Dear Ms. Clarke:

Pacific Gas and Electric (PG&E) is conducting additional cultural resources study for the PG&E CAES - Zamora Project. All cultural resource work is being conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA). PG&E has retained SWCA Environmental Consultants, Inc., to assist with this effort.

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Enclosure: Project Location Map

Pacific Gas and Electric Company

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Email: chd8@PGE.com

November 26, 2012

Kesner Flores
P.O. Box 1047
Wheatland, CA 95692

RE: Revised Cultural Resources Survey for the PG&E CAES - Zamora Project in Yolo County, California

Dear Mr. Flores:

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Enclosure: Project Location Map

Pacific Gas and Electric Company

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November 26, 2012

Yocha Dehe Wintun Nation
Reno Franklin, Cultural Resources Director
P.O. Box 18
Brooks, CA 95606

RE: Revised Cultural Resources Survey for the PG&E CAES - Zamora Project in Yolo County, California

Dear Mr. Franklin:

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Best regards,

Christophe Descantes
Sr. Cultural Resources Specialist
Enclosure: Project Location Map

Pacific Gas and Electric Company

Christophe Descantes, PhD
Sr. Cultural Resources Specialist
Land & Environmental Management

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San Francisco, CA 94105
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November 26, 2012

Yocha Dehe Wintun Nation
Leland Kinter, Native Cultural Renewal Committee
P.O. Box 18
Brooks, CA 95606

RE: Revised Cultural Resources Survey for the PG&E CAES - Zamora Project in Yolo County, California

Dear Mr. Kinter:

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November 26, 2012

Yocha Dehe Wintun Nation
Marshall McKay, Chairperson
P.O. Box 18
Brooks, CA 95606

RE: Revised Cultural Resources Survey for the PG&E CAES - Zamora Project in Yolo County, California

Dear Mr. McKay:

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Enclosure: Project Location Map

Pacific Gas and Electric Company

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Land & Environmental Management

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November 26, 2012

Cotina Wintun Environmental Protection Agency
P.O. Box 1630
Williams, CA 95987

RE: Revised Cultural Resources Survey for the PG&E CAES - Zamora Project in Yolo County, California

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November 26, 2012

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Charlie Wright, Chairperson
P.O. Box 1630
Williams, CA 95987

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Confidential Appendix C

California Department of Parks and Recreation Series 523 Forms

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary #
HRI #
Trinomial
NRHP Status Code
Other Listings
Review Code Reviewer Date

 ***Resource Name or #:** SWCA-CAES-01

P1. Other Identifier:

***P2. Location:** ☐ **Not for Publication** ☐ **Unrestricted** ***a. County:** Yolo

and (P2b and P2c or P2d. Attach a Location Map as necessary.)

***b. USGS 7.5' Quad:** Eldorado Bend **Date:** 1952 (PR 1973) **T** 11N ; **R** 1E ; NE ¼ **of** NE ¼ **of Sec** 10**;** M.D. **B.M.**

c. Address: City: Zip:

d. UTM: Zone: 10; 600694 mE/ 4297398 mN (G.P.S.)

e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate) Elevation: From Sacramentofollow Interstate 5 north to exit 548 toward Zamora and turn right. Turn left onto County Road 99W and left onto County Road 12. Follow County Road 12 for approximately 4.56 km and turn left on an access road. Follow the access road for approximately 830 meters north to another access road that runs to the west. The isolate is located on the north side of the second access road just west of the intersection of both access roads.

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

This a tertiary flake of black and green chert measuring approximately 2 cm x 2.5 cm x 0.75 cm. The chert is mostly black with a thin strip of green across the width. It is a unifacial flake with additional work on one edge. Two flake scars are present on the dorsal side and no evidence of cortex was observed. The object displays some possible recent battering due to its location on an access road. The isolate was not found in association with any other artifacts.

***P3b. Resource Attributes:** (List attributes and codes) AP16. other/isolate

***P4. Resources Present:** ☐Building ☐Structure ☐Object ☐Site ☐District ☐Element of District ☒Other (Isolates, etc.)



P5b. Description of Photo: (View, date, accession #) Detail of unifacial flake, August 3, 2012, DSCOOO58.jpg

***P6. Date Constructed/Age and Sources:** ☐Historic ☒Prehistoric ☐Both

***P7. Owner and Address:**

***P8. Recorded by:** (Name, affiliation, and address)
Kristin Rugroden
SWCA Environmental Consultants
150 S. Arroyo Parkway
Pasadena, CA 91105

***P9. Date Recorded:** 8/3/12

***P10. Survey Type:** (Describe)
Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.")
Cultural Resources Survey for the PG&E CAES Project, Yolo County, California

***Attachments:** ☐NONE ☒Location Map ☐Sketch Map ☐Continuation Sheet ☐Building, Structure, and Object Record ☐Archaeological Record ☐District Record ☐Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ☐ Other (List):

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

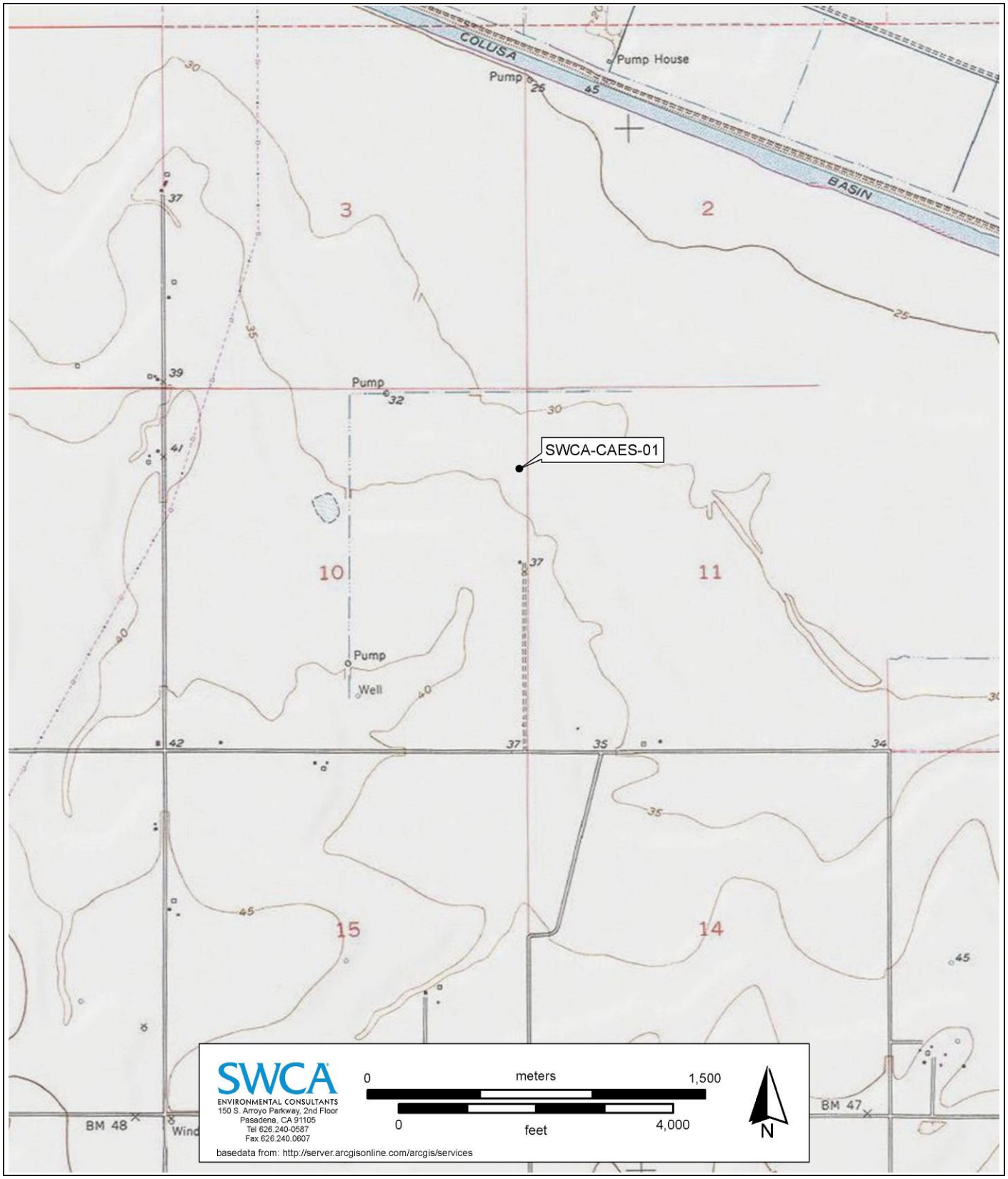
LOCATION MAP

Primary #
HRI#
Trinomial

***Resource Name or #:** SWCA-CAES-01

***Map Name:** Eldorado Bend, CA

***Scale:** 1:24,000 ***Date of Map:** 1952 (PR 1973)



***Required information**

11/28/2011

GEOLOGY AND GAS PRODUCTION OF THE ZAMORA GAS FIELD, YOLO COUNTY, CALIFORNIA

Douglas P. Imperato, Ph.D
Consulting Geologist
Santa Barbara, CA

EXECUTIVE SUMMARY

Nearly 6.5 BCF of natural gas have been produced from seven wells in the Zamora gas field since its discovery in 1977. Production is from three separate sandstone reservoirs of the Starkey Formation between depths of 3400 and 3700 feet. Maximum gas pool thickness ranges from approximately 20 to 40 feet, with areas ranging from 270 to 435 acres. Log-derived reservoir porosity averages 28 to 32 percent, with water saturation of 35 percent. Gas is entrapped in reservoirs by both structure and erosional truncation of reservoir sands at a regional unconformity. Two of the reservoirs exhibit a strong water-drive production mechanism with depletion and the onset of significant water production occurring with flowing pressure of approximately 1200 psi. One of the reservoirs has more of a depletion-drive component, with reservoir pressure dropping to less than 600 psi prior to the onset of significant water production

INTRODUCTION

This investigation includes evaluation of the subsurface stratigraphy, structure, rock properties, and gas production characteristics of the natural-gas reservoirs of the Zamora gas field in Yolo County, California. The field is located in the central part of the southern Sacramento Valley, about 20 miles northwest of the City of Sacramento, and about 2 to 3 miles northeast of the City of Zamora and Highway 5 (Attachment 1). The study area includes approximately six square miles in Township 11 North, Range 1 East (Attachment 2). Elevation of the ground surface

ranges from 30 in the east to 40 feet in the west and most of the field is actively farmed. The Colusa basin drainage canal is located along the northern border of the field.

History of Development

Humble Oil and Refining Company drilled the Hermle 1 in 1958 in Section 15, T.11N., R.1E which was abandoned at total depth of 5756 feet in the Late Cretaceous Kione Formation. In 1967, Kenyon Sills Operator re-entered the well and completed it in the Winters Formation, testing perforations at 4532-25 feet at a rate of 2310 mcf per day. Argo Petroleum subsequently operated the well and abandoned it without obtaining commercial production.

In April, 1977, Atlantic Richfield Company drilled and completed the first commercial gas well in the field, the AROW-Knaggs 1 (Section 10, T.11N., R.1E.) in the Starkey Formation interval 3581 to 3587 feet which tested at a rate of 4711 mcf per day through a 20/64 inch choke with tubing pressure of 1290 psi. The shut-in surface pressure was 1482 psi. Atlantic Richfield followed this discovery with the AROW-Knaggs 2 well in August, 1977 in the same section, completed in the same Starkey Formation interval.

In July 1977, Chevron USA Inc. completed the Knaggs-Wallace 1 well in Section 11 which tested at a rate of 2000 mcf per day from perforations at depths of 3447 to 3505 feet. Between 1977 and 1979, Chevron drilled four additional wells on the this lease (Attachment 3).

Pacific Inland Operating Corporation and Hartley Natural Resources eventually took over operations of the Chevron and ARCO wells, respectively. In the late 1990's, Lario Oil and Gas Company acquired a 26 square mile 3D-seismic survey that included the Zamora field. Three different operators subsequently drilled three unsuccessful wells in the field. There has been no production in the field since October, 1992, and all seven gas wells have been abandoned.

METHODS

This evaluation includes analysis of data from 20 exploration and development wells drilled in and around the Zamora gas field. Well history records for these wells were reviewed, and a digital well database was compiled that includes API number, operator, well name, number, status, total depth, elevation, spud date, location, latitude, longitude, and survey data for directional wells (Attachment 3). Latitude and longitude are referenced to the 1927 North America datum. Raster well-log images were obtained from commercial sources and on-line files of the California Division of Oil Gas and Geothermal Resources.

A well history summary was prepared for each gas well from well history records (Appendix I). Monthly gas production, water production, and pressure data were compiled from on-line records of the California Division of Oil, Gas and Geothermal Resources. Production data were compiled in spreadsheet format and production-decline curves were prepared (Appendix I). Well logs for each gas well, annotated with stratigraphic information and production information, is also included in Appendix I. Well completion and production information, including perforated intervals, initial production rate, and cumulative production for each interval, is included in Attachment 4. A summary of gas-pool data, which includes cumulative production, elevation of the gas-water contact, maximum net isochore thickness, and estimated area is included as Attachment 5. All digital well and production data were input into Landmark Geographix software for data manipulation, cross section preparation, and mapping.

A series of cross sections that included all wells in the study area were prepared and logs were annotated with available perforation information. Producing intervals and pertinent stratigraphic horizons were identified and correlated in all available wells. The thicknesses of the gas zones were calculated from Spontaneous Potential logs, and recorded in the database. A cutoff of 10 millivolts from the shale baseline was used in the net-sandstone calculations. The stratigraphic information was incorporated in the preparation of structure and isochore maps of the gas pools. Reservoir rock property data was compiled from well histories and CDOG publications.

REGIONAL GEOLOGY

The deepest well in the field is the Knaggs-Wallace 1 well in Section 12, drilled by Pexco, Inc. in 1962 to a total depth of 11,005 feet. The stratigraphic sequence penetrated in this well includes the age and approximate thicknesses of strata as follows:

Nonmarine Undifferentiated	Recent-Miocene	3000 feet
Domengine Formation	Eocene	250 feet
Capay Formation	Eocene	350 feet
Starkey Formation	Late Cretaceous	800 feet
Winters Formation	Late Cretaceous	1000 feet
Sacramento Shale	Late Cretaceous	350 feet
Kione Formation	Late Cretaceous	300 feet
Forbes Formation	Late Cretaceous	5000 feet+

Major unconformities are present at the base of the Nonmarine Undifferentiated strata and at the base of the Capay Formation. All gas pools in the Zamora gas field are in upper 200 to 300 feet of the Starkey Formation.

The Zamora gas field is located along the axial basin syncline, approximately five miles northeast of the Dunnigan Hills anticline (Attachment 6). Regional dip in this area is to the southeast. Northeast-directed thrust faults associated with the Dunnigan Hills uplift are present to the west of the field (Attachment 6).

RESERVOIR STRATIGRAPHY

The Starkey Formation represents deposition in a fluvial-deltaic environment and consists primarily of sandstone, inter-bedded with relatively thin shale and lignite layers. Sandstones were deposited as river-channel or delta-front deposits, with shale beds and lignites representing inter-channel marsh and swamp deposits, respectively. Shale beds in the upper Starkey

Formation in the Zamora gas field are generally less than 10 feet in thickness, and appear to contribute to gas entrapment.

Shale beds are generally laterally continuous, and regionally correlative shale beds subdivide the Starkey Formation into first through fifth members, in order of penetration by the drill bit, from top to bottom (Attachment 7). In the Zamora area, these five informal members of the Starkey Formation range in thickness from 50 to 100 feet. Production is from two intervals in the Second Starkey Formation and from the Third Starkey Formation. The lower productive interval in the Second Starkey Formation is described herein as the S2B interval.

The Second Starkey Formation is a 40 to 60 feet thick sequence of interbedded sandstone and shale, with a sandstone-to-shale ratio of roughly 50%. Sandstone beds are 5 to 15 feet thick, with shale inter-beds with thicknesses of 5 feet or less. In some wells, the Second Starkey gas pool is directly overlain by the sub-Capay Formation unconformity, whereas in other wells, it is overlain by a thin First Starkey Formation interval. The lowest elevation of gas in this interval is approximately -3442 feet subsea.

The Starkey S2B interval is a 50 to 70 feet thick massive sandstone bounded above and below by a shale interval with a thickness of less than five feet. In the Knaggs-Wallace 1 well, the S2B gas pool is overlain by the Second Starkey Formation, whereas in the Knaggs-Wallace 4, the S2B gas pool is directly below the sub-Capay Formation unconformity. There is a well-defined water table in both wells at an elevation of -3475 feet subsea.

The Third Starkey Formation is 75 to 100 feet in thickness, consisting of a basal shale bed 10 to 30 feet in thickness overlain by a massive sandstone with a thickness of 50 to 70 feet. Gas is trapped directly below the sub-Capay Formation unconformity, with a well-defined water table in the upper massive sandstone at -3540 feet subsea.

Starkey Formation strata dip gently to the east-southeast below the more steeply southwest-dipping Capay Formation, resulting in a angular disconformity at the contact (Attachment 7). The sub-Capay Formation unconformity is thus in contact with progressively older Starkey

Formation strata in the western part of the field relative to the east, with progressively older Starkey Formation members subcropping in a westerly direction. The Third Starkey Formation subcrops along a north-striking line in the center of Section 10 (Attachment 8), the Starkey S2B subcrop coincides with a fault along the western edge of Section 11 (Attachment 9), and the Second Starkey Formation subcrops along a parallel line in the center of Section 11 (Attachment 10). This erosional truncation of Starkey Formation sandstones at the sub-Capay unconformity is a significant component of gas entrapment in the field.

RESERVOIR ROCK PROPERTIES

Upper Cretaceous sandstones in the Sacramento basin are composed of quartzo-feldspathic detritus derived from the Sierran magmatic arc system to the east and northeast. Framework mineralogy is dominated by volcaniclastic and plutoniclastic grains, principally monocrystalline quartz, plagioclase and K-feldspar, biotite, and volcanic lithic fragments (Mertz, 1990), the Rumsey petrofacies of Ingersoll (1983). In the Zamora area, Upper Cretaceous sandstones are fine to medium-grained.

In the Zamora gas field, log-derived porosity for Starkey Formation sandstones average 28 to 32 percent, with a water saturation of 35 percent. The gas has a heating value of 954 Btu. Permeability measurements of for the Zamora gas field reservoirs are not available, but permeability of 50 to 100 md is reported by the California Division of Oil and Gas (1998) for other Starkey Formation reservoirs in the Zamora area.

STRUCTURE

The southeast dip of the Upper Cretaceous strata, and contrasting southwest dip of Eocene strata in the Zamora area indicate a pre-Eocene westward shift in the axial basin syncline. During the Late Cretaceous, the basin axis was east of the Zamora area, and shifted to the west after deposition of the Domengine Formation.

A north striking. west-dipping normal fault appears to separate the southeast-dipping eastern parts of the field, from the more steeply east dipping, western part of the field (Attachment 8). To the east, the Starkey Formation dips southeast at less than one degree, and is cut by a smaller north-dipping fault that intersect the north-striking fault at a high angle (Attachment 8). To the west, the Starkey Formation dips much more steeply due east.

This structural configuration and mechanisms for gas entrapment for the Zamora gas field, are in contrast to the structure presented by White (1984) and California Division of Oil and Gas (1998), whereby the field is mapped as an elongate structural dome, cut by two north-striking normal faults. The detailed stratigraphic analysis of the Starkey Formation conducted herein, in conjunction with the additional data acquired since these articles were published favors the interpretations presented herein.

The primary trap for the Third Starkey gas pool is created by erosional truncation of the interval at the sub-Capay unconformity, although folding along the subcrop line forms the critical lateral closure (Attachment 8). The vertical distance between the top of the Third Starkey Formation and the lowest closed contour is approximately 50 feet. Farther east in the northwest part of Section 11, the Third Starkey Formation appears to form a trapping configuration at the juncture of the two faults. No gas was present in this interval in the two wells that tested this closure, although these wells do not appear to have penetrated the trap in the most favorable structural position (Attachment 8).

A north-striking normal fault that coincides with the interval subcrop creates the primary trap for the Starkey S2B gas pool, with critical northern closure provided by an east-striking normal fault (Attachment 9). There is no direct evidence for such a fault, however, and the northern trap could be formed by folding. In either case, the vertical distance between the top of the formation and the lowest closed contour is approximately 30 feet.

The primary trap for the Second Starkey gas pool is formed by erosional truncation of the interval at the sub-Capay unconformity (Attachment 10). Regional dip provides the southeast closure, whereas folding appears to contribute to the trap to the northeast. The east-striking fault

that is critical to gas entrapment in the Starkey S2B gas pool may also form the northern trap for the Second Starkey gas pool (Attachment 10). The vertical distance between the top of the Second Starkey Formation and the lowest closed contour is approximately 40 feet.

GAS PRODUCTION

Production records from the California Division of Oil, Gas, and Geothermal Resources archives indicate that a total of 6,452 mmcf have been produced from the seven gas wells productive from three gas pools in the Zamora gas field (Attachments 4 and 5 and Appendix I).. Production began in September, 1978 and continued until October, 1992, with individual well production rates as much as 30,000 to 40,000 mcf per month (Attachment 5 and Appendix I).

The total gas volume produced from each of the three gas pools was determined by integrating the stratigraphic analysis with the history of completions and production (Appendix I). The three Starkey Formation gas pools produced roughly equal volumes of gas, with slightly less from the Starkey S2B gas pool (Attachment 5).

Second Starkey Formation production began in January, 1979, and production from most gas wells was terminated prior to April, 1982 (Attachment 11). The Knaggs-Wallace 1 well is the notable exception, with Second Starkey production continuing through November, 1984. This is presumably due to this well's location at the structurally highest position in the gas pool (Attachment 10). Second Starkey Formation production in the Knaggs-Wallace 1 well was co-mingled with Starkey S2B production through April, 1985, after which time the well produced only from the Second Starkey Formation. The relative contribution from each of the comingled zones was estimated based on the net isochore thickness of the intervals.

Production records indicate that the Second Starkey gas pool had a water-drive reservoir production mechanism, but with a significant component of depletion. This is typical of reservoirs like the Second Starkey Formation that consist of interbedded sandstone and shale with relatively low sandstone-to-shale ratios. In the Knaggs-Wallace 1 well, flowing casing pressure declined to approximately 600 psi before significant water production occurred. In the

structurally lower wells, significant water production occurred and wells were abandoned with flowing casing pressures of approximately 1000 psi.

Starkey S2B production also began in the Knaggs-Wallace 1 well in January, 1979 and continued in the Knaggs-Wallace 4 well through May, 1989 (Attachment 12). As noted above, the S2B interval was isolated from production in the Knaggs-Wallace 1 well in July, 1985. Production records indicate that the Starkey S2B gas pool has a strong water drive production mechanism. Significant water production occurred and the interval abandoned with flowing casing pressures of approximately 1200 psi.

Third Starkey Formation production began in September, 1978 and continued through December, 1990 (Attachment 13). The longer production duration and higher cumulative volume produced from the AROW- Knaggs 1 well can be attributed to the structurally higher position of the well (Attachment 8). Production records indicate that the Third Starkey Formation gas pool has a strong water drive production mechanism. Significant water production occurred and the interval abandoned with flowing casing pressures of approximately 1200 psi.

RESERVOIR VOLUMETRICS

The Second Starkey Formation gas pool has a maximum drilled net thickness of 20 feet and encompasses an area of 435 acres (Attachment 14). The Knaggs-Wallace 1 well appears to have penetrated the gas pool at, or near, the crest of the structure and maximum gas pool thickness. The reservoir volume calculated from net gas isochores is estimated at 5375 acre-feet. With a total production of 2,414,654 mcf, the gas recovery factor, or richness (total production divided by the reservoir volume) of this pool is 440 mcf/acre-ft.

The Starkey S2B gas pool has a maximum drilled net thickness of 26 feet and encompasses an area of 270 acres (Attachment 15). Mapping indicates that the crest of the structure and maximum gas pool thickness is located northwest of the productive wells, where net gas pool thickness could exceed 30 feet. The reservoir volume calculated from net gas isochores is

estimated at 4762 acre-feet. With a total production of 1,716,120 mcf, the gas recovery factor, or richness of this pool is estimated at 360 mcf/acre-ft.

The Third Starkey gas pool has a maximum drilled net thickness of 37 feet and encompasses an area of 320 acres (Attachment 16).). The AROW-Knaggs 1 well appears to have penetrated the gas pool at, or near, the crest of the structure and maximum gas pool thickness. The reservoir volume calculated from net gas isochores is estimated at 7350 acre-feet. With a total production of 2,320,932 mcf, the gas recovery factor, or richness of this pool is estimated at 315 mcf/acre-ft.

These recoverable gas richness values are generally consistent with expected values, and serve as a check on reservoir volume estimates. The higher value for the Second Starkey Formation gas pool is likely due to the favorable structural position of the Knaggs-Wallace 1 well near the crest of the structure. The lower richness values for the Third Starkey and Starkey S2B gas pools suggests that these gas pools may have some “attic” gas reserves.

REFERENCES

California Division of Oil and Gas, 1998, California Oil and Gas Fields, Central California: California Division of Oil and Gas v 1, TR10, unpaginated.

Ingersoll, R. V., 1983, Petrofacies and provenance of late Mesozoic farearc basin, northern and central California: American Association of Petroleum Geologists Bulletin, V. 67, p. 1125-1142.

Mertz, K. A., 1990, Summary of the diagenetic history of the Upper Cretaceous Forbes, Starkey, and Winters Formations, Sacramento Basin, California, in Ingersoll, R. V. and T. H. Nilsen, eds., 1990, Sacramento Valley Symposium and Guidebook: Pacific Section S.E.P.M., Vol. 65, p. 53-67.

White, W. F., 1984, Zamora Gas Field: California Division of Oil and Gas v 1, TR30. P. 1-9.

ATTACHMENTS

1. Regional map of the Sacramento Valley showing regional geography, oil and gas fields and the location of the Zamora gas field.

2. Topographic map of the Zamora gas field and vicinity showing wells, cumulative gas production, and outline of gas pools.

3. Project well list, including status, total depth, elevation, spud date, and location. Latitude and longitude are in NAD 1927 coordinates.

4. Production summary showing initial production rate, shut in pressure, formation, gas production, and water production for each productive interval in each gas well.

5. Gas pool summary showing gas production, elevation of gas-water contact, maximum net thickness, and area.

6. Structure-contour map on top of the Sacramento shale showing regional structural configuration of the Zamora gas field area.

7. Structural cross section WS1 showing the stratigraphy, structure, and gas pools of the Zamora gas field.

8. Structure-contour map on top of the Third Starkey Formation.

9. Structure-contour map on top of the Starkey S2B Formation.

10. Structure-contour map on top of the Second Starkey Formation.

11. Gas production curves for wells productive from the Second Starkey Formation gas pool..

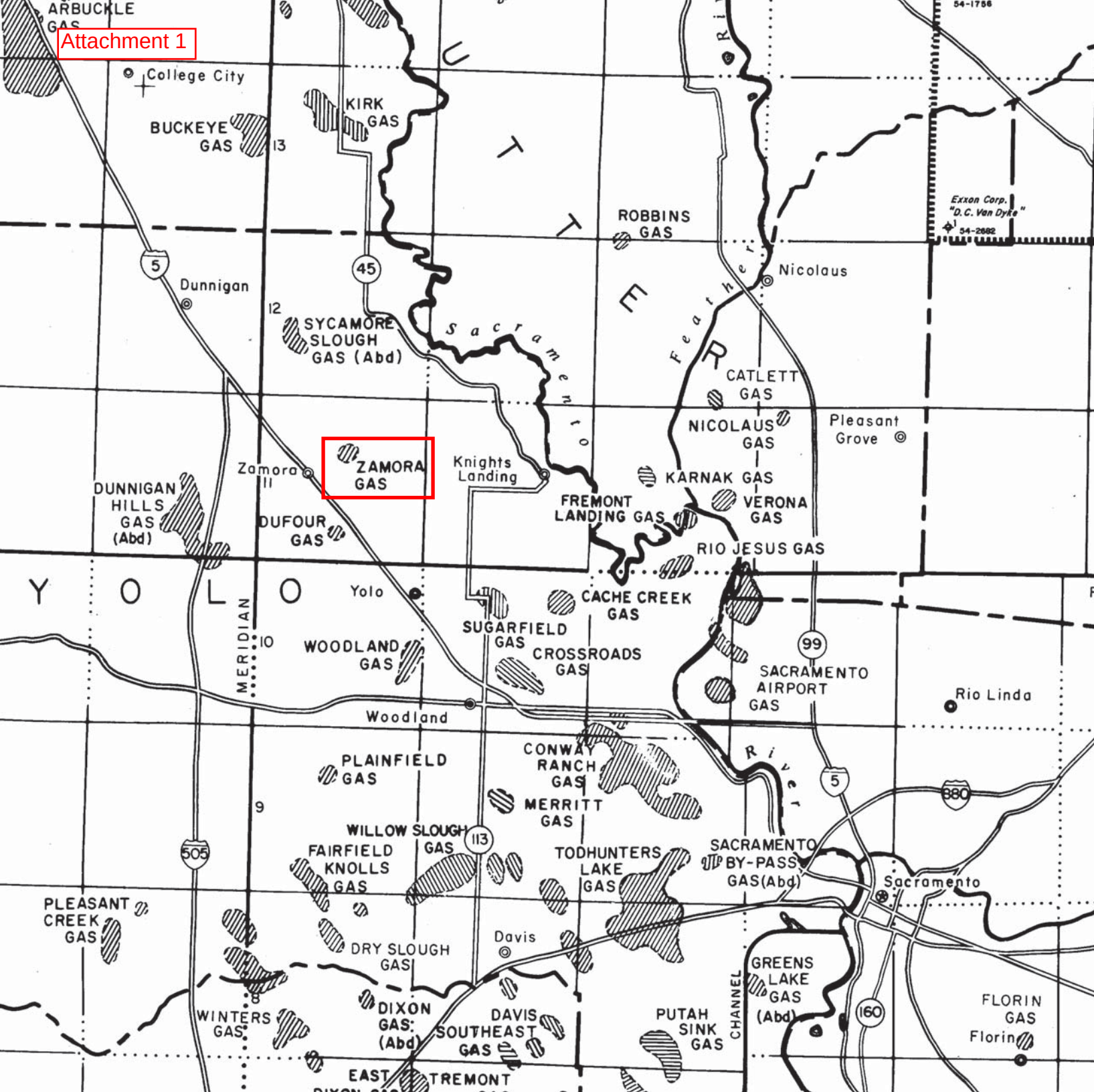
12. Gas production curves for wells productive from the Starkey S2B gas pool..

13. Gas production curves for wells productive from the Third Starkey Formation gas pool..

14. Net gas isochore map of the Second Starkey Formation gas pool.

15. Net gas isochore map of the Starkey S2B gas pool.

16. Net gas isochore map of the Third Starkey Formation gas pool.


Attachment 1
ARBUCKLE GAS
College City
KIRK GAS
BUCKEYE GAS
13
ROBBINS GAS
Exxon Corp. "D.C. Van Dyke" 1 54-2682
54-1756
5
Dunnigan
45
12
SYCAMORE SLOUGH GAS (Abd)
Sacramento
Feather
Nicolaus
CATLETT GAS
NICOLAUS GAS
Pleasant Grove
Zamora
11
ZAMORA GAS
Knights Landing
KARNAK GAS
VERONA GAS
FREMONT LANDING GAS
DUNNIGAN HILLS GAS (Abd)
DUFOUR GAS
RIO JESUS GAS
YOLO
Yolo
CACHE CREEK GAS
SUGARFIELD GAS
CROSSROADS GAS
MERIDIAN
10
WOODLAND GAS
99
SACRAMENTO AIRPORT GAS
Rio Linda
Woodland
River
CONWAY RANCH GAS
PLAINFIELD GAS
MERRITT GAS
5
9
WILLOW SLOUGH GAS
113
505
FAIRFIELD KNOLLS GAS
TODHUNTERS LAKE GAS
SACRAMENTO BY-PASS GAS(Abd)
Sacramento
PLEASANT CREEK GAS
Davis
DRY SLOUGH GAS
GREENS LAKE GAS (Abd)
CHANNEL
8
WINTERS GAS
DIXON GAS: (Abd)
DAVIS SOUTHEAST GAS
PUTAH SINK GAS
160
FLORIN GAS
Florin
EAST TREMONT

SIGNAL-MONTEREY-BELL1

BASIN

DRAINAGE

Pump

Pump

Pump

Well

Windmill

Z1

Z1

KNAGGS-WALLACE1
2,326,617 mcf

KNAGGS-WALLACE

387,185 mcf

AROW-KNAGGS2

CORDELIA WALKER ESTATE1

KNAGGS-WALLACE4

KNAGGS-WALLACE2
472,017 mcf

799,968 mcf

THIRD
STARKEY
GAS POOL

S2B
GAS POOL

KNAGGS-WALLACE6

SECOND
STARKEY
GAS POOL

ZAMORA UNIT1

HEIDRICK1

1,933,747 mcf

AROW-KNAGGS1

ZAMORA1

KNAGGS-WALLACE5
158,536 mcf

ZAMORA UNIT1

KNAGGS1

KNAGGS-WALLACE3
373,636 mcf

EATON-MARTIN1

KLEIN ZZ1-15

HERMLE1
1RD

MERCHANTS1-15

BM 48

BM 46

BM 50

BM 47

1000 0 1000 ft

Pacific Gas and Electric Company		
Zamora Gas Field **Base Map**		
Author: dpi	ATTACHMENT 2	**Date:** 25 November, 2011
	Scale: <scale>	

ATTACHMENT 3

ZAMORA GAS FIELD
PROJECT WELLS

API	OPERATOR	WELL NAME	NO.	LOCATION	LAT 27	LONG 27	SPUD	STAT	TD	ELEV	
04113001240000	ARGO PETROLEUM CORP.	HERMLE	1	TWP: 11 N - Range: 1 E - Sec. 15	38.807030	-121.856060	10/9/1958	P&A	5756	52	KB
04113001240001	KENYAN SILLS		1RD	TWP: 11 N - Range: 1 E - Sec. 15	38.807030	-121.856060	8/28/1967	AGS	4700	53	KB
04113002870000	CHEVRON U.S.A. INC.	CORDELIA WALKER ESTATE	1	TWP: 11 N - Range: 1 E - Sec. 10	38.818860	-121.840600	3/7/1953	P&A	6258	46	KB
04113002880000	PEXCO, INC.	KNAGGS-WALLACE	1	TWP: 11 N - Range: 1 E - Sec. 12	38.820700	-121.804230	2/1/1962	P&A	11005	39	KB
04113003110000	FRANWIN OIL & GAS CO	MERCHANTS	1-15	TWP: 11 N - Range: 1 E - Sec. 15	38.801810	-121.846940	9/7/1966	P&A	5800	53	KB
04113200670000	ALPINE OIL & GAS COR	ZAMORA UNIT	1	TWP: 11 N - Range: 1 E - Sec. 9	38.812580	-121.862380	7/29/1969	P&A	5224	53	KB
04113201690000	ARGO PETROLEUM CORP.	KNAGGS	1	TWP: 11 N - Range: 1 E - Sec. 10	38.809210	-121.843890	11/30/1972	P&A	6003	54	KB
04113201810000	ARGO PETROLEUM CORP.	HEIDRICK	1	TWP: 11 N - Range: 1 E - Sec. 10	38.813020	-121.853520	4/24/1973	P&A	5275	40	GR
04113202700000	SANTA FE ENERGY RESO	EATON-MARTIN	1	TWP: 11 N - Range: 1 E - Sec. 15	38.807850	-121.841440	8/14/1974	P&A	5220	48	KB
04113204260000	HARTLEY NATURAL RESO	AROW-KNAGGS	1	TWP: 11 N - Range: 1 E - Sec. 10	38.812090	-121.844160	3/24/1977	AGS	3805	50	KB
04113204530000	PACIFIC INLAND OPER.	KNAGGS-WALLACE	1	TWP: 11 N - Range: 1 E - Sec. 11	38.821880	-121.824670	8/10/1977	AGS	6500	46	DF
04113204570000	ARCO WESTERN ENERGY	AROW-KNAGGS	2	TWP: 11 N - Range: 1 E - Sec. 10	38.819550	-121.843690	8/5/1977	AGS	3769	46	KB
04113204800000	PACIFIC INLAND OPER.	KNAGGS-WALLACE	2	TWP: 11 N - Range: 1 E - Sec. 12	38.817630	-121.819940	12/9/1977	AGS	3807	37	DF
04113205300000	PACIFIC INLAND OPER.	KNAGGS-WALLACE	3	TWP: 11 N - Range: 1 E - Sec. 11	38.808880	-121.823150	3/24/1979	AGS	4500	37	KB
04113205720000	PACIFIC INLAND OPER.	KNAGGS-WALLACE	5	TWP: 11 N - Range: 1 E - Sec. 12	38.812470	-121.811540	12/12/1979	AGS	3900	38	KB
04113207790000	PACIFIC INLAND OPER.	KNAGGS-WALLACE	4	TWP: 11 N - Range: 1 E - Sec. 11	38.817930	-121.829730	2/21/1984	AGS	5006	42	KB
04113209400000	HARTLEY NATURAL RESO	ZAMORA UNIT	1	TWP: 11 N - Range: 1 E - Sec. 10	38.809160	-121.845900	5/2/1990	P&A	4800	50	DF
04113211300000	LARIO OIL & GAS CO.	KLEIN ZZ	1-15	TWP: 11 N - Range: 1 E - Sec. 15	38.807191	-121.844325	1/2/1999	P&A	4400	51	KB
04113212020000	PROD SPECIALTIES CO	KNAGGS-WALLACE	6	TWP: 11 N - Range: 1 E - Sec. 11	38.815600	-121.825200	8/13/2001	P&A	3730	41	KB
04113212430000	ROYALE ENERGY	ZAMORA	1	TWP: 11 N - Range: 1 E - Sec. 11	38.812592	-121.833296	10/15/2005	P&A	3701	42	KB

ATTACHMENT 4

ZAMORA GAS FIELD
PRODUCTION SUMMARY

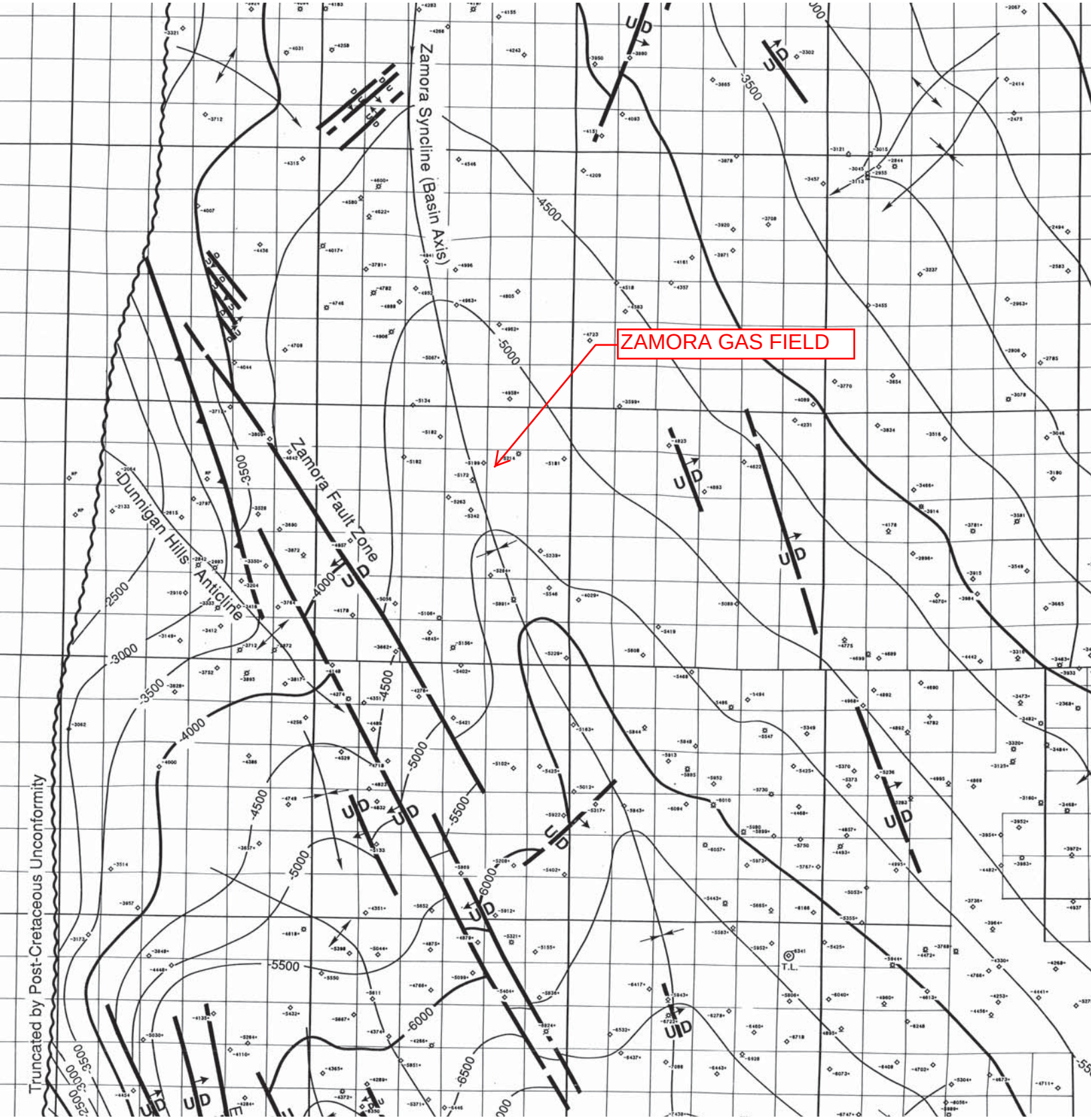
APINUM	WELL NAME/NO.		SPUD DATE	PROD INT. (FT)	INITIAL PRODUCTION RATE	SHUT IN PRESS (PSI)	FM.	CUM GAS (MCF)	CUM H2O (BBLS)
113-00124	HERMLE	1	10/10/58	4563-66, 4532-35	2310 mcfd @1550 psi	1610	Winters	0	0
113-20426	AROW-KNAGGS	1	03/24/77	3581-3587	3223 mcfd @1381 psi	1452	Starkey S3	1,933,747	27,301
113-20457	AROW-KNAGGS	2	08/05/77	3573-3578	2213 mcfd @1402 psi	1460	Starkey S3	387,185	23,900
113-20453	KNAGGS WALLACE	1	06/07/77	3495-3505, 3470-75, 3458-64, 3447-54	2000 mcfd @ 1366 psi	1421	Starkey S2B* Starkey S2*	916,152 1,410,465	27,494
113-20480	KNAGGS WALLACE	2	12/09/77	3464-70	1500 mcfd @ 1325 psi	1420	Starkey S2	472,017	32,291
113-20530	KNAGGS WALLACE	3	03/24/79	3462-72	1200 mcfd @ 1345 psi	1405	Starkey S2	373,636	14,985
113-20779	KNAGGS WALLACE	4	02/21/84	3475-95	1000 mcfd @ 1300 psi		Starkey S2B	799,968	16,166
113-20572	KNAGGS WALLACE	5	12/12/79	3472-78	800 mcfd @ 1310 psi	1360	Starkey S2	158,536	1,026
							TOTAL	4,125,089	

ATTACHMENT 5

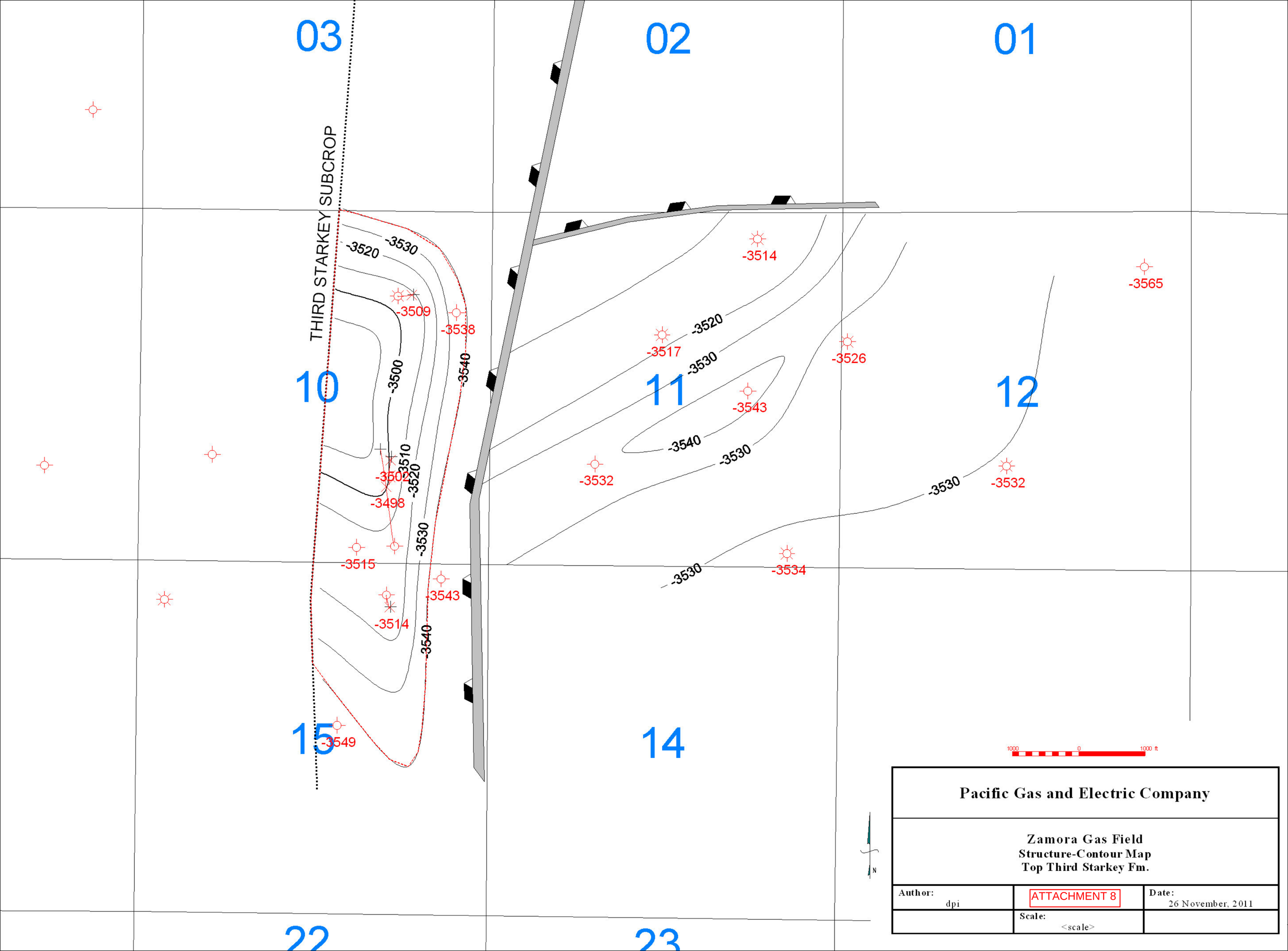
ZAMORA GAS FIELD
GAS POOL SUMMARY

GAS	GAS PRODUCTION (mcf)								GAS-WATER	MAX NET	AREA
POOL	Arow Knaggs 1	Arow Knaggs 2	Knaggs-Wallace 1*	Knaggs-Wallace 2	Knaggs-Wallace 3	Knaggs-Wallace 4	Knaggs-Wallace 5	Total	CONTACT (FT)	THICKNESS (FT)	(ACRES)
Second Starkey			1,410,465	472,017	373,636		158,536	2,414,654	-3442	20	435
Starkey S2B			916,152			799,968		1,716,120	-3473	27	270
Third Starkey	1,933,747	387,185						2,320,932	-3540	37	320
TOTAL	1,933,747	387,185	2,326,617	472,017	373,636	799,968	158,536	6,451,706			
*In the Knaggs Wallace 1 well, Second Starkey and S2B intervals were co- mingled through April, 1985											
the relative contribution from each of the comingled zones was estimated based on the net isochore thickness of the intervals.											

ATTACHMENT 6



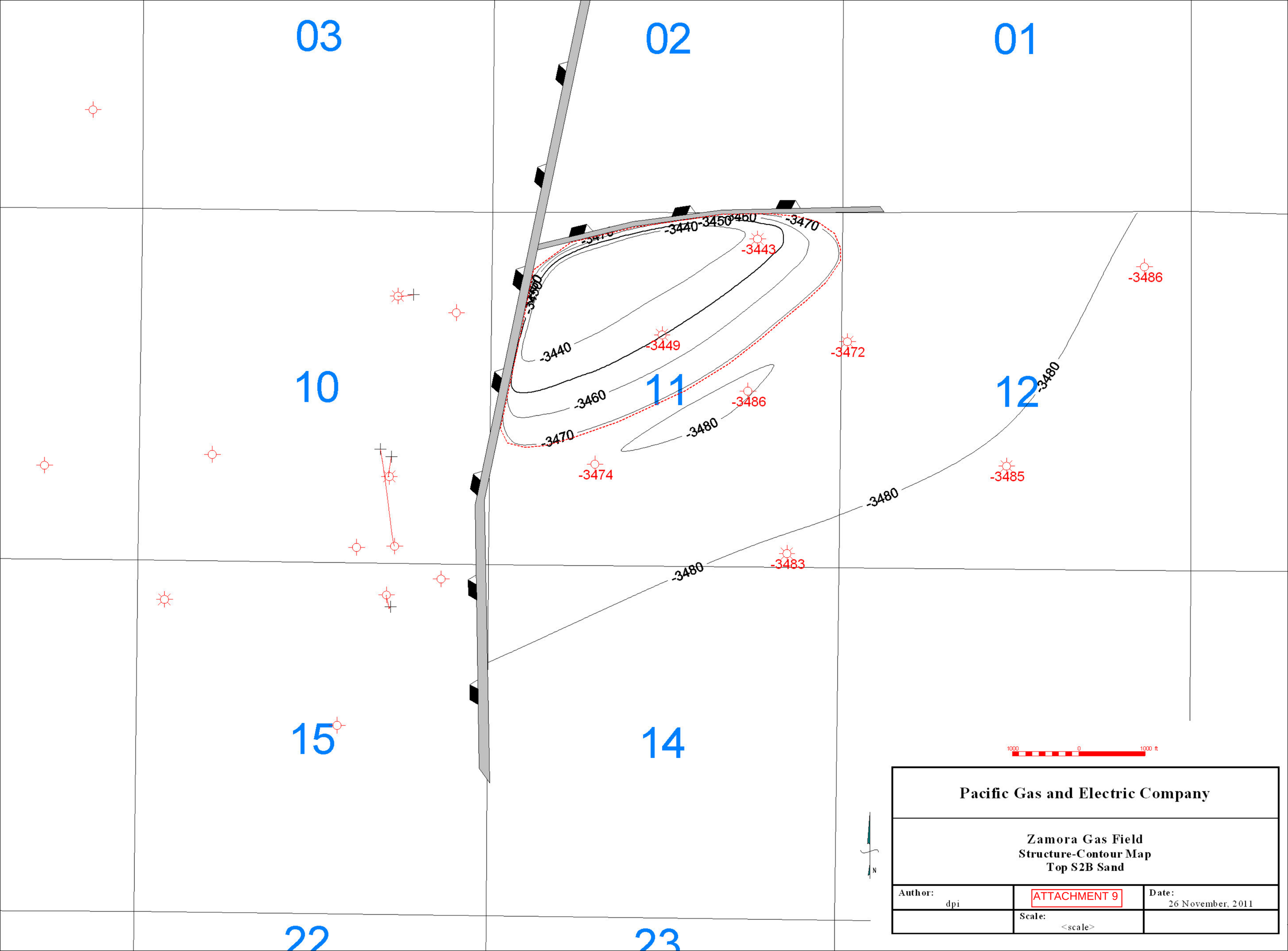
STRUCTURE-CONTOUR MAP TOP SACRAMENTO SHALE



Pacific Gas and Electric Company

Zamora Gas Field
Structure-Contour Map
Top Third Starkey Fm.

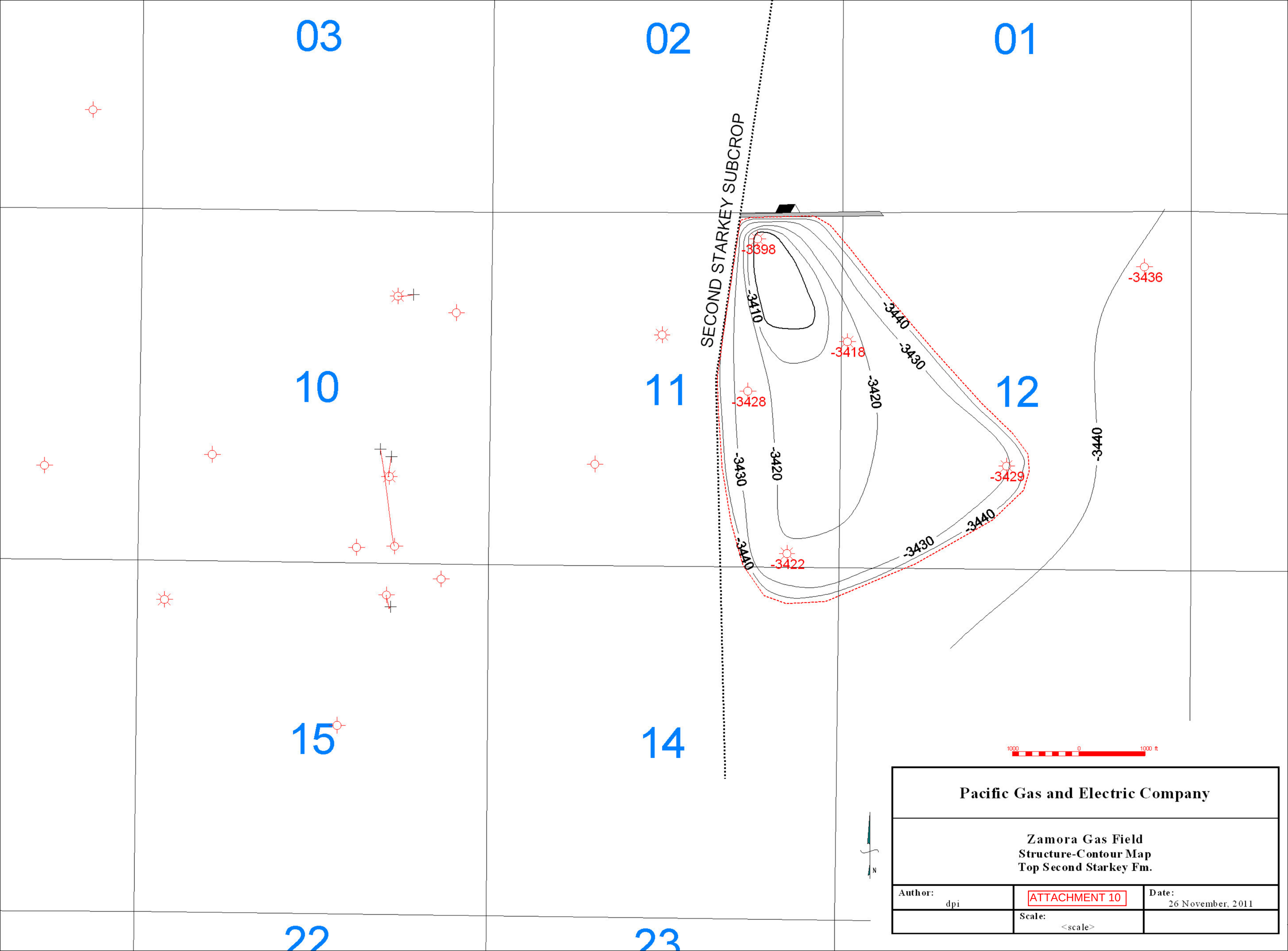
Author:	ATTACHMENT 8	Date:
dpi		26 November, 2011
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Pacific Gas and Electric Company

Zamora Gas Field
Structure-Contour Map
Top S2B Sand

Author: dpi	ATTACHMENT 9	Date: 26 November, 2011
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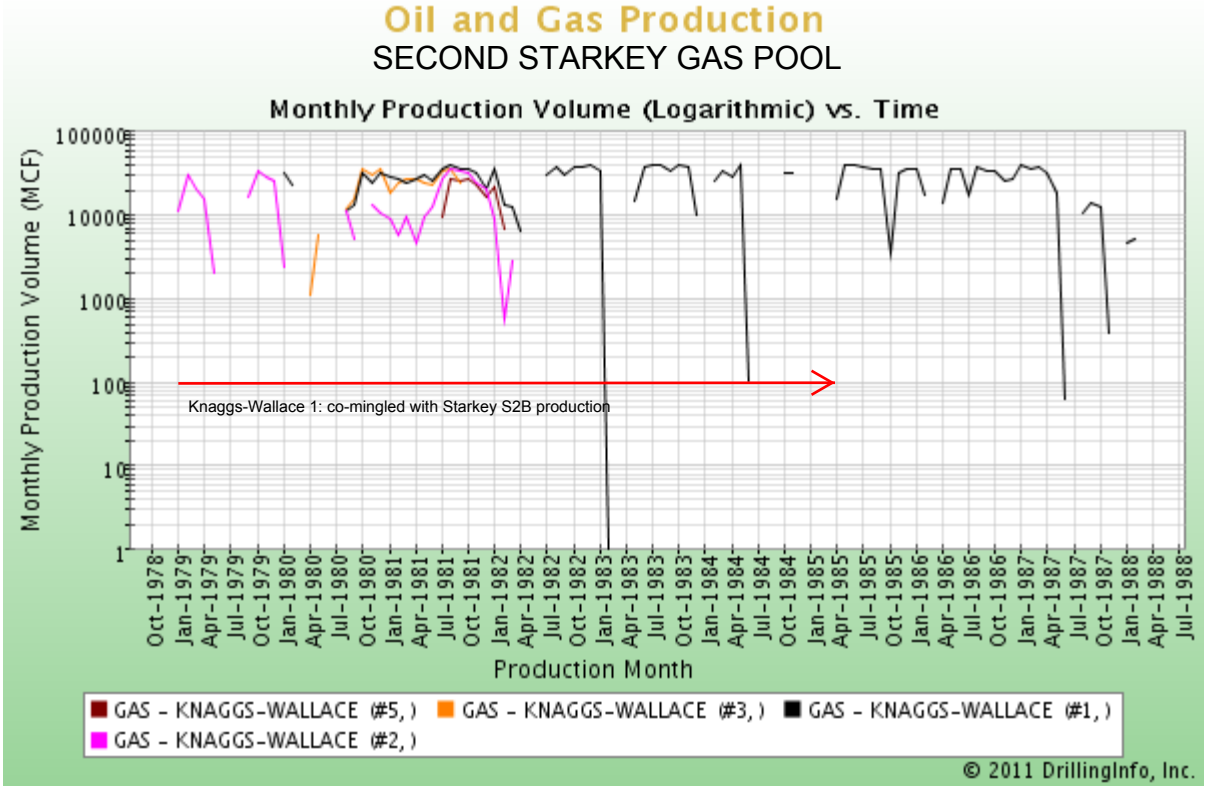


Pacific Gas and Electric Company

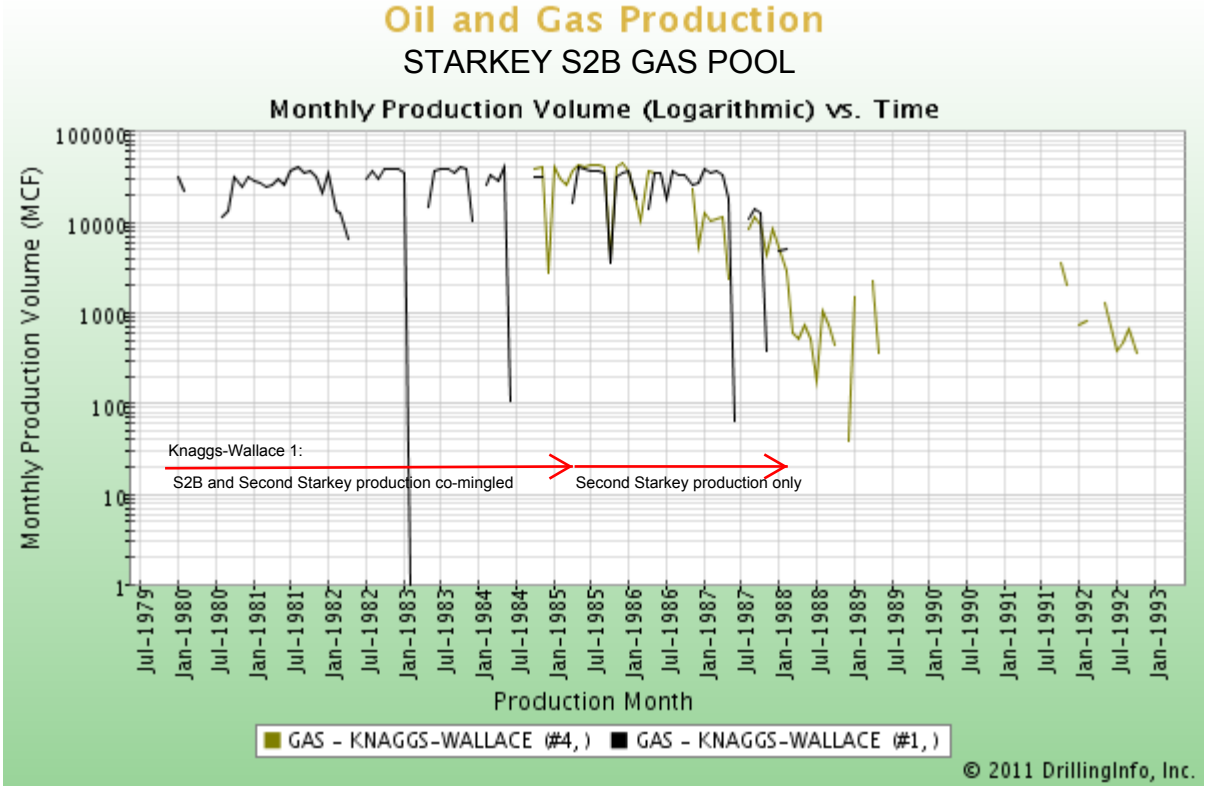
Zamora Gas Field
Structure-Contour Map
Top Second Starkey Fm.

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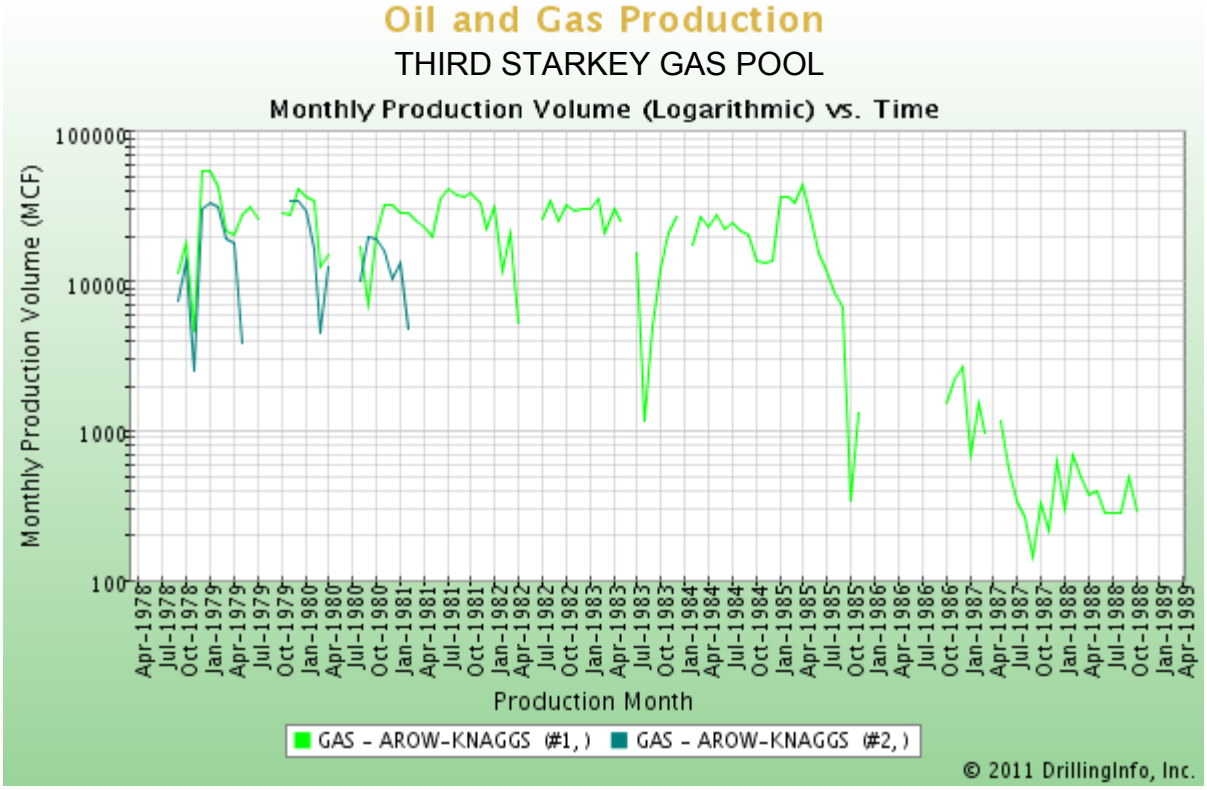
ATTACHMENT 11



ATTACHMENT 12



ATTACHMENT 13



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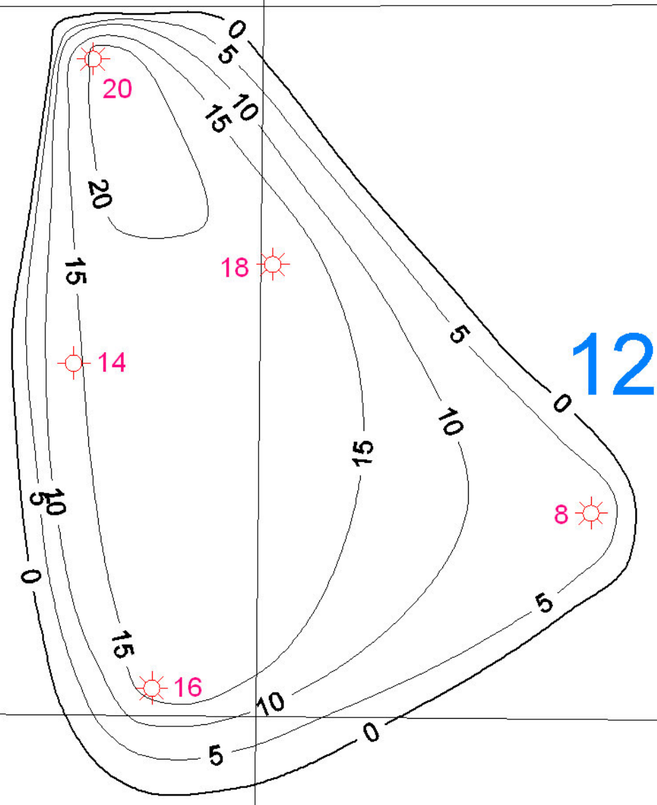
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Pacific Gas and Electric Company

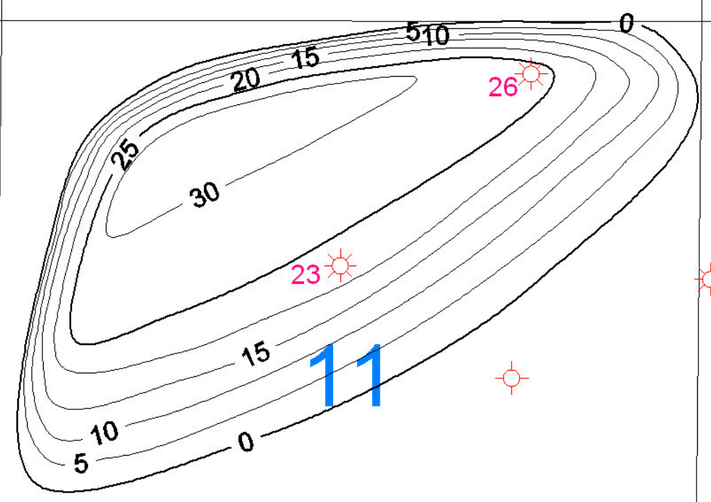
Zamora Gas Field
Net Gas Isochore Map
Second Starkey Gas Pool

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Pacific Gas and Electric Company

Zamora Gas Field
Net Gas Isochore Map
Starkey S2B Gas Pool

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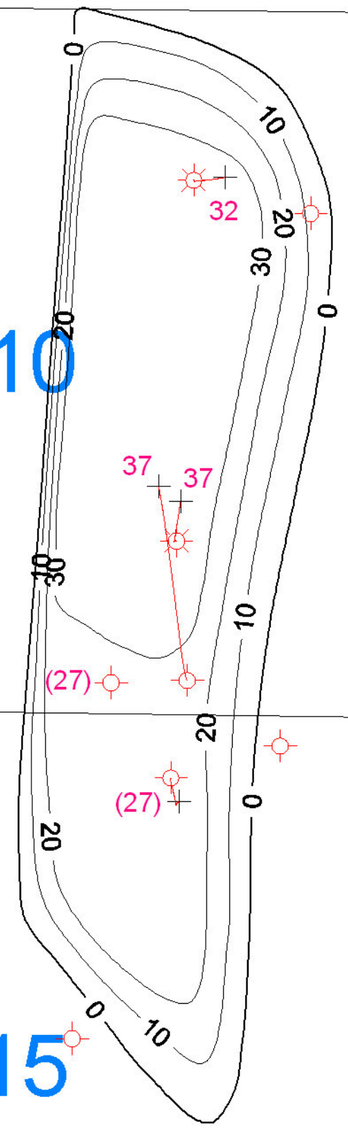
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Pacific Gas and Electric Company

Zamora Gas Field
Net Gas Isochore Map
Third Starkey Gas Pool

Author: dpi	ATTACHMENT 16	Date: 26 November, 2011
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APPENDIX I

A). Knaggs-Wallace 1, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

B). Knaggs-Wallace 2, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

C). Knaggs-Wallace 3, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

D). Knaggs-Wallace 4, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

E). Knaggs-Wallace 5, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

F). AROW-Knaggs 1, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

G). AROW-Knaggs 2, annotated well log, well-history summary, production-decline curves and tabulated gas production, water production, casing pressure, and tubing pressure data.

County of Yolo

PLANNING AND PUBLIC WORKS DEPARTMENT

John Bencomo
DIRECTOR

292 West Beamer Street
Woodland, CA 95695-2598
(530) 666-8775 FAX (530) 666-8156
www.yolocounty.org

OIL & GAS DRILLING OPERATION SITE PLAN CERTIFICATE FOR

Pacific Gas and Electric Company
Roosevelt Ranch 10-1
ZONE FILE #2013-0001

WHEREAS, no oil or gas drilling operation shall be established in the unincorporated area of the County of Yolo until the Director of the Yolo County Planning and Public Works Department (hereinafter "Director") or his designee has approved the site plan for such operation; and

WHEREAS, the Director has reviewed the applicant's site plan request and supplemental information to conduct an oil or gas drilling operation in the unincorporated area of the County of Yolo; and

WHEREAS, the Director has determined that the drilling operation is appropriate within the unincorporated area of the County of Yolo subject to the following criteria and conditions:

(1) Except for drill stem testing and emergency procedures, no drilling operation shall result in an ambient noise level in excess of sixty (60) decibels ([dBa] measured as an LDN average), measured at the outside of the nearest residence at the bedroom window closest to the drilling site; provided, however, if the applicant demonstrates that the ambient noise level at such location prior to the commencement of the drilling operation was fifty-seven (57) decibels ([dBa] measured as an LDN average) or higher, then the noise standard shall be that the drilling operation does not result in the addition of more than three (3) decibels ([dBa] measured as LDN average) to the preexisting ambient noise level.

The noise levels mandated by this subsection may be waived if the applicant has received a written waiver of the noise requirement from the resident of any residence at which the noise level would exceed the standards set forth in this subsection. If the dwelling is leased, the tenant shall execute the waiver.

(2) All lights on the drill site shall be erected/installed according to CAL-OSHA employee safety requirements and shall be shielded and/or directed so as to focus the direct rays from the lights onto the drilling site and away from the residences, except where required for aircraft warning purposes.

(3) All vehicles parking and maneuvering areas shall be treated in such a manner as to control dust. Such treatment may be accomplished by placing gravel on such areas and/or periodically watering the areas or by other means approved by the Director.

(4) The drilling operation shall comply with the requirements of all other agencies having jurisdiction over the site and operation. The Yolo County Planning and Public Works Department requires the following permits:

(i) A grading permit if the drilling operation results in any ground disturbance;
(ii) A building permit if the operation includes erection of structures;
(iii) A flood elevation certificate if construction occurs in a FEMA designated 100-year flood zone; and
(iv) An encroachment permit if the construction of access roads connect to county right-of-way.

(5) The drilling operation shall not be located within the following distances from the specified uses:

(i) Within 500 feet of any school;
(ii) Within 500 feet of any church or place of public worship;
(iii) Within 500 feet of any place of public assembly;
(iv) Within 500 feet of any dwelling, unless residents of such dwelling have filed a written waiver. If the dwelling is leased, the waiver shall be executed by the tenant;
(v) Within 100 feet of the property line to any County road or State Highway; provided, however, if the State Supervisor of Oil and Gas has approved a variance of the minimum setback required by State law, which variance would conflict with the provisions of this subsection, such variance shall take precedence over this subsection; or,
(vi) Within 250 feet of any levee owned by any public agency.

(6) Bonds. Before the site plan is approved, the applicant shall post a performance bond or other good and sufficient surety (Letter of Credit, Assurity, Cash Deposit) approved by the County in the amount of not less than Five Thousand and no/100ths ($5,000.00) dollars securing compliance with all the criteria and conditions imposed upon the approval of the Oil & Gas Drilling Operation Site Plan Certificate. The release of the performance bond by the Director is not to occur until the reclamation of the land disturbed during the drilling operation and the removal of all equipment not necessary for the normal maintenance of the oil and gas well is completed as specified in the Oil & Gas Drilling Operation Site Plan Certificate as approved by the Director.

(7) All equipment not necessary for the normal maintenance of the oil and gas well shall be removed upon the completion of the drilling operation. All disturbed areas shall be reclaimed to their former condition.

(8) In accordance with Section 8-2.2415 of the Yolo County Code, the applicant shall agree to indemnify, defend, and hold harmless the County or its agents, officers and employees from any claim, action, or proceeding (including damage, attorney fees, and court cost awards) against the County or its agents, officers, or employees to attack, set aside, void, or annul an approval of the County, advisory agency, appeal board, or legislative body concerning the permit or entitlement when such action is

brought within the applicable statute of limitations. The County shall promptly notify the applicant of any claim, action or proceeding and that the County cooperate fully in the defense. If the County fails to promptly notify the applicant of any claim, action, or proceeding, or if the County fails to cooperate fully in the defense, the applicant shall not thereafter be responsible to defend, indemnify, or hold the County harmless as to that action. The County may require that the applicant post a bond in an amount determined to be sufficient to satisfy the above indemnification and defense obligation.

(9) The applicant shall notify the Director of the Yolo County Planning and Public Works at such time when reclamation of the land disturbed during the drilling operation and the removal of all equipment not necessary for the normal maintenance of the oil and gas well has been completed, to request a final inspection of the drilling site by the County.

(10) Failure to comply with the above criteria and conditions shall immediately void this Certificate, requiring the applicant to immediately cease all drilling operations, secure the site so that it does not present a safety hazard, and obtain a valid conditional use permit to continue operation.

IT IS DETERMINED, by the issuance of this Core Drilling Operation Site Plan Certificate, that the described drilling operation to be located on County Assessor's Parcel Number (APN): 055-060-004 shown on the attached site location map (Exhibit "1") is hereby approved by the Assistant Director contingent on compliance with the above criteria and conditions. This Certificate shall only apply to the specific drilling site identified and is not transferable. This Certificate shall become void 180 days after the date of the Director's signature unless a letter requesting an extension of time is submitted to the Director and the Director approves the extension of time prior to this Certificate's termination.

Prepared by _____ Jan. 9, 2013
Stephanie Cormier, Senior Planner — Date
Yolo County Planning and Public Works

Approved by _____ 1-7-2013
David Morrison, Assistant Director — Date
Yolo County Planning and Public Works

Criteria and Conditions Agreed to by Applicant(s):

_____
Applicant(s) (signature) — Date

ERNIE RALSTON, PG1E — 1-14-13
Applicant(s) (print) — Date

Biological Assessment of Effects on Federally Listed Species

Pacific Gas and Electric Company Compressed Air Energy Storage Project, Zamora Well Pad B Development and Core Well Drilling, Yolo County, California

Prepared for:

U.S. Department of Energy, National Energy Technology Laboratory

At the Request of:

Pacific Gas and Electric Company

Prepared by:

SWCA Environmental Consultants

December 2012

BIOLOGICAL ASSESSMENT OF EFFECTS ON FEDERALLY LISTED SPECIES FOR THE PACIFIC GAS AND ELECTRIC COMPANY COMPRESSED AIR ENERGY STORAGE PROJECT, ZAMORA WELL PAD B DEVELOPMENT AND CORE WELL DRILLING

Prepared for

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National Energy Technology Laboratory
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December 24, 2012

SWCA Project No. 24494

TABLE OF CONTENTS

1. Introduction 1
1.1 Purpose of Biological Assessment 1
2. Consultation To Date 1
3. Proposed Action 1
3.1 Location 1
3.2 Environmental Setting 1
3.3 Proposed Action 2
4. Status of Federally Listed Species and Critical Habitat in the Action Area 3
4.1 Giant Garter Snake 7
5. Potential Effects 7
5.1 Direct Effects 7
5.2 Indirect Effects 8
5.3 Cumulative Effects 8
6. Recommendations 9
7. Conclusion and Determination 10
8. List of Preparers 10
9. References 12

TABLES

Table 1. Federally Listed Species Potential for Occurrence in the Proposed Action Area 4

APPENDICES

APPENDIX A: U.S. Fish and Wildlife Service Species List
APPENDIX B: Figures
APPENDIX C: Giant Garter Snake Habitat Assessment

1. INTRODUCTION

1.1 PURPOSE OF BIOLOGICAL ASSESSMENT

The purpose of this Biological Assessment (BA) is to review the proposed Zamora Well Pad B Development and Core Well Drilling (Proposed Action) in sufficient detail to determine the extent to which the Proposed Action may affect any threatened, endangered, or proposed species or designated critical habitat. This BA is prepared in accordance with legal requirements set forth under regulations implementing Section 7 of the Endangered Species Act (50 CFR 402; 16 U.S.C. 1536 (c)).

The determination of this BA is that the Proposed Action will have no effect on the federally threatened giant garter snake (*Thamnophis gigas*), or any other federally listed, proposed, or candidate species, and will have no effect on critical habitat for any federally listed species.

2. CONSULTATION TO DATE

On Wednesday, August 29, 2012, the Compressed Air Energy Storage team, including the PG&E biologist, met with staff from the U.S. Fish and Wildlife Service (UWFWS) Sacramento Valley Branch and California Department of Fish and Game Region 2 to discuss potential impacts that development of a well pad and core well drilling at the Zamora Well Pad D site may have on federally listed species. The wildlife agencies indicated concerns over the location of Zamora Well Pad D because of potential impacts related to changes of land use from rice fields that provide aquatic habitat for giant garter snake (GGS), disturbance to bird species in the adjacent native grassland parcel, and time of year for the proposed project (during the inactive season for GGS).

To address the agencies' concerns, PG&E is now exploring an alternate well pad site, Zamora Well Pad B, that is located in a dry fallow agricultural field away from rice fields or canals that may provide aquatic habitat for GGS, and that would avoid and minimize impacts to special-status wildlife species including GGS. To date, no meetings or discussions have been held with the USFWS to discuss potential impacts that development and core well drilling at the Well Pad B location may have on federally listed species. A list of species was generated from the USFWS Sacramento Office website (Eldorado Bend USGS topographic quadrangle and Yolo County) and is included as Appendix A.

3. PROPOSED ACTION

3.1 LOCATION

The Proposed Action area is within the USGS California Eldorado Bend 7.5-minute topographic quadrangle in Township 11 North, Range 01 East, Section 10. The site is located on the Roosevelt Ranch, approximately 2 miles east of the town of Zamora, immediately north of County Road (CR) 12 in Yolo County, California (Appendix B, Figure 1). The elevation range at the site is between approximately 40 and 45 feet above mean sea level. Surveys conducted in the Proposed Action area were based on an approximate 900-foot by 900-foot square study area centered at approximately 38.809888º, -121.845332º. The study area and proposed project footprint are shown in Figure 2 of Appendix B.

