Nevada
Environmental
Restoration
Project

DOE/NV--1106-REV. 1

National Nuclear Security Administration

Subsurface Completion Report for Amchitka Underground Nuclear Test Sites: Long Shot, Milrow, and Cannikin

Revision No.: 1

September 2006

Environmental Restoration
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U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office

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SUBSURFACE COMPLETION REPORT FOR AMCHITKA UNDERGROUND NUCLEAR TEST SITES: LONG SHOT, MILROW, AND CANNIKIN

U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office
Las Vegas, Nevada

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SUBSURFACE COMPLETION REPORT FOR AMCHITKA UNDERGROUND NUCLEAR TEST SITES: LONG SHOT, MILROW, AND CANNIKIN

Approved by: APPROVED SIGNATURE Date: 9/12/2006

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List of Acronyms and Abbreviations

ACCA	Aleut Culture and Communication Area
AEC	U.S. Atomic Energy Commission
AMNWR	Alaska Maritime National Wildlife Refuge
APIAI	Aleutian/Pribilof Islands Association, Inc
bgs	Below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
cm/year	Centimeters per year
CRESP	Consortium for Risk Evaluation with Stakeholder Participation
Cs	Cesium
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
EIS	Environmental Impact Statement
EM	Environmental Management
EPA	U.S. Environmental Protection Agency
°F	Degrees Fahrenheit
ft	Foot
ft^3	Cubic foot
ft bgs	Feet below ground surface
GZ	Ground zero
I.D.	Inside diameter
in.	Inch
km	Kilometer
kt	Kiloton
LM	Legacy Management
LTSMP	Long-Term Surveillance and Maintenance Plan

List of Acronyms and Abbreviations (Continued)

MDA	Minimum detection activity
mi	Mile
mi^2	Square mile
MOA	Memorandum of Agreement
mph	Miles per hour
mrem/yr	Millirem per year
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NTS	Nevada Test Site
O.D.	Outside diameter
ONR	Office of Naval Research
pCi/L	Picocuries per liter
Pu	Plutonium
SGZ	Surface ground zero
Sr	Strontium
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Executive Summary

Three underground nuclear tests were conducted on Amchitka Island, Alaska, in 1965, 1969, and 1971. The effects of the Long Shot, Milrow, and Cannikin tests on the environment were extensively investigated during and following the detonations, and the area continues to be monitored today.

This report is intended to document the basis for the Amchitka Underground Nuclear Test Sites: Long Shot, Milrow, and Cannikin (hereafter referred to as "Amchitka Site") subsurface completion recommendation of No Further Remedial Action Planned with Long-Term Surveillance and Maintenance, and define the long-term surveillance and maintenance strategy for the subsurface.

A number of factors were considered in evaluating and selecting this recommendation for the Amchitka Site. Historical studies and monitoring data, ongoing monitoring data, the results of groundwater modeling, and the results of an independent stakeholder-guided scientific investigation were also considered in deciding the completion action.

Water sampling during and following the testing showed no indication that radionuclides were released to the near surface, or marine environment with the exception of tritium, krypton-85, and iodine-131 found in the immediate vicinity of Long Shot surface ground zero. One year after Long Shot, only tritium was detectable (Merritt and Fuller, 1977). These tritium levels, which were routinely monitored and have continued to decline since the test, are above background levels but well below the current safe drinking water standard. There are currently no feasible means to contain or remove radionuclides in or around the test cavities beneath the sites.

Surface remediation was conducted in 2001. Eleven drilling mud pits associated with the Long Shot, Milrow and Cannikin sites were remediated. Ten pits were remediated by stabilizing the contaminants and constructing an impermeable cap over each pit. One pit was remediated by removing all of the contaminated mud for consolidation in another pit. In addition to the mud pits, the hot mix plant was also remediated.

Ongoing monitoring data does not indicate that radionuclides are currently seeping into the marine environment. Additionally, the groundwater modeling results indicate no seepage is expected for tens to thousands of years. If seepage does occur in the future, however, the rich, diverse ecosystems around the island could be at risk, as well as people eating foods from the area.

An independent science study was conducted by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) in accordance with the Amchitka Independent Science Plan (2003). The study report was published on August 1, 2005. The CRESP study states “our geophysical and biological analyses did not find evidence of risk from radionuclides from the consumption of marine foods, nor indication of any current radionuclide contaminated migration into the marine environment from the Amchitka test shots.” The study also found evidence supporting the groundwater modeling conclusions of very slow contaminant transport (CRESP, 2005).

While no further action is recommended for the subsurface of the Amchitka Site, long-term stewardship of Amchitka Island will be instituted and will continue into the future. This will include institutional controls management and enforcement, post-completion monitoring, performance of five-year reviews, public participation, and records management. Long-term stewardship will be the responsibility of the U.S. Department of Energy Office of Legacy Management.

The Department of Energy is recommending completion of the investigation phase of the Amchitka Sites. The recommended remedy for the Amchitka Site is No Further Action with Long-Term Monitoring and Surveillance.

The future long-term stewardship actions will be governed by a Long-Term Surveillance and Maintenance Plan. This Plan is currently being developed with input from the State, landowner, and other interested or affected stakeholders.

1.0 Introduction

Because of the environmental liability created by past nuclear testing activities at Amchitka Island, Alaska, the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Site Office (NNSA/NSO) must demonstrate due process and due diligence in its cleanup process. Therefore, proper documentation of site cleanup, particularly its completion, is essential in demonstrating and assuring sustained protection of human health and the environment. This report presents the basis and justification for the completion of the subsurface component of the Amchitka Underground Nuclear Test Sites: Long Shot, Milrow, and Cannikin (hereafter referred to as the "Amchitka Site").

The objectives of this report are to: 1) document the bases for the completion recommendation, and 2) define the long-term surveillance and maintenance strategy. Site monitoring, groundwater modeling and assessment, and surface cleanup conducted since 1971 form the basis for the completion recommendation.

This report consists of the following three major sections:

Section 1.0 - Provides an introduction to the site including: a background of historical as well as future use of the site; a description of the physical environment at Amchitka; historical site investigation reports throughout 2004 with groundwater modeling; and the regulations applicable to the site.

Section 2.0 - Describes the site completion justification including a discussion of current risk assessments, independent science studies (conducted in 2004 and 2005), and modeling.

Section 3.0 - Provides the site completion recommendation and strategy describing institutional controls, public participation, and long-term surveillance and maintenance.

1.1 Background

The following sections identify the location of Amchitka Island and present a high level summary of the historic, current, and planned future use of the island.

1.1.1 Location

Amchitka Island is located near the far west end of the Aleutian Islands, approximately 1,340 miles (mi) west-southwest of Anchorage, Alaska (Figures 1-1 and 1-2). The island is 42 mi long and from 1 to 4 mi wide, with a total area of approximately 116 square miles (mi^2). It is bound by the Bering Sea to the north and by the Pacific Ocean to the south.

1.1.2 Historic Uses

The Aleutian Islands were set aside from the public domain as a wildlife reserve by President Taft in 1913 to provide a breeding ground for native birds, the propagation of reindeer and fur-bearing animals, and the encouragement and development of the fisheries. The establishment of the reserve also specifically stated that it "shall not interfere with the use of the islands for lighthouse, military, or naval purposes." In 1940, the reserve was renamed the Aleutian Islands National Wildlife Refuge.

From World War II until the early 1990s, the island was used by multiple U.S. government agencies for a variety of military and research activities. During the late 1960s and early 1970s, drilling was performed in support of three deep subsurface nuclear tests conducted on Amchitka by the U.S. Department of Defense (DoD) and the U.S. Atomic Energy Commission (AEC) (predecessor agency to DOE).

There are numerous historic sites relating to the major occupations on the island, which include World War II U.S. Armed Forces, AEC/DOE nuclear testing period, and U.S. Navy Radar Station Operations.

The World War II facilities were the subject of a U.S. Army Corps of Engineers cleanup effort in 1986. At that time, several buildings were left in place because of potential historic significance, including the North and South Hangars, the Officer's Club, and the Chapel. The U.S. Navy subsequently demolished the North Hangar. The Chapel and the Officer's Club are collapsed, or nearly so, and no cleanup of these structures was attempted. The South Hangar, potentially eligible for inclusion on the National Register of Historic Places, was removed.

The nuclear testing period buildings, dating from the mid to late 1960s, were demolished (including some that were reused by the U.S. Navy during the radar station operations). They were not architecturally significant and were not eligible for inclusion on the National Register. The landscapes of the three surface ground zeroes (SGZs) were eligible. During 1972 and 1973, site reclamation efforts, a number of test-related wells were plugged and abandoned leaving only the wells identified as part of the Long-Term Hydrologic Monitoring program. These wells, locations, depths and abandonment method are identified in Table 1-2. The U.S. Navy demolished and removed all DoD buildings on the island in the summer of 2001. Also in 2001, the DOE conducted a series of surface mud pit closures and the final plugging and abandonment of the Long-Term Hydrologic Monitoring Program wells. Of the 24 monitoring wells, 16 were plugged and abandoned, 2 were protective covered, and 6 were either not found (under water) or the well structure and casing deteriorated to the point that plugging the well was not needed or possible. Details associated with each well are described in Table 1-2.

