HNF-30225
Revision 0

Protecting Groundwater and the Columbia River at the Hanford Site

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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P.O. Box 1000
Richland, Washington

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Fluor Hanford

Date Published
June 2006

To Be Presented at
American Nuclear Society (ANS)
September-October 2006

Published in
Radwaste Magazine

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Printed in the United States of America

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Michele Gerber, Fluor Hanford

For Radwaste Magazine, September-October 2006 Issue
Final

Along the remote shores of the Columbia River in southeast Washington state, a race is on. Fluor Hanford, a prime cleanup contractor to the U.S. Department of Energy (DOE) at the Hanford Site, is managing a massive, multi-faceted project to remove contaminants from the groundwater before they can reach the Columbia. Despite the daunting nature and size of the problem -- about 80 square miles of aquifer under the site contains long-lived radionuclides and hazardous chemicals -- significant progress is being made.

Many groups are watching, speaking out, and helping. A large, passionate, diverse, and geographically dispersed community is united in its desire to protect the Columbia River – the eighth largest in the world -- and have a voice in Hanford's future. Fluor Hanford and the DOE, along with the U.S. Environmental Protection Agency (EPA) and the Washington Department of Ecology (Ecology) interact with all the stakeholders to make the best decisions. Together, they have made some remarkable strides in the battle against groundwater contamination under the site.

Hanford's History Generated Soil, Groundwater Contaminants

The vast (586-square mile) Hanford Site was established in 1943 to produce special materials for atomic weapons to end World War II. In large measure, the site was chosen because a 51-mile swath of the Columbia River ran right through it, coming in from the west, arching north in a pointed horn, and then sweeping east and south in a giant arc. The site is divided into several distinct areas: the 100 Areas along the Columbia as it runs through Hanford's northern horn; the 300 Area along the Columbia just north of Richland, Washington (20-30 miles south of the reactors); and the 200 Areas in the center of the site about 8 miles from the river south of the reactors. Other Hanford areas existed to provide buffer land and support services, or were placed many years later to engage in non-defense activities.

By the end of 1943, uranium fuel manufacturing, along with radiochemical experimentation, was in full swing in the site's 300 Area. By autumn 1944, nuclear fuel was being irradiated in the giant B Reactor – the world's first such machine – in the 100 Areas. Within five months, two more massive reactors operated there. Just six days before the dawn of the victory year 1945, chemical separations (reprocessing) of irradiated uranium fuel began in the center of the site, about seven miles from the river on a plateau 250-300 feet above the groundwater.

Fuel-making and experimental wastes were drained from 300 Area buildings and grounds, and piped to a holding pond directly alongside the river. There, uranium and other heavy-metal dust combined with acids, trichloroethene, dichloroethene, perchloroethylene, acetone, kerosene, and many other hazardous substances percolated through shallow soil into the ground and surface water. In the 100 Areas (reactor areas), thousands of gallons per minute of Columbia River water treated with sodium dichromate ran through the reactor cores, became activated, and was pumped into open holding basins that eventually leaked into the soil and substrata. The dichromate was used to inhibit corrosion in the reactors' tubing.

In the 200 Areas (chemical-processing zones), site operations also laid waste to the soil. Acids as well as sodium bismuthate, potassium permanganate, lanthanum fluoride, and sodium hydroxide complexed with special nuclear materials and fission products were pumped into unlined trenches and drains, or into tanks that later leaked. As Hanford's postwar role in the arms race grew, new chemicals, in even greater amounts, were added to the soil and substrata. Tributyl phosphate, methyl isobytyl ketone, aluminum nitrate nonahydrate, and carbon tetrachloride, all contaminated with dissolved radioactive elements, were intentionally and unintentionally disposed to Hanford's sandy soils.

As early as 1948, Hanford's chief health physicist pointed out that groundwater mounds were developing due to the immense liquid volumes being disposed. Ground discharges and mound growth, however, increased continually, peaking during 1961-65. After that time, the production of materials for defense gradually decreased, resulting in fewer discharges to the soil. In the 1970s, the groundwater mounds began to subside... that subsidence continues.

In total, site records show that 440 billion gallons of contaminated liquids were intentionally released to the soil, and some high-level tank waste escaped unintentionally. In 1997, the DOE verified that tank wastes had reached the groundwater in the 200 Areas adjacent to the tank "farms." (At Hanford, groups of underground tanks in fenced areas are known as tank farms. Hanford has 18 such farms.)

Stopping Untreated Discharges and Focusing Groundwater Remediation Efforts

In 1995, Hanford took a crucial step in protecting the groundwater. The DOE stopped unpermitted discharges of liquid waste to the soil by starting up major new facilities and systems for collecting and treating liquid effluent in the 200 and 300 Areas.

Three years later, the DOE's Richland Operations Office (DOE/RL) established the newest cleanup project at Hanford. Then called the Groundwater Vadose Zone Project, it has since been re-named the Groundwater Remediation Project (GRP). (Note: The vadose zone comprises the soil layers between the ground surface and the groundwater table.)

The project is a cross-cutting endeavor managed by Fluor Hanford that works with scientists from the Pacific Northwest National Laboratory (PNNL) and other site contractors and subcontractors to understand and remediate contamination that could affect the Columbia River. Fluor's GRP integrates and consolidates the work of all parties to assure that the best decisions are made and implemented.

The GRP has four major tasks: shrink the footprint of contaminated areas; reduce "recharge" (or re-supply) of clean or contaminated water that may drive soil contaminants deeper into the subsurface; implement final groundwater remedies; and integrate groundwater monitoring needs. To accomplish these tasks, the GRP operates seven major pump-and-treat systems at key points on the Hanford Site where concentrated plumes of contamination can be intercepted and brought to the surface to be cleaned. The project also operates test systems, applying new approaches to chemically alter the contaminants in groundwater. Thus far, 2.8 billion gallons of contaminated groundwater have been treated, and multiple drivers of contaminants have been reduced or eliminated.

In addition, GRP decommissions old wells that act as preferential pathways for contaminants to move into groundwater more quickly. Extensive monitoring programs, underground mapping, records searches, and investigations of new technologies to provide better remedies for groundwater contamination are also vital components of Hanford's GRP.

Tackling the 100 Areas: 100 H Reactor Area Progress

Remediating large plumes of hexavalent chromium in the groundwater and soil of Hanford's 100 Areas is a central goal for GRP. Hanford's stakeholders and regulators have identified rivershore cleanup and restoration as a priority. During operation of the defense-production reactors from 1944-1971, the hundreds of thousands of pounds of sodium dichromate added to reactor cooling water contained hexavalent chromium. Piping and holding basins for effluent water cracked and leaked over time. Thus, a great deal of sodium dichromate reached the groundwater.

Hanford's 100 H Area, near the northernmost portion of the main Hanford Site, borders some of the most important and prolific salmon spawning areas in the United States. The Hanford Reach of the Columbia River – the 51-mile stretch of river flowing through the Hanford Site that was named a National Monument in 2000 – has been documented as an important habitat for salmon, steelhead and other fish species. Within the Hanford Reach, salmon preferentially spawn near the 100 H Area, making cleaning up the water there even more important.

In the mid-1990s, acting per an agreement negotiated with regulatory agencies under the Comprehensive Environmental Remediation, Compensation and Liability Act (CERCLA), Hanford engineers and operators drilled and turned on six extraction wells in the 100 H Area to remove contaminated groundwater. The water was treated using resin beads that sorbed hexavalent chromium contamination, purifying it. Hexavalent chromium is soluble and is a carcinogen.

