United States Air Force
611th Civil Engineer Squadron

Elmendorf AFB, Alaska

Final
Baseline Risk Assessment Report
Galena Airport
Alaska

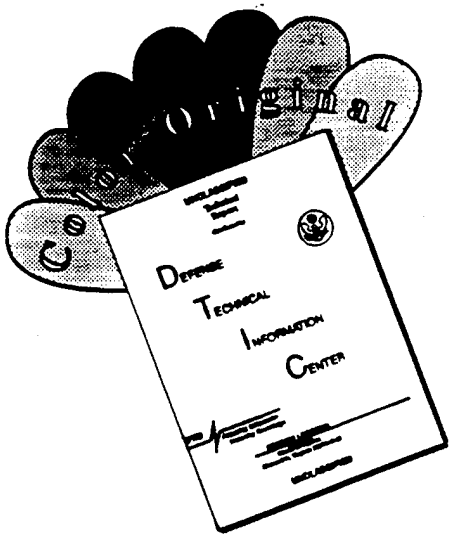
Volume 1 - Text

March 1996

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United States Air Force
611th Civil Engineer Squadron

Elmendorf AFB, Alaska

Final

Baseline Risk Assessment for the Fire Protection Training Area, POL Area, and the West Unit Source Areas of Galena Airport, Alaska

Volume 1—Text

March 1996

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EXECUTIVE SUMMARY

The U.S. Air Force (USAF), under the Installation Restoration Program (IRP), has conducted a remedial investigation (RI) at Galena Airport (formerly Galena Air Force Station). Within the framework of the IRP, the objective of the RI is to evaluate past hazardous waste disposal and spill sites at Galena Airport. The RI determines the nature and extent of possible contamination, identifies site physical characteristics that may affect contaminant distribution, and defines possible migration pathways.

A baseline risk assessment (BRA) was conducted to support the RI. The BRA determines whether there is a possible threat to human health and/or the environment attributable to the sites under investigation. For sites that pose an unacceptable threat to either human health or the environment, remedial actions will be developed.

ES.1 Background

Volumes 1-3 of this report present an assessment of the current and possible future risks to human health and the environment potentially attributable to three IRP sites at Galena Airport:

1. The Fire Protection Training Area (FPTA);

2. The POL Tank Farm; and

3. The West Unit.

The West Unit includes seven source areas: 1) Waste Accumulation Area; 2) Million Gallon Hill; 3) Power Plant UST No. 49; 4) JP-4 Fillstands; 5) Building 1845; 6) Building 1700; and 7) Building 1850. Only screening level data are available at this time for Building 1850; therefore, this source area is not included in the quantitative evaluation of risks. On the basis of the RI results, it has been recommended that Bldg. 1850 be removed as a continuing source area in the West Unit. A No Further Response Action (NFRAP) document will be prepared if the Alaska Department of Environmental Conservation (ADEC) accepts this recommendation.

The RI was completed for these three sites in early 1995. The RI report (USAF, 1995c) documents the investigations conducted during 1992, 1993, and 1994 at these sites, presents the results of sampling and analysis, and provides a basis for conclusions regarding the nature and extent of contamination. The BRA is based on the results and conclusions of the RI.

Additional sampling and analysis was conducted in the summer of 1995 at two more sites: the Southeast Runway Fuel Spill and the Control Tower Drum Storage Area, South. The Volume 4 Addendum addresses these two sites.

ES.2 Human Health Assessment

The overall strategy for the human health assessment as well as the technical approach used for individual steps conform to U.S. Environmental Protection Agency (USEPA) recommendations (USEPA, 1989b). Risks were evaluated for a range of potentially exposed human populations, including on-base residents, off-base (Galena) residents, on-base workers, and on-base boarding school students (hypothetical). The results of the human health assessment are presented as cancer risk estimates (an estimate of the incremental probability of developing cancer) and noncancer hazard indices (the ratio of an estimated exposure level to a level considered unlikely to cause adverse effects, summed for all chemicals with similar toxic endpoints).

For carcinogenic effects, the USEPA Superfund site remediation goal set forth in the National Contingency Plan (NCP) designates a cancer risk of 10^{-4} (1 in 10,000) to 10^{-6} (1 in one million). This range is designed to be protective of human health and to provide flexibility for consideration of other factors in risk management decisions. A cancer risk of 1 in one million is considered the *de minimis*, or a level of negligible risk. A cancer risk higher than 1 in one million is not necessarily considered unacceptable. The State of Alaska plans to use a cancer risk level of 10^{-5} (1 in 100,000) in making risk management decisions (USAF, 1996b). For noncarcinogenic effects, the Superfund site remediation goal is a total hazard index (HI) of 1 for chemicals with similar toxic endpoints.

Of the numerous chemicals detected in environmental media at the three sites, only two chemicals pose an estimated risk in excess of 1 in one million: benzene at all three sites and arsenic in the West Unit. Estimated noncancer HIs are below 1, the Superfund site remediation goal for noncarcinogens, for all scenarios at all three sites. An evaluation of combined impacts indicates that combining scenarios (e.g., child and adult), or adding individual site contributions to media at the same location, does not substantially increase the estimated cancer risks or noncancer HIs.

Risks associated with residual petroleum at the sites are addressed by quantifying risks for individual chemicals that are components of the residual petroleum. The results of the risk assessment can be used to evaluate the need to remediate diesel range organics (DRO) and gasoline range organics (GRO), but are not intended to be used to establish alternate cleanup levels for DRO and GRO. Remediation issues related to DRO, GRO, and free product are to be addressed outside the risk assessment.

Fire Protection Training Area

Estimated incremental cancer risks for all scenarios except the long-term on-base worker (reasonable maximum case) and construction worker (average and reasonable maximum cases) are below 1 in one million, considered the *de minimis*, or level of negligible risk. Estimated risk for the reasonable maximum long-term worker equals 1 in one million. The cancer risks estimated for the construction worker exceed 1 in one million but are well below the high end of the Superfund risk range goal of 1 in 10,000 and the State of Alaska target risk level of 1 in 100,000. Estimated noncancer HIs are below 1 for all scenarios.

If the subsurface soils are left undisturbed, risks posed by the FPTA are negligible for all human populations that might encounter site-related contaminants. On the basis of the results of the human health assessment, remedial action at the FPTA is not warranted as long as the airport remains operational or the land use remains industrial.

POL Tank Farm

The estimated incremental cancer risks for the long-term on-base worker and construction worker scenarios are greater than 1 in one million but do not exceed the high end of the Superfund risk range goal for carcinogens (1 in 10,000). Only the estimated risks for the construction worker exceed the State of Alaska target risk level of 1 in 100,000. The reasonable maximum cancer risk estimates for the short-term on-base worker and boarding school student scenarios slightly exceed 1 in one million. Estimated incremental cancer risks for all other scenarios at the POL Tank Farm are below 1 in one million. Estimated noncancer HIs are below 1 for all scenarios.

Inhalation of benzene that volatilizes from the subsurface soil contributes virtually

100% of the risk for the construction worker and 90 - 97% of the risk for other scenarios. The estimated annual average concentration of benzene in the air at the POL Tank Farm from volatilization from subsurface soils is 4.2 $\mu g/m^3$. Assuming excavation activities that expose the subsurface soils, the estimated concentration of benzene in the air during construction work is 2700-2800 $\mu g/m^3$.

Air sampling conducted by the USAF in and around the entire Galena Airport indicates that elevated levels of benzene due to anthropometric-related activities exist in the entire area surrounding Galena. Benzene results in the POL area ranged from 0.54 to 10 $\mu g/m^3$ upwind and 1.2 to 30 $\mu g/m^3$ downwind (USAF, 1994b). The air sample results may be due to refueling operations, vehicular traffic, and aircraft activity, in addition to any contribution from benzene-contaminated soils. It is not possible to differentiate the sources contributing to the measured concentrations of benzene in the air. It is possible that the contribution of benzene emissions from contaminated soils is minor when compared with sources related to the operation of an airport. Risks that slightly exceed 1 in one million for the long-term on-base worker cannot be distinguished from the risks of exposure to benzene in the air contributed by other sources. Eliminating the risk associated with volatilization from the soils in all likelihood would not substantially reduce the risk of benzene exposure for the on-base worker.

The emission estimates for benzene from subsurface soil during construction work are likely biased high. The construction worker scenario assumes that a worker will work in the immediate vicinity of the POL Tank Farm for 8 hours/day, 5 days/week for 3 to 6 months and that soil excavation/moving activities will occur over this entire time period. Moreover, the emissions calculation assumes that all subsurface soils containing benzene will be exposed and essentially become surface soils. Actual risks to a worker excavating soils in the POL area are probably much lower.

Moreover, the estimated benzene concentration from volatilization from subsurface soil is well below the proposed American Conference of Government Industrial Hygienists (ACGIH) threshold limit value (TLV) of 960 $\mu g/m^3$ and the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) of 3,200 $\mu g/m^3$ for worker exposure to benzene. Although the estimated concentration of benzene in air during construction work exceeded the proposed ACGIH TLV, the TLV is designed to be protective of long-term worker exposure. In the construction worker scenario, the estimated high air concentrations are only expected to occur for a few weeks to a few months.

On the basis of the results of the human health assessment, remedial action at the POL Tank Farm is not warranted.

West Unit

Estimated incremental cancer risks for the on-base residents, Old and New Town Galena residents, and boarding school students are below 1 in one million. The average and reasonable maximum cancer risk estimates for the short-term on-base worker and the construction worker either equal or slightly exceed 1 in one million. The average and reasonable maximum cancer risk estimates for the long-term on-base worker equal and slightly exceed 1 in 100,000, respectively. None of the estimates exceeds the high end of the Superfund risk range goal (1 in 10,000). Only the reasonable maximum estimate for the long-term on-base worker exceeds the State of Alaska target risk level of 1 in 100,000. Estimated noncancer HIs are below 1 for all scenarios.

Similar to the other two sites, inhalation of benzene that volatilizes from soils (primarily from surface and subsurface soil at Bldg. 1700 and from subsurface soil at the JP-4 Fillstands) contributes the highest percentage of the estimated risk for the worker scenarios. The above discussions on estimated and measured benzene concentrations at the installation, the ACGIH TLV and OSHA PEL, and the methodology used to estimate benzene emissions during construction work, also apply to the West Unit.

However, in the West Unit, risks higher than 1 in one million are also attributable to incidental ingestion of and dermal contact with soils containing arsenic. Arsenic is a chemical of potential concern in surface soil at Bldg. 1700 and in the subsurface soil at the Power Plant UST No. 49, Bldg. 1845, and Bldg. 1700 only because there were three or fewer results at these locations in these media and a statistical comparison with background concentrations could not be performed. The maximum detected concentrations of arsenic in soils at these locations are well below both the background upper tolerance limit (UTL) and 95% upper confidence limit (UCL) for arsenic in surface and subsurface soils. There is no reason to suspect that concentrations of arsenic at Bldg. 1700, Bldg. 1845, or the Power Plant UST No. 49 might be elevated above background. There is no known or suspected source for arsenic at these locations. Indeed, if risks for the same scenarios were computed using the background 95% UCL concentrations, risk due to contact with arsenic at the background location would be higher than the corresponding risk estimates at the West Unit.

Estimated risks for the West Unit scenarios cannot be distinguished from the risks of exposure to benzene in the air contributed by sources associated with an operating airport or from the risks of exposure to background levels of arsenic in soils. Therefore, on the basis of the results of the human health assessment, remedial action at the West Unit is not warranted.

ES.3 Ecological Assessment

Ecological risk assessment is defined as a process that evaluates the likelihood that adverse ecological effects may occur, or are occurring, as a result of exposure to one or more stressors (e.g., chemical contaminants). The methodology used to conduct the ecological assessment conforms to USEPA guidance (USEPA, 1992b). An in-depth ecological assessment problem formulation was completed for the Galena Airport (USAF, 1995e) prior to conduct of the ecological assessment.

Species evaluated for assessment of terrestrial ecosystems included terrestrial invertebrates, the American robin, the Savannah sparrow, the American kestrel, the meadow vole, and the red fox. These species represent several trophic levels in a terrestrial environment and include several upper trophic level species (kestrel and fox). Aquatic invertebrates and the spotted sandpiper, which feeds on aquatic invertebrates, were selected to evaluate the semiaquatic ecosystem (mudflats) at the edge of the Yukon River. The northern pike, a species of fish that is present in the Galena area for most of the year, represented the aquatic ecosystem in the Yukon River. Pike is not a migratory species, as are species of salmon that are present in the Galena area for only short periods of time.

The "quotient method" (Barnthouse et al., 1982; Urban and Cook, 1986) was used to arithmetically compare a toxicity benchmark (TB) concentration (the measurement endpoint) with the chemical-specific intake for each assessment endpoint species. An ecological quotient (EQ) is calculated by the general form:

EQ = Intake (mg/kg-day)/TB (mg/kg-day).

The TB is a reasonable estimate of a contaminant concentration that may result in adverse effects to an assessment endpoint species, if exceeded in a given environmental medium.

The results of the quotient method, the EQ values, were placed in three categories as follows:

- EQ < 1. Those contaminants with EQs less than one were assumed to pose no significant adverse ecological impacts;
- 10 > EQ ≥ 1. Contaminants with EQs greater than or equal to 1 and less than 10 were classified as contaminants of possible concern; and
- EQ ≥ 10. Contaminants with EQs greater than or equal to 10 were classified as contaminants of probable concern.

A high EQ does not necessarily mean that the local population of the species evaluated is at risk. Therefore, using the EQs, the ecological significance of potential impacts was also evaluated. A weight-of-evidence analysis of potential effects on assessment endpoint species was conducted by reviewing the physical, chemical, ecological, and toxicological properties of chemicals with EQs above 1. On the basis of both the EQ values and the weight-of-evidence evaluation, each chemical with an EQ value greater than 1 was rated for potential to cause local population impacts. This population impacts rating (high, medium, or low) provides the initial guidance for the decision-making process. Table ES-1 summarizes the weight-of-evidence findings for local populations of species evaluated in this assessment.

Fire Protection Training Area

Terrestrial Ecosystem—EQs were less than 1 for FPTA plants and terrestrial invertebrates, and for higher trophic level consumers such as the red fox and the kestrel. Through evaluation of the toxicity data and physical properties of the contaminants with EQs above 1, it was determined that only dioxin and fluorene have potential for risk to the meadow vole. The available habitat at the FPTA is small when compared with the surrounding area. Owing to sporadic human activity, the affected area does not represent a high-quality habitat. On the basis of affected area size relative to useable local habitat and the occasional human activity at the site, the population impacts were determined to be low. If surface soils remain in place, the local population of meadow voles should not be adversely affected.

After consideration of physical and chemical properties for contaminants with EQs above 1 for the savannah sparrow, it was determined that DDT, its breakdown products, and dioxin pose a medium to high potential for local population impacts. The grassy open field of the FPTA provides a unique habitat for the savannah sparrow. This field is also an area of breeding for the savannah sparrow. If the surface soils remain in place, risk to the savannah sparrow population from DDT, its breakdown products, and dioxin exist. However, DDT was historically broadcast throughout the Airport, and the FPTA does not represent a unique source of DDT.

Semiaquatic Ecosystem—DDT, dieldrin, heptachlor epoxide, thallium, and lead had EQ levels greater than 1 for the aquatic invertebrate at the semi-aquatic (mudflats) ecosystem. The spotted sandpiper, also at the mudflats, had EQs greater than 1 for lead and DDT. The mudflats represent a transient habitat that is dependent on the level of the Yukon River. Groundwater modeling did not account for volatilization, dilution, or binding of the constituent to sediment. Organochlorine pesticides,

Table ES-1
Summary of Potential for Local Population Impacts

Chemicals with EQs > 1	Assessment Endpoint Species								
	Terrestrial Ecosystem						Semiaquatic Ecosystem (Yukon River Mudflats)		Aquatic Ecosystem (Yukon River)
	Terrestrial Invertebrates	American Robin	Savannah Sparrow	American Kestrel	Meadow Vole	Red Fox	Aquatic Invertebrates	Spotted Sandpiper	Northern Pike
Fire Protection Training Area									
DDT	--	NA	Medium/High	--	--	--	Low	Low	--
DDE	--	NA	Medium/High	--	--	--	--	--	--
DDD	--	NA	Medium/High	--	--	--	--	--	--
Dieldrin	--	NA	--	--	--	--	Low	--	--
Dioxin	--	NA	Medium/High	--	Low	--	--	--	--
Fluorene	--	NA	--	--	Low	--	--	--	--
Heptachlor epoxide	--	NA	--	--	--	--	Low	--	--
Lead	--	NA	--	--	--	--	Low	Low	--
Thallium	--	NA	--	--	--	--	Low	--	--
POL Tank Farm									
DDT	NA	NA	NA	NA	NA	NA	Low	Low	--
DDE	NA	NA	NA	NA	NA	NA	Low	Low	--
DDD	NA	NA	NA	NA	NA	NA	Low	Low	--
Lead	NA	NA	NA	NA	NA	NA	Low	Low	--
Thallium	NA	NA	NA	NA	NA	NA	Low	Low	--
West Unit: Waste Accumulation Area									
DDT	--	Medium/High	NA	Low/Medium	--	--	Low	Medium/High	--
DDE	--	Medium/High	NA	--	--	--	--	--	--
DDD	--	Medium/High	NA	--	--	--	--	--	--
Dieldrin	--	--	NA	--	--	--	Low	--	--
gamma-BHC	Low	--	NA	--	--	--	--	--	--
Lead	--	Low	NA	--	--	--	Low	Low	--

Table ES-1
(Continued)

Chemicals with EQs > 1	Assessment Endpoint Species								
	Terrestrial Ecosystem						Semiaquatic Ecosystem (Yukon River Mudflats)		Aquatic Ecosystem (Yukon River)
	Terrestrial Invertebrates	American Robin	Savannah Sparrow	American Kestrel	Meadow Vole	Red Fox	Aquatic Invertebrates	Spotted Sandpiper	Northern Pike
West Unit: Million Gallon Hill									
DDT	--	Medium/High	NA	Low/Medium	--	--	Medium	Medium/High	--
DDE	--	Medium/High	NA	--	--	--	Low	Medium/High	--
DDD	--	Medium/High	NA	--	--	--	Medium	Medium/High	--
Dibenzofuran	--	Low	NA	--	--	--	--	--	--
gamma-BHC	Low	--	NA	--	--	--	--	--	--
Lead	--	Low	NA	--	--	--	--	Low	--
West Unit: Bldg. 1845									
Aldrin	NA	NA	NA	NA	NA	NA	Low	--	--
Cadmium	NA	NA	NA	NA	NA	NA	--	Low	--
DDT	NA	NA	NA	NA	NA	NA	Low	Medium/High	--
DDE	NA	NA	NA	NA	NA	NA	Low	Medium/High	--
DDD	NA	NA	NA	NA	NA	NA	Low	Medium/High	--
Dieldrin	NA	NA	NA	NA	NA	NA	Low	--	--
Endrin aldehyde	NA	NA	NA	NA	NA	NA	Low	--	--
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	Low	--	--
Lead	NA	NA	NA	NA	NA	NA	Low	--	--
West Unit: JP4-Fillstands									
Aldrin	NA	NA	NA	NA	NA	NA	Low	--	--
Arsenic	NA	NA	NA	NA	NA	NA	Low	Low	--
Barium	NA	NA	NA	NA	NA	NA	Low	Low	--
DDT	NA	NA	NA	NA	NA	NA	Low	Medium/High	--
DDE	NA	NA	NA	NA	NA	NA	--	--	--
DDD	NA	NA	NA	NA	NA	NA	Low	Medium/High	--
Dieldrin	NA	NA	NA	NA	NA	NA	Low	--	--
Endrin aldehyde	NA	NA	NA	NA	NA	NA	Low	--	--
Lead	NA	NA	NA	NA	NA	NA	Low	Low	--
Selenium	NA	NA	NA	NA	NA	NA	Low	Low	--

NA = Not applicable
-- = EQ < 1 or not quantified (not a chemical of potential ecological concern at the site in the medium that is contacted)

including DDT, were historically broadcast throughout the Airport for pest control, and the FPTA does not represent a unique source of DDT. In surface water, lead quickly binds to sediments. On the basis of the dilution effects and the transient nature of the mudflats ecosystem, the potential local population impacts to the spotted sandpiper and aquatic invertebrates are rated minimal to low.

Aquatic Ecosystem—EQs were less than 1 at the aquatic ecosystem (Yukon River) for the northern pike.

POL Tank Farm

Terrestrial Ecosystem—Since there is no habitat for terrestrial species at the POL Tank Farm, the terrestrial ecosystem was not evaluated at this site.

Semiaquatic Ecosystem—Toxic, chemical, and physical effects for those chemicals with EQs exceeding 1 were evaluated for all assessment endpoint species at the mudflats near the POL Tank Farm. For the aquatic invertebrates and the spotted sandpiper, organochlorine pesticides, lead, and thallium potentially could adversely affect these populations. However, organochlorine pesticides historically were used over the entire Airport for insect control, and the POL Tank Farm does not represent a unique area of contamination. Dilution and adsorption to sediments can attenuate the assessment endpoint species' exposure to lead and thallium. On the basis of the transient nature of the mudflats as an ecosystem, and the dilution of the constituents as they enter surface water, the potential impacts of groundwater from the POL Tank Farm on local populations of aquatic invertebrates and the spotted sandpiper at the mudflats are rated minimal to low.

Aquatic Ecosystem—Groundwater originating at the POL Tank Farm that discharges to the Yukon River does not pose a significant risk to the northern pike. EQs for the pike were less than 1.

West Unit

Terrestrial Ecosystem—The only areas of the West Unit with potential for terrestrial impacts were the Waste Accumulation Area and Million Gallon Hill. In both of these areas, only the organochlorine pesticides DDT, DDD, and DDE were determined to pose a medium to high potential for adverse impacts on local populations of the robin. DDT was determined to pose a low to medium potential for adverse impacts on local populations of the kestrel. All other contaminants with EQs greater than 1 were determined to pose only minimal to low potential for adverse population impacts on terrestrial species. Organochlorine pesticides detected at the West Unit do not represent hot spot areas of high concentrations relative to the Galena area in general. These chemicals were historically applied throughout the Airport for pest control.

Semiaquatic Ecosystem—After consideration of toxic and physical properties of contaminants with EQs greater than 1, only organochlorine pesticides (DDT, DDD, and DDE) originating in the groundwater at several source areas were determined to pose a medium to high potential for adverse impacts on local populations of aquatic invertebrates and the spotted sandpiper at the mudflats. All other contaminants with EQs greater than 1 were determined to pose only minimal to low potential for adverse population impacts on these species. As noted above, detections of pesticides in the West Unit are not unique to this site relative to concentrations that are present in the area from historical pesticide applications.

Aquatic Ecosystem—No chemicals were found to pose risk to the northern pike in the Yukon River.

Section 1
INTRODUCTION

The U.S. Air Force (USAF), under the Installation Restoration Program (IRP), has conducted a remedial investigation (RI) at Galena Airport (formerly Galena AFS), Alaska (Figure 1-1). Within the framework of the IRP, the objective of the RI is to evaluate past hazardous waste disposal and spill sites at Galena Airport. The RI determines the nature and extent of possible contamination, identifies site physical characteristics that may affect contaminant distribution, and defines possible migration pathways.

This baseline risk assessment (BRA) was conducted to support the RI. The BRA determines whether there is a possible threat to human health and/or the environment attributable to the sites under investigation. For sites that pose an unacceptable threat to either human health or the environment, remedial actions will be developed.

A draft BRA report was prepared and submitted to the Alaska Department of Environmental Conservation (ADEC) in August 1995. This final BRA report addresses written comments by ADEC on the draft report and reflects decisions made by ADEC at a comment resolution meeting held in February 1996.

1.1 IRP Sites

There are 13 identified IRP sites at the Galena Airport. Figure 1-2 shows the location of the IRP sites, source areas, and other areas of interest at the installation. Table 1-1 summarizes the nomenclature and IRP status for each site and identifies those sites currently under investigation.

Some sites have been closed or are proposed for closure. A BRA is not scheduled for the following sites at this time:

- SS002 Control Tower Drum Storage Area;
- ST003 Petroleum, oils, and lubricants (POL) Fuel Line Leak;
- ST004 JP-4 Fuel Truck Spill; and
- SS007 Drums, Perimeter Dike.

One site, SS006 Waste Accumulation Area, has been incorporated into the West Unit (ST009). Three other sites, LF008-Main Landfill, LF011-Alternate Landfill, and LF012-Southwest Runway Dump, will be addressed separately outside the IRP process.

Five sites remain "active" IRP sites:

- FT001 Fire Protection Training Area (FPTA);
- ST005 POL Tank Farm;
- ST009 West Unit;
- ST010 Southeast Runway Fuel Spill; and
- SS013 Control Tower Drum Storage Area, South.

The West Unit includes seven source areas: 1) Waste Accumulation Area (SS006); 2) Million Gallon Hill; 3) Power Plant Underground Storage Tank (UST) No. 49; 4) JP-4 Fillstands; 5) Building 1845; 6) Building 1700; and 7) Building 1850.

The RI was completed for the FPTA, the POL Tank Farm, and the West Unit in early 1995. The RI report (USAF, 1995c) documents the investigations conducted during 1992, 1993, and 1994 at these sites, presents the results of sampling and analysis, and provides a basis for conclusions regarding the nature and extent of contamination. Additional sampling and analysis was conducted during the summer of 1995 at the

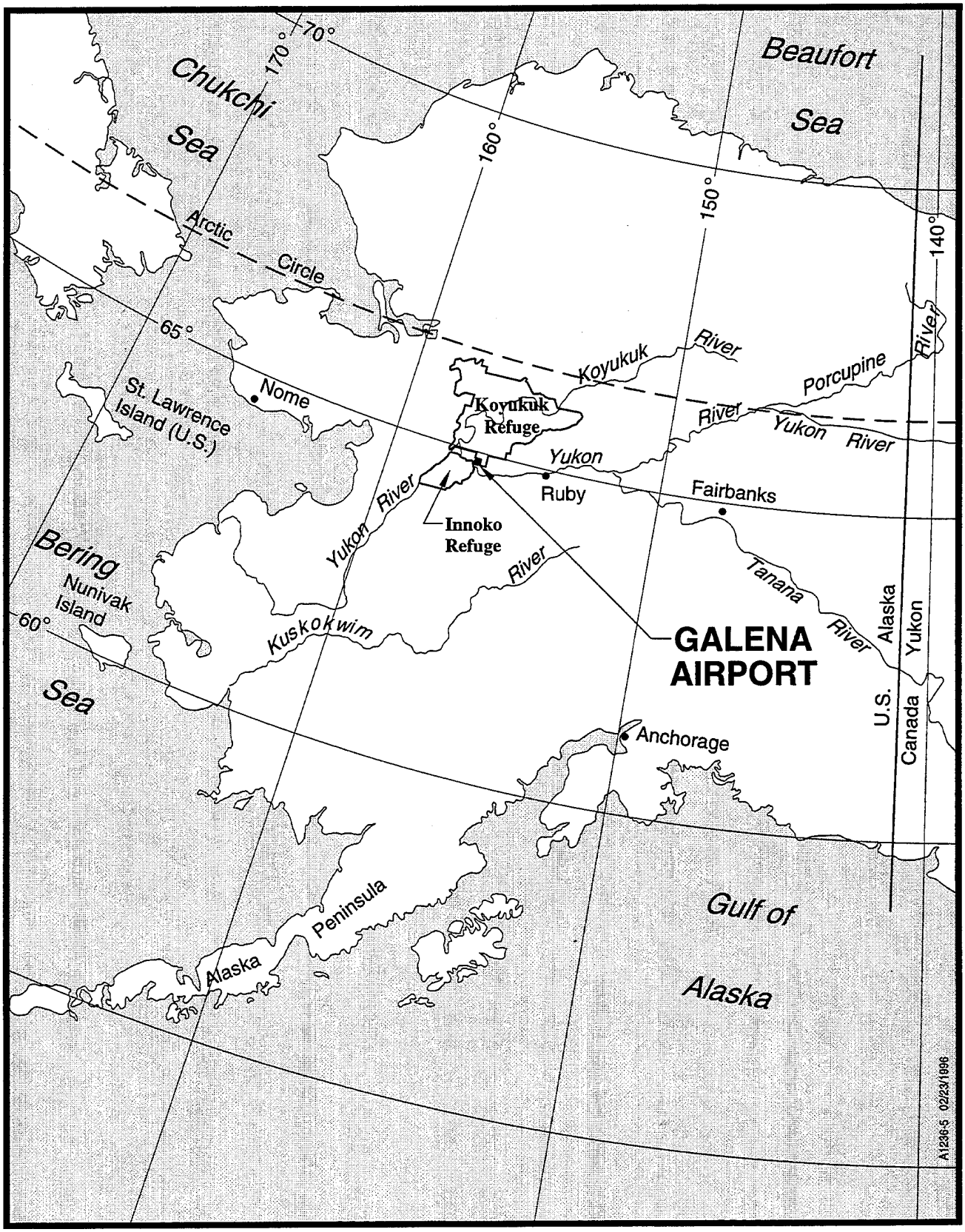
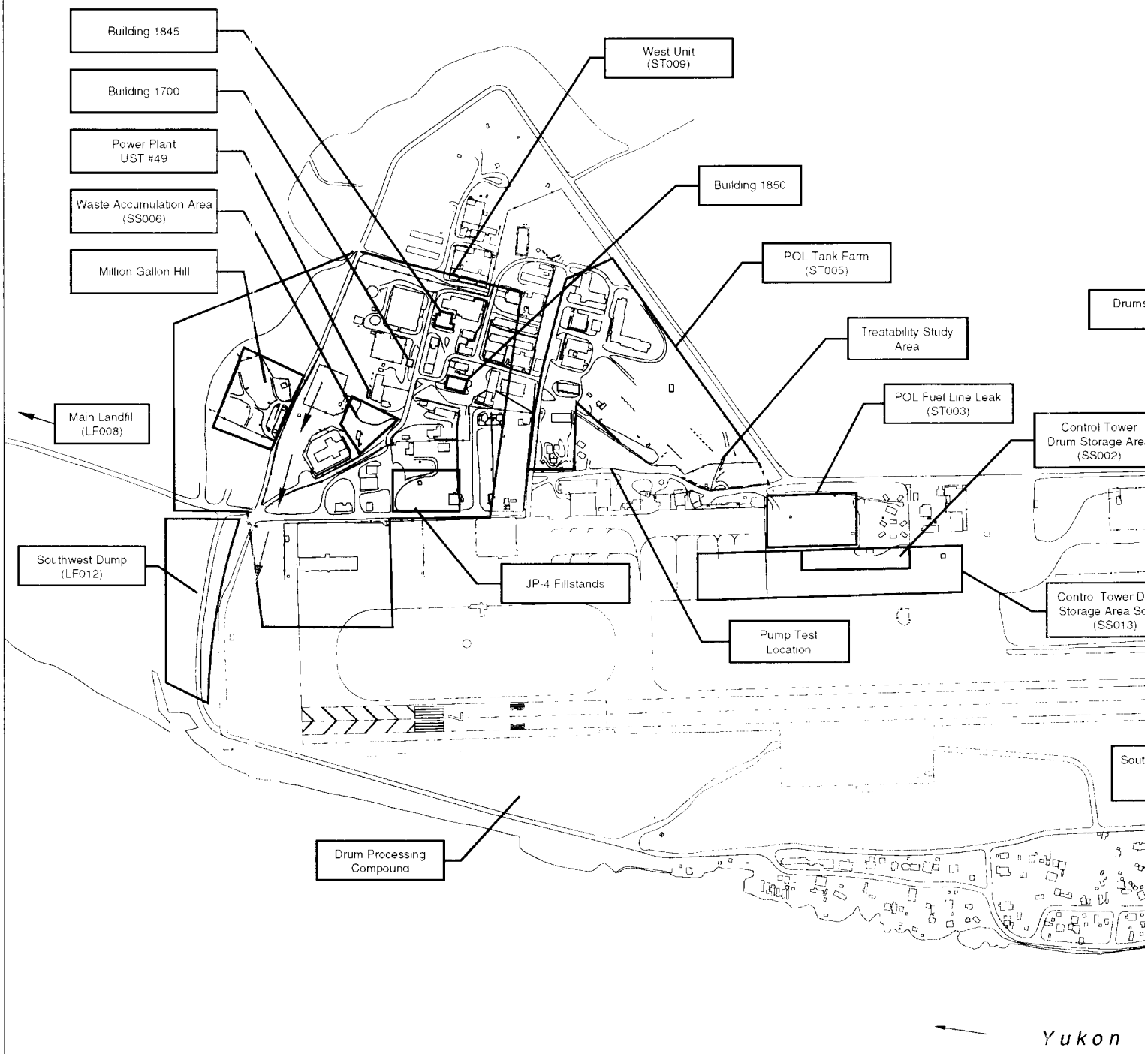


Figure 1-1. Location of Galena Airport, Alaska


Building 1845
Building 1700
Power Plant
UST #49
Waste Accumulation Area
(SS006)
Million Gallon Hill
West Unit
(ST009)
Building 1850
POL Tank Farm
(ST005)
Treatability Study
Area
POL Fuel Line Leak
(ST003)
Main Landfill
(LF008)
Southwest Dump
(LF012)
JP-4 Fillstands
Pump Test
Location
Drum Processing
Compound
Yukon

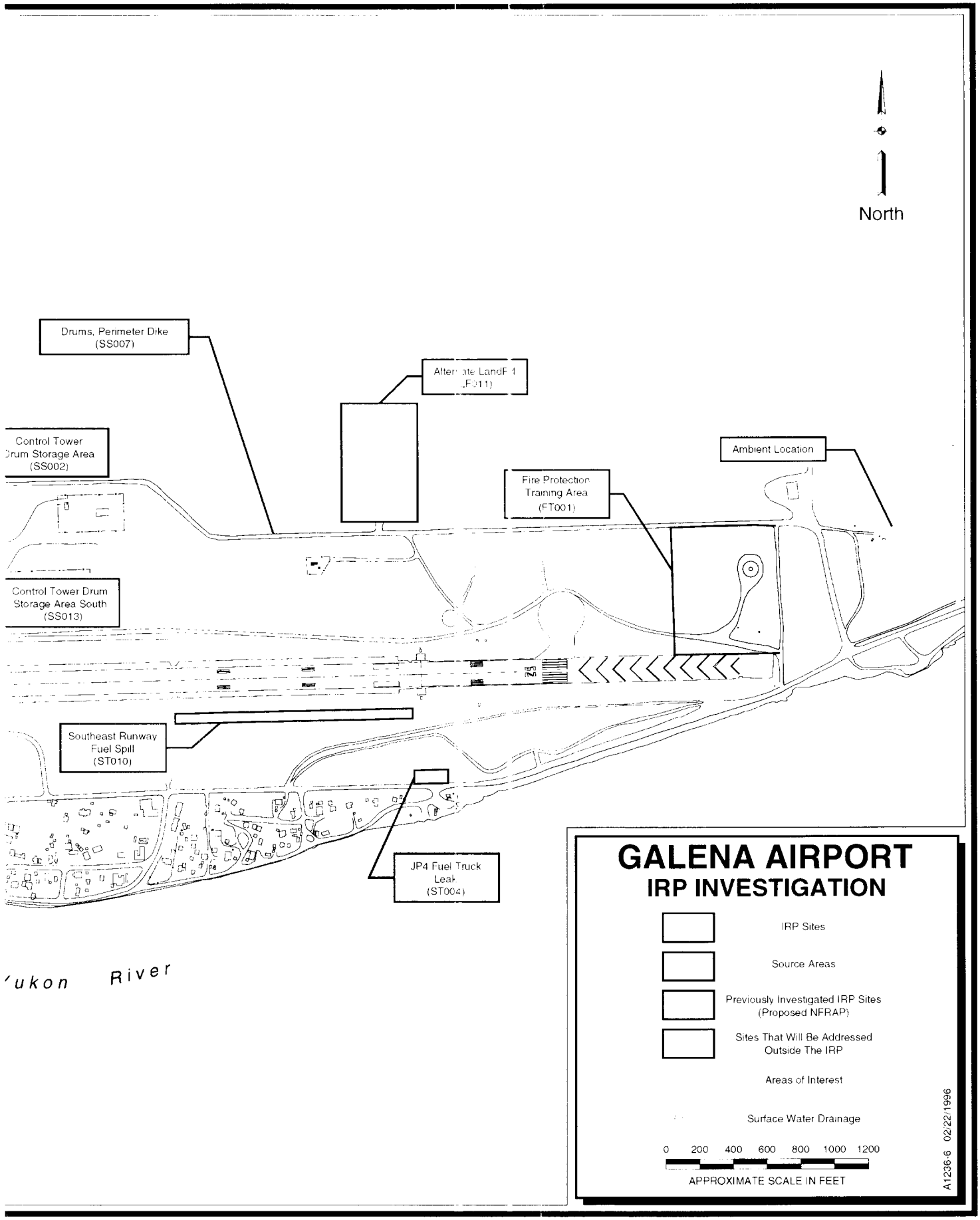


Figure 1-2. IRP Sites and Areas of Interest, Galena Airport, Alaska

Table 1-1
IRP Sites Galena Airport, Alaska

WIMS-ES Site IDs	Site Name	Site/Source Area Description	Current IRP Stage	Included in RI Report
FT001	Fire Protection Training Area	Burn Pit Area	RI	Yes
		Fuel Valve and Piping	PA/SI	Yes
SS002	Control Tower Drum Storage Area	Drum Storage Area, Spill Leak No. 1	RI	No
ST003	POL Fuel Line Leak	Spill/Leak No. 2	Site Closeout (proposed NFRAP)	No
ST004	JP-4 Fuel Truck Spill	Spill/Leak No. 3	Site Closeout (Proposed NFRAP)	No
ST005	POL Tank Farm	South POL, Spill/Leak Nos. 4 and 5	RI	Yes
		North POL	Site Closeout (Proposed NFRAP)	Yes
SS006	Waste Accumulation Area	West Accumulation and Drum Storage	RI	Yes
SS007	Drums Perimeter Dike	Perimeter Dike	PA/SI	Yes
LF008	Main Landfill	Refuse Landfill	--	No
ST009	West Unit	Million Gallon Hill, Pol Tanks	RI	Yes
		PowerPlant UST #49	RI	Yes
		JP-4 Fuel Stands	RI	Yes
		Bldg. 1850 Fuel Spill	RI	Yes
		Bldg. 1700 fuel Spill	RI	Yes
		Bldg. 1845 Vehicle Maintenance Facility	RI	Yes
ST010	Southeast Runway Fuel Spill	POL Pipe Leak	RI	Yes
LF011	Alternate Landfill	Temporary Refuse Landfill	Proposed Removal from IRP Process	Yes
LF012	Southwest Runway Dump	Abandoned Refuse Landfill	Proposed Removal from IRP Process	Yes
SS013	Control Tower Drum Storage Area, South	Drum Storage Area	RI	Yes

Note: RI = Remedial Investigation. NFRAP = No Further Response Action Planned. PA/SI = Preliminary Assessment/Site Inspection. POL = Petroleum, oils, and lubricants. UST = Underground storage tank.

Southeast Runway Fuel Spill and the Control Tower Drum Storage Area, South.

Volumes 1-3 of this BRA report focus on the three sites for which the RI was completed in early 1995. An addendum to this report (Volume 4) that addresses the two remaining sites was prepared after the RI for these sites was completed.

1.2 Purpose and Objectives of the Baseline Risk Assessment

The purpose of this BRA is to identify and characterize the current and potential future threats posed by the sites under investigation to humans living and working in and around Galena Airport and to the ecology of the area. The BRA has three specific objectives:

1. To determine the average and reasonable maximum carcinogenic risk (an estimate of incremental risk of developing cancer) to humans attributable to the sites under investigation;

2. To characterize the average and reasonable maximum likelihood for noncarcinogenic effects in humans; and

3. To evaluate the likelihood that adverse ecological effects may occur.

Average risk is a measure of the central tendency of the risk distribution. The reasonable maximum risk is the highest risk that is reasonably expected to occur.

Within the broader context of the IRP process, the BRA results will be used to make one of the following remedial action recommendations: 1) consider interim remedial action for sites with high current estimated human health risks and/or probable ecological risk; 2) negotiate the need for remedial action for sites with intermediate estimated human health risks and/or possible ecological risk; and 3) pursue no further response action for sites with negligible estimated human health or ecological risks. Figures 1-3 and 1-4 present how the BRA results will be used to support these recommendations.

For sites that require remedial action, the BRA can be used to do the following:

- Prioritize sites for allocation of resources;
- Identify data required for making remedial action decisions;
- Identify chemicals/media that require remedial action;
- Establish methods by which risk-based cleanup goals will be determined;
- Devise cleanup strategies that are protective of human health and the ecology; and
- Evaluate remedial action alternatives.

For sites that are determined to require no further action, the BRA will be used to provide technical support for "no further response action planned" (NFRAP) recommendations.

Figures 1-3 and 1-4 illustrate the decision logic applied to the results of the human health risk assessment and the ecological assessment, respectively. Section 3 provides descriptions of the methods used to assess human health risk and ecological risk and explains the terms used in Figures 1-3 and 1-4 to describe human health and ecological risk.

The human health risk assessment generates cancer risk estimates and noncancer hazard indices (HIs) associated with human exposure to site-related chemicals of potential concern (COPCs). Incremental cancer risk is expressed as a unitless probability of an individual developing cancer over a lifetime. The noncancer HI is the sum of individual chemical-specific values, which are ratios of projected exposures to toxici-

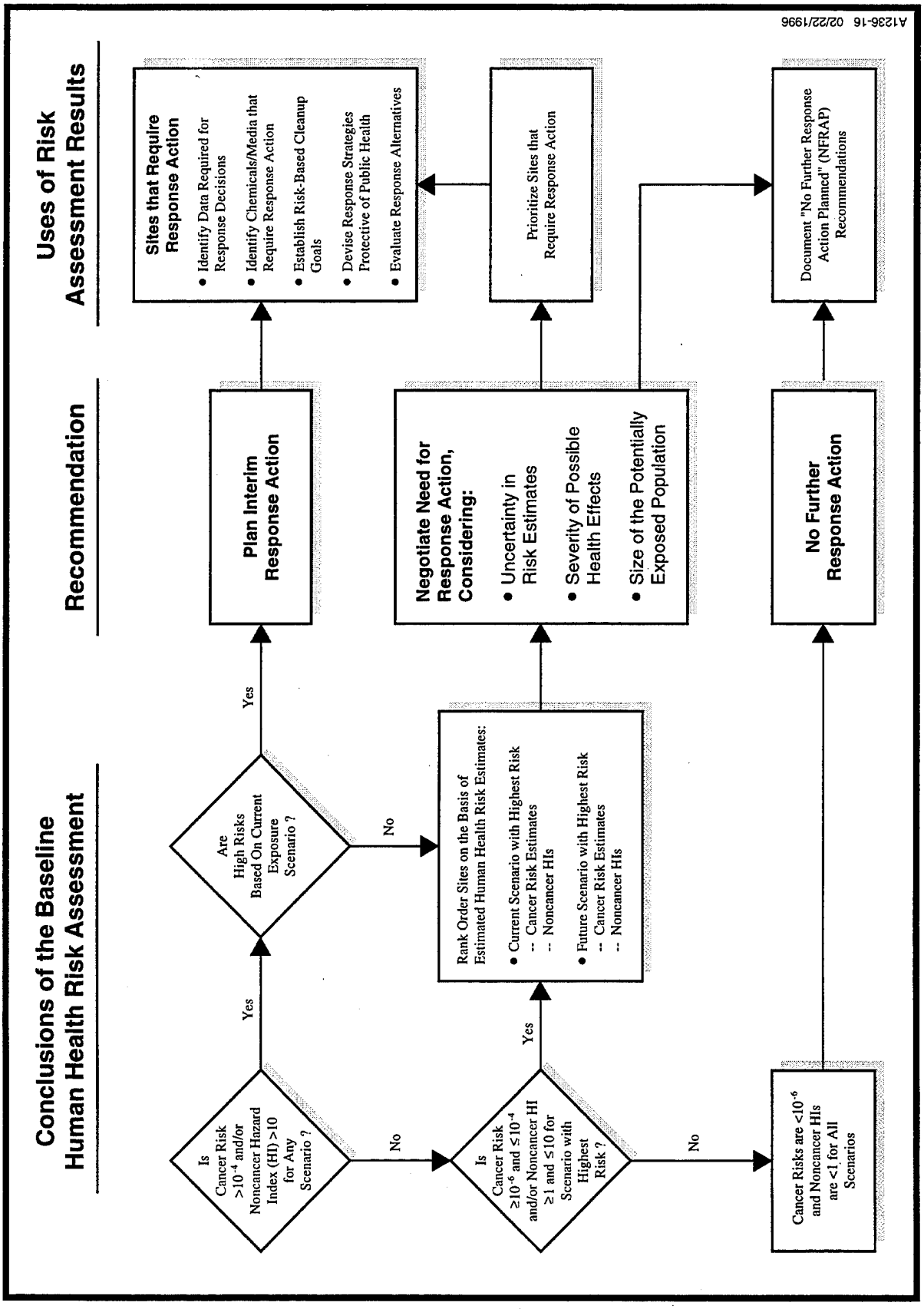


Figure 1-3. Baseline Human Health Risk Assessment Decision Flow Diagram

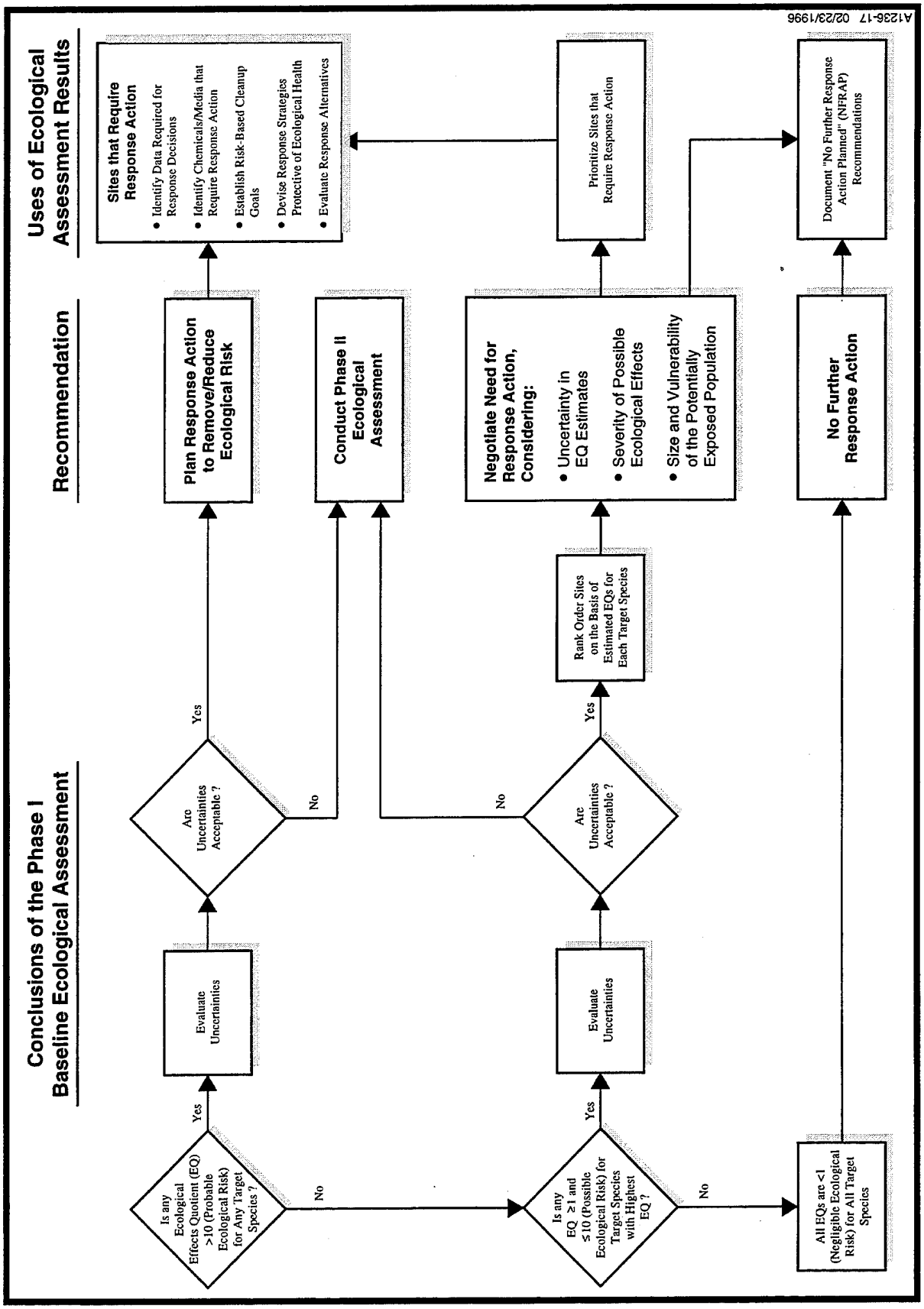


Figure 1-4. Baseline Ecological Assessment Decision Flow Diagram

ty values. The HI is not a statistical probability that a noncarcinogenic effect will occur.

The ecological assessment generates ecological effects quotients (EQs). The EQ is the ratio of an intake or an environmental concentration of a chemical in a specific medium to a toxicity benchmark concentration specific to the species of concern. The ecological assessment may require two phases. The Phase I assessment is based on existing data and information. The specific approach of a Phase II assessment is dependent on the outcome of the Phase I assessment. Activities in a Phase II assessment may consist of a more in-depth literature search for wildlife toxicity data, site-specific ecological studies, or field and/or laboratory toxicity studies.

1.3 Organization of the Baseline Risk Assessment Report

Volume 1 of this report is organized into 10 sections. Following the Introduction (Section 1), Section 2 describes details of the environmental setting at Galena Airport that are important for understanding contaminant transport and fate and the potential for human and ecological exposure to contaminants originating at the sites under investigation. Section 3 documents methods used to perform the human health and ecological assessments. Sections 4, 5, and 6 describe the site, summarize data available from the RI, and present the results of the human health and ecological assessments for the FPTA, the POL Tank Farm, and the West Unit, respectively. Section 7 addresses the potential combined impacts of individual sites and individual scenarios. Section 8 summarizes conclusions and recommendations. Section 9 lists acronyms and abbreviations and defines some of the terms used in the report. Finally, Section 10 lists references. The appendices provided in Volumes 2 and 3 supply supporting documentation for the assessments that were conducted. The Volume 4 Addendum provides the risk assessment results for the Southeast Runway Fuel Spill site and the Control Tower Drum Storage Area, South.

Section 2
ENVIRONMENTAL SETTING

Galena Airport is located in the west-central interior of Alaska on the Yukon River at the extreme southern end of the basin of the Koyukuk River (see Figure 1-1). The facility, occupying 166 acres, is approximately 350 miles northwest of Anchorage and 280 miles west of Fairbanks. Galena Airport is situated between two wildlife refuges, the Northern Unit of the Innoko National Wildlife Refuge and the Koyukuk National Wildlife Refuge. The entire airport installation in Galena is surrounded by a dike to protect the facility from flooding. The Million Gallon Hill Source area in the West Unit is actually part of the dike structure.

2.1 Regional Topography

The installation is located within the floodplain of the Yukon River. The regional topography is dominated by oxbow lakes and abandoned river meanders, reflecting the constant readjustment of the Yukon River system to changes initiated by seasonal flooding events. Spring flooding is common on the river because of high surface runoff associated with seasonal snow melt and the local formation of river ice dams during breakup. The land surrounding the installation is a lake-dotted lowland that is alternately forested and marshy. Ground elevation at Galena Airport is between 100 and 150 ft above mean sea level. The maximum relief in the Galena Airport area is approximately 40 ft.

2.2 Climate

The Galena Airport lies in the Continental Climatic Zone. The average summer temperatures in the area range from 38° to 68°F and winter temperatures range from -20° to 18°F. The temperature extremes have been noted as low as -88°F and as high as 92°F. Precipitation is light. The average yearly precipitation measures 14 in. and includes 54 in. (average) of snow. Winds are generally from the north at an average speed of 7.4 knots, and it is calm 13% of the time. The highest recorded winds have been from the east at 46 knots.

2.3 Groundwater Hydrology

Central and northern Alaska's cold climate has produced a condition termed "permafrost," a combination of geologic, hydrogeologic, and meteorologic characteristics that produce permanently frozen ground. The shallow alluvium at Galena Airport consists of thick vertical sequences of poor- to well-graded gravel and sand, with some silty zones. The hydraulic conductivity of this material probably ranges greatly, depending on the grain size and sorting of the material. In winter and spring months, shallow groundwater can freeze, forming frost layers and lenses that can affect and redirect shallow groundwater and subsurface contaminant movement. The unconfined aquifer at Galena Airport is greater than 200 ft deep and exhibits strong communication with the Yukon River. The depth to the water table varies from approximately 5 to 25 ft below ground level (bgl) on a seasonal cycle in response to changes in stage of the Yukon River (USAF, 1995d).

2.4 Surface Water Hydrology

The Yukon River system drains approximately 204,000 square miles of Alaska. The dominant element of the surface water regime in the region is the Yukon River, whose chemical and biological properties vary greatly throughout its length. Suspended sediment content varies with the drainage system and with the season, but is highest in spring and summer.

Streams and rivers in the vicinity of Galena Airport are characterized by low gradient, meandering course, and spring flooding. Thaw lakes, oxbow lakes, and river-flooded basins are also surface features of the nearby area. Surface water drainage occurs by overland flow into unnamed drainages that discharge directly into the Yukon River. Ephemeral discharge may occur into Bear Creek, which flows along an abandoned meander loop north of the Galena Airport boundary and discharges into the Yukon river approximately 5 miles downstream of Galena (USAF, 1995c).

2.5 Regional Ecology

The Galena Airport is located between two national wildlife refuges, Koyukuk to the north (7 miles) and the northern unit of Innoko to the south (Figure 1-1). Studies conducted for the Koyukuk and Innoko Refuges have identified 147 species of birds, 32 mammal species, and 19 fish species occurring, or potentially occurring, on refuge lands and in the vicinity of Galena (USFWS, 1987). The headquarters for the Koyukuk Refuge are located in Galena.

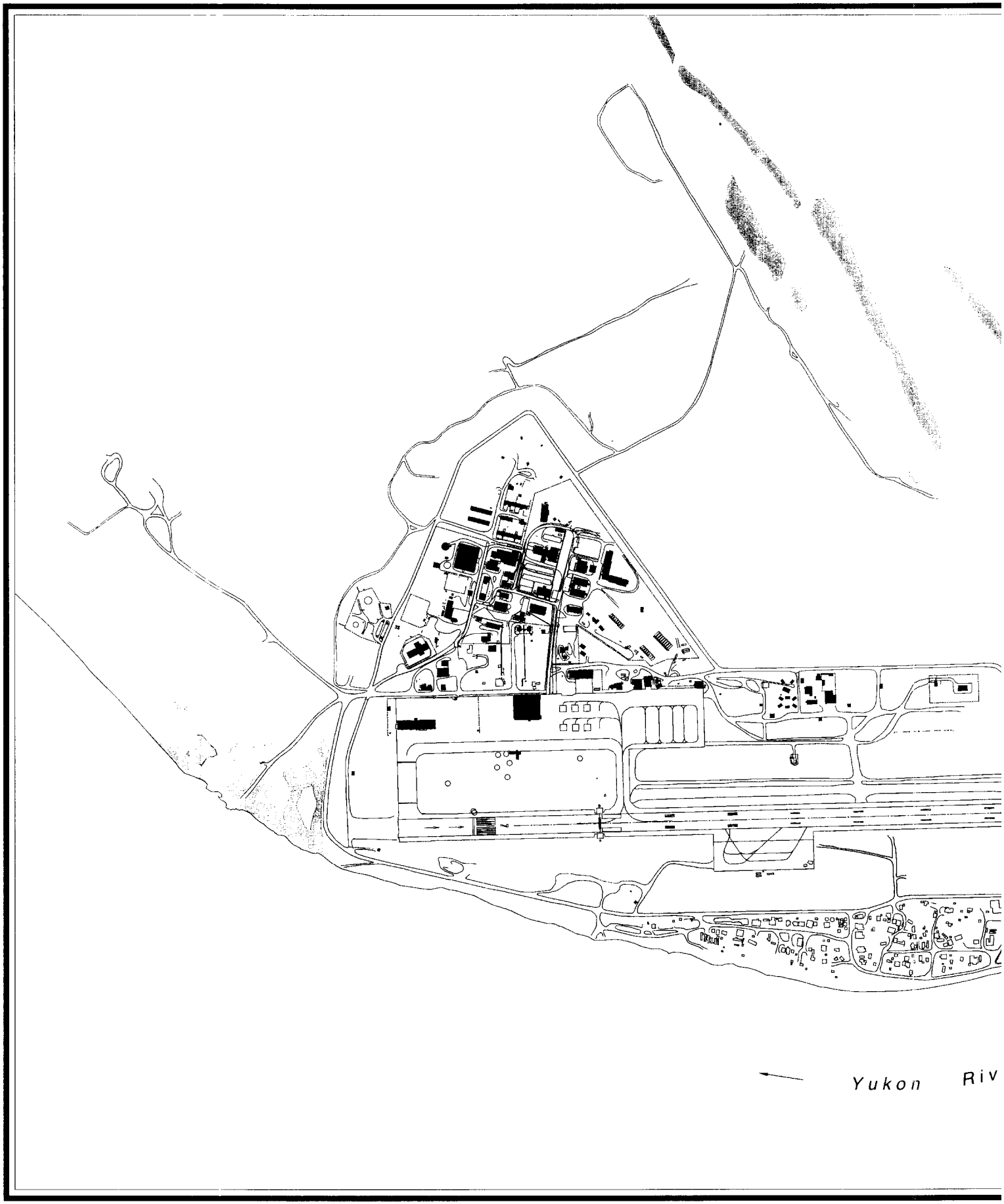
2.5.1 Regional Vegetation

The vegetation types in interior Alaska form a mosaic of patterns that is related in part to fire history, to slope and aspect, and to the presence or absence of permafrost. With the hot dry summers, fire is a major ecological force in the area and is caused naturally by lightning. The whole of the Alaskan interior, extending from the Kenai Peninsula to the south slopes of the Brooks Range and westward nearly to the Bering Sea, with the exception of the highest elevations, is covered with boreal spruce forest or taiga. Taiga are moist boreal forests of spruces, pines, and firs located in the subarctic. The predominant species is the white spruce (*Picea glauca*). On well-drained slopes without permafrost or where the soil thaws out in summer to a depth of 3 ft or more, white spruce grows virtually to the exclusion of all other trees. On very dry slopes it may be intermixed with the American aspen (*Populus tremuloides*) or, in the valleys, with the paper birch (*Betula papyrifera*) and, along the river banks, the balsam poplar or tacamahaca (*Populus balsamifera*). The mountain alder (*Alnus crispa*) is also present in varying numbers. In the spruce forests, the Alaska spiraea (*Spiraea beauverdiana*) occurs along with the rose (*Rosa acicularis*) and the high-bush cranberry (*Viburnum edule*).

Large stretches of the boggy lowlands are taken up by black spruce (*Picea mariana*). This forest type represents a subclimax vegetation and only suffers change as a result of fire. As a rule the trees are rather stunted. Other important species found in the black spruce forests are the Greenland type of labrador tea (*Ledum palustre groenlandicum*), cassandra (*Chamaedaphne calyculata*), and the bog bilberry (*Vaccinium uliginosum*). The cloudberry (*Rubus chamaemorus*) is found everywhere (Gohl, 1970). General vegetation types occurring on and around Galena Airport are presented in Figure 2-1 and include the following:

- Floodplain Thickets—Found on the floodplains of the rivers throughout interior Alaska, floodplain thickets form on newly exposed alluvial deposits that are periodically flooded. They develop quickly and may reach heights of 15 to 20 ft. The main dominant shrubs are willows (*Salix alaxensis*) and occasionally alders (*Alnus crispa*,) with a number of lower shrubs under the canopy.

- Mixed-deciduous Taiga or Bottomland Spruce-Poplar Forest—The bottomland spruce-poplar forest occurs in a broad band adjacent to the river on the flood-


Yukon

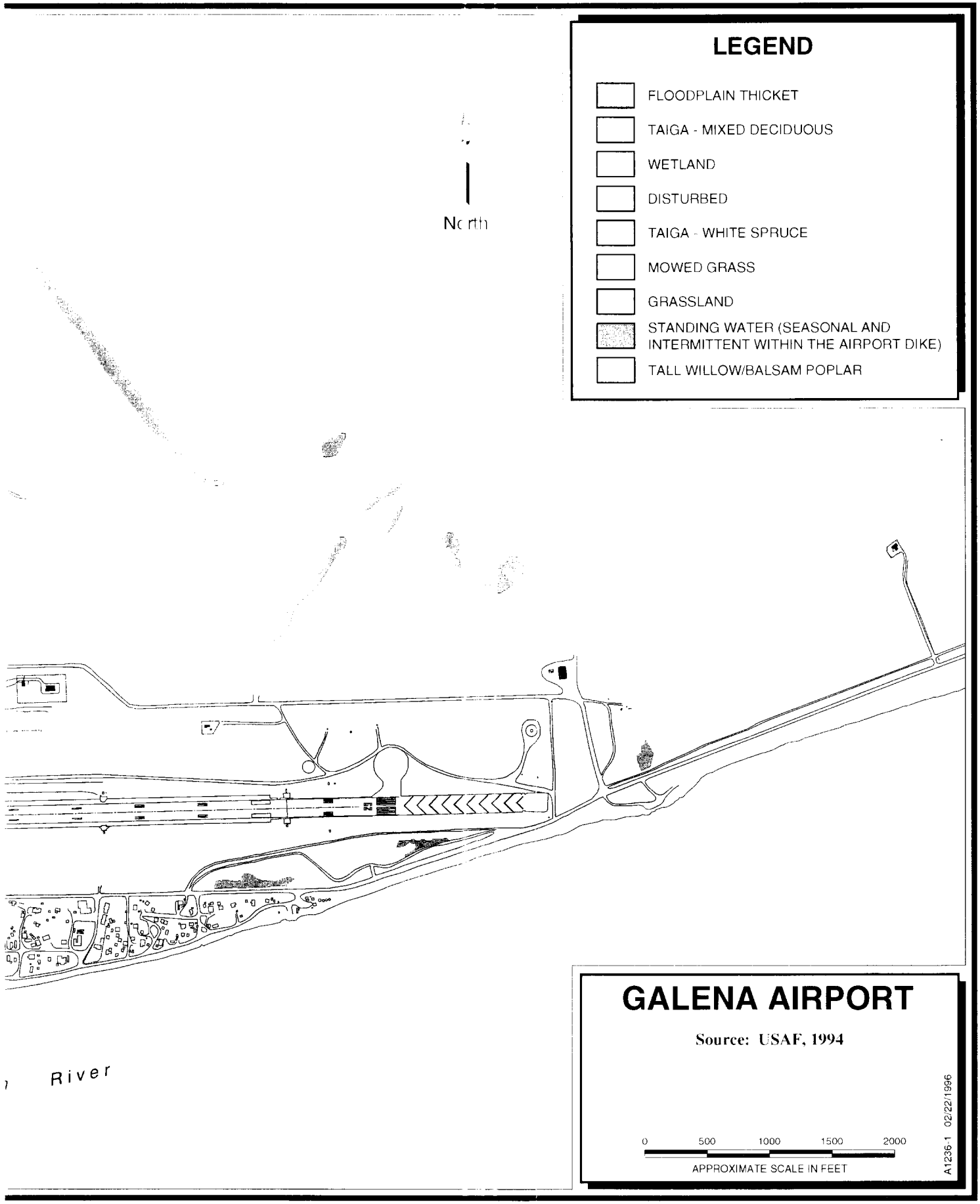


Figure 2-1. General Vegetation Map

plains and low terraces. The presence of black spruce characterizes moderate to poorly drained mineral soils. Deciduous trees, like balsam, poplar, and white birch, may be present.

- Wetland—Wetlands are areas that are inundated by surface or groundwater sufficient to support vegetation typically adapted for saturated soil conditions and are likely to meet federal criteria as a jurisdictional wetland.

- Disturbed Vegetation—These are areas that are subject to periodic disturbance, including industrial/residential land uses, and are characterized by sparse, low-growing vegetation, bare ground, and paved areas.

- White Spruce Taiga or Upland Spruce-Hardwood Forest—This forest is a widespread vegetation type of the higher, generally better drained, sites away from the river. Conifer stands containing primarily white spruce dominate this forest type in the Galena area. On dry slopes white spruce can be mixed with hardwoods such as aspen, birch, and balsam poplar.

- Mowed Grass—This is a classification for areas that are mowed as part of routine maintenance.

- Grassland—These are areas that have been cleared or disturbed in the past and have revegetated in an early successional grassland habitat type.

- Standing Water—Standing water areas are low-lying areas generally located below the water table and contain water for most or all of the year. This description also would apply to wetlands if hydrophtic vegetation is present. Standing water areas indicated on Figure 2-1 within the Airport dike are seasonal and contain water for only a short duration, usually during spring breakup of ice on the Yukon River.

- Tall Balsam Poplar/Willow—The poplar/willow areas are disturbed areas, primarily bordering the dike, that have revegetated with these fast growing poplar and willow species (USAF, 1994c).

2.5.2 Aquatic Ecology

The many lakes, pools, and stagnant waters outside the Airport dike provide excellent habitats for aquatic plants. Because of the permafrost these waters as a rule are fairly shallow. The yellow pond lily (*Nuphar polysepalum*) sometimes covers the entire surface of the water. Other important species are the horse tail (*Equisetum fluviatile*), sedges (*Carex aquatilis* and *Carac rostrata*), mare's tail (*Hippuris vulgaris*), the bog bean or water trefoil (*Menyanthes trifoliata*), the marsh cinquefoil (*Potentiall palustrus*), the spiked water-milfoil (*Myriphyllum spicatum*), various pondweeds (*Potamogeton*), and the poisonous *Cicuta mackenzieana,* which is closely related to the European water-hemlock (*Cicuta virosa*). These shallow lakes, with their rich vegetation, are of great importance to the moose (Gohl, 1970).

The Yukon River is a major ecological feature and serves as a migratory highway for several species of fish. King salmon (*Oncorhynchus tshswytscha*), coho salmon (*Oncorhynchus kisutch*), and chum salmon (*Oncorhynchus keta*) migrate far up the Yukon River in each annual migration to spawning grounds which are located distant from Galena Airport. These species of salmon are present in

the Yukon River near Galena Airport for only short periods of time during their migration. The king salmon enter the Yukon River in June and reach the Canadian border by mid- to late July. Coho salmon enter the Yukon River in mid- to late summer and generally spawn in spring-fed tributaries as far upstream as the Tanana River drainage (Figure 1-1). The chum salmon of the Yukon River have two distinct runs, one in the summer and the other later in the fall. During the summer run, which enters the Yukon River in May through June, the fish spawn in runoff tributaries of the lower Yukon River below the Koyukuk River. In the fall run, they migrate upstream starting in late June or July and spawn in spring-fed streams, mostly upstream of the Kantishna River. Some move upstream as far as the headwaters of the Yukon River near the Yukon-British Columbia border (USAF, 1994c).

Arctic grayling (*Thymallus arcticus*), northern pike (*Esox lucius*), burbot (*Lota lota*), and several species of whitefish (*Coregonus sp.*) are found throughout the main drainage of the Yukon River and most of its tributaries. Other species occurring in the Yukon River system are longnosed sucker (*Catostomus catostomus*), lake chub (*Couesius plumbeus*), Alaska blackfish (*Dallia pectoralis*), slimy sculpin (*Cottus cognatus*), and Arctic lamprey (*Lampetra japonica*) (USAF, 1994c).

2.5.3 Avian Ecology

Some of the more common waterfowl that nest or stop over in the area during their migratory flights include the American widgeon (*Anas americana*), mallard (*Anas platyrhynchos*), green-winged teal (*Anas crecca*), arctic loon (*Gavia arctica*), horned grebe (*Podiceps auritus*) and red-necked grebe (*Podiceps grisegena*), northern pintail (*Anas acuta*), surf (*Melanitta perpicillata*) and white-winged scoter (*Melanitta fusca*), Canada goose (*Branta canadensis*), and white-fronted goose (*Anser albifons*). This area also provides habitat for a variety of shorebirds such as the common snipe (*Capella gallinago*), spotted sandpiper (*Actitis macularia*), solitary sandpiper (*Tringa solitaria*), killdeer (*Charadrins vociferus*), and semi-palmated plover (*Charadrius semipalmatus*). Other aquatic birds, including mew gull (*Larus canus*), herring gull (*Larus argentatus*), and glaucous gull (*Larus hyperboreus*), also occur in the area. Occasionally, whimbrels (*Numenius phaeopus*), godwits (*Limosa sp.*), and lesser yellowlegs (*Tringa flavipes*) can be sighted in the area (USAF, 1994c).

Drainage ditches and low areas within the diked area of Galena Airport contain standing water for only short durations and therefore do not serve as valuable or well-utilized habitat for waterfowl. The open waters of the Yukon River and other surface water outside the diked area provide more consistent habitat for waterfowl.

Several raptors, notably red-tailed hawks (*Buteo jamaicensis*), great grey owls (*Strix nebulosa*), short-eared owls (*Asio flammeus*), sharped-shinned hawk (*Accipiter striatus*), American kestrel (*Falco sparverius*), and peregrine falcons (*Falco peregrinus anatum*), are found in the area. Numerous passerine species occur in the area. Common species include the American robins (*Turdus migratorius*), common raven (*Corvus corax*), yellow warblers (*Dendroica petechia*), yellow-rumped warblers (*Dendroica coronata*), hermit thrushes (*Catharus guttatus*), cliff swallows (*Petrochelidon pyrrhonota*), and white-crowned sparrows (*Zonotrichia leucophrys*) (USAF, 1994c). Cliff swallows are common at Galena Airport, and their nest building in USAF structures have created frequent maintenance problems and have interfered with equipment use.

2.5.4 Terrestrial Mammals

Representative mammals include beaver (*Castor canadensis*), black bear (*Ursus americanus*), brown bear (*Ursus middendorffi*), grizzly bear (*Ursus horribilis*), caribou (*Rangifer arcticus*), North American lynx (*Felis lynx*), marten (*Martes americana*), mink (*Mustela vison*), moose (*Alces alces*), muskrat (*Ondatra zibethica*), red fox (*Vulpes fulva*), snowshoe hare (*Lepus americanus*), wolf (*Canis lupus*), wolverine (*Guloluscus*), least weasel (*Mustela rixosa*), meadow vole (*Microtus pennsylvanicus*), and several shrew species (*Sorex sp*). There are an estimated 8000 to 10,000 moose on the Koyukuk Refuge. Caribou from the Western Arctic herd have migrated through or close to the general Galena area in recent years, far to the southeast of their pre-1985 range. Marten are one of the most important furbearers to trappers on the Koyukuk area and are also widely trapped by local residents. The Koyukuk and Innoko refuges support some of the most dense beaver populations in the state, but muskrat populations are low (USAF, 1994c).

2.5.5 Endangered and Protected Species

The U.S. Fish and Wildlife Service (USFWS) has identified the Yukon River as having known occurrences of the endangered American peregrine falcon (*Falco peregrinus anatum*) and possible occurrence of the arctic peregrine falcon (*Falco peregrinus tundris*). Peregrines typically nest on cliffs ranging from 30 to 1000 ft high in Alaska, and their nests often overlook lakes and waterways. There is no recorded evidence of peregrine nesting in the project area (USAF, 1994c).

Several candidate and proposed candidate species have been identified in the Galena area. A candidate for Category 2 listing denotes that the information indicates that proposing to list the species as endangered or threatened is possibly appropriate, but substantial data on biological vulnerability and threats are not currently known to support the immediate preparation of rules. Further biological research and field study will be necessary to ascertain the status and/or taxonomic validity of the taxa in Category 2. Candidate species for endangered listing under Category 2 are the North American lynx, harlequin duck (*Histrionicus histrionicus*), and northern goshawk (*Accipiter gentilis*). Proposed Category 2 candidate species are the Swainson's thrush (*Catharus ustulatus*), gray-cheeked thrush (*Catharus minimus*), blackpoll warbler (*Dendroica striata*), and Wilson's warbler (*Wilsonia pusilla*) (USAF, 1994c).

2.6 Community Profile

Galena is located in traditional Koyukon Athapaskan Indian territory. The Athapaskan name for Galena is "Notaalee Dinh," which means "place where the current goes around in a semicircle." Galena is in the band territory referred to as "Nowitna-Koyukuk" in historic records. The Koyukon frequently occupied large semipermanent villages during the summers, most commonly located near the primary fishing grounds, and dispersed from these into the tributary drainage for hunting and trapping in the fall and winter. There were 12 settlements located on the Yukon River between the Koyukuk River and the Nowitna River. These settlements were primarily summer fish camps.

Galena, located near an old fish camp site called Henry's Point, was established in 1918 as a supply and transshipment point for the Galena area lead ore mines. Beginning in 1920, Koyukon Athapaskans who had traditionally lived at Louden, 14 miles upriver, began moving to Galena. At the new site, natives had the opportunity to sell cord wood to steamboats and could work hauling freight for the mines. A school was established at Galena in the mid-1920s; a post office opened in 1932.

Galena remained small until World War II, when construction began on what is now Galena Airport. The Galena field became operational in 1942. In 1945, the community suffered a major flood—a seasonal problem that continues to this day. Rapid community growth did not begin until the establishment of military facilities at Galena Airport and nearby Campion AFS in the 1950s. Airport and road developments were completed in 1950, and a health clinic has operated since 1965.

Military construction and expansion in Galena in the 1940s and 1950s spurred population growth in Galena. By 1960, military personnel accounted for 359 of Galena's 620 residents, or nearly 60% of the population. As of 1990, the town's population had risen to about 900, not including the 300 military personnel assigned to the base. Since then, the Air Force has withdrawn all military personnel from Galena Airport and the installation is in caretaker status. The major industrial activities associated with the Galena Airport mission have been performed to maintain and support resident operations. The population of Galena is now approximately 500 (USAF, 1994c).

Galena is the largest community in western interior Alaska and serves as the transportation, government, and commercial center for this region. Other nearby communities along the Yukon River include Ruby, 50 miles to the east, and Koyukuk, 30 miles to the west of Galena. Galena is not connected by road to any other community and is accessible only by airplane or river craft in the navigable summer months.

Since Galena is not connected to other Alaska communities by road, air transportation is the only year-round mode available. During the summer months, Galena is served by Yutana Barge Lines. The Yukon and area rivers provide access to nearby communities and other areas during the summer months. During the winter, the frozen rivers are used for snow machine transportation.

The City of Galena comprises the original site ("Old Town") and "New Town." The distinction is based on location with respect to the Yukon River and does not affect the administration of municipal services. Old Town's proximity to the river has made it vulnerable to annual spring floods, when the snow melts and the frozen Yukon River begins to break up and rise out of its banks. The floodwaters, along with large slabs of river ice, have caused significant structural and property damage in Old Town, as well as accelerating the erosion of the shoreline.

After the severe flooding of 1971, New Town was established about two miles farther north (inland of the river). New Town contains most of the city's municipal offices, the school, health clinic, and various residential and commercial properties (USAF, 1994a).

Section 3.1 presents more information about the various human populations and their activities at Galena.