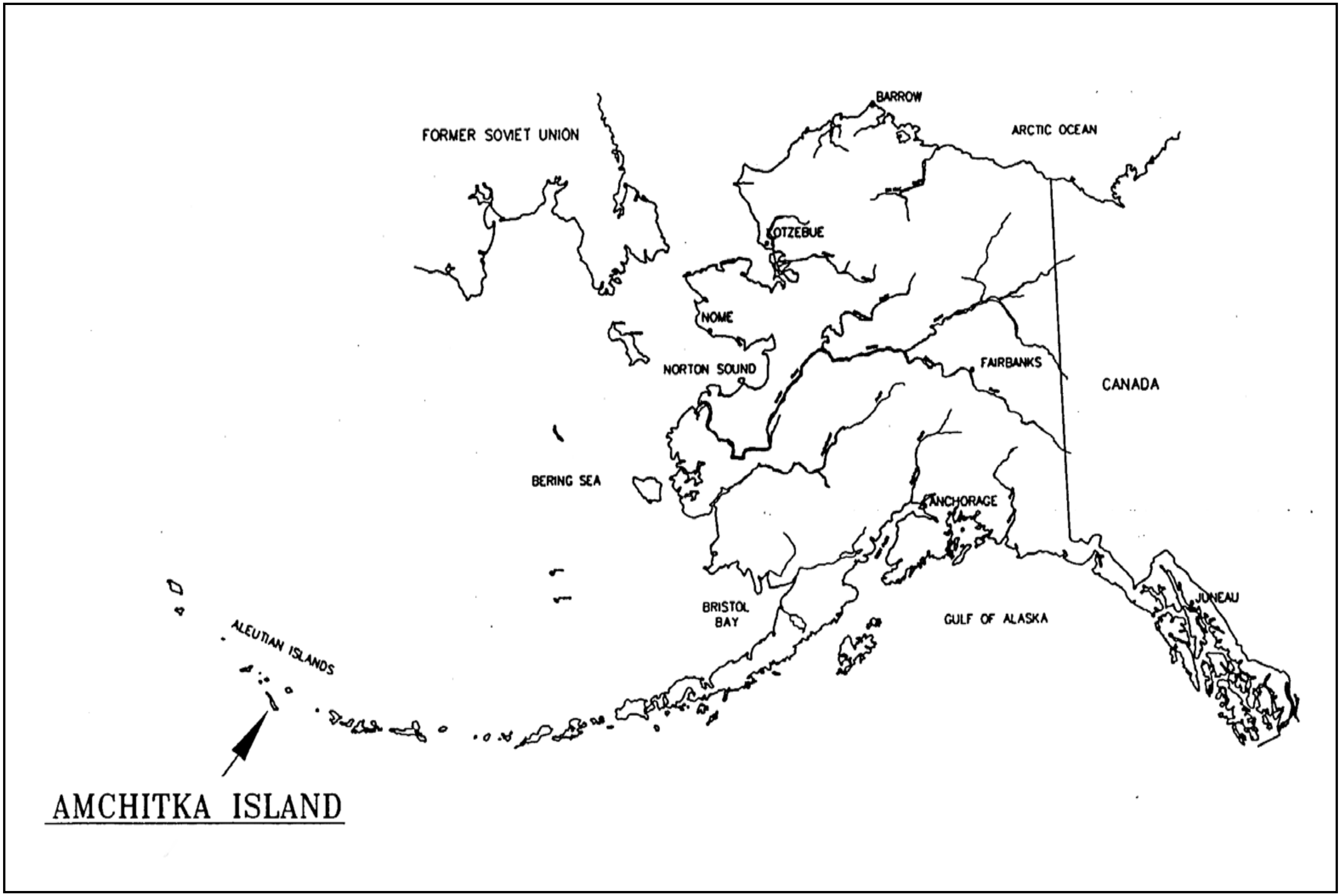

Figure 1-1
Aleutian Islands and Amchitka Island

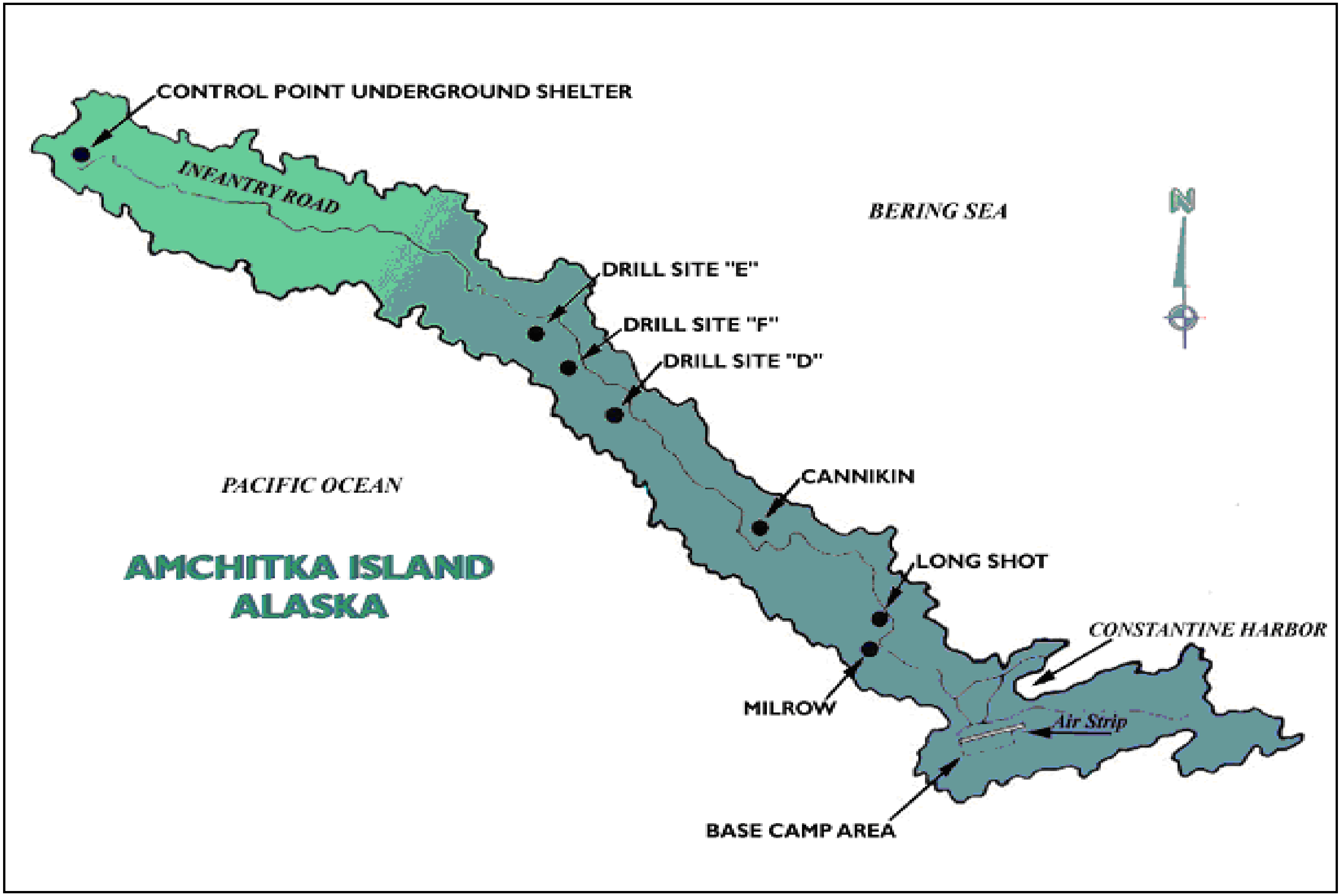

Figure 1-2
Amchitka Island Showing Drilling and Test Sites

Finally, the U.S. Navy's buildings from the 1987 to 1993 period are not considered eligible for inclusion on the National Register because the antenna system did not become operational until after 1989, the defined end of the Cold War era.

Table 1-1 presents historical activities on Amchitka Island.

Table 1-1
Amchitka Island Site History
(Page 1 of 2)

Date	Action
1868	America purchased Russian America, which included the Aleutian Islands.
3/3/1913	President Taft issued Executive Order 1733, setting the Aleutian Islands aside "… as a preserve and breeding ground for native birds …," with the stipulation that "… this designation would not interfere with use for lighthouses, military or naval purposes" (Federal Register, 1913).
1/1943	Began construction of the forward air base on Amchitka.
8/1950	Amchitka abandoned by the U.S. Army.
1951	The U.S. Department of Defense (DoD) drilled 34 test holes for Project Windstorm; however, the project was conducted at the Nevada Test Site.
1959-1961	White Alice communication system was operational.
4/1964	The U.S. Atomic Energy Commission (AEC) picked the preliminary Long Shot Project Site.
5/5/1964	Long Shot test planning began.
5/16-12/4, 1964	Exploratory drilling for Long Shot was conducted.
2/3/1964	Rat Island earthquake occurred.
6/2/1965	AEC and DoD signed a Memorandum of Agreement (MOA) for Long Shot.
10/29/1965	Long Shot test was conducted (80 kilotons at 2,297 feet [ft] below ground surface [bgs]).
1966	Department of Interior (DOI) granted permission for AEC to use Amchitka.
1966	Battelle Labs was contracted to conduct ecological studies on Amchitka.
1967	Amchitka Bioenvironmental Program was initiated.
1967	Holes for proposed testing were drilled at sites D, E, and F.
10/2/1969	Milrow test was conducted (about 1 megaton at 4,003 ft bgs).
6/12/1970	Draft Environmental Impact Statement (EIS) for Cannikin test was issued.
6/1971	Final EIS was issued for the Cannikin test.
1971	Site H was prepared for drilling, but no drilling took place.
11/6/1971	Cannikin test was conducted (less than 5 megatons at 5,873 ft bgs).
2/25/1972	Amchitka cleanup began.
5/19-21/1972	Holes related to Long Shot were plugged and abandoned.

Table 1-1
Amchitka Island Site History
(Page 2 of 2)

Date	Action
9/19-26/1972	All remaining holes were plugged and abandoned.
1973	AEC demolished approximately 400 World War II buildings.
9/1973	U.S. Fish and Wildlife Services (USFWS) signed off on completion of 120 AEC disturbed sites.
9/1973	AEC returned Amchitka Island to DOI.
1974	Long Shot mud pits were left intact for monitoring purposes.
1974	Decontamination water from Cannikin test was injected into the chimney and contaminated drilling tools were sealed in the re-entry hole.
1980	Alaska Maritime National Wildlife Refuge established 22,000 acres of Amchitka as a wilderness area.
5/1986	U.S. Navy and USFWS signed an MOA for joint use of the island.
1993	U.S. Department of Energy (DOE) conducted sampling to evaluate potential chemical impacts at disturbed sites.
1997	Ecological and sediment testing were conducted for radionuclide impacts.
1998	Further characterization of the mud pits was conducted.
6/2000	Engineering field study was conducted to assess remediation of mud pits.
12/2000	USFWS issued EA and finding of no significant impact; report assigned remediation responsibilities to DOE, U.S. Navy, and U.S. Army Corps of Engineers.
5/25/2001	Surface remediation activities (including mud pit caps and underground storage tank removal) began.
Summer 2001	16 wells were plugged and abandoned, 6 could not be found, 2 wells (GZ-1, GZ-2) were covered and locked, and 1 well (UAe-7e/h) was left open as a possible future monitoring well. The GZ-1, GZ-2, and UAe-7e/h wells were located during the 2006 Mud Pit Cap Inspection and the above status was verified. No other DOE wells exist on site and none are being monitored. The U.S. Navy demolished and removed all DoD buildings on the island.
9/10/2001	Surface remediation work was completed.
10/13/2001	Field base camp was demobilized.
2002	Evaluated groundwater flow and transport of radionuclides and presented findings in *Modeling Groundwater Flow and Transport of Radionuclides at Amchitka Island's Underground Nuclear Tests: Milrow, Long Shot and Cannikin* (NNSA/NV, 2002).
7/2003	Submitted *Amchitka Island Surface Closure Report* (NNSA/NSO, 2003).
8/2006	First 5-year cap inspection was completed. No deterioration of mud pit caps was noted. Report pending.

