

3.0 MONITORING ENDPOINTS

The remedies for OU A sites require institutional controls and periodic sampling of environmental media. Monitoring is performed to evaluate:

- Petroleum remedies (groundwater)
- CERCLA remedies (groundwater)
- Landfill compliance with ROD and regulatory requirements (groundwater, surface water, sediment)
- Marine tissue compliance with ROD and regulatory requirements
- Institutional control effectiveness

Chemical-specific criteria (Appendix F) are used as a means of quantitatively evaluating the progress of a remedy towards achieving the RAOs. Therefore, environmental restoration requires regular monitoring of multiple media that are directly related to the remedial objectives. Reviews are conducted at 5-year intervals to assess the progress of the remedies. The first 5-year review was conducted in 1999 (U.S. Navy 2001d).

This section of the CMP provides a discussion of the method and frequency of data analysis to be performed and the criteria for evaluating remedial progress and inspection activities. Recommendations for future modifications to the sampling and analysis program will be based on the data collected and will be supported by data analysis.

An endpoint criterion is represented by a set of chemical-specific conditions that indicate that the RAO has been met and monitoring can be terminated. Endpoints will be evaluated on a chemical-specific basis. Specific endpoint criteria are described herein by monitoring type.

3.1 PETROLEUM MONITORING

Three separate conditions are possible regarding monitoring endpoints at petroleum sites:

- Conditions meet endpoint criteria and monitoring may be terminated.

- Conditions do not meet endpoint criteria and monitoring will continue at existing frequency.
- Conditions do not meet endpoint criteria, however, are such that monitoring frequency can be reduced.

Sampling activities will be conducted annually in September or October.

Target analytes for petroleum monitoring sites are specified in the OU A ROD Section 10.3.2. Target analytes are site specific, and not all of the listed target analytes will necessarily be analyzed at each site. The monitoring program for each site (Appendix A) has site-specific analyses based upon historic results and the nature of the release. The following are the target analytes for petroleum monitoring sites:

- Gasoline range organics (GRO)
- Benzene, toluene, ethylbenzene, and total xylenes (BTEX)
- Diesel-range organics (DRO)
- Residual-range organics (RRO)
- Total lead
- Dissolved lead

3.1.1 Limited Groundwater Monitoring

The OU A ROD remedy of Limited Groundwater Monitoring specified quarterly sampling for a 1-year period. The CMP (U.S. Navy 2001b) further refined the endpoints for Limited Monitoring by providing for those sites to be transitioned into the natural attenuation remedy and monitoring program if they did not meet the chemical specific cleanup criteria within the specified number of sampling events.

Following completion of each annual monitoring event in 2000, 2001, and 2002, the monitoring report presents recommendations of no further action for sites that met the criteria. The site status summary presented in Appendix E provides the specific details for each site.

The two sites that did not meet the limited monitoring criteria are SA 79, Main Road Pipeline South End, and ROICC Contractor's Area, UST ROICC-7. As recommended in the annual monitoring report for the 2002 event, these sites were monitored for evaluation of natural attenuation in the 2003 and will continue to be monitored in future events. In addition, two sites (ASR-8 Facility and SA 77, Fuels Facility Refueling Dock and Small Drum Storage Area) have limited soil removal activities pending due to either utility or active facility loading interference;

these sites may be transitioned in the future to limited groundwater monitoring or no further action status.

For the 2003 monitoring program and future events, the monitoring regime of Limited Monitoring will be discontinued at the sites currently being monitored. The two remaining sites (ROICC-7 and SA 79) will be incorporated into the Monitored Natural Attenuation remedy and reported as part of that monitoring regime. Therefore, the 2003 and future monitoring events and reports will not have a remedy category titled "Limited Monitoring" unless dictated by the future analytical results from ASR-8 or SA 77.

3.1.2 Monitored Natural Attenuation Groundwater Sites

Petroleum-release sites with the OU A ROD remedy of monitored natural attenuation were sampled quarterly for a 1-year period. Quarterly sampling began in August 1999 and was completed in July 2000. Annual groundwater monitoring was conducted in 2001 and 2002. Annual monitoring is planned to continue to the next 5-year review, when the frequency will be evaluated.

Natural Attenuation Groundwater Monitoring Endpoint

Monitoring will be considered complete at a given location if chemical concentrations are below the endpoint criteria provided in Appendix F for two consecutive groundwater monitoring events.

As a secondary endpoint criteria, monitoring at a specific location could be substantially reduced if it can be demonstrated that (1) the concentrations are decreasing at a predictable rate with a degree of confidence of at least 80 percent and (2) the exceedance poses no reasonable threat to downgradient receptors. If both of these secondary endpoint criteria are met and can be demonstrated, it will be concluded that natural attenuation is progressing as predicted, that groundwater in the area poses no threat to humans or the environment, and that further monitoring can be substantially reduced to confirm achievement of RAOs at that location.

If an endpoint criterion is not met, one of the following actions will be taken:

- If the data tests indicate that the concentrations are decreasing over time, but it cannot be demonstrated that the exceedances pose no reasonable threat to downgradient receptors, monitoring will be continued.

- If the data tests indicate that there is not a significant change in concentrations or if the trend-line is found to be outside the confidence interval (i.e., there is uncertainty in the concentration trend), monitoring will be continued.
- If the data tests indicate that the concentrations are increasing, an evaluation will be performed to determine whether to continue monitoring or take additional action.

