

1.0 Introduction

Three underground nuclear tests were conducted in the deep subsurface of Amchitka Island in Alaska. The tests (i.e., Long Shot, Milrow, and Cannikin) were conducted in 1965, 1969, and 1971, respectively. There were many extensive investigations conducted on these tests and their effect on the environment of the island. Evaluations at the time of testing indicated limited release of radionuclides and absence of risk from the testing; however, as part of its environmental stewardship program, the U.S. Department of Energy (DOE) is reevaluating these sites.

The current risk investigation focuses on the possible movement of radionuclides from the underground test chambers, through geological formations, to the ocean floor. From the ocean floor, radionuclides could further travel into the marine waters and into marine organisms. Some of these marine organisms make up the subsistence diet for Native Alaskans living in the Aleutian Islands, while some are a part of the abundant commercial catch from the Northern Pacific Ocean. The marine organisms could take up radionuclides from the marine water, thereby exposing the Native Alaskans to radionuclides as a result of ingesting the organisms. Exposure to ionizing radiation from ingested radionuclides carries with it the potential for harm (e.g., cancer).

Whether such exposure could happen will be determined by a two-part investigation that examines the following: (1) the possible movement of radionuclides in the geological formations to the ocean floor (Hassan et al., 2001) and (2) the possible movement of radionuclides in the water and food webs near Amchitka Island. There are interim work products for both parts (e.g., IT Corporation [1999] presented information pertinent to the risk assessment). The IT Corporation report describes how the second part of the investigation, the screening risk assessment, will be calculated from potential radionuclide releases at the seafloor, through the food web, to subsistence users and commercial consumers. From this, the predicted cancer risks from the potential radionuclide releases can be calculated.

Document Organization

This report includes seven primary sections and one appendix. The figures called out in the text of the main document are provided after Section 8.0, References. Likewise, the figures called out in Appendix A are provided after Section A.15.0, References.

2.0 Objectives

The risk assessment is an important part of the DOE's environmental stewardship at Amchitka Island. Regarding the marine or ocean part of the system, there are three interrelated activities: a groundwater model and this screening risk assessment, both of which guide the decisions in the third activity, the site closure plan. Thus, the overall objective of the work is to understand, and subsequently manage, any risk to humans and the environment through a closure plan.

The objective of the screening risk assessment, which is the topic of this report, is to methodically predict whether possible releases of radionuclides at the ocean floor would represent potential risks to Native Alaskans by consumption of marine subsistence species. Also, risks will be predicted for consumers of commercial catches of marine organisms. These risks are calculated beginning with estimates of possible radionuclide seepage at the seafloor into the seawater (from the hydrogeologic study) through possible uptake by marine organisms, and finally possible consumption by humans.

3.0 Setting

The Aleutian Islands rise from the Aleutian Ridge, an elongated, curved rim that rises above the seafloor, extends westward from the Bering Shelf, and separates the Pacific Ocean on the south from the Bering Sea on the north (Figure 1). Amchitka Island, one of the Rat Islands situated near the center of the Aleutian chain, is a narrow, elliptically-shaped land mass oriented south, southeast (SSE) – north, northwest (NNW) along its major axis.

Amchitka Island was the site of three underground nuclear tests, at depths ranging from 2,300 to 5,875 feet (ft). Each test created a cavity around the center of the detonation and a chimney of fragmented and collapsed rock above. The cavities and the chimneys contain radioactive byproducts of the nuclear detonation; some of these products were trapped in glass, which was created when the rock melted by the detonations cooled and hardened.

The rock beneath the island is saturated with groundwater, and the water table is very near the land surface. Because the test cavities are in the saturated zone, there is a potential for radionuclides to migrate in groundwater. Given the island setting, groundwater migrates to the ocean floor, where it mixes with seawater. Therefore, there is a potential for radionuclides to migrate from the test cavities to seawater.

The waters around Amchitka Island (parts of the Pacific Ocean and the Bering Sea) contain abundant marine species, including various kinds of fish and marine mammals. These fish and mammals make up a large part of the subsistence diet of Native Alaskans who live in the Aleutians. The conceptual model (discussed in Section 4.0) briefly describes the potential flow of radionuclides from the ocean floor, to marine organisms, and ultimately to human subsistence consumers or consumers of commercial catches.

4.0 Conceptual Model

The conceptual model of transport of radionuclides from the ocean floor to human consumers is shown in Figure 2. From the ocean floor, radionuclides can potentially travel into the marine waters, where they would be moved by currents and diluted. This is indicated by the “Ocean Water and Currents” compartment of the conceptual model diagram.

Any materials (including radionuclides) in seawater are available for uptake by marine organisms. Some of these marine organisms are important subsistence species for Native Alaskans, such as Steller sea lions, harbor seals, northern fur seals, mussels and clams, crabs, octopus, pogie eggs and other fish eggs, sea urchins, migratory water fowl, bird eggs, and various species of fish. Important subsistence and commercial fish species include halibut, mackerel, pollock, and salmon. These species are included in the “Marine Food Webs” compartment of the conceptual model diagram (Figure 2). Some of these species reside in the upper depths of the ocean, while others live or feed mainly on the bottom. For example, sea urchins live on the ocean floor and sea otters dive to the bottom to prey on them, and crabs and octopus that live on the bottom are preyed upon by young halibut that live in deep water. The typical depth ranges of several of the subsistence species are shown in Figure 3. Migratory waterfowl are only briefly exposed to food from Amchitka sources; therefore, they are not considered further in this analysis.

Marine mammals and fish may be harvested near Amchitka Island and used for food by Native Alaskans. Also, some marine species may travel from the vicinity of Amchitka and be harvested in other areas. Harvested species are typically taken back to the villages, where they may be shared with everyone. These consumers are included in the “Human Exposure” compartment of the conceptual model diagram (Figure 2). Since a large fraction of their diet is marine species, the Native Alaskans are likely to receive a larger exposure to potential radionuclides in marine species than commercial-catch users.