Table 1-2
Well Abandonment Details
(Page 1 of 5)

Date	Site	Well	Depth	Activity
9/72	Site F	UA-3	531 ft	Concrete removed from 92-inch (in.) casing. Disconnected all 2-in. pipe lines, 90-in. wooden plug installed. Poured 2-foot (ft) cement cap on top of the gravel in the rat and mouse holes and mud trough with 8 cubic feet (ft^3) of slurry. Abandonment complete.
9/72		UAE-3	7,012 ft	Removed dirt from around the 13 3/8-in. outside diameter (O.D.) casing and found cement 1 ft bgs. Released pressure on casing head. Cemented to pad level with 2 ft^3 of slurry on top of the 9 5/8-in. O.D. casing. Abandonment complete.
9/72	Site D	UA-6	4,550 ft	Cemented from top of 92-in. casing to pad level 144 in. diameter. Abandonment complete.
9/72	Site D	UAE-6C	6,999 ft	Wooden plug placed at ground level minus 10 ft. Cemented 10-ft plug inside 13 3/8-in. casing with cement and sand slurry. Abandonment complete.
9/72	Sites E&F			Gravel and sand in both sides, rat holes, mouse holes, and suction trough pads. Poured cement on both sites. No problems with cementing plug.
9/72		UA-7	100 ft	The 144-in. inside diameter (I.D.) conductor casing and rat hole were filled with sand and gravel to 2 ft bgs. Cemented mud trough and rat hole to pad level with 43 ft^3 of cement slurry. Abandonment complete.
9/72	Site C	UAE-1	7,000 ft	Cut off the 9 5/8- and 13-3/8-in. O.D. casing to 1 ft bgs. Welded plate with hole marker on top of the 20-in. O.D. casing. Filled from ground level to minus 2 ft using 18-ft^3 sand-cement slurry. Abandonment complete
9/72	Site C	UA-1	6,150 ft	Cut 10 3/4-in. O.D. casing beneath the strongback and removed from top of the 9-in. I.D. casing. Concrete was removed from around the 92-in. casing to 1 ft bgs. Cut off 5-ft section of 92-in. casing to 1 ft bgs. Removed concrete from around the 54-in. I.D. casing to 1 ft bgs. Cut off 54-in. I.D. casing to 1 ft bgs. Removed from hole, cleaned out stemming sand. Cut cables below top of 54-in. casing. Cut off 10 3/4-in. O.D. casing to 1 ft bgs. Welded 1/2-in. plate to top of 92-in. I.D. casing. Poured cement cap from ground level minus 1 ft to pad level. Sand and cement slurry used - 81 ft^3. Poured 2-ft cement cap on 24-in. rat hole. Abandonment complete.
9/72	Site C	UA-1-DW	6,008 ft	Cut off plate on the 9 5/8-in.O.D. casing. Installed wood bridge plug at 10 ft inside the tubing with hook on top. Backfilled with cement from 2 ft bgs to ground level with cement and sand plug using 18 ft^3 of sand-cement slurry. Abandonment complete.

Table 1-2
Well Abandonment Details
(Page 2 of 5)

Date	Site	Well	Depth	Activity
9/72	Site C	UA-1-GH-1	101 ft	Backfilled with cement and sand slurry from ground level minus 1 in. using 9 ft^3. Abandonment complete.
9/72	Site B	UA-2-I-2	370 ft	Removed cement from 13 3/8-in. casing to 1 ft bgs. Welded steel plate with 4-in. by 5-ft marker to 13 3/8-in. casing. Cemented to surface with 5 ft^3 of sand-cement slurry. Abandonment complete.
9/72	Site B	UA-2	4,030 ft	Welded 1/2-in. plate over casing; placed rebar over plate. Chipped cement from pad level to minus 2 ft Cut off 13 3/8-in. casing at 2 ft bgs. Welded plate with 4-in. by 5-ft marker on 13 3/8-in. pipe. Cemented to ground level with 3 ft^3 of slurry. Poured cement and sand plug from top of 36-in. casing to pad level (130 ft); 90 ft^3 of slurry used on the top plug. Abandonment complete.
9/72	Long Shot Emplacement Hole			Cleaned up surface pad at Ground Zero. Removed cement from around 74-in. casing. Cut off casing 1 ft bgs. Removed cement from 74- to 54-in. casing 1 ft bgs. Abandonment complete.
9/72	Site C	UA-1-GH-2	100 ft	Backfilled with cement and sand slurry from ground level minus 1 ft using 9 ft^3 of slurry. Abandonment complete.
9/72	Site C	Small 6 5/8-ft Hole		(Hole used at RTP Pad for generator) From ground level to minus 3 ft with slurry. Abandonment complete.
9/72	Site C			Completely abandoned.
9/72	Site B	UA-2-I-1	6,500 ft	Poured cement plug from top marker plate. Welded 13 3/8-in. casing at ground level. 5 ft^3 of slurry used. Abandonment complete.
9/72	Long Shot Ground Zero			Cut off 54-in. casing 1 ft bgs. Removed all cement from 54 to 36 in. Cut off 36-in. casing 1 ft bgs. Welded 1/2-in. plate over all casing to 74-in. casing. Placed 5 pieces of 1 1/2-in. rebar extending over 74-in. plate covered with 2 ft cement. Abandonment complete.
9/72	Long Shot GZ	EH-1	1,606 ft	The name plate for this hole was welded to a 4-ft drill pipe marker at the side of Infantry Road. This location was in the middle of the road, and the casing was plugged with cement previously and cut off below the level of the road. Abandonment complete.
9/72	Long Shot GZ	EH-2	519 ft	Welded 4 in. by 5-ft marker plate and welded plate to 8 5/8 in. casing. Plugged with 20 ft^3 of cement. Abandonment complete.
9/72	Long Shot GZ	EH-3	2,801 ft	Excavated around 13 3/8-in. casing to 1 ft bgs, plugged with 6 ft^3 of cement. Abandonment complete.

Table 1-2
Well Abandonment Details
(Page 3 of 5)

Date	Site	Well	Depth	Activity
9/72	Long Shot GZ	EH-4	1,146 ft	Drained water from around location. Excavated around 13 3/8-in. casing, plugged with 4 ft^3 of cement. Abandonment complete.
9/72	Long Shot GZ	EH-5	2,607 ft	Cut casing off 1 ft bgs, also cut cables 1 ft bgs. Welded 1/2-in. plate with 4-in. by 5 ft-type marker to 13 3/8-in. casing, plugged with 20 ft^3 of cement. Abandonment complete.
9/72	Long Shot GZ	EH-6	Unknown	Drained water from around location. Excavated around 13 3/8-in. casing, plugged with 4 ft^3 of cement. Abandonment complete.
9/72	Long Shot		10 ft	Long Shot GZ - plugged with 81 ft^3 of cement. Abandonment complete.
5/73	Long Shot	OH-9	124 ft	10-ft cement plug; 0.857 ft^3 cement in hole. Welded 14 in. by 1/2 in. to each 13 3/8-in. casing. Cemented to 1 ft bgs. Abandonment complete.
5/73	Long Shot	OH-8	124 ft	10-ft cement plug; 0.857 ft^3 cement in hole. Welded 14 by 1/2 in. to each 13 3/8-in. casing. Cemented to 1 ft bgs. Abandonment complete.
5/73	Long Shot	OH-7	123 ft	10-ft cement plug; 0.857 ft^3 cement in hole. Welded 14 by 1/2 in. to each 13 3/8-in. casing. Cemented to 1 ft bgs. Abandonment complete.
5/73	Long Shot	OH-6	120 ft	10-ft cement plug; 0.857 ft^3 cement in hole. Welded 14 by 1/2 in. to each 13 3/8-in. casing. Cemented to 1 ft bgs. Abandonment complete.
5/73	Long Shot	OH-5	124 ft	10-ft cement plug; 0.857 ft^3 cement in hole. Welded 14 in. by 1/2 in. to each 13 3/8-in. casing. Cemented to 1 ft bgs. Abandonment complete.
5/73	Long Shot	OH-4	119 ft	10-ft cement plug; 0.857 ft^3 cement in hole. Welded 14 in. by 1/2 in. to each 13 3/8-in. casing. Cemented to 1 ft bgs. Abandonment complete.
5/73	Long Shot	OH-3	124 ft	10-ft cement plug; 0.857 ft^3 cement in hole. Welded 14 in. by 1/2 in. to each 13 3/8-in. casing. Cemented to 1 ft bgs. Abandonment complete.
5/73	Long Shot	UDH-8	123 ft	10-ft cement plug; 0.857 ft^3cement in hole. Welded 14 ft by 1/2 in. to each 13 3/8 in. casing. Cemented to 1 ft bgs. Abandonment complete.
5/73	Long Shot	UDH-2	525 ft	10-ft cement plug; 0.857 ft^3 cement in hole. Welded 14 in. by 1/2 in. to each 13 3/8-in. casing. Cemented to 1 ft bgs. Abandonment complete.

Table 1-2
Well Abandonment Details
(Page 4 of 5)

Date	Site	Well	Depth	Activity
5/73	Long Shot	Eff. Eval. Hole #1	700 ft	3.5 ft^3 cement in Eff. Eval. Hole #1. Welded 14 in. by 1/2 in. to each 13 3/8-in. casing. Cemented to 1 ft bgs. Abandonment complete.
7/01	Milrow	W-2	1.0 ft	Shallow well pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-3	3.7 ft	Shallow well pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-4	<10 ft	Shallow well pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-5	3.0 ft	Shallow well pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-6	3.5 ft	Shallow well pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-7	2.4 ft	Shallow well pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-8	5.1 ft	Shallow well pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-9	<10 ft	Shallow well (<10 ft) pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-10	6.7 ft	Not found under water.
7/01	Milrow	W-11	4.8 ft	Shallow well (<10 ft) pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-12	<10 ft	Shallow well (<10 ft) pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-13	3.4 ft	Not found under water.
7/01	Milrow	W-14	<10 ft	Shallow well (<10 ft) pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.