2.7 Land Use

2.7.1 Current Land Uses

Galena Airport is currently operating under caretaker status. The operational capabilities of the installation are being maintained so that it may be rapidly reactivated in the future should the need arise. The land is owned by the State of Alaska Department of Transportation and Public Facilities, which leases property to several government agencies. Some housing is available on the northern perimeter of the main installation triangle for contractor caretaker

personnel and state and federal agency employees.

Figure 2-2 illustrates current land use at the Galena Airport installation. It notes the locations of airfield activities, industrial support, housing, recreation, and services, administration, and open space. The figure also illustrates the building restriction line for the airport. As long as the airport remains operational, building cannot occur in the area encompassed by this line. Areas where building is restricted include the FPTA, the Control Tower Drum Storage Area, South, the Southeast Runway Fuel Spill area, and parts of the West Unit.

The open space designated on Figure 2-2 depicts areas that are currently undeveloped and unlikely to be developed as long as the airport remains operational.

2.7.2 Future Land Uses

There are no plans to close Galena Airport. On the contrary, the absence of roads connecting Galena to the rest of Alaska makes the continued operation of the airport extremely important for the local residents. The Alaska Department of Transportation and Public Facilities does not have plans to develop any land other than adding an apron and a partial parallel taxiway directly south of the control tower. The Bureau of Indian Affairs is considering a road from the northeast corner of the dike to New Town Galena (Foster, 1995). This road, which is only in early planning stages, will likely join the dike road at its northeastern corner and run east along the northern edge of the Ambient Location to New Town. Construction of the road is under consideration because of annual flooding of the current road from the Airport to New Town.

Future land use is therefore expected to remain the same as current land use with one exception—a dormitory on base may be opened to high school students as a boarding facility. The facility is planned for Grades 9-12 only (USAF, 1995b). The dormitory building is noted on Figure 2-2.

2.8 Airport and Community Water Supply

Water for drinking, cooking, cleaning, and sanitary purposes in the Galena area generally comes from water supply wells tapping both shallow and deep parts of the local aquifer. The following sections provide information on both the airport and community water supply wells.

2.8.1 Galena Airport Water Supply

Galena Airport has obtained water from seven water supply wells within the installation boundaries. Three of these wells have recently supplied water for consumption. Table 2-1 gives the status of all seven wells; the locations of the wells are shown in Figure 2-3.

Currently, Galena Airport obtains its potable water from two main wells, which are screened in alluvial sediments at approximately 200 ft bgl. Wells No. 1 and No. 7 pump at a rate of approximately 55 gallons per minute (gpm) and are switched off when the 100,000-gal. holding tank reaches capacity. Well No. 2, which was used for potable water supply until it was replaced by well No. 7 in September 1992, is now inactive and used only to monitor groundwater head changes in the deeper part of the aquifer.

Water for dust control and fire protection is supplied by well No. 3, which is not used for potable water and is inactive during the winter months (Gordon Cruger, personal communication, March 1993).

The Galena Airport wells that are used for consumption have been sampled triennially

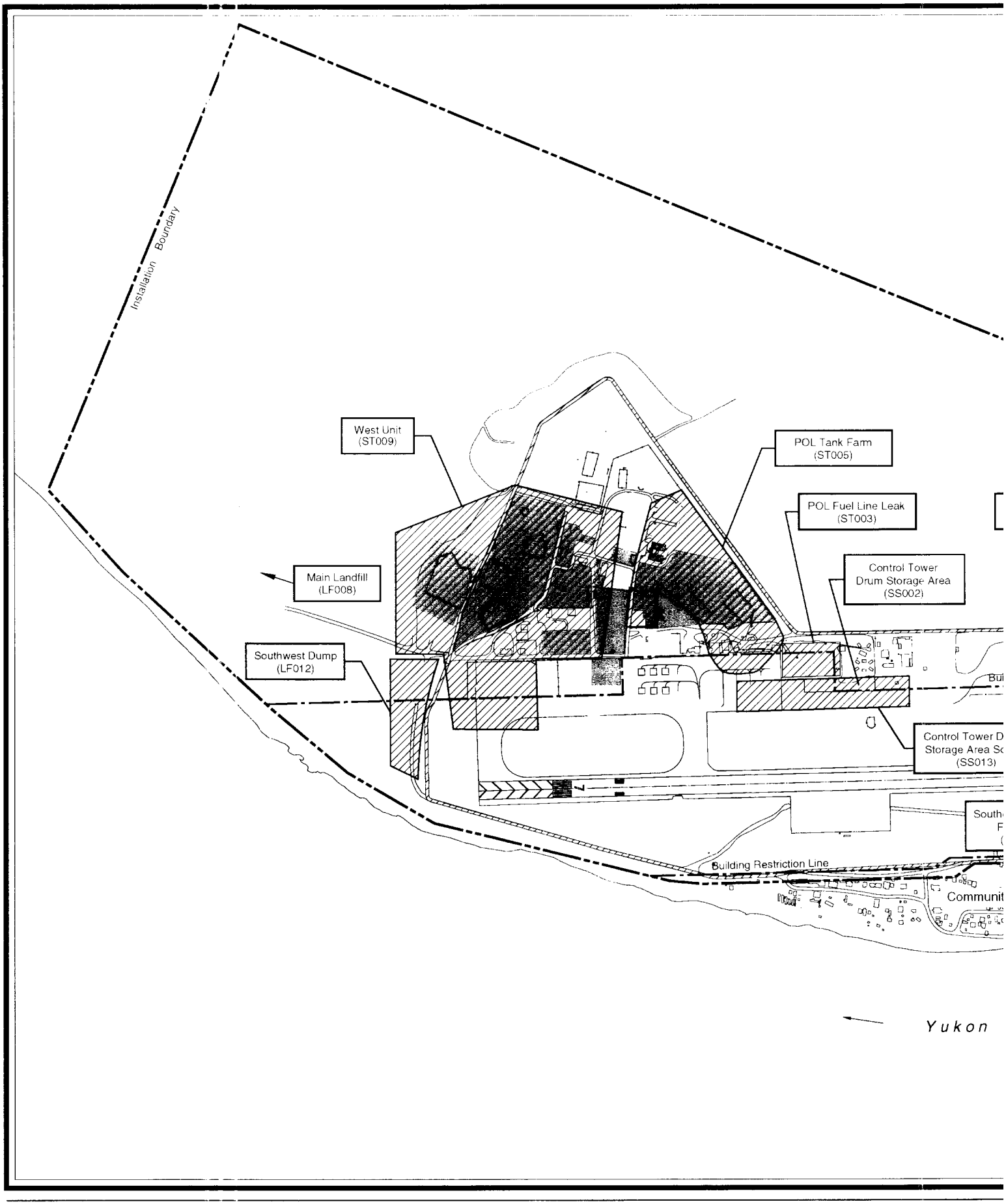
Table 2-1
Galena Airport Water Supply Well Data

	Well No. 1	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6	Well No. 7
Location	Bldg. 1549	Bldg. 1578	Bldg. 1812	Bldg. 1428	Bldg. 400	Bldg. 1401	Bldg. 1578
Depth (feet)	205	210	200	210	43	50	198
Casing Diameter (inches)	6	8	6	8	4	6	8
GPM (max pump flow)	130	--	500	--	10	10	100
Drawdown (feet)	10.83	4.4	4.4	--	--	--	36.7
Static Water Level (feet below surface)	80	196	196	--	14.6	35	18.5
Date of Installation	1963	1956	1956	1955	1954	1963	1990
Remarks	--	--	--	Capped	--	--	Replaced Well No. 2
Condition and Use	Operational (potable water supply)	Deactivated (former main water supply)	Standby fire protection	Inactive	Abandoned (formerly used for sanitary water only) [a]	Abandoned (formerly used for sanitary water only) [a]	Operational (potable water supply)

-- = unknown.

Source: Installation Documents dated January 1974. Updated March 1993 via personal communication with base personnel.

[a]Shallow nonpotable wells were abandoned during the base drawdown in the early 1990s. They cannot be accessed for future use (Gordon Cruger, Supervisor of Galena Airport water supply, personal communication, 11 January 1996).


Installation Boundary
West Unit (ST009)
POL Tank Farm (ST005)
POL Fuel Line Leak (ST003)
Main Landfill (LF008)
Control Tower Drum Storage Area (SS002)
Southwest Dump (LF012)
Control Tower D
Storage Area So
(SS013)
Building Restriction Line
Communit
Yukon

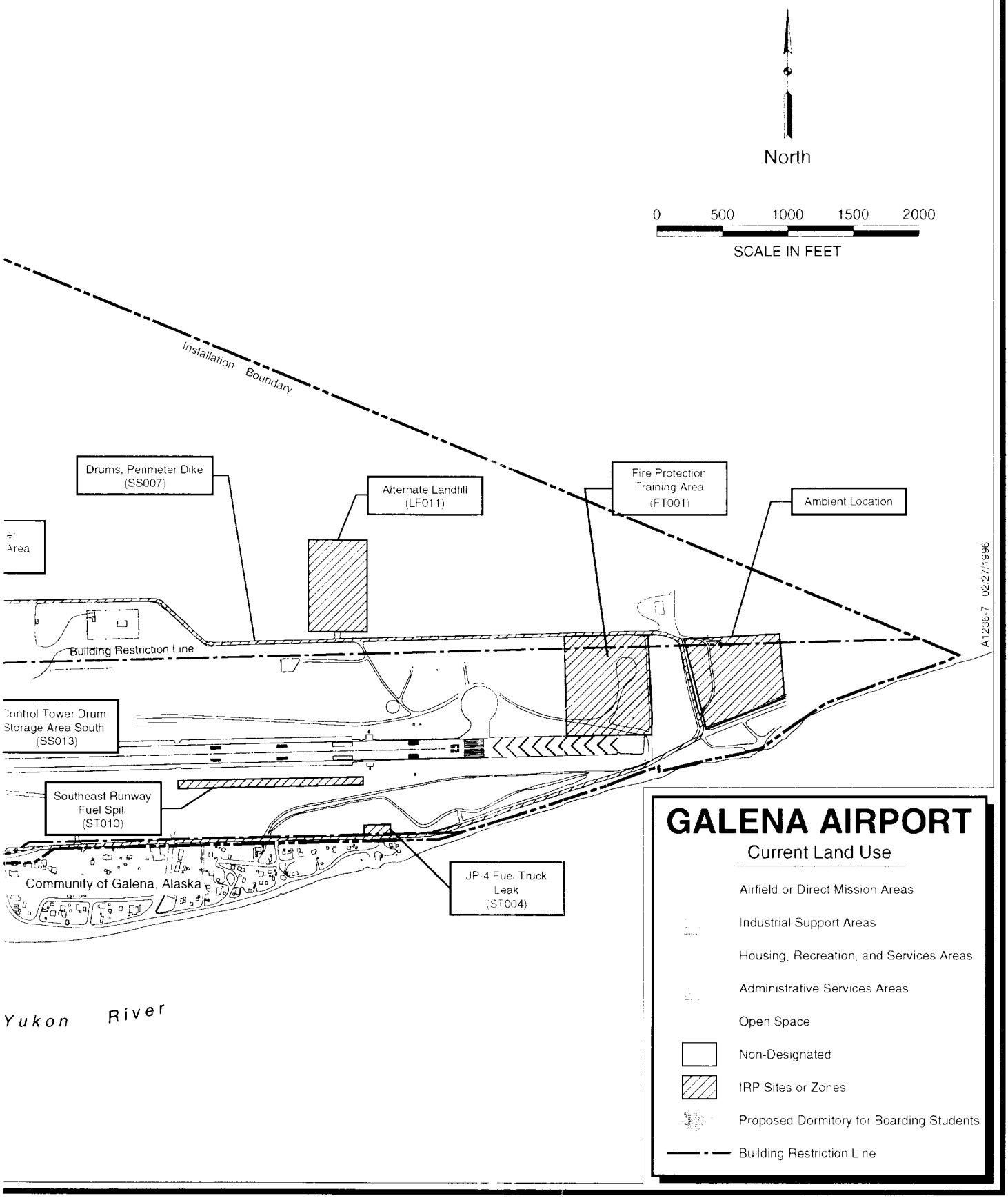


Figure 2-2. Current Land Use Map Galena Airport

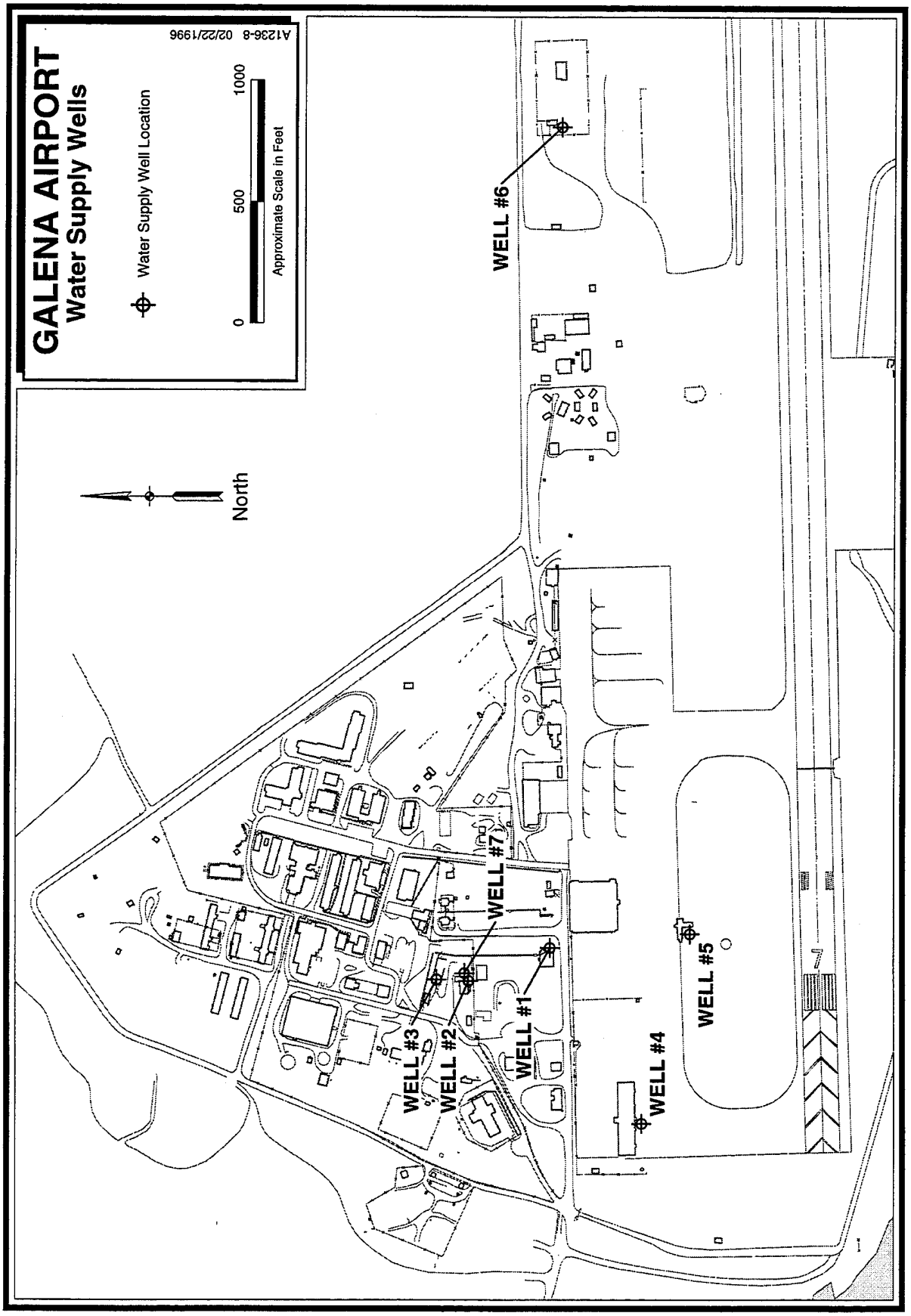


Figure 2-3. Location of the Galena Airport Water Supply Wells

by the USAF Bio-Environmental Group since the passage of the Clean Water Act in 1986 (Major L. Waterhouse, personal communication, April 1992). These water samples are analyzed for organic and inorganic compounds, bacteria, and radionuclides.

As part of the RI activities, airport supply wells Nos. 1, 2, 3, and 7 were sampled once or more from 1992 to 1994. Samples were collected from all active wells in the main airport triangle in 1992 and 1994, and analyzed for a full suite of compounds. Only one well—No. 7—was sampled in 1993, for volatile organic compounds (VOCs) only.

The potential risk of using nonpotable water supply at the airport for dust control and fire protection is not considered in this risk assessment. The very low concentrations of a few pesticides detected in samples from the deep non-potable well (No. 3) are not likely to pose a risk when used for dust control or fire protection. No VOCs were detected in this well.

2.8.2 Community of Galena Water Supply

Most residents of the community of Galena have drinking water trucked in from the city well in the New Town area, upgradient from the Galena Airport. However, interviews with community members and a review of City Hall records showed that at least seven private wells are still in use in the Old Town of Galena. Permission from owners was obtained to sample four of these wells, shown in Figure 2-4, in 1992 and 1993 as part of the RI. These wells, which are all less than 60 ft deep, supply water for cooking, cleaning, and drinking. One well is located on a sandbar of the Yukon River and supplies water to several private residences and businesses in the Old Town.

2.8.3 Remedial Investigation Conclusions

Pesticides have been detected in both airport and community supply wells. However, with the exception of chloroform in one of the nonpotable airport supply wells (well No. 3), detection of analytes in these water supply wells has been very inconsistent. Inconsistencies in the detections of pesticides may be an indicator that pesticides are not consistently present in the water supply or they may reflect analytical inconsistences such as differences in detection limits. The nonreproductibility of the data makes it difficult to draw any conclusions regarding potential contamination of the drinking water supply in the Galena area.

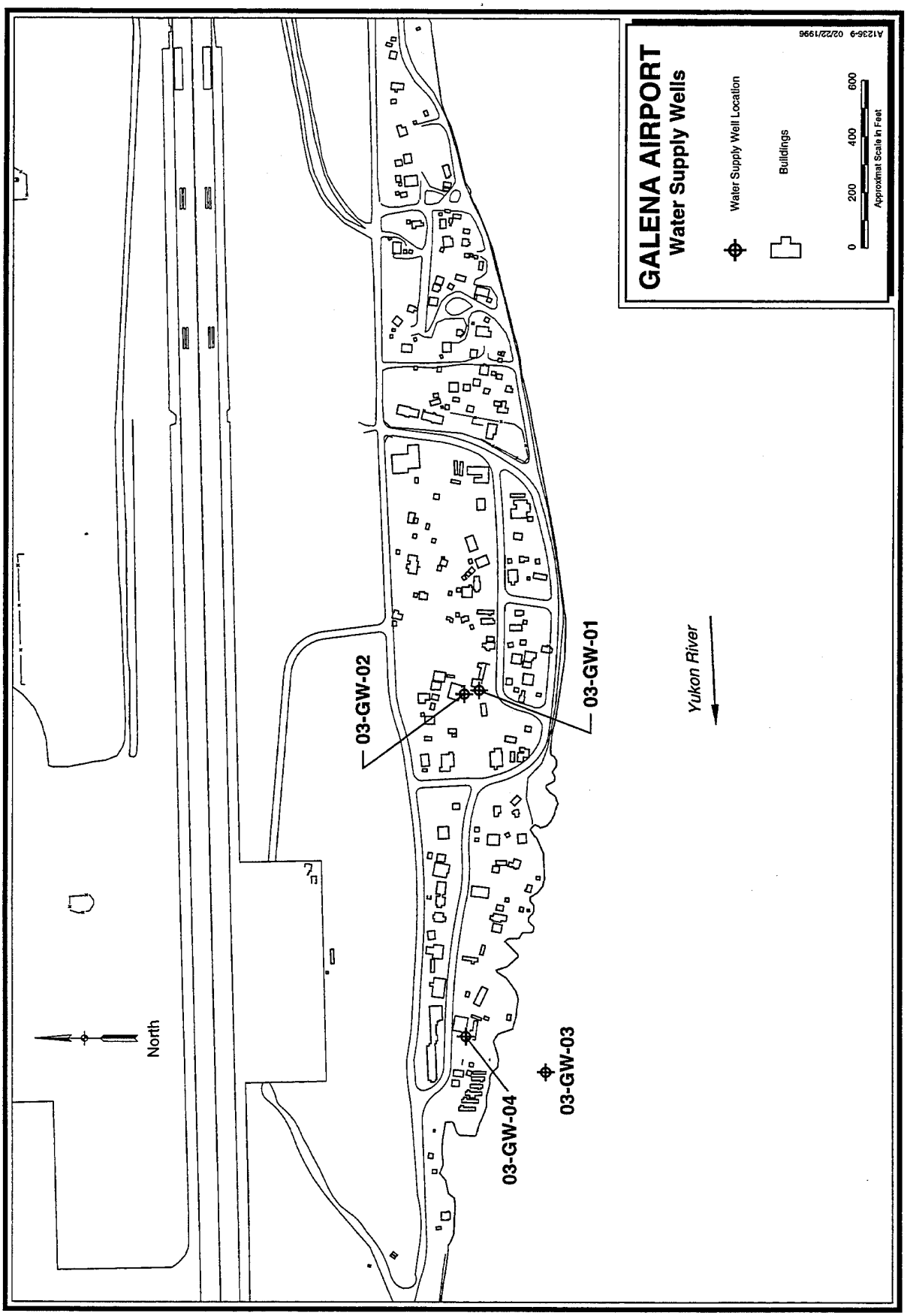


Figure 2-4. Location of Privately Owned Wells Sampled During the RI

Section 3
METHODS

The USAF document *Human and Ecological Baseline Risk Assessment Protocol for Galena Airport and Campion Air Force Station, Alaska* (USAF, 1995b) describes proposed methods to evaluate human health and ecological risk at Galena Airport. Alaska Department of Environmental Conservation (ADEC) reviewed the proposed methods and submitted comments on the protocol document to the USAF (Shannon & Wilson, 1995). A meeting attended by representatives of the USAF, ADEC, and their contractors was held on 19 April 1995 in Anchorage, Alaska, to discuss and resolve ADEC comments on the risk assessment protocol. At this meeting, most comments were discussed and decisions were made on appropriate methods to use for baseline risk assessments of Galena Airport sites. A Response to Comments document records the consensus that was reached at this meeting (USAF, 1995d). The protocol document, amended by the Response to Comments document, served as the work plan for the baseline human health and ecological assessment of the three sites that are the subject of Volume 1 of this report and the two sites that are the subject of the Volume 4 Addendum.

The *Ecological Risk Assessment Problem Formulation* (USAF, 1995e) for the sites was prepared and submitted to ADEC in June 1995. This document established the conceptual site models for ecological exposure, the ecological community components potentially at risk, and the assessment and measurement endpoints that were used in the ecological assessment.

Section 3.1 describes methods used to assess human health risks. Section 3.2 describes methods used to conduct the ecological assessment.

3.1 Human Health Assessment

The overall strategy for the human health assessment as well as the technical approach used for individual steps conform to U.S. Environmental Protection Agency (USEPA) recommendations (USEPA, 1989b). The human health assessment involved six steps:

1. **Data collection and evaluation.** Data on the location and identity of contaminants were gathered for each site and organized for the assessment.

2. **Identification of human health COPCs.** Site-related chemicals (detected at levels elevated above naturally occurring levels of the same chemical) with the potential to pose risks to humans or the environment were identified. Chemicals that pose only minimal risks were excluded from the assessment.

3. **Exposure assessment.** The magnitude, frequency, and duration of exposure were estimated. Pathways for actual or potential human exposure as well as current and hypothetical future scenarios were evaluated.

4. **Toxicity assessment.** Assessing toxicity involves two steps: hazard identification and dose-response evaluation. For most commonly encountered COPCs, numerical toxicity values have been established for human health risk estimation. When they exist, these established toxicity values were used. COPCs without established toxicity values or provisional values recommended by the Superfund

Health Risk Technical Support Center were evaluated qualitatively.

5. **Risk characterization.** Results from the exposure assessment and toxicity assessment were combined to produce quantitative risk estimates. These estimates indicate whether COPCs are present at or near levels of concern.

6. **Uncertainty analysis.** The methods and results were reviewed to identify the variables and assumptions that contribute to uncertainty in the assessment. The purpose of the uncertainty analysis is to provide perspective for remedial decision making rather than to generate statistical estimates of uncertainty.

Figure 3-1 provides a schematic overview of the steps involved in the risk assessment process.

3.1.1 Data Collection and Evaluation

The data on which the assessment was based include 1) field sampling and analytical results associated with environmental media at the sites, 2) quality assurance/quality control (QA/QC) data, 3) background information, 4) information on contaminant sources, 5) physical setting and environmental conditions, 6) area population and demographics, and 7) physical and chemical characteristics of chemicals detected at the sites.

3.1.2 Identification of Chemicals of Potential Concern

The purpose of the COPC identification process is to identify the set of site-related chemicals to be evaluated. The COPC identification process distinguishes those chemicals that are most likely to contribute substantially to risks at a site from those chemicals that are not site-related and/or pose only a minimal risk. USEPA guidance (USEPA, 1989b, 1992c) stipulates a nine-step data evaluation process to identify COPCs and organize the data into forms appropriate for a human health assessment:

Step 1: Gather and review information available from site investigations;

Step 2: Evaluate analytical methods;

Step 3: Evaluate the quality of the data with respect to quantitation limits;

Step 4: Evaluate the quality of data with respect to qualifiers and codes;

Step 5: Compare concentrations detected in blanks with concentrations detected in samples;

Step 6: Evaluate tentatively identified compounds;

Step 7: Compare potential site-related concentrations with background concentrations;

Step 8: Develop a data set for use in risk assessment; and

Step 9: Conduct additional screening to reduce the number of COPCs further.

Figure 3-2 presents a logic flow diagram of the decision process used to identify COPCs at the sites. The procedures outlined in Figure 3-2 follow USEPA guidance with a few exceptions, which are discussed in the subsections that follow. Appendix A provides details on the statistical analyses performed for the risk assessment.

Data Available from Site Investigations

Results of the RI conducted at Galena Airport during 1992, 1993, and 1994 provide

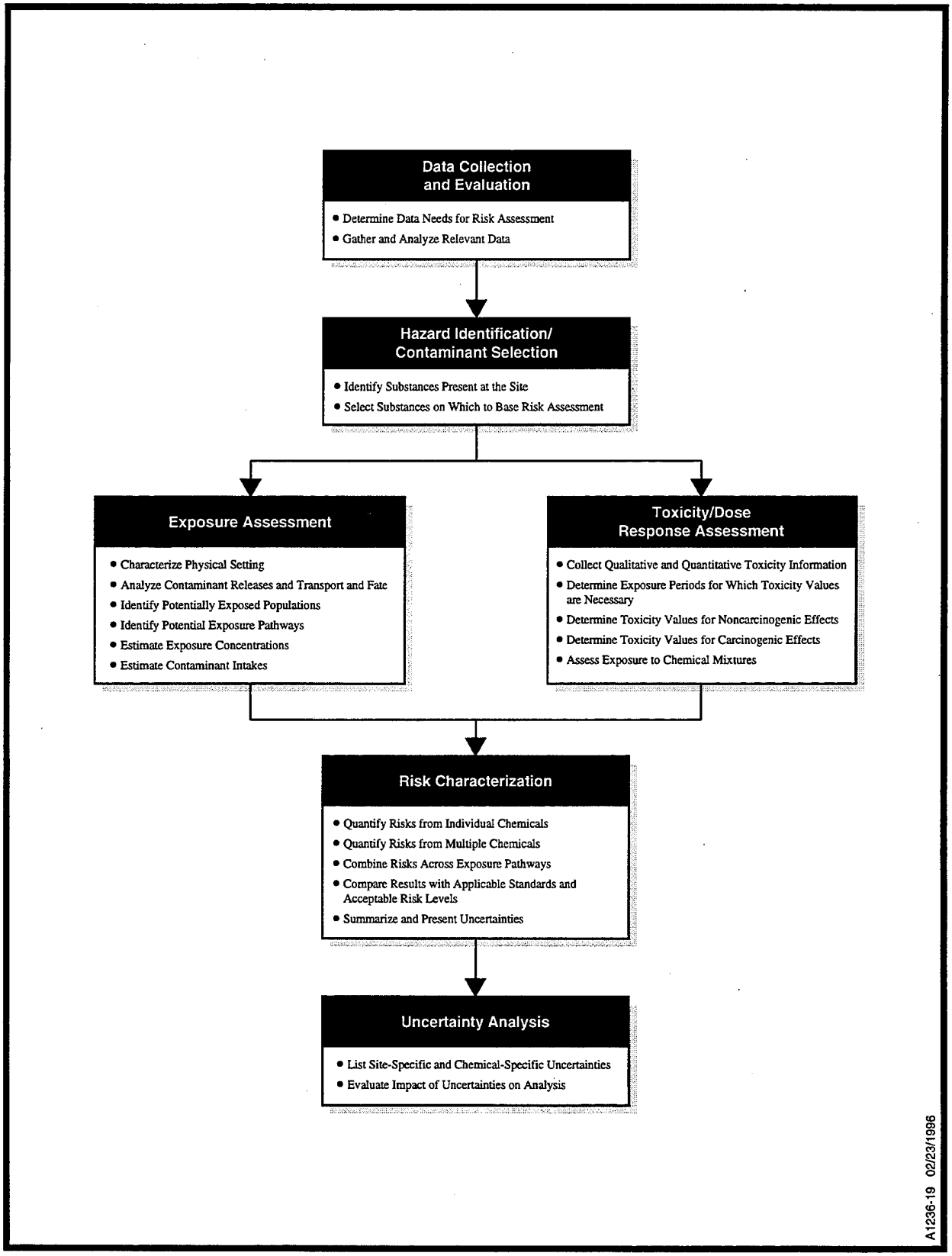


Figure 3-1. Overview of Human Health Risk Assessment

the data set used in the risk assessment. These data are fully documented in the RI report (USAF, 1995c). The following soil matrix sample types were collected:

- Soil boring (SB) samples were subsurface samples taken as exploratory borings at depths greater than 1 ft;
- Monitoring well (MW) samples were also subsurface samples taken at depths greater than 1 ft from soil borings that were converted into monitoring wells;
- Sediment (SD) samples were taken at the surface from areas that had standing water at one time greater than 6 in. deep; and
- Surface soil (SS) samples were collected at depths less than 6 in. deep.

The following water matrix sample types were collected:

- MW samples were water samples taken from groundwater monitoring wells;
- Groundwater (GW) samples were water samples taken from water supply wells; and
- Surface water (SW) samples were samples taken from drainage ditches or low areas where standing water had accumulated.

Table 3-1 summarizes the 1992, 1993, and 1994 RI field activities for the FPTA, the POL Tank Farm, and the West Unit. Table 3-2 reports the total number of samples collected for each site by sample type, including the ambient site where background data were collected.

Investigations were conducted at many of the Galena Airport sites prior to the 1992-1994 RI (USAF, 1989, 1991). Table 3-3 summarizes these activities and their findings. Data from those earlier investigations, which were limited in scope, were not used in the risk assessment. Data from the 1992-1994 RI provide more recent, comprehensive, and validated data to determine the nature and extent of contamination.

Data available from other sources were used when applicable. For example, the USAF Armstrong Laboratory/Environmental Sciences Branch performed limited air sampling at Galena Airport and analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) (USAF, 1994b).

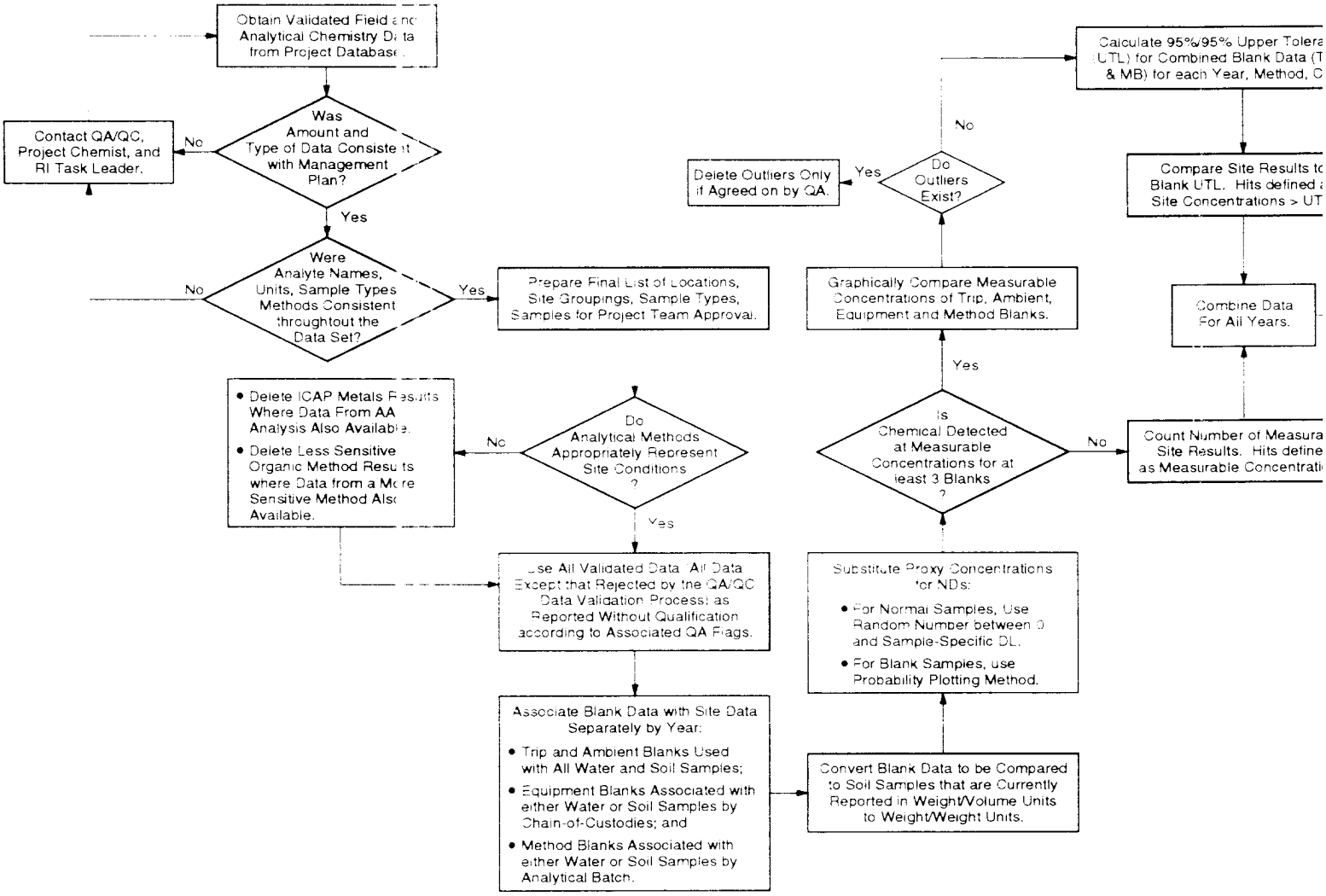
All data gathered in the field sampling effort were considered in the risk assessment. Prior to conducting the statistical analyses to identify the COPCs, site sampling locations that are outside defined areas of contamination were removed from the risk assessment data set. This was done to avoid "diluting" statistical summaries of contaminants that are present with results from locations that were sampled to determine the nature and extent of contamination and were determined to be uncontaminated.

Analytical Methods

Depending on the data quality objectives (DQOs), data generated during the RI fall into one of three analytical levels with respect to the level of quality control and analytical accuracy of the methods (USEPA, 1988a) as described in Table 3-4. Level I and Level II data, used for initial definition of potential areas of contamination, were generated by field screening methods and mobile field laboratories in support of the preliminary assessment activities at the newly defined source areas. The data were used to define quantitatively the presence or absence of

Data Evaluation

Blanks Comparison



Acronyms/Abbreviations

AA	Atomic Absorption	MB	Method Blank
AB	Ambient Blank	ND	Not Detected
BRA	Baseline Risk Assessment	QA/QC	Quality Assurance/Quality Control
COPC	Chemical of Potential Concern	RDA	Recommended Daily Allowance
DL	Detection Limit	TB	Trip Blank
EB	Equipment Blank	UCL	Upper Confidence Level
EPA	Environmental Protection Agency	UTL	Upper Tolerance Limit
ICAP	Inductively Coupled Argon Plasma		

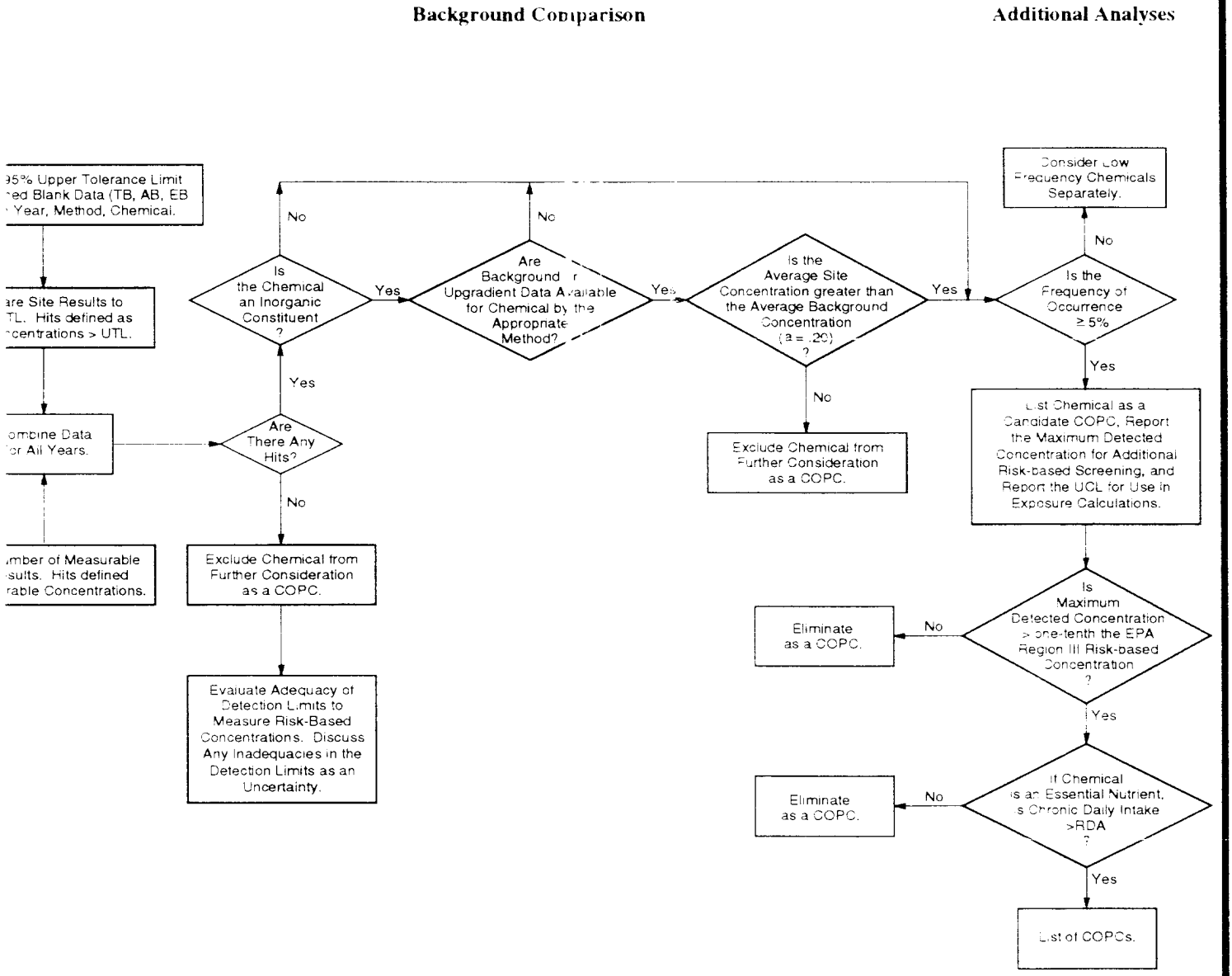


Figure 3-2. COPC Identification Process

Table 3-1
Summary of RI Field Activities for 1992, 1993, and 1994

Site/Source Area	1992 Activities	1993 Activities	1994 Activities
Fire Protection Training Area (FT001)	• Collected surface soil, water, and sediment samples; • Completed and sampled two soil borings; • Sampled existing monitoring wells; • Installed and sampled two monitoring wells; • Surveyed monitoring wells and conducted water level surveys; and • Completed in situ hydraulic conductivity tests to determine aquifer characteristics.	• Collected groundwater samples from wells installed in 1992; • Completed and sampled two soil borings; • Installed and sampled two monitoring wells; • Performed soil gas survey and hydropunch water sampling; and • Conducted geophysical surveys.	• Sampled surface and subsurface soils within the burn pit for dioxins and furans; and • Sampled six monitoring wells.
POL Tank Farm (ST005)	• Sampled surface soil, water, and sediment samples; • Completed and sampled three soil borings; • Sampled existing monitoring wells; • Installed and sampled six monitoring wells; • Surveyed monitoring wells and conducted water level surveys; and • Completed in situ hydraulic conductivity tests to determine aquifer characteristics.	• Collected groundwater samples from wells installed in 1992; • Conducted soil gas screening and collected groundwater confirmation samples; • Collected surface soils for arsenic and lead analysis to compare the means of these metals with background values; • Completed and sampled three soil borings; • Installed and sampled three downgradient monitoring wells; • Conducted baildown testing of hydrocarbon product on three wells to determine recovery rates; and • Conducted pumping/flowmeter test to determine aquifer hydraulic conductivity, storativity, and pumping cone of influence.	• Sampled ten monitoring wells; • Collected surface soil samples for characterization of pesticides; and • Conducted additional baildown and product recovery testing.
Waste Accumulation Area (SS006)—West Unit	• Collected surface soil, water, and sediment samples; • Completed and sampled two soil borings; • Sampled existing monitoring wells; • Installed and sampled a monitoring well; and • Surveyed monitor wells and conducted water level surveys.	• Collected groundwater samples from wells installed in 1992; and • Collected surface soil samples for arsenic and lead analysis to compare the means of these metals with background values.	• Sampled two monitoring wells; and • Collected surface soil samples for characterization of pesticides.
Million Gallon Hill—West Unit	• Sampled existing monitoring wells; • Collected surface soil, water, and sediment samples; • Installed and sampled seven monitoring wells; and • Surveyed all monitoring wells and conducted water level surveys.	• Collected groundwater samples from wells installed in 1992; • Conducted soil gas screening and collected groundwater confirmation samples; • Installed and sampled a downgradient monitor well; and • Conducted hydrocarbon baildown test on one well to determine recovery rate.	• Sampled ten monitoring wells; and • Conducted additional baildown testing.
Power Plant UST #49—West Unit	• Sampled all existing monitoring wells; • Collected a surface soil sample; • Completed and sampled one soil boring; and • Surveyed wells and conducted water level surveys.	• Collected surface soil samples for arsenic and lead analysis to compare the means of these metals with background values.	NA

Table 3-1
(Continued)

Site/Source Area	1992 Activities	1993 Activities	1994 Activities
JP-4 Fillstands—West Unit	• Collected surface soil samples; • Completed and sampled three soil borings; • Installed and sampled three monitoring wells; and • Surveyed wells and conducted water level surveys.	• Collected groundwater samples from wells installed in 1992; • Collected surface soil samples for arsenic and lead analysis to compare the means of these metals with background values; • Conducted soil gas screening and collected groundwater confirmation samples; • Installed and sampled one downgradient monitoring well; and • Abandoned one monitoring well.	• Sampled two monitoring wells.
Building 1845—West Unit	• Installed and sampled two monitoring wells.	• Conducted soil gas screening and collected groundwater confirmation samples; and • Installed and sampled one upgradient monitoring well.	• Sampled three monitoring wells.
Building 1700—West Unit	NA	• Conducted soil gas screening; • Collected one surface soil sample for arsenic and lead analysis; and • Completed and sampled one soil boring.	NA
Building 1850—West Unit	NA	• Conducted soil gas screening and collected soil confirmation samples.	NA

POL = Petroleum, oils, and lubricants
UST = Underground storage tank.
NA = Not applicable.

Table 3-2
Total Number of Samples Collected by Sample Type

Sample Type	Number of Samples Collected [a]			
	Fire Protection Training Area	POL Tank Farm	West Unit	Ambient Site [d]
Solids				
Surface soil/sediment [b]	25	23	59	4
Subsurface soil	25	30	82	7
Liquids				
Groundwater	22	43	84	6 [c]
Surface water	--	3	4	4

[a] Excluding samples determined to be uncontaminated that do not characterize nature and extent of contamination at a site.

[b] Surface soil and sediment samples were combined because the areas where sediment samples were collected are dry most of the time.

[c] Four for mercury, eight for arsenic and lead, and six for all other analytes.

[d] Ambient site is the area where background samples were collected (see background comparison discussion in this section for more information).

POL = Petroleum, oils, and lubricants.

Table 3-3
Previous Investigation Activities and Findings at Galena Airport

Site	Investigation	Activities/Findings
Fire Protection Training Area (FT001)	Phase I Records Search (USAF, 1985)	• Identified the type of potential contaminants and history of area.
	Stage 1 Confirmation and Quantification (USAF, 1989)	• Conducted groundwater and soil sampling. • Identified BTEX and TPH contamination in burn pit area.
POL Tank Farm (ST005)	Phase I Records Search (USAF, 1985)	• Conducted records search and site assessment. • Identified contaminant sources and recommended RI.
	Stage 1 Confirmation and Quantification (USAF, 1989)	• Conducted groundwater and soil sampling and a soil gas survey. • Identified BTEX and TPH contamination in soil and water. • Identified the presence of free-phase hydrocarbons on water table.
	Stage 2 RI/FS (USAF, 1992)	• Evaluated contaminant volumes and remedial technologies.
Waste Accumulation Area (SS006)—West Unit	Phase I Records Search (USAF, 1985)	• Identified types of wastes stored and documented leakage during site assessment.
	Stage 2 RI/FS (USAF, 1992)	• Conducted groundwater and soil sampling. • Identified BTEX, TPH, and chlorinated hydrocarbon contamination in water and soil.
Million Gallon Hill— West Unit	Phase I Records Search (USAF, 1985)	• Verified tank capacities and years of operation.
	Non-RI Study (USAF, 1992)	• Conducted groundwater and soil sampling. • Identified BTEX and TPH contamination in water and soil.
Power Plant UST No. 49—West Unit	Non-RI Study (USAF, 1992)	• Conducted groundwater and soil sampling. • Identified BTEX and TPH contamination in soil and TPH contamination in water.
JP-4 Fillstands—West Unit	Non-RI Study (USACE, 1993)	• Conducted subsurface soil sampling. • Identified pesticide, jet fuel, BTEX, and volatile and semivolatile organic contamination in soil.
Building 1845—West Unit	Phase I Records Search (USAF, 1985)	• Identified waste handling practices and quantities.
Buildings 1700 and 1850—West Unit	No Previous Investigations	• NA

Note: BTEX = benzene, toluene, ethylbenzene, and xylene.
FS = feasibility study.
NA = Not applicable.
POL = petroleum, oils, and lubricants.
RI = remedial investigation.
TPH = total petroleum hydrocarbons.

Table 3-4
Analytical Levels Used in the Remedial Investigation

Level	Type	Use	Data Quality Objective
I	Portable Instruments • PID/FID/CAT [a] • Infrared TPH/AH [b] Analyzer • Water Quality Meter and Field Test Kits • Immunoassay PCB [c] Test Kit	To reduce the overall schedule of the RI: • Generates "real time" data to direct the efforts of field screening activities; and • Allows for the strategic placement of monitoring wells and soil borings without delaying field crews.	Identify presence or absence of general types of contaminants or general range of concentrations for specific contaminant.
II	Mobile Gas Chromatography (GC) Laboratory	To confirm the presence of contamination as indicated by Level I results: • Allows for the speciation of several constituents in groundwater; and • Helps to determine potential sources and differentiate between contaminant plumes from adjacent source areas.	Quantitative data backed by basic laboratory quality control procedures.
III	CLP Laboratory Using USEPA Procedures	To produce defensible data: • Used in the baseline risk assessment, contingent upon validation.	Validated data based on all analytical quality assurance/quality control (QA/QC) procedures described in the quality assurance project plan (QAPP).

[a] PID = photoionization detector; FID = flame ionization detector; CAT = hydrocarbon analyzer with catalytic detector.

[b] TPH = total petroleum hydrocarbons; AH = aromatic hydrocarbons.

[c] PCB = polychlorinated biphenyls.

contamination at the site. Level III data were generated to support the investigations at the previously defined sites where defensible data were required to define nature and extent of contamination and to support the baseline risk assessment. Field screening data (Level I and Level II) were also used to narrow the focus of the investigation and direct the collection of Level III data.

Radian Analytical Services (RAS) performed all laboratory work for the analyses conducted in this project. Table 3-5 summarizes the analytical methods used during the remedial investigation. Most of these laboratory methods were published by USEPA in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW84*, Third Edition (USEPA, 1986), and *Methods for Chemical Analysis of Water and Wastes* (USEPA, 1983). Additional methods identified were published in *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act*, 40 CFR Part 136 (see also 49 *Federal Register*, 26 October 1984), *Annual Book of ASTM (American Society for Testing and Materials) Standards*, Volume 4.08, *Standard Methods for the Examination of Water and Wastewater* (APHA, 1984), and ADEC *Environmental Quality Monitoring Laboratory Operations Diesel and Gasoline Range Organic Methods*, February 5, 1992.

Quantitation Limits

Available analytical data consisted of a combination of censored (1992 - except organics) and uncensored (1993, 1994) data. Traditionally, analytical chemistry data have been censored at a concentration (e.g., method detection limit, practical quantitation limit, etc.). Censoring data involves substituting a Non Detect (ND) result in place of values indicated by instrument response that are below the designated reporting limit. If data are uncensored, an ND is reported only if there is no instrument response; consequently, low levels (greater than zero) of analytes are reported. However, the low levels reported may be similar to concentrations detected in blanks or attributed to systemic sources.

If a chemical was detected in any sample in any medium at a site, it was included on a list of possible COPCs for that site. Chemicals that were not detected in any sample in a medium were not considered COPCs in that medium. If a chemical was detected in some, but not all, samples in a medium, proxy values were assigned for all ND results.

USEPA guidance (USEPA, 1989b) suggests using one-half the detection limit (DL) as a proxy concentration for ND results. To assign proxy concentrations, this assessment used a random number between zero and the sample-specific DL for normal (site-related and background) samples, and a probability plotting method for blank samples. This method is described in Rao et al. (1991). The benefit of this approach is that the proxy concentrations more closely follow the distribution of measurements that could have been made by the analytical instrument. Appendix A provides more discussion about assigning proxy values.

If a chemical was eliminated as a COPC because it was not detected in any sample in a given medium, the adequacy of the detection limits to measure risk-based concentrations was evaluated. Any inadequacies in the detection limits are discussed as an uncertainty.

Data Qualifiers and Codes

The QA/QC data associated with field sampling and analytical measurements were reviewed to determine the useability and defensibility of the analytical results. The review focused on field and laboratory blanks, matrix spikes, surrogate recoveries, and laboratory

Table 3-5
Analytical Methods Used During the 1992-94 RI

Parameter	Fire Protection Training Area		POL Tank Farm		West Unit [a]	
	Soil	Water	Soil	Water	Soil	Water
Alkalinity - Total (SM403)	NA	92, 93, 94	NA	92, 93, 94	NA	92, 93, 94
Specific Conductance (E120.1)	NA	92, 93, 94	NA	92, 93, 94	NA	92, 93, 94
pH (E150.1 - aqueous, SW9045 - solids)	--	92, 93, 94	--	92, 93, 94	--	92, 93, 94
Total Dissolved Solids (E160.1)	NA	92, 93	NA	93	NA	--
Total Suspended Solids (E160.2)	NA	93	NA	93	NA	--
Temperature (E170.1)	NA	92, 93, 94	NA	92, 93, 94	NA	92, 93, 94
Turbidity (E180.1)	NA	93	NA	93	NA	93
Anions (E300)	NA	93	NA	93	NA	93
Nitrate-Nitrite (E353.1)	NA	93	NA	93	NA	93
Metals - ICP Screen (SW6010)	92	92, 93	92	92, 93	92	92, 93, 94
Arsenic (SW7060)	92	92, 93	92, 93	92, 93	92, 93	92, 93, 94
Lead (SW7421)	92	92, 93	92, 93	92, 93	92, 93	93, 94
Mercury - (SW7470 aqueous, SW7471 solid)	92	93	92	93	92	93
Selenium (SW7740)	92	92, 93	92	92, 93	92	92,93
Halogenated Volatile Organics (SW8010)	NA	92, 93	NA	92, 93	NA	92, 93
Nonhalogenated Volatile Organics (SW8015)	NA	92, 93	NA	92, 93	NA	92, 93
Aromatic Volatile Organics (SW8020)	NA	92, 93	NA	92, 93	NA	92, 93
Organochlorine Pesticides and PCBs (SW8080)	92	92, 93, 94	94	92, 93, 94	92	92, 93, 94
Semivolatile Organic Compounds (SW8270)	--	--	92, 93	92, 93, 94	92, 93	92, 93, 94
Polynuclear Aromatic Hydrocarbons (SW8310)	92, 93	92, 93	--	--	--	--
Volatile Organic Compounds (SW8240)	92, 93	NA	92, 93	NA	92, 93	NA
Volatile Organic Compounds (SW8260)	NA	94	NA	94	NA	94
Dioxins/Furans (SW8280)	94	--	--	--	--	--
Diesel Range Organics (AK102) [b]	92, 93	92, 93, 94	92, 93	92, 93, 94	92, 93	92, 93, 94
Gasoline Range Organics (AK101) [b]	92, 93	92, 93, 94	92, 93	92, 93, 94	92, 93	92, 93, 94
Soil Moisture Content (SW846) or ASTM 02216)	92, 93, 94	NA	92, 93	NA	92, 93	NA

[a] West Unit source areas combined.

[b] Method SW8015 MEMP used in 1992.

NA = Not applicable.

-- Analytical method not used for this medium (either a different method was used for this medium, for example to achieve better detection limits, or the method does not pertain to this medium).

control samples. Overall, QA/QC data associated with this program indicate that measurement data are acceptable and defensible. The QA/QC data indicate that the QC mechanisms were effective in ensuring measurement data reliability within the expected limits of sampling and analytical error. Appendix B of the RI report (USAF, 1995c) reports the results of the data validation process.

The only concern identified during the QA/QC review is that some surrogate recoveries for diesel range organics (DRO) were not within the acceptance limits of 60%-120%, as specified in the quality assurance project plan (QAPP). The surrogate was recovered both below and above the percent recovery acceptance criteria. The low recoveries were attributed to dilution of the samples because of high analyte concentration. The assignable cause for the high recoveries was matrix interference.

Very few data were rejected as a result of the validation process. Bis(2-ethylhexyl) phthalate results were invalidated for two groundwater samples collected at the POL Tank Farm in 1993.

For the purpose of quantifying risk, the risk assessment only used data subjected to Level III validation. Table 3-6 summarizes the data qualifiers and codes used to qualify the data reported in the RI report (USAF, 1995c).

Blanks Comparisons

Blanks comparisons were performed separately for each chemical/media combination and sampling round. For performing the comparison of site-related and background concentrations with concentrations detected in blanks, a three-step approach that involves statistical analysis of the data was used. First, measured concentrations in trip, ambient, equipment, and method blanks were compared graphically to determine whether outliers exist in the blanks data set. Outliers were deleted from the blanks data set unless QA review indicated that the data point should be retained. Next, the trip blank, ambient blank, equipment blank, and method blank data were combined, and a 95%/95% upper tolerance limit (UTL) was calculated for the combined data set. Finally, individual site-related and background concentrations were compared with the blanks' UTL. A concentration that exceeds the blanks' UTL was considered to be a positive result. Results that are less than or equal to the blanks' UTL were considered the same as an ND result. The benefit of this approach is that the blank data are used to empirically determine the upper limit to sample collection, sample handling, or sample analysis contamination rather than an arbitrary rule such as the 5X/10X rule suggested in USEPA guidance (USEPA, 1989b).

Arbitrary rules, such as the 5X/10X rule, can result in over- or underestimation of the potential for blank contamination with no control on how this bias affects conclusions about the site under investigation. Although not published, the UTL approach has been accepted as part of the COPC-determination process by USEPA Region X and ADEC for investigations at Elmendorf Air Force Base (AFB), Anchorage, Alaska. Appendix A contains a more detailed description of this methodology.

If, as a result of the blanks comparison, all results for a chemical are classified ND, that chemical was eliminated as a COPC. If, however, there was at least one positive result after the blanks comparison, the chemical was included as a possible COPC and all original results associated with that chemical were retained even if a result was less than the blank UTL.

Since the 1993 and later sampling events reported uncensored data (where an ND is

Table 3-6
Data Qualifiers and Codes

Data Flag	Definition
B	Sample concentration was less than or equal to the UTL calculated for the blanks for that analyte in that media. These data are considered indistinguishable from blank concentrations.
E	Analyte exceeded calibration range, but did not saturate the detector; therefore result is usable.
F	Co-elution or interference was suspected in the determination of the concentration of the flagged compound. These data may be biased high due to interference, although the QA/QC data for the sample were within acceptance criteria. These data are considered conservative (biased high) concentrations and are used in the risk assessment.
J	Result is less than sample-specific detection limit. Data with this flag should be interpreted with caution, but are used in the risk assessment.
K	The presence of the analyte was not confirmed because the compound was not detected on both the primary and secondary columns. Only "KJ" flagged data are reported and are intended for use as proxy values for risk assessment. This flag is used on methods requiring second-column confirmation (SW8010, SW8015, SW8015MP, SW8020, and SW8080).
L	QC evaluation determined that the result may be biased low; see QA report. This flag is used only on 1992 data. These data are used in the risk assessment.
NA	Sample not analyzed for the indicated parameter. In the case of SW8080, when results are reported for some compounds, the NA indicate that high concentrations of other target analytes precluded the determination of the flagged compound.
ND	Not detected. No instrument response for analyte or result less than zero.
P	The identification of the compound is not confirmed because the ratio of results from the primary and secondary columns differ by greater than a factor of three. The lower of the two values is reported with a "P" flag, since co-elution with a nontarget compound is suspected. Although they do not meet the confirmation criteria, it is likely that the compound is present; however, the concentration should be regarded as an estimate. This flag is used on methods requiring second-column confirmation (SW8010, SW8015, SW8015MP, SW8020, and SW8080). These data are used in the risk assessment.
R	Data did not meet QA/QC criteria. Sample was reanalyzed and acceptable results were reported and used in the risk assessment.
S	Metal concentration reported was obtained using the method of standard additions. This indicates that the analyst had some reason to believe that there was an interference with the determination and, therefore, the method of standard additions was used to determine the concentration. These data are used in the risk assessment.
T	Second-column confirmation was not performed for the flagged compound. In these cases, the sample was analyzed at two different dilutions and the confirmational analyses were performed for the samples analyzed at the higher dilution. These data should be considered estimates since they are not confirmed and were measured in the presence of compounds at much higher concentrations. These data are used in the risk assessment.
X	The recoveries of one or more of the internal standards were outside the applicable acceptance criteria. Method-appropriate (SW8240, SW8260, and SW8270) corrective actions were implemented to confirm matrix interferences. The X-flag indicates which compounds were quantitated using the affected internal standard(s). These data are used in the risk assessment.
Z	Oily drops suspended in sample extract. An homogenous subsample of the extract was analyzed. These data are used in the risk assessment.

reported only if there is no instrument response), very low levels (greater than zero) of many analytes were reported in both blanks samples and site samples. Consequently, many chemicals that are not common field or laboratory contaminants were "detected" in blanks samples and were eliminated as COPCs on the basis of the blanks comparison.

Tentatively Identified Compounds

Analyses of samples of soil or groundwater for organic compounds may reveal chromatogram peaks for compounds not included on the target compound list. When such a peak can be identified with confidence, the compound is named; however, the identity is usually highly uncertain. These compounds are called tentatively identified compounds (TICs). The concentration estimated for a TIC is also highly uncertain (USEPA, 1989b). TIC information is often not included in data summaries because of the uncertainty of the identity of the compound and its concentration. The Galena Airport data reports do not contain any TICs. Therefore, no TICs were included in this risk assessment.

Background Comparisons

Background samples were collected at a location referred to as the Ambient Site (shown as "Ambient Location" in Figure 1-2). The Ambient Site is located east of the runway and east of the FPTA in a field used for outdoor recreational activities. This site was chosen on the basis of a review of historical data that indicated that it has probably not been contaminated during the operation of the Galena Airport. Its position is hydrologically upgradient from the other investigative sites at Galena Airport. Prevailing wind direction is generally from the north; however, during the summer, the prevailing wind direction shifts to the west. A softball field occupies the northwestern portion of the site and the remaining area is an unused field. The eastern, western, and southern boundaries of the site are bordered by a raised gravel road and the northern boundary is wooded with primarily black spruce. A gravel-covered pathway used by pedestrians, snow machines, and small nonautomobile motorized vehicles transverses the site along the southern border.

Evaluation of the Ambient Site included sampling the surface water, groundwater, surface and subsurface soils, and sediments. No physical evidence of contamination, stained soils, strong odor, or elevated photoionization detector (PID) readings were encountered during sampling or well installation. Analytical results indicated that some minor soil contamination may exist at the site. Low levels of polynuclear aromatic hydrocarbons (PNAs) were detected in the soils, sediment, and surface water. Low levels of pesticides were detected in the soils and water; aggressive insect control measures taken in the past have resulted in base-wide low-level pesticide contamination. Methylene chloride, acetone, DRO, and gasoline range organics (GRO) were detected in soils and sediments at levels less than five times the DL of each analyte. Methylene chloride and acetone were detected in blanks suggesting that the source for those analytes may be laboratory contamination. Bis(2-ethylhexyl)phthalate was detected in groundwater samples.

Analytical results from inorganic analyses of soil, sediment, and water samples were used to statistically define background levels for inorganic analytes. Media-specific means comparisons were made between site-related inorganic concentrations and background inorganic concentrations in accordance with USEPA guidance (USEPA, 1989b). If the mean site-related concentration was higher than the mean background concentration using a confidence level of 0.20 (alpha=0.20), that analyte was retained as a possible COPC in that medium. If

the mean site-related concentration was the same as or lower than the mean background concentration, that analyte was eliminated as a COPC in that medium. Appendix A provides a more detailed description of the background comparison methodology.

Data Set for Use in Risk Assessment

USEPA guidance (USEPA, 1989b) stipulates that the list of COPCs include chemicals that were:

1. Positively detected in at least one sample in a given medium;

2. Detected at levels substantially greater than levels detected in associated blank samples (at least one result that exceeds the blanks UTL); and

3. Detected at levels substantially greater than naturally occurring background levels.

Further procedures for reducing the number of chemicals included in the quantitative risk assessment are permissible under USEPA guidance (USEPA, 1989b). Carrying a large number of chemicals through the quantitative risk assessment unnecessarily complicates the assessment and could distract from the dominant risks associated with a site. Therefore, additional screening was performed to identify the chemicals most likely to contribute substantially to the risks associated with the sites and to eliminate chemicals that pose only a minimal risk.

Additional Screening

Detection Frequency—Chemicals that are infrequently detected may be artifacts in the data resulting from sampling, analytical, or other problems, and therefore may not be related to site operations or disposal practices. Some chemicals that are widely dispersed in the environment are also not site related. For this assessment, a chemical was identified for possible elimination from the list of COPCs if it was detected infrequently (<5%). Chemicals detected at low frequency were further evaluated by two criteria: 1) Is the maximum detected concentration greater than conservative risk-based screening level (see discussion below)? and 2) Is the chemical potentially related to known or suspected contaminant sources? If the answer to either of these questions is *no*, the chemical was eliminated from the list of COPCs. If the answer to both questions is *yes*, the chemical was retained as a COPC but evaluated separately from the more frequently detected COPCs.

Essential Nutrients—Essential nutrients that are present at concentrations only slightly greater than background and that are toxic only at very high doses can be eliminated from the list of COPCs (USEPA, 1989a). Maximum daily intakes of essential nutrients were estimated assuming daily ingestion of 200 mg of soil or two liters of water at the maximum detected concentration in soil or water, respectively. If the maximum daily intake calculated in this manner exceeded the recommended dietary allowances (RDAs) for minerals and trace elements (NRC, 1989), the analyte was retained as a possible COPC. Otherwise, it was eliminated from further consideration.

Risk-Based Screening—If the maximum detected concentration of a chemical in a specified medium is lower than conservative, chemical- and media-specific risk-based concentrations, the chemical will not contribute significantly to the human health risks posed by a site. Its removal from the list of human health COPCs will not affect the overall estimated risks. The risk-based screen used in this assessment followed guidance by USEPA Region III (USEPA, 1993c) for deriving risk-based concentrations (RBCs). Use of USEPA Region III

RBCs is accepted by ADEC (L. Himmelbauer, 1994, ADEC, personal communication) and recommended by USEPA Region X (J. Sainsbury, 1994, USEPA Region X, personal communication). Figure 3-3 outlines the risk-based screening method used for this assessment. The Region III guidance involves deriving RBCs that correspond to a systemic hazard quotient (HQ) of 1.0 and/or a lifetime cancer risk of $1x10^{-6}$ to evaluate the risks of contaminants detected at the sites. The water RBCs are based on residential exposure algorithms and available reference doses (RfDs) and carcinogenic slope factors. The soil values are based on residential or industrial exposure algorithms. The residential soil RBCs were used for all sites. Algorithms used in the risk-based screening address exposures from the ingestion and inhalation of contaminants during residential water use and the ingestion of contaminants found in soils.

To ensure a conservative assessment, chemicals were eliminated as COPCs only if the ratio of the highest detected concentration to the Region III RBC for that chemical in a specific medium is less than 0.1. A ratio of 0.1 is used because the Region III RBCs do not address exposure to multiple chemicals in more than one medium and do not account for soil-related inhalation or dermal contact exposures. Using a ratio 0.1 effectively adjusts the RBCs to correspond to a noncancer HQ of 0.1 and a cancer risk of 10^{-7} instead of 10^{-6}.

Chemicals of Potential Concern

Sections 4, 5, and 6 document each step in the COPC identification process for the FPTA, the POL Tank Farm, and the West Unit, respectively. For each site evaluated, tables list all chemicals positively detected in each medium and show, for each chemical, whether 1) sample concentrations were distinguishable from blank concentrations, 2) concentrations were significantly different from background concentrations, 3) the chemical was detected in at least 5% of the samples, 4) the chemical was eliminated as an essential nutrient, and 5) the chemical was eliminated by risk-based screening.

3.1.3 Exposure Assessment

Exposure assessment is the determination or estimation of the magnitude, frequency, duration, and route of exposure to COPCs that are present at or migrating from the site. The first step in exposure assessment involves evaluating the potential for contaminant release, transport, and fate. After it is determined where a contaminant might travel in the environment, potentially exposed populations can be identified. Exposure scenarios are developed that represent different segments of the potentially exposed populations. Each scenario consists of a combination of one or more exposure pathways. An exposure pathway exists only if there is a point of potential contact with a contaminated medium and an exposure route (e.g., ingestion). The final step in exposure assessment, quantification of exposure, involves determining exposure point concentrations (the concentration at the point where exposure occurs) and estimating contaminant intake for each relevant route of exposure.

The following subsections discuss contaminant fate and transport, potentially exposed human populations, human exposure scenarios, human exposure pathways, exposure point concentrations, and contaminant intakes. Sections 4, 5, and 6 provide additional site-specific information relevant to assessing exposure for the FPTA, the POL Tank Farm, and the West Unit, respectively, and present in graphical form conceptual site models that identify contaminant sources, release mechanisms, transport and fate, exposure pathways, and human receptors.

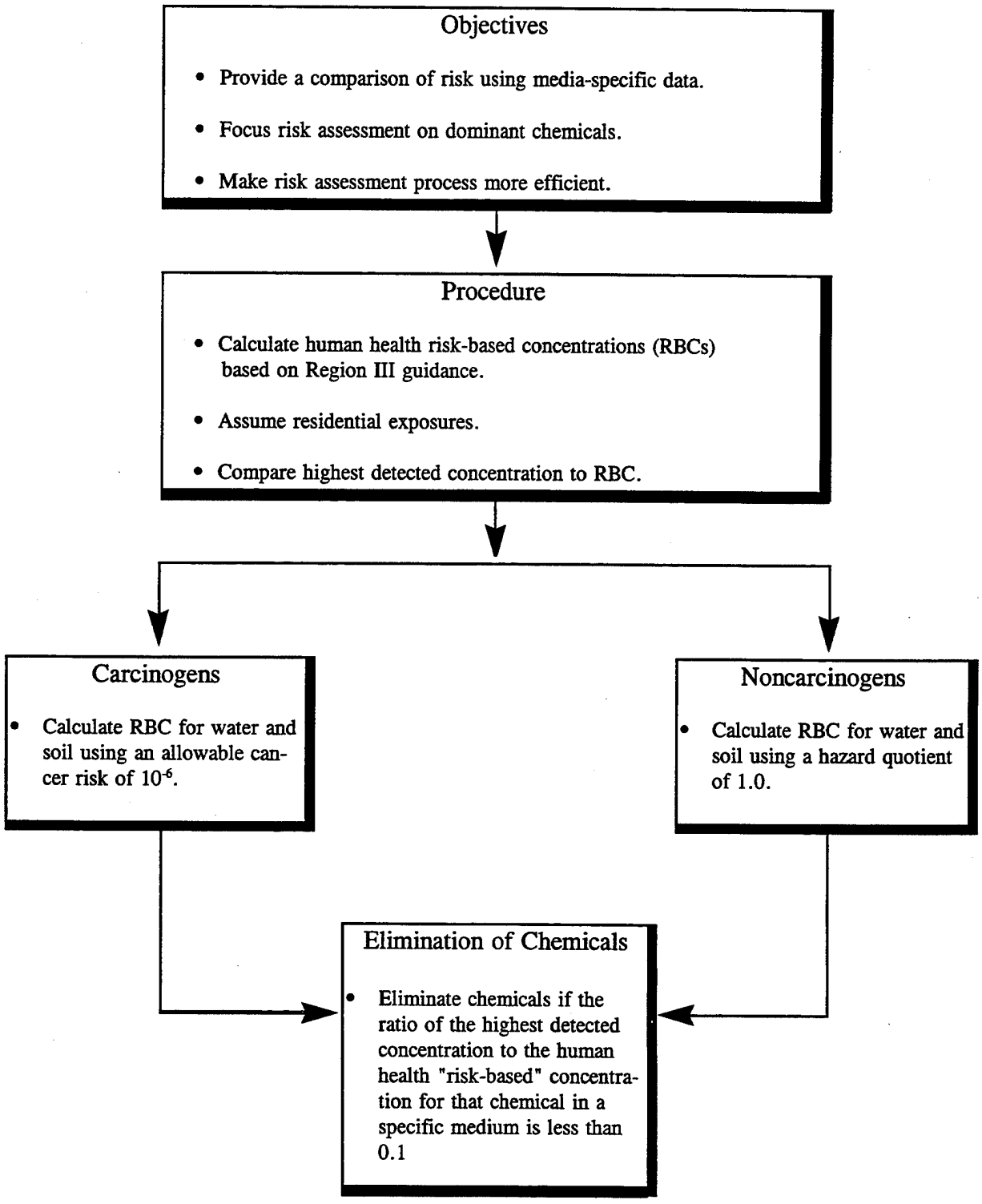


Figure 3-3. Risk-Based Screening to Identify COPCs

Contaminant Release, Fate, and Transport

Contaminants have been detected in the surface and subsurface soils at the FPTA, POL Tank Farm, and the West Unit, and in the groundwater underlying these sites. Limited sampling of sediments and surface water from areas where water pools intermittently at or near these sites also indicates the presence of some contaminants in these media. Mechanisms of contaminant release and migration include 1) migration to/transport in groundwater; 2) air emissions/atmospheric dispersion and deposition; 3) surface runoff; and 4) uptake by biota. The potential for transport of contaminants in various environmental media depends largely on the chemical and physical properties of the contaminants. A chemical may be physically transformed (e.g., volatilization), chemically altered (e.g., hydrolysis, photolysis), biodegraded, and/or bioaccumulated in one or more media.

Migration to/Transport in Groundwater—As discussed in Section 2, groundwater at Galena Airport exists in an unconfined aquifer that is greater than 200 ft deep and exhibits strong communication with the Yukon River. The depth to the water table varies from approximately 5 to 25 ft bgl on a seasonal cycle in response to changes in stage of the Yukon River. Groundwater flows generally to the southwest and discharges in the river; however, groundwater flow is reversed and the river recharges the local unconfined groundwater aquifer for a short period when the river floods in spring and early summer.

Groundwater modeling was performed to predict fate and transport of contaminants detected in the shallow portion of the aquifer at the FPTA, the POL Tank Farm, and the West Unit. Appendix C describes the modeling methodology and presents modeling results. New Town Galena is upgradient of the Galena Airport sites. Old Town Galena is downgradient of some portions of the airport installation; however, it is not directly downgradient of the FPTA, the POL Tank Farm, or the West Unit. Nevertheless, groundwater modeling results were reviewed to evaluate the potential significance of 1) using the groundwater for drinking water or other uses in the home or to irrigate home gardens in Old Town Galena; and 2) uptake by fish in the Yukon River and subsequent ingestion of fish by humans.

There is no evidence that the base water supply wells that are 200 ft deep (well Nos. 1 and 7) have been affected by the contamination that has been found in the shallow portion of the aquifer in the main base triangle area. However, since these deep wells are close to areas with shallow groundwater contamination, it would be very difficult to prove conclusively that contaminants will not migrate vertically to these wells in the future. Therefore, rather than developing a groundwater model to estimate the potential impact of the shallow groundwater contamination on these deep base supply wells, this risk assessment concedes that there is potential health risk associated with contaminant migration to the deep supply wells and recommends that measures be pursued to prevent unacceptable exposures from occurring. An engineering evaluation/cost analysis (EE/CA) has been developed by the USAF to address potential impacts on the Galena Airport drinking water supply (USAF, 1995a). The purpose of the EE/CA is to initiate actions that will prevent exposure to contamination by current and future users of the water supply.

Air Emissions/Atmospheric Dispersion and Deposition—Emissions of volatile chemicals from soils and groundwater may occur at ground level in the gaseous phase. Fugitive dusts can also be generated from surface soils. The gases and particulates may subsequently disperse in the

ambient air according to local meteorological conditions. Ambient ground level concentrations are highest at the source and typically drop off rapidly. As discussed in Section 2, winds are generally from the north. Therefore, the highest annual-average ground level concentrations usually will occur south of the sites.

To evaluate releases to the air at sites with contaminated surface and subsurface media, four types of emissions mechanisms need to be considered: 1) volatilization of organic compounds from surface contamination; 2) volatilization of organic compounds from subsurface contamination; 3) wind entrainment of contaminated surface soil; and 4) emissions from construction-related activities. Emission rates of COPCs were calculated using predictive equations applicable to the relevant emission mechanisms. The predicted emission rates provided input to an USEPA-approved dispersion model to estimate chemical concentrations in the atmosphere at identified receptor locations. Appendix D describes the modeling methodology and presents modeling results.