3.2 ENVIRONMENTAL SETTING

The Proposed Action area is located in agricultural lands west of the Sacramento River and east of the Dunnigan Hills in the southwestern corner of the Roosevelt Ranch. Roosevelt Ranch contains a mixture of active row and rice crops and an extensive network of wetlands that are managed for waterfowl and other wildlife. The Colusa Basin Drainage Canal is located approximately 1.8-mile north of the site.

Well Pad B is proposed in the southwest corner of an approximately 75-acre fallow agricultural field that was previously farmed in row crops. At the time of surveys the field was disked and devoid of vegetation.

This field is bordered by ruderal vegetation along its southern margins near CR 12, and along a dirt road west of the site that runs north from CR 12. An irrigation canal is located approximately 400 feet north of the study area. This canal conveys water from a large man-made lake located approximately 1200 feet east of the study area to active rice (*Oryza sativa*) fields immediately north of the canal. Plant species such as cattail (*Typha latifolia*), curly dock (*Rumex crispus*), wild radish (*Raphanus raphanistrum*), and an unidentified species of rush (*Juncus* spp.) were observed in wet areas and along the banks of the canal. Approximately 1000 feet east of the study area, a dirt road with ruderal vegetation along its margins runs north from CR 12 and separates the fallow field from the lake. A large field of non-native grassland borders the southern edge of the man-made lake just east of this dirt road. Species observed in ruderal and non-native grassland areas include Bermuda grass (*Cynodon dactylon*), ripgut brome (*Bromus diandrus*), yellow star thistle (*Centaurea solstitialis*), hoary cress (*Lepidium draba*), Russian thistle (*Salsola* spp.), common tarweed (*Centromadia pungens*), and field bindweed (*Convolvulus arvensis*). Row crops and fields planted in alfalfa (*Medicago sativa*) are present to the south of CR 12. Figure 3 in Appendix B shows the location of these habitat types in relation to the Proposed Action area.

According to representatives of the Roosevelt Ranch, the field surrounding the Proposed Action area will be planted with winter wheat for the 2013 growing season, and the rice fields north of the Proposed Action will remain in rice production.

3.3 PROPOSED ACTION

The objective of the project is to collect approximate 4-inch diameter geological core samples from the subsurface natural gas formation at depth of approximately 4,000-5,000 feet. Cores will be used to determine the suitability of the subsurface formation for compressed air storage. Compressed air storage involves utilizing appropriate geological formations (e.g., depleted natural gas reservoirs) to store surplus energy in the form of compressed air during periods of low electric demand. This stored energy can then be utilized during periods of higher electric demand, improving the efficiency of energy distribution through the power grid.

New access road construction will be necessary between CR 12 and the proposed well pad site north of CR 12 in an agricultural field. The access road will be built perpendicular from CR 12 to the location of the well pad. Access road construction will require some minimal grading but will largely consist of compaction of the subgrade, delivery of approximately 23 truckloads of aggregate, placing aggregate road base, and compaction of the final road grade to establish an approximately 14-foot-wide and 100-foot-long (approximately 0.03 acre) roadway. Once the access road has been established, a well pad with the dimensions of approximately 220 feet by 120 feet (approximately 0.6 acre) will be constructed. Construction of the well pad will consist of minimal grading, compaction of the subgrade, delivery of 70 truckloads of sand and crushed rock, placement of sand base and then crushed rock to approximately 1 foot thick, and compaction with a roller. The proposed project footprint (Appendix B, Figure 2) may shift up to 150 feet to the west, north, or east, based on the final engineering layout and site-specific conditions.

All vehicle traffic to the well pad will be via the gravel access road and all staging will be contained to the new well pad workspace. Water trucks will be used as necessary to reduce dust during site access and other construction activities. Approximately 110 truck trips will be required to import well pad material to the site. An additional five truck trips will be required to remove drill cuttings and associated material from the site. If the well pad site is restored to pre-project conditions, an additional 110 truck trips will be required to remove temporary well pad materials, which will total approximately 318 truck trips for the entire scope of this activity. Standard PG&E Best Management Practices (BMPs) and Avoidance and Minimization Measures (AMMs) will be implemented to avoid impacts to sensitive resources in the vicinity of the project.

After the well pad has been established, well drilling equipment will be moved onto the pad. The primary equipment includes the drill rig, mud and water tanks and pumps, shaker tanks, electric generators, diesel fuel tanks, and drill pipe racks. Geologic sampling will consist of drilling a 10-inch diameter well to a depth of approximately 4,000-5,000 feet and extracting a geological core sample not greater than 4 inches in diameter. All sections of the core sample will be removed offsite for analysis and storage. All peripheral material (e.g., cuttings and drilling mud) removed during the coring process will be immediately placed in proper storage receptacles and removed offsite for disposal at an authorized facility. The drilling crew, plus engineers, temporary workers and site visitors, will consist of an average of approximately 12 workers per shift, with three shifts per day. A maximum of 20 workers may be present during various operations. In addition to worker vehicles, service and delivery vehicles will access the site during the drilling phase including equipment trucks for all aspects of the effort. All drilling activities will be completed in compliance with the Yolo County Gas and Oil Well Site Plan approval.

Once the core sample is obtained and the core hole is plugged and abandoned per California Division of Oil Gas and Geothermal Resources (DOGGR) requirements, the drilling equipment will be dismantled and demobilized from the site. Construction equipment similar to that used during well pad development will be used to remove the pad materials and return the site to near pre-project conditions. All removed material will be disposed of at suitable landfills or recycled consistent with county grading or other permit requirements. However, the property owner may elect to retain the pad for farm equipment staging and storage.

Access road and well pad construction will occur over a two-week period commencing as early as January 2013. Drilling activities will occur virtually continuously for up to approximately three weeks. If the well pad is elected to be removed, restoration of the site will take up to two weeks.

4. STATUS OF FEDERALLY LISTED SPECIES AND CRITICAL HABITAT IN THE ACTION AREA

A list of federally threatened, endangered, and proposed species was generated from the USFWS Sacramento Office website (Appendix A), and was compared with records of occurrence from the California Natural Diversity Database in the vicinity of the Proposed Action area to determine which species may have potential to occur. The USFWS Critical Habitat Mapper was also reviewed to determine if critical habitat for any federally listed or proposed species is present in the Proposed Action area. Potential for federally listed species to occur in the Proposed Action Area was determined after review of these records and verification of habitat conditions during the field surveys (survey methodology and results are discussed further in the Giant Garter Snake Habitat Assessment, Appendix C).

Based on the database review and habitat conditions observed in the field, no critical habitat is present and there is no potential for federally listed species to occur within the Proposed Action area. Table 1 outlines the federally listed species and critical habitat in the vicinity of the Proposed Action area, their general habitat requirements, and their potential for occurrence in the Proposed Action area. Because there are occurrence records of GGS in the Colusa Basin Drainage Canal approximately 1.8 mile north of the Proposed Action and suitable aquatic habitat is present approximately 1100 feet north of the Proposed Action, further discussion of the species' habitat requirements and rationale for its lack of occurrence within the Proposed Action area are provided below.

Table 1. Federally Listed Species Potential for Occurrence in the Proposed Action Area

Species Name	Listing Status	Habitat Requirements	Occurrence Potential
Palmate-bracted bird's-beak (*Cordylanthus palmatus*)	Endangered	Hemiparasitic annual herb; occurs along edges of channels and drainages, in seasonally-wet depressions, and in grasslands in seasonally-flooded, saline-alkali soils in lowland plains and basins. Flowers May-October. 5-155 m.	**No potential to occur.** Channels and drainages in saline-alkali soils are not present in the Proposed Action area.
Colusa grass (*Neostapfia colusana*)	Threatened / Critical Habitat	Annual herb; occurs in large vernal pools. Flowers May-August. 5-200 m.	**No potential to occur.** Vernal pools are not present in the Proposed Action area. Critical habitat is outside of the Proposed Action area.
Keck's checkerbloom (*Sidalcea keckii*)	Endangered	Annual herb; occurs in serpentine and clay cismontane woodlands and valley/foothill grasslands. Flowers April-June. 75-650 m.	**No potential to occur.** Serpentine and clay cismontane woodlands and valley/foothill grasslands are not present in the Proposed Action area. Additionally, the Proposed Action area is below the species' elevation range.
Solano grass (*Tuctoria mucronata*)	Endangered / Critical Habitat	Annual herb; occurs in vernal pools. Flowers April-August. 5-10 m.	**No potential to occur.** Vernal pools are not present in the Proposed Action area. Critical habitat is outside of the Proposed Action area.
Conservancy fairy shrimp (*Branchinecta conservatio*)	Endangered	Requires ephemeral or temporary pools of fresh water (vernal pools) that form in winter and dry in summer.	**No potential to occur.** Vernal pools are not present in the Proposed Action area.
Vernal pool fairy shrimp (*Branchinecta lynchi*)	Threatened	Requires ephemeral or temporary pools of fresh water (vernal pools) that form in winter and dry in summer.	**No potential to occur.** Vernal pools are not present in the Proposed Action area.
Valley elderberry longhorn beetle (*Desmocerus californicus Dimorphus*)	Threatened	Occurs in the central valley of California and vicinity, in association with elderberry (*Sambucus* spp.) shrubs.	**No potential to occur.** Elderberry shrubs are not present in the Proposed Action area, or in the surrounding vicinity.
Delta green ground beetle (*Elaphrus viridis*)	Threatened	Occupies vernal pool habitats and surrounding grasslands.	**No potential to occur.** Vernal pools are not present in the Proposed Action area.
Vernal pool tadpole shrimp (*Lepidurus packardi*)	Endangered / Critical Habitat	Requires ephemeral or temporary pools of fresh water (vernal pools) that form in winter and dry in summer.	**No potential to occur.** Vernal pools are not present in the Proposed Action area. Critical habitat is outside of the Proposed Action area.
California freshwater shrimp (*Syncaris pacifica*)	Endangered	Occupies fresh water channels with submerged undercut banks, overhanging plants such as blackberry, woody debris, and the exposed live root systems of willow or alder.	**No potential to occur.** Aquatic habitat with undercut banks and overhanging plants is not present in the Proposed Action area.

Species Name	Listing Status	Habitat Requirements	Occurrence Potential
Green sturgeon, southern DPS (*Acipenser medirostris*)	Threatened	Green sturgeon utilize both freshwater and saltwater habitat, and spawn in deep pools or "holes" in large, turbulent, freshwater river mainstems.	**No potential to occur.** Suitable freshwater habitat is not present in the Proposed Action area
Delta smelt (*Hypomesus transpacificus*)	Threatened / Critical Habitat	Euryhaline species (tolerant of a wide salinity range) occurring in estuarine waters up to 14 ppt salinity. Found only from the Suisun Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano and Yolo counties.	**No potential to occur.** Estuarine waters are not present in the Proposed Action area. Critical habitat is outside of the Proposed Action area.
Central Valley steelhead ESU (*Oncorhynchus mykiss*)	Threatened / Critical Habitat	Clear, cool water with abundant in-stream cover, gravel or cobble bottom, well-vegetated stream margins, and relatively stable water flow.	**No potential to occur.** Cool freshwater habitat is not present in the Proposed Action area. Critical habitat is outside of the Proposed Action area.
Central Valley spring-run chinook salmon ESU (*Oncorhynchus tshawytscha*)	Threatened / Critical Habitat	Cool, clean water with appropriate depth, quantity and flow velocities; upland and riparian vegetation to stabilize soil and provide shade; clean gravel for spawning and egg-rearing; large woody debris to provide resting and hiding places; varied channel forms; and adequate food.	**No potential to occur.** Cool freshwater habitat is not present in the Proposed Action area. Critical habitat is outside of the Proposed Action area.
Winter-run chinook salmon, Sacramento River ESU (*Oncorhynchus tshawytscha*)	Endangered / Critical Habitat	Cool, clean water with appropriate depth, quantity and flow velocities; upland and riparian vegetation to stabilize soil and provide shade; clean gravel for spawning and egg-rearing; large woody debris to provide resting and hiding places; varied channel forms; and adequate food.	**No potential to occur.** Cool freshwater habitat is not present in the Proposed Action area. Critical habitat is outside of the Proposed Action area.
California tiger salamander (*Ambystoma californiense*)	Threatened / Critical Habitat	Vernal pools within grassland or oak woodlands; require seasonal water, ground squirrel burrows or other underground refuges.	**No potential to occur.** Seasonal wetlands or vernal pools are not present in the Proposed Action area. Critical habitat is outside of the Proposed Action area.
California red-legged frog (*Rana draytonii*)	Threatened	California red-legged frogs inhabit permanent and sometimes temporary water features such as streams, ponds, freshwater seeps, and marshes in lowlands and foothills between sea level and approximately 6,500 feet. Adjacent upland habitat consisting of extensive vegetation is preferred for foraging and cover. The species may make longer overland movements during migration to breeding ponds.	**No potential to occur.** The Proposed Action area is located outside the known range of the California red-legged frog and there are no reported occurrences within 5 miles of the Proposed Action area.

Species Name	Listing Status	Habitat Requirements	Occurrence Potential
Giant garter snake (*Thamnophis gigas*)	Threatened	Utilizes canals, creeks, ponds, and other areas that support permanent water with vegetative cover. The GGS uses grasses, weeds, cattails, tule, and other vegetation for basking, foraging and cover. Requires sufficient water during the active season (May 1 to October 1) to support a prey base. Species also requires upland refuge and hibernacula, such as small mammal burrows.	**No potential to occur.** No suitable aquatic or upland habitat is present within 200 feet of the Proposed Action area. The closest suitable aquatic habitat for the species is located in an irrigation canal approximately 1100 feet north of the Proposed Action.
Western snowy plover (*Charadrius alexandrinus nivosus*)	Threatened	The western snowy plover requires a sandy, gravelly or friable soil substrate for nesting. Nests are shallow depressions in the sand or soil, sometimes lined with small pebbles, glass fragments, or gravel. Foraging occurs along upper dry margins of beaches along the coast.	**No potential to occur.** Coastal wetlands and dune habitat are not present in the Proposed Action area.
Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	Candidate	The western yellow-billed cuckoo inhabits deciduous riparian thickets or forests with dense, low-level or understory foliage, and which abut on slow-moving watercourses, backwaters, or seeps.	**No potential to occur.** Riparian habitat is not present in the Proposed Action area.
Northern spotted owl (*Strix occidentalis caurina*)	Threatened	The range of the northern spotted owl includes southwestern British Columbia, western Washington and Oregon, and northwestern California south to Marin County. The species inhabits multi-layered, multi-species forest canopy with moderate to high canopy closure.	**No potential to occur.** Forest habitat is not present in the Proposed Action area.
Least Bell's vireo (*Vireo bellii pusillus*)	Endangered	Breed in and inhabit diverse riparian woodlands along water courses.	**No potential to occur.** Riparian habitat is not present in the Proposed Action area.

4.1 GIANT GARTER SNAKE

The GGS is a highly aquatic snake found in sloughs, marshes, ponds, low-gradient streams, as well as in rice fields, irrigation canals, and drainages and surrounding uplands (USFWS 1993). Basic habitat requirements include the following:

1. Sufficient water during the active summer season to supply cover and prey items such as small fish and amphibians;

2. Emergent, herbaceous aquatic vegetation accompanied by vegetated banks to provide basking and foraging habitat;

3. Bankside burrows, holes and crevices to provide short-term aestivation sites;

4. High ground or upland habitat above the annual high water mark to provide cover and refuges from floodwaters during the dormant winter season.

Burrows and other underground refuge are important to GGS during summer and winter to escape unfavorable winter cold temperatures or excessive summer heat. The GGS recovery plan states that wintering habitat can be up to 250 meters (820 feet) from the edge of marsh habitat (Miller et al. 1999). Typically, the USFWS defines upland as 218 linear feet of bankside habitat, which incorporates adjacent uplands to a width of 200 feet from the edge of bank (White 1997). Based on these habitat descriptions, the highest potential for adverse impacts on GGS exists within 200 feet of aquatic habitat, with decreasing likelihood of adverse impacts to wintering habitat up to 820 feet from suitable aquatic habitat.

The irrigation canal, rice fields, and associated uplands north of the Proposed Action area provide suitable habitat for GGS. The nearest known GGS population is located in the Colusa Basin Drainage Canal, approximately 1.8-mile north of the Proposed Action area. The rice fields and irrigation canal near the Proposed Action area are directly connected to the Colusa Basin Drainage Canal through a series of wetlands, ditches, and canals within the Roosevelt Ranch property. During field visits, bullfrogs and other small prey items that would provide a suitable prey base for GGS were observed in the irrigation canal and adjacent rice fields. Therefore, there is potential for the species to occur in these aquatic habitats, the nearest of which is approximately 1100 feet north of the Proposed Action area.

Upland habitat for GGS in the Proposed Action area is poor due to agricultural activities including disking, tilling, and cultivation of crops. Additionally, no burrows, other refugia, or ground squirrel activity were observed in the Proposed Action area during field surveys. Based on the distance from suitable aquatic habitat (greater than 820 feet), the lack of burrows or other refugia, and the lack of ground squirrel or other small mammal activity near the Proposed Action area, there is no suitable habitat for GGS in the Proposed Action area and all construction activities would take place outside of any potential wintering habitat.

5. POTENTIAL EFFECTS

As discussed above, the GGS is not expected to occur within the Proposed Action area, and thus effects on GGS are not anticipated as described below.

5.1 DIRECT EFFECTS

Direct effects are those that are caused by or will result from the Proposed Action at the time of the proposed action. Direct effects may include mortality, increased risk of predation, and increased stress resulting from:

- Crushing, dismemberment, and other injuries resulting from filling or crushing of burrows or crevices used for refuge;

- Crushing, dismemberment, and other injuries resulting from contact with vehicles and other construction equipment during construction activities;

- GGS movement into areas of unsuitable habitat where they will experience greater risk of predation or other sources of mortality;

- Silting, fill, or spill of oil or other chemicals resulting direct mortality or a reduction of prey items.

Because no suitable aquatic or upland GGS habitat is present in the Proposed Action area, direct effects resulting from construction of the access road and well pad are not expected. The proposed location of Well Pad B is approximately 1100 feet from the nearest suitable aquatic habitat, and all construction activities will occur beyond the upland wintering range for GGS (within 820 feet of aquatic habitat, as outlined in the species' recovery plan). Even if the construction footprint were to move 150 feet to the north (closer to suitable aquatic habitat for GGS) due to final engineering and site conditions as described in the Proposed Action section above, the footprint would be 950 feet away from any suitable aquatic habitat, and would remain outside of the known wintering range of the species. Recommendations have been developed to assure that construction activities do not have direct effects on GGS or suitable upland habitat in the vicinity of the Proposed Action, and are presented in Section 6 below.

5.2 INDIRECT EFFECTS

Indirect effects are those that are caused by or will result from the Proposed Action and occur later in time. The Proposed Action is a short-term construction activity that is anticipated to be completed within ten weeks. The construction of Zamora Well Pad B is not expected to significantly alter habitat suitability for GGS from existing conditions. Once the pad is installed and core sampling is complete, the pad will be returned to agricultural use or will become permanent. The Proposed Action is not anticipated to result in indirect effects on GGS due to its temporary nature, minimal size, and minimal impact on availability of suitable GGS habitat.

5.3 CUMULATIVE EFFECTS

Cumulative effects are those effects resulting from future state, local, and private actions that are reasonably certain to occur in the action area. The Proposed Action is not expected to change existing land uses that could result in cumulative effects, or otherwise contribute to cumulative effects on GGS. All irrigation ditches and canals in the vicinity are subject to management related to maintaining viable agricultural water delivery to irrigate crops. The adjacent agricultural lands are also subject to ongoing management as part of ongoing agricultural operations. Management actions in proximity to the Proposed Action area are expected to continue after implementation of the proposed project.

If core sampling determines that the geology of the site is suitable for compressed air storage and the site is selected for compression testing, then it would be subject to a separate federal action and consultation requirements established in Section 7 of the Endangered Species Act (ESA) and, therefore, are not considered cumulative to the proposed action at this time. Because it is yet to be determined if this site would be selected, farming activities will continue on the site and there are no reasonably foreseeable projects planned that would affect the area.

6. RECOMMENDATIONS

The following recommendations have been incorporated into the Proposed Action in order to avoid or minimize the potential for adverse effects on GGS.

1. Prior to working on-site, all workers shall be provided with Environmental Awareness Training by a qualified biologist approved by USFWS. The training shall address the identification and general ecology of GGS and other species that have potential to occur in the vicinity of the Proposed Action, and the recommendations to be implemented in order to avoid impacts to these resources. Construction workspace boundaries and avoidance areas shall also be addressed in the training. Please contact project biologist, Catalina Reyes (925-808-8811) two weeks prior to construction to schedule the training.

2. Prior to construction, all work areas (e.g., vehicle access, parking, staging) needed to complete the project shall be identified and clearly marked in coordination with the on-site biologist. All work areas shall be limited to the minimum area necessary to complete work.

3. If practicable, ground disturbing activity (e.g. vegetation removal, compaction, and placement of gravel fill) at the well pad site shall be conducted during the active season for GGS (i.e., between May 1 and October 1). Additionally, all work shall be conducted at least 250 meters (820 feet) from GGS aquatic habitat to minimize potential impacts to GGS wintering habitat.

4. A qualified biologist approved by USFWS shall perform a general pre-construction survey within 72 hours of the start of project construction. Please contact PG&E Biologist Catalina Reyes (925-808-8811) two weeks prior to construction to schedule surveys.

5. Any and all potential nesting substrate (e.g., shrubs and trees) that requires removal to construct the project should be removed before the onset of the nesting season (i.e., prior to February 15), if feasible. This will help preclude nesting and substantially decrease the likelihood of direct impacts on nesting birds. If this is not feasible then a nesting bird survey of potential nesting substrate will be performed 72 hours prior to its removal.

6. Access to the well pad shall be confined to existing roads, road shoulders, and other compacted areas such as access roads included in the Proposed Action. Travel along access roads shall be restricted to the centerline.

7. To ensure that wildlife does not become trapped or entangled, no wattles with plastic monofilament netting are permitted. Burlap or coconut wattles are appropriate substitutes.

8. Escape ramps at a 45 degree angle or less shall be provided for any excavations that are greater than one foot deep that are left open overnight. Smaller holes shall be covered so that no gaps occur and shall be inspected each morning and prior to backfilling for wildlife. If special-status wildlife becomes entrapped, work shall stop and PG&E Project Biologist Catalina Reyes (925-808-8811) shall be notified immediately to determine next steps.

9. All construction personnel shall visually check for wildlife under vehicles and equipment prior to moving them.

10. Construction equipment shall be maintained to prevent leaks of fuels, lubricants or other pollutants.

11. Whenever possible, refueling and maintenance of vehicles shall occur offsite. In cases when this is not possible refueling and maintenance of vehicles and equipment shall be conducted over drip pans and at least 100 feet from any waterway.

12. Open ends of pipes, conduits or other materials stored onsite shall be covered to exclude wildlife and shall be inspected prior to use.

13. Vehicular speed within the Proposed Action area shall be limited to 15 miles per hour (mph) in order avoid impacts to wildlife that may be located on or near roadways.

14. Watering of roads during dry season work shall be performed as necessary (approximately 3– 4 times per day) in order to reduce potential dust resulting from project-associated traffic.

15. Caution shall be used when handling and/or storing chemicals (fuel, hydraulic fluid, etc.). As part of standard PG&E Best Management Practices (BMPs), crews shall have appropriate materials on site to provide secondary containment and prevent and manage spills. If groundwater is encountered, crews shall contact PG&E Environmental Specialist Bryon Nicholson (415-990-0139).

16. Crews shall implement all standard PG&E BMPs outlined in the Good Housekeeping Activity Specific Erosion and Sediment Control Plan (January 2011) as needed.

17. If the scope of work or project location changes, crews shall contact project biologist Catalina Reyes (925-808-8811) as soon as possible and prior to commencing work. The project biologist or Land Planner (Ernie Ralston, 515-973-3215) shall contact the USFWS Sacramento Fish & Wildlife Office ESA/Regulatory Division upon notice of any such changes.

18. Construction-related trash shall be removed from the site daily and upon work completion and the Proposed Action area shall be returned to near pre-construction contours and conditions upon project completion.

7. CONCLUSION AND DETERMINATION

Well Pad B construction, including access, is not expected to have any adverse impact on GGS or their habitat. The Proposed Action workspace is approximately 1100 feet south of the irrigation canal that may provide aquatic habitat for the GGS. Although GGS may move more than 200 feet from aquatic habitat to seek upland burrows in winter, it is likely a rare occurrence. The lack of burrows and cover in the study area due to continuous agricultural use virtually precludes the potential for use by GGS. Further, while the GGS recovery plan states that wintering habitat can be up to 820 feet from the edge of marsh habitat (Miller et al. 1999), even if the project was shifted up to 150 feet to the north (closer to suitable aquatic habitat present in the irrigation canal), project workspaces would still remain more than 820 feet from any suitable aquatic habitat.

With implementation of the recommendations provided in Section 6 above, it has been determined that:

- The Zamora Well Pad B Development and Core Well Drilling Project will have no effect on the giant garter snake or any other federally listed, proposed, or candidate species, and will have no effect on critical habitat for any federally listed species.

8. LIST OF PREPARERS

- Benjamin Hart, Project Manager / Biologist, SWCA

- Karen Swaim, Biologist, SBI
- Catalina Reyes, Biologist, PG&E

9. REFERENCES

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USFWS. National Wetlands Inventory Wetlands Mapper. Online. http://107.20.228.18/Wetlands/WetlandsMapper.html#. Site visited September 2012.

White, Wayne S. 1997. Programmatic formal consultation for U.S. Army Corps of Engineers 404 permitted projects with relatively small effects on the giant garter snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo Counties, California, edited by A. Champ. Sacramento, California: Sacramento Fish and Wildlife Office.

APPENDIX A
U.S. Fish and Wildlife Service Species List

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U.S. Fish & Wildlife Service
Sacramento Fish & Wildlife Office
Federal Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 121016114039

Database Last Updated: September 18, 2011

Quad Lists

Listed Species

Invertebrates

Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Lepidurus packardi
vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
Critical habitat, winter-run chinook salmon (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)

Rana draytonii
California red-legged frog (T)

Reptiles

Thamnophis gigas
giant garter snake (T)

Candidate Species

Birds

Coccyzus americanus occidentalis
Western yellow-billed cuckoo (C)

Quads Containing Listed, Proposed or Candidate Species:

ELDORADO BEND (530D)

County Lists

Yolo County

Listed Species

Invertebrates

Branchinecta conservatio
Conservancy fairy shrimp (E)

Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Elaphrus viridis
delta green ground beetle (T)

Lepidurus packardi
Critical habitat, vernal pool tadpole shrimp (X)
vernal pool tadpole shrimp (E)

Syncaris pacifica
California freshwater shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
Critical habitat, delta smelt (X)
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
Critical habitat, winter-run chinook salmon (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)
Critical habitat, CA tiger salamander, central population (X)

Rana draytonii
California red-legged frog (T)

Reptiles

Thamnophis gigas
giant garter snake (T)

Birds

Charadrius alexandrinus nivosus
western snowy plover (T)

Strix occidentalis caurina
northern spotted owl (T)

Vireo bellii pusillus
Least Bell's vireo (E)

Plants

Cordylanthus palmatus
palmate-bracted bird's-beak (E)

Neostapfia colusana
Colusa grass (T)
Critical habitat, Colusa grass (X)

Sidalcea keckii
Keck's checker-mallow (=checkerbloom) (E)

Tuctoria mucronata
Critical habitat, Solano grass (=Crampton's tuctoria) (X)
Solano grass (=Crampton's tuctoria) (E)

Candidate Species

Birds

Coccyzus americanus occidentalis
Western yellow-billed cuckoo (C)

Key:

(E) *Endangered* - Listed as being in danger of extinction.
(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.
(P) *Proposed* - Officially proposed in the Federal Register for listing as endangered or threatened.
(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.
(C) *Candidate* - Candidate to become a proposed species.
(V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.
(X) *Critical Habitat* designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, **or may be affected by** projects within the quads covered by the list.

within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list. See our Protocol and Recovery Permits pages.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

> Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.

  During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.

- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.

  Should your survey determine that federally listed or proposed species occur in the area and are

  likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our Map Room page.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6520.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be January 14, 2013.

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APPENDIX B
Figures

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Figure 1: Project Location and Vicinity

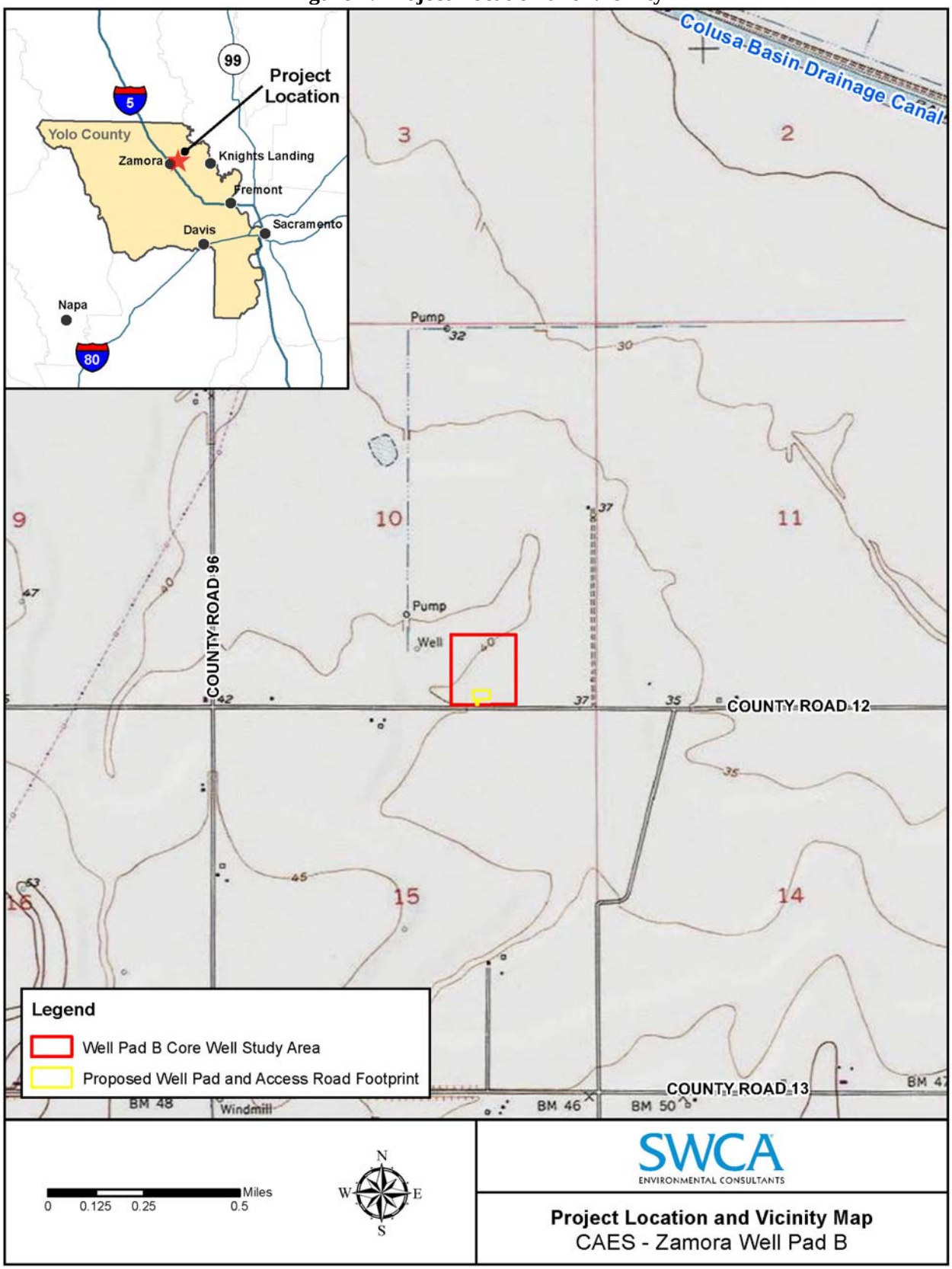


Figure 2: Project Area

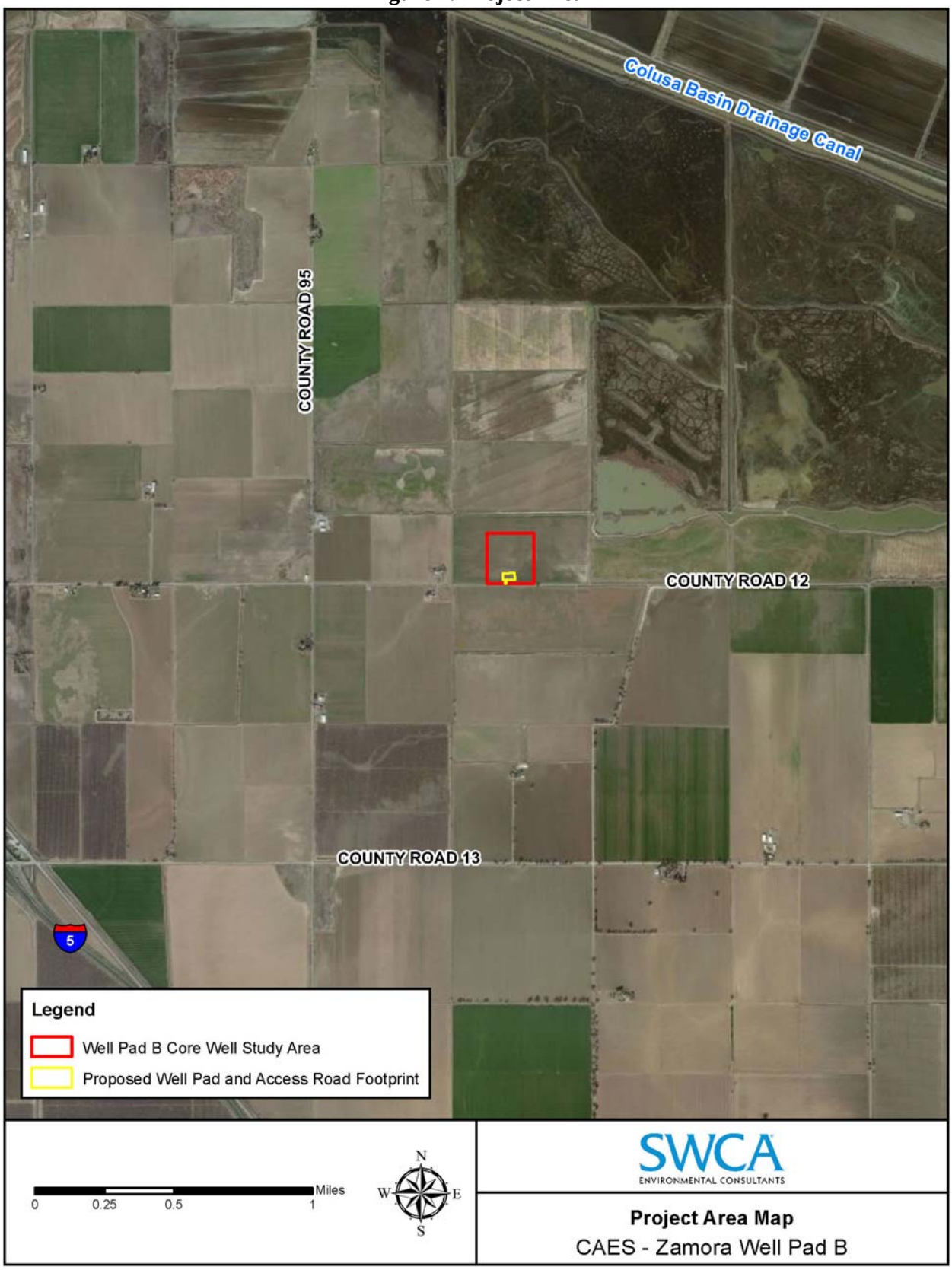
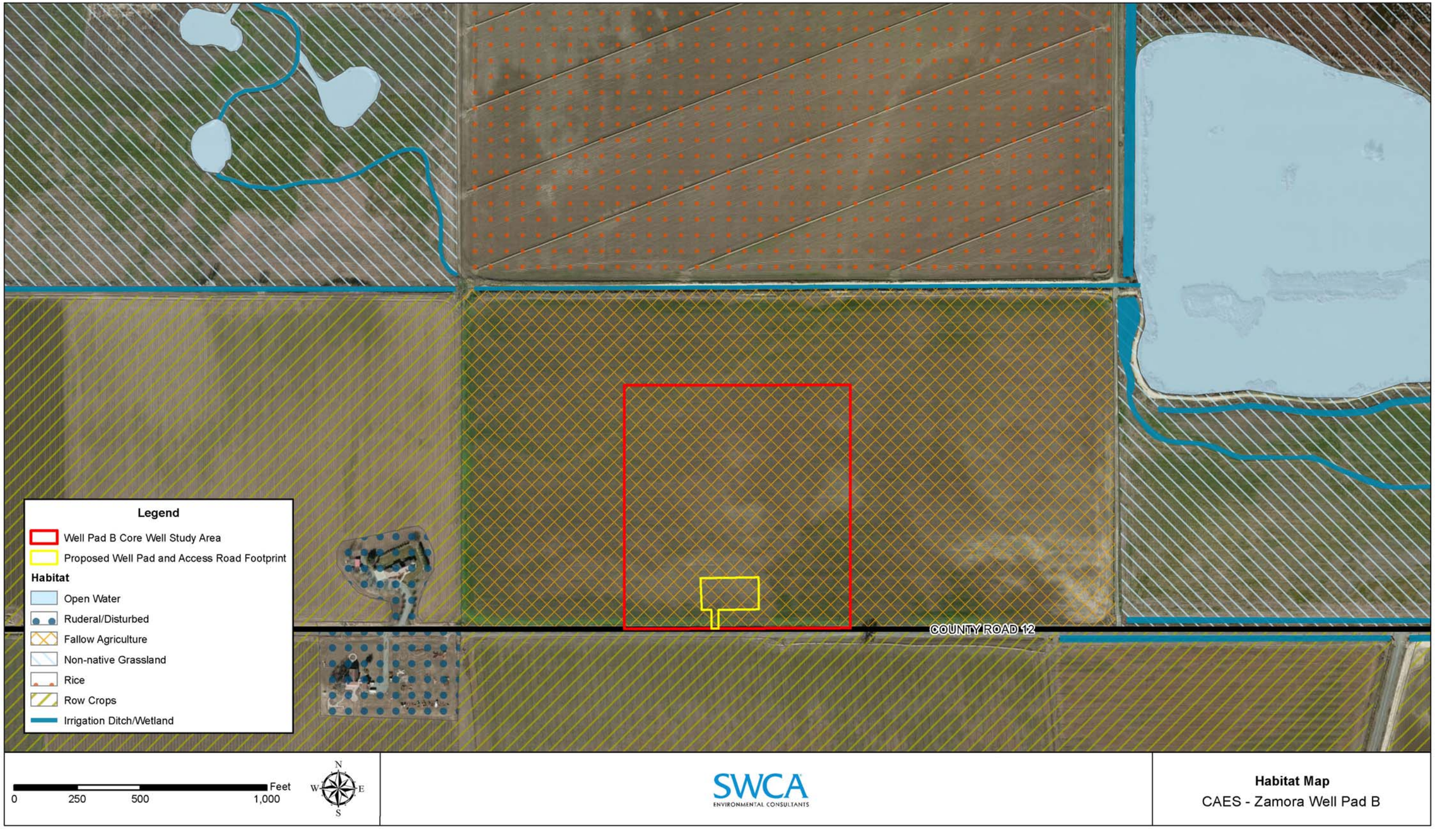


Figure 3: Habitat Types



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APPENDIX C
Giant Garter Snake Habitat Assessment

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Swaim Biological Incorporated
4435 First Street PMB #312
Livermore, CA 94551

To: Pacific Gas and Electric Company
From: Karen Swaim
Date: November 18, 2012
Re: Giant Garter Snake Habitat Assessment for the Zamora Well Pad B Construction and Core Drilling Project

This memo provides a reconnaissance level constraints analysis for construction and operation of proposed Well Pad B, for Pacific Gas and Electric Company's Compressed Air Energy Storage Project (Project), located near Zamora in Yolo County, California (Attachment A). The proposed well pad, Well Pad B, is located in the southwest corner of the Roosevelt Ranch Preserve.

The Project is located within the current range of the giant garter snake (GGS) and suitable GGS habitat is present in portions of the Roosevelt Ranch. GGS have been documented on the Roosevelt Ranch during USGS trapping and telemetry study in the vicinity of the Colusa Basin Drainage Canal (Wylie and Amarillo 2006). These observations are approximately 1.8 miles north of the proposed well pad.

Methods

Prior to visiting the site, SBI reviewed available locality data for GGS within a 10 mile radius of the project site. Data reviewed included the California Natural Diversity Data Base and consulting/research reports currently or previously available on-line. Aerial images both current and past available through Google Earth were also reviewed to determine the distribution of aquatic habitats in the vicinity over time. The assessment for GGS was conducted by SBI Biologist Karen Swaim.

Site visits were conducted on July 14, August 2, September 14, and October 1, 2012. During site visits, aquatic habitats were visually surveyed to assess their suitability to provide habitat for GGS. Site visits included driving and walking ranch roads in the study area from County Road 12 north to the Roosevelt Ranch Boundary (Attachment A).

The GGS is a highly aquatic snake found in sloughs, marshes, ponds, low-gradient streams, as well as in rice fields, irrigation canals, and drainages and surrounding uplands (USFWS 1993). Basic habitat requirements include the following:

1. Sufficient water during the active summer season to supply cover and prey items such as small fish and amphibians;
2. Emergent, herbaceous aquatic vegetation accompanied by vegetated banks to provide basking and foraging habitat;
3. Bankside burrows, holes and crevices to provide short-term aestivation sites;
4. High ground or upland habitat above the annual high water mark to provide cover and refuges from floodwaters during the dormant winter season.

Results

No suitable aquatic habitat for GGS was found within 200 feet of the proposed Well Pad B Study area or access route. The area proposed for Well Pad B is located within an approximately 71 acre fallow field that is virtually devoid of vegetation and rodent burrows (Appendix A-Site Photos).

The closest potential aquatic habitat for GGS is located approximately 1100 feet north of the proposed well pad (Attachments B and C). This aquatic habitat consists of an agricultural ditch/canal that has well-established emergent aquatic vegetation, abundant potential prey (fish and breeding bullfrog population), and adjacent upland grassland habitat with abundant rodent burrows.

Conclusions

Well Pad B construction, including access is not expected to have any adverse impact on GGS or their habitat. The well pad workspace, as currently proposed, is approximately 1100 feet south of the drainage ditch that may provide aquatic habitat for the GGS. Although GGS may move more than 200 feet from aquatic habitat to seek upland burrows in winter, it is likely a rare occurrence. The lack of burrows and cover in the study area due to continuous agricultural use virtually precludes the potential for use by GGS to be expected. Further, while the GGS recovery plan states that wintering habitat can be up to 250 meters (820 feet) from the edge of marsh habitat (Miller et al. 1999), even if the project was shifted up to 150 feet to the north (closer to suitable aquatic habitat present in the drainage ditch), project workspaces would still remain more than 820 feet from any suitable aquatic habitat.

Recommendations

The project should maximize the distance between Well Pad B and the drainage ditch to the north. This would provide the highest degree of avoidance of GGS possible for the project.

Literature Cited

California Department of Fish and Game (CDFG). 2012. California Natural Diversity Database (CNDDB). Database query for the Willows, Chico, Portola, Lakeport, Yuba City, Truckee, Healdsburg, Sacramento, and Placerville 7 ½ - minute quadrangles. May 2012.

Miller, K. J., Kelly Hornaday, U. S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, and The Giant Garter Snake Recovery Team. 1999. Draft recovery plan for the giant garter snake (*Thamnophis gigas*): U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). 1993. Determination of threatened status for the giant garter snake / RIN 1018-AB73. Federal Register. 58: 1654 lines.

Wylie, M. and M. Amerello. 2006. Results of 2006 Monitoring for Giant Garter Snakes (*Thamnophis gigas*) For the Bank Protection Project on the Left Bank of the Colusa Basin Drainage Canal in Reclamation District 108, Sacramento River Bank Protection Project, Phase II Administrative Report Prepared for Environmental Planning

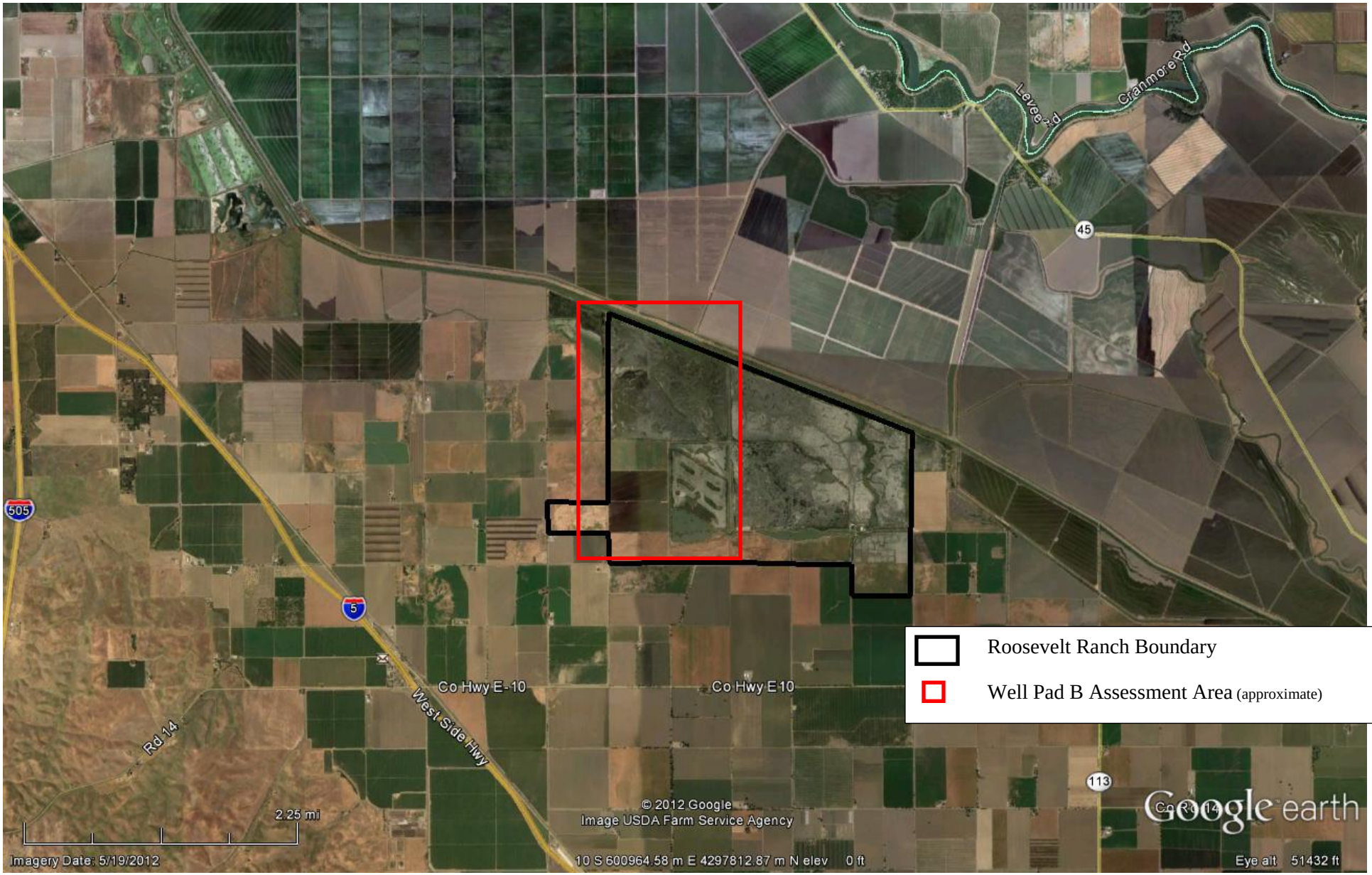
If you have any questions regarding this memo or need further information feel free to contact me.

Sincerely,

Karen E. Swain

A- PROJECT SITE LOCATION
B- AQUATIC HABITAT IN THE VICINITY OF WELL PAD B STUDY AREA
C- PROJECT AND VICINITY PHOTOS

ATTACHMENT A- PROJECT SITE LOCATION



ATTACHMENT B: AQUATIC HABITAT IN THE VICINITY OF THE WELL PAD B


Early Harvest Rice Crop
Rd 12
Potential GGS Aquatic Habitat
Well Pad B and Access Area
Roosevelt Ranch Boundary
801 ft
Imagery Date: 5/19/2012
10 S 600295.48 m E 4296381.66 m N elev 0 ft
Google earth
Eye alt 3465 ft

ATTACHMENT C- SITE AND VICINITY PHOTOS



Photo 1. View east along County Road (CR) 12 with fallow field to the north, where Well Pad B is proposed. The crop south of CR 12 is alfalfa.



Photo 2. View northeast across the fallow field from the southwest corner of Rooosevelt Ranch toward the proposed Well Pad B location.



Photo 3. View north from CR 12 toward the irrigation ditch that parallels the north edge of the fallow field. Vegetation bordering the ditch is visible along the horizon.



Photo 4. View west toward the proposed location of Well Pad B from the Roosevelt Ranch access road that parallels the eastern edge of the fallow field.



Photo 5. View south from the irrigation ditch that parallels the northern edge of the fallow field. This is the closest aquatic feature to the study area that provides potential aquatic habitat for the giant garter snake.



Photo 6. Close up of typical condition of the fallow field, which has virtually no burrows or vegetation.

Gas Field GIS Environmental Evaluation

Field Name: **Zamora**

Resource Category	Presence/Potential Direct Effects: Station	Field	0.25mi	5mi	Linears	Indirect Effects	Comments & Mitigation Options	R-Y-G
Scenic Highway	N	N	N	N	N			
Airport/Approach Patterns	N	N	N	N	N			
Envirostor List Site								
Federal Sensitive Species								
Suitable Habitat	N	N	N	N	N		Dunnigan Hills Gen-Tie route has no CNDDB reports but may be habitat	
Critical Habitat								
State Sensitive Species								
Suitable Habitat	N	N	N	Y	Y		SwHa, Dunnigan Hills	
ACEC/Protected Lands	N	Y	Y	Y	N		NRCS Wetland Conservation Easement over most of field	
Land Use/Zoning	AP	Ag	Ag	Ag	Ag		Yolo County - 'Cogen' permitted as Minor Use Permit in AP	
Public Lands	N	N	N	N	N			
Tribal Lands	N	N	N	N	N			
Williamson Act Contracts	N	Y	Y	Y	Y			
Farmland Class	P	P/U	P/U	P/U	P/U			
Crop Types	Row	Rice	Rice	Rice	Grazing			
Wetlands	N	N	N	N	N			
Vernal Pools	N	N	N	N	N			
Flood Zones	P	Y	Y	Y	N		Station site partially in 100 yr	

Locational Assumptions:

Station Site: **Located on county road just opposite wetland conservation easement on non WA property.**

Gas: **3 miles along County Road 12 to Line 172A [20" dia., MAOP 800#, Installed 1957]**

Electric: **Extend W & SW ~9 miles to Cortina Vaca 230kV line, following existing property lines to Dunnigan Hills, then straight line to existing 230kV. Three residences along the route.**

Waste water source: **None in close proximity**

Env Policy Criteria

Sources of noise: **Farming operations only - no other transportation, commercial or industrial sources.**

Other power generational facilities and industrial areas that could be cumulatively significant: **None**

Sensitive receptors: **Nearest farm residences from station are ~ 3000 ft to W and SW**

Economic status of lands/EJ communities:

Known wildlife corridors/connectivity areas, nesting areas, Audubon IBAs: **Known waterfowl migration route & potential collision w/gen-tie, otherwise subject to further review - none sho**

Conservation Easements: **NRCS easement for wetlands on N side of Rd 12**

Riparian Areas: **None**

Areas that would be preferred for siting such as degraded or disturbed lands: **None in vicinity - surrounded by ag**

wn in GIS.

Laboratory Test Report
Applied Technology Services
3400 Crow Canyon Road
San Ramon, CA 94583

Report #: **402.34-13.1**

Pacific Gas and Electric Company

SUBJECT: 2012 ZAMORA DRILLING SOUND MODEL

Ernie,

Applied Technology Services was asked to model the noise environment in Zamora, CA on Road 12 between Road 95 and Road 96, as seen in Figure 1 for purposes of determining the current sound environment and likely effects of proposed well drilling for a proposed compressed-air energy storage facility. The goal of the model was to predict and validate sound effects of the proposed drill rig for permitting purposes. Ambient noise levels of the area were also measured for comparison of the model and to determine the baseline noise conditions for the permit.

Sound Measurement Terms

A-weighted decibel levels (dBA) account for sensitivity of the human ear by making numerical adjustments to the various octave frequency bands, and it is the most often used metric in noise exposure measurements.

L_{eq} is a single-valued level that expresses the time-averaged total energy of a widely varying or fluctuating sound level.

L_{dn} is an averaging metric for 24-hour community noise exposure that differentiates between daytime and nighttime noise exposures and adds a 10-dBA penalty for noise between the hours of 10pm and 7am.

County of Yolo Drill Permit Regulation

The *Oil & Gas Drilling Operation Site Plan Review Request Form* from the County of Yolo Planning and Public Works Department states that no drilling operation shall cause sound levels to exceed the existing ambient level by more than 3 dBA, L_{dn}.

> "... no drilling operation shall result in an ambient noise level in excess of sixty (60) decibels ([dBa] measured as an LDN average), measured at the outside of the nearest residence at the bedroom window closest to the drilling site; provided, however, if it is demonstrated that the ambient noise level at such location prior to the commencement of the drilling operation was fifty-seven (57) decibels ([dBa] measured as an LDN average) or higher, then the noise standard shall be that the drilling operation does not result in the addition of more than three (3) decibels ([dBa] measured as LDN average) to the preexisting ambient noise level."

pc:

Date: 1/3/2013

Modeled by: Ed Collyer

Reviewed by: Dave Poffenbarger

Subject: 2012 Zamora Drilling Sound Model
ATS Lab File No.: 402.34-13.1

Methodology

The drill site and surrounding environment using SoundPLAN 7.1 software by Braunstein + Berndt GmbH. Based on the *Oil & Gas Drilling Operation Site Plan Review Request Form* from the County of Yolo Planning and Public Works Department noise regulations, the A-weighted L_{dn} sound levels were used for all modeling and results. The existing sound levels at the site were measured to determine compliance.

Sound levels for the noise sources used for the model were taken at Drill Rig 4 on 12/26/2012 in Williams. The measurements were taken around the site at several locations using a Larson-Davis Model 824 sound level meter which include frequency content (spectra) and overall equivalent sound level in dBA and dBC. Several points were taken at distances from 20 to 40 feet from the drill rig to be used for calibration of the model. The remaining measurements were taken at approximately three to five feet from the sources that will be used for near-field source data. The near field measurements are used as the inputs for the model then the calibration points are used to adjust the results.

Community noise measurements were taken continuously on weekend and weekday periods at the corner of Road 12 and Road 96 from 12/13-16/ 2012 to determine ambient sound levels around the site. These measurements were taken using Larson-Davis Model 820 Community Noise Monitors. The community monitors were placed approximately 6 ft. above ground level on PG&E power poles.

Results

The existing ambient sound level was measured at 54 dBA, L_{dn}. According to the *Oil & Gas Drilling Operation Site Plan Review Request Form* from the County of Yolo Planning and Public Works Department, the maximum allowable noise level for the drill rig is thus 60 dBA L_{dn}. This value was used as the limiting value for this model and will be used for permitting.

Table 1 summarizes the results of the model in terms of A-weighted L_{dn}. Figure 1 gives a visual description of the noise contour lines as modeled in the preliminary run.

Table 1: Modeled sound levels at Nearby Houses in terms of A-weighted LDN.
Levels based on PRELIMINARY model.

	House A	House B	House C	House D	House E	House F
LDN (dBA)	58.5	57.5	46	45	44	47
Leq (dBA)	52	51	40	38	38	41

Conclusions and Recommendations

Based on the data measured by ATS, the drill rig will meet the requirements put forth by the *Oil & Gas Drilling Operation Site Plan Review Request Form* from the County of Yolo Planning and Public Works Department. While likely not required to meet the noise specification, if additional noise mitigation is incorporated, the site will be well within compliance of those requirements. PG&E is planning on using noise mitigation techniques such as vinyl sound blankets and hay bales.

There are several noise sources within the drill rig that are highly directional and produce the majority of the noise including the generator and main engine. It is recommended that these sources be oriented such the noisiest direction be placed as far away and oriented away from the closest sensitive receptor. These

sources were modeled to the far east of the site footprint, away from the closest sensitive receptor but may bring the site to the limit of compliance if they are setup towards the west end of the footprint, closest to the nearest sensitive receptor.

It was noted during the site visit that the drill riggers personal and auxiliary trailers were setup around the site. It is recommended that the trailers be setup between the drill rig and the sensitive receptors to the west if possible for additional interference of noise propagation.

Given the data taken, the possibility of trailer location, and use of noise mitigation, the drill rig will be within compliance of the 60 dBA L_{dn} limit set by the *Oil & Gas Drilling Operation Site Plan Review Request Form* from the County of Yolo Planning and Public Works Department. However, on-site measurements during drilling should be taken at the sensitive receptors during drilling to ensure that the site remains in compliance.

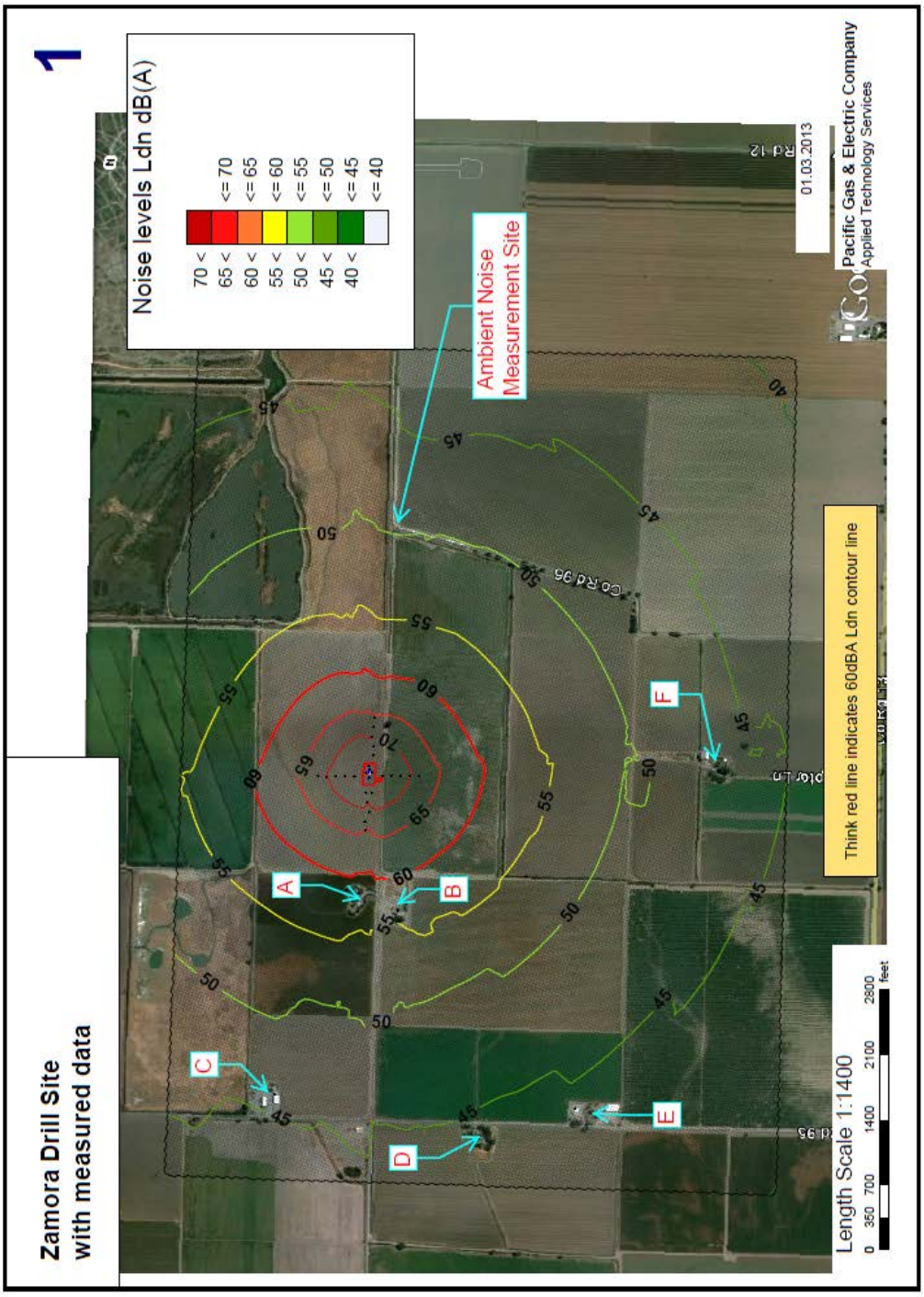


Figure 1: Final results of Zamora sound model in terms of A-weighted Ldn sound levels

Notice of Exemption

Form D

To: Office of Planning and Research
P.O. Box 3044, Room 212
Sacramento, CA 95812-3044

County Clerk
County of _____

_____

_____

From: (Public Agency) Department of Conservation
Division of Oil, Gas, and Geothermal Resources
801 K Street, MS 18-05, Sacramento, CA 95814
(Address)

Project Title: Roosevelt Ranch 10-1

Project Location - Specific:

Section 10, Township 11 North, Range 1 East, MDB&M, Yolo County

Project Location – City: _____ Project Location – County: Yolo

Description of Nature, Purpose and Beneficiaries of Project:

Activities to drill and test one core well by Pacific Gas & Electric.

Name of Public Agency Approving Project: Division of Oil, Gas, and Geothermal Resources

Name of Person or Agency Carrying Out Project: Pacific Gas & Electric

Exempt Status: **(check one)**

- ☐ Ministerial (Sec. 21080(b)(1); 15268);
- ☐ Declared Emergency (Sec. 21080(b)(3); 15269(a));
- ☐ Emergency Project (Sec. 21080(b)(4); 15269(b)(c));
- ☒ Categorical Exemption. State type and section number: Information Collection (Section 15306, Class 6)
- ☐ Statutory Exemptions. State code number: _____

Reasons why project is exempt:

Project proposed to drill and test one core well in an agricultural field. Project will be completed and removed within 3 months resulting in no significant effect to the environment.

Lead Agency Contact Person: Tim Kustic Area Code/Telephone/Extension: (916) 323-1779

If filed by applicant:

1. Attach certified document of exemption finding.
2. Has a Notice of Exemption been filed by the public agency approving the project? ☐ Yes ☐ No

Signature: _____ Date: 2/7/13 Title: State Oil and Gas Supervisor

☐ Signed by Lead Agency

☐ Signed by Applicant

Date received for filing at OPR: _____

RECEIVED
FEB 07 2013
STATE CLEARING HOUSE

Revised 2005

ZAMORA GAS FIELD
YOLO COUNTY, CALIFORNIA

CAES FIELD TESTING DESIGN
PERMEABILITY REFINEMENT

Overview

The Compressed Air Energy Storage (CAES) well test design calculations for the Zamora field require knowledge of the average reservoir permeability for the potential field pilot test areas. However, there are no reported permeability data in the field records from whole core, sidewall core and/or from transient well tests. To investigate the level of permeability for the two target reservoirs in the field, the Third Starkey and Starkey S2B zones, existing well performance data were matched using classical gas rate performance equations. In addition, some permeability data were located for a nearby analogous gas field.

Theoretical Gas Performance Equation

A pseudosteady-state (Pss) solution was used to derive formation permeabilities and calculate theoretical gas rates in order to match the observed gas rates in two key wells in the Zamora gas field. The key wells selected were the Arow-Knaggs 1 well completed in the Starkey Third Zone and the Knaggs-Wallace 4 well completed in the Starkey 2B Zone. The Pss formula assumptions and rate calculations for each zone are attached to this summary page.

The Pss calculations are very sensitive to the pressure drop, or the difference between the static reservoir pressure (Pr) and the bottomhole flowing pressure (Pwf), associated with the reported gas rate. The pressure data required for the Pss formula were unknown for the selected gas well rates and therefore had to be derived from other sources. The Pr information came from a DOGGR publication on Zamora (TR-30) and static tubing pressure data reported in the on-line DOGGR production data. The downhole Pwf values were estimated from respective surface flowing tubing pressure data.

The range of formation permeability that matched the observed gas rates and wellhead pressures are shown in the following table.

Zone	Gas Rate		Assumed Permeability, md
	Observed, mcfd	Calculated, mcfd	
Starkey S2B	1,394 - 1,435	1,188 - 1,782	100 - 150
Starkey S3	1,305 - 1,848	1,346 - 1,871	300 - 350

The Pss rate calculations are also sensitive to the rate dependent skin factor. This factor takes into account the non-Darcy flow effects near the wellbore where the gas rates can become extremely high and turbulent because of the converging flow as the gas approaches the wellbore. The net effect is a higher pressure gradient when these inertial effects become important. For this simple theoretical analysis, a typical level of effective skin was assumed in the equation.

Analogous Field Data

The following information was obtained from the California Oil and Gas Fields, Northern California, Volume 3, 4th Edition, 1982 (Publication TR-10).

Dunnigan Hills Gas Field
1-3 Pool
Depth 2,450 feet, Porosity 34 - 38%, Pi = 1,040 psi
IP = 5,000 mcfd, 28/64ths
Permeability to air = 300 md – 1,700 md

By comparison:
Zamora Gas Field
Starkey Pool
Depth 3,580 feet, Porosity 28 - 32%, Pi = 1,474 psi
IP = 3,479 mcfd, 24/64ths
Permeability to air = NA

PSEUDOSTEADY-STATE RATE SOLUTION FOR GAS WELLS*

Estimated q =	1,871	mcfd	
Field	Zamora		
Zone	Third Starkey		
Well	Arow-Knaggs 1		1305 mcfd and 1425 psig WHP in Oct 1978; 1848 mcfd and 1420 psig WHP in Dec 1978
k	**300**	**md**	
Pr	1569	psi	Initial pressure = 1569 psi (DOGGR Pub. TR30)
Pwf	1556	psi	1420 Tbg psig converted to bhp
CA	5.38	shape factor	
A	320	acres	
rw	0.33	ft	
z	0.9		
u	0.015	cp	
Tr	110	deg F	
Effective skin	3		
h	20	ft	

CA = 30.88 for well in center of square drainage shape
CA = 5.38 for 4:1 retangular shape
CA = 21.8 for 2:1 rectangular shape

* Petroleum Engineering Handbook, SPE, Bradley, 1989, pg 35-12

PSEUDOSTEADY-STATE RATE SOLUTION FOR GAS WELLS*			
Estimated q =	1,346	mcfd	
Field	Zamora		
Zone	Third Starkey		
Well	Arow-Knaggs 1		1305 mcfd and 1425 psig WHP in Oct 1978; 1848 mcfd and 1420 psig WHP in Dec 1978
k	**350**	**md**	
Pr	1569	psi	Initial pressure = 1569 psi (DOGGR Pub. TR30)
Pwf	1561	psi	1425 Tbg psig converted to bhp
CA	5.38	shape factor	
A	320	acres	
rw	0.33	ft	
z	0.9		
u	0.015	cp	
Tr	110	deg F	
Effective skin	3		
h	20	ft	
CA = 30.88 for well in center of square drainage shape			
CA = 5.38 for 4:1 retangular shape			
CA = 21.8 for 2:1 rectangular shape			
* Petroleum Engineering Handbook, SPE, Bradley, 1989, pg 35-12			

PSEUDOSTEADY-STATE RATE SOLUTION FOR GAS WELLS*

Estimated q =	1,188	mcfd	
Field	Zamora		
Zone	Starkey S2B		
Well	Knaggs-Wallace 4		1394 mcfd and 1275 psig WHP in Nov 1984; 1435 mcfd and 1275 psig WHP in Jan 1985
k	**100**	**md**	
Pr	1460	psi	Nearby static WHP=1360 psi Jun1984 Knaggs-Wallace 1
Pwf	1400	psi	1275 tbg psig converted to bhp
CA	21.8	shape factor	
A	320	acres	
rw	0.33	ft	
z	0.9		
u	0.015	cp	
Tr	110	deg F	
Effective skin	5		
h	10	ft	

CA = 30.88 for well in center of square drainage shape
CA = 5.38 for 4:1 retangular shape
CA = 21.8 for 2:1 rectangular shape

* Petroleum Engineering Handbook, SPE, Bradley, 1989, pg 35-12

PSEUDOSTEADY-STATE RATE SOLUTION FOR GAS WELLS*

Estimated q =	1,782	mcfd	
Field	Zamora		
Zone	Starkey S2B		
Well	Knaggs-Wallace 4		1394 mcfd and 1275 psig WHP in Nov 1984; 1435 mcfd and 1275 psig WHP in Jan 1985
k	**150**	**md**	
Pr	1460	psi	Nearby static WHP=1360 psi Jun1984 Knaggs-Wallace 1
Pwf	1400	psi	1275 tbg psig converted to bhp
CA	21.8	shape factor	
A	320	acres	
rw	0.33	ft	
z	0.9		
u	0.015	cp	
Tr	110	deg F	
Effective skin	5		
h	10	ft	

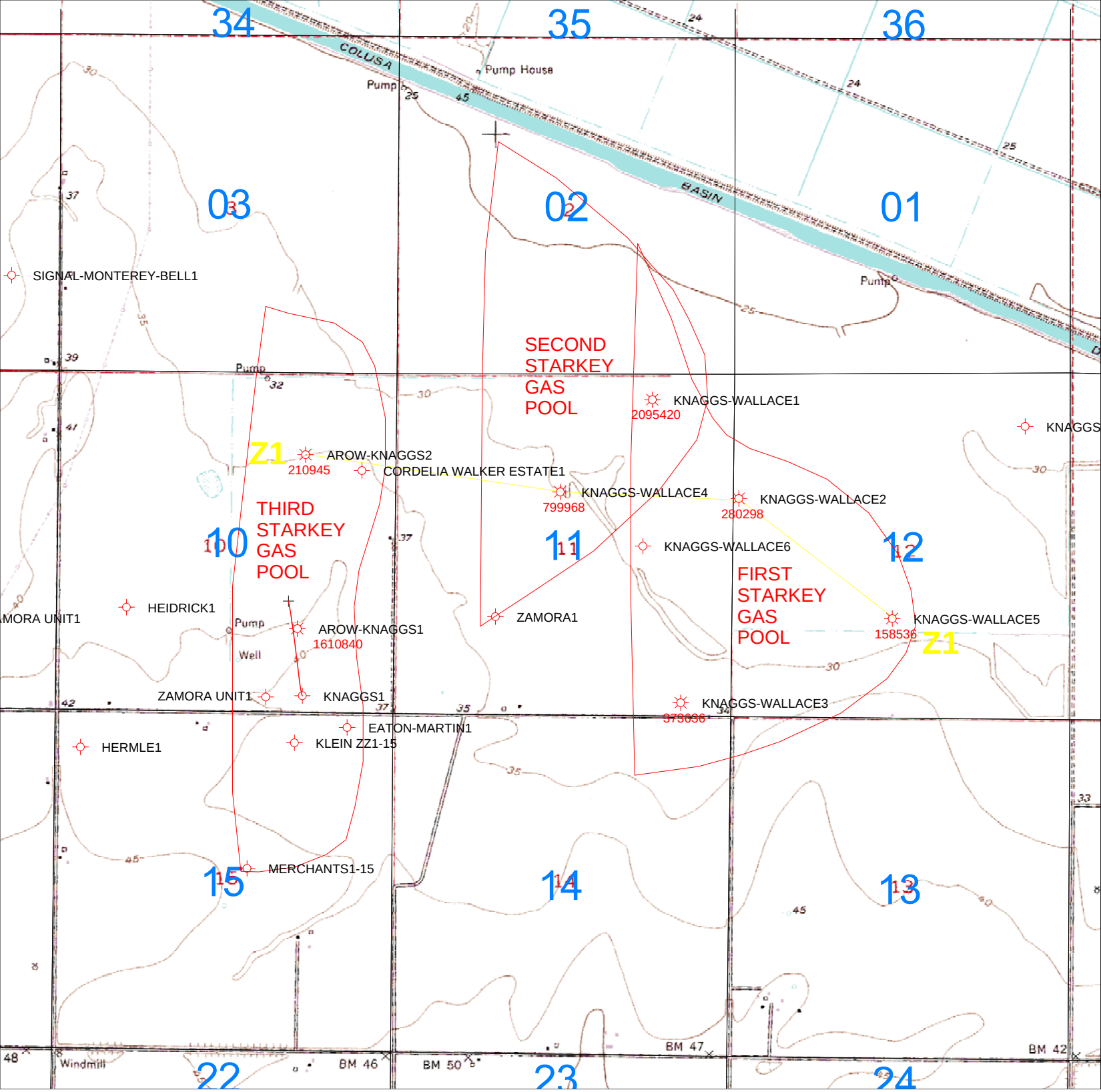
CA = 30.88 for well in center of square drainage shape
CA = 5.38 for 4:1 retangular shape
CA = 21.8 for 2:1 rectangular shape

* Petroleum Engineering Handbook, SPE, Bradley, 1989, pg 35-12

Zamora Gas Field Reconnaissance

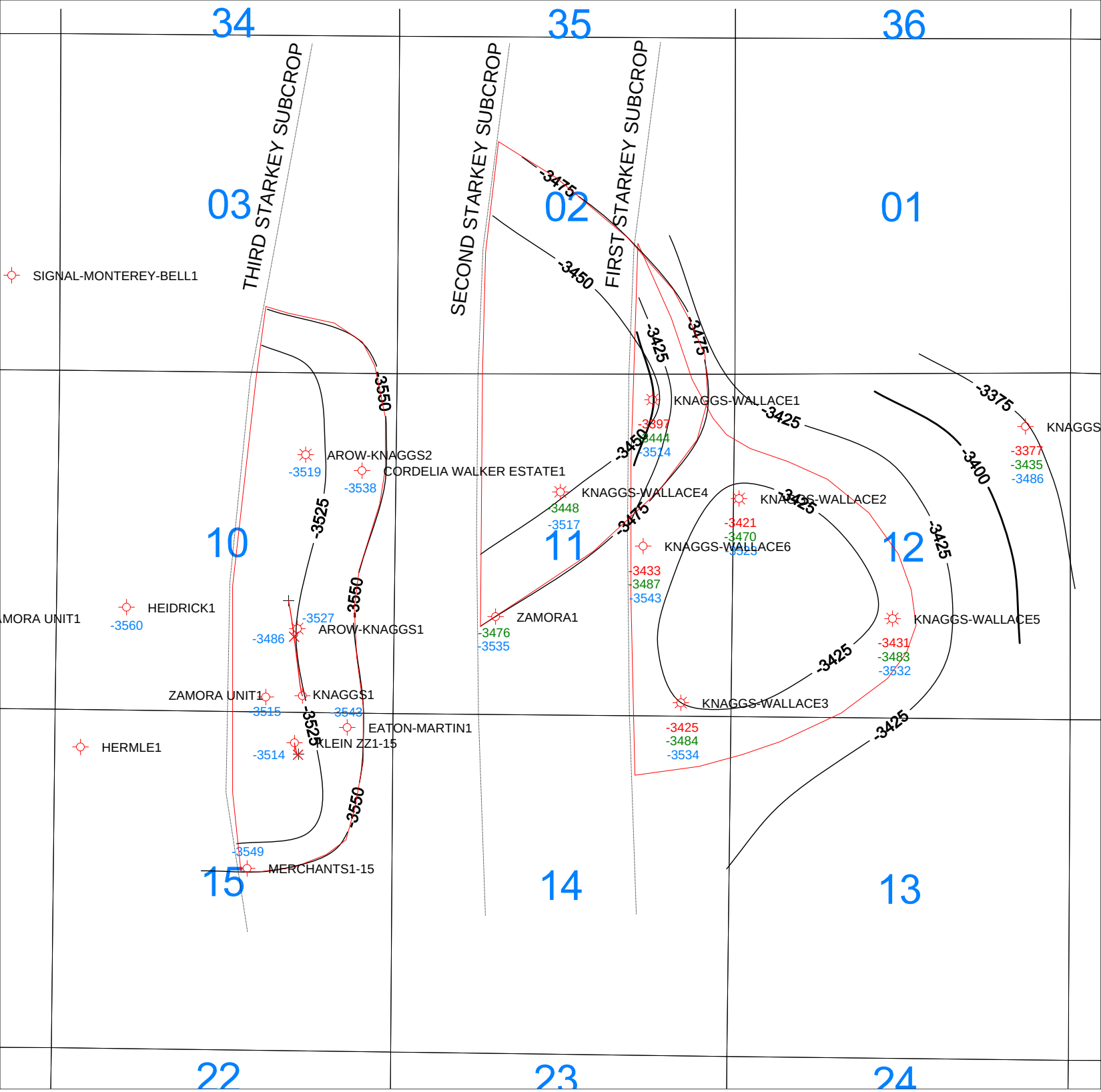
10/25/11

Field Discovery Date:	April, 1977
Productive Zone(s):	Three Late Cretaceous Starkey Formation gas pools: First, Second and Third Starkey Intervals
2011 Field Production (thru 6/11):	0
Cumulative Gas Production (2009):	All three gas pools combined 6,494 mmcf
Reserves (CDDOGR 2009):	0
Number of gas wells:	7 abandoned
Average Reservoir Depth:	First Starkey 3475 ft, Second Starkey 3500 ft, Third Starkey 3575 ft
Reservoir Area:	First Starkey 475 ac, Second Starkey 400 ac, Third Starkey 500 ac
Maximum Net Pay Thickness:	First Starkey 15 ft, Second Starkey 25 ft, Third Starkey 25 ft
Trapping Mechanism:	Truncation of east-dipping Strarkey Formation sands at west-dipping sub-Capay Formation unconformity
Surface Conditions:	Elevation 30-40 ft, topographic map (updated 1973) shows no development, aerial photo (9/09) shows some agricultural usage with surface disturbance, possible major development in progress, over a large area.
Notes:	3D seismic data has been acquired over the field and may be available for purchase.