Table 1-2
Well Abandonment Details
(Page 5 of 5)

Date	Site	Well	Depth	Activity
7/01	Milrow	W-15	3.7 ft	Not found under water
7/01	Milrow	W-16	<10 ft	Shallow well (<10 ft) pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-17	<10 ft	Shallow well (<10 ft) pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Milrow	W-18	1.8 ft	Not found under water
7/01	Milrow	W-19	3.0 ft	Shallow well (<10 ft) pulled out of ground; hole filled w/ sodium bentonite chips; remaining casing in ground filled w/ bentonite chips. Abandonment complete.
7/01	Long Shot	WL-1	8.2 ft	Removed PVC well casing and fill with bentonite. Abandonment complete.
7/01	Long Shot	WL-2	11.5 ft	Removed PVC well casing and fill with bentonite. Abandonment complete.
7/01	Long Shot	GZ-1	100 ft	Protective cover and lock
7/01	Long Shot	GZ-2	50 ft	Protective cover and lock
7/01	Long Shot	EPA-1	253 ft	Well casing was deteriorated beyond plugging
7/01	Cannikin	HTH-3	152 ft	Well casing was deteriorated beyond plugging

Three underground nuclear tests were conducted on Amchitka Island in 1965, 1969, and 1971. These tests were respectively designated Long Shot, Milrow, and Cannikin. Long Shot was detonated at a depth of 2,297 feet (ft) and had an 80-kiloton yield (DOE, 1988). It was detonated shortly after a nearby 8.7 magnitude earthquake as part of the Vela Uniform project to determine whether monitoring techniques could differentiate between natural seismicity and nuclear explosions. After a screening process conducted subsequent to Long Shot, Amchitka Island was selected as one of the Supplemental Test Sites (the other was in Central Nevada) for testing higher yield underground nuclear explosives that could not be tested at the Nevada Test Site (NTS) due to the impact of ground motion on high-rise buildings in Las Vegas. Milrow was a seismic calibration test detonated at a depth of 4,003 ft, with about a 1 megaton yield. Cannikin was detonated at a depth of 5,873 ft, with a yield of less than 5 megatons. In addition to these three tests, drilling was performed at three other sites (D, E, and F) where nuclear testing was considered but not performed. The locations of all six sites are indicated on Figure 1-2.

The tests, conducted at depths ranging from 2,300 to 5,875 ft below ground surface (bgs), created a subsurface cavity around the center of each detonation and a chimney of fragmented and collapsed rock above. The cavities and chimneys contain radioactive by-products of the nuclear detonations, some of which were trapped in fused rock created when rock melted by the detonations cooled and hardened.

1.1.3 Current and Future Use

Amchitka is part of the Aleutian Islands Unit of the Alaska Maritime National Wildlife Refuge (AMNWR), which is administered by the U.S. Fish and Wildlife Service (USFWS). The island will remain under the jurisdiction of the USFWS for the foreseeable future and is currently uninhabited. The island, which is accessible by air and ship, is not currently used for commercial or active military purposes. Fishermen and other mariners infrequently visit the island for recreational purposes. The Alaska Volcano Observatory recently installed an automated communications station on Amchitka to relay data from seismic monitoring equipment located on several neighboring islands. The Corps of Engineers is planning for site visits within the next 5 years to locate and remove unexploded ordnance. Foreseeable future land uses include limited on-site activities by USFWS and research partners in support of the refuge's wildlife conservation and wilderness purposes. Limited visits by recreational and subsistence users are anticipated to continue. The original establishing order that provided for military purposes will remain in effect. The DoD retains the right to use the island, if determined necessary, for national defense purposes.

1.2 Physical Environment

The island's coastline is very rugged with sea cliffs, isolated sandy and gravel beaches, and grassy slopes. The lowest elevations are on the eastern third of the island and are characterized by isolated, shallow ponds and heavily vegetated drainages. The central portion of the island has higher elevations, is more prone to wind erosion, and has fewer lakes. The westernmost three miles of the island are barren. The area contains a windswept rocky plateau with sparse vegetation, except for those areas (e.g., stream drainages) protected from the wind. The average surface elevation at the western end of the island is approximately 800 ft. The highest elevation on the island is approximately 1,600 ft.

1.2.1 Climate

Amchitka Island is characterized by a pronounced maritime climate, including frequent storms, strong winds, and often-cloudy skies. There is no prevailing wind direction, although during the summer months the winds are generally out of the southwest. The mean wind speed between December and February is 30 miles per hour (mph); between March and May it is 26 mph; between June and August it is 22 mph; and between September and November it is 27 mph. The maximum-recorded wind velocity on Amchitka is 115 mph. The ocean moderates temperatures, which average 31 degrees Fahrenheit (°F) in winter (January) and 48°F in summer (August). Annual precipitation is about 33 inches (in.), including approximately 71 in. of snow.

1.2.2 Geology

Amchitka Island apparently formed in early Tertiary time (roughly 50 million years ago) as a result of tectonic uplift and deposition of volcanic flow and marine sediments collectively known as the Amchitka Formation. Amchitka is located in the Aleutian arc, a 3500-km long chain of volcanoes produced by subduction (one plate is thrust beneath another) of the Pacific plate beneath the North American plate. The Pacific plate thrusts underneath the North American plate at a rate that varies from 6-8 centimeters per year (cm/year), with the rate increasing to the west, and the direction of plate convergence becoming more oblique to the Aleutian trench in the west. Tectonic activity can impact subsurface fluid flow directly through slip on local faults, or indirectly through strong shaking or changes in the stress field resulting from strong earthquakes nearby.

A combination of geological evidence, submarine mapping, and new site velocities measured with the Global Positioning System (GPS) suggests that Amchitka Pass, immediately to the east of Amchitka island, is a site of concentrated extension, and that west of Amchitka Pass there are major strike-slip faults located within or north of the arc (Freymueller et al., 2002). The GPS data show that the most reasonable model would have fault slip rates on the order of 2 cm/year on extensional faults within Amchitka Pass and strike-slip faults to the north of Amchitka. For comparison, this rate is about 1/2 to 2/3 as fast as the San Andreas Fault system in California, and one to two orders of magnitude more rapid than the slip rates on faults within or near the Nevada Test Site or the proposed Yucca Mountain storage facility.

Most of the island contains only a thin, discontinuous veneer of unconsolidated sediments overlying the volcanic bedrock. Over most of the island, organic soils, including peat, overlie the unconsolidated sediments. The principal organic soil on the island blankets much of the poorly drained areas, marine terraces and other topographically low areas, and contains constituent plant materials that have decomposed and often contain horizons of peat. In the most topographically depressed and wettest parts of the island, the soils are typically peaty, with a thick mat of vegetation and little organic decomposition. In the drier and topographically higher areas, the soils are folists (well-drained organic soil). Limited areas of poorly developed sandy soils exist in dune areas in a narrow strip along the Bering Sea coastal bluffs.

1.2.3 Hydrology

Amchitka Island is covered with hundreds of small, shallow ponds up to 330 ft wide and up to 10 ft deep. The smaller ponds are considerably shallower, typically ranging from 12 to 20 in. deep. Ponds are most numerous on the eastern two-thirds of the island (approximately 26 ponds per mi^2), where they have developed above marine terraces and are confined by thick vegetation peat. Many lakes in this region lack a definite inlet or outlet. Fewer ponds are present on the western third of the island, where they typically occupy bedrock depressions. Larger pond sediments are either floc (suspension of low-density detrital organic material) over gravel, organic silts over gravel, or clean gravel. The bottoms of smaller ponds are usually composed of peat or fine sediment covered with floc.

Watersheds on Amchitka Island are generally limited to 1 to 3 mi in length because all streams drain perpendicular to the long axis of the island into either the Bering Sea or the Pacific Ocean. Streams on the eastern part of the island flow slowly through tundra-covered watersheds, range from 3 to 10 ft wide, are up to 12 in. deep, and are characterized by low gradients and flow velocities. Streams in the central and western regions range from 6 to 13 ft wide and are up to 14 in. deep. Most of the streams in the island flow year-round. During relatively dry periods, stream flows are sustained by baseflow from soils and the underlying weathered bedrock; surface runoff and baseflow contribute to flows during wet periods.

The hydrogeology beneath the surface of Amchitka Island is governed by the dynamics of the saltwater intrusion typical of islands. The groundwater system consists of a freshwater lens floating on seawater. To sustain this lens, there must be active groundwater circulation. Rainfall that infiltrates is fresher, and less dense, than the underlying seawater. Continued recharge results in the buildup of a lens of fresh water floating above the seawater, and the flow of freshwater from the center of the island outward to the ocean. Groundwater flow is generally characterized by recharge along a shallow water table, downward flow in the interior of the island, and upward flow approaching the coast, with freshwater discharge in seeps along the sea floor. The nearly saturated subsurface conditions, combined with low hydraulic conductivity and high rainfall, leads to significant runoff and the development of shallow groundwater zones that rapidly discharge water in springs and seeps rather than allowing deep infiltration.

Data collected from shallow and deep boreholes on the island are consistent with this conceptual model of flow. Seven wells with depths of hundreds to over a thousand meters below land surface were drilled and tested in the 1960s and 1970s, as well as numerous shallow wells. These wells encountered fresh water at shallow depths and increasing salinity at greater depth (Beetem et al., 1971; U.S. Army Corps of Engineers and USGS, 1965). Static water levels declined in the wells with increasing depth below land surface (Ballance, 1970a,b, 1972a,b, and 1973a,b; Dudley, et al., 1977), indicating the potential for downward directed groundwater flow. Seventy four hydraulic tests were run in discrete intervals in the deep wells (Ballance, 1970a,b, 1972a,b, and 1973a,b; Ballance and

Dinwiddie, 1972; U.S. Army Corps of Engineers and USGS, 1965); analysis of these tests (Hassan et al., 2002) is notable for a wide range of variability and overall relatively low values. Measurements of precipitation and stream gages noted a close relationship between surface water and shallow groundwater systems (Dudley et al., 1977; Gonzalez, 1977). Many of these data are presented and discussed in Hassan et al. (2002) and are also summarized by Dudley et al. (1977).

The water in streams, lakes, and springs on Amchitka Island is generally of excellent quality. However, the chemical character of surface water on the island is quite varied. The surface water generally has less than 200 milligrams per liter total dissolved solids, with sodium and chloride as the dominant cation and anion, respectively.

1.3 Previous Investigations

Amchitka Island has been the subject of many studies throughout its history. During the 1960s and 1970s, both before and after the underground nuclear tests were conducted, scientists carried out extensive investigations of the environment on Amchitka Island. Data collected from these investigations include information on the geology, hydrology, climate, geomorphology, and the land and marine biota of the island as well as information on environmental contaminants and the effects of nuclear testing. Table 1-3 provides selected references to island-wide investigations and individual studies. Some of these studies and investigations are summarized and discussed in the following sections.

1.3.1 The Environment of Amchitka Island (Merritt and Fuller, 1977)

The Amchitka Bioenvironmental Program was developed in support of the Amchitka Island underground nuclear tests, specifically the Milrow and Cannikin sites. The objectives of the program were to conduct appropriate field and laboratory studies to predict, evaluate, and document the effects on the bioenvironment of Amchitka Island that might result from the nuclear tests and to recommend measures for minimizing these effects. The program began in 1967, after the Long Shot test but before the Milrow test in 1969. It concluded in 1973, following completion of the Cannikin test.