The effectiveness of the selected remedies will be evaluated during the 5-year reviews. The 5-year review reports will define the results of monitoring, determine the frequency for continued monitoring, and identify future actions, as necessary.

Trend Analysis

The purpose of a trend analysis is to statistically determine whether the concentration of petroleum-related chemicals at each location is decreasing, increasing, or remaining constant and to estimate when the chemicals in groundwater at each monitored site will achieve the criteria provided in Appendix F. The nonparametric Mann-Kendall test (Gilbert 1987) will be used to estimate if a trend exists. This test can be used with data sets that include both missing data and a mixture of detected and nondetected results. When nondetected results are used, one-half the detection limit would be applied for that result.

Data that include both detected and nondetected results are called censored data in the statistical literature (see Appendix G). At the time of the 2003 monitoring program the data set for each monitoring location (inclusive of 2002 measurements) consists of less than nine measurements. The exception being four monitoring locations that have nine or more measurements for one or more analytes. The statistical evaluation for 2003 and future events will include review of the censored data and application additional statistical methods as needed. Appendix G, Section 4.7 (Gilbert 1987) presents alternative means of evaluating censored data. The approach described above, using one-half the detection limit, is generally acceptable for data sets consisting of less than 15 percent nondetected results. The cleanup evaluations in this monitoring program will include trend evaluation after achieving at least two measurements below criteria. These two measurements could potentially be nondetect results. Assuming a data set consisting of 10 measurements, this equates to a 20 percent censored data set. In the methods presented in Appendix G, the statistical analyses of 2003 (and future) data will evaluate and apply the methods applicable to data with between 15 to 50 percent nondetected results. Because the nondetected value (detection limit) is seldom a consistent value, application of Cohen's method may not be valid. Other methods described in Appendix G, Section 4.7.2 will be reviewed for use in the monitoring report.

If use of the Mann-Kendall test indicates that the concentration trend line is significantly different from zero (i.e., concentrations are decreasing or increasing), the Sen's test (Gilbert 1987) will be used to calculate the slope (i.e., concentration change over time) of the trend line. Once the slope of the trend line is calculated using Sen's test, the time necessary to reach an endpoint concentration can be estimated on a chemical-specific basis. Use of slope for time predictions is to be conducted only when the slope is negative (concentrations are decreasing) and concentrations are greater than the chemical specific endpoint criteria (Appendix F). Finally, nonparametric confidence intervals around the trend line will be calculated to evaluate the degree of confidence in the results. The OU A ROD (Section 10.3.3) requires a minimum confidence interval of 80 percent certainty (Sokal and Rohlf 1995). This confidence interval refers to the statistical power of the monitoring program and not to the confidence interval surrounding a mean or regression line. The preferred method for performing these calculations is to use a statistical program similar or equivalent to DataPlot, DataQuest, or Systat to provide a consistent package to reproduce trend analyses results for auditable output. If a statistical program is not used, calculations and examples should be provided to allow the statistical evaluation to be reproduced. The procedures required to perform these statistical tests are described in Appendix G based upon methods described in Gilbert (1987).

A trend analysis is performed for each natural attenuation monitoring location where an exceedance of the chemical specific cleanup criterion occurs (or has occurred, since monitoring was initiated in 1999, but has not reached the endpoint criterion). The trend analysis may be performed at any time as long as there is a minimum of four data points. However, a minimum of nine data points is required to obtain a confidence interval of 80 percent certainty. Three statistical evaluations have been completed, one for each annual event in 2000, 2001, and 2002. The number of measurements varies by location and by analyte at a location. Therefore, trend evaluations through 2002 do not have the confidence level to be conclusive.

With the exception of four monitoring locations that have sufficient historical data, the number of measurements for each monitoring location varies between three and eight measurements. Historical sampling events provide data analyzed using older analytical methods, which may differ from the current CMP data. Comparison of the historical aliphatic and aromatic method results with the current total GRO method results will be facilitated by appropriately summing the aliphatic and aromatic results. This summing may slightly understate the aliphatic and aromatic total relative to actual values because BTEX are not included in the aliphatic and aromatic method.

One of the three objectives in the ROD (Section 10.2.2) is to estimate the rate of natural attenuation to demonstrate achievement of endpoint criteria within 75 years. In the event that the 5-year review does not demonstrate that the 75-year time frame will be met, enhancement of monitored natural attenuation or use of alternative remedial actions will be evaluated and

discussed with Alaska DEC. Additional data reviews will be performed beyond the 5-year review after every fifth sampling interval, or until the monitoring endpoint is reached.

3.2 SURFACE WATER PROTECTION GROUNDWATER MONITORING AND ENDPOINT

The OU A ROD Section 10.3 specifies that groundwater monitoring will be conducted for CERCLA and petroleum sites where groundwater concentrations exceed water quality criteria and could discharge to regulated surface water. The purpose is to verify that potential contaminants are not migrating into surface water bodies as required by 18 AAC 75.345(f). Per the OU A ROD, the surface water bodies being protected by this monitoring requirement are Sweeper Cove, Sweeper Creek, Kuluk Bay, and Clam Lagoon.

The chemical-specific criteria applicable to this monitoring are specified in 18 AAC 70.020 (b) (5)(A) (iii) for the aquaculture water use category. Relative to petroleum contaminants, the criteria specify that total aqueous hydrocarbons (TAqH) in the water column may not exceed 15 µg/L, and that total aromatic hydrocarbons (TAH) in the water column may not exceed 10 µg/l. The location of compliance for the surface water criteria is further clarified in the Alaska DEC Technical Memorandum 01-005, as being at the soil/surface water interface.