Modeling of soil gas movement into buildings was not performed because the migration of soil gas into buildings is difficult to simulate. Available equations are highly unreliable and usually result in overestimates of indoor concentrations (Smith et al., 1995). The concern for this pathway increases if contaminated groundwater is very close to the surface and in contact with the building (e.g., basement) or is seeping into the basement. There are no basements in Galena. Note also that the building proposed for use as a student dormitory does not overlie a groundwater plume.

The civilian flight services buildings do overlie the main POL groundwater plume. Several buildings in the West Unit also overlie groundwater plumes. Indoor air monitoring results for benzene, toluene, ethylbenzene, and xylene (BTEX) are available for some buildings potentially impacted by groundwater plumes (USAF, 1994b). These data are discussed in the site-specific sections of this report. It should be noted that this report concludes, with respect to indoor air concentrations detected in the POL area, that "it is difficult to differentiate the POL contribution from the civilian refueling operations for a number of reasons: 1) the civilian flying services and POL results are variable and do not clearly identify where contaminants originate, 2) there is a large number of refueling tanks used in the civilian air operations, 3) many of the civilian aircraft buildings have evidence of past or current storage of fuel oil and other petroleum products (e.g., gasoline), with evidence of spills and leaks outside of the buildings and, 4) all of the hanger openings are right on the apron and aircraft pass directly by the entrance to the hangers" (USAF, 1994b).

Surface Runoff—Surface water within the diked portion of Galena Airport is limited to ephemeral drainage ditches and associated small stagnant water bodies. During the summer of 1992, small ponds composed of Yukon River floodwater persisted for several months (USAF, 1995c). Generally, precipitation rates do not exceed the soil's infiltration capacity, and surface water flow in the drainage ditches is rare. However, in the early spring, when the shallow subsurface soil remains frozen, precipitation runoff and snow melt flows to open ditches and ultimately accumulates in the southwest corner of the installation. There, the pump lift station pumps the water to the Yukon River. These lift pumps are used only for a short period each year during spring breakup when large quantities of snow melt accumulate in the southwest corner of the facility (USAF, 1995c).

The only mechanism for surface runoff from sites within the diked area to reach surface

water bodies in the area is via pumping of surface accumulation to the pump outfall at the Yukon River. Two surface soil/sediment samples were collected in 1994 at the pump station outfall, located just outside the diked area at the southwest corner of the installation. The only analytes detected in these samples were low levels of 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, and gamma-BHC. These and other pesticide compounds have been detected in soil and water samples from throughout the Galena Airport facility. In general, their occurrence does not appear to result from spills or leaks in areas of bulk storage or waste accumulation, but from widespread application for insect control (USAF, 1995c). Analytical results from the pump station outfall samples provide evidence that surface runoff from the sites within the diked area (which include the FPTA, the POL Tank Farm, and most of the source areas in the West Unit) is not a significant migration pathway for COPCs at these sites.

The Million Gallon Hill source area in the West Unit is actually part of the dike structure on the west side of the installation. Million Gallon Hill is made up mostly of fill (sandy gravel) and is sparsely vegetated with grass. Several large tanks cover part of the area. Runoff gullies do exist along the sides of the hill, indicating that erosion of soil from the surface does occur. However, the erosion gullies do not extend beyond the hill itself. Immediately to the south of the hill, toward the Yukon River, the land is thickly vegetated with grass and trees. A raised roadbed is located about 400 ft south of the hill. If any runoff reaches this far, the raised roadbed would intercept its progress toward the Yukon River. The river itself is about 1400 ft from the south base of the hill. One surface soil sample taken near the southwest base of the hill, well north of the raised roadbed, showed only very low concentrations of DRO, much lower than the Alaska cleanup standard for DRO of 200 mg/kg (USAF, 1995c). Consequently, it is unlikely that surface runoff from Million Gallon Hill can affect the Yukon River or marshy areas adjacent to the Yukon River (see Figure 2-1). It is also unlikely that surface runoff from Million Gallon Hill can affect Bear Creek. At its closest point, Bear Creek is more than two miles east of Million Gallon Hill.

Seasonal flooding can reach the base of Million Gallon Hill. It is theoretically possible for petroleum products floating on the groundwater surface to be released to floodwaters if the groundwater rises to the ground surface. However, this kind of release is very difficult to quantify with any degree of confidence. The magnitude of any such releases is likely to be minor in comparison with the potential for the contaminant plume to reach the Yukon River through groundwater migration.

For these reasons, the migration of COPCs via surface runoff is not evaluated further.

Uptake by Biota—Plants and terrestrial and aquatic animals are potentially exposed to contaminants originating from the sites under investigation. Human exposure can subsequently occur via ingestion of affected plants, meat from exposed animals, or fish in the Yukon River, should contaminants in the groundwater reach the river.

Although a lower percentage of Galena households rely on subsistence when compared with the region's small villages, subsistence foods are still a major portion of the diet, even for Galena residents who have full-time employment. Many residents prefer traditional foods to store-bought products. In addition, they have strong cultural, historic, and family ties to subsistence activities. Moose meat and fish are

the most important subsistence foods harvested by Galena residents. Berries provide an important food resource in the summer (USAF, 1994a).

Wild Fruits and Berries—A variety of berries are harvested, including high- and low-bush cranberries, blueberries, raspberries, cloudberries, and rosehips. Other types of plants gathered for food include rhubarb, wild onions, spearmint, mushrooms, and roots (USAF, 1994a). Areas where plants are gathered include the roadsides around town (Old Town and New Town Galena), river banks, north of Galena Airport, and between the airport and New Town (USAF, 1994a). Berry bushes and other plants that are gathered for food do not grow directly in areas of contamination. Contaminants in the soils, sediments, and groundwater from the sites under investigation could theoretically reach some of these areas via generation of fugitive dust from the sites, dispersion in the ambient air, and deposition onto the plants and the soils in which the plants are growing and via migration of the groundwater to the shoreline of the Yukon River. Typically, wind-blown dust does not travel very far before settling to the ground.

The most common berry that is gathered by residents in the area is cranberries from both high bush and low bush cranberry plants located far from the Galena Airport sites. People who gather berries and other food plants from the wild are unlikely to gather enough berries or other vegetation from plants .that are close enough to the sites to be affected by wind-blown dust or groundwater migration to make up more than a minor portion of their overall diet. The size of the area that could potentially be affected by contaminant migration from the sites under investigation is extremely small relative to the size of the area from which wild fruits, berries, and other plants may be gathered.

Since the plants gathered for food are not growing directly in the areas of known contamination, the potential for migration to areas where plants are gathered is low, and the size of the area that might be affected is so small relative to the areas available for gathering these plants, uptake of site-related contaminants by wild fruits, berries, and other plants is not evaluated further.

Cultivated Crops—Some residents grow vegetables in home gardens in Old Town and New Town Galena. Also, residents grow vegetables in one area of the airport installation, between the runway and the southern portion of the perimeter dike. This area is not known to be contaminated; however, it is directly downgradient of the Southeast Runway fuel Spill, which will be the subject of an addendum to this risk assessment report. It is not downgradient of the FPTA, the POL Tank Farm, or the West Unit.

Vegetables that are grown include potatoes, carrots, cabbage, lettuce, broccoli, spinach, tomatoes, beets, squash, zucchini, and green beans (USAF, 1994a). Some residents reported using Yukon River water, city water, ponds and lakes, and base water to irrigate the gardens. None reported using groundwater from the shallow portion of the aquifer to irrigate their gardens. New Town Galena is upgradient of the Galena Airport sites. Old Town Galena is downgradient of some portions of the airport installation; however, it is not directly downgradient of the FPTA, the POL Tank Farm, or the West Unit. Nevertheless, the results of groundwater modeling were reviewed to evaluate the potential significance of using the groundwater to irrigate or subirrigate vegetable gardens in Old Town Galena.

Game Meat—Locally obtained game meat may contribute a major component of the

diet of some Galena residents. Animals that are hunted for food include moose, fowl, rabbits, bear, beaver, lynx, and caribou (USAF, 1994a). In the fall, families begin hunting large game to supply themselves with meat for the winter. Moose, which are the most commonly hunted large mammal, are actively hunted during September's 20-day open season. Black bears are taken when they are available throughout summer and fall. Waterfowl are also hunted near their staging areas prior to southerly migrations.

Game species do not inhabit, or even visit, the areas of contamination, particularly those sites in the diked area. However, it is theoretically possible for these animals to contact areas outside the dike that have been affected by site-related contaminants, primarily through ingestion of water and/or plants at the edge of the Yukon River downgradient of the sites under investigation. It is also possible for moose and other animals to forage in the Million Gallon Hill area outside the perimeter dike. Even if an occasional moose walked on Million Gallon Hill, or ingested some standing water or vegetation in the immediate area, the contribution of this exposure in relation to the animal's complete diet would be negligible. The foraging range of these animals, the large mammals in particular, is considerably larger than areas affected, actually or potentially, by site-related contamination. Therefore, it is not likely that site-related contaminants will enter the food chain and transport to a substantial degree to animal species that comprise the game meat populations. Uptake of site-related contaminants by game meat populations is not evaluated further.

Fish—After spring break up, many families prepare for a fast-paced salmon harvest for food as well as income for commercial fishing households. Much of the subsistence fishing in the region takes place at remote fish camps (USAF, 1994a). Fish are usually harvested with nets or fishwheels and dried on racks for later use. Chum salmon is the most important subsistence species harvested. Whitefish may arrive as early as May, but many families defer their harvests of these species until after the king salmon and summer chum salmon runs of June and July. Fall runs of chum salmon normally begin in August and may be available until freeze up. Pike, trout, and grayling are also harvested in late summer and early fall.

Any site-related contaminants that reach the Yukon River are expected to be diluted to such a degree that uptake by fish is not likely to result in concentrations that are a cause for concern. Moreover, local game fish species are migratory and do not spend a substantial amount of time in the river near Galena. King, coho, and chum salmon migrate far up the Yukon River in each annual migration to spawning grounds located distant from Galena Airport, and are only in the area of the airport for short durations. As noted above, much of the fishing takes place at remote fish camps. Other species, such as arctic grayling, northern pike, burbot, and whitefish are found throughout the main drainage of the Yukon River and most of its tributaries throughout the year. Therefore, the results of groundwater modeling were reviewed to evaluate the potential significance of uptake of site-related contaminants by fish.

Potentially Exposed Human Populations

Human exposure to contaminants originating at the sites under investigation may occur 1) in industrial and residential areas close to and downwind of the sites via inhalation of the ambient air; 2) in areas where direct contact with contaminated soils is possible; and 3) in residences that use groundwater potentially affected by site-related contaminants for drinking water, bathing, cooking, washing dishes and

clothes, and/or irrigation of home-grown vegetables and fruits.

Current Populations—This assessment evaluated the following three populations to determine potential exposures and consequent health risks for each site:

1. On-base residents, including contractor caretakers who reside on base for a few years and longer term residents;

2. Galena residents, including both Old Town and New Town residents; and

3. On-base workers, including contractor caretakers, construction workers, and other longer term workers.

It is also possible for a site visitor or trespasser or a roaming resident to encounter site-related contaminants in the surface soil or ambient air. There are no secured access restrictions except for some small fenced areas in the airport area. However, it is not necessary to evaluate this population because the on-base workers encounter a much higher level of exposure than would ever result from a trespasser or resident who intermittently roams the area.

Future Populations—With one exception, it is not expected that the potentially exposed human populations in the future will differ significantly from those identified at present. This conclusion is based on the expectation, discussed in Section 2, that land use at Galena Airport is unlikely to change for the foreseeable future. The potential for residential development at any of the sites under investigation at Galena Airport is extremely low and will not occur as long as the airport is in operation. The locations of existing housing areas are the most likely locations for future residential development. Future residents were evaluated at the location of current housing. As long as the airport is in operation, current work practices of on-base workers are likely to remain substantially unchanged in the future.

Most of the open space areas within the dike are restricted with regards to future development due to proximity of the runway (see the building restriction line on Figure 2-2). The majority of the open space area south and west (down-gradient) of Million Gallon Hill is occupied by landfills (active and inactive), roads, and a sewage line from the airport. The development of this area is very unlikely.

Since there are plans to adapt facilities at Galena Airport for use by boarding school students, this future student population is evaluated to determine potential exposures and consequent health risks. Current plans are to board high school students only (Grades 9-12); however, it is possible that the boarding facilities will expand to include younger students. If the plans are implemented, the students will attend school in Galena but reside on base. Adult dormitory counselors, who may live in contractor caretaker housing or in Galena, are not evaluated separately from other on-base residents. Risks for adult counselors would be higher than those estimated for students in this assessment only if the counselors reside in the dorm for more than 14 years and spend every day while residing at the dorm "playing" in the area of the POL Tank Farm.

Human Exposure Scenarios

To address the range of exposures that may occur now and in the future, eight exposure scenarios were considered for applicability to each site. The exposure scenarios consist of the following:

Current Scenarios (also applicable as future scenarios)

1. Short-Term On-Base Resident (adult only);

2. Long-Term On-Base Resident (adult and child);

3. Old Town Galena Resident (adult and child);

4. New Town Galena Resident (adult and child);

5. Short-Term On-Base Worker (adult only);

6. Long-Term On-Base Worker (adult only);

7. Construction Worker (adult only); and

Future Scenarios

8. Boarding School Student.

Table 3-7 lists the eight scenarios, describes the population, and summarizes the underlying assumptions that were used to quantify exposure. Carcinogenic and noncarcinogenic risks were evaluated for both chronic (seven-year to lifetime) exposure scenarios and subchronic (two-week to seven year) exposure scenarios. Although less than seven years in duration, residential child scenarios were evaluated as chronic scenarios, using chronic toxicity values. An average case and a reasonable maximum exposure case were developed and evaluated for each exposure scenario.

Human Exposure Pathways

An exposure pathway describes the course a chemical or physical agent takes from the source to the exposed individual. An exposure pathway generally consists of the following: 1) a source and mechanism of chemical release; 2) a retention or transport medium (or media in cases involving media transfer of chemicals); 3) a point of potential contact with the contaminated medium; and 4) an exposure route (e.g., ingestion). Table 3-8 summarizes the exposure pathways considered for evaluation. These include the following:

Soil Pathways

- Incidental ingestion of soil; and
- Dermal contact with soil.

Air Pathways

- Inhalation of fugitive dust; and
- Inhalation of vapors that volatilize from surface and subsurface media.

Groundwater Pathways

- Ingestion of drinking water;
- Dermal contact with water while showering;
- Inhalation of vapors that volatilize from water while showering; and
- Ingestion of plants irrigated or subirrigated with groundwater.

Surface Water Pathways

- Ingestion of fish from the Yukon River.

Groundwater pathways are applicable only if groundwater modeling indicates that contaminants from any site might migrate to Old Town Galena. Surface water pathways are applicable only if groundwater modeling indicates that toxicologically significant concentrations of contaminants originating from any site

Table 3-7
Exposure Scenarios

Exposure Scenario	Population	Basis/Assumptions
Current Scenarios[a]		
Short-Term On-Base Resident (Subchronic)	Contractor caretakers (Space Mark employees) and other contractor personnel. Population includes adults only who reside on base while under contract to perform activities related to operating the airport.	• Residence at current on-base housing locations for 2-5 years. • Soils at current on-base housing locations are not contaminated by chemicals migrating from the sites under investigation.[b] • Drinking water from Galena Airport water supply.[c] • Inhalation of wind-blown dust and vapor phase chemicals.
Long-Term On-Base Resident (Chronic)	Personnel who may reside on base for a longer time period than contractor caretakers. Population includes adults and children who reside on base while at least one family member is employed on the base.	• Residence at current on-base housing locations for 9-25 years. • Soils at current on-base housing locations are not contaminated by chemicals migrating from the sites under investigation.[b] • Drinking water from Galena Airport water supply.[c] • Inhalation of wind-blown dust and vapor phase chemicals.
Old Town Galena Resident (Chronic)	Residents of Old Town Galena, including adults and children.	• Residence at Old Town Galena for 25-70 years. • Soils in Old Town Galena are not contaminated by chemicals migrating from the sites under investigation. • Drinking water from private wells drawing from the shallow portion of the aquifer.[d,e] • Inhalation of wind-blown dust and vapor phase chemicals. • Use of water from private wells to irrigate home garden.[e] • Ingestion of fish from Yukon River.[e]
New Town Galena Resident (Chronic)	Residents of New Town Galena, including adults and children.	• Residence at New Town Galena for 25-70 years. • Soils in New Town Galena are not contaminated by chemicals migrating from the sites under investigation. • Drinking water from deep well in New Town Galena that is upgradient of all Galena Airport sites. • Inhalation of wind-blown dust and vapor phase chemicals. • Ingestion of fish from Yukon River.[e]
Short-Term On-base Worker (Subchronic)	Contractor caretakers (Space Mark employees) and other contractor personnel. Population includes adults only who perform activities related to operating the airport.	• Work activities outdoors, in vicinity of contaminated areas, every work day for duration of employment (2-5 years). • Drinking water from Galena Airport water supply.[c] • Dermal contact with and incidental ingestion of surface soils. • Inhalation of wind-blown dust and vapor phase chemicals.
Long-Term On-base Worker (Chronic)	Workers who may be employed at the installation for a longer time period. Population includes adults only who perform activities related to operating the airport.	• Work activities outdoors, in vicinity of contaminated areas, every work day for duration of employment (25 years). • Drinking water from Galena Airport water supply.[c] • Dermal contact with and incidental ingestion of surface soils. • Inhalation of wind-blown dust and vapor phase chemicals.

Table 3-7
(Continued)

Exposure Scenario	Population	Basis/Assumptions
Construction Worker (Subchronic)	Workers involved in short-term construction-related activities.	• Work activities outdoors, at location of contaminated areas, every work day for duration of construction project (3-6 months). • Construction activity involves moving soil such that contaminated subsurface soils are exposed. • Drinking water from Galena Airport water supply.[c] • Dermal contact with and incidental ingestion of surface and subsurface soils. • Inhalation of dust and vapor phase chemicals generated during construction activities.
Future Scenarios		
Boarding School Student (Subchronic/Chronic)	Students who come to Galena to attend school. Students attend school in Galena but reside at a dormitory on base.	• Residence at dormitory on base while attending school in Galena for 4-14 years.[f] • Drinking water from Galena Airport water supply.[c] • Dermal contact with and incidental ingestion of surface soils at the POL Tank Farm, which is adjacent to the proposed dormitory. • Inhalation of wind-blown dust and vapor phase chemicals. • Although students may roam to other areas at the airport, infrequent, intermittent exposures to contaminated soils at other sites is not quantified.[g]

[a] Current scenarios are also applicable as future scenarios.

[b] Sampling of soils at the BLM housing area indicated the presence of a few pesticide compounds, which are attributable to widespread pesticide spraying activities and not to migration from sites under investigation. Some PNAs were also detected which are not attributable to migration from sites under investigation.

[c] There is no indication that the base water supply wells that are 200 ft deep have been affected by contamination that has been found in the shallow portion of the aquifer. However, since the potential exists for vertical migration to occur, the USAF has prepared an EE/CA to initiate activities that will prevent exposure to contamination by current and future users of the water supply (USAF, 1995d).

[d] Most residents of Old Town Galena have drinking water trucked in from the city well in New Town Galena that is upgradient of the Galena Airport. However, at least seven private wells are still in use in Old Town Galena (USAF, 1995c). Samples from four of those wells indicated the sporadic presence of several pesticide compounds, which are attributable to widespread pesticide spraying activities and not to migration from the sites under investigation.

[e] The results of groundwater modeling were reviewed to evaluate the future possible significance of 1) using the water for drinking water or other uses in the home or to irrigate home gardens; and 2) uptake by fish in the Yukon River and subsequent ingestion of fish by humans.

[f] Current plans are to board high school students only (Grades 9-12); however, it is possible that the boarding facilities may expand to include younger students (Grades 1-12, with 2 years repeated, was assumed).

[g] It is not necessary to evaluate a roaming student because the on-base workers encounter a much higher level of exposure than would ever be encountered by a student who intermittently and infrequently roams the areas. Cleanup levels that are protective of workers will certainly also protect the roaming student.

Table 3-8
Exposure Routes Considered for Evaluation

Exposure Route	Potentially Exposed Populations	Exposure Media	Comments
Soil Pathways			
Incidental Ingestion	On-Base Workers and Construction Workers Boarding School Students	Surface and Subsurface Soil [a]	On-base workers may directly contact potentially contaminated soils. There is no soil contamination in current residential areas. There is soil contamination in the area where boarding school students may board in the future.
Dermal Contact			
Air Pathways			
Inhalation of Volatile Organic Compounds and Fugitive Dust in Ambient Air	On-Base Residents Galena Residents On-Base Workers and Construction Workers Boarding School Students	Ambient Air	Residents and workers may be exposed to contaminants that volatilize from surface or subsurface media or to dust through inhalation of ambient air.
Groundwater Pathways [b]			
Ingestion	Old Town Galena Residents (depending on the results of groundwater modeling)	Groundwater (Old Town Galena wells) Air Inside Shower Stall Fruits and Vegetables Irrigated or Subirrigated with Groundwater	If groundwater modeling indicates that contaminants at any site might migrate to Old Town Galena, residential use of the water as a domestic water source and for irrigation at home gardens may be a cause for concern.
Dermal Contact with Water While Showering			
Inhalation of Volatiles While Showering			
Ingestion of Plants Irrigated with Groundwater			

Table 3-8
(Continued)

Exposure Route	Potentially Exposed Populations	Exposure Media	Comments
Surface Water Pathways[b]			
Ingestion of Fish from Yukon River	Galena Residents	Fish	Even if groundwater modeling indicates that toxicologically significant concentrations of contaminants at any site might migrate to the Yukon River, potentially impacted groundwater will contribute only a minuscule volume of water to the river in comparison to the water that flows past Galena. However, the results of groundwater modeling were reviewed to evaluate the significance of this pathway.

[a] Workers (except construction workers) and students are assumed to directly contact surface soils only. Construction workers can directly contact surface and subsurface soils. Although the possibility exists that future workers or students might come into contact with subsurface soils that have been brought to the surface by digging and other construction activities, it is highly improbable that a sufficient volume of subsurface soils would ever be relocated to the surface to make this a pathway of true concern.

[b] The results of groundwater modeling were reviewed to evaluate the significance of these pathways on a site-specific and combined impacts basis.

might reach the Yukon River. To determine if the concentrations of contaminants are toxicologically significant, groundwater modeling results for each site were compared to USEPA Region III tap water RBCs and estimated concentrations in fish were compared to Region VII fish RBCs. Ingestion of fish from the river is the most likely avenue for exposures to occur. Direct contact with or incidental ingestion of river water is not evaluated. The surface water of the Yukon River in the immediate vicinity of Galena Airport is not regularly used for recreational activities. Of 30 people interviewed during preparation of the Community Relations Plan for Galena Airport (USAF, 1994a), only two indicated that they swim in the Yukon River (at unspecified locations) and only four responded that they engage in other water-contact activities such as boating and canoeing. Standing water on the installation is intermittent and contact with this water is assumed to be minimal.

Tables presented in Sections 4, 5, and 6 provide site-specific matrixes of exposure scenarios and exposure pathways that apply at the FPTA, POL Tank Farm, and the West Unit, respectively. These tables also specify the exposure points and the data that were used to derive concentrations in the exposure media.

Exposure Concentrations

The subsections that follow describe the derivation of exposure concentration estimates in the various media. The estimates are based on measured concentrations in various media at various locations, as reported in the RI report (USAF, 1995c), and the results of transport and fate modeling. Sample locations that were determined by analytical tests to be uncontaminated were deleted from the risk assessment data set so that statistical summaries of the data were not biased low. Areas of concern were define to include only contaminated or potentially contaminated areas.

Surface Soil—Surface soil was defined to include soil from 0 to 2 ft in depth (surface soil samples and soil boring samples from 0 to 2 ft). The majority of the samples taken to characterize this medium were collected from the top 6 in. of soil; however, soil boring samples with a bottom depth of 2 ft or less were included in the surface soil data set at each site. The 95% upper confidence limit (UCL) of the mean of the data set, calculated according to procedures recommended by USEPA (USEPA, 1992f), or the maximum detected concentration (if lower), was used to define the surface soil exposure concentration. The methods used to calculate the 95% UCL are described in Appendix A. This concentration was used to quantify incidental ingestion of and dermal contact with soil for workers (except construction workers) and (for the POL Tank Farm) boarding school students, both average and reasonable maximum cases.

It was not necessary to determine yard-sized hot spots within any of the sites because there is no residential exposure scenario located right on top of any of the sites. Typical work activities at the airport installation involve worker movement around the entire area of a defined site. It was assumed that the future boarding school student in dormitories adjacent to the POL Tank Farm essentially use the entire POL area as a yard. Therefore, data from the north area of the POL, which is closer to the proposed dormitories, were combined with data from the remainder of the site to evaluate soil ingestion and dermal contact with soil by boarding students. Although the analytes detected in the soils and the levels of contamination are similar in the north area and the remaining areas of the POL Tank Farm, the extent of soil contamination in the north area is smaller. Groundwater is less contaminated in the north area.

Subsurface Soil—Subsurface soil was defined to include soil greater than 2 ft bgl. The 95% UCL, or the maximum detected concentration (if lower), was used to characterize the magnitude of subsurface soil contamination and define the subsurface soil exposure concentration. Construction workers were assumed to be involved in soil excavation, which would expose them to both surface and subsurface soils. The higher of either the surface soil exposure concentration or the subsurface soil exposure concentration was used to define the exposure concentration for "mixed" soil. This concentration was used to quantify incidental ingestion of and dermal contact with soil for the construction worker, both average and reasonable maximum cases.

Ambient Air—Emission rates from volatilization and wind entrainment of dust were estimated from the exposure concentrations in the surface soil and subsurface soil. Emissions from groundwater were determined to be so low that they were not included in the air pathway assessment (see Appendix D). Dispersion in the ambient air was modeled using a USEPA-approved dispersion model (Industrial Source Complex). This model now calculates concentrations in air directly above a source in addition to concentrations at more distant receptors. Dispersion modeling results at identified receptor locations were used to quantify inhalation of ambient air for all exposure scenarios. Appendix D presents the dispersion modeling methodology and data.

Deposition of airborne particulates was not evaluated because windblown dust generated at ground level generally settles to the ground relatively near the original source and does not serve to greatly expand the area of contamination. Deposition is usually considered a potentially significant migration pathway only for major point sources of particulate emissions.

Groundwater—Groundwater modeling was performed to determine whether toxicologically significant concentrations of contaminants might reach Old Town Galena wells or the shoreline of the Yukon River. The model used the maximum detected concentration in the individual groundwater plumes as the source or "starting" concentration. The model was calibrated to conform with detected concentrations of analytes in groundwater downgradient of the source. Modeling results were used to evaluate the applicability of the groundwater pathways at each of the sites under investigation and to quantify ingestion of drinking water, volatilization from water used in the home, and uptake by vegetables irrigated or subirrigated by the groundwater, if any of these pathways were determined to be applicable. Appendix C presents the groundwater modeling methodology and results.

The 95% UCL of the measurement data for each of the individual groundwater contaminant plumes was also calculated. The UCLs were not used in exposure calculations because there was no direct exposure to groundwater at the sites.

Surface Water—Dilution modeling was performed to estimate concentrations of COPCs in the surface water of the Yukon River that might result from groundwater discharge to the river. The final river concentrations were calculated for a five-foot mixing zone from the shoreline. The mixing zone was assumed to be restricted to five feet from the river's edge to provide conservative estimates of river concentrations as well as simulate actual river flow characteristics. River dilution modeling results were used to evaluate uptake by fish. Appendix C presents the dilution modeling methodology and results.

Air in Shower Stall—Results of groundwater modeling and data from shower volatilization experiments were used to estimate concentrations in air while showering or bathing, if groundwater modeling indicated that toxicologically significant concentrations of contaminants might reach Old Town Galena wells. Toxicological significance was determined by comparing modeled concentrations with USEPA Region III tap water RBCs.

Fruits and Vegetables—Results of groundwater modeling were used to estimate uptake by fruit and vegetable plants irrigated or subirrigated with the groundwater, if groundwater modeling results indicated that toxicologically significant concentrations of contaminants might reach Old Town Galena wells.

Fish—Results of groundwater modeling at the shoreline of the Yukon River, additional calculations to determine concentrations in the river within 5 ft of the shoreline (see "Surface Water" above), and chemical-specific fish bioconcentration factors (BCFs) were used to quantify uptake by fish. Estimated concentrations in fish were calculated as the product of the estimated concentrations in the river within 5 ft of the shoreline and the BCF. This methodology assumes that the fish spend the majority of time within 5 ft of the shoreline in the immediate vicinity of the Galena Airport. Since most game fish species in the area are migratory, actual concentrations in fish caught by area residents are very likely to be lower than estimated concentrations. Migratory species do not spend a substantial amount of time in the river near Galena, particularly within 5 ft of the shoreline. Note also that much of the subsistence fishing in the region takes place at remote fish camps.

Appendix E lists the human health exposure concentrations used in the risk assessment.

Contaminant Intakes

Exposure is defined as the contact rate of an organism with a chemical or physical agent. Intake is exposure normalized for time and body weight and is expressed in units of mg chemical/kg body weight-day (USEPA, 1989b).

The generic equation (USEPA, 1989b) for calculating chemical intakes is:

$$I = (C \times CR \times EFD)/BW \times 1/AT,$$

where:

I = intake; the amount of chemical at the exchange boundary (mg/kg body weight-day);

Chemical-related variable

C = chemical concentration; the concentration contacted over the exposure period (e.g., mg/L water);

Variables that describe the exposed population

CR = contact rate; the amount of contaminated medium contacted per unit time or event (e.g., L/day);

EFD = exposure frequency and duration; describes how long and how often exposure occurs. This is often calculated using two terms (EF and ED):

EF = exposure frequency (days/year);

ED = exposure duration (years);

BW = body weight; the average body weight over the exposure period (kg); and

Assessment-determined variable

AT = averaging time; period over which exposure is averaged (days).

For inhalation exposures, a methodology based on calculating an "effective air concentration" (EAC) was used instead of calculating intake into the body. Most recent inhalation toxicity values are developed on the basis of toxic effects at the exposure concentration (e.g., $\mu g/m^3$) and are independent of body weight. Direct use of the concentration-based inhalation toxicity values is preferable to converting them to intake-based values using standard intake assumptions (USEPA, 1990), although the resulting risk estimate will not differ substantially from risk estimated using intake-based values. The EAC calculation adjusts the measured or estimated concentration in ambient air using site-specific exposure parameters so that it can be used directly with concentration-based toxicity values that generally assume continuous (24 hours/day, 365 days/year), long-term (70 year) exposure. The equation for calculating the EAC is:

$$EAC = (CA \times IRE \times ET \times EF \times ED)/(IRD \times AT),$$

where:

EAC = effective air concentration ($\mu g/m^3$);

CA = chemical concentration in ambient air ($\mu g/m^3$);

IRE = inhalation rate during exposure (m^3/hour);

ET = exposure time (hours/day);

EF = exposure frequency (days/year);

ED = exposure duration (years);

IRD = daily inhalation rate (m^3/day); and

AT = averaging time; period over which exposure is averaged (days).

Appendix F contains tables summarizing the values used to estimate the exposure for each exposure pathway and scenario. The rationale for selecting individual values is explained. The tables also document the equations used for calculating pathway-specific intakes.

This appendix lists intake equations and exposure parameters that were revised in response to ADEC comments on those proposed in the protocol (USAF, 1995b) and in accordance with discussions that occurred at a meeting attended by representatives of ADEC, USAF, and their contractors (USAF, 1995d).

Exposure assumptions recommended in the *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors* (USEPA, 1991b), the *Risk Assessment Guidance for Superfund* (USEPA, 1989b), the *Exposure Factors Handbook* (USEPA, 1989a), and the available dermal guidance (USEPA, 1991a and 1992a) were used when available and applicable. Site- and chemical-specific values were used when available data justified their use; otherwise, conservative default values were substituted.

3.1.4 Toxicity Assessment

Toxicity assessment involves determining whether exposure to an agent can increase the incidence of a particular adverse effect (e.g., cancer, birth defects) in humans, characterizing the nature and strength of evidence of causation, and if sufficient data are available, quantifying the relationship between the dose of the contaminant and the incidence of adverse health effects

in the exposed population. Toxicity values are derived from the quantitative dose-response relationship. These values can be used to estimate the incidence or potential for adverse effects as a function of human exposure to the contaminant.

USEPA has performed the toxicity assessment step for numerous chemicals, and the resulting toxicity information and toxicity values have undergone internal USEPA workgroup review. Toxicity values used to evaluate noncarcinogenic effects (effects other than cancer) include the following:

- Oral RfD in units of mg/kg-day; and
- Inhalation reference concentration (RfC) in units of $\mu g/m^3$.

The oral RfDs and the inhalation RfCs are estimates (with uncertainty spanning perhaps three orders of magnitude) of the daily exposure to the human population (including sensitive subgroups) likely to be without an appreciable risk of deleterious effects during a portion of the lifetime, in the case of a subchronic RfD, or during the lifetime, in the case of a chronic RfD.

Toxicity values used to evaluate carcinogenic effects include the following:

- Weight of evidence classification;
- Slope factor in units of $(mg/kg\text{-}day)^{-1}$; and
- Inhalation unit risk in units of $(\mu g/m^3)^{-1}$.

The weight of evidence classification is an USEPA classification system for characterizing the extent to which the available data indicate that an agent is a human carcinogen. To determine the carcinogenic potential of a chemical, USEPA classifies the chemical into one of the following groups according to the weight of evidence from epidemiological studies and animal studies:

Group A: Human carcinogen (sufficient evidence of carcinogenicity in humans);

Group B: Probable human carcinogen (B1—limited evidence of carcinogenicity in humans; B2—sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans);

Group C: Possible human carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data);

Group D: Not classifiable as to human carcinogenicity (inadequate or no evidence); or

Group E: Evidence of noncarcinogenicity for humans (no evidence of carcinogenicity in adequate studies).

USEPA performs quantitative carcinogenic risk assessments for chemicals in Groups A and B, and on a case-by-case basis for chemicals in Group C. Cancer slope factors are estimated by using mathematical extrapolation models, most commonly the linearized multistage model, for estimating the largest possible linear slope (within the 95% confidence limit) at low extrapolated doses consistent with the data. The slope factor is characterized as a plausible upperbound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upperbound probability of an individual developing cancer as result of an average lifetime of exposure to a particular level of a potential carcinogen. Slope factors for some chemicals have been derived for oral and/or inhalation exposure since the carcinogenic potential of a compound can be dependent on the route of

exposure. The inhalation unit risk is the quantitative estimate of incremental risk in terms of risk per $\mu g/m^3$ air breathed.

The risk assessment used only toxicity values developed by USEPA. The following sources of information, in order of priority, were consulted to identify toxicity values for chemicals of concern with potential for human exposure:

- USEPA's Integrated Risk Information System (IRIS)—IRIS is updated monthly, provides verified RfDs and slope factors, and is the Agency's preferred source of toxicity information.

- USEPA's Health Effects Assessment Summary Tables (HEAST)—HEAST provides information on interim (not yet verified by USEPA workgroups) as well as verified RfDs and slope factors, and is used only to obtain toxicity values for chemicals not listed in IRIS;

- Other USEPA documents, such as *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (USEPA, 1993b); and

- Provisional or interim toxicity values recommended by the Superfund Health Risk Technical Support Center, as listed in USEPA (1995b).

If toxicity values were unavailable, a discussion of any available health effects information was included in Appendix G and the lack of toxicity values was listed as an uncertainty. Likely impact of this uncertainty on risk estimates is discussed.

Route-to-route extrapolations from oral toxicity values to derive inhalation values, and vice versa, were not made.

Dermal toxicity values are not available in IRIS and HEAST. Because of the high level of uncertainty associated with deriving dermal toxicity values from oral toxicity values, oral toxicity values were used to evaluate dermal exposures. The uncertainties associated with this approach are evaluated and discussed in Sections 4, 5, and 6. USEPA guidance (USEPA, 1989b) recommends that PNAs, which might cause skin cancer through direct action at the point of application, should not be evaluated for dermal exposure using the oral slope factor. The Superfund Health Risk Technical Support Center currently supports this recommendation (Dollarhide, 1994b). Since there is no accepted methodology, dermal exposures to PNAs were not evaluated. Dermal exposure to beryllium was also not quantified because evidence indicates that it is unlikely that beryllium is absorbed through intact skin (ATSDR *Toxicological Profile for Beryllium*, April 1993).

DRO and GRO were not evaluated as groups of chemicals. The assessment addresses individual chemicals only that are speciated by chemical analysis. The analysis of individual chemicals includes many of the constituent compounds of DRO and GRO. Quantifying the risk associated with exposure to DRO and GRO in the risk assessment of individual chemicals would result in double-counting the risks associated with chemicals that are also constituents of DRO and GRO. Remedial action decisions will be made based on application of State of Alaska DRO and GRO standards. Floating product will be removed from the aquifer where it exists.

Benzo(a)pyrene is one of the few PNAs for which a cancer slope factor has been established. Oral slope factors for other PNAs were determined using the potential potency factors as described in USEPA guidance (USEPA, 1993b). USEPA Region X supports the use of these potential potency values. Since there is currently no inhalation unit risk for benzo(a)pyrene, the USEPA guidance directs that the potential potency values should be applied only to assessment of carcinogenic hazard from oral exposure to PNAs.

Toxicity values for dioxins and furans were derived using toxicity equivalency factor (TEF) values for dioxin-like compounds, based on the potency of 2,3,7,8-TCDD (USEPA, 1994b).

Lead was evaluated using the Integrated Exposure Uptake Biokinetic (IEUBK) model for lead in children (USEPA, 1994c). The California lead model LEADSPREAD (California DTSC, 1992), an adaptation of the USEPA model, was used to evaluate adult exposures to lead.

Sections 4, 5, and 6 present the toxicity values by exposure route (i.e., inhalation, ingestion, dermal) for COPCs at the FPTA, the POL Tank Farm, and the West Unit, respectively. Critical physiological effects are summarized and confidence levels for the toxicity values as presented in IRIS and HEAST, along with any uncertainty or modifying factors, are presented in Appendix G.

3.1.5 Risk Characterization

Risk characterization involves integrating the possible exposure pathways and estimated chemical intakes with the appropriate toxicity values to form quantitative and qualitative expressions of potential health risk. Risks for carcinogenic effects and noncarcinogenic effects are characterized separately.

Carcinogenic Effects

The cancer slope factor converts estimated daily intakes to an estimate of incremental risk. The slope factor is the upper 95th percentile confidence limit of the probability of a response based on experimental animal data and an assumption of linearity in the low dose portion of a dose-response curve. Therefore, the carcinogenic risk estimate is generally an upper-bound estimate. This means "true risk" probably does not exceed the risk estimates generated in this assessment and is likely to be less than the risk predicted by this method (USEPA, 1989b).

For carcinogens, probabilities that an individual will develop cancer over a lifetime are estimated from the projected intake and the cancer slope factor. Intake is quantified from the amount of a chemical available at the exchange boundary (i.e., skin, lungs, etc.) and potential for absorption. The carcinogenic risk was calculated for each oral and dermal exposure pathway using the following equation:

$$\text{Risk} = \text{Intake} \times \text{Slope Factor}.$$

Risk was calculated for inhalation pathways as follows:

$$\text{Risk} = \text{Effective Air Concentration} \times \text{Inhalation Unit Risk}.$$

The USEPA Superfund site remediation goal set forth in the National Contingency Plan (NCP) allows a cancer risk of 10^{-4} (1 in 10,000) to 10^{-6} (1 in one million). This range is designed to be protective of human health. In effect, risks that are less than 10^{-6} are generally considered negligible. Risks that are greater than 10^{-4} are usually considered sufficient justification for undertaking remedial action. Risks in the intermediate range between these two values can be considered acceptable on a case-by-case basis.

Noncarcinogenic Effects

To characterize potential noncarcinogenic effects, comparisons are made between projected intakes of substances over a specified time period and toxicity values, primarily oral and dermal RfDs and inhalation RfCs. The ratio of exposure to toxicity value is the HQ. The HQ was calculated for each oral and dermal exposure pathway using the following equation:

$$\text{HQ} = \text{Intake/RfD}.$$

The HQ was calculated for inhalation pathways as follows:

$$\text{HQ} = \text{Effective Air Concentration/RfC}.$$

The HQ is not a statistical probability of a noncarcinogenic effect occurring. If the exposure level exceeds the appropriate toxicity value (i.e., the HQ is greater than one), there may be cause for concern regarding the potential noncarcinogenic effects as set forth in the NCP.

Chronic RfDs are used in the HQ calculation for chronic exposure scenarios (exposure durations from 7 years to lifetime). Subchronic RfDs are used for subchronic scenarios (exposure durations from 2 weeks to 7 years).

Combining Risks Associated with Chemicals and Exposure Pathways

For each scenario addressed in this risk assessment, the carcinogenic risk was estimated on a chemical-by-chemical basis for each relevant pathway of exposure. The estimated risk was summed for each chemical associated with a specific pathway to determine total risk by pathway. To determine the total exposure scenario risk, total risks for all pathways were summed.

The total risk number assumes that different carcinogens affect the same target organ to produce a cancer response, ignoring potential antagonistic or synergistic effects or disparate effects on different target organs. It also assumes that the single individual in the exposure scenario is exposed to site-related contaminants at estimated exposure concentrations by all pathways that make up the scenario. The scenarios were constructed to include all potential pathways of exposure; it is possible for a single individual to be exposed by all pathways in a scenario. It is less likely, however, that a single individual will be exposed by each pathway at the conservatively estimated concentrations in the exposure media.

Likewise, the estimated HQ for noncarcinogenic effects was generated on a chemical-by-chemical basis for each relevant pathway of exposure. The HQs were then summed for each chemical associated with a specific pathway to determine the hazard index (HI) by pathway. The HIs for all pathways were summed to determine the total HI for the exposure scenario.

If the total HI for a scenario is greater than one, indicating a potential cause for concern, the risk assessment segregated the hazard index by critical effect and mechanism of action and summed the HQs only for chemicals that affect the same target organ (USEPA, 1989b). If the HI summed for all relevant pathways of exposure but segregated by target organ is less than one, there is less cause for concern about potential noncarcinogenic effects.

Combined Impacts

Combinations of exposure pathways make up a defined exposure scenario. Combinations of certain exposure scenarios are evaluated and discussed in Section 7. Exposure scenario combinations that are addressed include the following:

1. Child and adult Galena resident (to represent an individual who is born in Galena and continues to live there through adulthood);

2. On-base resident and on-base worker (to represent an individual who lives and works on base); and

3. Construction workers at the individual sites (to represent construction workers who work at more than one site during different time periods).

The combined impacts of the individual sites were also addressed. Media that might receive contributions of contaminants from the different sites at the same location include the ambient air, groundwater, and surface water in the Yukon River. Combined impacts on these media from the FPTA, POL Tank Farm, and the West Unit are evaluated and discussed in Section 7.

3.1.6 Uncertainty Analysis

Uncertainty is inherent to the risk assessment process. To resolve uncertainty, sometimes simplifying and/or conservative assumptions are made that can lead to over- or underestimates of risk. Gathering additional data will not always resolve or reduce uncertainty. The uncertainty analysis is intended to identify and evaluate key uncertainties so that a level of confidence in the risk estimates can be considered when risk management decisions are made.

Risk characterization results are not fully probabilistic estimates of risk, but rather conditional estimates of risk that should be interpreted in light of the considerable number of assumptions required to quantify exposure, intake, and dose-response. Uncertainties associated with each step in the risk assessment process contribute to the level of confidence that can be placed in the risk characterization results.

The uncertainty analysis for the Galena Airport sites involved identifying the key uncertainties and discussing the likely effect of the uncertainty on the risk estimates. This evaluation was primarily qualitative and descriptive. In some cases, however, the quantitative impact of individual sources of uncertainty was investigated. For example, if there is a very high level of uncertainty regarding whether a COPC was contributed to the environment by site-related activities, risks may be estimated both including and excluding that chemical. This can occur when background data are insufficient to perform an adequate background comparison or in the case of chemicals that are widespread in the environment (such as pesticides).

Tables in Sections 4, 5, and 6 summarize the major uncertainties associated with assessment of human health risks at the FPTA, POL Tank Farm, and the West Unit, respectively. The tables list the source of uncertainty and describe the impact on the risk characterization.

3.2 Ecological Assessment

Ecological risk assessment (ERA) is defined as a process that evaluates the likelihood that adverse effects may occur, or are occurring, as a result of exposure to one or more stressors. As defined by USEPA (1992b), a stressor is any physical, chemical, or biological entity that can induce an adverse ecological response. A risk does not exist unless 1) the stressor has the inherent ability to cause adverse effects, and 2) it co-occurs with or contacts an ecological component (i.e., organism, populations, communities, or ecosystem) long enough and at sufficient intensity to elicit the identified adverse effect. Adverse responses can range from sublethal chronic effect in an individual organism to a loss of ecosystem function.

The three major segments of an ERA are presented in Figure 3-4. Problem formulation is the first phase of an ERA and establishes its goals, breadth, and focus. The second phase is termed analysis and consists of two activities—detailed characterization of exposure and detailed characterization of ecological effects. The third phase is risk characterization in which the results of the exposure and ecological effects analyses are used to evaluate the likelihood of adverse ecological effects associated with exposure to a stressor (USEPA, 1992b).

3.2.1 Problem Formulation

The problem formulation process begins with evaluating the stressors and their characteristics and the ecosystem potentially at risk (Figure 3-4). An-in depth problem formulation has been completed for the Galena Airport (USAF, 1995e) and is summarized in the ERA for each site in Sections 4, 5, and 6.

The problem formulation process begins with evaluating the stressor characteristics, the ecosystems potentially at risk, and possible ecological effects. Stressor characteristics include identification of type of contamination (organic or inorganic), identification of chemical classes of contaminants (pesticide, metal, or PNA), and identification of contaminated media (surface soil, surface water, etc.). An examination of the ecosystems includes an overview of

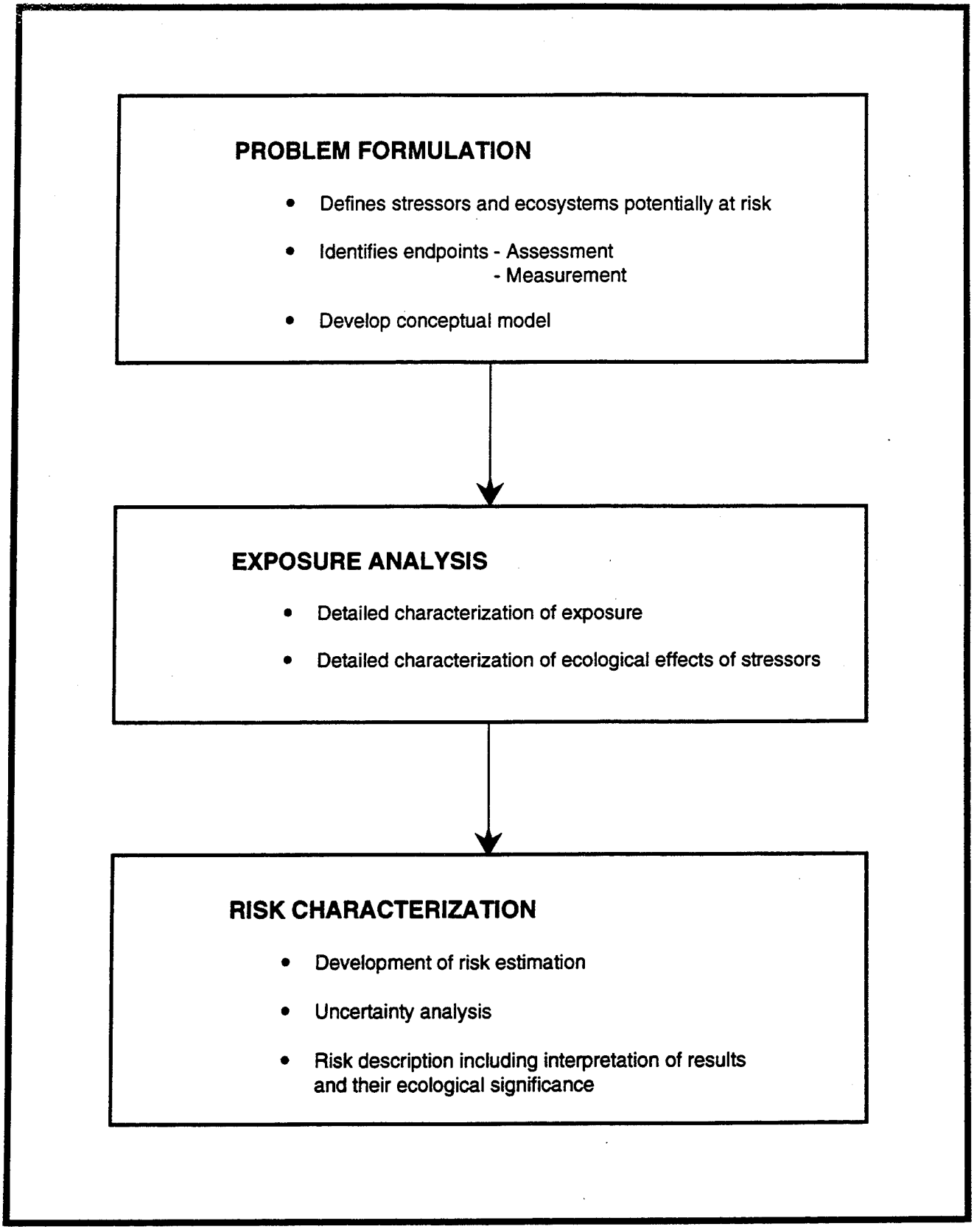


Figure 3-4. Ecological Risk Assessment Process

the types of mammals, birds, fish, or insects that may utilize the ecosystem. The possible ecological effects are first hypothesized in the problem formulation, using characteristics of the stressor, characteristics of the ecosystem, which media are contaminated, and identification of possible ecological receptors.

Information compiled in the first stage of problem formulation is used to help select ecologically based assessment and measurement endpoints. An assessment endpoint is a quantifiable expression of the environmental value considered to be at risk. Assessment endpoints have associated assessment endpoint species that are primary receptors at a site evaluated by the ecological risk assessment process for potential adverse impacts. A measurement endpoint is a measurable response to a stressor, such as a lowest observed adverse effects level (LOAEL) or LD_{50} (lethal dose to 50% of the test population), that can be related, either qualitatively or quantitatively, to the assessment endpoint. For example, a decline in sport fish population (the assessment endpoint with a speckled trout as the assessment endpoint species) may be evaluated using laboratory studies on the mortality of surrogate species, such as the fathead minnow (the measurement endpoint is the LC_{50}-lethal concentration to 50% of the test population) (USEPA, 1992b). Endpoints were developed by using the following criteria from Suter (1993):

- Ecological relevance;
- Unambiguous operational definition;
- Accessibility to prediction and measurement;
- Susceptibility to contaminants; and
- Societal relevance.

Ecological relevance is a primary criterion in selecting an endpoint. The ecological relevance of an assessment endpoint is determined by its importance in maintenance of the viability and production of the ecosystem as a whole. That is, an endpoint was considered ecologically relevant if it met other pertinent criteria (explained below) and if risk to the endpoint significantly affects the integrity of higher levels of ecological organization and functions.

An assessment endpoint must have an unambiguous operational definition. That is, adverse effects to assessment endpoint species selected must be quantifiable. Depending on the assessment and measurement endpoints selected, quantification of effects may be numerical (e.g., 20% reduction in age-specific reproductive rates) or simply indicators of the direction of change in the assessment endpoint parameter in question (e.g., a decrease in population size).

Assessment endpoints must be measurable or estimated from measurements of related responses to contaminants. Measurement endpoints are the results of studies or tests that quantify these responses. The LOAEL for mortality or reproductive effects was the primary toxicity value used for measurement endpoints. If LOAEL values were not available, NOAEL, LD_{50}, or LC_{50} values were used. Appendix J contains all of the toxicity information used in developing the measurement endpoints. The spreadsheets found in Appendix K list each toxicity value used and defines it as a LOAEL, NOAEL, LD_{50}, or LC_{50} and for which test species. The LOAEL data were taken from the available literature for those species used as assessment endpoints. If toxicity data were not available for assessment endpoint species, toxicity data were used for surrogate species that were similar physiologically and in life history patterns to the assessment endpoint species.

Assessment endpoint species were chosen that are susceptible to the contaminants. The home range size of assessment endpoint species, seasonality, migratory patterns, and foraging behavior are among the parameters

evaluated that potentially could expose the species to the contaminants.

The societal relevance criterion addresses the public's and the regulators' understanding and value of the assessment and measurement endpoints. This is a controversial criterion; however, it is a criterion that should be considered because it may strongly influence potential corrective action decisions. Nevertheless, the criteria of ecological relevance and susceptibility were not compromised to satisfy the societal relevance criterion.

Selection of assessment and measurement endpoints for each appropriate site was performed in conjunction with development of site-specific conceptual models during problem formulation. These conceptual models are presented in Sections 4 to 6. Through the use of fate and transport analysis and the description of the ecological setting, qualitative exposure scenarios were developed that illustrate the mechanisms of potential exposure of terrestrial or aquatic receptors to site-related contaminants for all media. The conceptual site model describes the exposure pathways from each contaminant source to the ecological receptors. The pathway descriptions include contaminant sources, release mechanisms, transport media, exposure routes, and potential ecological receptors.

3.2.2 Identification of Chemicals of Potential Ecological Concern

As defined by USEPA (1992e), the determination of stressor characteristics begins with the identification of 1) chemicals of potential ecological concern (COPECs) or 2) physical stressors. Chemical stressors include both inorganic and organic substances. Physical stressors include extremes of natural conditions (e.g., temperature and hydrologic changes) and habitat alteration or destruction. Chemical, not physical, stressors are the subject of this ERA.

The COPECs were identified from the list of chemicals detected at Galena Airport. Surface soil (0-2 ft), sediment and surface water from the drainage ditches, and discharged groundwater were evaluated in this assessment. COPECs in surface soil were determined in the same manner as human health COPCs with the exception of a screening comparison to RBCs. Contaminants modeled in the groundwater model (Appendix C) were used as COPECs in discharged groundwater sediment and surface water sampling data was used from two sampling points inthe West Unit. Availability to ecological receptors was the primary criterion in determining which media to evaluate in the ERA. Therefore, subsurface soil (below 2 ft in depth) and groundwater contamination directly beneath the sites were not considered. Although groundwater is not available to receptors at the sites, groundwater does migrate to the Yukon River where it is available to shoreline receptors such as wading birds and fish in the river. This ERA did evaluate this pathway where appropriate. No biota samples were chemically analyzed.

Contaminants reported at the Galena Airport were eliminated from consideration as COPECs if they met any one of the following conditions:

- The analytical method did not report results for individual chemicals (e.g., DRO, GRO, or TPH);
- The chemicals were associated with contamination in blank samples such as laboratory, method, or field blanks; and
- The chemicals did not exceed naturally occurring levels or are essential nutrients. Calcium, magnesium, iron, and potassium were not considered as COPECs because they are essential nutrients and harmful only at high doses.

Sections 4, 5, and 6 present the lists of COPECs, in surface soil, sediment, surface water and groundwater (shoreline and Yukon River concentrations) on a site-specific basis. Summary statistics for contaminants reported in soils, surface water, and groundwater are pre-

sented in Appendix A. The 95% UCL for COPECs in surface soils was used to calculate exposures. Maximum detections were used with the surface water and sediment data because only two samples were available. Modeled groundwater concentrations discharged to surface water were used to calculate exposures to aquatic and semi-aquatic receptors.

3.2.3 Exposure Assessment

The purpose of the exposure assessment phase of an ERA is to characterize pathways of contaminant exposure and the ecological effects of the contaminants. The exposure assessment uses the qualitative exposure analysis of the conceptual site model and the selection of assessment and measurement endpoints from the problem formulation to develop estimates of contaminant intake for assessment endpoint species. This section describes the potential pathways by which plants and wildlife could be exposed to the contaminants reported in surface soil, sediment, surface water, and groundwater discharged to surface water at the Galena Airport. Additionally, this section also presents the methods used to calculate the chemical concentrations in water, soil, and food sources to which the assessment endpoint species may be exposed to, or the amount that may enter the animal's body. The ecological effects of the contaminants are discussed on a site-by-site basis in Sections 4, 5, and 6.

Identification of Potential Exposure Pathways

Plants and wildlife can be exposed to contaminants in media at the Galena Airport by the following direct and indirect pathways:

- Incidental ingestion of surface soil;
- Dermal contact with surface soil;
- Uptake via roots;
- Ingestion of contaminated vegetation;
- Inhalation of vapors or dust;
- Foliar uptake of vapors or dust;
- Ingestion of animals that have ingested contaminated items;
- Ingestion or contact with groundwater discharged to surface waters;
- Ingestion of sediments; and
- Dermal contact with sediments.

Dermal contact generally is not quantified because of lack of ecological toxicity information and uncertainty in determining the rate of dermal contact for a given species. This pathway is discussed qualitatively for appropriate species and sites in Sections 4-6. Inhalation exposure also is difficult to assess ecologically not only due to the general absence of toxicity information but also lack of site-specific analytical data applied to groundlevel within the top 6-12 inches of soil where a small mammal may burrow. This pathway also is discussed qualitatively for appropriate species and sites in Sections 4, 5, and 6.

Selection of Assessment Endpoint Species

Assessment endpoint species were selected because evaluating potential effects on all species that occur at Galena Airport is not feasible. Assessment endpoint species are defined as organisms that are likely to be exposed to the contaminants and/or are likely to be vulnerable or sensitive to the stressors (i.e., contaminants). The criteria considered for selecting assessment endpoint species included:

- Species that regularly occur at the Galena Airport;
- Endangered or threatened species;
- Species with relatively long residence times that are likely to be chronically exposed to the contaminants of concern;

- Species representative of different food chains and occupying different trophic levels within the ecosystem;
- Species with economic or recreational value; and
- Species whose behavioral patterns or habitat preferences may expose them to high levels of contamination.

The American kestrel (*Falco sparverius*), American robin (*Turdus migratorius*), meadow vole (*Microtus pennsylvanicus*), northern pike (*Esox lucius*), red fox (*Vulpes vulpes*), savannah sparrow (*Passerculus sandwichensis*), and spotted sandpiper (*Actitis macularia*) were selected as assessment endpoint species for this ERA. Lifestyle patterns of the assessment endpoint species that make them appropriate to investigate as receptors in this ERA are described below and exposure parameters, such as body weight, are presented in Appendix I.

American Kestrel—The American kestrel, or sparrow hawk, is the most common falcon in open and semi-open areas throughout North America. Falcons are found in a variety of habitats, from cities to the most remote areas. They consume many kinds of animals, including insects, reptiles, small mammals, and birds. Predators of the kestrel include large raptors such as the great horned owls, golden eagles, and red-tailed hawks. Adult kestrels are solitary, except during the breeding season, and maintain territories in winter. Kestrels build their nests in tree cavities, but have used holes in telephone poles, buildings, or stream banks when tree cavities are not available (USEPA, 1993d). The kestrel was selected as an assessment endpoint species for the following reasons:

- The kestrel is common to the area and has been noted at the Galena Airport (USAF, 1994c).
- The kestrel represents a secondary consumer, preying upon the small songbirds like the robin or sparrow.

American Robin—The American robin is a common songbird, 9-11 in. in size, that adapts well to civilization. The robin was selected as an assessment endpoint species for the following reasons:

- The robin is commonly seen on site (USAF, 1995e) and is representative of the large number of small songbirds that occur at the Galena Airport.
- The robin occurs throughout most of the continental United States and Canada during breeding season. Nests are built out of mud, dried grass, and weedy stems. Nest building behavior could potentially expose the robin to contamination.
- Robins forage by hopping along the ground in search of ground-dwelling invertebrates, exposing the robin to contaminants in the surface soils.
- The robin represents a primary consumer as well as a food source for the American kestrel (USEPA, 1993d).

Meadow Vole—Ingestion of contaminated plant material and ingestion of soil were assumed to be the most significant exposure pathways for the meadow vole. The meadow vole was selected as an assessment endpoint species for the following reasons:

- The meadow vole is a common year-round resident of the Galena area (personal communication B. Johnson, June 23, 1995).
- Meadow voles are herbivorous rodents that represent a primary consumer in the trophic structure. Their diet consists

primarily of grasses, herbs, and seeds (West, 1979).

- Voles occur in relatively high densities in grasslands like those found on the base.
- Voles living in burrows and feeding on vegetation in contaminated areas could have a high exposure frequency to contaminants in the surface.
- Voles are a food source for several carnivore species observed at the Galena Airport.

Northern Pike—Pikes are carnivorous fishes. The northern pike can be up to 55 in. in length and weigh 46 lb (Ransom, 1981). The pike was selected as an assessment endpoint species for the following reasons:

- The pike is found throughout the main drainage of the Yukon River and most of its tributaries (USAF, 1994c); and
- The pike is a representative secondary consumer in the Yukon River ecosystem.

Red Fox—Red foxes are present throughout the United States and Canada except in the southeast, extreme southwest, and parts of the central states. As the most widely distributed carnivore in the world, the red fox can live in habitats ranging from arctic to temperate deserts. Red foxes utilize many types of habitat including cropland, rolling farmland, brush, pastures, hardwood stands, and coniferous forests. The red fox feeds on both animal and plant material, mostly small mammals, birds, insects, and fruit. They also are noted scavengers on carcasses or other refuse. Most activity is nocturnal and at twilight. A fox family, the basic social unit, consists of a mated pair or one male and several related females. The additional females are usually nonbreeders that often help the breeding female (USEPA, 1993d). Red fox were selected as an assessment endpoint species for the following reasons:

- Red foxes do not hibernate and are active all year.
- Mated pairs maintain a territory throughout the year.
- Red foxes represent a secondary consumer with meadow voles being a major food source.
- Red foxes have been reported at the Galena Airport by site workers.

Savannah Sparrow—The savannah sparrow is a small songbird and is found in fields, fresh or salt meadows, beach dunes, prairies, or open country. It is a resident from Alaska and Canada to Mexico (Ransom, 1981). The savannah sparrow was selected as an assessment endpoint species for the following reasons:

- The savannah sparrow was noted in the 1995 site visit as breeding at the FPTA and is commonly seen at the Galena Airport (USAF, 1995e).
- It is representative of the large number of small songbirds that occur at the Galena Airport.
- The savannah sparrow breeds in open areas with grass or short vegetation. Nests are built on the ground (Harrison, 1978), possibly exposing the birds to contaminants in surface soils.
- Savannah sparrows forage along the ground for invertebrates, and seeds possibly exposing them to contaminants in the surface soils.
- The savannah sparrow represents an omnivore as well as a food source for the American kestrel (USEPA, 1993d).

Spotted Sandpiper—The spotted sandpiper is a member of the family (*Scoipacidace*), which includes numerous shorebirds. Most sandpipers forage on sandy beaches and mudflats. Spotted sandpipers are migratory, breeding throughout most of Alaska, Canada, and the northern United States (where they spend winters on the Pacific coast), Mexico, Central America, and much of South America. Significant exposure mechanisms for the spotted sandpiper include ingestion of contaminated invertebrates, sediment, and water. The spotted sandpiper was selected as an assessment endpoint species for the following reasons:

- The mudflats on the shoreline of the Yukon River and the drainage ditches create habitat unique to a wading bird.
- The spotted sandpiper has been observed at the Galena Airport (USAF, 1995e).
- The spotted sandpiper's foraging habits could potentially expose it to contamination. They feed almost exclusively on small invertebrates, either by probing or gleaning from the shoreline or mudflat areas (USEPA, 1993d).

The moose and black bear were not chosen as assessment endpoint species, although they frequent the areas outside of the Galena Airport fence. The home range of the moose and bear is considerably larger than the site areas available at the Galena Airport. Therefore, the moose and bear would spend a small proportion of time feeding from the site areas and represent only a minor exposure pathway. A small rodent such as the meadow vole, in contrast, would forage almost completely from the site areas representing a major exposure pathway. Additionally, the bears are primarily using the area as a passageway to the town dump and do not forage the area for food.

No endangered or protected species was chosen as an assessment endpoint species. The USFWS has observed the endangered American peregrine falcon and, possibly, the arctic peregrine falcon along the Yukon River. However, there is no recorded evidence of these birds nesting in the project area (USAF, 1994c).

Several candidate and proposed candidate species have been identified in the Galena area. Candidate species for endangered listing are the North America lynx, harlequin duck, and northern goshawk. Proposed candidate species are the Swainson's thrush, gray-cheeked thrush, blackpoll warbler, and Wilson's warbler (USAF, 1994c). The harlequin duck, northern goshawk, and blackpoll warbler are all noted as occurring uncommonly at the Galena Airport. None of these species were observed during the site inspection in May 1995 (USAF, 1995e).

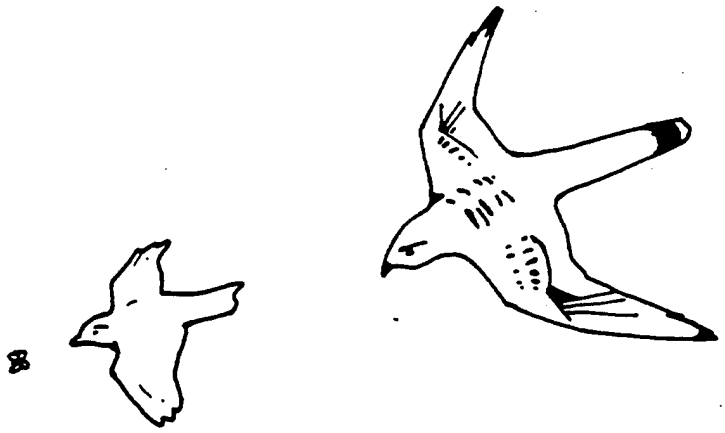
Quantification of Exposure

This section describes the methods and assumptions used to calculate the amount of each COPEC to which the assessment endpoint species are exposed. The daily doses of contaminated media, and the selected measurement endpoints and uncertainty factors were used to calculate ecological quotients (Section 3.2.4). These calculations (Appendix K) consider environmental fate of the contaminants, food chain interactions (including bioaccumulation potential), magnitude and frequency of indicator species exposure, and seasonal variations of exposure. Exposure pathways for terrestrial, semiaquatic, and aquatic receptors at the Galena Airport are shown in Figures 3-5 and 3-6.

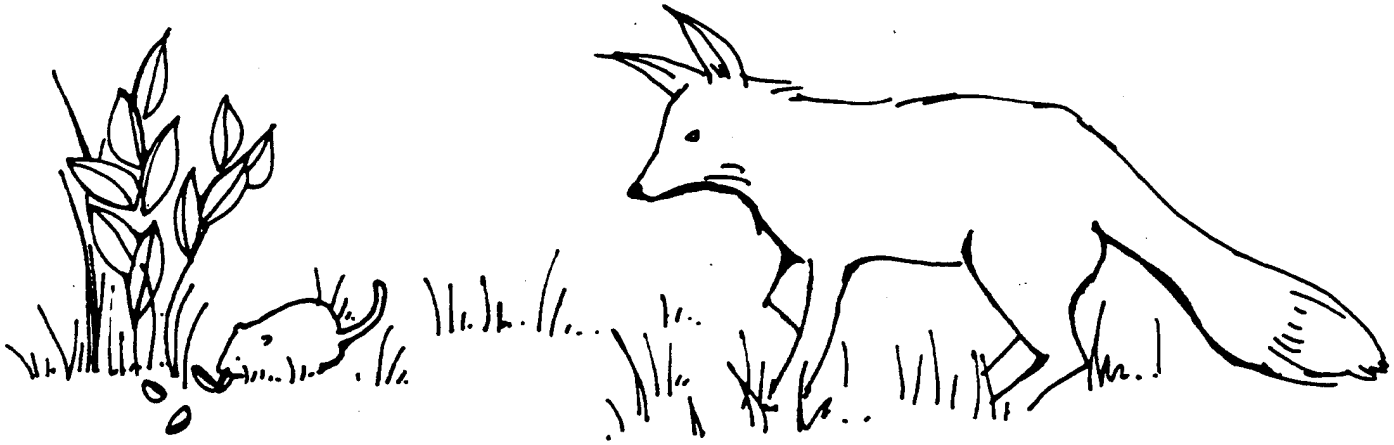
Each trophic level of the food chain was analyzed for contaminant intake using the soil, surface water, sediment, and discharged groundwater concentrations. Exposure scenarios in the form of conceptual models are shown for each site in Section 4-6. Intake by the assessment endpoint species is described by the general equation:

$$\text{Intake (mg/kg-day)} = HR/BW[(EC_{food} \times FI \times F) + (EC_{soil} \times FI \times S) + (EC_{water} \times WI)],$$

where:



Soil/water ⟶ Insect /Invertebrate ⟶ Robin or Savannah Sparrow ⟶ American Kestral



Soil/water ⟶ Plant ⟶ Meadow Vole ⟶ Red Fox

Figure 3-5. Terrestrial Exposure Pathways

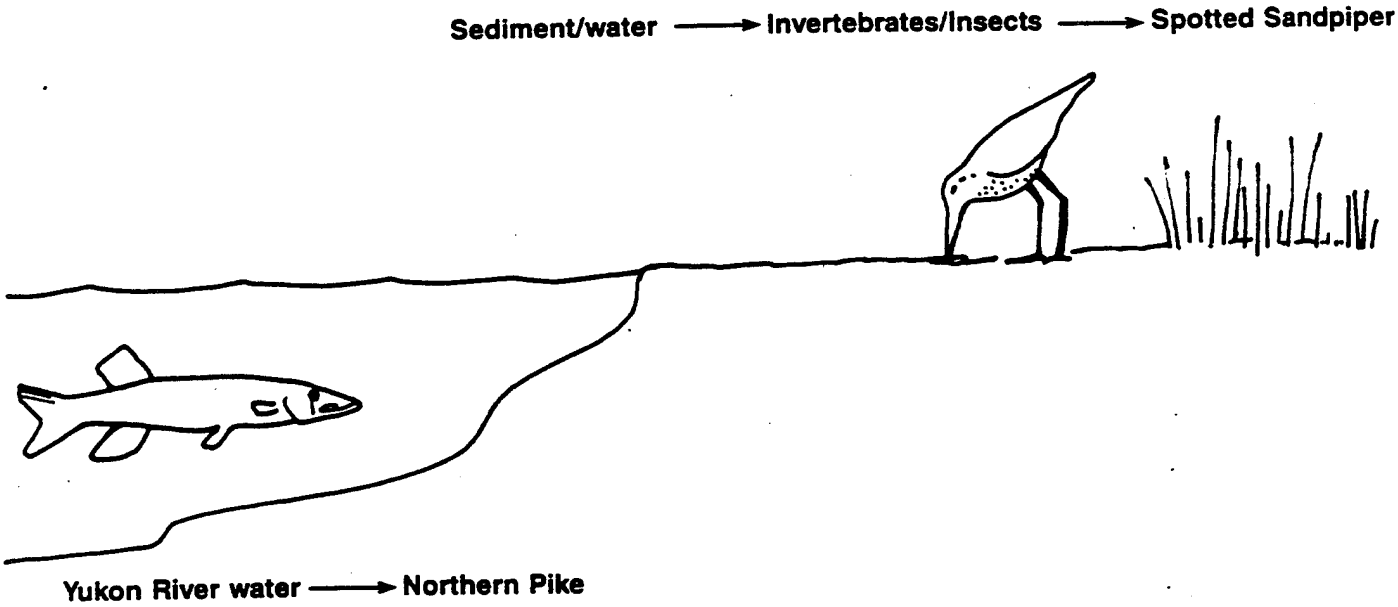


Figure 3-6. Aquatic and Semiaquatic Exposure Pathways

HR = Home range factor, site area/species' home range, given $0 < HR \leq 1$ (unitless);

BW = Body weight (kg);

EC = Environmental concentration of contaminant (mg/kg or mg/L);

FI = Food ingestion rate (kg/day);

F = Portion of daily intake that is food, 1-S (unitless);

S = Portion of daily intake that is soil (unitless); and

WI = Water ingestion rate (L/day).

The home range factor, HR, estimates exposure frequency as the proportion of time the organism would be expected to use the contaminated resource relative to its home range size. Home range is defined as the geographic area encompassed by an animal's activities (except migration) over time. The size and spatial attributes of a home range often are defined by foraging activities, but also might depend on the location of specific resources such as dens or nest sites. An animal may not visit all areas of its home range every day or every week, but over longer time periods, it can be expected to visit most of the areas within the home range that contain needed resources such as food items or protected nesting areas (USEPA, 1993d).

Body weights and soil ingestion rates of assessment endpoint species were obtained from the literature. The lowest reported body weights and the highest reported soil ingestion rates were used in the risk calculations to provide a conservative estimate of ecological impacts. Body weights are reported as fresh weight, as might be obtained by weighing a live animal in the field. Adult body weights are listed for all species in Appendix I. Many wildlife species ingest soil deliberately or incidentally when they ingest soil-laden vegetation or animals that contain soil. Deliberate soil ingestion by wildlife is well documented; the list of animals recorded visiting salt licks or ingesting soil is greater than 50 species. Some avian species consume grit, either to supplement their calcium or because it is abrasive. Other organisms ingest soil inadvertently. Sandpipers probing for invertebrates on a mud flat, for example, ingest soil with food items. Ingested soil may be the principal means of exposure to some environmental contaminants or the principal source of certain minerals (Beyer et al., 1994).

Food ingestion rates vary with many factors, including metabolic rate, the energy devoted to growth and reproduction, and composition of diet. Food ingestion rates specific to the species were used whenever possible, otherwise, USEPA (1993d) and Nagy (1987) guidance was used. For passerines (perching birds), such as the robin and savannah sparrow, the following equation was used to estimate food ingestion (FI):

$$FI\ (g/day) = 0.398\ BW^{0.850}(g),$$

Food ingestion for the American kestrel (non-passerines) was estimated by:

$$FI\ (g/day) = 0.301\ BW^{0.751}\ (g).$$

The spotted sandpiper food ingestion rate was estimated using the equation for seabirds:

$$FI(g/day) = 0.495\ BW^{0.704}(g).$$

For the meadow vole, food ingestion was estimated by the equation for rodents:

$$FI(g/day) = 0.621\ BW^{0.564}(g).$$

Herbivores tend to consume more food than carnivores or omnivores on a dry-weight basis because of lower energy content of the herbivorous diets. On an energy basis (e.g., kilocalories), the ingestion rates of carnivores and herbivores are not significantly different (USEPA, 1993d).

For the red fox, food ingestion was estimated by the following equation for mammals:

$$FI(g/day) = 0.235\ BW^{0.822}(g).$$

Water intake rates depend on the rate at which animals lose water to the environment owing to evaporation and excretion. Loss rates depend on body size, ambient temperature and physiological adaptations for conserving water. Equations for water intake rates were taken from USEPA, 1993d. The water intake (WI) for all birds is described below:

$$WI\ (L/day) = 0.059\ BW^{0.67}\ (kg).$$

In general, birds drink less water than do mammals of equivalent body weights. Because of relatively high metabolic rates, the quantity of metabolic water produced by birds is greater in relationship to body size than that produced by other vertebrates (USEPA, 1993d).