The studies conducted under this program included climate, geology, hydrology, and biota. The Merritt and Fuller report presents a summary of these studies in a series of individual papers within the report, which are grouped into major sections on the land, the sea, marine mammals, and environmental contaminants. The report also includes a summary of the island setting (geographic, geologic, hydrologic, weather and climate, prehistoric human occupation, and previous scientific investigations) and a paper summarizing the observed and measured effects of the nuclear tests on the island.

The following sections present summaries of the major studies conducted as part of the Bioenvironmental Program.

Ecological Consequences of Nuclear Testing (Fuller and Kirkwood, 1977)

The detonations at Milrow and Cannikin and related activities resulted in the loss of or damage to terrestrial habitat totaling approximately 1.5 percent of the total area of Amchitka Island. A number of lakes and streams were temporarily affected by site activities but recovered quickly. Several freshwater areas of the island were irreversibly impacted, however, including channel alteration along one stream and the creation of a new lake. An intertidal bench was displaced to a level above the intertidal zone.

Localized terrestrial, freshwater, and marine ecosystem habitat losses were minor and had no permanent effects on the associated biotic populations. No plant or animal population on or around the island was lost or endangered, although substantial numbers of sea otters and freshwater and marine fish were killed by the Cannikin detonation. However, post-test studies indicated that these populations recovered quickly.

The detonations also produced scattered terrain disturbances around the island, some of which were severe in localized areas. In these instances, the landscape was visibly altered, and may remain so for decades or even centuries.

Radionuclides in Air, Water, and Biota (Seymour and Nelson, 1977)

Air, water, and biological samples were collected before and after the three underground nuclear detonations at Amchitka Island and were analyzed for natural and fallout radionuclides by gamma spectrometry. Select samples were also analyzed for tritium, iron-55, and strontium (Sr)-90. The primary objective of this study was to identify the origin of the fallout radionuclides (i.e., the Amchitka Island detonations versus natural background and/or other sources).

Samples from 81 types of organisms were collected and analyzed for radionuclides potentially available to man through the food web from areas likely to be contaminated if seepage of radionuclides from the detonation sites occurred. The studies showed that there was no escape of radionuclides from the detonation sites except for trace amounts of radionuclides, primarily tritium, in water and soil gas samples from the immediate vicinity of the SGZ for the Long Shot test (see Section 1.3.2). In general, radionuclide values for Amchitka Island samples were similar to those from comparable samples from other geographical areas.

Marine Fish Communities (Simenstad et al., 1977)

The Fisheries Research Institute of the University of Washington studied and evaluated the impact of the Milrow and Cannikin tests on marine fish off Amchitka Island from the summer of 1967 to the fall of 1973. Information was collected on 92 fish species taken from marine waters around Amchitka Island, not only providing information to support the nuclear testing efforts, but also significantly expanding the knowledge of the Aleutian marine fish communities.

The pressure pulses and shock waves resulting from the nuclear detonations, particularly Cannikin, killed large numbers of several species of fish in offshore waters and changed marine habitat through uplifting of some rock benches. The effects were short term, however, with no detectable effects on the fish populations observed within a year after the Cannikin detonation. Because the total area of marine habitat affected by the tests was a small fraction of the total habitat around the island, the overall effect of the tests on the Amchitka Island marine ecosystem was considered temporary and insignificant.

Aquatic Ecology (Valdez et al., 1977)

The freshwater ponds and streams on Amchitka Island support few species of vertebrates and invertebrates. However, these waters do support six species of freshwater fish, including pink and silver salmon, which use the streams for spawning.

The Milrow and Cannikin detonations significantly affected ponds and streams within about 2 kilometers (km) of SGZ at each site. Ponds were drained by fissuring or tilting, and stream channels were altered. Local fish populations were adversely impacted by terrain alterations and pressure waves generated by the detonations. Habitat alterations were not permanent. Fish populations fully recovered within five years of each test.

Preparations for the nuclear tests also had deleterious effects on the freshwater vertebrates and invertebrates. Drilling mud released and/or spilled into streams and ponds smothered the macroinvertebrates, which in turn depressed fish populations because of the absence of food organisms. The populations have recovered, and there are no known lasting impacts from the mud.

Avifaunal Investigations (White et al., 1977)

Bird populations on and near Amchitka Island were studied between 1967 and 1973 to determine species composition, ecological distribution, density, productivity, and seasonal movements. A total of 131 species were recorded, and evidence of breeding for 28 species was obtained.

The investigators predicted that the impacts of the Milrow and Cannikin nuclear testing could include habitat and nest-site destruction, destruction of birds, and accidental release of radionuclides. These predictions led to two recommendations regarding conduct of the tests. The first recommendation was to not conduct the tests during the height of the breeding season, when the greatest number of birds would be affected. The second was to conduct the tests during the winter months (November to February) to eliminate possible radionuclide transport by fall migrants and birds resident on Amchitka during the summer.

No actual direct effects of the Milrow test were detected in any bird populations. The immediate, actual results of the Cannikin test, however, were 15 test-related bird deaths, the loss of two peregrine falcon eyries that involved only one pair of falcons, additional damage to a falcon eyrie originally damaged by Milrow, the loss of six bald eagle nests, and damage to one eagle nest. The long-term effects of the tests could not be assessed at the time of the study, but a baseline of data was established for future studies.

1.3.2 Tritium Sampling

Tritium activity has been monitored in surface water and shallow groundwater on Amchitka Island from 1965 to the present under various programs (see Section 1.3.) Following the Long Shot detonation, anomalous concentrations of tritium were found in the vicinity of SGZ 27 days after the original test (Castagnola, 1969). The main activity front of radioactive gases reached the surface roughly six months or more after the Long Shot detonation. At least three and one-half years after the Long Shot test, anomalous concentrations of tritium in water existed in several surface waters in the vicinity of Long Shot SGZ, reaching a maximum observed concentration of about 5,000 tritium units (approximately 16,000 picocuries per liter [pCi/L]) in September 1966.

The drinking water standard for tritium is 20,000 pCi/L. Tritium levels in some of the groundwater and surface water samples collected by the U.S. Environmental Protection Agency (EPA) in 1997 (Faller and Farmer, 1998) remain above background levels but well below the current safe drinking water levels. At locations around the SGZ, tritium concentrations continue to decrease faster than would be expected from tritium decay alone, indicating that dilution is also an important factor. Dasher et al. (2000) noted that tritium measurements taken since the Long Shot detonation indicate that radioactive gases escaped to the near surface shortly after the detonation but do not indicate long-term movement from the contaminated groundwater to the Long Shot SGZ surface environment.

In addition to the fact that tritium concentrations are declining faster than the rate of decay alone, hydrologic measurements at Amchitka indicate a downward flow for recharge water to a freshwater/saline water zone where movement occurs laterally. With the exception of a brief pathway from Long Shot immediately after the test that has since been flushed out, the results of hydrological tests indicate that there is no complete exposure pathway from the subsurface radionuclide source areas beneath the island to the shallow groundwater beneath or to surface water on the island (Claassen, 1978; Fenske, 1972a; Wheatcraft, 1995).

1.3.3 Investigation of Radionuclides in Amchitka Island, Alaska Ecosystems (Dasher et al., 2004)

In 1996, the Greenpeace organization reported that radionuclides associated with the three Amchitka Island underground nuclear test sites were leaking into the surface environments on the island. This report was based on limited sampling and analysis of selected biota on the island. In response to this report, radioecological studies of Amchitka freshwater and marine environments were conducted in 1997 and 1998 under the auspices of the Amchitka Technical Advisory Group, which consisted of representatives from the Alaska Department of Environmental Conservation, the DOE, the EPA, the

USFWS, University of Alaska-Fairbanks, Aleutian/Pribilof Islands Association, Inc. (APIA), and other stakeholders.

Sampling transects of varying lengths were established on stream courses in four drainages, three associated with the underground test sites and a single reference location 8 km upgradient from each major test location. Four biota sampling sites were designated within each stream transect, and representative plant and sediment samples were collected at each. Marine transects for sampling marine algae were located at the outfalls of the streams. Sediment samples were obtained at each sampling location. In 1998, the same four stream drainages were resampled as well as four additional drainages on Amchitka. Three new stream transects on nearby Adak Island and at Cold Bay on the Alaska Peninsula were also added to the 1998 survey. In addition, 76 upland soil cores (100 square centimeters) and 34 lichen samples (0.25 square meters) were collected at 11 locations on Amchitka and at three sites each on Adak Island and at Cold Bay. All samples were analyzed for gamma- and alpha-emitters by conventional radioanalytical methods at three different laboratories. In addition, plutonium (Pu)-240 and Pu-239 ratios were determined by thermal ionization mass spectrometry, and low-level tritium enrichment analyses were performed on selected surface water and precipitation samples.

Analytical results were comparable between the 1997 and 1998 surveys and the various laboratories, and concluded that worldwide fallout was the major source of radionuclides in surface environments of Amchitka Island. No indications were found suggesting “leakage” of radionuclides from the deep underground test cavity sources to the surface environment.

1.3.4 Long-Term Hydrologic Monitoring Program

A long-term hydrologic monitoring network was established on Amchitka Island in 1967 to document the effect of the underground nuclear testing on the island LTHM ceased in 2001 and the wells were either plugged or abandoned. Before 1972, ground and surface water sampling at the NTS and off-site areas, including Amchitka Island, was conducted by the U.S. Public Health Service, the U.S. Geological Survey, the AEC, and various contractor organizations. In 1972, all of the water sampling programs were combined under the Long-Term Hydrologic Monitoring Program, which is funded by NNSA/NSO and operated by the EPA Radiation and Indoor Environments National Laboratory in Las Vegas.

Previous monitoring at Amchitka Island consisted of sampling and analyzing surface and groundwater samples on a biannual basis during odd years from the Long Shot, Milrow, and Cannikin test sites and from other locations on the island designated as background. (Sampling was not conducted in 1995, however, due to budget restrictions.) See Table 1-3 for a list of groundwater wells and the sampling depths for each. Tritium and gamma-spectral analyses were routinely performed, and new water sources were also initially analyzed for Sr-89 and Sr-90, radium-226, Pu-238 and Pu-239, and uranium isotopes. Sampling required approximately two weeks per year, and about 40 samples were analyzed per year.