Pacific Gas and Electric Company		
Zamora Gas Field Base Map		
Author: dpi	DRAFT	Date: 26 October, 2011
	Scale: <scale>	


38.838662, -121.861338
N
© 2011 Google
Co Hwy E 10
Google
Imagery Date: 9/23/2009
lat 38.815436° lon -121.831159° elev 34 ft
Eye alt 15960 ft



Pacific Gas and Electric Company

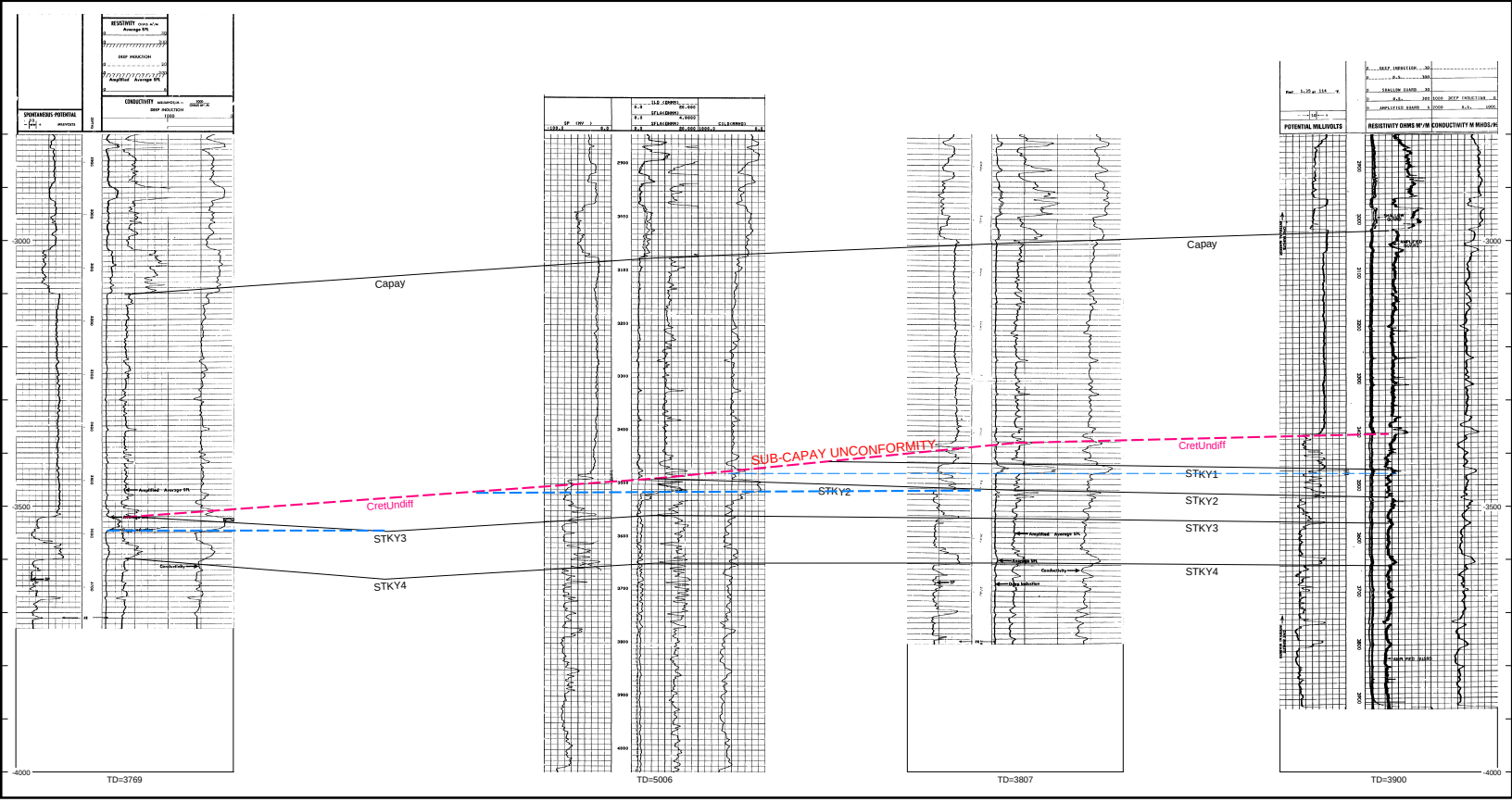
Zamora Gas Field
Structure-Contour Map
First, Second, Third Starkey Formation Gas Pools

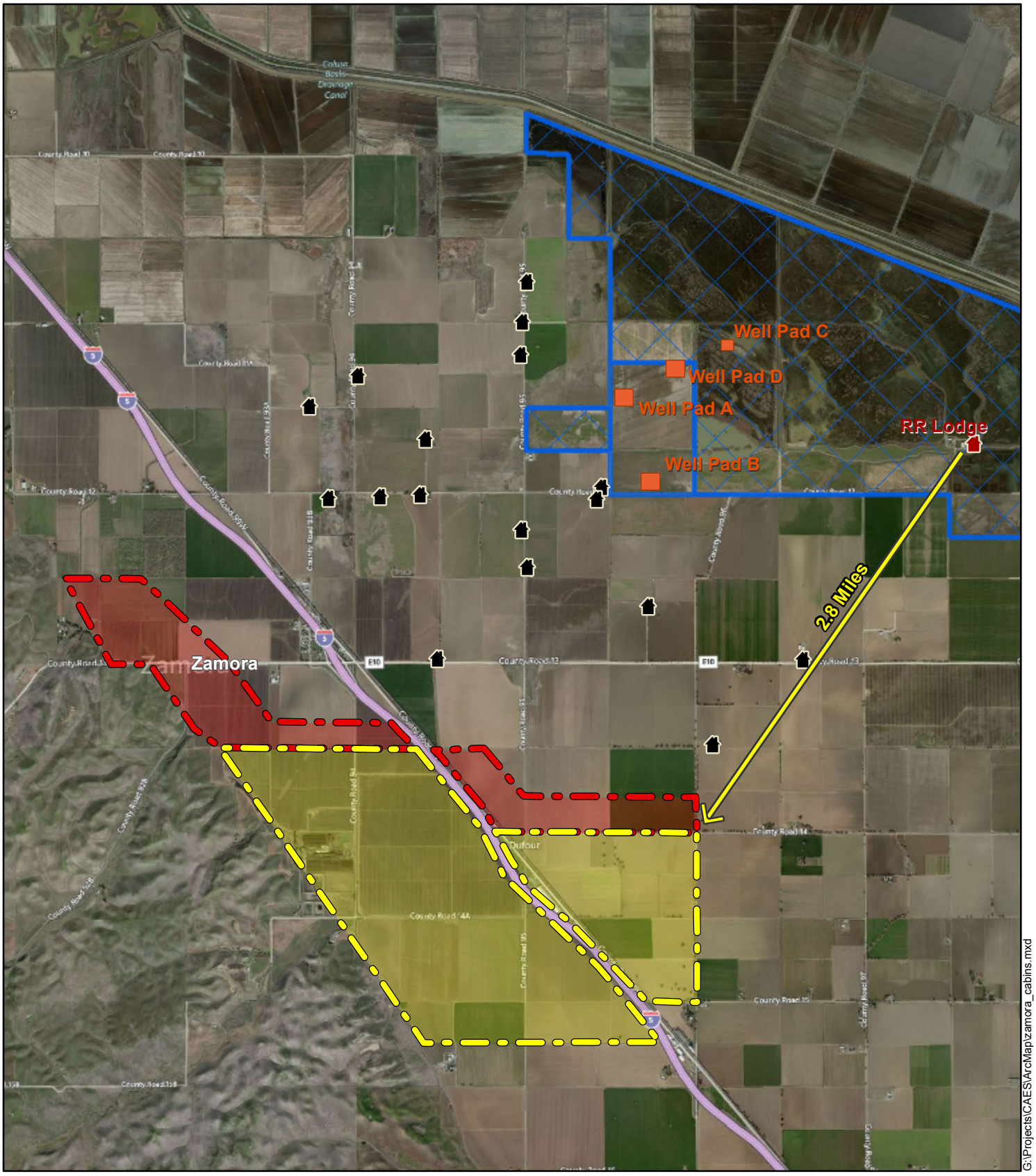
Author:		Date:
dpi	DRAFT	26 October, 2011
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PACIFIC GAS AND ELECTRIC COMPANY
ZAMORA GAS FIELD
STRUCTURAL CROSS SECTION Z1

DRAFT

Cum Gas All Zones: 210945 MCF		Cum Gas All Zones: 799968 MCF		Cum Gas All Zones: 280298 MCF		Cum Gas All Zones: 158536 MCF
04113204570000		04113207790000		04113204800000		04113205720000
Spud Date=8/5/1977	3989 ft	Spud Date=2/21/1984	2715 ft	Spud Date=12/9/1977	2813 ft	Spud Date=12/12/1979
ARCO WESTERN ENERGY		PACIFIC INLAND OPER.		PACIFIC INLAND OPER.		PACIFIC INLAND OPER.
AROW-KNAGGS 2		KNAGGS-WALLACE 4		KNAGGS-WALLACE 2		KNAGGS-WALLACE 5
1320 S 1300 W NE		1900 S 2519 W NE		1800 S 100 E NW		1429 N 2656 E SW
TWP: 11 0 - Range: 1 1 - Sec. 0		TWP: 11 N - Range: 1 E - Sec. 11		TWP: 11 N - Range: 1 E - Sec. 12		TWP: 11 N - Range: 1 E - Sec. 12





Zamora ECF Siting

12/18/2012

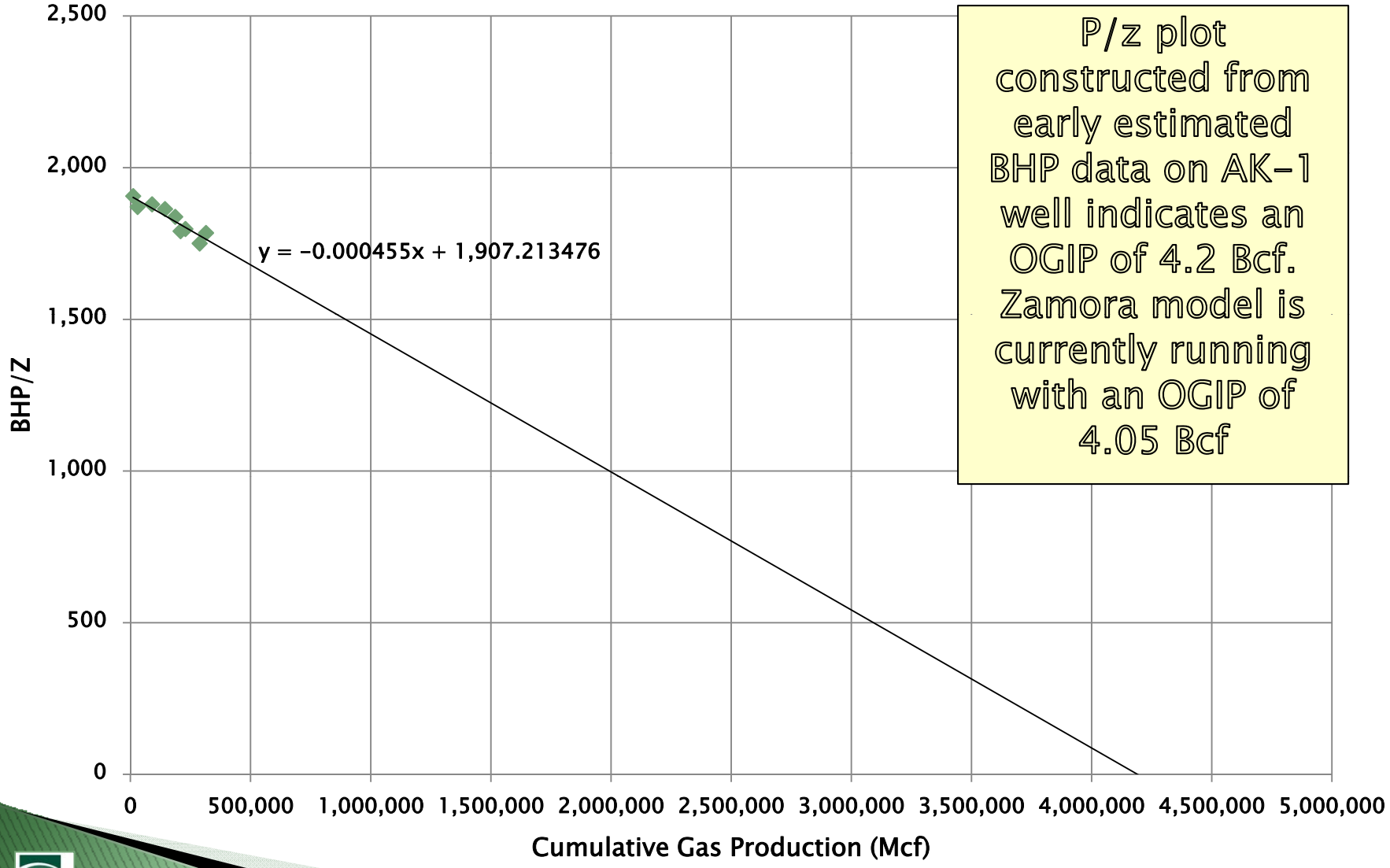
- Potential ECF Site Base Case
- Alternative ECF Site
- Well Pad
- Roosevelt Ranch
- Easement
- RR Lodge
- Residences

0 0.5 1 Miles

CAES – Zamora S3 Dynamic Model

History Match Status
as of September 12, 2012

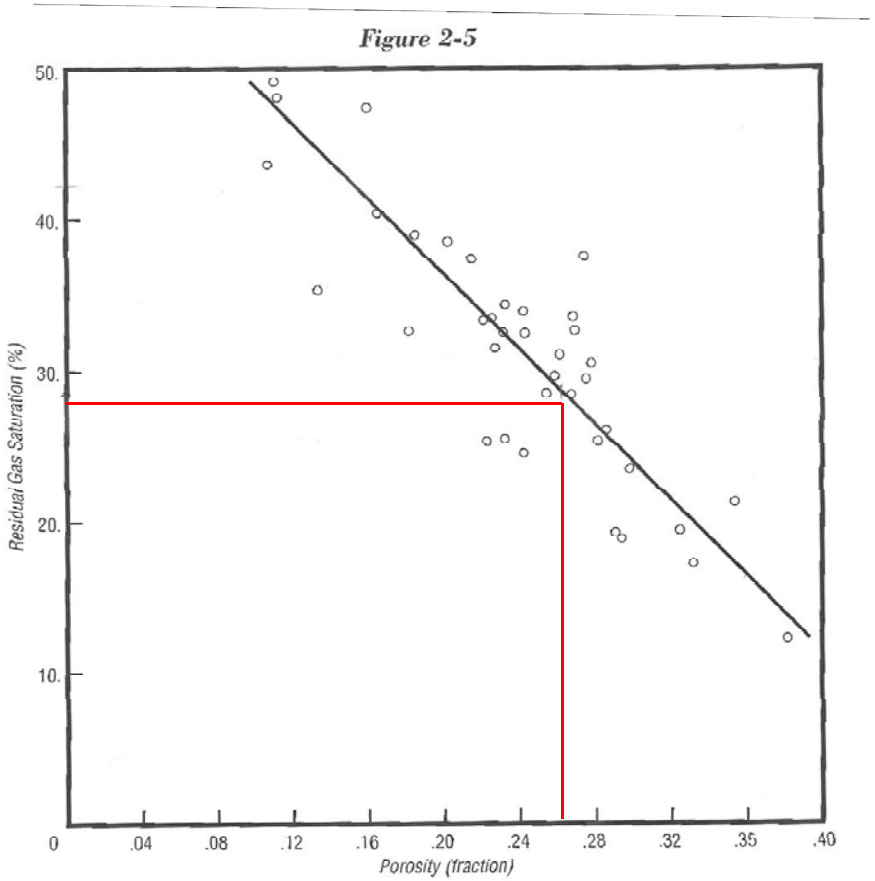
P/Z Plot from Well AK-1; Zamora Field
(Initial Data Only; Gray VFP)



P/z plot constructed from early estimated BHP data on AK-1 well indicates an OGIP of 4.2 Bcf. Zamora model is currently running with an OGIP of 4.05 Bcf

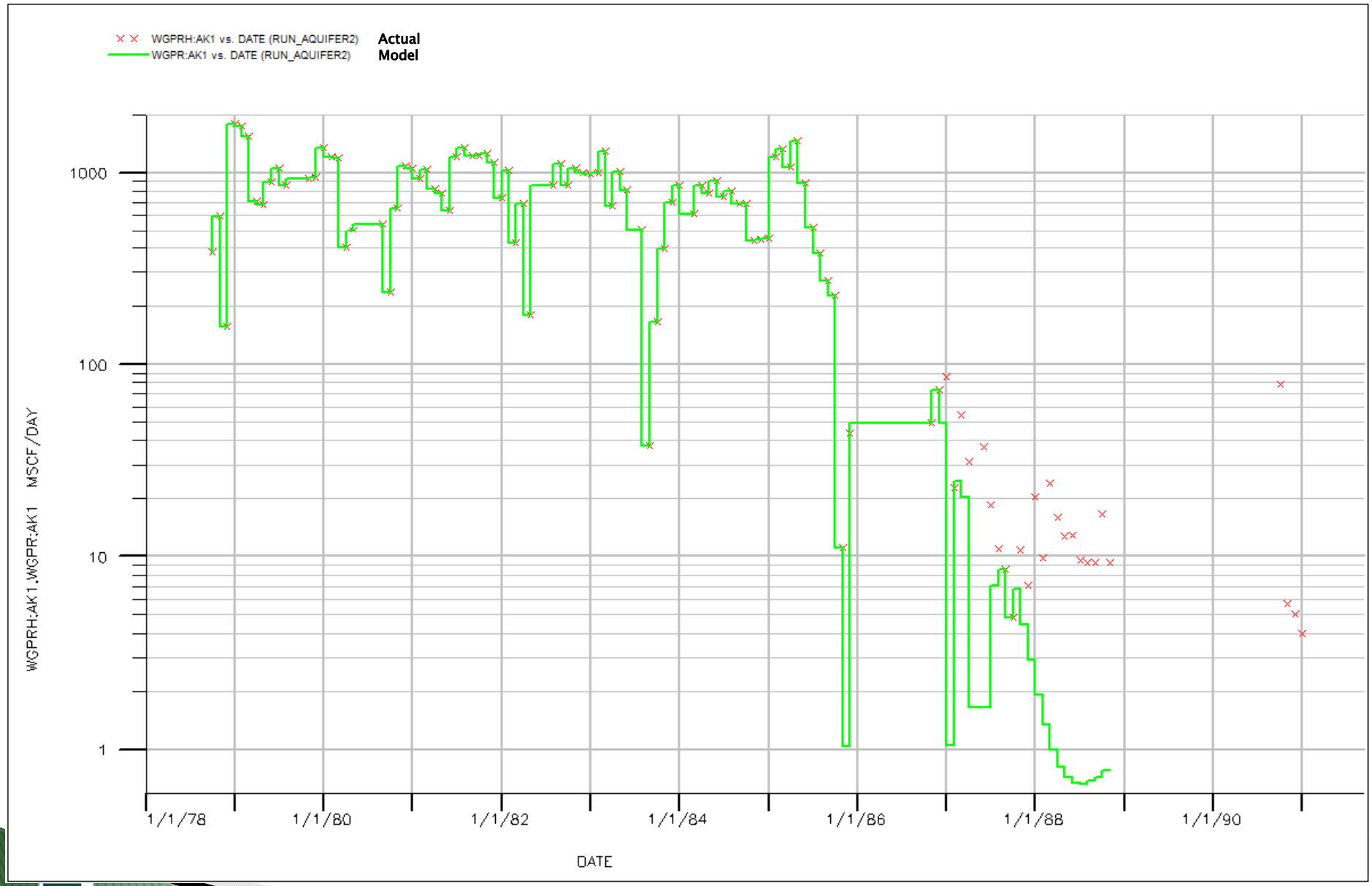
Porosity vs. Residual Gas Saturation

Red Line = 3rd Starkey Zone – Zamora Field

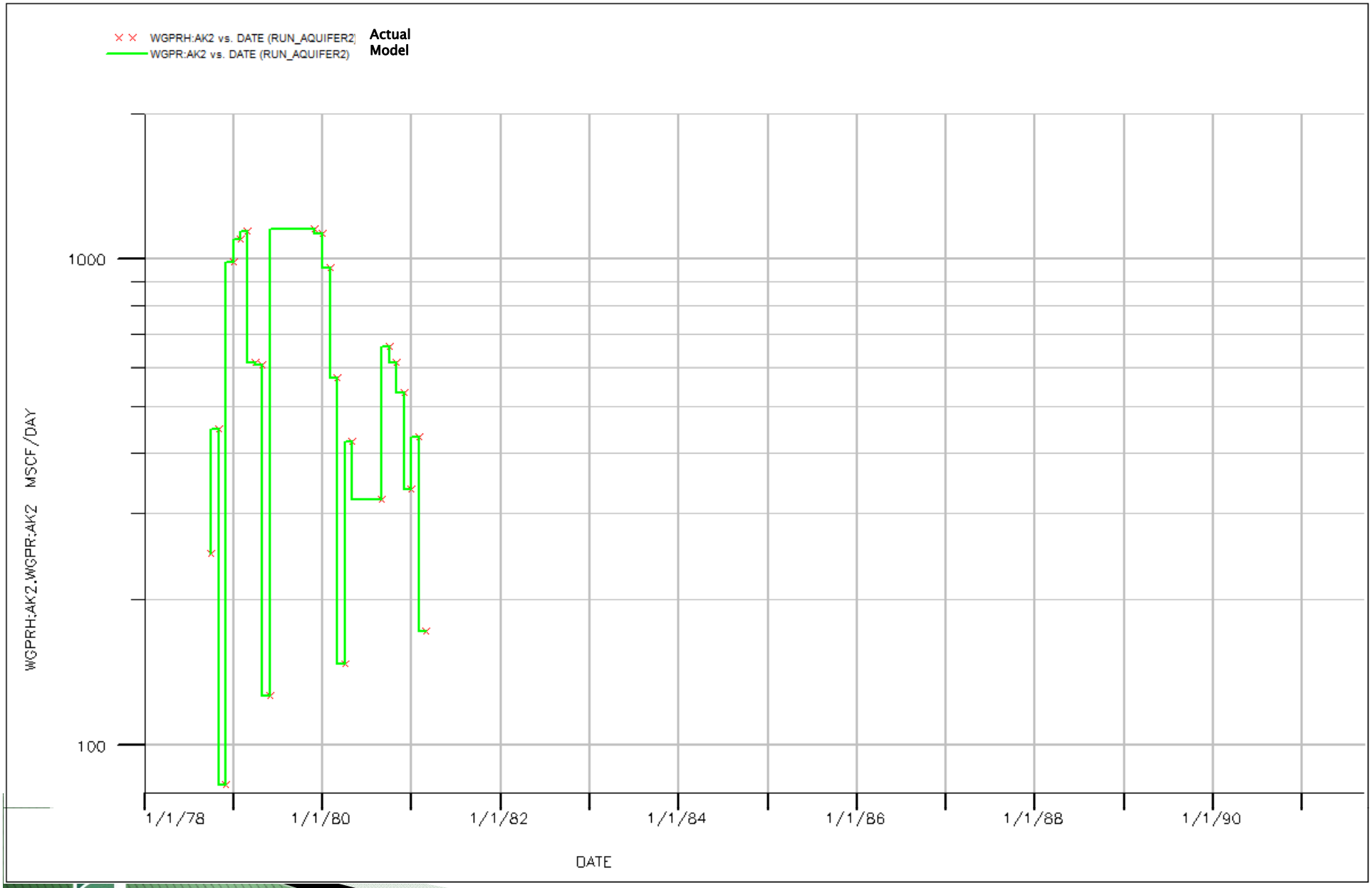


Residual Gas Saturation After Flooding
Various Sandstones and Unconsolidated Cores
(Katz et al, 1966)

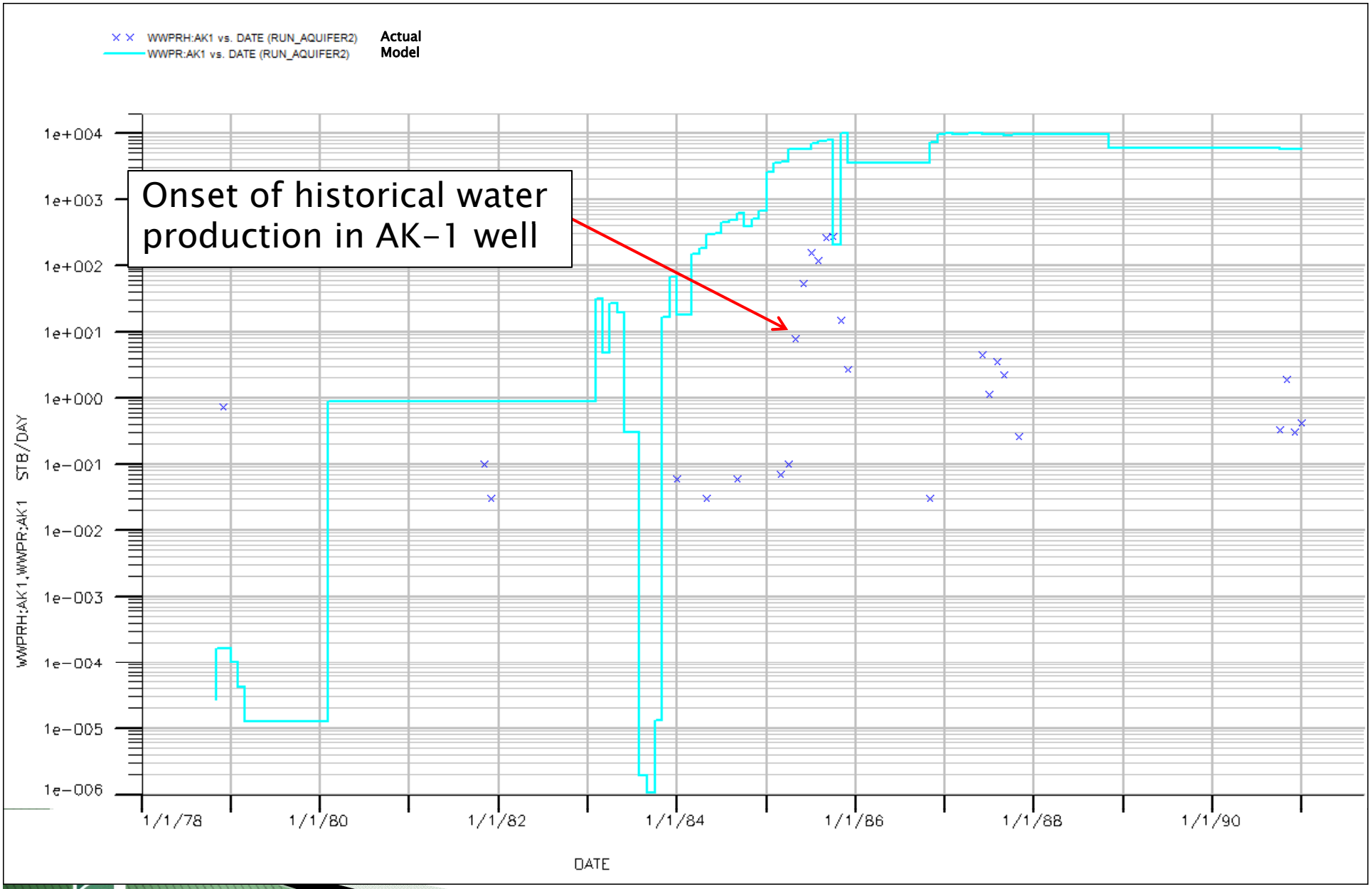
Model vs Actual Gas Production – AK-1 well



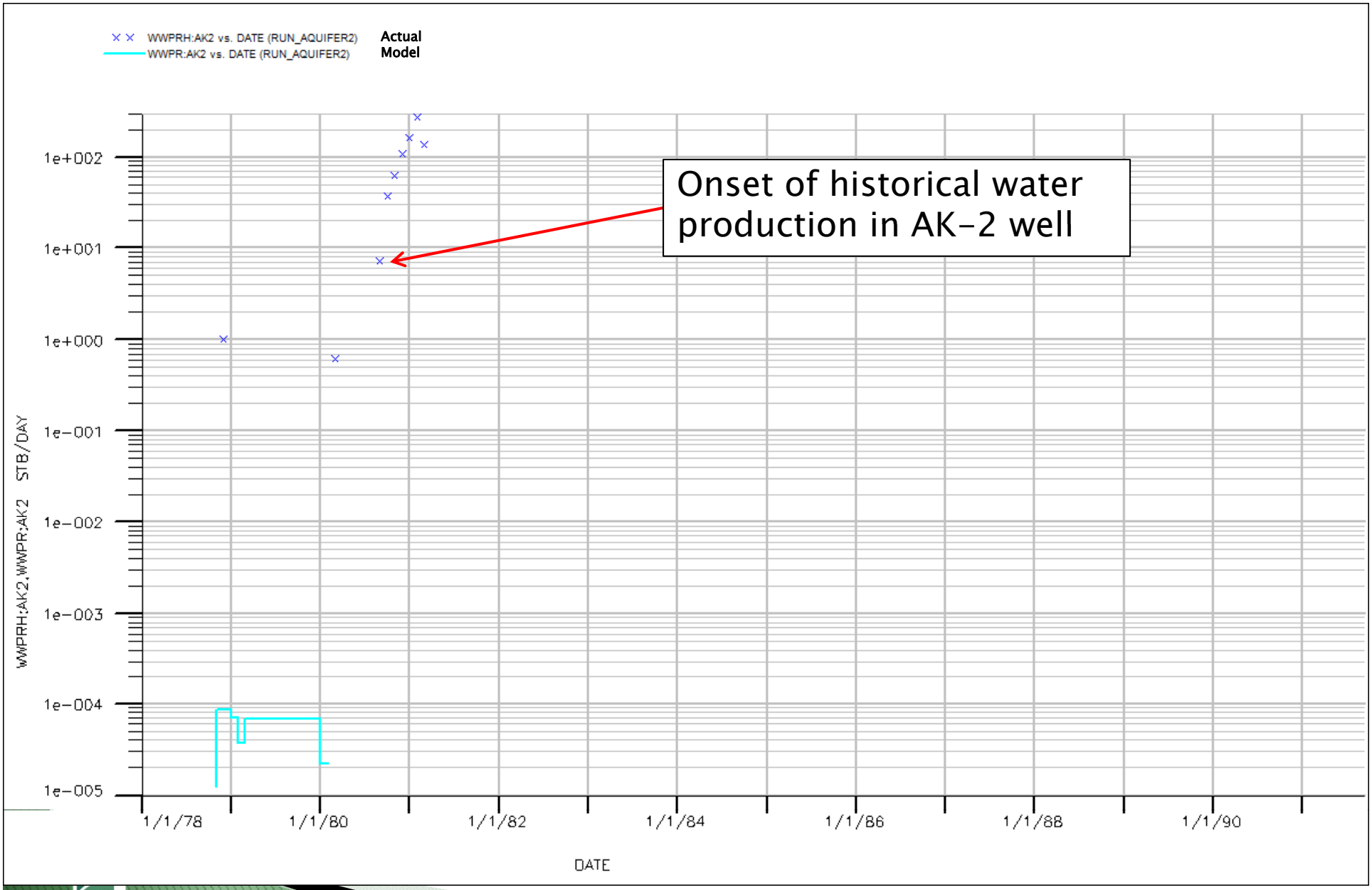
Model vs Actual Gas Production – AK-2 well



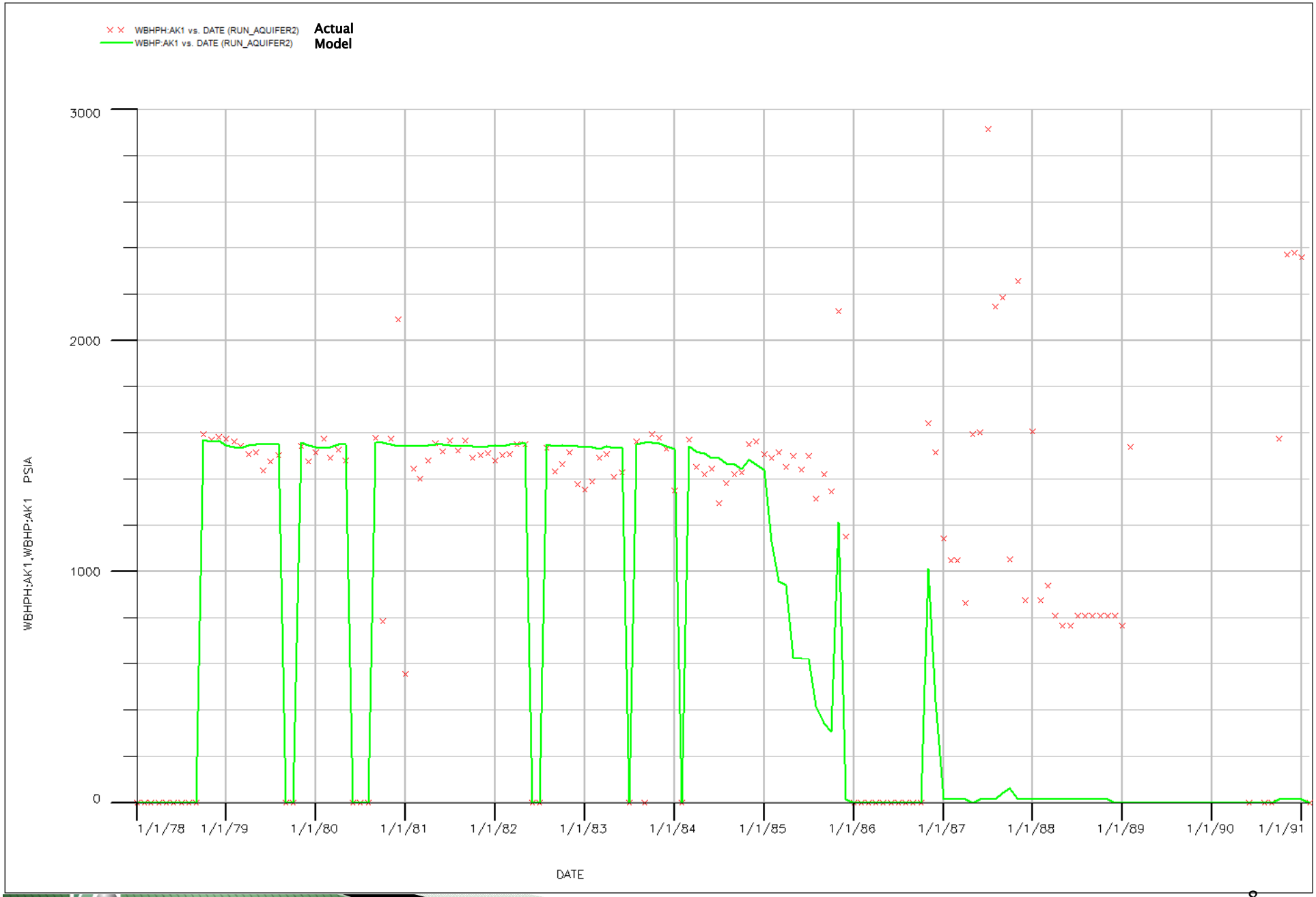
Model vs Actual Water Production – AK-1 well



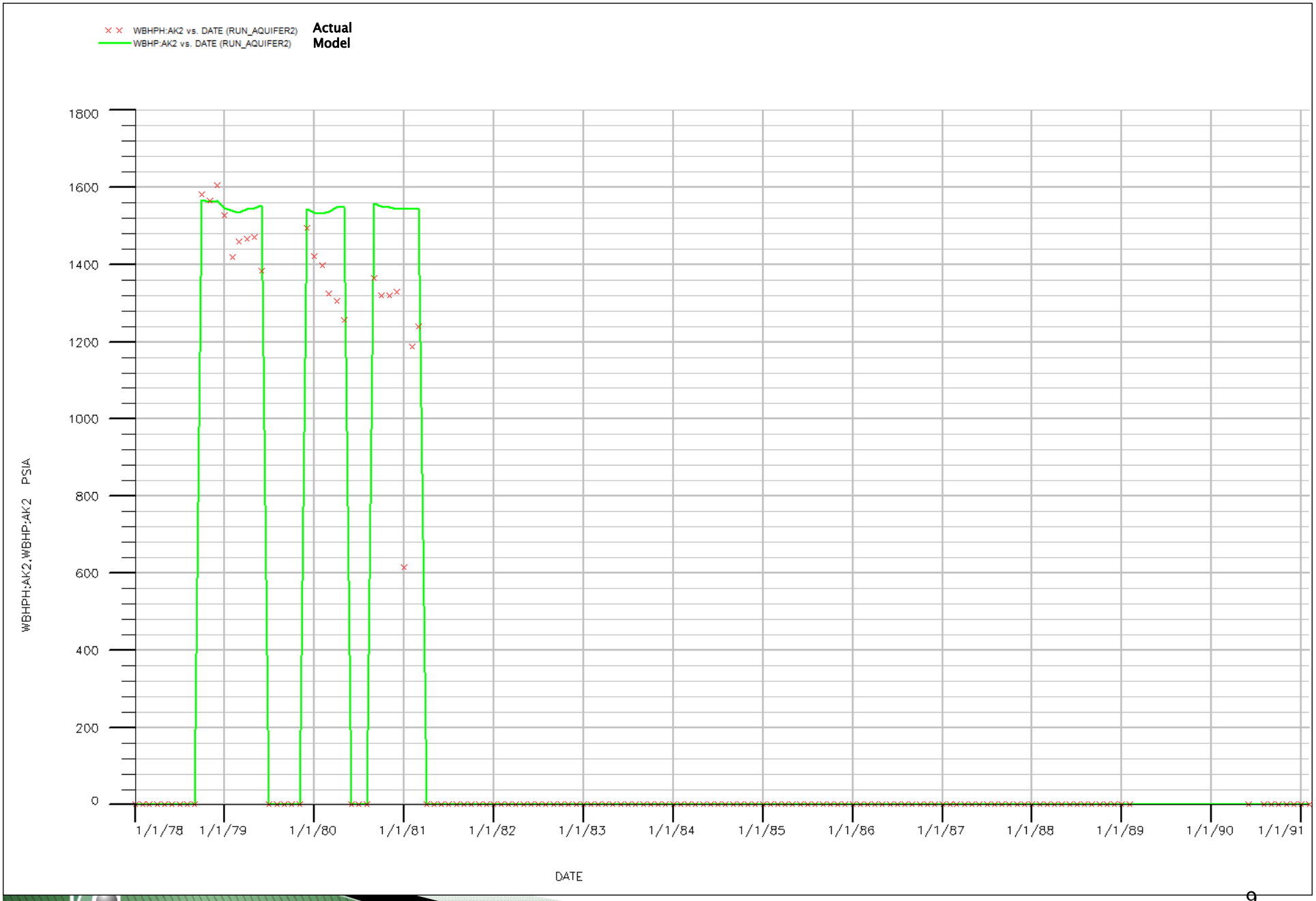
Model vs Actual Water Production – AK-2 well



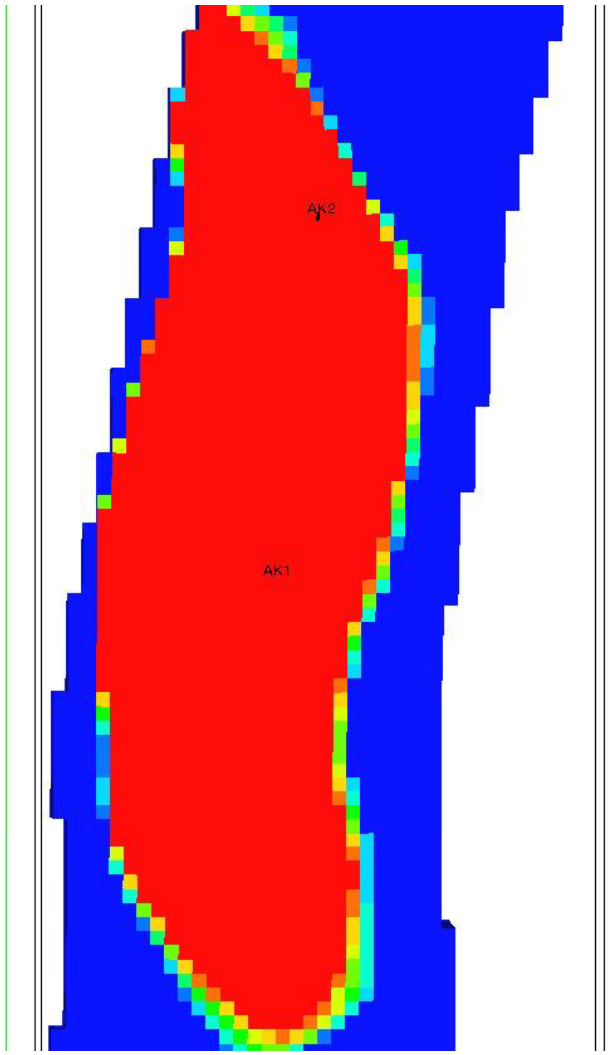
Model vs Observed BHP (based on avg. actual tubing pressures) AK-1 well

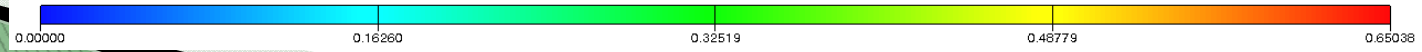


Model vs Observed BHP (based on avg. actual tubing pressures) AK-2 well

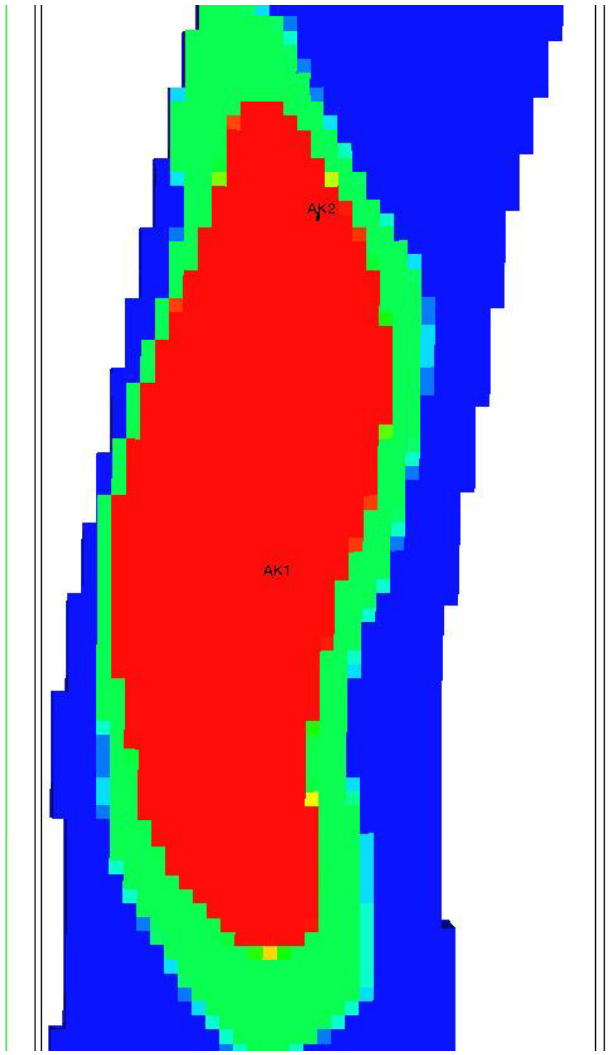


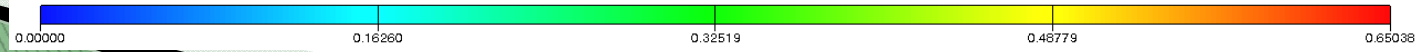
Model Gas Saturation Map – Start of Production
(Well AK-1 is bottom; Well AK-2 is top)



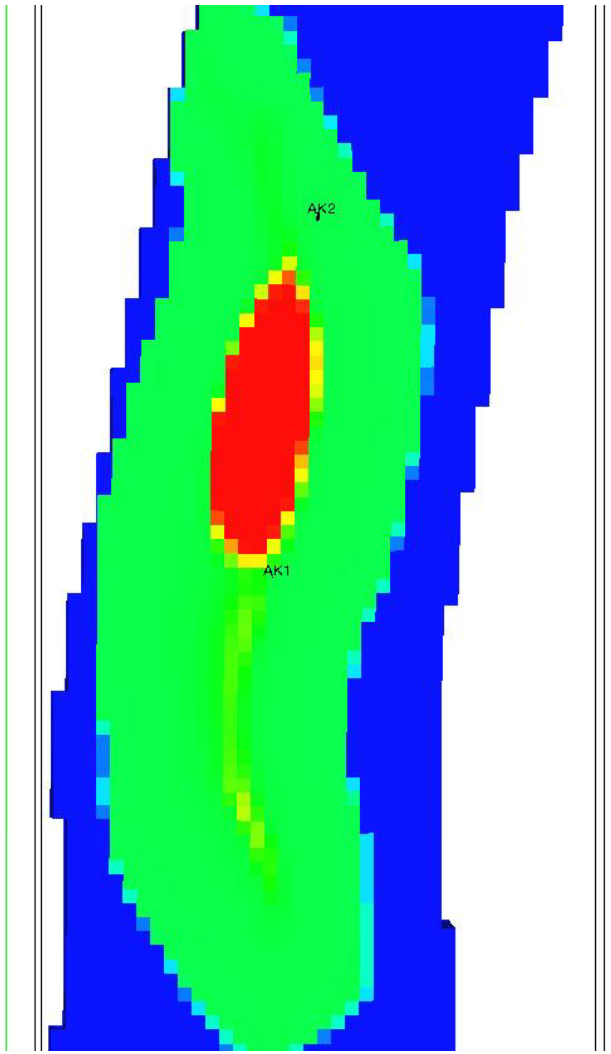


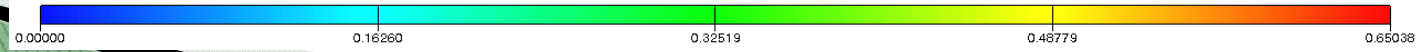
Model Gas Saturation Map – July 1980 (Time of BT in AK-2)
(Well AK-1 is bottom; Well AK-2 is top)





Model Gas Saturation Map – April 1985 (Time of BT in AK-1)
(Well AK-1 is bottom; Well AK-2 is top)





Zamora 3D Geologic Model

07/02/2012

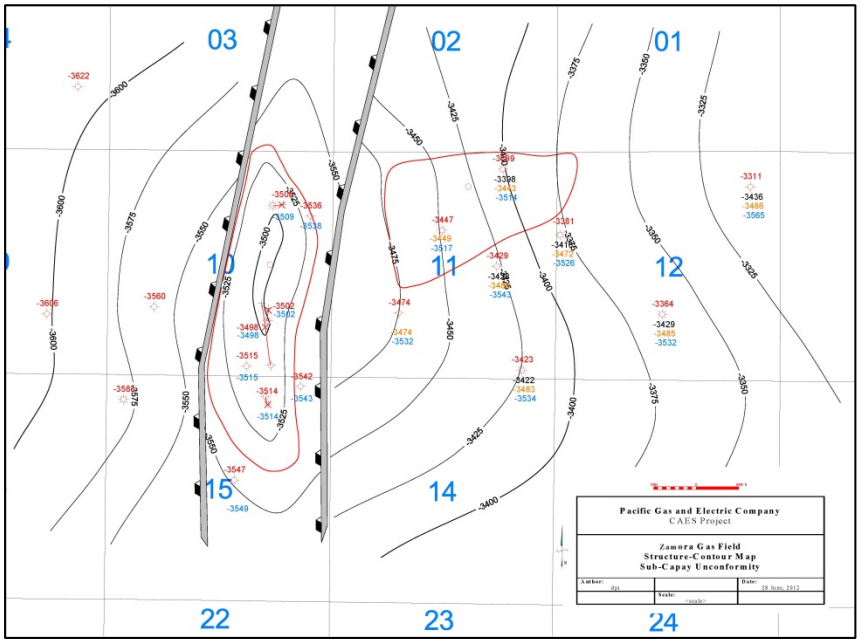
MHA Petroleum Consultants

Zamora Static Model

- MHA built structural framework for Zamora static model using original maps, cross-sections and geologic picks obtained from D. Imperato in early June 2012
- Original geologic maps were difficult to implement in 3D static model (problems were intersecting grids and truncated S3 and S2B features)
- Subsequent interaction between MHA and D. Imperato resulted in revisions to geological interpretation for Starkey S3 and S2B reservoirs
- Starkey S2B and S3 Pools Remapped by D. Imperato
  - Zamora 3D seismic volume purchased
  - Geologic interpretation re-visited based on consultant's integration of seismic data
  - New geologic maps generated and passed To MHA on 28Jun2012
- New maps and faults have been imported and digitized by MHA
- MHA constructed new 3D static model based on updated geological interpretation
- Ready for review 2JUL2012

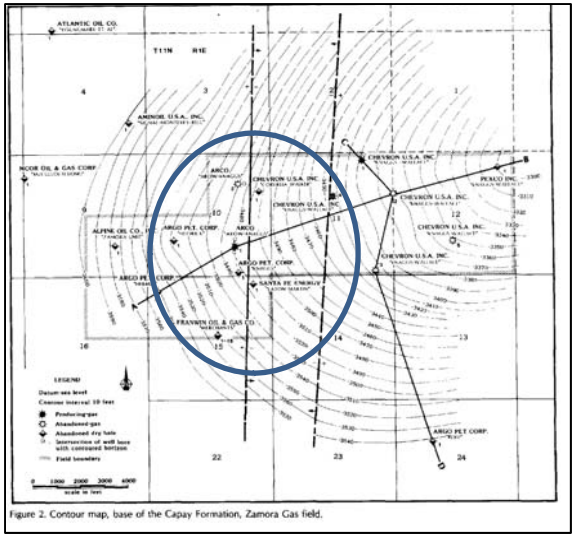
Unconformity Surface Structure Map - New

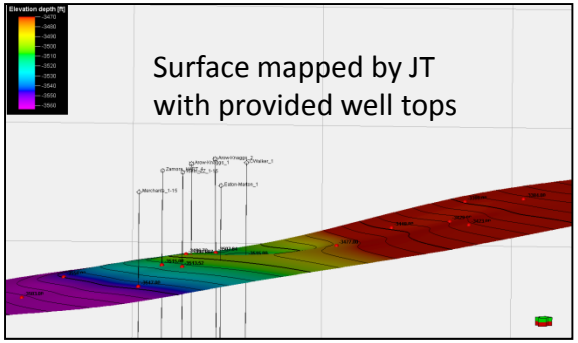
Unconformity – 06-28-2012
(not provided originally)



New unconformity surface has significant structural relief compared to White reference

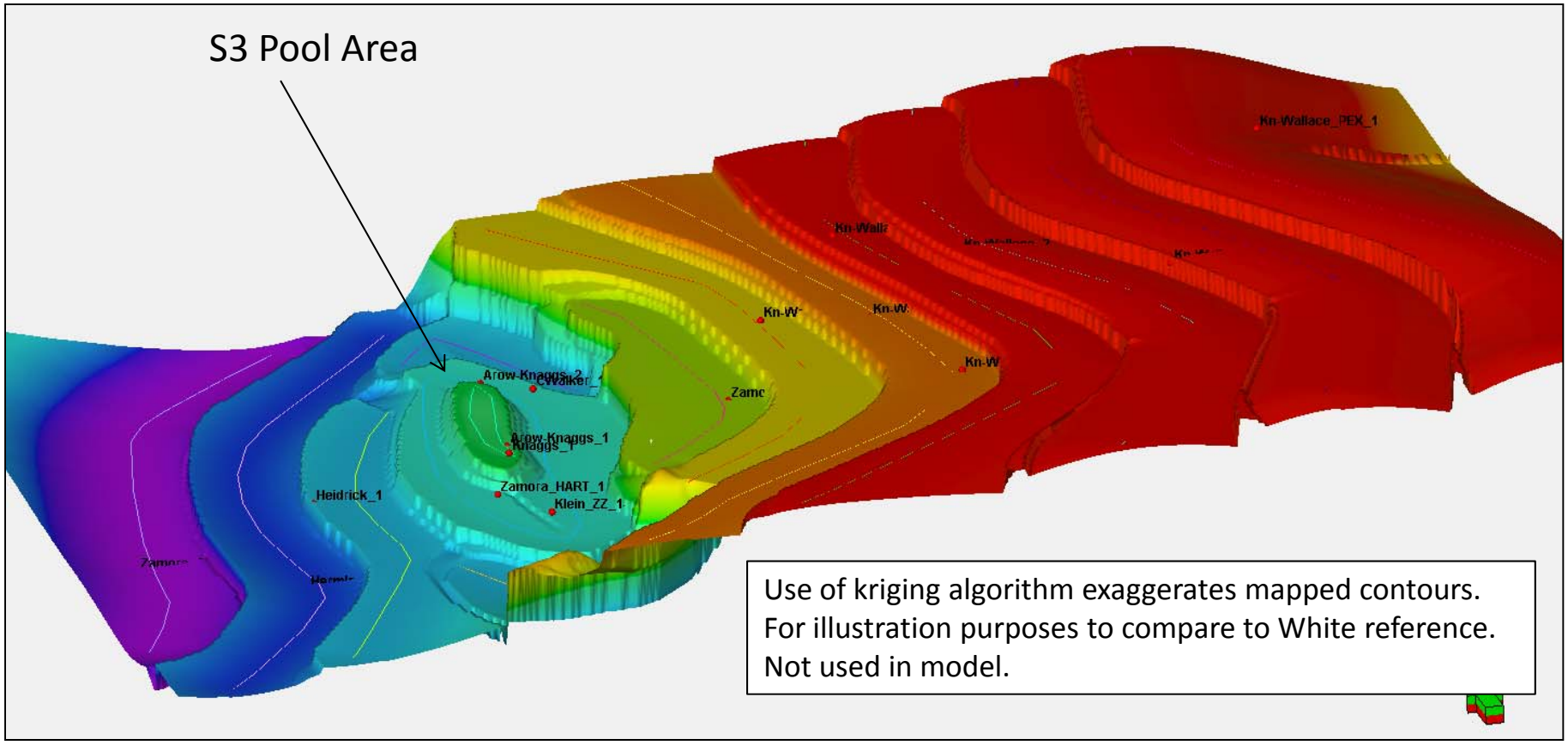
White Reference





10x vertical exaggeration

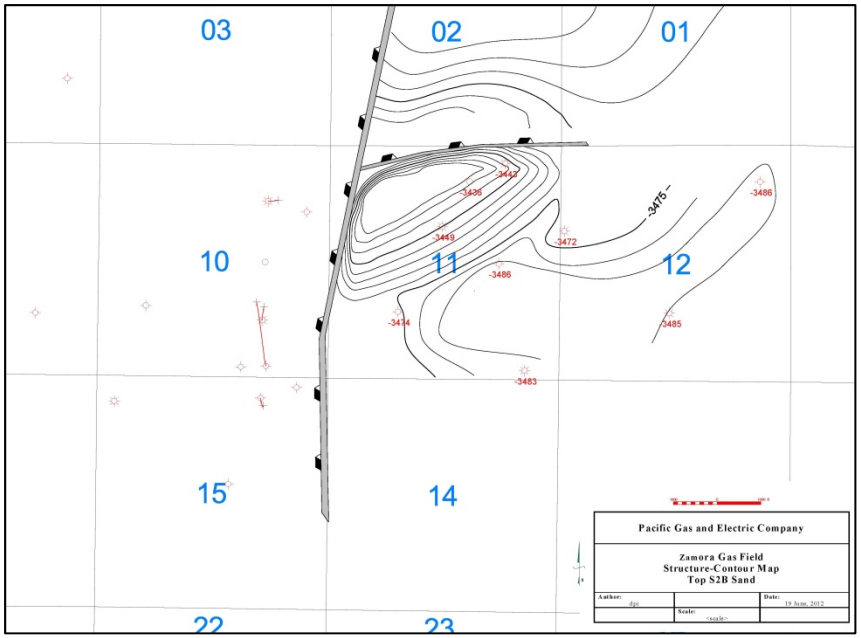
New Unconformity Surface Mapped from Received Contour File



Vertical exaggeration 10x

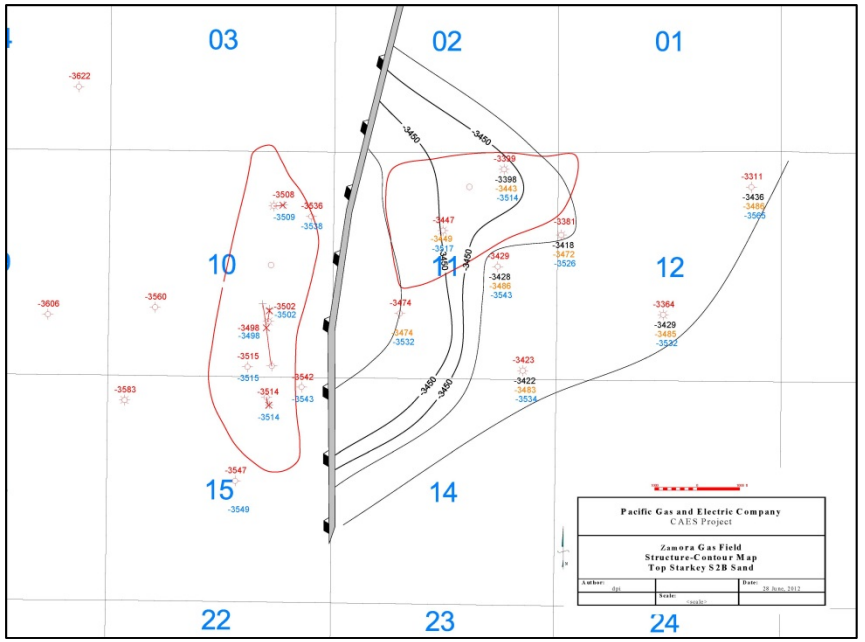
New Structure Map – S2B Pool

S2B - Original



2 Bounding Faults: N-S and E-W

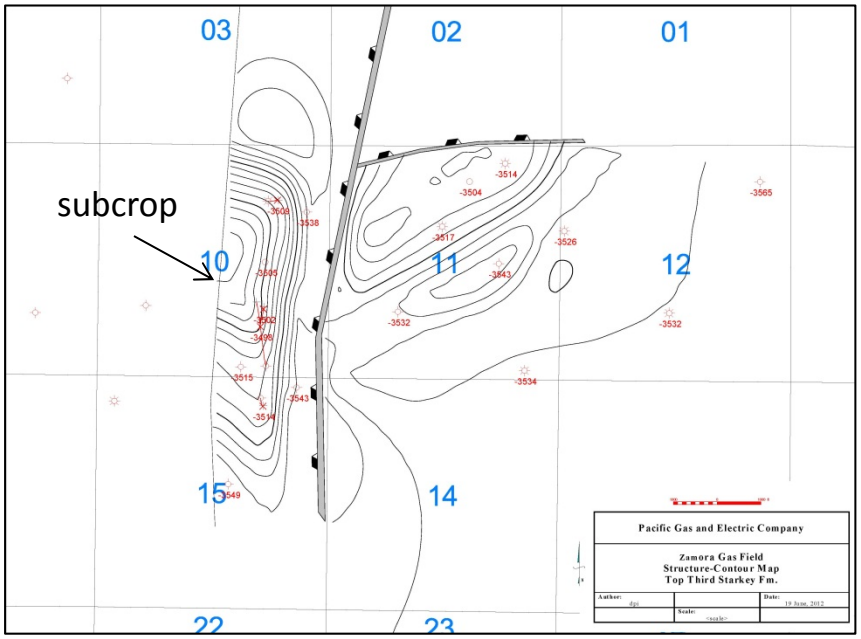
S2B – Received 06-28-2012



E-W fault cannot be substantiated with seismic. No closure to N or S other than contours wrapping into fault. Interpretation = uncertain

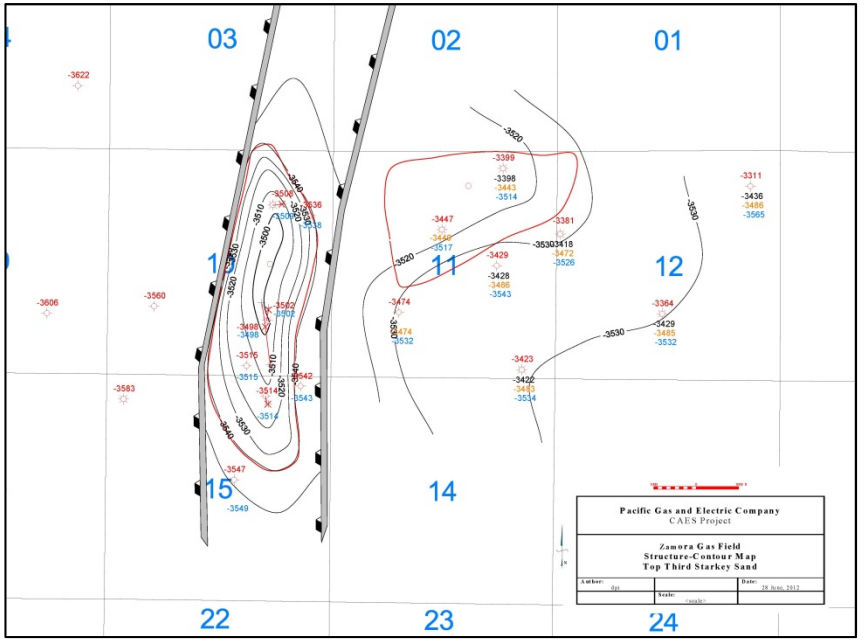
New Structure Map – S3 Pool

S3 - Original



2 faults: N-S and E-W

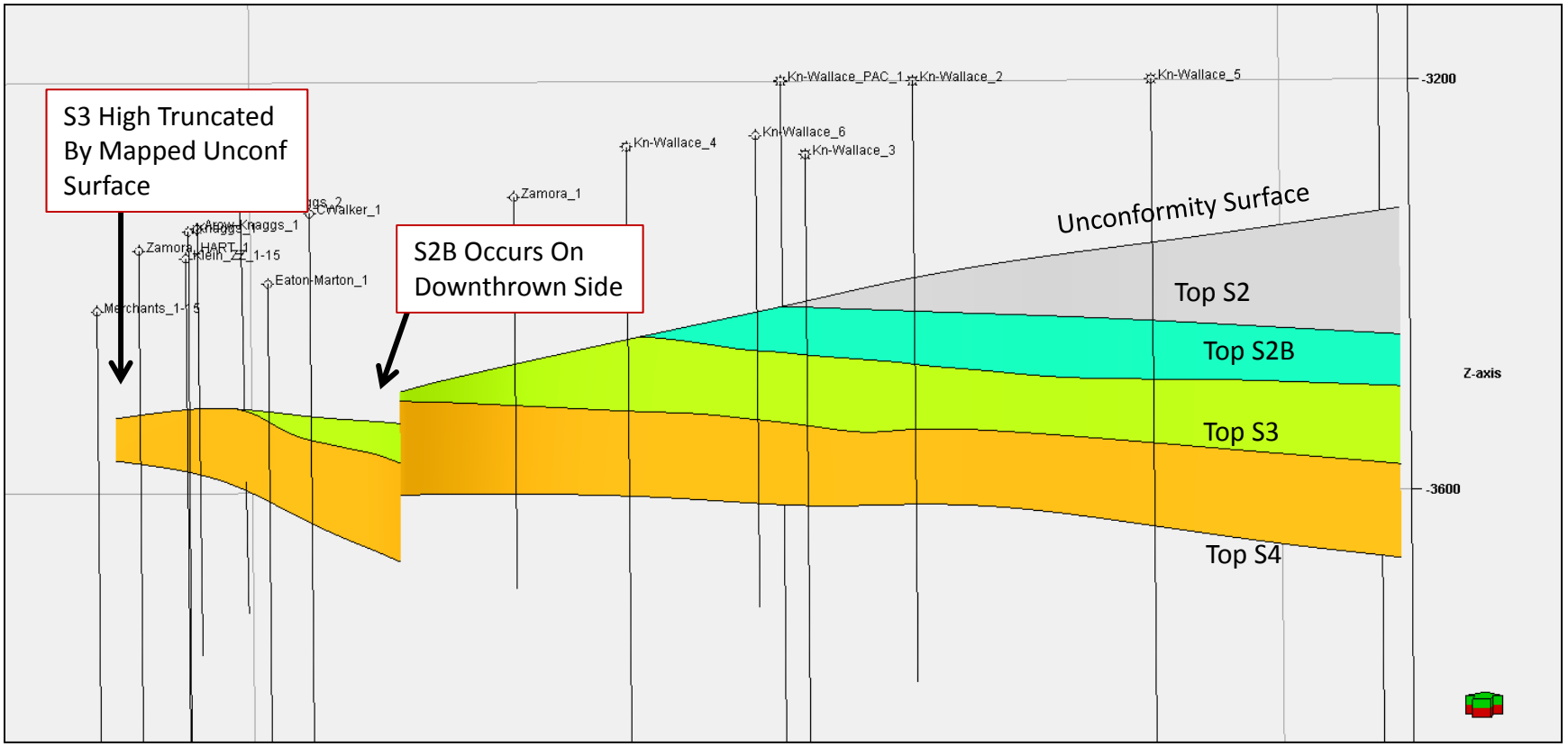
S3 – 06-28-2012



E-W fault cannot be substantiated with seismic.
S3 subcrop termination coincides w/2nd N-S fault.

3D Model Built With 5 Surfaces BEFORE New Interpretation

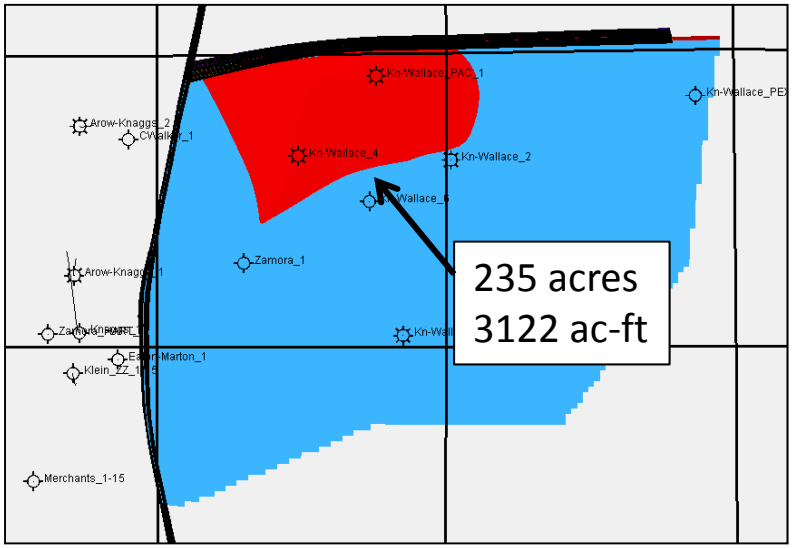
Unconformity Surface (mapped from well tops)
S2 (mapped from well tops (DI map not used))
S2B (digitized from DI map)
S3 (digitized from DI map)
S4 (mapped from well tops)



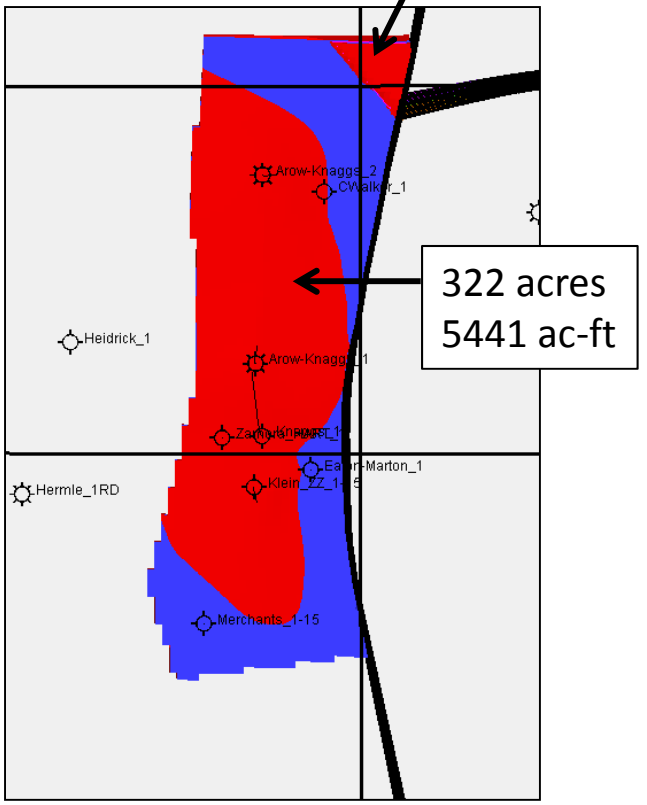
Vertical exaggeration 10x

3D Model With Original Geologic Interpretation
(Flat Gas-water Contact, Not Mapped Surface)

S2B Pool



S3 Pool



3D Model Volumetrics With Original Geologic Interpretation

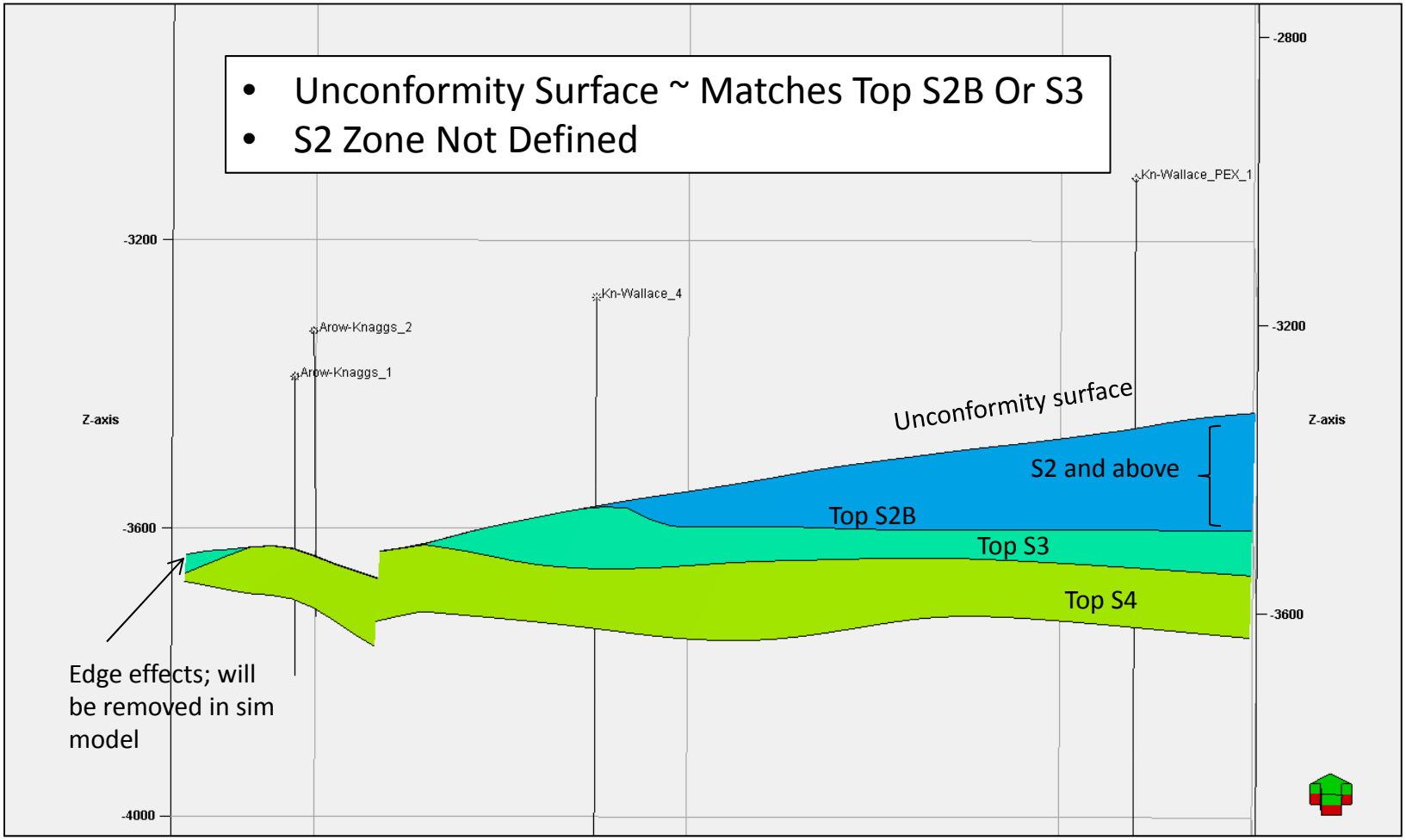
Original S2B and S3 Maps

Reservoir Parameters

- 28% porosity
- 35% SW
- 90% NTG
- Bg = 0.009250 rcf/scf

- **S3 Pool West of N-S Fault** = 5.239 BCF (after removal of edge effects)
  - GWC at -3,540 ft
  - RF = 44%
  - Also Gas Above GWC To East of N-S Fault (12.75 BCF)
- **S2B Pool** = 2.684 BCF
  - GWC at -3,470 ft
  - RF = 64%

New 3D Static Model With Revised Geologic S2B and S3 Maps

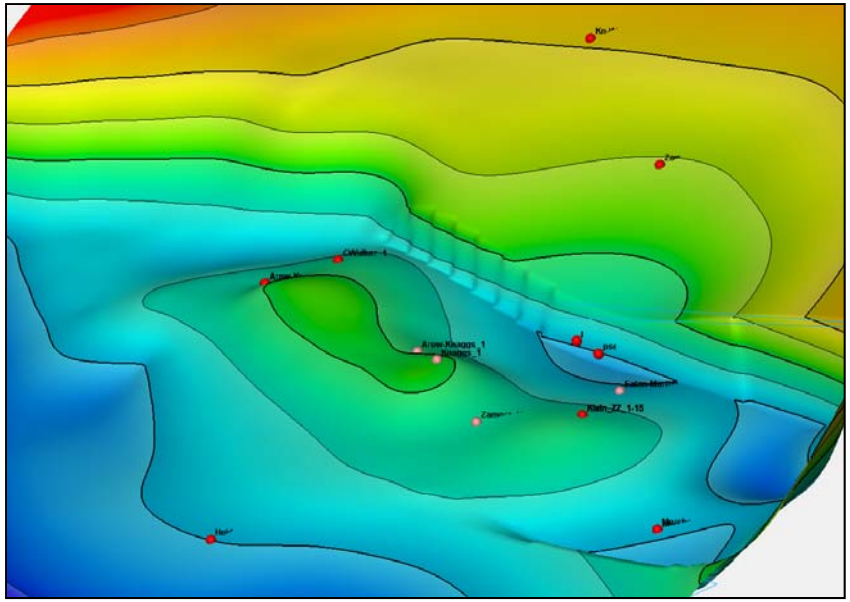


Vertical exaggeration 10x

3D Model Built With New Geologic Interpretation

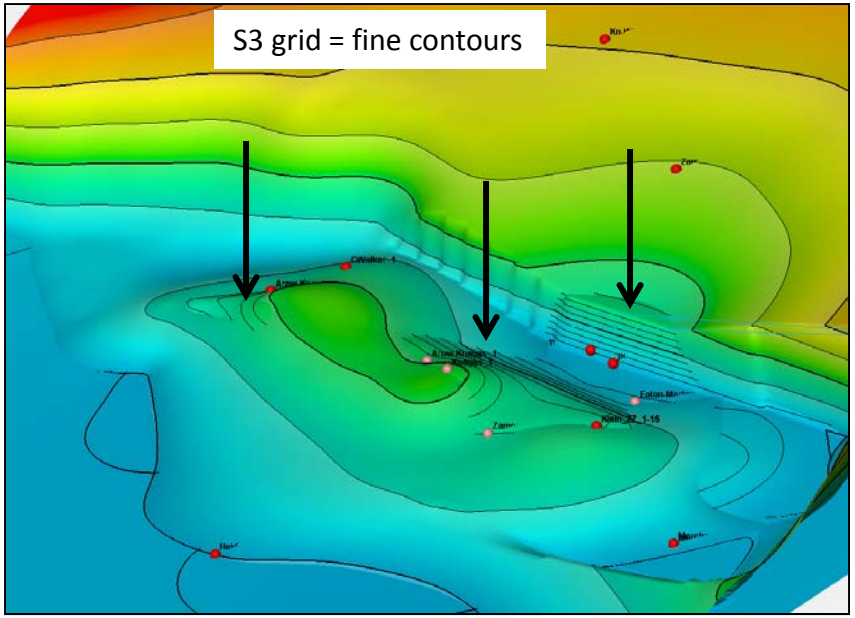
New Maps Improved 3D Work But Some Problems Remained

Unconformity surface At S3 Pool



Vertical exaggeration 10x

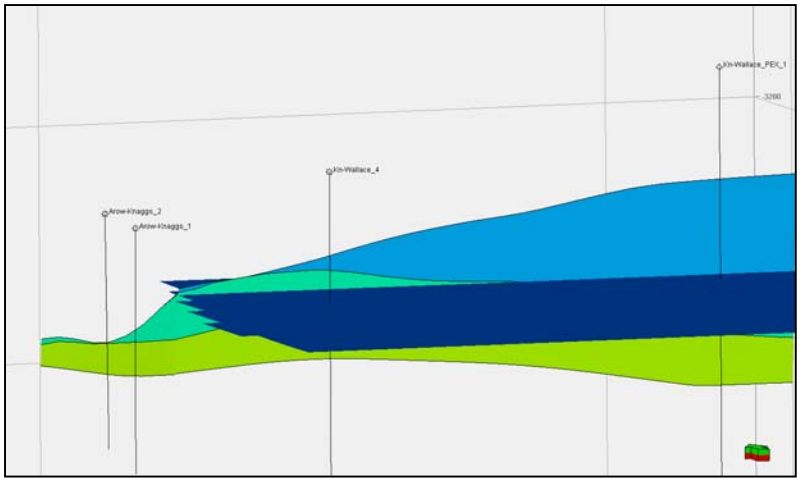
S3 Grid Extends Above Unconformity Surface in some areas



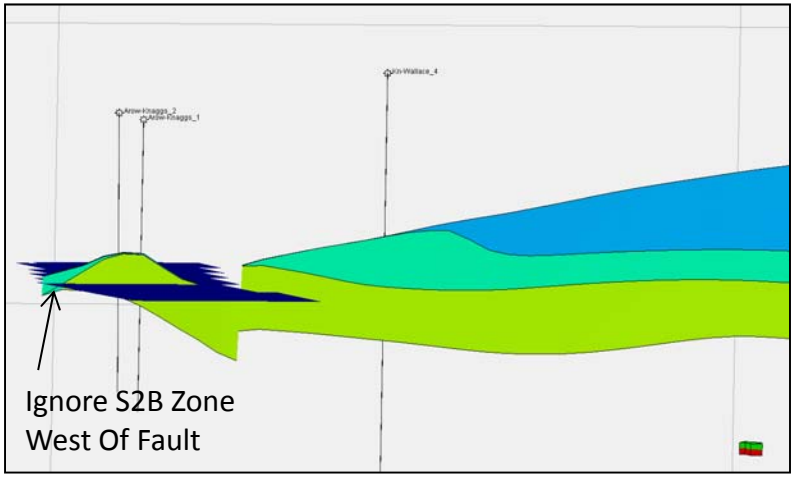
Minor Crossing Grid Effects Removed Prior To Building Static Model

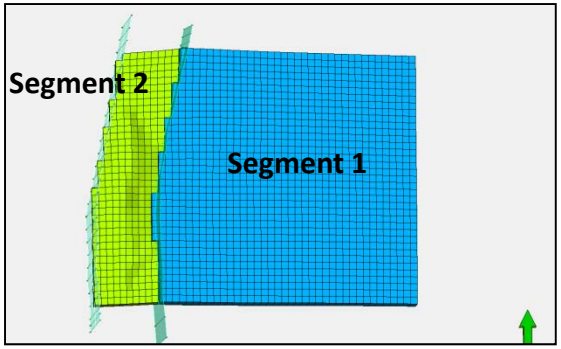
Same View of New 3D Static Model with GWC Surface Added

S2B GWC -3470 ft In Segment 1



S3 GWC -3540 Ft In Segment 2

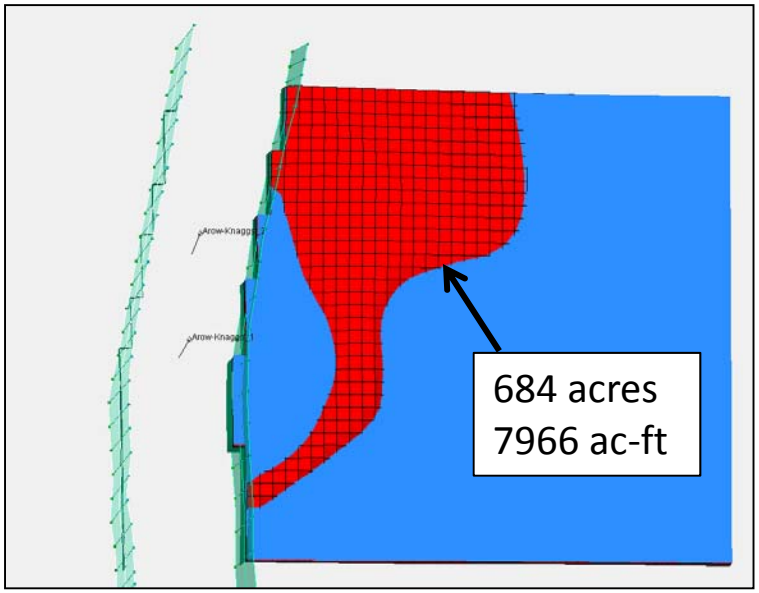




Vertical exaggeration 10x

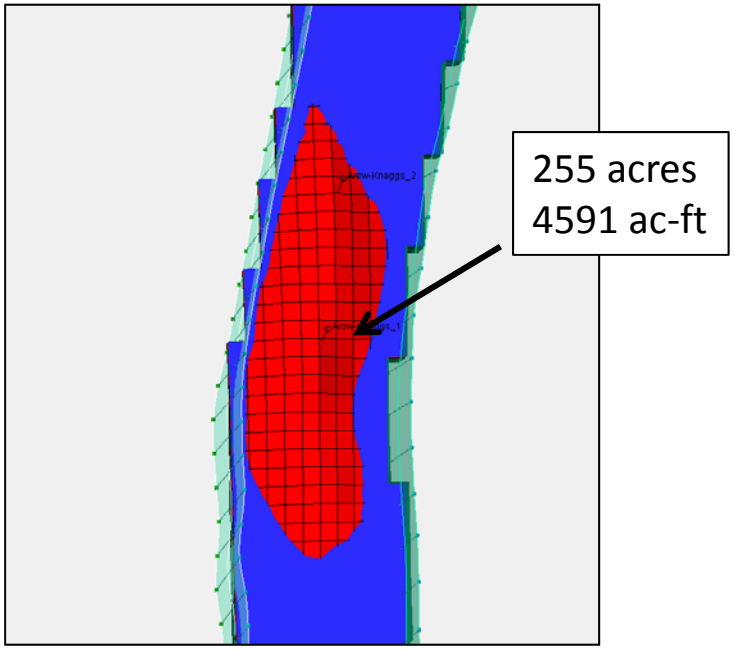
Map View Of S2B and S3 Gas Pools

S2B Pool Above GWC -3,470 ft



Gas = Red
Blue = water

S3 Pool Above GWC -3,540 ft



- Very Large “wet gassy” anomaly on seismic
- Difficult to map dry gas area
- Accumulation is 2.5 – 3 x larger than original interp.

