

Executive Summary

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 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.

A screening risk assessment of potential radionuclide release into the marine environment is an important part of the DOE's environmental stewardship at Amchitka Island. The risk assessment is one of 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 and long-term stewardship plan.

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

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, including marine mammals, fish, invertebrates, and waterfowl. Important subsistence and commercial fish species include halibut, mackerel, pollock, and salmon.

For this risk assessment, it was assumed that marine mammals and fish are harvested near Amchitka Island and used for food by Native Alaskan's subsistence consumers. 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 which is

part of this report. Since a large fraction of their diet is marine species, the Native Alaskans are likely to receive a larger exposure to any radionuclides that may be present in their subsistence foods than would commercial-catch users.

The risk assessment model has 11 elements, progressing from potential release at the seafloor through water and food chains to human intake, and are as follows:

1. Radionuclides of potential concern
2. Locations of releases
3. Seabed substrates
4. Transport by currents
5. Dilution, including plume
6. Human receptors
7. Distribution of diet
8. Bioconcentration factors
9. Fraction of contaminated diet
10. Cancer morbidity risk coefficients
11. Limits to cancer risk

Data for each of these elements were systematically found and synthesized from many sources and represent the best available knowledge. Whenever precise data were lacking, the most conservative data were selected. Conservative assumptions and values were used for radionuclide uptake factors and for marine food ingestion rates by human receptors. The dispersion of material in the marine environment utilized a U.S. Environmental Protection Agency (EPA)-approved model (CORMIX). In addition, the screening level of 1×10^{-6} or 1 excess cancer in 1 million is considered by the EPA to be below the level of concern. The end result, as presented in this report, is a highly conservative estimate of potential risks.

Three dietary exposure scenarios were evaluated using these data and conservative assumptions: two for subsistence diets and one for consumption of commercial catch. Within each of the two subsistence dietary exposure scenarios, two nearshore conditions were evaluated: no kelp at Milrow and with kelp present at Milrow. One offshore condition, the large Aleut culture and communication area, was also evaluated. This results in nine scenarios applied to two groundwater models: the base-case model that represents the best estimate of groundwater transport, and a sensitivity case that reduced matrix diffusion an order of magnitude below the best estimate. These scenarios are as follows:

- Combined source of Cannikin, Long Shot, and Milrow (no kelp); base-case groundwater model and sensitivity-case groundwater model
 - *Scenario 1:* Fish subsistence diet
 - *Scenario 2:* Marine mammal subsistence diet
 - *Scenario 3:* Commercial catch diet
- Combined source of Cannikin, Long Shot, and Milrow (with kelp); base-case groundwater model and sensitivity-case groundwater model
 - *Scenario 4:* Fish subsistence diet
 - *Scenario 5:* Marine mammal subsistence diet
 - *Scenario 6:* Commercial catch diet
- Combined sources of Cannikin, Long Shot, and Milrow (with kelp) in Aleut culture and communication area; base-case groundwater model and sensitivity-case groundwater model
 - *Scenario 7:* Fish subsistence diet
 - *Scenario 8:* Marine mammal subsistence diet
 - *Scenario 9:* Commercial catch diet

Because the radionuclide source data from the Amchitka tests remain classified, the screening risk assessment methods required an innovative approach. The exposure terms were combined to form a radionuclide risk factor which is annual risk per picocurie per day of radionuclide flux. These factors are applied to compute the potential risk.

The most important result of the Amchitka Island human health screening risk assessment is that the predicted lifetime risk values for the mean radionuclide flux from the 19 radionuclides released from the test detonations in 1965, 1969, and 1971 ranged from approximately 10,000-fold to 1,000,000-fold below EPA's point of departure for risk (1.00×10^{-6}). Even incorporating considerable uncertainty or conservatism into the calculation of radionuclide flux through groundwater and retaining the conservatism in the risk assessment parameters, the risk is still well below the EPA's lower level of concern. These values were predicted for the 1,000-year period from 1965 through 2965 for all nine risk scenario combinations.

In summary, the screening risk assessment, using conservative data and assumptions, shows potential risk levels to be well below the EPA's most conservative risk threshold for both subsistence users and commercial-catch consumers.