The planned surface water protection monitoring regime uses groundwater samples collected from wells located adjacent to and or upgradient from surface water. The evaluation of monitoring results will compare analytical results for petroleum compounds to the surface water criteria. If this comparison indicates an exceedance and a significant increase in concentrations over three measurements at locations that are in close hydraulic continuity with the surface water the following actions will be initiated:

- Evaluation of chemicals and their concentrations identified in surface water protection wells relative to the potential for a reasonable threat to downgradient aquatic receptors
- Evaluation and planning for collection of one upgradient and one downgradient surface water sample at the soil/surface water interface closest to the subject sentinel well location
- Review of final remedy for nearest upgradient site and the remedy performance relative to surface water protection

The endpoint for surface water protection monitoring is directly dependent upon the associated upgradient site achieving the remedial endpoint criteria. Once the upgradient site has achieved the remedial endpoint and it can be demonstrated that there is no reasonable threat to the down-gradient receptor, surface water monitoring at the associated location will be terminated.

Results of the 2002 sentinel monitoring show detections in 27 of the 31 sentinel locations sampled (two locations were not sampled). The detections are commonly minimum values either J-qualified as below the practical quantitation limit, or in the 200- to 300- $\mu\text{g/L}$ range. Of the 27 locations with detected values, 6 locations had results that exceeded the numeric groundwater endpoint criteria. Of these six locations with exceedances, four locations are adjacent to a surface water body. Of these four locations, three are at the South Runway 18/36 Area, which is a free-product site being evaluated in the FFS process.

The fourth location is SWMU 61 (Tank Farm B), which is an MNA remedy site adjacent to North Sweeper Creek. This site was addressed in the Navy's Natural Attenuation Optimization Program completed in May 2003. A new location was installed closer to the creek that yielded groundwater samples containing GRO at concentrations ranging from 8,000 to 9,000 $\mu\text{g/L}$.

3.3 CERCLA GROUNDWATER SITE MONITORING

Target analytes for CERCLA groundwater monitoring sites are specified by site and monitoring location in Appendix A. Target analytes are site-specific, and not all of the listed target analytes will necessarily be analyzed at each site. The following are the target analytes specified in Table 10-3 of the OU A ROD for CERCLA groundwater monitoring sites:

- Total thallium
- Dissolved antimony
- Methylene chloride
- Tetrachloroethene
- Trichloroethene
- Bis(2-ethylhexyl)phthalate

Target analytes vary by CERCLA site. Compounds detected during each CERCLA annual monitoring event are evaluated for inclusion or removal as target analytes based upon a comparison to endpoint criteria. However, revision of the target analytes or the monitoring frequency will be conducted during each 5-year review. The groundwater analyses are expanded on a site-specific basis from that specified in the ROD, with the addition of the mono- and di-chlorinated compounds because these are daughter products of interest. However, remedy evaluations and trends will be conducted using only those compounds listed in the ROD.

Monitoring will be considered complete at a given location if the target analyte concentrations are below the endpoint criteria 18 AAC 73.345, Table C (shown in Appendix F) for two consecutive sampling rounds.

A secondary endpoint can be established based on the statistical analysis discussed in Section 3.1.2, if the following can be demonstrated:

- The concentrations are decreasing at a predictable rate with a degree of confidence of at least 80 percent.
- The exceedance poses no reasonable threat to downgradient receptors (U.S. Navy, Alaska DEC and USEPA 2000).

Generally, if the statistical analysis does not indicate that an endpoint has been met, monitoring will continue on an annual basis. Additional data reviews will be performed after every fifth sampling interval until a monitoring endpoint is reached. However, if the analysis indicates that the concentration is increasing, an additional evaluation will be performed to determine whether to continue monitoring or to take additional action.

At the 5-year review, the results and analyses of the monitoring will be presented in a report. This document will include a discussion of the need for continued monitoring and recommend changes to the monitoring program (i.e., increase frequency, decrease frequency, or discontinue).

3.4 LANDFILL MONITORING

Monitoring activities at the four landfills will be performed as dictated by the State of Alaska solid waste regulations 18 AAC 60 (specific citations are provided within text) or CERCLA requirements, depending upon the landfill. SWMUs 18/19 (White Alice Landfill) and SWMU 25 (Roberts Landfill) are monitored according to State of Alaska solid waste regulations and landfill closure plans (U.S. Navy 1998b, 1996a, 1996b, and 1996c). SWMU 11 (Palisades Landfill) and SWMU 13 (Metals Landfill) are monitored under CERCLA.

Alaska solid waste regulations (18 AAC 60.397[a][3]) require groundwater monitoring of Class II landfills for 30 years. (Roberts Landfill is the only Class II landfill of seven landfills on Adak). Regulation 18 AAC 60.397(b)(1) indicates that the length of the post-closure-care period may be decreased if Alaska DEC finds that the reduced period is sufficient to protect public health and the environment. Groundwater monitoring at monofills, such as the White Alice Landfill (Alaska DEC 2003e), is required only if Alaska DEC finds it is necessary to protect public health, safety, or welfare, or the environment (18 AAC 60.490). Alaska DEC has categorized the Palisades and Metals Landfills as nonmunicipal landfills, which are not specifically defined in the regulations, but are presumed to have no more stringent requirements than monofills. Section 10.4 of the ROD specifies that monitoring will be conducted for 3 to 5 years at the Roberts and White Alice Landfills. Landfill closure dates, class, and monitoring type are identified in Table 3-1. The risk assessment for Kuluk Bay determined that there is an unacceptable risk to subsistence consumption of sole and blue mussel. SWMUs 11 and 13 are adjacent to and directly discharge to the marine environment of Kuluk Bay. However, the marine tissue sampling is conducted in conjunction with the Kuluk Bay risk assessment and is not part of the monitoring program at SWMUs 11 and 13.