As of June 2006, the Remedial Action Objective (RAO) of 20 parts per billion (ppb) hexavalent chromium had been reached. For the first time in nearly 50 years, the levels of hexavalent chromium were below (within) the drinking-water standard of 100 micrograms per liter($\mu g/L$) established by the U.S. EPA. (A microgram per liter is a measure of parts per billion.) Seven major chromium liquid waste sites in the soil have been remediated. The EPA has praised this work, stating that "excellent progress has been made over the past several years in cleaning up waste sites along the Columbia."

100 D and DR Groundwater Treatment System Expanded

At the 100 D Reactor Area, just upstream of the 100 H Area, GRP has operated pump-and-treat systems for over eight years, processing about 365-million gallons of groundwater and removing over 600 pounds of hexavalent chromium. In 1999, the program also installed a passive, underground chemical barrier system. The *InSitu* Redox Manipulation (ISRM) barrier works in the groundwater using a chemical oxidation-reduction process to convert the hexavalent chromium into trivalent chromium, which is less soluble.

However in 2004, new and more concentrated groundwater plumes – measuring up to 3,000 ppb of hexavalent chromium – were detected northwest of the old D and DR Reactors. The plumes contain some of the highest known concentrations of hexavalent chromium anywhere at Hanford.

Almost immediately, GRP ramped up pumping in the 100 D Area. In 2005, it added another pump-and-treat system that uses more efficient resins to treat the hexavalent chromium. Also, treatment capacity was increased to nearly 50 gpm, and there are plans to further increase that capacity by 500 gpm in the next few years.

Groundwater Treatability Test in 100 K Area a Success; Other Pumping Expands

At the 100 K Reactor Area, about three miles west of 100 D, GRP recently tested an innovative system to treat groundwater. The 100 KR-4 treatability test almost immediately cut levels of hexavalent chromium in the groundwater from about 70 ppb to less than 10 ppb at the test site. It used calcium polysulfide to treat hexavalent chromium *in situ.* Groundwater was pumped out, mixed with calcium polysulfide in an above-ground tank, and re-introduced to the aquifer. The calcium polysulfide chemically reacted with the hexavalent chromium in the aquifer, reducing it to trivalent chromium.

Because the 100 KR-4 test was so important to everyone, the concept was developed, approved by DOE and the EPA, wells drilled, and the test underway all within eight months. When the test ended in mid-2006, the hexavalent chromium concentrations were essentially undectectable at the test site. Now, the test zone in the 100 K Area has developed a reducing environment whose lingering effects will continue to transform hexavalent chromium to a less toxic and less mobile form.

However, some of the water re-injected into the ground had lower concentrations of oxygen than are desirable for fish. The hypo-oxygenation issue is now being studied before the technology is applied in other areas of the site.

At the same time, GRP moved rapidly to remediate another elevated plume of hexavalent chromium contamination in groundwater recently detected under the western edge of the 100 K Area. The plume shows hexavalent chromium levels of about 40μg/L near the river shore, and about 500μg/L approximately one-quarter mile inland.

A treatment building was built and four wells were drilled this summer; treatment of the water is anticipated to begin this December. "We're planning to remediate this plume aggressively," says Ron Jackson, Fluor Hanford's GRP project manager for the 100 Areas. "Our strategy is to contain and treat this plume while we work to identify and remove the source."

The new 100 K treatment system will use conventional ion-exchange technology, due to the immediacy of the need, and the high concentrations of contaminants in a relatively small, discrete area. It will pump about 100 gpm in the beginning, and then will increase throughput to 200 gpm using two more extraction wells if needed.

Over the past 10 years, treatment efforts have been directed at a very large hexavalent chromium plume in the 100 K Area, associated with a mile-long trench just east of the K Reactors. That plume, which used to stretch in a semi-circular arc from a land disposal site just northeast of the KE Reactor nearly all the way to N Reactor, has been cut by more than half and split into two parts by remediation efforts.

New Ideas, Techniques Tried in 100 N Area

Hugging the Columbia River shore between the 100 D and 100 K Areas lies 100 N Area, home to the largest production reactor ever built at the site. The New Production Reactor (or N Reactor) was unique for Hanford. It operated longer than any of the other production reactors (23 years), had larger fuel assemblies, irradiated its fuel for weeks to months longer, and produced electric power.

All of these factors combined to produce a large plume of Sr-90 in the soil and the groundwater. Sr-90 is harmful to living organisms because it concentrates in bones, replacing calcium and weakening the hosts (including humans) it enters. In the 100 N Area, about 96 acres of groundwater are contaminated with strontium at levels more than one thousand times those allowed in drinking water. Strontium also has been found in river plants and clams.

The battle to prevent Sr-90 from reaching the Columbia began in 1995. Unfortunately, the pump-and-treat system originally installed removed far less Sr-90 than is naturally removed by radioactive decay. The system was placed in cold standby in 2006.

Now, GRP scientists and engineers are implementing a new, *in situ* approach to cleaning up the strontium. In an extensive test this past summer, they pumped a solution of a calcium-phosphate compound into the soil along a 300-foot grid to bind the strontium. The calcium compound – which forms an apatite barrier – is similar to that found in tooth enamel. PNNL scientists devised a way to coat it with citrate to slow and spread its diffusion through the ground. Gradually, soil bacteria eat away the citrate, leaving the diffused apatite to chemically react with the Sr-90 and bind it in place for decades, keeping it from the river while it radioactively decays. The GRP may inject wells in the grid with higher concentrations of apatite next year.

In the past, both the EPA and Washington State have been critical of program to remediate the groundwater in the100 N Area groundwater. However, upon seeing the new apatite barrier last spring, Jane Hedges, nuclear waste program manager for Ecology, was cautiously optimistic. The simplicity of the technique is a plus, she said. "This [new technique] should give us some real answers about the strontium waste...This [river shore area cleanup] is a high priority for us...The strontium and uranium plumes that have reached the river concern us greatly, and we're working with USDOE to remediate the problem. The apatite sequestration demonstration project is a part of that effort."

Grappling with the 200 Areas: Final Processing Area Groundwater Treatment System

In the 200 West chemical processing area of Hanford, on a plateau known as central Hanford or the Central Plateau, GRP has also expanded a system for removing and treating carbon tetrachloride (CCl_4) near the region where final processing took place. A soil-disposed collection of approximately 1.1-million pounds of CCl_4 has been an important concern at Hanford since cleanup became Job One at the site in 1989.

In 2005, four new extraction wells were added to a set of five wells that have operated for the past nine years to treat CCl_4, increasing the pumping capacity from approximately 200 gpm to 350 gpm. Still today, concentrations of CCl_4 in the groundwater in the plume sometimes exceed 4,000 $\mu g/L$, considerably above the EPA standard of five $\mu g/L$ CCl_4 in drinking water.

The CCl_4 contamination stems from historical processing operations. Liquid wastes containing CCl_4 were discharged to nearby trenches and cribs from 1955 to 1973. ("Crib" is a Hanford term that refers to liquid waste disposal trenches.)

An interim Record of Decision (ROD) is currently in place, agreed to by the signatories of the Tri-Party Agreement -- the pact among EPA, Washington State and the DOE that has governed site cleanup since 1989. The interim ROD calls for groundwater concentration of CCl_4 to be reduced to less than 2,000 $\mu g/L$. A full remedial action feasibility study, a required process under CERCLA, will begin in 2007 to evaluate multiple approaches to mitigating the plume. It will also determine the final end state, through public participation.