~ 15 - 20% Smaller Than
Original Interpretation

3D Model Volumetrics With New Geologic Interpretation

Revised Geologic Maps for S2B and S3
Reservoir Parameters

- 28% porosity
- 35% SW
- 90% NTG
- Bg = 0.009250 rcf/scf

- **S3 Pool West of N-S Fault** = 3.943 BCF (vs. 5.24 BCF w/original maps)
  - GWC -3,470 ft
  - RF = 59%
  - Also S3 Gas Above GWC To East of N-S Fault (18.4 BCF)

- **S2B Pool** = 6.824 BCF (vs. 2.68 BCF w/original maps)
  - GWC -3,470 ft
  - RF = 25%

Conclusions
Zamora Static Model Framework

- Significant changes to geologic interpretation pre- and post-3D seismic data
- Uncertainty may be further reduced with a geophysical interpretation of 3D seismic volume (tied to depth)
- S2B Pool

  Original: 235 acres with 2.684 BCF IGIP (RF 64%)

  Revised: 684 acres with 6.824 BCF IGIP (RF 25%)
- S3 Pool

  Original: 322 acres with 5.239 BCF IGIP (RF 44%)

  Revised: 255 acres with 3.943 BCF IGIP (RF 59%)

Engineering Volumetric Calcs (based on original geologic maps)

IGIP Reservoir Volumetric Calculations - to original GWC and Swi												
Field	Res Acres	ft (avg)	acre-ft	PHI	Initial Sw	Initial Press. (psia)	Temp degF	Zi (gas)	Bg, ft3/scf	IGIP, MMSCF	Cum Prod MMCF	Gas Rec Factor
Zamora - 3rd Starkey	300	20.0	6,000	28.0%	35.0%	1,569	110	0.900	0.009250	5,142.6	2,320.9	45.1%
Zamora - S2B Starkey	250	17.5	4,375	28.0%	35.0%	1,569	110	0.900	0.009250	3,749.8	1,716.1	45.8%

Uncertainty In New Geologic Interpretation

- Unconformity Surface Quite Different From White Reference and mapped well data
- 3D Seismic Volume In Time Only. No Depth Conversion Has Been Done
  - 3D Volume Providing Only Qualitative Guide To Geologic Interpretation
  - Possible velocity issues
  - Seismic over S2B pool blurred by large wet gassy zone
  - Some Differences Between Seismic And Well Data
    - Example: S3 Pool Seismic Dips to North But Well Dips To East
- Recommendation
  - To Reduce Uncertainty In New Geologic Interpretation, 3D Seismic Should Be Reviewed And Interpreted By Geophysicist

Digitized Well Logs
Status As Of 07/02/2012

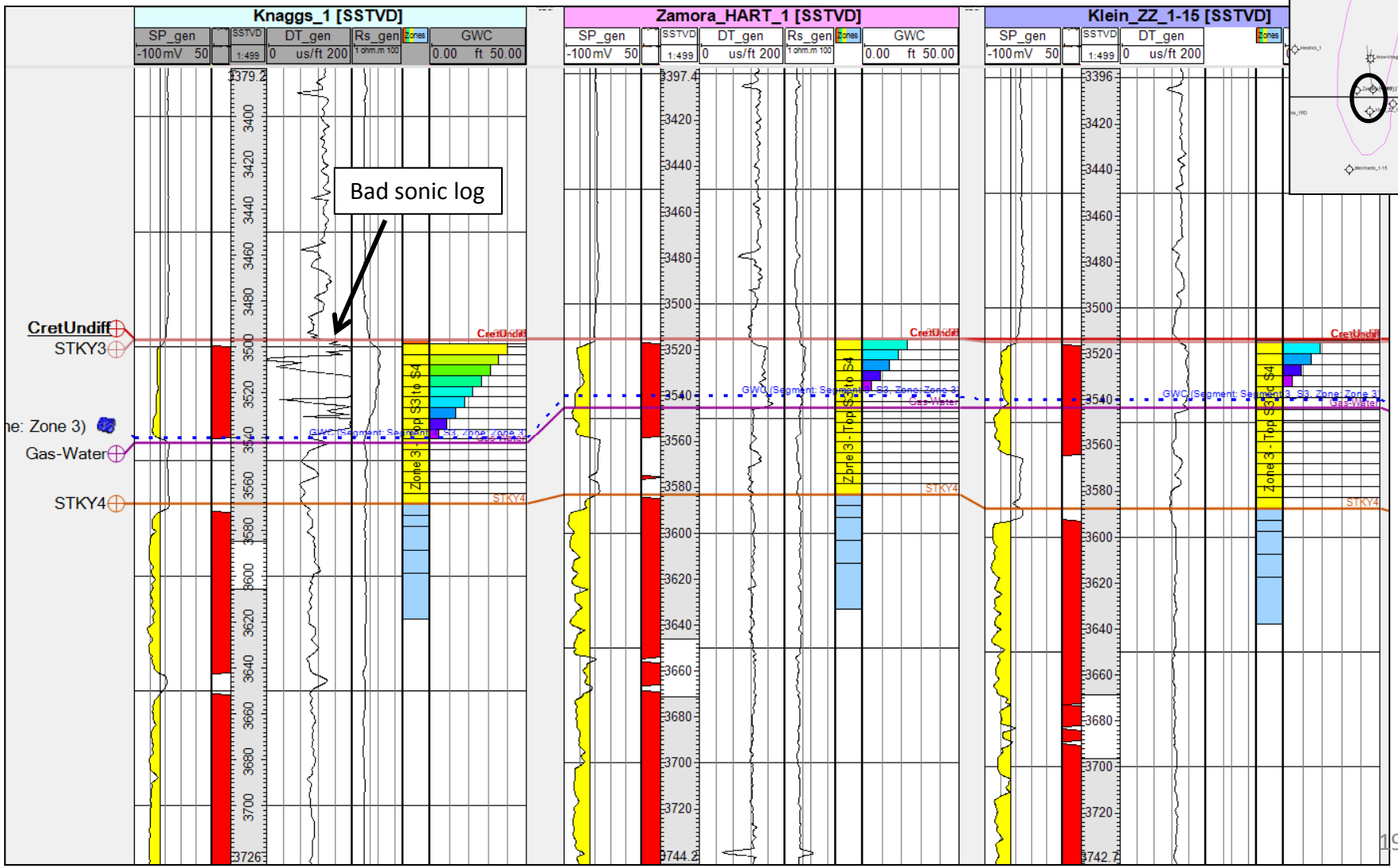
WELL NAME	NO.	Digitized 07/01/2012?	LOGS
HERMLE	1	Y	Induction electric
	1RD	n/a	None
CORDELIA WALKER ESTATE	1	Y	Electric
KNAGGS-WALLACE	1	N	Electric, lithologic
MERCHANTS	1-15	Y	Induction electric, lithologic
ZAMORA UNIT	1	N	Dip, induction electric, lithologic
KNAGGS	1	Y	Lateral electric, sonic, dip
HEIDRICK	1	Y	Induction electric, lithologic
EATON-MARTIN	1	Y	Electric, lithologic
AROW-KNAGGS	1	Y	Lateral electric, sonic, lithologic
KNAGGS-WALLACE	1	Y	Compensated neutron density, induction electric, lithologic, sonic
AROW-KNAGGS	2	Y	Induction electric, sonic
KNAGGS-WALLACE	2	Y	Compensated neutron density, induction electric, dip
KNAGGS-WALLACE	3	Y	Induction electric, sonic, dip
KNAGGS-WALLACE	5	Y	compensated acoustic velocity, compensated density neutron, dip, lithologic, induction guard
KNAGGS-WALLACE	4	Y	FDC/CNL/GR, dual induction SFL, borehole compensated sonic
ZAMORA UNIT	1	Y	dual induction acoustic velocity
KLEIN ZZ	1-15	Y	high resolution induction borehole compensated sonic, lithologic
KNAGGS-WALLACE	6	N	array induction/SP/BHC sonic/caliper, lithologic
ZAMORA	1	N	array induction/SP/BHC sonic/caliper, lithologic, CCBNL

- 4 Wells Remaining to be received
- 15 Wells Received…. But some Key Well Logs missing
  (Highlighted Wells = Rec'd With Sonic Logs)

Digitized Well Logs
Status Within Static Model

- 15 Wells Loaded Into Petrel Model
  - All Wells Except one Have SP and Resistivity
    - Merchants_1-15 = GR only, no SP
  - 3 Wells Have Sonic Logs, All in S3 Pool Area
    - Zamora_1, Klein_1-15, Knaggs_1
    - Knaggs_1 Sonic Not Useable
- Normalization And Alias Naming Of Curves
  - Significant Shifting Of SP Shale Baseline Required

S3 Pool – Wells With Sonic Logs
GWC and Model Layering Shown

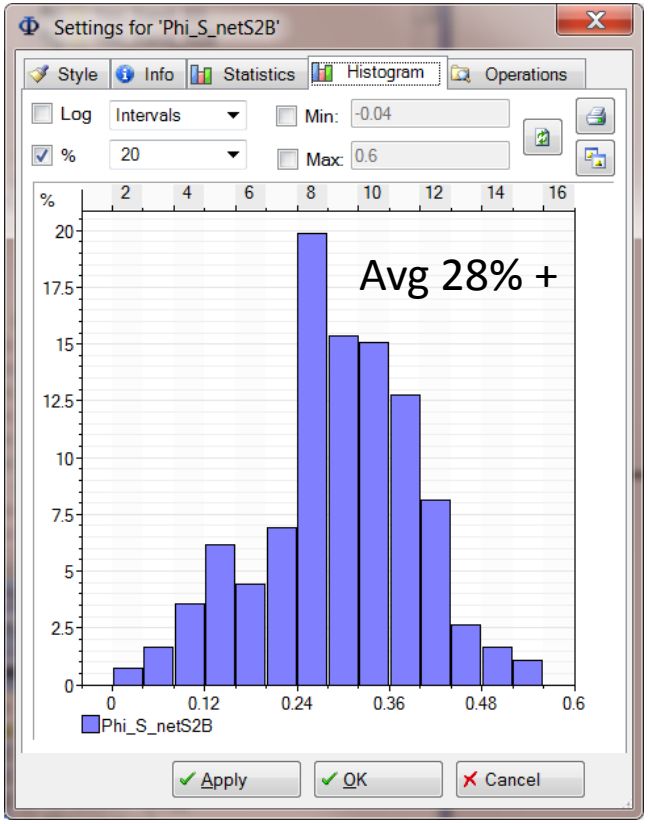


Sonic Porosity

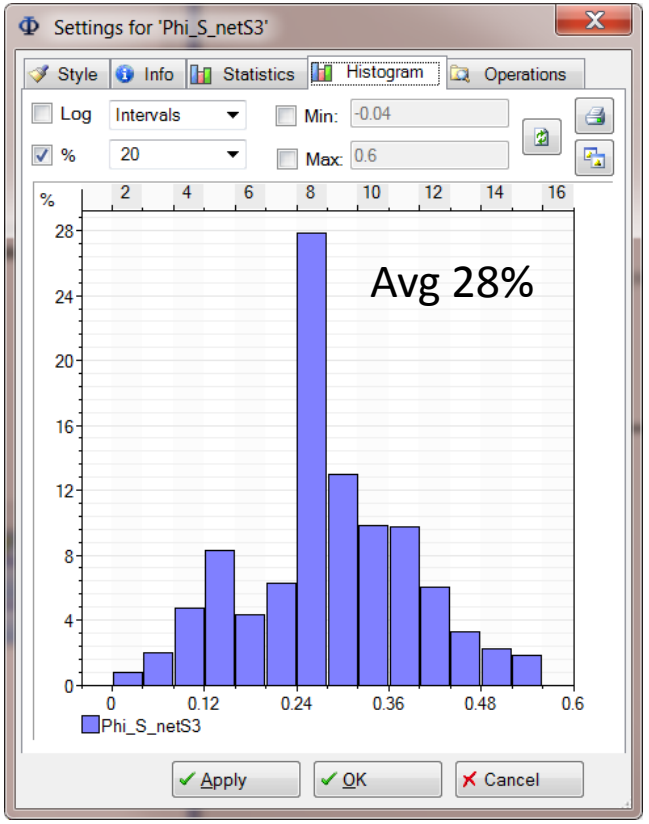
- First Pass Calculation Of Sonic Porosity
  - Both Wells With Useable Sonic Logs = Very Consistent
    - DT ~ Same Between Wells In Gas Zone And Also in Water Leg
  - Corrections Applied For Gas Effect (Gas & Wtr Leg) and Unconsolidated Sand
    - Tma = 51.3 (sandstone), Tf = 189 (fresh wtr assumed), Tsh = 138
    - Gas Effect Correction = PhiS * 0.7
    - Unconsolidated Sand Correction = 1/Cp where Cp = (Tsh * C)/100 (C ~ 1)
  - Calculated Porosity ~ 36 to 39% In Gas Zone
    - Even After Corrections Porosity Reading Too High
  - Calculated Porosity Between 25% and 33% In Water Leg
    - More Reasonable

Calculated Sonic Porosity

S2B – Net Sand



S3 – Net Sand



After DT normalization and correction for gas effect and unconsolidated ss

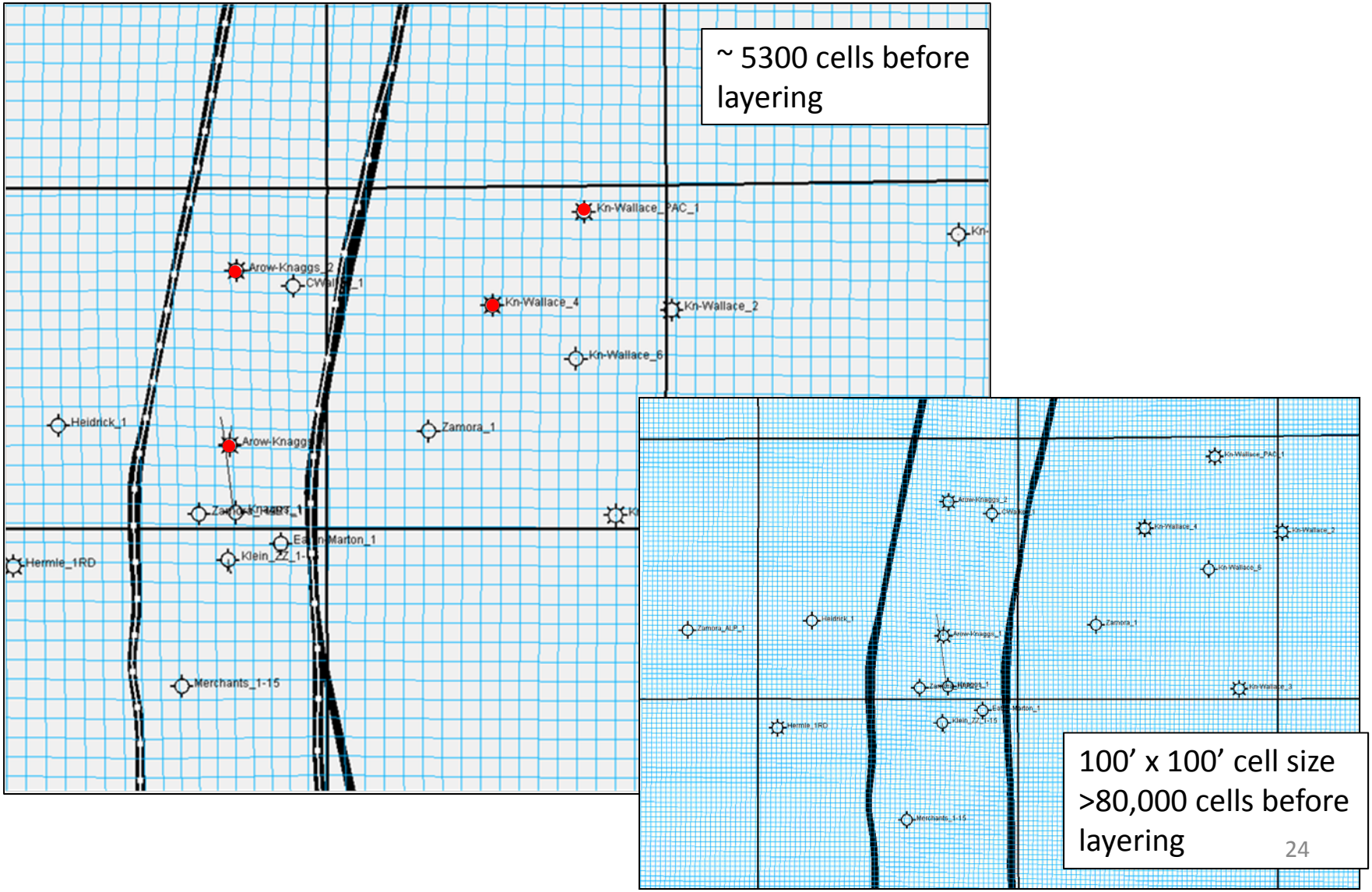
Initial Water Saturation Calculation

- Swi Options for Simulation Model
  - Capillary Pressure Data Preferred Over Log Calculated Sw
  - Calculate Log-Derived Sw From PhiS:
    - F Factor: Assume Humble Formula For Unconsolidated Sands
    - F = 0.62/phi^2.15
    - Assume ‘n’ = 2
- Need Estimate of Rw

Static Model Layering Using Well Logs

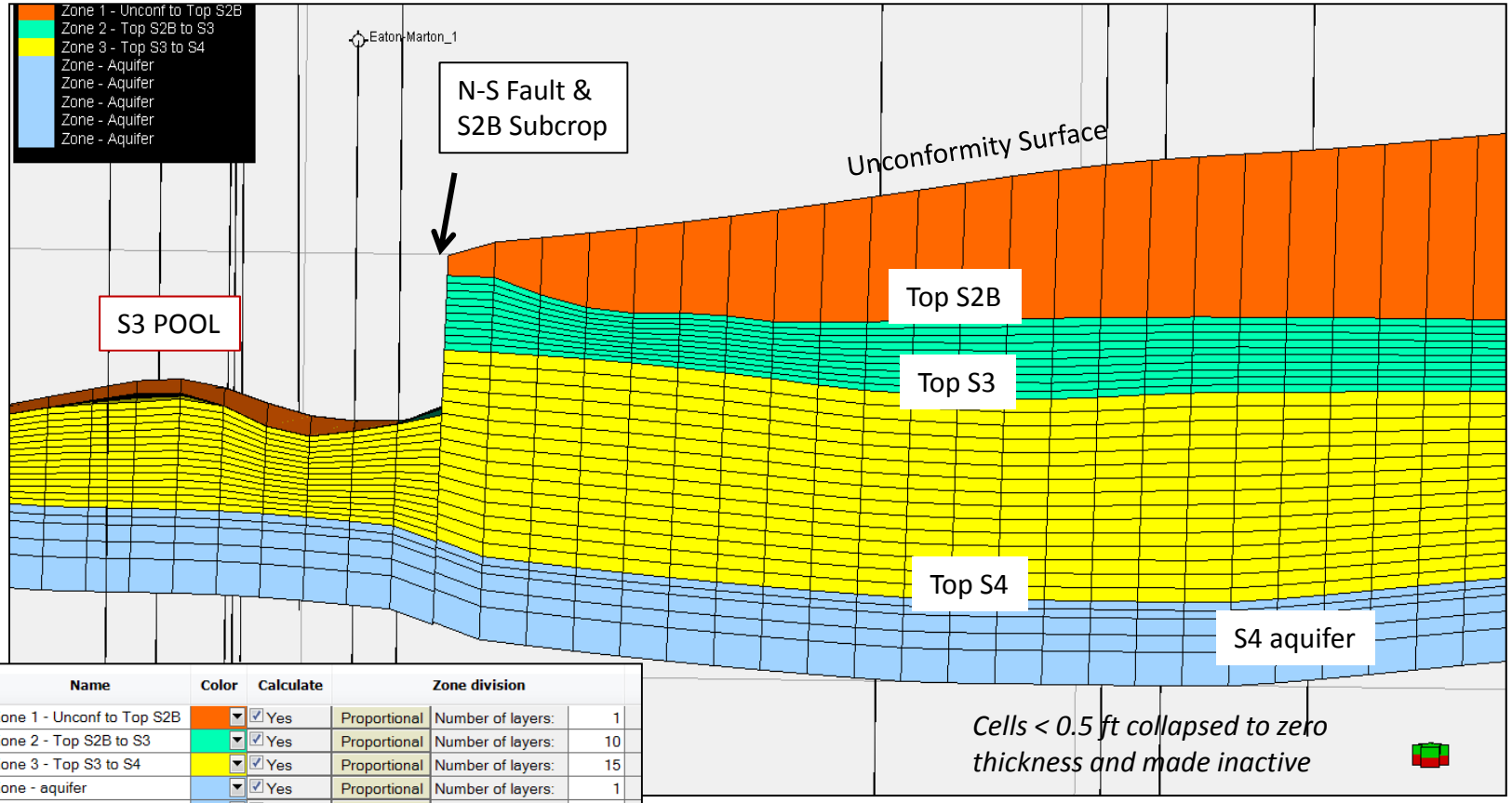
- Size Of Model Allows Finely Gridded Zones
  - 100’ x 100’ Grid Cell vs 300’ x 300’ Grid Cell
- Blocky Sands Without Much Variation
  - Use 5 Ft Layers In S3 & S2B Gas Zones & Immediately Below
  - Use Fractional Layers In Deeper Water Leg (~50 ft)
    - 2- 5 Ft zones, 2 – 10 Ft zones, 1 – 20 ft

300’ x 300’ Grid Cell Size



Static Model Layering

Model Stats: 300’ x 300’ grid cell size
48 x 37 x 31
Total 55,056 cells

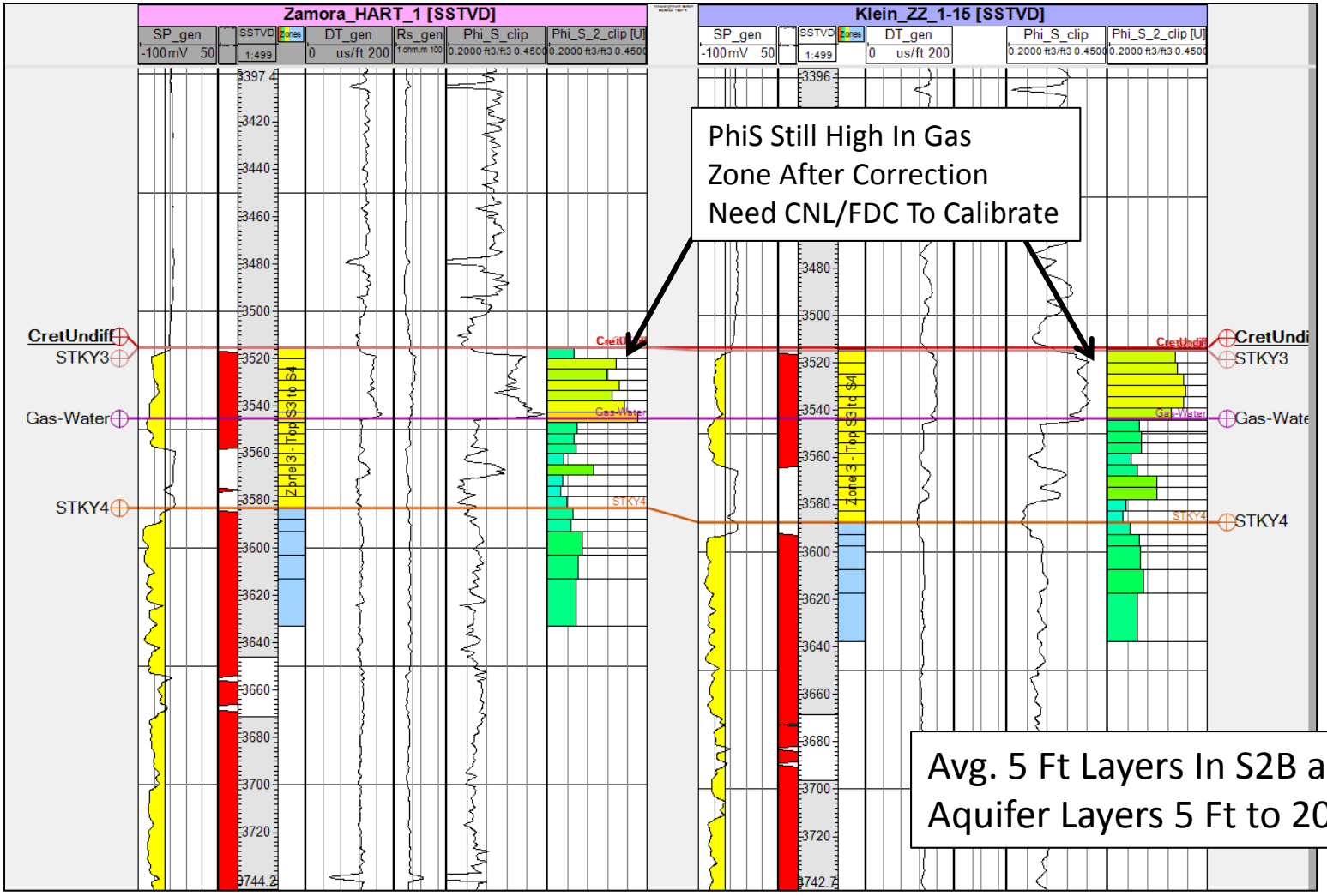


Name	Color	Calculate	Zone division		
Zone 1 - Unconf to Top S2B		Yes	Proportional	Number of layers:	1
Zone 2 - Top S2B to S3		Yes	Proportional	Number of layers:	10
Zone 3 - Top S3 to S4		Yes	Proportional	Number of layers:	15
Zone - aquifer		Yes	Proportional	Number of layers:	1
Zone - aquifer		Yes	Proportional	Number of layers:	1
Zone - aquifer		Yes	Proportional	Number of layers:	1
Zone - aquifer		Yes	Proportional	Number of layers:	1
Zone - aquifer		Yes	Proportional	Number of layers:	1

J = 33
10x vertical exaggeration

Static Model - Sonic Log Upscaling

5 Ft Layering Captures Variance



Remaining Steps

- Finalize framework of Zamora static model for any final changes to geologic maps
- Determine the available porosity logs over Starkey interval
  - Get These Digitized
  - If Possible Calibrate Sonic Porosity With N/D Logs
  - Calculate Final Porosity
  - Calculate Sw
- Upscale final well logs into static model
- Distribute properties in 3D space
  - Determine Methodology For NTG Grid
- Calculate volumetrics
- Get final approvals
- Export static model in ECLIPSE format

ZAMORA RESERVOIR

Summary and Decision

The Zamora Reservoir is located in Yolo County, California (near the City of Zamora and approximately 20 miles northwest of the City of Sacramento) (Zamora—Aerial Map.pdf). See: Overall Site Map.

Based on the final Cost Model, Zamora was ranked in the top five sites and was given an Amber rating as part of the environmental screening. As a top site, PG&E pursued the associated temporary and permanent rights/agreements that were needed to allow the reservoir testing (core drilling and air injection test), and if selected, the full development of a CAES facility. However, a significant constraint emerged related to the proximity of the core well, Injection/Withdrawal well, and permanent well sites to giant garter snake (GGS) sensitive areas. Additionally, throughout evaluation, four potential storage reservoirs were identified: First Starkey (S1), Second Starkey (S2), Third Starkey (S3), and Fourth Starkey (S4).

In May 2013, the project team determined that the time and resources estimated to acquire the necessary land rights to achieve site control prior to drilling a core well at Zamora did not meet the project's schedule. Zamora also proved challenging from a subsurface perspective for several reasons, including: size limitations, relatively low rock permeability, and development risk related to the S4 reservoir. The project team was instructed to cease further activities at Zamora other than those necessary to closeout/quitclaim all discussions and agreements.

If CAES in depleted gas reservoirs proves to be a viable technology, Zamora could have potential for a smaller development in the future, most likely in the 100- to 200-MW range.

Subsurface/Reservoir Screening

Preliminary Screening Results

Zamora was identified early in the reservoir screening process for the CAES project. Of the four potential reservoirs, three of the reservoirs in the Starkey formation combined for natural gas production of approximately 6.5 Bcf from depths of 3,400 to 3,700 ft. A preliminary geological report, prepared on October 25, 2011 (Zamora—Reconnaissance Report.pdf), highlighted the approximate location of the three producing reservoirs and noted that 3D seismic data was available for purchase from ECHO Geophysical Corp (titled: "Zamora" survey).

Detailed Geological Summary

On November 28, 2011, a detailed geological report was issued (Zamora—Detailed Geological Report.pdf). As a result of this analysis, the project team determined that the easternmost reservoir, which produced from the second Starkey formation, was the least desirable of the three

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reservoirs due to its relatively large aerial extent and thin producing interval (maximum of 20 net ft). The team also determined that this reservoir would be very difficult to access given the surface restrictions of the existing conservation easement, as outlined in the section below entitled "Siting and Environment" (Zamora—Conservation Easement Map.pdf).

Focus shifted to the S2B (central) and S3 (western) reservoirs, with a combined storage capacity of approximately 4.0 Bcf. The location of these reservoirs presented fewer access challenges for testing and development.

Reservoir Modeling and Evaluation

The Zamora reservoirs were judged to have lower permeability than some of the other candidate reservoirs. In November 2011, a reservoir modeling summary, which evaluated potential performance over a 10-hour withdrawal based on reservoir net thickness and permeability (kH) was completed (CAES—Reservoir Modeling Summary.pdf). Based on this analysis and additional modeling work, the team determined that Zamora might not have sufficient capacity for a full 300-MW CAES facility; however, a smaller development could still be viable.

In May 2012, the available data was analyzed to determine permeability for the S2B and S3 reservoirs (Zamora—Permeability Review.docx). Based on that analysis, S2B's permeability was estimated at 100 to 150 mD and S3 at 300 to 350 mD.

The 3D seismic data package was acquired over the Zamora field in early 2012, resulting in a more detailed geological analysis issued on June 28, 2012 (Zamora—3D Seismic—First Interpretation.pdf). That analysis not only provided additional data on the S2B and S3 reservoirs, but also uncovered another potential storage reservoir in the S4 zone. The S4 reservoir characteristics are very similar to the S3 reservoir, but did not produce native natural gas, most likely due to a hydraulic connection between the reservoirs allowing gas migration from the S4 to the S3.

In July 2012, a static model was developed based on the updated geological interpretation that incorporated the 3D seismic data (Zamora—Static Model.pdf). A second interpretation of the 3D seismic data was provided to address concerns about the location of faults within the field (Zamora—3D Seismic—Second Interpretation.pdf). This analysis was followed by a history match of the S3 production data in September 2012 (Zamora—S3 Reservoir Modeling and History Match.pdf).

With the "discovery" of the potential of the S4 reservoir, the preferred development for Zamora became a combination of the S3 and S4 reservoirs. This combination eliminated the key surface access issues for the S2B reservoir and would provide for a much more compact development. The S2B could be retained as a backup or expansion opportunity if development proceeded in the S3 and/or the S4.

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Testing/Development Potential

Based on the available data, the subsurface team estimated that an S3/S4 combination development could result in approximately a 225-MW CAES facility, or 75% of the desired 300 MW. The risk is that the communication between the S4 and S3 reservoirs may be such that the S4 is not a viable alternative, in which case the S3 reservoir alone could be developed for an estimated 120 MW.

If Zamora were selected for coring, a single well could be designed to obtain core from both the S4 and S3 reservoirs. Regarding a testing plan, if Zamora were selected for testing, one of the objectives of the program would be an attempt to see if communication exists between the S4 and S3 reservoirs. Detailed testing procedures had not been developed by the time reservoirs were selected for coring.

Siting and Environmental Evaluation

After preliminary evaluations of various siting scenarios, the project team conducted a final GIS evaluation for the gas field, potential ECF site, and interconnection linears. This evaluation did not identify any fatal flaws, but the presence of a conservation easement over the majority of the gas fields was determined to be problematic unless directional drilling was feasible (Zamora—GIS Evaluation.xls). Various core well drilling pad sites were evaluated, starting near the existing conservation easement where the proximity to a giant garter snake (GGS) habitat precluded pad construction and core drilling within the proposed project schedule.

At the time, PG&E concentrated on the northernmost site (which was in or immediately adjacent to GGS habitat). The PG&E schedule required core drilling during the GGS inactive period of October 1 through May 1. The U.S. Fish and Wildlife Service (USFWS) typically does not issue incidental take permits for that period, instead requiring all work be done during the snake's active period. The USFWS and California Department of Fish and Wildlife (CDFW) strongly suggested PG&E not attempt the work at that location as proposed; PG&E thus determined that the risk was too great to proceed. As such, PG&E moved the well pad south and outside GGS habitat and buffer area when the subsurface team determined PG&E could use the southwesternmost part of the reservoir.

Alternate sites to the south, moving away from potential snake habitat, were evaluated. A site was selected on Road 12 where no biological resource issues exist. The regional state and federal wildlife agencies were briefed on the project on two occasions. A Biological Assessment and a Biological Constraints Analysis (BCA) were conducted, based on this new well pad site, with negative results (Zamora—FWS Biological Effects Assessment.pdf, Zamora—Biological Constraints Analysis.pdf)). A Cultural Resources survey was conducted and a report was drafted; however, the report was never submitted to the Department of Energy (DOE) because the site was eliminated from consideration (Zamora—Cultural Resources Report.pdf).

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A Yolo County Oil and Gas Drilling Operation Site Plan approval was obtained for the core drilling (Zamora—Drilling Operation Site Plan.pdf). The application included a noise study to document that the attenuated drilling noise would not exceed county standards at the nearest residence just east of the well pad on Road 12 (Zamora—Noise Study.pdf).

The California Division of Oil, Gas, and Geothermal Resources (DOGGR) issued a drilling permit and completed a California Environmental Quality Act (CEQA) review, finding the project Categorically Exempt under Class 6 – Experimental and Data Collection activities (Zamora—DOGGR Drilling Permit—Roosevelt Ranch 10-1 613-0006.docx). A Notice of Exemption was filed with the State Clearinghouse (Zamora—Notice of Exemption—Roosevelt Ranch 10-1.pdf).

Land Acquisition/Site Control

Deployment

In April 2012 two landmen were deployed to the Zamora Reservoir to negotiate with select property owners (Zamora—APN Map.pdf). Concurrently, terms and financial compensation to owners were tracked individually and in total, to determine the total acquisition cost for the necessary land rights to support a CAES Project at the Zamora reservoir.

Preliminary Title Work

In December 2011, Western Land Services (WLS) began to compile the necessary title work for the properties identified as potential pore space, along with an appropriate buffer. The original search contemplated two different strategies to develop a combination of the three reservoirs: central paired (S2B) with the easterly reservoirs (S2), and central paired (S2B) with the westerly (S3) reservoirs. This search covered 23 Assessor's Parcel Numbers (APNs) and identified 7 pore space and 3 severed mineral owners. Ultimately, based on a combination of optimized geologic characteristics and environmental restrictions, PG&E project management decided to pursue an acquisition strategy targeting the central and westerly reservoirs.

Surface and Pore Space Ownership

Title review showed the majority of pore space ownership belonging to a single owner. In February 2012, PG&E met with representatives of this owner to discuss the CAES Project. The majority of the property had been placed in a conservation easement under the jurisdiction of the National Resources Conservation Service (NRCS), eliminating the owner's ability to take the property out of wetlands for industrial uses. The owner expressed a number of concerns regarding the project, including:

1. Visual and audible impacts from drilling wells

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2. Increased traffic, specifically due to the location of the of project's Energy Conversion Facility (ECF) in relation to the ranch headquarters and the NRCS Conservation Easement.

These concerns were driven by the potential impacts that the ECF would have on the wildlife in the area. To address these concerns, discussions on the potential siting of the ECF led to a strategy of locating the ECF at least two miles from the southwest corner of the ranch, thus defining a "corridor" that would guide future siting efforts (Zamora—Roosevelt Ranch ECF Corridor Map.pdf). Complying with this ECF siting restriction, along with addressing other stated concerns, led to the successful negotiation and execution of a Compressed Air Lease Agreement (CALA) with the property owner in February 2013.

In June 2012, PG&E entered into CALAs with two additional pore space owners. These two property owners believed that a CAES Project involving the pore space under their property had little to no impact upon their operations, and few changes were requested to the form contract. One of these owners simply requested additional compensation upon execution, and a higher fixed annual rental increase.

Other Pore Space and Mineral Ownership

Due to the small size of the population of the town of Zamora, it quickly became common knowledge to the town's residents that a CAES Project was being considered in the area. Three pore space owners and two of the severed mineral owners approached a local oil and gas attorney to collectively represent them during negotiation. In June 2012, PG&E met with the local attorney to discuss PG&E's form CALA, Mineral Owner Consent (MOC), and the larger CAES Project. In general, the issues of interest can be summarized as follows:

- Most Favoured Nations Clause
- Shorter lease terms of 34 years
- Reimbursement for all legal fees incurred to negotiate the agreement
- Annual rental increases tied to the Consumer Price Index (CPI) rather than a fixed percentage
- No warranties of title
- Royalty payment in the amount of 25% if PG&E produces and sells natural gas
- Elimination of PG&E's ability to drill water wells on the property
- Leases to encumber entire parcel rather than partial takes

In May 2013, PG&E project management decided that the time necessary to acquire all the land rights did not meet the project schedule. None of the agreements being negotiated by this attorney were executed by PG&E. The rights that PG&E had acquired under the three executed CALAs were quitclaimed with no further obligation required.

ECF Site Control

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Potential ECF sites were limited due to the restriction of the corridor discussed previously and the establishment of a maximum linear distance that an ECF could economically be sited from the reservoir. Further, a large portion of this potential area was planted with mature almond orchards, which would prove cost prohibitive to put under an Option to Purchase Agreement. Several of the owners of these properties asserted that they were not interested in selling their property. None of the Option Agreements were executed by PG&E.

References

1) Zamora - Aerial Map.pdf
2) Zamora - Reconnaissance Report.pdf
3) Zamora - Detailed Geological Report.pdf
4) Zamora - Conservation Easement Map.pdf
5) CAES - Reservoir Modeling Summary.pdf
6) Zamora - Permeability Review.docx
7) Zamora - 3D Seismic - First Interpretation.pdf
8) Zamora - Static Model.pdf
9) Zamora - 3D Seismic - 2nd Interpretation.pdf
10) Zamora - S3 Reservoir Modeling and History Match.pdf
11)
12) Zamora - FWS Biological Effects Assessment.pdf
13) Zamora - Biological Constraints Analysis.pdf
14) Zamora - Cultural Resources Report.pdf
15) Zamora - Drilling Operation Site Plan.pdf
16) Zamora - Noise Study.pdf
17) Zamora - DOGGR Drilling Permit - Roosevelt Ranch 10-1 613-0006.docx
18) Zamora - Notice of Exemption - Roosevelt Ranch 10-1.pdf
19) Zamora - APN Map.pdf
20) Zamora - Roosevelt Ranch ECF Corridor Map.pdf

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A311: 111019 - Screening_CAES_Model_GIPtoWVol

CAES RESERVOIR SIZE DETERMINATION

Gas Simulation Model Results

Case	Reservoir Properties								Rates and Cum Gas per well				Results for 10 hour withdrawal					Approx.
	K	H	KH	Temp	Pi	Pwf	Drainage Area/well		In-Place	Well Rate	10 hr Cum	Target 10 hr	# Wells	Working	Field Size	Ratio	Depth	Field Size
Run ID	md	ft	md-ft	degF	psi	psi	Rad., Ft	Acres	MMCF	MMCFD	MMCF	MMCF	1.1 bcfd	Vol, MMCF	BCF	IGIP/WV	MD	Acres
1f	500	30	15,000	112	1,200	1,050	200	3.7	116.95	32.0	13.14	13.33	34	452.0	4.0	8.9	2,771	126
1c	300	30	9,000	112	1,200	1,050	250	5.7	184.20	32.0	13.00	13.33	34	442.0	6.3	14.2	2,771	195
1d	100	30	3,000	112	1,200	1,050	250	5.7	184.20	13.0	5.42	5.42	85	460.7	15.7	34.0	2,771	488
1d2	100	30	3,000	112	1,200	1,050	300	8.3	264.90	14.0	5.78	5.83	79	456.6	20.9	45.8	2,771	653
1d3	60	50	3,000	112	1,200	1,050	300	8.3	441.80	14.0	5.78	5.83	79	456.6	34.9	76.4	2,771	653
2a	500	30	15,000	123	1,500	1,050	106	1.0	41.82	32.0	13.30	13.33	34	452.2	1.4	3.1	3,464	35
2c	300	30	9,000	123	1,500	1,050	110	1.1	45.03	32.0	13.33	13.33	34	453.2	1.5	3.4	3,464	38
2e	100	30	3,000	123	1,500	1,050	150	2.1	84.86	32.0	13.31	13.33	34	452.5	2.9	6.4	3,464	70
3a	500	30	15,000	134	1,800	1,050	80	0.6	28.74	32.0	13.27	13.33	34	451.2	1.0	2.2	4,157	20
3c	300	30	9,000	134	1,800	1,050	86	0.7	32.40	32.0	13.33	13.33	34	453.2	1.1	2.4	4,157	23
3e	100	30	3,000	134	1,800	1,050	100	0.9	44.69	32.0	13.33	13.33	34	453.2	1.5	3.4	4,157	31

Case	Reservoir Properties								Rates and Cum Gas per well				Results for 5 hour withdrawal					Approx.
	K	H	KH	Temp	Pi	Pwf	Drainage Area/well		In-Place	Well Rate	5 hr Cum	Target 5 hr	# Wells	Working	Field Size	Ratio	Depth	Field Size
Run ID	md	ft	md-ft	degF	psi	psi	Rad., Ft	Acres	MMCF	MMCFD	MMCF	MMCF	1.1 bcfd	Vol, MMCF	BCF	IGIP/WV	MD	Acres
1g	500	30	15,000	112	1,200	1,050	150	2.1	66.67	32.0	6.67	6.67	34	226.8	2.3	10.0	2,771	70
1h	300	30	9,000	112	1,200	1,050	200	3.7	116.95	32.0	6.67	6.67	34	226.8	4.0	17.5	2,771	125
1k	100	30	3,000	112	1,200	1,050	160	2.4	74.85	13.0	2.71	2.71	85	230.4	6.4	27.6	2,771	200
2b	500	30	15,000	123	1,500	1,050	78	0.6	23.23	32.0	6.67	6.67	34	226.8	0.8	3.5	3,464	19
2d	300	30	9,000	123	1,500	1,050	82	0.6	25.03	32.0	6.67	6.67	34	226.8	0.9	3.8	3,464	21
2f	100	30	3,000	123	1,500	1,050	106	1.0	41.82	32.0	6.67	6.67	34	226.8	1.4	6.3	3,464	35
3b	500	30	15,000	134	1,800	1,050	60	0.3	15.77	32.0	6.67	6.67	34	226.8	0.5	2.4	4,157	11
3d	300	30	9,000	134	1,800	1,050	63	0.4	17.39	32.0	6.67	6.67	34	226.8	0.6	2.6	4,157	12
3f	100	30	3,000	134	1,800	1,050	70	0.4	21.46	32.0	6.67	6.67	34	226.8	0.7	3.2	4,157	15

Other model properties:

- Porosity = 28 percent
- Sw = 20 percent
- Sg = 80 percent (air only)
- 11x22x4 layers (2 wells)
- No aquifer
- No standoff from GWC

A312: 120127 - Evaluation Summary Composite

Ranking by: Composite by Reservoir Team

Updated 1/27/2012

	RESERVOIR CHARACTERISTICS	SCORING WEIGHT	KING ISLAND DESCR.	KING ISLAND RAW SCORE (1 TO 10)	KING ISLAND WEIGHTED SCORE	EAST ISLANDS DESCR.	EAST ISLANDS RAW SCORE (1 TO 10)	EAST ISLANDS WEIGHTED SCORE	CACHE SLOUGH (Midland Pool) DESCR.	CACHE SLOUGH (Midland Pool) RAW SCORE (1 TO 10)	CACHE SLOUGH (Midland Pool) WEIGHTED SCORE	ZAMORA DESCR.	ZAMORA RAW SCORE (1 TO 10)	ZAMORA WEIGHTED SCORE
1	OGIP Size (Bcf)	**10**	16	10	100	5-7	10	100	12.1	10	100	5	9	90
2	Net Thickness	**8**	140	10	80	85	8	64	70	9	72	50	7	56
3	Reservoir Size (Acres)	**6**	235	9	54	200	9	54	600	8	48	800	7	42
4	Original Pressure (psig)/Depth	**10**	2,150/4,700	8	80	2,000/4,600	8	80	2,120/4,750	8	80	1,460/3,500	10	100
5	Drive Mechanism	**6**	Mod WD	6	36	Strong WD	5	30	Strong WD	5	30	Combined	8	48
6	Caprock Thickness (ft)	**8**	100	8	64	90	8	64	200-400	9	72	300-400	10	80
7	# of Traps for Storage Development	**10**	1	10	100	1	10	100	1	10	100	2	8	80
8	Permeability (md)	**10**	Exc.	8	80	200-400	6	60	High	8	80	50-100	4	40
9	Porosity	**3**	28.7%	8	24	30%	9	27	33%	10	30	28-32%	10	30
10	Remaining reserves (Bcf)	**5**	.5-1.5	7	35	.025-.05	9	45	0	10	50	0	10	50
11	Water Saturation	**8**	22%	10	80	40-45%	6	48	35%	8	64	35%	8	64
12	# Abandoned Wells	**10**	1	10	100	3	10	100	12	5	50	7	7	70
13	# Producing/Idle Wells	**4**	2	10	40	1	10	40	0	8	32	0	8	32
14	# Abandoned Wells w/ Issues	**6**	0	10	60	0	10	60	0	10	60	0	10	60
15	Age of Wells (Years)	**5**	25	9	45	30	8	40	67	5	25	34	8	40
16	Trapping Mechanism	**4**	Channel	10	40	Channel	10	40	Fault	6	24	Fault	6	24
	TOTAL WEIGHTED SCORE (Maximum Possible = 1,130)				**1018**			**952**			**917**			**906**

	RESERVOIR CHARACTERISTICS	SCORING WEIGHT	MERRILL AVENUE (Southeast) DESCR.	MERRILL AVENUE (Southeast) RAW SCORE (1 TO 10)	MERRILL AVENUE (Southeast) WEIGHTED SCORE	WILLOW SLOUGH (GREINER) DESCR.	WILLOW SLOUGH (GREINER) RAW SCORE (1 TO 10)	WILLOW SLOUGH (GREINER) WEIGHTED SCORE	MCMULLIN RANCH (B-5 & B-5A) DESCR.	MCMULLIN RANCH (B-5 & B-5A) RAW SCORE (1 TO 10)	MCMULLIN RANCH (B-5 & B-5A) WEIGHTED SCORE
1	OGIP Size (Bcf)	**10**	10.5	10	100	7	10	100	36	8	80
2	Net Thickness	**8**	30' Max	5	40	200+	10	80	44	5	40
3	Reservoir Size (Acres)	**6**	2,000 est.	5	30	150	10	60	1,650	6	36
4	Original Pressure (psig)/Depth	**10**	2,700/6,300	5	50	2,200/4,850	7	70	2,273/5,250	6	60
5	Drive Mechanism	**6**	Depletion	10	60	Strong WD	5	30	Depletion	10	60
6	Caprock Thickness (ft)	**8**	>300	10	80	>200	9	72	40	5	40
7	# of Traps for Storage Development	**10**	1	10	100	4+	2	20	Stacked	5	50
8	Permeability (md)	**10**	Low	4	40	50-100	4	40	597	8	80
9	Porosity	**3**	???	6	18	25-31%	8	24	28.0%	8	24
10	Remaining reserves (Bcf)	**5**	Significant	2	10	0	10	50	0	8	40
11	Water Saturation	**8**	???	7	56	43-50%	5	40	35%	8	64
12	# Abandoned Wells	**10**	0	10	100	3	5	50	16	5	50
13	# Producing/Idle Wells	**4**	6	9	36	2	10	40	13	6	24
14	# Abandoned Wells w/ Issues	**6**	0	10	60	1	5	30	0	10	60
15	Age of Wells (Years)	**5**	22	9	45	37	7	35	51	4	20
16	Trapping Mechanism	**4**	Anticline	9	36	Fault	6	24	Anticline	9	36
17	**TOTAL WEIGHTED SCORE** (Maximum Possible = 1,130)				**861**			**765**			**764**

A313: 120822 - Evaluation Summary Composite

Ranking by: SS Team Composite

Updated 8/22/2012

	RESERVOIR CHARACTERISTICS	SCORING WEIGHT	KING ISLAND DESCR.	KING ISLAND RAW SCORE (1 TO 10)	KING ISLAND WEIGHTED SCORE	EAST ISLANDS DESCR.	EAST ISLANDS RAW SCORE (1 TO 10)	EAST ISLANDS WEIGHTED SCORE	CACHE SLOUGH (Midland Pool) DESCR.	CACHE SLOUGH (Midland Pool) RAW SCORE (1 TO 10)	CACHE SLOUGH (Midland Pool) WEIGHTED SCORE	ZAMORA (S3 & S2B) DESCR.	ZAMORA (S3 & S2B) RAW SCORE (1 TO 10)	ZAMORA (S3 & S2B) WEIGHTED SCORE
1	Production (Bcf)	**10**	10.1	10	100	4.0	5	50	12.1	10	100	2.3/1.7	5	50
2	Net Thickness	**8**	140	10	80	60	8	64	70	9	72	37/26	5	40
3	Reservoir Size (Acres)	**10**	190	7	70	110	4	40	600	8	80	255/270	8	80
4	Original Pressure (psig)/Depth	**10**	2,150/4,700	8	80	2,000/4,600	8	80	2,120/4,750	8	80	1,460/3,500	10	100
5	Drive Mechanism	**6**	Mod WD	6	36	Strong WD	5	30	Strong WD	5	30	Combined	8	48
6	Caprock Thickness (ft)	**5**	100	10	50	90	10	50	200-400	10	50	300-400	10	50
7	# of Traps for Storage Development	**10**	2	8	80	1	10	100	1	10	100	2	8	80
8	Permeability (md)	**10**	Exc.	8	80	200-400	8	80	High	8	80	50-300	6	60
9	Porosity	**3**	28.7%	8	24	30%	9	27	33%	10	30	28-32%	10	30
10	Remaining reserves (Bcf)	**5**	.5-1.5	7	35	.025-.05	9	45	0	10	50	0	10	50
11	Water Saturation	**8**	22%	10	80	40-45%	6	48	35%	8	64	35%	8	64
12	# Abandoned Wells	**10**	1	10	100	3	10	100	12	4	40	7	5	50
13	# Producing/Idle Wells	**4**	2	10	40	1	10	40	0	8	32	0	8	32
14	# Abandoned Wells w/ Issues	**6**	0	10	60	0	10	60	0	10	60	0	10	60
15	Age of Wells (Years)	**5**	25	9	45	30	8	40	67	5	25	34	8	40
16	Trapping Mechanism	**4**	Fault/Channel	8	32	Channel	10	40	Fault	6	24	Fault	6	24
	TOTAL WEIGHTED SCORE				**992**			**894**			**917**			**858**
	(Maximum Possible = 1,100)													

	RESERVOIR CHARACTERISTICS	SCORING WEIGHT	PERKINS LAKE DESCR.	PERKINS LAKE RAW SCORE (1 TO 10)	PERKINS LAKE WEIGHTED SCORE	CROSSROADS (Amstar & Dinsdale) DESCR.	CROSSROADS (Amstar & Dinsdale) RAW SCORE (1 TO 10)	CROSSROADS (Amstar & Dinsdale) WEIGHTED SCORE
1	Production (Bcf)	**10**	34.4	8	80	6.2	10	100
2	Net Thickness	**8**	110'	10	80	15' to 20'	4	32
3	Reservoir Size (Acres)	**10**	970	8	80	600 est.	8	80
4	Original Pressure (psig)/Depth	**10**	1,450/3,500	10	100	2,050/4,150	8	80
5	Drive Mechanism	**6**	Depletion	10	60	Depletion	10	60
6	Caprock Thickness (ft)	**5**	1,000	10	50	???	5	25
7	# of Traps for Storage Development	**10**	Multiple	8	80	2	8	80
8	Permeability (md)	**10**	Low	4	40	Excellent	8	80
9	Porosity	**3**	30%	9	27	25-34%	8	24
10	Remaining reserves (Bcf)	**5**	<1.0 Bcf	7	35	0	10	50
11	Water Saturation	**8**	25%	9	72	40-45%	6	48
12	# Abandoned Wells	**10**	7	5	50	5	7	70
13	# Producing/Idle Wells	**4**	5	6	24	0	10	40
14	# Abandoned Wells w/ Issues	**6**	???	5	30	???	5	30
15	Age of Wells (Years)	**5**	55	6	30	35	8	40
16	Trapping Mechanism	**4**	Structural	8	32	Fault	6	24
17	**TOTAL WEIGHTED SCORE**				**870**			**863**
	(Maximum Possible = 1,100)							

A314: CAES High Level Review

CAES – HIGH LEVEL REVIEW

Bowerbank:

- Production was from thin, lenticular Piocene San Joaquin and Etchegoin sands, 4-24 feet thick. Sands are also trapped against cross faults on anticline.
- Many small discontinuous pools.
- Land may be difficult unless shallow rights can be bought. Much of land is believed to be leased for Miocene Monterey shale resource play.

Cache Slough:

- Simple faulted anticlinal nose apparently not complicated by additional faulting.
- Shale top seal.
- Good depth – 4,800'.
- Good permeable reservoir – Paleocene Mokelumne River/1st Massive sands.
- Thick original gas column (~90'); small area (500 acres).
- About a dozen wells in pool; produced about 12.5 Bcf.

Clarksburg:

- Winters sands too deep (7,450'), produce from several small stratigraphic pools.
- Lower Starkey pool may be good candidate; 4,400' deep.
- Production (~6.7 Bcf) apparently produced from a single pool; ~ 4 wells.
- Wells had between 50 and 60 feet of Starkey pay.
- Good permeable thick reservoir in faulted, erosional trap (underlies Markley shale submarine canyon).
- May be potential surface problems; Sacramento River and ship channel cross area; many of wells were directionally drilled.

Crossroads:

- Good reserves (17.2 Bcf), but broken up into several fault blocks and pools.
- At least four main fault blocks and at least that many Starkey pools (best reservoir). Deeper Winters sands are also in fault traps but additionally are highly compartmentalized by stratigraphic complications.
- Starkey reservoir average depth 4,150 feet; I.P. = 2,050 PSI.
- DOGGR lists 11 Starkey wells. This is the best and most continuous reservoir. The Starkey Field produced 7.9 Bcf of gas. Best pool (of the 4+) estimated to have produced about 3 Bcf max.
- Field is spread out over about 9 square miles; may require a very large gathering system.

King Island:

- Good permeable reservoir (Mokelumne River).
- Good reserves, produced 10.5 Bcf.
- Thick gas column – 120 feet max; small area (~350 acres).
- Simple erosional trap by Meganos channel has truncated reservoir sands, has limited an active water drive. Lateral closure against Meganos Channel shales.
- Gas in Mokelumne River pool produced from two wells.

McMullin Ranch:

- Large 4-way anticlinal structure has produced 63.7 Bcf from Blewett, Tracy and Lathrop sandstones. Lathrop pool too deep to be considered (7,200'); Tracy too small, produced a limited amount of gas; Blewett sands (B4, B5 and B5a) produced an estimated 40 Bcf of gas and should be only reservoirs considered.
- Blewett sands are good permeable reservoirs.
- Simple anticlinal structure not complicated by faulting.
- Thick gas column (~ 70') at crest of B5a horizon; structure covers ~ 1,400 acres.
- B4 reservoir covers only about 300 acres w/maximum 20' fill-up; reserves may be too low.
- An estimated 17 idle and/or suspended wells.

Merrill Avenue:

- Thick Blewett sand in a primary stratigraphic trap that has good lateral and up-dip closure into low permeability shale.
- Thick (64') column of gas; field produced 19.7 Bcf of gas; most from one well in one pool.
- Complex Blewett sand stratigraphy, 3-D seismic data may be needed to accurately define pool limits.
- Map be too deep: 6,300'.

Merritt Island:

- Winters sand reservoirs in multiple pools.
- Main trap is stratigraphic, drained by one well that produced 4.38 Bcf of the 5.6 Bcf of field reserves; produced from an 8 foot thick sand at up dip edge.
- Later wells found a 10 to 15 foot thick depleted sand covering about 300 acres.
- Probably too deep (7,400').
- Sacramento River over trap necessitates directional wells.
- Surface culture is primarily pear orchards.

Tremont:

- Produced about 5 Bcf of gas from two separate fault closures.
- Traps are located about one mile from one another.
- Stacked reservoirs between 6,000’ and 6,500’.
- Single reservoir too small and complicated.

Trico NW:

- Thin (~10’) lenticular Pliocene sands in stratigraphic traps on broad nose; at least three reservoirs.
- Shallow depths between 2,400’ and 3,800’.
- To get enough reservoir volume, need large surface footprint.

Zamora:

- Produced ~6.5 Bcf from good Starkey sand reservoir.
- Shallow depth ~ 3,600’.
- Combination structural and truncation traps; 3 small gas pools.

Bounde Creek:

- Multiple stacked gas reservoirs on anticlinal feature.
- Significant stratigraphic component to traps.
- Depths to reservoirs appear to be Princeton Cyn/Torres sand (8.6 Bcf) and Forbes McGowan sand (~20 Bcf).
- Both sands could have stratigraphic complications.
- Seven wells produced from Torres zone; 19 from McGowan.

French Camp:

- Large active field chiefly producing from deeper Lathrop sandstones.
- Target sand for the study would be Starkey sands, good reservoir.
- Produced only 2.3 Bcf from Starkey sands from 2 structural pools.
- Too small.

Tracy:

- 1st commercial gas field in California.
- Reservoir, structure, original gas reserves are ideal.
- Tremendous liability issues; early wells through reservoir not properly abandoned and cannot be properly abandoned because of housing tracts.

Perkins Lake:

- Production from basal Eocene Markley channel sands.
- Excellent reservoir; gas reserves (38 Bcf) produced from 5 wells.
- Good depth (~3,400') and pressure (1,600 PSI).
- Reservoir may be too large?
- Sands have stratigraphic complications.

Vernalis:

- Very large field (104 Bcf) chiefly producing from Blewett sandstones.
- Good depths (3,800' to 4,200') of Blewett B-1 through B-4 sands.
- Good Blewett pressures (1,765 PSI to ~ 2,000 PSI).
- Overlying Azevedo sands may also be potential candidates; thick sands but laterally discontinuous and, in part, truncated by Miocene unconformity.
- Large Blewett anticlinal structure complicated by faulting and permeability changes; sands may be compartmentalized.
- Large number of wells; 9 producing, 24 shut-in as of 2006.
- May need 3-D seismic to accurately define reservoirs.

East Islands:

- Simple compaction anticlinal closed up dip by a fault.
- Moderate depth (4,600') and pressure (estimated at 2,000 PSI).
- Good thick permeable reservoir; Paleocene Meganos Channel sand.
- Field discovered in late 1970s; now near economic limit.
- Four productive wells; main 2-well pool produced majority of gas.
- Small reservoir (4.0 Bcf); most gas produced from a single well (3.7 Bcf) w/50' pay column.
- Main pool (2 wells) covers about 150 acres.

Liberty Island:

- Simple truncation trap of permeable Midland sand by shale-filled Markley Channel.
- Field discovered 1960, ~ 13 wells drilled within productive limits; all now abandoned.
- Moderate depth (4,725') and pressure (2,020 PSI).
- Good size (27.4 Bcf); 690 acres.
- Permeable reservoir; wells averaged 30' of pay.
- Minor faulting may compartmentalize reservoir.

Rio Jesus:

- Simple truncation trap of permeable Mokelumne River and Starkey sands by shale-filled Markley Channel.
- Field discovered 1972; four wells drilled within productive limits; all now abandoned.
- Shallow depth (2,400'), good pressure (1,275 PSI).
- Good permeable sands; 35' average pay.
- Small area (~200 acres); 3.9 Bcf.
- Erosion by Markley channel has truncated three stacked reservoirs, these most likely will act like multiple pools/compartments.
- Water encroachment only from down dip direction; sand truncated laterally and up dip.

Schohr Ranch:

- Anticlinal structure has produced 2.1 Bcf from permeable Kione sandstone.
- Field discovered 1957; half dozen wells drilled within productive limits; now abandoned.
- Shallow depth (2,570'), good pressure (1,220 PSI).
- Simple anticlinal structure; minor faulting.
- Thin average pay (15') on top of thick sands covers 360 acres.
- Small size and compartmentalization of reservoir downgrades this field as a candidate.

West Thornton/Walnut Grove

- Approximately 20 Bcf in pool.
- Meganos Channel sands are good permeable reservoirs.
- Overlying Capay Shale drapes over channel sand forming good top on simple compaction anticline.
- Depth to reservoir (3,500') good; reservoir pressure good (1,540 PSI).
- Reservoir is believed to be uncomplicated by stratigraphy and faulting.

A315: CAES Reservoir Size Determination

CAES RESERVOIR SIZE DETERMINATION

Gas Simulation Model Results

Case	Reservoir Properties								Rates and Cum Gas per well				Results for 10 hour withdrawal					Approx.
	K	H	KH	Temp	Pi	Pwf	Drainage Area/well		In-Place	Well Rate	10 hr Cum	Target 10 hr	# Wells	Working	Field Size	Ratio	Depth	Field Size
Run ID	md	ft	md-ft	degF	psi	psi	Rad., Ft	Acres	MMCF	MMCFD	MMCF	MMCF	1.1 bcfd	Vol, MMCF	BCF	IGIP/WV	MD	Acres
1f	500	30	15,000	112	1,200	1,050	200	3.7	116.95	32.0	13.14	13.33	34	452.0	4.0	8.9	2,771	126
1c	300	30	9,000	112	1,200	1,050	250	5.7	184.20	32.0	13.00	13.33	34	442.0	6.3	14.2	2,771	195
1d	100	30	3,000	112	1,200	1,050	250	5.7	184.20	13.0	5.42	5.42	85	460.7	15.7	34.0	2,771	488
1d2	100	30	3,000	112	1,200	1,050	300	8.3	264.90	14.0	5.78	5.83	79	456.6	20.9	45.8	2,771	653
1d3	60	50	3,000	112	1,200	1,050	300	8.3	441.80	14.0	5.78	5.83	79	456.6	34.9	76.4	2,771	653
2a	500	30	15,000	123	1,500	1,050	106	1.0	41.82	32.0	13.30	13.33	34	452.2	1.4	3.1	3,464	35
2c	300	30	9,000	123	1,500	1,050	110	1.1	45.03	32.0	13.33	13.33	34	453.2	1.5	3.4	3,464	38
2e	100	30	3,000	123	1,500	1,050	150	2.1	84.86	32.0	13.31	13.33	34	452.5	2.9	6.4	3,464	70
3a	500	30	15,000	134	1,800	1,050	80	0.6	28.74	32.0	13.27	13.33	34	451.2	1.0	2.2	4,157	20
3c	300	30	9,000	134	1,800	1,050	86	0.7	32.40	32.0	13.33	13.33	34	453.2	1.1	2.4	4,157	23
3e	100	30	3,000	134	1,800	1,050	100	0.9	44.69	32.0	13.33	13.33	34	453.2	1.5	3.4	4,157	31

Case	Reservoir Properties								Rates and Cum Gas per well				Results for 5 hour withdrawal					Approx.
	K	H	KH	Temp	Pi	Pwf	Drainage Area/well		In-Place	Well Rate	5 hr Cum	Target 5 hr	# Wells	Working	Field Size	Ratio	Depth	Field Size
Run ID	md	ft	md-ft	degF	psi	psi	Rad., Ft	Acres	MMCF	MMCFD	MMCF	MMCF	1.1 bcfd	Vol, MMCF	BCF	IGIP/WV	MD	Acres
1g	500	30	15,000	112	1,200	1,050	150	2.1	66.67	32.0	6.67	6.67	34	226.8	2.3	10.0	2,771	70
1h	300	30	9,000	112	1,200	1,050	200	3.7	116.95	32.0	6.67	6.67	34	226.8	4.0	17.5	2,771	125
1k	100	30	3,000	112	1,200	1,050	160	2.4	74.85	13.0	2.71	2.71	85	230.4	6.4	27.6	2,771	200
2b	500	30	15,000	123	1,500	1,050	78	0.6	23.23	32.0	6.67	6.67	34	226.8	0.8	3.5	3,464	19
2d	300	30	9,000	123	1,500	1,050	82	0.6	25.03	32.0	6.67	6.67	34	226.8	0.9	3.8	3,464	21
2f	100	30	3,000	123	1,500	1,050	106	1.0	41.82	32.0	6.67	6.67	34	226.8	1.4	6.3	3,464	35
3b	500	30	15,000	134	1,800	1,050	60	0.3	15.77	32.0	6.67	6.67	34	226.8	0.5	2.4	4,157	11
3d	300	30	9,000	134	1,800	1,050	63	0.4	17.39	32.0	6.67	6.67	34	226.8	0.6	2.6	4,157	12
3f	100	30	3,000	134	1,800	1,050	70	0.4	21.46	32.0	6.67	6.67	34	226.8	0.7	3.2	4,157	15

Other model properties:

- Porosity = 28 percent
- Sw = 20 percent
- Sg = 80 percent (air only)
- 11x22x4 layers (2 wells)
- No aquifer
- No standoff from GWC

A316: East Islands Cultural Resource Survey Final

North State Resources, Inc.

Date:	October 12, 2012	**PG&E Order #:**	8105484
To:	Land and Environmental Management—Catalina Reyes, Biologist		
From:	North State Resources, Inc.— John W. Hunt, Biologist		
Project:	PG&E Compressed Air Energy Storage Sites–Proposed Investigative Geologic Core Sampling at the East Island Morais Well.		
Subject:	Final Biological Constraints Analysis of the East Island Morais Well, San Joaquin County, California		

Introduction and Summary

Mr. John W. Hunt, NSR Biologist, conducted a biological constraints analysis for the proposed Geologic Core Sampling Phase of Pacific Gas and Electric Company (PG&E) Compressed Air Energy Storage Project (project) at the proposed East Island Morais natural gas well pad expansion area and associated access roads (project area). The area surveyed consist of all areas within 20 feet of proposed access roads and all areas within 250 feet of the existing well pad and the proposed well pad expansion area (Figure 1, Appendix A). The objective of the project is to expand and utilize the existing footprint of the Morais natural gas well site to stage geological core sampling equipment. The geological core sampling will be used to determine the suitability of the project vicinity for compressed air storage within depleted subterranean natural gas reservoirs.

A field reconnaissance was conducted on August 20, 2012 with Ms. Catalina Reyes, PG&E Biologist. The project area includes all the proposed access road, existing well pad and staging area, and well pad expansion areas identified by PG&E technical staff during the field review on August 20, 2012 (Figure 2, Appendix A).

Giant garter snake, listed as threatened under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA); Swainson's hawk, listed as threatened under CESA; loggerhead shrike, designated as California species of special concern (SC); and white-tailed kite, a state fully protected (FP) species, have the potential to be adversely affected or impacted by the project This document provides Avoidance and Minimization Measures (AMMs) that will avoid effects on these species.

The vegetated irrigation ditches within the project area appear to meet wetland criteria and may qualify as waters of the United States. All other portions of the existing access road, the existing well pad, and the well pad expansion area do not appear to meet wetland criteria and are not considered to qualify as potential waters of the United States. All determinations concerning waters of the United States should be considered preliminary and tentative unless verified in writing by the U.S. Army Corps of Engineers.

The proposed project will receive federal funding from the U.S. Department of Energy (USDOE). As such, the USDOE is required under section 7 of the federal Endangered Species Act to determine whether the proposed project may affect federally listed and proposed species or proposed or designated critical habitat. If the USDOE determines that the project may affect federally listed species or critical habitat, consultation with the U.S. Fish and Wildlife Service and/or National Marine Fisheries Services is required.

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Project Description

The objective of the project is to collect approximate 10-inch diameter geological core samples from the subsurface natural gas formation at depth approximately 4,000-5,000 feet. Cores will be used determine the suitability of the subsurface formation for compressed air storage. Compressed air storage involves utilizing appropriate geological formations (e.g., depleted natural gas reservoirs) to store surplus energy in the form of compressed air during periods of low electric demand. This stored energy can then be utilized during periods of higher electric demand, improving the efficiency of energy distribution through the power grid.

The project area is located approximately 6 miles northwest of the city of Stockton in northwestern San Joaquin County, California. It is situated south of State Highway 12 approximately 1.3 miles west of Interstate 5 at approximately 38.103683°, -121.433416° (Figure 2, Appendix A). Site access is from the northwest along Guard Road, which is a public road. A smaller, unnamed dirt road provides access to the Morais Well from Guard Road.

Given that existing access roads are available, road construction necessary for project will be limited to widening of approximately 150 feet of access immediately east of the existing well pad. Improvements to this section of road include widening the access road approximately 4 feet to the north (14-foot final width) along approximately 150 feet of road (approximately 0.01 acre). A turning radius will be constructed on the east side of the existing road east of the culvert to provide a sufficient turning radius. Expansion of the road and turning radius will involve clearing existing crops grading, compacting the subgrade, placing aggregate base, and compacting the final road grade. At the junction of the Morais well pad access with the primary unnamed dirt access road, steel plates will be laid over timbers placed to span the primary irrigation ditch, extending the effective access 10 feet south of the culvert. Placement of the steel plates will facilitate site access while avoiding direct impacts or modifications on the existing primary irrigation ditch. Additional improvements to the existing access roads from the culvert to 350 feet south will be limited to light graveling of the unnamed dirt road if determined necessary (e.g., work to occur during the wet season) with the assumption no additional grading will be required. No road improvement will occur east of the 90 degree corner towards Guard Road. If grading is required, it will be limited to the existing road and will not extend beyond the compacted surface. All vehicle traffic will be on the existing access roads and all staging will be contained within the existing well pad. Water trucks will be used as necessary to reduce dust during site access and other construction activities. Approximately 28 truck trips will be required to import well pad material to the site. An additional five truck trips will be required to remove drill-core samples and associated material from the site. If well pad expansion area is restored to pre-project conditions, an additional 28 truck trips will be required to remove temporary well pad expansion materials, which will total 61 truck trips. Best Management Practices (BMPs) and AMMs will be implemented to avoid impacts on potential waters of the United States.

The existing Morais well pad will be expanded north and east of the existing well pad to total approximately 0.8-acre area (220 x 160 feet), which increases the size by approximately 0.5 acre. Cropland within the selected area will be cleared in order to accommodate the well pad expansion. After clearing the vegetation, approximately 1 foot of crushed rock will be placed within the cleared area and compacted with a roller. If necessary, woven geotextile fabric will be placed as an underlayment for the overlying gravel fill.

After the well pad expansion area has been established (i.e., cleared of vegetation, rocked, and compacted), well drilling equipment will be moved onto the expansion area. The primary equipment includes the drill rig, mud and water tanks and pumps, shaker tanks, electric generators, diesel fuel tanks,

and drill pipe racks. Geologic sampling will consist of drilling a 10 inch diameter well to a depth of approximately 4,000-5,000 feet and extracting a geological core sample not greater than 4 inches in diameter. All sections of the core sample will be removed offsite for analysis and storage. All peripheral material (e.g., cuttings and drilling mud) removed during the coring process will be immediately placed in proper storage receptacles and removed offsite for disposal at an authorized facility. The drilling crew, plus engineers, temporary workers and site visitors, will consist of an average of approximately 12 workers per shift, with three shifts per day. A maximum of 20 workers may be present during various operations. In addition to worker vehicles, service and delivery vehicles will access the site during the drilling phase including equipment trucks for all aspects of the effort. All drilling activities will be completed in compliance with the County Gas and Oil Well Improvement Plan approval.

Once the core samples are obtained and the remaining hole is plugged and abandoned per California Division of Oil Gas and Geothermal Resources (DOGGR) and Environmental Protection Agency (EPA) standards, the drilling equipment will be dismantled and demobilized from the site. Construction equipment similar to that used during well pad development will be used to remove the pad materials and return the site to near pre-project conditions. This includes spreading of any surface vegetation or roots stockpiled during site preparation. All removed material will be disposed of at suitable landfills or recycled consistent with county grading or other permit requirements. However, the property owner may elect to retain the pad for farm equipment staging and storage.

Well pad construction and improvements to access roads will occur over a two-week period commencing as early as October 2012. Drilling activities will occur virtually continuously for up to approximately six weeks. If elected to remove the well pad, restoration of the site will take up to two weeks.

Habitat and Affected Environment

The project area is situated in a landscape that currently supports active agricultural operations, an existing natural gas well site, and access roads. The project area is located within the “Delta Islands”. The Delta Islands are areas of former marshlands of the Sacramento–San Joaquin Delta that were historically reclaimed for agricultural use by the construction of levees/dikes and draining to enable farming.

Habitats within the areas surveyed (Figure 3 and Figure 4, Appendix A) include flood irrigated row crops, irrigation ditches, and ruderal herbaceous vegetation along the unnamed dirt access road to the Morais Well. Irrigated pastures, row crops, irrigation ditches, scattered ornamental trees, and fresh emergent wetland border segments of Guard Road (paved) leading to the unnamed dirt access road.

Fields around the well pad are planted in corn (*Zea mays*). Corn and safflower (*Carthamus tinctorius*) were planted in fields along the access roads. Some of the cornfields adjacent to the access roads in the project area were being flood irrigated during the August 20, 2012 field reconnaissance. All agricultural fields within the project area are disked and cropped on an annual rotation. All fields are actively farmed and regularly disked, harvested and/or disturbed to the edge of the existing access road. Ruderal vegetation along the perimeter of the well pad includes rip-gut brome (*Bromus diandrus*), Bermuda grass (*Cynodon dactylon*), black mustard (*Brassica nigra*), and knotweed (*Polygonum arenastrum*).

Irrigation ditches are maintained for irrigation purposes and are often mechanically and chemically cleared of vegetation. When vegetated, plants dominating these features include watergrass (*Echinochloa crus-galli*) in wetter areas to ruderal upland vegetation dominated by Bermuda grass and Johnson grass (*Sorghum halepense*). These features are only flooded during irrigation cycles, which are typically every two weeks.

The fresh emergent wetland occurring southeast of Guard Road is densely vegetated by bulrush (*Schoenoplectus acutus*). Fremont's cottonwood (*Populus fremontii*) and dense ruderal herbaceous understory dominated by poison hemlock (*Conium maculatum*) border the perimeter of the wetland.

Methods

The determination of the potential for the project area to support habitat for special-status species, waters of the United States, and other sensitive biological resources was established through desktop review and a field reconnaissance. The desktop review was completed using a series of database searches and a review of pertinent resources (Attachment 1). Special-status species[1] listed in the U.S. Fish and Wildlife (USFWS) species list for San Joaquin County and species reported in the CNDDB to occur within a 5-mile radius of the project area were considered in the evaluation (e.g., listed shrimp, valley elderberry longhorn beetle, giant garter snake) (Appendix B). Additionally, special-status species not included in the USFWS species list or CNDDB records were considered due to their known geographic range and/or the presence of potential habitat (e.g., white-tailed kite, loggerhead shrike, ringtail). Special-status species shown in the USFWS and CNDDB queries (Appendix B) that are not included in Table 1 lack habitat within the project area or the project area is not within the range of the species. These species are not analyzed further in this document.

Following completion of the field reconnaissance, an assessment of local, state, and federal permitting requirements was conducted to determine if the proposed project requires permits or authorizations from the local government or state and federal regulatory agencies. No local or state, permits addressing biological resources are anticipated to be required. Depending on final configuration of the proposed well pad expansions and access, authorization from the United States Army Corps of Engineers (Corps) may be required for discharge of fill into waters of the United States.

Special-Status Species and Potential Impacts

The fresh emergent wetland and irrigation ditches within the project area contains potentially suitable habitat for eleven special-status plant species including: watershield (*Brasenia schreberi*), bristly sedge (*Carex comosa*), woolly rose-mallow (*Hibiscus lasiocarpus* var. *occidentalis*), Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), Mason's lilaeopsis (*Lilaeopsis masonii*), Delta mudwort (*Limosella subulata*), eel-grass pondweed (*Potamogeton zosteriformis*), Sanford's arrowhead (*Sagittaria sanfordii*), marsh skullcap (*Scutellaria galericulata*), side-flowering skullcap (*Scutellaria lateriflora*), and Suisun marsh aster (*Symphyotrichum lentum*). The proposed project will not result in disturbance to the fresh emergent wetland and irrigation ditches. Therefore, the proposed project will not result in impacts on special-status plant species.

Special-status animal species that were determined to have the potential to occur in or near the project area, and that could be adversely affected by the proposed project, include giant garter snake (*Thamnophis gigas*), Swainson's hawk (*Buteo swainsoni*), white-tailed kite (*Elanus leucurus*), and loggerhead shrike (*Lanius ludovicianus*) (Table 1).

The fresh emergent wetland, irrigation ditches, and associated uplands within and near the project area provide potentially suitable habitat for giant garter snake (GGS). The CNDDB reports GGS occurrences from marsh habitat within Coldani Marsh approximately 0.4 mile east of the project. If GGS are present within the project area during the inactive season (i.e., October 1 to May 1), when work is anticipated to

[1] Special-status species: Listed, candidate, or proposed for listing as threatened or endangered under the Endangered Species Act, or California Endangered Species Act, California Native Plant Protection Act, California Species of Special Concern, and California Fully Protected Species. Special-status plants include California rare plant rank (RPR) 1A, 1B and 2.

occur, adverse impacts (e.g., injury or death) on GGS could result from vehicular traffic or ground disturbance associated with project activities.

The fresh emergent wetland along Guard Road provides high quality habitat for GGS (Figure 3); however, Guard Road is paved and no road improvements (i.e. addition of gravel or grading) that could have potential negative effects on inactive GGS are required to access the well pad. In addition, during the inactive period from October 1 to May 1(when work is scheduled), the likelihood of encountering GGS on the road is low since GGS are likely in burrows and are not as active on the surface; thus, no effects on GGS are expected to result from additional travel on Guard Road. However, if construction occurs during the GGS active period, the likelihood of encountering a snake along or within Guard Road greatly increases.

Irrigation ditches adjacent to the project area could provide dispersal habitat for juvenile GGS and the uplands in the project area may provide wintering habitat. However, these ditches are only flooded during irrigation cycles, which are typically every two weeks and water delivery is anticipated to end prior to the fall or winter harvest. These ditches are also maintained (e.g., vegetation removal and recontouring) to sufficiently deliver water to crops, which reduces the amount of emergent vegetation required for GGS escape cover and foraging habitat (Miller, Hornaday et al. 1999). These ditches do not support a prey base (e.g., amphibians or fish), which further reduces the likelihood GGS would occur in these ditches along dirt access roads and around the well pad area.

Burrows and other underground refuge are important to GGS during summer and winter to escape unfavorable winter cold temperatures or excessive summer heat. The GGS recovery plan states that wintering habitat can be up to 250 meters (820 feet) from the edge of marsh habitat (Miller, Hornaday et al. 1999). A fresh emergent wetland approximately 1,800 feet southeast of the Morais Well provides both aquatic and upland habitat for GGS. A series of irrigation ditches connects this fresh emergent wetland to the proposed well pad expansion area thus, irrigation ditches could provide dispersal habitat for juvenile GGS and the uplands in the project area may provide wintering habitat. Typically, the USFWS defines upland habitat as all areas occurring within 200 feet of aquatic habitat (White 1997). Following this guideline, the highest potential of adverse impacts on GGS is most likely to occur from project activities along the access roads since they are located within 200 feet of aquatic habitat and provide potential habitat for winter burrows. If burrows are located under the access roads that require improvement, burrows can collapse and snakes can become entombed.

Despite the presence of vegetated irrigation ditches that may support dispersal of GGS, these provide marginal to poor habitat. Based on landscape habitat use analysis of studies conducted by Wylie et al (Wylie, Graham et al. 1995; Wylie, Casazza et al. 1997; Wylie, Casazza et al. 2002; Wylie, Casazza et al. 2002) provided in the Solano Multispecies Habitat Conservation Plan (Solano HCP), low quality ditch habitat associated with rice fields provided an artificial marsh habitat that provides the essential components (e.g., appropriate cover, high food availability, and upland refuge) to support GGS. Alternatively, studies conducted in high quality marsh habitat surrounded by fallow fields did not locate GGS or found them at very low densities. Based on these results, areas supporting marginal to poor habitat or small, isolated patches of good habitat are presumed to not support GGS due to lack of surrounding aquatic habitat (Solano County Water Agency 2009). Within the project area, the surrounding aquatic habitat is of marginal to poor quality and thus, it is unlikely that GGS would use these for dispersal.