Monitoring of institutional controls is the only monitoring requirement at three of the landfills: SWMU2 (Causeway Landfill), SWMU 4 (South Davis Road Landfill), and SWMU 29 (Finger Bay Landfill). Monitoring for potential chemicals in selected media at each of the remaining four landfills will be reviewed during each 5-year review period. Monitoring at SWMU 2 (Causeway Landfill), SWMU 4 (South Davis Road Landfill), and SWMU 29 (Finger Bay Landfill) is limited to visual site inspections as outlined in the ICMP in Appendix D.

Target analytes vary by landfill site. The LMP (Appendix B) specifies target analytes by landfill. The groundwater analyses are expanded, on a site-specific basis from that specified in the ROD, with the addition of the monochlorinated and dichlorinated compounds because these are daughter products of interest. However, remedy evaluations and trends will be conducted using only those compounds listed in the ROD.

3.4.1 SWMU 11, Palisades Landfill

Palisades Landfill was closed in 1996. Monitoring at Palisades Landfill is conducted in accordance with CERCLA requirements. The ROD-specified RAOs for the Palisades Landfill are to protect human and ecological receptors from exposure to landfill debris and soil that could result in a cancer risk greater than 1×10^{-5} , or a noncancer risk above a hazard index of 1.0. The ROD remedy is a combination of institutional and engineering controls. The ROD (Section 7.1.1) concluded that placing a cover over the landfill and subsequent monitoring were an adequate and final remedy because the cover prevents direct exposure of debris and surface soil to human and ecological receptors, and monitoring will verify that there are no downgradient

impacts. Future land use is restricted to recreational or industrial uses. Residential use is prohibited. The remedy requires periodic collection of fresh surface water, freshwater sediment, and intertidal sediment for chemical analyses. Marine tissue samples may also be collected for chemical analyses as part of the Kuluk Bay risk assessment. The OU A ROD is the legal instrument through which institutional controls have been prescribed at OU A. The institutional controls prohibit residential use at SWMU 11, restrict land use to recreational or industrial applications, restricts groundwater use, and prohibits excavation. The ICMP describes implementation and monitoring of institutional controls at OU A and reporting of inspections. Language constituting an equitable servitude is included in the Interim Conveyance that transfers the property from the United States to The Aleut Corporation so that the use restrictions run with the land and are binding on future landowners. Site conditions will be reviewed every 5 years to evaluate protectiveness of the remedy as part of the engineering controls. Annual site visits will be conducted to inspect engineered controls. Monitoring requirements will also be reviewed every 5 years, in conjunction with Alaska DEC and EPA, to re-evaluate the need for monitoring, monitoring frequency, and target analytes.

Sediments and surface water have been sampled at Palisades Landfill periodically since May 1996. As of October 2002, 10 post-closure sampling events have occurred at the Palisades Landfill. In May 1996, prior to landfill closure activities, two surface water and sediment locations were sampled and analyzed for pesticides/Aroclors (Method P/A-CLP), SVOCs (Method SV-CLP), and total inorganic compounds (TIN; Method IN-CLP). Surface water was also analyzed for dissolved inorganics (DIN; Method, DIN-CLP), BTEX, and turbidity. Sediments were analyzed for total organic carbon (TOC) (Method 9060). In August and November 1996, following landfill closure, samples were collected again and analyzed for the same chemicals and parameters. In 1997, sampling was performed at the same locations for sediment and surface water. In June 1998, September 1999, November 2000, September 2001, and October 2002, sediment and surface water sampling was performed.

SVOCs (carcinogenic PAHs [cPAHs], acenaphthene, anthracene, fluoranthene, fluorene, phenanthrene, and pyrene), pesticide compounds (4,4-DDD, endrine ketone, heptachlor epoxide and delta-BHC), and PCBs (Aroclors 1254 and 1260) have periodically been detected at concentrations above the reporting limit in sediments between 1998 and 2002. Additional SVOCs and pesticides have been detected in sediments between 1996 and 1997, but have not been reported above detection limits in more recent sampling events. Inorganics (arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, vanadium, and zinc) have periodically been detected in sediments between 1996 and 2002 at concentrations above the background levels.

Bis(2-ethylhexyl)phthalate was detected at least once in surface water at a concentration of 54 µg/L or less between 1996 and 1999; bis(2-ethylhexyl)phthalate was not detected in 2000 or 2001. Total iron and total and dissolved manganese have periodically been detected in surface water between 1996 and 2002 at levels at or below 1,190 µg/L, 72.6 µg/L, and 57.9 µg/L, respectively. In addition, low levels of antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, nickel, selenium, vanadium, and zinc have been reported in surface water between 1996 and 2002. Tissue results are summarized in Section 3.5.