"For now," says Mark Byrnes, groundwater task lead, "Fluor Hanford and the Tri-Party Agreement signatories have decided that expanding the pump-and-treat system for this groundwater plume is a prudent interim measure."

The contaminated water pumped from the nine wells in the final processing area travels to a small treatment building where an air-stripper tower removes CCl_4 from the water. Contaminated air from the tower is then routed through a granulated activated carbon filter that captures the CCl_4. Clean air is then released to the environment. When the filter becomes saturated, it is regenerated.

Treated groundwater is re-injected into the aquifer at points up-gradient from the CCl_4 plume. In other words, the clean water is put into the groundwater at points where it will flow back through the contaminated plume – helping to dilute it and drive it to the extraction wells. To date, about 21,000 pounds of CCl_4have been removed from the groundwater. However, GRP expects to pump from the nine extraction wells in the final processing area at least through 2008.

The groundwater protection program at Hanford is also utilizing other methods to understand and mitigate the CCl_4 contamination under the 200-West Area. Since 1991, site projects have used a vapor-extraction technique to remove about 173,500 pounds of CCl_4 from soil in the area. Soil vapor extraction removes subsurface air laden with CCl_4 vapors. The air is then purified using granulated activated carbon.

In early 2006, Fluor Hanford drilled a unique borehole, slanted at a 32-degree angle, nearly 150 feet into the soil (123 vertical feet) under a highly contaminated trench near the final processing area. The Z-9 trench or crib became one of the most contaminated ground sites at Hanford during the 1950s and 1960s, when it received liquid wastes containing TBP and CCl_4 contamination with nuclear materials from processing operations. In addition to migrating downward, the CCl_4 dispersed laterally throughout the vadose zone. The slant borehole was drilled to better understand that migration by sampling the soil and the vapors in the soil and studying the physical properties of the soil itself.

Of special interest is whether, or to what extent, the $CCl_4$is present in a dense, nonaqueous-phase liquid (DNAPL) form, which in turn, can substantially affect the pattern of migration

U Area Treatment Successes

At the U Area on Hanford's 200 West Area plateau, elevated concentrations of uranium and technetium 99 (Tc-99) in groundwater were discovered in the mid-1980s -- as high as 38,000 picocuries (pCi)/L for Tc-99, and 4,000μg/L for uranium. (A picocurie is one-trillionth of a curie.) Even as the Tri-Parties agreed to focus efforts on the Columbia River shore, they targeted U Area's uranium and Tc-99, as well as CCl_4 in central Hanford, for interim remedial action.

Ten wells were installed and pump-and-treat operations began in U Area in 1995. In 1997, soon after Hanford's large 200 Area Effluent Treatment Facility started up, contaminated water removed from U Area's extraction wells was routed to it. That same year, an Interim RAO defined success for the U Area groundwater as reducing levels of U contamination to 480 ppb (approximately 480μg/L) and Tc-99 contamination to 9,000 pCi/L.

Early in 2006, the U Area pump-and-treat systems achieved what some thought was impossible. The heart, or high concentration zone, of the uranium/Tc-99 plume was removed and pumping was temporarily stopped. These systems removed over 450 pounds of uranium; two curies (119 grams) of Tc-99; and 79,000 pounds of nitrate.

"One of our key elements of Hanford's groundwater remediation strategy is to remove the sources of groundwater contamination in the vadose zone and avoid recontamination of the sites already cleaned or those undergoing remediation," says Dib Goswami, senior program hydrogeologist with Ecology.

Investigations Expanding In Tank Farms and 200 Area Waste Sites

Although Hanford's Tri-Party Agreement is concerned with all forms and locations of site wastes, it had to set priorities and deal with the worst situations first. Much of the groundwater contamination under the 200 Areas, given the area's low rainfall and thick vadose zone, was not placed among the highest priorities in early actions.

However, recently, due to several cleanup successes, the signatories have agreed that it is time to ramp up operations in central Hanford. The GRP has launched increasingly vigorous and invasive tests in the areas in and around tank farms and waste disposal trenches, cribs, French drains, lagoons and tile fields.

In and around the three tank farms (containing 40 single-shelled tank) and 23 ground waste sites of B Plant, GRP scientists are finding that Tc-99 and U are the chief contaminants of concern, although many additional contaminants are present.

Just to the south in 200 East Area, the multiple waste sites and tanks associated with processing operations have spread Tc-99, iodine 129 (I-129), tritium, nitrates, Sr-90, manganese, arsenic, chromium, and vanadium through the soil and the groundwater. A few miles further south, a unique collection of trenches known as the B/C cribs received the liquid wastes from a recycling process that separated uranium from tank waste. Cobalt 60 and uranium, along with cyanide, and chromium are evident in near-surface trenches and cribs there.

Under the T, TX, and TY tank farms and trenches in the 200 West Area – tanks and facilities that served the world's first radiochemical plant – high concentrations of Tc-99, uranium, and CCl_4 are being found. The task now is to drill, sample, investigate, map, and implement remediation strategies to take to the Tri-Parties for consideration in the CERCLA process.

Wrestling with the 300 Area

More than 20 million uranium fuel elements were manufactured and coated, or jacketed, in the 300 Area for irradiation in Hanford's reactors. It is, therefore, not surprising that uranium is the prime contaminant of concern in groundwater under the small (1.4-square-mile) area. In approximately four-tenths of a square mile, groundwater concentrations exceed 10μg/L uranium, compared to natural background concentrations of 5-8 μg/L. In forty percent of the plume, concentrations exceed the drinking water standard of 30 μg/L. In some places this past year, levels reached 97μg/L.

Organic compounds from the fuel processes, as well as Sr-90, nitrates, tritium, and arsenic are also present in above-standard levels. As a result, an ambitious program is underway to drill over a dozen new wells in this area during 2006. In addition, experiments using polyphosphate to bind the uranium are being developed and tested. They will be deployed if successful.

Special, Additional Funding Brought to Bear on Hanford's Contaminated Groundwater

In autumn 2005, Congress passed a special appropriation to increase the GRP's ability to remediate groundwater. It allocated an extra $10-million to be used in fiscal years (FYs) 2006 and 2007, boosting Hanford's GRP budget about ten percent over the two years.

After a selection and peer review process, the DOE's Environmental Management (EM) Office of Cleanup Technologies (EM-21), decided to allocate approximately half of the money to address hexavalent chromium contamination in Hanford's 100 D Area. "With this new funding," says Scott Petersen, technology project lead, "we'll implement a 'systems approach' in the 100 D Area, and attack the contamination in a more comprehensive, aggressive manner."

First, to make ISRM the barrier more effective, more reducing agent will be added to change the hexavalent chromium to trivalent chromium. Micron-size (a micron is one-millionth of a meter, or about one-four hundred thousandth of an inch) iron particles will be injected into the existing ISRM Barrier.

In addition, Fluor Hanford will expand the existing pump-and-treat systems in the 100 D Area, especially in the larger downstream portion of the plume. The new funding will also be used to test electro-coagulation – a technique that releases charged particles into water. The particles then attract and coagulate the contaminants in the water. An initial field test will be performed later this year.

In a separate but important action, GRP investigators will try to pinpoint the source of the large hexavalent chromium plumes that stretch under various parts of Hanford's 100 Areas. Much of the work to be performed with the remaining half of the new $10-million allocation will be investigation, characterization and unique demonstration efforts conducted by PNNL under the overall umbrella of the integrated Hanford GRP.