Mammals have a water intake rate defined as:

$$WI\ (L/day) = 0.099\ BW^{0.90}(kg).$$

Concentration in Plants as a Food Source—Ingestion of plant tissue is the primary means of exposure for the meadow vole. Plant uptake factors, the ratio between the concentration in a plant and the concentration in the surrounding soil, were used to calculate concentrations in plant tissue. Uptake factors vary widely between plants and depend on conditions such as pH, the form and concentration of the chemical present, and type of soil (Baes et al., 1984). A generic formula for the estimation of chemical concentration in edible plants is as follows:

$$Cp = Cs \times UP,$$

where:

Cp = Chemical concentration in edible plant (mg/kg);

Cs = Chemical concentration in soil (mg/kg); and

UP = Uptake factor for plants (unitless).

Uptake factors for inorganic elements have been derived by Baes et al. (1984) for plant parts associated with vegetative functions (leaves, stems, etc.) and for plant parts usually associated with reproductive or storage functions (fruits, seeds, tubers, etc.). The plant uptake factors are derived by linear regression based on data from numerous studies on a variety of primarily domesticated plants species.

Briggs et al. (1983) indicated that organic chemicals with log octanol-water partition coefficient (K_{ow}) greater than 2.0 accumulate in plant tissue. Plant uptake is dependent upon the solubility of a chemical in water, which is inversely proportional to the K_{ow}. Organic contaminant concentrations in plants were calculated, using plant uptake factors based on the observed relationship between 29 chemical K_{ow}s and measured plant uptake factors (Travis and Arms, 1988). The following equation describes this relationship:

$$\log UP = 1.588 - 0.578 \times \log K_{ow},$$

where:

UP = Plant uptake factor (unitless), and

K_{ow} = Octanol-water partition coefficient (unitless).

The chemicals used to derive this relationship included many pesticides and several semivolatile organic compounds. The plants used in the studies were primarily domesticated species.

Bioconcentration into Upper Trophic Levels—BCFs were used to estimate the environmental concentration (EC) in the assessment

endpoint species consumed by the primary and secondary consumers. These species include the insects and invertebrates, meadow vole, robin, and savannah sparrow. Bioaccumulation is the process of absorption and retention of a substance by an organism from the surrounding media, including residues in food, soil, water, and/or sediment. It is quantified by the calculation of a bioaccumulation factor (BAF). Bioconcentration is a component of bioaccumulation, accounting only for the process of uptake from a single medium (usually water). It is quantified by the calculation of a BCF. Both BAFs and BCFs are proportionality constants relating the concentration of a contaminant in the tissue of an organism to the concentration in the surrounding environment (Amdur et al., 1991; USEPA, 1989c).

Although BAFs are a more comprehensive measure of uptake by an organism in its natural environment, BCFs are more readily determined and correlate well with BAFs. Elevated levels of contaminants found in freshwater fish and aquatic and soil invertebrates usually result from direct concentration of the contaminant from the water, soil, or sediment rather than through the food chain (USEPA, 1989c). Thus, BCFs are representative of bioaccumulation for these organisms, and also are suitable indicators of potential bioaccumulation for biota in general (Amdur et al., 1991).

In the absence of acceptable measured BCFs, a BCF was calculated from available environmental mobility data based on physical/chemical characteristics of the contaminant in the following order of preference: octanol/water partition coefficient (K_{ow}) or soil absorption coefficient (K_{oc}).

If the K_{ow} for a given COPEC was available, the following equation, obtained from USEPA (1993e), was used to calculate a BCF:

$$\log BCF = 0.791 \log K_{ow} - 0.40.$$

If a K_{oc} was available for a COPEC in the absence of a K_{ow}, the following equation, derived by Kenaga and Goring (1978) and obtained from Bysshe (1982), was used to calculate a BCF:

$$\log BCF = 1.119 \log K_{oc} - 1.579.$$

In summary, for the aquatic pathways available, aquatic BCFs were used for estimating tissue concentrations in aquatic invertebrates that were considered food items of wading birds (the spotted sandpiper). If BCFs were not available in the literature, they were derived using the above partition coefficient equations. For terrestrial food chains, earthworm BAFs were used for estimating intake of chemicals from consumption of invertebrate by the savannah sparrow and the robin. If earthworm BAFs were unavailable, experimentally derived BCFs were used. If BCFs were not available in the literature, they were derived using the above partition coefficient equations.

3.2.4 Effects Assessment

The "quotient method" (Barnthouse et al., 1982; Urban and Cook, 1986) was used to arithmetically compare a toxicity benchmark (TB) concentration (the measurement endpoint) with the intake for each COPEC and assessment endpoint species. An EQ is calculated of the general form:

$$EQ = \text{Intake (mg/kg-day)/TB (mg/kg-day)}.$$

The TB is a dose or concentration (e.g., LOAEL) at which a critical effect, defined by the assessment and measurement endpoints, occurs. The critical effects used in this ERA were mortality or reproductive effects. This method assumes that the TB is a reasonable estimate of the level of a contaminant concentration that may result in ecological toxicity effects to an assessment endpoint species if exceeded in a given environmental medium. Conservativeness of TBs was reinforced by using the lowest

available values and modifying them by uncertainty factors when appropriate.

The use of uncertainty factors (UFs) in an ERA is conceptually well established. UFs are intentionally biased to ensure that uncertainties do not result in the under-estimation of potential impacts. The selected measurement endpoints (e.g., LOAELs) were divided by these factors to produce a more conservative measurement endpoint, a TB. Comparisons of the physiology and life history patterns were made in addition to direct taxonomic comparison between the measurement endpoint species and the assessment endpoint species. UFs were derived from Calabrese and Baldwin (1993) and are presented below.

- If available data are obtained from an acute rather than a chronic study, a factor of 10 was applied to the uncertainty. Studies were defined as chronic or acute on the basis of their duration and test organism. Studies were considered to provide chronic toxicity data if conducted for a minimum of 90 days in mammals, 28 days in birds, or 7 days in invertebrates. Shorter studies were considered acute.

- If LOAEL data were not available for a contaminant, the next preferred form of toxicity data was the median lethal doses (LD_{50}) or median lethal concentration (LC_{50}). These factors were modified by a factor of 10 if the LD_{50} or LC_{50} studies were chronic studies and a factor of 100 if the studies were acute in duration.

- Application of measurement endpoint from the genera within the same family as the assessment endpoint species (10).

- Application of a measurement endpoint from a family within the same order as the assessment endpoint species (30).

- Application of a measurement endpoint from an order within the same class as the assessment endpoint species (60).

- Application of a measurement endpoint from a class within the same phylum as the assessment endpoint species (100).

For exposure to soil at the installation, the preferred TB was the lowest appropriate LOAEL for mortality or reproductive effects on the basis of chronic studies. Data for other toxic effects were used if mortality or reproductive effects are not available. If LOAEL data were not available for a contaminant, the next preferred form of toxicity data for use as a TB was a median lethal dose (LD_{50}) or a median lethal concentration (LC_{50}) in diet.

For aquatic receptors in surface water, the acute and chronic TBs were the lowest value established by USEPA as ambient water quality criteria (AWQC) for the protection of aquatic life. If these criteria were lacking for a chemical, aquatic toxicity data from the Aquatic Information Retrieval (AQUIRE) database or Hazardous Substance Database (HSDB) were used. The databases were searched for the lowest recorded LOAEL, LC_{50}, or EC_{50} (effect concentration at which 50% of the test population exhibits a reproductive effect).

For exposures to sediments, the preferred TBs were Federal sediment quality criteria. If these values were not available for a chemical, site-specific screening values were developed using the equilibrium partitioning approach as outlined in the *Guidelines for Deriving Site-Specific Sediment Quality Criteria for the Protection of Benthic Organisms* (USEPA, 1993a). This methodology was used only for nonpolar organic compounds. Generally, the equilibrium partitioning approach is founded in the correlation of concentration-response relationships with interstitial water (pore water) concentrations (Di Toro et al., 1991). The sediment quality criteria (SQC) for nonpolar

organic compounds is computed by the following equations:

$$SQC = (K_p)(FCV),$$

where:

K_p = the partition coefficient between sediment and water (L/kg); and

FCV = final chronic value using the AWQC guidelines (μg/L) (Stephan et al., 1985).

K_p is dependent on the fraction of organic carbon in the sediment (f_{oc}) and may be derived by the following equation:

$$K_p = (f_{oc})(K_{oc}),$$

where:

K_{oc} = the organic carbon partition coefficient (ml/g).

If K_{oc} is not available for a chemical, it may be estimated by the regression equation derived by Di Toro et al. (1985):

$$\log K_{oc} = 0.00028 + 0.983 \log K_{ow}.$$

The FCV term of the SQC equation is the USEPA AWQC for protection of aquatic life. If these criteria were not available, a formal derivation of an AWQC not performed, since this was beyond the scope of the risk assessment. An alternative value was substituted for the FCV term that is consistent with the selection of TBs for surface water. Aquatic toxicity data from the AQUIRE or HSBD databases were used. The databases were searched for the lowest recorded LOAEL, LC_{50}, or EC_{50}. The lowest (most conservative) value from the preferred data, modified by uncertainty factors as necessary, was used as the TB value for each sediment COPEC.

The equilibrium partitioning methodology described above does not address polar compounds. Thus, for polar compounds for which there are no Federal criteria, the effects range-low (ER-L) and the effects range-median (ER-M) values of Long et al. (1993) were used. These values are the 10th and 15th percentile concentrations of the distribution of adverse-effect concentrations available in the literature.

3.2.5 Ecological Risk Characterization

The results of the quotient method, the EQ values, were placed in three categories as follows:

- EQ < 1. Those contaminants with EQs less than one were assumed to pose no significant adverse ecological impacts;
- 10 > EQ > 1. Contaminants with EQs greater than 1 and less than or equal to 10 were classified as contaminants of possible concern; and
- EQ > 10. Contaminants with EQs greater than 10 were classified as contaminants of probable concern.

In addition to the numerical classifications of EQ values, components comprising the EQ also were assessed (i.e. percent of total EQ contributed by soil, water, or food sources). This assessment of the contributors to the total EQ will aid in remediation decisions in the future because the degree to which each medium impacts the assessment endpoint species will be clearly defined.

Using the EQs, the ecological significance of potential impacts was evaluated. Consideration was given to the nature and magnitude of potential adverse effects through evaluation of the mechanisms of toxic effects at the individual organism level and potential consequences of such effects at higher levels of ecological community organization. Assessment of the ecological significance of impacts also

considered spacial and temporal patterns of effects and the potential for recovery.

3.2.6 Uncertainty Assessment

The uncertainty analysis addresses the uncertainties associated with each primary aspect of the ERA and is presented on a site-by-site basis in Sections 4 to 6. Particular attention was given to assumptions associated with development of the conceptual site model, estimation of exposures, and potential adverse impacts. Table 3-9 describes uncertainties which apply to all of the sites.

Table 3-9
Uncertainties of ERA

Parameter	Assumptions	Uncertainty
Selection of Assessment Endpoint Species	Potential effects of the selected assessment endpoint species are representative of other animals at Galena Airport.	Exposures and chemical sensitivities vary among species. Magnitude of uncertainty could be lower or higher. Bias would be neutral.
Identification of COPECs	Exposure to subsurface soil are insignificant.	Surface soil exposures are probably the most significant for the selected indicator species. Some exposures to subsurface soils may occur in meadow vole burrows or via root uptake. Magnitude of uncertainty would be low, bias would be neutral.
	Exposures to groundwater are insignificant at the sites.	Of the contaminated water present, exposure does not occur to the assessment endpoint species at the sites. Magnitude of uncertainty is low, bias would be over.
	Effects of reported concentrations of non-specific analytes (e.g., diesel, fuel) were not evaluated.	Many of the specific compounds that comprise significant fractions of these mixtures were evaluated separately. Magnitude of uncertainty would be low-high, bias would be neutral.
Chemical Concentrations	Chemical concentrations in soil are equal to the 95% UCL.	The actual average chemical concentration is most likely to be less than the 95% UCL. The magnitude of uncertainty would be medium, bias would be over.
Exposure Route Selection	Surface water in the drainage ditches provides 100% of water intake for assessment endpoint MGH and WAA.	Exposure through surface water intake is not considered in any other source areas, except MGH and WAA. The assumption that 100% of an assessment endpoint species' water intake is conservative. The magnitude of uncertainty would be medium and the bias over.
	Dermal exposure is negligible compared to other exposure pathways.	Dermal absorption of contaminants in soil is more likely to be significant for meadow voles than other indicator species, but a lack of available studies makes quantitation difficult. The magnitude of uncertainty would be low-high and the bias neutral.
	Ingestion of food, soil, and surface waters directly from the contaminated areas is the most significant exposure pathway for the indicator species.	Indirect exposure to off-site receptors could occur, but are generally less than direct on-site receptors. The magnitude of uncertainty would be low-high and the bias neutral.
Food Chain Transport	Average reported plant uptake factors for inorganics are assumed to be applicable to all plant types and plant parts that may be ingested.	Root uptake and translocation are variable, depending on: plant species, soil characteristics, plant part and growing conditions. Actual concentrations in ingested plants could be higher or lower. The bias would be neutral.
	Organic chemicals plant uptake based on the octanol-water partition coefficient are representative of actual conditions at Galena Airport.	
Ingestion Rates	Because of their small home ranges, meadow voles ingest food and soil only from the contaminated areas.	Site-specific home ranges and feeding habits have not been studied. The magnitude of uncertainty would be low-high and bias would be over.

Table 3-9
(Continued)

Parameter	Assumptions	Uncertainty
Ingestion Rates (Con't)	An animal's average plant ingestion rate is representative of all individuals' ingestion rates.	Actual ingestion rates can vary among individual animals. The magnitude of uncertainty would be low, bias neutral.
	Food ingestion rates based on observed correlations with body weight are representative of actual ingestion rates.	The correlation coefficients for the allometric equations indicate that for a given body weight, food consumption can vary. The magnitude of uncertainty would be low-high, bias neutral.
Body Weight	Average body weights from the available literature are representative of the population.	There is individual variation in body weight in animal populations. Magnitude of uncertainty would be low and the bias neutral.
Home Range	Home range values taken from the literature are representative of home ranges of the assessment endpoint species.	There are individual and population variations in home range, depending on habitat quality and availability. Members of the same species or different species within the ecosystem could also influence home range. Magnitude of uncertainty would be low-high, bias over.
Assessment Endpoint Selection	Population changes are indicative of adverse environmental impacts.	Other endpoints could be more or less sensitive. The magnitude of uncertainty would be low-high, the bias would be neutral.
Measurement Endpoint Selection	Toxicological values from laboratory bioassays are applicable to environmental exposures.	Bioassay conditions rarely reflect site-specific exposure conditions. The magnitude of uncertainty would be low-high, bias over.
	Surrogate toxicological values are applicable.	Toxicological data for some chemicals (i.e., endrin aldehyde) were unavailable. Parent compound (endrin) toxicological data was used and is assumed to be representative. Magnitude of uncertainty would be low-high, bias neutral.
	The selected measurement endpoints are relevant to the assessment endpoints.	The selected endpoints were based on available data. The quality and quantity of toxicological studies varies greatly among chemicals. Endpoints directly related to the specified assessment endpoint were not always available. Magnitude of uncertainty would be high, bias over.
	Bioassays using surrogate species are a realistic method for evaluating effects.	Toxicity to surrogate species may not reflect toxicity to the indicator species. Magnitude of uncertainty would be high, bias over.
Uncertainty Factor Selection	The selected uncertainty factors are adequate to insure that the selected measurement endpoints will not underestimate the impact on populations of the indicator species.	Although the selected uncertainty factors increase the probability of false positive results and decrease the probability of false negative results, it would be difficult to determine the exact degree of protection provided by the uncertainty factors. Magnitude of uncertainty would be low-high, bias neutral.

Magnitude of uncertainty is the subjective approximation of the magnitude of the uncertainty.

The bias is a subjective approximation of the most likely direction of bias in the calculated EQs.

Over = Over estimation
Neutral = Over or under estimation
Under = Under estimation

Section 4
FIRE PROTECTION TRAINING AREA

This section contains a site-specific baseline risk assessment for the Fire Protection Training Area (FPTA). Section 4.1 provides a description of the site and Section 4.2 summarizes data evaluation. Section 4.3 presents the human health risk assessment results. Section 4.4 presents the ecological assessment results.

4.1 Site Description

The FPTA is located north of the runway overrun at the eastern extreme of the airport (Figure 1-2). According to Department of Transportation (DOT) land occupancy records updated 3 May 1988, the formal FPTA covers 476,000 ft^2 and is currently occupied by the "Army Corps Fire Training Area." The site now consists of an unlined, shallow soil burn pit that is surrounded by a small sand and gravel dike. An aircraft mock-up that occupied the center of the burn pit was removed during the summer of 1992.

The FPTA is surrounded to the north and east by the flood control dike, to the south by the runway overrun, and to the west by an open field vegetated primarily by tall grasses. The addition of fill material to build up the runway overrun altered the original topography of the site. The ground now slopes to the northeast, resulting in a topographic low in the area of the burn pit. During the spring breakup, surface water from snowpack melt accumulates on top of the frozen soil and floods the area. Beyond the installation dike wall north and east of the site, the natural terrain consists of Yukon River floodplain lowlands, which are marshy and forested.

The FPTA is located entirely within the building restriction line (see Figure 2-2); therefore future development/building construction in this area is not possible as long as the airport remains operational.

4.1.1 Sources of Contamination

Galena firefighters have conducted fire training activities at the FPTA since the late 1950s. Review of aerial photographs taken from 1963 to 1978 suggest that drums of unknown (but presumably flammable) materials were stored on the ground around the burn pit area. An underground pipeline connecting an aboveground fuel valve to fuel sprayers around the aircraft mock-up is believed to have been used to deliver flammable liquids to the burn pit during fire training exercises. Figure 4-1 shows the location of these potential source areas. According to the Phase I Records Search (USAF, 1985), the training pit area was used through 1985 about once per week from June to November. In the wetter months of April and May, the training sessions were conducted about once per month. The facility was not used in the winter months from December to March. The training area has reportedly been closed to burning activity since 1991 (USAF, 1991).

Approximately 300 to 500 gal. of fuel were used per fire, and two fires per training session were typical. When the surface soils were not frozen, the combustion pit was prewetted with water before pouring fuel on the surface. No water was applied when the ground was frozen. Some surface soil areas are stained black, probably from unburned materials and residual materials remaining after ignition. Until 1991, fuels used were clean and contaminated JP-4. In the 1950s and 1960s, some combustible wastes such as AVGAS, thinners, paints, oils, and so forth were also used. Fire extinguishing agents used at the site have included protein

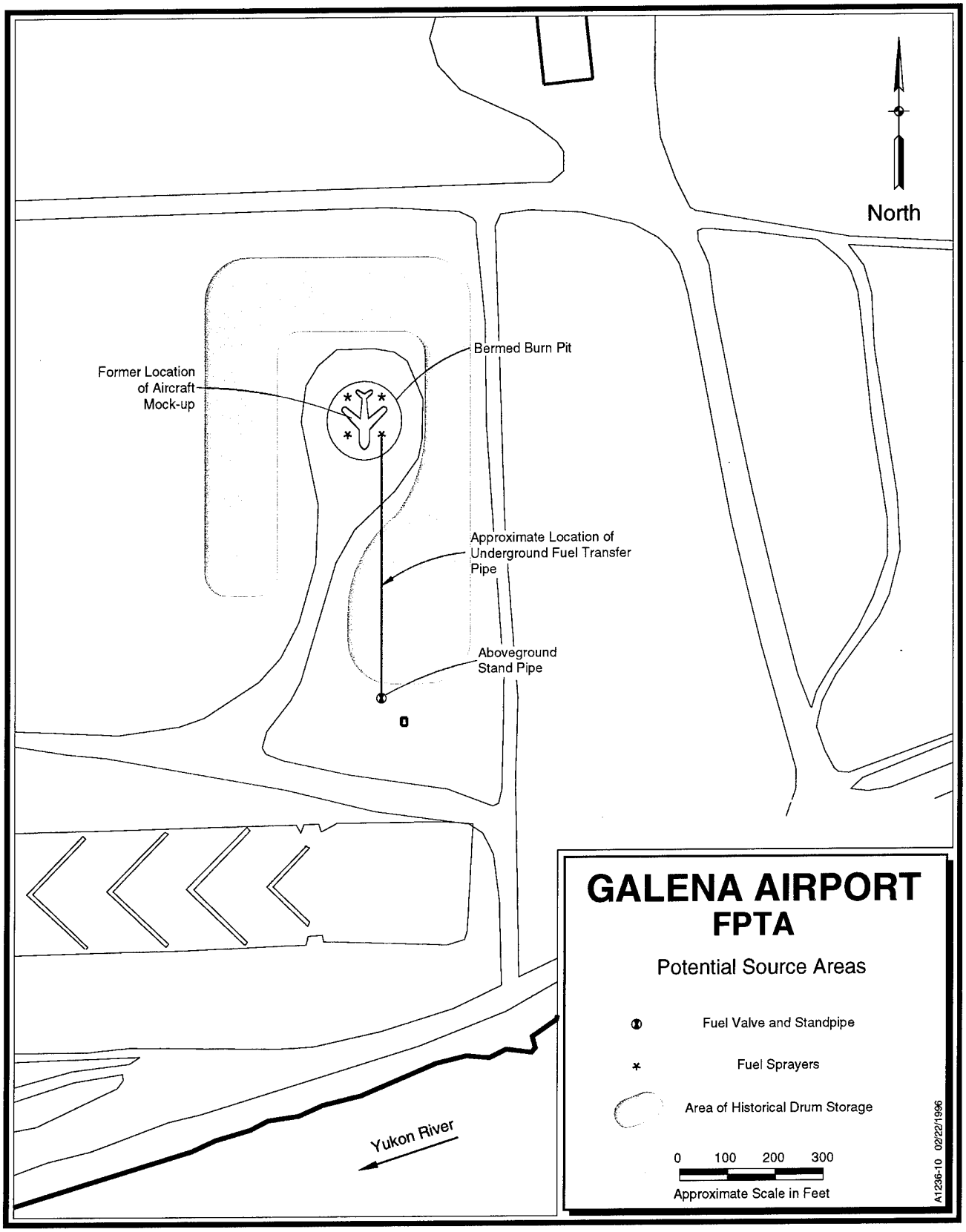


Figure 4-1. Location of Former Potential Source Areas at the Fire Protection Training Area (FT001)

foam, chlorobromomethane, dry chemicals, halon, and aqueous film-forming foam.

4.1.2 RI Activities

Field investigations conducted at the FPTA from 1992 to 1994 included the installation and sampling of four monitoring wells; the sampling of four preexisting wells; the collection and analysis of surface and subsurface soil, sediment, and surface water samples; the completion of a geophysical survey; and the completion of a soil gas and groundwater field screening survey. The analytical results for soil and water samples are presented in Appendix A of the RI report (USAF, 1995c).

4.1.3 RI Conclusions

The analytical results suggest that the soil and groundwater at the FPTA are contaminated with fuels that were used as flammables during past fire protection training exercises. Burn products, such as polynuclear aromatics (PNAs), also appear to be present in the shallow subsurface soils. The soil contamination is mainly limited to the area within the burn pit.

Two areas of groundwater benzene contamination were identified at the FPTA. The northern area is the result of migration of surface soil contamination through the unsaturated zone to the water table. The groundwater contamination appears to extend from the burn pit to the southwest, but does not appear to have migrated to a monitoring well located about 300 ft downgradient of the burn pit. The southern area of groundwater contamination is likely the result of fuel and waste liquid handling that occurred in the vicinity of the pipeline fuel valve that supplied the mock-up with combustible material. Another possible source of the groundwater contamination in the southern plume is the release of fuel from drums stored on site. Groundwater monitoring results at the FPTA suggest that the benzene plume has stabilized with respect to both location and concentration.

4.2 Data Evaluation

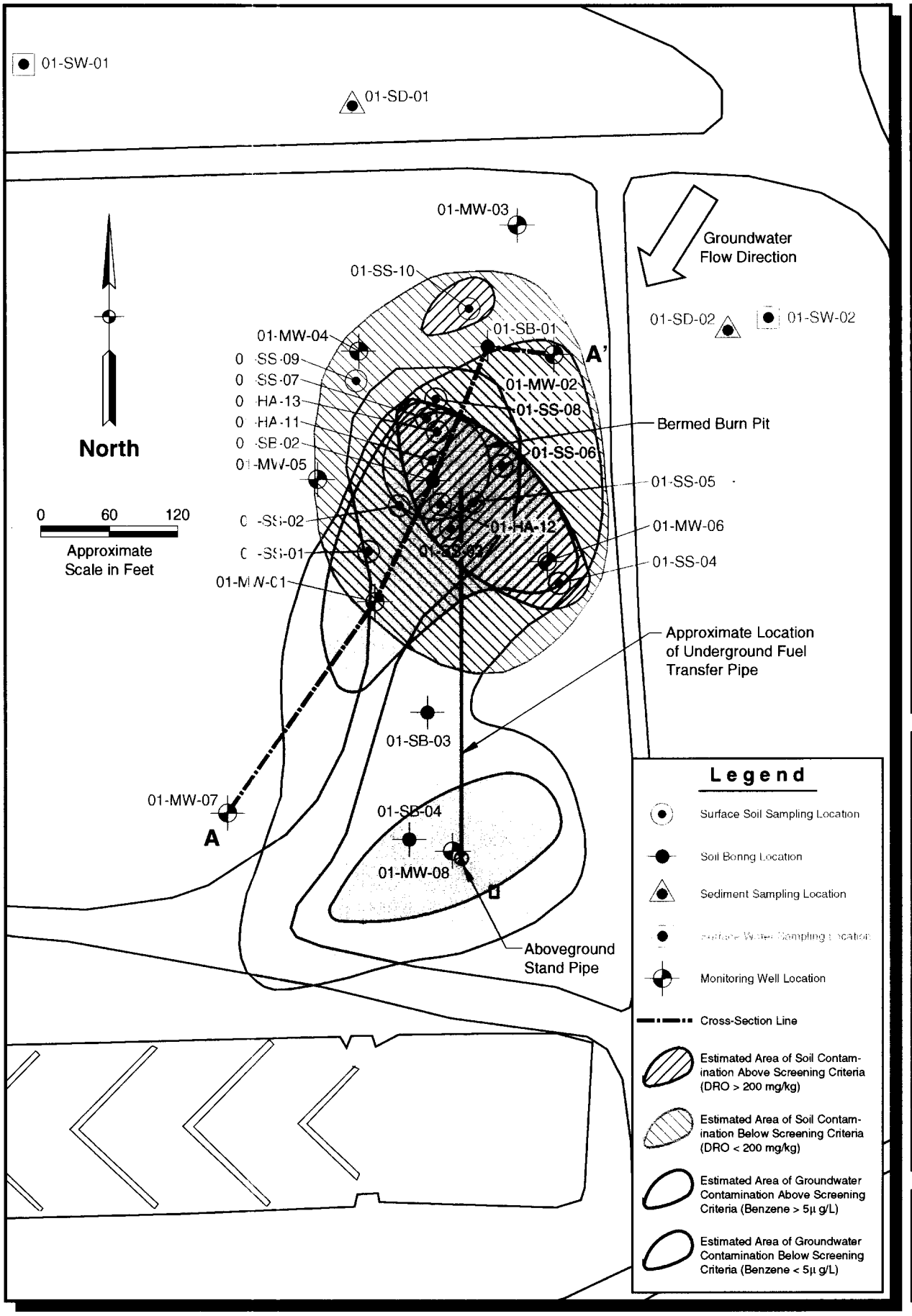
Data available from the RI (USAF, 1995c) were used to evaluate human health risks and ecological effects posed by the FPTA. After removing samples that were determined to be uncontaminated, analytical results from a total of 25 surface soil and sediment samples, 25 subsurface soil samples, and 22 groundwater samples made up the risk assessment data set. Results from one surface water sample from standing water located about 250 ft northeast of the burn pit were also available for evaluation. Table 4-1 lists the analytical methods used to test the soil and water samples during the 1992-1994 RI.

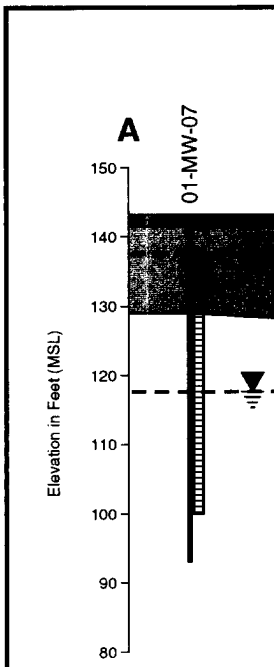
Figure 4-2 presents a conceptual diagram for the FPTA from the RI report (USAF, 1995c). This diagram provides a plan view, a geologic cross section, and a table that lists the range of detected concentrations for analytes that have exceeded the screening criteria used in the RI report (Alaska cleanup standards, USEPA Region III industrial soil ingestion RBCs, and drinking water MCLs). The plan view shows the location of all analytical data points (surface soil samples, surface water samples, soil borings, sediment samples, and monitoring well locations). The areas of soil and groundwater contamination (exceeding screening criteria) are shown as an overlay to the plan view. The area of soil contamination is defined by samples where DRO was detected above 200 mg/kg, and the area of groundwater contamination is defined by 5 µg/L benzene and greater. Areas of detections less than the screening criteria are also shown. The plan view and the lithologic cross section can be used in conjunction to provide a three-dimensional visualization of site characteristics and contaminants.

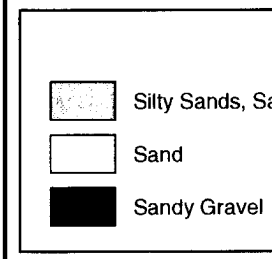
Table 4-1
Analytical Methods Used at the Fire Protection Training Area During the 1992-94 RI

Parameter	Soil	Water
Alkalinity - Total (SM403)	NA	92, 93, 94
Specific Conductance (E120.1)	NA	92, 93, 94
pH (E150.1 - aqueous, SW9045 - solids)	--	92, 93, 94
Total Dissolved Solids (E160.1)	NA	92, 93
Total Suspended Solids (E160.2)	NA	93
Temperature (E170.1)	NA	92, 93, 94
Turbidity (E180.1)	NA	93
Anions (E300)	NA	93
Nitrate-Nitrite (E353.1)	NA	93
Metals - ICP Screen (SW6010)	92	92, 93
Arsenic (SW7060)	92	92, 93
Lead (SW7421)	92	92, 93
Mercury - (SW7470 aqueous, SW7471 solid)	92	93
Selenium (SW7740)	92	92, 93
Halogenated Volatile Organics (SW8010)	NA	92, 93
Nonhalogenated Volatile Organics (SW8015)	NA	92, 93
Aromatic Volatile Organics (SW8020)	NA	92, 93
Organochlorine Pesticides and PCBs (SW8080)	92	92, 93, 94
Polynuclear Aromatic Hydrocarbons (SW8310)	92, 93	92, 93
Volatile Organic Compounds (SW8240)	92, 93	NA
Volatile Organic Compounds (SW8260)	NA	94
Dioxins/Furans (SW8280)	94	--
Diesel Range Organics (AK102)[a]	92, 93	92, 93, 94
Gasoline Range Organics (AK101)[a]	92, 93	92, 93, 94
Soil Moisture Content (SW846) or ASTM 02216)	92, 93, 94	NA

[a] Method S8015 MEMP used in 1992.
NA = Not applicable.
-- Analytical method not used for this medium (either a different method was used for this medium, for example to achieve better detection limits, or the method does not pertain to this medium.

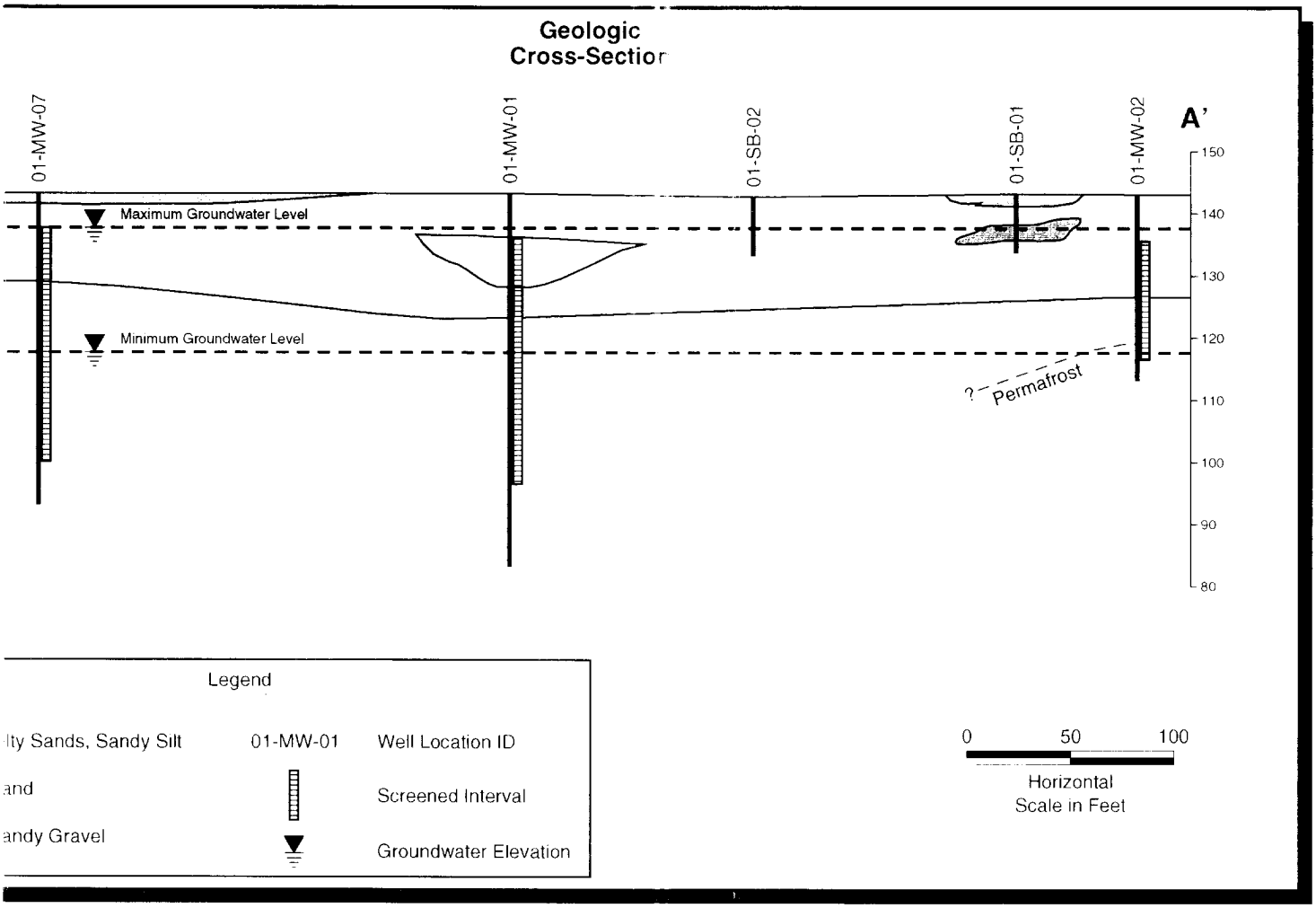






Analyte

Benzene
Benzo(a)pyrene
Ethylbenzene
Toluene
Xylenes
DRO
GRO



Compounds Exceeding RI Screening Criteria

te	Soil		Groundwater	
	Screening Criteria (µg/kg)	Range of Detections (µg/kg)	Screening Criteria (µg/L)	Range of Detections (µg/L)
	500 AK	3,000 - 120,000	5 M	22 - 420
pyrene	780 RC	2.7 - 1,500		
zene	15,000 AK	2,300 - 200,000		
	15,000 AK	$1.4x10^4$ - $1.1x10^6$		
	15,000 AK	$1.2x10^4$ - $1.2x10^6$		
	200,000 AK	27,000 - $7.2x10^7$		
	100,000 AK	130,000 - $2.4x10^7$		

Key:
AK - State of Alaska Cleanup Standard
RC - EPA Region III Risk-Based Concentration, Carcinogenic (Industrial Soil Ingestion)
M - Maximum Contaminant Level

Galena Airport - FPTA

Conceptual Diagram and Summary of Compounds Exceeding Screening Criteria

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Figure 4-2. Conceptual Diagram for the Fire Protection Training Area (FT001)

Statistical analyses, in accordance with methods summarized in Section 3 and described in detail in Appendix A, were conducted on the available data to identify contaminants that were:

1. Positively detected in at least one sample in a given medium;

2. Detected at levels substantially greater than levels detected in associated blank samples (at least one result that exceeds the blanks UTL); and

3. Detected at levels substantially greater than naturally occurring background levels.

Table 4-2 lists the chemicals that were positively detected in the various media at the FPTA. Sediment samples were classified with surface soil and are not distinguished separately. Surface water samples did not exist for this site that were located in an applicable area. These are considered possible COPCs that were subjected to blanks and background comparisons and to additional screening and evaluation for the human health assessment and the ecological assessment before they were identified *positively* as COPCs for human health or COPECs. Appendix A lists all chemicals that were tested in the various media and indicates, on a medium-specific basis, whether or not there were measurable results after conducting the blanks evaluation and whether or not the average site-related concentration is greater than the average background concentration (metals only).

An evaluation of the adequacy of detection limits was performed by comparing the minimum detection limit for each chemical eliminated as a COPC because it was not detected in a medium with the USEPA Region III residential RBCs. Appendix B contains the results of this detection limit screening process. The uncertainties associated with detection limits that are not low enough to detect risk-based concentrations are summarized in Section 4.3.5.

4.3 Human Health Risk Assessment Results

The human health evaluation for the FPTA included identification of COPCs (Section 4.3.1), exposure assessment (Section 4.3.2), toxicity assessment (Section 4.3.3), risk characterization (Section 4.3.4), and uncertainty assessment (Section 4.3.5). These tasks were performed according to the methods specified in Section 3. Section 4.3.6 summarizes conclusions of the human health risk assessment for the FPTA and recommendations for remedial action based on the risk assessment results.

4.3.1 Chemicals of Potential Concern

Additional screening of the candidate COPCs was performed, in accordance with the methods described in Section 3, to identify the COPCs carried through the human health assessment. The additional screening involved examining the frequency of detection, evaluating essential nutrients, and comparing maximum detected concentrations to USEPA Region III RBCs.

Frequency of Detection

At the FPTA, there were no chemicals that were eliminated from the list of COPCs on the basis of a low (< 5%) frequency of detection.

Essential Nutrients

Essential nutrients that are often present either in the soil and water media were not detected at the FPTA at concentrations elevated above background concentrations.

Risk-Based Screening

Maximum detected concentrations of numerous analytes were lower than one-tenth the media-specific USEPA Region III residential

Table 4-2
Analytes Detected at the Fire Protection Training Area

Chemical	Groundwater	Surface Soil	Subsurface Soil
1,1,1-Trichloroethane	ND	D	D
1,1,2,2-Tetrachloroethane	ND	D	ND
1,1-Dichloroethane	ND	ND	D
1,2-Dichloroethane	D	ND	ND
2-Butanone (MEK)	ND	D	D
2-Hexanone	ND	D	ND
4,4'-DDD	ND	D	D
4,4'-DDE	ND	D	D
4,4'-DDT	D	D	D
4-Methyl-2-Pentanone (MIBK)	ND	ND	D
Acenaphthene	D	D	D
Acenaphthylene	ND	D	D
Acetone	D	D	D
Aldrin	D	D	D
Anthracene	ND	D	D
Benz(a)anthracene	ND	D	D
Benzene	D	D	D
Benzo(a)pyrene	ND	D	D
Benzo(b)fluoranthene	ND	D	D
Benzo(g,h,i)perylene	ND	D	D
Benzo(k)fluoranthene	ND	D	D
Bromodichloromethane	ND	D	ND
Chlorobenzene	ND	D	ND
Chloromethane	D	ND	ND
Chrysene	ND	D	D
Dibenz(a,h)anthracene	D	D	D
Dibromomethane	D	--	--

Table 4-2
(Continued)

Chemical	Groundwater	Surface Soil	Subsurface Soil
Dieldrin	D	D	D
Endosulfan I	D	D	D
Endosulfan II	D	D	D
Endosulfan sulfate	D	D	D
Endrin	D	D	D
Endrin aldehyde	D	D	D
Ethylbenzene	D	ND	D
Fluoranthene	ND	D	D
Fluorene	ND	D	D
Heptachlor	D	D	D
Heptachlor epoxide	D	D	D
HpCDD totals	--	D	D
Indeno(1,2,3-cd)pyrene	D	D	D
Methoxychlor	D	D	D
Methylene chloride	D	D	D
Naphthalene	ND	D	D
OCDD	--	D	D
Phenanthrene	ND	D	D
Pyrene	ND	D	D
Toluene	D	D	D
Vinyl acetate	ND	D	ND
Xylene (total)	D	D	D
alpha-BHC	D	D	D
beta-BHC	D	D	D
delta-BHC	D	D	D
gamma-BHC	D	D	D
Aluminum	D	D	D

Table 4-2
(Continued)

Chemical	Groundwater	Surface Soil	Subsurface Soil
Antimony	D	ND	ND
Arsenic	D	D	D
Barium	D	D	D
Beryllium	D	D	D
Cadmium	D	D	D
Calcium	D	D	D
Chromium	D	D	D
Cobalt	D	D	D
Copper	D	D	D
Iron	D	D	D
Lead	D	D	D
Magnesium	D	D	D
Manganese	D	D	D
Mercury	D	D	D
Molybdenum	D	ND	ND
Nickel	D	D	D
Potassium	D	D	D
Selenium	D	ND	ND
Silver	D	ND	ND
Sodium	D	D	D
Thallium	D	ND	ND
Vanadium	D	D	D
Zinc	D	D	D

D = Detected
ND = Not detected
-- = Not tested

RBCs and were eliminated from the list of COPCs. Appendix B contains the risk-based screening results.

COPC Summary

Tables 4-3, 4-4, and 4-5 summarize conclusions for all chemicals that were positively detected in the surface soil or sediments, subsurface soil, and groundwater media, respectively, at the FPTA. The tables indicate, for each analyte, whether sample concentrations were distinguishable from blank concentrations, whether concentrations were significantly different from background concentrations, whether the chemical was detected in at least 5% of the samples, and whether the chemical was eliminated as an essential nutrient or by the risk-based screen. Note that since 1993 and later sampling events reported uncensored data (where an ND is reported only if there is no instrument response), very low levels (greater than zero) of many analytes were reported in both blanks samples and site samples. Consequently, many chemicals that are not common field or laboratory contaminants were "detected" in blanks samples and were eliminated as COPCs on the basis of the blanks comparison. No analytes were detected in blanks at concentrations considered to represent a blanks contamination problem requiring corrective action as a result of the data validation process.

Table 4-6 lists the COPCs for the FPTA. It includes all chemicals, by medium, with positive results that were greater than background and blank concentrations, that exceeded 5% detection frequency, and that were not eliminated as an essential nutrient or by risk-based screening.

Appendix A of the RI report (USAF, 1995c) provides a complete listing of analytical results from the RI. The appendix reports the sampling location, analytical result, any data qualifiers, and the sample detection limit.

Tables 4-7, 4-8, and 4-9 provide a statistical summary of the values used in the risk assessment for human health COPCs in surface soil and sediments, subsurface soil, and groundwater, respectively. Surface water was not evaluated at this site. The tables list the detection frequency, maximum detected concentration, mean, standard deviation, and 95% UCL of the data.

4.3.2 Exposure Assessment

Human exposure to COPCs that are present at or migrating from the FPTA was assessed in accordance with methods described in Section 3.

Human Exposure Scenarios

Eight human exposure scenarios were addressed in the assessment of risks posed by the FPTA:

Current Scenarios (also applicable as future scenarios)

1. Short-Term On-Base Resident (subchronic adult only);
2. Long-Term On-Base Resident (chronic adult and child);
3. Old Town Galena Resident (chronic adult and child);
4. New Town Galena Resident (chronic adult and child);
5. Short-Term On-Base Worker (subchronic adult only);
6. Long-Term On-Base Worker (chronic adult only); and

Table 4-3
Identification Criteria for Surface Soil COPCs at the Fire Protection Training Area

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
1,1,1-Trichloroethane	-	-	-	-	X	-
1,1,2,2-Tetrachloroethane	-	-	-	-	X	-
2-Butanone (MEK)	-	-	-	-	X	-
2-Hexanone	-	-	-	-	-	YES
4,4'-DDD	-	-	-	-	X	-
4,4'-DDE	-	-	-	-	X	-
4,4'-DDT	-	-	-	-	-	YES
Acenaphthene	-	-	-	-	X	-
Acenaphthylene	-	-	-	-	-	YES
Acetone	X	-	-	-	-	-
Aldrin	-	-	-	-	-	YES
Anthracene	-	-	-	-	X	-
Benz(a)anthracene	-	-	-	-	X	-
Benzene	-	-	-	-	X	-
Benzo(a)pyrene	-	-	-	-	-	YES
Benzo(b)fluoranthene	-	-	-	-	X	-
Benzo(g,h,i)perylene	-	-	-	-	-	YES
Benzo(k)fluoranthene	-	-	-	-	X	-
Bromodichloromethane	-	-	-	-	X	-
Chlorobenzene	-	-	-	-	X	-
Chrysene	-	-	-	-	X	-
Dibenz(a,h)anthracene	-	-	-	-	X	-
Dieldrin	-	-	-	-	X	-

Table 4-3
(Continued)

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
Endosulfan I	-	-	-	-	X	-
Endosulfan II	-	-	-	-	X	-
Endosulfan sulfate	X	-	-	-	-	-
Endrin	-	-	-	-	X	-
Endrin aldehyde	-	-	-	-	X	-
Fluoranthene	-	-	-	-	X	-
Fluorene	-	-	-	-	X	-
Heptachlor	-	-	-	-	X	-
Heptachlor epoxide	-	-	-	-	-	YES
HpCDD Totals	-	-	-	-	-	YES
Indeno(1,2,3-cd)pyrene	-	-	-	-	X	-
Methoxychlor	-	-	-	-	X	-
Methylene chloride	-	-	-	-	X	-
Naphthalene	-	-	-	-	X	-
OCDD	-	-	-	-	-	YES
Phenanthrene	-	-	-	-	-	YES
Pyrene	-	-	-	-	X	-
Toluene	-	-	-	-	X	-
Vinyl acetate	-	-	-	-	X	-
Xylene (total)	-	-	-	-	X	-
alpha-BHC	-	-	-	-	X	-
beta-BHC	-	-	-	-	X	-
delta-BHC	-	-	-	-	X	-
gamma-BHC	-	-	-	-	X	-

Table 4-3
(Continued)

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
Aluminum	-	X	-	-	-	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Beryllium	-	X	-	-	-	-
Cadmium	-	-	-	-	X	-
Calcium	-	X	-	-	-	-
Chromium	-	X	-	-	-	-
Cobalt	-	X	-	-	-	-
Copper	-	X	-	-	-	-
Iron	-	X	-	-	-	-
Lead	-	-	-	-	-	YES
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	-	X	-	-	-	-
Nickel	-	X	-	-	-	-
Potassium	-	X	-	-	-	-
Sodium	-	X	-	-	-	-
Vanadium	-	X	-	-	-	-
Zinc	-	X	-	-	-	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- Not eliminated through this criterion.

Table 4-4
Identification Criteria for Subsurface Soil COPCs at the Fire Protection Training Area

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
1,1,1-Trichloroethane	-	-	-	-	X	-
1,1-Dichloroethane	-	-	-	-	X	-
2-Butanone (MEK)	X	-	-	-	-	-
4,4'-DDD	-	-	-	-	X	-
4,4'-DDE	-	-	-	-	X	-
4,4'-DDT	-	-	-	-	X	-
4-Methyl-2-Pentanone(MIBK)	-	-	-	-	X	-
Acenaphthene	-	-	-	-	X	-
Acenaphthylene	-	-	-	-	-	YES
Acetone	-	-	-	-	X	-
Aldrin	-	-	-	-	X	-
Anthracene	-	-	-	-	X	-
Benz(a)anthracene	-	-	-	-	-	YES
Benzene	-	-	-	-	-	YES
Benzo(a)pyrene	-	-	-	-	-	YES
Benzo(b)fluoranthene	-	-	-	-	-	YES
Benzo(g,h,i)perylene	-	-	-	-	-	YES
Benzo(k)fluoranthene	-	-	-	-	X	-
Chrysene	-	-	-	-	X	-
Dibenz(a,h)anthracene	-	-	-	-	-	YES
Dieldrin	-	-	-	-	X	-
Endosulfan I	X	-	-	-	-	-
Endosulfan II	X	-	-	-	-	-

Table 4-4
(Continued)

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
Endosulfan sulfate	X	-	-	-	-	-
Endrin	X	-	-	-	-	-
Endrin aldehyde	X	-	-	-	-	-
Ethylbenzene	-	-	-	-	X	-
Fluoranthene	-	-	-	-	X	-
Fluorene	-	-	-	-	X	-
Heptachlor	-	-	-	-	X	-
Heptachlor epoxide	X	-	-	-	-	-
HpCDD Totals	-	-	-	-	-	YES
Indeno(1,2,3-cd)pyrene	-	-	-	-	X	-
Methoxychlor	-	-	-	-	X	-
Methylene chloride	X	-	-	-	-	-
Naphthalene	-	-	-	-	X	-
OCDD	-	-	-	-	X	-
Phenanthrene	-	-	-	-	-	YES
Pyrene	-	-	-	-	X	-
Toluene	-	-	-	-	X	-
Xylene (total)	-	-	-	-	X	-
alpha-BHC	-	-	-	-	X	-
beta-BHC	X	-	-	-	-	-
delta-BHC	-	-	-	-	X	-
gamma-BHC	-	-	-	-	X	-
Aluminum	-	X	-	-	-	-
Arsenic	-	X	-	-	-	-

Table 4-4
(Continued)

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
Barium	-	X	-	-	-	-
Beryllium	-	X	-	-	-	-
Cadmium	-	X	-	-	-	-
Calcium	-	X	-	-	-	-
Chromium	-	X	-	-	-	-
Cobalt	-	X	-	-	-	-
Copper	-	X	-	-	-	-
Iron	-	X	-	-	-	-
Lead	-	-	-	-	-	YES
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	-	X	-	-	-	-
Nickel	-	X	-	-	-	-
Potassium	-	X	-	-	-	-
Sodium	-	X	-	-	-	-
Vanadium	-	X	-	-	-	-
Zinc	-	X	-	-	-	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- Not eliminated through this criterion.

Table 4-5
Identification Criteria for Groundwater COPCs at the Fire Protection Training Area

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
1,2-Dichloroethane	-	-	-	-	-	YES
4,4'-DDT	-	-	-	-	X	-
Acenaphthene	X	-	-	-	-	-
Acetone	X	-	-	-	-	-
Aldrin	X	-	-	-	-	-
Benzene	-	-	-	-	-	YES
Chloromethane	-	-	-	-	-	YES
Dibenz(a,h)anthracene	X	-	-	-	-	-
Dibromomethane	-	-	-	-	-	YES
Dieldrin	-	-	-	-	-	YES
Endosulfan I	X	-	-	-	-	-
Endosulfan II	X	-	-	-	-	-
Endosulfan sulfate	X	-	-	-	-	-
Endrin	X	-	-	-	-	-
Endrin aldehyde	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	X	-
Heptachlor	-	-	-	-	-	YES
Heptachlor epoxide	-	-	-	-	-	YES
Indeno(1,2,3-cd)pyrene	X	-	-	-	-	-
Methoxychlor	-	-	-	-	X	-
Methylene chloride	X	-	-	-	-	-
Toluene	-	-	-	-	X	-
Xylene (total)	-	-	-	-	X	-

Table 4-5
(Continued)

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
alpha-BHC	-	-	-	-	-	YES
beta-BHC	-	-	-	-	-	YES
delta-BHC	X	-	-	-	-	-
gamma-BHC	-	-	-	-	-	YES
Aluminum	X	-	-	-	-	-
Antimony	X	-	-	-	-	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Beryllium	X	-	-	-	-	-
Cadmium	-	X	-	-	-	-
Calcium	-	X	-	-	-	-
Chromium	-	X	-	-	-	-
Cobalt	-	X	-	-	-	-
Copper	X	-	-	-	-	-
Iron	-	X	-	-	-	-
Lead	-	-	-	-	-	YES
Magnesium	-	X	-	-	-	
Manganese	-	X	-	-	-	-
Mercury	-	X	-	-	-	-
Molybdenum	X	-	-	-	-	-
Nickel	-	X	-	-	-	-
Potassium	-	X	-	-	-	-
Selenium	-	X	-	-	-	-
Silver	X	-	-	-	-	-

Table 4-5
(Continued)

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
Sodium	-	X	-	-	-	-
Thallium	X	-	-	-	-	-
Vanadium	X	-	-	-	-	-
Zinc	-	X	-	-	-	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III tap water RBC.
- Not eliminated through this criterion.

Table 4-6
Chemicals of Potential Concern at the Fire Protection Training Area

Chemical	Media		
	Surface Soil	Subsurface Soil	Groundwater
Metals			
Lead	X	X	X
PNAs			
Acenaphthylene[a]	X	X	
Benz(a)anthracene		X	
Benzo(a)pyrene	X	X	
Benzo(b)fluoranthene		X	
Benzo(g,h,i)perylene[a]	X	X	
Dibenz(a,h)anthracene		X	
Phenanthrene[a]	X	X	
Pesticides			
Aldrin	X		
alpha-BHC			X
beta-BHC			X
gamma-BHC			X
4,4'-DDT	X		
Dieldrin			X
Heptachlor			X
Heptachlor epoxide	X		X
Dioxins			
HpCDD totals	X	X	
OCDD	X		
Semi-volatiles			
2-Hexanone[a]	X		

Table 4-6
(Continued)

Chemical	Media		
	Surface Soil	Subsurface Soil	Groundwater
Volatiles			
Benzene		X	X
Bromochloromethane			X
Chloromethane			X
Dibromomethane[a]			X
1,2-Dichloroethane			X

[a] Retained as a COPC for qualitative evaluation only. Toxicity values are not available to perform risk quantification at this time.

Table 4-7
Statistical Summary of Values Used in the Human Health Risk Assessment for Surface Soil at the Fire Protection Training Area

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
Dioxins					
OCDD	3/5	8.73e-04	3.45e-04	3.24e-04	**6.54e-04**
HpCDD Totals	2/5	1.37e-04	5.31e-05	4.81e-05	**1.06e-04**
Metals					
Lead [a]	10/10	8.90e+01	4.39e+01	2.76e+01	**5.99e+01**
Pesticides					
Heptachlor epoxide	10/10	1.00e-02	1.27e-03	3.08e-03	**3.06e-03**
Aldrin	6/10	3.30e-02	3.40e-03	1.04e-02	**9.43e-03**
4,4'-DDT	10/10	**4.00e-01**	9.04e-02	1.44e-01	4.39e-01
PNAs					
Benzo(a)pyrene	10/12	2.70e-02	6.21e-03	8.43e-03	**1.73e-02**
Phenanthrene [b]	7/12	1.60e+01	1.68e+00	4.62e+00	**8.08e+00**
Acenaphthylene [b]	4/12	4.10e-01	7.21e-02	1.40e-01	**1.45e-01**
Benzo(g,h,i)perylene [b]	11/12	**4.70e-02**	1.76e-02	1.87e-02	7.38e-02
Semivolatiles					
2-Hexanone [b]	1/12	3.70e+00	1.88e+00	1.04e+00	**2.42e+00**

Bold numbers indicate the value used for the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK model was used to calculate risk from lead.
[b] No toxicity data available.

Table 4-8
Statistical Summary of Values Used in the Human Health Risk Assessment for Subsurface Soil at the Fire Protection Training Area

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
Dioxins					
HpCDD Totals	2/3	**7.01e-05**	5.38e-05	1.50e-05	7.92e-05
Metals					
Lead [a]	8/8	8.20e+01	2.10e+01	2.55e+01	**3.81e+01**
PNAs					
Benzo(a)pyrene	12/14	1.50e+00	1.10e-01	4.00e-01	**2.99e-01**
Benzo(b)fluoranthene	13/14	9.40e-01	7.15e-02	2.50e-01	**1.90e-01**
Dibenz(a,h)anthracene	7/14	2.60e-01	1.99e-02	6.91e-02	**1.60e-02**
Benz(a)anthracene	10/14	1.40e+00	1.02e-01	3.74e-01	**4.43e-01**
Phenanthrene [b]	13/14	6.40e+00	1.13e+00	2.04e+00	**1.77e+00**
Acenaphthylene [b]	2/14	1.40e-01	6.91e-02	3.59e-02	**8.61e-02**
Benzo(g,h,i)perylene [b]	13/14	7.50e-01	6.62e-02	1.97e-01	**9.30e-02**
Volatiles					
Benzene	6/14	1.20e+02	1.23e+01	3.36e+01	**2.82e+01**

Bold numbers indicate the value used for the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK Model was used to calculate risk from lead.

[b] No toxicity data available.

Table 4-9
Statistical Summary of Values Used in the Human Health Risk Assessment for Groundwater at the Fire Protection Training Area

Chemical Name	Detection Frequency	Max Detect mg/L	Mean mg/L	Standard Deviation	95% UCL mg/L
Metals					
Lead [a]	8/10	1.48e-02	3.95e-03	4.11e-03	**7.01e-03**
Pesticides					
gamma-BHC	3/14	1.44e-05	6.90e-06	4.10e-06	**8.80e-06**
Heptachlor epoxide	7/14	1.20e-05	2.80e-06	3.50e-06	**6.10e-06**
Heptachlor	6/14	9.40e-06	2.90e-06	3.70e-06	**4.70e-06**
Dieldrin	10/14	1.60e-05	5.20e-06	4.70e-06	**8.50e-06**
alpha-BHC	5/14	3.10e-05	8.70e-06	9.10e-06	**1.82e-05**
beta-BHC	3/14	1.44e-05	8.00e-06	4.40e-06	**1.00e-05**
Volatiles					
Chloromethane	4/6	6.10e-04	3.36e-04	2.13e-04	**5.11e-04**
1,2-Dichloroethane	6/6	1.40e-03	1.01e-03	3.31e-04	**1.28e-03**
Benzene	5/6	**2.24e-01**	6.63e-02	9.73e-02	1.30e+01
Dibromomethane [b]	1/6	2.20e-04	1.46e-04	7.82e-05	**2.10e-04**
Bromochloromethane [b]	4/4	**1.98e-02**	1.74e-02	2.46e-03	2.02e-02

Bold numbers indicate the lower value used for the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK model was used to calculate risk from lead.
[b] No toxicity data available.

7. Construction Worker (subchronic adult only).

Future Scenarios

8. Boarding School Student (subchronic/chronic).

These scenarios are described in Section 3. The on-base worker scenarios assume that workers at the FPTA are engaged in activities outdoors, every work day, for the duration of employment. However, there have been no regular employees in the area of the FPTA since the training area was closed to burning activity in 1991. Therefore, the worker scenarios better represent reasonable worst-case exposures that might occur at any time in the future, assuming resumption of frequent fire training activities or other industrial use of the land involving primarily outdoor work.

Exposure Pathways

Exposure pathways considered for applicability to each FPTA exposure scenario included the following:

Soil Pathways

- Incidental ingestion of soil; and
- Dermal contact with soil.

Air Pathways

- Inhalation of fugitive dust; and
- Inhalation of vapors that volatilize from surface and subsurface media.

Groundwater Pathways

- Ingestion of drinking water;
- Dermal contact with water while showering;
- Inhalation of vapors that volatilize from water while showering; and
- Ingestion of plants irrigated with groundwater.

Surface Water Pathways

- Ingestion of fish from the Yukon River.

Groundwater pathways are applicable only if groundwater modeling indicates that contaminants from the FPTA might migrate to Old Town Galena. Surface water pathways are applicable only if groundwater modeling indicates that toxicologically significant concentrations of contaminants originating from the FPTA might reach the Yukon River.

Contaminants detected in the groundwater at the FPTA were modeled to the shoreline of the Yukon River. Assuming a generally southwestern flow direction, most of Old Town Galena is not directly downgradient of the FPTA. However, modeled concentrations at the shoreline provide a worst-case estimate of possible impacts on wells that could be located at the extreme eastern edge of town.

Concentrations of contaminants in the Yukon River within 5 ft of the shoreline were also estimated, assuming that mixing is limited to river flow within that 5 ft. This assumption was made because there is not instant dilution of contaminants entering the river in the groundwater by the entire volume of river flow that passes by Galena. Rather, a plume would follow the shoreline downstream.

Table 4-10 summarizes the modeled shoreline and river concentrations for the COPCs

Table 4-10
Comparison of Fire Protection Training Area Groundwater Modeling Results at the Shoreline to USEPA Region III Risk-Based Concentrations (RBCs)

Chemical	Modeled Shoreline Concentration (ug/L)	Modeled River Concentration [a] (ug/L)	Fish BCF [b]	Estimated Concentration in Fish [c] (mg/kg)	USEPA Region III RBC [d]	
					Tap water (ug/L)	Fish (mg/kg)
1,2-Dichloroethane	1.03e-01	5.35e-06	2	1.07e-08	0.12	0.035
alpha-BHC	3.92e-04	2.03e-08	1100	2.23e-08	0.011	0.0005
Benzene	7.98e-02	4.12e-06	4.27	1.76e-08	0.36	0.11
beta-BHC	6.02e-04	3.11e-08	1460	4.55e-08	0.037	0.0018
Bromochloromethane	5.25e+00	2.71e-04	22	5.97e-06	NV	NV
Chloromethane	4.45e-05	2.30e-09	2.88	6.63e-12	1.4	0.24
Dibromomethane	1.61e-05	8.30e-10	5	4.15e-12	NV	NV
Dieldrin	4.93e-04	2.55e-08	2700	6.88e-08	0.0042	0.0002
gamma-BHC	5.48e-04	2.83e-08	319	9.04e-09	0.052	0.0024
Heptachlor	3.93e-41	2.03e-45	20	4.06e-47	0.0023	0.0007
Heptachlor epoxide	5.78e-04	2.98e-08	20	5.97e-10	0.0012	0.00035
Lead	1.27e+00	6.58e-05	42	2.76e-06	NV	NV

a Estimated concentration in Yukon River within 5 feet of shoreline, assuming mixing is limited to river flow within that 5 feet.
b Fish bioconcentration factor. See Appendix J (Ecological Assessment Toxicity Profiles).
c Concentration in water (ug/L) x 1 L/kg x 1 mg/ 1000 ug x BCF (unitless).
d U.S. Environmental Protection Agency (USEPA) Region III, Risk-Based Concentration Table, January-June 1995, March 7, 1995.
NV = No value

in groundwater at the FPTA. It also lists applicable chemical-specific fish BCFs and estimated concentrations in fish exposed to river water within 5 ft of the shoreline. Finally, the table lists the USEPA Region III RBCs for tap water and fish. The modeled shoreline concentrations, considered the worst-case possible impact on any well located at the eastern edge of Old Town Galena, are all below the respective Region III tap water RBCs. The estimated fish concentrations also are all below the Region III RBCs for fish. The groundwater and surface water pathways are therefore not quantified for the FPTA.

Appendix C describes the groundwater modeling methodology and provides the groundwater modeling data. Likewise, Appendix D describes the emissions estimating and air dis

persion modeling methodology and provides the air modeling results.

Conceptual Site Model

A conceptual site model presents the current understanding of possible sources of contamination and the likely mechanisms for movement of contamination within and beyond site boundaries. Figure 4-3 is a conceptual site model flow diagram showing the primary sources of contamination at the FPTA, their migration pathways, exposure media, and exposure routes that may lead to human exposure. The figure effectively summarizes the results of the human health exposure assessment. It illustrates complete exposure pathways for the exposure scenarios that are evaluated and indicates which pathways are quantified for each scenario. It also notes which pathways are possibly complete but probably not significant. These pathways are not quantified.

Quantification of Exposure

Table 4-11 provides a matrix of exposure scenarios and exposure pathways that are applicable to the FPTA and specifies the exposure points and data that were used to derive concentrations in the exposure media at this site. Appendix E summarizes the human health exposure point concentrations used to quantify exposure.

Section 3 describes the methods used to quantify exposure. Human health intake equations and exposure parameters are documented in Appendix F. Intakes were quantified separately for evaluation of carcinogenic and non-carcinogenic effects. Daily intakes for analysis of carcinogenic effects are averaged over a 70-year lifetime. Daily intakes for analysis of non-carcinogenic effects are averaged over the exposure duration only.

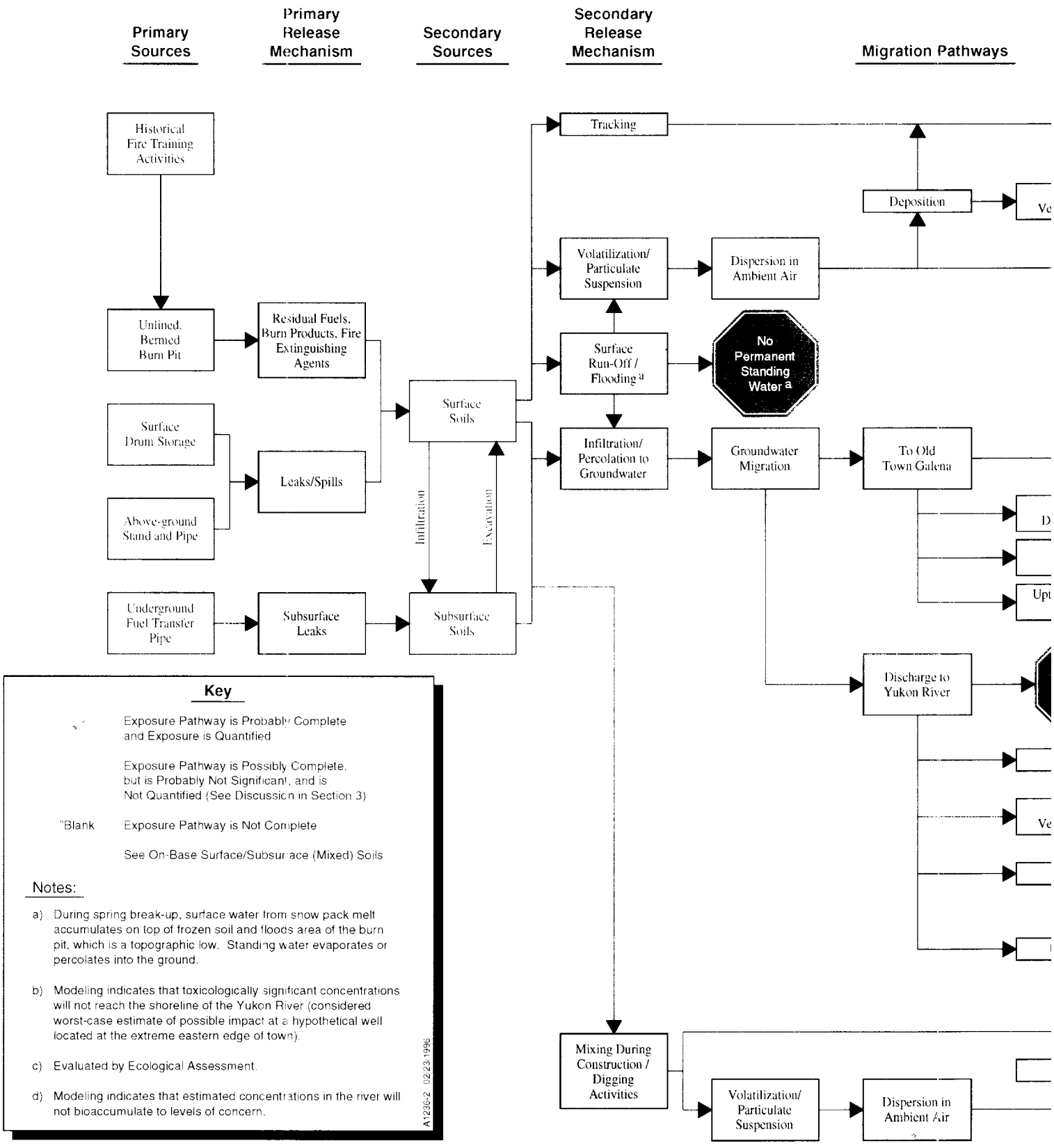
4.3.3 Toxicity Assessment

Table 4-12 presents the toxicity values used in the human health risk assessment for COPCs at the FPTA. Most of the toxicity values in this table were obtained from IRIS searches conducted in July 1995 or from HEAST (USEPA, 1994d). Carcinogenic values for some PNAs were calculated using methodologies in provisional guidance for calculating potential potency based on values for benzo(a)pyrene (USEPA, 1993b). Although the oral slope factor for benzo(a)pyrene is listed in IRIS, the inhalation slope factor has been withdrawn from IRIS and HEAST. Since there is no inhalation unit risk for benzo(a)pyrene, the USEPA guidance directs that the potential potency values should be applied only to assessment of carcinogenic hazard from oral exposure to PNAs (USEPA, 1993b).

The carcinogenic values for the dioxins were derived using TEF values for dioxin-like compounds (USEPA, 1994b).

The inhalation RfDs for benzene and 1,2-dichloroethane are provisional values recom-

Figure 4-3. Human Exposure Conceptual Model f



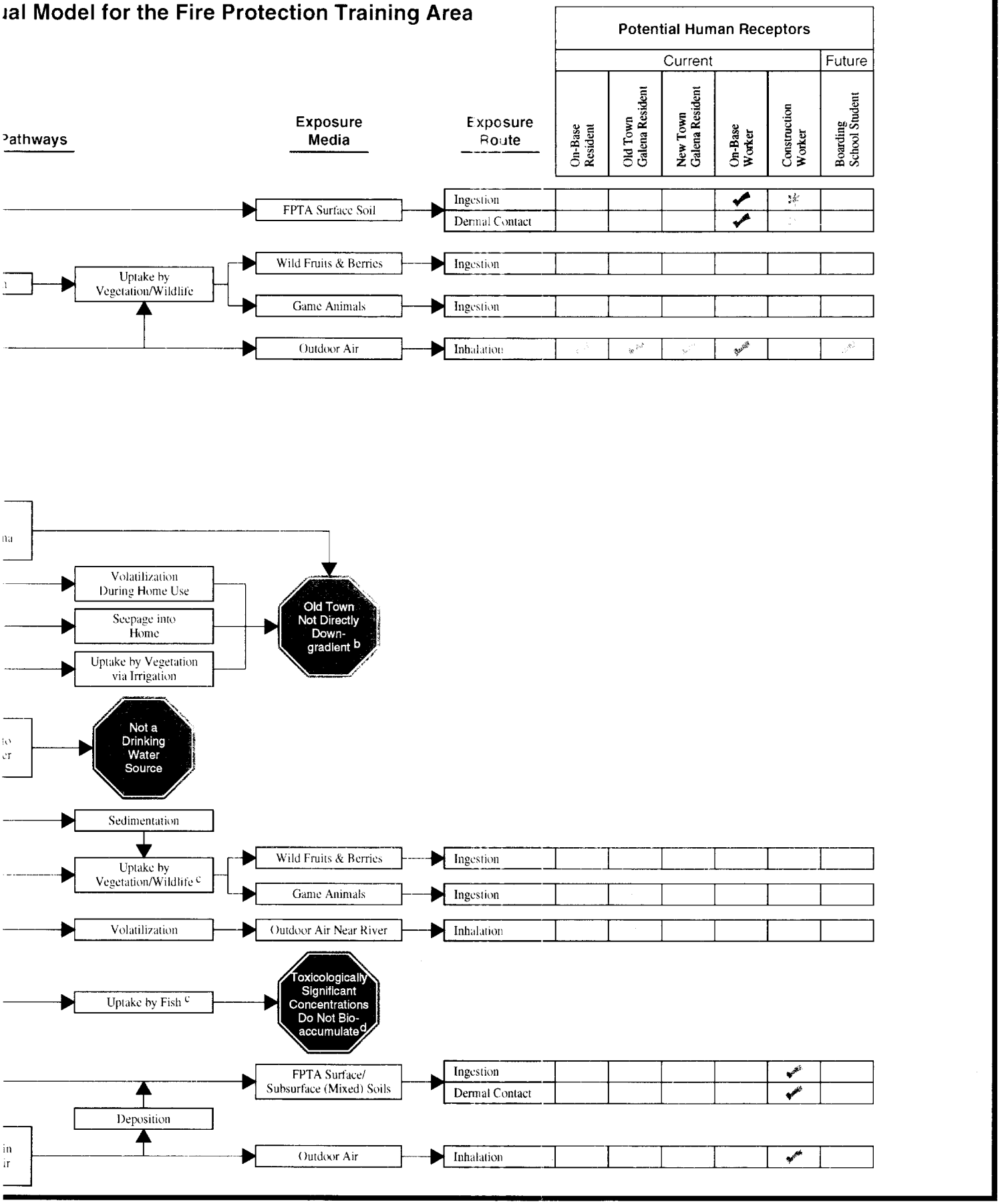


Figure 4-3. Human Exposure Conceptual Model for the Fire Protection Training Area

Table 4-11
Data Used to Derive Exposure Concentrations in Exposure Media at the Fire Protection Training Area

Exposure Scenario	Exposure Pathways		
	Ingestion of Soil	Dermal Contact with Soil	Inhalation of Vapor Phase Chemicals and Fugitive Dust in Ambient Air
Current Scenarios			
On-Base Residents -Short Term -Long Term	NA	NA	Modeled concentration of vapor phase chemicals (E) and wind-blown dust (F) at closest downwind on-base residential receptor.
Galena Residents	NA	NA	
-Old Town			Modeled concentration of vapor phase chemicals (E) and wind blown dust (F) at closest downwind Old Town Galena residential receptor.
-New Town			Modeled concentration of vapor phase chemicals (E) and wind-blown dust (F) at closest downwind New Town Galena residential receptor.
On-Base Workers			
-Short Term	Surface Soil (A)	Surface Soil (A)	Modeled concentration of vapor phase chemicals (E) and wind-blown dust (F) directly above the FPTA site.
-Long Term	Surface Soil (A)	Surface Soil (A)	Modeled concentration of vapor phase chemicals (E) and wind-blown dust (F) directly above the FPTA site.
-Construction	Mixed Soil (C)	Mixed Soil(C)	Modeled concentration of vapor phase chemicals (G) and dust generated by construction activity (H) directly above the FPTA site.
Future Scenarios			
Boarding School Student	NA	NA	Modeled concentration of vapor phase chemicals (E) and wind-blown dust (F) at the location of the proposed student dormitory.

Table 4-11
(Continued)

Exposure Media

Remedial Investigation Data:
(A) Measured concentrations in surface soils, represented by the 95% UCL, or the maximum detected concentration if lower, in soils within 2 ft of the ground surface at the FPTA.
(B) Measured concentrations in subsurface soils, represented by the 95% UCL, or the maximum detected concentration if lower, in soils greater than 2 ft below the ground surface at the FPTA.
(C) Mixed surface and subsurface soil, represented by the highest of either the surface soil concentration (A) or the subsurface soil concentration (B).
(D) Measured concentrations in shallow groundwater, represented by the 95% UCL, or the maximum detected concentration if lower, in groundwater at the FPTA.