The upland habitat that the project area provides (i.e., upland habitat along access routes and within well pad expansion area) is also poor to marginal habitat for GGS. As part of existing agricultural activities,

potential upland habitat for GGS within and immediately around proposed project area are extensively disked, tilled and planted with row crops to the edge of the existing well pad and likely precludes occupation of burrowing mammals that would provide refugia for GGS Additionally, no burrows or other refugia were observed around the existing well pad, in the pad expansion area, or along the Morais well access road proposed for expansion, and no ground squirrel activity was observed during the field reconnaissance in these area. Based on the distance from high quality aquatic habitat (greater than 200 feet), poor quality dispersal habitat provided by the irrigation ditches (e.g., lack of perennial water, periodic clearing of vegetation), documented lack of use in non-rice agricultural lands, the lack of burrows or other refugia, and the lack of ground squirrel activity near the well pad expansion area, the irrigation ditches and the associated farmed upland provide low quality habitat and the likelihood for GGS to occur within the pad expansion area and portions of the access roads to be graded is very low. However, because of the proximity of a known population 0.4 miles east of the project and the availability of moderate to high quality marsh aquatic habitat 1,800 feet southeast of the proposed well pad expansion area, AMMS are provided to avoid potential impacts on GGS.

To minimize potential adverse effects on GGS during road improvement activities and well pad construction, a survey for burrows shall be conducted 24 hours prior to any modifications to access roads or well pad construction (i.e., grading compacting, or addition of gravels). If burrows are observed during the inactive period, they shall be flagged and grading or addition of gravel along the shoulder shall avoid all burrows. To minimize impacts during the active or inactive period, all vehicles will travel in the road center along all dirt or paved access roads at a speed limit of 10 mph or less.

Due to the aquatic habitat along Guard Road (Figure 3) and poor visibility while driving, if construction activities, occurs during the active period, a biological monitor will drive in front of heavy construction vehicles (i.e. dump trucks, drill rigs, etc.) on all dirt roads during entry/exit of project site. The biologist will lead vehicles at a maximum speed of 10 mph, watch for signs of snakes, and stop and investigate the road if there are any concerns. The preferred access road will be likely used; however, if the alternate route along King Island Road is used, all AMMs developed for dirt roads will be implemented.

Potential nesting habitat (e.g., trees, power poles/towers) for Swainson's hawk occurs within the project area and within 0.5 mile of the project area. Noise generated by expanding the pad, exploration drilling, site restoration, and other construction activities could adversely affect this species if active nests are located within 0.5 mile. Project implementation is expected to commence as early as October 2012 and extend for a total of four to six weeks, which is outside of the nesting season for these species. If project implementation is confined to this period, the proposed project will not result in adverse effects on this species. However, if work will occur during the nesting season (i.e., March 1–July 31), protocol-level surveys for Swainson's hawk will be required. If active nests are detected present within 0.5 mile of project activities, construction activity will stop immediately and will not resume until the PG&E Biologist or Land Planner contacts the USFWS and California Department of Fish and Game (CDFG) Biologist to discuss possible AMMs, which could include avoidance buffers, reconsidering access routes, and additional surveys.

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T/—	Elderberry shrubs associated with riparian forests which occur along rivers and streams.	None. No elderberry shrubs were observed within the project area.	None required
Delta smelt *Hypomesus transpacificus* **Critical habitat**	T/T	Estuarine systems in the Sacramento-San Joaquin Delta.	None. Irrigation ditches are intermittently flooded, often dry, and do not provide habitat for this species. The nearest CNDDB record is 3.1 miles west of the project area. Additionally, connectivity between the fresh emergent wetland along Guard Road and sloughs is fragmented through multiple levees joined by culverts, which reduces the likelihood for this species to occur. Traffic is common on Guard Road and access to the site will not require any modifications to Guard Road or its shoulders adjacent to the fresh emergent wetland, thus access to the project area would not affect this species.	None required
Sacramento splittail *Pogonichthys macrolepidotus*	—/SC	Shallow, dead-end sloughs with submerged vegetation.	None. Irrigation ditches are intermittently flooded, often dry, and do not provide habitat for this species. The nearest CNDDB record is 7.3 miles northwest of the project area. Additionally, connectivity between the fresh emergent wetland and sloughs is fragmented through multiple levees joined by culverts, which reduces the likelihood for this species to occur. Traffic is common on Guard Road and access to the site will not require any modifications to Guard Road or its shoulders adjacent to the fresh emergent wetland, thus access to the project area would not affect this species.	None required

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Longfin smelt *Spirinchus thaleichthys*	—/SC	Sloughs of Suisun Bay and Delta.	None. Irrigation ditches are intermittently flooded, often dry, and do not provide habitat for this species. Additionally, connectivity between the fresh emergent wetland and sloughs is fragmented through multiple levees joined by culverts, which reduces the likelihood for this species to occur. Traffic is common on Guard Road and access to the site will not require any modifications to Guard Road or its shoulders adjacent to the fresh emergent wetland, thus access to the project area would not affect this species.	None required
California red-legged frog *Rana draytonii*	T/SC	Require aquatic habitat for breeding, also uses a variety of other habitat types including riparian and upland areas. Adults prefer dense, shrubby or emergent vegetation associated with deep-water pools with fringes of cattails and dense stands of overhanging vegetation. This species also breeds in ephemeral ponds that support little or no vegetation.	None . This species is outside the current known range (CWHR) and there are no occurrences within 5 miles of the project area. Additionally, the San Joaquin County Multispecies Habitat Conservation and Open Space Plan (SJMHCP) concludes that CRLF is extirpated from the valley floor (San Joaquin County 2000). This species is not expected to occur in the project area.	None required.

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Giant garter snake *Thamnophis gigas*	T/T	Freshwater marshes and low gradient streams with emergent vegetation. Adapted to drainage canals and irrigation ditches with mud substrate.	Very Low. An extant population of giant garter snake (GGS) occurs within the Coldani Marsh area approximately 0.4 mile to the east of the project area. The fresh emergent wetland approximately 1,800 feet southeast of the Morais Well provides both aquatic and upland habitat for GGS.GGS may occur in the irrigation ditches adjacent to the Morais well pad, however, these features appeared to be heavily managed (e.g., regularly clearing of vegetation and recontouring) and it is expected that potential GGS occupancy would not be sustainable and likely limited to dispersal. Burrows are absent from the upland habitat further reducing potential for occupancy.	Pre construction surveys Biological monitor Water quality BMPs
Western pond turtle *Emys marmorata*	—/SC	Slow water aquatic habitat with available basking sites. Hatchlings require shallow water with dense submergent or short emergent vegetation. Requires an upland oviposition site near the aquatic site.	None. The fresh emergent wetland along Guard Road may provide aquatic habitat for this species. Traffic is common on Guard Road and access to the site will not require any modifications to Guard Road or its shoulders adjacent to the fresh emergent wetland, thus access to the project area would not affect this species.	None required.
California black rail *Laterallus jamaicensis coturniculus*	—/T, FP	Coastal and inland marsh habitat.	None. The fresh emergent wetland adjacent to Guard Road provides breeding and foraging habitat for this species. Traffic is common on Guard Road and access to the site will not require any modifications to Guard Road or its shoulders adjacent to the fresh emergent wetland, thus access to the project area would not affect this species.	None required

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Swainson's hawk *Buteo swainsoni*	—/T	Breeds in stands with few trees in juniper-sage flats, riparian areas, and oak savannah; forages in adjacent livestock pasture, grassland or grain fields.	Moderate. Larger trees and stands of trees occurring within 0.5 mile of the project area provide potential nesting habitat for Swainson's hawk. There are fourteen recorded CNDDB occurrences of nesting Swainson's hawk within 5 miles of the project area with the nearest occurring 2 miles northeast. Noise generated by project activities could disrupt nesting behavior and nest success if Swainson's hawks are nesting within 0.5 mile of the project area.	If work is expected to occur during nesting season (March 1 to July 31), Swainson's hawk nesting surveys will be performed following CDFG protocol developed by the Swainson's Hawk Technical Advisory Committee.
White-tailed kite *Elanus leucurus*	—/FP	Nests in tall shrubs and trees, forages in grasslands, agricultural fields and marshes.	Moderate. Isolated trees and shrubs near proposed access roads and existing farm facilities provide potential nesting habitat for this species. The nearest CNDDB record is 2.7 miles southeast of the project area.	Nesting bird surveys required within the breeding season (February 15-August 31).
Loggerhead shrike *Lanius ludovicianus*	—/SC	Nests in tall shrubs and dense trees, forages in grasslands, marshes, and ruderal habitats.	Low. Isolated trees and shrubs near proposed access roads and existing farm facilities provide potential nesting habitat for this species.	Nesting bird surveys required within the breeding season (February 15-August 31).

[1]Status Codes: : Federal and State Codes: T = Threatened; SC = Species of Special Concern (State), FP = Fully Protected (State)

Cornfields border all sides of the proposed well pad and provide potential foraging habitat for Swainson's hawks. These fields were actively growing during the August 20, 2012 field visit and are anticipated to be harvested in late fall/early winter. CDFG Swainson's hawk guidelines (California Department of Fish and Game 1994) were considered in assessing impacts on the loss of foraging habitat for Swainson's hawk and although fallow cornfields are listed as potential foraging habitat, the fields around the well pad are largely inaccessible during the breeding season and would lie fallow after most Swainson's hawks have migrated south. These fields provide limited foraging opportunities and the conversion of approximately 0.5 acre of corn would have no significant affects on Swainson's hawk foraging habitat.

Nesting habitat for loggerhead shrike and white-tailed kite occur in the trees and shrubs adjacent to Guard Road within the project area. As with the Swainson's hawk, construction activities could have adverse impacts on nesting success for these species depending on the timing of the work. Disturbance to vegetation and removal of existing crops for well pad expansion should be conducted outside of the nesting season (i.e., between August 31-February 15) in order to avoid potential effects on nesting birds. If work is to occur during the nesting season for these species (February 15–August 31), nesting bird surveys will occur 72 hours prior to the start of construction to determine if birds are nesting in the area. If nesting birds are found PG&E will halt work and consult with CDFG and USFWS to establish AMM's to protect nest (i.e. establish buffers).

Waters of the United States and Potential Impacts

An assessment for potential waters of the United States was conducted during the August 20, 2012 field reconnaissance. Two irrigation ditches were observed at the East Island Morais Well pad site. A primary vegetated irrigation ditch (primary ditch) flows from south to north, paralleling the west side of the existing ranch road (Figure 4, Appendix A). This ditch flows through a culvert under the junction of the ranch road with the Morais Well access road. A second vegetated irrigation ditch (secondary ditch) flows from east to west from the primary ditch. This ditch parallels the southern boundary of the Morais Well pad access road before turning north and terminating in the northwest corner of the existing well pad.

The primary irrigation ditch was recently recontoured and largely cleared of vegetation, however, watergrass (a hydrophytic plant) was observed re-colonizing the ditch and was the dominant species bordering this feature. The secondary irrigation ditch supported a prevalence of hydrophytic vegetation (monotypic stand of watergrass); however, this feature appeared to have been regularly flood irrigated at intervals and was in the process of being irrigated at the time of the field reconnaissance. Irrigation ditches adjacent to the access road within the project area were also observed to support a prevalence of hydrophytic vegetation; many of these features contained flowing or ponded water and are a primary conveyance for irrigation or tail water within and near the project area. The ditches within the project area are part of an extensive irrigation system that drains into or are adjacent (separated by a berm) to White Slough, which qualifies as waters of the United States. Water is generally pumped in or out of White Slough depending on need to irrigate farmland or to pump out water to keep the area from flooding. Given that the irrigation ditches support hydrophytic vegetation, are subject to extended inundation and/or saturation, and are tributary to waters of the United States, the features are considered as potential waters of the United States. A discharge of fill is not anticipated at this time and no potential waters of the United States would be directly impacted. If a discharge of fill is required (e.g., to replace a culvert), authorization to discharge fill into a waters of the United States from the Corps may be required. AMMs have been incorporated into the proposed project to avoid the potential for indirect impacts on waters of the United States.

Although the USFWS National Wetlands Inventory identifies the entire project area as farmed wetlands, the existing access roads, the existing well pad, and the proposed well pad expansion areas (excluding the irrigation ditches) do not appear to currently meet wetland criteria. The existing access roads and the

existing well pad consist of compacted surfaces that are graded and unvegetated; and do not exhibit evidence of long-duration ponding or saturation, or exhibit other indications of wetland hydrology. The proposed well pad expansion areas currently support a leveled and routinely disked agricultural field that is planted with corn. Field inspection of this area did not identify the presence of hydrophytic vegetation or evidence of soil inundation/saturation unrelated to routine irrigation. Based on observation of the water level in an unnamed irrigation canal approximately 0.4 miles north of the existing well pad, the surface of the agricultural field appeared to be at least 3 feet above the water table at the time of the field inspection. Given the lack of hydrophytic vegetation and an absence of indications of a current wetland hydrology, the existing access roads, the existing well pad, and the proposed well pad expansion areas above the existing irrigation ditches are not considered to qualify as potential waters of the United States.

It is important to note that the field assessment did not involve a formal delineation using the Corps methodology and no detailed investigations for wetland hydrology were conducted. The entire project area was historically Sacramento–San Joaquin Delta marshland prior to dikes/draining and conversion to agricultural production. Areas of agricultural production that were formerly wetlands may still qualify as jurisdictional wetlands if hydrological characteristics remain to the extent that hydrophytic vegetation would return if the agricultural activities ceased. The determinations provided in this document concerning wetland hydrology are based on a single visual assessment conducted on August 20, 2012. Definitive documentation of the status of wetland hydrology generally cannot be provided by a single visual assessment during the dry season. Therefore, all determinations provided in this document concerning waters of the United States should be considered preliminary and tentative unless verified in writing by the Corps.

Other Sensitive Biological Resources

Migratory birds and raptors (i.e., birds of prey) protected under the federal Migratory Bird Treaty Act and the California Department of Fish and Game Code may nest on open ground, vegetation, or structures within the project area. Construction activities could have adverse impacts on nesting success for birds nesting near the construction site. If disturbance to vegetation and removal of existing crops for well pad expansion is conducted outside of the nesting season, then no impacts to nesting birds are expected to result from well pad expansion activities. If work is to occur during the nesting season for these species (February 15–August 31), nesting bird surveys will be occur 72 hours prior to the start of construction required to determine if birds are nesting in the area.If nesting birds are found PG&E will halt work and consult with CDFG and USFWS to establish AMM's to protect nest (i.e. establish buffers).

Avoidance and Minimization Measures (22 total):

1. Prior to working on-site, all workers shall be provided with Environmental Awareness Training by a qualified biologist approved by USFWS and CDFG. The training shall address the identification and general ecology of GGS Swainson's hawk, nesting birds and other special-status species that have potential to occur in the project area, and the AMMS to be implemented in order to avoid impacts on these resources. Areas to be avoided shall also be addressed in the training. Please contact project biologist, Catalina Reyes (925-808-8811) two weeks prior to construction to schedule the training.

2. Prior to construction, all work areas (e.g., vehicle access, parking, staging) needed to complete the project shall be identified in coordination with the on-site biologist. Due to the presence of sensitive resources, some work areas may need to be adjusted. All work areas shall be limited to the minimum area necessary to complete work.

3. If practicable, ground disturbing activity (e.g. vegetation removal, compaction, and placement of gravel fill) at all the well pad site shall be conducted during the active season for giant garter snake (GGS) (i.e., between May 1 and October 1). If ground-disturbing activity cannot be conducted during the GGS active season, preconstruction surveys for potential GGS wintering sites (i.e., burrows and soils crevices) shall be conducted within two weeks by a qualified biologist approved by USFWS and CDFG to determine the if potential GGS habitat is present within proposed areas of ground disturbing activity (e.g., the well pad expansion site, road work, application of gravel) and again within 24 hours prior to ground disturbing activity).

4. All burrows or potential refuge habitat shall be flagged and avoided. If work is suspended for a period of five days or greater, then the project area must be resurveyed. If it is determined that potential GGS wintering habitat (e.g., burrows and crevices) is present within areas planned for ground disturbance, ground-disturbing activities shall be postponed until the GGS active season (i.e., between May 1 and October 1). If GGS is encountered at any time during the project, work will stop immediately and the USFWS and CDFG will be contacted before work proceeds.

5. A biological monitor shall be on site during all phases of construction to direct access and construction work around irrigation ditches and other sensitive habitats capable of supporting GGS. If any GGS are observed within the project area during work activities, work shall cease and the on-site project manager shall immediately contact the project biologist, Catalina Reyes (925-808-8811) prior to resuming work. The biological monitor has the authority to stop construction to resolve any biological concerns.

6. Access to well pads shall be confined to existing roads, road shoulders, and other compacted areas. Travel along roads shall be restricted to the centerline. If placement of gravel on access roads is necessary, the placement shall be limited to the existing road surface. No gravels shall be placed ditch banks or other areas that may support burrows that could be used by GGS. No grading shall occur along segments of existing roads that may support burrows that could be used by GGS.

7. The fresh emergent marsh and irrigation ditches will be designated as environmentally sensitive areas and physical disturbance to these features will be avoided during construction.

8. If deemed necessary, an exclusionary fence shall be erected to protect potentially sensitive habitat adjacent to the existing well pad. To ensure that GGS does not become trapped or entangled, no wattles with plastic monofilament netting are permitted. Burlap or coconut wattles are appropriate substitutes.

9. A qualified biologist approved by USFWS and CDFG shall perform a general pre-construction survey within 72 hours of the start of project construction.

10. Provide escape ramps at a 45 degree angle or less for any excavations that are greater than one foot that are left open overnight. For smaller holes, cover so that no gaps occur and inspect each morning for wildlife. Inspect prior to filling any trenches or holes. If special-status wildlife becomes entrapped, work shall stop and the PG&E project biologist, Catalina Reyes, shall be notified immediately to determine next steps.

11. All construction personnel shall visually check for snakes and other wildlife under vehicles and equipment prior to moving them.

12. Construction equipment will be maintained to prevent leaks of fuels, lubricants or other pollutants into aquatic habitats.

13. Whenever possible, refueling and maintenance of vehicles shall occur offsite. In cases when this is not possible, refueling and maintenance of vehicles and equipment will be conducted over drip pans and at least 100 feet from any waterway.

14. Open ends of pipes, conduits or other materials stored onsite will be covered to exclude wildlife and will be inspected prior to use.

15. Vehicular speed within the project area shall be limited to 10 miles per hour in order avoid impacts on wildlife that may be located on or near roadways. If construction activities, including addition of gravel, occurs during the active period, a biological monitor will drive in front of heavy construction vehicles (i.e. dump trucks, drill rigs, etc.) on all dirt roads during entry/exit of project site. Biologist will lead vehicles at a minimum speed of 10 mph, watch for signs of snakes, and stop and investigate the road if there are any concerns.

16. Watering of roads during dry season work shall be performed as necessary (approximately 3–4 times a day) in order to reduce potential dust resulting from project associated traffic.

17. All potential nesting substrate (e.g., shrubs and trees) that requires removal to construct the project should be removed before the onset of the nesting season (i.e., prior to February 15), if feasible. This will help preclude nesting and substantially decrease the likelihood of direct impacts on nesting birds. If this is not feasible then a nesting bird survey of potential nesting substrate will be performed 72 hours prior to its removal.

18. Surveys for nesting raptors and migratory birds (including Swainson's hawk) shall be required if project construction is to occur during the nesting season (February 15–August 31; March 1-July 31 for Swainson's hawk). Surveys shall be conducted by a qualified biologist approved by USFWS and CDFG .

    Surveys for Swainson's hawk shall follow the California Department of Fish and Game protocol developed by the Swainson's Hawk Technical Advisory Committee (Appendix C).

    Surveys for other nesting birds will consist of performing an initial survey after February 15, 2013 or within a month of the start of project date if project is to begin later in the nesting bird season. A second nesting bird survey shall be performed within 72 hours of the start of construction. The surveys shall be repeated if work is suspended for five days or more. Please contact project biologist, Catalina Reyes (925-808-8811) 2 weeks prior to construction schedule surveys.

19. Caution shall be used when handling and/or storing chemicals (fuel, hydraulic fluid, etc.). As part of standard PG&E Best Management Practices (BMPs) crews shall have appropriate materials shall be on site to provide secondary containment and prevent and manage spills. If groundwater is encountered, contact PG&E Environmental Specialist Bryon Nicholson (415-990-0139).

20. Crews shall implement all standard PG&E BMPs outlined in the Good Housekeeping Activity Specific Erosion and Sediment Control Plan (January 2011) as needed.

21. If the scope of work or project location changes, contact project biologist Catalina Reyes (925-808-8811) prior to commencing work. The project biologist or Land Planner (Ernie Ralston, 515-973-3215) will contact the USFWS Bay-Delta Fish & Wildlife Office ESA/Regulatory Division and the Dept. of Fish & Game-Bay Delta Region upon notice of any such changes.

22. Remove construction related trash from the site daily and upon work completion and return site to near pre-construction contours and conditions upon project completion.

Attachment 1. Desktop Review Results

Source	Results
County	San Joaquin
USGS Quadrangle	Terminous, California (Unsectioned Area of the Empire Tract)
Aerial Photographs – Google Earth 2012 & Bing Aerial Imagery 2012	Primarily row crops, ditches and potential emergent or other wetlands present.
Land Ownership California Protected Areas Database (CPAD)	None. Private Ownership.
USFWS official list	Attached.
Federally Designated Critical Habitat (within 5-mile radius)	Within Delta Smelt Critical Habitat and approximately 1-mile north of steelhead critical habitat.
CNDDB-5-mile radius	Attached.
CNDDB owl viewer	Not within range of Spotted Owl.
CNPS-9 quad search	Attached.
PG&E Raptor Concentration Zones (RCZ)	Within RCZ.
National Audubon Society Important Bird Areas (IBA)	Within Sacramento-San Joaquin IBA.
U.S. Department of Agriculture (USDA) Web Soil Survey	Project area entirely within guard clay loam, poorly drained.
USFWS National Wetlands Inventory	Entire project area included within farmed wetlands (Pf) in USFWS NWI with scatter fringes of freshwater emergent marsh (PEM) near access roads.
PG&E San Joaquin HCP or other HCPs, NCCPs	Within PG&E San Joaquin HCP.
Known Swainson's Hawk, golden or bald eagle nest sites	CNDDB Swainson's hawk nesting record within 5 miles of project area. Nearest CNDDB occurrence is 2 miles northeast of the project area. No golden or bald eagle occurrences within 5 miles.
PG&E VELB Conservation Program Range	Within PG&E VELB Conservation Program Range.
CWHR (California Wildlife Habitat Relations) species.	CWHR was reviewed to identify other species that habitat is present and within range (e.g., white-tailed kite, ringtail).

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Photograph 1. View west from paved Guard Road onto unnamed dirt access road.



Photograph 2. Fresh emergent wetland adjacent to Guard Road.



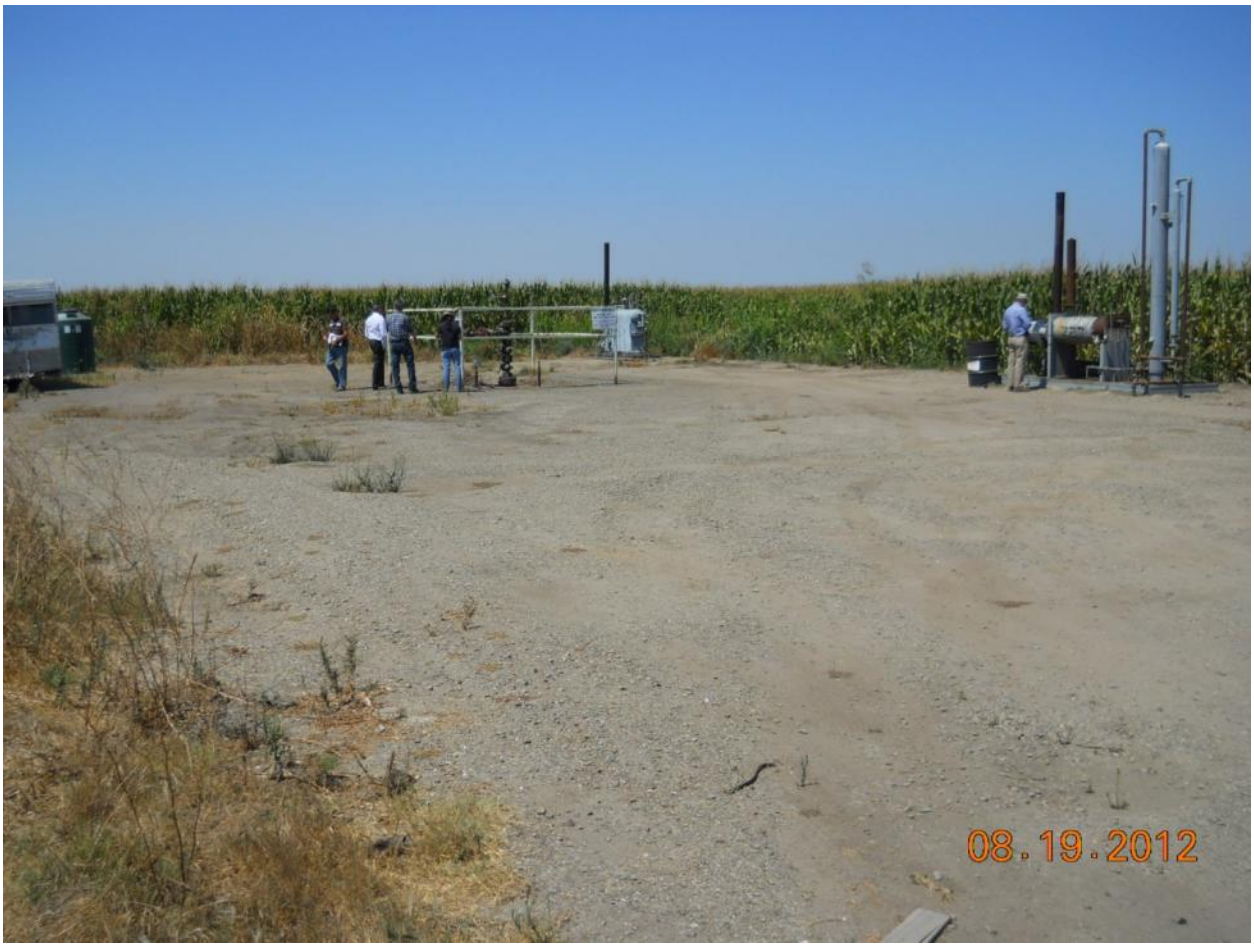
Photograph 4. View south at the junction of the unnamed dirt access road and entrance to the East Island Morais well pad showing the primary irrigation ditch running south-north along the west side of the unnamed dirt access road .



Photograph 5. Primary irrigation ditch running south-north along the west side of the unnamed dirt access road at the intersection to the access road for Morais Well.



Photograph 6. Secondary irrigation ditch running east-west along the south side of the access road leading to the East Island Morais Well pad.



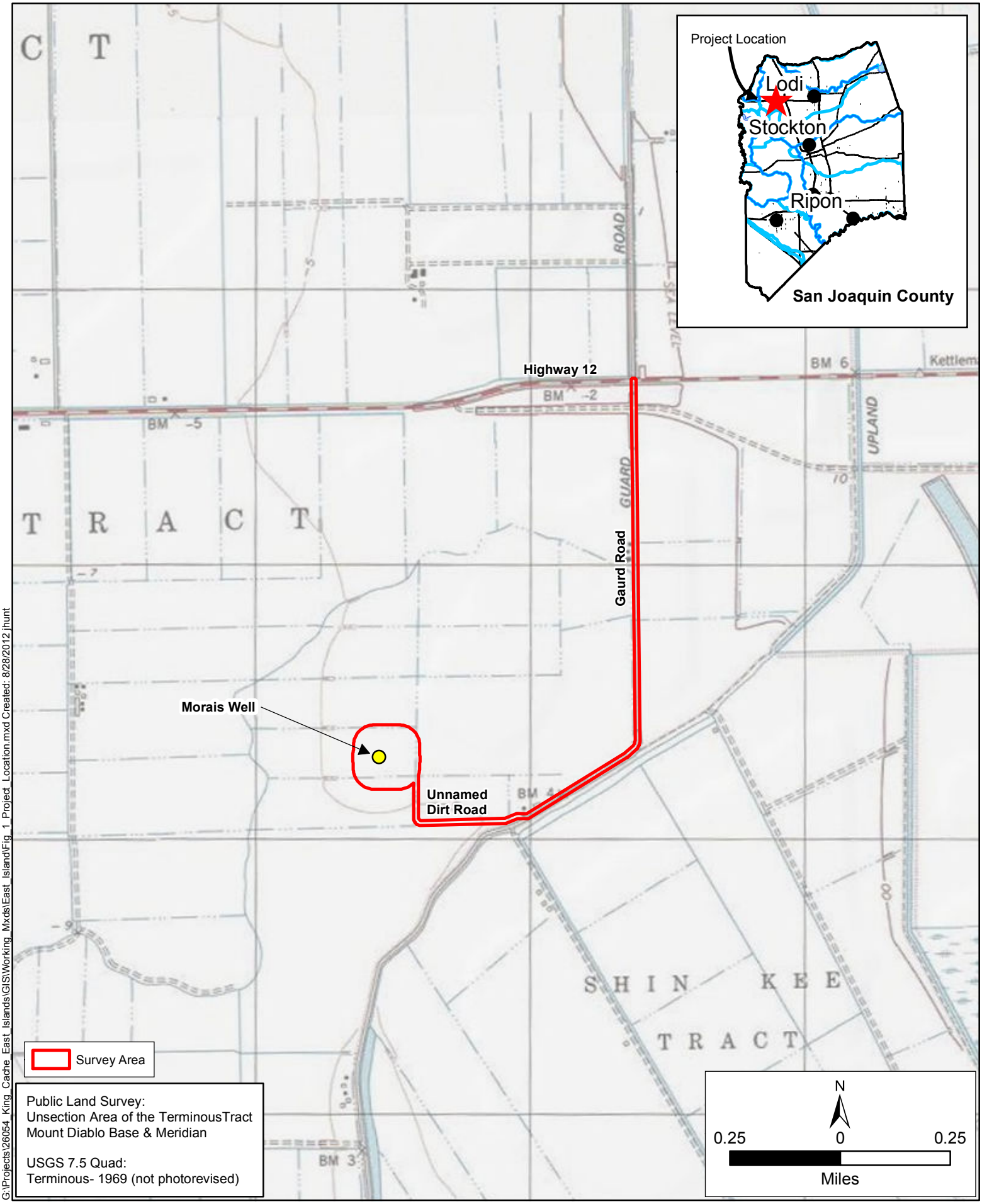
Photograph 7. The existing well pad consists of packed dirt and gravels.



Photograph 9. View northwest toward proposed expansion area from existing East Island Morais well pad. Existing fields were previously disked and farmed to the north edge of the existing well pad and well pad access road with no intervening vegetation.

APPENDIX A

Figures



North State Resources, Inc.

East Island, San Joaquin County, California

Figure 1. Project Location and Vicinity Map



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North State Resources, Inc.

East Island, San Joaquin County, California

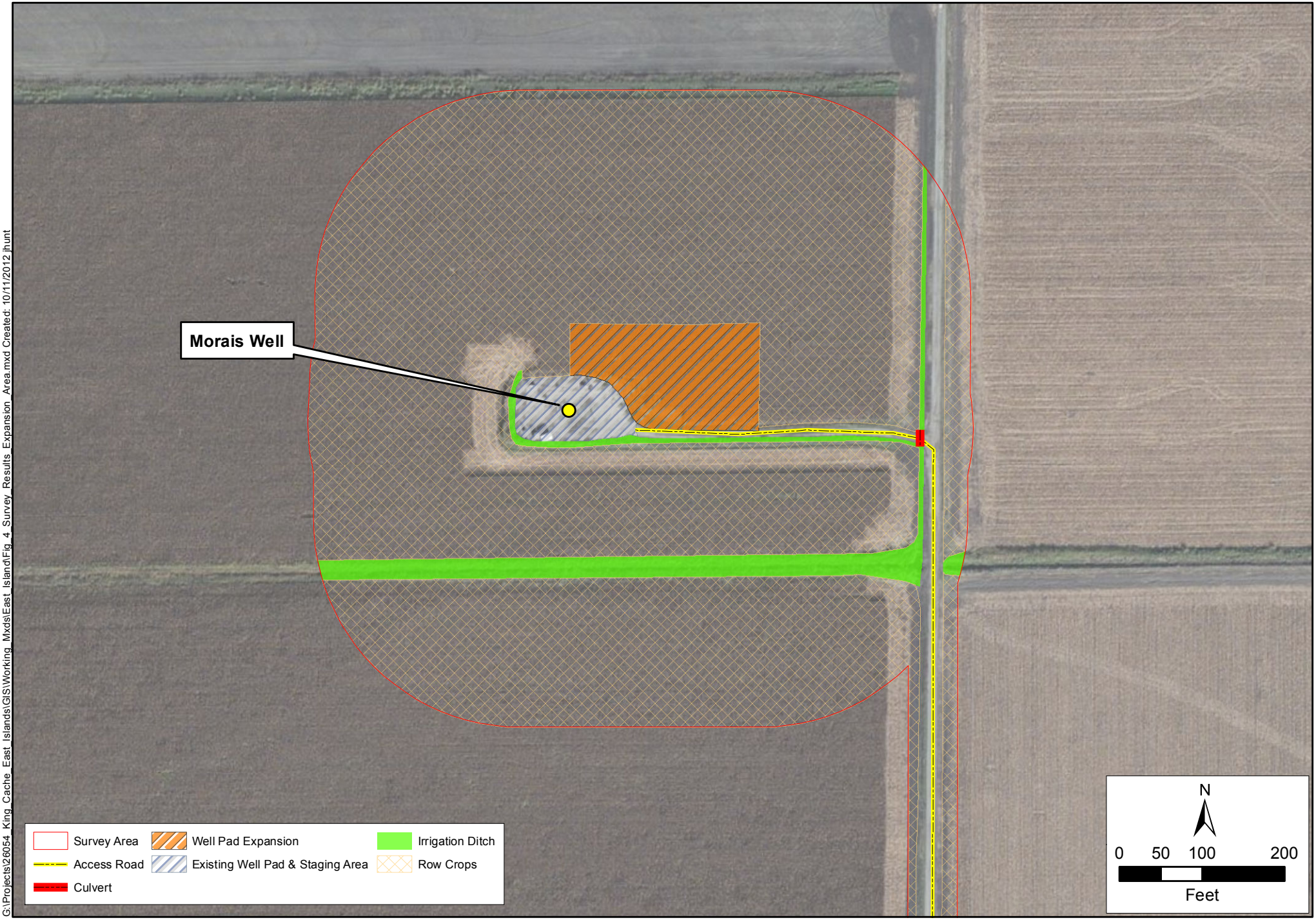
Figure 2. Project Area



East Island, San Joaquin County, California

North State Resources, Inc.

Figure 3. Survey Results



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East Island, San Joaquin County, California

North State Resources, Inc.

Figure 4. Survey Results - Well Pad Expansion Area

APPENDIX B

USFWS, CNDDB, and CNPS Queries

U.S. Fish & Wildlife Service

Sacramento Fish & Wildlife Office

Federal Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 120816041228

Database Last Updated: September 18, 2011

Quad Lists

Listed Species

Invertebrates

Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Lepidurus packardi
vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
Critical habitat, delta smelt (X)
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)

Rana draytonii
California red-legged frog (T)

Reptiles

Thamnophis gigas
giant garter snake (T)

Mammals

Sylvilagus bachmani riparius
riparian brush rabbit (E)

Quads Containing Listed, Proposed or Candidate Species:

TERMINOUS (479C)

County Lists

San Joaquin County

Listed Species

Invertebrates

Branchinecta conservatio
Conservancy fairy shrimp (E)
Critical habitat, Conservancy fairy shrimp (X)

Branchinecta longiantenna
longhorn fairy shrimp (E)

Branchinecta lynchi
Critical habitat, vernal pool fairy shrimp (X)
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Elaphrus viridis
delta green ground beetle (T)

Lepidurus packardi
Critical habitat, vernal pool tadpole shrimp (X)
vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
Critical habitat, delta smelt (X)
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
Critical habitat, winter-run chinook salmon (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)
Critical habitat, CA tiger salamander, central population (X)

Rana draytonii
California red-legged frog (T)
Critical habitat, California red-legged frog (X)

Reptiles

Masticophis lateralis euryxanthus
Alameda whipsnake [=striped racer] (T)

Critical habitat, Alameda whipsnake (X)

Thamnophis gigas
giant garter snake (T)

Birds

Rallus longirostris obsoletus
California clapper rail (E)

Vireo bellii pusillus
Least Bell's vireo (E)

Mammals

Neotoma fuscipes riparia
riparian (San Joaquin Valley) woodrat (E)

Sylvilagus bachmani riparius
riparian brush rabbit (E)

Vulpes macrotis mutica
San Joaquin kit fox (E)

Plants

Amsinckia grandiflora
Critical habitat, large-flowered fiddleneck (X)
large-flowered fiddleneck (E)

Arctostaphylos myrtifolia
Ione manzanita (T)

Castilleja campestris ssp. succulenta
Critical habitat, succulent (=fleshy) owl's-clover (X)
succulent (=fleshy) owl's-clover (T)

Cordylanthus palmatus
palmate-bracted bird's-beak (E)

Lasthenia conjugens
Critical habitat, Contra Costa goldfields (X)

Orcuttia viscida
Critical habitat, Sacramento Orcutt grass (X)
Sacramento Orcutt grass (E)

Tuctoria greenei
Greene's tuctoria (=Orcutt grass) (E)

Candidate Species

Birds

Coccyzus americanus occidentalis
Western yellow-billed cuckoo (C)

Key:

(E) *Endangered* - Listed as being in danger of extinction.
(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.
(P) *Proposed* - Officially proposed in the Federal Register for listing as endangered or threatened.
(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.
(C) *Candidate* - Candidate to become a proposed species.
(V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.
(X) *Critical Habitat* designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, **or may be affected by** projects within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list. See our Protocol and Recovery Permits pages.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.

  During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.

- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.

  Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our Map Room page.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6520.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be November 14, 2012.

Count of CNAME						
SNAME	**CNAME**	**FEDLIST**	**CALLIST**	**RPLANTRANK**	**SRANK**	**Total**
Brasenia schreberi	**watershield**	None	**None**	2.3	S2	1
Buteo swainsoni	**Swainson's hawk**	None	**Threatened**	(blank)	S2	18
Coastal and Valley Freshwater Marsh	**Coastal and Valley Freshwater Marsh**	None	**None**	(blank)	S2.1	3
Elanus leucurus	**white-tailed kite**	None	**None**	(blank)	S3	1
Emys marmorata	**western pond turtle**	None	**None**	(blank)	S3	14
Hibiscus lasiocarpos var. occidentalis	**woolly rose-mallow**	None	**None**	1B.2	S2.2	17
Hypomesus transpacificus	**Delta smelt**	Threatened	**Endangered**	(blank)	S1	3
Laterallus jamaicensis coturniculus	**California black rail**	None	**Threatened**	(blank)	S1	3
Lathyrus jepsonii var. jepsonii	**Delta tule pea**	None	**None**	1B.2	S2.2	2
Lepidurus packardi	**vernal pool tadpole shrimp**	Endangered	**None**	(blank)	S2S3	1
Lilaeopsis masonii	**Mason's lilaeopsis**	None	**Rare**	1B.1	S2	10
Limosella subulata	**Delta mudwort**	None	**None**	2.1	S2.1	3
Scutellaria lateriflora	**side-flowering skullcap**	None	**None**	2.2	S1	2
Symphyotrichum lentum	**Suisun Marsh aster**	None	**None**	1B.2	S2	10
Thamnophis gigas	**giant garter snake**	Threatened	**Threatened**	(blank)	S2S3	3
Valley Oak Woodland	**Valley Oak Woodland**	None	**None**	(blank)	S2.1	1
Grand Total						**92**

CNPS Inventory of Rare and Endangered Plants

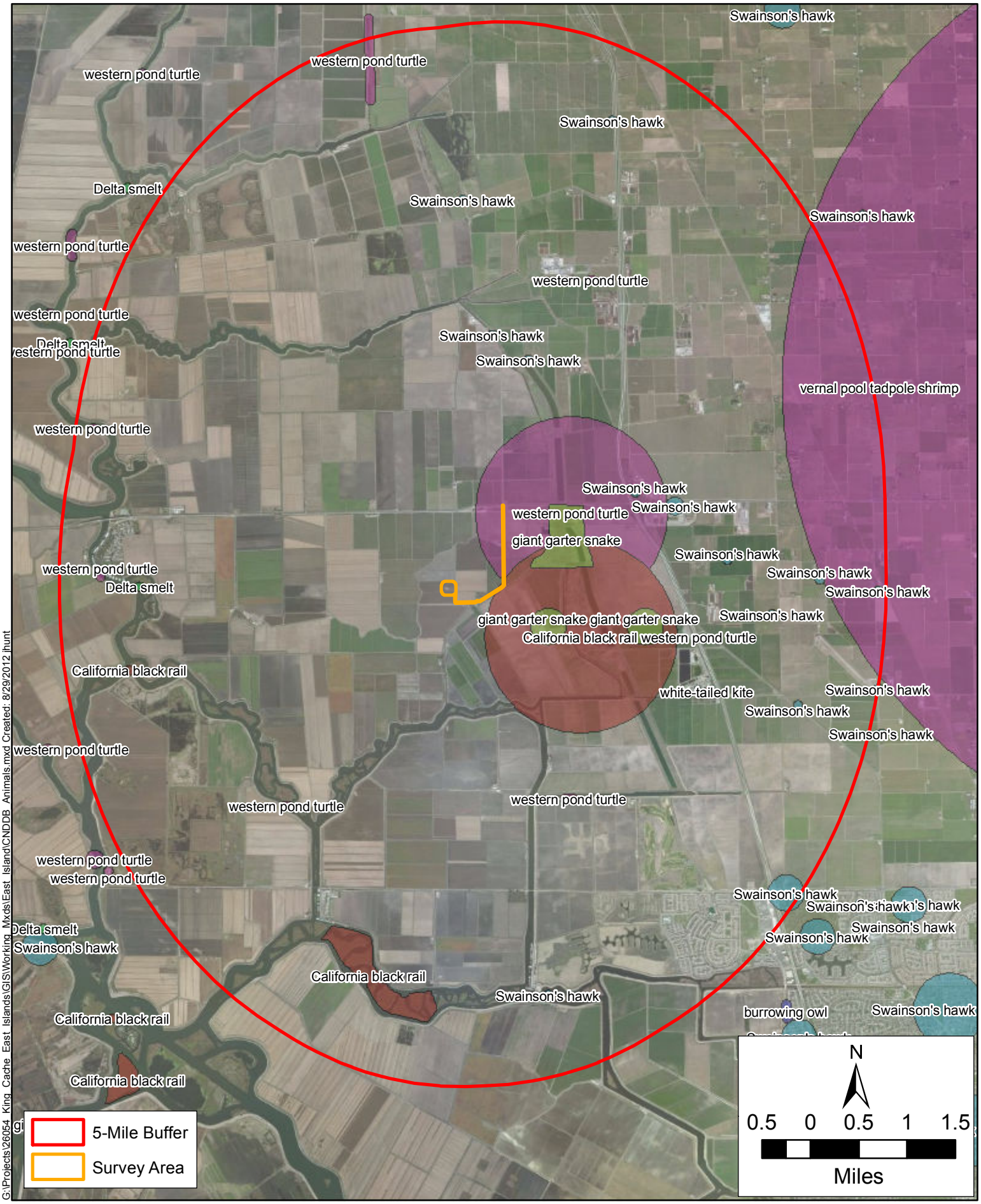
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Reformat list as: Standard List - with Plant Press controls

ECOLOGICAL REPORT

scientific	family	life form	blooming	communities	elevation	CNPS
Astragalus tener var. tener	Fabaceae	annual herb	Mar-Jun	•Playas (Plyas) •Valley and foothill grassland (VFGrs)(adobe clay) •Vernal pools (VnPls)/alkaline	1 - 60 meters	List 1B.2
Atriplex cordulata var. cordulata	Chenopodiaceae	annual herb	Apr-Oct	•Chenopod scrub (ChScr) •Meadows and seeps (Medws) •Valley and foothill grassland (VFGrs)(sandy)/saline or alkaline	0 - 560 meters	List 1B.2
Atriplex joaquinana	Chenopodiaceae	annual herb	Apr-Oct	•Chenopod scrub (ChScr) •Meadows and seeps (Medws) •Playas (Plyas) •Valley and foothill grassland (VFGrs)/alkaline	1 - 835 meters	List 1B.2
Blepharizonia plumosa	Asteraceae	annual herb	Jul-Oct	•Valley and foothill grassland (VFGrs)/Usually clay.	30 - 505 meters	List 1B.1
Brasenia schreberi	Cabombaceae	perennial rhizomatous herb aquatic	Jun-Sep	•Marshes and swamps (MshSw)/freshwater	30 - 2200 meters	List 2.3
California macrophylla	Geraniaceae	annual herb	Mar-May	•Cismontane woodland (CmWld) •Valley and foothill grassland (VFGrs)/clay	15 - 1200 meters	List 1B.1
Carex comosa	Cyperaceae	perennial rhizomatous herb	May-Sep	•Coastal prairie (CoPrr) •Marshes and swamps (MshSw)(lake margins) •Valley and foothill grassland (VFGrs)	0 - 625 meters	List 2.1
Chloropyron palmatum	Orobanchaceae	annual herb hemiparasitic	May-Oct	•Chenopod scrub (ChScr) •Valley and foothill grassland (VFGrs)/alkaline	5 - 155 meters	List 1B.1
Eryngium	Apiaceae	annual/perennial		•Riparian scrub (RpScr)	3 - 30	List

racemosum		herb	Jun-Oct	(vernally mesic clay depressions)	meters	1B.1
Hibiscus lasiocarpos var. occidentalis	Malvaceae	perennial rhizomatous herb emergent	Jun-Sep	•Marshes and swamps (MshSw)(freshwater)	0 - 120 meters	List 1B.2
Juglans hindsii	Juglandaceae	perennial deciduous tree	Apr-May	•Riparian forest (RpFrs) •Riparian woodland (RpWld)	0 - 440 meters	List 1B.1
Lathyrus jepsonii var. jepsonii	Fabaceae	perennial herb	May-Jul(Sep), Months in parentheses are uncommon.	•Marshes and swamps (MshSw)(freshwater and brackish)	0 - 4 meters	List 1B.2
Legenere limosa	Campanulaceae	annual herb	Apr-Jun	•Vernal pools (VnPls)	1 - 880 meters	List 1B.1
Lilaeopsis masonii	Apiaceae	perennial rhizomatous herb	Apr-Nov	•Marshes and swamps (MshSw)(brackish or freshwater) •Riparian scrub (RpScr)	0 - 10 meters	List 1B.1
Limosella subulata	Scrophulariaceae	perennial stoloniferous herb	May-Aug	•Marshes and swamps (MshSw)	0 - 3 meters	List 2.1
Potamogeton zosteriformis	Potamogetonaceae	annual herb aquatic	Jun-Jul	•Marshes and swamps (MshSw)(assorted freshwater)	0 - 1860 meters	List 2.2
Sagittaria sanfordii	Alismataceae	perennial rhizomatous herb emergent	May-Oct	•Marshes and swamps (MshSw)(assorted shallow freshwater)	0 - 650 meters	List 1B.2
Scutellaria galericulata	Lamiaceae	perennial rhizomatous herb	Jun-Sep	•Lower montane coniferous forest (LCFrs) •Meadows and seeps (Medws) (mesic) •Marshes and swamps (MshSw)	0 - 2100 meters	List 2.2
Scutellaria lateriflora	Lamiaceae	perennial rhizomatous herb	Jul-Sep	•Meadows and seeps (Medws) (mesic) •Marshes and swamps (MshSw)	0 - 500 meters	List 2.2
Symphyotrichum lentum	Asteraceae	perennial rhizomatous herb	May-Nov	•Marshes and swamps (MshSw)(brackish and freshwater)	0 - 3 meters	List 1B.2
Tropidocarpum capparideum	Brassicaceae	annual herb	Mar-Apr	•Valley and foothill grassland (VFGrs)(alkaline hills)	1 - 455 meters	List 1B.1

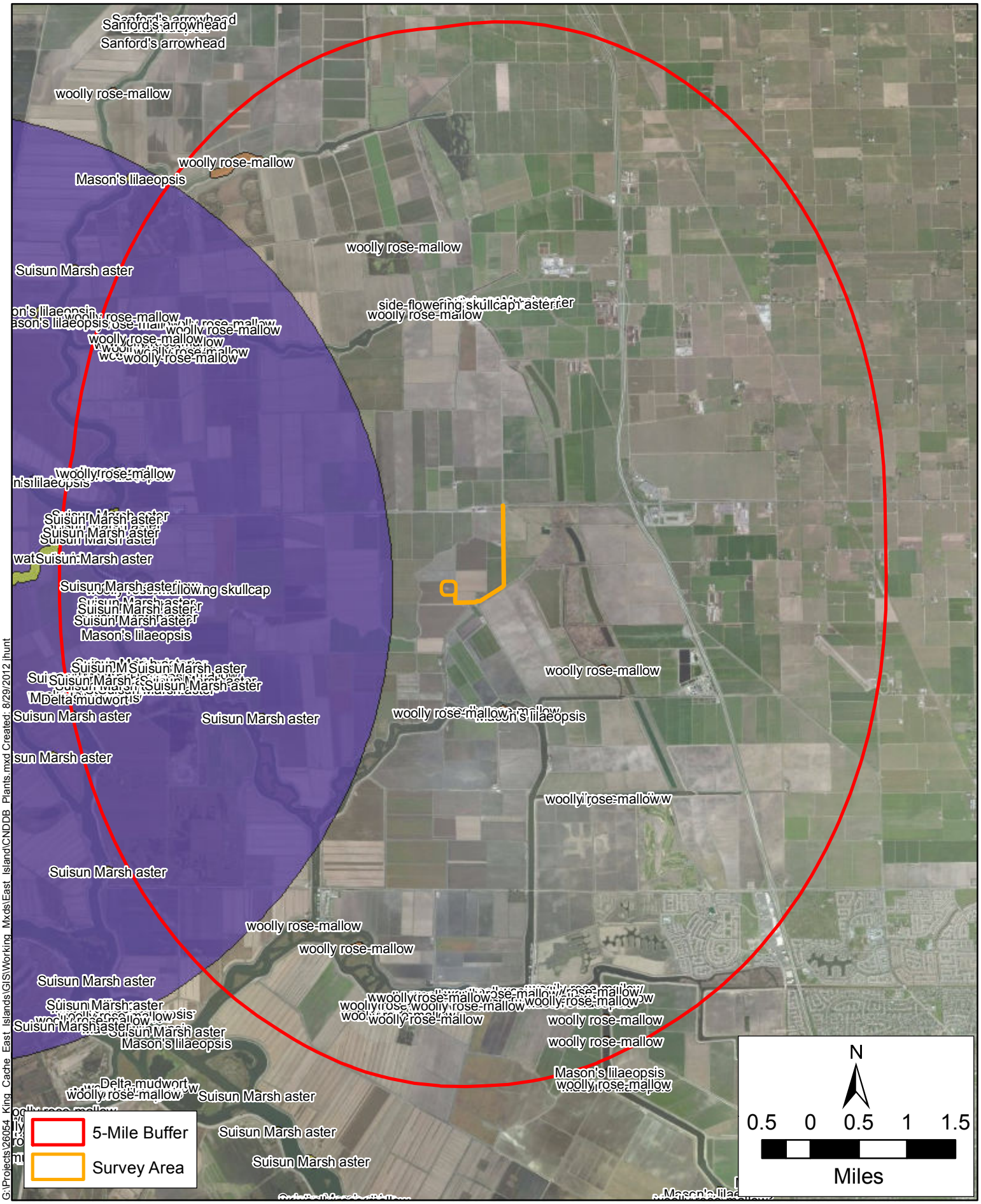


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East Island, San Joaquin County, California

North State Resources, Inc.

Animals CNDDB Results



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East Island, San Joaquin County, California

North State Resources, Inc.

Plants CNDDB Results

APPENDIX C

Swainson's Hawk Survey Protocol

RECOMMENDED TIMING AND METHODOLOGY FOR SWAINSON'S HAWK NESTING SURVEYS IN CALIFORNIA'S CENTRAL VALLEY

Swainson's Hawk Technical Advisory Committee

May 31, 2000

This set of survey recommendations was developed by the Swainson's Hawk Technical Advisory Committee (TAC) to maximize the potential for locating nesting Swainson's hawks, and thus reducing the potential for nest failures as a result of project activities/disturbances. The combination of appropriate surveys, risk analysis, and monitoring has been determined to be very effective in reducing the potential for project-induced nest failures. As with most species, when the surveyor is in the right place at the right time, Swainson's hawks may be easy to observe; but some nest sites may be very difficult to locate, and even the most experienced surveyors have missed nests, nesting pairs, mis-identified a hawk in a nest, or believed incorrectly that a nest had failed. There is no substitute for specific Swainson's hawk survey experience and acquiring the correct search image.

METHODOLOGY

Surveys should be conducted in a manner that maximizes the potential to observe the adult Swainson's hawks, as well as the nest/chicks second. To meet the California Department of Fish and Game's (CDFG) recommendations for mitigation and protection of Swainson's hawks, surveys should be conducted for a ½ mile radius around all project activities, and if active nesting is identified within the ½ mile radius, consultation is required. In general, the TAC recommends this approach as well.

Minimum Equipment

Minimum survey equipment includes a high-quality pair of binoculars and a high quality spotting scope. Surveying even the smallest project area will take hours, and poor optics often result in eye-strain and difficulty distinguishing details in vegetation and subject birds. Other equipment includes good maps, GPS units, flagging, and notebooks.

Walking vs Driving

Driving (car or boat) or "windshield surveys" are usually preferred to walking if an adequate roadway is available through or around the project site. While driving, the observer can typically approach much closer to a hawk without causing it to fly. Although it might appear that a flying bird is more visible, they often fly away from the observer using trees as screens; and it is difficult to determine from where a flying bird came. Walking surveys are useful in locating a nest after a nest territory is identified, or when driving is not an option.

Angle and Distance to the Tree

Surveying subject trees from multiple angles will greatly increase the observer's chance of detecting a nest or hawk, especially after trees are fully leafed and when surveying multiple trees

in close proximity. When surveying from an access road, survey in both directions. Maintaining a distance of 50 meters to 200 meters from subject trees is optimal for observing perched and flying hawks without greatly reducing the chance of detecting a nest/young: Once a nesting territory is identified, a closer inspection may be required to locate the nest.

Speed
Travel at a speed that allows for a thorough inspection of a potential nest site. Survey speeds should not exceed 5 miles per hour to the greatest extent possible. If the surveyor must travel faster than 5 miles per hour, stop frequently to scan subject trees.

Visual and Aural Ques
Surveys will be focused on both observations and vocalizations. Observations of nests, perched adults, displaying adults, and chicks during the nesting season are all indicators of nesting Swainson's hawks. In addition, vocalizations are extremely helpful in locating nesting territories. Vocal communication between. hawks is frequent during territorial displays; during courtship and mating; through the nesting period as mates notify each other that food is available or that a threat exists; and as older chicks and fledglings beg for food.

Distractions
Minimize distractions while surveying. Although two pairs of eyes may be better than one pair at times, conversation may limit focus. Radios should be off, not only are they distracting, they may cover a hawk's call.

Notes and Species Observed
Take thorough field notes. Detailed notes and maps of the location of observed Swainson's hawk nests are essential for filling gaps in the Natural Diversity Data Base; please report all observed nest sites. Also document the occurrence of nesting great homed owls, red-tailed hawks, red-shouldered hawks and other potentially competitive species. These species will infrequently nest within 100 yards of each other, so the presence of one species will not necessarily exclude another.

TIMING

To meet **the minimum level** of protection for the species, surveys should be completed for **at least** the two survey periods immediately prior to a project's initiation. For example, if a project is scheduled to begin on June 20, you should complete 3 surveys in Period III and 3 surveys in Period V. However, it is always recommended that surveys be completed in Periods II, III and V. **Surveys should not be conducted in Period IV.**

The survey periods are defined by the timing of migration, courtship, and nesting in a "typical" year for the majority of Swainson's hawks from San Joaquin County to Northern Yolo County. Dates should be adjusted in consideration of early and late nesting seasons, and geographic differences (northern nesters tend to nest slightly later, etc). If you are not sure, contact a TAC member or CDFG biologist.

Survey dates **Justification and search image**	**Survey time**	**Number of Surveys**
I. *January-March 20 (recommended optional)*	*All day*	*1*

Prior to Swainson's hawks returning, it may be helpful to survey the project site to determine potential nest locations. Most nests are easily observed from relatively long distances, giving the surveyor the opportunity to identify potential nest sites, as well as becoming familiar with the project area. It also gives the surveyor the opportunity to locate and map competing species nest sites such as great homed owls from February on, and red-tailed hawks from March on. After March 1, surveyors are likely to observe Swainson's hawks staging in traditional nest territories.

II. *March 20 to April 5*	*Sunrise to 1000* *1600 to sunset*	*3*

Most Central Valley Swainson's hawks return by April 1, and immediately begin occupying their traditional nest territories. For those few that do not return by April 1, there are often hawks ("floaters") that act as place-holders in traditional nest sites; they are birds that do not have mates, but temporarily attach themselves to traditional territories and/or one of the site's "owners." Floaters are usually displaced by the territories' owner(s) if the owner returns.

Most trees are leafless and are relatively transparent; it is easy to observe old nests, staging birds, and competing species. The hawks are usually in their territories during the survey hours, but typically soaring and foraging in the mid-day hours. Swainson's hawks may often be observed involved in territorial and courtship displays, and circling the nest territory. Potential nest sites identified by the observation of staging Swainson's hawks will usually be active territories during that season, although the pair may not successfully nest/reproduce that year.

III. *April 5 to April 20*	*Sunrise to 1200* *1630 to Sunset*	***3***

Although trees are much less transparent at this time, 'activity at the nest site increases significantly. Both males and females are actively nest building, visiting their selected site frequently. Territorial and courtship displays are increased, as is copulation. The birds tend to vocalize often, and nest locations are most easily identified. This period may require a great deal of "sit and watch" surveying.

IV. *April 21 to June 10*	*Monitoring known nest sites only* ***Initiating Surveys is not recommended***	

Nests are extremely difficult to locate this time of year, and even the most experienced surveyor will miss them, especially if the previous surveys have not been done. During this phase of nesting, the female Swainson's hawk is in brood position, very low in the nest, laying eggs, incubating, or protecting the newly hatched and vulnerable chicks; her head may or may not be visible. Nests are often well-hidden, built into heavily vegetated sections of trees or in clumps of mistletoe, making them all but invisible. Trees are usually not viewable from all angles, which may make nest observation impossible.

Following the male to the nest may be the only method to locate it, and the male will spend hours away from the nest foraging, soaring, and will generally avoid drawing attention to the nest site. Even if the observer is fortunate enough to see a male returning with food for the female, if the female determines it is not safe she will not call the male in, and he will not approach the nest; this may happen if the observer, or others, are too close to the nest or if other threats, such as rival hawks, are apparent to the female or male.

V. ***June 10 to JuIy 30 (post-fledging)*** ***Sunrise to 1200*** ***3***
1600 to sunset

Young are active and visible, and relatively safe without parental protection. Both adults make numerous trips to the nest and are often soaring above, or perched near or on the nest tree. The location and construction of the nest may still limit visibility of the nest, young, ‘and adults.

DETERMINING A PROJECT'S POTENTIAL
FOR IMPACTING SWAINSON'S HAWKS

LEVEL OF RISK	REPRODUCTIVE SUCCESS (Individuals)	LONGTERM SURVIVABILITY (Population)	NORMAL SITE CHARACTERISTICS (Daily Average)	NEST MONI-TORING
HIGH	Direct physical contact with the nest tree while the birds are on eggs or protecting young. (Helicopters in close proximity)	Loss of available foraging area.	Little human-created noise, little human use: nest is well away from dwellings, equipment yards, human access areas, etc. *Do not include general cultivation practices in evaluation.*	**MORE**
		Loss of nest trees.		
	Loss of nest tree after nest building is begun prior to laying eggs.	Loss of potential nest trees.		
	Personnel within 50 yards of nest tree (out of vehicles) for extended periods while birds are on eggs or protecting young that are < 10 days old.	Cumulative: Multi-year, multi-site projects with substantial noise/personnel disturbance.		
	Initiating construction activities (machinery and personnel) within 200 yards of the nest after eggs are laid and before young are > 10 days old.	Cumulative: Single-season projects with substantial noise/personnel disturbance that is greater than or significantly different from the daily norm.		
	Heavy machinery only working within 50 yards of nest.		Substantial human-created noise and occurrence: nest is near roadways, well-used waterways, active airstrips, areas that have high human use. *Do not include general cultivation practices in evaluation.*	
	Initiating construction activities within 200 yards of nest before nest building begins or after young > 10 days old.	Cumulative: Single-season projects with activities that "blend" well with site's "normal' activities.		
LOW	All project activities (personnel and machinery) greater than 200 yards from nest.			**LESS**

A317: East Island Biological Constraints Final Analysis

North State Resources, Inc.

Date:	October 12, 2012	**PG&E Order #:**	8105484
To:	Land and Environmental Management—Catalina Reyes, Biologist		
From:	North State Resources, Inc.— John W. Hunt, Biologist		
Project:	PG&E Compressed Air Energy Storage Sites–Proposed Investigative Geologic Core Sampling at the East Island Morais Well.		
Subject:	Final Biological Constraints Analysis of the East Island Morais Well, San Joaquin County, California		

Introduction and Summary

Mr. John W. Hunt, NSR Biologist, conducted a biological constraints analysis for the proposed Geologic Core Sampling Phase of Pacific Gas and Electric Company (PG&E) Compressed Air Energy Storage Project (project) at the proposed East Island Morais natural gas well pad expansion area and associated access roads (project area). The area surveyed consist of all areas within 20 feet of proposed access roads and all areas within 250 feet of the existing well pad and the proposed well pad expansion area (Figure 1, Appendix A). The objective of the project is to expand and utilize the existing footprint of the Morais natural gas well site to stage geological core sampling equipment. The geological core sampling will be used to determine the suitability of the project vicinity for compressed air storage within depleted subterranean natural gas reservoirs.

A field reconnaissance was conducted on August 20, 2012 with Ms. Catalina Reyes, PG&E Biologist. The project area includes all the proposed access road, existing well pad and staging area, and well pad expansion areas identified by PG&E technical staff during the field review on August 20, 2012 (Figure 2, Appendix A).

Giant garter snake, listed as threatened under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA); Swainson's hawk, listed as threatened under CESA; loggerhead shrike, designated as California species of special concern (SC); and white-tailed kite, a state fully protected (FP) species, have the potential to be adversely affected or impacted by the project This document provides Avoidance and Minimization Measures (AMMs) that will avoid effects on these species.

The vegetated irrigation ditches within the project area appear to meet wetland criteria and may qualify as waters of the United States. All other portions of the existing access road, the existing well pad, and the well pad expansion area do not appear to meet wetland criteria and are not considered to qualify as potential waters of the United States. All determinations concerning waters of the United States should be considered preliminary and tentative unless verified in writing by the U.S. Army Corps of Engineers.

The proposed project will receive federal funding from the U.S. Department of Energy (USDOE). As such, the USDOE is required under section 7 of the federal Endangered Species Act to determine whether the proposed project may affect federally listed and proposed species or proposed or designated critical habitat. If the USDOE determines that the project may affect federally listed species or critical habitat, consultation with the U.S. Fish and Wildlife Service and/or National Marine Fisheries Services is required.

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Project Description

The objective of the project is to collect approximate 10-inch diameter geological core samples from the subsurface natural gas formation at depth approximately 4,000-5,000 feet. Cores will be used determine the suitability of the subsurface formation for compressed air storage. Compressed air storage involves utilizing appropriate geological formations (e.g., depleted natural gas reservoirs) to store surplus energy in the form of compressed air during periods of low electric demand. This stored energy can then be utilized during periods of higher electric demand, improving the efficiency of energy distribution through the power grid.

The project area is located approximately 6 miles northwest of the city of Stockton in northwestern San Joaquin County, California. It is situated south of State Highway 12 approximately 1.3 miles west of Interstate 5 at approximately 38.103683°, -121.433416° (Figure 2, Appendix A). Site access is from the northwest along Guard Road, which is a public road. A smaller, unnamed dirt road provides access to the Morais Well from Guard Road.

Given that existing access roads are available, road construction necessary for project will be limited to widening of approximately 150 feet of access immediately east of the existing well pad. Improvements to this section of road include widening the access road approximately 4 feet to the north (14-foot final width) along approximately 150 feet of road (approximately 0.01 acre). A turning radius will be constructed on the east side of the existing road east of the culvert to provide a sufficient turning radius. Expansion of the road and turning radius will involve clearing existing crops grading, compacting the subgrade, placing aggregate base, and compacting the final road grade. At the junction of the Morais well pad access with the primary unnamed dirt access road, steel plates will be laid over timbers placed to span the primary irrigation ditch, extending the effective access 10 feet south of the culvert. Placement of the steel plates will facilitate site access while avoiding direct impacts or modifications on the existing primary irrigation ditch. Additional improvements to the existing access roads from the culvert to 350 feet south will be limited to light graveling of the unnamed dirt road if determined necessary (e.g., work to occur during the wet season) with the assumption no additional grading will be required. No road improvement will occur east of the 90 degree corner towards Guard Road. If grading is required, it will be limited to the existing road and will not extend beyond the compacted surface. All vehicle traffic will be on the existing access roads and all staging will be contained within the existing well pad. Water trucks will be used as necessary to reduce dust during site access and other construction activities. Approximately 28 truck trips will be required to import well pad material to the site. An additional five truck trips will be required to remove drill-core samples and associated material from the site. If well pad expansion area is restored to pre-project conditions, an additional 28 truck trips will be required to remove temporary well pad expansion materials, which will total 61 truck trips. Best Management Practices (BMPs) and AMMs will be implemented to avoid impacts on potential waters of the United States.

The existing Morais well pad will be expanded north and east of the existing well pad to total approximately 0.8-acre area (220 x 160 feet), which increases the size by approximately 0.5 acre. Cropland within the selected area will be cleared in order to accommodate the well pad expansion. After clearing the vegetation, approximately 1 foot of crushed rock will be placed within the cleared area and compacted with a roller. If necessary, woven geotextile fabric will be placed as an underlayment for the overlying gravel fill.

After the well pad expansion area has been established (i.e., cleared of vegetation, rocked, and compacted), well drilling equipment will be moved onto the expansion area. The primary equipment includes the drill rig, mud and water tanks and pumps, shaker tanks, electric generators, diesel fuel tanks,

and drill pipe racks. Geologic sampling will consist of drilling a 10 inch diameter well to a depth of approximately 4,000-5,000 feet and extracting a geological core sample not greater than 4 inches in diameter. All sections of the core sample will be removed offsite for analysis and storage. All peripheral material (e.g., cuttings and drilling mud) removed during the coring process will be immediately placed in proper storage receptacles and removed offsite for disposal at an authorized facility. The drilling crew, plus engineers, temporary workers and site visitors, will consist of an average of approximately 12 workers per shift, with three shifts per day. A maximum of 20 workers may be present during various operations. In addition to worker vehicles, service and delivery vehicles will access the site during the drilling phase including equipment trucks for all aspects of the effort. All drilling activities will be completed in compliance with the County Gas and Oil Well Improvement Plan approval.

Once the core samples are obtained and the remaining hole is plugged and abandoned per California Division of Oil Gas and Geothermal Resources (DOGGR) and Environmental Protection Agency (EPA) standards, the drilling equipment will be dismantled and demobilized from the site. Construction equipment similar to that used during well pad development will be used to remove the pad materials and return the site to near pre-project conditions. This includes spreading of any surface vegetation or roots stockpiled during site preparation. All removed material will be disposed of at suitable landfills or recycled consistent with county grading or other permit requirements. However, the property owner may elect to retain the pad for farm equipment staging and storage.

Well pad construction and improvements to access roads will occur over a two-week period commencing as early as October 2012. Drilling activities will occur virtually continuously for up to approximately six weeks. If elected to remove the well pad, restoration of the site will take up to two weeks.

Habitat and Affected Environment

The project area is situated in a landscape that currently supports active agricultural operations, an existing natural gas well site, and access roads. The project area is located within the “Delta Islands”. The Delta Islands are areas of former marshlands of the Sacramento–San Joaquin Delta that were historically reclaimed for agricultural use by the construction of levees/dikes and draining to enable farming.

Habitats within the areas surveyed (Figure 3 and Figure 4, Appendix A) include flood irrigated row crops, irrigation ditches, and ruderal herbaceous vegetation along the unnamed dirt access road to the Morais Well. Irrigated pastures, row crops, irrigation ditches, scattered ornamental trees, and fresh emergent wetland border segments of Guard Road (paved) leading to the unnamed dirt access road.

Fields around the well pad are planted in corn (*Zea mays*). Corn and safflower (*Carthamus tinctorius*) were planted in fields along the access roads. Some of the cornfields adjacent to the access roads in the project area were being flood irrigated during the August 20, 2012 field reconnaissance. All agricultural fields within the project area are disked and cropped on an annual rotation. All fields are actively farmed and regularly disked, harvested and/or disturbed to the edge of the existing access road. Ruderal vegetation along the perimeter of the well pad includes rip-gut brome (*Bromus diandrus*), Bermuda grass (*Cynodon dactylon*), black mustard (*Brassica nigra*), and knotweed (*Polygonum arenastrum*).

Irrigation ditches are maintained for irrigation purposes and are often mechanically and chemically cleared of vegetation. When vegetated, plants dominating these features include watergrass (*Echinochloa crus-galli*) in wetter areas to ruderal upland vegetation dominated by Bermuda grass and Johnson grass (*Sorghum halepense*). These features are only flooded during irrigation cycles, which are typically every two weeks.

The fresh emergent wetland occurring southeast of Guard Road is densely vegetated by bulrush (*Schoenoplectus acutus*). Fremont's cottonwood (*Populus fremontii*) and dense ruderal herbaceous understory dominated by poison hemlock (*Conium maculatum*) border the perimeter of the wetland.

Methods

The determination of the potential for the project area to support habitat for special-status species, waters of the United States, and other sensitive biological resources was established through desktop review and a field reconnaissance. The desktop review was completed using a series of database searches and a review of pertinent resources (Attachment 1). Special-status species[1] listed in the U.S. Fish and Wildlife (USFWS) species list for San Joaquin County and species reported in the CNDDB to occur within a 5-mile radius of the project area were considered in the evaluation (e.g., listed shrimp, valley elderberry longhorn beetle, giant garter snake) (Appendix B). Additionally, special-status species not included in the USFWS species list or CNDDB records were considered due to their known geographic range and/or the presence of potential habitat (e.g., white-tailed kite, loggerhead shrike, ringtail). Special-status species shown in the USFWS and CNDDB queries (Appendix B) that are not included in Table 1 lack habitat within the project area or the project area is not within the range of the species. These species are not analyzed further in this document.

Following completion of the field reconnaissance, an assessment of local, state, and federal permitting requirements was conducted to determine if the proposed project requires permits or authorizations from the local government or state and federal regulatory agencies. No local or state, permits addressing biological resources are anticipated to be required. Depending on final configuration of the proposed well pad expansions and access, authorization from the United States Army Corps of Engineers (Corps) may be required for discharge of fill into waters of the United States.

Special-Status Species and Potential Impacts

The fresh emergent wetland and irrigation ditches within the project area contains potentially suitable habitat for eleven special-status plant species including: watershield (*Brasenia schreberi*), bristly sedge (*Carex comosa*), woolly rose-mallow (*Hibiscus lasiocarpus* var. *occidentalis*), Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), Mason's lilaeopsis (*Lilaeopsis masonii*), Delta mudwort (*Limosella subulata*), eel-grass pondweed (*Potamogeton zosteriformis*), Sanford's arrowhead (*Sagittaria sanfordii*), marsh skullcap (*Scutellaria galericulata*), side-flowering skullcap (*Scutellaria lateriflora*), and Suisun marsh aster (*Symphyotrichum lentum*). The proposed project will not result in disturbance to the fresh emergent wetland and irrigation ditches. Therefore, the proposed project will not result in impacts on special-status plant species.

Special-status animal species that were determined to have the potential to occur in or near the project area, and that could be adversely affected by the proposed project, include giant garter snake (*Thamnophis gigas*), Swainson's hawk (*Buteo swainsoni*), white-tailed kite (*Elanus leucurus*), and loggerhead shrike (*Lanius ludovicianus*) (Table 1).

The fresh emergent wetland, irrigation ditches, and associated uplands within and near the project area provide potentially suitable habitat for giant garter snake (GGS). The CNDDB reports GGS occurrences from marsh habitat within Coldani Marsh approximately 0.4 mile east of the project. If GGS are present within the project area during the inactive season (i.e., October 1 to May 1), when work is anticipated to

[1] Special-status species: Listed, candidate, or proposed for listing as threatened or endangered under the Endangered Species Act, or California Endangered Species Act, California Native Plant Protection Act, California Species of Special Concern, and California Fully Protected Species. Special-status plants include California rare plant rank (RPR) 1A, 1B and 2.

occur, adverse impacts (e.g., injury or death) on GGS could result from vehicular traffic or ground disturbance associated with project activities.

The fresh emergent wetland along Guard Road provides high quality habitat for GGS (Figure 3); however, Guard Road is paved and no road improvements (i.e. addition of gravel or grading) that could have potential negative effects on inactive GGS are required to access the well pad. In addition, during the inactive period from October 1 to May 1(when work is scheduled), the likelihood of encountering GGS on the road is low since GGS are likely in burrows and are not as active on the surface; thus, no effects on GGS are expected to result from additional travel on Guard Road. However, if construction occurs during the GGS active period, the likelihood of encountering a snake along or within Guard Road greatly increases.

Irrigation ditches adjacent to the project area could provide dispersal habitat for juvenile GGS and the uplands in the project area may provide wintering habitat. However, these ditches are only flooded during irrigation cycles, which are typically every two weeks and water delivery is anticipated to end prior to the fall or winter harvest. These ditches are also maintained (e.g., vegetation removal and recontouring) to sufficiently deliver water to crops, which reduces the amount of emergent vegetation required for GGS escape cover and foraging habitat (Miller, Hornaday et al. 1999). These ditches do not support a prey base (e.g., amphibians or fish), which further reduces the likelihood GGS would occur in these ditches along dirt access roads and around the well pad area.

Burrows and other underground refuge are important to GGS during summer and winter to escape unfavorable winter cold temperatures or excessive summer heat. The GGS recovery plan states that wintering habitat can be up to 250 meters (820 feet) from the edge of marsh habitat (Miller, Hornaday et al. 1999). A fresh emergent wetland approximately 1,800 feet southeast of the Morais Well provides both aquatic and upland habitat for GGS. A series of irrigation ditches connects this fresh emergent wetland to the proposed well pad expansion area thus, irrigation ditches could provide dispersal habitat for juvenile GGS and the uplands in the project area may provide wintering habitat. Typically, the USFWS defines upland habitat as all areas occurring within 200 feet of aquatic habitat (White 1997). Following this guideline, the highest potential of adverse impacts on GGS is most likely to occur from project activities along the access roads since they are located within 200 feet of aquatic habitat and provide potential habitat for winter burrows. If burrows are located under the access roads that require improvement, burrows can collapse and snakes can become entombed.

Despite the presence of vegetated irrigation ditches that may support dispersal of GGS, these provide marginal to poor habitat. Based on landscape habitat use analysis of studies conducted by Wylie et al (Wylie, Graham et al. 1995; Wylie, Casazza et al. 1997; Wylie, Casazza et al. 2002; Wylie, Casazza et al. 2002) provided in the Solano Multispecies Habitat Conservation Plan (Solano HCP), low quality ditch habitat associated with rice fields provided an artificial marsh habitat that provides the essential components (e.g., appropriate cover, high food availability, and upland refuge) to support GGS. Alternatively, studies conducted in high quality marsh habitat surrounded by fallow fields did not locate GGS or found them at very low densities. Based on these results, areas supporting marginal to poor habitat or small, isolated patches of good habitat are presumed to not support GGS due to lack of surrounding aquatic habitat (Solano County Water Agency 2009). Within the project area, the surrounding aquatic habitat is of marginal to poor quality and thus, it is unlikely that GGS would use these for dispersal.

The upland habitat that the project area provides (i.e., upland habitat along access routes and within well pad expansion area) is also poor to marginal habitat for GGS. As part of existing agricultural activities,

potential upland habitat for GGS within and immediately around proposed project area are extensively disked, tilled and planted with row crops to the edge of the existing well pad and likely precludes occupation of burrowing mammals that would provide refugia for GGS Additionally, no burrows or other refugia were observed around the existing well pad, in the pad expansion area, or along the Morais well access road proposed for expansion, and no ground squirrel activity was observed during the field reconnaissance in these area. Based on the distance from high quality aquatic habitat (greater than 200 feet), poor quality dispersal habitat provided by the irrigation ditches (e.g., lack of perennial water, periodic clearing of vegetation), documented lack of use in non-rice agricultural lands, the lack of burrows or other refugia, and the lack of ground squirrel activity near the well pad expansion area, the irrigation ditches and the associated farmed upland provide low quality habitat and the likelihood for GGS to occur within the pad expansion area and portions of the access roads to be graded is very low. However, because of the proximity of a known population 0.4 miles east of the project and the availability of moderate to high quality marsh aquatic habitat 1,800 feet southeast of the proposed well pad expansion area, AMMS are provided to avoid potential impacts on GGS.

To minimize potential adverse effects on GGS during road improvement activities and well pad construction, a survey for burrows shall be conducted 24 hours prior to any modifications to access roads or well pad construction (i.e., grading compacting, or addition of gravels). If burrows are observed during the inactive period, they shall be flagged and grading or addition of gravel along the shoulder shall avoid all burrows. To minimize impacts during the active or inactive period, all vehicles will travel in the road center along all dirt or paved access roads at a speed limit of 10 mph or less.

Due to the aquatic habitat along Guard Road (Figure 3) and poor visibility while driving, if construction activities, occurs during the active period, a biological monitor will drive in front of heavy construction vehicles (i.e. dump trucks, drill rigs, etc.) on all dirt roads during entry/exit of project site. The biologist will lead vehicles at a maximum speed of 10 mph, watch for signs of snakes, and stop and investigate the road if there are any concerns. The preferred access road will be likely used; however, if the alternate route along King Island Road is used, all AMMs developed for dirt roads will be implemented.

Potential nesting habitat (e.g., trees, power poles/towers) for Swainson's hawk occurs within the project area and within 0.5 mile of the project area. Noise generated by expanding the pad, exploration drilling, site restoration, and other construction activities could adversely affect this species if active nests are located within 0.5 mile. Project implementation is expected to commence as early as October 2012 and extend for a total of four to six weeks, which is outside of the nesting season for these species. If project implementation is confined to this period, the proposed project will not result in adverse effects on this species. However, if work will occur during the nesting season (i.e., March 1–July 31), protocol-level surveys for Swainson's hawk will be required. If active nests are detected present within 0.5 mile of project activities, construction activity will stop immediately and will not resume until the PG&E Biologist or Land Planner contacts the USFWS and California Department of Fish and Game (CDFG) Biologist to discuss possible AMMs, which could include avoidance buffers, reconsidering access routes, and additional surveys.

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T/—	Elderberry shrubs associated with riparian forests which occur along rivers and streams.	None. No elderberry shrubs were observed within the project area.	None required
Delta smelt *Hypomesus transpacificus* **Critical habitat**	T/T	Estuarine systems in the Sacramento-San Joaquin Delta.	None. Irrigation ditches are intermittently flooded, often dry, and do not provide habitat for this species. The nearest CNDDB record is 3.1 miles west of the project area. Additionally, connectivity between the fresh emergent wetland along Guard Road and sloughs is fragmented through multiple levees joined by culverts, which reduces the likelihood for this species to occur. Traffic is common on Guard Road and access to the site will not require any modifications to Guard Road or its shoulders adjacent to the fresh emergent wetland, thus access to the project area would not affect this species.	None required
Sacramento splittail *Pogonichthys macrolepidotus*	—/SC	Shallow, dead-end sloughs with submerged vegetation.	None. Irrigation ditches are intermittently flooded, often dry, and do not provide habitat for this species. The nearest CNDDB record is 7.3 miles northwest of the project area. Additionally, connectivity between the fresh emergent wetland and sloughs is fragmented through multiple levees joined by culverts, which reduces the likelihood for this species to occur. Traffic is common on Guard Road and access to the site will not require any modifications to Guard Road or its shoulders adjacent to the fresh emergent wetland, thus access to the project area would not affect this species.	None required

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Longfin smelt *Spirinchus thaleichthys*	—/SC	Sloughs of Suisun Bay and Delta.	None. Irrigation ditches are intermittently flooded, often dry, and do not provide habitat for this species. Additionally, connectivity between the fresh emergent wetland and sloughs is fragmented through multiple levees joined by culverts, which reduces the likelihood for this species to occur. Traffic is common on Guard Road and access to the site will not require any modifications to Guard Road or its shoulders adjacent to the fresh emergent wetland, thus access to the project area would not affect this species.	None required
California red-legged frog *Rana draytonii*	T/SC	Require aquatic habitat for breeding, also uses a variety of other habitat types including riparian and upland areas. Adults prefer dense, shrubby or emergent vegetation associated with deep-water pools with fringes of cattails and dense stands of overhanging vegetation. This species also breeds in ephemeral ponds that support little or no vegetation.	None . This species is outside the current known range (CWHR) and there are no occurrences within 5 miles of the project area. Additionally, the San Joaquin County Multispecies Habitat Conservation and Open Space Plan (SJMHCP) concludes that CRLF is extirpated from the valley floor (San Joaquin County 2000). This species is not expected to occur in the project area.	None required.