Table 1-3
Groundwater Wells and Sampling Depths
(Page 1 of 2)

Site	Well	Depth	Sample Depth
Milrow	W-2	1.0 ft	1.0 ft
Milrow	W-3	3.7 ft	3.0 ft
Milrow	W-4	<10 ft	2.5 ft
Milrow	W-5	3.0 ft	2.8 ft
Milrow	W-6	3.5 ft	3.1 ft
Milrow	W-7	2.4 ft	2.4 ft
Milrow	W-8	5.1 ft	5.1 ft
Milrow	W-9	<10 ft	<10 ft
Milrow	W-10	6.7 ft	6.0 ft
Milrow	W-11	4.8 ft	4.0 ft
Milrow	W-12	<10 ft	<10 ft
Milrow	W-13	3.4 ft	3.4 ft
Milrow	W-14	<10 ft	<10 ft
Milrow	W-15	3.7 ft	3.0 ft
Milrow	W-16	<10 ft	<10 ft
Milrow	W-17	<10 ft	<10 ft
Milrow	W-18	1.7 ft	1.7 ft
Milrow	W-19	3.0 ft	3.0 ft
Long Shot	WL-1	8.2 ft	5.5 ft
Long Shot	WL-2	11.5 ft	10.0 ft

Table 1-3
Groundwater Wells and Sampling Depths
(Page 2 of 2)

Site	Well	Depth	Sample Depth
Long Shot	GZ-1	100.0 ft	90.0 ft
Long Shot	GZ-2	50.0 ft	40.0 ft
Long Shot	EPA-1	25.5 ft	20.5 ft
Cannikin	HTH-3	152 ft	140 ft

Since long-term hydrologic monitoring commenced on Amchitka, no significant concentrations of radionuclides attributable to the three underground test sites have been observed, with the exception of tritium from the Long Shot site (see Section 1.3.2). Concentrations of tritium at Long Shot have been steadily declining, however, and are below the safe drinking water standard. Monitoring under the Long-Term Hydrologic Monitoring Program last occurred in 2001.

1.3.5 Groundwater Modeling

The purpose of the 2002 groundwater modeling effort (NNSA/NV, 2002) was to provide information needed to conduct a human-health risk assessment of the potential hazard posed by the three underground nuclear tests on Amchitka Island. The modeling focused on subsurface transport of radionuclides released from the underground detonation cavities and their movement through the groundwater system to the point they seep out of the ocean floor into the marine environment.

Conceptual models for flow and transport for the tests were developed. A multiparameter uncertainty analysis was performed to address uncertainty in the supporting data, and separate sensitivity analyses were evaluated for specific conceptual uncertainties. The final modeling assumes that groundwater moves predominantly through fractures in the rock and considers multiple realizations of the flow field by drawing values of hydraulic conductivity, recharge, and porosity from their distributions. An additional separate sensitivity case was also presented addressing uncertainty in the matrix diffusion process.

The final model calibrations depict a deeper transition zone on the Bering Sea side of the island, as compared to the Pacific side. Transport results indicate that radionuclide movement at Long Shot is much faster than at Milrow and Cannikin. This faster rate is due to the location of the Long Shot cavity being shallow as compared to the other two tests. Long Shot is above the transition zone in all realizations, whereas Milrow and Cannikin tend to be within or below the transition zone. Below the transition zone, the flowpath toward the seafloor is lengthened and groundwater velocities are much slower. The arrival time of the peaks of mass flux and concentration for tritium was on the order of 20 to 30 years for Long Shot and 100 to 125 years for Milrow and Cannikin. This led to higher mass fluxes and concentrations breaking through at Long Shot than at Cannikin or Milrow, particularly due to the process of radioactive decay reducing mass as time proceeds.

The groundwater model results included a mean (expected) value and a standard deviation (measure of uncertainty). The standard deviation was large as a result of uncertainties in exact parameter values and their variability in the subsurface. The most significant uncertain parameter was found to be the porosity assigned to the fracture system. Uncertainty in the transition zone location also led to large variation in transport results from one realization to the next. The Consortium for Risk Evaluation with Stakeholder Participation (CRESP) independent science study (see Section 2.2 summary) provided new data regarding both porosity and the location of the transition zone. These data, along with new bathymetric profiles, were used to verify the Amchitka groundwater models, revise and update the model parameter distributions, and reduce uncertainty in the model results (CRESP, 2005).

Through a series of analyses, it was found that the new data provided by CRESP were consistent with the conceptual framework and range of parameter values used in the 2002 groundwater flow and transport model. The 2002 model was verified through a number of components. First, the high-resolution bathymetric data obtained by CRESP (2005) closely matched the profiles used in the models. Second, the posterior distributions for recharge, hydraulic conductivity, and their ratio (all constrained by the transition zone location information from CRESP), are encompassed within the original prior distributions used in the 2002 model, verifying that the original distributions were wide enough to include the new data. Third, the updated flow solution results in an ensemble mean matching the head and chemistry data within +/- one standard deviation of the original models. When the new data provided better control on parameter ranges, the wide uncertain range was trimmed from both sides, resulting in a new set of possible solutions encompassed within the original set of possible solutions. Though the CRESP data indicate a deeper transition zone at Milrow than indicated by site chemistry data, the possibility of a deeper transition zone was accounted for in the 2002 model by the wide range of recharge and hydraulic conductivity considered.

After updating the models with the new CRESP data, the resulting groundwater fluxes had the same distribution as the original model. A dramatic reduction in uncertainty was achieved by conditioning on all available data sets. The parameter distributions cover a much narrower range than originally used in the 2002 model. Using the new porosity profiles from CRESP (2005) results in very slow flow velocities, orders of magnitude slower than the velocities produced by the 2002 model. With the new porosities, radionuclides require thousands of years to reach the seafloor. No breakthrough resulted for any of the three sites within the 2000-year model timeframe in the updated model, despite ignoring all retardation mechanisms (sorption, radionuclide trapping in glass, matrix diffusion, and radioactive decay). In the 2002 model, the standard deviation of mass flux was larger than the mean, implying that the lower limit for radionuclide mass flux was essentially zero. This value is now indicated by the CRESP data, and was included in the possibilities presented by Hassan et al. (2002).

1.4 Regulations

Neither Amchitka Island nor the three test sites on the island are listed on the National Priorities List, and they are not subject to the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) or the *Resource Conservation and Recovery Act*. Because they are not CERCLA sites, CERCLA regulations do not directly apply. However, these regulations are being used as guidance during the completion of these sites.

It is DOE’s objective to conduct its completion activities at Amchitka Island so that radiation exposures to members of the public are maintained within the limits established by the DOE Order 5400.5, “Radiation Protection of the Public and the Environment” (DOE, 1993), and to control radioactive contamination through the management of real and personal property. It is also DOE’s objective to protect the environment from radioactive contamination to the extent practicable.

2.0 Site Completion Justification

Numerous investigations have been conducted on Amchitka Island to document the existing island environment as well as to assess the impact of the underground nuclear tests to environments on and surrounding the island. These investigations are listed in Table 1-3 of this report, and certain of these investigations are discussed in detail within Section 1.3. These investigations, in particular the 2002 groundwater modeling and the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) study, indicate that there is no complete exposure pathway from the subsurface radionuclide source areas beneath the island to the shallow groundwater beneath or to surface water on the island and provide the basis for completion of the Amchitka site surface cleanup. A conceptual model of flow and transport for Amchitka Island has been developed based on the results of these investigations and is shown in Figure 2-1.

2.1 Groundwater Modeling

The purpose of the 2002 groundwater modeling effort (NNSA/NV, 2002), as described in detail in Section 1.3.5 of this report, was to provide information needed to assess the potential hazard posed by the three underground nuclear tests on Amchitka Island. The modeling focused on subsurface transport of radionuclides released from the underground detonation cavities and their movement through the groundwater system to the point they seep out of the ocean floor into the marine environment. The results of the modeling indicate that it takes thousands of years for radionuclides to reach the seafloor, and no breakthrough of radionuclides is estimated for any of the three sites within the 2000-year model timeframe.

2.2 Independent Science Study

The CRESP study was an independent scientific investigation of the hazards associated with the subsurface nuclear testing performed on Amchitka Island. The investigation was intended to address concerns from stakeholders regarding possible human health and ecological effects of this testing, and to provide current and relevant data to help DOE move toward long-term surveillance and maintenance of the site.

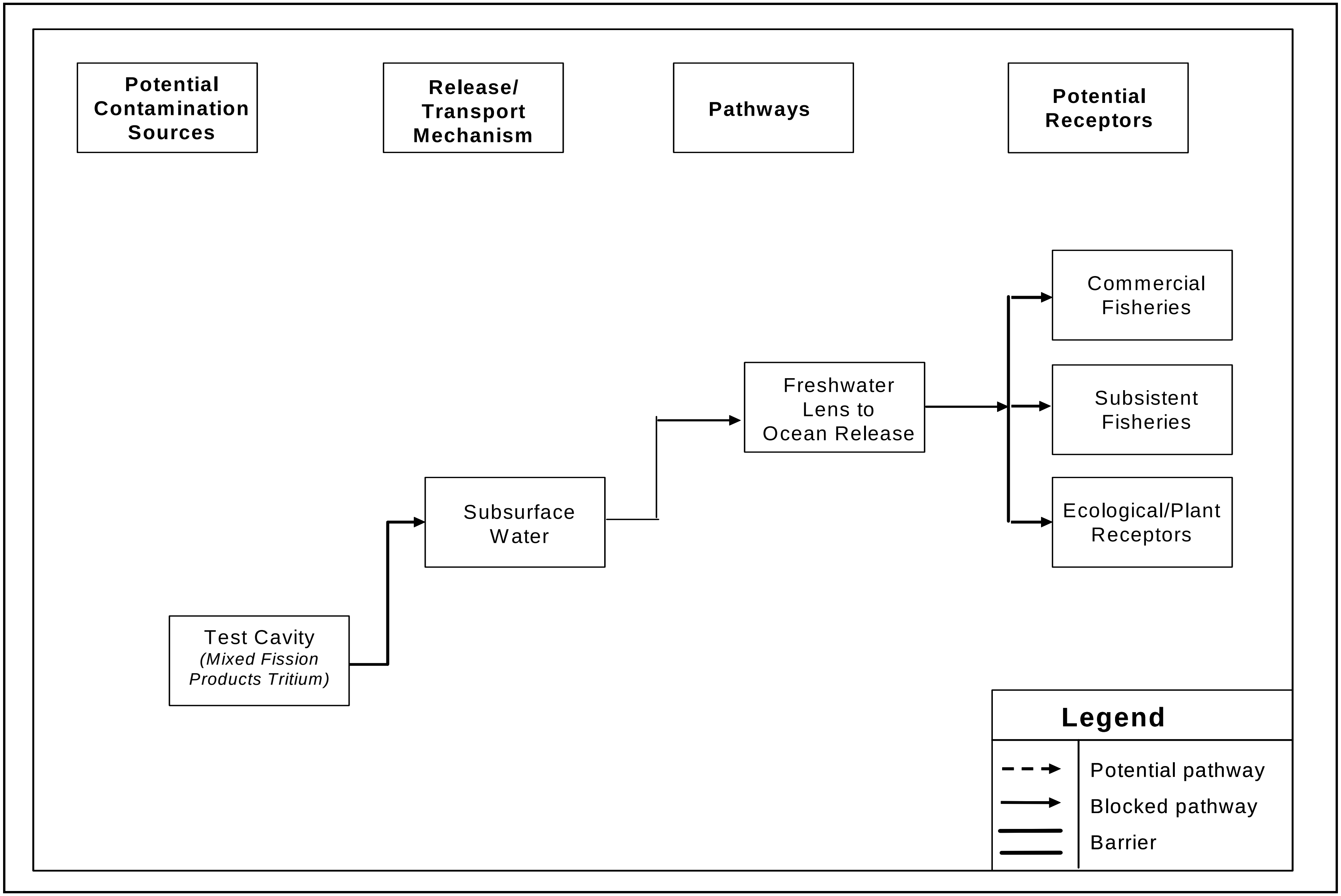

Figure 2-1
Conceptual Model

The results of the CRESP study were released in the *Final Report of the Consortium for Risk Evaluation with Stakeholder Participation, Amchitka Independent Science Assessment: Biological and Geophysical Aspects of Potential Radionuclide Exposure in the Amchitka Marine Environment,* (CRESP, 2005).