Transport and Fate Modeling:
(E) Estimated concentration of vapor phase chemicals in ambient air based on emissions from surface soil (A), subsurface soil (B), and groundwater (D) and dispersion modeling to specific receptor locations.
(F) Estimated concentration of wind-blown dust based on particulate emissions from surface soil (A) and dispersion modeling to specific receptor locations.
(G) Estimated concentration of vapor phase chemicals in ambient air assuming subsurface soil is brought to the surface by construction activities, based on emissions from mixed soils (C) and groundwater (D) and dispersion modeling to specific receptor locations.
(H) Estimated concentration of dust generated by construction activities directly above the site, based on particulate emissions from mixed soil (C) and dispersion modeling to specific receptor locations.
NA = Not Applicable

Table 4-12
Toxicity Values for FPTA COPCs

COPCs	EPA Class	Chronic						Subchronic		Dermal Absorption Factor[a] (unitless)
		Oral RfD (mg/kg/day)	Inhal RfD (mg/kg/day)	Inhal RfC (mg/m^3)	Oral SF 1/(mg/kg/day)	Inhal SF 1/(mg/kg/day)	Inhal Unit Risk 1/($\mu g/m^3$)	Oral RfD (mg/kg/day)	Inhal RfC ($\mu g/m^3$)	
Dioxins										
HpCDD Totals		--	--	--	1.56E+03[b]	1.16E+03[b]	3.3E-07[b]	--	--	1.00E-01
OCDD		--	--	--	1.56E+02[b]	1.16E+02[b]	3.3E-07[b]	--	--	1.00E-01
Metals										
Lead [e]	B2 [d]		--	--	--	--	--	--	--	--
PNAs										
Acenaphthylene	D [d]	--	--	--	--	--	--	--	--	--
Benz(a)anthracene	B2 [d]	--	--	--	7.30E-01 [h]	--	--	--	--	--
Benzo(a)pyrene	B2 [d]	--	--	--	7.30E+00 [d]	--	--	--	--	--
Benzo(b)fluoranthene	B2 [d]	--	--	--	7.30E-01 [h]	--	--	--	--	--
Benzo(g,h,i)perylene	D [d]	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	B2 [d]	--	--	--	7.30E+00 [h]	--	--	--	--	--
Phenanthrene	D [d]	--	--	--	--	--	--	--	--	--
Pesticides										
4,4'-DDT	B2 [d]	5.00E-04 [d]	--	--	3.40E-01 [d]	3.40E-01 [f]	9.70E-05 [d]	5.00E-04 [f]	--	1.00E-01
Aldrin	B2 [d]	3.00E-05 [d]	--	--	1.70E+01 [d]	1.70E+01 [f]	4.90E-03 [d]	3.00E-05 [f]	--	1.00E-01
Alphs-BHC	B2 [d]	--	--	--	6.30E+00 [d]	6.30E+00 [f]	1.80E-03 [d]	--	--	1.00E-01
beta-BHC	C [d]	--	--	--	1.80E+00 [d]	1.80E+00 [f]	5.30E-04 [d]	--	--	1.00E-01
gamma-BHC	B2/C [f]	3.00E-04 [d]	--	--	1.30E+00 [f]	--	--	3.00E-03 [f]	--	1.00E-01
Heptachlor	B2 [d]	5.00E-04 [d]	--	--	4.50E+00 [d]	4.50E+00 [f]	1.30E-03 [d]	5.00E-04 [f]	--	1.00E-01
Heptachlor Epoxide	B2 [d]	1.30E-05 [d]	--	--	9.10E+00 [d]	9.10E+00 [f]	2.60E-03 [d]	1.30E-05 [f]	--	1.00E-01
Semivolatiles										
2-Hexanone		--	--	--	--	--	--	--	--	1.00E-01
Volatiles										
1,2-Dichloroethane	B2 [d]	--	2.86E-03 [c]	1.00E-02 [i]	9.10E-02 [d]	9.10E-02 [f]	2.60E-05 [d]	--	--	1.00E-01
Benzene	A [d]	--	1.71E-03 [c]	6.00E-03 [i]	2.90E-02 [d]	2.90E-02 [f]	8.30E-06 [f]	--	--	1.00E-01
Bromochloromethane	D [d]	--	--	--	--	--	--	--	--	1.00E-01
Chloromethane	C [f]	--	--	--	1.30E-02 [f]	6.30E-03 [f]	1.80E-06 [i]	--	--	1.00E-01
Dibromomethane			--	--	--	--	--	--	--	1.00E-01

Table 4-12
(Continued)

[a] Absorption factor of 1% was used for inorganic analytes and an absorption factor of 10% was used for organic analytes, otherwise noted. PNAs are not evaluated for dermal exposures (see discussion in Section 3.1.4 of Volume 1).
[b] Dioxin toxicity values were derived using Toxicity Equivalency Factors (TEFs) in *Estimating Exposure to Dioxin-like Compounds* 00 (EPA/600/6-88/005) dated June 1994.
[c] Value was taken from Region III RBC table dated 1/31/95. The table states that this is a provisional value from EPA-ECAO Regional Support.
[d] U.S. Environmental Protection Agency (USEPA), 1995. Integrated Risk Information System (IRIS). Database search, October 20, 1995.
[e] Risk from exposure to lead was evaluated using the USEPA IEUBK Model.
[f] U.S. Environmental Protection Agency (EPA), 1994. Health Effects Assessment Summary Tables Annual Update, FY 1994. EPA 540-R-020, March 1994.
[g] Provisional value recommended by Superfund Health Risk Technical Support Center; this value is based on the oral slope factor for this chemical (Dollarhide, 1994a).
[h] PNA toxicity values were derived using the *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (EPA/600/R-93/089) dated July 1993.
[i] Value was calculated using the appropriate inhalation reference dose or inhalation slope factor with 20 m^3 breathing rate and 70 kg adult body weight.

mended by the Superfund Health Risk Technical Support Center (footnoted EPA-ECAO in the USEPA Region III RBC table, USEPA, 1995b). These provisional RfDs were converted to RfCs for use in the risk calculations.

Toxicity values were not available for six COPCs at the FPTA. These include lead, acenaphthylene, benzo(g,h,i)perylene, phenanthrene, 2-hexanone, and dibromomethane. Lead was initially screened using the USEPA-recommended screening level (400 mg/kg) for lead in soil for residential land use (USEPA, 1994e) and the drinking water action level for lead (USEPA, 1994a), and if necessary, evaluated using the USEPA IEUBK model for lead in children (USEPA, 1994c). Available health effects information for these COPCs is included in Appendix G, and the impact of the lack of toxicity values for these COPCs is discussed as an uncertainty in Section 4.3.5.

Dermal toxicity values are not listed in Table 4-12. Because of the high level of uncertainty associated with adjusting oral toxicity values (which are generally based on administered dose) to evaluate dermal exposure (which is calculated as an absorbed dose), unadjusted oral values were used to quantify dermal pathway risks. Dermal absorption factors used to quantify dermal exposures are listed in Table 4-12. Default values of 1% for inorganic analytes and 10% for organic analytes were used. PNAs were not evaluated for dermal exposure (see discussion in Section 3.1.4.).

Appendix G contains toxicological profiles for all of the human health COPCs at the FPTA.

4.3.4 Risk Characterization

Carcinogenic risk and noncancer HIs were estimated for each exposure scenario according to procedures outlined in Section 3. The carcinogenic risk and noncarcinogenic risk estimates are presented in Appendix H.

Carcinogenic Effects

For each potentially carcinogenic COPC, the incremental probability that an individual will develop cancer over a lifetime was estimated from projected intake levels and the cancer slope factor or the inhalation unit risk. The USEPA Superfund site remediation goal set forth in the NCP designates a cancer risk of 10^{-4} (1 in 10,000) to 10^{-6} (1 in one million). This range is designed to be protective of human health and to provide flexibility for consideration of other factors in risk management decisions. A cancer risk of 1 in one million is considered the *de minimis*, or a level of negligible risk, for risk management decisions. A cancer risk higher than 1 in one million is not necessarily considered unacceptable. The State of Alaska plans to use a cancer risk level of 10^{-5} (1 in 100,000) in making risk management decisions (USAF, 1996b).

Table 4-13 summarizes the cancer risk estimates for each exposure scenario at the FPTA. Estimated incremental cancer risks for all scenarios except for the long-term on-base worker (reasonable maximum case) and the construction worker (average and reasonable maximum) are below 1 in one million. Estimated risks lower than 1 in one million are considered "negligible" and do not warrant remedial action.

The reasonable maximum risk estimated for the long term on-base worker scenario equals 1 in one million. Inhalation of benzene that volatilizes from subsurface soils accounts for the highest chemical-specific risk (46% of the total risk estimate).

The average and reasonable maximum risks estimated for the construction worker

Table 4-13
Summary of Carcinogenic Risks[a] by Exposure Scenario for the FPTA

Scenario	Child		Adult	
	Average	Reasonable Maximum	Average	Reasonable Maximum
Current Scenarios				
Short-Term On-Base Resident	NA	NA	7E-12	2E-11
Long-Term On-Base Resident	2E-11	3E-11	3E-11	1E-10
Old Town Galena Resident	1E-10	2E-10	6E-10	2E-09
New Town Galena Resident	7E-11	9E-11	3E-10	1E-09
Short-Term On-Base Worker	NA	NA	5E-08	3E-07
Long-Term On-Base Worker	NA	NA	6E-07	**1E-06**
On-Base Construction Worker	NA	NA	**3E-06**	**6E-06**
Future Scenarios				
Boarding School Student[b]	1E-11	4E-11	NA	NA

NOTE: risk estimates printed in bold type equal or exceed the Superfund site remediation threshold of 10^{-6} (1 in one million) for carcinogens.

[a]Carcinogenic risk is expressed as a unitless probability of an individual developing cancer.
[b]Age 15-18 (Grades 9-12) for the average case and age 6-19 (Grades 1-12, plus two repeat years) for the reasonable maximum case.
NA = Not Applicable

scenario exceed 1 in one million, but are well below the high end of the Superfund risk range goal (10^{-4}). Inhalation of benzene that volatilizes from the subsurface soil when it is brought to the surface by construction-related excavations contributes the majority of the risks (100% and 99% for the average and reasonable maximum, respectively). Risks associated with exposure to all other chemicals are negligible.

Risk summary tables for each exposure scenario are provided in Appendix H. The tables detail the cancer risk estimates for each applicable chemical and exposure pathway and show the percent contribution of each chemical and pathway to the total estimated risk.

Noncarcinogenic Effects

To characterize the potential noncancer effects of chemicals, comparisons were made between projected intakes of COPCs over a specified time and toxicity values, primarily oral RfDs and inhalation RfCs. An HQ, which is the ratio between exposure to a chemical and that chemical's toxicity value, was calculated for each noncarcinogenic COPC and exposure pathway. Chemical-specific HQs were then summed for each COPC and each pathway of exposure to calculate the total HI.

The HI is not a statistical probability of a systemic effect occurring. If the exposure level exceeds the appropriate toxicity value (i.e., the HQ is greater than one), there may be cause for concern. The Superfund site remediation goal for noncarcinogens is a total HI of 1 for chemicals with similar toxic endpoints.

Table 4-14 summarizes the noncancer hazard estimates for each exposure scenario. The HIs for all scenarios are well below the Superfund site remediation goal of 1 for noncarcinogens, indicating that there is little cause for concern about noncarcinogenic effects.

Noncancer risk summary tables for each exposure scenario are provided in Appendix H. The tables detail the noncancer hazard estimates for each applicable chemical and exposure pathway and show the percent contribution of each chemical and pathway to the total estimated HI.

Effects of Exposure to Lead

The maximum detected concentrations of lead at the FPTA are 89 mg/kg in the surface soil, 83 mg/kg in the subsurface soil, and 15 µg/L in the groundwater. The maximum soil concentrations are well below the 400 mg/kg recommended screening level for lead in residential soil (USEPA, 1994c), which was derived using the IEUBK lead model (USEPA, 1994e). The maximum detected groundwater concentration is equal to the 15-µg/L drinking water action level for lead at the tap (USEPA, 1994a). Since the soil concentrations are well below the soil screening level and the maximum detected groundwater concentration does not exceed the drinking water action level, lead was not evaluated further.

Major Factors Driving Estimated Risks

Tables 4-15 and 4-16 present a risk characterization summary for carcinogenic risk estimates and noncarcinogenic hazard estimates, respectively. For each scenario the tables specify the exposure pathways that were quantified, the estimated risks for each case, the chemicals and pathways that are major contributors to the estimated risks, and the primary uncertainties associated with the estimates.

The only chemical and pathway that contribute a chemical- and pathway-specific risk greater than 1 in one million is inhalation of benzene by a construction worker who works in the immediate vicinity of the FPTA for 8 hours/day, 5 days/week for 3-6 months. It is

Table 4-14
Summary of Noncarcinogenic Hazard Indices[a] by Exposure Scenario for the FPTA

Scenario	Child		Adult	
	Average	Reasonable Maximum	Average	Reasonable Maximum
Current Scenarios				
Short-Term On-Base Resident	NA	NA	< 0.001	< 0.001
Long-Term On-Base Resident	< 0.001	< 0.001	< 0.001	< 0.001
Old Town Galena Resident	< 0.001	< 0.001	< 0.001	< 0.001
New Town Galena Resident	< 0.001	< 0.001	< 0.001	< 0.001
Short-Term On-Base Worker	NA	NA	0.003	0.004
Long-Term On-Base Worker	NA	NA	0.01	0.04
On-Base Construction Worker	NA	NA	0.005	0.01
Future Scenarios				
Boarding School Student[b]	< 0.001	< 0.001	NA	NA

NOTE: Hazard Indices printed in bold type equal or exceed the Superfund site remediation goal of 1 for noncarcinogens.

[a]Noncarcinogenic risk is not expressed as a probability of an adverse effect but rather a comparison between exposure and a reference dose (Hazard Index).
[b]Age 15-18 (Grades 9-12) for the average case and age 6-19 (Grades 1-12, plus two repeat years) for the reasonable maximum case.

NA = Not Applicable

Table 4-15
Risk Characterization Summary for the FPTA: Carcinogenic Risks

Scenario	Pathways Quantified	Case	Estimated Total Cancer Risk [a]		Chemicals and Pathways that Contribute a Chemical- and Pathway-Specific Cancer Risk Greater than 1 in One Million [b]	Primary Site-Specific Uncertainties
			Average	Reasonable Maximum		
Current Scenarios						
Short-Term On-Base Resident (subchronic)	1. Inhalation of vapors and dust	Adult	7E-12	2E-11	None	Applicability of cancer risk estimation methodology to subchronic exposure durations.
Long-Term On-Base Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	2E-11 3E-11	3E-11 1E-10	None	Duration of residence.
Old Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	1E-10 6E-10	2E-10 2E-09	None	Risk from accessing the site was not quantified.
New Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	7E-11 3E-10	9E-11 1E-09	None	Risk from accessing the site was not quantified.
Short-Term On-Base Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	5E-08	3E-07	None	Likelihood of workers at the FPTA. Nature and duration of work activities at the FPTA. Applicability of cancer risk estimation methodology to subchronic exposure durations.
Long-Term On-Base Worker (chronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	6E-07	**1E-06**	None	Likelihood of workers at the FPTA. Nature and duration of work activities at the FPTA.
On-Base Construction Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	**3E-06**	**6E-06**	1. Inhalation of benzene in ambient air.	Likelihood of construction activity at the FPTA. Duration of construction activity. Emissions of benzene from subsurface soils during soil excavation. Applicability of cancer risk estimation methodology to subchronic exposure durations.

Table 4-15
(Continued)

Scenario	Pathways Quantified	Case	Estimated Total Cancer Risk [a]		Chemicals and Pathways that Contribute a Chemical- and Pathway-Specific Cancer Risk Greater than 1 in One Million [b]	Primary Site-Specific Uncertainties
			Average	Reasonable Maximum		
Future Scenarios						
Boarding School Student (subchronic/ chronic)	1. Inhalation of vapors and dust	Student	1E-11	4E-11	None	Extension of facility from Grades 9-12 to Grades 1-12. Risk from accessing the site was not quantified.

[a]Estimated cancer risks printed in bold type equal or exceed the Superfund site remediation threshold of 1E-06 (1 in one million).
[b]Applicable only if the total cancer risk exceeds 1 in one million (estimated risk printed in bold type in column titled "Estimated Total Cancer Risk").

Table 4-16
Risk Characterization Summary for the FPTA: Noncarcinogenic Risks

Scenario	Pathways Quantified	Case	Estimated Total Hazard Index [a]		Chemicals and Pathways that Contribute a Chemical- and Pathway- Specific Noncancer Hazard Quotient Greater than 1 [b]	Primary Site-Specific Uncertainties
			Average	Reasonable Maximum		
Current Scenarios						
Short-Term On-Base Resident (subchronic)	1. Inhalation of vapors and dust	Adult	< 0.001	< 0.001	None	Lack of subchronic inhalation toxicity values for COPCs.
Long-Term On-Base Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	< 0.001 < 0.001	< 0.001 < 0.001	None	Duration of residence.
Old Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	< 0.001 < 0.001	< 0.001 < 0.001	None	Risk from accessing the site was not quantified.
New Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	< 0.001 < 0.001	< 0.001 < 0.001	None	Risk from accessing the site was not quantified.
Short-Term On-Base Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	0.003	0.004	None	Likelihood of workers at the FPTA. Nature and duration of work activities at the FPTA. Lack of subchronic inhalation toxicity values for COPCs.
Long-Term On-Base Worker (chronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	0.01	0.04	None	Likelihood of workers at the FPTA. Nature and duration of work activities at the FPTA.
On-Base Construction Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	0.005	0.01	None	Likelihood of construction activity at the FPTA. Duration of construction activity. Emissions of benzene from subsurface soils during soil excavation. Lack of subchronic inhalation toxicity values for COPCs.

Table 4-16
(Continued)

Scenario	Pathways Quantified	Case	Estimated Total Hazard Index[a]		Chemicals and Pathways that Contribute a Chemical- and Pathway- Specific Noncancer Hazard Quotient Greater than 1[b]	Primary Site-Specific Uncertainties
			Average	Reasonable Maximum		
Future Scenarios						
Boarding School Student (subchronic/ chronic)	1. Inhalation of vapors and dust	Student	< 0.001	< 0.001	None	Extension of facility from Grades 9-12 to Grades 1-12. Risk from accessing the site was not quantified.

[a]Hazard indices printed in bold type equal or exceed the Superfund site remediation goal of 1 for noncarcinogens.
[b]Applicable only if the total hazard index exceeds 1.

unlikely that a construction worker will be exposed to unacceptably high concentrations of benzene in the ambient air for the following reasons:

1. As long as Galena Airport is operating as an airport, building construction at the FPTA, located at the east end of the runway, is improbable.

2. Given the relatively small size of the contaminated area (approximately 2 acres), it is improbable that any construction project would require 3 to 6 months to complete. Moreover, excavation activities for building foundations, underground utilities, etc., generally only occur in the first few weeks of a construction project and certainly do not continue throughout the duration of the project.

3. The emission estimates for benzene from the subsurface soil during construction work are likely biased high. The emissions calculation assumes that all subsurface soils containing benzene are exposed and essentially become surface soils. It is more likely that excavations during construction would involve less than 100% of the contaminated area, unless the purpose of excavation is to remove contaminated soil.

If construction involving soil excavation were assumed to occur over less than a 3-month period and if it were assumed that excavations involved less than 50% of the contaminated soil rather than 100%, the reasonable maximum risk estimate for the construction worker would decrease to less than 1 in one million. Moreover, the estimated exposure concentrations of benzene in air to the on-Base worker and construction worker are 0.29 $\mu g/m^3$ and 130 $\mu g/m^3$, respectively. These concentrations are substantially lower than both the proposed American Conference of Governmental Industrial Hygienists threshold limit value (ACGIH TLV) of 960 $\mu g/m^3$ and the Occupational Safety and Health Administration permissible exposure limit (OSHA's PEL) of 3200 $\mu g/m^3$ for worker exposure to benzene.

4.3.5 Uncertainty Assessment

The risk characterization results are not fully probabilistic estimates of risk but rather conditional estimates of risk that should be interpreted in light of the considerable number of assumptions required to quantify exposure, intake, and dose-response. Uncertainties associated with identification of COPCs, the exposure assessment, and the toxicity assessment all contribute to the level of confidence that can be placed in the risk characterization results.

In general, risk assessment uncertainty was addressed in the BRA by:

1. Incorporating both average and reasonable maximum values for input parameters, whenever possible, to provide a range of results rather than a single value;

2. Erring on the side of conservatism when defining the reasonable maximum case; and

3. Identifying and discussing the major sources of uncertainty and their effect on the risk estimates so that the results can be properly interpreted.

Table 4-17 summarizes the primary sources of uncertainty specific to this assessment and the likely impact on risk estimates.

Table 4-17
Summary of the Major Uncertainties Associated with the Risk Estimates

Source of Uncertainty	Impact on Risk Characterization
Chemicals of Potential Concern	
Samples representing site media	Could result in an overestimate or underestimate of risks if the samples do not adequately represent media at the site. However, the number and location of samples collected at the FPTA were sufficient to identify the area of contamination in soils and groundwater and assess the magnitude and extent of contamination.
Analytical methods used to test samples	If the analytical methods used do not apply to some chemicals that are present at the site, risks could be underestimated. Since a full suite of analytical methods was selected to test for chemicals known or suspected to be present at the site, the potential for underestimation is reduced. In some cases, different methods were used to test for the same analyte during different phases of the RI. In such cases, data from one method were selected to derive representative concentrations in a medium.
Presence of pesticides	Pesticides detected at the FPTA were evaluated in the same fashion as all other COPCs. However, the pesticides result from widespread application for insect control and estimated risks from exposure to pesticides are not attributable to the FPTA.
Contamination of blanks	Sporadic presence of chemicals in blanks samples was accounted for in blanks comparison. Blanks data do not indicate extensive field or laboratory contaminants.
Tentatively identified compounds	Tentatively identified compounds were not reported or assessed. Most such chemicals are not known to be highly toxic.
Diesel Range Organics and Gasoline Range Organics	DRO and GRO were not evaluated in the risk assessment as groups of chemicals. The assessment addresses individual chemicals only that were speciated by chemical analysis, which includes many constituent compounds of DRO and GRO. However, some constituent compounds were not on the target analyte list. The majority of the risk associated with exposure to DRO and GRO is probably accounted for in an assessment of individual chemicals.
Detection Limit Adequacy	The minimum detection limit for a few analytes in soil that were eliminated as COPC (because they were not detected) exceeds USEPA Region III residential soil ingestion RBCs. These include 2,3,7,8-TCDD, arsenic, beryllium, and thallium. The same is true for several metals, PNAs, VOCs, and PCBs in groundwater (when compared to Region III tap water RBCs). If these analytes are in fact present at the site and were contributed to the site by site-related activities, the estimated risks for this site may be underestimated. However, since 1993 and later sampling events reported uncensored data (where an ND is reported only if there is no instrument response), the impact on the risk estimates is minimized.

Table 4-17
(Continued)

Source of Uncertainty	Impact on Risk Characterization
Exposure Assessment	
Use of current measured concentrations to represent current and future concentrations in the exposure media	Because concentrations of chemicals in the soils and groundwater at the FPTA may decrease over time as the chemicals migrate and/or degrade, risks estimates for the current scenarios do not necessarily represent risks that will occur in the future.
Estimation of volatile emissions to the air	The methodology used to estimate volatile emissions to the air is conservative and probably results in an overestimate of risks from inhalation of benzene.
Groundwater modeling	Results of groundwater modeling are indicative of worst-case concentrations that might reach the Yukon River. Impacts are likely overestimated, including uptake by fish.
Access to site	Access to the FPTA is open. On-base residents and Galena residents are not restricted from walking on the site. Exposure of a roaming resident was not quantified (see discussion in Section 3). If a resident spends a significant amount of time in the FPTA area, estimated risks for that resident may be underestimated.
Construction worker scenario	Since construction is unlikely to occur at the FPTA, estimated risks for the construction worker scenario do not represent a current or likely future population. The exposure duration for this scenario is biased high.
Exposure parameter estimation	The standard assumptions regarding body weight, period exposed, life expectancy, and population characteristics may not be representative of any actual exposure situation. Some assumptions may underestimate risks, but most probably overestimate risk. In some cases, nonstandard assumptions were used for site-specific reasons, such as the reasonable maximum exposure duration of 70 years for Galena residents. The use of a 14-year exposure duration for the boarding school student overstates the likely duration of residence for most students.
Toxicity Assessment	
Absence of toxicity values for some chemicals detected at the site	Lack of toxicity values may result in underestimation of risk; however, most chemicals that lack toxicity values are not very toxic or carcinogenic. Therefore, the degree of underestimation is probably low.
Use of unverified toxicity values for some chemicals	Could result in an overestimate of risk. However, chemicals with unverified toxicity values do not contribute significantly to estimated risks at the FPTA.

Table 4-17
(Continued)

Source of Uncertainty	Impact on Risk Characterization
Toxicity Assessment (Continued)	
Bases for derivation of toxicity values	Some common sources of uncertainty in toxicity values include 1) use of information obtained from dose-response studies conducted in laboratory animals to predict effects that are likely to occur in humans; 2) use of dose-response information from effects observed at high doses to predict adverse health effects that may occur at the low levels to which humans are likely to be exposed in the environment; 3) use of information obtained from short-term exposure studies to predict health effects in humans exposed on a long-term basis; 4) use of toxicity values that have been developed for one route of exposure and employing it under a different exposure route; and 5) use of information gathered in studies using homogeneous animal populations (inbred strains) or health human populations (occupational exposures) to predict the effects that are likely to occur in the general human population.
Absence of dermal toxicity values	Unadjusted oral toxicity values were used to evaluate dermal exposures. Since most oral values are based on administered dose and dermal exposure is quantified as an absorbed dose, risks from dermal exposure might be underestimated. PNAs were not evaluated for dermal exposures per USEPA guidance (see discussion in Section 3). PNAs are associated with neoplasia in a variety of mammalian systems. The inability to quantify risks from dermal exposure to PAHs results in an underestimation of risks for the dermal pathway for PAHs.
Possible synergistic or antagonistic effects of exposure to multiple chemicals	Unknown impact on risk estimates. Chemical- and pathway-specific risk and hazard quotients are summed to account for possible additive effects.
Risk Characterization	
Applicability of cancer risk estimation methodology to subchronic exposure durations	The estimated intake for cancer risk estimation is averaged over a 70-year period. Exposure to higher concentrations of potential carcinogens for a short duration of time probably does not have the same effect as exposure to lower concentrations over a long duration.

Note that the risk from accessing the site was not quantified for Galena residents and is listed in Table 4-17 as an uncertainty. However, although there is no physical restriction to site access, there is no road or path to the FPTA from the dike road, the sides of which are generally thickly vegetated. The mockup of the aircraft was removed to eliminate any appeal the site may have had to local children. The proposed new road will not affect site access. It is proposed as an eastern extension of the existing dike road, which already runs along the north edge of the site.

4.3.6 Conclusions and Recommendations

If the subsurface soils are left undisturbed, the FPTA does not pose an unacceptable health risk to current on-base residents, Old and New Town Galena residents, workers who spend a majority of the workday outside in the immediate vicinity of the FPTA for less than 25 years, or to future boarding school students. The FPTA does not even pose an unacceptable health risk to a construction worker involved in soil excavation work on a project lasting less than 3 months in duration and involving less than 50% of the contaminated soil.

On the basis of the results of the human health assessment, there is no need to propose remedial action at the FPTA as long as the airport remains operational or the land use remains industrial.

4.4 Ecological Risk Assessment Results

4.4.1 Site Ecology

Ecological features at the FPTA are limited. Herbaceous vegetation grows to the west and south of the FPTA in an open field. Beyond the installation dike wall north and east of the site, the natural terrain consists of Yukon River floodplain lowlands, which are mixed deciduous taiga. The area beyond the dike is not known to be affected by the FPTA operations. Wildlife habitat in and adjacent to the FPTA is poor and use of this area by local fauna is generally limited to small rodents and common birds. The common raven, robin, and cliff swallow are species identified throughout the Galena Airport, including the FPTA. Breeding savannah sparrows *(Passerculus sandwichensis)* were observed singing and foraging during the site inspection in May 1995. Mike Spindler of the USFWS (personal communication, May 22, 1995) has reported that golden plovers *(Pluvialis dominica)*, pectoral sandpiper *(Calidris melanotos)*, and semipalmated sandpiper *(Calidris pusilla)* are known to frequent the grassy areas of the Airport, including areas adjacent to the FPTA. Mr. Spindler also reported that waterfowl may be found in the FPTA when water accumulates within its small earthen berms. Red fox, red squirrel (*Tamiasciurus hudsonicus*), and evidence of bear have been noted by field crews at the source area.

There is open access to the site, but perimeter fencing around the installation generally inhibits all but small mammals and birds from entering the source area. The area immediately adjacent to the FPTA is vegetated with grasses and other herbaceous plants. The slopes of the perimeter dike to the north and east of the FPTA are dominated by balsam poplar and grasses.

4.4.2 Chemicals of Potential Ecological Concern

As discussed in Section 4.1.1, the area of soil contamination is generally limited to the area within, and adjacent to, the burn pit (Figure 4-4). The only surface water samples collected in this area were from standing water outside the diked area, which were not affected by runoff from the FPTA. Groundwater that discharges to the Yukon River was modeled (see Appendix C). COPECs for the FPTA are presented in Table 4-18. Section 3.2.2 details the methods of COPEC identification. COPECs from surface

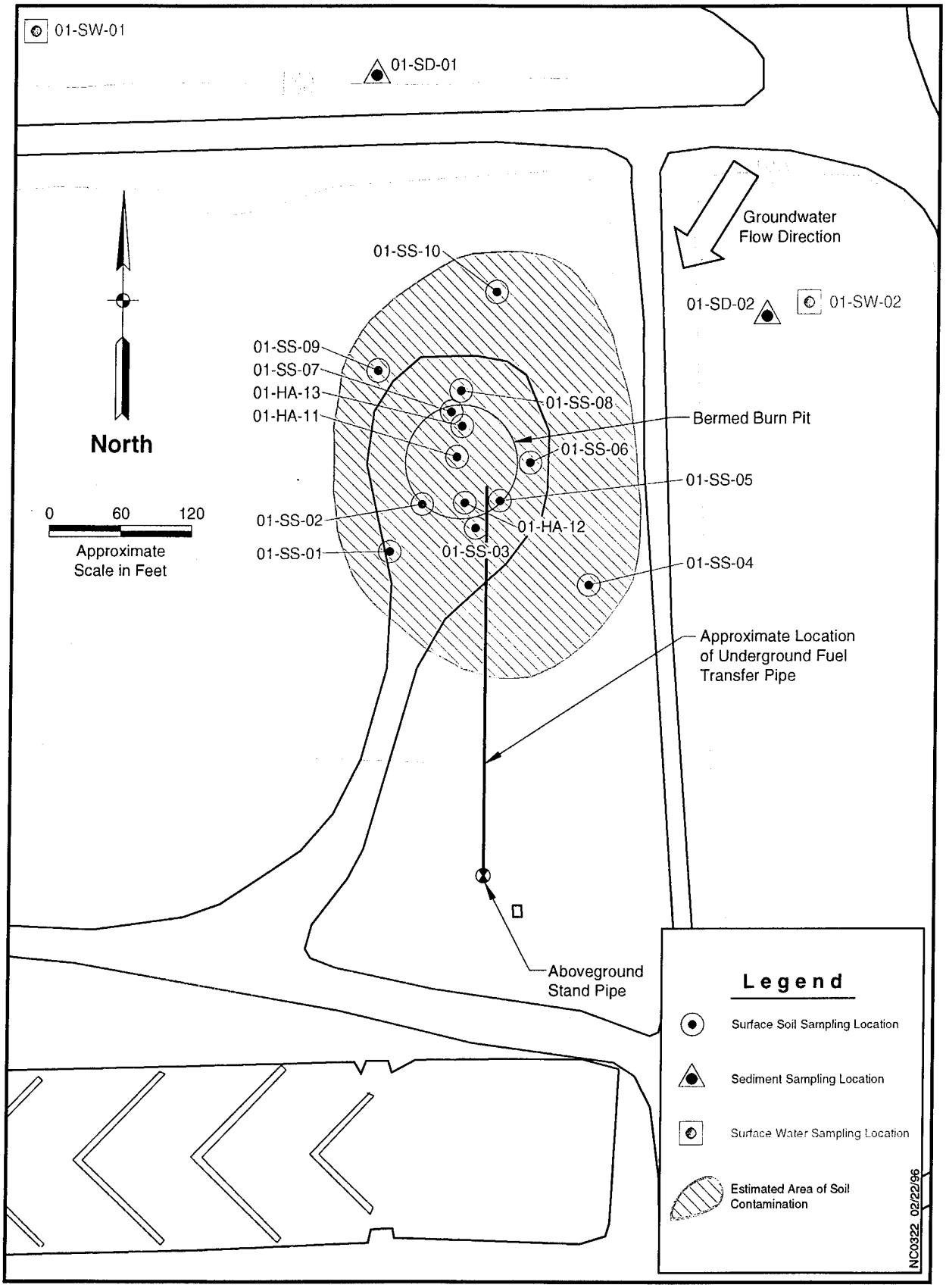


Figure 4-4. Galena Airport - FPTA

Table 4-18
Contaminants of Potential Ecological Concern in Surface Soil and Discharged Groundwater from the FPTA

Chemical	Media	
	Surface Soil	Discharged Groundwater
Metals		
Cadmium	X	
Lead	X	X
PNAs		
Acenaphthene	X	
Acenaphthylene	X	
Anthracene	X	
Benz(a)anthracene	X	
Benzo(a)pyrene	X	
Benzo(b)fluoranthene	X	
Benzo(g,h,i)perylene	X	
Benzo(k)fluoranthene	X	
Chrysene	X	
Dibenz(a,h)anthracene	X	
Fluoranthene	X	
Fluorene	X	
Indeno(1,2,3-cd)pyrene	X	
Naphthalene	X	
Phenanthrene	X	
Pyrene	X	
Pesticides		
4,4'-DDD	X	
4,4'-DDE	X	
4,4'-DDT	X	X
Aldrin	X	
alpha-BHC	X	X
beta-BHC	X	X
delta-BHC	X	

Table 4-18
(Continued)

Chemical	Media	
	Surface Soil	Discharged Groundwater
Dieldrin	X	X
Endosulfan I	X	
Endosulfan II	X	
Endrin aldehyde	X	
Endrin	X	
gamma-BHC	X	X
Heptachlor	X	X
Heptachlor epoxide	X	X
Methoxychlor	X	X
Dioxins		
OCDD	X	
HpCDD		
Semi-volatiles		
2-Hexanone	X	
2-Butanone (MEK)	X	
Volatiles		
1,1,2,2-Tetrachloroethane	X	
1,1,1-Trichloroethane	X	
1,2-Dichloroethane		X
Benzene	X	X
Bromodichloromethane	X	X
Chlorobenzene	X	
Chloromethane		X
Dibromomethane		X
Ethylbenzene		X
Methylene chloride	X	
Toluene	X	X
Vinyl acetate	X	
Xylene (total)	X	X

soil were used to address terrestrial receptors and discharged groundwater COPECs were used to evaluate aquatic and semiaquatic receptors. This table includes all chemicals, by medium, with positive results greater than background and blank concentrations, and that were not eliminated as an essential nutrient.

4.4.3 Exposure Assessment

Figure 4-5 shows the conceptual model for potential receptors and exposure pathways at the FPTA. Receptors at the FPTA include both terrestrial and aquatic species. Surface soil contamination could affect receptors by contact (ingestion and dermal) with soils and/or ingestion of plants that have taken up the contaminants. Inhalation of vapors and/or fugitive dust also could be a route of exposure. Surface water may accumulate within the bermed area of the FPTA in the early spring and during times of heavy rainfall. Waterfowl may frequent the FPTA during these brief periods. However, the frequency and duration of these periods are relatively short and do not pose significant exposure. Drainage ditches do not occur in the immediate FPTA and therefore surface water impacts to wading birds (i.e., spotted sandpiper) do not occur. Groundwater migration of contaminants to the Yukon River shoreline and river water is evaluated for the aquatic and semiaquatic (i.e., shoreline habitat) pathways.

Tables 4-19 and 4-20 list the assessment and measurement endpoints for the FPTA. Plants, invertebrates, savannah sparrow, American kestrel, meadow vole, and red fox represent the terrestrial receptors. Aquatic invertebrates, spotted sandpiper, and northern pike represent the aquatic receptors. Figures 3-5 and 3-6 in Section 3 depict the trophic food chains graphically.

4.4.4 Effects Assessment

Ecological quotients (EQs) were calculated for the assessment endpoint species at the FPTA. The results of this evaluation are presented in Table 4-21 for the terrestrial trophic system and Table 4-22 for the aquatic and semiaquatic system. Supporting spreadsheets are presented in Appendix K.

4.4.5 Ecological Risk Characterization

Tables 4-23 and 4-24 list the EQ values greater than 1 for terrestrial and aquatic species, respectively. These tables also provide the order of magnitude for the EQ results. No EQs above 1 were found for the pike, red fox, or kestrel.

4.4.6 Uncertainty Assessment

Uncertainty occurs in almost every step of the ERA process. As stated previously, uncertainty is often addressed by making intentionally biased (health conservative) assumptions so that impacts will not be underestimated. Individual assumptions are therefore conservative, but because of compounded bias the calculated EQs are biased higher than any individual assumption. Table 3-9 in Section 3 lists uncertainties associated with the ERA. Uncertainties specific to the FPTA are listed in Table 4-25.

4.4.7 Conclusions and Recommendations

EQs greater than 1 were noted in each of the trophic pathways. Each pathway is discussed below.

Terrestrial—Mammal (soil → plant → meadow vole →red fox)

Table 4-23 lists the species and order of magnitude of the EQs that exceed 1. EQs greater than 1 were not noted for the red fox or plants. Adequate toxicity information was found in the literature for the red fox; however, this was not the case with the plants. Despite searches of the Phytotox and the HSDB databases, little applicable information was found; therefore, the impacts to plants from soil contaminants at the FPTA could not be assessed completely.

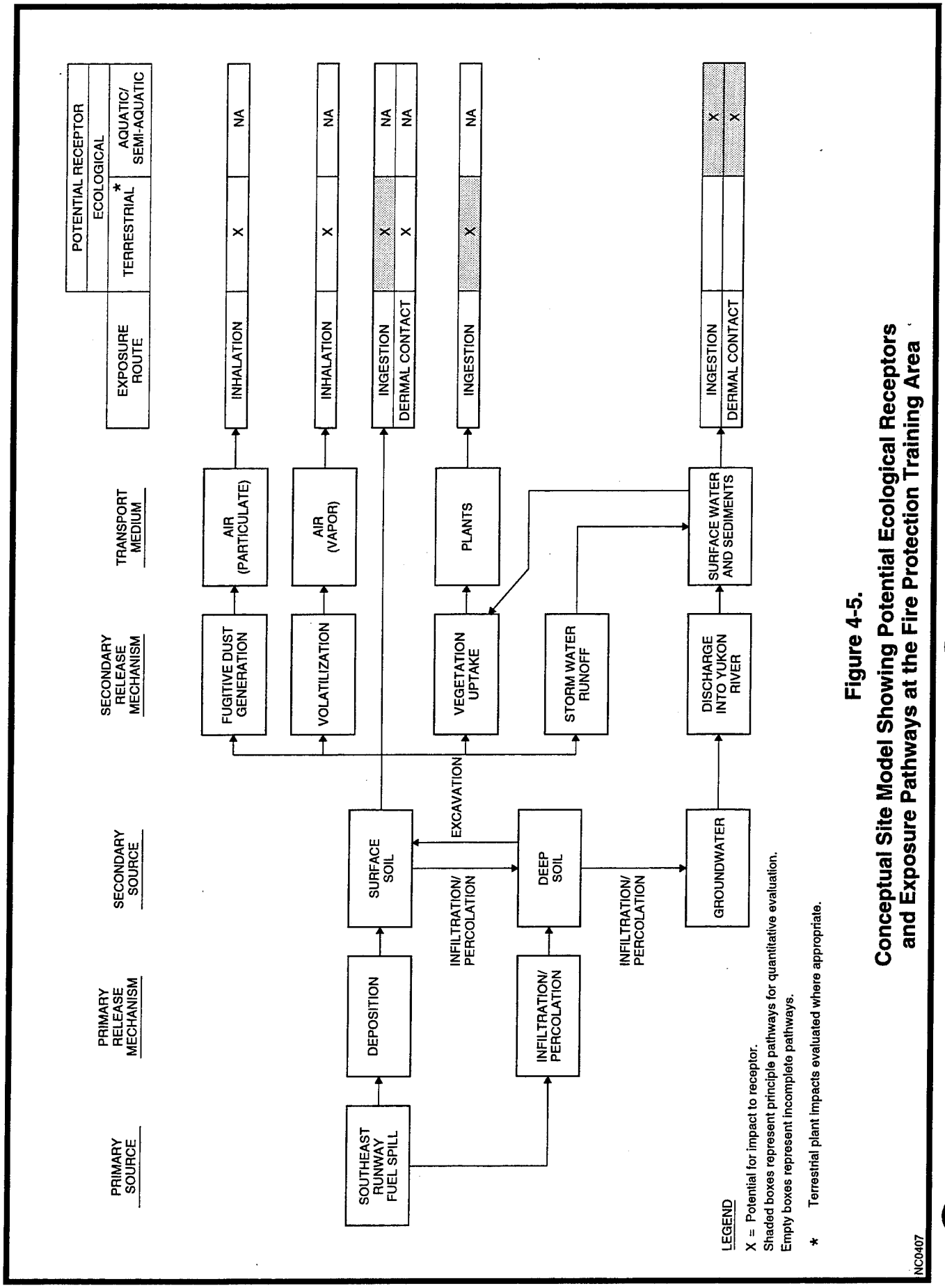


Figure 4-5.
Conceptual Site Model Showing Potential Ecological Receptors and Exposure Pathways at the Fire Protection Training Area

Table 4-19
Assessment and Measurement Endpoints for the Evaluation of Terrestrial Ecosystems at the FPTA

Assessment Endpoint	Measurement Endpoint
Decrease in balsam poplar and herbaceous plant survivorship.	Experimental effects such as reduced plant growth taken from available literature[a].
Decrease in terrestrial invertebrate, savannah sparrow, and American kestrel productivity and local population survivorship.	LOAELs[b] with effects such as decrease in eggshell thickness or reduced survival.
Decrease in meadow vole and red fox productivity and local population survivorship.	LOAELs[b] with effects such as decrease in litter number or reduced survival.

[a] Species-specific information will be used whenever possible, but plants may have to be aggregated because there may be insufficient phytotoxicity data or plant uptake data to perform taxon-specific assessments.
[b] If LOAELs were unavailable, LD_{50} values were used.

Table 4-20
Assessment and Measurement Endpoints for the Evaluation of Surface Water[a] Contamination Originating at the FPTA

Assessment Endpoint	Measurement Endpoint
Decrease in aquatic invertebrate productivity and local population survivorship.	AWQC for the protection of aquatic life.[b]
Decrease in spotted sandpiper productivity and survivorship.	LOAELs[c] with effects such as decreased eggshell thickness or reduced survival.
Decrease in local northern pike productivity and population survivorship in the Yukon River.	LOAELs with effects such as decreased gamete production, growth rate, or reduced survival.

[a] The aquatic ecosystem is the Yukon River. Individual surface water areas include mudflats that may exist part of the year. Modeled groundwater discharge data that potentially migrates from the site to the mudflats and Yukon River were used.
[b] If AWQCs are unavailable (including AWQC recommended LOAELs), LC_{50} values were used.
[c] If LOAELs are unavailable, LC_{50} values were used.

Table 4-21
Summary of Terrestrial EQs

Chemical	EQ Terrestrial Plants	EQ Meadow Vole	EQ Red Fox	EQ Terrestrial Invertebrate	EQ Savannah Sparrow	EQ Kestrel
1,1,1-Trichloroethane	a	1.42E-05	3.58E-10	a	8.80E-06	4.82E-08
1,1,2,2-Tetrachloroethane	a	2.72E-02	1.17E-04	1.19E-01	**9.75E+00**	2.67E-02
2-Butanone (MEK)	a	6.58E-01	1.89E-03	a	**1.30E+00**	3.60E-04
2-Hexanone	a	1.47E-01	7.61E-05	a	2.31E-01	2.16E-04
4,4'-DDD	a	2.46E-04	5.88E-07	a	**4.17E+01**	6.88E-02
4,4'-DDE	a	5.60E-05	1.52E-07	a	**1.18E+01**	1.94E-02
4,4'-DDT	a	1.19E-03	2.83E-06	a	**2.01E+02**	3.31E-01
Acenaphthene	a	**1.76E+00**	4.36E-05	a	**1.03E+00**	4.15E-04
Acenaphthylene	a	1.23E-02	1.39E-06	a	a	a
Aldrin	a	1.31E-04	3.53E-07	a	1.03E-01	8.36E-04
alpha-BHC	a	3.09E-05	2.58E-06	1.94E-01	1.05E-03	1.50E-06
Anthracene	a	3.46E-01	5.54E-05	a	a	a
Benz(a)anthracene	a	2.64E-01	9.96E-05	a	a	a
Benzene	a	1.38E-04	6.79E-07	4.21E-02	2.61E-01	1.51E-04
Benzo(a)pyrene	a	4.42E-02	2.31E-05	1.73E-01	7.96E-03	1.47E-05
Benzo(b)fluoranthene	a	1.36E-02	6.75E-06	a	a	a
Benzo(g,h,i)perylene	a	**2.13E+00**	1.23E-03	a	a	a
Benzo(k)fluoranthene	a	3.45E-03	1.71E-06	a	a	a
beta-BHC	a	1.07E-05	5.36E-08	2.28E-01	1.24E-03	1.76E-06
Bromodichloromethane	a	a	a	a	a	a
Cadmium	2.01E-01	3.28E-03	5.47E-06	9.42E-01	5.72E-01	1.57E-03
Chlorobenzene	a	2.56E-03	1.33E-05	a	a	a
Chrysene	a	2.57E-03	9.59E-07	a	1.23E-02	3.97E-02
delta-BHC	a	1.97E-04	1.53E-05	5.32E-01	2.89E-03	4.11E-06
Dibenz(a,h)anthracene	a	6.14E-03	3.19E-03	a	a	a
Dieldrin	a	7.52E-04	1.42E-06	**1.51E+01**	8.58E-03	2.18E-05
Endosulfan I	a	7.74E-04	9.16E-06	a	2.13E-03	3.97E-05
Endosulfan II	a	8.42E-04	9.92E-06	a	1.58E-03	2.95-E05
Endrin	a	3.51E-04	8.49E-07	a	4.02E-03	1.03E-05
Endrin aldehyde	a	2.63E-03	4.38E-06	a	2.76E-03	7.09E-06

Table 4-21
(Continued)

Chemical	EQ Terrestrial Plants	EQ Meadow Vole	EQ Red Fox	EQ Terrestrial Invertebrate	EQ Savannah Sparrow	EQ Kestrel
Fluoranthene	a	1.13E-04	2.44E-08	9.30E-01	3.25E-04	2.72E-07
Fluorene	a	**1.45E+01**	1.79E-03	5.58E-02	a	a
gamma-BHC	a	5.01E-06	4.76E-09	**1.60E+00**	1.05E-04	1.49E-07
Heptachlor	a	4.34E-06	1.28E-08	2.27E-01	1.04E-03	8.41E-06
Heptachlor epoxide	a	1.28E-05	3.73E-08	6.50E-01	2.97E-03	2.40E-05
HpCDD Totals	a	3.30E-01	2.98E-06	a	3.21E-01	2.19E-03
Indeno(1,2,3-cd)pyrene	a	6.54E-03	3.78E-06	a	a	a
Lead	a	3.22E-02	2.50E-05	**1.20E+03**	5.70E-01	8.18E-05
Methoxychlor	a	8.17E-06	7.02E-08	a	4.81E-04	7.07E-05
Methylene chloride	a	1.18E-02	5.58E-06	4.52E-03	1.87E-02	3.17E-05
Naphthalene	a	6.76E-01	2.37E-06	**8.43E+00**	3.24E-01	5.65E-04
OCDD	a	**2.10E+00**	1.85E-05	a	**1.97E+00**	1.35E-02
Phenanthrene	a	**1.18E+00**	1.58E-04	**1.35E+01**	4.25E-01	2.99E-05
Pyrene	a	2.10E-02	4.98E-06	a	a	a
Toluene	5.18E-04	6.13E-04	2.56E-06	4.71E-02	8.06E-02	9.84E-04
Vinyl acetate	a	**9.3E+00**	4.21E-03	**1.12E+00**	**1.31E+01**	1.08E-02
Xylene (total)	5.60E-01	1.54E-01	1.50E-04	**2.80E+02**	**2.75E+01**	4.16E-02

[a]No toxicity data available

Table 4-22
Summary of Aquatic EQs

Chemical	EQ Aquatic Invertebrates	EQ Spotted Sandpiper	EQ Northern Pike
1,2-Dichloroethane	5.17e-05	8.52e-04	2.67e-07
4,4'-DDT	**2.04e+01**	**2.66e+02**	1.05e-01
alpha-BHC	3.92e-03	7.23e-03	6.33e-03
Benzene	1.50e-03	1.35e-03	7.78e-06
beta-BHC	6.02e-03	1.44e-02	9.73e-03
Bromochloromethane	a	a	a
Chloromethane	1.65e-03	3.46e-07	8.52e-07
Dibromomethane	a	a	a
Dieldrin	**2.60e+00**	1.06e-01	1.34e-02
Ethylbenzene	1.29e-02	8.86e-04	4.33e-06
gamma-BHC	1.19e-03	1.74e-04	1.23e-03
Heptachlor	1.03e-37	1.91e-40	5.34e-40
Heptachlor epoxide	**1.52e+00**	2.81e-03	7.85e-03
Lead	**3.98e+00**	**6.66e+00**	2.06e-02
Methoxychlor	1.32e-01	1.52e-03	6.82e-04
Toluene	3.89e-11	2.04e-10	2.01e-13
Xylene (total)	**6.25e+00**	2.92e-02	3.11e-05

a = no toxicity information available

Table 4-23
EQ Values Greater than 1 for Terrestrial Species

Chemical	EQ	
	1-9.9	≥10
1,1,2,2-Tetrachloroethane	Sparrow	
2-Butanone	Sparrow	
4,4'-DDT		Sparrow
4,4'-DDE		Sparrow
4,4'-DDD		Sparrow
Acenaphthene	Sparrow, MV	
Benzo(g,h,i)perylene	MV	
Dieldrin		INV
Fluorene		MV
gamma-BHC	INV	
Lead		INV
Naphthalene	INV	
OCDD	Sparrow, MV	
Phenanthrene	MV	INV
Vinyl acetate	INV, MV	Sparrow
Xylene (total)		Sparrow, INV

INV = Terrestrial invertebrates
Sparrow = Savannah sparrrow
MV = Meadow vole
Note: No EQs greater than 1 for the red fox or kestrel.

Table 4-24
EQ Values Greater than 1 for Aquatic and Semiaquatic Species

Chemical	EQ	
	1-9.9	≥10
4,4'-DDT		INV, SS
Dieldrin	INV	
Heptachlor epoxide	INV	
Lead	INV, SS	
Xylene (total)	INV	

INV = Invertebrates
SS = Spotted Sandpipers
Note: No EQs greater than 1 for the pike.

Table 4-25
Uncertainties of ERA at the FPTA

Parameter	Assumption	Uncertainty
Pathway: Soil → Plant → Meadow Vole → Red Fox		
Toxicity Data	Adequate toxicity information was not available to assess impacts to plants. The site visit and modeling of contaminants through the food chain provided the assessment in this ERA for plants.	Impacts to plants could be greater or less than this ERA predicted. The uncertainty would be low-high, bias neutral.
Uncertainty factor - fluorene	An uncertainty factor (UF) of 6,000 was applied to the measurement endpoint to account for taxonomical differences and acute study duration.	The conservatism associated with the UF may be low or high. The magnitude of the uncertainty would be low-high, bias neutral.
Surface soil exposure	Surface soil samples were taken from 0-2 ft. and composited. This sample is assumed to represent the surface soil available to ecological receptors (Meadow vole).	The method may overestimate exposure concentrations, especially volatiles in the 2 ft anoxic range. The magnitude of the uncertainty would be high, bias high.
Pathway: Soil → Invertebrate → Savannah sparrow → Kestrel		
Toxicity data	Adequate toxicity data was not available to assess impacts to terrestrial invertebrates. The food chain assessment provided the mechanism for evaluating contaminants through invertebrates.	Impacts to terrestrial invertebrates could be higher or lower. The uncertainty would be low-high, bias neutral.
Surface soil exposure	Surface soil samples were taken from 0-2 ft and composited. This sample is assumed to represent the surface soil available to ecological receptors (Savannah sparrow).	The method may overestimate exposure concentrations for vinyl acetate, xylene, 1,1,2,2-tetrachloroethane and 2-butanone. The magnitude of uncertainty would be high, bias low.
Uncertainty factors - vinyl acetate, 2-butanone, and 1,1,2,2-tetrachloroethane	Measurement endpoints from mammal studies were applied to assess impacts to avian receptors. Large UFs were applied to account for taxonomical differences.	The conservatism associated with the UF may be low or high. The magnitude of the uncertainty would be high, bias neutral.
Use of BCFs or BAFs	BAFs are more representitive of terrestrial bioaccumulation than BCFs; however, when BAFs were unavailable for terrestrial receptors, BCFs were used.	BAFs may be more or less representative of terrestrial bioaccumulation. When a BCF was used, bias would be high because BCFs represent bioconcentration from submersion in the medium. Magnitude of uncertainty would be low.

Table 4-25
(Continued)

Parameter	Assumption	Uncertainty
Pathway: Surface water → Pike		
Groundwater migration	Groundwater beneath the POL migrates and is discharged to the Yukon River where exposure to the pike occurs.	Concentrations were modeled from the POL to the shoreline with no commingling or interferences. The magnitude of the uncertainty would be low, bias neutral.
	Groundwater modeling accurately estimated the concentration of COPECs in the Yukon River.	Dilution factors may not represent conditions in the Yukon. Concentrations may be higher or lower. Magnitude of uncertainty would be low-high, bias neutral.
Assessment endpoint species - Pike	Pike are present in the Yukon River near Galena all year.	Pike are present in the general area but may not be near Galena all year. The ERA assumption is conservative, uncertainty would be low, bias high.
Pathway: Surface water → Invertebrates → Spotted sandpiper		
AWQC	AWQC are protective of most aquatic life and are conservative measurement endpoints.	AWQC may be more or less conservative than necessary for aquatic invertebrates at the Galena Airport shoreline. The magnitude of the uncertainty would be low, bias high.
Groundwater migration	Groundwater modeling accurately estimated the concentration along the mudflats/shoreline.	No dilution, volatility factors or attenuation was applied to these concentrations. Actual exposure concentrations are likely much lower than predicted. The magnitude of uncertainty would be low, bias high.
Exposure concentration and time	Invertebrates and sandpiper are exposed to the estimated concentrations at the mudflats during entire time species are on site.	Invertebrates may remain in a small geographic area and could be exposed to discharging groundwater continually. However, the spotted sandpiper is mobile and this assumption is highly conservative. The magnitude of uncertainty is low, bias high.
	The spotted sandpiper's water intake is 100% from the discharging groundwater.	The spotted sandpiper travels along the shorelines searching for food. To assume that 100% of water intake is from discharging groundwater is highly conservative. The magnitude of uncertainty is low, bias high.

Table 4-25
(Continued)

Parameter	Assumption	Uncertainty
Bioavailability of COPECs	All COPECs were assumed to be 100% bioavailable.	Bioavailability changes as physical conditions such as pH or % carbon change. This assumption is conservative. The magnitude would be low-high, bias high.
Bioconcentration factors	Bioconcentration factors (BCF) were applied to estimated invertebrate tissue concentrations of COPECs.	BCFs can vary depending on condition of the study that determined the BCF. Applied to this ERA, they may over or underestimate tissue concentrations. Magnitude of uncertainty is low-high, bias neutral.

Uptake of the contaminants into the plants was modeled (Section 3.2.3) to assess intake by the meadow vole. Several compounds were noted in the meadow vole with EQs greater than 1: PNAs, dioxins, and vinyl acetate. Only fluorene had an EQ above 10, indicating probable ecological risk. However, there is a large degree of uncertainty associated with the fluorene EQ because the toxicity benchmark is an acute dose for a measurement endpoint that is only within the same taxonomic class as the meadow vole. While EQs greater than 1, but less than 10, are categorized as indicating possible risk, the potential for risk to PNAs in this EQ category is likely to be insignificant because current data (Eisler, 1987c) indicate that consumers such as meadow voles metabolize PNAs rapidly. The EQ for vinyl acetate is 9.3 indicating possible ecological risk. However, the reported concentration of vinyl acetate is likely biased because several surface soil samples were composites from 0 to 2 ft. Exposure to ecological receptors at the surface for vinyl acetate is likely minimal because this chemical is volatile and undergoes biodegradation in soils.

In summary, there appears to be no potential for risk to higher trophic level consumers such as the red fox. Results of the risk evaluation for plants was inconclusive because of the lack of available toxicity data. However, during the May 1995 site visit, there were no signs of stress to vegetation growing outside of the FPTA earthen berm. The EQ results, taken together with their associated uncertainties, indicate that only fluorene and dioxin may pose risk to small mammals such as meadow voles.

Terrestrial—Bird (soil → invertebrate → savannah sparrow → kestrel)

Table 4-23 lists the compounds and magnitude of the EQs greater than 1. As with the plant toxicity information, little terrestrial invertebrate toxicity information was found.

Earthworm BAFs were used when found in the literature. If earthworm BAFs were not available, aquatic BCFs were used; however, this probably overestimates the bioaccumulation that occurs in terrestrial systems. Toxicity endpoint data specific to birds were used whenever possible, but this was not always feasible. Non-bird toxicity information was used only if the study was chronic in duration and the effect was ecologically relevant (i.e., reduced litter size).

EQ calculations showed no potential for risk for the kestrel. For the savannah sparrow, several compounds had EQs greater than 10 indicating probable ecological risk: 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, vinyl acetate, and xylene. 1,1,2,2-Tetrachloroethane, 2-butanone, acenaphthene, and dioxin have EQs between 1 and 10 indicating possible ecological risk. For vinyl acetate, 2-butanone, and 1,1,2,2-tetrachloroethane, mammal endpoints were used with large uncertainties when applied to the sparrow. These compounds were modeled through the trophic pathway using aquatic BCFs, not earthworm BAFs. Thus, the EQ for these chemicals likely overestimates the potential for risk. Additionally, the reported concentrations for the volatile compounds, vinyl acetate, 1,1,2,2-tetrachloroethane, and xylene, are likely biased because several surface soil samples were composites from 0 to 2 ft. Acenaphthene was the only PNA noted in this pathway to have an EQ greater than 1 (EQ = 1.03). Although this EQ level indicates possible risk, the potential for risk from PNAs is unlikely due to rapid metabolism of PNAs by vertebrates (Eisler, 1987c).

Considering the uncertainties associated with the EQ calculations, those chemicals that potentially pose risk to passerine receptors such as the savannah sparrow are DDT, and its breakdown products, and dioxin. Pesticides (DDT) were historically broadcast throughout the Airport for pest control, and therefore, the FPTA

does not represent an isolated area of high concentrations.

Aquatic (surface water → pike); Semiaquatic (surface water → invertebrates → spotted sandpiper)

Table 4-24 shows the EQ values greater than 1 for the aquatic and semiaquatic pathways. No EQs greater than 1 were noted for the pike in the Yukon River. On the mudflats, the DDT EQ of 265 indicates probable risk, and the lead EQ of 6.6 indicates possible risk for the spotted sandpiper. AWQC were used to assess impacts to the aquatic invertebrates. Dieldrin, heptachlor epoxide, lead, and xylene all exhibit an EQ within the possible risk range for the invertebrates. Only DDT has an EQ in the probable risk range for invertebrates. For all of these contaminants, except xylene, AWQC were applied, which were highly conservative.

Modeled groundwater concentrations at the Yukon River mudflats did not account for river dilution effects or volatilization effects for chemicals such as xylenes (Appendix C). Thus, it is expected that these risk estimates are very conservative primarily because of conservative assumptions used in the groundwater modeling (see Appendix C). Site-specific analytical data (i.e., groundwater seep chemical concentrations) may provide a better basis for estimating potential risk. However, there is a low feasibility of obtaining such data accurately so that it can be attributed directly to the FPTA groundwater.

Tables 4-26 and 4-27 show the different contributions of the intake media to the EQ for the terrestrial and semiaquatic pathways, respectively. These percent contributions are only provided for the EQs determined to exceed 1. As shown in Table 4-27, the meadow vole and savannah sparrow were the only terrestrial assessment endpoint species with EQs exceeding 1. In general, the trophic pathway (i.e., food) provided the main route of exposure for the assessment endpoint species, with the exception of several PNAs and OCDD. These compound have high (> 6.0) log K_{ow} values. Plant uptake is dependent upon the solubility of a chemical in water, which is inversely proportional to the K_{ow}. These compounds have a low affinity for water (i.e., lipophilic) and therefore are unlikely to be translocated appreciably in plants (Trapp et al., 1995).

No potential risks were obtained for FPTA plants and terrestrial invertebrates, and for higher trophic level consumers such as the red fox and the kestrel. Through evaluation of the toxicity data and physical properties of the contaminants with EQs above 1 in the context of the FPTA, it was determined that only dioxin and fluorene have potential for risk to the meadow vole. The available habitat at the FPTA is small when compared to the surrounding area. Due to sporadic human activity, the affected area does not represent a high quality habitat. On the basis of the size of the affected area relative to useable local habitat and the occasional human activity at the site, the population impacts are determined to be low. If surface soils remained in place, the local population of meadow voles would not be adversely impacted.

After consideration of toxic and physical properties for contaminants with EQs above 1 for the savannah sparrow, it was determined that DDT, its breakdown products, and dioxin showed potential for risk. The grassy open field of the FPTA provides a unique habitat for the savannah sparrow. This field is also an area of breeding for the savannah sparrow. If the surface soils remained in place, risk to the savannah sparrow population from DDT, its breakdown products, and dioxin showed potential for risk. However, DDT was historically broadcast throughout the Airport, and the FPTA does not represent a unique source of DDT.

Table 4-26
Percent Contribution to EQ by Soil and Food Intake

Chemical	EQ	%EQ Soil	% EQ Food
Meadow Vole[a]			
Acenaphthene	1.76	10.48	89.52
Benzo(g,h,i)perylene	2.13	78.40	21.60
Fluorene	14.5	14.04	85.96
OCDD	2.1	93.93	6.07
Phenanthrene	1.18	17.76	82.24
Vinyl acetate	9.3	0.47	99.53
Savannah Sparrow[b]			
1,1,2,2-Tetrachloroethane	9.75	0.56	99.44
2-Butanone (MEK)	1.3	10.70	89.30
4,4'-DDD	41.7	2.29	97.71
4,4'-DDE	11.8	2.29	97.71
4,4'-DDT	201	2.29	97.71
Acenaphthene	1.03	25.66	74.34
OCDD	1.97	2.29	97.71
Vinyl acetate	13.1	1.89	98.11
Xylene (total)	27.5	5.82	94.18

[a] The percent contribution to the EQ by food ingestion for the meadow vole is due to the ingestion of plants.
[b] The percent contribution to the EQ by food ingestion for the savannah sparrow is due to the ingestion of invertebrates.

Table 4-27
Percent Contribution to EQ by Water and Food Intake

Chemical	EQ	% EQ Water	% EQ Food
Spotted Sandpiper[a]			
4,4'-DDT	265.63	0.91	99.09
Lead	6.66	72.34	27.66

[a] The percent contribution to the EQ by food ingestion for the spotted sandpiper is due to the ingestion of invertebrates.

For the aquatic and semiaquatic pathways, no potential risks were obtained for the pike. DDT, dieldrin, heptachlor epoxide, and lead had EQ levels greater than 1 for the aquatic invertebrate. The spotted sandpiper had EQs greater than 1 for lead and DDT. The mudflats represent a transient habitat and is dependent upon the level of the Yukon River. Groundwater modeling did not account for volatilization, dilution, or binding of the constituent to sediment. Organochlorine pesticides, including DDT, were historically broadcast throughout the Airport for pest control, and the FPTA does not represent a unique source of DDT. In surface waters, lead quickly binds to sediments. On the basis of the dilution effects, and transient nature of the ecosystem, the potential local population impacts to the spotted sandpiper and aquatic invertebrates is minimal to low.

Section 5
POL TANK FARM

This section contains a site-specific BRA for the POL Tank Farm. Section 5.1 provides a description of the site and Section 5.2 summarizes data evaluation. Section 5.3 presents the human health risk assessment results. Section 5.4 presents the ecological assessment results.

5.1 Site Description

The POL Tank Farm is located in the eastern portion of the main airport triangle (Figure 1-2). It lies immediately north of the main road to all civilian airport facilities at Galena Airport and east of the base housing complex. Passenger and freight terminals for the flying services associated with the airport are located just south of this road.

The topography at the POL Tank Farm is generally flat, except for the earthen dikes surrounding the fuel storage tanks. Vegetation within the diked area is generally low and sparse and consists mostly of grass. Willows grow along some dike slopes and in the southeast corner of the site.

5.1.1 Sources of Contamination

The POL Tank Farm has contained as many as 33 tanks to manage jet fuel, MOGAS, diesel, and other fuels used at Galena Airport. The tanks, ranging in capacity from 25,000 to 50,000 gal., were situated horizontally on wooden or concrete saddles and surrounded by clay-lined dikes. Tank trucks or buried transfer lines were used to carry fuels from the barge loading area to the POL Tank Farm; aboveground distribution lines were used to transfer fuels from the tanks to several fillstands. Fuel was released from leaking pipes, tanks, and spills and has subsequently migrated downward into the soils and to the water table.

With the exception of eight tanks located in the northwest part of the POL, all saddle tanks at the site have been removed. Four of the eight tanks are empty, two contain diesel, and two contain MOGAS. The west central portion of the POL Tank Farm was regraded following removal of the saddle tanks. A new million-gallon fuel tank was built during 1994. Figure 5-1 shows the location of former and current fuel storage and distribution features at the POL Tank Farm.

Leaks were detected at the POL area through inventory control and annual pressure testing of the transfer pipeline before loading fuels. Several of the following spills occurred in the area over the years:

- The MOGAS fillstand lost an estimated 200 to 500 gal. in 1985 (spill/leak #4);
- Valve pit #2 was the location of periodic small equipment leaks; and
- Ten to 15 gal. of AVGAS sludge were allowed to weather on the ground following tank cleaning every three years (prior to the early 1980s).

The contamination that began initially around the saddle tanks has now migrated laterally beneath the airport tarmac as both free-phase and dissolved-phase contaminants. The free product layer provides a continuing source of contaminants to the soil and groundwater.

There are no underground storage tanks (USTs) at the POL Tank Farm, although some of the piping runs underneath roads and within dikes. Although the original sources of contamination were largely surface sources, redistribu-

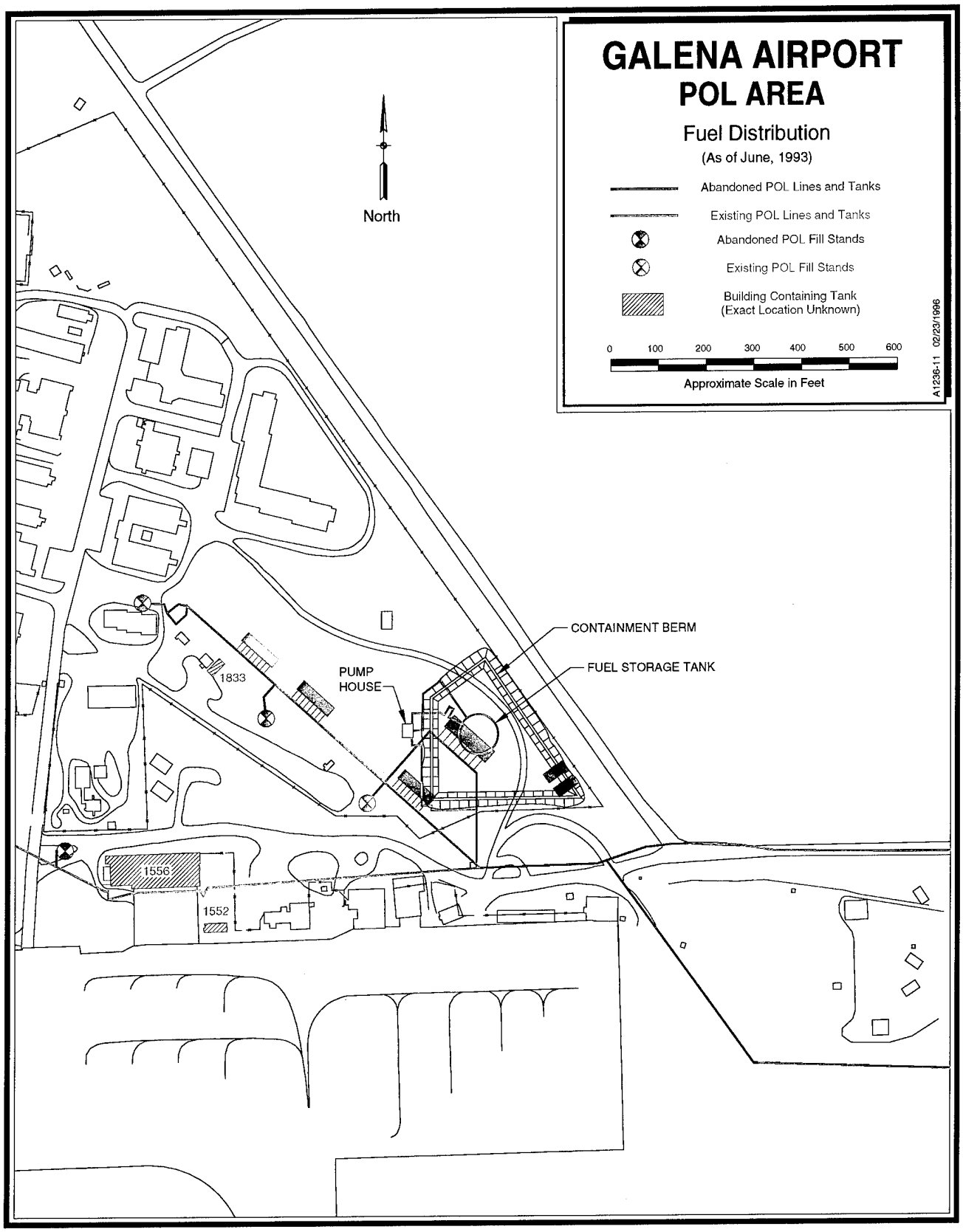


Figure 5-1. Fuel Distribution and Storage Features at the POL Tank Farm (ST005)

tion of the contamination to the subsurface by the seasonal rise and fall of groundwater has occurred.

5.1.2 RI Activities

During the 1992, 1993, and 1994 field seasons, preexisting monitoring wells were sampled; nine new wells were installed and sampled; five soil borings were drilled and sampled; and surface soil, water, and sediment samples were collected to characterize contamination at the POL Tank Farm. Field screening was conducted to define contaminant plumes and direct the 1993 RI sampling effort. Analytical data for soil and water samples are presented in Appendix A of the RI report (USAF, 1995c).

5.1.3 RI Conclusions

It appears that surface and subsurface spills and leaks from several sources have contributed to the soil and groundwater contamination at the POL Tank Farm over time. Fuels that leaked to the soil have percolated downward and have accumulated on top of the water table. These light nonaqueous phase liquid (LNAPL) hydrocarbons are further distributed in the soil by the seasonal fluctuations of the groundwater table. Following are the main findings of the investigation conducted at the POL Tank Farm:

- An amount estimated between 30,000 and 75,000 gal. of LNAPL hydrocarbons is present in subsurface soils and groundwater in the southern portion of the site;

- The true formation thickness of the LNAPL is not well defined and appears to change seasonally;

- Evidence of fuel contamination is present in the northwestern portion of the site, most likely as the result of leaks and spills from POL tanks previously located in this area;

- Fuel contamination appears to be migrating slowly to the south/southwest with prevailing groundwater flow; contamination from the southern portion of the POL has moved south (downgradient) and extends beneath the flight services buildings; and

- LNAPL appears to be moving much more slowly than the rate of groundwater movement; attenuation on soil particles during the seasonal rise and fall of the water table and possibly permafrost lenses are slowing migration.

5.2 Data Evaluation

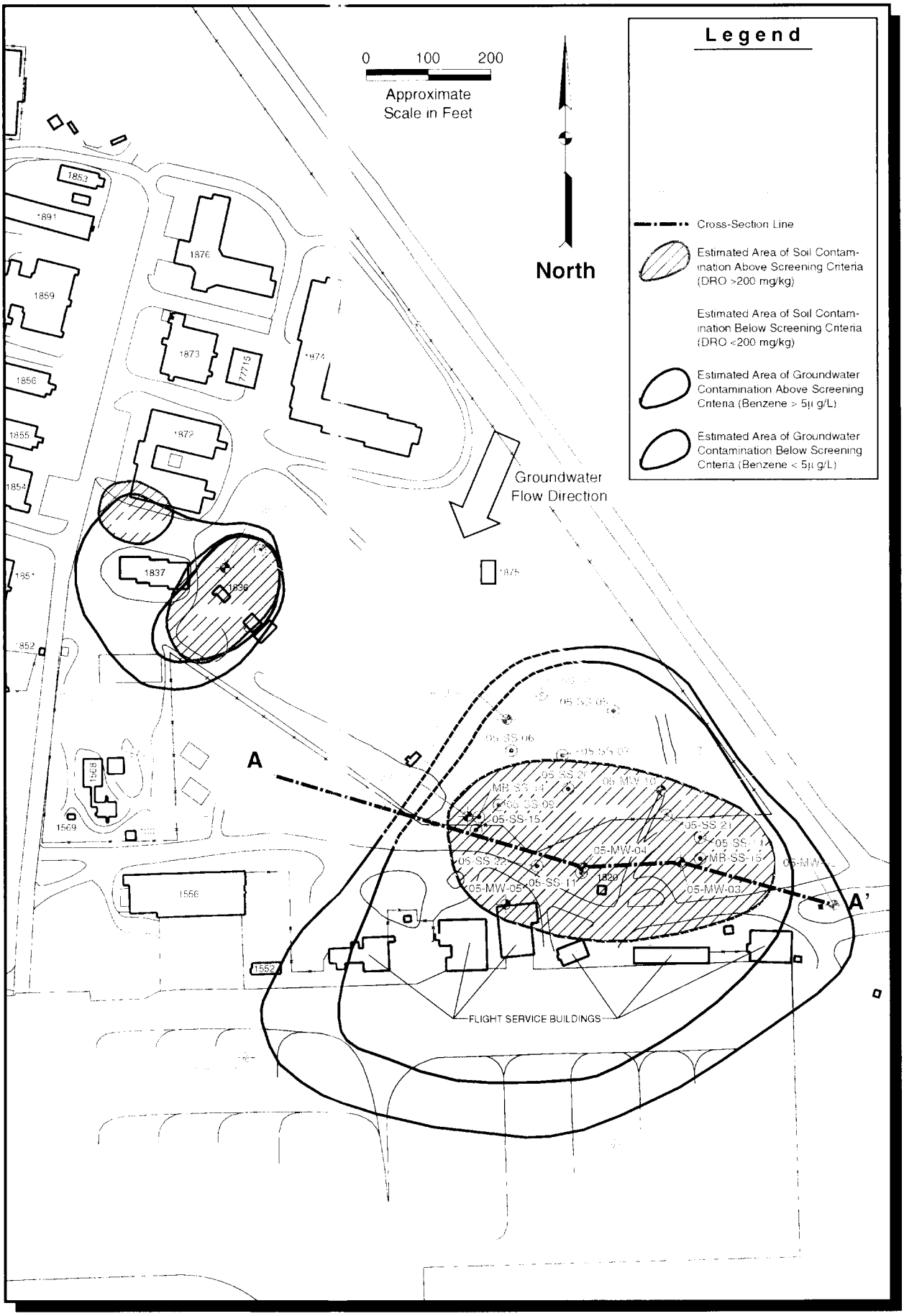
Data available from the RI (USAF, 1995c) were used to evaluate human health risks and ecological effects posed by the POL Tank Farm. After removing samples that were determined to be uncontaminated, analytical results from a total of 30 surface soil and sediment samples, 23 subsurface soil samples, 43 groundwater samples, and 3 surface water samples comprised the risk assessment data set. Table 5-1 lists the analytical methods used to test the soil and water samples during the 1992-1994 RI.