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Giant garter snake *Thamnophis gigas*	T/T	Freshwater marshes and low gradient streams with emergent vegetation. Adapted to drainage canals and irrigation ditches with mud substrate.	Very Low. An extant population of giant garter snake (GGS) occurs within the Coldani Marsh area approximately 0.4 mile to the east of the project area. The fresh emergent wetland approximately 1,800 feet southeast of the Morais Well provides both aquatic and upland habitat for GGS.GGS may occur in the irrigation ditches adjacent to the Morais well pad, however, these features appeared to be heavily managed (e.g., regularly clearing of vegetation and recontouring) and it is expected that potential GGS occupancy would not be sustainable and likely limited to dispersal. Burrows are absent from the upland habitat further reducing potential for occupancy.	Pre construction surveys Biological monitor Water quality BMPs
Western pond turtle *Emys marmorata*	—/SC	Slow water aquatic habitat with available basking sites. Hatchlings require shallow water with dense submergent or short emergent vegetation. Requires an upland oviposition site near the aquatic site.	None. The fresh emergent wetland along Guard Road may provide aquatic habitat for this species. Traffic is common on Guard Road and access to the site will not require any modifications to Guard Road or its shoulders adjacent to the fresh emergent wetland, thus access to the project area would not affect this species.	None required.
California black rail *Laterallus jamaicensis coturniculus*	—/T, FP	Coastal and inland marsh habitat.	None. The fresh emergent wetland adjacent to Guard Road provides breeding and foraging habitat for this species. Traffic is common on Guard Road and access to the site will not require any modifications to Guard Road or its shoulders adjacent to the fresh emergent wetland, thus access to the project area would not affect this species.	None required

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Swainson's hawk *Buteo swainsoni*	—/T	Breeds in stands with few trees in juniper-sage flats, riparian areas, and oak savannah; forages in adjacent livestock pasture, grassland or grain fields.	Moderate. Larger trees and stands of trees occurring within 0.5 mile of the project area provide potential nesting habitat for Swainson's hawk. There are fourteen recorded CNDDB occurrences of nesting Swainson's hawk within 5 miles of the project area with the nearest occurring 2 miles northeast. Noise generated by project activities could disrupt nesting behavior and nest success if Swainson's hawks are nesting within 0.5 mile of the project area.	If work is expected to occur during nesting season (March 1 to July 31), Swainson's hawk nesting surveys will be performed following CDFG protocol developed by the Swainson's Hawk Technical Advisory Committee.
White-tailed kite *Elanus leucurus*	—/FP	Nests in tall shrubs and trees, forages in grasslands, agricultural fields and marshes.	Moderate. Isolated trees and shrubs near proposed access roads and existing farm facilities provide potential nesting habitat for this species. The nearest CNDDB record is 2.7 miles southeast of the project area.	Nesting bird surveys required within the breeding season (February 15-August 31).
Loggerhead shrike *Lanius ludovicianus*	—/SC	Nests in tall shrubs and dense trees, forages in grasslands, marshes, and ruderal habitats.	Low. Isolated trees and shrubs near proposed access roads and existing farm facilities provide potential nesting habitat for this species.	Nesting bird surveys required within the breeding season (February 15-August 31).

[1]Status Codes: : Federal and State Codes: T = Threatened; SC = Species of Special Concern (State), FP = Fully Protected (State)

Cornfields border all sides of the proposed well pad and provide potential foraging habitat for Swainson's hawks. These fields were actively growing during the August 20, 2012 field visit and are anticipated to be harvested in late fall/early winter. CDFG Swainson's hawk guidelines (California Department of Fish and Game 1994) were considered in assessing impacts on the loss of foraging habitat for Swainson's hawk and although fallow cornfields are listed as potential foraging habitat, the fields around the well pad are largely inaccessible during the breeding season and would lie fallow after most Swainson's hawks have migrated south. These fields provide limited foraging opportunities and the conversion of approximately 0.5 acre of corn would have no significant affects on Swainson's hawk foraging habitat.

Nesting habitat for loggerhead shrike and white-tailed kite occur in the trees and shrubs adjacent to Guard Road within the project area. As with the Swainson's hawk, construction activities could have adverse impacts on nesting success for these species depending on the timing of the work. Disturbance to vegetation and removal of existing crops for well pad expansion should be conducted outside of the nesting season (i.e., between August 31-February 15) in order to avoid potential effects on nesting birds. If work is to occur during the nesting season for these species (February 15–August 31), nesting bird surveys will occur 72 hours prior to the start of construction to determine if birds are nesting in the area. If nesting birds are found PG&E will halt work and consult with CDFG and USFWS to establish AMM's to protect nest (i.e. establish buffers).

Waters of the United States and Potential Impacts

An assessment for potential waters of the United States was conducted during the August 20, 2012 field reconnaissance. Two irrigation ditches were observed at the East Island Morais Well pad site. A primary vegetated irrigation ditch (primary ditch) flows from south to north, paralleling the west side of the existing ranch road (Figure 4, Appendix A). This ditch flows through a culvert under the junction of the ranch road with the Morais Well access road. A second vegetated irrigation ditch (secondary ditch) flows from east to west from the primary ditch. This ditch parallels the southern boundary of the Morais Well pad access road before turning north and terminating in the northwest corner of the existing well pad.

The primary irrigation ditch was recently recontoured and largely cleared of vegetation, however, watergrass (a hydrophytic plant) was observed re-colonizing the ditch and was the dominant species bordering this feature. The secondary irrigation ditch supported a prevalence of hydrophytic vegetation (monotypic stand of watergrass); however, this feature appeared to have been regularly flood irrigated at intervals and was in the process of being irrigated at the time of the field reconnaissance. Irrigation ditches adjacent to the access road within the project area were also observed to support a prevalence of hydrophytic vegetation; many of these features contained flowing or ponded water and are a primary conveyance for irrigation or tail water within and near the project area. The ditches within the project area are part of an extensive irrigation system that drains into or are adjacent (separated by a berm) to White Slough, which qualifies as waters of the United States. Water is generally pumped in or out of White Slough depending on need to irrigate farmland or to pump out water to keep the area from flooding. Given that the irrigation ditches support hydrophytic vegetation, are subject to extended inundation and/or saturation, and are tributary to waters of the United States, the features are considered as potential waters of the United States. A discharge of fill is not anticipated at this time and no potential waters of the United States would be directly impacted. If a discharge of fill is required (e.g., to replace a culvert), authorization to discharge fill into a waters of the United States from the Corps may be required. AMMs have been incorporated into the proposed project to avoid the potential for indirect impacts on waters of the United States.

Although the USFWS National Wetlands Inventory identifies the entire project area as farmed wetlands, the existing access roads, the existing well pad, and the proposed well pad expansion areas (excluding the irrigation ditches) do not appear to currently meet wetland criteria. The existing access roads and the

existing well pad consist of compacted surfaces that are graded and unvegetated; and do not exhibit evidence of long-duration ponding or saturation, or exhibit other indications of wetland hydrology. The proposed well pad expansion areas currently support a leveled and routinely disked agricultural field that is planted with corn. Field inspection of this area did not identify the presence of hydrophytic vegetation or evidence of soil inundation/saturation unrelated to routine irrigation. Based on observation of the water level in an unnamed irrigation canal approximately 0.4 miles north of the existing well pad, the surface of the agricultural field appeared to be at least 3 feet above the water table at the time of the field inspection. Given the lack of hydrophytic vegetation and an absence of indications of a current wetland hydrology, the existing access roads, the existing well pad, and the proposed well pad expansion areas above the existing irrigation ditches are not considered to qualify as potential waters of the United States.

It is important to note that the field assessment did not involve a formal delineation using the Corps methodology and no detailed investigations for wetland hydrology were conducted. The entire project area was historically Sacramento–San Joaquin Delta marshland prior to dikes/draining and conversion to agricultural production. Areas of agricultural production that were formerly wetlands may still qualify as jurisdictional wetlands if hydrological characteristics remain to the extent that hydrophytic vegetation would return if the agricultural activities ceased. The determinations provided in this document concerning wetland hydrology are based on a single visual assessment conducted on August 20, 2012. Definitive documentation of the status of wetland hydrology generally cannot be provided by a single visual assessment during the dry season. Therefore, all determinations provided in this document concerning waters of the United States should be considered preliminary and tentative unless verified in writing by the Corps.

Other Sensitive Biological Resources

Migratory birds and raptors (i.e., birds of prey) protected under the federal Migratory Bird Treaty Act and the California Department of Fish and Game Code may nest on open ground, vegetation, or structures within the project area. Construction activities could have adverse impacts on nesting success for birds nesting near the construction site. If disturbance to vegetation and removal of existing crops for well pad expansion is conducted outside of the nesting season, then no impacts to nesting birds are expected to result from well pad expansion activities. If work is to occur during the nesting season for these species (February 15–August 31), nesting bird surveys will be occur 72 hours prior to the start of construction required to determine if birds are nesting in the area.If nesting birds are found PG&E will halt work and consult with CDFG and USFWS to establish AMM's to protect nest (i.e. establish buffers).

Avoidance and Minimization Measures (22 total):

1. Prior to working on-site, all workers shall be provided with Environmental Awareness Training by a qualified biologist approved by USFWS and CDFG. The training shall address the identification and general ecology of GGS Swainson's hawk, nesting birds and other special-status species that have potential to occur in the project area, and the AMMS to be implemented in order to avoid impacts on these resources. Areas to be avoided shall also be addressed in the training. Please contact project biologist, Catalina Reyes (925-808-8811) two weeks prior to construction to schedule the training.

2. Prior to construction, all work areas (e.g., vehicle access, parking, staging) needed to complete the project shall be identified in coordination with the on-site biologist. Due to the presence of sensitive resources, some work areas may need to be adjusted. All work areas shall be limited to the minimum area necessary to complete work.

3. If practicable, ground disturbing activity (e.g. vegetation removal, compaction, and placement of gravel fill) at all the well pad site shall be conducted during the active season for giant garter snake (GGS) (i.e., between May 1 and October 1). If ground-disturbing activity cannot be conducted during the GGS active season, preconstruction surveys for potential GGS wintering sites (i.e., burrows and soils crevices) shall be conducted within two weeks by a qualified biologist approved by USFWS and CDFG to determine the if potential GGS habitat is present within proposed areas of ground disturbing activity (e.g., the well pad expansion site, road work, application of gravel) and again within 24 hours prior to ground disturbing activity).

4. All burrows or potential refuge habitat shall be flagged and avoided. If work is suspended for a period of five days or greater, then the project area must be resurveyed. If it is determined that potential GGS wintering habitat (e.g., burrows and crevices) is present within areas planned for ground disturbance, ground-disturbing activities shall be postponed until the GGS active season (i.e., between May 1 and October 1). If GGS is encountered at any time during the project, work will stop immediately and the USFWS and CDFG will be contacted before work proceeds.

5. A biological monitor shall be on site during all phases of construction to direct access and construction work around irrigation ditches and other sensitive habitats capable of supporting GGS. If any GGS are observed within the project area during work activities, work shall cease and the on-site project manager shall immediately contact the project biologist, Catalina Reyes (925-808-8811) prior to resuming work. The biological monitor has the authority to stop construction to resolve any biological concerns.

6. Access to well pads shall be confined to existing roads, road shoulders, and other compacted areas. Travel along roads shall be restricted to the centerline. If placement of gravel on access roads is necessary, the placement shall be limited to the existing road surface. No gravels shall be placed ditch banks or other areas that may support burrows that could be used by GGS. No grading shall occur along segments of existing roads that may support burrows that could be used by GGS.

7. The fresh emergent marsh and irrigation ditches will be designated as environmentally sensitive areas and physical disturbance to these features will be avoided during construction.

8. If deemed necessary, an exclusionary fence shall be erected to protect potentially sensitive habitat adjacent to the existing well pad. To ensure that GGS does not become trapped or entangled, no wattles with plastic monofilament netting are permitted. Burlap or coconut wattles are appropriate substitutes.

9. A qualified biologist approved by USFWS and CDFG shall perform a general pre-construction survey within 72 hours of the start of project construction.

10. Provide escape ramps at a 45 degree angle or less for any excavations that are greater than one foot that are left open overnight. For smaller holes, cover so that no gaps occur and inspect each morning for wildlife. Inspect prior to filling any trenches or holes. If special-status wildlife becomes entrapped, work shall stop and the PG&E project biologist, Catalina Reyes, shall be notified immediately to determine next steps.

11. All construction personnel shall visually check for snakes and other wildlife under vehicles and equipment prior to moving them.

12. Construction equipment will be maintained to prevent leaks of fuels, lubricants or other pollutants into aquatic habitats.

13. Whenever possible, refueling and maintenance of vehicles shall occur offsite. In cases when this is not possible, refueling and maintenance of vehicles and equipment will be conducted over drip pans and at least 100 feet from any waterway.

14. Open ends of pipes, conduits or other materials stored onsite will be covered to exclude wildlife and will be inspected prior to use.

15. Vehicular speed within the project area shall be limited to 10 miles per hour in order avoid impacts on wildlife that may be located on or near roadways. If construction activities, including addition of gravel, occurs during the active period, a biological monitor will drive in front of heavy construction vehicles (i.e. dump trucks, drill rigs, etc.) on all dirt roads during entry/exit of project site. Biologist will lead vehicles at a minimum speed of 10 mph, watch for signs of snakes, and stop and investigate the road if there are any concerns.

16. Watering of roads during dry season work shall be performed as necessary (approximately 3–4 times a day) in order to reduce potential dust resulting from project associated traffic.

17. All potential nesting substrate (e.g., shrubs and trees) that requires removal to construct the project should be removed before the onset of the nesting season (i.e., prior to February 15), if feasible. This will help preclude nesting and substantially decrease the likelihood of direct impacts on nesting birds. If this is not feasible then a nesting bird survey of potential nesting substrate will be performed 72 hours prior to its removal.

18. Surveys for nesting raptors and migratory birds (including Swainson's hawk) shall be required if project construction is to occur during the nesting season (February 15–August 31; March 1-July 31 for Swainson's hawk). Surveys shall be conducted by a qualified biologist approved by USFWS and CDFG .

    Surveys for Swainson's hawk shall follow the California Department of Fish and Game protocol developed by the Swainson's Hawk Technical Advisory Committee (Appendix C).

    Surveys for other nesting birds will consist of performing an initial survey after February 15, 2013 or within a month of the start of project date if project is to begin later in the nesting bird season. A second nesting bird survey shall be performed within 72 hours of the start of construction. The surveys shall be repeated if work is suspended for five days or more. Please contact project biologist, Catalina Reyes (925-808-8811) 2 weeks prior to construction schedule surveys.

19. Caution shall be used when handling and/or storing chemicals (fuel, hydraulic fluid, etc.). As part of standard PG&E Best Management Practices (BMPs) crews shall have appropriate materials shall be on site to provide secondary containment and prevent and manage spills. If groundwater is encountered, contact PG&E Environmental Specialist Bryon Nicholson (415-990-0139).

20. Crews shall implement all standard PG&E BMPs outlined in the Good Housekeeping Activity Specific Erosion and Sediment Control Plan (January 2011) as needed.

21. If the scope of work or project location changes, contact project biologist Catalina Reyes (925-808-8811) prior to commencing work. The project biologist or Land Planner (Ernie Ralston, 515-973-3215) will contact the USFWS Bay-Delta Fish & Wildlife Office ESA/Regulatory Division and the Dept. of Fish & Game-Bay Delta Region upon notice of any such changes.

22. Remove construction related trash from the site daily and upon work completion and return site to near pre-construction contours and conditions upon project completion.

Attachment 1. Desktop Review Results

Source	Results
County	San Joaquin
USGS Quadrangle	Terminous, California (Unsectioned Area of the Empire Tract)
Aerial Photographs – Google Earth 2012 & Bing Aerial Imagery 2012	Primarily row crops, ditches and potential emergent or other wetlands present.
Land Ownership California Protected Areas Database (CPAD)	None. Private Ownership.
USFWS official list	Attached.
Federally Designated Critical Habitat (within 5-mile radius)	Within Delta Smelt Critical Habitat and approximately 1-mile north of steelhead critical habitat.
CNDDB-5-mile radius	Attached.
CNDDB owl viewer	Not within range of Spotted Owl.
CNPS-9 quad search	Attached.
PG&E Raptor Concentration Zones (RCZ)	Within RCZ.
National Audubon Society Important Bird Areas (IBA)	Within Sacramento-San Joaquin IBA.
U.S. Department of Agriculture (USDA) Web Soil Survey	Project area entirely within guard clay loam, poorly drained.
USFWS National Wetlands Inventory	Entire project area included within farmed wetlands (Pf) in USFWS NWI with scatter fringes of freshwater emergent marsh (PEM) near access roads.
PG&E San Joaquin HCP or other HCPs, NCCPs	Within PG&E San Joaquin HCP.
Known Swainson's Hawk, golden or bald eagle nest sites	CNDDB Swainson's hawk nesting record within 5 miles of project area. Nearest CNDDB occurrence is 2 miles northeast of the project area. No golden or bald eagle occurrences within 5 miles.
PG&E VELB Conservation Program Range	Within PG&E VELB Conservation Program Range.
CWHR (California Wildlife Habitat Relations) species.	CWHR was reviewed to identify other species that habitat is present and within range (e.g., white-tailed kite, ringtail).

References

California Department of Fish and Game (1994). Staff report regarding mitigation for impacts to Swainson's hawks (Buteo swainsoni) in the Central Valley of California**:** 13.

Miller, K. J., K. Hornaday, et al. (1999). Draft recovery plan for the giant garter snake (Thamnophis gigas), U.S. Fish and Wildlife Service**:** 192.

Solano County Water Agency (2009). Solano Multispecies Habitat Conservation Plan Final Administrative Draft.

White, W. S. (1997). Programmatic formal consultation for U.S. Army Corps of Engineers 404 permitted projects with relatively small effects on the giant garter snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo Counties, California. A. Champ. Sacramento, California, Sacramento Fish and Wildlife Office.

Wylie, G. D., M. L. Casazza, et al. (1997). 1996 Progress report for giant garter snake study. Unpublished report. Dixon, CA, USGS Biological Resources Division Dixon Research Station.

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Wylie, G. D., M. L. Casazza, et al. (2002). Monitoring giant garter snakes at Colusa National Wildlife Refuge: 2002 progress report. Prepared for U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation. Dixon, CA, USGS Western Ecological Research Center, Dixon Field Station.

Wylie, G. D., T. Graham, et al. (1995). National biological service giant garter snake study progress report for the 1995 field season. Unpublished report. Dixon, CA, USGS Biological Resources Division, Dixon Research Station.



Photograph 1. View west from paved Guard Road onto unnamed dirt access road.



Photograph 2. Fresh emergent wetland adjacent to Guard Road.



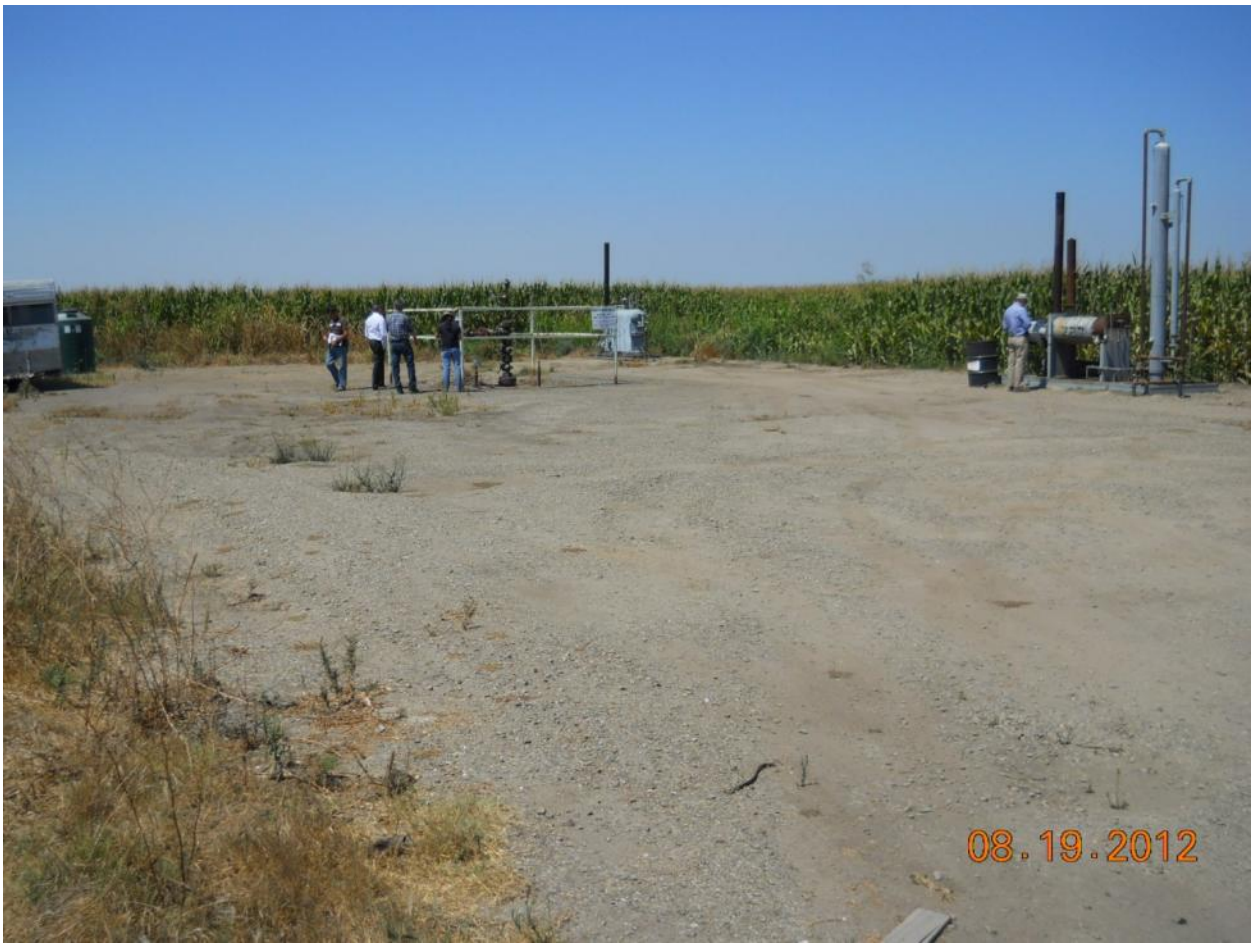
Photograph 4. View south at the junction of the unnamed dirt access road and entrance to the East Island Morais well pad showing the primary irrigation ditch running south-north along the west side of the unnamed dirt access road .



Photograph 5. Primary irrigation ditch running south-north along the west side of the unnamed dirt access road at the intersection to the access road for Morais Well.



Photograph 6. Secondary irrigation ditch running east-west along the south side of the access road leading to the East Island Morais Well pad.



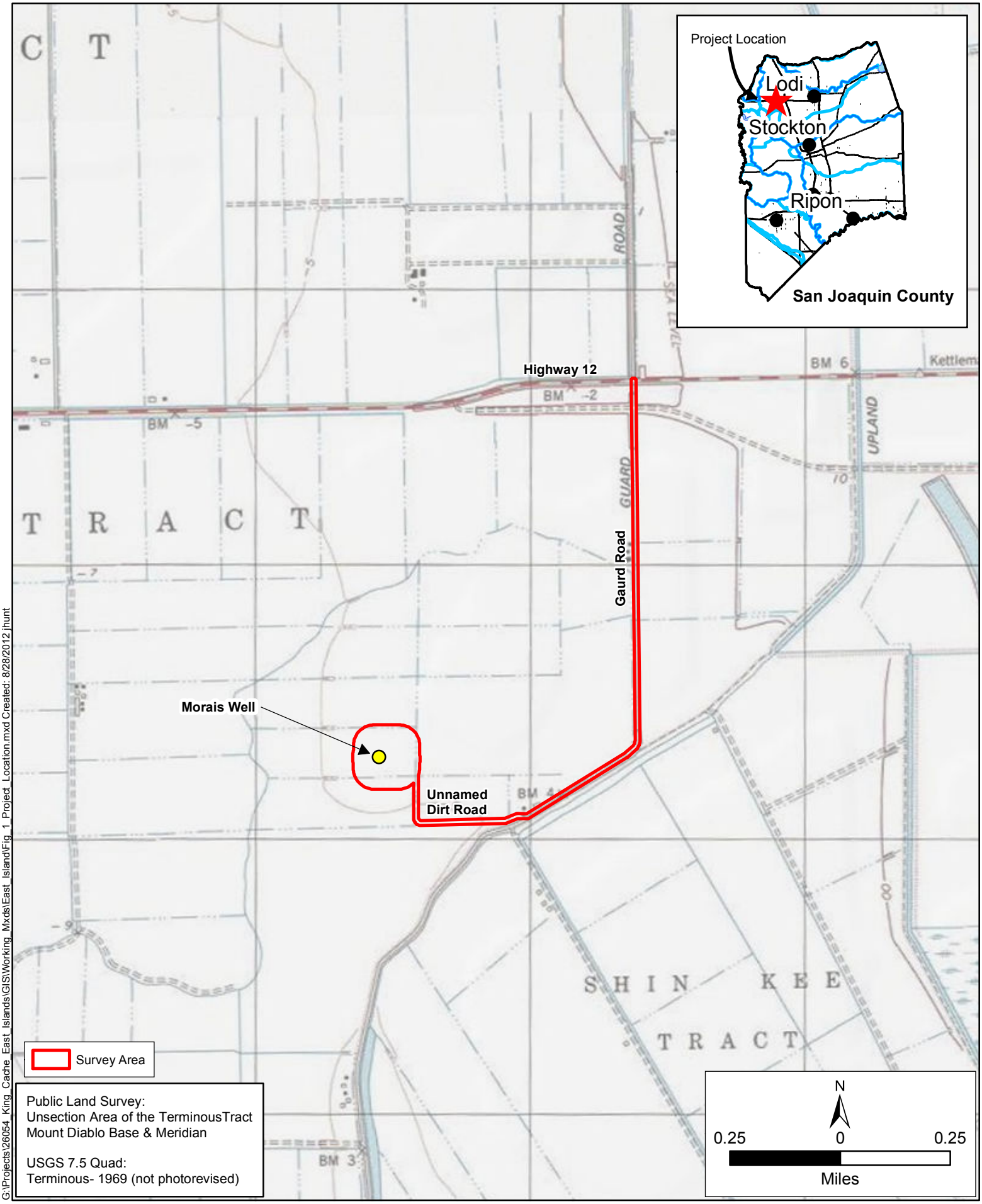
Photograph 7. The existing well pad consists of packed dirt and gravels.



Photograph 9. View northwest toward proposed expansion area from existing East Island Morais well pad. Existing fields were previously disked and farmed to the north edge of the existing well pad and well pad access road with no intervening vegetation.

APPENDIX A

Figures



North State Resources, Inc.

East Island, San Joaquin County, California

Figure 1. Project Location and Vicinity Map



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North State Resources, Inc.

East Island, San Joaquin County, California

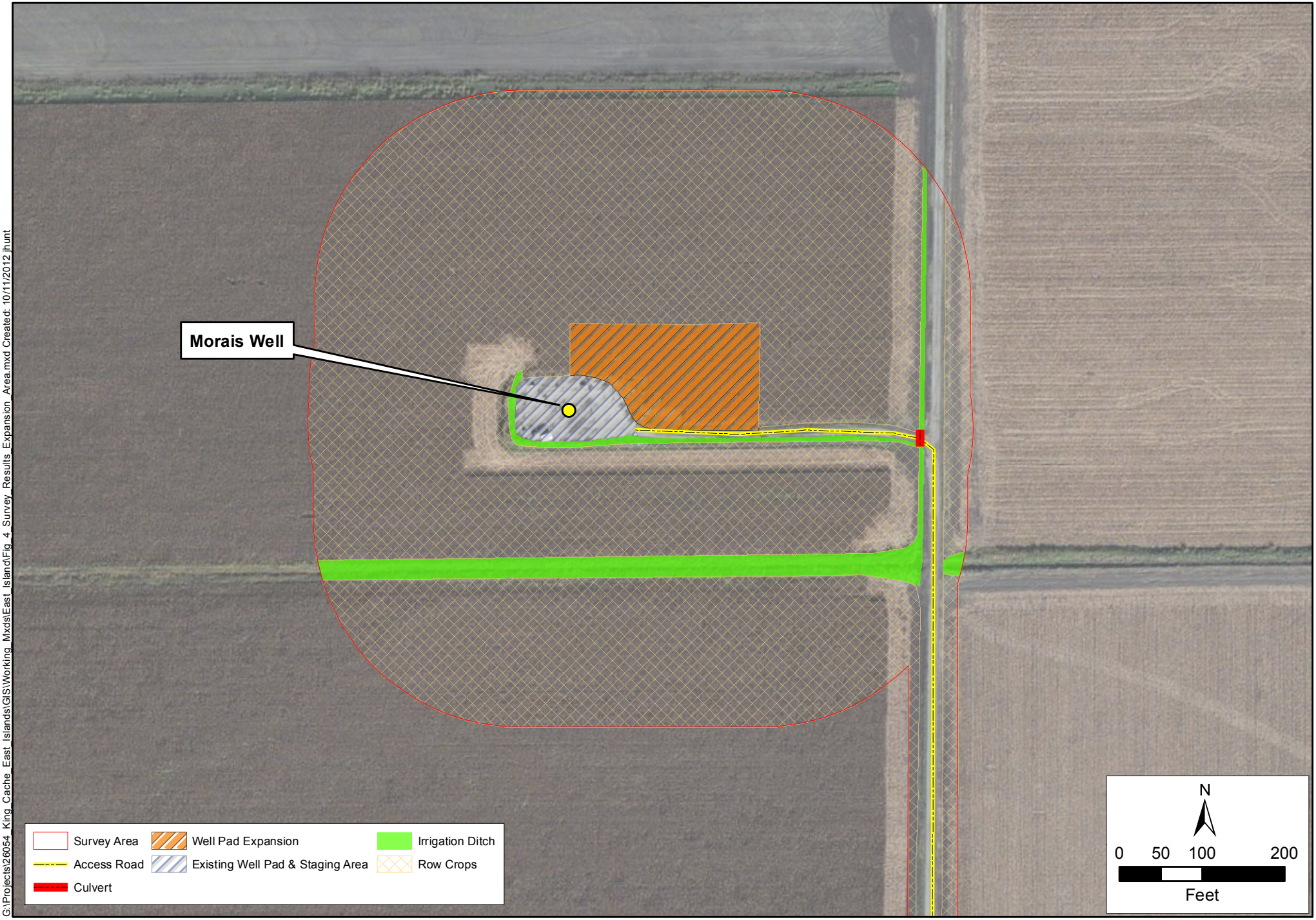
Figure 2. Project Area



East Island, San Joaquin County, California

North State Resources, Inc.

Figure 3. Survey Results



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East Island, San Joaquin County, California

North State Resources, Inc.

Figure 4. Survey Results - Well Pad Expansion Area

APPENDIX B

USFWS, CNDDB, and CNPS Queries

U.S. Fish & Wildlife Service

Sacramento Fish & Wildlife Office

Federal Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 120816041228

Database Last Updated: September 18, 2011

Quad Lists

Listed Species

Invertebrates

Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Lepidurus packardi
vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
Critical habitat, delta smelt (X)
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)

Rana draytonii
California red-legged frog (T)

Reptiles

Thamnophis gigas
giant garter snake (T)

Mammals

Sylvilagus bachmani riparius
riparian brush rabbit (E)

Quads Containing Listed, Proposed or Candidate Species:

TERMINOUS (479C)

County Lists

San Joaquin County

Listed Species

Invertebrates

Branchinecta conservatio
Conservancy fairy shrimp (E)
Critical habitat, Conservancy fairy shrimp (X)

Branchinecta longiantenna
longhorn fairy shrimp (E)

Branchinecta lynchi
Critical habitat, vernal pool fairy shrimp (X)
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Elaphrus viridis
delta green ground beetle (T)

Lepidurus packardi
Critical habitat, vernal pool tadpole shrimp (X)
vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
Critical habitat, delta smelt (X)
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
Critical habitat, winter-run chinook salmon (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)
Critical habitat, CA tiger salamander, central population (X)

Rana draytonii
California red-legged frog (T)
Critical habitat, California red-legged frog (X)

Reptiles

Masticophis lateralis euryxanthus
Alameda whipsnake [=striped racer] (T)

Critical habitat, Alameda whipsnake (X)

Thamnophis gigas
giant garter snake (T)

Birds

Rallus longirostris obsoletus
California clapper rail (E)

Vireo bellii pusillus
Least Bell's vireo (E)

Mammals

Neotoma fuscipes riparia
riparian (San Joaquin Valley) woodrat (E)

Sylvilagus bachmani riparius
riparian brush rabbit (E)

Vulpes macrotis mutica
San Joaquin kit fox (E)

Plants

Amsinckia grandiflora
Critical habitat, large-flowered fiddleneck (X)
large-flowered fiddleneck (E)

Arctostaphylos myrtifolia
Ione manzanita (T)

Castilleja campestris ssp. succulenta
Critical habitat, succulent (=fleshy) owl's-clover (X)
succulent (=fleshy) owl's-clover (T)

Cordylanthus palmatus
palmate-bracted bird's-beak (E)

Lasthenia conjugens
Critical habitat, Contra Costa goldfields (X)

Orcuttia viscida
Critical habitat, Sacramento Orcutt grass (X)
Sacramento Orcutt grass (E)

Tuctoria greenei
Greene's tuctoria (=Orcutt grass) (E)

Candidate Species

Birds

Coccyzus americanus occidentalis
Western yellow-billed cuckoo (C)

Key:

(E) *Endangered* - Listed as being in danger of extinction.
(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.
(P) *Proposed* - Officially proposed in the Federal Register for listing as endangered or threatened.
(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.
(C) *Candidate* - Candidate to become a proposed species.
(V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.
(X) *Critical Habitat* designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, **or may be affected by** projects within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list. See our Protocol and Recovery Permits pages.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.

  During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.

- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.

  Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our Map Room page.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6520.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be November 14, 2012.

Count of CNAME						
SNAME	**CNAME**	**FEDLIST**	**CALLIST**	**RPLANTRANK**	**SRANK**	**Total**
Brasenia schreberi	**watershield**	None	**None**	2.3	S2	1
Buteo swainsoni	**Swainson's hawk**	None	**Threatened**	(blank)	S2	18
Coastal and Valley Freshwater Marsh	**Coastal and Valley Freshwater Marsh**	None	**None**	(blank)	S2.1	3
Elanus leucurus	**white-tailed kite**	None	**None**	(blank)	S3	1
Emys marmorata	**western pond turtle**	None	**None**	(blank)	S3	14
Hibiscus lasiocarpos var. occidentalis	**woolly rose-mallow**	None	**None**	1B.2	S2.2	17
Hypomesus transpacificus	**Delta smelt**	Threatened	**Endangered**	(blank)	S1	3
Laterallus jamaicensis coturniculus	**California black rail**	None	**Threatened**	(blank)	S1	3
Lathyrus jepsonii var. jepsonii	**Delta tule pea**	None	**None**	1B.2	S2.2	2
Lepidurus packardi	**vernal pool tadpole shrimp**	Endangered	**None**	(blank)	S2S3	1
Lilaeopsis masonii	**Mason's lilaeopsis**	None	**Rare**	1B.1	S2	10
Limosella subulata	**Delta mudwort**	None	**None**	2.1	S2.1	3
Scutellaria lateriflora	**side-flowering skullcap**	None	**None**	2.2	S1	2
Symphyotrichum lentum	**Suisun Marsh aster**	None	**None**	1B.2	S2	10
Thamnophis gigas	**giant garter snake**	Threatened	**Threatened**	(blank)	S2S3	3
Valley Oak Woodland	**Valley Oak Woodland**	None	**None**	(blank)	S2.1	1
Grand Total						**92**

CNPS Inventory of Rare and Endangered Plants

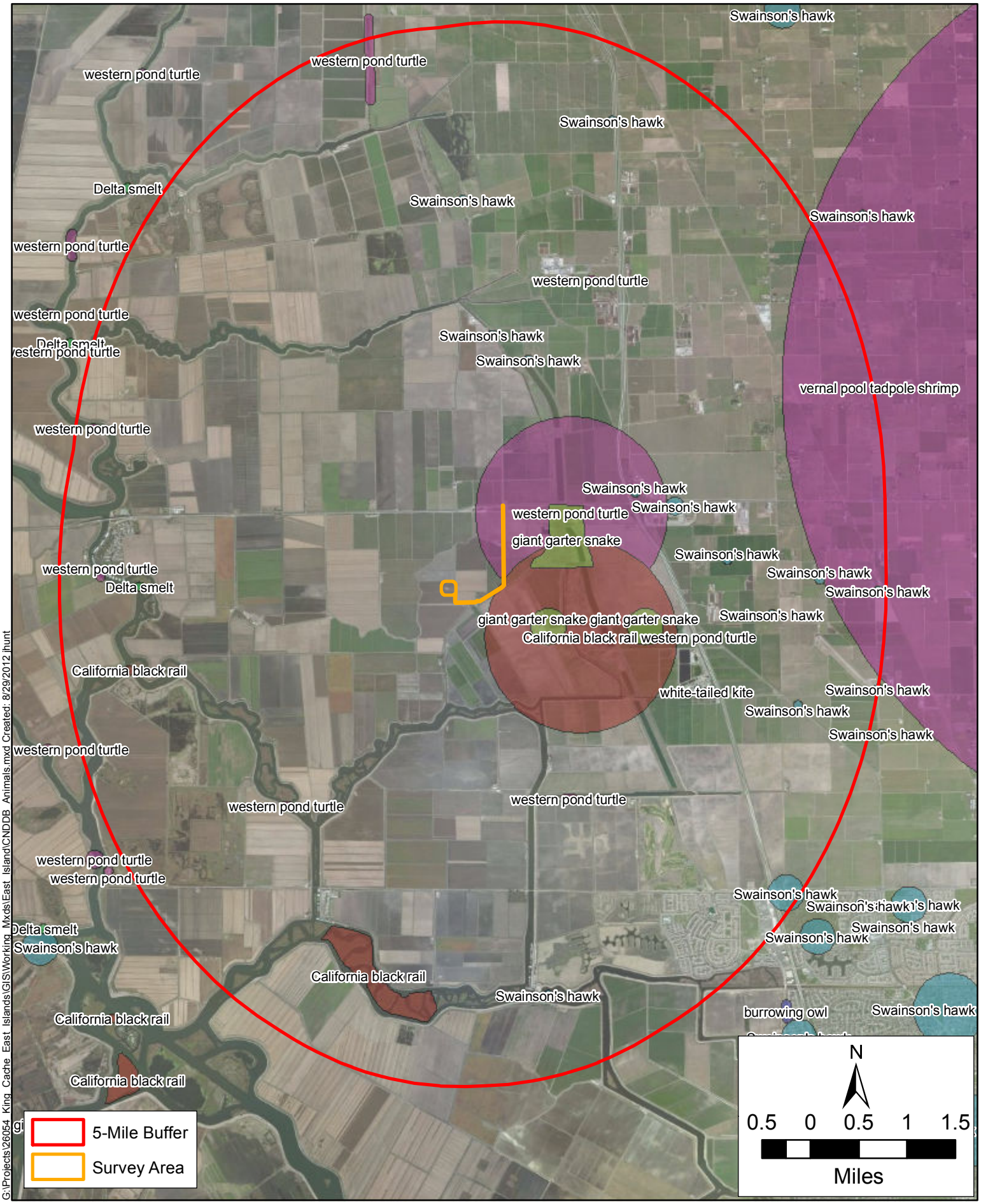
Status: Plant Press Manager window with 21 items - Fri, Aug. 17, 2012 18:17 c

Reformat list as: Standard List - with Plant Press controls

ECOLOGICAL REPORT

scientific	family	life form	blooming	communities	elevation	CNPS
Astragalus tener var. tener	Fabaceae	annual herb	Mar-Jun	•Playas (Plyas) •Valley and foothill grassland (VFGrs)(adobe clay) •Vernal pools (VnPls)/alkaline	1 - 60 meters	List 1B.2
Atriplex cordulata var. cordulata	Chenopodiaceae	annual herb	Apr-Oct	•Chenopod scrub (ChScr) •Meadows and seeps (Medws) •Valley and foothill grassland (VFGrs)(sandy)/saline or alkaline	0 - 560 meters	List 1B.2
Atriplex joaquinana	Chenopodiaceae	annual herb	Apr-Oct	•Chenopod scrub (ChScr) •Meadows and seeps (Medws) •Playas (Plyas) •Valley and foothill grassland (VFGrs)/alkaline	1 - 835 meters	List 1B.2
Blepharizonia plumosa	Asteraceae	annual herb	Jul-Oct	•Valley and foothill grassland (VFGrs)/Usually clay.	30 - 505 meters	List 1B.1
Brasenia schreberi	Cabombaceae	perennial rhizomatous herb aquatic	Jun-Sep	•Marshes and swamps (MshSw)/freshwater	30 - 2200 meters	List 2.3
California macrophylla	Geraniaceae	annual herb	Mar-May	•Cismontane woodland (CmWld) •Valley and foothill grassland (VFGrs)/clay	15 - 1200 meters	List 1B.1
Carex comosa	Cyperaceae	perennial rhizomatous herb	May-Sep	•Coastal prairie (CoPrr) •Marshes and swamps (MshSw)(lake margins) •Valley and foothill grassland (VFGrs)	0 - 625 meters	List 2.1
Chloropyron palmatum	Orobanchaceae	annual herb hemiparasitic	May-Oct	•Chenopod scrub (ChScr) •Valley and foothill grassland (VFGrs)/alkaline	5 - 155 meters	List 1B.1
Eryngium	Apiaceae	annual/perennial		•Riparian scrub (RpScr)	3 - 30	List

racemosum		herb	Jun-Oct	(vernally mesic clay depressions)	meters	1B.1
Hibiscus lasiocarpos var. occidentalis	Malvaceae	perennial rhizomatous herb emergent	Jun-Sep	•Marshes and swamps (MshSw)(freshwater)	0 - 120 meters	List 1B.2
Juglans hindsii	Juglandaceae	perennial deciduous tree	Apr-May	•Riparian forest (RpFrs) •Riparian woodland (RpWld)	0 - 440 meters	List 1B.1
Lathyrus jepsonii var. jepsonii	Fabaceae	perennial herb	May-Jul(Sep), Months in parentheses are uncommon.	•Marshes and swamps (MshSw)(freshwater and brackish)	0 - 4 meters	List 1B.2
Legenere limosa	Campanulaceae	annual herb	Apr-Jun	•Vernal pools (VnPls)	1 - 880 meters	List 1B.1
Lilaeopsis masonii	Apiaceae	perennial rhizomatous herb	Apr-Nov	•Marshes and swamps (MshSw)(brackish or freshwater) •Riparian scrub (RpScr)	0 - 10 meters	List 1B.1
Limosella subulata	Scrophulariaceae	perennial stoloniferous herb	May-Aug	•Marshes and swamps (MshSw)	0 - 3 meters	List 2.1
Potamogeton zosteriformis	Potamogetonaceae	annual herb aquatic	Jun-Jul	•Marshes and swamps (MshSw)(assorted freshwater)	0 - 1860 meters	List 2.2
Sagittaria sanfordii	Alismataceae	perennial rhizomatous herb emergent	May-Oct	•Marshes and swamps (MshSw)(assorted shallow freshwater)	0 - 650 meters	List 1B.2
Scutellaria galericulata	Lamiaceae	perennial rhizomatous herb	Jun-Sep	•Lower montane coniferous forest (LCFrs) •Meadows and seeps (Medws) (mesic) •Marshes and swamps (MshSw)	0 - 2100 meters	List 2.2
Scutellaria lateriflora	Lamiaceae	perennial rhizomatous herb	Jul-Sep	•Meadows and seeps (Medws) (mesic) •Marshes and swamps (MshSw)	0 - 500 meters	List 2.2
Symphyotrichum lentum	Asteraceae	perennial rhizomatous herb	May-Nov	•Marshes and swamps (MshSw)(brackish and freshwater)	0 - 3 meters	List 1B.2
Tropidocarpum capparideum	Brassicaceae	annual herb	Mar-Apr	•Valley and foothill grassland (VFGrs)(alkaline hills)	1 - 455 meters	List 1B.1

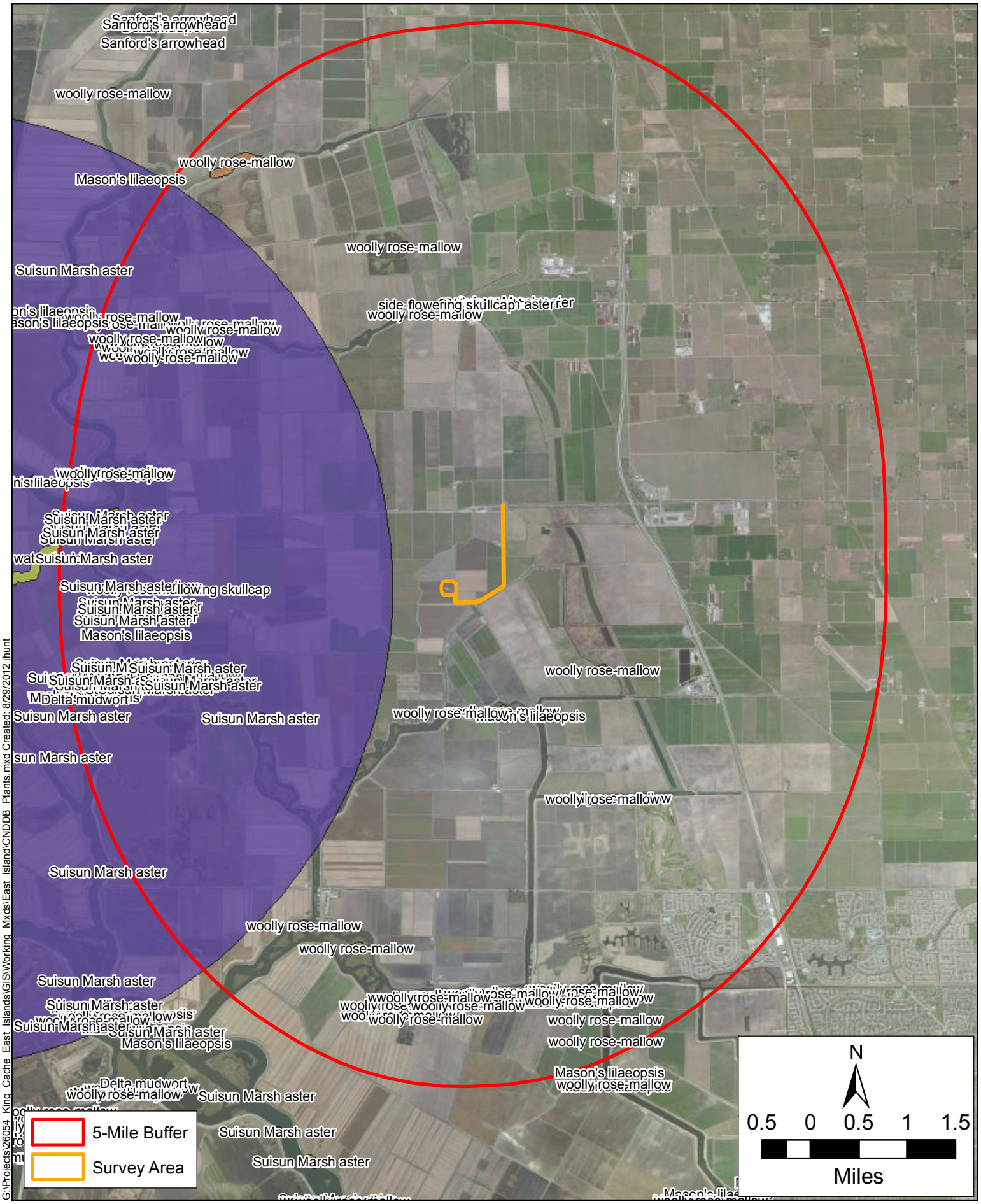


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East Island, San Joaquin County, California

North State Resources, Inc.

Animals CNDDB Results



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East Island, San Joaquin County, California

North State Resources, Inc.

Plants CNDDB Results

APPENDIX C

Swainson's Hawk Survey Protocol

RECOMMENDED TIMING AND METHODOLOGY FOR SWAINSON'S HAWK NESTING SURVEYS IN CALIFORNIA'S CENTRAL VALLEY

Swainson's Hawk Technical Advisory Committee

May 31, 2000

This set of survey recommendations was developed by the Swainson's Hawk Technical Advisory Committee (TAC) to maximize the potential for locating nesting Swainson's hawks, and thus reducing the potential for nest failures as a result of project activities/disturbances. The combination of appropriate surveys, risk analysis, and monitoring has been determined to be very effective in reducing the potential for project-induced nest failures. As with most species, when the surveyor is in the right place at the right time, Swainson's hawks may be easy to observe; but some nest sites may be very difficult to locate, and even the most experienced surveyors have missed nests, nesting pairs, mis-identified a hawk in a nest, or believed incorrectly that a nest had failed. There is no substitute for specific Swainson's hawk survey experience and acquiring the correct search image.

METHODOLOGY

Surveys should be conducted in a manner that maximizes the potential to observe the adult Swainson's hawks, as well as the nest/chicks second. To meet the California Department of Fish and Game's (CDFG) recommendations for mitigation and protection of Swainson's hawks, surveys should be conducted for a ½ mile radius around all project activities, and if active nesting is identified within the ½ mile radius, consultation is required. In general, the TAC recommends this approach as well.

Minimum Equipment

Minimum survey equipment includes a high-quality pair of binoculars and a high quality spotting scope. Surveying even the smallest project area will take hours, and poor optics often result in eye-strain and difficulty distinguishing details in vegetation and subject birds. Other equipment includes good maps, GPS units, flagging, and notebooks.

Walking vs Driving

Driving (car or boat) or "windshield surveys" are usually preferred to walking if an adequate roadway is available through or around the project site. While driving, the observer can typically approach much closer to a hawk without causing it to fly. Although it might appear that a flying bird is more visible, they often fly away from the observer using trees as screens; and it is difficult to determine from where a flying bird came. Walking surveys are useful in locating a nest after a nest territory is identified, or when driving is not an option.

Angle and Distance to the Tree

Surveying subject trees from multiple angles will greatly increase the observer's chance of detecting a nest or hawk, especially after trees are fully leafed and when surveying multiple trees

in close proximity. When surveying from an access road, survey in both directions. Maintaining a distance of 50 meters to 200 meters from subject trees is optimal for observing perched and flying hawks without greatly reducing the chance of detecting a nest/young: Once a nesting territory is identified, a closer inspection may be required to locate the nest.

Speed
Travel at a speed that allows for a thorough inspection of a potential nest site. Survey speeds should not exceed 5 miles per hour to the greatest extent possible. If the surveyor must travel faster than 5 miles per hour, stop frequently to scan subject trees.

Visual and Aural Ques
Surveys will be focused on both observations and vocalizations. Observations of nests, perched adults, displaying adults, and chicks during the nesting season are all indicators of nesting Swainson's hawks. In addition, vocalizations are extremely helpful in locating nesting territories. Vocal communication between. hawks is frequent during territorial displays; during courtship and mating; through the nesting period as mates notify each other that food is available or that a threat exists; and as older chicks and fledglings beg for food.

Distractions
Minimize distractions while surveying. Although two pairs of eyes may be better than one pair at times, conversation may limit focus. Radios should be off, not only are they distracting, they may cover a hawk's call.

Notes and Species Observed
Take thorough field notes. Detailed notes and maps of the location of observed Swainson's hawk nests are essential for filling gaps in the Natural Diversity Data Base; please report all observed nest sites. Also document the occurrence of nesting great homed owls, red-tailed hawks, red-shouldered hawks and other potentially competitive species. These species will infrequently nest within 100 yards of each other, so the presence of one species will not necessarily exclude another.

TIMING

To meet **the minimum level** of protection for the species, surveys should be completed for **at least** the two survey periods immediately prior to a project's initiation. For example, if a project is scheduled to begin on June 20, you should complete 3 surveys in Period III and 3 surveys in Period V. However, it is always recommended that surveys be completed in Periods II, III and V. **Surveys should not be conducted in Period IV.**

The survey periods are defined by the timing of migration, courtship, and nesting in a "typical" year for the majority of Swainson's hawks from San Joaquin County to Northern Yolo County. Dates should be adjusted in consideration of early and late nesting seasons, and geographic differences (northern nesters tend to nest slightly later, etc). If you are not sure, contact a TAC member or CDFG biologist.

Survey dates **Justification and search image**	**Survey time**	**Number of Surveys**
I. *January-March 20 (recommended optional)*	*All day*	*1*

Prior to Swainson's hawks returning, it may be helpful to survey the project site to determine potential nest locations. Most nests are easily observed from relatively long distances, giving the surveyor the opportunity to identify potential nest sites, as well as becoming familiar with the project area. It also gives the surveyor the opportunity to locate and map competing species nest sites such as great homed owls from February on, and red-tailed hawks from March on. After March 1, surveyors are likely to observe Swainson's hawks staging in traditional nest territories.

II. *March 20 to April 5*	*Sunrise to 1000* *1600 to sunset*	*3*

Most Central Valley Swainson's hawks return by April 1, and immediately begin occupying their traditional nest territories. For those few that do not return by April 1, there are often hawks ("floaters") that act as place-holders in traditional nest sites; they are birds that do not have mates, but temporarily attach themselves to traditional territories and/or one of the site's "owners." Floaters are usually displaced by the territories' owner(s) if the owner returns.

Most trees are leafless and are relatively transparent; it is easy to observe old nests, staging birds, and competing species. The hawks are usually in their territories during the survey hours, but typically soaring and foraging in the mid-day hours. Swainson's hawks may often be observed involved in territorial and courtship displays, and circling the nest territory. Potential nest sites identified by the observation of staging Swainson's hawks will usually be active territories during that season, although the pair may not successfully nest/reproduce that year.

III. *April 5 to April 20*	*Sunrise to 1200* *1630 to Sunset*	***3***

Although trees are much less transparent at this time, 'activity at the nest site increases significantly. Both males and females are actively nest building, visiting their selected site frequently. Territorial and courtship displays are increased, as is copulation. The birds tend to vocalize often, and nest locations are most easily identified. This period may require a great deal of "sit and watch" surveying.

IV. *April 21 to June 10*	*Monitoring known nest sites only* ***Initiating Surveys is not recommended***	

Nests are extremely difficult to locate this time of year, and even the most experienced surveyor will miss them, especially if the previous surveys have not been done. During this phase of nesting, the female Swainson's hawk is in brood position, very low in the nest, laying eggs, incubating, or protecting the newly hatched and vulnerable chicks; her head may or may not be visible. Nests are often well-hidden, built into heavily vegetated sections of trees or in clumps of mistletoe, making them all but invisible. Trees are usually not viewable from all angles, which may make nest observation impossible.

Following the male to the nest may be the only method to locate it, and the male will spend hours away from the nest foraging, soaring, and will generally avoid drawing attention to the nest site. Even if the observer is fortunate enough to see a male returning with food for the female, if the female determines it is not safe she will not call the male in, and he will not approach the nest; this may happen if the observer, or others, are too close to the nest or if other threats, such as rival hawks, are apparent to the female or male.

V. ***June 10 to JuIy 30 (post-fledging)*** ***Sunrise to 1200*** ***3***
1600 to sunset

Young are active and visible, and relatively safe without parental protection. Both adults make numerous trips to the nest and are often soaring above, or perched near or on the nest tree. The location and construction of the nest may still limit visibility of the nest, young, ‘and adults.

DETERMINING A PROJECT'S POTENTIAL
FOR IMPACTING SWAINSON'S HAWKS

LEVEL OF RISK	REPRODUCTIVE SUCCESS (Individuals)	LONGTERM SURVIVABILITY (Population)	NORMAL SITE CHARACTERISTICS (Daily Average)	NEST MONI-TORING
HIGH	Direct physical contact with the nest tree while the birds are on eggs or protecting young. (Helicopters in close proximity)	Loss of available foraging area.	Little human-created noise, little human use: nest is well away from dwellings, equipment yards, human access areas, etc. *Do not include general cultivation practices in evaluation.*	**MORE**
		Loss of nest trees.		
	Loss of nest tree after nest building is begun prior to laying eggs.	Loss of potential nest trees.		
	Personnel within 50 yards of nest tree (out of vehicles) for extended periods while birds are on eggs or protecting young that are < 10 days old.	Cumulative: Multi-year, multi-site projects with substantial noise/personnel disturbance.		
	Initiating construction activities (machinery and personnel) within 200 yards of the nest after eggs are laid and before young are > 10 days old.	Cumulative: Single-season projects with substantial noise/personnel disturbance that is greater than or significantly different from the daily norm.		
	Heavy machinery only working within 50 yards of nest.		Substantial human-created noise and occurrence: nest is near roadways, well-used waterways, active airstrips, areas that have high human use. *Do not include general cultivation practices in evaluation.*	
	Initiating construction activities within 200 yards of nest before nest building begins or after young > 10 days old.	Cumulative: Single-season projects with activities that "blend" well with site's "normal' activities.		
LOW	All project activities (personnel and machinery) greater than 200 yards from nest.			**LESS**

A318: King Cultural Resource Survey Final

Cultural Resource Survey for the PG&E CAES – King Island Project, San Joaquin County, California

Prepared for

Pacific Gas and Electric Company

Prepared by

SWCA Environmental Consultants

October 2012

CONFIDENTIAL – NOT FOR PUBLIC DISTRIBUTION

CULTURAL RESOURCE SURVEY FOR THE PG&E CAES – KING ISLAND PROJECT SAN JOAQUIN COUNTY, CALIFORNIA

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SWCA Project No. 23910
SWCA Cultural Resource Report No. 12-392

October 2012

Keywords: Cultural resource survey; 4 potential cultural resources; 41.4 acres; San Joaquin County; Terminous quadrangle; Township 3 North, and Range 5 East

Archaeological and other heritage resources can be damaged or destroyed through uncontrolled public disclosure of information regarding their location. This document contains sensitive information regarding the nature and location of archaeological sites which should not be disclosed to the general public or unauthorized persons.

Information regarding the location, character, or ownership of a cultural resource is exempt from the Freedom of Information Act pursuant to 16 USC 470w-3 (National Historic Preservation Act) and 16 USC Section 470(h) (Archaeological Resources Protection Act).

MANAGEMENT SUMMARY

Purpose and Scope: SWCA Environmental Consultants (SWCA) was retained by Pacific Gas and Electric Company (PG&E) to conduct a cultural resource study in support of the PG&E Compressed Air Energy Storage (CAES) – King Island Project (project). The study area consists of 16.75 hectares (41.4 acres) of land located approximately 14.25 kilometers (8.9 miles) southwest of the City of Lodi in San Joaquin County, California. The cultural resource study consisted of a cultural resource record and literature search, Native American consultation, cultural resource survey of the study area, and preparation of a cultural resource technical report documenting the results of the inventory and providing management recommendations.

Dates of Investigation: A search of the California Historical Resources Information System (CHRIS) was conducted by the Central California Information Center (CCIC) at California State University, Stanislaus in Turlock, California, and the results were received on August 28, 2012. Cultural resource specialists conducted an intensive-level cultural resource survey on August 28, 2012.

Findings of the Investigation: Seven prior cultural resource studies have been conducted within a 1.6-kilometer (1-mile) radius of the area of potential effects (APE), one of which included a portion of the APE. The records and literature search also indicates that five cultural resources have been previously recorded within a 1-mile radius of the APE, none of which are located in the study area. Three buildings (SWCA-KING-1, SWCA-KING-2, and SWCA-KING-3) were identified in the study area along one of the potential access roads (Alternate B). Visual observation and initial research of these buildings suggest that they may be older than 50 years and as such, could be potential cultural resources. SWCA archaeologists did not identify any other cultural resources in the APE.

Investigation Constraints: Ground visibility was generally poor throughout the study area due to obstruction by vegetative ground cover, pavement, and gravel. A portion of the study area along the eastern side of Alternate B was unable to be fully surveyed to the full 25-foot-wide buffer from the edge of the access road due to an adjacent waterway.

Recommendations Summary: SWCA cultural resource specialists identified three buildings and an irrigation canal along Alternate B as a result of the intensive-level survey (SWCA-KING-1, SWCA-KING-2, SWCA-KING-3, and SWCA-KING-4). Visual observation and initial research of these resources suggest that they may be potential cultural resources. Until these resources are formally recorded and evaluated, SWCA recommends that they be treated as though they are significant, and that the project avoid impacting them. Alternate A would not have direct or indirect effects on these buildings, and SWCA recommends that the project use this access route, while avoiding the use of Alternate B. If it becomes necessary to use Alternate B, SWCA recommends that SWCA-KING-1, SWCA-KING-2, SWCA-KING-3, SWCA-KING-4 be formally evaluated to determine their significance before the start of any construction activities.

However, in the event that cultural resources are discovered during construction grading, trenching, or excavation, project personnel should halt earth-moving activities in the immediate area and notify a qualified archaeologist to evaluate the resource. In the event of the discovery of human remains during project implementation, relevant state law shall be followed, beginning with a cessation of disturbance and the placing of a call to the county coroner.

Disposition of Data: This report will be on file with the following entities: the CCIC at California State University, Stanislaus; PG&E; and SWCA. All field notes and records related to the current project are on file at SWCA's Pasadena office. All geographical information systems data created during this study is on file at SWCA's Pasadena office and PG&E.

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CONTENTS

Management Summary ..... **i**

Introduction **1**
Project Description 1
Area of Potential Effects 1

Regulatory Setting **5**
Federal 5
National Historic Preservation Act 5
State 6
California Environmental Quality Act 6

Environmental Setting **7**

Cultural Setting **8**
Prehistoric Overview 8
Windmiller Pattern (2500–500 B.C.) 9
Berkeley Pattern (500 B.C.–A.D. 500) 9
Augustine Pattern (A.D. 500–historic contact) 10
Ethnographic Overview 10
Historic Overview 12
San Joaquin County 12

Background Research **13**
California Historical Resources Information System Records Search 13
Prior Cultural Resources Studies within 1 Mile of the APE 14
Previously Recorded Cultural Resources within 1-mile of the APE 14
Historic Map Review 15
Sacred Lands File Search and Initial Native American Coordination 15

Methods **17**

Results **17**

Discussion and Recommendations **21**
Discussion 21
Recommendations 21
Inadvertent Discovery of Cultural Resources 21
Inadvertent Discovery of Human Remains 21

References Cited **23**

APPENDICES

Appendix A. Records Search Results Summary from CCIC
Appendix B. Native American Coordination Correspondence
Appendix C. California Department of Parks and Recreation Series 523 Forms

TABLES

Table 1. Prior Cultural Resource Studies within 1 Mile of the APE 14
Table 2. Previously Recorded Cultural Resources within 1 Mile of the APE 15
Table 3. Record of Native American Coordination Efforts 16

FIGURES

Figure 1. Location of the study area. 2
Figure 2. Detailed location of the study area. 3
Figure 3. **T**he area of the potential effects. 4
Figure 4. Overview of study area; view to north. 7
Figure 6. Agricultural activities in the study area; view to the west. 18
Figure 7. Paved access road (Alternate B) and irrigation canal; view to the south. 19
Figure 8. Potential cultural resources map in relation to the study area. 20

INTRODUCTION

SWCA Environmental Consultants (SWCA) was retained by Pacific Gas and Electric Company (PG&E) to conduct a cultural resource study in support of the PG&E Compressed Air Energy Storage (CAES) – King Island Project (project). The study area consists of 16.75 hectares (41.4 acres) of land located approximately 14.25 kilometers (8.9 miles) southwest of the City of Lodi in San Joaquin County, California. The cultural resource study consisted of a cultural resource record and literature search, Native American consultation, cultural resource survey of the study area, and preparation of a cultural resource technical report documenting the results of the inventory and providing management recommendations.

Project Description

The project would use renewable energy from sources such as wind to inject compressed air into an underground reservoir and then use it to help power a turbine generator during peak periods when the energy is needed most. It would be implemented in three phases: site selection and feasibility analysis, licensing and permitting, and construction and operation.

The King Island reservoir site consists of the expansion of the existing Piacentine well pad to the west for a total area of 42 × 67 meters (m) (140 × 220 feet). The well pad will support a drilling rig and other equipment for the purpose of core drilling tests to determine whether the King Island reservoir is a viable candidate for the CAES project. Construction of the well pad will require importing non-native fill material (e.g., sand and gravel) to stabilize the site so that it can support a drilling rig. Access routes may also require grading prior to construction. Site preparation will include importing gravel and sand and performing grading and compaction, and will occur over a 1- to 2-week period starting as early as October 2012. Core drilling is planned to start as early as November 2012 following site preparation, and will consist of mobilizing a drill rig with supporting equipment, conducting core drilling to approximately 1,524 m (5,000 feet) below the surface.

Area of Potential Effects

An area of potential effects (APE) is defined as the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties (36 Code of Federal Regulations [CFR] 800.16(d)). The proposed project is located within unincorporated San Joaquin County in an area primarily characterized by agricultural land use. The archaeological or direct APE boundary represents portions of the study area that will be directly affected by the proposed undertaking, and includes areas where ground disturbance may result from the proposed project. Specifically, the direct APE consists of the construction footprint, or well pad site, and two potential access roads (Alternate A and Alternate B). The vertical APE extends to approximately 1,524 m (5,000 feet) below the existing ground surface, or the depth to which core drilling will be conducted. A study area was established to include both direct and indirect effects, and included an approximately 61-m (200-foot) buffer around the well pad site, and a 7.6-m (25-foot) buffer from the edges of each of the potential access roads (Figure 3).

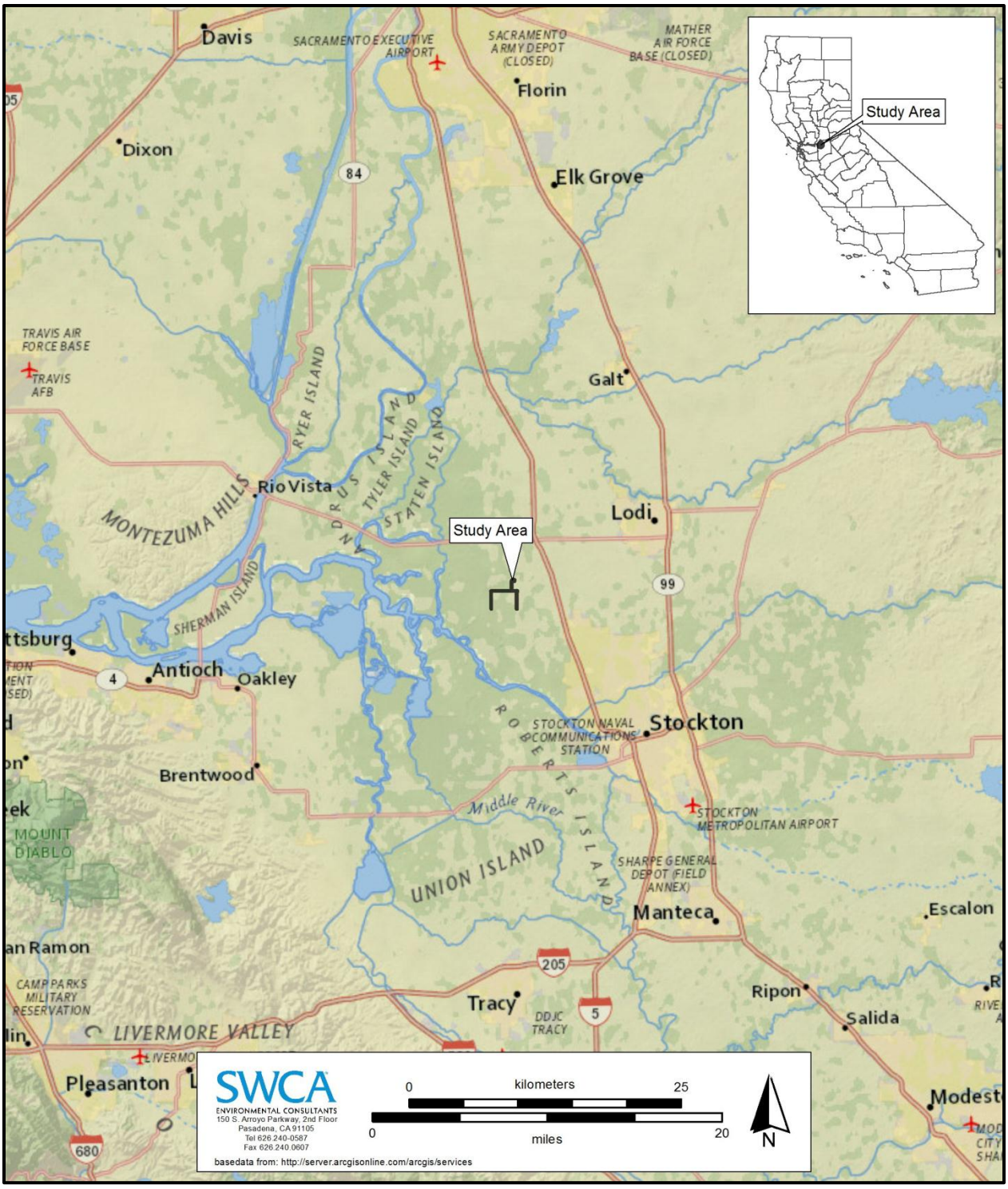


Figure 1. Location of the study area.

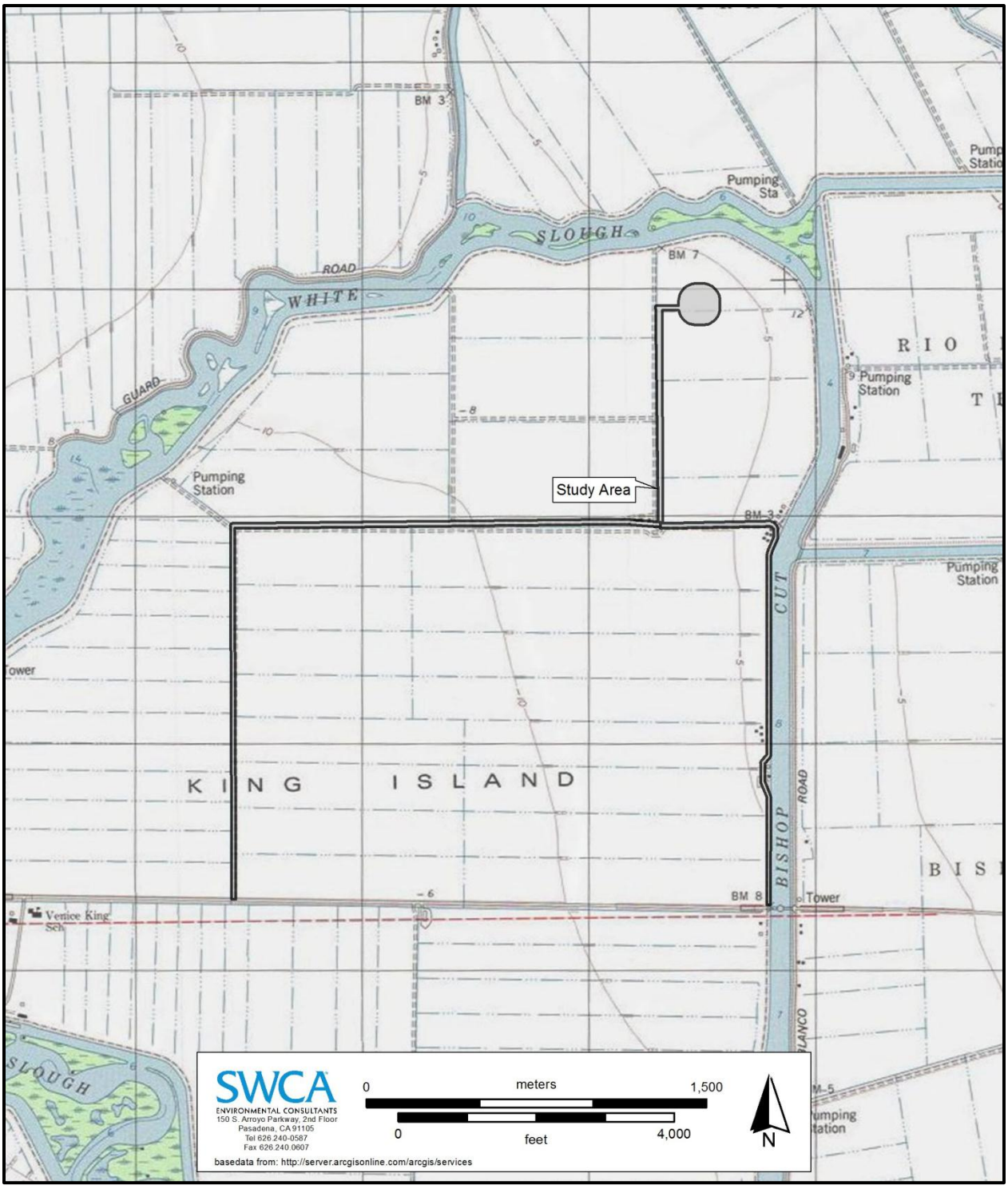


Figure 2. Detailed location of the study area.



Figure 3. The area of the potential effects in relation to Alternate A and B.

REGULATORY SETTING

This section identifies federal regulations, state legislation, and local statutes, ordinances, and guidelines that govern the identification and treatment of cultural resources and analysis of project-related effects on cultural resources. The lead agency must consider these requirements in making decisions on projects that may affect cultural resources. The current study was conducted in compliance with both federal and state laws, particularly Section 106 of the National Historic Preservation Act (NHPA) and the California Environmental Quality Act (CEQA).

Federal

National Historic Preservation Act

The current study was completed under the provisions of the NHPA of 1966, as amended (16 United States Code 470f). Cultural resources are considered during federal undertakings chiefly under Section 106 of the NHPA through one of its implementing regulations, 36 CFR 800 (Protection of Historic Properties), as well as the National Environmental Policy Act (NEPA). Properties of traditional religious and cultural importance to Native Americans are considered under Section 101(d)(6)(A) of the NHPA. Other relevant federal laws include the Archaeological Data Preservation Act of 1974, the American Indian Religious Freedom Act of 1978, the Archaeological Resources Protection Act of 1979, and the Native American Graves Protection and Repatriation Act of 1989.

Section 106 requires federal agencies to take into account the effects of their undertakings on any district, site, building, structure, or object that is included in or eligible for the National Register of Historic Places (NRHP) and to afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings (36 CFR 800.1). Under Section 106, cultural resources must be identified and evaluated; effects on historic properties are reduced to acceptable levels through mitigation measures or agreements among consulting and interested parties. Historic properties are those resources that are listed in or are eligible for the NRHP in accordance with the criteria listed below (36 CFR 60.4) (ACHP 2010).

The quality of *significance* in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess *integrity* of location, design, setting, materials, workmanship, feeling and association and that

(A) are associated with events that have made a significant contribution to the broad patterns of our history; or

(B) are associated with the lives of persons significant in our past; or

(C) embody the distinctive characteristics of a type, period, or method of installation, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(D) have yielded, or may be likely to yield, information important in prehistory or history.

Impacts of a project to significant cultural resources that affect the characteristics of any resource that qualify it for the NRHP are considered a significant effect on the environment. Under 36 CFR 800.5(a)(2), adverse effects on historic properties include, but are not limited to

(i) physical destruction of or damage to all or part of the property;

(ii) alteration of a property;

(iii) removal of the property from its historic location;

(iv) change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;

(v) introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features;

(vi) neglect of a property which causes its deterioration;

(vii) transfer, lease, or sale of property out of federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

State

California Environmental Quality Act

CEQA requires a lead agency to determine whether a project may have a significant effect on historical resources (Section 21084.1). If it can be demonstrated that a project will cause damage to a unique archaeological resource, the lead agency may require that reasonable efforts be made to permit any or all of these resources to be preserved in place or left in an undisturbed state. To the extent that they cannot be left undisturbed, mitigation measures are required (Section 21083.2[a], [b], and [c]).

Section 21083.2(g) defines a *unique archaeological resource* as an archaeological artifact, object, or site about which it can be clearly demonstrated that without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

(1) Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.

(2) Has a special and particular quality such as being the oldest of its type or the best available example of its type.

(3) Is directly associated with a scientifically recognized important prehistoric or historic event or person.

A *historical resource* is a resource listed in, or determined to be eligible for, the California Register of Historical Resources (CRHR) (Section 21084.1); a resource included in a local register of historical resources (Section 15064.5[a][2]); or any object, building, structure, site, area, place, record, or manuscript that a lead agency determines to be historically significant (Section 15064.5[a][3]).

Public Resources Code (PRC) Section 5024.1, Section 15064.5 of the CEQA Guidelines, and PRC Sections 21083.2 and 21084.1 were used as the basic guidelines for this cultural resource study. PRC Section 5024.1 requires an evaluation of historical resources to determine their eligibility for listing in the CRHR. The purpose of the register is to maintain listings of the state's historical resources and to indicate which properties are to be protected from substantial adverse change. The criteria for listing resources on the CRHR were expressly developed to be in accordance with previously established criteria developed for listing in the NRHP, enumerated below.

According to PRC Section 5024.1(c)(1–4), a resource is considered historically significant if it (i) retains "substantial integrity," and (ii) meets at least one of the following criteria:

(1) Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage.

(2) Is associated with the lives of persons important in our past.

(3) Embodies the distinctive characteristics of a type, period, region, or method of installation, or represents the work of an important creative individual, or possesses high artistic values.

(4) Has yielded, or may be likely to yield, information important in prehistory or history.

Impacts to significant cultural resources that affect the characteristics of any resource that qualify it for the NRHP or adversely alter the significance of a resource listed on or eligible for the CRHR are considered a significant effect on the environment. These impacts could result from "physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of an historical resource would be materially impaired" (CEQA Guidelines, Section 15064.5 [b][1], 2000). Material impairment is defined as demolition or alteration "in an adverse manner [of] those characteristics of an historical resource that convey its historical significance and that justify its inclusion in, or eligibility for inclusion in, the California Register…" (CEQA Guidelines Section 15064.5[b][2][A]).

ENVIRONMENTAL SETTING

The study area is in the Sacramento-San Joaquin Delta region, an area in the California Central Valley lowlands that is defined by the confluence of the Sacramento, American, Mokelumne, and San Joaquin Rivers. The topography of the study area is virtually flat, with elevations ranging from approximately 0 to 3 meters (0 to 10 feet) above mean sea level (Figure 4). The region's climate is characterized by warm, dry summers, and mild, moist winters. Summer temperatures have highs around 32 degrees Celsius (90 degrees Fahrenheit), and winter temperatures have highs around 13 degrees Celsius (55 degrees Fahrenheit).



Figure 4. Overview of study area; view to the north.

Although current land uses in the APE include agricultural croplands, the area near the APE was characterized historically by vegetation communities that included freshwater marshland near permanent water in low-lying areas, seasonal wetlands and vernal pools within grasslands and woodlands, riparian scrub/forest along drainages, and grasslands and oak woodlands in valley foothill areas. With this mosaic of ecological communities, and in view of the ethnographic descriptions of the Plains Miwok (Kroeber 1925; Latta 1977; Wallace 1978) who historically occupied the area, it would appear that the study area and surround area would have provided a very productive environment for its prehistoric occupants, one well-suited to a hunting-gathering economy with a variety of fish, waterbirds, small and large mammals, and edible plant species.

CULTURAL SETTING

Prehistoric Overview

California prehistory is divided into three broad temporal periods that reflect similar cultural characteristics throughout the state: Paleoindian period (ca. 9000–6000 B.C.), Archaic period (6000 B.C.–A.D. 500), and Emergent period (A.D. 500–Historic Contact) (Fredrickson 1973, 1974, 1994a). The Archaic is divided further into Lower (6000–3000 B.C.), Middle (3000–1000 B.C.), and Upper (1000 B.C.– A.D. 500) periods, generally governed by climatic and environmental variables, such as the drying of pluvial lakes at the transition from the Paleoindian to the Lower Archaic.

The APE lies in what generally is described as the Delta subregion of the Central Valley Archaeological Region, which is one of eight arbitrary organizational divisions of the state (Moratto 1984). This archaeological subregion surrounds the Sacramento-San Joaquin Delta in the middle of the Central Valley and mainly includes portions of Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties.