Annual monitoring will include sampling of fresh surface water, freshwater sediment, and marine sediment. Sampling of blue mussel tissue is currently being conducted as described in the marine tissue monitoring plan (Appendix C) in relation to the Kuluk Bay risk assessment. Five-year reviews will be conducted to evaluate monitoring data and site conditions to determine the need for additional action or reduction of controls, as appropriate.

Comparison criteria for surface water sampling results are the Alaska surface water quality standards 18 AAC 70.020(a)(1)(C) for toxic and other deleterious organic and inorganic substances. Comparison criteria for marine and freshwater sediment samples are human health and ecological RBSCs. These criteria are presented in Appendix F. As stated in the ROD Section 6.1 these criteria are based upon a cancer risk of 1×10^{-6} or 1×10^{-7} , whereas the ROD requirement for cleanup is based upon achieving acceptable human health risk conditions at an acceptable level based upon 1×10^{-5} . As a result these comparisons criteria are conservative.

Based on historical detections, target analytes for marine sediment, freshwater sediment, and surface water at Palisades Landfill are total PCBs and Aroclors, bis(2-ethylhexyl)phthalate, PAHs, antimony, arsenic, chromium, and nickel. Target analytes for tissue at Palisades Landfill are PCB congeners.

3.4.2 SWMU 13, Metals Landfill

The Metals Landfill was closed in 1996. The ROD-specified RAOs for the Metals Landfill are to protect human and ecological receptors from exposure to landfill debris and soil that could result in a cancer risk greater than 1×10^{-5} , or a noncancer risk above a hazard index of 1.0. The ROD remedy is a combination of institutional and engineering controls. The ROD (Section 7.1.1) concluded that placing a cover over the landfill and subsequent monitoring were an adequate and final remedy because the cover prevents direct exposure of debris and surface soil to human and ecological receptors, and monitoring will verify that there are no downgradient impacts. Future land use is restricted to recreational or industrial uses. Residential use is prohibited. Groundwater for domestic use is also prohibited.

The remedy requires periodic collection of fresh surface water, freshwater sediment, and intertidal sediment for chemical analyses. Marine tissue samples may also be collected for chemical analyses as part of the Kuluk Bay risk assessment. The OU A ROD is the legal instrument through which institutional controls have been prescribed. The institutional controls prohibit residential use at SWMU 13, restrict land use to recreational or industrial applications, restricts groundwater use, and prohibits excavation. The ICMP describes implementation and monitoring of institutional controls at OU A and reporting of inspections. Language constituting an equitable servitude is included in the Interim Conveyance that transfers the property from the United States to The Aleut Corporation so that the use restrictions run with the land and are binding on future landowners. Engineering controls require periodic collection of fresh surface water and groundwater samples for chemical analyses. Site conditions will be reviewed every 5 years to evaluate protectiveness of the remedy as part of the engineering controls. Annual site visits will be conducted to inspect engineered controls.

To date, 10 post-closure sampling events at the Metals Landfill have occurred from 1996 through 2002. Groundwater samples were collected from eight locations and were analyzed for VOCs, SVOCs, PCBs, pesticides, TIN, and DIN. Surface water seep samples have not been collected because seeps have not been observed and there is no requirement in the ROD for surface water sampling.

Dissolved inorganics (antimony, arsenic, barium, cadmium, chromium, iron, manganese, selenium, and zinc) and total inorganics (arsenic, barium, chromium, copper, iron, manganese, selenium, and vanadium) were detected at least once at concentrations above the background level in groundwater samples from Metals Landfill between 1996 and 2002 (U.S. Navy 2003e and 2003f).

VOCs (1,1-dichloroethane; 1,1,1-trichloroethane; 1,2-dichlorobenzene; 1,2-dichloroethane; 1,2,4-trichlorobenzene; 1,3-dichlorobenzene; 1,4-dichlorobenzene; acetone; benzene; carbon disulfide; chlorobenzene, chloroethane; chloromethane; cis-1,2-dichloroethene; dichlorodifluoromethane; methylene chloride; tetrachloroethene; toluene; trans-1,2-dichloroethane; trichloroethene; vinyl chloride; xylenes] and SVOCs [anthracene; bis[2-ethylhexyl]phthalate; butylbenzylphthalate; di-n-octylphthalate) have been detected in groundwater at low concentrations between 1996 and 2002. However, during the most recent sampling event (in 2002), the only organic compound reported above the reporting limit was 1,4-dichlorobenzene. No pesticides/Aroclors were detected in either 2001 or 2002. Tissue results are summarized in Section 3.5.

Annual monitoring will include sampling of groundwater and blue mussel tissue. Sampling of blue mussel tissue is currently being conducted as described in the marine tissue monitoring plan (Appendix C) in relation to the Kuluk Bay risk assessment. Five-year reviews will be conducted

to evaluate monitoring data and site conditions to determine the need for additional action or reduction of controls, as appropriate. Monitoring requirements will also be reviewed every 5 years, in conjunction with Alaska DEC and EPA, to re-evaluate the need for monitoring, monitoring frequency, and target analytes.

Comparison criteria for surface water sampling results are the Alaska surface water quality standards (18 AAC 70.020[a][1][C]) for toxic and other deleterious organic and inorganic substances. Comparison criteria for marine and freshwater sediment samples are human health and ecological RBSCs. These criteria are presented in Appendix F. As stated in the ROD Section 6.1, these criteria are based upon a cancer risk of 1×10^{-6} or 1×10^{-7} , whereas the ROD requirement for cleanup is based upon achieving acceptable human health risk conditions at an acceptable level based upon 1×10^{-5} . As a result, these comparison criteria are conservative.