That work includes expanded work on the phosphate and apatite to trap Sr-90 in the 100 N Area, tests of polyphosphate to bind uranium in the aquifer under the 300 Area, and various trials to find and remediate CCl_4 and Tc-99 under the 200 Areas. The rate of natural degradation of CCl_4 by hydrolysis will be measured in the laboratory.

"We all care about this river both professionally and personally," says Petersen. "Each of the projects funded by the new EM-21 money directly addresses the problem of contamination entering the Columbia River, most in new and innovative ways. This new funding gives us a great opportunity to tackle areas that need cleaning up most, and we're excited about applying them over the next 18 months."

Decommissioning Old Wells Is Essential Work

A crucial task for Hanford's GRP is decommissioning old wells – once used to either monitor water levels or groundwater contamination or to inject liquid waste. Many of the old wells can be pathways that allow contamination to reach groundwater.

In total, more than 7,000 wells were drilled on the Hanford Site. Today, approximately 1,500 are potential candidates for decommissioning. Of those, about 800 may need physical decommissioning, while the remainder can be administratively decommissioned (a paperwork process).

Decommissioning a well essentially means sealing it, usually with special cement called grout. Where possible, the well casings (both inside and outside) are filled with grout as they are withdrawn from the ground. If the casings cannot be withdrawn, they must be perforated so that grout can be injected under pressure through the perforations and can fill void spaces in the soil that have developed along the outside of the casings.

Decommissioning wells with double or even triple casings provides the most challenging cases. A technique called "jet-shot" perforation uses explosive devices inside the wells to perforate all the casings. Seventy wells were decommissioned using jet shot techniques last year. About 450 Hanford wells have been physically decommissioned since 200, and over 1,600 have been administratively decommissioned.

In conjunction with the DOE, EPA and Ecology, GRP sets priorities for which wells will be decommissioned first. The wells with the highest risks are those closest to waste sites that penetrate through the vadose zone and into the groundwater. The highest priority, however, is given to wells that are impacted by site cleanup project schedules. Fortunately, many of the highest risk wells are located within expedited cleanup sites already being worked by other cleanup projects.

Preventing Recharge of Contaminants

Along with decommissioning old wells, GRP works to reduce water recharge into contaminated soil areas by re-lining leaky water lines using a process called mortar-lining. Scraping out the old buildup of scale and corrosion and then re-lining the pipes eliminates leaks that drive contaminants downward to the water table.

The application of the mortar-lining technique at Hanford has won national awards. In 2005, crews successfully used a different method of cleaning out the old piping. They opened a port into each pipe and inserted a hard rubber device shaped like a rounded torpedo – called a "pig." They then sealed the port, and used pressurized water to force the pig through the pipe, scraping out the encrusted material. In total, about 2,600 feet of old, leaking pressurized fresh-water lines have been lined at the site in the past three years.

Well Drilling at Hanford

In recent years, the GRP well-drilling program at Hanford has exceeded expectations. By April 2006, it had already finished all 60 of the wells required for calendar year (CY) 2006 in Tri-Party Agreement milestones and other agreements with the DOE. In addition, ten of the CY 2007 wells were finished by June 2006.

"This level of effort and success is just outstanding," says Dick Wilde, GRP vice president. "The well-drilling team here has been raising the bar continually over the last few years – drilling more and more wells each year. This year the team is really outdoing even its own record. Its work is safe and effective and speedy."

The FY 2006 well-drilling achievements represent a steady increase from the time that Fluor Hanford began managing GRP in 2002. In CY 2003, the GRP drilled 20 wells, then climbed to 26 wells in CY 2004, reached 34 wells in CY 2005, and made the largest leap to date in CY 2006.

The wells range in depth from about 80 feet in the 100 Areas, where the water table is closer to the surface, to 350-420 feet in central Hanford. Most 300 Area wells range from 80-120 feet deep, and a few of the 100 N Area wells very near the rivershore are only 26-30 feet deep.

The drilling total of over 12,000 vertical feet of wells with no accidents in FY 2006 is extremely significant, given the fact that drilling is one of the more hazardous industrial activities listed by the Occupational Safety and Health Administration (OSHA).

Fluor Hanford's President Ron Gallagher has been especially impressed by GRP's recent accomplishments, stating that "none of the groundwater protection methods implemented at Hanford could be successful without a first-class well drilling program. It is the active implementation arm of the monitoring programs across the site. I'm extremely proud of their safe and productive record."

Safety and Field Operations in the GRP

In addition to reducing and preventing pollution, perhaps GRP's most satisfying achievement has been the dramatic improvement in safety. The project recently received a special award for achieving a million safe work hours (hours without a lost time injury), representing almost three years of work in the project.

At least 17 subcontractors performed in-field work for GRP last year. Because work at Hanford is inherently more risky and contains more potential surprises than other sites where the subcontractors are used to working, Fluor insisted that they all adhere to a single safety system. The results have been amazing. The recordable injury rate (as measured by OSHA standards) for the GRP was 0.55 last year (per 100,000 hours worked), vastly lower than the national average of nearly 5.9 for well-drilling and environmental work. Recently, GRP submitted its application for recognition in DOE's Voluntary Protection Program – a strict safety program modeled on that of OSHA.

An organization of approximately 100 people under field operations manager Brian Von Bargen works constantly behind the scenes. They coordinate, plan, monitor, and assure the safety of all groundwater and ecological research, as well as remediation project work, performed on the Hanford Site.

Hanford, because of its vast size and unique hazards, has a very formal system of controlling work to ensure that safe practices are followed. The hazards of every proposed work project at the site are formally evaluated, and safety requirements are set. Hazards identification can be doubly difficult when the work is going to penetrate far below the surface. "It's a challenge to forecast the hazards that may be encountered 50 feet or more below the surface, particularly when work is being performed near a waste site," says Von Bargen. "We've learned to expect the unexpected."

Von Bargen's group assures that the GRP follows site requirements, and synchronizes needs so that all parties can move their equipment and people in and out of job sites without interfering with the ongoing work of others. Importantly, the group provides radiological control, safety, industrial hygiene, work control, waste management and logistical support and, in many cases, personnel. Most wells and boreholes generate purge water (flush water) as a waste product and sometimes generate other solid wastes.

As the visibility of Hanford's groundwater programs rises ever higher, the support work also grows almost exponentially. "The GRP field operations group is the true integrator in the field," says Von Bargen. "Hanford is a tightly regulated site, with rules in place to assure safety everywhere people need to work. We've learned over time that you can't just place a contract or a subcontract and invite people out onto the site. By providing assistance and oversight, we're making sure that work is done safely, injuries are avoided, and all groups can meet their work goals."

Conclusion

In conclusion, the Fluor Hanford Groundwater Remediation Project is making major strides in finding and treating contaminated groundwater, and protecting the Columbia River. Radionuclides and chemicals of long-term concern are being tracked, intercepted and treated at their most concentrated points and at the places where they most threaten crucial natural resources. Innovative chemical barriers and treatments, as well as more standard pump-and-treat methods are being used as the DOE and Fluor strive to respond to the stated concerns of stakeholders and regulatory agencies, and protect the Hanford region.