Some of the conclusions from the CRESP studies are:

- None of the marine organisms tested had radiation levels that would pose a threat to humans, and all results are well below published human health food safety standards and guidelines.

- The levels of radionuclides measured in biota are within the range found in biota from other marine environments in the Northern Hemisphere and are far below levels found in known contaminated marine areas, such as the Irish Sea. They are also below any levels known to impact organisms or ecosystems.

- The levels of europium-152, cobalt-60, Sr-90, iodine-129, and technetium-99 were all or almost all below the minimum detection activity (MDA) levels, which, in turn, were 10 times or more lower than food safety standards and guidelines. Several organisms had accumulated americium-241 to just above the MDA, but there was no pattern with respect to species, trophic level, or island. Cesium (Cs)-137, plutonium, and uranium isotopes were found more widespread.

- For most radionuclides, there were no significant differences between Amchitka and Kiska (the reference site) in either the number of values above the MDAs or in the average concentrations.

- There were differences among species in the levels of some radionuclides: high trophic level predators had higher Cs-137 levels than others lower on the food chain, and primary producers (algae) had significantly higher levels of Pu-239 and Pu-240 than all others. These findings are consistent with the findings in other scientific studies in that they indicate that fish bioaccumulate cesium from the food chain and algae takes up Pu at a rate many times higher than do other biota.

- Substantial localized discharge of freshwater through the ocean floor within the study area was not indicated based on ocean floor salinity measurements. Thus, no specific preferential pathway (i.e., large freshwater flow through geologic faults) for contaminant migration along with fresh groundwater from the tests was found.

- Geophysical investigations indicate that all three tests were within the transition zone between fresh and salt groundwater, and that greater subsurface pore volume was present than assumed by earlier studies, suggesting very long travel times for any contaminant migration from the tests to the marine environment.

- The CRESP expedition did not find either geophysical or biological evidence of recent or current radionuclide migration into the marine environment from the Amchitka nuclear tests. The nature and spatial pattern of detectable radionuclides, do not suggest that they are attributable to the Amchitka nuclear tests.

As stated in the executive summary from the final report: "Overall, our geophysical and biological analyses did not find evidence of risk from radionuclides from the consumption of marine foods, nor indication of any current radionuclide contaminated migration into the marine environment from the Amchitka nuclear tests. Our data are useful in reducing the uncertainties in the groundwater models and risk assessments, to indicate that there are species at multiple trophic levels that would be at risk if there were contaminated seepage from the tests, and to provide insights for selecting bioindicators for a monitoring plan for the future and a baseline useful for comparison in any future biomonitoring." (CRESP, 2005).

3.0 Completion Recommendation and Strategy

As discussed previously, monitoring, modeling and assessment of radionuclide transport from the test cavities to the surface and marine environments of Amchitka Island have found no current seepage into these areas. Additionally, biomonitoring results indicate very low levels of radionuclides in some marine organisms, levels significantly below any health concern and at similar levels found in other marine environments where no known releases or sources of radionuclides exist. Although radionuclides remain in the deep subsurface of the island environment, there is no complete pathway from the subsurface to surface environment, and no technically feasible method exists to contain or remove them. Based on these study results, in particular those of the groundwater modeling and the CRESP study, a recommendation of No Further Remedial Action Planned with Long-Term Surveillance and Maintenance is made for the Amchitka Site.

3.1 Recommendations

3.1.1 Recommended Alternative

The recommended remedy for the Amchitka Site is No Further Remedial Action Planned with Long-Term Surveillance and Maintenance.

3.2 Institutional Controls

There are several institutional controls currently implemented at Amchitka Island with the intent to protect human health and the environment from surface and subsurface areas:

- The Amchitka Site is located in a designated wilderness portion of the AMNWR under the jurisdiction of the USFWS. Administrative control is achieved by limiting the land use to recreation, use as a wildlife refuge, and subsistence use by local native inhabitants. The DoD retains the right to use the island, if determined necessary, for national defense purposes.

- The USFWS is the landowner and maintains all mineral rights for the island.

- A bronze plaque was mounted onto a concrete monument and placed at SGZ for each of the three events. Each plaque explained the event and restrictions that apply to the nearby area. The event description plaque at Milrow is missing, but the restrictions plaque is still intact. A steel "hole-marker" post with a nameplate, extending about 4 ft above the land surface, was installed at each of the plugged holes. The restrictions on the plaques, mounted onto the concrete monuments at each event site, read as follows:

<u>Long Shot</u>:

"No excavation, drilling, and/or removal of materials is permitted, without U.S. Government approval, between ground surface and 914 meters (3,000 feet) below mean sea level and out to a horizontal distance of 305 meters (1,000 feet) from GZ"

<u>Milrow</u>:

"No excavation, drilling, and/or removal of materials is permitted, without U.S. Government approval, between ground surface and 1,524 meters (5,000 feet) below mean sea level and out to a horizontal distance of 305 meters (1,000 feet) from GZ"

<u>Cannikin</u>:

"No excavation, drilling, and/or removal of materials is permitted, without U.S. Government approval, between ground surface and 1,890 meters (6,200 feet) below mean sea level and out to a horizontal distance of 914 meters (3,000 feet) from GZ"

Additional institutional controls restricting subsurface activities may be established under the LTSMP in coordination with the landowner and stakeholders.

3.3 Long-Term Surveillance and Maintenance

With the planned completion of the Amchitka Site characterization and implementation of the chosen remedial action, the Amchitka Site will move from a characterization and remedial action phase to a long-term surveillance and maintenance phase. To align this change with DOE's operational structure, the DOE is transitioning the operation of the site from the DOE's Office of Environmental Management (EM) to the DOE's Office of Legacy Management (LM). The LM's mission is to manage the DOE's post-closure responsibilities and ensure the future protection of human health and the environment. The LM is responsible in perpetuity for implementing long-term surveillance and maintenance, which includes all necessary monitoring and any future response actions.

3.4 Governing Documents

The purpose of this report is to document EM's efforts to date and to serve as a mechanism to obtain regulator concurrence on the completion of the site. Upon acceptance of this Completion Report, EM and LM will work together to transition the site to LM (October 1, 2006). Future long-term surveillance and maintenance actions will be governed by an LTSMP. The LTSMP is being developed with LM as the lead author with support from EM, and reviews by regulators and stakeholders.

3.4.1 Long-Term Surveillance and Maintenance Plan Requirements

The LTSMP and subsequent related documents will provide the details of the monitoring strategy including species to be sampled, frequency of collection, method of collection, and radionuclides analyzed. The primary purpose of the plan is to ensure protection of human health and the environment through an effective monitoring process whereby unanticipated risk would be identified in a timely manner allowing corrective action. The identification of risk from other contaminants in the environment from non-DOE activities is not part of the long-term surveillance and maintenance program.

Based on the investigations conducted to date and documented in this report, the regular periodic monitoring strategy will include foodstuff and biota monitoring. Groundwater and surface water monitoring on a regular basis may be pursued based on the results of the groundwater model and independent science study. Biota and foodstuff monitoring directly monitor the completed risk pathway and serve as the most effective measure of human health and ecological risk. The LTSMP will include a Contingency Analysis of extreme events (such as earthquakes or volcanoes) that will identify potential conditions, probable consequences, and contingency actions.

The LTSMP shall determine the target biota to be monitored on a regular periodic basis using, but not limited to, the following criteria:

- Presence in the risk pathway – Species should be part of the food web or indicators for a part of the food web that acts as the completed risk pathway. Preference will be given to species that are part of the completed risk pathway, but indicator species will also be considered.

- Bioaccumulation potential – Species with high potential for bioaccumulation provide early indication of contamination in the food web.

- Trophic level – Species from various parts of the food web should be sampled to allow for increased confidence in detection of contamination in the food web.

- Species availability – Species should be available at the site, collection of the species should not adversely impact the species population, and the collection should not be overly difficult nor expensive.

The LTSMP will define the monitoring frequency and analysis methods for the biota sampling. The sampling frequency and analysis methods shall be designed to identify contamination before it presents a human health risk. Care should be taken to design a system that can be implemented in a cost-efficient manner.

The LTSMP will consider the use of faster-moving radionuclides present at the site as indicators of contaminant migration. Regular monitoring for slow-moving radionuclides (those whose movement is retarded by reactions with rock and sediment) would be less effective. The potential for bioaccumulation will be considered in selection of radionuclides for monitoring. The analytical suite will be expanded in case migration of indicator radionuclides is detected.

The LTSMP will favor the use of local hunters/fishermen, as well as commercial catch operators, as collection methods for the biota monitoring program, provided the program goals can be effectively met by those methods. Additionally, specimens may be collected during the surface cap inspection site visits. There are a variety of organizations that are well suited to the monitoring task that could be used for efficient, representative biota sampling, including the University of Alaska-Fairbanks, Aleutian Pribilof Islands Association, U.S. Fish and Wildlife Service, and National Oceanographic and Atmospheric Administration.

The LTSMP and subsequent related documents will provide a strategy to retain and archive biota samples. The plan will evaluate the value of this baseline information for comparison to future sampling and make recommendations on the disposition of the samples.