Target analytes for groundwater at Metals Landfill are bis(2-ethylhexyl)phthalate, chlorobenzene, 1,4-dichlorobenzene, 1,3-dichlorobenzene, ethenes, arsenic, and barium. PCBs have been dropped from the list of analytes because PCBs have not been detected in groundwater samples collected at the site since 1991. Target analytes for tissue in Kuluk Bay, (Metals Landfill is adjacent to Kuluk Bay) are PCB congeners.

3.4.3 SWMUs 18/19, White Alice Landfill

White Alice Landfill was closed in 1997. The remedy was to place an engineered cap over the landfill and to initiate a monitoring program. According to Alaska solid waste regulations 18 AAC 60.490, groundwater monitoring is required for monofills such as the White Alice Landfill only if Alaska DEC determines that it is necessary to protect the public health, safety, or welfare, or the environment. Quarterly monitoring of surface water and groundwater was conducted in 1996 and annual monitoring has been ongoing since 1997. Results of the monitoring is reported on an annual basis. Monitoring requirements will be reviewed every 5 years, in conjunction with Alaska DEC and EPA, to re-evaluate the need for monitoring, monitoring frequency, and target analytes.

Dissolved inorganics (arsenic and zinc) and total inorganics (barium, chromium, and iron) were detected at least once at a concentration above background levels in the wells sampled at White Alice Landfill between 1996 and 2002 (U.S. Navy 2001, 2003e, and 2003f). VOCs in groundwater were reported at concentrations greater than the reporting limit in 1996; however, VOCs were not reported above the reporting limit in subsequent sampling events. The following constituents were detected at least once above the reporting limit in the surface water sampled at White Alice Landfill between 1996 and 2002 (U.S. Navy 2001, 2003e, and 2003f): total inorganics (arsenic, barium, chromium, cobalt, copper, iron, lead, manganese, nickel, vanadium,

and zinc). The only VOC detected in surface water at a concentration greater than the reporting limit was carbon disulfide (in 1997). Carbon disulfide was not detected in subsequent samples.

Analytical results for surface water sampling will be compared to Alaska surface water quality standards (18 AAC 70.020) for toxic and other deleterious organic and inorganic substances. Groundwater analytical results will be evaluated as specified in 18 AAC 60 and 18 AAC 70.

Target analytes for groundwater and fresh surface water at the White Alice Landfill are arsenic, barium, nickel, and chromium.

3.4.4 SWMU 25, Roberts Landfill

Roberts Landfill was closed in 2002. Quarterly monitoring was conducted in 1995, and annual monitoring has been ongoing since 1996. Monitoring includes sampling of surface water and groundwater. Groundwater monitoring is generally required for Class II landfills, such as Roberts Landfill, for 30 years (18 AAC 60.397[a][3]). Alaska solid waste regulation 18 AAC 60.397(b)(1) indicates that the length of the post-closure care period may be decreased if Alaska DEC finds that the reduced period is sufficient to protect public health and the environment. Results of the monitoring will be reported annually. Monitoring requirements will be reviewed every 5 years, in conjunction with Alaska DEC and EPA, to re-evaluate the need for monitoring, monitoring frequency, and target analytes.

Total inorganics (barium, chromium, cobalt, copper, iron, lead, manganese, nickel, vanadium, and zinc) were detected at least once at a concentration above background levels in the wells sampled at Roberts Landfill between 1996 and 2002 (U.S. Navy 2001, 2003e, and 2003f). VOCs in groundwater were reported at concentrations greater than the contract required quantitation limit in 1996; however, between 1997 and 2002, only ethylbenzene, toluene, and total xylenes were reported once (in 2000) above the contract required quantitation limit. The following constituents were detected at least once above the contract required quantitation limit in the surface water sampled at Roberts Landfill between 1996 and 2002 (U.S. Navy 2001, 2003e, and 2003f): total inorganics (antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, thallium, vanadium, and zinc). VOCs (1,1-dichloroethane; 2-butanone, 2-chloroethyl vinyl ether; 4-methyl-2-pentanone; acetone, carbon disulfide, chloroethane, chloromethane, cis-1,2-dichloroethene; isobutyl alcohol, methylene chloride, naphthalene, and trichlorofluoromethane) were detected in surface water at a concentration greater than the contract required quantitation limit in 1996 or 1997; of these, only 1,1-dichloroethane, chloroethane, cis-1,2-dichloroethene, and methylene chloride have been detected above the contract required quantitation limit in subsequent sampling events between 1998 and 2000. No VOCs were detected above the contract required quantitation limit in surface water between 2001 and 2002.

Comparison criteria for surface water sampling results are the Alaska surface water quality standards (18 AAC 70.020[a][1][C]) for toxic and other deleterious organic and inorganic substances. Comparison criteria for marine and freshwater sediment samples are human health and ecological RBSCs. These criteria have been presented in Appendix F. As stated in the ROD Section 6.1 these criteria are based upon a cancer risk of 1×10^{-6} or 1×10^{-7} , whereas the ROD requirement for cleanup is based upon achieving acceptable human health risk conditions at an acceptable level based upon 1×10^{-5} . As a result, these comparison criteria are conservative.

Target analytes for groundwater and fresh surface water at Roberts Landfill are ethenes, BTEX, and priority pollutant metals.