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Photos and Photo Captions
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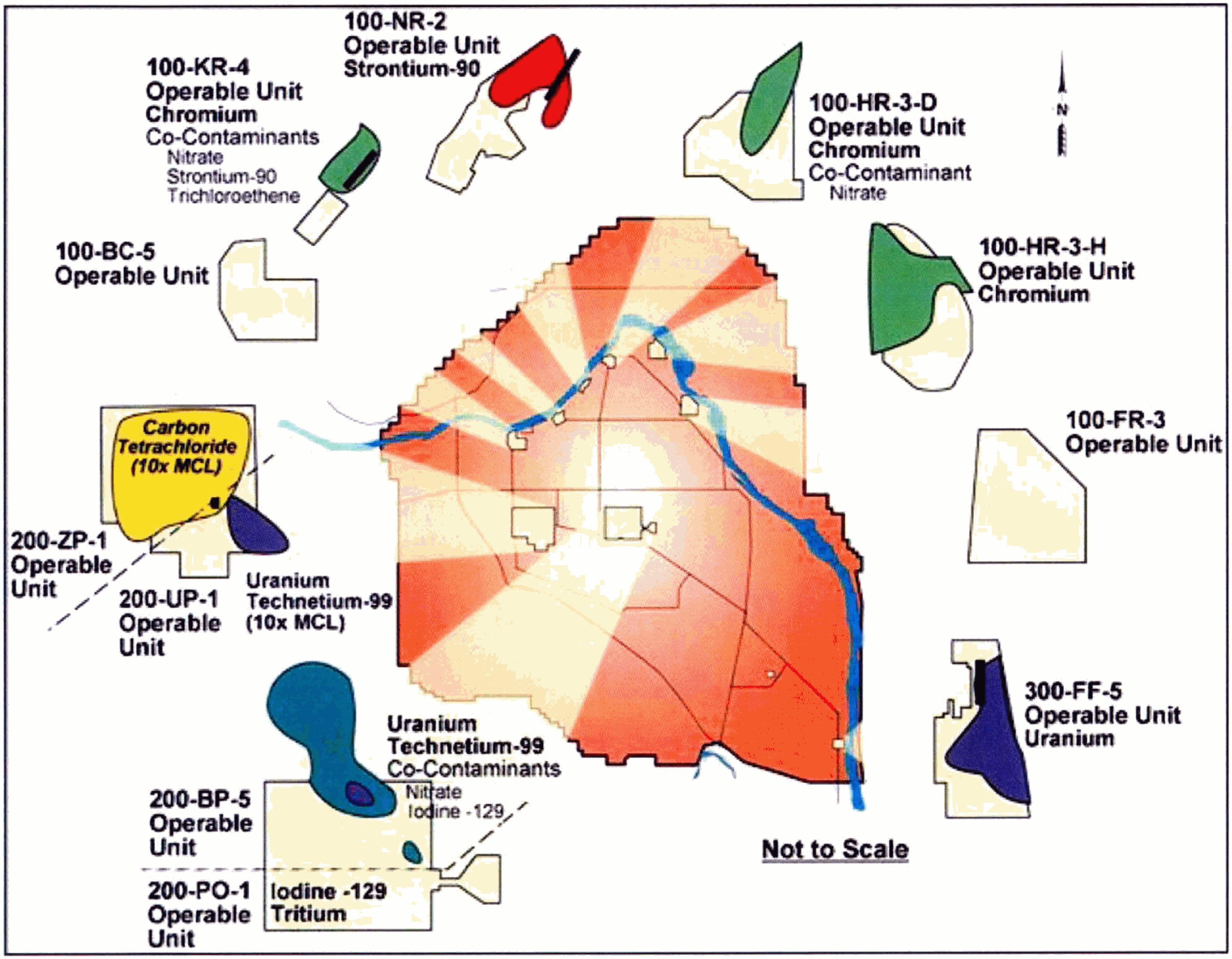
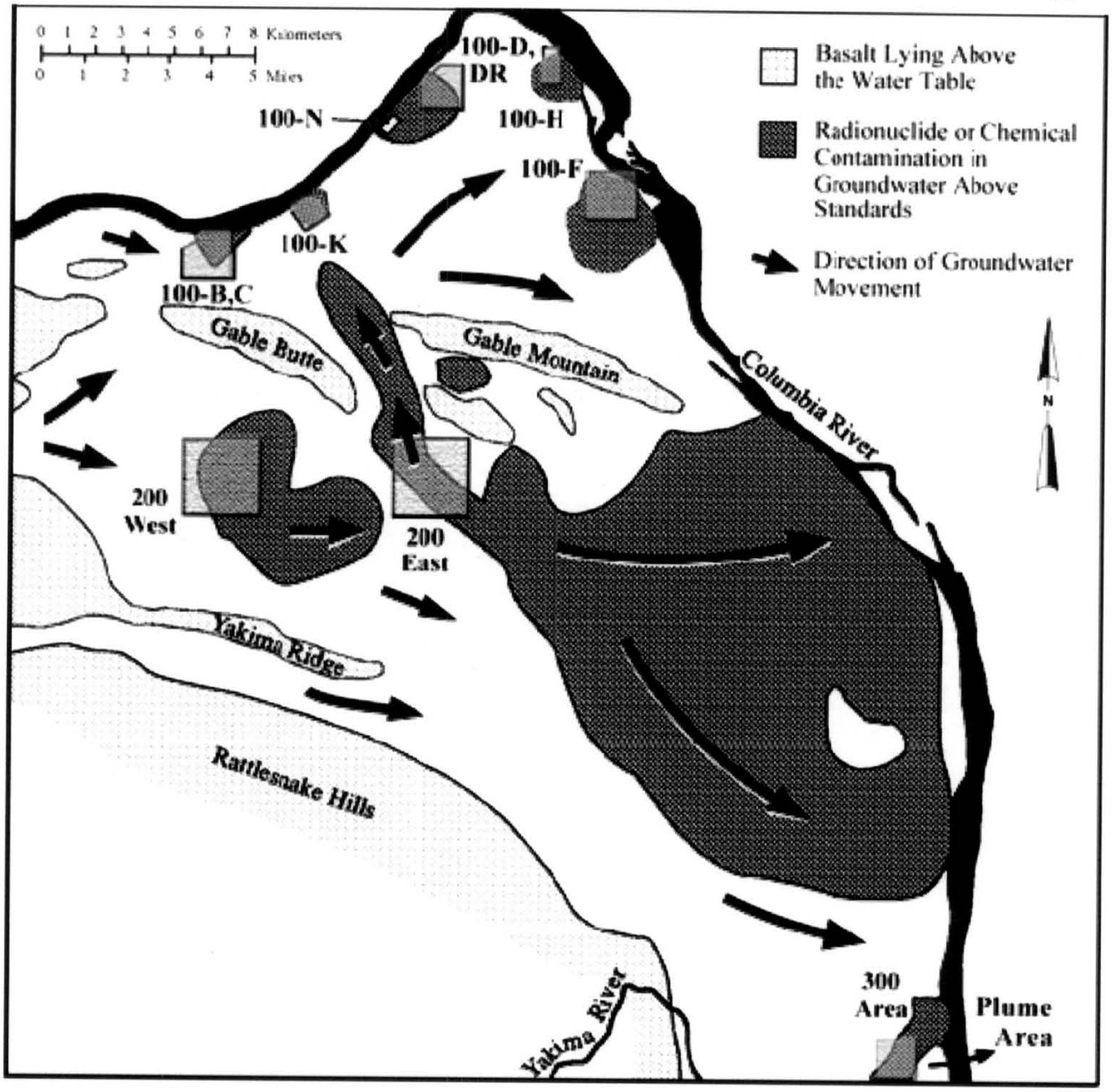
1. Plumes Map.2005 – Schematic representation of the various contaminated groundwater areas at the Hanford Site.
2. Graphic.3 – Schematic detailing the flow of groundwater toward the Columbia River at Hanford.
3. Effluent Basins.Shore – 1962 photo showing how reactor effluent water laden with chromium contamination seeped into Columbia River shoreline areas near Hanford's reactors. 100 K Area is shown.
4. 100-K Area Plumes – Plumes of chromium contamination have shrunk dramatically in recent years in Hanford's 100 K Area.
5. 100N Drilling.2.06 – Fluor Hanford's Groundwater Remediation Project drilling new wells in Hanford's 100 N Area in early 2006, as part of a pilot project that injects calcium phosphate deep into soils to bind contaminants and keep them from the Columbia River. Portions of Hanford's N Reactor, as well as the White Bluffs and Saddle Mountains are shown in the background.
6. 100N.5.06 – 110df -- Fluor Hanford Vice President for Groundwater Remediation Dick Wilde (left, gesturing) explains the 100 N Area calcium phosphate pilot test to Drew Willison, clerk, U.S. Senate Energy and Water Appropriations Subcommittee (right), May 2006. In center, John Morse (orange vest), DOE project engineer, and Keith Klein, Manager, DOE's Richland Operations office, look on.
7. Crib.Z Plant – Historical construction of a ground disposal site (known as a "crib") for liquid wastes at Hanford, 1950s. The cribs were not lined.
8. Z-9 Drilling Operations – Workers dressed in full protective clothing and wearing supplied air breathing equipment drilling some of the four new wells to extract carbon tetrachloride from groundwater in central Hanford, 2005.
9. 06050006-106df AND 0605006-162.df - use both photos with same caption -- Fluor Hanford workers carefully handle probes being used to sample contamination in soil in central Hanford, spring 2006. Special containment enclosures are established to safely manage the contaminated samples.
10. – (see #8 above)
11. A-8 Crib.Cable Tool risk controls – Plastic-lined wood enclosure established to control contamination as a borehole is drilled in a ground waste site in Hanford's 200 East Area. A High-Efficiency Particulate Air filter captures and holds airborne radionuclides.
12. Well Drilling.IDF - The exceptionally productive Fluor Hanford well-drilling program drills a well at the new Interim Disposal Facility in the site's 200 East Area.
13. Table – Groundwater Remediation Technologies
14. Table – EPA Drinking Water Standards