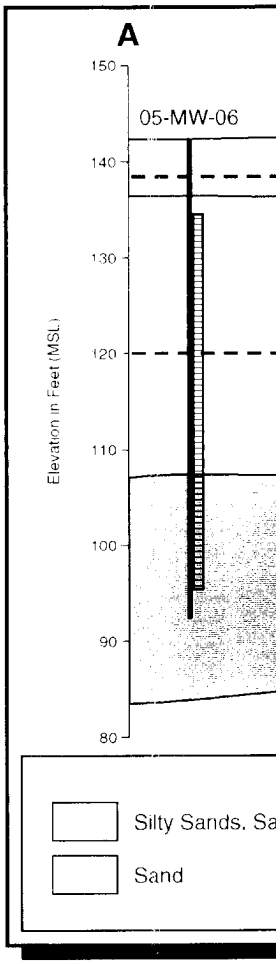
Figure 5-2 presents a conceptual diagram for the POL Tank Farm from the RI report (USAF, 1995c). This diagram provides a plan view, a geologic cross section, and a table that lists the range of detected concentrations for analytes that have exceeded the RI screening criteria (identified in the key to the figure). The plan view shows the location of all analytical data points (surface soil samples, surface water samples, soil borings, sediment samples, and monitoring well locations). Estimated areas of soil and groundwater contamination are shown as an overlay to the plan view. An area of free

Table 5-1
Analytical Methods Used at the POL Tank Farm During the 1992-94 RI

Parameter	POL Tank Farm [a]	
	Soil	Water
Alkalinity - Total (SM403)	NA	92, 93, 94
Specific Conductance (E120.1)	NA	92, 93, 94
pH (E150.1 - aqueous, SW9045 - solids)	--	92, 93, 94
Total Dissolved Solids (E160.1)	NA	93
Total Suspended Solids (E160.2)	NA	93
Temperature (E170.1)	NA	92, 93, 94
Turbidity (E180.1)	NA	93
Anions (E300)	NA	93
Nitrate-Nitrite (E353.1)	NA	93
Metals - ICP Screen (SW6010) Arsenic (SW7060) Lead (SW7421) Mercury - (SW7470 aqueous, SW7471 solid) Selenium (SW7740)	92 92, 93 92, 93 92 92	92, 93 92, 93 92, 93 93 92, 93
Halogenated Volatile Organics (SW8010)	NA	92, 93
Nonhalogenated Volatile Organics (SW8015)	NA	92, 93
Aromatic Volatile Organics (SW8020)	NA	92, 93
Organochlorine Pesticides and PCBs (SW8080)	94	92, 93, 94
Semivolatile Organic Compounds (SW8270)	92, 93	92, 93, 94
Volatile Organic Compounds (SW8240)	92, 93	NA
Volatile Organic Compounds (SW8260)	NA	94
Diesel Range Organics (AK102)[a]	92, 93	92, 93, 94
Gasoline Range Organics (AK101)[a]	92, 93	92, 93, 94
Soil Moisture Content (SW846) or ASTM 02216)	92, 93	NA

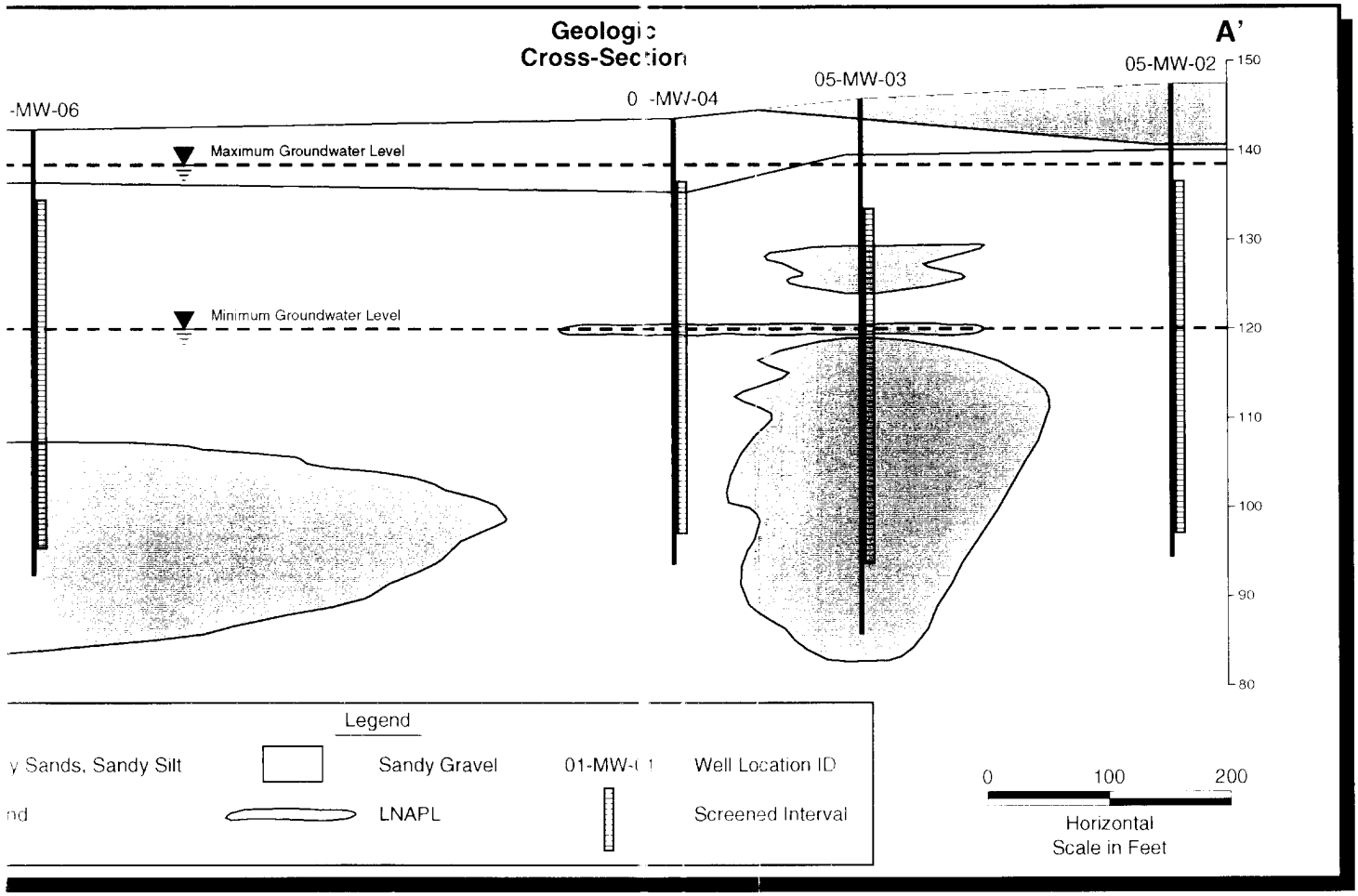
[a] Method SW8015 MEMP used in 1992.
NA = Not applicable.
-- Analytical method not used for this medium.





Analyte

1,2-Dichloroethane
trans-1,3-Dichloropropane
4-Methylphenol (p-cresol)
Arsenic
Benzene
Cadmium
Chloromethane
Ethylbenzene
Toluene
Xylenes
DRO
GRO
Lead
Manganese
Beryllium
Acetone
Methylene Chloride
4-Methyl-2-Pentanone
1,1,2,2-Tetrachloroethane
bis(2-Ethylhexyl)phthalate



Compounds Exceeding RI Screening Criteria

e	Soil		Groundwater	
	Screening Criteria (µg/kg)	Range of Detection (µg/kg)	Screening Criteria (µg/L)	Range of Detections (µg/L)
ethane			5 M	0.43 - 59.2
hloropropane			[illegible] RC	0.158
ol (p-cresol)			180 RN	13 - 660
	24,000 RN	4,000 - 71,000	5 M	
	500 AK	160 - 310,000	5 M	10 - 63,000
			4 RC	4.3 - 12.6
ne			700 M	0.350 - 222
	15,000 AK	16 - 350,000	1.000 M	0.32 - 1,800
	15,000 AK	73 - 1.4×10^{4}	5 M	0.04 - 160,000
	15,000 AK	25 - 1.5×10^{5}		0.61 - 270,000
	200,000 AK	2.7×10^{4} - 1.6×10^{5}		
	100,000 AK	5.3×10^{4} - 5.5×10^{5}		
	400,000 EL	3,010 - 480,000		
	390,000 RN	130,000 - 650,000		
	150 RC	170 - 390		
hloride			3,700 RN	5.23 - 24,000
entanone			5 M	3.60 - 398
chloroethane			2,900 RN	2.81 - 3,800
exyl)phthalate			0.052 RC	0.220
			6 M	3.51 - 880

Key:
AK - State of Alaska Cleanup Standard
E - EPA Lead Directive
M - Maximum Contaminant Level
RC - EPA Region III Risk-Based Concentration, Carcinogenic **
RN - EPA Region III Risk-Based Concentration, Non-Carcinogenic **
** Soil: Residential Soil Ingestion Groundwater: Tap Water

Galena Airport - POL Area

Conceptual Diagram and Summary of Compounds Exceeding Screening Criteria

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Figure 5-2. Conceptual Diagram for the POL Tank Farm (ST005)

product was estimated on the basis of observations in monitoring wells (free-phase hydrocarbons). The southern boundary of this area was estimated through the soil gas survey. The plan view and the lithologic cross section can be used in conjunction to provide a three-dimensional visualization of site characteristics.

Statistical analyses, in accordance with methods summarized in Section 3 and described in detail in Appendix A, were conducted on the available data to identify contaminants that were:

1. Positively detected in at least one sample in a given medium;

2 Detected at levels substantially greater than levels detected in associated blank samples (at least one result that exceeds the blanks UTL); and

3. Detected at levels substantially greater than naturally occurring background levels.

Table 5-2 lists the chemicals that were positively detected in the various media at the POL Tank Farm. These are considered possible COPCs that were subjected to blanks and background comparisons and to additional screening and evaluation for the human health assessment and the ecological assessment before they were identified as COPCs for human health or COPECs. Appendix A lists all chemicals that were tested in the various media and indicates, on a medium-specific basis, whether or not there were measurable results after conducting the blanks evaluation and whether or not the average site-related concentration is greater than the average background concentration (metals only).

An evaluation of the adequacy of detection limits was performed by comparing the minimum detection limit for each chemical eliminated as a COPC because it was not detected in a medium with the USEPA Region III residential RBCs. Appendix B contains the results of this detection limit screening process. The uncertainties associated with detection limits that are not low enough to detect risk-based concentrations are summarized in Section 5.3.5.

5.3 Human Health Risk Assessment Results

The human health evaluation for the POL Tank Farm included identification of COPCs (Section 5.3.1), exposure assessment (Section 5.3.2), toxicity assessment (Section 5.3.3), risk characterization (Section 5.3.4), and uncertainty assessment (Section 5.3.5). These tasks were performed according to the methods specified in Section 3. Section 5.3.6 summarizes conclusions of the human health risk assessment for the POL Tank Farm and recommendations for remedial action based on the risk assessment results.

5.3.1 Chemicals of Potential Concern

Additional screening of the candidate COPCs was performed, in accordance with the methods described in Section 3, to identify the COPCs carried through the human health assessment. The additional screening involved examining the frequency of detection, evaluating essential nutrients, and comparing maximum detected concentrations with USEPA Region III RBCs.

Frequency of Detection

At the POL Tank Farm, 12 analytes in subsurface soils and 10 analytes in groundwater were detected at a low (< 5%) frequency. Analytes detected infrequently in subsurface soils were benzo(g,h,i)perylene, benzyl alcohol, butylbenzylphthalate, 4-chloro-3-methylphenol, dibenz(a,h)anthracene, dibutyl phthalate, 1,2-dichloroethane, di-n-octylphthalate, 2-hexanone, indeno(1,2,3-cd)pyrene, 4-methyl-2-pentanone,

Table 5-2
Analytes Detected at the POL Tank Farm

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
1,1-Dichloroethene	D	-	ND	ND
1,2-Dichloroethane	D	-	ND	D
2,4-Dimethylphenol	D	-	ND	ND
2-Butanone (MEK)	D	-	D	D
2-Methylnaphthalene	D	-	D	D
2-Methylphenol(o-cresol)	D	-	ND	D
4,4'-DDD	D	ND	D	-
4,4'-DDE	D	ND	D	-
4,4'-DDT	D	-	D	-
4-Methyl-2-Pentanone (MIBK)	D	-	ND	D
4-Methylphenol(p-cresol)	D	-	ND	D
4-Methylphenol/3-Methylphenol	D	-	-	-
4-Nitrophenol	D	-	ND	ND
Acenaphthene	D	-	D	ND
Acetone	D	-	D	D
Aldrin	D	D	ND	-
Anthracene	D	-	D	D
Benz(a)anthracene	ND	-	D	D
Benzene	D	-	D	D
Benzo(a)pyrene	ND	-	D	D
Benzo(b)fluoranthene	ND	-	D	D
Benzo(g,h,i)perylene	ND	-	D	D
Benzo(k)fluoranthene	ND	-	D	D
Benzoic acid	D	-	D	D
Benzyl alcohol	D	-	D	D
Chlorobenzene	D	-	D	ND
Chloroethane	D	-	ND	ND
Chloromethane	D	-	ND	ND
Chrysene	ND	-	D	D
Di-n-octylphthalate	D	-	D	D
Dibenz(a,h)anthracene	ND	-	D	D
Dibenzofuran	D	-	D	D
Dibromomethane	D	-	-	-
Dieldrin	D	-	D	-

Table 5-2
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
Diesel Range Organics	D	-	D	D
Endosulfan I	D	-	ND	-
Endosulfan II	D	-	ND	-
Endosulfan sulfate	D	D	D	-
Endrin	D	-	D	-
Endrin aldehyde	D	-	ND	-
Ethylbenzene	D	-	D	D
Fluoranthene	D	-	D	D
Fluorene	D	-	D	D
Gasoline Range Organics	D	-	D	D
Heptachlor	D	-	D	-
Heptachlor epoxide	D	D	D	-
Indeno(1,2,3-cd)pyrene	ND	-	D	D
Isophorone	D	-	ND	ND
Methoxychlor	ND	D	ND	-
Methylene chloride	D	-	D	D
Naphthalene	D	-	D	D
Phenanthrene	D	-	D	D
Phenol	D	-	ND	ND
Pyrene	D	-	D	D
Toluene	D	-	D	D
Trichloroethene	D	-	ND	ND
Trichlorofluoromethane	D	-	-	-
Xylene (total)	D	-	D	D
alpha-BHC	D	ND	ND	-
beta-BHC	D	-	ND	-
bis(2-Ethylhexyl)phthalate	D	-	D	D
delta-BHC	D	D	ND	-
gamma-BHC	D	D	D	-
Aluminum	D	-	D	D
Antimony	D	-	D	ND
Arsenic	D	-	D	D
Barium	D	-	D	D
Beryllium	D	-	D	D

Table 5-2
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
Cadmium	D	-	D	D
Calcium	D	-	D	D
Chromium	D	-	D	D
Cobalt	D	-	D	D
Copper	D	-	D	D
Iron	D	-	D	D
Lead	D	-	D	D
Magnesium	D	-	D	D
Manganese	D	-	D	D
Mercury	D	-	D	D
Molybdenum	D	-	ND	ND
Nickel	D	-	D	D
Potassium	D	-	D	D
Selenium	D	-	D	D
Silver	D	-	D	D
Sodium	D	-	D	D
Thallium	D	-	ND	ND
Vanadium	D	-	D	D
Zinc	D	-	D	D

and 1,1,1-trichloroethane. Each of these analytes was detected in only one sample at a concentration well below the USEPA Region III RBC for residential soil, except for benzo(g,h,i)perylene, 4-chloro-3-methylphenol, and 2-hexanone. No toxicity values are available for these three chemicals and therefore USEPA Region III does not list an RBC. These chemicals were eliminated from the list of COPCs.

Infrequently detected analytes in groundwater consisted of aluminum, antimony, anthracene, chromium, copper, di-n-octylphthalate, endosulfan II, isophorone, 4-nitrophenol, and vanadium. With the exception of antimony, the maximum detected concentration of each of these chemicals was well below the Region III tap water RBC. These chemicals were eliminated from the list of COPCs. The maximum detected concentration of antimony (82 μg/L) is about five times higher than the tap water RBC (15 μg/L). However, since antimony is not associated with known sources of contamination at the POL Tank Farm and exposure to the groundwater does not occur at the site, it was also eliminated from the list of COPCs.

Essential Nutrients

The essential nutrient iron was detected in groundwater at concentrations that exceeded background concentrations. Selenium was detected in soil at concentrations that exceeded background concentrations. The maximum daily intakes of selenium, assuming daily ingestion of 200 mg of soil at the maximum detected concentration in soil, does not exceed its recommended dietary allowance (RDA) for minerals and trace elements (NRC, 1989). It was therefore eliminated from the list of COPCs. It is also eliminated by virtue of risk-based screening (see below). Iron was retained as a COPC because the maximum daily intake, assuming ingestion of 2 L/day of groundwater, exceeded the RDA for iron. Appendix B contains tables that show the comparison of maximum daily intakes with the RDAs.

Risk-Based Screening

Maximum detected concentrations of numerous analytes were lower than one-tenth the media-specific USEPA Region III residential RBCs and were eliminated from the list of COPCs. Appendix B contains the risk-based screening results.

COPC Summary

Tables 5-3, 5-4, and 5-5 summarize conclusions for all chemicals that were positively detected in the surface soil or sediments, subsurface soil, and groundwater media at the POL Tank Farm. The tables indicate, for each analyte, whether sample concentrations were distinguishable from blank concentrations, whether concentrations were significantly different than background concentrations, whether the chemical was detected in at least 5% of the samples, and whether the chemical was eliminated as an essential nutrient or by the risk-based screen. Note that since 1993 and later sampling events reported uncensored data (where an ND is reported only if there is no instrument response), very low levels (greater than zero) of many analytes were reported in both blanks samples and site samples. Consequently, many chemicals that are not common field or laboratory contaminants were "detected" in blanks samples and were eliminated as COPCs on the basis of the blanks comparison. No analytes were detected in blanks at concentrations considered to represent a blanks contamination problem requiring corrective action as a result of the data validation process.

Table 5-6 lists the COPCs for the POL Tank Farm. It includes all chemicals, by medium, with positive results that were greater than

Table 5-3
Identification Criteria for Surface Soil COPCs at the POL Tank Farm

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
2-Butanone (MEK)	-	-	-	-	X	-
2-Methylnaphthalene	-	-	-	-	-	YES
4,4'-DDD	-	-	-	-	X	-
4,4'-DDE	-	-	-	-	X	-
4,4'-DDT	-	-	-	-	X	-
Acenaphthene	-	-	-	-	X	-
Acetone	X	-	-	-	-	-
Anthracene	-	-	-	-	X	-
Benz(a)anthracene	-	-	-	-	-	YES
Benzene	-	-	-	-	X	-
Benzo(a)pyrene	-	-	-	-	-	YES
Benzo(b)fluoranthene	-	-	-	-	-	YES
Benzo(g,h,i)perylene	-	-	-	-	-	YES
Benzo(k)fluoranthene	-	-	-	-	X	-
Benzoic acid	-	-	-	-	X	-
Benzyl alcohol	-	-	-	-	X	-
Chlorobenzene	-	-	-	-	X	-
Chrysene	-	-	-	-	X	-
Di-n-octylphthalate	-	-	-	-	X	-
Dibenz(a,h)anthracene	-	-	-	-	-	YES
Dibenzofuran	-	-	-	-	X	-
Dieldrin	-	-	-	-	-	YES
Endosulfan sulfate	-	-	-	-	X	-
Endrin	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	X	-

Table 5-3
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Fluoranthene	-	-	-	-	X	-
Fluorene	-	-	-	-	X	-
Heptachlor	-	-	-	-	X	-
Heptachlor epoxide	-	-	-	-	X	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	X	-
Methylene chloride	-	-	-	-	X	-
Naphthalene	-	-	-	-	X	-
Phenanthrene	-	-	-	-	-	YES
Pyrene	-	-	-	-	X	-
Toluene	-	-	-	-	X	-
Xylene (total)	-	-	-	-	X	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	X	-
gamma-BHC	-	-	-	-	X	-
Aluminum	-	X	-	-	-	-
Antimony	-	X	-	-	-	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Beryllium	-	X	-	-	-	-
Cadmium	-	-	-	-	X	-
Calcium	-	X	-	-	-	-
Chromium	-	X	-	-	-	-
Cobalt	-	X	-	-	-	-
Copper	-	X	-	-	-	-
Iron	-	X	-	-	-	-
Lead	-	-	-	-	-	YES
Magnesium	-	X	-	-	-	-

Table 5-3
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Manganese	-	X	-	-	-	-
Mercury	-	X	-	-	-	-
Nickel	-	X	-	-	-	-
Potassium	-	X	-	-	-	-
Selenium	-	-	-	X	X	-
Silver	-	X	-	-	-	-
Sodium	-	X	-	-	-	-
Vanadium	-	X	-	-	-	-
Zinc	-	X	-	-	-	-

a Indistinguishable from blank concentrations.
b Not significantly elevated above background concentrations.
c Detected at a frequency less than 5%.
d Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
e Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 5-4
Identification Criteria for Subsurface Soil COPCs at the POL Tank Farm

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
1,1,1-Trichloroethane	-	-	X	-	-	-
1,2-Dichloroethane	-	-	X	-	-	-
2-Butanone (MEK)	-	-	-	-	X	-
2-Hexanone	-	-	X	-	-	-
2-Methylnaphthalene	-	-	-	-	-	YES
2-Methylphenol(o-cresol)	-	-	-	-	X	-
4-Chloro-3-methylphenol	-	-	X	-	-	-
4-Methyl-2-Pentanone(MIBK)	-	-	X	-	-	-
4-Methylphenol(p-cresol)	-	-	-	-	X	-
Acetone	-	-	-	-	X	-
Anthracene	-	-	-	-	X	-
Benz(a)anthracene	-	-	-	-	X	-
Benzene	-	-	-	-	-	YES
Benzo(a)pyrene	-	-	-	-	-	YES
Benzo(b)fluoranthene	-	-	-	-	X	-
Benzo(g,h,i)perylene	-	-	X		-	-
Benzo(k)fluoranthene	-	-	-	-	X	-
Benzoic acid	-	-	-	-	X	-
Benzyl alcohol	-	-	X	-	-	-
Butylbenzylphthalate	-	-	X	-	-	-
Chrysene	-	-	-	-	X	-
Di-n-octylphthalate	-	-	X	-	-	-
Dibenz(a,h)anthracene	-	-	X	-	-	-
Dibenzofuran	-	-	-	-	X	-
Dibutyl phthalate	-	-	X	-	-	-
Ethylbenzene	-	-	-	-	X	-
Fluoranthene	-	-	-	-	X	-
Fluorene	-	-	-	-	X	-
Indeno(1,2,3-cd)pyrene	-	-	X	-	-	-
Methylene chloride	-	-	-	-	X	-

Table 5-4
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Naphthalene	-	-	-	-	X	-
Phenanthrene	-	-	-	-	-	YES
Pyrene	-	-	-	-	X	-
Toluene	-	-	-	-	X	-
Xylene (total)	-	-	-	-	X	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	X	-
Aluminum	-	X	-	-	-	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Beryllium	-	X	-	-	-	-
Cadmium	-	X	-	-	-	-
Calcium	-	X	-	-	-	-
Chromium	-	X	-	-	-	-
Cobalt	-	X	-	-	-	-
Copper	-	X	-	-	-	-
Iron	-	X	-	-	-	-
Lead	-	X	-	-	-	-
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	-	X	-	-	-	-
Nickel	-	X	-	-	-	-
Potassium	-	X	-	-	-	-
Selenium	-	X	-	-	-	-
Silver	-	X	-	-	-	-
Sodium	-	X	-	-	-	-
Vanadium	-	X	-	-	-	-
Zinc	-	X	-	-	-	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 5-5
Identification Criteria for Groundwater COPCs at the POL Tank Farm

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
1,1-Dichloroethene	-	-	-	-	-	YES
1,2-Dichloroethane	-	-	-	-	-	YES
2,4-Dimethylphenol	-	-	-	-	-	YES
2-Butanone (MEK)	-	-	-	-	-	YES
2-Methylnaphthalene	-	-	-	-	-	YES
2-Methylphenol(o-cresol)	-	-	-	-	-	YES
4,4'-DDD	-	-	-	-	-	YES
4,4'-DDE	-	-	-	-	-	YES
4,4'-DDT	-	-	-	-	-	YES
4-Methyl-2-Pentanone(MIBK)	-	-	-	-	X	-
4-Methylphenol(p-cresol)	-	-	-	-	-	YES
4-Methylphenol/3-Methylphenol	-	-	-	-	-	YES
4-Nitrophenol	-	-	X	-	-	-
Acenaphthene	-	-	-	-	-	YES
Acetone	-	-	-	-	-	YES
Aldrin	-	-	-	-	-	YES
Anthracene	-	-	X	-	-	-
Benzene	-	-	-	-	-	YES
Benzoic acid	-	-	-	-	-	YES
Benzyl alcohol	-	-	-	-	X	-
Bromochloromethane	-	-	-	-	-	YES
Chlorobenzene	-	-	-	-	-	YES
Chloroethane	-	-	-	-	X	-
Chloromethane	-	-	-	-	-	YES
Di-n-octylphthalate	-	-	X	-	-	-
Dibenzofuran	-	-	-	-	-	YES
Dibromomethane	-	-	-	-	-	YES
Dieldrin	-	-	-	-	-	YES
Endosulfan I	-	-	-	-	X	-
Endosulfan II	-	-	X	-	-	-

Table 5-5
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Endosulfan sulfate	-	-	-	-	X	-
Endrin	-	-	-	-	X	-
Endrin aldehyde	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	-	YES
Fluoranthene	-	-	-	-	X	-
Fluorene	-	-	-	-	-	YES
Heptachlor	-	-	-	-	-	YES
Heptachlor epoxide	-	-	-	-	-	YES
Isophorone	-	-	X	-	-	-
Methylene chloride	-	-	-	-	-	YES
Naphthalene	-	-	-	-	-	YES
Phenanthrene	-	-	-	-	-	YES
Phenol	-	-	-	-	X	-
Pyrene	-	-	-	-	X	-
Toluene	-	-	-	-	-	YES
Trichloroethene	-	-	-	-	-	YES
Trichlorofluoromethane	-	-	-	-	X	-
Xylene (total)	-	-	-	-	-	YES
alpha-BHC	-	-	-	-	-	YES
beta-BHC	-	-	-	-	-	YES
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	YES
delta-BHC	-	-	-	-	X	-
gamma-BHC	-	-	-	-	-	YES
Aluminum	-	X	-	-	-	-
Antimony	-	X	-	-	-	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Beryllium	-	X	-	-	-	-
Cadmium	-	X	-	-	-	-
Calcium	-	X	-	-	-	-
Chromium	-	X	-	-	-	-

Table 5-5
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Cobalt	-	X	-	-	-	-
Copper	-	X	-	-	-	-
Iron	-	-	-	-	-	YES
Lead	-	-	-	-	-	YES
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	X	-	-	-	-	-
Molybdenum	X	-	-	-	-	-
Nickel	-	X	-	-	-	-
Potassium	-	X	-	-	-	-
Selenium	-	X	-	-	-	-
Silver	X	-	-	-	-	-
Sodium	-	X	-	-	-	-
Thallium	-	-	-	-	-	YES
Vanadium	-	X	-	-	-	-
Zinc	-	X	-	-	-	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 5-6
Chemicals of Potential Concern at the POL Tank Farm

Chemical	Media		
	Surface Soil	Subsurface Soil	Groundwater
Metals			
Iron [a]			X
Lead	X		X
Thallium			X
PNAs			
2-Methylnaphthalene [a]	X	X	X
Acenaphthene			X
Benz(a)anthracene	X		
Benzo(a)pyrene	X	X	
Benzo(b)fluoranthene	X		
Benzo(g,h,i)perylene [a]	X		
Dibenz(a,h)anthracene	X		
Fluorene			X
Naphthalene			X
Phenanthrene [a]	X	X	X
Pesticides			
Aldrin			X
alpha-BHC			X
beta-BHC			X
gamma-BHC			X
4,4'-DDD			X
4,4'-DDE			X
4,4'-DDT			X
Dieldrin	X		X
Heptachlor			X
Heptachlor epoxide			X

Table 5-6
(Continued)

Chemical	Media		
	Surface Soil	Subsurface Soil	Groundwater
Semivolatiles			
Benzoic acid			X
2-Butanone (MEK)			X
Dibenzofuran			X
2,4-Dimethylphenol			X
bis(2-Ethylhexyl)phthalate			X
2-Methylphenol (o-cresol)			X
4-Methylphenol (p-cresol)			X
4-Methylphenol/3-Methylphenol			X
Volatiles			
Acetone			X
Benzene		X	X
Bromochloromethane [a]			X
Chlorobenzene			X
Chloromethane			X
Dibromomethane [a]			X
1,2-Dichloroethane			X
1,1-Dichloroethene			X
Ethylbenzene			X
Methylene chloride			X
Toluene			X
Trichloroethene			X
Xylene (total)			X

[a] Retained as a COPC for qualitative evaluation only. Toxicity values are not available to perform risk quantification at this time.

background and blank concentrations, that exceeded 5% detection frequency, and that were not eliminated as an essential nutrient or by risk-based screening.

Appendix A of the RI report (USAF, 1995c) provides a complete listing of analytical results from the RI. The appendix reports the sampling location, analytical result, any data qualifiers, and the sample detection limit.

Tables 5-7, 5-8, and 5-9 provide a statistical summary of the values used in the risk assessment for human health COPCs in surface soil and sediments, subsurface soil, and groundwater, respectively. The tables list the detection frequency, maximum detected concentration, mean, standard deviation, and 95% UCL of the data. Note that summary statistics in Tables 5-7 through 5-9 were generated from the data set used to make the risk calculations. Results from analytical methods that were not included in the risk assessment data set are reported in the RI report (USAF, 1995c) and in some cases in figures that came directly from the RI report (e.g., Figure 5-2).

5.3.2 Exposure Assessment

Human exposure to COPCs that are present at or migrating from the POL Tank Farm was assessed in accordance with methods described in Section 3.

Human Exposure Scenarios

Eight human exposure scenarios were addressed in the assessment of risks posed by the POL Tank Farm:

Current Scenarios (also applicable as future scenarios)

1. Short-Term On-Base Resident (subchronic adult only);
2. Long-Term On-Base Resident (chronic adult and child);
3. Old Town Galena Resident (chronic adult and child);
4. New Town Galena Resident (chronic adult and child);
5. Short-Term On-Base Worker (subchronic adult only);
6. Long-Term On-Base Worker (chronic adult only); and
7. Construction Worker (subchronic adult only).

Future Scenarios

8. Boarding School Student (subchronic/ chronic).

These scenarios are described in Section 3. The on-base worker scenarios assume that workers at the POL Tank Farm are engaged in activities outdoors, every work day, for the duration of employment.

Exposure Pathways

Exposure pathways considered for applicability to each POL Tank Farm exposure scenario included:

Soil Pathways

- Incidental ingestion of soil; and
- Dermal contact with soil.

Air Pathways

- Inhalation of fugitive dust; and

Table 5-7
Statistical Summary of Values Used in the Human Health Risk Assessment for Surface Soil at the POL Tank Farm

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
Metals					
Lead [a]	27/27	4.80e+02	6.17e+01	1.10e+02	**8.56e+01**
PNAs					
2-Methylnaphthalene [b]	4/20	8.70e+01	4.36e+00	1.95e+01	**1.19e+01**
Benz(a)anthracene	5/20	**3.70e-01**	3.09e-02	8.18e-02	4.73e-02
Benzo(a)pyrene	7/20	1.00e-01	1.92e-02	3.27e-02	**3.19e-02**
Benzo(b)fluoranthene	8/20	**1.80e-01**	2.54e-02	4.56e-02	3.96e-02
Benzo(g,h,i)perylene [b]	4/20	**1.50e-01**	2.67e-02	3.19e-02	3.41e-02
Dibenz(a,h)anthracene	1/20	2.70e-02	1.32e-02	8.36e-03	**1.64e-02**
Phenanthrene [b]	7/20	2.30e+00	1.23e-01	5.12e-01	**3.21e-01**
Pesticides					
Dieldrin	2/3	**1.17e-02**	9.14e-03	3.76e-03	1.55e-02

Bold numbers indicate the value used for the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK Model was used to calculate risk from lead.

[b] No toxicity data available.

Table 5-8
Statistical Summary of Values Used in the Human Health Risk Assessment for Subsurface Soil at the POL Tank Farm

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
PNAs					
2-Methylnaphthalene [a]	13/23	1.40e+02	1.87e+01	3.96e+01	**3.29e+01**
Benzo(a)pyrene	2/23	3.80e-02	1.11e-02	8.47e-03	**1.42e-02**
Phenanthrene [a]	5/23	8.50e-01	7.42e-02	1.99e-01	**1.46e-01**
Volatiles					
Benzene	19/23	**3.40e+02**	5.20e+01	1.02e+02	7.97e+03

Bold numbers indicate the value used for the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] No toxicity data available.

Table 5-9
Statistical Summary of Values Used in the Human Health Risk Assessment for Groundwater at the POL Tank Farm

Chemical Name	Detection Frequency	Max Detect mg/L	Mean mg/L	Standard Deviation	95% UCL mg/L
Metals					
Iron [a]	19/23	1.20e+02	2.53e+01	3.46e+01	**3.77e+01**
Lead [b]	20/23	1.64e-02	5.41e-03	4.91e-03	**1.10e-02**
Thallium	11/23	7.98e-02	7.05e-03	1.91e-02	**1.39e-02**
PNAs					
2-Methylnaphthalene [c]	14/31	1.20e+00	1.13e-01	2.64e-01	**3.78e-01**
Acenaphthene	6/31	3.50e-01	1.28e-02	6.27e-02	**3.19e-02**
Fluorene	8/31	2.60e-01	9.80e-03	4.66e-02	**2.40e-02**
Naphthalene	14/31	8.80e-01	9.79e-02	1.89e-01	**1.56e-01**
Phenanthrene [c]	7/31	2.30e-02	1.26e-03	4.06e-03	**1.56e-03**
Pesticides					
4,4'-DDD	10/30	2.20e-04	1.77e-05	4.37e-05	**3.13e-05**
4,4'-DDE	3/30	2.70e-04	1.35e-05	4.86e-05	**2.86e-05**
4,4'-DDT	15/30	1.60e-04	1.11e-05	2.99e-05	**2.27e-05**
Aldrin	14/28	4.07e-05	1.00e-05	1.10e-05	**1.72e-05**
alpha-BHC	15/30	1.61e-04	3.15e-05	4.39e-05	**5.43e-05**
beta-BHC	13/30	1.40e-04	2.16e-05	4.08e-05	**3.42e-05**
Dieldrin	14/30	2.60e-05	7.00e-06	5.80e-06	**1.03e-05**
gamma-BHC	20/30	1.56e-04	2.99e-05	3.57e-05	**5.98e-05**
Heptachlor	18/30	2.61e-05	4.90e-06	6.60e-06	**6.90e-06**
Heptachlor epoxide	24/30	1.24e-04	2.06e-05	2.96e-05	**1.00e-04**
Semivolatiles					
2-Butanone (MEK)	3/10	4.00e-01	4.36e-02	1.25e-01	**1.16e-01**
2-Methylphenol(o-cresol)	14/31	1.70e+00	1.44e-01	3.31e-01	**2.45e-01**
4-Methylphenol(p-cresol)	10/21	6.60e-01	9.45e-02	1.62e-01	**1.55e-01**
4-Methylphenol/3-Methylphenol	4/10	2.52e-01	6.49e-02	9.37e-02	**1.78e-01**
2,4-Dimethylphenol	10/31	2.30e-01	2.27e-02	4.92e-02	**3.77e-02**
bis(2-Ethylhexyl)phthalate	16/31	8.80e-01	6.65e-02	2.19e-01	**1.33e-01**
Benzoic acid	13/31	5.90e+01	2.89e+00	1.07e+01	**6.16e+00**
Dibenzofuran	9/31	3.40e-01	1.30e-02	6.09e-02	**3.15e-02**
Volatiles					
1,2-Dichloroethane	7/10	5.92e-02	9.88e-03	2.05e-02	**2.17e-02**
1,1-Dichloroethene	1/10	1.75e-02	9.64e-03	4.96e-03	**1.25e-02**
Acetone	10/10	7.45e-01	8.98e-02	2.31e-01	**1.41e-01**
Benzene	10/10	4.10e+01	9.71e+00	1.53e+01	**1.86e+01**
Bromochloromethane [c]	9/9	2.08e-02	1.82e-02	1.47e-03	**1.91e-02**
Chlorobenzene	1/10	1.75e-02	1.08e-02	5.44e-03	**1.40e-02**

Table 5-9
(Continued)

Chemical Name	Detection Frequency	Max Detect mg/L	Mean mg/L	Standard Deviation	95% UCL mg/L
Chloromethane	5/10	2.22e-01	2.27e-02	7.00e-02	**2.56e-02**
Dibromomethane [c]	1/10	2.20e-04	1.17e-04	6.96e-05	**1.58e-04**
Ethylbenzene	6/10	8.10e-01	2.53e-01	3.49e-01	**4.55e-01**
Methylene chloride	10/10	3.98e-01	4.24e-02	1.25e-01	**1.15e-01**
Toluene	9/10	2.02e+01	5.49e+00	8.54e+00	**1.04e+01**
Trichloroethene	1/10	4.50e-03	2.68e-03	1.31e-03	**3.44e-03**
Xylene (total)	15/20	2.70e+02	1.47e+01	6.01e+01	**3.79e+01**

Bold numbers indicate the value used for the risk assessment, which was the lower of either the UCL or the maximum detect concentration.

[a] Maximum daily intake for iron exceeded the recommended daily allowance.
[b] USEPA IEUBK Model was used to calculate risk from lead.
[c] No toxicity data available.

- Inhalation of vapors that volatilize from surface and subsurface media.

Groundwater Pathways

- Ingestion of drinking water;
- Dermal contact with water while showering;
- Inhalation of vapors that volatilize from water while showering; and
- Ingestion of plants irrigated with groundwater.

Surface Water Pathways

- Ingestion of fish from the Yukon River.

Groundwater pathways are applicable only if groundwater modeling indicates that contaminants from the POL Tank Farm might migrate to Old Town Galena. Surface water pathways are applicable only if groundwater modeling indicates that toxicologically significant concentrations of contaminants originating from the POL Tank Farm might reach the Yukon River.

Contaminants detected in the groundwater at the POL Tank Farm were modeled to the shoreline of the Yukon River. Assuming a generally southwestern flow direction, most of Old Town Galena is not directly downgradient of the POL Tank Farm. However, modeled concentrations at the shoreline provide a worst-case estimate of possible impacts on wells located at the extreme western edge of town.

Concentrations of contaminants in the Yukon River within 5 ft of the shoreline were also estimated, assuming that mixing is limited to river flow within that 5 ft. This assumption was made because there is not instant dilution of contaminants entering the river in the groundwater by the entire volume of river flow that passes by Galena. Rather, a plume would follow the shoreline downstream.

Table 5-10 summarizes the modeled shoreline and river concentrations for the COPCs in groundwater at the POL Tank Farm. It also lists applicable chemical-specific fish BCFs and estimated concentrations in fish exposed to river water within 5 ft of the shoreline. Finally, the table lists the USEPA Region III RBCs for tap water and fish. Except for heptachlor epoxide and thallium, the modeled shoreline concentrations, considered the worst-case possible impact on any well located at the extreme western edge of Old Town Galena, are below the respective Region III tap water RBCs. At an estimated shoreline concentration of 0.002 μg/L, heptachlor epoxide exceeds the tap water RBC of 0.0012 μg/L by a factor of about two. The estimated shoreline concentration for thallium (5 μg/L) exceeds the tap water RBC, which ranges from 2.9 to 3.3 μg/L for various thallium compounds, by a factor of less than two. However, the risks of exposure to these estimated concentrations of thallium and heptachlor epoxide in the groundwater were not calculated for several reasons, including the following:

- The presence of heptachlor epoxide and thallium in groundwater is not attributable to the POL Tank Farm.
- The groundwater model is conservative and probably overpredicts concentrations that might reach the shoreline.
- Groundwater flows in a generally southwestern direction, probably taking on a more westerly direction as it moves closer to the river. To reach the extreme western edge of Old Town Galena,

Table 5-10
Comparison of POL Tank Farm Groundwater Modeling Results at the Shoreline to USEPA Region III Risk-Based Concentrations (RBCs)

Chemical	Modeled Shoreline Concentration (ug/L)	Modeled River Concentration [a] (µg/L)	Fish BCF [b]	Estimated Concentration in Fish [c] (mg/kg)	USEPA Region III RBC [d]	
					Tap water (ug/L)	Fish (mg/kg)
1,1-Dichloroethene	2.77e-05	2.06e-09	2.5	5.15e-12	0.044	0.0053
1,2-Dichloroethane	7.63e-02	1.10e-05	2	2.20e-08	0.12	0.035
2,4-Dimethylphenol	6.28e-43	4.68e-47	0.07	3.28e-51	730	27
2-Butanone (MEK)	1.67e-42	1.25e-46	0.98	1.23e-49	1900	810
2-Methylnaphthalene	7.64e+01	5.70e-03	1000	5.70e-03	NV	NV
2-Methylphenol (o-cresol)	1.74e-42	1.30e-46	18	2.34e-48	1800	68
4,4'-DDD	1.24e-02	9.22e-07	12000	1.11e-05	0.28	0.013
4,4'-DDE	1.52e-02	1.13e-06	12000	1.36e-05	0.2	0.0093
4,4'-DDT	2.85e-03	3.17e-07	12000	3.80e-06	0.2	0.0093
4-Methylphenol (p-cresol)	7.44e-22	5.54e-26	17	9.42e-28	180	6.8
4-Methylphenol/3-Methylphenol	1.61e+01	1.20e-03	17	2.04e-05	180/ 1800	6.8/ 68
Acenaphthene	1.89e-02	1.41e-06	2.6	3.67e-09	2200	81
Acetone	1.00e-40	7.49e-45	0.69	5.17e-48	3700	140
Aldrin	7.93e-04	5.91e-08	3140	1.86e-07	0.004	0.00019
alpha-BHC	5.70e-05	2.45e-08	1100	2.70e-08	0.011	0.0005
Benzene	4.48e-06	4.12e-06	4.27	1.76e-08	0.36	0.11
Benzoic acid	6.81e+02	5.08e-02	21	1.07e-03	150000	5400
beta-BHC	5.22e-07	3.12e-08	1460	4.56e-08	0.037	0.0018
bis(2-Ethylhexyl)phthalate	2.46e-02	1.83e-06	1000	1.83e-06	4.8	0.23
Chlorobenzene	1.05e-02	7.80e-07	70	5.46e-08	39	27
Chloromethane	1.92e-10	2.30e-09	2.88	6.62e-12	1.4	0.24
Dibenzofuran	1.43e-18	1.07e-22	589	6.30e-23	150	5.4
Dibromomethane	1.91e-13	8.30e-10	5	4.15e-12	NV	NV
Dieldrin	5.63e-04	6.74e-08	2700	1.82e-07	0.0042	0.0002

Table 5-10
(Continued)

Chemical	Modeled Shoreline Concentration (ug/L)	Modeled River Concentration [a] (µg/L)	Fish BCF [b]	Estimated Concentration in Fish [c] (mg/kg)	USEPA Region III RBC [d]	
					Tap water (ug/L)	Fish (mg/kg)
Ethylbenzene	1.64e-01	1.24e-05	144	1.79e-06	1300	140
Fluorene	3.20e-06	2.38e-10	5000	1.19e-09	1500	54
gamma-BHC	2.89e-05	3.05e-08	319	9.73e-09	0.052	0.0024
Heptachlor	8.79e-116	2.03e-45	20	4.06e-47	0.0023	0.0007
Heptachlor epoxide	2.22e-03	1.95e-07	20	3.90e-09	0.0012	0.00035
Iron	5.39e+03	4.02e-01	10	4.02e-03	NV	NV
Lead	1.04e+00	1.44e-04	42	6.05e-06	NV	NV
Methylene chloride	3.45e-10	2.57e-14	2.3	5.91e-17	4.1	0.42
Naphthalene	3.97e-02	2.96e-06	1000	2.96e-06	1500	54
Phenanthrene	1.52e-03	1.13e-07	325	3.67e-08	NV	NV
Thallium	5.08e+00	3.79e-04	34	1.29e-05	2.9-3.3 e	0.11-0.12 e
Toluene	2.69e-19	3.51e-13	90	3.16e-14	750	270
Trichloroethene	1.23e-01	9.16e-06	17	1.56e-07	1.6	0.29
Xylene (total)	3.48e+02	2.59e-02	80	2.07e-03	12000	2700

a Estimated concentration in Yukon River within 5 feet of shoreline, assuming mixing is limited to river flow within that 5 feet. Upstream Galena Airport source contributions are included in these estimates.
b Fish bioconcentration factor. See Appendix J (Ecological Assessment Toxicity Profiles).
c Concentration in water (ug/L) x 1 L/kg x 1 mg/ 1000 ug x BCF (unitless).
d U.S. Environmental Protection Agency (USEPA) Region III, Risk-Based Concentration Table, January-June 1995, March 7, 1995.
e Range for thallium compounds.
NOTE: Shaded values exceed Region III RBC for tap water or fish.
NV = No value

contaminants in the groundwater at the POL Tank Farm would need to flow directly south.

The estimated fish concentrations are all below the Region III RBCs for fish. The surface water pathways are therefore not quantified for the POL Tank Farm.

Appendix C describes the groundwater modeling methodology and provides the groundwater modeling data. Likewise, Appendix D describes the emissions estimating and air dispersion modeling methodology and provides the air modeling results.

Conceptual Site Model

A conceptual site model presents the current understanding of possible sources of contamination and the likely mechanisms for movement of contamination within and beyond site boundaries. Figure 5-3 is a conceptual site model flow diagram showing the primary sources of contamination at the POL Tank Farm, their migration pathways, exposure media, and exposure routes that may lead to human exposure. The figure effectively summarizes the results of the human health exposure assessment. It illustrates complete exposure pathways for the exposure scenarios that are evaluated and indicates which pathways are quantified for each scenario. It also notes which pathways are possibly complete but probably not significant. These pathways are not quantified.

Quantification of Exposure

Table 5-11 provides a matrix of exposure scenarios and exposure pathways that are applicable to the POL Tank Farm and specifies the exposure points and data that were used to derive concentrations in the exposure media at this site. Appendix E summarizes the human health exposure point concentrations used to quantify exposure.

Note that only one building, Bldg. 1872, is being proposed for potential use as a boarding facility. Soil boring and soil gas data suggest that contamination is limited to the area south of the building. Groundwater data are available from several wells downgradient of Building 1872. Monitoring wells 05-MW-06, -12, and -13 have not indicated the presence of significant contamination from the northwest POL area. Samples from monitoring well 05-MW-11, located near a valve pit southeast of Building 1872, have contained from 10 to 30 μg/L benzene. There is no evidence of the presence of free product in this area.

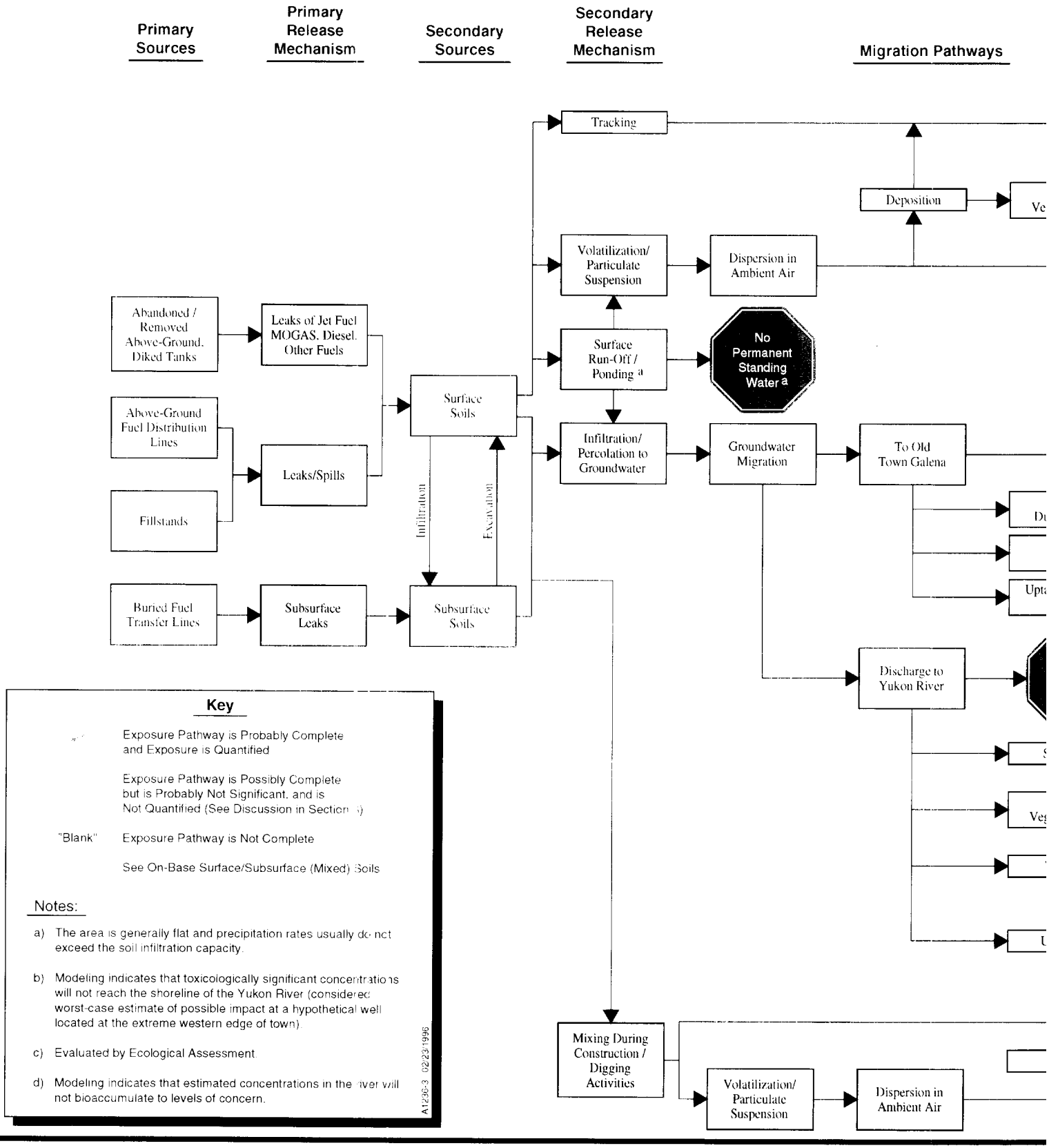
Section 3 describes the methods used to quantify exposure. Human health intake equations and exposure parameters are documented in Appendix F. Intakes were quantified separately for evaluation of carcinogenic and noncarcinogenic effects. Daily intakes for analysis of carcinogenic effects are averaged over a 70-year lifetime. Daily intakes for analysis of noncarcinogenic effects are averaged over the exposure duration only.

5.3.3 Toxicity Assessment

Table 5-12 presents the toxicity values used in the human health risk assessment for COPCs at the POL Tank Farm. Most of the toxicity values in this table were obtained from IRIS searches conducted in July 1995 or from HEAST (USEPA, 1994). Carcinogenic values for some PNAs were calculated using methodologies in provisional guidance for calculating potential potency based on values for benzo(a)pyrene (USEPA, 1993c). Although the oral slope factor for benzo(a)pyrene is listed in IRIS, the inhalation slope factor has been withdrawn from IRIS and HEAST. Since there is no inhalation unit risk for benzo(a)pyrene, the USEPA guidance directs that the potential potency values should be applied only to assess-

(1)

Figure 5-3. Human Exposure Conceptual M



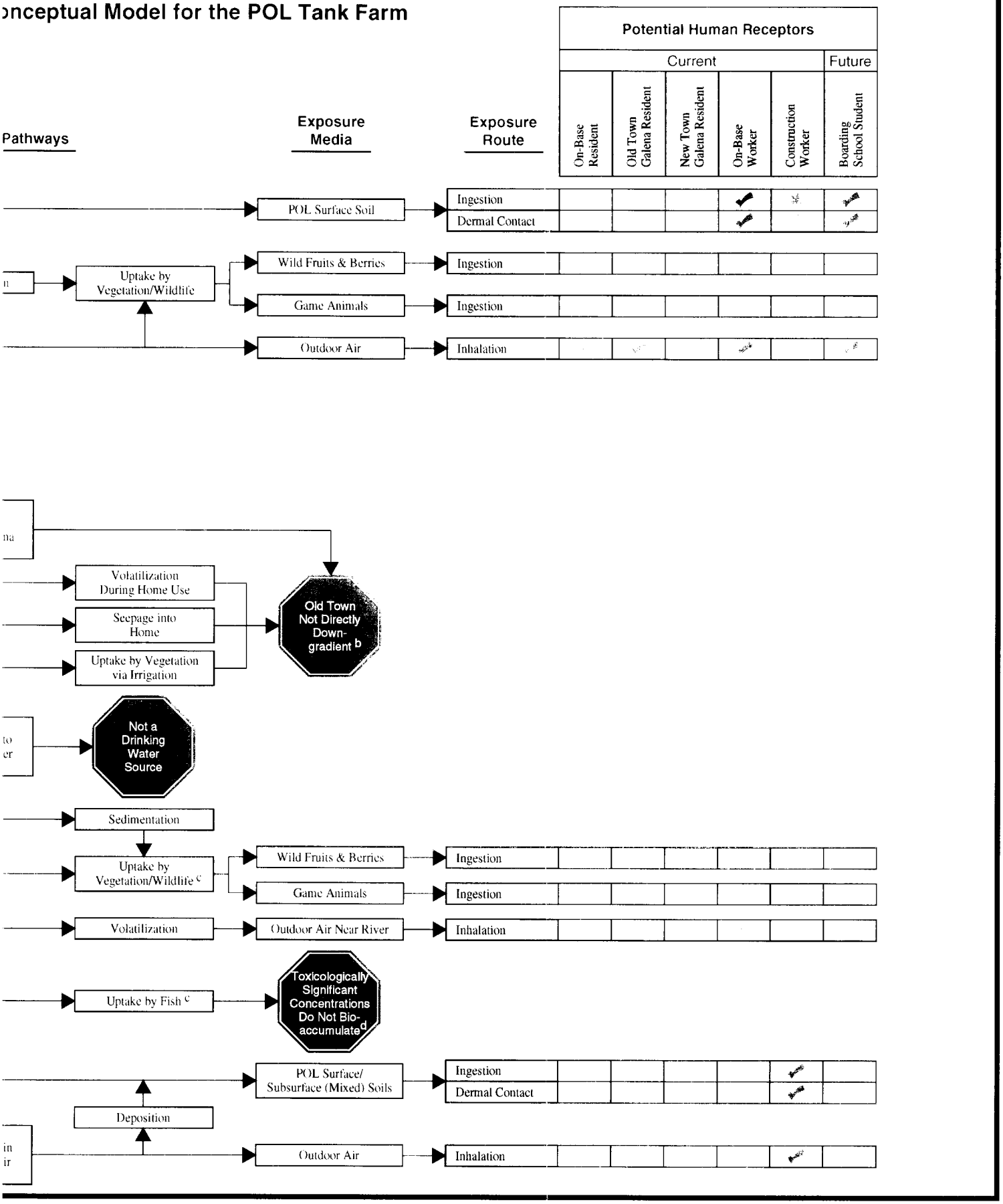


Figure 5-3. Human Exposure Conceptual Model for the POL Tank Farm

Table 5-11
Data Used to Derive Exposure Concentrations in Exposure Media at the POL Tank Farm

Exposure Scenario	Exposure Pathways		
	Ingestion of Soil	Dermal Contact with Soil	Inhalation of Vapor Phase Chemicals and Fugitive Dust in Ambient Air
Current Scenarios			
On-Base Residents -Short Term -Long Term	NA	NA	Modeled concentration of vapor phase chemicals (E) and wind-blown dust (F) at closest downwind on-base residential receptor.
Galena Residents	NA	NA	
-Old Town			Modeled concentration of vapor phase chemicals (E) and wind blown dust (F) at closest downwind Old Town Galena residential receptor.
-New Town			Modeled concentration of vapor phase chemicals (E) and wind-blown dust (F) at closest downwind New Town Galena residential receptor.
On-Base Workers			
-Short Term	Surface Soil (A)	Surface Soil (A)	Modeled concentration of vapor phase chemicals (E) and wind-blown dust (F) directly above the POL Tank Farm site.
-Long Term	Surface Soil (A)	Surface Soil (C)	Modeled concentration of vapor phase chemicals (E) and wind-blown dust (F) directly above the POL Tank Farm site.
-Construction	Mixed Soil (C)	Mixed Soil(C)	Modeled concentration of vapor phase chemicals (G) and dust generated by construction activity (H) directly above the POL Tank Farm site.
Future Scenarios			
Boarding School Student	Surface Soil (A)	Surface Soil (A)	Modeled concentration of vapor phase chemicals (E) and wind-blown dust (F) at the location of the proposed student dormitory.

Table 5-11
(Continued)

Exposure Media

Remedial Investigation Data:
(A) Measured concentrations in surface soils, represented by the 95% UCL, or the maximum detected concentration if lower, in soils within 2 ft of the ground surface at the POL Tank Farm (northwestern and southeastern areas of concern combined).
(B) Measured concentrations in subsurface soils, represented by the 95% UCL, or the maximum detected concentration if lower, in soils greater than 2 ft below the ground surface at the POL Tank Farm (northwestern and southeastern areas of concern combined).
(C) Mixed surface and subsurface soil, represented by the highest of either the surface soil concentration (A) or the subsurface soil concentration (B).
(D) Measured concentrations in shallow groundwater, represented by the 95% UCL, or the maximum detected concentration if lower, in groundwater at the POL Tank Farm (northwestern and southeastern areas of concern combined).

Transport and Fate Modeling:
(E) Estimated concentration of vapor phase chemicals in ambient air based on emissions from surface soil (A), subsurface soil (B), and groundwater (D) and dispersion modeling to specific receptor locations.
(F) Estimated concentration of wind-blown dust based on particulate emissions from surface soil (A) and dispersion modeling to specific receptor locations.
(G) Estimated concentration of vapor phase chemicals in ambient air right above the site assuming subsurface soil is brought to the surface by construction activities, based on emissions from mixed soils (C) and groundwater (D), and dispersion in the air above the site..
(H) Estimated concentration of dust generated by construction activities in air right above the site, based on particulate emissions from mixed soil (C) and dispersion in the air above the site.
NA = Not Applicable

Table 5-12
Toxicity Values for POL Tank Farm COPCs

COPCs	EPA Class	Chronic						Subchronic		Dermal Absorption Factor [a] (unitless)
		Oral RfD (mg/kg/day)	Inhal RfD (mg/kg/day)	Inhal RfC (mg/m³)	Oral SF 1/(mg/kg/day)	Inhal SF 1/(mg/kg/day)	Inhal Unit Risk 1/(µg/m³)	Oral RfD (mg/kg/day)	Inhal RfC (µg/m)	
Metals										
Iron		--	--	--	--	--	--	--	--	1.00E-02
Lead [e]	B2 [d]	--	--	--	--	--	--	--	--	--
Thallium (sulfate)	D [d]	8.00E-05 [d]	--	--	--	--	--	--	--	1.00E-02
PNAs										
2-Methylnaphthalene		--	--	--	--	--	--	--	--	--
Acenaphthene		6.00E-02 [d]	--	--	--	--	--	6.00E-01 [f]	--	--
Benz(a)anthracene	B2 [d]	--	--	--	7.30E-01 [h]	--	--	--	--	--
Benzo(a)pyrene	B2 [d]	--	--	--	7.30E+00 [d]	--	--	--	--	--
Benzo(b)fluoranthene	B2 [d]	--	--	--	7.30E-01 [h]	--	--	--	--	--
Benzo(g,h,i)perylene	D [d]	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	B2 [d]	--	--	--	7.30E+00 [h]	--	--	--	--	--
Fluorene	D [d]	4.00E-02 [d]	--	--	--	--	--	4.00E-01 [f]	--	--
Naphthalene	D [d]	4.00E-02 [f]	--	--	--	--	--	--	--	--
Phenanthrene	D [d]	--	--	--	--	--	--	--	--	--
Pesticides										
4,4'-DDD	B2 [d]	--	--	--	2.40E-01 [d]	--	--	--	--	1.00E-01
4,4'-DDE	B2 [d]	--	--	--	3.40E-01 [d]	--	--	--	--	1.00E-01
4,4'-DDT	B2 [d]	5.00E-04 [d]	--	--	3.40E-01 [d]	3.40E-01 [f]	9.70E-05 [d]	5.00E-04 [f]	--	1.00E-01
Aldrin	B2 [d]	3.00E-05 [d]	--	--	1.70E+01 [d]	1.70E+01 [f]	4.90E-03 [d]	3.00E-05 [f]	--	1.00E-01
alpha-BHC	B2 [d]	--	--	--	6.30E+00 [d]	6.30E+00 [f]	1.80E-03 [d]	--	--	1.00E-01
beta-BHC	C [d]	--	--	--	1.80E+00 [d]	1.80E+00 [f]	5.30E-04 [d]	--	--	1.00E-01
Dieldrin	B2 [d]	5.00E-05 [d]	--	--	1.60E+01 [d]	1.60E+01 [f]	4.60E-03 [d]	5.00E-05 [f]	--	1.00E-01
gamma-BHC	B2/C [f]	3.00E-04 [d]	--	--	1.30E+00 [f]	--	--	3.00E-03 [f]	--	1.00E-01
Heptachlor	B2 [d]	5.00E-04 [d]	--	--	4.50E+00 [d]	4.50E+00 [f]	1.30E-03 [d]	5.00E-04 [f]	--	1.00E-01
Heptachlor Epoxide	B2 [d]	1.30E-05 [d]	--	--	9.10E+00 [d]	9.10E+00 [f]	2.60E-03 [d]	1.30E-05 [f]	--	1.00E-01

Table 5-12
(Continued)

COPCs	EPA Class	Chronic						Subchronic		Dermal Absorption Factor [a] (unitless)
		Oral RfD (mg/kg/day)	Inhal RfD (mg/kg/day)	Inhal RfC (mg/m³)	Oral SF 1/(mg/kg/day)	Inhal SF 1/(mg/kg/day)	Inhal Unit Risk 1/(µg/m³)	Oral RfD (mg/kg/day)	Inhal RfC (µg/m)	
Semi-Volatiles										
2,4-Dimethylphenol	D [d]	2.00E-02 [d]	--	--	--	--	--	2.00E-01 [f]	--	1.00E-01
2-Butanone (MEK)	C [d]	6.00E-01 [d]	--	1.00E+00 [d]	--	--	--	2.00E+00 [f]	--	1.00E-01
2-Methylphenol (o-cresol)	C [d]	5.00E-02 [d]	--	--	--	--	--	5.00E-01 [f]	--	1.00E-01
3-Methylphenol (m-cresol)	C [d]	5.00E-03 [f]	--	--	--	--	--	5.00E-03 [f]	--	1.00E-01
4-Methylphenol (p-cresol)	C [d]	5.00E-02 [d]	--	--	--	--	--	5.00E-01 [f]	--	1.00E-01
Benzoic acid	D [d]	4.00E+00 [d]	--	--	--	--	--	4.00E+00 [f]	--	1.00E-01
bis(2-Ethylhexyl) phthalate	B2 [d]	2.00E-02 [d]	--	--	1.40E-02 [d]	--	4.00E-06 [g,i]	--	--	1.00E-01
Dibenzofuran	D [d]	4.00E-03 [c]	--	--	--	--	--	--	--	1.00E-01
Volatiles										
1,1-Dichloroethene	C [d]	9.00E-03 [d]	--	--	6.00E-01 [d]	--	5.00E-05 [d]	9.00E-03 [f]	--	1.00E-01
1,2-Dichloroethane	B2 [d]	--	2.86E-03 [c]	1.00E-02 [i]	9.10E-02 [d]	9.10E-02 [f]	2.60E-05 [d]	--	--	1.00E-01
Acetone	D [d]	1.00E-01 [d]	--	--	--	--	--	1.00E+00 [f]	--	1.00E-01
Benzene	A [d]	--	1.71E-03 [c]	6.00E-03 [i]	2.90E-02 [d]	2.90E-02 [f]	8.30E-06 [d]	--	--	1.00E-01
Bromochloromethane	D [d]	--	--	--	--	--	--	--	--	1.00E-01
Chloromethane	C [f]	--	--	--	1.30E-02 [f]	6.30E-03 [f]	1.80E-06 [i]	--	--	1.00E-01
Dibromomethane	--	--	--	--	--	--	--	--	--	1.00E-01
Ethylbenzene	D [d]	1.00E-01 [d]	--	1.00E+00 [d]	--	--	--	--	--	1.00E-01
Methylene chloride	B2 [d]	6.00E-02 [d]	--	3.00E+00 [f]	7.50E-03 [d]	--	4.70-07 [d]	6.00E-02 [f]	3.00E+00 [f]	1.00E-01
Toluene	D [d]	2.00E-01 [d]	--	4.00E-01 [d]	--	--	--	2.00E+00 [f]	--	1.00E-01
Trichloroethene	-- [j]	6.00E-03 [c]	--	--	1.10E-02 [b]	6.00E-03 [c]	1.70E-06 [i]	--	--	1.00E-01
Xylene (total)	D [d]	2.00E+00 [d]	--	--	--	--	--	--	--	1.00E-01

[a] Absorption factor of 1% was used for inorganic analytes and an absorption ofactor of 10% was used for organic analytes. PNAs are not evaluated for dermal exposures (see discussion in Section 3.1.4).
[b] These values were withdrawn from both IRIS and HEAST. However, Region III recommends using these values in deriving RBCs and they are presented in the Region III RBC table dated 1/31/95.
[c] Value was taken from Region III RBC table dated 1/31/95. The table states that this is a provisional vaue from EPA-ECAO Regional Support.
[d] U.S. Environmental Protection Agency (EPA), 1995. Integrated Risk Information Sytem (IRIS). Database search. First Quarter 1995.
[e] Risk from exposure to lead was evaluated using the USEPA IEUBK model.
[f] U.S. Environmental Protection Agency (EPA), 1994. Health Effects Assessment Summary Tables Annual Update, FY 1994. EPA 540-R-020, March 1994.
[g] Provisional value recommended by Superfund Health Risk Technical Support Center; this value is based on the oral slope factor for this chemical (Dollarhide, 1994a).
[h] PNA toxicity values were derived using the *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (EPA/600/R-93/089) dated July 1993.
[i] Value was calculated using the appropriate inhalation reference dose or inhalation slope factor with 20 m³ breathing rate and 70 kg adult body weight.
[j] Withdrawn.

ment of carcinogenic hazard from oral exposure to PNAs (USEPA, 1993c).

The inhalation RfDs for benzene, chlorobenzene, and 1,2-dichloroethane are provisional values recommended by the Superfund Health Risk Technical Support Center (footnoted EPA-ECAO in the USEPA Region III RBC table, USEPA, 1995). These provisional RfDs were converted to RfCs for use in the risk calculations. Provisional toxicity values are also used for naphthalene, dibenzofuran, and trichloroethene.

Toxicity values were not available for seven COPCs at the POL Tank Farm: lead, iron, benzo(g,h,i)perylene, phenanthrene, 2-methylnaphthalene, bromochloromethane, and dibromomethane. Lead was initially screened using the USEPA recommended screening level (400 mg/kg) for lead in soil for residential land use (USEPA, 1994c) and the drinking water action level for lead (USEPA, 1994e), and, if necessary, evaluated using the USEPA IEUBK model for lead in children (USEPA, 1994d). Available health effects information for these COPCs is included in Appendix G and the impact of the lack of toxicity values for these COPCs is discussed as an uncertainty in Section 5.3.5.

Dermal toxicity values are not listed in Table 5-12. Because of the high level of uncertainty associated with adjusting oral toxicity values (which are generally based on administered dose) to evaluate dermal exposure (which is calculated as an absorbed dose), unadjusted oral values were used to quantify dermal pathway risks. Dermal absorption factors used to quantify dermal exposures are listed in Table 5-12. Default values of 1% for inorganic analytes and 10% for organic analytes were used. PNAs were not evaluated for dermal exposure (see discussion in Section 3.1.4).

Appendix G contains toxicological profiles for all of the human health COPCs at the POL Tank Farm.

5.3.4 Risk Characterization

Carcinogenic risk and noncancer HIs were estimated for each exposure scenario according to procedures outlined in Section 3. Carcinogenic risk and noncarcinogenic risk estimates are presented in Appendix H.

Carcinogenic Effects

For each potentially carcinogenic COPC, the incremental probability that an individual will develop cancer over a lifetime was estimated from projected intake levels and the cancer slope factor or the inhalation unit risk. The USEPA Superfund site remediation goal set forth in the NCP designates a cancer risk of 10^{-4} (1 in 10,000) to 10^{-6} (1 in one million). This range is designed to be protective of human health and to provide flexibility for consideration of other factors in risk management decisions. A cancer risk of 1 in one million is considered the *de minimis*, or a level of negligible risk, for risk management decisions. A cancer risk higher than 1 in one million is not necessarily considered unacceptable. The State of Alaska plans to use a cancer risk level of 10^{-5} (1 in 100,000) in making risk management decisions (USAF, 1996b).

Table 5-13 summarizes the cancer risk estimates for each exposure scenario at the POL Tank Farm. The reasonable maximum cancer risk estimates for the short-term on-base worker and the boarding school student scenarios slightly exceed 1 in one million. The average and reasonable maximum cancer risk estimates for the long-term on-base worker also exceed 1 in one million. The cancer risk estimates for the construction worker exceed 1 in 100,000. None of the estimates exceeds the high end of the Superfund risk range goal (10^{-4}), although the

Table 5-13
Summary of Carcinogenic Risks[a] by Exposure Scenario for the POL Tank Farm

Scenario	Child		Adult	
	Average	Reasonable Maximum	Average	Reasonable Maximum
Current Scenarios				
Short-Term On-Base Resident	NA	NA	4E-08	1E-07
Long-Term On-Base Resident	1E-07	2E-07	2E-07	6E-07
Old Town Galena Resident	1E-08	2E-08	5E-08	2E-07
New Town Galena Resident	8E-10	1E-09	3E-09	1E-08
Short-Term On-Base Worker	NA	NA	2E-07	**2E-06**
Long-Term On-Base Worker	NA	NA	**3E-06**	**9E-06**
On-Base Construction Worker	NA	NA	**6E-05**	**1E-04**
Future Scenarios				
Boarding School Student[b]	4E-07	**2E-06**	NA	NA

NOTE: Risk estimates printed in bold type equal or exceed the Superfund site remediation threshold of 10^{-6} (1 in one million) for carcinogens.

[a]Carcinogenic risk is expressed as a unitless probability of an individual developing cancer.
[b]Age 15-18 (Grades 9-12) for the average case and age 6-19 (Grades 1-12, plus two repeat years) for the reasonable maximum case.

NA = Not Applicable

reasonable maximum estimate for the construction worker equals this goal.

The estimated cancer risks for all other scenarios are below 1 in one million. Estimated risks lower than 1 in one million are considered negligible and do not warrant remedial action.

The cancer risk estimate for the short-term on-base worker is based primarily (97%) on the inhalation of benzene that volatilizes from subsurface soils. Risk estimates from all other COPCs for short-term workers are less than 1 in one million.

Inhalation of benzene that volatilizes from subsurface soils contributes the majority of the risks for the long-term on-base worker (95% in the average case and 97% in the reasonable maximum case). Estimated risks from exposure to all other COPCs by the long-term worker are lower than 1 in one million.

Inhalation of benzene that volatilizes from subsurface soil that is brought to the surface by construction-related excavations contributes virtually 100% of the risks for the construction worker for both average and reasonable maximum exposure cases. Construction worker exposure to all other COPCs via inhalation, incidental ingestion, and dermal contact results in risks that are three to four orders of magnitude lower than the estimated risk from inhalation of benzene.

As in the previous scenarios, the inhalation of volatilized benzene (from subsurface soil) was the primary contributor (90%) to the total risk estimate for the boarding school student scenario. Estimated risks from all other COPCs by boarding school students are lower than 1 in one million.

Risk summary tables for each exposure scenario are provided in Appendix H. The tables detail the cancer risk estimates for each applicable chemical and exposure pathway and show the percent contribution of each chemical and pathway to the total estimated risk.

Noncarcinogenic Effects

To characterize the potential noncancer effects of chemicals, comparisons were made between projected intakes of COPCs over a specified time and toxicity values, primarily oral RfDs and inhalation RfCs. An HQ, which is the ratio between exposure to a chemical and that chemical's toxicity value, was calculated for each noncarcinogenic COPC and exposure pathway. Chemical-specific HQs were then summed for each COPC and each pathway of exposure to calculate the total HI.

The HI is not a statistical probability of a systemic effect occurring. If the exposure level exceeds the appropriate toxicity value (i.e., the HQ is greater than 1), there may be cause for concern. The Superfund site remediation goal for noncarcinogens is a total HI of 1 for chemicals with similar toxic endpoints.

Table 5-14 summarizes the noncancer hazard estimates for each exposure scenario. The HIs for all scenarios are well below the Superfund site remediation goal of 1 for noncarcinogens, indicating that there is little cause for concern about noncarcinogenic effects.

Noncancer risk summary tables for each exposure scenario are provided in Appendix H. The tables detail the noncancer hazard estimates for each applicable chemical and exposure pathway and show the percent contribution of each chemical and pathway to the total estimated HI.

Table 5-14
Summary of Noncarcinogenic Hazard Indices[a] by Exposure Scenario for the POL Tank Farm

Scenario	Child		Adult	
	Average	Reasonable Maximum	Average	Reasonable Maximum
Current Scenarios				
Short-Term On-Base Resident	NA	NA	< 0.001	< 0.001
Long-Term On-Base Resident	0.03	0.04	0.03	0.04
Old Town Galena Resident	0.003	0.004	0.003	0.004
New Town Galena Resident	< 0.001	< 0.001	< 0.001	< 0.001
Short-Term On-Base Worker	NA	NA	< 0.001	< 0.001
Long-Term On-Base Worker	NA	NA	0.2	0.5
On-Base Construction Worker	NA	NA	< 0.001	0.002
Future Scenarios				
Boarding School Student[b]	< 0.001	0.1	NA	NA

NOTE: HIs printed in bold type equal or exceed the Superfund site remediation goal of 1 for non-carcinogens.