3.5 MARINE TISSUE MONITORING

The purpose of marine tissue monitoring is to evaluate PCB concentrations in blue mussel and rock sole organisms from Sweeper Cove and Kuluk Bay with respect to overall site management. This includes reduction and elimination to the maximum extent practical of terrestrial sources to limit human and ecological exposures to Adak, as well as to minimize any migration to surface waters and the marine environment. The monitoring program is expected to provide results that show decreasing levels, no change, or increasing levels. These results will then be reviewed in the context of the effectiveness of the overall site management strategy. In addition, the subsistence level risk assessment for Kuluk Bay indicated a potential adverse risk associated with the level of consumption of blue mussel and rock sole from Sweeper Cove and Kuluk Bay. Therefore, the baseline marine tissue monitoring program will also evaluate the need for continued consumption advisories of these organisms from these two water bodies.

Marine tissue samples were collected on an annual basis for baseline marine tissue monitoring program over a 5-year period at Sweeper Cove and Kuluk Bay. The last sampling effort was conducted in 2003. Marine sampling efforts conducted prior to 2003 are as follows:

- Marine sampling for OU A RI/FS report (U.S. Navy 1997a)
- Marine sampling for Kuluk Bay risk assessment (U.S. Navy 1997b)
- U.S. Geological Survey (USGS) Biological Resources Division (BRD) investigations of PCBs and other organochlorine compounds in the Aleutian chain (1996 and 1999 through 2002)

The blue mussel average PCB concentration for the 1999 samples is significantly less than the average for two samples collected in Sweeper Cove in 1994, slightly below the average of six samples collected in July 1996 and slightly above the RBSC concentration of 0.031 mg/kg. With the exception of a single sampling location (inner Sweeper Cove), all PCB concentration levels in blue mussel tissue from the 2000 field season were below the RBSC of 0.031 mg/kg.

The primary conclusion drawn from the 2000 fish sampling data is that three of four species sampled in Kuluk Bay during the summer of 2000 contain mean PCB concentrations less than the RBSC of 0.0065 mg/kg given as a remedial action criterion in the OU A ROD. The species with mean PCB concentrations less than the RBSC are greenling, rock sole, and gray cod.

The data for the sampling efforts for 2001 through 2002 are currently not available and have not been evaluated in terms of trends. These data will be evaluated after the 2003 sampling event.

Remedial actions to control sources of PCBs affecting Sweeper Cove and Kuluk Bay were completed in 1999. Prior to the remedial actions, PCBs were detected in 18 of 19 sediment sampling stations in Sweeper Cove, but no areas with elevated PCB concentrations were found that would be candidates for active remedial action. PCBs were detected in only 1 of 19 sediment sampling stations in Kuluk Bay. Therefore, the preferred remedial alternative for Sweeper Cove and Kuluk Bay was identified as a combination of institutional controls, advising subsistence fishers of the potential risks associated with the consumption of certain species of fish and shellfish, and chemical monitoring of fish and shellfish tissue contaminant concentrations.

The 4 years of data will be evaluated separately for each embayment. In addition, blue mussel tissue samples will be collected annually with some of these locations proximal to SWMUs 11 and 13. If PCB concentrations in shellfish and rock sole collected in an embayment drop below the established RBSCs, the fishery advisory will be removed for that embayment and the tissue sampling may be discontinued. Similarly, if the target-analyte concentrations in blue mussel collected near the landfills remain below the RBSCs in Appendix F through the 2003 sampling event, then the tissue sampling may be discontinued.

Sampling in 2003 will consist of five composite samples of rock sole tissue and five composite samples of blue mussel tissue in each of three embayments: Sweeper Cove, Kuluk Bay, and Bay of Islands. The Bay of Islands will serve as a background location. Target analytes for marine tissue monitoring are PCB congeners, as specified in the marine tissue monitoring plan. The marine tissue monitoring plan (Appendix C) describes specific sampling methods and procedures.

3.5.1 Trend Evaluation

The primary purpose of the tissue analytical data from the landfills is to evaluate whether general trends are developing over the course of the monitoring program and to identify evidence of releases from the landfill.

Data analysis of the biomonitoring results will be performed using a regression analysis to track the temporal change in PCB concentrations in mussels and fish species. This analysis will be used to evaluate whether PCB concentrations are decreasing (as expected) and to predict how long it will take to reach the endpoints discussed in Section 3.4.2. The “best fit” linear or nonlinear regression equation will be selected and used to estimate the temporal trends. The best-fit equation will be identified as the equation with the largest coefficient of determination and/or the smallest residual sum of squares. Previously collected data have been shown to be lognormally distributed. Subsequent data collected under this CMP is assumed to be lognormally distributed. The concentration values will be transformed logarithmically and used in a regression relationship with years. Samples with “nondetected” as a result will be assigned a concentration value of one-half the detection limit before any statistical analyses are performed. All data from an embayment will be pooled on an annual basis to reflect the general integration of harvest patterns for blue mussels and of feeding and home range for the finfish.

The slope of any concentration trend over time should be demonstrated to be significantly different from zero by using a statistical test, such as the Mann-Kendall test (Gilbert 1987). The data set, or the transformed data set, should be checked to verify assumptions of normality for the regression relationship and for heterogeneity of variances for the purposes of data pooling. After these tests and after discussion with regulatory agencies, the framework for evaluation may be modified. The marine tissue monitoring plan in Appendix C lists the procedures to test data sets for normality. The specific test to be used is determined by sample size.