Occupation in the Sacramento-San Joaquin Delta region during the Prehistoric period is estimated to have occurred as early as 12,000 years ago, but only a few archaeological sites have been identified that predate 5,000 years ago. It is possible that Holocene alluvial deposits buried many prehistoric sites in this area, and Moratto (1984:214) estimates that as much as 10 m of sediment accumulated along the lower stretch of the Sacramento River drainage system during the last 5,000–6,000 years. CA-CCO-637 in eastern Contra Costa County, for example, is one of the few early Holocene-age sites in the region, with a record of human occupation as early as 8,500 years ago during the Lower Archaic (Meyer and Rosenthal 1998). The archaeological remains at that site were discovered approximately 2 m below the surface within an alluvial fan near Kellogg Creek.

Prehistoric material culture in central California subsequent to the Paleoindian and Lower Archaic periods has been categorized according to “horizons” or “patterns” that define broad technological, economic, social, and ideological elements over long periods of time and large areas. The taxonomic system historically used for central California is a tripartite classification scheme with Early, Middle, and Late Horizons. This Central California Taxonomic System (CCTS) was the result of efforts of a number of researchers (e.g., Beardsley 1954; Heizer 1949) and was developed further after the advent of radiocarbon dating (Fredrickson 1973, 1974; Heizer 1958; Ragir 1972).

Today, a series of generalized periods associated with regionally based “patterns” are typically used as part of the CCTS for the Sacramento Delta area, San Francisco Bay area, and North Coast ranges (Bennyhoff and Fredrickson 1969; Fredrickson 1973, 1974). Smaller units of patterns are referred to as “aspects” and “phases,” which emphasize more local features. Revisions of the widely accepted CCTS (Bennyhoff 1994; Fredrickson 1994a, 1994b) are found in a recent volume edited by Hughes (1994).

Fredrickson (1973, 1974) defined several regionally based patterns, three of which are specific to the prehistory of the APE. Referred to as the Windmiller Pattern, Berkeley Pattern, and Augustine Pattern, each represents a general pattern of resource exploitation, as identified between 2500 B.C. and the beginning of Euro-American contact in the early 1800s. The Windmiller Pattern was first identified at the Windmiller site (CA-SAC-107) near the Cosumnes River in Sacramento County; the Berkeley Pattern was initially identified at the West Berkeley site (CA-ALA-307) in Alameda County on the east side of the San Francisco Bay; and the Augustine Pattern was identified at the Augustine site (CA-SAC-127) in the Sacramento-San Joaquin Delta. These patterns are present within the following horizon sequences: Middle Archaic period/Windmiller Pattern (formerly Early Horizon), Upper Archaic period/Berkeley Pattern (formerly Middle Horizon), and Emergent period/Augustine Pattern (formerly Late Horizon).

Windmiller Pattern (2500–500 B.C.)

Clearly documented evidence for human occupation in the general area is found at sites characteristic of the Windmiller Pattern during the Middle Archaic period. These sites date to as early as 4,500 years ago and as late as 2,500 years ago (2500–500 B.C.). Such sites often contain manos and metates (grinding stones), as well as many mortar fragments, indicating that acorns and/or various seeds formed an important part of the diet (Moratto 1984:201).

In addition to plant foods, the subsistence system included many other food resources, such as deer, elk, pronghorn, rabbits, and waterfowl. Numerous faunal remains have been documented at Windmiller Pattern sites, along with large quantities of projectile points. Also, the presence of angling hooks and baked clay artifacts possibly used as net or line sinkers, along with the remains of sturgeon, salmon, and smaller fishes, indicates that fishing was an additional source of food (Fredrickson 1973; Heizer 1949; Ragir 1972). Items made of baked clay included net sinkers, pipes, and discoids, as well as cooking "stones." Ground and polished charmstones, impressions of twined basketry, shell beads, and bone tools also have been found at Windmiller Pattern sites. Some items, such as shell beads, obsidian tools, and quartz crystals, were obtained by trade.

The archaeological record during the Windmiller pattern indicates that people practiced a mixed procurement strategy of both game and wild plants, with the addition of acorns and/or seeds. The mixed exploitation of a wide range of natural resources ties into a seasonal foraging strategy. Populations likely occupied the lower elevations of the Sacramento Valley in the winter months and shifted to higher elevations during the summer (Moratto 1984:206). Mortuary practices included burials, accompanied by grave goods, in cemeteries that were separate from the habitation sites.

Berkeley Pattern (500 B.C.–A.D. 500)

Over a 1,000-year period, the Windmiller Pattern began to shift to the more specialized adaptive Berkeley Pattern during the Upper Archaic period. A shift to a greater reliance on acorns as a dietary staple is interpreted during the Berkeley Pattern from the increase in mortars and pestles, along with a decrease in manos and metates. Mortars and pestles are better suited to crushing and grinding acorns, whereas manos and metates were used primarily for grinding wild grass grains and seeds (Moratto 1984:209–210).

As demonstrated by the artifact assemblage, hunting remained an important aspect of food procurement during the Berkeley Pattern (Fredrickson 1973:125–126). The archaeological record, which consists of numerous large shell midden/mounds, also demonstrates that occupants at most Berkeley Pattern sites near water (both fresh and salt) made intensive use of aquatic resources.

The artifact assemblage also includes shell beads and ornaments, as well as numerous types of bone tools. Interment continues to dominate mortuary practices, but a few cremations are also found at Berkeley Pattern sites.

Artifact assemblages and radiocarbon dating of sites from this period suggest this subsistence pattern may have developed in the San Francisco Bay region and later spread to surrounding coastal locales and into central California. Moratto (1984:207–211) suggests that the pattern is related to the expansion of Eastern Miwok populations from the San Francisco Bay area to the Sacramento Valley and Sierra foothills.

Augustine Pattern (A.D. 500–historic contact)

The Augustine Pattern is evidenced by a number of changes in subsistence, foraging, and land-use patterns that begin to reflect the use pattern known from Historic period Native American groups in the area. A substantial increase in the intensity of subsistence exploitation (including fishing, hunting, and gathering [particularly the acorn]) evidenced in the archaeological record correlates directly with population growth (Moratto 1984:211–214).

Tools and cooking implements include shaped mortars and pestles, hopper mortars, bone awls used for producing coiled baskets, and the bow and arrow. Pottery vessels, known as Cosumnes Brownware, are found in some parts of the Central Valley and most likely developed during this period from the prior baked clay industry.

During this period, an increase in sedentism led to the development of social stratification, accompanied by a shift to elaborate ceremonial and social organization. Exchange networks, with the use of clamshell disk beads as currency, also developed during the Augustine Pattern. Mortuary practices during this pattern included flexed burials and pre-interment burning of offerings in a grave pit, as well as cremation of high-status individuals (Fredrickson 1973:127–129; Moratto 1984:211). Additional items of material culture include flanged tubular pipes, harpoons, and small Gunther barbed series projectile points. The Augustine Pattern may represent the southward expansion of Wintu populations (Moratto 1984: 211–214).

Ethnographic Overview

The APE is located in an area historically occupied by the Penutian-speaking Plains Miwok, a subgroup of the Eastern Miwok (Kroeber 1925; Levy 1978; Shipley 1978:84). The Plains Miwok historically occupied the lower Mokelumne River, Cosumnes River, and the Sacramento River from Rio Vista to Freeport (Levy 1978:398–399). Neighboring groups included the Nisenan to the north, Patwin and Bay Miwok to the west, Northern Valley Yokuts to the south, and the Washoe to the east.

Spanish mission records, diaries, and journals have provided the most comprehensive study of the Miwok, as well as some ethnographical studies done in the first half of the twentieth century (Bennyhoff 1977; Levy 1978:399). Much of the history of the Plains Miwok, however, is incomplete.

The villages of the Plains Miwok were divided into "tribelets," political units that were also structured by similarities in language and ethnicity. The tribelets averaged 300–500 persons, and each held claim to a designated portion of territory within the lands of the Plains Miwok, which also extended to the natural resources within each territory (Levy 1978:410). Each tribelet's territory contained a main village and smaller satellite villages. Within a tribelet's main village was an assembly or dance house, either a large semi-subterranean structure or a simpler circular brush structure (Kroeber 1925:447). Other structures included semi-subterranean or aboveground conical houses made with tule-matting, conical sweathouses,

winter grinding houses, and acorn granaries (Levy 1978:408–409). The Plains Miwok also practiced cremation (Kroeber 1925:452).

The rich resources of the Sacramento-San Joaquin Delta and surrounding areas provided the Plains Miwok with food and material needs. The primary food staple was the acorn, supplemented by waterfowl, fish, shellfish, and large and small mammals (Bennyhoff 1977; Levy 1978). The Miwok are best described as seasonally mobile hunter-gatherers with semi-permanent villages. The delta islands were also used regularly for hunting and fishing base camps. Permanent settlements of the Plains Miwok were located on high ridges or knolls near watercourses or on the sandy islands in the delta.

The Plains Miwok collected plant greens and roots in the spring; seeds and nuts in the spring, summer, and early fall; and acorns in the late fall/early winter (Levy 1978:402–403). Acorns, particularly from the prevalent valley oak (*Quercus lobata*) could be stored for some time in the conical-shaped granaries prior to processing. Tule elk, pronghorn antelope, and mule deer, as well as smaller mammals such as jackrabbits, cottontails, beaver, squirrels, and woodrats, were regularly hunted. Game birds included many types of waterfowl, mountain and valley quail, pigeons, jays, and woodpeckers. In addition to salmon, the Plains Miwok fished for sturgeon and lamprey (Levy 1978:402–403).

A wide array of tools, implements, and enclosures were used by the Plains Miwok for hunting and gathering of natural resources. Among those used for hunting land mammals and birds were the bow and arrow, traps and snares, nets, and enclosures/blinds. Communal hunting drives were employed for both large and small mammals. Many plants were collected using wooden tools: long poles for dislodging acorns and pinecones, fire-hardened digging sticks for roots, and beaters for dislodging seeds. Once collected, seeds, roots, and nuts were placed in burden baskets and transported for processing or storage (Levy 1978:403–404).

The Plains Miwok used a variety of tools to process food resources. These included portable stone mortars and pestles, bedrock mortars, anvils, woven strainers and winnowers, leaching and boiling baskets, woven drying trays, and knives. Unprocessed acorns were stored in conical granaries. Various foods were baked in earth ovens. Exotic items such as obsidian, steatite, and shell indicate they traded with coastal groups and mountain tribes (Levy 1978).

The Native American population in the Sacramento Valley came into contact with European culture beginning in the late 1700s, as a result of increased incursions into the area by the Spanish. Traditional lifeways were drastically altered during the early to mid-1800s as Spanish colonization and proselytization, Mexican land grants, and the American takeover and settlement pushed indigenous peoples into the rugged California interior and reduced their numbers through transport to the missions, disease, and slaughter. Beginning in the early 1800s, most of the Plains Miwok converts were transported to Mission San José (Levy 1978:400–402). Many resisted and tried to return to their villages in the delta. Plains Miwok fought the invaders in the 1820s and 1830s, and with neighboring Yokuts, they also attacked Mexican coastal settlements. The secularization of the missions followed, spurred in part by these activities. During the war with Mexico in the 1840s, the Miwoks aided the United States (Cook 1960, 1962).

The California Gold Rush of 1849 and the continuing influx of Euro-Americans into formerly remote regions of California was the final cultural blow for many California Indians, including the Miwok bands near the study area. With the loss of most of their traditional lands, as well as enslavement, slaughter, and disease, surviving Miwok labored for the growing lumber, ranching, farming, and mining industries (Levy 1978:401).

During the first half of the twentieth century, acquisitions of land by the federal government (from 2 acres to more than 300 acres) created a number of reservations, or *rancherias*, for the Plains Miwok, along with

the Northern and Central Sierra Miwok. Between 1934 and 1972, the U.S. Bureau of Indian Affairs then terminated relations with most of these rancherias, although since 1984, the status has been restored to most of the rancherias (Slagle 2005). Today, although there is no unified California Miwok tribal organization at a state or federal level, there are seven rancherias that have primarily or exclusively Eastern Miwok populations. These are the Buena Vista Rancheria (Plains Miwok/Amador County), the Chicken Ranch Rancheria (Central Sierra division of Eastern Miwok/Tuolumne County), the Ione Rancheria (Northern Sierra and Plains Miwok/Amador County), the Jackson Rancheria (Northern Sierra and Plains Miwok/Amador County), the Sheep Ranch Rancheria (Northern Sierra Miwok/Calaveras County), the Shingle Springs Rancheria (Plains Miwok/El Dorado County), and the Tuolumne Rancheria (Central Sierra Miwok/Tuolumne County) (Slagle 2005).

Historic Overview

Post-contact history for the state of California is generally divided into three periods: the Spanish period (1769–1822), the Mexican period (1822–1848), and the American period (1848–present). Although there were brief visits by Spanish, Russian, and British explorers from 1529 to 1769, the beginning of Spanish settlement in California occurred in 1769 with an establishment of Mission San Diego, one of the 21 missions established from 1769 to 1823. The Mexican period began when news of the successful revolution by Mexico against the Spanish crown reached California in 1822. This period is marked by an extensive era of land grants, most of which were in the interior of the state, and by exploration by American fur trappers west of the Sierra Nevada Mountains.

With the signing of the Treaty of Guadalupe Hidalgo in 1848, ending the Mexican-American War, California became a territory of the United States. The discovery of gold in 1848 at Sutter's Mill near Sacramento and the resulting Gold Rush era influenced the history of the state and the nation. The rush of tens of thousands of people to the gold fields also had a devastating impact on the lives of indigenous Californians, with the introduction and concentration of diseases; the loss of land and territory, including traditional hunting and gathering locales; violence; malnutrition; and starvation. Thousands of settlers and immigrants continued to pour into the state, particularly after the completion of the transcontinental railroad in 1869.

With continued growth, California continues to be a national leader in agriculture and poultry production, ranching (cattle and sheep), aerospace and communications industries, as well as the film and entertainment business. The wealth of California's natural resources (e.g., lumber, petroleum deposits, minerals, fish) also continues to contribute to its growth and development.

San Joaquin County

San Joaquin County was one of the original 27 counties of California, created in 1850 at the time of statehood (Hoover et al. 2002:369). The county's geographical location in the center of the state between the Sierra Nevada mountain range to the east and the San Francisco Bay to the west has made it a prime location for business and industry. The county is accessible from almost all parts of the state by means of the Port of Stockton, the interstate highway system, railroads, and airports. Captain Charles M. Weber was instrumental in developing the city of Stockton as the county seat and as a port of entry, where the two large rivers that drain the northern and southern halves of the great Central Valley meet at the Sacramento-San Joaquin Delta. Ships today still deliver cargo to the Port of Stockton via the Stockton Channel, the deep-water slough that leads into the San Joaquin River, next to which Captain Weber laid out the town of Tuleburg (now Stockton) in 1847.

Agriculture and livestock have defined San Joaquin County's past and continue to play an important role in the present and foreseeable future. The many rivers in the area, including the San Joaquin, Cosumnes,

Mokelumne, and Calaveras Rivers, form rich agricultural land as well as marshlands for abundant wildlife. In 1813, Lieutenant Gabriel Moraga led an expedition in the lower portion of California's Central Valley, giving the name San Joaquin to the large river that flows northward through the county (Hoover et al. 2002:369). Later immigrants were attracted to the abundance of wildlife within or along the rivers, including waterfowl, fish, and fur-bearing animals. In 1827, American explorer and trapper Jedediah Smith traveled through the San Joaquin Valley. Other trappers soon followed, including employees of the Hudson's Bay Company in 1832 (Hoover et al. 2002:370).

Irrigation is an important part of the history of the productive agricultural and livestock economy of the county. The Miller and Lux Company, a cattle company known across the west, had vast holdings in the San Joaquin Valley. Founded by German immigrant Henry Miller (formerly Heinrich Alfred Kaiser) and partner Charles Lux, their lands and herds could be found throughout the state of California. They built an empire by acquiring rancho property and driving cattle to market in San Francisco (Hoover et al. 2002:435). The Miller and Lux Company also pioneered irrigation projects in the San Joaquin Valley, beginning with completion of the San Joaquin Canal in the 1870s. This ambitious project began on the San Joaquin River near Fresno Slough, and then ran north through Merced County and into Stanislaus County. The company also controlled more than 50 miles of land along Kern River, which they were able to parlay into a system of canals to irrigate dry lands that then became productive agricultural fields (Beck and Haase 1974:76; Hoover et al. 2002:94).

The history of San Joaquin County would not be complete without mention of the Tidewater Southern Railway. Begun as an electric interurban railway, the line opened its initial 32 miles of mainline between Stockton and Modesto in October 1912 (Tidewater Southern Railway 2007). The railway connected on the north to the Central California Traction Company Railroad, which served the Central Valley from Stockton to Sacramento. The Tidewater Southern was a successful venture, with 24 trains operating daily between Stockton and Modesto by 1916. The same year, it extended the rails to Turlock and to Hilmar. The last tracks of the Tidewater Southern were added in 1918, a 6.6-mile-long north-south branch between Manteca and Manteca Junction. The previous year, most of the rolling stock had been purchased by the Western Pacific Railroad. The number of passengers declined with the onset of the Depression, and the last interurban ran in 1932. This decline was offset, however, by an increase in freight transport, particularly agricultural products. Diesel power entirely replaced the electrified type by the late 1940s, and the line was upgraded in the 1950s and 1960s. Today, the original Tidewater Southern line between Stockton and Turlock is served as part of the Union Pacific Railroad; the Western Pacific merged into the Union Pacific in 1982.

BACKGROUND RESEARCH

California Historical Resources Information System Records Search

On August 22, 2012, a search was requested of the California Historical Resources Information System (CHRIS) at the Central California Information Center (CCIC), located at California State University, Stanislaus in Turlock, California. The search included any previously recorded cultural resources and investigations within a 1.6-kilometer (1-mile) radius of the APE. The CHRIS search also included a review of the NRHP, the CRHR, the California Points of Historical Interest list, the California Historical Landmarks list, the Archaeological Determinations of Eligibility list, and the California State Historic Resources Inventory list. Additionally, the records search included a review of historic maps covering the APE. A letter dated August 23, 2012, from the CCIC summarizing the results of the records search and providing a bibliography of prior cultural resources studies is provided in Appendix A of this report.

Prior Cultural Resources Studies within 1 Mile of the APE

The records searches identified seven prior cultural resource studies within 1 mile of the APE (Table 1). Of this, one (SJ-00767) was conducted within a portion the APE; a brief summary of this study is provided in the paragraph that follows.

Table 1. Prior Cultural Resource Studies within 1 Mile of the APE

CCIC Report No.	Title of Study	Author	Year	Proximity to the APE
SJ-00727	Cultural Resources Evaluation for the Proposed Water Supply Pipeline and treatment Plant Locations for the City of Stockton, San Joaquin County, California	Chavez, David	1978	Outside
SJ-00767	Cultural Resource Investigations of the Eight Mile Road Bridge No. 1043 Over Bishop Cut, San Joaquin County, California	Napton, L. Kyle	1982	**Within**
SJ-05534	A Cultural and Paleontological Resources Study for the Paradise Village Development Project	Kelley, John and Susan Huster	2003	Outside
SJ-05985	Caltrans Historic Bridge Inventory Update: Metal Truss, Movable, and Steel Arch Bridges	McMorris, Christopher	2004	Outside
SJ-06331	Archaeological/Resources Presence/Absence Testing at P-39-004492 (Southern Bishop Tract Farm Site), Westlake Villages Project, Stockton, San Joaquin County, California	Longfellow, J.	2006	Outside
SJ-06410	A Cultural and Paleontological Resources Study for the Spanos Parcel Project	Kelley, John, Susan Huster, and Ben Matzen	2005	Outside
SJ-06843	Stockton Delta Project: Cultural Resources Inventory Report	ESA	2007	Outside

SJ-00767

In 1982, L. Kyle Napton prepared *Cultural Resource Investigations of the Eight Mile Road Bridge No. 1043 Over Bishop Cut San Joaquin County, California* for the County of San Joaquin, Department of Public Works. The cultural resource assessment preceded the proposed replacement of the Eight Mile Bridge No. 1043 over Bishop Cut, with a survey area that encircled the bridge by approximately 500 feet, and which includes small portion of the current APE. Methods of investigation included a review of ethnographic literature, the NRHP, and the California Register of Historic Sites, as well as search of records at the California Office of Historic Preservation. Additionally, a field survey of the study area was undertaken by professional archaeologists. No cultural resources were identified as a result of the study, and a finding of no significant impact upon cultural resources was determined.

Previously Recorded Cultural Resources within 1 Mile of the APE

The records searches identified five previously recorded cultural resources within 1 mile of the APE (Table 2). Of these five, none are located in the study area. Two resources (Bridge #29C-0114 and Bridge

#29C-0290) were not formally listed by the CCIC, but rather referenced in *Caltrans Structure Maintenance & Investigations, Historical Significance – Local Agency Bridge, San Joaquin County* (2012) as not eligible for the NRHP.

Table 2. Previously Recorded Cultural Resources within 1 Mile of the APE

Primary No.	Trinomial	Resource Description	NRHP Eligibility	Recorder and Year	Proximity to Study Area
P-39-004492	–	Southern Bishop Tract Farm	Not evaluated; updated records states buildings are no longer extant	Kelley, John, and Susan Huster, 2003; and Longfellow, Joy, 2006.	Outside
P-39-004540	–	Bridge #29C-0219 – White Slough	Ineligible	CDM/JMC, 2003	Outside
P-39-005038	–	Venice School	Not evaluated	San Joaquin County Superintendent of Schools	Outside
–	–	Bridge #29C-0114 – Bishop Canal	Ineligible	Caltrans	Outside
–	–	Bridge #29C-0290 – Telephone Cut	Ineligible	Caltrans	Outside

Historic Map Review

In addition to reviewing previously conducted studies and previously recorded site records, SWCA examined the study area on historic maps provided by the CCIC. Maps from the mid- to late-nineteenth century show the study area as largely undeveloped, describing it as "swamp and overflowed land." By 1939, a U.S. Geological Survey (USGS) map shows development of the levee system, with the present-day irrigation canal in place along the eastern portion of the study area, and initial roads encircling the interior of what is by then named "King Island." A USGS map from 1952 shows the development of the additional access roads and buildings, including what appear to be the three extant buildings in the current study area (SWCA-KING-1, SWCA-KING-2, and SWCA-KING-3).

Sacred Lands File Search and Initial Native American Coordination

Native American coordination was initiated for this project on August 24, 2012. As part of the process of identifying cultural resources in or near the APE, SWCA contacted the Native American Heritage Commission (NAHC) to request a review of the Sacred Lands File. The NAHC faxed a response on August 28, 2012 (Appendix B), and stated that Native American cultural resources were not identified within 0.5 mile of the APE, but noted that it is always possible for cultural resources to be unearthed during construction activities. The NAHC also provided a contact list of seven Native American individuals or tribal organizations that may have knowledge of cultural resources in or near the APE. Letters were prepared and mailed to each of the NAHC-listed contacts on September 4, 2012, requesting information regarding any Native American cultural resources in or adjacent to the APE.

One response has been received to date in regarding the coordination letters, and is included in Appendix B of this report. In an email dated September 8, 2012, Ms. Silvia Burley of the Miwok Tribe requested that she be contacted if artifacts or human remains associated with the Miwok Tribe were discovered during the course of the project.

No additional responses have been received to date. One follow-up phone call will be made to each Native American contact on September 18, 2012. The results of these efforts will be forwarded to the PG&E at that time. Table 3 provides a complete record of Native American coordination to date.

Table 3. Record of Native American Coordination Efforts

NAHC-Provided Contact	Coordination Efforts	Results of Coordination Efforts
Miwok 4305 39th Avenue Sacramento, California 95824 Contact: Randy Yonemura	**9/2/12:** Letter sent via U.S. Mail	To be determined
Miwok P.O. Box 84 Wilseyville, California 95987 Contact: Briana Creekmore	**9/2/12:** Letter sent via U.S. Mail	To be determined
Buena Vista Rancheria 1418 20th Street, Suite 200 Sacramento, California 95811 Contact: Rhonda Morningstar Pope, Chairperson	**9/2/12:** Letter sent via U.S. Mail	To be determined
California Valley Miwok Tribe 10601 North Escondido Place Stockton, California 95212 Contact: Silvia Burley, Chairperson	**9/2/12:** Letter sent via U.S. Mail **9/8/12:** Ms. Burley replied via email that she had no concerns regarding the project, but asked that she is notified if Miwok artifacts or human remains are discovered during the course of the project.	No further reaction required
Ione Band of Miwok Indians P.O. Box 699 Plymouth, California 95669 Contact: Yvonne Miller, Chairperson	**9/2/12:** Letter sent via U.S. Mail	To be determined
Ione Band of Miwok Indians Cultural Committee 604 Pringle Avenue #42 Galt, California 95632 Contact: Billie Blue, Chairperson	**9/2/12:** Letter sent via U.S. Mail	To be determined
Wilton Rancheria 9300 West Stockton, Suite 200 Elk Grove, California 95758 Contact: Andrew Franklin, Chairperson	**9/2/12:** Letter sent via U.S. Mail	To be determined.
Wilton Rancheria 9300 West Stockton, Suite 200 Elk Grove, California 95758 Contact: Steven Hutchason, Director of Cultural Preservation	9/2/12: Letter sent via U.S. Mail	To be determined.

METHODS

SWCA Cultural Resources Specialists Katie Martin and William Kendig conducted an intensive-level pedestrian survey to identify any archaeological or historic built environment resources (i.e., buildings, structures, and objects) that may occur in the study area. Ms. Martin and Mr. Kendig surveyed the entire study area by walking linear transects spaced no more than 15 m (49 feet) apart. The ground surface was examined for the presence of prehistoric artifacts (e.g., flaked stone tools, tool-making debris, stone milling tools), historic artifacts (e.g., metal, glass, ceramics), sediment discoloration that might indicate the presence of a cultural midden, and depressions and other features indicative of the former presence of structures or buildings (e.g., post holes, foundations). A Trimble global positioning system (GPS) receiver with sub-meter accuracy was used to maintain transect accuracy and to record the location of cultural resources in the study area.

Ms. Martin and Mr. Kendig documented their fieldwork using field forms, a digital camera, close-scale field maps, and aerial photographs. Copies of the field notes and digital photographs are on file at the SWCA Pasadena office.

RESULTS

During the intensive-level field survey for cultural resources, ground visibility was poor in the study area (approximately 0% in some areas) due to obstruction by vegetative ground cover. Other areas of the study area were heavily disturbed due the construction of the access roads and agricultural activities (Figures 5 and 6). A portion of the study area along the eastern side of Alternate B was unable to be fully surveyed to the full 25-foot-wide buffer from the edge of the access road due to an adjacent waterway (Figure 7).

Four potential cultural resources were identified in the study area as a result of the intensive-level survey and were recorded on California Department of Parks and Recreation 523 series forms (Appendix C). Three buildings, SWCA-KING-1, SWCA-KING-2, and SWCA-KING-3, and an irrigation canal, SWCA-KING-4, are situated within the 25-foot-wide buffer of the Alternate B access road (Figure 8). Visual observation and initial research using historic maps indicate SWCA-KING-1, SWCA-KING-2, and SWCA-KING-3 were constructed between 1939 and 1952. Each of the three buildings is rectangular in plan and feature gabled roofs, sheathed in corrugated metal sheets.

SWCA-KING-4 is a segment of an irrigation canal, which is commonly known as Bishop Cut. The canal, which historic topographic maps indicate was constructed by 1939, is approximately 330 feet wide and connects White Slough from the north to Disappointment Slough 2.75 miles to the south. The waterfront portion of the canal is composed of rip-rap along steep banks, and it is bound by Rio Blanco Road to the east and a private access road to the west. SWCA-KING-4 includes the 1 mile portion of the canal from the vicinity of Telephone Cut to Bridge #29C-0114 to the south.



Figure 5. Portion of the study area; view to the east.



Figure 6. Agricultural activities in the study area; view to the west.



Figure 7. Paved access road (Alternate B) and irrigation canal; view to the south.

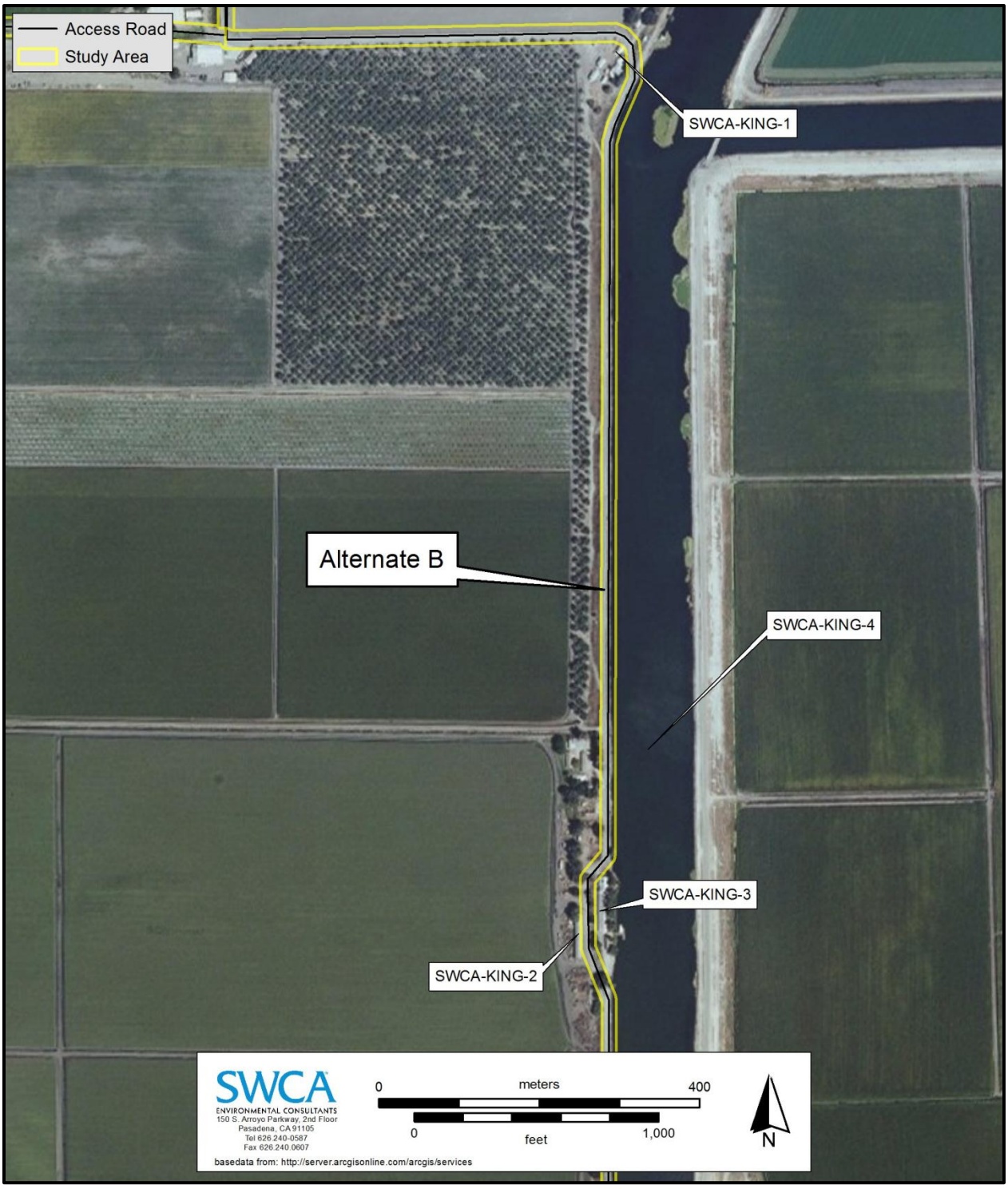


Figure 8. Potential cultural resources in relation to the study area.

DISCUSSION AND RECOMMENDATIONS

Discussion

The goal of this study is to identify cultural resources in the PG&E CAES King Island study area and provide management recommendations for those resources. The results of the records search indicate that a small portion of the study area was surveyed by qualified archaeologists in 1982. Although the records search also identified five previously recorded cultural resources within 1 mile of the APE, none were in the current study area or listed as eligible for the NRHP. Additionally, the NAHC Sacred Lands File search was negative for Native American cultural resources within 0.8 km (0.5 mile) of the APE.

SWCA cultural resources specialists identified four potential historic built resources as a result of the intensive-level survey (SWCA-KING-1, SWCA-KING-2, SWCA-KING-3, and SWCA-KING-4). They were not formally recorded or evaluated, and no determination of their significance was made at this time. However, visual inspection and initial research suggests that that they may be over 50 years old, and as a result, have the potential to be eligible for the NRHP.

Recommendations

The historical significance of the buildings and irrigation canal (SWCA-KING-1, SWCA-KING-2, SWCA-KING-3, and SWCA-KING-4), which are located along road Alternate B, was not determined as part of the current study. However, visual inspection and initial research using historic maps suggest they may be considered cultural resources. Until these resources are formally evaluated, SWCA recommends that they be treated as though they are significant, and that the project avoid impacting them. Alternate A would not have direct or indirect effects on these buildings or the canal, and SWCA recommends that the project use this access route, while avoiding the use of Alternate B. If it becomes necessary to use Alternate B, SWCA recommends that SWCA-KING-1, SWCA-KING-2, SWCA-KING-3, SWCA-KING-4 be formally evaluated to determine their significance before any construction activities begin.

Although SWCA did not identify any additional cultural resources, ground disturbance associated with the proposed project could impact previously unrecorded cultural resources. SWCA recommends that the following measures be taken to identify additional cultural resources in the study area to prevent or reduce the significance of project-related impacts to cultural resources and to satisfy the requirements of Section 106 and CEQA.

Inadvertent Discovery of Cultural Resources

In the event that cultural resources are exposed during ground-disturbing activities, construction activities (e.g., grading, grubbing, or vegetation clearing) should be halted in the immediate vicinity of the discovery. An archaeologist who meets the Secretary of the Interior's Professional Qualifications Standards (National Park Service 1983) should then be retained to evaluate the find's significance under CEQA. If the discovery proves to be significant, additional work, such as data recovery excavation, may be warranted and should be discussed in consultation with the lead agency.

Inadvertent Discovery of Human Remains

The discovery of human remains is always a possibility during ground disturbances; State of California Health and Safety Code Section 7050.5 addresses these findings. This code section states that no further disturbance shall occur until the county coroner has made a determination of origin and disposition

pursuant to PRC Section 5097.98. The coroner must be notified of the find immediately. If the human remains are determined to be prehistoric, the coroner will notify the NAHC, which will determine and notify a most likely descendant. The most likely descendant shall complete the inspection of the site within 48 hours of notification and may recommend scientific removal and nondestructive analysis of human remains and items associated with Native American burials.

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A319: King Island Biological Constraints Final Analysis

North State Resources, Inc.

Date:	October 12, 2012	**PG&E Order #:**	8105484
To:	Land and Environmental Management—Catalina Reyes, Biologist		
From:	North State Resources, Inc.— John W. Hunt, Biologist		
Project:	PG&E Compressed Air Energy Storage Sites–Proposed Investigative Geologic Core Sampling at the King Island Piacentine Well.		
Subject:	Final Biological Constraints Analysis of the King Island Piacentine Well, San Joaquin County, California		

Introduction and Summary

Mr. John W. Hunt, NSR Biologist, conducted a biological constraints analysis for the proposed Geologic Core Sampling Phase of the Pacific Gas and Electric Company (PG&E) Compressed Air Energy Storage Project (project) at the proposed King Island Piacentine natural gas well pad expansion area and associated access roads (project area). The survey area consists of all areas within 20 feet of proposed access roads and all areas within 250 feet of the existing well pad and the proposed well pad expansion area (Figure 1, Appendix A). The objective of the project is to expand and utilize the existing footprint of the Piacentine natural gas well site to stage geological core sampling equipment. The geological core sampling will be used to determine the suitability of the project vicinity for compressed air storage within depleted subterranean natural gas reservoirs.

A field reconnaissance was conducted on August 20, 2012 with Ms. Catalina Reyes, PG&E Biologist. The project area includes all proposed access roads, existing well pad and staging area, and well pad expansion area identified by PG&E technical staff during the field review on August 20, 2012 (Figure 2, Appendix A).

Giant garter snake, listed as threatened under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA); Swainson's hawk, listed as threatened under CESA; loggerhead shrike, designated as California species of special concern (SC); and white-tailed kite, a state fully protected (FP) species, have the potential to be adversely affected or impacted by the project This document provides Avoidance and Minimization Measures (AMMs) that will avoid effects on these species.

The irrigation ditches within the project area appear to meet wetland criteria and are considered to qualify as potential waters of the United States. The existing access roads, the existing well pad, and the proposed well pad expansion area do not appear to meet wetland criteria and are not considered to qualify as potential waters of the United States. All determinations concerning waters of the United States should be considered preliminary and tentative unless verified in writing by the U.S. Army Corps of Engineers.

The proposed project will receive federal funding from the U.S. Department of Energy (USDOE). As such, the USDOE is required under section 7 of the federal Endangered Species Act to determine whether the proposed project may affect federally listed and proposed species or proposed or designated critical habitat. If the USDOE determines that the project may affect federally listed species or critical habitat, consultation with the U.S. Fish and Wildlife Service and/or National Marine Fisheries Services is required.

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Project Description

The objective of the project is to collect approximate 10-inch diameter geological core samples from the subsurface natural gas formation at depth approximately 4,000-5,000 feet. Cores will be used to determine the suitability of the subsurface formation for compressed air storage. Compressed air energy storage involves utilizing appropriate geological formations (e.g., depleted natural gas reservoirs) to store surplus energy in the form of compressed air during periods of low electric demand. This stored energy can then be utilized during periods of higher electric demand, improving the efficiency of energy distribution through the power grid.

The project area is located approximately 5 miles northwest of the city of Stockton in northwestern San Joaquin County, California. It is situated immediately north of West 8 Mile Road between White Slough and Bishop Cut, and can be accessed from Interstate 5 via West 8 Mile Road at approximately 38.082284°, -121.421892° (Figure 2, Appendix A). For project construction, the preferred site access (preferred access) is from the southwest along an unnamed dirt road. The dirt road is graded and well-maintained, and is surfaced with gravel. The alternative site access (alternative access) is from the southeast along the King Island Road.

Given that existing access roads are available, no road construction is necessary for project construction. Improvements to the existing access roads from the ranch yard to approximately 900 feet north will be limited to light graveling of the unnamed dirt road if determined to be necessary (e.g., work to occur during the wet season) with the assumption no additional grading will be required. If grading is required, it will be limited to the existing road and will not extend beyond the compacted surface. All vehicle traffic will be on the existing access roads and all staging will be contained within the southeast portion of the existing well pad. Water trucks will be used as necessary to reduce dust during site access and other construction activities. Approximately 28 truck trips will be required to import well pad material to the site. An additional five truck trips will be required to remove drill cuttings and associated material from the site. If well pad expansion area is restored to pre-project conditions, an additional 28 truck trips will be required to remove temporary well pad expansion materials, which will total 61 truck trips. Best Management Practices (BMPs) and AMMs will be implemented to avoid impacts on potential waters of the United States.

The well pad expansion area will occupy an approximately 0.18-acre area (80 x 100 feet) that abuts the existing Piacentine well pad and access road. Approximately 5–6 rows of walnut trees (approximately 4 inches diameter at breast height) and intercropped safflower will be cleared in order to accommodate the well pad expansion. After clearing the vegetation, approximately 1 foot of crushed rock will be placed within the cleared area and compacted with a roller. If necessary, woven geotextile fabric will be placed as an underlayment for the overlying gravel fill. Final pad dimensions will be 220 (east-west) by 140 feet (north-south).

After the well pad expansion area has been established (i.e., cleared of vegetation, compacted and surfaced with gravel), well drilling equipment will be moved onto the expansion area. The primary equipment includes the drill rig, mud and water tanks and pumps, shaker tanks, electric generators, diesel fuel tanks, and drill pipe racks. Geologic sampling will consist of drilling a 10 inch diameter well to a depth of approximately 4,000-5,000 feet and extracting a geological core sample not greater than 4 inches in diameter. All sections of the core sample will be removed offsite for analysis and storage. All peripheral material (e.g., cuttings and drilling mud) removed during the coring process will be immediately placed in proper storage receptacles and removed offsite for disposal at an authorized facility. The drilling crew, plus engineers, temporary workers and site visitors, will consist of an average of approximately 12 workers per shift, with three shifts per day. A maximum of 20 workers may be

present during various operations. In addition to worker vehicles, service and delivery vehicles will access the site during the drilling phase including equipment trucks for all aspects of the effort. All drilling activities will be completed in compliance with the County Gas and Oil Well Improvement Plan approval.

Once the core sample is obtained and the remaining hole is plugged and abandoned per California Division of Oil Gas and Geothermal Resources (DOGGR) and Environmental Protection Agency (EPA) standards, the drilling equipment will be dismantled and demobilized from the site. Construction equipment similar to that used during well pad development will be used to remove the pad materials and return the site to near pre-project conditions. This includes spreading of any surface vegetation or roots stockpiled during site preparation. All removed material will be disposed of at suitable landfills or recycled consistent with county grading or other permit requirements. However, the property owner may elect to retain the pad for farm equipment staging and storage.

Well pad construction and improvements to access roads will occur over a two-week period commencing as early as October 2012. Drilling activities will occur virtually continuously for up to approximately six weeks. If elected to remove the well pad, restoration of the site will take up to two weeks.

Habitat and Affected Environment

The project area is situated in a landscape that currently supports active agricultural operations, an existing natural gas well site, access roads, a farmhouse, and appurtenant facilities/equipment (e.g., farm equipment, staging area, and barn). The project area is located within the "Delta Islands". The Delta Islands are areas of former marshlands of the Sacramento–San Joaquin Delta that were historically reclaimed for agricultural use by the construction of levees/dikes and draining to enable farming.

Habitats within the project area (Figure 3-1 through 3-4 and Figure 4, Appendix A) include flood irrigated row crops (e.g., corn, asparagus, onions, safflower) and walnut orchards intercropped with safflower. Some of the cornfields adjacent to the access roads in the project area were being flood irrigated during the August 20, 2012 field reconnaissance. The proposed well pad expansion area is entirely within a young walnut orchard intercropped with safflower and is disked on an annual rotation. With the exception of asparagus crops in the westernmost portion of the project area, all agricultural habitats within the project area are disked and cropped on an annual rotation. All fields are actively farmed and regularly disked, harvested and/or disturbed to the edge of the existing access road.

A series irrigation ditches parallel the entire length of the preferred access route to its junction with the graveled Piacentine well access road approximately 550 feet west of the Piacentine well. The irrigation ditches and their appear to be subject to regular vegetation management using both mechanical and chemical techniques. Habitat within the channel is predominantly open water. In addition to the open water habitat, intermittent patches of floating aquatic and emergent vegetation including water primrose (*Ludwigia* sp.), cattails (*Typha* sp.), smartweed (*Persicaria* sp.), mosquito fern (*Azolla* sp.) and water hyacinth (*Eichhornia crassipes*) are present within the channel. Ruderal herbaceous species occurring along the banks and adjacent road shoulders include common mallow (*Malva neglecta*), poison hemlock (*Conium maculatum*), Johnson grass (*Sorghum halepense*), redroot pigweed (*Amaranthus retroflexus*) and common knotweed (*Polygonum aviculare*).

Methods

The determination of the potential for the project area to support habitat for special-status species, waters of the United States, and other sensitive biological resources was established through desktop review and a field reconnaissance. The desktop review was completed using a series of database searches and a

review of pertinent resources (Appendix B). Special-status species[1] listed in the U.S. Fish and Wildlife (USFWS) species list for San Joaquin County and species reported in the CNDDB to occur within a 5-mile radius of the project area were considered in the evaluation (e.g., listed shrimp, valley elderberry longhorn beetle, giant garter snake) (Appendix B). Additionally, special-status species not included in the USFWS species list or CNDDB records were considered due to their known geographic range and/or the presence of potential habitat (e.g., white-tailed kite, loggerhead shrike, ringtail). Special-status species shown in the USFWS and CNDDB queries (Appendix B) that are not included in Table 1 lack habitat within the project area or the project area is not within the range of the species. These species are not analyzed further in this document.

Following completion of the field reconnaissance, an assessment of local, state, and federal permitting requirements was conducted to determine if the proposed project requires permits or authorizations from the local government or state and federal regulatory agencies. No local, state, or federal permits addressing biological resources are anticipated to be required.

Special-Status Species and Potential Impacts

The project area contains potentially suitable habitat for eleven special-status plant species including: watershield (*Brasenia schreberi*), bristly sedge (*Carex comosa*), woolly rose-mallow (*Hibiscus lasiocarpus* var. *occidentalis*), Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), Mason's lilaeopsis (*Lilaeopsis masonii*), Delta mudwort (*Limosella subulata*), eel-grass pondweed (*Potamogeton zosteriformis*), Sanford's arrowhead (*Sagittaria sanfordii*), marsh skullcap (*Scutellaria galericulata*), side-flowering skullcap (*Scutellaria lateriflora*), and Suisun marsh aster (*Symphyotrichum lentum*). The potentially suitable habitat for these species is located within the irrigation ditches that are present within the project area. The proposed project will not result in disturbance to the irrigation ditches. Therefore, the proposed project will not result in impacts on special-status plant species.

Special-status animal species that were determined to have the potential to occur in or near the project area, and that could be adversely affected by the proposed project, include giant garter snake (*Thamnophis gigas*), Swainson's hawk (*Buteo swainsoni*), white-tailed kite (*Elanus leucurus*), and loggerhead shrike (*Lanius ludovicianus*) (Table 1).

Within the project vicinity the perennial irrigation ditches and the nearby slough, Bishop Cut and associated uplands, provide potential suitable habitat for giant garter snake (GGS). The perennial irrigation ditches are located immediately adjacent to the preferred access road and the Bishop Cut is located adjacent to the alternate access road, King island Road (Figure 3-1 through 3-4). The CNDDB contains reported GGS occurrences from marsh habitat within Coldani Marsh less than 0.5 mile from the project. If GGS are present within the project area during the inactive season (i.e., October 1 to May 1), when work is anticipated to occur, adverse impacts (e.g., injury or death) on GGS could result from vehicular traffic or ground disturbance associated with project activities.

Although, vegetation is actively managed along ditches, emergent vegetation persists and may provide suitable habitat for GGS. Because these aquatic habitats (ditches) appear to be subject to regular vegetation management using both mechanical and chemical technique, these aquatic habitats offer poor to marginal habitat to GGS. Additionally, no fish or amphibians which serve as prey items were observed in these ditches during the August 20, 2012 field survey.

[1] Special-status species: Listed, candidate, or proposed for listing as threatened or endangered under the Endangered Species Act, or California Endangered Species Act, California Native Plant Protection Act, California Species of Special Concern, and California Fully Protected Species. Special-status plants include California rare plant rank (RPR) 1A, 1B and 2.

Burrows and other underground refuge are important to GGS during summer and winter to escape unfavorable winter cold temperatures or excessive summer heat. The GGS recovery plan states that wintering habitat can be up to 250 meters (820 feet) from the edge of marsh habitat (Miller, Hornaday et al. 1999). An irrigation ditch with perennial flow is located approximately 400 feet west of the potential well pad expansion area could provide dispersal habitat for juvenile GGS and the uplands in the project area may provide wintering habitat. Typically, the USFWS defines upland habitat as all areas occurring within 200 feet of aquatic habitat (White 1997). Because the proposed well pad expansion area is greater than 200 feet from potential GGS aquatic habitat, the risk of encountering GGS out of its burrow is greatly reduced. The highest potential of adverse impacts on GGS is most likely to occur from project activities along the access roads since they are located within 200 feet of aquatic habitat and provide potential habitat for winter burrows. If burrows are located under the access roads project activities can result in the collapse of burrows and snakes can become entombed.

Despite the presence of vegetated irrigation ditches that may support dispersal of GGS, these provide marginal to poor habitat. Based on landscape habitat use analysis of studies conducted by Wylie et al (Wylie, Graham et al. 1995; Wylie, Casazza et al. 1997; Wylie, Casazza et al. 2002; Wylie, Casazza et al. 2002) provided in the Solano Multispecies Habitat Conservation Plan (Solano HCP), low quality ditch habitat associated with rice fields provided an artificial marsh habitat that provides the essential components (e.g., appropriate cover, high food availability, and upland refuge) to support GGS. Alternatively, studies conducted in high quality marsh habitat surrounded by fallow fields did not locate GGS or found them at very low densities. Based on these results, areas supporting marginal to poor habitat or small, isolated patches of good habitat are presumed to not support GGS due to lack of surrounding aquatic habitat (Solano County Water Agency 2009). In the case of the project area, the surrounding aquatic habitat is of marginal to poor quality and thus, it is unlikely that GGS would use these for dispersal.

The upland habitat that the project area provides (i.e. upland habitat along access routes and within well pad expansion area) is also poor to marginal habitat for GGS. As part of existing agricultural activities, potential upland habitat for GGS within and immediately around proposed project area are extensively disked, tilled and planted with row crops to the edge of the existing well pad and likely precludes occupation of burrowing mammals that would provide refugia for GGS. Additionally, no burrows or other refugia were observed around the existing well pad, in the pad expansion area, or along the Piacentine well access roads (alternative or primary), and no ground squirrel activity was observed during the field reconnaissance on August 20, 2012 in these areas. Based on the observation of low quality habitat (i.e. distance from moderate to poor quality dispersal habitat provided by the primary irrigation ditches (greater than 200 feet), documented lack of use in non-rice agricultural lands, the lack of upland habitat including burrows or other refugia, and the lack of ground squirrel activity near the well pad expansion area, the primary irrigation ditches and the associated farmed upland provide low quality habitat and the likelihood for GGS to occur within the pad expansion area is very low.

To minimize potential adverse effects on GGS along the access roads, a survey for burrows shall be conducted 24 hours prior to any modifications to access roads (i.e., grading or addition of gravels). If burrows are observed during the inactive period, they shall be flagged and grading or addition of gravel along the shoulder shall avoid all burrows. In addition, all vehicles will travel in the road center and speed limit of 10 mph will be maintained which will also minimize potential impact on this species.

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T/—	Elderberry shrubs associated with riparian forests which occur along rivers and streams.	None. No elderberry shrubs were observed within the project area.	None required
Delta smelt *Hypomesus transpacificus* **Critical habitat**	T/T	Estuarine systems in the Sacramento-San Joaquin Delta.	None. The irrigation ditches and Bishop Cut occurring within the project area and along the access roads provide potential habitat for this species and are connected to higher quality habitat (marshes and sloughs) occurring outside of the project area. However, all potential habitat for this species occurs outside of planned activity areas (i.e., access roads, existing well pads, and well pad expansions areas) and no impacts or modifications to potential habitat are expected.	None required
Sacramento splittail Pogonichthys macrolepidotus	—/SC	Shallow, dead-end sloughs with submerged vegetation.	None. The irrigation ditches and Bishop Cut occurring within the project area and along the access roads provide potential habitat for this species and are connected to higher quality habitat (marshes and sloughs) occurring outside of the project area. However, all potential habitat for this species occurs outside of planned activity areas (i.e., access roads, existing well pads, and well pad expansions areas) and no impacts or modifications to potential habitat are expected.	None required
Longfin smelt Spirinchus thaleichthys	—/SC	Sloughs of Suisun Bay and Delta.	None. The irrigation ditches and Bishop Cut occurring within the project area and along the access roads provide potential habitat for this species and are connected to higher quality habitat (marshes and sloughs) occurring outside of the project area. However, all potential habitat for this species occurs outside of planned activity areas (i.e., access roads, existing well pads, and well pad expansions areas) and no impacts or modifications to potential habitat are expected.	None required

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
California red-legged frog *Rana draytonii*	T/SC	Require aquatic habitat for breeding, also uses a variety of other habitat types including riparian and upland areas. Adults prefer dense, shrubby or emergent vegetation associated with deep-water pools with fringes of cattails and dense stands of overhanging vegetation. This species also breeds in ephemeral ponds that support little or no vegetation.	None . This species is outside the current known range (CWHR) and there are no occurrences within 5 miles of the project area. Additionally, the San Joaquin County Multispecies Habitat Conservation and Open Space Plan (SJMHCP) concludes that CRLF is extirpated from the valley floor (San Joaquin County 2000). This species is not expected to occur in the project area.	None required.
Giant garter snake *Thamnophis gigas*	T/T	Freshwater marshes and low gradient streams with emergent vegetation. Adapted to drainage canals and irrigation ditches with mud substrate.	Low. The irrigation ditches and associated uplands within the project area provide potential habitat. A known extant population of GGS occurs within the Coldani Marsh-White Slough area approximately 0.5 mile to the northeast of the project area. The location of this population is hydrologically connected to irrigation ditches within the project area. Ground disturbance activities that disrupt burrows within the project area could adversely affect this species.	Pre construction surveys Biological monitor Water quality BMPs

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
Western pond turtle *Emys marmorata*	--/SC	Slow water aquatic habitat with available basking sites. Hatchlings require shallow water with dense submergent or short emergent vegetation. Requires an upland oviposition site in the vicinity of the aquatic site.	None. Although ditches in the project area are perennial, and contain fresh emergent vegetation, the banks are steep and do not contain available basking sites. Ditches are actively maintained and likely preclude the occupation of pond turtles. Additionally, upland breeding sites are unavailable in the cropland habitat around the well expansion site and access roads. Due to lack of basking habitat and upland oviposition sites, the potential for pond turtles to occur in the project area is unlikely.	None required.
California black rail *Laterallus jamaicensis coturniculus*	—/T, FP	Coastal and inland marsh habitat.	None. The irrigation ditches occurring within the project area provide poor to no potential habitat for this species and are connected to higher quality habitat (marshes and sloughs) occurring outside of the project area. However, potential habitat for this species occurs outside of planned activity areas (i.e., access roads, existing well pads, and well pad expansions areas) and no impacts or modifications to potential habitat are expected.	None required
Swainson's hawk *Buteo swainsoni*	--/T	Breeds in stands with few trees in juniper-sage flats, riparian areas, and oak savannah; forages in adjacent livestock pasture, grassland or grain fields.	Moderate. Larger trees and stands of trees occurring within 0.5 mile of the project area provide potential nesting habitat for Swainson's hawk. There are sixteen recorded CNDDB occurrences of nesting Swainson's hawk within 5 miles of the project area with the nearest approximately 2 miles west of the project area. Noise generated by project activities could disrupt nesting behavior and nest success if Swainson's hawks are nesting within 0.5 mile of the project area.	If work is expected to occur during nesting season (March 1 to July 31), Swainson' hawk nesting surveys will be performed following CDFG protocol developed by the Swainson's Hawk Technical Advisory Committee.

Table 1. Special-Status Species with Potential to Occur in the Project Area, Impacts Analysis, and Avoidance and Minimization Measures

Common Name Scientific Name	Listing Status[1] (Fed/State)	Habitat Requirements	Potential for Significant Impact	Avoidance and Minimization Measures
White-tailed kite *Elanus leucurus*	—/FP	Nests in tall shrubs and trees, forages in grasslands, agricultural fields and marshes.	Low. Isolated trees and shrubs near proposed access roads and existing farm facilities provide potential nesting habitat for this species.	Nesting bird surveys required within the breeding season (February 15-August 31).
Loggerhead shrike *Lanius ludovicianus*	—/SC	Nests in tall shrubs and dense trees, forages in grasslands, marshes, and ruderal habitats.	Low. Isolated trees and shrubs near proposed access roads and existing farm facilities provide potential nesting habitat for this species.	Nesting bird surveys required within the breeding season (February 15-August 31).

[1]Status Codes: : Federal and State Codes: T = Threatened; SC = Species of Special Concern (State), FP = Fully Protected (State)

However, if construction occurs during the GGS active period, the likelihood of encountering a snake along or within access roads bordering GGS aquatic habitat greatly increases. Due to the aquatic habitat along the unnamed dirt road and King Island Road (Figure 2), if construction activities, occurs during the active period, a biological monitor will drive in front of heavy construction vehicles (i.e. dump trucks, drill rigs, etc.) on all dirt roads during entry/exit of project site. The biologist will lead vehicles at a maximum speed of 10 mph, watch for signs of snakes, and stop and investigate the road if there are any concerns. The preferred access road will be likely used; however, if the alternate route along King Island Road is used, all AMMs developed for dirt roads will be implemented.

Because of the proximity of a known population 0.5 miles northeast of the project and the availability of moderate to high quality marsh aquatic habitat in larger canals 900 feet north of the proposed well pad expansion area, AMM's are provided in this document to avoid potential impacts on GGS.

Potential nesting habitat (e.g., trees, power poles/towers) for Swainson's hawk occurs within the project area and within 0.5 mile of the project area. Noise generated by expanding the pad, exploration drilling, site restoration, and other construction activities could adversely affect this species if active nests are located within 0.5 mile. Project implementation is expected to commence as early as October 2012 and extend for a total of four to six weeks, which is outside of the nesting season for these species. If project implementation is confined to this period, the proposed project will not result in adverse effects on this species. However, if work will occur during the nesting season (i.e., March 1–July 31), protocol -level surveys for Swainson's hawk will be required. If active nests are detected within 0.5 mile of project activities, construction activity will stop immediately and will not resume until PG&E Biologist or Land Planner contacts USFWS and California Department of Fish and Game (CDFG) Biologists to discuss possible AMM's, which could include avoidance buffers, reconsidering access routes, and additional surveys.

Walnut orchards within the proposed area of expansion do not provide foraging habitat for Swainson's hawks and removal of approximately 0.18 acre of this crop to expand the well pad would not affect available foraging habitat for Swainson's hawks.

Nesting habitat for loggerhead shrike and white-tailed kite occur in the trees and shrubs adjacent to the project area. As with the Swainson's hawk, construction activities could have adverse impacts on nesting success for these species depending on the timing of the work. Disturbance to vegetation and removal of existing crops (i.e., walnut orchards and safflower) for well pad expansion should be conducted outside of the nesting season (i.e., between August 31-February 15) in order to avoid potential effects on nesting birds. If work is to occur during the nesting season for these species (February 15–August 31), nesting bird surveys will occur 72 hours prior to the start of construction to determine if birds are nesting in the area. If nesting birds are found PG&E will halt work and consult with CDFG and USFWS to establish AMM's to protect nest (i.e. establish buffers).

Waters of the United States and Potential Impacts

An assessment for potential waters of the United States was conducted during the August 20, 2012 field reconnaissance. The irrigation ditches adjacent to roadways within the project area were observed to support a prevalence of hydrophytic vegetation, and some reaches of the irrigation ditches contained flowing or ponded water. Water is generally pumped in or out of White Slough depending on need to irrigate farmland or to pump out water to keep the area from flooding. The irrigation ditches within the project area drain into or are adjacent (separated by a berm) to White Slough, which qualifies as waters of the United States. Given that the irrigation ditches support hydrophytic vegetation, are subject to extended inundation and/or saturation, and are tributary to waters of the United States, the features are considered as potential waters of the United States. The Bishop Cut is a navigable water and is subject to

USACE jurisdiction. The project will not result in any physical disturbance of irrigation ditches or Bishop Cut within the project area; thus, the proposed project would not result in direct impacts on the irrigation ditches. AMMs have been incorporated into the proposed project to avoid the potential for indirect impacts.

Although the USFWS National Wetlands Inventory identifies the entire project area as farmed wetlands, the existing access roads, the existing well pad, and the proposed well pad expansion area do not appear to currently meet wetland criteria. The existing access roads and the existing well pad consist of compacted surfaces that are graded and unvegetated; and do not exhibit evidence of long-duration ponding or saturation, or exhibit other indications of wetland hydrology. The proposed well pad expansion area currently supports a leveled and routinely disked agricultural field that is planted with a young walnut orchard intercropped with safflower. Field inspection of this area did not identify the presence of hydrophytic vegetation or evidence of soil inundation/saturation unrelated to routine irrigation. Based on observation of the water level in ponded portions of the irrigation ditch, the surface of the agricultural field appeared to be several feet above the water table. Given the lack of hydrophytic vegetation and an absence of indications of a current wetland hydrology, the existing access roads, the existing well pad, and the proposed well pad expansion area are not considered to qualify as potential waters of the United States.

It is important to note that the field assessment did not involve a formal delineation using U.S. Army Corps of Engineers (USACE) methodology and no detailed investigations for wetland hydrology were conducted. The entire project area was historically Sacramento–San Joaquin Delta marshland prior to dikes/draining and conversion to agricultural production. Areas of agricultural production that were formerly wetlands may still qualify as jurisdictional wetlands if hydrological characteristics remain to the extent that hydrophytic vegetation would return if the agricultural activities ceased. The determinations provided in this document concerning wetland hydrology are based on a single visual assessment conducted on August 20, 2012. Definitive documentation of the status of wetland hydrology generally cannot be provided by a single visual assessment during the dry season. Therefore, all determinations provided in this document concerning waters of the United States should be considered preliminary and tentative unless verified in writing by the USACE.

Other Sensitive Biological Resources

Migratory birds and raptors (i.e., birds of prey) protected under the federal Migratory Bird Treaty Act and the California Department of Fish and Game Code may nest on open ground, vegetation, or structures within the project area. Construction activities could have adverse impacts on nesting success for birds nesting near the construction site. If disturbance to vegetation and removal of existing crops (i.e., walnut orchards and safflower) for well pad expansion is conducted outside of the nesting season, then no impacts to nesting birds are expected to result from well pad expansion activities. If work is to occur during the nesting season for these species (February 15–August 31), nesting bird surveys will be occur 72 hours prior to the start of construction required to determine if birds are nesting in the area. If nesting birds are found PG&E will halt work and consult with CDFG and USFWS to establish AMM's to protect nest (i.e. establish buffers).

Avoidance and Minimization Measures (22 total):

1. Prior to working on-site, all workers shall be provided with Environmental Awareness Training by a qualified biologist approved by USFWS and CDFG. The training shall address the identification and general ecology of GGS, Swainson's hawk, nesting birds and other special-status species that have potential to occur in the project area, and the AMMS to be implemented in order to avoid impacts on these resources. Areas to be avoided shall also be addressed in the

training. Please contact project biologist, Catalina Reyes (925-808-8811) two weeks prior to construction to schedule the training.

2. Prior to construction, all work areas (e.g., vehicle access, parking, staging) needed to complete the project shall be identified in coordination with the on-site biologist. Due to the presence of sensitive resources, some work areas may need to be adjusted. All work areas shall be limited to the minimum area necessary to complete work.

3. If practicable, ground disturbing activity (e.g. vegetation removal, compaction, and placement of gravel fill) at all the well pad site shall be conducted during the active season for giant garter snake (GGS) (i.e., between May 1 and October 1). If ground-disturbing activity cannot be conducted during the GGS active season, preconstruction surveys for potential GGS wintering sites (i.e., burrows and soils crevices) shall be conducted within two weeks by a qualified biologist approved by USFWS and CDFG to determine the if potential GGS habitat is present within proposed areas of ground disturbing activity (e.g., the well pad expansion site, road work, application of gravel) and again within 24 hours prior to ground disturbing activity which includes any modification to access roads.

4. All burrows or potential refuge habitat shall be flagged and avoided. If work is suspended for a period of five days or greater, than the project area must be resurveyed. If it is determined that potential GGS wintering habitat (e.g., burrows and crevices) is present within areas planned for ground disturbance, ground-disturbing activities shall be postponed until the GGS active season (i.e., between May 1 and October 1). If GGS is encountered at any time during the project, work will stop immediately and the USFWS and CDFG will be contacted before work proceeds.

5. A biological monitor shall be on site during all phases of construction to direct access and construction work around irrigation ditches and other sensitive habitats capable of supporting GGS. If any GGS are observed within the project area during work activities, work shall cease and the on-site project manager shall immediately contact the project biologist, Catalina Reyes (925-808-8811) prior to resuming work. The biological monitor has the authority to stop construction to resolve any biological concerns.

6. Access to well pads shall be confined to existing roads, road shoulders, and other compacted areas. Travel along roads shall be restricted to the centerline. If placement of gravel or grading on access roads is necessary, the placement shall be limited to the existing road surface. No gravel shall be placed on ditch banks or other areas that may support burrows that could be used by GGS. No grading shall occur along segments of existing roads that may support burrows that could be used by GGS.

7. The irrigation ditches and Bishop Cut will be designated as environmentally sensitive areas and physical disturbance to ditches will be avoided during construction.

8. If deemed necessary, an exclusionary fence shall be erected to protect potentially sensitive habitat adjacent to the existing well pad. To ensure that GGS does not become trapped or entangled, no wattles with plastic monofilament netting are permitted. Burlap or coconut wattles are appropriate substitutes.

9. A qualified biologist approved by USFWS and CDFG shall perform a general pre-construction survey within 72 hours of the start of project construction.

10. Provide escape ramps at a 45 degree angle or less for any excavations that are greater than one foot that are left open overnight. For smaller holes, cover so that no gaps occur and inspect each morning for wildlife. Inspect prior to filling any trenches or holes. If special-status wildlife becomes entrapped, work shall stop and the PG&E project biologist, Catalina Reyes, shall be notified immediately to determine next steps.

11. All construction personnel shall visually check for snakes and other wildlife under vehicles and equipment prior to moving them.

12. Construction equipment will be maintained to prevent leaks of fuels, lubricants or other pollutants into aquatic habitats.

13. Whenever possible, refueling and maintenance of vehicles shall occur offsite. In cases when this is not possible, refueling and maintenance of vehicles and equipment will be conducted over drip pans and at least 100 feet from any waterway.

14. Open ends of pipes, conduits or other materials stored onsite will be covered to exclude wildlife and will be inspected prior to use.

15. Vehicular speed within the project area shall be limited to 10 miles per hour in order avoid impacts on wildlife that may be located on or near roadways. If construction activities, including addition of gravel, occurs during the active period, a biological monitor will drive in front of heavy construction vehicles (i.e. dump trucks, drill rigs, etc.) on all dirt roads during entry/exit of project site. Biologist will lead vehicles at a minimum speed of 10 mph, watch for signs of snakes, and stop and investigate the road if there are any concerns.

16. Watering of roads during dry season work shall be performed as necessary (approximately 3–4 times a day) in order to reduce potential dust resulting from project associated traffic.

17. All potential nesting substrate (e.g., shrubs and trees) that requires removal to construct the project should be removed before the onset of the nesting season (i.e., prior to February 15), if feasible. This will help preclude nesting and substantially decrease the likelihood of direct impacts on nesting birds. If this is not feasible then a nesting bird survey of potential nesting substrate will be performed 72 hours prior to its removal.

18. Surveys for nesting raptors and migratory birds (including Swainson's hawk) shall be required if project construction is to occur during the nesting season (February 15–August 31; March 1-July 31 for Swainson's hawk). Surveys shall be conducted by a qualified biologist approved by USFWS and CDFG.

    Surveys for Swainson's hawk shall follow the California Department of Fish and Game protocol developed by the Swainson's Hawk Technical Advisory Committee (see Appendix C).

    Surveys for other nesting birds, surveys will consist of performing an initial survey after February 15, 2013 or within a month of the start of project date if project is to begin later in the nesting bird season. A second nesting bird survey shall be performed within 72 hours of the start of construction. The surveys shall be repeated if work is suspended for five days or more. Please contact project biologist, Catalina Reyes (925-808-8811) two weeks prior to construction schedule surveys.

19. Caution shall be used when handling and/or storing chemicals (fuel, hydraulic fluid, etc.). As part of standard PG&E Best Management Practices (BMPs), crews shall have appropriate materials on site to provide secondary containment and prevent and manage spills. If groundwater is encountered, contact PG&E Environmental Specialist Bryon Nicholson (415-990-0139).

20. Crews shall implement all standard PG&E BMPs outlined in the Good Housekeeping Activity Specific Erosion and Sediment Control Plan (January 2011) as needed.

21. If the scope of work or project location changes, contact project biologist Catalina Reyes (925-808-8811) prior to commencing work. The project biologist or Land Planner (Ernie Ralston, 515-973-3215) will contact the USFWS Bay-Delta Fish & Wildlife Office ESA/Regulatory Division and the Dept. of Fish & Game-Bay Delta Region upon notice of any such changes.

22. Remove construction related trash from the site daily and upon work completion and return site to near pre-construction contours and conditions upon project completion.

Attachment 1. Desktop Review Results

Source	Results
County	San Joaquin
USGS Quadrangle	Terminous, California (Unsectioned Wetlands of the Empire Tract)
Aerial Photographs – Google Earth 2012 & Bing Aerial Imagery 2012	Row crop region on Delta Island. Preferred Access Road: runs north for approximately 1.0 mile, turning east for approximately 1.2 miles, then turns north to parallel secondary access road for 0.6 mile to entrance of Piacentine Well site (along west bank of unnamed irrigation ditch). Total of 2.7 miles along east and south bank of large (approximately 40 foot wide) irrigation ditch to entrance of Piacentine Well site. Irrigation ditch supports patches of emergent vegetion. Alternate Access Road: approximately 1.85 miles long. Runs north along west bank of Bishop Cut (large Delta channel) for approximately 1.0 mile, then jogs west between vineyard and (maybe) orchards for approximately 0.3 mile, then turns north for 0.6 mile, joining proposed primary access road along east bank of unnamed irrigation ditch. Piacentine Well: Approximately 0.12 mile of raised gravel access road going to well pad. Well pad access and associated well pad access road entirely within orchard.
Land Ownership California Protected Areas Database (CPAD)	None. Private Ownership.
USFWS official list	Attached.
Federally Designated Critical Habitat (within 5-mile radius)	Within Delta Smelt Critical Habitat.
CNDDB-5-mile radius	Attached.
CNDDB owl viewer	Not within range of Spotted Owl.
CNPS-9 quad search	Attached.
PG&E Raptor Concentration Zones (RCZ)	Within RCZ.
National Audubon Society Important Bird Areas (IBA)	Within Sacramento-San Joaquin IBA.
U.S. Department of Agriculture (USDA) Web Soil Survey	Project area within organic muck over alluvium: Kingile muck, Kingile-Ryde complex, and Ryde-Peltier complex.
USFWS National Wetlands Inventory	Entire project area included within farmed wetlands (Pf) in USFWS NWI.
PG&E San Joaquin HCP or other HCPs, NCCPs	Within PG&E San Joaquin HCP and San Joaquin County Multispecies HCP.
Known Swainson's Hawk, golden or bald eagle nest sites	CNDDB Swainson's hawk nesting record within 5 miles of project area. Nearest CNDDB occurrence is 0.4 mile south of the project area. No golden or bald eagle occurrences within 5 miles.
PG&E VELB Conservation Program Range	Within PG&E VELB Conservation Program Range.
CWHR (California Wildlife Habitat Relations) species.	Potential giant garter snake habitat is found in association with the irrigation ditches and associated uplands within the project area. Potential nesting habitat for Swainson's hawk occurs in several areas within 0.5 mile of the project area.

References

San Joaquin County. 2000. San Joaquin County Multi-Species Habitat Conservation and Open Space Plan (SJMSCP). Stockton, CA. Available online at - http://www.sjcog.org/programs-projects/Habitat_files/SJMSCP%20Document%20and%20Appendixes/San%20Joaquin%20Multi%20Species%20Habitat%20Conservation%20and%20Open%20Space%20Plan.pdf

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Solano County Water Agency (2009). Solano Multispecies Habitat Conservation Plan Final Administrative Draft.

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Wylie, G. D., T. Graham, et al. 1995. National biological service giant garter snake study progress report for the 1995 field season. Unpublished report. Dixon, CA, USGS Biological Resources Division, Dixon Research Station.



Photograph 1. View north along irrigation ditch and preferred access road from junction of preferred access with West 8 Mile Road. Photograph shows (from left to right) existing corn crops, graded levees road (with no burrows or crevices in surface), unnamed ditch (with bankside vegetation and patches of floating aquatic vegetation), another levee road, and asparagus crops.



Photograph 2. View north toward preferred access road crossing of existing ditch structures showing ruderal vegetation along edge of road bed and well-graded road bed with no burrows or crevices.



Photograph 3. View west along ditch and east–west portion of preferred access road. Photograph shows (from left to right) harvested and disked row crops (safflower), preferred access road (with no burrows or crevices in surface), unnamed ditch (with ruderal bankside vegetation, floating aquatic vegetation and patches of emergent vegetation), another levee road, and flood-irrigated corn crops.



Photograph 4. View west along irrigation ditch and east–west portion of preferred access road. Photograph shows (from left to right) harvested and disked row crops (safflower), preferred access road (with no burrows or crevices in surface), unnamed ditch (with ruderal bankside vegetation.



Photograph 5. View north along unnamed irrigation ditch and preferred access road from farm facilities. Photograph shows (from left to right) unnamed graded levee road, unnamed ditch (with patches of ruderal vegetation and dense patches of emergent vegetation), preferred access road (with no burrows or crevices in surface), young walnut orchard intercropped with safflower.



Photograph 6. View west along graveled access road to King Island Piacentine well pad. Well pad is shown on left and will be expanded into the adjacent cropland. No burrows or crevices were observed in the road surface (young walnut orchard intercropped with safflower shown in background).



Photograph 7. View northeast of existing King Island Piacentine Well pad, natural gas facilities and staged agricultural supplies. No burrows or crevices were observed in the existing well pad (young walnut orchard intercropped with safflower shown in background).



Photograph 8. View east of existing King Island Piacentine well and staged agricultural supplies. No burrows or crevices were observed in the existing well pad (young walnut orchard intercropped with safflower shown in background).



Photograph 9. View north toward proposed King Island Piacentine well pad expansion area showing young walnut orchard intercropped with safflower characteristic of proposed expansion area (staged agricultural equipment on existing Piacentine well pad in foreground).



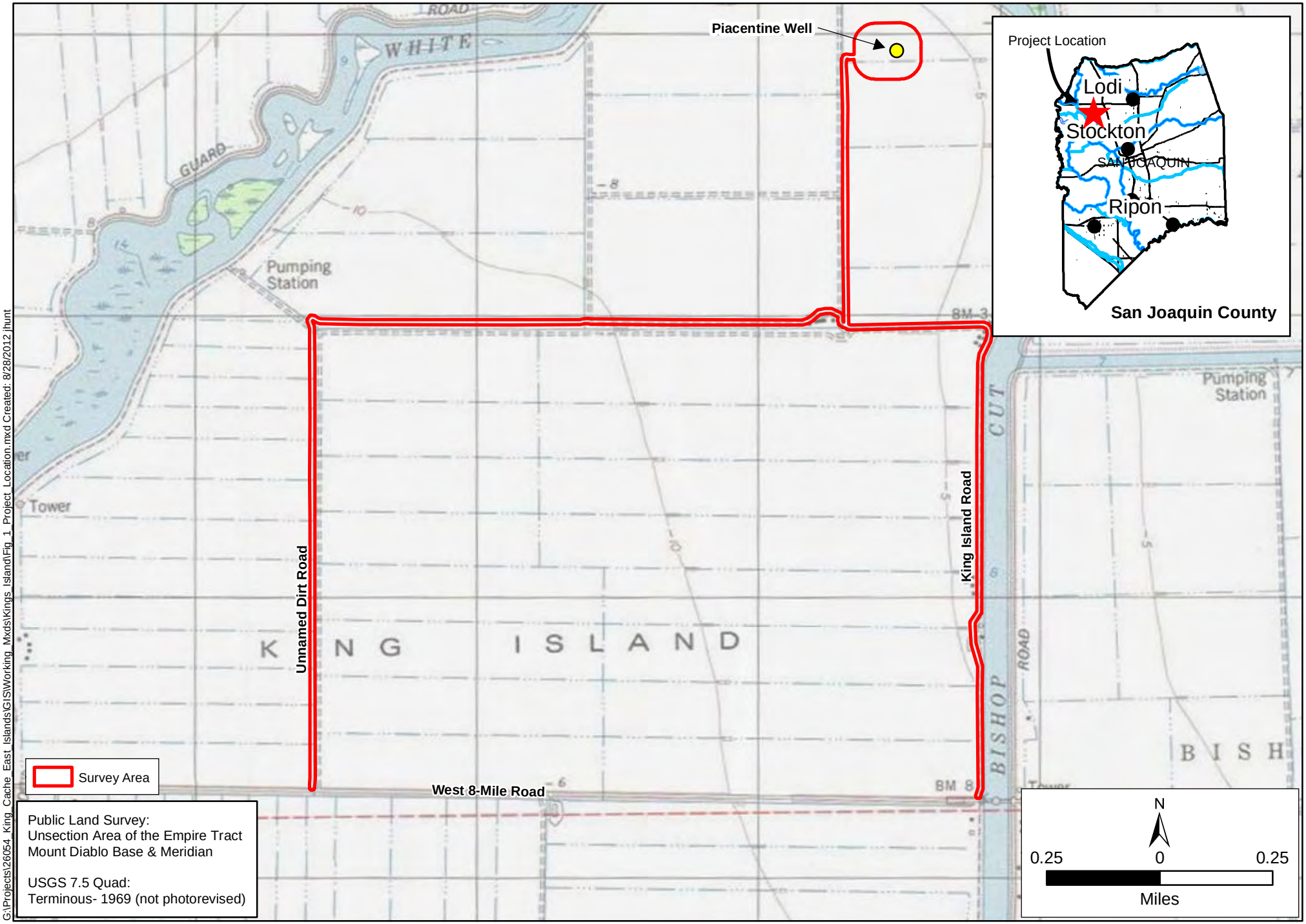
Photograph 10. View of existing agricultural facility staging area at junction of preferred and alternate access roads.



Photograph 11. View of south along King Island Road. Photograph shows (from left to right) the open water of Bishop Cut, rip-rapped banks and ruderal vegetation, King Island Road with fringing ruderal vegetation, and mature walnut orchards.

APPENDIX A

Figures

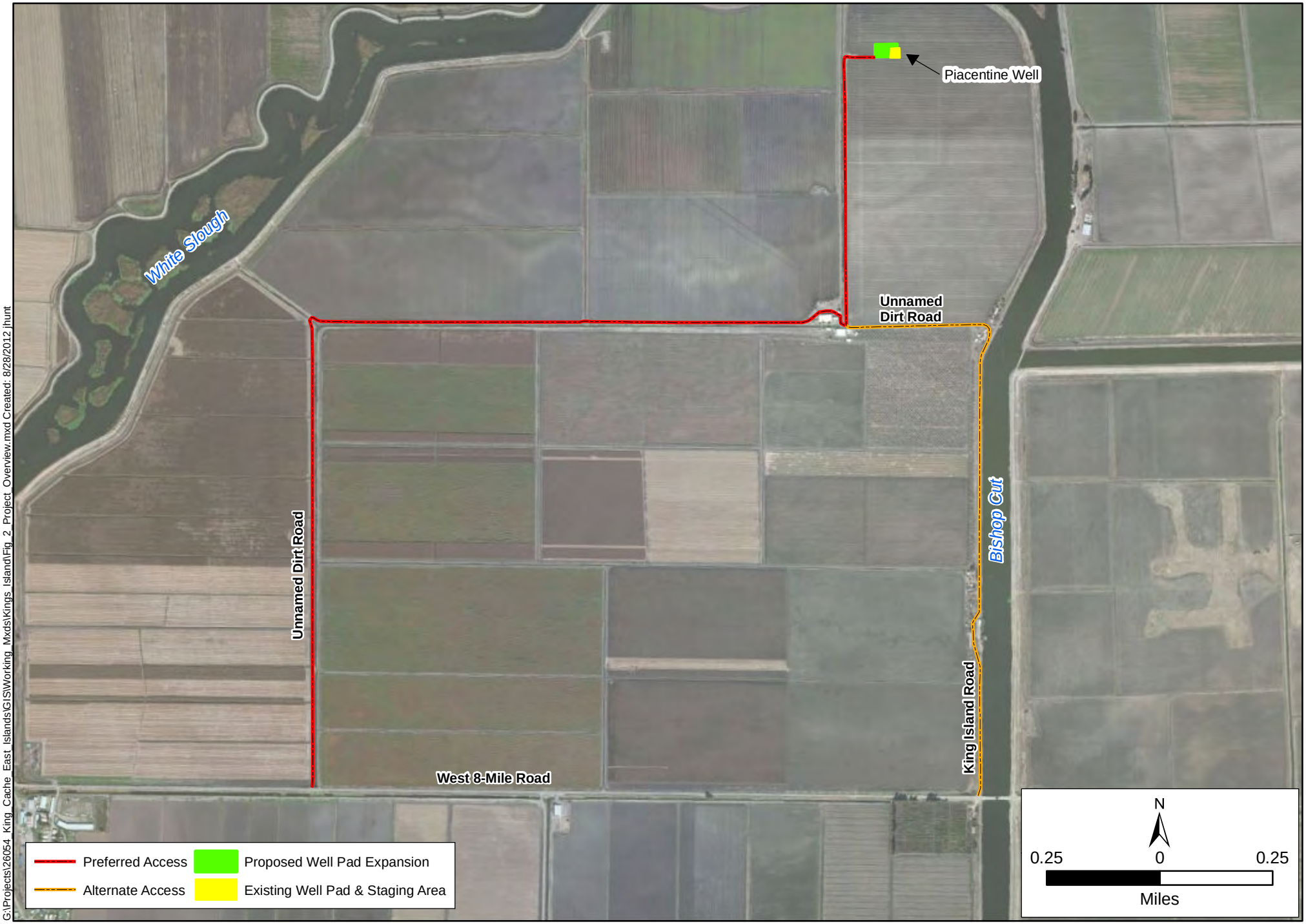


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North State Resources, Inc.