[a]Noncarcinogenic risk is not expressed as a probability of an adverse effect but rather a comparison between exposure and a reference dose (HI).
[b]Age 15-18 (Grades 9-12) for the average case and age 6-19 (Grades 1-12, plus two repeat years) for the reasonable maximum case.

NA = Not Applicable

Effects of Exposure to Lead

The maximum detected concentrations of lead at the POL Tank Farm are 480 mg/kg in the surface soil and 16 μg/L in the groundwater. It is not present in subsurface soils above the background levels. The maximum surface soil concentration is slightly higher than the 400 mg/kg recommended screening level for lead in residential soil (USEPA, 1994c), which was derived using the IEUBK lead model (USEPA, 1994d). The maximum detected groundwater concentration also slightly exceeds the 15 μg/L drinking water action level for lead at the tap (USEPA, 1994e). The 95% UCL lead concentration in surface soil (86 mg/kg) and in groundwater (11 μg/L) are below the respective screening levels. However, the IEUBK model and California Department of Toxic Substances Control (DTSC) lead model were run to evaluate lead uptake by children (boarding school students) and workers, respectively, at the POL Tank Farm.

The 95% UCL lead concentrations in the surface soil and in the groundwater at the POL Tank Farm were used to quantify lead uptake. The IEUBK model predicts a geometric mean blood lead level associated with ingestion of groundwater and ingestion of and dermal contact with soils at the site of 3.1 μg/dL in children. The model predicts that the percentage of the exposed population that will have blood lead levels exceeding 10 μg/dL, the "concern threshold" identified by the Centers for Disease Control (CDC), is 0.61%. USEPA guidance suggests that the percentage of the target population (i.e., exposed children) that exceeds the level of concern should not exceed 5% (USEPA, 1994c). These results indicate that potential lead exposures are not expected to contribute significantly to the risk for children (i.e., boarding students) who may contact soils at the POL Tank Farm. The California DTSC lead risk assessment spreadsheet model, Version 1.1, (California DTSC, 1992) confirms the IEUBK model results for children and also indicates that estimated blood lead levels in adults (99th percentile blood lead concentration of 3.6 μg/dL) are well below levels of concern. The model output is provided in Appendix H.

Major Factors Driving Estimated Risks

Tables 5-15 and 5-16 present a risk characterization summary for carcinogenic risk estimates and noncarcinogenic hazard estimates, respectively. For each scenario the tables specify the exposure pathways that were quantified, the estimated risks for each case, the chemicals and pathways that are major contributors to the estimated risks, and the primary uncertainties associated with the estimates.

The only chemical and pathway that contribute a chemical- and pathway-specific risk greater than 1 in one million is inhalation of benzene by:

1. A short- or long-term worker who works outdoors in the vicinity of the POL Tank Farm for 8 hours/day, 5 days/week, for 5 or more years; and

2. A construction worker who works in the immediate vicinity of the POL Tank Farm for 8 hours/day, 5 days/week for 3-6 months.

Inhalation of benzene by the hypothetical future boarding school students under reasonable maximum exposure conditions results in a chemical- and pathway-specific risk of 1 in one million (1.4E-06 unrounded).

The estimated annual average concentration of benzene in the air at the POL Tank Farm resulting from volatilization from subsurface

Table 5-15
Risk Characterization Summary for the POL Tank Farm: Carcinogenic Risks

Scenario	Pathways Quantified	Case	Estimated Total Cancer Risk [a]		Chemicals and Pathways that Contribute a Chemical- and Pathway-Specific Cancer Risk Greater than 1 in One Million [b]	Primary Site-Specific Uncertainties
			Average	Reasonable Maximum		
Current Scenarios						
Short-Term On-Base Resident (subchronic)	1. Inhalation of vapors and dust	Adult	4E-08	1E-07	None	Applicability of cancer risk estimation methodology to subchronic exposure durations.
Long-Term On-Base Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	1E-07 2E-07	2E-07 6E-07	None	Duration of residence.
Old Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	1E-08 5E-08	2E-08 2E-07	None	Risk from accessing the site was not quantified.
New Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	8E-10 3E-09	1E-09 1E-08	None	Risk from accessing the site was not quantified.
Short-Term On-Base Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	2E-07	**2E-06**	Inhalation of benzene in ambient air.	Nature and duration of work activities at the POL area. Applicability of cancer risk estimation methodology to subchronic exposure durations.
Long-Term On-Base Worker (chronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	**3E-06**	**9E-06**	Inhalation of benzene in ambient air.	Nature and duration of work activities at the POL area. Emissions of benzene from subsurface soils.
On-Base Construction Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	**6E-05**	**1E-04**	Inhalation of benzene in ambient air.	Duration of construction activity. Emissions of benzene from subsurface soils during soil excavation. Applicability of cancer risk estimation methodology to subchronic exposure durations.
Future Scenarios						
Boarding School Student (subchronic/ chronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Student	4E-07	**2E-06**	Inhalation of benzene in ambient air.	Extension of facility from Grades 9-12 to Grades 1-12. Use of site as a "yard."

[a] Estimated cancer risks printed in bold type equal or exceed the Superfund site remediation threshold of 1E-06 (1 in one million).
[b] Applicable only if the total cancer risk exceeds 1 in one million (estimated risk printed in bold type in column titled "Estimated Total Cancer Risk").

Table 5-16
Risk Characterization Summary for the POL Tank Farm: Noncarcinogenic Risks

Scenario	Pathways Quantified	Case	Estimated Total Hazard Index [a]		Chemicals and Pathways that Contribute a Chemical- and Pathway-Specific Noncancer Hazard Quotient Greater than 1 [b]	Primary Site-Specific Uncertainties
			Average	Reasonable Maximum		
Current Scenarios						
Short-Term On-Base Resident (subchronic)	1. Inhalation of vapors and dust	Adult	< 0.001	< 0.001	None	Lack of subchronic inhalation toxicity values for COPCs.
Long-Term On-Base Resident (chronic)	1. Inhalation of vapors and dust	Child	0.03	0.04	None	Duration of residence.
		Adult	0.03	0.04		
Old Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child	0.003	0.004	None	Risk from accessing the site was not quantified.
		Adult	0.003	0.004		
New Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child	< 0.001	< 0.001	None	Risk from accessing the site was not quantified.
		Adult	< 0.001	< 0.001		
Short-Term On-Base Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	< 0.001	< 0.001	None	Nature and duration of work activities at the POL area. Lack of subchronic inhalation toxicity values for COPCs.
Long-Term On-Base Worker (chronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	0.2	0.5	None	Nature and duration of work activities at the POL area. Emissions of benzene from subsurface soils.
On-Base Construction Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	< 0.001	0.002	None	Duration of construction activity. Emissions of benzene from subsurface soils during soil excavation. Lack of subchronic inhalation toxicity values for COPCs.
Future Scenarios						
Boarding School Student (subchronic/ chronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Student	< 0.001	0.01	None	Extension of facility from Grades 9-12 to Grades 1-12. Use of site as a "yard."

[a]Hazard indices printed in bold type equal or exceed the Superfund site remediation goal of 1 for noncarcinogens.
[b]Applicable only if the total hazard index exceeds 1.

soils is 4.2 $\mu g/m^3$. This estimated concentration is well below both the proposed ACGIH TLV and the OSHA PEL (960 and 3,200 $\mu g/m^3$, respectively) for worker exposure to benzene. Assuming excavation activities that expose the subsurface soils, the estimated concentration of benzene in the air during construction work is 2,700-2,800 $\mu g/m^3$. Although these estimated air concentrations exceed the ACGIH TLV, the OSHA PEL and TLV are designed to be protective of long-term worker exposure to benzene. The estimated air concentrations during construction work do not exceed the OSHA PEL.

Air sampling conducted by the USAF in and around the entire Galena Airport indicates that benzene concentrations that exceed the USEPA Region III RBC for air (0.22 $\mu g/m^3$) are widespread; elevated levels due to anthropogenic-related activities exist in the entire area surrounding Galena (USAF, 1994c). Benzene results in the POL area ranged from 0.54 $\mu g/m^3$ to 10 $\mu g/m^3$ upwind and 1.2 to 30 $\mu g/m^3$ downwind. The air sample results may be due to refueling operations, vehicular traffic, and aircraft activity, in addition to any contribution from benzene-contaminated soils. It is not possible to differentiate the sources contributing to the measured concentrations of benzene in the air. It is possible that the contribution of benzene emissions from contaminated soils is minor compared with sources related to the operation of an airport.

The emission estimates for benzene from subsurface soil during construction work are likely biased high. The emissions calculation assumes that all subsurface soils containing benzene are exposed and essentially become surface soils. It is more likely that excavations during construction would involve less than 100% of the contaminated area, unless the purpose of the excavation is to remove contaminated soil.

Moreover, excavation activities for building foundations, underground utilities, and the like generally only occur in the first few weeks of a construction project and certainly would not continue throughout the duration of the project.

5.3.5 Uncertainty Assessment

The risk characterization results are not fully probabilistic estimates of risk but rather conditional estimates of risk that should be interpreted in light of the considerable number of assumptions required to quantify exposure, intake, and dose-response. Uncertainties associated with identification of COPCs, the exposure assessment, and the toxicity assessment all contribute to the level of confidence that can be placed in the risk characterization results.

In general, risk assessment uncertainty was addressed in the BRA by the following actions:

1. Incorporating both average and reasonable maximum values for input parameters, whenever possible, to provide a

   range of results rather than a single value;

2. Erring on the side of conservatism when defining the reasonable maximum case; and

3. Identifying and discussing the major sources of uncertainty and their effect on the risk estimates so that the results can be properly interpreted.

Table 5-17 summarizes the primary sources of uncertainty specific to this assessment and the likely impact on risk estimates.

5.3.6 Conclusions and Recommendations

Environmental contamination at the POL Tank Farm does not pose an unacceptable health risk to current on-base residents or Old and New Town Galena residents. Risks that exceed 1 in one million for the short- and long-term on-base worker and the hypothetical future boarding school student cannot be distinguished from the risks of exposure to benzene in the air contributed by sources associated with an operating airport.

Estimated risks for the construction worker are elevated above the threshold risk of 1 in one million, but do not exceed the high end of the Superfund risk range goal. The reasonable maximum estimate equals this goal, but this estimate is attributable entirely to modeled benzene emissions during construction work which are very likely overestimated. The risk estimates for the construction worker, which are driven by inhalation of benzene, are biased high. Actual risks are likely much lower.

On the basis of the results of the human health assessment, remedial action at the POL Tank Farm is not warranted.

5.4 Ecological Risk Assessment Results

5.4.1 Site Ecology

Figure 5-4 shows the location of the features of the POL Tank Farm, including topography. The POL Tank Farm consists primarily of industrial development, and thus ecological features are limited. Mixed deciduous taiga exists outside of the installation dike and perimeter fence northeast of the POL tank site. Vegetation has been noted within the diked area but is generally sparse and consists mostly of grasses. Willows grow along some dike slopes and in the southeast corner of the site. Small mammals (such as muskrat, fox, and rodents) and birds could potentially be exposed to potential site contaminants. However, wildlife habitat is poor at the POL Tank Farm. Use of this area by fauna would be marginal at best, and is likely limited to small mammals such as the meadow vole and common birds such as the cliff swallow and robin. Owing to the lack of accessible habitat and human activities, receptor exposure to surface soil for the POL Tank Farm was not evaluated. Groundwater located beneath the site that has migrated to the shoreline and Yukon River was evaluated for aquatic and semiaquatic receptors (i.e., pike, invertebrates, and spotted sandpiper).

5.4.2 Chemicals of Potential Ecological Concern

The results of the RI suggest that fuel transport, handling, and storage activities at the POL Tank Farm resulted in the contamination of surface soil, subsurface soil, and groundwater. A soil gas survey conducted at the site identified several areas of potential contamination from volatile organic compounds (VOCs) in surface soils (Figure 5-4). As stated above, ecological receptor exposure to soil was not considered because of the lack of habitat. Thus, there are no COPECs for soil. A groundwater model was developed to estimate potential migration of chemicals to the Yukon River. POL Tank Farm groundwater COPECs are presented in Table 5-18. It includes all chemicals in the groundwater that were greater than background and blank concentrations, and that were not eliminated as essential nutrients.

5.4.3 Exposure Assessment

Figure 5-5 shows the conceptual model for potential receptors and exposure pathways at the POL Tank Farm. The area provides little ecological habitat because of industrial develop-

Table 5-17
Summary of the Major Uncertainties Associated with the Risk Estimates

Source of Uncertainty	Impact on Risk Characterization
Chemicals of Potential Concern	
Samples representing site media	Could result in an overestimate or underestimate of risks if the samples do not adequately represent media at the site. However, the number and location of samples collected at the POL Tank Farm were sufficient to identify the area of contamination in soils and groundwater and assess the magnitude and extent of contamination.
Analytical methods used to test samples	If the analytical methods used do not apply to some chemicals that are present at the site, risks could be underestimated. Since a full suite of analytical methods was selected to test for chemicals known or suspected to be present at the site, the potential for underestimation is reduced. In some cases, different methods were used to test for the same analyte during different phases of the RI. In such cases, data from one method were selected to derive representative concentrations in a medium.
Presence of pesticides	Pesticides detected at the POL Tank Farm were evaluated in the same fashion as all other COPCs. However, the pesticides result from widespread application for insect control and estimated risks from exposure to pesticides are not attributable to the POL Tank Farm.
Contamination of blanks	Sporadic presence of chemicals in blanks samples was accounted for in blanks comparison. Blanks data do not indicate extensive field or laboratory contaminants.
Tentatively identified compounds	Tentatively identified compounds were not reported or assessed. Most such chemicals are not known to be highly toxic.
Diesel Range Organics and Gasoline Range Organics	DRO and GRO were not evaluated in the risk assessment as groups of chemicals. The assessment addresses individual chemicals only that were speciated by chemical analysis, which includes many constituent compounds of DRO and GRO. However, some constituent compounds were not on the target analyte list. The majority of the risk associated with exposure to DRO and GRO is probably accounted for in an assessment of individual chemicals.
Detection Limit Adequacy	The minimum detection limit for only one analyte in soil that was eliminated as a COPC (because it was not detected) exceeds USEPA Region III residential soil ingestion RBCs—thallium. The same is true for a number of metals, PNAs, pesticides, VOCs, and PCBs in groundwater (when compared to Region III tap water RBCs). If these analytes are in fact present at the site and were contributed to the site by site-related activites, the estimated risks for this site may be underestimated. However, since 1993 and later sampling events reported uncensored data (where an ND is reported only if there is no instrument response), the impact on the risk estimates is minimized.

Table 5-17
(Continued)

Source of Uncertainty	Impact on Risk Characterization
Exposure Assessment	
Use of current measured concentrations to represent current and future concentrations in the exposure media	Because concentrations of chemicals in the soils and groundwater at the POL Tank Farm may decrease over time as the chemicals migrate and/or degrade, risk estimates for the current scenarios do not necessarily represent risks that will occur in the future.
Estimation of volatile emissions to the ambient air	The methodology used to estimate volatile emissions to the air is conservative and probably results in an overestimate of risks from inhalation of benzene.
Estimation of volatile emissions to indoor air	Estimation of volatile emissions from the groundwater to indoor air was not performed. The building slated as the student dormitory does not overlie a groundwater plume. The civilian flight services buildings do overlie the main POL groundwater plume. Indoor air monitoring results for benzene, toluene, ethylbenzene, and xylene are available for Larry's Flying Service building, Frontier Flying Service building, and Mark Air Express building (USAF, 1994b). Of the 10 samples collected inside these buildings, four positive results were obtained: 3.1, 3.2, 4.3, and 30 $\mu g/m^3$. Results could not be quantified for the six other samples at limits of detection ranging from 3 to 44 $\mu g/m^3$. The modeled annual-average ambient air benzene concentration in the POL area from emissions from contaminated soil was 4.2 $\mu g/m^3$, and this value was used to quantify risks to workers in the POL area. This value is not significantly different than three of the four measured results for indoor air in the area. The report (USAF, 1994b) concludes that "it is difficult to differentiate the POL contribution from the civilian refueling operations for a number of reasons: 1) the civilian flying services and POL results are variable and do not clearly identify where contaminants originate, 2) there is a large number of refueling tanks used in the civilian air operations, 3) many of the civilian aircraft buildings have evidence of past or current storage of fuel oil and other petroleum products (e.g., gasoline), with evidence of spills and leaks outside of the buildings and, 4) all of the hanger openings are right on the apron and aircraft pass directly by the entrance to the hangars."
Groundwater modeling	Results of groundwater modeling are indicative of worst-case concentrations that might reach the Yukon River. Impacts are likely overestimated, including uptake by fish.

Table 5-17
(Continued)

Source of Uncertainty	Impact on Risk Characterization
Exposure Assessment (Continued)	
Access to site	Access to the POL Tank Farm is open. On-base residents and Galena residents are not restricted from walking onto the site. Exposure of a roaming resident was not quantified (see discussion in Section 3). If a resident spends a significant amount of time in the POL Tank Farm area, estimated risks for that resident may be under-estimated. However, it was assumed that the boarding student essentially uses the POL area as a yard and incidental ingestion of and dermal contact with soils was quantified for this scenario. Since the boarding student will attend school in Galena, and is expected to find more attractive areas to use as a "yard," the risks for this scenario are probably overestimated.
Construction worker scenario	The exposure duration for this scenario is biased high.
Base water supply	Migration of chemicals in the groundwater of the POL area to base supply wells was not evaluated (see discussion in Section 3). If the contaminant plume migrates to base supply wells and the planned water treatment system does not function as designed, risks for users of the base water supply (resident and workers) may be underestimated.
Exposure parameter estimation	The standard assumptions regarding body weight, period exposed, life expectancy, and population characteristics may not be representative of any actual exposure situation. Some assumptions may underestimate risks, but most probably overestimate risk. In some cases, nonstandard assumptions were used for site-specific reasons, such as the reasonable maximum exposure duration of 70 years for Galena residents. The use of a 14-year exposure duration for the boarding school student overstates the likely duration of residence for most students.
Toxicity Assessment	
Absence of toxicity values for some chemicals detected at the site	Lack of toxicity values may underestimate risk; however, most chemicals that lack toxicity values are not very toxic or carcinogenic. Therefore, the degree of underestimation is probably low.
Use of unverified toxicity values for some chemicals	Could overestimate risk. However, chemicals with unverified toxicity values do not contribute significantly to estimated risks at the POL Tank Farm.

Table 5-17
(Continued)

Source of Uncertainty	Impact on Risk Characterization
Toxicity Assessment (Continued)	
Bases for derivation of toxicity values	Some common sources of uncertainty in toxicity values include 1) Use of information obtained from dose-response studies conducted in laboratory animals to predict effects that are likely to occur in humans; 2) use of dose-response information from effects observed at high doses to predict adverse health effects that may occur at the low levels to which humans are likely to be exposed in the environment; 3) use of information obtained from short-term exposure studies to predict health effects in humans exposed on a long-term basis; 4) use of toxicity values that have been developed for one route of exposure and employing it under a different exposure route; and 5) use of information gathered in studies using homogeneous animal populations (inbred strains) or healthy human populations (occupational exposures) to predict the effects that are likely to occur in the general human population.
Absence of dermal toxicity values	Unadjusted oral toxicity values were used to evaluate dermal exposures. Since most oral values are based on administered dose and dermal exposure is quantified as an absorbed dose, risks from dermal exposure might be underestimated. PNAs were not evaluated for dermal exposures per USEPA guidance (see discussion in Section 3). PNAs are associated with neoplasia in a variety of mammalian systems. The inability to quantify risks from dermal exposure to PNAs results in an underestimation of risks for the dermal pathway for PNAs.
Possible synergistic or antagonistic effects of exposure tomultiple chemicals	Unknown impact on risk estimates. Chemical- and pathway-specific risk and hazard quotients are summed to account for possible additive effects.
Risk Characterization	
Applicability of cancer risk estimation methodology to subchronic exposure durations	The estimated intake for cancer risk estimation is averaged over a 70-year period. Exposure to higher concentrations of potential carcinogens for a short duration of time probably does not have the same effect as exposure to lower concentrations over a long duration.

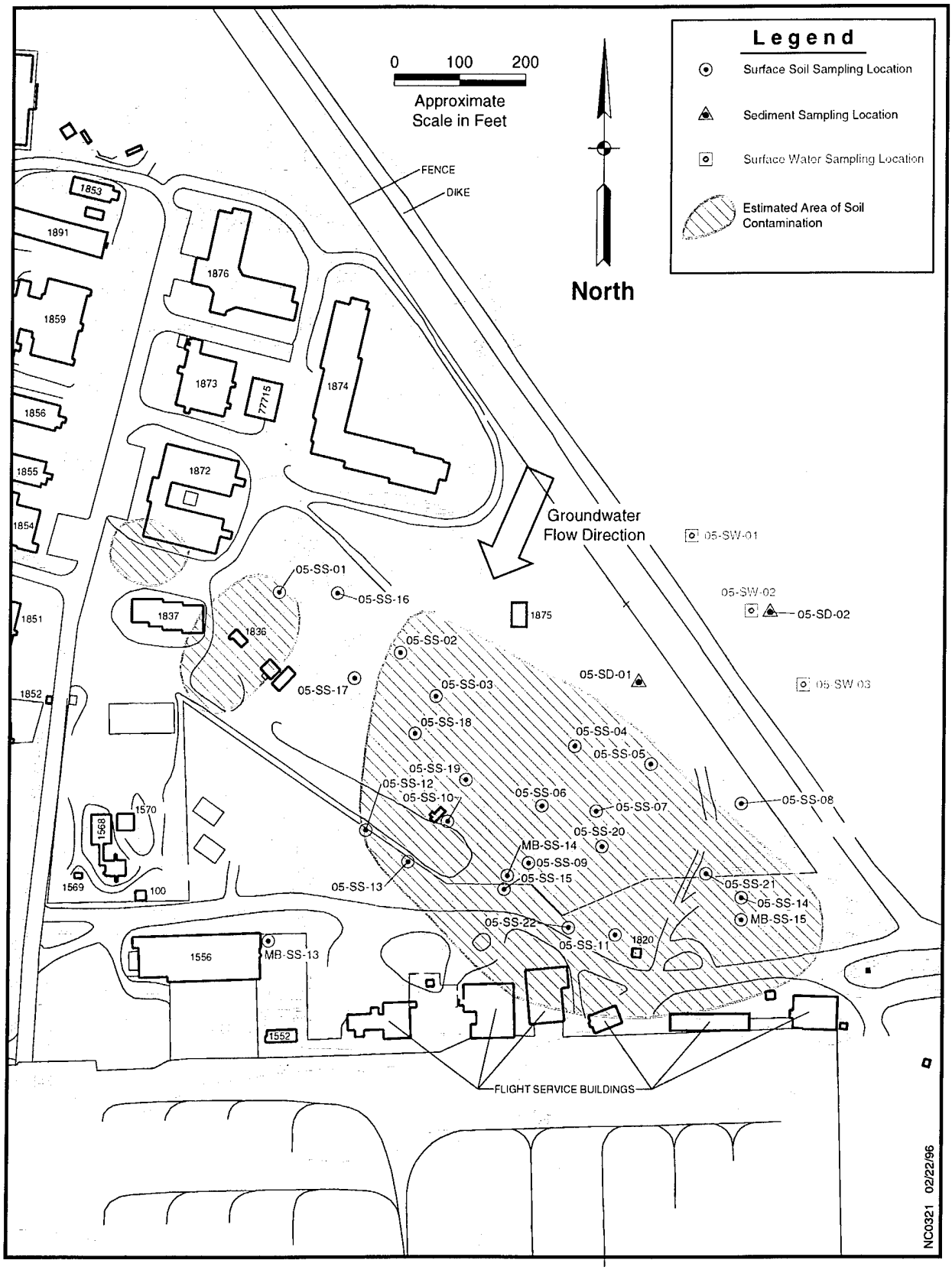


Figure 5-4. Galena Airport - POL Area

Table 5-18
Chemicals of Potential Ecological Concern at the POL in Discharged Groundwater

Chemical	
Metals	
Lead	Thallium
PNAs	
2-methylnaphthalene	Naphthalene
Acenaphthylene	Phenanthrene
Fluroene	
Pesticides	
4,4-DDD	Dieldrin
4,4-DDE	Endosulfan I
4,4-DDT	Endosulfan sulfate
Aldrin	gamma-BHC
alpha-BHC	Heptachlor
beta-BHC	Heptachlor epoxide
Dioxins	
Dibenzofuran	
Semivolatiles	
,bis(2-ethylhexyl)phthalate	4-Methylphenol
2,4-Dimethylphenol	4-Methylphenol/3-Methylphenol
2-Butanone	Benzoic acid
2-Methylphenol	Benzyl alcohol
4-Methyl-2-Pentanone	Phenol
Volatiles	
1,1-Dichloroethene	Dibromomethane
1,2-Dichloroethane	Ethylbenzene
Acetone	Methylene chloride
Benzene	Toluene
Bromochloromethane	Trichloroethane
Chlorobenzene	Trichlorofluoromethane
Chloroethane	Xylene
Chloromethane	

Note: No other media evaluated for COPECs.

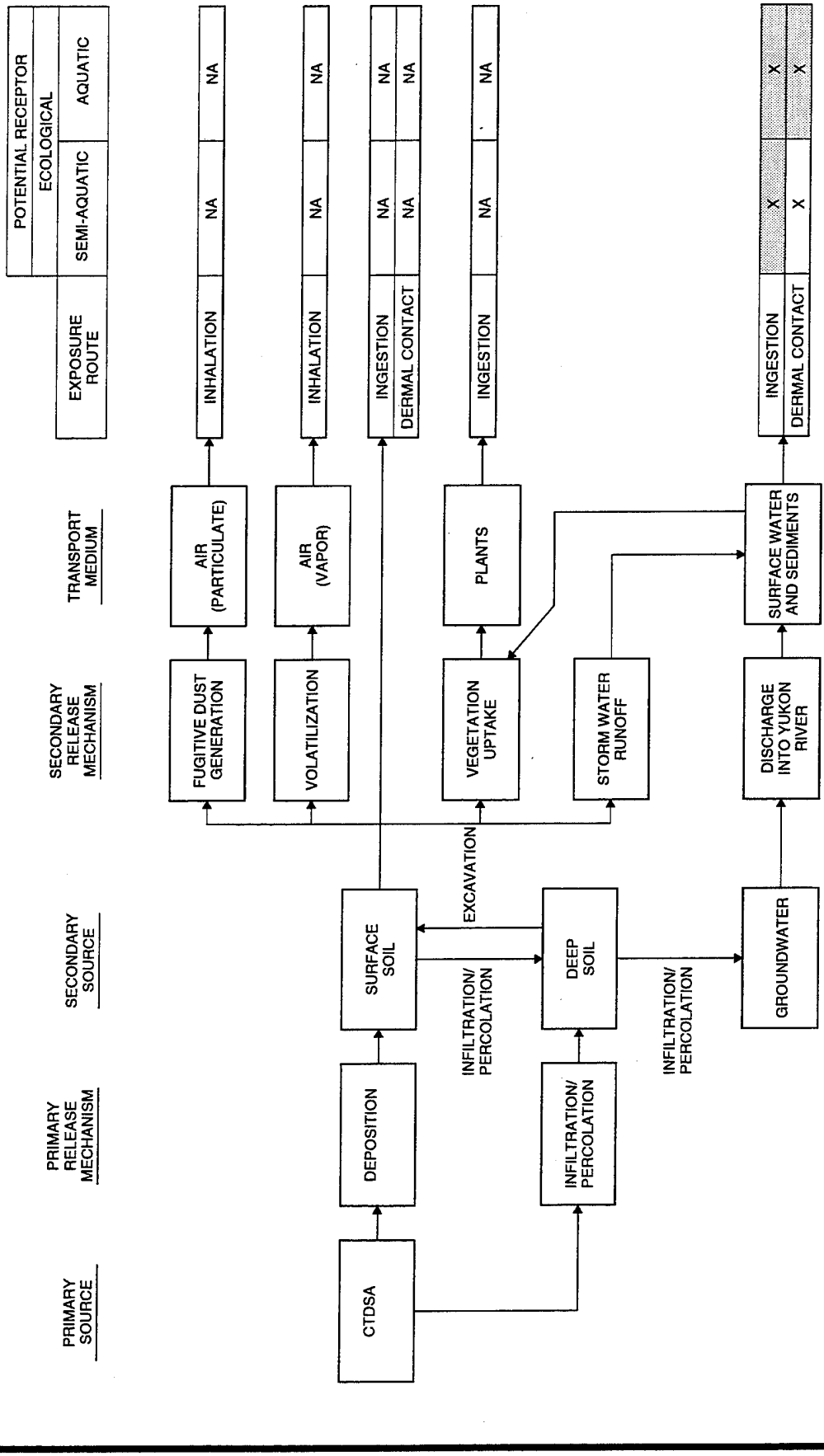


Figure 5-5.
Conceptual Site Model Showing Potential Ecological Receptors and Exposure Pathways at the POL Tank Farm

ment, human activity, and lack of vegetation. Transportation of contaminants to the Yukon River, via groundwater was the only exposure pathway evaluated. Ecological receptors evaluated in this pathway were the northern pike in the Yukon River and invertebrates and spotted sandpipers at the shoreline. This pathway is the only potentially ecologically significant exposure route for these source areas. The assessment and measurement endpoints are shown in Table 5-19.

5.4.4 Effects Assessment

EQs were calculated for the assessment endpoint species at the POL Tank Farm. The results of this evaluation are presented in Table 5-20. Supporting spreadsheets are presented in Appendix K.

5.4.5 Ecological Risk Characterization

Table 5-21 lists the EQ values greater than 1 for the aquatic and semiaquatic species. This table also provides the order of magnitude for the EQ results.

5.4.6 Uncertainty Assessment

Uncertainty occurs in almost every step of the ERA process. As stated previously, uncertainty is addressed by making intentionally biased (health conservative) assumptions so that impacts will not be underestimated. Individual assumptions are therefore conservative, but because of compounded bias, the calculated EQs are biased higher than any individual assumptions. Table 3-9 lists uncertainties associated with the entire Phase I ERA. Table 5-22 lists uncertainties associated with the ERA conducted for the POL Tank Farm.

5.4.7 Conclusions and Recommendations

Aquatic (surface water → pike)

This exposure pathway considered groundwater beneath the POL that potentially could migrate to the Yukon River where exposure to the northern pike potentially could occur. Two compounds had EQs above 1. 2-Methylnaphthalene (EQ = 28.5) exhibited an EQ in the probable impact category, and 4,4-DDE (EQ = 1.13) exhibited an EQ in the possible risk category. The AWQC was used as the measurement endpoint for 4,4-DDE and an LC_{50} for the fathead minnow was the measurement endpoint for 2-methylnaphthalene. An uncertainty factor of 10,000 was applied to the LC_{50}, since the study considered acute exposure and the assessment species and the test species (measurement endpoint) were from different orders (Pike - *Clupeiformes*, minnow - *Cypriniformes*). AWQC are highly conservative since they are designed to protect all aquatic life.

The EQ for DDT in the pike did not exceed 1 (EQ = 0.317) while the breakdown product DDE did (EQ = 1.13). DDE has been correlated with reduced eggshell thickness and brood sizes of ospreys, bald eagles, and some species of falcons (Weimeyer, 1991). Effects to aquatic systems (e.g., the pike) would be minimal compared to the effects to the higher trophic levels (fish eating birds). The fact that the concentration of DDE (1.13E-06 mg/L) is higher than DDT (3.17E-07) indicates that no new sources of DDT are present, and what is in the ecosystem is being degraded. Moreover, pesticides (DDT) were historically broadcast throughout the Airport for pest control, and the POL Tank Farm does not represent an isolated area of high concentration.

Actual impacts to aquatic receptors is likely less than the EQs indicate and are not likely to be significant. That is, the dilution effects of the groundwater model are very conservative, and actual dilution by the Yukon River is likely sufficient to reduce exposure potential to levels too low to produce significant risk. Moreover, PNAs are metabolized by fish

Table 5-19
Assessment and Measurement Endpoints for the Evaluation of Surface Water[a] Contaminants Originating From the POL Tank Farm

Assessment Endpoint	Measurement Endpoint
Decrease in aquatic invertebrate productivity and local population survivorship.	AWQC for the protection of aquatic life.[b]
Decrease in spotted sandpiper productivity and survivorship.	LOAELs[c] with effects such as decreased eggshell thickness or reduced survival.
Decrease in local northern pike productivity and population survivorship in the Yukon River.	LOAELs[c] with effects such as decreased gamete production, growth rate, or reduced survival.

[a] Individual surface water areas include where mudflats exist part of the year. The aquatic ecosystem is the Yukon River. Modeled groundwater data that migrated from the site to the mudflats and Yukon River was used.

[b] If AWQCs are unavailable (including AWQC recommended LOAELs), LC_{50} values were used.

[c] If LOAELs are unavailable, LC_{50} values were used.

Table 5-20
Summary of Aquatic and Semiaquatic EQs

Chemical	Northern Pike EQ	Aquatic Invertebrate EQ	Sandpiper EQ
1,1-Dichloroethene	1.78e-10	2.38e-08	2.85e-07
1,2-Dichloroethane	5.52e-07	3.82e-05	9.94e-05
2,4-Dimethylphenol	2.75e-44	2.96e-43	2.21e-41
2-Butanone (MEK)	2.23e-46	5.20e-44	9.37e-45
2-Methylnaphthalene	**2.85e+01**	**6.95e+03**	**2.84e+02**
2-Methylphenol(o-cresol)	8.63e-46	1.16e-43	2.00e-45
4,4'-DDD	9.22e-01	**1.24e+02**	**2.55e+03**
4,4'-DDE	**1.13e+00**	**1.52e+02**	**3.13e+03**
4,4'-DDT	3.17e-01	**2.85e+01**	**5.87e+02**
4-Methyl-2-Pentanone(MIBK)	3.13e-46	3.83e-44	1.18e-42
4-Methylphenol(p-cresol)	3.70e-25	4.96e-23	8.55e-25
4-Methylphenol/3-Methylphenol	7.98e-03	**1.07e+00**	1.85e-02
Acetone	1.07e-44	1.62e-44	1.51e-42
Acenaphthylene	1.27e-04	1.71e-02	6.83e-03
Aldrin	3.11e-02	**4.17e+00**	3.12e-01
alpha-BHC	7.66e-03	5.70e-04	1.66e-03
Benzene	7.78e-06	8.45e-09	1.20e-07
Benzoic acid	a	a	**2.51e+02**
Benzyl alcohol	1.47e-02	**1.97e+00**	1.49e-01
beta-BHC	9.74e-03	5.22e-06	1.98e-05
bis(2-Ethylhexyl)phthalate	3.40e-05	4.56e-04	1.07e-01
Bromochloromethane	a	a	a
Chlorobenzene	4.62e-04	5.82e-01	1.03e-02
Chloroethane	a	a	a
Chloromethane	8.52e-07	7.13e-10	2.37e-12
Dibenzofuran	1.07e-16	1.43e-12	3.64e-13
Dibromomethane	a	a	a
Dieldrin	3.55e-02	**2.96e+00**	1.92e-01
Endosulfan I	1.19e-69	1.60e-67	4.77e-71
Endosulfan sulfate	2.32e-02	**3.12e+00**	9.33e-04
Endrin	1.86e-03	2.49e-01	9.88e-04
Endrin aldehyde	2.89e-03	3.88e-01	1.54e-03
Ethylbenzene	2.94e-03	5.98e-02	6.50e-02
Fluorene	4.76e-06	3.20e-04	4.45e-05
gamma-BHC	1.33e-02	6.29e-05	1.45e-05
Heptachlor	5.34e-40	2.31e-112	6.76e-115
Heptachlor epoxide	5.14e-02	**5.84e+00**	1.71e-02
Lead	4.49e-02	**3.26e+00**	**8.65e+00**

Table 5-20
(Continued)

Chemical	Northern Pike EQ	Aquatic Invertebrate EQ	Sandpiper EQ
Methylene chloride	1.33e-12	1.54e-12	2.48e-08
Naphthalene	4.77e-06	6.41e-04	6.01e-02
Phenanthrene	1.80e-05	2.41e-04	5.15e-03
Phenol	5.08e-90	6.81e-88	1.26e-85
Thallium	9.47e-03	**1.27e+01**	**5.69e+01**
Toluene	2.01e-13	1.54e-22	1.28e-20
Trichloroethene	4.18e-07	5.61e-05	8.50e-04
Trichlorofluoromethane	a	a	a
Xylene (total)	1.92e-01	**2.68e+03**	**1.98e+02**

a = no toxicity data available

Table 5-21
EQ Values Greater than 1 for Aquatic and Semiaquatic Species

Chemical	EQ		
	1-9.9	10-99	> 100
2-methylnaphthalene		Pike	Inv, SS
4,4-DDD			Inv, SS
4,4-DDE	Pike		Inv, SS
4,4-DDT		Inv	
4-methylphenol/3-methylphenol	Inv		
Aldrin	Inv		
Benzoic acid			SS
Benzyl alcohol	Inv		
Dieldrin	Inv		
Endosulfan sulfate	Inv		
Heptachlor epoxide	Inv		
Lead	Inv, SS		
Thallium		Inv, SS	
Xylene			Inv, SS

Inv = Invertebrate
SS = Spotted sandpiper

Table 5-22
Uncertainties of ERA at the POL Tank Farm

Parameter	Assumption	Uncertainty
Pathway: Surface Water → Pike		
Groundwater migration	Groundwater beneath the POL migrates and is discharged to the Yukon River where exposure to the pike occurs.	Concentrations were modeled from the POL to the shoreline with no co-mingling or interferences. The magnitude of the uncertainty would be low, bias neutral.
	Groundwater modeling accurately estimated the concentration of COPECs in the Yukon River.	Due to restricted dilution (5 ft. from shoreline) actual concentrations that pike are exposed to are probably over-estimated. Concentrations may be higher or lower. Magnitude of uncertainty would be low-high, bias high.
Assessment endpoint species - Pike	Pike are present in the Yukon River near Galena all year.	Pike are present in the general area, but may not be near Galena all year. The ERA assumption is conservative, uncertainty would be low, bias high.
Uncertainty factor - 2-methylnaphthalene	An uncertainty factor (UF) of 10,000 was applied to the LC_{50} measurement endpoint to account for taxonomical difference and acute study duration.	The conservatism associated with the UF may be high or low. The magnitude of uncertainty would be low-high, bias high.
Pathway: Surface water → Invertebrates → Spotted Sandpiper		
Groundwater migration	Groundwater modeling accurately estimated the concentration along the mudflats/shoreline	No dilution, volatility factors or attenuation was applied to these concentrations. Actual exposure concentrations are likely much lower than predicted. The magnitude of uncertainty would be low, bias high.
Exposure concentration and time	Invertebrates and sandpiper are exposed to the estimated concentrations at the mudflats during entire time species are on site.	Invertebrates may remain in a small geographic area and could be exposed to discharging groundwater continually; however, the spotted sandpiper is mobile and this assumption is highly conservative. The magnitude of uncertainty is low, bias high.
	The spotted sandpiper's water intake is 100% from the discharging groundwater.	The spotted sandpiper travels along the shorelines searching for food. To assume that 100% of water intake is from discharging groundwater is highly conservative. The magnitude of uncertainty is low, bias high.
Bioavailability of COPECs	All COPECs were assumed to be 100% bioavailable.	Bioavailability changes as physical conditions such as pH or % carbon changes. This assumption is conservative. The magnitude would be low-high, bias high.
Bioconcentration factors	Bioconcentration factors (BCF) were applied to estimated invertebrate tissue concentrations of COPECs.	BCFs can vary depending on conditions of the study that determined the BCF. Applied to this ERA, they may over or underestimate tissue concentrations. Magnitude of uncertainty is low-high, bias neutral.

(Eisler, 1987c), greatly reducing the potential for toxic effects.

Semiaquatic (surface water → invertebrate → spotted sandpiper)

This exposure pathway used modeled concentrations of contaminants in groundwater discharging to the surface at the Yukon River mudflats. No dilution or volatility factors were applied to the discharged concentrations. EQs greater than 1 were noted for the invertebrates and spotted sandpiper and are shown in Table 5-21. Pesticides, PNAs, metals, volatiles and semivolatiles are all listed on this table. DDT, DDE, DDD, 2-methylnaphthalene, benzoic acid, thallium, and xylene all have EQ values greater than 10, indicating probable risk.

DDT and its metabolites are organochlorine pesticides that are ubiquitous, recalcitrant, and highly lipophilic compounds which can enter the food chain easily. This lipophilic property, combined with a long half-life, results in bioaccumulation and biomagnification of residues into high trophic levels such as fish-eating birds. Because of the extensive past use of DDT worldwide, and the persistence of the compounds, these materials are virtually ubiquitous and are continually being transformed and redistributed in the environment (ATSDR, 1992a). Organochlorine pesticides such as DDT, dieldrin, heptachlor, and endosulfan were used extensively at the Galena Airport for insect control. The POL Tank Farm does not represent a unique source for these pesticides.

Due to the lipophilic, ubiquitous, and recalcitrant properties of organochlorine pesticides, extensive scientific and ecological information exists in the literature. Chronic AWQC were available as the toxicity benchmarks for the pike, and invertebrates and heron NOAELs were available for the sandpiper EQ calculation. An uncertainty factor of 1 was applied to these toxicity benchmarks due to the conservatism already present in AWQC and NOAEL measurement endpoints.

2-Methylnaphthalene was the only PNA to have an EQ above 1 for the invertebrate (EQ = 6950) and the sandpiper (EQ = 284), both indicating probable risk. Large uncertainties are associated with the EQ calculations for 2-methylnaphthalene. An acute 96-hour LC_{50} for the grass shrimp was used for the invertebrate toxicity benchmark, a rat LD_{50} was used for the spotted sandpiper calculations. It is estimated that the invertebrate and sandpiper risk estimates for 2-methylnaphthalene are very conservative because of conservative assumptions used in the groundwater modeling (Appendix C), in addition to the large uncertainties associated in with the lack of dilution factors applied. Moreover, PNAs are metabolized by vertebrates, including birds and do not pose a long-term risk to population survival. Thus, those facts, together with the lack of dilution factors applied to the discharge concentrations, indicate that the potential for risk to mudflat invertebrates and sandpipers is minimal.

Table 5-23 shows the percent contribution of the intake media to the spotted sandpiper EQs. DDT and its breakdown products and 2-methylnaphthalene affect the spotted sandpiper via invertebrate uptake. Direct ingestion of water did not heavily contribute to the sandpiper intake because of the lack of water solubility of these compounds.

Benzoic acid (EQ = 251 probable risk in sandpiper and benzyl alcohol (EQ = 1.97 probable risk in the invertebrate) have short half-lives in soil, water, and biological systems. Benzoic acid and benzyl alcohol have log k_{ow}s of 1.87 and 1.1, respectively indicating that these compounds are not lipophilic and will not sorb

Table 5-23
Percent Contribution to Sandpiper EQ from Water and Invertebrate Intake

Chemical	EQ	% EQ Water	% EQ Invertebrate
2-Methylnaphthalene	284	9.9	90.1
4,4-DDD	2550	0.9	99.0
4,4-DDE	3130	0.9	99.0
4,4-DDT	587	0.9	99.0
Benzoic acid	251	83.9	16.0
Lead	8	72.3	27.6
Thallium	56	76.4	23.6
Xylene	198	57.9	42.1

strongly to soil. Table 5-23 indicates this by showing that the majority of the sandpiper intake is from direct ingestion of water. Natural dilution, volatilization and degradation of these compounds indicates that they are not likely to cause adverse impacts to the ecological system at the Galena Airport.

Methylphenol (4-methylphenol/3-methylphenol) was evaluated to have an EQ = 1.07 for the invertebrate. Neither 2-methylphenol or 4-methylphenol showed possible ecological impacts, just the 3,4 mixture. Methylphenols, or cresols, are used widely by industry. Uses include disinfectants, dyes, fragrances, food flavoring, herbicides, and wood preservatives. Methylphenols also occur naturally. In general, methylphenols degrade in surface waters rapidly, but persist in groundwater due to lack of microorganisms. Methylphenols will not bioconcentrate in aquatic organisms and are not expected to adsorb to sediment, organic matter or soil, therefore terrestrial bioconcentration is also not expected (ATSDR, 1990e). Chronic AWQC were used to calculate the EQs for the invertebrate. As indicated previously, neither 4-methylphenol or 2-methylphenol had EQ calculated above 1, only the isomer mixture. The spotted sandpiper did not show possible impacts from any of the isomers, including the mixture. The EQ for methylphenol was just within the possible risk range. With the incorporation of river volatilization and dilution effects in the groundwater discharge model, the EQ evaluation would likely show no significant potential for risk. This fact, together with the expected environmental fate of the 3,4 isomer mixture, the absence of the other methylphenol isomers demonstrating possible impacts in the invertebrate and the total lack of impacts calculated for the sandpiper, 4-methylphenol/3-methylphenol should not be considered an agent of ecological impacts.

Xylene was analyzed as total (i.e., a mixture of three isomers). Xylenes had an EQ of 2680 in the invertebrate and 198 in the spotted sandpiper. A 24-hour LC_{50} using goldfish as the measurement endpoint species was used as the toxicity endpoint for the invertebrate. A vole NOAEL was used for the spotted sandpiper. Both measurement endpoint tests were carried out using mixed isomers.

Xylenes are a single ring aromatic compound containing two methyl groups, and are commonly found in petroleum products. Most of the xylenes released to the environment partition to the atmosphere. However, xylenes in groundwater may persist for several years. Once released to the environment, rapid oxidation of xylene isomers precludes bioconcentration in higher animal systems, and therefore, bioaccumulation up the food chain is unlikely. Lower trophic levels in aquatic systems may bioconcentrate xylenes moderately (BCFs range from 8-95) with a reported steady state tissue concentration after 10 days (ATSDR, 1993d).

Effects of xylenes to the semiaquatic ecosystem at the mudflats would be self limiting due to dilution and volatilization of the xylenes upon introduction to the surface. Uptake by invertebrates would be minimal, although the modeled water concentration of 3.48 mg/L is the highest concentration on the COPEC list for the POL Tank Farm. A BCF factor of 80 was used to estimate invertebrate tissue concentration at 278 mg/kg. This level along with the estimated spotted sandpiper intake of 36 mg/kg/day appears overly conservative. Table 5-23 indicates that 58% of the sandpiper intake is from direct ingestion of water. This concentration was not attenuated by volatilization, degradation, or dilution.

EQs for lead were determined to be 3.26 in the invertebrate, using an AWQC as the toxicity benchmark, and 8.65 for the spotted sandpiper, using an acute dose in a day-old herring gull. The chemistry of lead is complex. In water, lead is most soluble and bioavailable under conditions of low pH, low organic carbon, low suspended sediment concentration , and low concentrations of calcium, iron, manganese, zinc, and cadmium salts. Most of the lead discharged into surface water is rapidly incorporated into sediments (Eisler, 1987a).

Plants and animals may bioaccumulate lead, but biomagnification in aquatic or terrestrial food chains has not been observed. In general, the toxicity of heavy metals is governed by many physiological factors, genetic variants, and other xenobiotics present in the body. The estimated daily intake of lead by the spotted sandpiper was 0.086 mg/kg. About 2.0 ppm lead in the liver can adversely affect some important enzymatic pathways. Variations in the biological concentration of heavy metals in wild birds are closely associated with feeding habits and habitats (Husain et al., 1990). Although lead does not biomagnify, its concentration tends to increase with age of the animal. Lead is toxic to all aquatic biota and organisms higher in the food chain. Given that the EQ levels for lead in the invertebrate and spotted sandpiper were less than 10, incorporation of dilution effects on the groundwater discharge model would likely show no significant risk. This fact, together with the general ecological toxicity of lead, indicates that ecological impacts would be considered low.

The final constituent which had EQs exceeding 1 at the POL Tank Farm mudflats was thallium. The EQ for invertebrates was 12.7, using AWQC as the toxicity benchmark, and 56.9 for the sandpiper, using a rat LOAEL both indicating probable risk. Thallium is acutely toxic to fish (Zitko, 1975). Thallium may be bioconcentrated by organisms from water, although Table 5-23 indicates that the spotted sandpiper received 76.4% of its intake from water ingestion directly. To account for bioconcentration, the maximum BCF for bluegill sunfish of 34 was used in this ERA. There is evidence that thallium is a developmental toxicant (ATSDR, 1992b).

Toxicity, chemical, and physical effects in the context of the Yukon River for those chemicals with EQs exceeding 1 were evaluated for all assessment endpoints. For the pike, it was determined that there was no significant potential for risk from POL Tank Farm groundwater discharge.

For the aquatic invertebrates and the spotted sandpiper, organochlorine pesticides, lead, and thallium potentially could impact these populations adversely. However, organochlorine pesticides historically were used over the entire Airport for insect control and the POL Tank Farm does not represent a unique area of contamination. Dilution and adsorption to sediments can attenuate the assessment endpoint species' exposure to lead and thallium. On the basis of the transient nature of the mudflats as an ecosystem, and the dilution of the constituents as they enter surface water, the population impacts of groundwater from the POL Tank Farm at the mudflats are minimal.

Section 6
WEST UNIT

This section contains a site-specific BRA for the West Unit. Section 6.1 provides a description of the site and Section 6.2 summarizes data evaluation. Section 6.3 presents the human health risk assessment results. Section 6.4 presents the ecological assessment results.

6.1 Site Description

The West Unit is located in the western half of the Galena Airport main base "triangle." It is made up of seven separate source areas that, because of their proximity and some degree of overlap, are treated as one management zone. The individual source areas are the following:

- The Waste Accumulation Area (SS006);
- Million Gallon Hill;
- The Power Plant UST No. 49;
- The JP-4 Fillstands;
- Building 1845;
- Building 1700 (Refueling Vehicle Maintenance Building); and
- Building 1850.

Figure 1-1 shows the location of the West Unit and the seven source areas within it.

The area of the West Unit contained within the dike road, in general, has been graded and filled with gravel and sand. Vegetation is sparse and consists of grass and shrubs in the manicured areas around the buildings and grasses, willows, and alders in the drainage ditches. To the west of Million Gallon Hill, outside of the dike road, native soils and vegetation prevail. Vegetation here is generally much thicker than within the dike, and includes wooded areas of birch and black spruce. Standing water sometimes occurs to the west of Million Gallon Hill, especially in the spring following breakup.

The majority of the open space area south and west of Million Gallon Hill, which is actually part of the dike structure, is occupied by active and inactive landfills, roads, and a sewage line from the airport. The development of this area is unlikely.

The following sections summarize the history and past waste handling procedures, RI activities, and RI conclusions for each of the source areas in the West Unit. All of the West Unit analytical data for 1992 through 1994 are presented in Appendix A of the RI report (USAF, 1995c).

6.1.1 Waste Accumulation Area (SS006) Sources of Contamination

Until 1984, when the State of Alaska discontinued permits for road oiling, the bulk of the liquid wastes were accumulated and applied to the local roads for dust control. In recent years, liquid wastes have been stored at the Waste Accumulation Area prior to shipment off base for disposal. Waste lube oil, antifreeze, solvent, oily rags, and other miscellaneous wastes were stored in drums near the power plant. These drummed wastes were originally stored on the ground until a bermed concrete pad was constructed to control drum leakage. During a 1985 site visit, it was noted that part of the concrete berm was broken, and wastes were draining to the ground (USAF, 1985). As excess drums accumulated, waste storage also occurred outside the bermed area in a cordoned-

off zone.

RI Activities

During the 1992 to 1994 field seasons, a preexisting monitoring well was sampled; a new well was installed and sampled; two soil borings were completed; and surface soil, water, and sediment samples were collected and analyzed to characterize contamination at the Waste Accumulation Area.

Because of the nature of the source, soil contamination originating at the Waste Accumulation Area is likely to be most pronounced in surface soils and sediments and shallow soil-boring samples. This observation is generally supported by the data. However, the presence of numerous aboveground potential sources of contamination in this area makes it difficult to predict the origin and extent of contamination. There is some surface soil contamination associated with the storage of wastes at this site. However, isolated areas of shallow soil contamination pose minimal threat to groundwater quality.

6.1.2 Million Gallon Hill

Sources of Contamination

Sludge from the periodic cleaning of the large bulk fuel (POL) tanks at Million Gallon Hill (USTs No. 37 and No. 38) has been placed in drums for off-base disposal in recent years. In earlier years it is presumed the sludge was allowed to weather on the ground. Occasionally, water from these tanks needed to be drained and the drained water-fuel mixture was taken to a waste fuel tank (USAF, 1985). Leaks and small spills may have resulted in further contamination of soils around and beneath tank areas; a tracer study indicated that the USTs at Million Gallon Hill may be leaking (USAF, 1992).

RI Activities

Field investigations at the Million Gallon Hill source area included the sampling of all preexisting groundwater monitoring wells, the installation and sampling of eight new wells, the completion of one soil boring, and the collection and analysis of surface soil samples. Field screening activities were also conducted at this source area to help direct the RI sampling efforts.

6.1.3 Power Plant UST No. 49

Sources of Contamination

As with the USTs at Million Gallon Hill, sludge from the periodic cleaning of the Power Plant UST No. 49 has been placed in drums for off-base disposal in recent years. It is presumed that the sludge was once allowed to weather on the ground. Occasionally, water from UST No. 49 was drained, and the resultant water-fuel mixture may also have been drained to the ground (USAF, 1985). Leaks and small spills may have resulted in further contamination of soils around and beneath tank areas; a tracer study indicated that USTs No. 49 may be leaking (USAF, 1992). Aerial photographs taken in 1974 show that drums were stored along the south side of the power plant, near an area of stained soil.

RI Activities

During RI activities at this source area, two preexisting groundwater monitoring wells were sampled, a soil boring was drilled and sampled, and surface soil samples were collected to define and characterize contamination. A sediment sample (06-SD-01) was also collected from a drainage ditch west of the steam plant in 1992.

The RI work conducted from 1992 to 1994 has not revealed elevated levels of any BTEX compounds in groundwater at the Power Plant UST No. 49 source area. The presence of fuel-related soil contamination to the south and west of the power plant may be the result of past

waste management practices, such as allowing sludge from the tanks to weather on the ground (USAF, 1985). Leaks and spills from drums that were stored near the power plant may have also contributed to the apparent contamination.

6.1.4 JP-4 Fillstands

Sources of Contamination

The JP-4 Fillstands source area is located in the south-central part of the West Unit, just to the north of one of the main east-west roadways within the Galena Airport. Two fuel islands, diesel to the east and JP-4 to the west, are located within the JP-4 Fillstands source area. Approximately 100 ft east of the fuel islands there is a JP-4 separator building (Building 1572) and a buried 2000 gal. waste fuel tank. A floor drain in the fuel/water separator building is connected to the waste fuel tank by a drain pipe. An underground diesel fuel pipeline extends WNW to ESE across the site approximately 100 ft north of the fuel island. The pipeline, originating from Diesel Tank No. 37 on Million Gallon Hill, supplies diesel to the fillstands. The depths of the pipelines are not known.

RI Activities

Field investigations conducted at the JP-4 Fillstands source area included the installation and sampling of four monitoring wells, completion of five soil borings, and the collection and analysis of surface soil samples. Field screening activities were also conducted to direct the RI sampling efforts. A soil gas survey was conducted at the JP-4 Fillstands source area to help determine the source and extent of contamination.

It appears that fuel handling and transport activities at the JP-4 Fillstands source area have resulted in the contamination of soil and groundwater. The analytical results support the presence of multiple surface and subsurface sources of fuel contamination within the investigation area.

6.1.5 Building 1845

Sources of Contamination

Building 1845, which houses the current vehicle maintenance facility, is a newly defined source area that was discovered during investigations at the Waste Accumulation Area. Solvent contamination in groundwater at the West Unit has been linked to this facility.

It is suspected that past practices such as component washing with solvents and discharge/-disposal from floor drains have contributed to the contamination of the groundwater, downgradient of Building 1845. An upgrade of the floor drains was conducted in 1988; however, no information could be found for the floor drains prior to 1988. It is suspected that there may have been a discharge from the sump located near the center of the southern edge of the building. Currently, the contents of this sump are now pumped to a holding tank to await disposal. However, if the sump was damaged prior to the upgrade, it may have provided a point source for contaminant transport to the soil and groundwater. Shop personnel who were asked for information in the summer of 1993 had no knowledge of the previous condition of the sump or floor drains, or of past waste handling procedures.

RI Activities

The principal component of groundwater contamination at the Building 1845 source area is trichloroethene (TCE). The two monitoring wells installed at this site, 06-MW-01 and -02, were originally installed to characterize groundwater contamination at the Waste Accumulation Area. However, when TCE was first detected in groundwater samples from monitoring well 06-MW-01, Building 1845 was targeted for investigation as a potential source of solvent leaks or

spills, although none have been reported. Field screening was conducted during the 1993 field season to help determine the nature and extent of contamination at this source area.

6.1.6 Building 1700, Refueling Vehicle Maintenance Building

Sources of Contamination

Building 1700 is a newly defined source area within the West Unit. Liquid wastes from maintenance activities conducted at Building 1700 were collected in a floor drain that led to an oil-water separator. A 2-in. pipe allowed the oil layer to drain into a buried waste oil tank made from a 55-gal. drum. A 4-in. pipe from the separator emptied the water layer into an underground dry well located 5 ft from the southwest corner of Building 1700. This dry well is constructed from a gravel-filled 55-gal. drum with the bottom removed, allowing the water to drain to the environment.

RI Activities

The results of a soil gas survey conducted to determine the source of TCE contamination in the northern portion of the West Unit revealed a previously unidentified contaminant plume originating at Building 1700. These elevated hydrocarbon readings appear to be the result of fuel spills or releases associated with maintenance activities in Building 1700.

One soil boring, 06-SB-03, was placed at the southwest corner of Building 1700 to further investigate the nature and vertical extent of the contamination identified by field screening activities.

The field screening and analytical results at this site indicate the presence of fuel contamination from a subsurface source that is separate from the Building 1845 source area. This contamination probably originates from the dry well and waste oil tank associated with Building 1700.

6.1.7 Building 1850

Sources of Contamination

Fuel-stained soil was discovered during recent construction of an aboveground waste oil tank to the south of Building 1850. The origin of this staining is unknown, and it appeared to be weathered. No spills or leaks have been reported at this location.

RI Activities

Field screening was conducted around the perimeters of Building 1850 and the waste oil tank to define the nature and extent of the apparent contamination. Nine soil gas samples were collected from around the building and analyzed with photoionization detector (PID) and flame ionization detector (FID) portable analyzers. Thirteen soil gas samples were collected from the tank area and analyzed with the PID and a catalytic hydrocarbon (CAT) analyzers. The PID responds only to compounds that contain double bonds (and ethers, aldehydes, and ketones with less sensitivity), and the CAT responds to all combustible compounds. The FID and CAT will generally have comparable responses. Subsurface soil samples were collected at a depth of 5 ft at 11 of the soil gas points. These samples were analyzed using the field IR method for AH and TPH.

The area of petroleum contamination at Building 1850 is approximately 30 ft in diameter, as indicated by soil gas concentrations greater than 200 ppmV. The soil gas and AH/TPH data suggest that this spill may be weathered. In newer fuel spills, both saturated and unsaturated hydrocarbon compounds typically occur. Over time, the residual, or saturated, hydrocarbons are left while the unsaturated, or aromatic, hydrocarbons are volatilized or leached away. Neither the nature nor the source of these

hydrocarbons is known, and no spills or leaks have been reported for this location.

The RI report (USAF, 1995c) recommended that Building 1850 be eliminated as a continuing source area for the West Unit. The limited area and apparent age of the release suggest that this site will not pose an unacceptable risk to human or ecological receptors. Since only field screening data are available for Building 1850, it is not included as a source area in quantifying risks associated with the West Unit.

6.1.8 West Unit Summary

Groundwater contamination at the West Unit is of two basic types: chlorinated solvents (primarily TCE) and fuel-related compounds. The highest levels of TCE contamination are located in the northeast portion of the West Unit. Building 1845, the original vehicle maintenance building, is presumed to be the source. Lower levels of TCE contamination also occur in the Million Gallon Hill source area. Groundwater contamination by fuel-related analytes at the West Unit is widespread. Individual plumes of contamination have been identified in the Million Gallon Hill and JP-4 Fillstand source areas. BTEX compounds are the primary contaminants that appear to be attributable to Million Gallon Hill; benzene appears to be the primary contaminant in the JP-4 Fillstand area.

Soil contamination at the West Unit consists primarily of fuel-related compounds and pesticides. DRO, GRO, and BTEX were present in numerous surface soils and sediments throughout the West Unit, suggesting that spills and leaks have occurred at several locations over a period of time. Past waste management practices, such as allowing sludge from tank cleaning to weather on the ground, may have also contributed to surface contamination at the Million Gallon Hill and Power Plant UST No. 49 source areas. Subsurface soil contamination by fuels occurs at several locations within the West Unit. Subsurface contamination at the JP-4 Fillstand source area appears to be associated with the fuel-water separator building. The fuel contamination has migrated to groundwater and may be spread by both vertical and horizontal movement of the groundwater. Building 1700 is a newly discovered source area of petroleum contamination, which appears to originate from the drainage of maintenance-related wastes to an underground waste oil tank and dry well. The vertical extent of this contamination appears to be limited. Soil gas and soil samples collected for field TPH analysis confirmed the presence of contamination by organic compounds to the south of Building 1850, another newly defined service area. However, this soil contamination appears to be old, and probably does not represent a source for groundwater contamination.

6.2 Data Evaluation

Data available from the RI (USAF, 1995c) were used to evaluate human health risks and ecological effects posed by the West Unit. After removing samples that were determined to be uncontaminated, analytical results from a total of 59 surface soil and sediment samples, 82 subsurface soil samples, 84 groundwater samples, and 4 surface water samples comprised the risk assessment data set. Table 6-1 lists the analytical methods used to test the soil and water samples during the 1992-1994 RI.

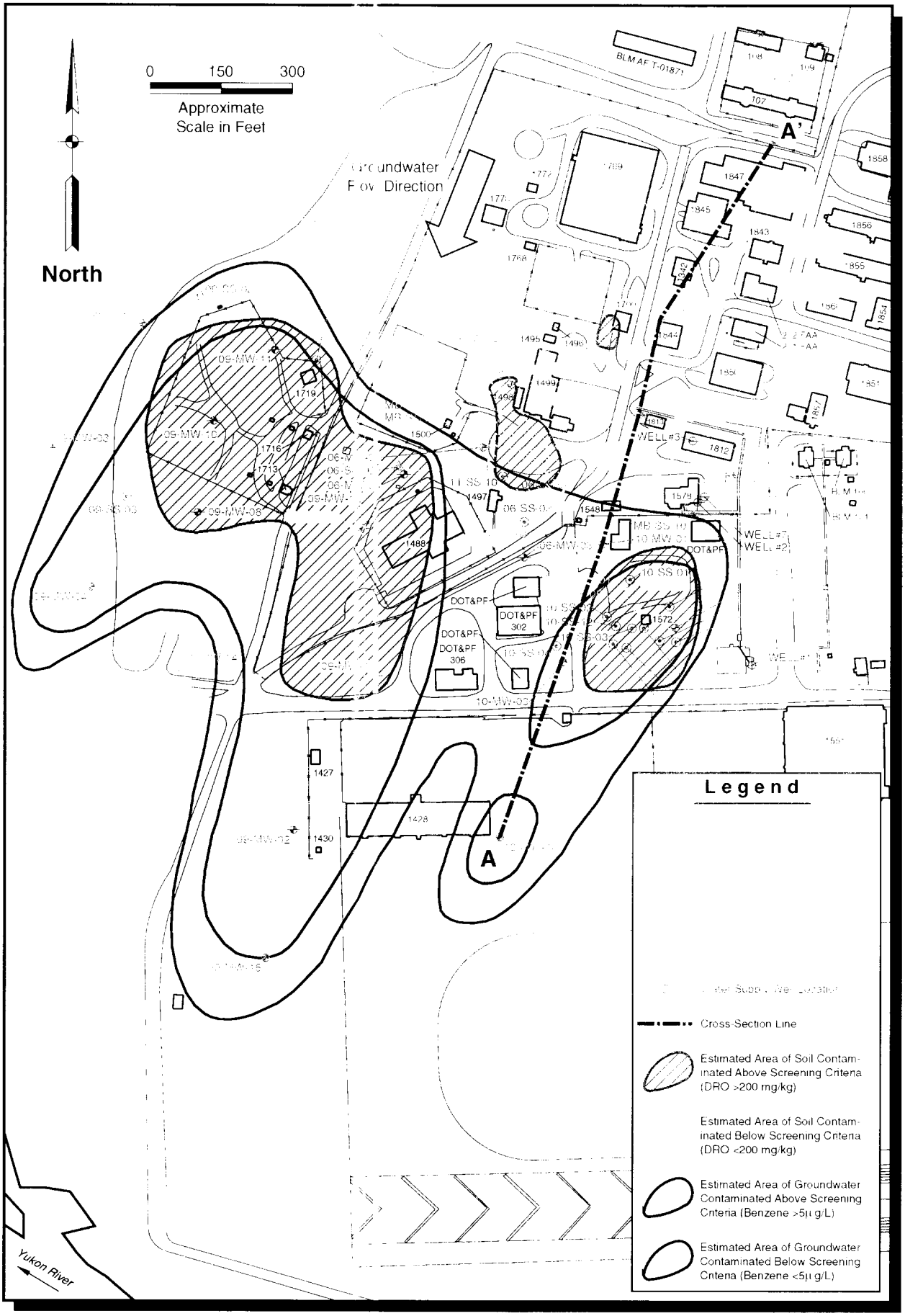
Figure 6-1 presents a conceptual diagram for the West Unit from the RI report (USAF, 1995c). This diagram provides a plan view, a geologic cross section, and a table that lists the range of detected concentrations for analytes that have exceed the RI screening criteria (identified in the key to the figure). The plan view shows the location of all analytical data points (surface soil samples, surface water samples, soil borings, sediment samples, and monitoring well loca-

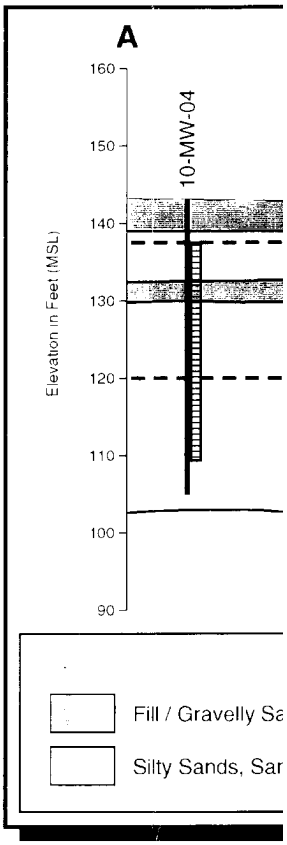
Table 6-1

Analytical Methods Used at the West Unit [a] During the 1992-94 RI

Parameter	West Unit [a]	
	Soil	Water
Alkalinity - Total (SM403)	NA	92, 93, 94
Specific Conductance (E120.1)	NA	92, 93, 94
pH (E150.1 - aqueous, SW9045 - solids)	--	92, 93, 94
Total Dissolved Solids (E160.1)	NA	--
Total Suspended Solids (E160.2)	NA	--
Temperature (E170.1)	NA	92, 93, 94
Turbidity (E180.1)	NA	93
Anions (E300)	NA	93
Nitrate-Nitrite (E353.1)	NA	93
Metals - ICP Screen (SW6010)	92	92, 93, 94
Arsenic (SW7060)	92, 93	92, 93, 94
Lead (SW7421)	92, 93	93, 94
Mercury - (SW7470 aqueous, SW7471 solid)	92	93
Selenium (SW7740)	92	92, 93
Halogenated Volatile Organics (SW8010)	NA	92, 93
Nonhalogenated Volatile Organics (SW8015) [b]	NA	92, 93
Aromatic Volatile Organics (SW8020)	NA	92, 93
Organochlorine Pesticides and PCBs (SW8080)	92	92, 93, 94
Semivolatile Organic Compounds (SW8270)	92, 93	92, 93, 94
Volatile Organic Compounds (SW8240)	92, 93	NA
Volatile Organic Compounds (SW8260)	NA	94
Diesel Range Organics (AK102)	92, 93	92, 93, 94
Gasoline Range Organics (AK101)	92, 93	92, 93, 94
Soil Moisture Content (SW846) or ASTM 02216)	92, 93	NA

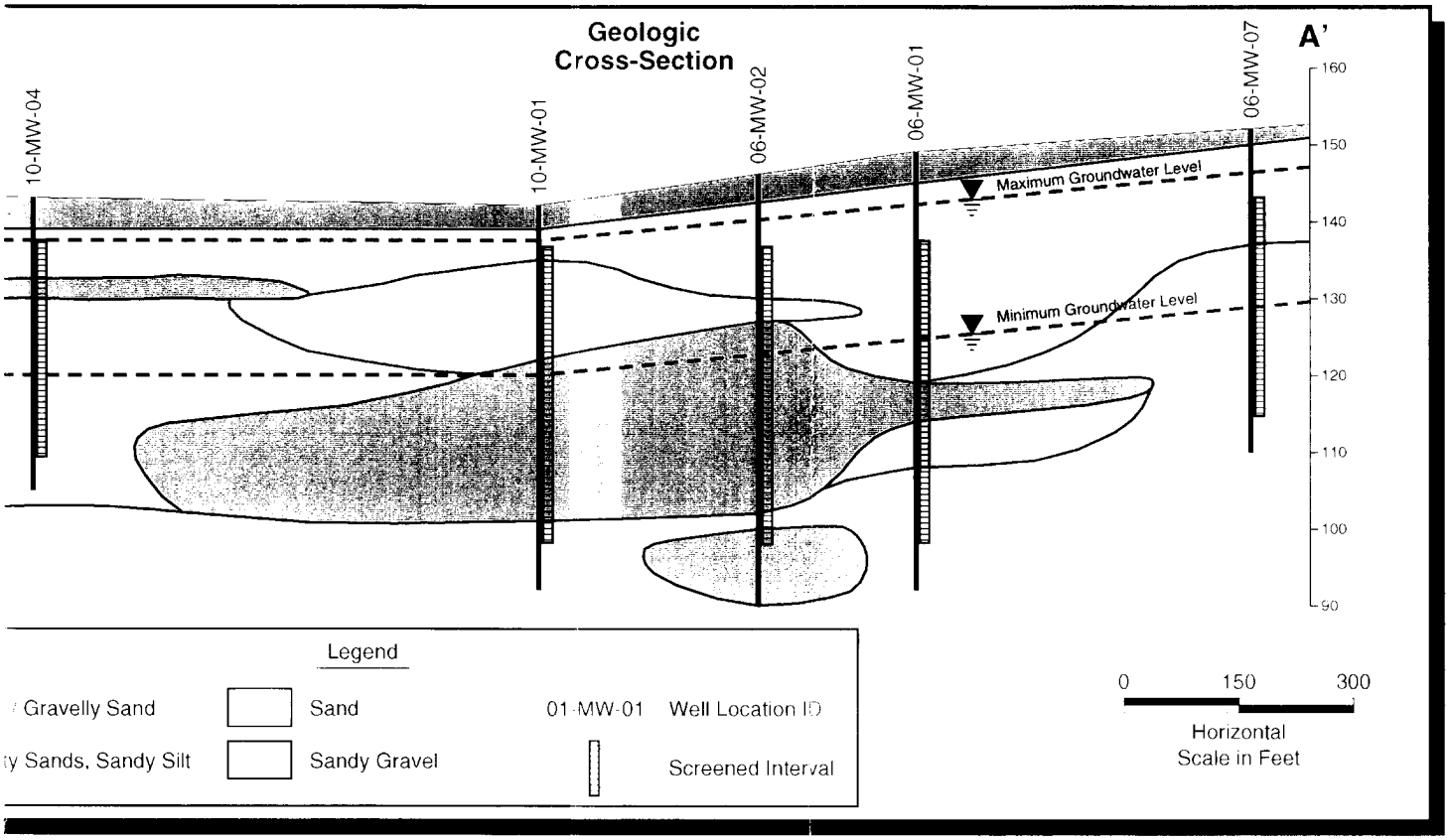
[a] West Unit source areas combined.
[b] Method SW8015 MEMP used in 1992.
NA = Not applicable.
-- Analytical method not used for this medium.





Analyte

Arsenic
Benzene
Benzo(a)pyrene
bis(2-Ethylhexyl)phthalate
Chlorobenzene
Ethylbenzene
Lead
Toluene
TCE
Xylenes
DRO
GRO
1,2-Dichloroethane
1,1,2,2-Tetrachloroethane
4-Methyl-2-Pentanone
Chloromethane
Cadmium
cis-1,2-Dichloroethene
trans-1,2-Dichlorethene
Methylene Chloride
Naphthalene



Compounds Exceeding RI Screening Criteria

	Soil		Groundwater	
	Screening Criteria (µg/kg)	Range of Detections (µg/kg)	Screening Criteria (µg/L)	Range of Detections (µg/L)
			50 M	3.2 - 60
	500 AK	16 - 68,000	5 M	0.18 - 12,000
rene	390 RC	7 - 520		
hexyl)phthalate			6 M	1.17 - 184
rene			100 M	0.07 - 280
ne	15,000 AK	3,000 - 100,000	700 M	0.30 - 2,100
	400,000 EL	3,200 - 2,080,000	15 M	8.3 - 20
	15,000 AK	11 - 480,000	1,000 M	0.04 - 15,000
			5 M	0.18 - 13,000
	15,000 AK	11 - 1.4×10^6		
	200,000 AK	29,000 - 4.7×10^7		
	100,000 AK	41,000 - 1.2×10^7		
oethane			5 M	0.11 - 0.52
rachloroethane			0.052 RC	0.79
-Pentanone			2,900 RN	6,200 - 7,600
hane			1.4 RC	14 - 48
			5 M	6.51
hloroethene			70 M	0.52 - 2,600
ichlorethene			100 M	143 - 185
Chloride			5 M	22 - 60
ne			1,500 RN	49 - 2,570

Key:
AK - State of Alaska Cleanup Standard
EL - EPA Lead Directive
M - Maximum Contaminant Level
RC - EPA Region III Risk-Based Concentration, Carcinogenic **
** Soil: Industrial Soil Ingestion Groundwater: Tap Water

Galena Airport - West Unit

Conceptual Diagram and Summary of Compounds Exceeding Screening Criteria

A1236-14 02/23/96

Figure 6-1. Conceptual Diagram for the West Unit (ST009)

tions). The extent of soil and groundwater contamination (exceedance of screening criteria) is shown as an overlay to the plan view. The area of groundwater contamination is defined by samples where benzene was detected above 5 µg/L; the area of soil contamination is defined by samples where DRO exceeded 200 mg/kg. Areas where these compounds were detected, but were below the screening criteria, are also shown in Figure 6-1. The plan view and the lithologic cross section can be used in conjunction to provide a three-dimensional visualization of site characteristics and contaminants. The areal extent of another type of groundwater contamination, defined by the presence of TCE, is shown in Figure 6-2.