3.5.2 Monitoring Endpoints

Analytical results for marine tissue sampling will be compared to the RBSCs presented in Appendix F. This comparison is to determine if target analytes may have affected the downgradient surface water body.

Two approaches for identifying endpoints will be evaluated to determine if PCB concentrations have decreased to acceptable levels: comparison to human health risk-based PCB concentrations and comparison to background PCB concentrations. The human health risk-based action levels were established in the OU A ROD (U.S. Navy, Alaska DEC, and USEPA 2000) as 0.0065 mg PCBs/kg fresh-weight tissue for fish and 0.031 mg PCBs/kg fresh-weight tissue for shellfish. Human health RBSCs were calculated based on the cancer effects of PCBs using the OU A ROD

specified lifetime cancer risk of 10^{-5} . The background PCB concentrations will be established by collecting samples from Bay of Islands. Sweeper Cove and Kuluk Bay results will be analyzed separately so that a determination can be made separately for each water body. Pooling samples from Kuluk Bay and Sweeper Cove limits the ability to detect declines in contaminant concentrations in individual embayments.

Remedial project managers may elect to use the results of the regression analysis to suspend further monitoring, if it can be satisfactorily shown that PCB concentrations in biota will reach the action levels or reference area concentrations within an acceptable time frame. Based on the results of these statistical tests and discussions with regulatory agencies, the framework for evaluation may be modified.

EPA provides guidance on the statistical methodology for evaluating tissue residue data. Their recommended statistical methodology is to compare the arithmetic mean concentration of target analytes measured in replicate composite samples to the action level using hypothesis testing (USEPA 2000). The null hypothesis is that PCB concentrations in biota at a site are less than or equal to the action level or reference area concentration. If hypothesis testing shows that the PCB concentrations in mussels or fish from either Sweeper Cove or Kuluk Bay are less than or equal to the action level or reference area concentrations, remedial project managers may decide to suspend further monitoring and remove institutional controls that advise people of potential health hazards from consumption of fish and shellfish.

3.6 INSTITUTIONAL CONTROLS

Institutional controls are defined as those legal mechanisms that ensure that restrictions on land use and any engineering requirements put in place to implement the selected remedy are maintained (U.S. Navy, Alaska DEC, and USEPA 2000; Section 8.1.2). The identified institutional controls are land use restrictions, deed restrictions/restrictive covenants, fishing advisories, groundwater use restrictions, and, on an area-wide basis, soil excavation restrictions. The controls vary with the site or area. Conducting site visits and inspections on a regular basis and making repairs or upgrades as necessary are the associated operation and maintenance requirements.

3.6.1 Engineering Requirements

Engineering requirements are site monitoring (which involves groundwater, surface water, sediment, and tissue sampling) and site inspections (including visual inspections of landfill caps, fences and gates, monitoring wells, and sample locations) to determine the status of the remedial action and the effectiveness of institutional controls, and educational requirements (which involve classroom orientation to convey information about potential health and safety issues or

risks to residents of or visitors to Adak Island). Two other engineering requirements are signage (of landfill caps, fishing advisory, and ordnance) and the “dig permit.”

3.6.2 Land Use Requirements

Institutional controls are viable alternatives and focus on preventing certain land uses. Depending on the type of institutional control, these controls may be removed in the future by petitioning the regulatory agencies and by a clear demonstration (e.g., monitoring results) that site conditions no longer warrant the particular controls.

3.6.3 Endpoint Criteria

If a remedy has performed as expected and cleanup objectives have been met, vacation of portions of the restrictions in the Interim Conveyance and/or revision of other institutional controls put in place to ensure the protectiveness of the remedy will be required. Institutional controls can be removed once it has been demonstrated that the site is suitable for unrestricted use. For example, if an intended action will alter or negate the need for the institutional control (e.g., a construction activity that will include removing contamination on site that forms the basis for the institutional control), the institutional control will be removed after EPA and Alaska DEC concurrence. Another example is documented evidence that the site has achieved its RAOs and met appropriate cleanup levels such that the institutional control is no longer necessary to protect human health and the environment.

In such a case, the institutional controls will be revised as appropriate. The EPA and Alaska DEC will be petitioned to remove or terminate the institutional control. The written petition will provide the appropriate documentation that an unrestricted land use is appropriate. Vacating provisions of the Interim Conveyance must be accomplished in accordance with the terms of the conveyance.

**Figure 3-1 Logic Flow Diagram for Limited Groundwater Sampling Sites and
Monitored Natural Attenuation Sites**

**Table 3-1
Landfill Closure Dates, Classes, and Remedy Types**

Landfill	Closure Date	Landfill Class	Remedy Type
SWMU 2 (Causeway Landfill)	Early 1960	Nonmunicipal	Institutional controls
SWMU 4 (South Davis Road Landfill)	Late 1940	Nonmunicipal monofill	Institutional controls
SWMU 11 (Palisades Landfill)	1996	Nonmunicipal	CERCLA compliance, institutional controls
SWMU 13 (Metals Landfill)	1996	Nonmunicipal	CERCLA compliance, institutional controls
SWMUs 18/19 (White Alice Landfill)	1997	Nonmunicipal monofill	State solid waste compliance, institutional controls
SWMU 25 (Roberts Landfill)	2002	Class II – Municipal	State solid waste compliance, institutional controls
SWMU 29 (Finger Bay Landfill)	1975	Municipal	Institutional controls