King Island, San Joaquin County, California

Figure 1. Project Location and Vicinity Map

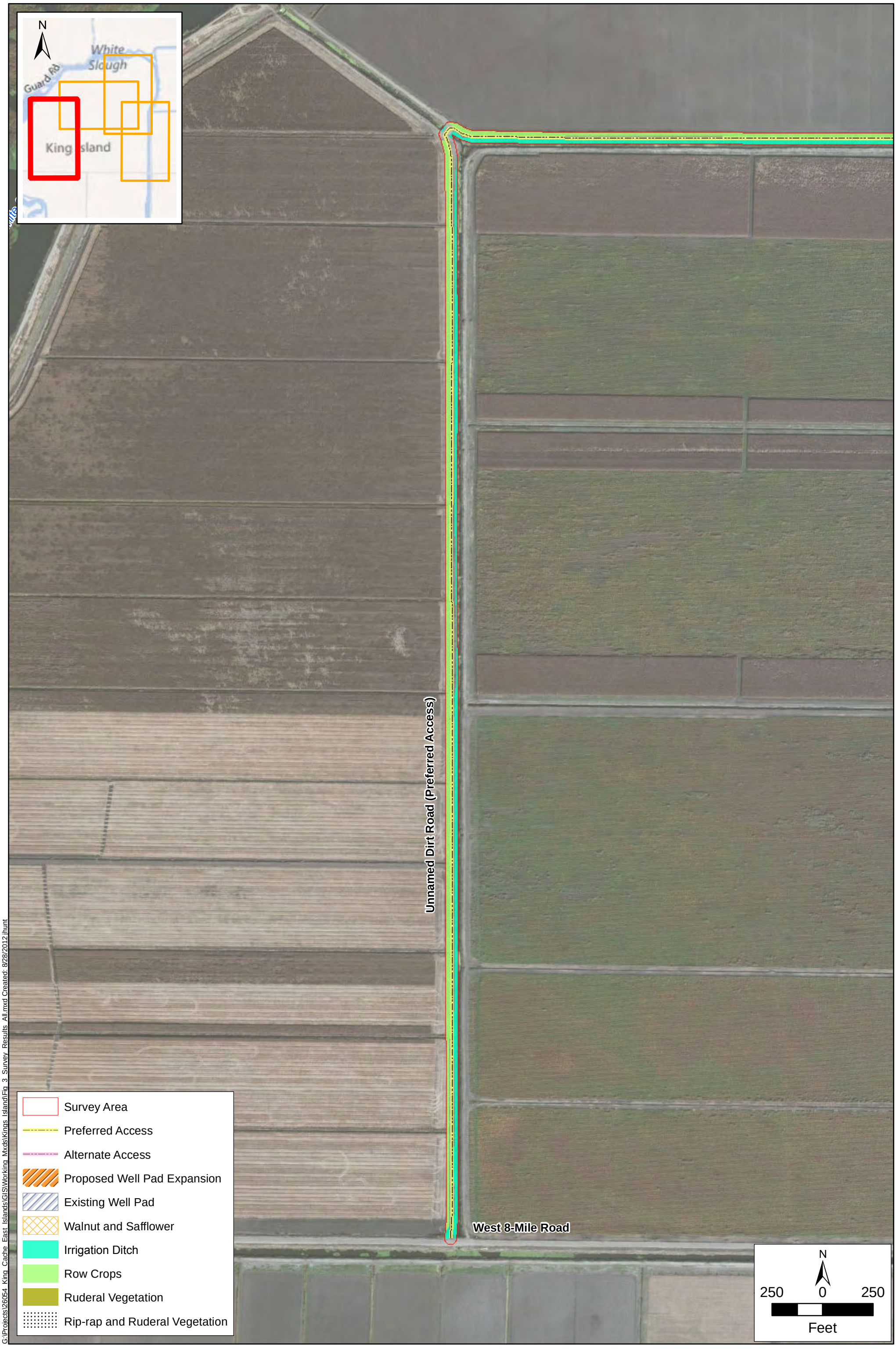


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North State Resources, Inc.

King Island, San Joaquin County, California

Figure 2. Project Area



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North State Resources, Inc.

King Island, San Joaquin County, California

Figure 3-1. Survey Results

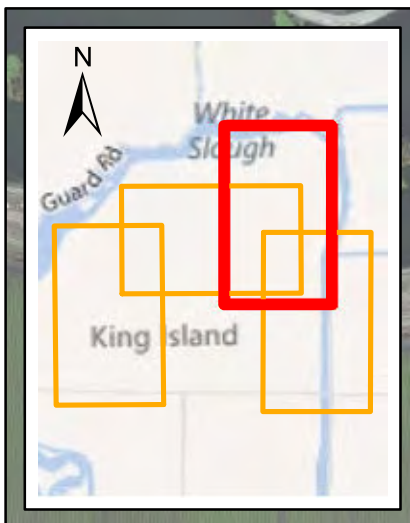


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North State Resources, Inc.

King Island, San Joaquin County, California

Figure 3-2. Survey Results



Piacentine Well

Unnamed Dirt Road
(Alternate Access)

eferred Access)

Survey Area
Preferred Access
Alternate Access
Proposed Well Pad Expansion
Existing Well Pad
Walnut and Safflower
Irrigation Ditch
Row Crops
Ruderal Vegetation
Rip-rap and Ruderal Vegetation

N
250 0 250
Feet

ess)

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North State Resources, Inc.

King Island, San Joaquin County, California

Figure 3-3. Survey Results



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King Island, San Joaquin County, California

North State Resources, Inc.

Figure 3-4. Survey Results



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King Island, San Joaquin County, California

North State Resources, Inc.

Figure 4. Survey Results - Well Pad Expansion Area

APPENDIX B

USFWS, CNDDB, and CNPS Queries

U.S. Fish & Wildlife Service

Sacramento Fish & Wildlife Office

Federal Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 120816041228

Database Last Updated: September 18, 2011

Quad Lists

Listed Species

Invertebrates

Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Lepidurus packardi
vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
Critical habitat, delta smelt (X)
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)

Rana draytonii
California red-legged frog (T)

Reptiles

Thamnophis gigas
giant garter snake (T)

Mammals

Sylvilagus bachmani riparius
riparian brush rabbit (E)

Quads Containing Listed, Proposed or Candidate Species:

TERMINOUS (479C)

County Lists

San Joaquin County

Listed Species

Invertebrates

Branchinecta conservatio
Conservancy fairy shrimp (E)
Critical habitat, Conservancy fairy shrimp (X)

Branchinecta longiantenna
longhorn fairy shrimp (E)

Branchinecta lynchi
Critical habitat, vernal pool fairy shrimp (X)
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Elaphrus viridis
delta green ground beetle (T)

Lepidurus packardi
Critical habitat, vernal pool tadpole shrimp (X)
vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
green sturgeon (T) (NMFS)

Hypomesus transpacificus
Critical habitat, delta smelt (X)
delta smelt (T)

Oncorhynchus mykiss
Central Valley steelhead (T) (NMFS)
Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
Central Valley spring-run chinook salmon (T) (NMFS)
Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
Critical habitat, winter-run chinook salmon (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
California tiger salamander, central population (T)
Critical habitat, CA tiger salamander, central population (X)

Rana draytonii
California red-legged frog (T)
Critical habitat, California red-legged frog (X)

Reptiles

Masticophis lateralis euryxanthus
Alameda whipsnake [=striped racer] (T)

Critical habitat, Alameda whipsnake (X)

Thamnophis gigas
giant garter snake (T)

Birds

Rallus longirostris obsoletus
California clapper rail (E)

Vireo bellii pusillus
Least Bell's vireo (E)

Mammals

Neotoma fuscipes riparia
riparian (San Joaquin Valley) woodrat (E)

Sylvilagus bachmani riparius
riparian brush rabbit (E)

Vulpes macrotis mutica
San Joaquin kit fox (E)

Plants

Amsinckia grandiflora
Critical habitat, large-flowered fiddleneck (X)
large-flowered fiddleneck (E)

Arctostaphylos myrtifolia
Ione manzanita (T)

Castilleja campestris ssp. succulenta
Critical habitat, succulent (=fleshy) owl's-clover (X)
succulent (=fleshy) owl's-clover (T)

Cordylanthus palmatus
palmate-bracted bird's-beak (E)

Lasthenia conjugens
Critical habitat, Contra Costa goldfields (X)

Orcuttia viscida
Critical habitat, Sacramento Orcutt grass (X)
Sacramento Orcutt grass (E)

Tuctoria greenei
Greene's tuctoria (=Orcutt grass) (E)

Candidate Species

Birds

Coccyzus americanus occidentalis
Western yellow-billed cuckoo (C)

Key:

(E) *Endangered* - Listed as being in danger of extinction.
(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.
(P) *Proposed* - Officially proposed in the Federal Register for listing as endangered or threatened.
(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.
(C) *Candidate* - Candidate to become a proposed species.
(V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.
(X) *Critical Habitat* designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, **or may be affected by** projects within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list. See our Protocol and Recovery Permits pages.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.

  During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.

- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.

  Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our Map Room page.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6520.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be November 14, 2012.

Count of ELMCODE CNAME	SNAME	FEDLIST	CALLIST	RPLANTRANK	SRANK	Total
burrowing owl	Athene cunicularia	None	None	(blank)	S2	1
California black rail	Laterallus jamaicensis coturniculus	None	Threatened	(blank)	S1	6
Coastal and Valley Freshwater Marsh	Coastal and Valley Freshwater Marsh	None	None	(blank)	S2.1	7
Delta mudwort	Limosella subulata	None	None	2.1	S2.1	8
Delta smelt	Hypomesus transpacificus	Threatened	Endangered	(blank)	S1	3
Delta tule pea	Lathyrus jepsonii var. jepsonii	None	None	1B.2	S2.2	4
giant garter snake	Thamnophis gigas	Threatened	Threatened	(blank)	S2S3	5
great blue heron	Ardea herodias	None	None	(blank)	S4	1
Mason's lilaeopsis	Lilaeopsis masonii	None	Rare	1B.1	S2	18
side-flowering skullcap	Scutellaria lateriflora	None	None	2.2	S1	2
Suisun Marsh aster	Symphyotrichum lentum	None	None	1B.2	S2	25
Swainson's hawk	Buteo swainsoni	None	Threatened	(blank)	S2	25
Valley Oak Woodland	Valley Oak Woodland	None	None	(blank)	S2.1	1
vernal pool tadpole shrimp	Lepidurus packardi	Endangered	None	(blank)	S2S3	1
watershield	Brasenia schreberi	None	None	2.3	S2	1
western pond turtle	Emys marmorata	None	None	(blank)	S3	11
white-tailed kite	Elanus leucurus	None	None	(blank)	S3	1
woolly rose-mallow	Hibiscus lasiocarpos var. occidentalis	None	None	1B.2	S2.2	28
Grand Total						148

CNPS Inventory of Rare and Endangered Plants

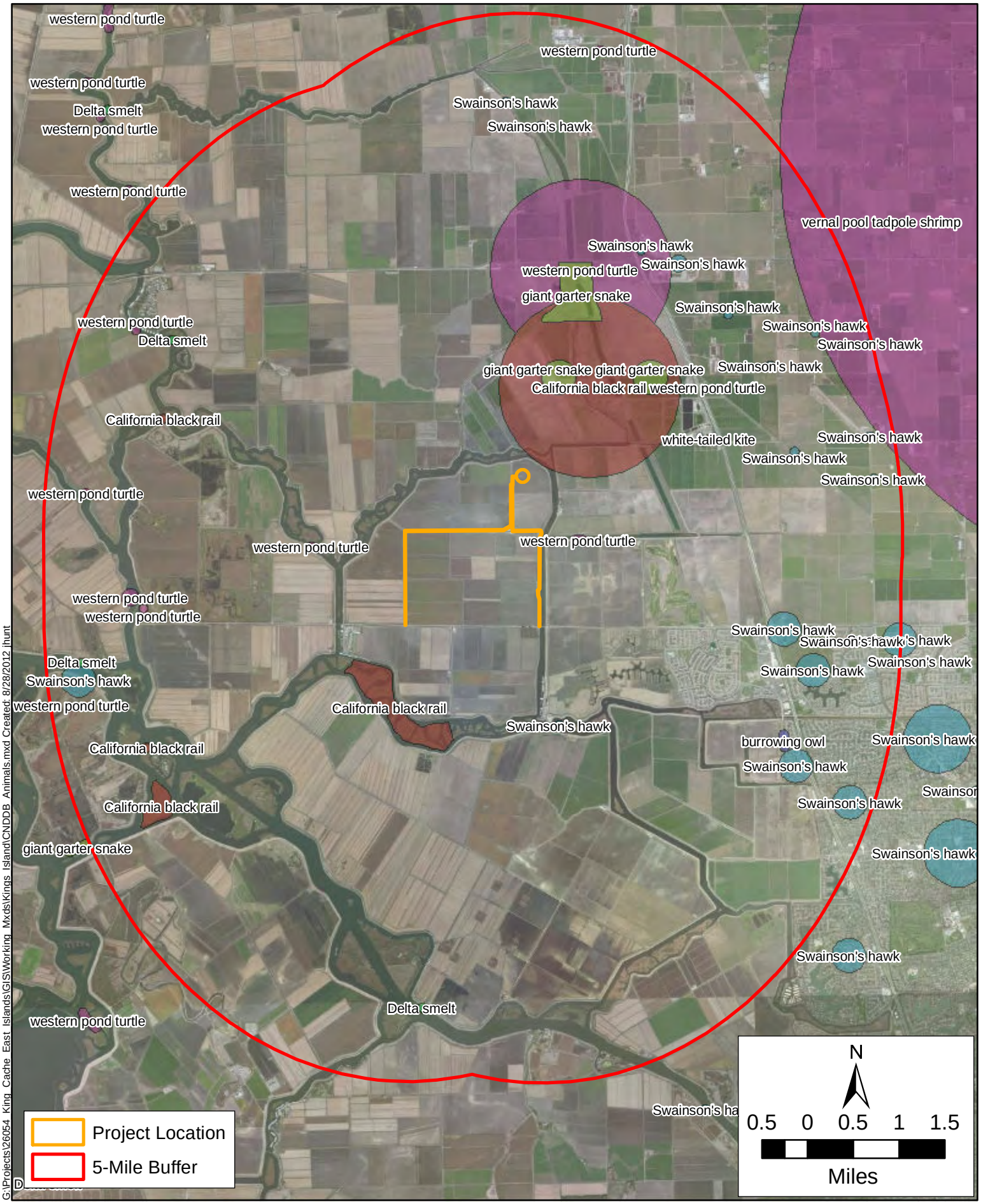
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Reformat list as: Standard List - with Plant Press controls

ECOLOGICAL REPORT

scientific	family	life form	blooming	communities	elevation	CNPS
Astragalus tener var. tener	Fabaceae	annual herb	Mar-Jun	•Playas (Plyas) •Valley and foothill grassland (VFGrs) (adobe clay) •Vernal pools (VnPls)/alkaline	1 - 60 meters	List 1B.2
Atriplex cordulata var. cordulata	Chenopodiaceae	annual herb	Apr-Oct	•Chenopod scrub (ChScr) •Meadows and seeps (Medws) •Valley and foothill grassland (VFGrs) (sandy)/saline or alkaline	0 - 560 meters	List 1B.2
Atriplex joaquinana	Chenopodiaceae	annual herb	Apr-Oct	•Chenopod scrub (ChScr) •Meadows and seeps (Medws) •Playas (Plyas) •Valley and foothill grassland (VFGrs)/alkaline	1 - 835 meters	List 1B.2
Blepharizonia plumosa	Asteraceae	annual herb	Jul-Oct	•Valley and foothill grassland (VFGrs)/Usually clay.	30 - 505 meters	List 1B.1
Brasenia schreberi	Cabombaceae	perennial rhizomatous herb aquatic	Jun-Sep	•Marshes and swamps (MshSw)/freshwater	30 - 2200 meters	List 2.3
California macrophylla	Geraniaceae	annual herb	Mar-May	•Cismontane woodland (CmWld) •Valley and foothill grassland (VFGrs)/clay	15 - 1200 meters	List 1B.1
Carex comosa	Cyperaceae	perennial rhizomatous herb	May-Sep	•Coastal prairie (CoPrr) •Marshes and swamps (MshSw) (lake margins) •Valley and foothill grassland (VFGrs)	0 - 625 meters	List 2.1
Chloropyron palmatum	Orobanchaceae	annual herb hemiparasitic	May-Oct	•Chenopod scrub (ChScr) •Valley and foothill grassland (VFGrs)/alkaline	5 - 155 meters	List 1B.1
Eryngium racemosum	Apiaceae	annual/perennial herb	Jun-Oct	•Riparian scrub (RpScr)(vernally mesic clay depressions)	3 - 30 meters	List 1B.1

Hibiscus lasiocarpos var. occidentalis	Malvaceae	perennial rhizomatous herb emergent	Jun-Sep	•Marshes and swamps (MshSw) (freshwater)	0 - 120 meters	List 1B.2
Juglans hindsii	Juglandaceae	perennial deciduous tree	Apr-May	•Riparian forest (RpFrs) •Riparian woodland (RpWld)	0 - 440 meters	List 1B.1
Lathyrus jepsonii var. jepsonii	Fabaceae	perennial herb	May-Jul(Sep), Months in parentheses are uncommon.	•Marshes and swamps (MshSw) (freshwater and brackish)	0 - 4 meters	List 1B.2
Legenere limosa	Campanulaceae	annual herb	Apr-Jun	•Vernal pools (VnPls)	1 - 880 meters	List 1B.1
Lilaeopsis masonii	Apiaceae	perennial rhizomatous herb	Apr-Nov	•Marshes and swamps (MshSw) (brackish or freshwater) •Riparian scrub (RpScr)	0 - 10 meters	List 1B.1
Limosella subulata	Scrophulariaceae	perennial stoloniferous herb	May-Aug	•Marshes and swamps (MshSw)	0 - 3 meters	List 2.1
Potamogeton zosteriformis	Potamogetonaceae	annual herb aquatic	Jun-Jul	•Marshes and swamps (MshSw) (assorted freshwater)	0 - 1860 meters	List 2.2
Sagittaria sanfordii	Alismataceae	perennial rhizomatous herb emergent	May-Oct	•Marshes and swamps (MshSw) (assorted shallow freshwater)	0 - 650 meters	List 1B.2
Scutellaria galericulata	Lamiaceae	perennial rhizomatous herb	Jun-Sep	•Lower montane coniferous forest (LCFrs) •Meadows and seeps (Medws) (mesic) •Marshes and swamps (MshSw)	0 - 2100 meters	List 2.2
Scutellaria lateriflora	Lamiaceae	perennial rhizomatous herb	Jul-Sep	•Meadows and seeps (Medws) (mesic) •Marshes and swamps (MshSw)	0 - 500 meters	List 2.2
Symphyotrichum lentum	Asteraceae	perennial rhizomatous herb	May-Nov	•Marshes and swamps (MshSw) (brackish and freshwater)	0 - 3 meters	List 1B.2
Tropidocarpum capparideum	Brassicaceae	annual herb	Mar-Apr	•Valley and foothill grassland (VFGrs) (alkaline hills)	1 - 455 meters	List 1B.1

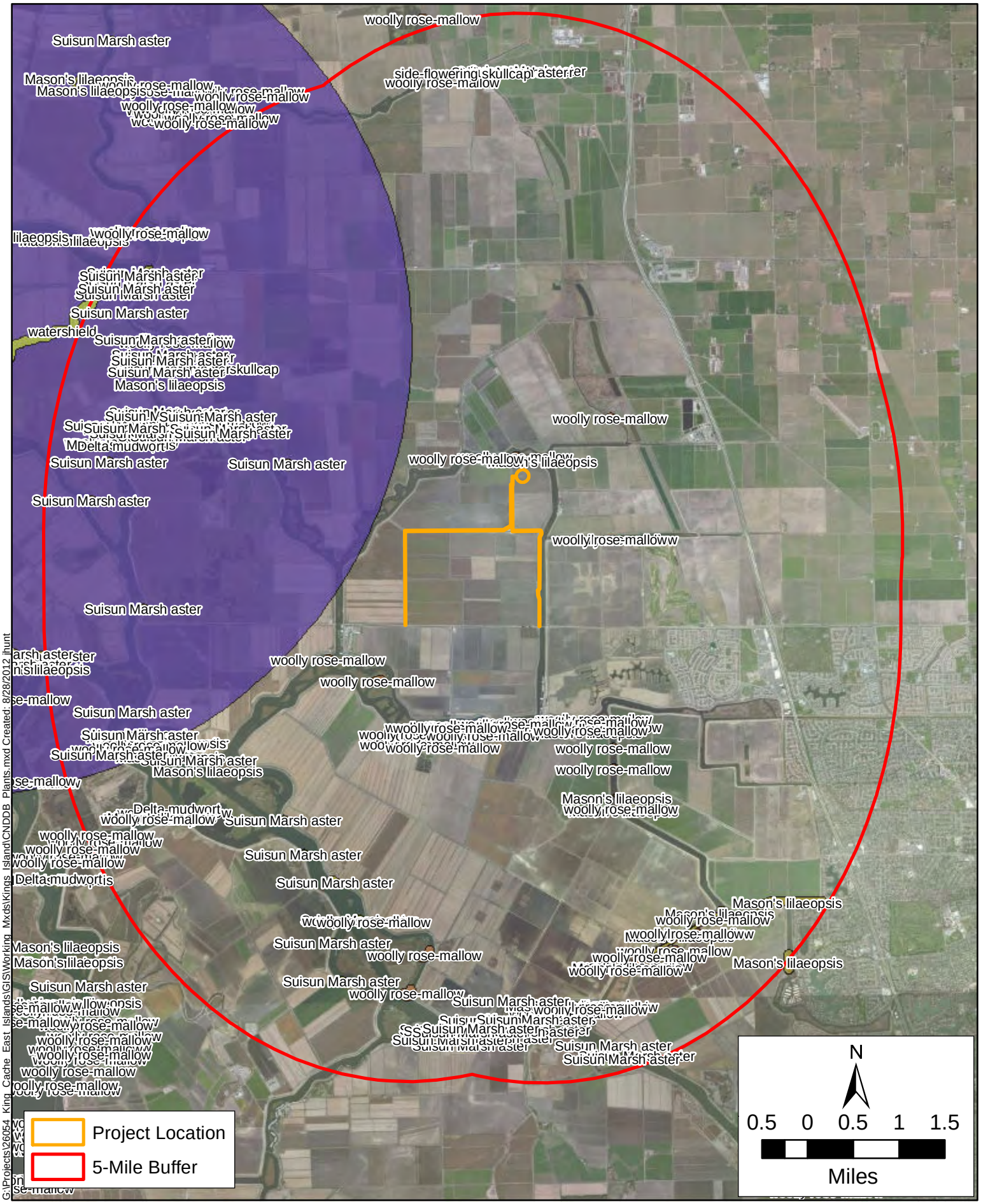


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Kings Island, San Joaquin County, California

North State Resources, Inc.

Animal CNDDB Results



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Kings Island, San Joaquin County, California

North State Resources, Inc.

Plants CNDDB Results

APPENDIX C

Swainson's Hawk Survey Protocol

RECOMMENDED TIMING AND METHODOLOGY FOR SWAINSON'S HAWK NESTING SURVEYS IN CALIFORNIA'S CENTRAL VALLEY

Swainson's Hawk Technical Advisory Committee

May 31, 2000

This set of survey recommendations was developed by the Swainson's Hawk Technical Advisory Committee (TAC) to maximize the potential for locating nesting Swainson's hawks, and thus reducing the potential for nest failures as a result of project activities/disturbances. The combination of appropriate surveys, risk analysis, and monitoring has been determined to be very effective in reducing the potential for project-induced nest failures. As with most species, when the surveyor is in the right place at the right time, Swainson's hawks may be easy to observe; but some nest sites may be very difficult to locate, and even the most experienced surveyors have missed nests, nesting pairs, mis-identified a hawk in a nest, or believed incorrectly that a nest had failed. There is no substitute for specific Swainson's hawk survey experience and acquiring the correct search image.

METHODOLOGY

Surveys should be conducted in a manner that maximizes the potential to observe the adult Swainson's hawks, as well as the nest/chicks second. To meet the California Department of Fish and Game's (CDFG) recommendations for mitigation and protection of Swainson's hawks, surveys should be conducted for a ½ mile radius around all project activities, and if active nesting is identified within the ½ mile radius, consultation is required. In general, the TAC recommends this approach as well.

Minimum Equipment

Minimum survey equipment includes a high-quality pair of binoculars and a high quality spotting scope. Surveying even the smallest project area will take hours, and poor optics often result in eye-strain and difficulty distinguishing details in vegetation and subject birds. Other equipment includes good maps, GPS units, flagging, and notebooks.

Walking vs Driving

Driving (car or boat) or "windshield surveys" are usually preferred to walking if an adequate roadway is available through or around the project site. While driving, the observer can typically approach much closer to a hawk without causing it to fly. Although it might appear that a flying bird is more visible, they often fly away from the observer using trees as screens; and it is difficult to determine from where a flying bird came. Walking surveys are useful in locating a nest after a nest territory is identified, or when driving is not an option.

Angle and Distance to the Tree

Surveying subject trees from multiple angles will greatly increase the observer's chance of detecting a nest or hawk, especially after trees are fully leafed and when surveying multiple trees

in close proximity. When surveying from an access road, survey in both directions. Maintaining a distance of 50 meters to 200 meters from subject trees is optimal for observing perched and flying hawks without greatly reducing the chance of detecting a nest/young: Once a nesting territory is identified, a closer inspection may be required to locate the nest.

Speed
Travel at a speed that allows for a thorough inspection of a potential nest site. Survey speeds should not exceed 5 miles per hour to the greatest extent possible. If the surveyor must travel faster than 5 miles per hour, stop frequently to scan subject trees.

Visual and Aural Ques
Surveys will be focused on both observations and vocalizations. Observations of nests, perched adults, displaying adults, and chicks during the nesting season are all indicators of nesting Swainson's hawks. In addition, vocalizations are extremely helpful in locating nesting territories. Vocal communication between. hawks is frequent during territorial displays; during courtship and mating; through the nesting period as mates notify each other that food is available or that a threat exists; and as older chicks and fledglings beg for food.

Distractions
Minimize distractions while surveying. Although two pairs of eyes may be better than one pair at times, conversation may limit focus. Radios should be off, not only are they distracting, they may cover a hawk's call.

Notes and Species Observed
Take thorough field notes. Detailed notes and maps of the location of observed Swainson's hawk nests are essential for filling gaps in the Natural Diversity Data Base; please report all observed nest sites. Also document the occurrence of nesting great homed owls, red-tailed hawks, red-shouldered hawks and other potentially competitive species. These species will infrequently nest within 100 yards of each other, so the presence of one species will not necessarily exclude another.

TIMING

To meet **the minimum level** of protection for the species, surveys should be completed for **at least** the two survey periods immediately prior to a project's initiation. For example, if a project is scheduled to begin on June 20, you should complete 3 surveys in Period III and 3 surveys in Period V. However, it is always recommended that surveys be completed in Periods II, III and V. **Surveys should not be conducted in Period IV.**

The survey periods are defined by the timing of migration, courtship, and nesting in a "typical" year for the majority of Swainson's hawks from San Joaquin County to Northern Yolo County. Dates should be adjusted in consideration of early and late nesting seasons, and geographic differences (northern nesters tend to nest slightly later, etc). If you are not sure, contact a TAC member or CDFG biologist.

Survey dates **Justification and search image**	**Survey time**	**Number of Surveys**
I. *January-March 20 (recommended optional)*	*All day*	*1*

Prior to Swainson's hawks returning, it may be helpful to survey the project site to determine potential nest locations. Most nests are easily observed from relatively long distances, giving the surveyor the opportunity to identify potential nest sites, as well as becoming familiar with the project area. It also gives the surveyor the opportunity to locate and map competing species nest sites such as great homed owls from February on, and red-tailed hawks from March on. After March 1, surveyors are likely to observe Swainson's hawks staging in traditional nest territories.

II. *March 20 to April 5*	*Sunrise to 1000* *1600 to sunset*	*3*

Most Central Valley Swainson's hawks return by April 1, and immediately begin occupying their traditional nest territories. For those few that do not return by April 1, there are often hawks ("floaters") that act as place-holders in traditional nest sites; they are birds that do not have mates, but temporarily attach themselves to traditional territories and/or one of the site's "owners." Floaters are usually displaced by the territories' owner(s) if the owner returns.

Most trees are leafless and are relatively transparent; it is easy to observe old nests, staging birds, and competing species. The hawks are usually in their territories during the survey hours, but typically soaring and foraging in the mid-day hours. Swainson's hawks may often be observed involved in territorial and courtship displays, and circling the nest territory. Potential nest sites identified by the observation of staging Swainson's hawks will usually be active territories during that season, although the pair may not successfully nest/reproduce that year.

III. *April 5 to April 20*	*Sunrise to 1200* *1630 to Sunset*	***3***

Although trees are much less transparent at this time, 'activity at the nest site increases significantly. Both males and females are actively nest building, visiting their selected site frequently. Territorial and courtship displays are increased, as is copulation. The birds tend to vocalize often, and nest locations are most easily identified. This period may require a great deal of "sit and watch" surveying.

IV. *April 21 to June 10*	*Monitoring known nest sites only* ***Initiating Surveys is not recommended***	

Nests are extremely difficult to locate this time of year, and even the most experienced surveyor will miss them, especially if the previous surveys have not been done. During this phase of nesting, the female Swainson's hawk is in brood position, very low in the nest, laying eggs, incubating, or protecting the newly hatched and vulnerable chicks; her head may or may not be visible. Nests are often well-hidden, built into heavily vegetated sections of trees or in clumps of mistletoe, making them all but invisible. Trees are usually not viewable from all angles, which may make nest observation impossible.

Following the male to the nest may be the only method to locate it, and the male will spend hours away from the nest foraging, soaring, and will generally avoid drawing attention to the nest site. Even if the observer is fortunate enough to see a male returning with food for the female, if the female determines it is not safe she will not call the male in, and he will not approach the nest; this may happen if the observer, or others, are too close to the nest or if other threats, such as rival hawks, are apparent to the female or male.

V. ***June 10 to JuIy 30 (post-fledging)*** ***Sunrise to 1200*** ***3***
1600 to sunset

Young are active and visible, and relatively safe without parental protection. Both adults make numerous trips to the nest and are often soaring above, or perched near or on the nest tree. The location and construction of the nest may still limit visibility of the nest, young, ‘and adults.

DETERMINING A PROJECT'S POTENTIAL
FOR IMPACTING SWAINSON'S HAWKS

LEVEL OF RISK	REPRODUCTIVE SUCCESS (Individuals)	LONGTERM SURVIVABILITY (Population)	NORMAL SITE CHARACTERISTICS (Daily Average)	NEST MONI-TORING
HIGH	Direct physical contact with the nest tree while the birds are on eggs or protecting young. (Helicopters in close proximity)	Loss of available foraging area.	Little human-created noise, little human use: nest is well away from dwellings, equipment yards, human access areas, etc. *Do not include general cultivation practices in evaluation.*	**MORE**
		Loss of nest trees.		
	Loss of nest tree after nest building is begun prior to laying eggs.	Loss of potential nest trees.		
	Personnel within 50 yards of nest tree (out of vehicles) for extended periods while birds are on eggs or protecting young that are < 10 days old.	Cumulative: Multi-year, multi-site projects with substantial noise/personnel disturbance.		
	Initiating construction activities (machinery and personnel) within 200 yards of the nest after eggs are laid and before young are > 10 days old.	Cumulative: Single-season projects with substantial noise/personnel disturbance that is greater than or significantly different from the daily norm.		
	Heavy machinery only working within 50 yards of nest.		Substantial human-created noise and occurrence: nest is near roadways, well-used waterways, active airstrips, areas that have high human use. *Do not include general cultivation practices in evaluation.*	
	Initiating construction activities within 200 yards of nest before nest building begins or after young > 10 days old.	Cumulative: Single-season projects with activities that "blend" well with site's "normal' activities.		
LOW	All project activities (personnel and machinery) greater than 200 yards from nest.			**LESS**

A320: Master List

Field	County	TWP	RNG	Initial Pressure (psi)	Producing Formation	Avg depth	Avg Thick-ness	Porosity %	Perme-ability MD	Cum. Gas (BCF)	Cum. Oil (Mbbl)	Cum. Water (Mbbl)	Gas/Oil	Gas/Water	Producing Wells	Shut-in Wells	Status (abd, SI, prod)	Remaining Reserves 12/09 (DOG)	Recommen-dation	Comment
Afton	Glenn	18N, 19N	1W	800	Capay	1830	30	25	NA	Pool breakdown in production table does not match reservoir tables										YES - Looks good MAYBE - May be good candidate, need to look at field data NO - Not good
Afton	Glenn	18N, 19N	1W	1225	Afton	2650	25	30	NA											
Total Afton										**19.72**	**0**	**Low**	**0**	**Low**	**4**	**2**	**Prod**	**0.2**	**MAYBE**	**Still in production, though reserves are low. All other factors appear good.**
Arbuckle	Colusa	3N, 14	2W	2200-4800	Forbes	430-715	5 to 90	23	NA	87.46	0	Low	0	Low	19	11	Prod	2.74	MAYBE	May be abandoned areas or sands that could be used even though field is still producing
Ash Slough	Madera	3N, 14	2W		Zilch					0.001	0	Low	0	Low	None	None	Abd			
Ash Slough	Madera	3N, 14	2W	2391	Blewett	5500	13	30	NA	6.103	0	Low	0	Low	None	None	Abd			
Total Ash Slough										**6.104**	**0**	**Low**	**0**	**0**	**None**	**None**	**Abd**		**MAYBE**	**Modest in size but abandoned, Blewett has good properties, net sand is low but total zone may be thicker, will need to review whether gas sits on thick wet sand. Zilch is apparently very small**
Bounde Creek	Colusa-Gle	18N	1W,2W	1300	iceton Canyon	2840	30	31	NA											
Bounde Creek	Colusa-Gle	18N	1W,2W	2130	Kione	3700	45	24-28	NA											
Bounde Creek	Colusa-Gle	18N	1W,2W	5450	Guinda	6965	35	15-20	NA											
Bounde Creek	Colusa-Gle	18N	1W,2W		Total of above					44.99	0	Low	0	Low	16	4	Prod			
Bounde Creek	Colusa-Gle	18N	1W,2W	3810-4905	Forbes	5450	265	15-24	NA	0.727	0	Low	0	Low	None	1	SI			
Total Bounde Creek										**45.72**	**0**	**Low**	**0**	**Low**	**16**	**5**	**Prod**	**1.203**	**MAYBE**	**Production tables lumped several zones, one or more may be abandoned. Reservoir properties good.**
Bixler	Contra	1N	3E							5.58	0	Low	0	Low			Abd		MAYBE	Need to research
Bowerbank	Kern	29S	23E, 24	na	2nd Mya	3140	4	29	1700											
Bowerbank	Kern	29S	23E, 24	1720	Root	4000	4	28	1200	No pool breakdown in production tables										
Bowerbank	Kern	29S	23E, 24	1600	4-23	4200	20	28	1100											
Bowerbank	Kern	29S	23E, 24	1832	Espee	4300	10	28	1100											
Bowerbank	Kern	29S	23E, 24	2069	Sub Scalez	4600	22	28	1000											
Total Bowerbank										**24.99**	**0**	**Low**	**0**	**Low**	**None**	**5**	**SI**	**0.576**	**YES**	**Good reservoir properties, multiple zones, large field, still producing but at a low level, remaining reserves are modest**
Brentwood	Contra	1N	2E	1600	Prewett	3520	34	20-24	NA	4.716	951	0	4958.991	0			Abd			
Brentwood	Contra	1N	2E	1600	First Massive	3500	50-100	20-24	NA	32.41	1130	0	28682.3	0			Abd			
Brentwood	Contra	1N	2E	1600	econd Massiv	3700	50-100	20-24	NA	9.369	2228	0	4205.117	0			Abd			
Brentwood	Contra	1N	2E	1600	Third Massive	3700	30	20-24	NA	5.6	4198	0	1333.969	0			Abd			
Total Brentwood										**52.1**	**8507**	**0**	**6123.898**	**0**	**None**	**None**	**Abd**		**NO**	**History of oil production, noted that this is black oil and not condensate**
Brentwood, East	Contra	1N	3E	3641	Third Massive	8000	170	20	NA	47.39	77	Low	615506.5	Low	2	None	Prod	0.089	YES	PZI initial field report completed
Buckeye	Colusa	13N	1E,1W	3600	Forbes	850-851	10-30	21-24	NA	**23.46**	0	Low	0	Low	11	3	Prod	2.578	MAYBE	Still in production with significant remaining reserves. Good size, probably good reservoir properties
Butte Sink	Colusa/Sut	16N	1W	460	-Foot Zone (K	1000	10	25	NA											
Butte Sink	Colusa/Sut	16N	1W	735	-Foot Zone (K	1600	20	25	NA	No pool breakdown in production tables										
Butte Sink	Colusa/Sut	16N	1W	930	-Foot Zone (K	1950	20	25	NA											
Butte Sink	Colusa/Sut	16N	1W	935	-Foot Zone (K	2000	80	25	NA											
Butte Sink	Colusa/Sut	16N	1W	NA	-Foot Zone (K	2600	20	25	NA											
Butte Sink	Colusa/Sut	16N	1W	1220	-Foot Zone (K	2650	15	25	NA											
Total Butte Sink					**Kione**					**7.586**	**0**	**Low**	**0**	**Low**	**1**	**1**	**Prod**	**0.166**	**NO**	**Not a large field, most of it is too shallow and will be low pressure**
Butte Slough	Colusa/Sut	5N,16	1W,1E	835	letcher (Kione	1815	35	25	NA	No pool breakdown in production tables										
Butte Slough	Colusa/Sut	5N,16	1W,1E	3250-5000	named (Forb	700-727	6-80	15-20	NA											
Total Butte Slough										**11.01**	**0**	**Low**	**0**	**Low**	**7**	**2**	**Prod**	**1.731**	**MAYBE**	**Good reservoir properties, still producing, significant remaining reserves**
Buttonwillow	Kern	7S, 28	2E, 23	1000	Joaquin Gas Z	300-320	15	25	700	38.36	0	0	0	0	None	None	Abd		NO	Most of field is too shallow and will be low pressure
Cache Slough	Solano	4N	2E,3E	2120	d (Mokelumn	4730	35	33	NA	No pool breakdown in production tables										
Cache Slough	Solano	4N	2E,3E	2235	ed (Mokelumn	5335	5	25-30	NA											
Total Cache Slough										**12.52**	**0**	**Low**	**0**	**Low**	**None**	**None**	**Abd**		**YES**	**Good reservoir properties, good size, abandoned**
Chowchilla	Madera	9S, 10S	13E, 14	1000	Zilch(Upper)	2700	15	29-35	NA	2.334	0	Low			None	1	SI			
Chowchilla	Madera	9S, 10S	13E, 14	1140	Zilch(1-20)	2830	35	33	NA	2.251	0	Low			None	None	Abd			
Chowchilla	Madera	9S, 10S	13E, 14	1365	Domengine	3003	9	32	71	0.69	0	Low			None	None	Abd			
Chowchilla	Madera	9S, 10S	13E, 14	1513	Garzas	3350	17	39	60	0.296	0	Low			1	None	Prod			
Chowchilla	Madera	9S, 10S	13E, 14	3614	Cretaceous	7500	50	26.5	60	25.14	0	Low			None	1	SI	0.022		
Total Chowchilla										**30.71**	**0**	**Low**	**0**	**Low**	**1**	**2**	**Prod**	**0.022**	**MAYBE**	**PZI initial field report completed in draft, nearly depleted, some zones abandoned, permeability could be low**
Clarksburg	Yolo	6N,7N	4E	1360	irkley Canyon	~3000		35		1.879	0	Low	0	Low	None	None				
Clarksburg	Yolo	6N,7N	4E	2300	Starkey	~5000		32		6.742	0	Low	0	Low	None	None				
Clarksburg	Yolo	6N,7N	4E	3360	ollock (Winter	7450	20	28	NA	5.42	0	Low	0	Low	None	None				
Clarksburg	Yolo	6N,7N	4E	5109	Forbes	11100	50	22	NA	0.141	0	Low	0	Low	None	1	SI			
Total Clarksburg										**14.18**	**0**	**Low**	**0**	**Low**	**None**	**1**	**SI**		**YES**	**Good size, apparently good reservoir properties, may be nearly abandoned, no reserves listed**
Coles Levee N	Kern	30S	24E, 25	2300	Etchegoin	5300	35	25	400	13.05	0	Low	0	Low	None	10	SI		NO	Permeability may be low, field is in production from deeper zones
Coles Levee S	Kern	31S	25E	1840	Mya (San Joac	4200	200	29	1200	No pool breakdown in production tables										
Coles Levee S	Kern	31S	25E	2287	Etchegoin	5120	35	25	400											
Total Coles Levee S										**43.78**	**2**	**Low**	**22**	**Low**	**None**	**3**	**SI**		**NO**	**Permeability may be low, field is in production from deeper zones**
Compton Landing	Colusa	17N	1W, 2W	860	per Carter (Kio	2020	40	30	NA											
Compton Landing	Colusa	17N	1W, 2W	950	ver Carter (Kio	2190	60	28-31	NA											
Compton Landing	Colusa	17N	1W, 2W	980	Catfish (Kione	2310	20	30	NA											
Compton Landing	Colusa	17N	1W, 2W	1015	Tuttle (Kione)	2550	40	28	NA											
Compton Landing	Colusa	17N	1W, 2W		Total Kione					12.84					2	2	Prod	0.619		
Compton Landing	Colusa	17N	1W, 2W	4450	nnamed (Forb	6260	15	20-24	NA	3.153					1		Prod	0.749		
Total Compton Landing										**15.99**	**0**	**Low**	**0**	**Low**	**3**	**2**	**Prod**		**MAYBE**	**Reservoir properties are good, some zones too shallow, modest remaining reserves but few active wells**
Conway Ranch	Yolo	9N,10N	2E,3E	1340	Mokelumne Riv	850-310	0-80	24-30	NA	No pool breakdown in production tables										
Conway Ranch	Yolo	9N,10N	2E,3E	1762	Starkey	300-430	0-60	26-32	NA											
Conway Ranch	Yolo	9N,10N	2E,3E	2380	Winters	150-530	0-50	22-28	NA											
Conway Ranch	**Yolo**	**9N, 10N**	**2E, 3E**							**40.77**	**0**	**Moderate**	**0**	**Moderate**	**6**	**5**	**Prod**	**2.545**	**NO**	**Showed some evidence of water drive, significant remaining reserves**
Corning	Tehama	24N,25	3W	415-645	ng Sands (Mic	380-1450	5-120	29-33	NA	**8.266**	**0**	**Low**	**0**	**Low**	None	None	Abd		NO	Too shallow
Corning South	Tehama	24N	2W,3W	520	A-2 (Miocene)	1185	10	29-33	NA	No pool breakdown in production tables										
Corning South	Tehama	24N	2W,3W	680	A (Miocene)	1560	15	29-33	NA											
Corning South	Tehama	24N	2W,3W	1010	A-5 (Kione)	2340	20	25-28	NA											
Corning South	**Tehama**	**24N**	**2W, 3W**							**5.072**	**0**	**Moderate**	**0**	**Moderate**	**3**	**2**	**Prod**	**1.006**	**NO**	**Small, and part of reservoir is too shallow, still producing, moderate remaining reserves**
Crossroads	Yolo	10N	2E,3E	2050	Starkey	4150	35	28-34	NA	**7.908**	**0**	**Low**	**0**	**Low**	**None**	**None**	**Abd**			
Crossroads	Yolo	10N	2E,3E	2440	Winters	4985	20	22-28	NA	**9.288**	**0**	**Low**	**0**	**Low**	**None**	**None**	**Abd**			
Total Crossroads										**17.2**	**0**	**Low**	**0**	**Low**	**None**	**None**	**Abd**		**YES**	**Good size, good reservoir properties, abandoned**
Dudley Ridge	Kings	23S	19E, 20	440	Tulare	1100	20	NA	NA	4.866	0	Low	0	Low			Abd		MAYBE	Small size but structure may be bigger than gas pool, good reservoir properties, abandoned
Dutch Slough	Contra	2N	3E	3161	Anderson	7000	50	28	NA											
Dutch Slough	Contra	2N	3E	3257	B-I	7200	50	27	195											
Dutch Slough	Contra	2N	3E	3281	B-II	7300	50	27	195	No pool breakdown in production tables										
Dutch Slough	Contra	2N	3E	3317	B-III	7400	95	26	34											
Dutch Slough	Contra	2N	3E	3505	econd Massiv	8100	15	NA	NA											
Total Dutch Slough										**151.2**	**244**	**Low**	**1**	**Low**	**13**	**13**	**Prod**	**13.526**	**MAYBE**	**Very large field, still significant production and reserves, would only be viable if one or more zones are abandoned**

Dunnigan Hills	Yolo	0N, 11	1W, 1E	1040	1-3 (Winters)	2450	40	34-38	300-1700												
Dunnigan Hills	Yolo	0N, 11	1W, 1E	1060	ermle (Winter	2465	65	34-38	NA												
Dunnigan Hills	Yolo	0N, 11	1W, 1E	1080	ubois (Winter	2650	30	34-38	NA	No pool breakdown in production tables											
Dunnigan Hills	Yolo	0N, 11	1W, 1E	5005	ederer (Forbes	8400	15	16-25	NA												
Total Dunnigan Hills										**13.02**	**0**	**Low**	**0**	**Low**	**5**	**2**	**Prod**	**2.662**	**NO**	**Modest sized field, all but Forbes are too shallow, significant remaining reserves**
Elkhorn Slough	Solano	5N	3E	3900	Winters	8600	10-30	20	NA	14.05	**0**	**Low**	**o**	**Low**	**2**	**1**	Prod	3.246	MAYBE	Good size, good reservoir properties, significant reserves but well count is low so remaining reserves may be too high
French Camp	San Joaqui	1N, 1S	6E	2320	2ND Tracy	5000	30	22-26	NA												
French Camp	San Joaqui	1N, 1S	6E	2420	3RD Tracy	5308	17	20-24	NA	No pool breakdown in production tables											
French Camp	San Joaqui	1N, 1S	6E	4990	Lathrop	6925	45	18-22	NA												
Total French Camp										**41.53**	**0**	**Modera te**	**0**	**Moderate**	**16**	**4**	**Prod**	**14.012**	**MAYBE**	**Reservoir properties are good, but still has a lot of producing wells and large reserves, would only be viable if one or more zones are abandoned**
Garrison City	Kern	28S	24E	1380	Island (San Jo	3450	10	29	1600												
Garrison City	Kern	28S	24E	2340	ilinia (Etchego	4500	15	28	1200	No pool breakdown in production tables											
Garrison City	Kern	28S	24E	2340	tchel (Etchego	5970	25	24	300												
Total Garrison City										**2.622**	**0**	**Low**	**0**	**Low**	**None**	**None**	**Abd**		**MAYBE**	**Abandoned, mostly good reservoir properties, permeability may be low, structure may be larger than the gas pool in it**
Grimes	Colusa/Sut	4N,15	1W		Kione					**0.096**	0	Low	0	Low	1		SI			
Grimes	Colusa/Sut	4N,15	1W	2780-6000	Forbes	900-880	5-50	25-30	NA	**701.6**	0	Low	0	Low	237	68	Prod			
Total Grimes										**701.7**	**0**	**Low**	**0**	**Low**	**238**	**68**	**Prod**	**78.825**	**NO**	**Kione is too small, Forbes still has very high current production and reserves**
Harvester	Kings	23S	21E,22	1150	rst Mya (Tular	2800	6	30+	NA	**1.408**	0	Low	0	Low	None	None	Abd			
Harvester	Kings	23S	21E,22	1690	Island (San Jo	3750	10	25+	NA	**7.533**	0	Low	0	Low	None	None	Abd			
Total Harvester										**8.941**	**0**	**Low**	**0**	**Low**	**None**	**None**	**Abd**		**MAYBE**	**Abandoned, permeability could be low, good size**
Hollister	San Benito	12S	4E, 5E	NA	risima (Plioce	000-350	35	NA	NA	8.457	0	Low	0	Low	2	3	Prod	0.041	NO	Geologic setting is faulted and structurally complex, too difficult to map with available data
Hood-Franklin	Sacrament	6N	4E	3400	Winters	7500	20	~18	NA	**3.772**	0	Low	0	Low	4	None	Prod	9.174	NO	Single zone, significant remaining reserves still in production
King Island	San Joaqui	3N	5E	2150	okelumne Riv	4750	20	~25	NA	**10.57**	0	Low	0	Low	2	0	Prod	0.062	YES	Good size, good reservoir, production is low and remaining reserves are low
Kirby Hill	Solano	4N	1E,1W	250	Markely	1100	30	18-24	NA	Probably included in "unnamed"											
Kirby Hill	Solano	4N	1E,1W	1160	Nortonville	250-225	35	25	NA	Probably included in "unnamed"											
Kirby Hill	Solano	4N	1E,1W	1195	Domengine	550-285	130	19	NA	13.98	0	Low	0	Low	8	None	Prod			
Kirby Hill	Solano	4N	1E,1W	2205	Wagenet	850-540	150	20-24	NA	Probably included in "unnamed"					7	None	Prod			
Kirby Hill	Solano	4N	1E,1W	3915	Unnamed	5425	40	NA	NA	40.26	0				2	2	Prod			
Total Kirby Hill										**54.33**	**0**	**Low**	**0**	**Low**	**17**	**2**	**Prod**	**0.081**	**NO**	**Gas storage**
Kirk	Colusa/Sut	13N	1E	3750-5750	Forbes	330-871	15-95	24-29	NA	20.4	0	Low	0	Low	14	4	Prod	4.793	NO	Good size, single zone, still in production with significant reserves
Kirkwood	Tehama	12S	4E, 5E	1080	entiated Mari	2400	25	20-30	NA												
Kirkwood	Tehama	12S	4E, 5E	1020	Kione	2430	40	25-28	NA	No pool breakdown in production tables											
Kirkwood	Tehama	12S	4E, 5E	1970	Forbes	4020	30	18-25	NA												
Total Kirkwood										**17.09**	**0**	**Low**	**0**	**Low**	**6**	**2**	**Prod**		**MAYBE**	**Has some active wells but no reserves given, may have abandoned zones**
Knights Landing	Sutter				Mokelumne River					0.824	0	Low	0	Low	None	2	SI			
Knights Landing	Sutter				Hamilton					0.213	0	See left	0		None	None				May be water drive
Knights Landing	Sutter			1240	Starkey	2865	40	35	NA	16.84	0	See left	0		None	None				May be water drive
Knights Landing	Sutter				Winters					2.575	0	See left	0		None	None				May be water drive
Total Knights Landing										**20.45**	**0**	**High-mo**	**0**	**High-mod**	**None**	**2**	**SI**	**None listed**	**CONFIRM**	**At least one reservoir may have water drive. Recommend to confirm water drive, No, if it is and Yes if not**
Lathrop	San Joaqui	1S	5E, 6E	1920	evedo (Blewe	3950	75	NA	NA												
Lathrop	San Joaqui	1S	5E, 6E	2240-2810	Tracy	747-629	50-75	NA	NA	No pool breakdown in production tables											
Lathrop	San Joaqui	1S	5E, 6E	3610-4240	Lathrop	906-842	75-550	23-27	48-79												
Total Lathrop										**365.2**	**0**	**Low**	**0**	**Low**	**18**	**17**	**Prod**	**4.984**	**NO**	**One of the biggest fields in the state, still many active wells and reserves.**
Llano Seco	Butte/Glen	9N,20	1W	740	hamed (Mioce	1600	20	25	NA												
Llano Seco	Butte/Glen	9N,20	1W	1494-1762	nar-Estes (Kio	3275	17	26-32	NA	No pool breakdown in production tables											
Llano Seco	Butte/Glen	9N,20	1W	2086-2686	hamed (Forbe	550-520	5-20	22-28	NA												
Total Llano Seco										**5.944**	**0**	**Low**	**0**	**Low**	**None**	**None**	**Abd**		**YES**	**Good reservoir properties, abandoned**
Lodi	San Joaqui	4N	7E	987	Domengine	2280	25	25-30	NA						8	None	Prod			
Lodi	San Joaqui	4N	7E	1093	Midland	2515	35	25-30	NA						7	None	Prod			
Total Lodi										**23.2**	**0**		**0**		**15**		**Prod**	**None listed**	**NO**	**Gas storage**
Lone Star	Colusa	15N	2W	2150	Forbes	4740	20	28	NA	**4.85**	0	Low	0	Low	8	2	Prod	2.144	NO	Small with a lot of wells and significant reserves
Los Medanos	Contra Cos	2N	1W,2W	1665	Nortonville	4300	40	26	NA	**1.613**	0	Low	0	Low	None	None	Abd			
Los Medanos	Contra Cos	2N	1W,2W	1760	Domengine	4000	150	30	500	**32.29**	0	Low	0		20	1	Prod	0.6		
Los Medanos	Contra Cos	2N	1W,2W	1570	pper Cretaceo	2800	10	NA	NA	**4.534**	0	Low	0	Low	1	0	Prod	0.08		
Total Los Medanos										**38.44**	**0**	**Low**	**0**	**Low**	**20**	**1**	**Prod**	**0.68**	**NO**	**Gas storage**
Malton-Black Butte	Glenn/Teh	2N, 23	3W, 4W	592	Tehama	1550	70	25-33	NA	0.009	0	Moderate	0	Moderate	None	1	SI			
Malton-Black Butte	Glenn/Teh	2N, 23	3W, 4W	760	entiated Mari	1900	10	20-30	NA											
Malton-Black Butte	Glenn/Teh	2N, 23	3W, 4W	860	Kione	900-220	50	25-28	NA	3.048	0	Moderate	0	Moderate	4	15	Prod			
Malton-Black Butte	Glenn/Teh	2N, 23	3W, 4W	1580-2940	Forbes	250-495	5-40	18-25	100-1200	13.97	0	Moderate	0	Moderate	30	8	Prod			
Malton-Black Butte	Glenn/Teh	2N, 23	3W, 4W		No Pool Breakdown					135.4	0	Moderate	0	Moderate	26	8	Prod			
Total Malton-BB										**152.5**	**0**	**Moderate**	**0**	**Moderate**	**59**	**20**	**Prod**	**15.564**	**NO**	**Large zones still have many active wells and large reserves**
McDonald Island	San Joaqui	1N,2N	4E,5E	2350	cDonald Islan	5220	45	31-34	1500	185.6	0	Low	0	Low	52	29	Prod	3.19	NO	Gas storage
McMullin Ranch	San Joaqui	2S	6E,7E	2415	Blewett	4525	2-30	26-30	597	43.26	0	Low	0	Low	None	10	SI			
McMullin Ranch	San Joaqui	2S	6E,7E	2900	Tracy	6005	2-15	26-30	117											
McMullin Ranch	San Joaqui	2S	6E,7E	3625-4120	E Zone	7200	3-30	23-27	NA	20.4	0	Low	0	Low	None	5	SI			
McMullin Ranch	San Joaqui	2S	6E,7E		Cretaceous					NA	0	Low	0	Low	None	1	SI			
Total McMullin Ranch										**63.66**	**0**	**Low**	**0**	**Low**	**None**	**16**	**SI**		**YES**	**Good size zones, permeability should be checked (appears low for the total production), has unusual number of idle wells**
Merril Avenue	Fresno	11S	3E, 14	2100	Blewett	6300	70	23	NA	19.67	0	Low	0	Low	1	1	Prod	None listed	YES	Good size, production is now low
Merril Avenue SE	Fresno	11S	14E	2350	Blewett	6700	35	23	NA	9.612	0	Low	0	Low	4	None	Prod	None listed	NO	Good size, but still in production
Merritt	Yolo	9N	2E	2500	Winters	5550	15	25-29	NA	4.084	0	See left	0		None	None	Abd	None listed	MAYBE	Abandoned as of 8/11, one well showed some water, others very little, probably not reservoir water drive but needs study
Merritt Island	Sacrament	6N	4E	3450	Courtland	7400	15	20-26	NA	5.627	0	See left	0		None	None	Abd		YES	Small but abandoned, probably good reservoir properties. Some water production but not clear water drive
Moffat Ranch	Madera	1S, 12	4E, 15	1750	Kreyenhagen	3900	10	26-33	0.1-70.0	9.817	0	Low	0	Low	2	3	Prod	0.022		
Moffat Ranch	Madera	1S, 12	4E, 15	1779	Domengine	4000	12	NA	NA	1.097	0	Low	0	Low	None	None	Abd			
Moffat Ranch	Madera	1S, 12	4E, 15	2135	Valley/Blewe	5700	11	27	NA	5.192	0	Low	0	Low	2	1	Prod	0.181		
Moffat Ranch	Madera	1S, 12	4E, 15	2400	arkey (Cretac	5400	7	36	NA	2.491	0	Moderate	0	Moderate	3		**Prod**	0.08		
Moffat Ranch	Madera	1S, 12	4E, 15	3400	hrop (Cretace	7700	28	28	NA											
Total Moffat Ranch										**18.65**	**0**	**Mod-low**	**0**	**Mod-low**	**7**	**4**	**Prod**	**0.283**	**MAYBE**	**Still in production though reserves are low, reservoir properties appear good, several zones are large enough**
Oakley	Contra	2N	3E	166	3-III (Martinez	7822	60	24-26	NA	0.015	0		0		None	None	**Abd**			
Oakley	Contra	2N	3E		Third Massive					5.098	6	See left	849667		None	None	Abd			Few wells, erratic water production pattern that is difficult to interpret without further study
Total Oakley										**5.114**	**6**	**See left**	**852333**		**None**	**None**	**Abd**		**NO**	**Abandoned, Third Massive usually has good reservoir properties, small**
Oakley, South	Contra	1N	2E, 3E	2819	Third Massive	7475	50	18	NA	71.92	83	Low	866506	Low	3	None	Prod	0.236	YES	PZI initial field report completed
Ord Bend	Glenn	21N	1W,2W	1615	Knight	3660	13	26-32	NA	23.2	0		0		3	3	Prod	0.611	MAYBE	Single zone, good reservoir properties, moderate production and reserves
Perkins Lake	Butte	20N	1W	1575-1600	ake(Princeton	3400	10-130	31	NA	38.03	0	Low	0	Low	5	1	Prod	0.296		
Perkins Lake	Butte	20N	1W		Forbes					0.104	0	Low	0	Low	None	None	Abd			
Total Perkins Lake										**38.14**	**0**	**Low**	**0**	**Low**	**5**	**1**	**Prod**	**0.296**	**MAYBE**	**Good reservoir properties, main zone is still producing with modest remaining reserves**
Pierce Road	Sutter	14N	2E		Forbes					10.02	0	Low	0	Low	4	3	Prod	0.906		
Pierce Road	Sutter	14N	2E	2700	Guinda	6000	70	24	NA	1.101	0	Low	0	Low	None	1	SI			
Total Pierce Road										**11.12**	**0**	**Low**	**0**	**Low**	**4**	**4**	**Prod**	**0.906**	**MAYBE**	**Still producing with modest remaining reserves**
Pleasant Creek	Yolo	8N	1W	1670	Rominger	3700	25	31-34	NA	0.31	0	Low	0	Low	None	None	Abd			

Pleasant Creek	Yolo	8N	1W	1270	Peters	2800	30	31-34	1000	4.768	0	Low	0	Low	5	1	Prod			
Total Pleasant Creek										**5.079**	**0**	**Low**	**0**	**Low**	**5**	**1**	**Prod**	**None listed**	**NO**	**Gas storage**
Princeton	Colusa	18N	1W,2W	1015	Kione	2170	110	27-29	125-320	11.3	0		0		None	3	SI	0.155	NO	Gas storage
Putah Sink	Yolo	7N,8N	2E,3E	2420	S-4 (Starkey)	5550	50	29-33	NA	5.812	0	Low	0	Low	1	None	Prod	None listed		
Putah Sink	Yolo	7N,8N	2E,3E	2710	Dunn (Winters	6210	20	25-28	NA	47.06	0	Low	0	Low	1	2	Prod	0.039		
Putah Sink	Yolo	7N,8N	2E,3E	2995	Dowell (Winters	6500	60	25-28	NA											
Total Putah Sink										**52.87**	**0**	**Low**	**0**	**Low**	**1**	**2**	**Prod**	**0.039**	**YES**	**Large field, good properties, current production and reserves are low**
Rancho Capay	Glenn	2N, 23	2W	660	Moda	1710	20	30-34	NA											
Rancho Capay	Glenn	2N, 23	2W	1120	Kione	2580	10	24-28	NA	No pool breakdown in production tables										
Rancho Capay	Glenn	2N, 23	2W	2405-2705	Unnamed	540-500	1-30	18-24	NA											
Total Rancho Capay										**13.42**	**0**	**Low**	**0**	**Low**	**11**	**3**	**Prod**	**1.621**	**NO**	**Upper zones too shallow, still producing with significant reserves**
Rice Creek	Tehama	23N	2W, 3W	970-1270	Unnamed	000-266	5-40	25-28	NA											
Rice Creek	Tehama	23N	2W, 3W	2260-3140	Unnamed	250-550	5-30	17-23	NA											
Total Rice Creek										**57.23**	**0**	**Moderate**	**0**	**Moderate**	**67**	**15**	**Prod**	**11.013**	**NO**	**Too much production and reserves, although not specified production is probably mostly from lower zone and upper zone is too shallow**
Rice Creek East	Tehama	23N	2W	1270	Forbes	4950	16	17-21	NA	20.89	0	Low	0	Low	16	2	Prod	1.108	NO	Still producing, significant reserves
Rio Vista	Solano	3N, 4N	2E, 3E	1110	Sidney	2450	50	25-32	5-10											
Rio Vista	Solano	3N, 4N	2E, 3E	1190	Markley	2630	24	26-32	400-1800	No pool breakdown in production tables										
Rio Vista	Solano	3N, 4N	2E, 3E	1230	Nortonville	700-420	25	30	NA											
Rio Vista	Solano	3N, 4N	2E, 3E	1715-1915	High(Domengi	800-430	40-315	34	NA											
Rio Vista	Solano	3N, 4N	2E, 3E	1930	Capay	500-510	20-40	26	NA											
Total Rio Vista										**3667**	**1789**	**Low**	**2049691**	**Low**	**183**	**121**	**Prod**	**313.767**	**MAYBE**	**Very large field, still significant production and reserves, would only be viable if one or more zones are abandoned**
River Break	Contra	1N, 2N	2E	2220	Hamilton	5015	30	24	NA	3.928	3	Low	**1309333**		1	1	Abd	0.007		
River Break	Contra	1N, 2N	2E	2500	Dal Porto	5450	40	23	NA	12.18	12	Low	2049691	Low	1	None	SI	0.067		
River Break	Contra	1N, 2N	2E	2500	Romiti	5540	25	23	NA											
River Break	Contra	1N, 2N	2E	2520	First Massive	5660	60	22	NA	1.118	9	Low	124222	Low	None	None		0.007		
Total River Break										**17.23**	**24**	**Low**	**717875**	**Low**	**2**	**1**	**SI**	**0.073**	**NO**	**PZI initial field report completed**
River Island	Sacrament	3N, 4N	3E 4E	1285	Markley	3110	5	26-32	NA	42.09	0	Low	0	0	2	6	Prod	0.068		
River Island	Sacrament	3N, 4N	3E 4E	1780	Nortonville	3600	5	26-31	340	0.036	0	Low	0	0	1	None	Prod	None listed		
River Island	Sacrament	3N, 4N	3E 4E	1860	Domengine	3730	20	28-32	NA	19.66	0	Low	0	0	4	1	Prod	0.588		
River Island	Sacrament	3N, 4N	3E 4E	1760	Lokelumne Riv	4230	20	27-33	NA	51.29	0	Low	0	0	10	4	Prod	8.529		
River Island	Sacrament	3N, 4N	3E 4E	1940	Starkey	4350	40	29-34	NA	1.789	0	Low	0	0	2	0	Prod	0.711		
River Island	Sacrament	3N, 4N	3E 4E	3955	Winters	8450	30	26	NA	64.74	12	Low	5395167	0	4	3	Prod	5.589		
Total River Island										**179.6**	**12**	**Low**	**14967583**	**0**	**23**	**14**	**Prod**	**15.485**	**YES**	**All zones appear to be in production with moderate to significant reserves**
Robbins	Sutter	2N,13	3E	2964	Forbes	7100	75	17-23	NA	**30.68**	**0**	**Low**	**0**	**Low**	**6**	None	Prod	None listed	MAYBE	Check current producing status of each well, might be good if field is near depletion
Roberts Island	San Joaqui	1N, 1S	5E, 6E	2340	Donald Island S	5250	10	29-33	NA	36.52	0	Low	0	Low	1	4	Prod	0.563	MAYBE	Check current producing status of each well, might be good if field is near depletion
Sacramento Airport	Sac-Sutter	10N	3E,4E	1080	Lokelumne Riv	2200	23	29-35	NA	11.96	0	Moderate	0	Moderate	2	4	Prod	0.105		
Sacramento Airport	Sac-Sutter	10N	3E,4E	1200-1330	Starkey	600-290	12-15	28-33	50-100	3.399	0	Low	0	Low	1	None	Prod	0.002		
Sacramento Airport	Sac-Sutter	10N	3E,4E	NA	Other	NA	NA	NA	NA	0.114					None	None				
Total Sacramento Airport										**15.44**	**0**	**Moderate**	**0**	**Moderate**	**3**	**4**	**Prod**	**0.107**	**NO**	**Too shallow**
Saxon	Solano-Yol	6N,7N	3E	2865	4 Sand (Starke	6280	30	26-31	NA	16.18	0	Low	0	Low	1	None	Prod	10.758		
Saxon	Solano-Yol	6N,7N	3E	3100	Unnamed (Starke	6820	8	19-25	NA									0.315		
Saxon	Solano-Yol	6N,7N	3E	3355	Glide (Winters	7050	10	19-25	NA	34.9	0	Low	0	Low	1	1	Prod			
Total Saxon										**50.72**	**0**	**Low**	**0**	**Low**	**2**	**1**	**Prod**	**11.073**	**MAYBE**	**Zones are large with probably good properties, reported reserves are large compared to the few remaining wells, need to confirm field status**
Semitropic	Kern	27S	23E,	1365	San Joaquin (Ga	200-440	5-15	28	1100	17.28	4	Low	0	Low	None	1	SI		MAYBE	Shallow gas zone is nearly abandoned, deeper oil zone is being redeveloped, permeability may be low
Sherman Island	Sacrament	2N, 3N	2E	1874	Nortonville	4770	10	25	NA											
Sherman Island	Sacrament	2N, 3N	2E	2591	Hamilton (Megan	5750	75	25-29	NA	32.57	0	Low	0	Low	None	None		None listed		
Sherman Island	Sacrament	2N, 3N	2E	NA	Massive (Mart	6700	25	22	NA											
Sherman Island	Sacrament	2N, 3N	2E	3112	Merson (Martir	6100	50	29-32	NA	0.351	0	High	0	High	None	None	Abd	None listed		Appears to have water drive
Total Sherman Island										**32.92**	**0**	**Low**	**0**	**Low**	**None**	**None**	**Abd?**	**None listed**	**NO**	**Field may be abandoned or close to it, no production reported recently, good reservoir properties, good size**
Snodgrass Slough	Sacrament	5N	4E	3500	Winters	7985	30	20	NA	4.637	0		0		None	None	Abd	None listed	MAYBE	Small but abandoned, need to research properties
Stegeman	Colusa	7N,18	1W,2W	1110	Stegeman/Kion	2490	25	27-29	NA	8.048	0	Low	0	Low	1	2	Prod	0.091		
Stegeman	Colusa	7N,18	1W,2W		Forbes					0.749	0	Low	0	Low	None	None	Abd			
Total Stegeman										**8.797**	**0**	**Low**	**0**	**Low**	**1**	**2**	**Prod**	**0.091**	**NO**	**Main zone too shallow**
Stockton	San Joaqui	1N	6E	3625	Starkey	7985	25	20	NA	5.328	0		0		None	None	Abd		MAYBE	Small but abandoned, need to research properties
Sutter Buttes	Sutter	5N,16	1E	1500-4300	med Sand Stri	100-600	1-60	15-28	108	213.1	0	Low	0	Low	86	27	Prod	62.395	NO	Still has many active wells and high reserves
Sutter City(Main Are	Sutter	4N,15	1E,2E	650	Unnamed	1440	30	20-25	NA	22.85	0	Low	0	Low	2	6	Prod	0.507		
Sutter City(Main Are	Sutter	4N,15	1E,2E	800	Kione	1700	140	25-30	NA											
Sutter City(South Are	Sutter	4N,15	1E,2E	2040-3500	med Sand Stri	950-683	3-50	18-30	NA	99.07	0	Low	0	Low	16	6	Prod	3.684		
Sutter City(South Are	Sutter	4N,15	1E,2E	3210	G-Zone	160-662	5-20	15-20	NA											
Total Sutter City										**121.9**	**0**	**Low**	**0**	**Low**	**18**	**12**	**Prod**	**4.19**	**NO**	**Still producing from all zones. Kione is too shallow**
Sycamore	Colusa-Sut	15N	1W	642	entiated Mari	1480	25	25-30	NA											
Sycamore	Colusa-Sut	15N	1W	1195	Kione	2750	40	28-33	NA	No pool breakdown in production tables										
Sycamore	Colusa-Sut	15N	1W	2860-5720	Forbes	734-737	4-40	25-30	NA											
Total Sycamore										**66.68**	**0**	**Low**	**0**	**Low**	**45**	**14**	**Prod**	**15.704**	**MAYBE**	**All but Forbes are too shallow, must verify where existing production and reserves are coming from - if Forbes then no**
Thornton	Sacrament	5N	5E	750	Unnamed a/	2315	15	27-31	NA											
Thornton	Sacrament	5N	5E	1130	Unnamed a/	2580	25	27-31	NA	No pool breakdown in production tables										
Thornton	Sacrament	5N	5E	1500	Capital	3300	30	31-35	NA											
Total Thornton										**54.53**	**0**	**Low**	**0**	**Low**	**None**	**None**	**Abd**	**None listed**	**MAYBE**	**All but Capital are too shallow, need to research if Capital is big enough**
Thornton-West Walr	San Joaqui	4N, 5N	4E, 5E	NA	Burchell	2410	6	NA	NA		5		0		8		Abd			
Thornton-West Walr	San Joaqui	4N, 5N	4E, 5E	1285	Deadhorse	2810	30	28-31	NA											
Thornton-West Walr	San Joaqui	4N, 5N	4E, 5E	1400	Thornville String	2980	3-6	26-30	NA	126.1	2	Low	15859.55	Low	5		Prod	3.122		
Thornton-West Walr	San Joaqui	4N, 5N	4E, 5E	1390	Domengine	2880	2-5	26-30	NA											
Thornton-West Walr	San Joaqui	4N, 5N	4E, 5E	1420	Capay Stringer	3280	3	NA	NA											
Thornton-West Walr	San Joaqui	4N, 5N	4E, 5E		Winters					2.295	2	Low	871459.7	Low	2		Prod	None listed		
Total Thornton-W.Walnut										**128.4**	**4**	**Low**	**31143.92**	**Low**	**7**		**Prod**	**3.122**	**MAYBE**	**Some of reservoirs may be abandoned, several are grouped for production reporting, significant reserves remaining**
Tisdale	Sutter	14N	2E	3350	Forbes	6200	2-20	24-32	NA	58.08	0	Low	0	Low	14	4	Prod	1.325		
Tisdale	Sutter	14N	2E		Guinda					4.407	0	Low	0	Low	1	1	Prod	0.395		
Total Tisdale										**62.49**	**0**	**Low**	**0**	**Low**	**15**	**5**	**Prod**	**1.72**	**NO**	**Remaining reserves are low to moderate, but still has many active wells**
Todhunters Lake	Yolo	8N,9N	2E,3E		No Pool Breakdown					97.6	0	Low	0	Low	4	4	Prod	7.396		
Todhunters Lake	Yolo	8N,9N	2E,3E		Markley Canyon					1.816	0	Low	0	Low	2	1	Prod	None listed		
Todhunters Lake	Yolo	8N,9N	2E,3E	644	Lokelumne Riv	1420	30-60	22-35	NA	7.347	0	See left	0	Low	4	7	Prod	None listed		Some wells show a lot of water, others little. Water disposal well listed as in this zone
Todhunters Lake	Yolo	8N,9N	2E,3E		Massive					0.563	0	Low	0	Low	None	4	SI	None listed		
Todhunters Lake	Yolo	8N,9N	2E,3E	720-1060	Starkey	580-233	5-55	27-35	NA	0.686	0	See left	0		None	None	Abd			Some wells show water, others little. Several water disposal wells assigned to this zone
Todhunters Lake	Yolo	8N,9N	2E,3E	990-1030	Winters	180-227	20-40	22-28	NA	4.033	0	Moderate	0	Moderate	1	2	Prod	None listed		
Total Todhunters Lake										**120**	**0**	**Low**	**0**	**Low**	**11**	**18**	**Prod**	**7.396**	**MAYBE**	**Very large multi-zone field, available data do not allow adequate characterization without further study of well and field-level data**
Tompkins Hill(Main A	Humboldt	3N	1W	890-2450	Rio Dell	100-580	1-50	26	NA	123.9	0	Low	0	Low	29	10	Prod	8.307		
Tompkins Hill(West A	Humboldt	3N	1W	3575	Rio Dell	5920	20	27	12	0.038	0	Low	0	Low	None	None	Abd			

Total Tompkins Hill										**123.9**	**0**	**Low**	**0**	**Low**	**29**	**10**	**Prod**	**8.307**	**NO**	**Significant remaining reserves**
Tracy	San Joaqui	2S	5E	1854	Blewett	3900	40	28	NA	13.8	0	See left	0		None	None	Abd			One well listed as "no pool breakdown" had significant water, may have been in this zone
Tracy	San Joaqui	2S	5E	1850	Miocene sands	5200	10	20	NA	2.863	0	Low	0	Low	None	None	Abd			
Tracy	San Joaqui	2S	5E		Lathrop					0.451	0	Low	0	Low	None	1	SI			
Total Tracy										**17.11**	**0**	**See left**	**0**		**None**	**1**	**Abd**		**YES**	**Abandoned or nearly so, good size reservoirs. Good properties, see above comment about water**
Tremont	Solano	7N,8N	2E	2550	Starkey	6050	20	28-32	NA	No pool breakdown in production tables										
Tremont	Solano	7N,8N	2E	2810	Winters	6560	7	24-28	NA											Some wells have high water, others very little. Needs further study
Total Tremont										**4.928**	**0**	**See left**	**0**		**None**	**None**	**Abd**		**YES**	**Small but abandoned, reservoir properties appear good, need to study water production pattern**
Trico	Kern/Kings	5,24	5,22	E,23	1150	First Mya	2525	20	NA	NA	No pool breakdown in production tables									
Trico	Kern/Kings	5,24	5,22	E,23	1480	Atwell Island	3225	24	NA	NA		0	See left							Many wells show no production, some have high water, others little. Needs further study.
Total Trico										**201.4**	**0**	**See left**	**0**		**None**	**14**	**SI**		**YES**	**Large field, does not appear to be active currently, permeability and pressure may be too low, water production needs study**
Trico NW	Kings	23S	21E,22		1250	First Mya	2750	8	NA	NA	2.71	0	Low	0	Low	None	None	Abd			
Trico NW	Kings	23S	21E,22		1555	Atwell Island	3800	10	NA	NA	6.349	0	Low	0	Low	None	None	Abd			
Total Trico NW											**9.059**	**0**	**Low**	**0**	**Low**	**None**	**None**	**Abd**		**YES**	**Abandoned, permeability may be low**
Van Sickle Island	Solano	3N	1E		1450	Markley	3250	45	20-25	NA											
Van Sickle Island	Solano	3N	1E		2980	Nortonville a/	6760	10	15	NA	No pool breakdown in production tables										
Van Sickle Island	Solano	3N	1E		3000	Domengine a/	6800	150	18	NA											
Total Van Sickle Island											**32.03**	**67**	**Low**	**2091854**	**Low**	**8**	**2**	**Prod**	**19.463**	**MAYBE**	**Still has large reserves, may be viable if one of the zones is abandoned**
Vernalis	San Joaqui	3S	6E		1425	Banta	3000	25	30	NA											
Vernalis	San Joaqui	3S	6E		1680	Azevedo	3600	40	25-28	NA											
Vernalis	San Joaqui	3S	6E		1765	Blewett	3800	80	27-30	70-320	No pool breakdown in production tables										
Vernalis	San Joaqui	3S	6E		2110	gged Valley S	4650	40	25	NA											
Vernalis	San Joaqui	3S	6E		2220	Tracy	4925	10	25-28	NA											
Total Vernalis											**104.6**	**0**	**Low**	**0**	**Low**	**8**	**20**	**Prod**	**0.847**	**MAYBE**	**Still has active wells and modest reserves, may be viable if one of the zones is abandoned**
West Butte	Sutter	16N	1W,1E		1920-4380	Forbes	260-650	8-50	18-25	NA	4.368	0	Low	0	Low	5	None	Prod	5.582	NO	Significant remaining reserves
Wild Goose	Butte/Colu	17N	1E		1105	Hangtown	2400	10	30	NA											
Wild Goose	Butte/Colu	17N	1E		1200-1310	pper Wild Goo	2500	200	30	NA	No pool breakdown in production tables										
Wild Goose	Butte/Colu	17N	1E		1335	Afton	2850	30	30	NA											
Wild Goose	Butte/Colu	17N	1E		1345-1500	wer Wild Goo	2900	250	30	NA											
Total Wild Goose											**103.7**	**0**	**Low**	**0**	**Low**	**9**	**4**	**Prod**	**None listed**	**NO**	**Active wells, may be viable if one or more zones is abandoned**
Willow Pass	Contra	2N	1W		530-1335	Nortonville	500-310	35	26	NA	1.672	0	Low	0	Low	None	None	Abd			
Willow Pass	Contra	2N	1W		650	Domengine	1800	50	25-30	NA	1.754	0	Low	0	Low	None	None	Abd			
Willow Pass	Contra	2N	1W		NA	Main Area					3.006	0	Low	0	Low	None	None	Abd			
Total Willow Pass											**6.432**	**0**	**Low**	**0**	**Low**	**None**	**None**	**Abd**		**MAYBE**	**Abandoned, modest size, may be too shallow**
Willow Slough	Yolo	8N,9N	1E,2E		2200	Starkey	4850	25	27-31	NA	14.52	0	See left	0		None	5	SI	None listed		A few wells show high water production, most do not
Willow Slough	Yolo	8N,9N	1E,2E		2530	Winters	5990	10	25-29	NA	3.616	0	See left	0		None	5	SI	None listed		A few wells show high water production, most do not
Total Willow Slough											**18.14**	**0**	**See left**	**0**		**None**	**10**	**SI**	**None listed**	**MAYBE**	**Good reservoir properties, still producting, reserves unknown so need to research, also study water production**
Willows-Beehive Ber	Glenn	9N,20	W,2W,3		909	ceton Canyon	2045	55	30	NA	Not listed in production tables										
Willows-Beehive Ber	Glenn	9N,20	W,2W,3		900-1705	Kione	930-365	10-80	26-32	400	14.69	0	Low	0	Low	19	3	Prod			
Willows-Beehive Ber	Glenn	9N,20	W,2W,3		2200-4200	Forbes	420-640	3-60	24-30	300	36.14	0	Low	0	Low	85	9	Prod			
Willows-Beehive Ber	Glenn	9N,20	W,2W,3		4400	Dobbins	6700	20	18	NA	412.3	0	Low	0	Low	90	13	Prod			
Willows-Beehive Ber	Glenn	9N,20	W,2W,3		NA	Guinda	7350	70	NA	NA											
Total Willows-Beehive Bend											**463.8**	**0**	**Low**	**0**	**Low**	**191**	**23**	**Prod**	**131.358**	**NO**	**Too much production from all zones**
Winters	Solano/Yo	7N, 8N	1E, 1W		1920	Capay(Hooper	4615	3	30	NA											
Winters	Solano/Yo	7N, 8N	1E, 1W		2107	McCune	4850	20	28-32	340-650											
Winters	Solano/Yo	7N, 8N	1E, 1W		2489	Unit	4920	5	30-34	NA	No pool breakdown in production tables										
Winters	Solano/Yo	7N, 8N	1E, 1W		2489	Unit Oil Zone	5585	5	NA	NA											
Total Winters											**44.21**	**0.00**	**Low**	**0**	**Low**	**10**	**None**	**Prod**	**2.241**	**MAYBE**	**Still producing but must research from which pools, significant remaining reserves**
Zamora	Yolo	11N	1E		1474	Starkey	3580	30	28-32	NA	6.494	0.00	High-mod	0	High-mod	None	None	Abd		YES	Abandoned, probably good reservoir properties

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