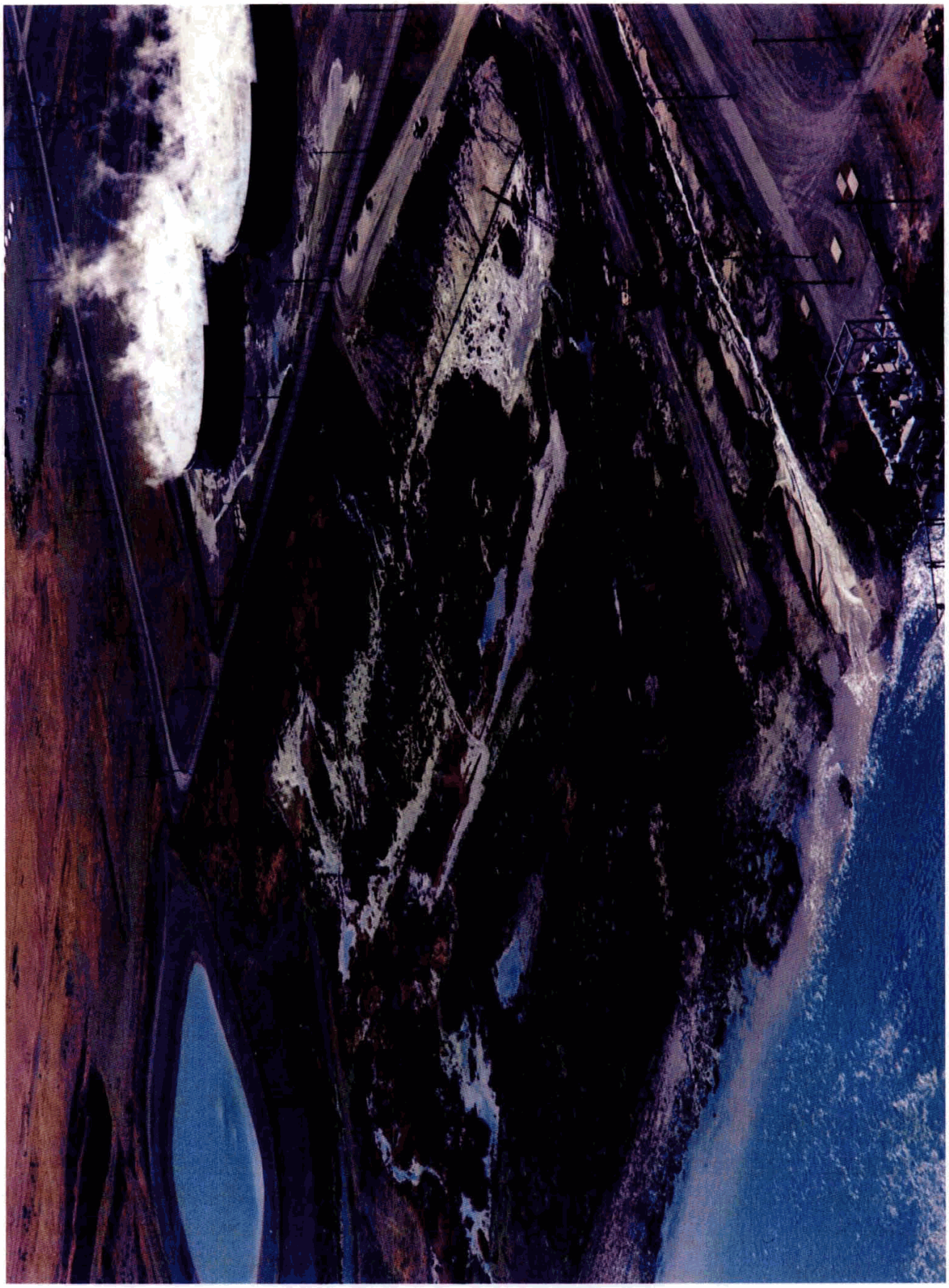
P-1


100-NR-2
Operable Unit
Strontium-90
100-KR-4
Operable Unit
Chromium
Co-Contaminants
Nitrate
Strontium-90
Trichloroethene
100-HR-3-D
Operable Unit
Chromium
Co-Contaminant
Nitrate
N
100-BC-5
Operable Unit
100-HR-3-H
Operable Unit
Chromium
100-FR-3
Operable Unit
Carbon
Tetrachloride
(10x MCL)
200-ZP-1
Operable
Unit
200-UP-1
Operable
Unit
Uranium
Technetium-99
(10x MCL)
300-FF-5
Operable Unit
Uranium
Uranium
Technetium-99
Co-Contaminants
Nitrate
Iodine -129
200-BP-5
Operable
Unit
200-PO-1
Operable
Unit
Iodine -129
Tritium
Not to Scale