3.5 Public Participation

Several groups and entities have an interest in Amchitka Island, the remediation efforts there, and future activities on and use of the island. The primary Amchitka Site stakeholders include:

- Alaska Department of Environmental Conservation
- U.S. Fish and Wildlife Service, Alaska Maritime Wildlife Refuge
- U.S. Army Corps of Engineers, Alaska District
- U.S. Navy
- Aleutian/Pribilof Islands Association, Inc.
- Alaska Community Action on Toxics

Public participation has been a key aspect to the remediation efforts on Amchitka. Listed below are the public meetings that have been held to date regarding DOE's involvement with Amchitka:

- November 18-19, 1996: Anchorage, Alaska – Meeting with multiagency/stakeholder representatives

- December 16-17, 1996: Anchorage, Alaska – Agency and stakeholder issues/proposed investigative activities

- May 1, 2001: Anchorage, Alaska – APIA Board of Directors Meeting

- May 2, 2001: Anchorage, Alaska – Public Information Meeting

- December 4, 2001: Anchorage, Alaska – Public Information Meeting and Open House

- December 5, 2001: Anchorage, Alaska – APIA Presentation

- December 4, 2002: Anchorage, Alaska – Public Information Meeting

- May 13, 2003: Dutch Harbor, Alaska – Public Information Meeting

- May 14, 2003: Anchorage, Alaska – Public Information Meeting

Although a public reading room is not available, site documents are archived and can be accessed at the following location:

Aleutian/Pribilof Islands Association, Inc.
201 East 3rd Avenue
Anchorage, AK 99501-2455
www.apiai.com

Legacy Management has the ultimate responsibility for maintaining site records in accordance with the federal disposition schedule. Laboratory analytical data are maintained at the Denver Federal Records Center in Denver, Colorado. All other site documentation (e.g., waste records, correspondence, field data) and library material are maintained at the Legacy Management office in Grand Junction, Colorado.

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Appendix A

ADEC and FWS Comment Responses for Amchitka Completion Report

(8 Pages)

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number *Subsurface Completion Report for Amchitka Underground Nuclear Test Sites Long Shot, Milrow, and Cannikin, dated June, 2006*	2. Document Date June, 2006
3. Revision Number 0	4. Originator/Organization John Halverson
5. Responsible NNSA/NSO ERP Subproject Mgr. John B. Jones, Pete Sanders	6. Date Comments Due Comments received August 23, 2006
7. Review Criteria _______	
8. Reviewer/Organization/Phone No. John Halverson, ADEC_____	9. Reviewer's Signature _

10. Comment Number/ Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept
1. Exec Summ; p. ES-1		The third paragraph still includes a reference to the screening level risk assessment, which should be deleted. Also, DEC comment #4 on the prior draft requested a statement be added noting there are no feasible means to contain or remove radionuclides in or around the shot cavities beneath the site. The response to comments states this was added to the 4th paragraph, but the text was not included in the document.	Reference deleted Statement was added	
2. Section 1.1.2, p. 3		It refers to the 1972-'73 site reclamation efforts. DEC has a copy of the June 1972 Demob, Restoration, and Monitoring Plan Directive prepared by the Atomic Energy Commission. It describes sites disturbed by AEC activates and reclamation or restoration plans for each. However, I was unable to locate a copy of any report documenting what was actually done during the reclamation efforts. Does DOE have such a report that can be added to our files and the public information repositories? Such a report could provide valuable information on disposal areas or wastes that may remain in place and consideration for future land use planning.	An AEC document titled "Summary Report Amchitka Demobilization and Restoration Activities" Dated June 1974 document number NVO-146 is available at: www.osti.gov/bridge/product.biblio.jsp?query_id=1&page=0&osti_id=4303684	

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

Document Title/Number ______ Revision Number _____

Reviewer/Organization

3. Table 1-1		a) The "12/2000" row still refers to USFW conducting an EIS, which should be changed to an Environmental Assessment (EA).	Change made	
		b) The "Summer 2001" row states, "no well locations that require monitoring remain on site"; the report should clarify the location and construction details for wells that do remain, regardless of whether they require monitoring. Table 1-2 does identify two remaining wells, but it is unclear if any others exist.	Change to read: "16 wells were plugged and abandoned, 6 could not be found, 2 wells (GZ-1, GZ-2) were covered and locked, and 1 well (UAe-7e/h) was left open as a possible future monitoring well. The GZ-1, GZ-2, and UAe-7e/h wells were located during the 2006 Mud Pit Cap Inspection and the above status was verified. No other DOE wells exist on site and none are being monitored. The U.S. Navy demolished and removed all DoD buildings on the island."	
4. Table 1-2		Thank you for providing additional details on the various wells installed as part of the underground testing program. Several of the descriptions of the abandonment activity warrant clarification, as follows: a) Many of the activity descriptions conclude with the statement, "Abandonment Complete" but others do not; were additional steps planned to complete abandonment on the other wells?	Added "Abandonment Complete" statement to all wells that were plugged and abandoned.	

[a]Comment Types: M = Mandatory, S = Suggested.
Return Document Review Sheets to NNSA/NSO Environmental Restoration Division, Attn: QAC, M/S 505.

		b) Many of the activity descriptions partially describe how the wells were decommissioned and closed or are unclear. For example, wells OH-6 through 9 state, "10-in cement plug; .857 ft3 cement in hole. Welded 14 by 12 ft to each 13 3/8-ft casing. Cemented to 1 ft bgs." While such descriptions provide some detail, they are unclear and do not address the deeper portions of the holes/wells and whether they were filled with drilling mud, infiltrating groundwater, or other materials.	Descriptions of well decommissioning are based on various reports generated by contractors back in the early 70's and information is often vague. We will clarify each well's activities to the best extent possible.	
		c) It appears the symbols for inches and feet have been interchanged on some of the entries. Many wells are noted as having a 10" cement plug, please verify whether these are correct. Others such as W-2 through W-19 are listed as shallow wells (< 10").	Units of measure have been corrected.	
		d) Wells GZ-1 and -2 are listed as having a protective cover and lock. Is there a reason these were not decommissioned and closed?	No information is available as to why these two wells were not decommissioned (perhaps they are the two wells that DOE reconditioned but actually belong to the DoD).	
		e) Wells EPA-1 and HTH-3 are listed as "not found or casing was deteriorated beyond plugging." Please clarify which is correct.	Well casings were deteriorated beyond plugging	
5. Table 1-3 and Table 1-2		The well depths should be listed consistently between the tables. Table 1-2 lists the W series wells as <10 feet, however, Table 1-3 lists specific depths for some of them and unknown for others.	Data in both tables was combined.	

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6. Table 1-3		Based on Table 1-3, it appears prior hydrologic monitoring program entailed collection groundwater samples at depths ranging from 1 to 140 feet below ground surface. Please verify whether this is the deepest groundwater monitoring that was conducted, with the exception of the drill-back work done shortly after the testing.	Based on available reports 140 feet was the deepest sampling conducted under the LTHMP.	

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7. Section 1.3.5, p. 25-26		The Desert Research Institute refined some of its 2002 modeling based on information complied during the CRESP Independent Science Assessment conducted during 2004. The refined model results are described in this section. Unfortunately, we have not yet had a chance for a third party modeler to review the report. Please note, questions may arise on the modeling in the future. Also, the second and third paragraphs on page 25 state the 2006 modeling verified the 2002 modeling. Recommend the words "verify", "verified", and "verifying" be replaced with "refine", "update" or "support" (using correct tense) instead. Verifying and validating typically infer collecting groundwater data to demonstrate actual measured parameters fall within the modeled parameters. In this case deeper groundwater has not been monitored.	The 2002 modeling is not verified by the 2006 modeling, but rather by the data collected by CRESP. Model verification was one of the activities listed under the principles of the Letter of Intent between DOE and the State of Alaska, Department of Environmental Conservation. DOE's funding for the CRESP assessment was with the explicit understanding that a focus of the data collection was model verification and reduction of risk uncertainty. We agree that verifying and validating usually involve comparing a model to data not used in the model development. That is precisely what was done with the Amchitka models. The independent data collected by CRESP were used to evaluate model parameters with the finding that the new measurements are within the ranges used in the original model. In addition, the new data were used to tighten the parameter ranges, thereby reducing uncertainty in the model results. The data provided by CRESP extended very deep into the subsurface, deeper than the groundwater models. The magneto-telluric imaging provided salinity and porosity profiles to depths of 5 km at each of the three test sites. For a detailed discussion of model validation, please see Hassan, A. E., 2004. Validation of Numerical Ground Water Models Used to Guide Decision Making, Ground Water, 42(2), 277-290, and Hassan, A. E., 2004. A Methodology for Validating Numerical Ground Water Models, Ground Water, 42(3), 347-362.	

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8. Figure 2-1		It is unclear why "blocked pathways" and "barrier" are depicted. These should be deleted and the "potential pathways" depicted. Footnotes or text in the document could be used to further describe the fate and transport of radionuclides originating from the source areas/test cavities.	Conceptual Model being revised with better descriptions	
9. Section 3.2, Institutional Controls		The second bullet item states that it is assumed mineral rights have been withdrawn. This needs to be verified with the USFWS.	This has been verified with the USFWS. Change bullet to read: "The USFWS is the landowner, and maintains all mineral rights for the island."	
10. Section 3.2, Institutional Controls		I understand the Milrow plaque is missing and needs to be replaced. This should be done as part of the completion work unless there is an agreement that the Office of Legacy Management will do it.	Added sentence: "The Milrow event description plaque is missing but, the restrictions plaque is still in tact."	
11. Section 3.5, Public Participation		It should list "U.S. Fish and Wildlife Service, Alaska Region" or "U.S. Fish and Wildlife Service, Alaska Maritime Wildlife Refuge" and "U.S. Army Corps of Engineers, Alaska District".	Changes made to both.	
12. Appendix A, Response to Comments		The following responses to prior DEC comments have not been adequately addressed or warrant further discussion:		
		a) See comment #1 above	Addressed above	

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		b) Comment 8, first bullet item – the comment states that test holes or wells remaining on the island should be secured and information on them provided to the landowner and LM. The response states the comment was not incorporated because it is not within the scope of the document. This seems like a critical component completion and transition into long term surveillance and maintenance.	Comment response was changed to read: "Added and expanded tables 1-2 and 1-3 to address status of wells on the Island" Also see response to comments 4b and c above.	

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		c) Comment 18, Institutional Controls: the comment stated subsurface activities need to be restricted in the vicinity of the three test shots and that the Milrow plaque is reportedly missing. The response states noted and that restrictions will be addressed in the LTSM plan. Section 3.2 in the report is on Institutional Controls and states that several controls are in place namely that it is refuge land administered by the USFWS, an assumption that mineral rights have been withdrawn, and a plaque at each SGZ noting that restrictions apply. However, one of the plaques is reportedly missing and should be replaced. It seems appropriate to add a statement that additional institutional controls restricting subsurface activities will be established under the LTSM plan in coordination with the landowner and stakeholders.	Page 31, Section 3.2, 3rd bullet, after the second sentence, add: "The event description plaque for Milrow is missing, but the restrictions plaque is still intact." Page 32, immediately before section 3.3 add: "Additional institutional controls restricting subsurface activities may be established under the LTSM plan in coordination with the landowner and stakeholders."	

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