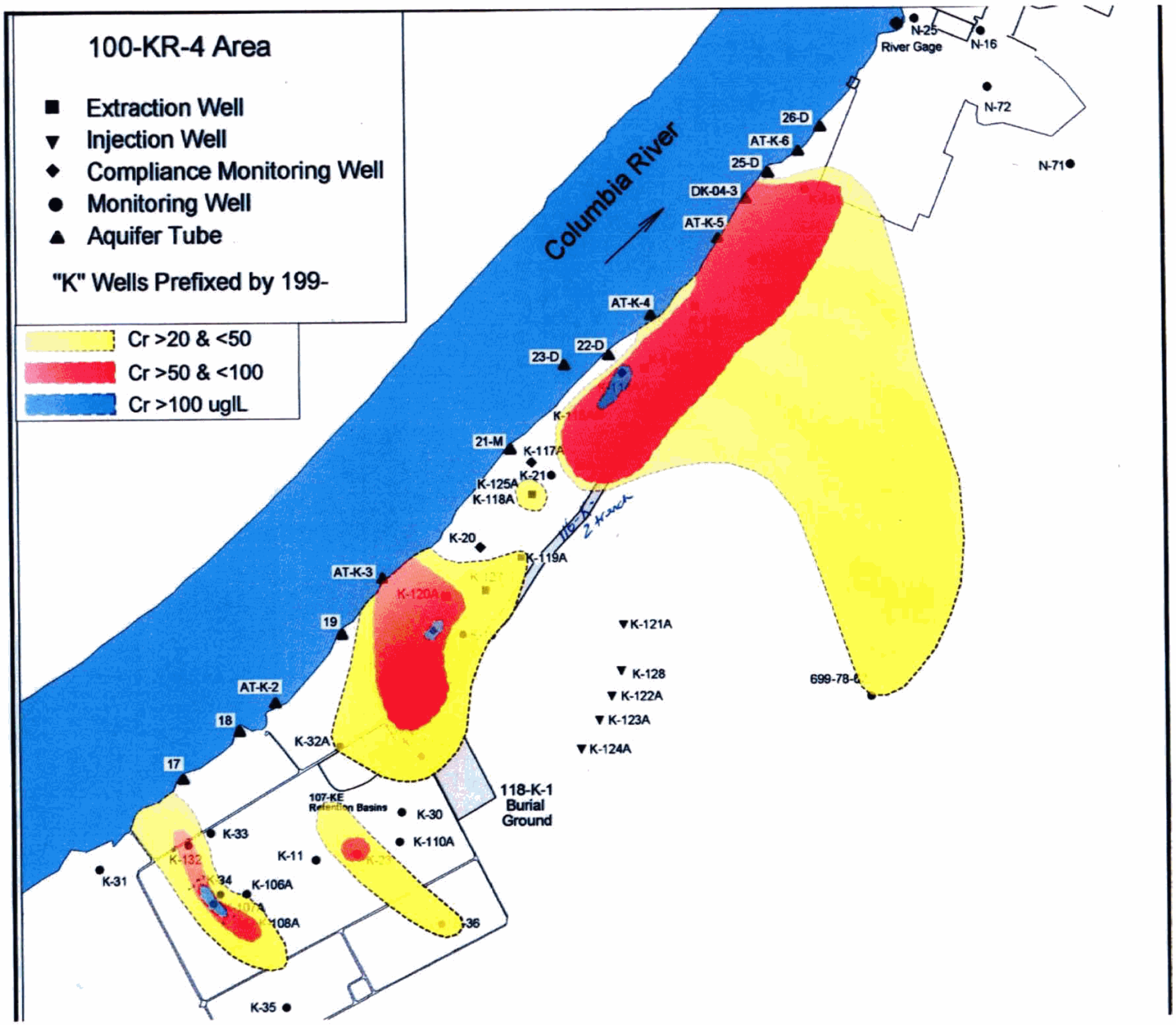
P-(2)

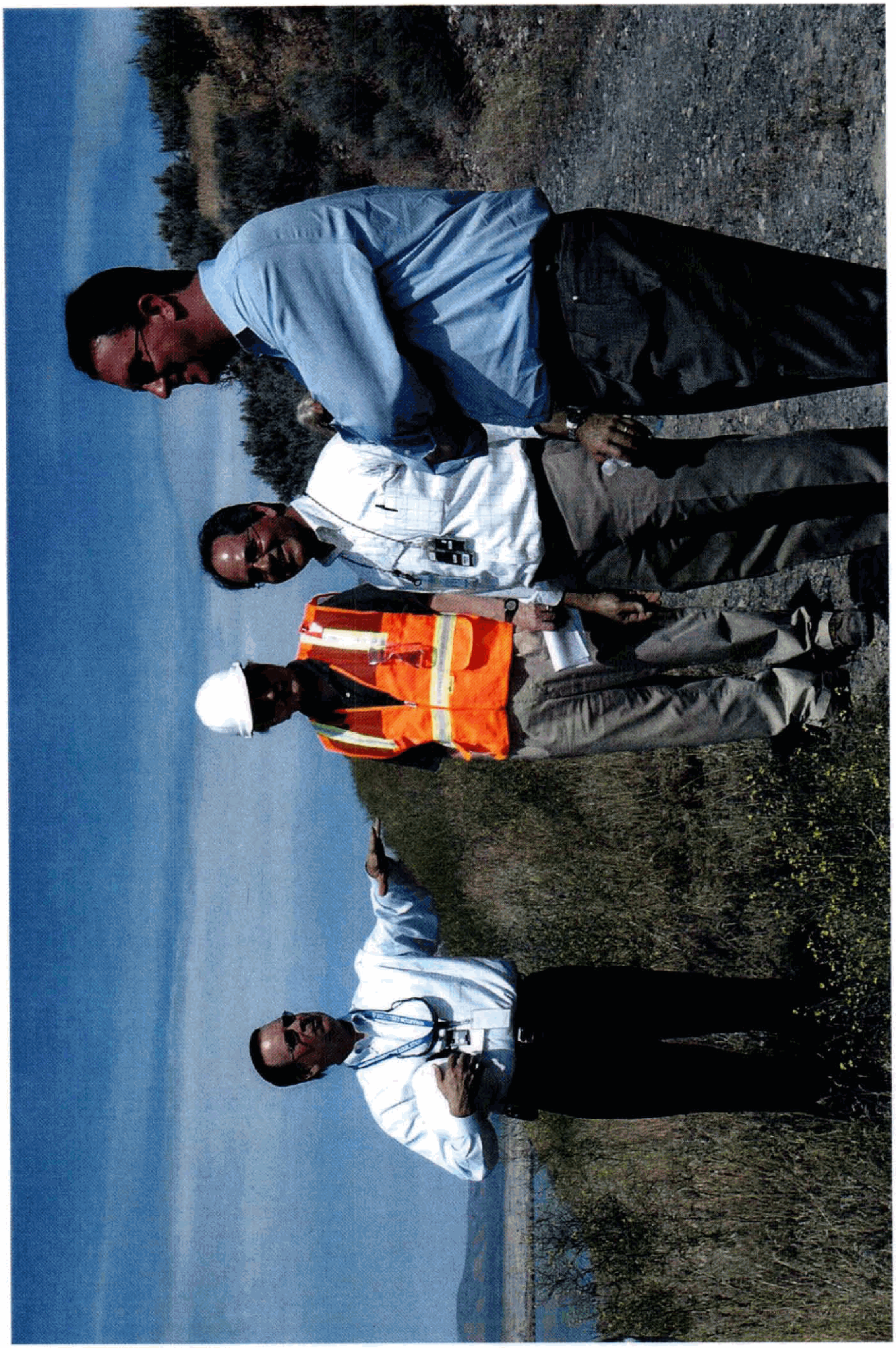

0 1 2 3 4 5 6 7 8 Kilometers
0 1 2 3 4 5 Miles
Basalt Lying Above the Water Table
Radionuclide or Chemical Contamination in Groundwater Above Standards
Direction of Groundwater Movement
N
100-D, DR
100-N
100-H
100-F
100-K
100-B,C
Gable Butte
Gable Mountain
Columbia River
200 West
200 East
Yakima Ridge
Rattlesnake Hills
Yakima River
300 Area
Plume Area

741fb.93



p-4

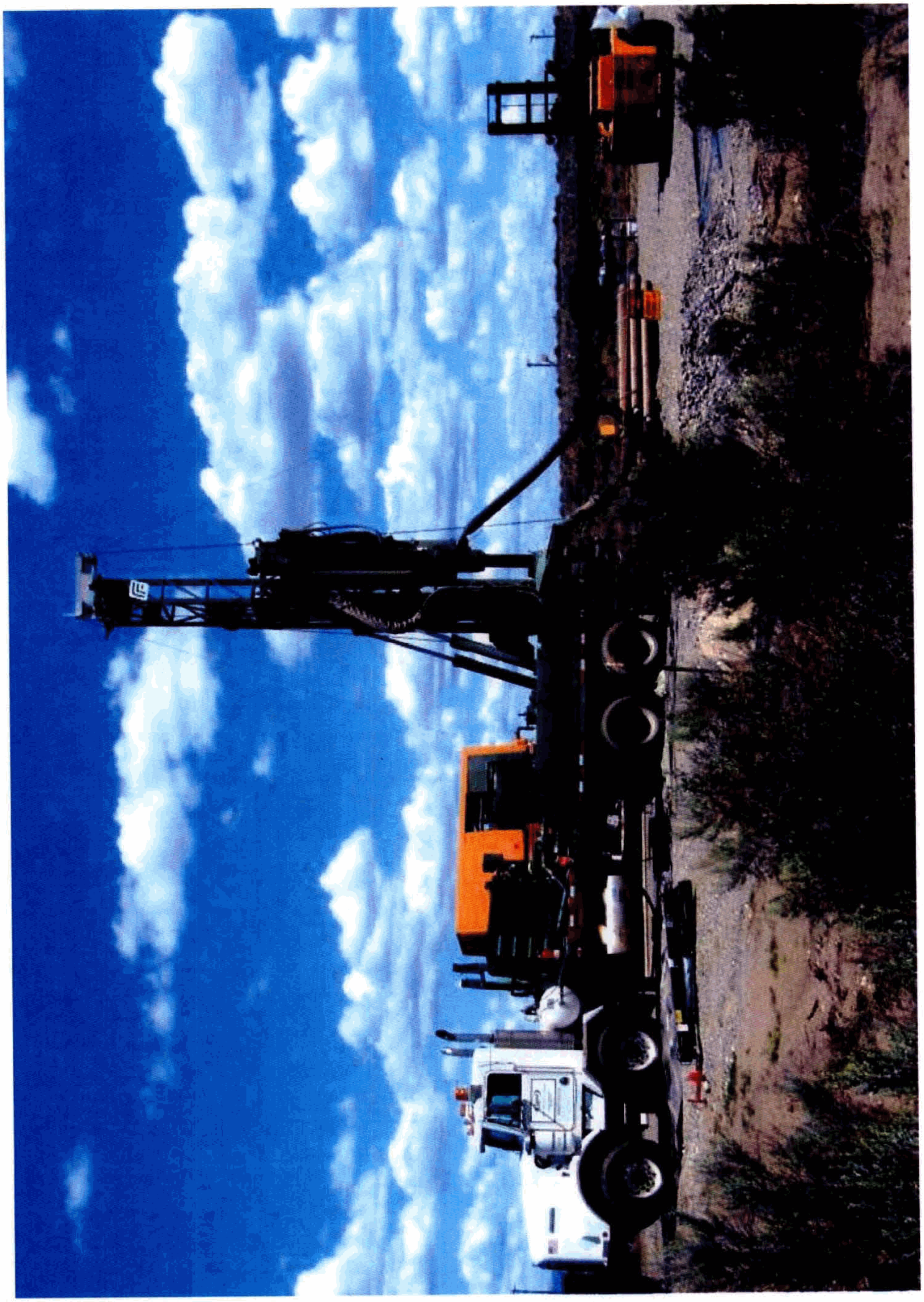

100-KR-4 Area
Extraction Well
Injection Well
Compliance Monitoring Well
Monitoring Well
Aquifer Tube
"K" Wells Prefixed by 199-
Cr >20 & <50
Cr >50 & <100
Cr >100 ugIL
Columbia River
River Gage
N-25
N-16
N-72
N-71
26-D
AT-K-6
25-D
DK-04-3
AT-K-5
AT-K-4
22-D
23-D
21-M
K-117A
K-21
K-125A
K-118A
K-20
K-119A
AT-K-3
K-120A
19
AT-K-2
18
17
K-32A
118-K-1
Burial
Ground
K-121A
K-128
K-122A
K-123A
K-124A
699-78-
K-30
K-110A
K-33
K-11
K-31
K-106A
K-108A
K-35
K-132
36



P-6

p- 10

P-11



P-12

T-13

Hanford Site Groundwater Remediation Technologies By Area

100-H	100-D	100-K	100-N	200-ZP (Central Plateau)	U Area (Central Plateau)	300 Area	Tank Farms (Central Plateau)	B/C Cribs (Central Plateau)	All Site Areas
Pump-and-treat: Resins in ion exchange column reduce Cr+6 to Cr+3. Clean water re-injected in upgradient wells.	Expanded pump-and-treat: Resins in ion exchange column reduce Cr+6 to Cr+3. Underground In-Situ Redox Manipulation Barrier: Sodium dithionate reduces Cr +6 to Cr +3.	Pump-and-treat: Calcium polysulfide reduces Cr+6 to Cr+3. Treated water re-injected in upgradient wells.	Pump-and-treat used resins in ion exchange column to remove Sr-90. Treated water re-injected in upgradient wells. New test system injects calcium citrate and di-sodium phosphate to form apatite: Binds Sr-90 allowing decay while preventing migration.	Expanded pump-and-treat: Air stripper tower receives groundwater containing CCl4 and separates contaminant, which is subsequently sorbed to Granular Activated Carbon. Treated water re-injected in upgradient wells.	Aged, leaking water lines being re-lined with mortar to prevent recharge of soil contaminants into groundwater. Pump-and-treat for U and Tc-99 removal on standby pending rebound tests – may not restart	Boreholes and aquifer tubes are sampling and mapping U contamination. Polyphosphate test being developed.	Sampling wells being drilled to map Tc-99 and other contaminants.	Investigative work ongoing. Remediation strategies being defined.	Old wells being decommissioned to prevent them from providing preferential pathways for movement of contamination to groundwater.

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Table: EPA Drinking Water Standards for Contaminants of Concern

Constituent	Abbreviation	*DWS- ug/L	*DWS – pCi/L
Carbon tetrachloride	CCl4	5	
Trichloroethene	TCE	5	
Chloroform	TCM	100	
Uranium	U	30	
Technetium 99	Tc-99		900
Strontium 90	Sr-90		8
Iodine 129	I-129		1
Tritium	H3		20,000
Chromium 6	Cr+6	100	10
Nitrate	NO3	45,000	250
Cobalt-60	Co60		100
Arsenic	As		10
Manganese	Mn		5
Vanadium	V		25
Cyanide			5

*Drinking Water Standard – ug/L (micrograms per liter)
*Drinking Water Standard – pCi/L (picocuries per liter)
*Aquatic Standard – ug/L (micrograms per liter)