Statistical analyses, in accordance with methods summarized in Section 3 and described in detail in Appendix A, were conducted on the available data to identify contaminants that were:

1. Positively detected in at least one sample in a given medium;

2 Detected at levels substantially greater than levels detected in associated blank samples (at least one result that exceeds the blanks UTL); and

3. Detected at levels substantially greater than naturally occurring background levels.

Tables in an attachment immediately following this section list the chemicals that were positively detected in the various media at the different source areas in the West Unit. These were considered possible COPCs that were subjected to blanks and background comparisons and to additional screening and evaluation for the human health assessment and the ecological assessment before they were identified as COPCs for human health or as COPECs. Appendix A lists all chemicals that were tested in the various media and indicates, on a media-specific basis, whether or not there were measurable results after conducting the blanks evaluation and whether or not the average site-related concentration is greater than the average background concentration (metals only).

An evaluation of the adequacy of detection limits was performed by comparing the minimum detection limit for each chemical eliminated as a COPC because it was not detected in a medium with USEPA Region III RBCs. Appendix B contains the results of this detection limit screening process. The uncertainties associated with detection limits that are not low enough to detect risk-based concentrations are summarized in Section 6.3.5.

6.3 Human Health Risk Assessment Results

The human health evaluation for the West Unit included identification of COPCs (Section 6.3.1), exposure assessment (Section 6.3.2), toxicity assessment (Section 6.3.3), risk characterization (Section 6.3.4), and uncertainty assessment (Section 6.3.5). These tasks were performed according to the methods specified in Section 3. Section 6.3.6 summarizes conclusions of the human health risk assessment for the West Unit and recommendations for remedial action based on the risk assessment results.

6.3.1 Chemicals of Potential Concern

Additional screening of the candidate COPCs was performed, in accordance with the methods described in Section 3, to identify the COPCs carried through the human health assessment. The additional screening involved examining the frequency of detection, evaluating essential nutrients, and comparing maximum detected concentrations to USEPA Region III RBCs.

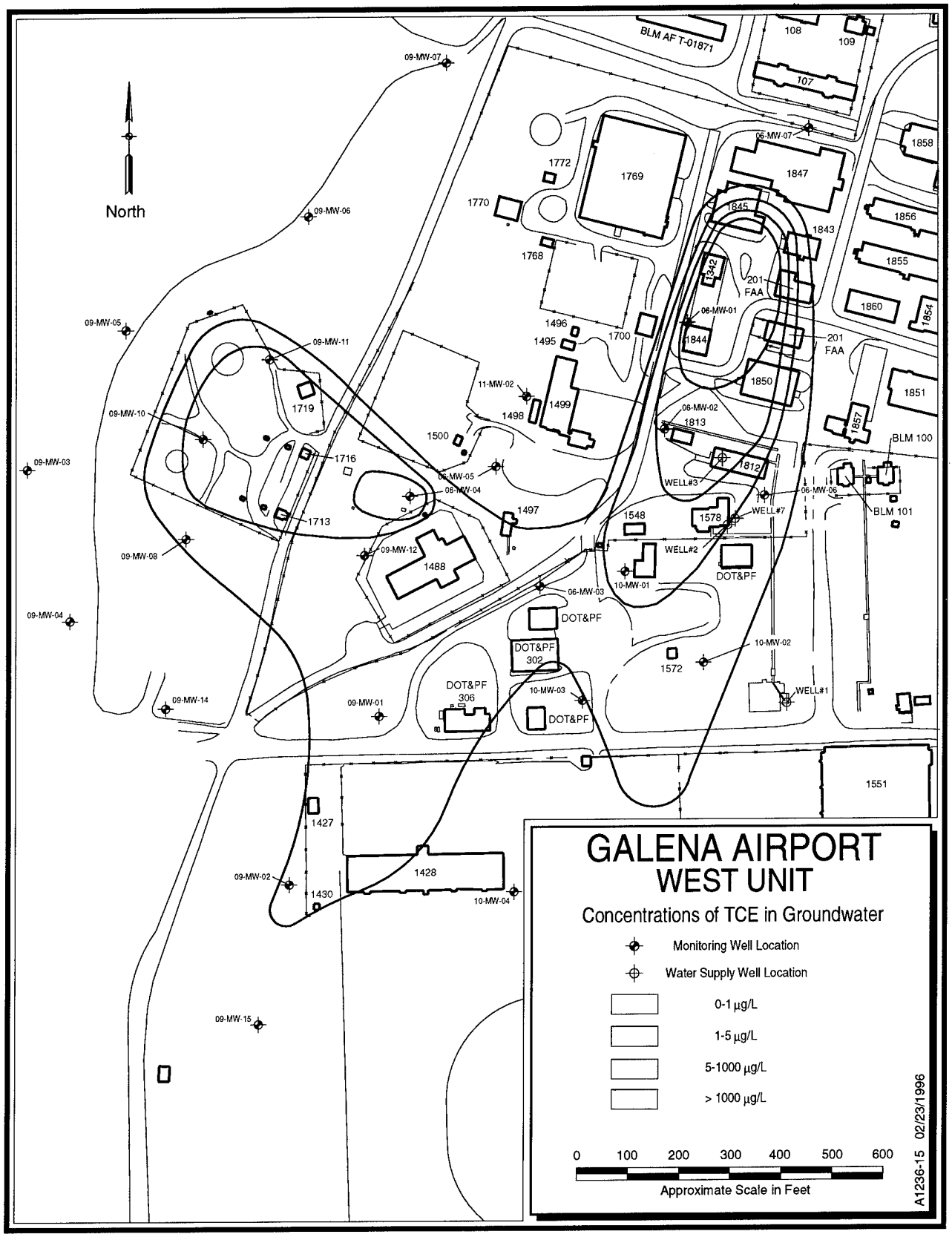


Figure 6-2. Approximate Concentration Contours of TCE in Groundwater at the West Unit (ST009)

Frequency of Detection

In the West Unit, eight analytes in groundwater at Million Gallon Hill were detected at a low (< 5%) frequency: beryllium, silver, endrin, 2,4-dimethylphenol, pyrene, fluorene, anthracene, and endosulfan I. Except for beryllium, each of these analytes was detected at a maximum concentration well below the USEPA Region III RBC for residential tap water. They were eliminated from the list of COPCs. The maximum detected concentration of beryllium (2 µg/L) exceeds the Region III RBC for beryllium (0.016 µg/L) by more than two orders of magnitude. However, since beryllium is not associated with known sources of contamination at Million Gallon Hill and exposure to the groundwater does not occur at the site, it was eliminated from the list of COPCs.

Essential Nutrients

Several essential nutrients that are often present in the soil and water media were detected at the West Unit at concentrations elevated above background concentrations. These include calcium, iron, magnesium, potassium, sodium, copper, selenium, and zinc in soil and/or groundwater. Maximum daily intakes of these nutrients were calculated assuming ingestion of 200 mg/day of soil and 2 L/day of groundwater containing the maximum detected concentration at any source in the West Unit. Except for iron in groundwater, the calculated maximum daily intakes were well below RDAs for minerals and trace elements (NRC, 1989). Selenium, copper, and zinc were also eliminated by risk-based screening (see below). These nutrients were eliminated from the list of COPCs for the West Unit. The calculated maximum daily intake of iron in groundwater (300 mg/day) at the JP4-Fillstands and Million Gallon Hill exceeded the RDA for iron (10 mg/day). Therefore, iron remained on the list of COPCs for the West Unit. Appendix B contains tables comparing the calculated maximum daily intake with the RDA.

Risk-Based Screening

Maximum detected concentrations of numerous analytes were lower than one-tenth the media-specific USEPA Region III residential RBCs and were eliminated from the list of COPCs. Appendix B contains the risk-based screening results.

COPC Summary

Tables in the attachment immediately following this section summarize conclusions for all chemicals that were positively detected in the surface soil or sediments, subsurface soil, groundwater, and surface water media at each source area in the West Unit. The tables indicate, for each analyte, whether sample concentrations were distinguishable from blank concentrations, whether concentrations were significantly different from background concentrations, whether the chemical was detected in at least 5% of the samples, and whether the chemical was eliminated as an essential nutrient or by the risk-based screen. Note that since 1993 and later sampling events reported uncensored data (where an ND is reported only if there is no instrument response), very low levels (greater than zero) of many analytes were reported in both blanks samples and site samples. Consequently, many chemicals that are not common field or laboratory contaminants were "detected" in blanks samples and were eliminated as COPCs on the basis of the blanks comparison. No analytes were detected in blanks at concentrations considered to represent a blanks contamination problem requiring corrective action as a result of the data validation process.

Table 6-2 lists the COPCs for the West Unit. It includes all chemicals, by medium, with positive results that were greater than background and blank concentrations, that exceeded

Table 6-2
Chemicals of Potential Concern at the West Unit

Chemical	Media																	
	Surface Soil						Subsurface Soil						Groundwater					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6[b]
Metals																		
Aluminum			X						X		X							
Arsenic						X			X		X	X			X	X	X	
Barium														X	X	X		
Beryllium			X						X		X							
Cadmium																	X	
Iron[a]														X	X	X		
Lead	X	X	X	X		X			X		X	X		X	X	X	X	
Manganese			X						X		X				X			
PNAs																		
2-Methylnaphthalene[a]	X	X	X	X		X	X	X	X	X	X	X		X		X		
Acenaphthylene[a]				X				X										
Benz(a)anthracene	X	X		X				X										
Benzo(a)pyrene	X	X		X			X	X		X								
Benzo(b)fluoranthene	X	X		X				X		X								
Benzo(k)fluoranthene				X														
Benzo(g,h,i)perylene[a]	X	X		X				X										
Chrysene				X														
Dibenz(a,h)anthracene	X			X				X										
Indeno(1,2,3-cd)pyrene	X	X		X				X										
Naphthalene														X		X		
Phenanthrene[a]	X	X		X			X	X		X		X		X			X	
Pesticides																		
Aldrin	X													X		X	X	
alpha-BHC			X						X				X	X		X	X	
beta-BHC														X	X	X	X	

Table 6-2
(Continued)

Chemical	Media																	
	Surface Soil						Subsurface Soil						Groundwater					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6[b]
gamma-BHC	X								X					X	X	X	X	
4,4'-DDD	X			X						X	X			X			X	
4,4'-DDE	X			X										X			X	
4,4'-DDT	X			X						X	X			X	X		X	
Dieldrin	X		X						X				X	X	X		X	
Heptachlor													X	X		X	X	
Heptachlor epoxide	X								X					X		X	X	
Semi-volatiles																		
2-Butanone (MEK)														X				
Dibenzofuran														X				
bis(2-Ethylhexyl)phthalate												X	X	X		X	X	
2-Hexanone[a]			X							X								
4-Methylphenol (p-cresol)														X				
Pentachlorophenol				X														
Volatiles																		
Acetone														X				
Benzene						X				X		X	X	X		X	X	
Bromochloromethane[a]													X	X		X	X	
Chloroform																	X	
Chloromethane													X	X			X	
Dibromomethane[a]													X	X				
1,2-Dichloroethane													X	X		X	X	
1,1-Dichloroethene														X			X	
cis-1,2-Dichloroethene														X			X	
trans-1,2-Dichloroethene																	X	
Ethylbenzene														X				

Table 6-2
(Continued)

Chemical	Media																	
	Surface Soil						Subsurface Soil						Groundwater					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6[b]
Methylene chloride														X				
1,1,2,2-Tetrachloroethane										X								
Tetrachloroethene																	X	
Toluene														X				
1,1,2-Trichloroethane																	X	
Trichloroethene														X		X	X	
Vinyl chloride													X	X			X	
Xylene (total)														X				

[a] Retained as a COPC for qualitative evaluation only. Toxicity values are not available to perform risk quantification at this time.
[b] No groundwater data are available for Building 1700.

West Unit Source Areas:
1 = Waste Accumulation Area
2 = Million Gallon Hill
3 = Power Plant UST No. 49
4 = JP-4 Fillstands
5 = Building 1845
6 = Building 1700

5% detection frequency, and that were not eliminated as an essential nutrient or by risk-based screening.

Appendix A of the RI report (USAF, 1995c) provides a complete listing of analytical results from the RI. The appendix reports the sampling location, analytical result, any data qualifiers, and the sample detection limit.

Tables in the attachment immediately following this section provide a statistical summary of the values used in the risk assessment for human health COPCs in surface soil and sediments, subsurface soil, and groundwater, respectively. The tables list the detection frequency, maximum detected concentration, mean, standard deviation, and 95% UCL of the data. There is no human exposure to surface water; however, surface water is evaluated in the ecological assessment.

6.3.2 Exposure Assessment

Human exposure to COPCs that are present at or migrating from the West Unit was assessed in accordance with methods described in Section 3.

Human Exposure Scenarios

Eight human exposure scenarios were addressed in the assessment of risks posed by the West Unit:

Current Scenarios (also applicable as future scenarios)

1. Short-Term On-Base Resident (subchronic adult only);
2. Long-Term On-Base Resident (chronic adult and child);
3. Old Town Galena Resident (chronic adult and child);
4. New Town Galena Resident (chronic adult and child);
5. Short-Term On-Base Worker (subchronic adult only);
6. Long-Term On-Base Worker (chronic adult only); and
7. Construction Worker (subchronic adult only).

Future Scenarios

8. Boarding School Student (subchronic/chronic).

These scenarios are described in Section 3. The on-base worker scenarios assume that workers at the West Unit are engaged in activities outdoors, every work day, for the duration of employment. At present, approximately 10 people work regularly in the West Unit in support of operating the airport. The workers are not confined to any one area in the West Unit, but rather move about the area to perform their duties. It is assumed that the on-base workers and construction workers are exposed to each source area in the West Unit for an equal amount of time, regardless of the size of the source area or the area of contamination. Therefore, the defined area of concern for worker exposure is the entire area of the West Unit.

Exposure Pathways

Exposure pathways considered for applicability to each West Unit exposure scenario include the following:

Soil Pathways

- Incidental ingestion of soil; and
- Dermal contact with soil.

Air Pathways

- Inhalation of fugitive dust; and
- Inhalation of vapors that volatilize from surface and subsurface media.

Groundwater Pathways

- Ingestion of drinking water;
- Dermal contact with water while showering;
- Inhalation of vapors that volatilize from water while showering; and
- Ingestion of plants irrigated with groundwater.

Surface Water Pathways

- Ingestion of fish from the Yukon River.

Groundwater pathways are not applicable to the West Unit because Old Town Galena is not downgradient of any of the source areas in the West Unit. Surface water pathways are applicable only if groundwater modeling indicates that toxicologically significant concentrations of contaminants originating from the West Unit might reach the Yukon River.

Contaminants detected in the groundwater at the West Unit were modeled to the shoreline of the Yukon River. Concentrations of contaminants in the Yukon River within 5 ft of the shoreline were also estimated, assuming that mixing is limited to river flow within that 5 ft. This assumption was made because there is not instant dilution of contaminants entering the river in the groundwater by the entire volume of river flow that passes by Galena. Rather, a plume would follow the shoreline downstream.

Tables 6-3 through 6-6 summarize the modeled shoreline and river concentrations for the COPCs in groundwater at Waste Accumulation Area, Million Gallon Hill, Power Plant UST No. 49, JP-4 Fillstands, and Bldg. 1845 source areas in the West Unit. It also lists applicable chemical-specific fish BCFs and estimated concentrations in fish exposed to river water within 5 ft of the shoreline. Finally, the table lists the USEPA Region III RBCs for tap water and fish. The modeled shoreline concentrations for a few chemicals (arsenic, cis-1,2-dichloroethene, TCE, and vinyl chloride) exceed their tap water RBC, but there is no human exposure to the groundwater at that location. The flow of the Yukon River quickly dilutes the concentrations entering the river from the groundwater by more than four orders of magnitude. The estimated fish concentrations are all below the Region III RBCs for fish. The groundwater and surface water pathways are therefore not quantified for the West Unit.

Appendix C describes the groundwater modeling methodology and provides the groundwater modeling data. Likewise, Appendix D describes the emissions estimating and air dispersion modeling methodology and provides the air modeling results.

Conceptual Site Model

A conceptual site model presents the current understanding of possible sources of contamination and the likely mechanisms for movement of contamination within and beyond site boundaries. Figure 6-3 is a conceptual site model flow diagram showing the primary sources of contamination at the West Unit, their migration pathways, exposure media, and exposure routes that may lead to human exposure. The figure effectively summarizes the results of the human health exposure assessment. It illustrates complete exposure pathways for the exposure scenarios that are evaluated and indicates which

Table 6-3
Comparison of West Unit (Waste Accumulation Area and Power Plant UST No. 49) Groundwater Modeling Results at the Shoreline with USEPA Region III Risk-Based Concentrations (RBCs)

Chemical	Modeled Shoreline Concentration [a] (µg/L)	Modeled River Concentration [a] (µg/L)	Fish [b] BCF	Estimated Concentration in Fish [c] (mg/kg)	USEPA Region III RBC [d]	
					Tap Water (µg/L)	Fish (mg/kg)
1,2-Dichloroethane	5.52e-03	1.03e-07	2	2.06e-10	0.12	0.035
4,4'-DDT	2.42e-03	4.51e-08	12000	5.41e-07	0.2	0.0093
alpha-BHC	2.70e-05	5.04e-10	1100	5.54e-10	0.011	0.0005
Arsenic	6.40e-01	1.19e-05	9	1.07e-07	0.038c, 11n [e]	0.0018c, 0.41n [e]
Barium	5.63e+01	1.05e-03	120	1.26e-04	2600	95
Benzene	1.81e-09	3.38e-14	4.27	1.44e-16	0.36	0.11
beta-BHC	4.72e-05	8.79e-10	1460	1.28e-09	0.037	0.0018
bis(2-Ethylhexyl)phthalate	9.14e-03	1.70e-07	1000	1.70e-07	4.8	0.23
Bromochloromethane	2.34e+00	4.36e-05	22	9.59e-07	NV	NV
Chloromethane	5.20e-11	9.69e-16	2.88	2.79e-18	1.4	0.24
Dibromomethane	1.68e-11	8.30e-10	5	4.15e-12	NV	NV
Dieldrin	6.72e-04	1.25e-08	2700	3.38e-08	0.0042	0.0002
gamma-BHC	4.43e-05	8.25e-10	319	2.63e-10	0.052	0.0024
Heptachlor	1.40e-99	2.62e-104	20	5.23e-106	0.0023	0.0007
Lead	2.30e+00	4.29e-05	42	1.80e-06	NV	NV
Vinyl Chloride	1.69e-03	3.16e-08	5.1	1.61e-10	0.019	0.0017

[a] Estimated concentration in Yukon River within 5 ft of shoreline, assuming mixing is limited to river flow within that 5 ft. Upstream Galena Airport source contributions are included in these estimates.
[b] Fish bioconcentration factor. See Appendix J (Ecological Assessment Toxicity Profiles).
[c] Concentration in water (ug/L) x 1 L/kg x 1 mg/ 1000 µg x BCF (unitless).
[d] U.S. Environmental Protection Agency (USEPA). "Region III, Risk-Based Concentration Table," March 7, 1995.
[e] c = carcinogen, n = noncarcinogen.
NOTE: Shaded values exceed Region III RBC for tap water or fish.
NV = No value

Table 6-4
Comparison of West Unit (Million Gallon Hill) Groundwater Modeling Results at the Shoreline with USEPA Region III Risk-Based Concentrations (RBCs)

Chemical	Modeled Shoreline Concentration (µg/L)	Modeled River Concentration [a] (µg/L)	Fish BCF [b]	Estimated Concentration in Fish [c] (mg/kg)	USEPA Region III RBC [d]	
					Tap water (µg/L)	Fish (mg/kg)
1,1-Dichloroethene	1.11e-06	3.44e-11	2.5	8.61e-14	0.044	0.0053
1,2-Dichloroethane	3.28e-03	2.05e-07	2	4.09e-10	0.12	0.035
2-Butanone (MEK)	8.06e-36	2.50e-40	0.98	2.45e-43	1900	810
2-Methylnaphthalene	6.07e+02	1.88e-02	1000	1.88e-02	NV	NV
4,4'-DDD	6.36e-02	1.97e-06	12000	2.37e-05	0.28	0.013
4,4'-DDE	9.11e-03	2.83e-07	12000	3.39e-06	0.2	0.0093
4,4'-DDT	2.99e-03	1.38e-07	12000	1.66e-06	0.2	0.0093
4-Methylphenol/3-Methylphenol	4.63e-01	1.21e-03	18	2.18e-05	180/ 1800	6.8/ 68
Acenaphthene	1.49e-02	4.64e-07	2.6	1.21e-09	2200	81
Acetone	1.81e-35	5.63e-40	0.69	3.89e-43	3700	140
Aldrin	3.80e-04	1.18e-08	3140	3.70e-08	0.004	0.00019
alpha-BHC	1.64e-04	5.60e-09	1100	6.16e-09	0.011	0.0005
Barium	1.19e+01	1.42e-03	120	1.70e-04	2600	95
Benzene	1.57e-05	4.88e-10	4.27	2.08e-12	0.36	0.11
beta-BHC	1.61e-04	5.87e-09	1460	8.58e-09	0.037	0.0018
bis(2-Ethylhexyl)phthalate	2.53e-02	9.56e-07	1000	9.56e-07	4.8	0.23
Bromochloromethane	2.52e+00	1.22e-04	22	2.68e-06	NV	NV
Chloromethane	3.67e-09	1.15e-13	2.88	3.31e-16	1.4	0.24
cis-1,2-Dichloroethene	3.58e+00	1.14e-04	23	2.62e-06	61	14
Dibenzofuran	5.69e-15	1.77e-19	589	1.04e-19	150	5.4
Dibromomethane	4.59e-09	8.30e-10	5	4.15e-12	NV	NV
Dieldrin	1.01e-03	4.39e-08	2700	1.19e-07	0.0042	0.0002
Ethylbenzene	2.52e-01	7.83e-06	144	1.13e-06	1300	140

Table 6-4
(Continued)

Chemical	Modeled Shoreline Concentration (µg/L)	Modeled River Concentration [a] (µg/L)	Fish BCF [b]	Estimated Concentration in Fish [c] (mg/kg)	USEPA Region III RBC [d]	
					Tap water (µg/L)	Fish (mg/kg)
gamma-BHC	4.62e-05	2.26e-09	319	7.21e-10	0.052	0.0024
Heptachlor	2.81e-100	3.49e-104	20	6.98e-106	0.0023	0.0007
Heptachlor epoxide	7.02e-04	2.18e-08	20	4.36e-10	0.0012	0.00035
Iron	1.66e+04	5.23e-01	10	5.23e-03	NV	NV
Lead	2.56e+00	1.22e-04	42	5.14e-06	NV	NV
Methylene chloride	4.59e-09	1.68e-13	2.3	3.87e-16	4.1	0.42
Naphthalene	3.27e+00	1.02e-04	1000	1.02e-04	1500	54
Phenanthrene	2.53e-01	7.87e-06	325	2.56e-06	NV	NV
Toluene	6.12e-17	1.90e-21	90	1.71e-22	750	270
Trichloroethene	7.68e-01	2.38e-05	17	4.05e-07	1.6	0.29
Vinyl Chloride	1.10e-02	3.73e-07	5.1	1.90e-09	0.019	0.0017
Xylene (total)	4.63e+01	1.44e-03	80	1.15e-04	12000	2700

[a] Estimated concentration in Yukon River within 5 ft of shoreline, assuming mixing is limited to river flow within that 5 ft. Upstream Galena Airport source contributions are included in these estimates.
[b] Fish bioconcentration factor. See Appendix J (Ecological Assessment Toxicity Profiles).
[c] Concentration in water (ug/L) x 1 L/kg x 1 mg/ 1000 µg x BCF (unitless).
[d] U.S. Environmental Protection Agency (USEPA), "Region III, Risk-Based Concentration Table," March 7, 1995.
NV= No value

Table 6-5
Comparison of West Unit (JP-4 Fillstands) Groundwater Modeling Results at the Shoreline with USEPA Region III Risk-Based Concentrations (RBCs)

Chemical	Modeled Shoreline Concentration (µg/L)	Modeled River Concentration [a] (µg/L)	Fish BCF [b]	Estimated Concentration in Fish [c] (mg/kg)	USEPA Region III RBC [d]	
					Tap water (µg/L)	Fish (mg/kg)
1,2-Dichloroethane	2.01e-03	3.75e-08	2	7.50e-11	0.12	0.035
2-Methylnaphthalene	8.72e-01	1.62e-05	1000	1.62e-05	NV	NV
Aldrin	7.50e-04	1.40e-08	3140	4.39e-08	0.004	0.00019
alpha-BHC	3.44e-05	6.41e-10	1100	7.05e-10	0.011	0.0005
Arsenic	5.40e+00	1.01e-04	9	9.06e-07	0.038c, 11n [e]	0.0018c, 0.41n [e]
Barium	1.12e+02	2.09e-03	120	2.50e-04	2600	95
Benzene	3.85e-07	7.18e-12	4.27	3.06e-14	0.36	0.11
beta-BHC	4.61e-05	8.59e-10	1460	1.25e-09	0.037	0.0018
bis(2-Ethylhexyl)phthalate	1.09e-02	2.03e-07	1000	2.03e-07	4.8	0.23
Bromochloromethane	2.51e+00	4.67e-05	22	1.03e-06	NV	NV
gamma-BHC	1.73e-05	3.22e-10	319	1.03e-10	0.052	0.0024
Heptachlor	2.42e-99	4.50e-104	20	9.00e-106	0.0023	0.0007
Heptachlor epoxide	2.22e-04	4.14e-09	20	8.29e-11	0.0012	0.00035
Iron	1.92e+04	3.58e-01	10	3.58e-03	NV	NV
Lead	1.14e+00	2.12e-05	42	8.91e-07	NV	NV
Naphthalene	1.85e-02	3.44e-07	1000	3.44e-07	1500	54
Trichloroethene	9.42e-02	1.76e-06	17	2.98e-08	1.6	0.29

[a] Estimated concentration in Yukon River within 5 ft of shoreline, assuming mixing is limited to river flow within that 5 ft. Upstream Galena Airport source contributions are included in these estimates.
[b] Fish bioconcentration factor. See Appendix J (Ecological Assessment Toxicity Profiles).
[c] Concentration in water (ug/L) x 1 L/kg x 1 mg/ 1000 µg x BCF (unitless).
[d] U.S. Environmental Protection Agency (USEPA). " Region III, Risk-Based Concentration Table," March 7, 1995.
[e] c = carcinogen, n = noncarcinogen.
NOTE: Shaded values exceed Region III RBC for tap water or fish.
NV = No value

Table 6-6
Comparison of West Unit (Building 1845) Groundwater Modeling Results at the Shoreline with USEPA Region III Risk-Based Concentrations (RBCs)

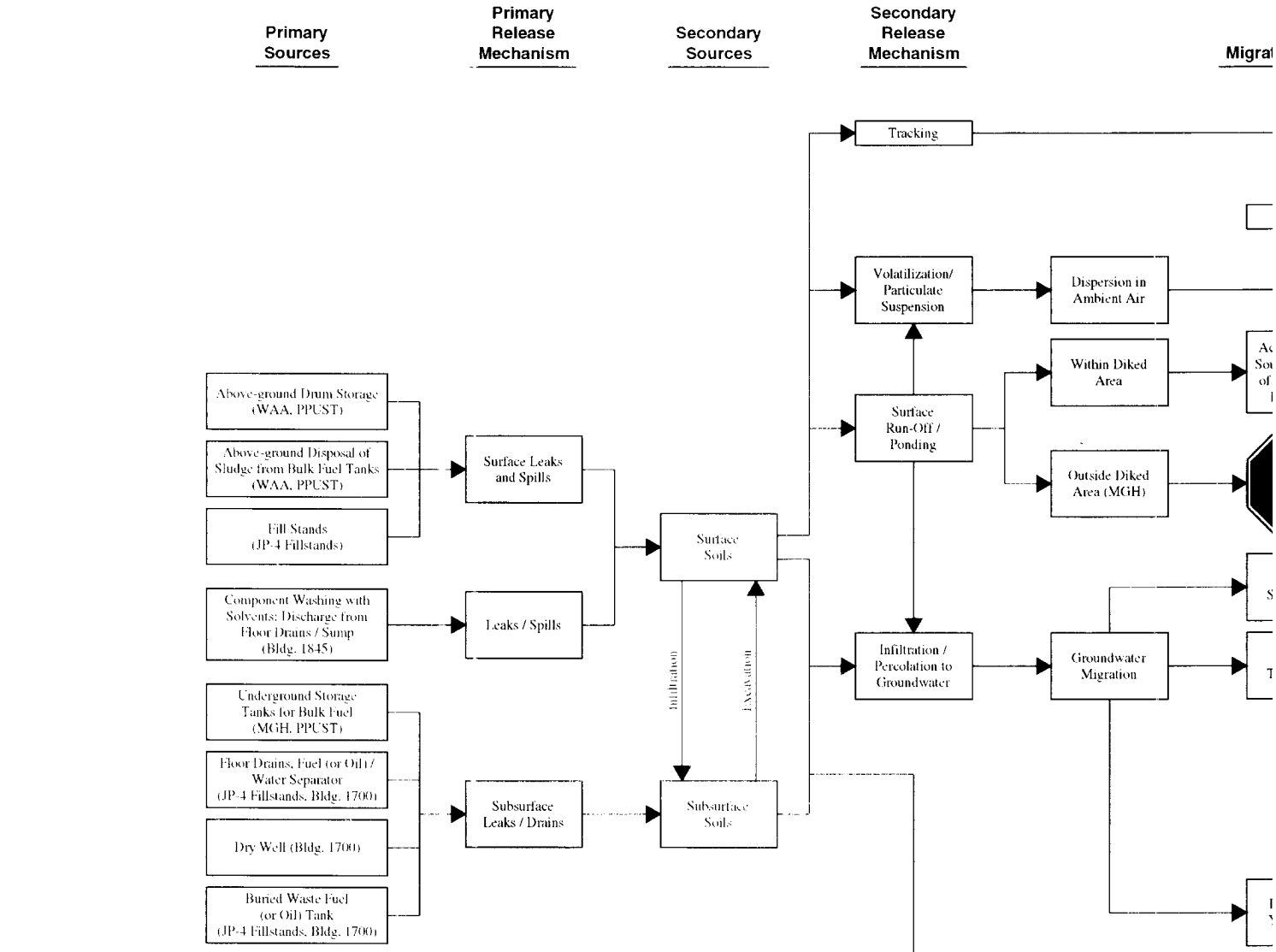
Chemical	Modeled Shoreline Concentration (µg/L)	Modeled River Concentration [a] (µg/L)	Fish BCF [b]	Estimated Concentration in Fish [c] (mg/kg)	USEPA Region III RBC [d]	
					Tap water (µg/L)	Fish (mg/kg)
1,1,2-Trichloroethane	3.16e-02	4.87e-07	17	8.28e-09	0.19	0.055
1,1-Dichloroethene	8.95e-05	1.38e-09	2.5	3.45e-12	0.044	0.0053
1,2-Dichloroethane	5.52e-03	8.51e-08	2	1.70e-10	0.12	0.035
4,4'-DDD	1.05e-02	1.61e-07	12000	1.93e-06	0.28	0.013
4,4'-DDE	8.75e-04	1.35e-08	12000	1.62e-07	0.2	0.0093
4,4'-DDT	1.96e-03	3.02e-08	12000	3.62e-07	0.2	0.0093
Aldrin	2.87e-03	4.43e-08	3140	1.39e-07	0.004	0.00019
alpha-BHC	6.89e-05	1.06e-09	1100	1.17e-09	0.011	0.0005
Arsenic	1.69e+00	2.60e-05	9	2.34e-07	0.038c,11n [e]	0.0018c, 0.41n [e]
Benzene	2.98e-09	4.58e-14	4.27	1.96e-16	0.36	0.11
beta-BHC	3.05e-04	4.69e-09	1460	6.85e-09	0.037	0.0018
bis(2-Ethylhexyl)phthalate	1.36e-02	2.09e-07	1000	2.09e-07	4.8	0.23
Bromochloromethane	2.73e+02	4.20e-03	22	9.24e-05	NV	NV
Cadmium	1.08e+00	1.66e-05	2213	3.67e-05	18	0.68
Chloroform	1.30e-01	2.00e-06	8	1.60e-08	0.15	0.52
Chloromethane	4.05e-11	6.24e-16	2.88	1.80e-18	1.4	0.24
cis-1,2-Dichloroethene	3.33e+02	5.13e-03	23	1.18e-04	61	14
Dieldrin	2.54e-03	3.91e-08	2700	1.06e-07	0.0042	0.0002
gamma-BHC	1.00e-04	1.54e-09	319	4.91e-10	0.052	0.0024
Heptachlor	2.62e-98	4.04e-103	20	8.08e-105	0.0023	0.0007
Heptachlor epoxide	1.12e-03	1.73e-08	20	3.46e-10	0.0012	0.00035
Lead	1.22e+00	1.87e-05	42	7.85e-07	NV	NV
Phenanthrene	4.55e-03	7.01e-08	325	2.28e-08	NV	NV
Tetrachloroethene	8.10e-03	1.25e-07	49	6.13e-09	1.1	0.061

Table 6-6
(Continued)

Chemical	Modeled Shoreline Concentration (µg/L)	Modeled River Concentration [a] (µg/L)	Fish BCF [b]	Estimated Concentration in Fish [c] (mg/kg)	USEPA Region III RBC [d]	
					Tap water (µg/L)	Fish (mg/kg)
trans-1,2-Dichloroethene	2.37e+01	3.65e-04	23	8.39e-06	120	27
Trichloroethene	4.71e+02	7.26e-03	17	1.23e-04	1.6	0.29
Vinyl Chloride	6.43e-02	9.91e-07	5.1	5.06e-09	0.019	0.0017

[a] Estimated concentration in Yukon River within 5 ft of shoreline, assuming mixing is limited to river flow within that 5 ft. Upstream Galena Airport source contributions are included in these estimates.
[b] Fish bioconcentration factor. See Appendix J (Ecological Assessment Toxicity Profiles).
[c] Concentration in water (ug/L) x 1 L/kg x 1 mg/ 1000 µg x BCF (unitless).
[d] U.S. Environmental Protection Agency (USEPA), "Region III, Risk-Based Concentration Table," March 7, 1995.
[e] c = carcinogen, n = noncarcinogen.
NOTE: Shaded values exceed Region III RBC for tap water or fish.
NV = No value

Figure 6-3. Human Exposure Concept



Conceptual Model for the West Unit

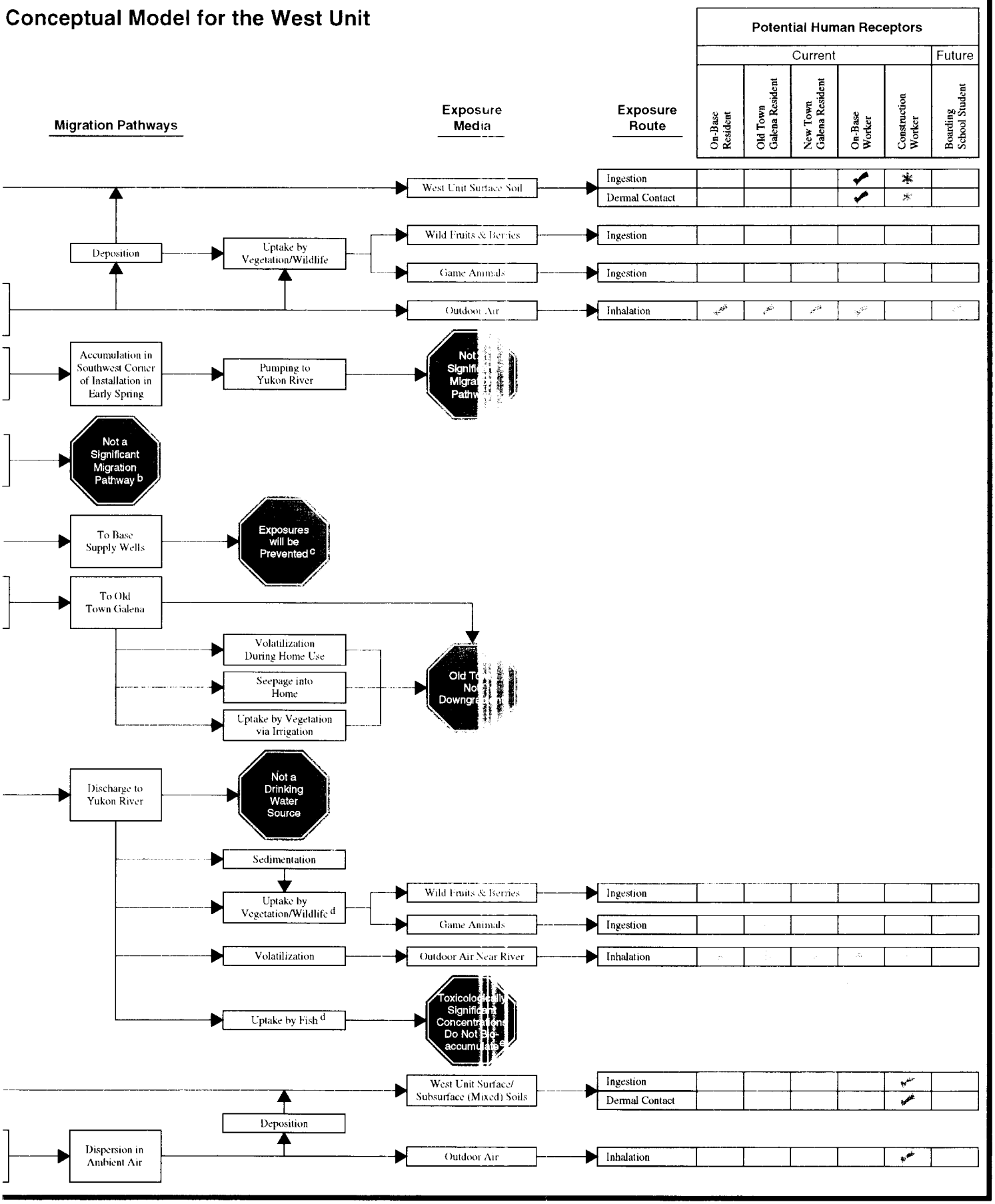


Figure 6-3. Human Exposure Conceptual Model for the West Unit

pathways are quantified for each scenario. It also notes which pathways are possibly complete but probably not significant. These pathways are not quantified.

Quantification of Exposure

Table 6-7 provides a matrix of exposure scenarios and exposure pathways that are applicable to the West Unit and specifies the exposure points and data that were used to derive concentrations in the exposure media at this site. Appendix E summarizes the human health exposure point concentrations used to quantify exposure.

Since the entire area in the West Unit comprises the area of concern for worker exposure, an unweighted average concentration was computed from the representative concentration (the lower of the maximum detected concentration or the 95% UCL) at each source area to derive worker exposure concentrations in surface soil, subsurface soil, and air. An unweighted average concentration was used, even though some of the source areas are larger than others, because it was not possible to apportion the amount of time a worker might spend in the different source areas. It was assumed that the workers spend an equal amount of time at each source area in the West Unit. It should be noted that workers in the West Unit also spend time at locations outside all of the source areas, but this was not addressed in deriving worker exposure concentrations.

Appendix E contains tables that show the derivation of worker soil and air exposure concentrations for the West Unit. To derive the West Unit exposure concentration, a value of 0 for a source area was included in the average only if the chemical was not detected in any samples from that source area. If the chemical was not tested for in samples from a source area or if a medium was not sampled, it was not included in computing an average. If a chemical was not a COPC in a source area because the concentrations detected were lower than background or risk-based screening values, a representative concentration (the lower of the maximum detected concentration or the 95% UCL) was included in computing the average.

Section 3 describes the methods used to quantify exposure. Human health intake equations and exposure parameters are documented in Appendix F. Intakes were quantified separately for evaluation of carcinogenic and non-carcinogenic effects. Daily intakes for analysis of carcinogenic effects are averaged over a 70-year lifetime. Daily intakes for analysis of non-carcinogenic effects are averaged over the exposure duration only.

6.3.3 Toxicity Assessment

Table 6-8 presents the toxicity values used in the human health risk assessment for COPCs at the West Unit. Most of the toxicity values in this table were obtained from IRIS searches conducted in July 1995 or from HEAST (USEPA, 1994). Carcinogenic values for some PNAs were calculated using methodologies in provisional guidance for calculating potential potency based on values for benzo(a)pyrene (USEPA, 1993d). Although the oral slope factor for benzo(a)pyrene is listed in IRIS, the inhalation slope factor has been withdrawn from IRIS and HEAST. Since there is no inhalation unit risk for benzo(a)pyrene, the USEPA guidance directs that the potential potency values should be applied only to assessment of carcinogenic hazard from oral exposure to PNAs.

The inhalation RfDs for benzene and 1,2-dichloroethane are provisional values recommended by the Superfund Health Risk Technical Support Center (footnoted EPA-ECAO in the USEPA Region III RBC table, USEPA, 1995b).

Table 6-7
Data Used to Derive Exposure Concentrations in Exposure Media at the West Unit

Exposure Scenario	Exposure Pathways		
	Ingestion of Soil	Dermal Contact with Soil	Inhalation of Vapor-Phase Chemicals and Fugitive Dust in Ambient Air
Current Scenarios			
On-Base Residents -Short Term -Long Term	NA	NA	Modeled concentration of vapor-phase chemicals (E) and wind-blown dust (F) at closest downwind on-base residential receptor (total contribution of all West Unit source areas).
Galena Residents	NA	NA	
-Old Town			Modeled concentration of vapor-phase chemicals (E) and wind-blown dust (F) at closest downwind Old Town Galena residential receptor (total contribution of all West Unit source areas).
-New Town			Modeled concentration of vapor-phase chemicals (E) and wind-blown dust (F) at closest downwind New Town Galena residential receptor (total contribution of all West Unit source areas).
On-Base Workers			
-Short Term	Surface Soil (A)	Surface Soil (A)	Modeled concentration of vapor-phase chemicals (G) and wind-blown dust (H) directly above the West Unit source areas.
-Long Term	Surface Soil (A)	Surface Soil (C)	Modeled concentration of vapor-phase chemicals (G) and wind-blown dust (H) directly above the West Unit source areas.
-Construction	Mixed Soil (C)	Mixed Soil (C)	Modeled concentration of vapor-phase chemicals (I) and dust generated by construction activity (J) directly above the West Unit source areas.
Future Scenarios			
Boarding School Student	NA	NA	Modeled concentration of vapor-phase chemicals (E) and wind-blown dust (F) at the location of the proposed student dormitory (total contribution of all West Unit source areas).

Table 6-7
(Continued)

Exposure Media

Remedial Investigation Data:
(A) Measured concentrations in surface soils, represented by the unweighted average of the exposure concentration (the 95% UCL, or the maximum detected concentration if lower) at the West Unit source areas, in soils within 2 ft of the ground surface.
(B) Measured concentrations in subsurface soils, represented by the unweighted average of the exposure concentration (the 95% UCL, or the maximum detected concentration if lower) at the West Unit source areas, in soils greater than 2 ft below the ground surface.
(C) Mixed surface and subsurface soil, represented by the highest of either the surface soil concentration (A) or the subsurface soil concentration (B).
(D) Measured concentrations in shallow groundwater, represented by the 95% UCL, or the maximum detected concentration if lower, at the individual source areas in the West Unit.

Transport and Fate Modeling:
(E) Estimated concentration of vapor-phase chemicals in ambient air based on emissions from surface soil, subsurface soil, and groundwater at each source area in the West Unit, represented by the 95% UCL or maximum detected concentration if lower at each source area, and dispersion modeling to specific receptor locations.
(F) Estimated concentration of wind-blown dust based on particulate emissions from surface soil at each source area in the West Unit, represented by the 95% UCL or maximum detected concentration if lower at each source area, and dispersion modeling to specific receptor locations.
(G) Estimated concentration of vapor-phase chemicals in ambient air at the West Unit, represented by the unweighted average of the estimated concentration (E) directly above each source area in the West Unit.
(H) Estimated concentration of wind-blown dust in ambient air at the West Unit, represented by the unweighted average of the estimated concentration (F) directly above each source area in the West Unit.
(I) Estimated concentration of vapor-phase chemicals in ambient air at the West Unit during construction work, assuming subsurface soil is brought to the surface by construction activities, represented by the unweighted average of the estimated concentration directly above each source area. The estimated concentration directly above each source area is based on emissions from mixed soils (C) and groundwater (D) at each source area and dispersion in the area above the source.
(J) Estimated concentration of dust generated by construction activities in ambient air at the West Unit, assuming subsurface soil is brought to the surface during construction, represented by the unweighted average of the estimated dust concentration directly above each source area. The estimated dust concentration directly above each source area is based on particulate emissions from mixed soil (C) at each source area and dispersion in the area above the source.
NA = Not Applicable

Table 6-8
Toxicity Values for the West Unit COPCs

COPCs	EPA Class	Chronic						Subchronic		Dermal Absorption Factor [a] (unitless)
		Oral RfD (mg/kg/day)	Inhal RfD (mg/kg/day)	Inhal RfC (mg/m^3)	Oral SF 1/(mg/kg/day)	Inhal SF 1/(mg/kg/day)	Inhal Unit Risk 1/($\mu g/m^3$)	Oral RfD (mg/kg/day)	Inhal RfC ($\mu g/m^3$)	
Metals										
Aluminum		1.00E+00 [c]	--	--	--	--	--	--	--	1.00E-02
Arsenic	A [d]	3.00E-04 [d]	--	--	1.50E+00 [e]	5.00E+01 [f]	4.30E-03 [d]	3.00E-04 [f]	--	1.00E-02
Barium		7.00E-02 [d]	--	5.00E-04 [g]	--	--	--	7.00E-02 [f]	5.00E-03 [g]	1.00E-02
Beryllium	B2 [d]	5.00E-03 [d]	--	--	4.30E+00 [d]	8.40E+00 [f]	2.40E-03 [d]	5.00E-03 [f]	--	--
Cadmium (water)	B1 [d]	5.00E-04 [d]	--	--	--	--	1.80E-03 [d]	--	--	1.00E-02
Iron		--	--	--	--	--	--	--	--	1.00E-02
Lead [b]	B2 [d]	--	--	--	--	--	--	--	--	--
Manganese (food/dust)	D [d]	1.40E-01 [d]	--	5.00E-05 [d]	--	--	--	1.40E-01 [f]	--	1.00E-02
Manganese (water)	D [d]	5.00E-03 [d]	--	--	--	--	--	--	--	1.00E-02
PNAs										
2-Methylnaphthalene		--	--	--	--	--	--	--	--	--
Acenaphthene		6.00E-02 [d]	--	--	--	--	--	6.00E-01 [f]	--	--
Acenaphthylene	D [d]	--	--	--	--	--	--	--	--	--
Benz(a)anthracene	B2 [d]	--	--	--	7.30E-01 [h]	--	--	--	--	--
Benzo(a)pyrene	B2 [d]	--	--	--	7.30E+00 [d]	--	--	--	--	--
Benzo(b)fluoranthene	B2 [d]	--	--	--	7.30E-01 [h]	--	--	--	--	--
Benzo(g,h,i)perylene	D [d]	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	B2 [d]	--	--	--	7.30E-02 [h]	--	--	--	--	--
Chrysene	B2 [d]	--	--	--	7.30E-03 [h]	--	--	--	--	--
Dibenz(a,h)anthracene	B2 [d]	--	--	--	7.30E+00 [h]	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	B2 [d]	--	--	--	7.30E-01 [h]	--	--	--	--	--
Naphthalene	D [d]	4.00E-02 [f]	--	--	--	--	--	--	--	--
Phenanthrene	D [d]	--	--	--	--	--	--	--	--	--
Pesticides										
4,4'-DDD	B2 [d]	--	--	--	2.40E-01 [d]	--	--	--	--	1.00E-01
4,4'-DDE	B2 [d]	--	--	--	3.40E-01 [d]	--	--	--	--	1.00E-01
4,4'-DDT	B2 [d]	5.00E-04 [d]	--	--	3.40E-01 [d]	3.40E-01 [f]	9.70E-05 [d]	5.00E-04 [f]	--	1.00E-01
Aldrin	B2 [d]	3.00E-05 [d]	--	--	1.70E+01 [d]	1.70E+01 [f]	4.90E-03 [d]	3.00E-05 [f]	--	1.00E-01
alpha-BHC	B2 [d]	--	--	--	6.30E+00 [d]	6.30E+00 [f]	1.80E-03 [d]	--	--	1.00E-01
beta-BHC	C [d]	--	--	--	1.80E+00 [d]	1.80E+00 [f]	5.30E-04 [d]	--	--	1.00E-01
Dieldrin	B2 [d]	5.00E-05 [d]	--	--	1.60E+01 [d]	1.60E+01 [f]	4.60E-03 [d]	5.00E-05 [f]	--	1.00E-01
gamma-BHC	B2/C [f]	3.00E-04 [d]	--	--	1.30E+00 [f]	--	--	3.00E-03 [f]	--	1.00E-01
Heptachlor	B2 [d]	5.00E-04 [d]	--	--	4.50E+00 [d]	4.50E+00 [f]	1.30E-03 [d]	5.00E-04 [f]	--	1.00E-01
Heptachlor Epoxide	B2 [d]	1.30E-05 [d]	--	--	9.10E+00 [d]	9.10E+00 [f]	2.60E-03 [d]	1.30E-05 [f]	--	1.00E-01

Table 6-8
(Continued)

COPCs	EPA Class	Chronic						Subchronic		Dermal Absorption Factor [a] (unitless)
		Oral RfD (mg/kg/day)	Inhal RfD (mg/kg/day)	Inhal RfC (mg/m³)	Oral SF 1/(mg/kg/day)	Inhal SF 1/(mg/kg/day)	Inhal Unit Risk 1/(µg/m³)	Oral RfD (mg/kg/day)	Inhal RfC (µg/m³)	
Semivolatiles										
2-Butanone (MEK)	D [d]	6.00E-01 [d]	--	1.00E+00 [d]	--	--	--	2.00E+00 [f]	--	1.00E-01
2-Hexanone		--	--	--	--	--	--	--	--	1.00E-01
4-Methylphenol(p-cresol)	C [d]	5.00E-03 [f]	--	--	--	--	--	5.00E-03 [f]	--	1.00E-01
bis(2- Ethylhexl)phthalate	B2 [d]	2.00E-02 [d]	--	--	1.40E-02 [d]	--	4.00E-06 [j,k]	--	--	1.00E-01
Dibenzofuran	D [d]	4.00E-03 [c]	--	---	--	--	--	--	--	1.00E-01
Pentachlorophenol	B2 [d]	3.00E-02 [d]	--	--	1.20E-01 [d]	--	--	3.00E-02 [f]	--	1.00E-01
Volatiles										
1,1,2,2-Tetrachloroethane	C [d]	--	--	--	2.00E-01 [d]	--	5.80E-05 [d]	--	--	1.00E-01
1,1,2-Trichloroethane	C [d]	4.00E-03 [d]	--	--	5.70E-02 [d]	--	1.60E-05 [d]	4.00E-02 [f]	--	1.00E-01
1,1-Dichloroethene	C [d]	9.00E-03 [d]	--	--	6.00E-01 [d]	--	5.00E-05 [d]	9.00E-03 [f]	--	1.00E-01
1,2-Dichloroethane	B2 [d]	--	2.86E-03 [c]	1.00E-02 [k]	9.10E-02 [d]	9.10E-02 [f]	2.60E-05 [d]	--	--	1.00E-01
Acetone	D [d]	1.00E-01 [d]	--	--	--	--	--	1.00E+00 [f]	--	1.00E-01
Benzene	A [d]	--	1.71E-03 [c]	6.00E-03 [k]	2.90E-02 [d]	2.90E-02 [f]	8..30E-06 [d]	--	--	1.00E-01
Bromochloromethane	D [d]	--	--	--	--	--	--	--	--	1.00E-01
Chloroform	B2 [f]	1.00E-02 [d]	--	--	6.10E-03 [d]	8.10E-02 [f]	2.30E-05 [d]	1.00E-02 [f]	--	1.00E-01
Chloromethane	C [d]	--	--	--	1.30E-02 [f]	6.30E-03 [f]	1.80E-06 [k]	--	--	1.00E-01
cis-1,2-Dichloroethene	D [d]	1.00E-02 [d]	--	--	--	--	--	1.00E-01 [f]	--	1.00E-01
Dibromomethane		--	--	--	--	--	--	--	--	1.00E-01
Ethylbenzene	D [d]	1.00E-01 [d]	--	1.00E+00 [d]	--	--	--	--	--	1.00E-01
Methylene chloride	B2 [d]	6.00E-02 [d]	--	3.00E+00 [f]	7.50E-03 [d]	--	4.70E-07 [d]	6.00E-02 [f]	3.00E+00 [f]	1.00E-01
Tetrachloroethene		1.00E-02 [d]	--	--	5.20E-02 [c]	2.03E-03 [c]	5.80E-07 [k]	1.00E-01 [f]	--	1.00E-01
Toluene	D [d]	2.00E-01 [d]	--	4.00E-01 [d]	--	--	--	2.00E+00 [f]	--	1.00E-01
trans-1,2-Dichloroethene		2.00E-02 [d]	--	--	--	--	--	2.00E-01 [f]	--	1.00E-01
Trichloroethene		6.00E-03 [c]	--	--	1.10E-02 [i]	6.00E-03 [c]	1.70E-06 [k]	--	--	1.00E-01
Vinyl Chloride	A [f]	--	--	--	1.90E+00 [f]	3.00E-01 [f]	8.40E-05 [f]	--	--	1.00E-01
Xylene (total)	D [d]	2.00E+00 [d]	--	--	--	--	--	--	--	1.00E-01

[a] Absorption factor of 1% was used for inorganic analytes and an absorption ofactor of 10% was used for organic analytes unless otherwise noted. PNAs are not evaluated for dermal exposures (see discussion in Section 3.1.4).

[b] Risk from exposure to lead was evaluated using the USEPA IEUBK model.

[c] Value was taken from Region III RBC table dated 1/31/95. The table states that this is a provisional vaue from EPA-ECAO Regional Support.

[d] U.S. Environmental Protection Agency (EPA), 1995. Integrated Risk Information Sytem (IRIS). Database search. First Quarter 1995.

[e] U.S. Environmental Protectin Agency (EPA) 1995. Integrated Risk Information System (IRIS) July 1995.

[f] U.S. Environmental Protection Agency (EPA), 1994. Health Effects Assessment Summary Tables Annual Update, FY 1994. EPA 540-R-020, March 1994.

Table 6-8
(Continued)

[g] U.S. Environmental Protection Agency (EPA), 1994. Health Effects Assessment Summary TablesAannual Update, FY 1994, Table 2: Alternate Methods, EPA 540-R-94-020, March 1994.

[h] PNA toxicity values were derived using the *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (EPA/600/R-93/089) dated July 1993.

[i] These values were withdrawn from both IRIS and HEAST. However, Region III recommends using these values in deriving RBCs and they are presented in the Region III RBC table dated 1/31/95.

[j] Provisional value recommended by Superfund Health Risk Technical Support Center; this value is based on the oral slope factor for this chemical (Dollarhide, 1994a).

[k] Value was calculated using the appropriate inhalation reference dose or inhalation slope factor with 20 m^3 breathing rate and 70 kg adult body weight.

These provisional RfDs were converted to RfCs for use in the risk calculations.

Provisional oral RfDs for aluminum and TCE, a provisional oral slope factor for tetrachloroethene, and provisional inhalation unit risks for tetrachloroethene and TCE, were also used to quantify risk. An oral RfD for naphthalene and an oral slope factor for trichloroethene have been withdrawn from IRIS and HEAST. However, these toxicity values are used by USEPA Region III to derive an RBC so therefore they were used to quantify risks in this assessment.

Toxicity values were not available for eight COPCs at the West Unit. These include lead, 2-methylnaphthalene, acenaphthylene, benzo(g,h,i)perylene, phenanthrene, 2-hexanone, bromochloromethane, and dibromomethane. Lead was initially screened using the USEPA recommended screening level (400 mg/kg) for lead in soil for residential land use (USEPA, 1994a) and the drinking water action level for lead (USEPA, 1994e), and if necessary, evaluated using the USEPA IEUBK model for lead in children (USEPA, 1994d). Available health effects information for these COPCs is included in Appendix G and the impact of the lack of toxicity values for these COPCs is discussed as an uncertainty in Section 6.3.5.

Dermal toxicity values are not listed in Table 6-8. Because of the high level of uncertainty associated with adjusting oral toxicity values (which are generally based on administered dose) to evaluate dermal exposure (which is calculated as an absorbed dose), unadjusted oral values were used to quantify dermal pathway risks. Dermal absorption factors used to quantify dermal exposures are listed in Table 6-8. Default values of 1% for inorganic analytes and 10% for organic analytes were used. Beryllium and the PNAs were not evaluated for dermal exposure (see discussion in Section 3.1.4).

Appendix G contains toxicological profiles for all of the human health COPCs at the West Unit.

6.3.4 Risk Characterization

Carcinogenic risk and noncancer HIs were estimated for each exposure scenario according to procedures outlined in Section 3. Carcinogenic risk and noncarcinogenic risk estimates are presented in Appendix H.

Carcinogenic Effects

For each potentially carcinogenic COPC, the incremental probability that an individual will develop cancer over a lifetime was estimated from projected intake levels and the cancer slope factor or the inhalation unit risk. The USEPA Superfund site remediation goal set forth in the NCP designates a cancer risk of 10^{-4} (1 in 10,000) to 10^{-6} (1 in one million). This range is designed to be protective of human health and to provide flexibility for consideration of other factors in risk management decisions. A cancer risk of 1 in one million is considered the *de minimis*, or a level of negligible risk, for risk management decisions. An cancer risk higher than 1 in one million is not necessarily considered unacceptable. The State of Alaska plans to use a cancer risk level of 10^{-5} (1 in 100,000) in making risk management decisions (USAF, 1996b).

Table 6-9 summarizes the cancer risk estimates for each exposure scenario at the West Unit. Estimated incremental cancer risks for the short- and long-term on-base resident, Old and New Town Galena residents, and boarding school students are below 1 in one million. Estimated risks lower than 1 in one million are considered negligible and do not warrant remedial action.

Table 6-9
Summary of Carcinogenic Risks[a] by Exposure Scenario for the West Unit

Scenario	Child		Adult	
	Average	Reasonable Maximum	Average	Reasonable Maximum
Current Scenarios				
Short-Term On-Base Resident	NA	NA	8E-09	2E-08
Long-Term On-Base Resident	2E-08	3E-08	3E-08	1E-07
Old Town Galena Resident	2E-09	3E-09	9E-09	3E-08
New Town Galena Resident	2E-10	2E-10	7E-10	3E-09
Short-Term On-Base Worker	NA	NA	**1E-06**	**5E-06**
Long-Term On-Base Worker	NA	NA	**1E-05**	**3E-05**
On-Base Construction Worker	NA	NA	**1E-06**	**4E-06**
Future Scenarios				
Boarding School Student[b]	1E-08	3E-08	NA	NA

NOTE: Risk estimates printed in bold type equal or exceed the Superfund site remediation threshold of 10^{-6} (1 in one million) for carcinogens.

NA = Not Applicable

[a]Carcinogenic risk is expressed as a unitless probability of an individual developing cancer.
[b]Ages 15-18 (Grades 9-12) for the average case and ages 6-19 (Grades 1-12, plus two repeat years) for the reasonable maximum case.

The average and reasonable maximum cancer risk estimates for the short-term on-base worker and for the construction worker either equal or exceed 1 in one million. The average and reasonable maximum cancer risk estimates for the long-term on-base worker equal and slightly exceed 1 in 100,000, respectively. None of the estimates exceeds the high end of the Superfund risk range goal (10^{-4}).

Inhalation of benzene that volatilizes from surface and subsurface soil at Building 1700 and from subsurface soil at the JP-4 Fillstands contributes the highest percentage of the estimated risk for the worker scenarios (38%-89% in most cases). Another 4%-42% of the estimated risk is attributable to incidental ingestion of, and dermal contact with, soil containing arsenic for most worker scenarios. For the average short- and long-term on-base worker, arsenic in soils contributes the greatest percentage (42%) of the risk. In the reasonable maximum long-term worker's case, ingestion of and dermal contact with dieldrin in soil contributes 4% of the risk (1 in one million). Estimated risks from exposure to all other COPCs are lower than 1 in one million.

Risk summary tables for each exposure scenario are provided in Appendix H. The tables detail the cancer risk estimates for each applicable chemical and exposure pathway and show the percent contribution of each chemical and pathway to the total estimated risk.

Noncarcinogenic Effects

To characterize the potential noncancer effects of chemicals, comparisons were made between projected intakes of COPCs over a specified time and toxicity values, primarily oral RfDs and inhalation RfCs. An HQ, which is the ratio between exposure to a chemical and that chemical's toxicity value, was calculated for each noncarcinogenic COPC and exposure pathway. Chemical-specific HQs were then summed for each COPC and each pathway of exposure to calculate the total HI.

The HI is not a statistical probability of a systemic effect occurring. If the exposure level exceeds the appropriate toxicity value (i.e., the HQ is greater than one), there may be cause for concern. The Superfund site remediation goal for noncarcinogens is a total HI of 1 for chemicals with similar toxic endpoints.

Table 6-10 summarizes the noncancer hazard estimates for each exposure scenario. The HIs for all scenarios are below the Superfund site remediation goal of 1 for noncarcinogens, indicating that there is little cause for concern about noncarcinogenic effects.

Noncancer risk summary tables for each exposure scenario are provided in Appendix H. The tables detail the noncancer hazard estimates for each applicable chemical and exposure pathway and show the percent contribution of each chemical and pathway to the total estimated HI.

Effects of Exposure to Lead

The maximum detected concentrations of lead at the West Unit are 2080 mg/kg in the surface soil (Million Gallon Hill), 19 mg/kg in the subsurface soil (Building 1700), and 20 µg/L in the groundwater (JP-4 Fillstands and Million Gallon Hill). The maximum surface soil concentration exceeds the 400 mg/kg recommended screening level for lead in residential soil (USEPA, 1994e), which was derived using the IEUBK lead model (USEPA, 1994c). Elevated lead concentrations in surface soils are present only in the Million Gallon Hill area, however, and the computed average lead exposure concentration for surface soil in the West Unit (329 mg/kg) does not exceed the screening level. The maximum detected groundwater concentration

Table 6-10
Summary of Noncarcinogenic Hazard Indices[a] by Exposure Scenario for the West Unit

Scenario	Child		Adult	
	Average	Reasonable Maximum	Average	Reasonable Maximum
Current Scenarios				
Short-Term On-Base Resident	NA	NA	< 0.001	< 0.001
Long-Term On-Base Resident	0.005	0.007	0.005	0.007
Old Town Galena Resident	< 0.001	< 0.001	< 0.001	< 0.001
New Town Galena Resident	< 0.001	< 0.001	< 0.001	< 0.001
Short-Term On-Base Worker	NA	NA	0.05	0.06
Long-Term On-Base Worker	NA	NA	0.3	0.9
On-Base Construction Worker	NA	NA	0.08	0.5
Future Scenarios				
Boarding School Student[b]	< 0.001	0.003	NA	NA

NOTE: Hazard indices printed in bold type equal or exceed the Superfund site remediation goal of 1 for non-carcinogens.

NA = Not Applicable

[a]Noncarcinogenic risk is expressed not as a probability of an adverse effect but rather as a comparison between exposure and a reference dose (hazard index).

[b]Ages 15-18 (Grades 9-12) for the average case and ages 6-19 (Grades 1-12, plus two repeat years) for the reasonable maximum case.

also exceeds the 15 µg/L drinking water action level for lead at the tap (USEPA, 1994e). Since the surface soil and groundwater maximum concentrations exceed the soil and water screening levels, lead was evaluated using the USEPA IEUBK model for the uptake by children and the California DTSC (1992) lead model for adult exposure.

The 95% UCL lead concentrations (or maximum detected concentration if lower) in the surface soil and in the groundwater were used to quantify lead uptake. The IEUBK model predicts a geometric mean blood lead level associated with ingestion of groundwater and ingestion of and dermal contact with soils at the site of 6.2 µg/dL in children. The probability that a blood lead level will exceed 10 µg/dL, the "concern threshold" identified by the CDC, is 15%. USEPA guidance suggests that the percentage of the target population (i.e., exposed children) that exceeds the level of concern should not exceed 5% (USEPA, 1994c). These results indicate that lead concentrations in the West Unit, particularly concentrations detected in the surface soil at Million Gallon Hill, might result in elevated blood lead levels in children if a residence were located in the West Unit. Since there are no residences in the West Unit, and residential development is not anticipated as a future land use, children will not be exposed to soil in the West Unit to the extent assumed by the IEUBK model.

The California DTSC lead risk assessment spreadsheet model, Version 1.1, (California DTSC, 1992) indicates that estimated blood lead levels in adults (99th percentile blood lead concentration of 5.0 µg/dL) are below levels of concern. Since there is not cause for concern about lead uptake by residential adults, exposure to lead in the soils by workers in the West Unit is also no cause for concern. The model output is provided in Appendix I.

Major Factors Driving Estimated Risks

Tables 6-11 and 6-12 present a risk characterization summary for carcinogenic risk estimates and noncarcinogenic hazard estimates, respectively. For each scenario the tables specify the exposure pathways that were quantified, the estimated risks for each case, the chemicals and pathways that are major contributors to the estimated risks, and the primary uncertainties associated with the estimates.

The only chemicals and pathways that contribute a chemical- and pathway-specific risk greater than 1 in one million are the following:

1. Inhalation of benzene by a worker who works outdoors in the West Unit for 8 hours/day, 5 days/week, for 5 or more years, and by a construction worker who works in the West Unit for 8 hours/day, 5 days/week for 3-6 months; and

2. Incidental ingestion of and dermal contact with soil containing arsenic by long-term workers and construction workers.

Added together, dermal contact with and ingestion of dieldrin in soil pose a risk of 1 in one million in the reasonable maximum long-term on-base worker scenario.

There are no scenarios that exceed the noncancer HI goal of 1, but the 0.9 HI estimated for the reasonable maximum long-term on-Base worker scenario approaches 1. This HI is primarily the result of inhalation of benzene (88%).

Benzene—The estimated annual average concentration of benzene in the air at the West Unit resulting from volatilization from surface and subsurface soils is 7.3 µg/m^3. Assuming excavation activities that expose the subsurface soils, the estimated concentration of benzene in

Table 6-11
Risk Characterization Summary for the West Unit: Carcinogenic Risks

Scenario	Pathways Quantified	Case	Estimated Total Cancer Risk [a]		Chemicals and Pathways that Contribute a Chemical- and Pathway-Specific Cancer Risk Greater than 1 in One Million [b]	Primary Site Specific Uncertainties
			Average	Reasonable Maximum		
Current Scenarios						
Short-Term On-Base Resident (subchronic)	1. Inhalation of vapors and dust	Adult	8E-09	2E-08	None	Applicability of cancer risk estimation methodology to subchronic exposure durations.
Long-Term On-Base Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	2E-08 3E-08	3E-08 1E-07	None	Duration of residence.
Old Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	2E-09 9E-09	3E-09 3E-08	None	Risk from accessing the site was not quantified.
New Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	2E-10 7E-10	2E-10 3E-09	None	Risk from accessing the site was not quantified.
Short-Term On-Base Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	**1E-06**	**5E-06**	1. Inhalation of benzene in ambient air (Reasonable maximum only).	Applicability of cancer risk estimation methodology to subchronic exposure durations. Emissions of benzene from surface and subsurface soil at Bldg. 1700.
Long-Term On-Base Worker (chronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	**1E-05**	**3E-05**	1. Inhalation of benzene in ambient air. 2. Incidental ingestion of arsenic in soil. 3. Dermal contact with arsenic in soil.	Emissions of benzene from surface and subsurface soil at Bldg. 1700. Presence of arsenic above background concentrations. Applicability of oral slope factor for arsenic to soil exposure pathways.
On-Base Construction Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	**1E-06**	**4E-06**	1. Inhalation of benzene in ambient air. 2. Incidental ingestion of arsenic in soil.	Emissions of benzene from subsurface soils at Bldg. 1700 during soil excavation. Presence of arsenic above background concentrations. Duration of construction activity. Applicability of cancer risk estimation methodology to subchronic exposure durations. Applicability of oral slope factor for arsenic to soil exposure pathways.

Table 6-11
(Continued)

Scenario	Pathways Quantified	Case	Estimated Total Cancer Risk [a]		Chemicals and Pathways that Contribute a Chemical- and Pathway-Specific Cancer Risk Greater than 1 in One Million [b]	Primary Site Specific Uncertainties
			Average	Reasonable Maximum		
Future Scenarios						
Boarding School Student (subchronic/ chronic)	1. Inhalation of vapors and dust	Student	1E-08	3E-08	None	Extension of facility from Grades 9-12 to Grades 1-12. Risk from accessing the site was not quantified.

[a]Estimated cancer risks printed in bold type equal or exceed the Superfund site remediation threshold of 1E-06 (1 in one million).
[b]Applicable only if the total cancer risk exceeds 1 in one million (estimated risk printed in bold type in column titled "Estimated Total Cancer Risk").

Table 6-12
Risk Characterization Summary for the West Unit: Noncarcinogenic Risks

Scenario	Pathways Quantified	Case	Estimated Total Hazard Index [a]		Chemicals and Pathways that Contribute a Chemical- and Pathway-Specific Non-cancer Hazard Quotient Greater than 1 [b]	Primary Site Specific Uncertainties
			Average	Reasonable Maximum		
Current Scenarios						
Short-Term On-Base Resident (subchronic)	1. Inhalation of vapors and dust	Adult	< 0.001	< 0.001	None	Lack of subchronic inhalation toxicity values for COPCs.
Long-Term On-Base Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	0.005 0.005	0.007 0.007	None	Duration of residence.
Old Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	< 0.001 < 0.001	< 0.001 < 0.001	None	Risk from accessing the site was not quantified.
New Town Galena Resident (chronic)	1. Inhalation of vapors and dust	Child Adult	< 0.001 < 0.001	< 0.001 < 0.001	None	Risk from accessing the site was not quantified.
Short-Term On-Base Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	0.05	0.06	None	Lack of subchronic inhalation toxicity values for COPCs. Emissions of benzene from surface and subsurface soil at Bldg. 1700. Lack of subchronic inhalation toxicity values.
Long-Term On-Base Worker (chronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	0.3	0.9	None	Emissions of benzene from surface and subsurface soil at Bldg. 1700. Presence of arsenic above background concentrations.
On-Base Construction Worker (subchronic)	1. Inhalation of vapors and dust 2. Incidental ingestion of soil 3. Dermal contact with soil	Adult	0.08	0.5	None	Emissions of benzene from subsurface soil at Bldg. 1700 during soil excavation. Presence of arsenic above background concentrations. Lack of subchronic inhalation toxicity values. Duration of construction activity.
Future Scenarios						
Boarding School Student (subchronic/ chronic)	1. Inhalation of vapors and dust	Student	< 0.001	0.003	None	Extension of facility from Grades 9-12 to Grades 1-12. Access to site.

[a]Hazard indices printed in bold type equal or exceed the Superfund site remediation goal of 1 for noncarcinogens.
[b]Applicable only if the total hazard index exceeds 1.

the air during construction work is 45 - 46 $\mu g/m^3$.

Although these estimated concentrations of benzene in air result in risk estimates that are greater than 1 in one million, these concentrations are well below both the OSHA PEL and ACGIH TLV for worker exposure to benzene. The TLV and PEL are 960 and 3200 $\mu g/m^3$, respectively.

Air sampling conducted by the USAF in and around the entire Galena Airport indicates that benzene concentrations that exceed the USEPA Region III RBC for air (0.22 $\mu g/m^3$) are widespread; elevated levels due to anthropomegenic-related activities exist in the entire area surrounding Galena (USAF, 1994b). Benzene results from two samples in the West Unit area were 0.33 $\mu g/m^3$ and 1.8 $\mu g/m^3$ (USAF, 1994b). The only two results from samples collected upwind and downwind from the Million Gallon Hill area could not be quantified, but were less than 14 $\mu g/m^3$ (USAF, 1994b). The air sample results may be due to refueling operations, vehicular traffic, and aircraft activity, in addition to any contribution from benzene-contaminated soils. It is not possible to differentiate the sources contributing to the measured concentrations of benzene in the air. It is possible that the contribution of benzene emissions from contaminated soils is minor compared with sources related to the operation of an airport. A copy of the figure from the report (USAF, 1994b) that shows air sampling locations in the West Unit is presented in Attachment 1 at the end of this section.

The emission estimates for benzene from subsurface soil during construction work are likely biased high. The emissions calculation assumes that all subsurface soils containing benzene are exposed and essentially become surface soils. It is more likely that excavations during construction would involve less than 100% of the contaminated area, unless the purpose of the excavation is to remove contaminated soil.

Moreover, excavation activities for building foundations, underground utilities, and so forth, generally only occur in the first few weeks of a construction project and certainly would not continue throughout the duration of the project.

Arsenic—Arsenic is a COPC in surface soil at Building 1700 and in the subsurface soil at the Power Plant UST No. 49, Building 1845, and Building 1700 only because there were three or fewer results at these locations in these media and a statistical comparison with background concentrations could not be performed. Arsenic is not a COPC in soils at other West Unit sources because detected concentrations were determined to be at or below background concentrations.

The maximum detected concentrations of arsenic at these locations are as follows:

- Building 1700 surface soil: 8.1 mg/kg;
- Building 1700 subsurface soil: 8.2 mg/kg;
- Building 1845 subsurface soil: 9.3 mg/kg; and
- Power Plant UST No. 49 subsurface soil: 10 mg/kg.

These maximum detected concentrations are well below both the background UTLs for arsenic in surface soil (15 mg/kg) and in subsurface soil (20 mg/kg) (USAF, 1995c) and the 95% UCL for arsenic in surface soil (13.8 mg/kg) and in subsurface soil (14 mg/kg) at the background

location. There is no reason to suspect that concentrations of arsenic at Building 1700, Building 1845, or the Power Plant UST No. 49 might be elevated above background; there is no known or suspected source for arsenic at these locations. Arsenic is a COPC at these locations only because a background comparison could not be performed.

If, as the evidence suggests, arsenic is not elevated at these locations and it is removed as a COPC at the West Unit, the estimated cancer risks for scenarios associated with direct contact with soil decrease by about 50%. Table 6-13 summarizes the West Unit cancer risk estimates, excluding the calculated risk associated with exposure to arsenic.

Dieldrin—Although ingestion of and dermal contact with soil containing dieldrin together pose a risk of 1 in one million to the long-term worker (reasonable maximum case), dieldrin is present in the soils as a result of widespread pesticide spraying and is not attributable to waste management practices at any of the source areas in the West Unit. The highest detected concentration of dieldrin in the West Unit is 0.21 mg/kg in the surface soil at the Waste Accumulation Area.

6.3.5 Uncertainty Assessment

The risk characterization results are not fully probabilistic estimates of risk but rather conditional estimates of risk that should be interpreted in light of the considerable number of assumptions required to quantify exposure, intake, and dose-response. Uncertainties associated with identification of COPCs, the exposure assessment, and the toxicity assessment all contribute to the level of confidence that can be placed in the risk characterization results.

In general, risk assessment uncertainty was addressed in the BRA by the following:

1. Incorporating both average and reasonable maximum values for input parameters, whenever possible, to provide a range of results rather than a single value;

2. Erring on the side of conservatism when defining the reasonable maximum case; and

3. Identifying and discussing the major sources of uncertainty and their effect on the risk estimates so that the results can be properly interpreted.

Table 6-14 summarizes the primary sources of uncertainty specific to this assessment and the likely impact on risk estimates.

6.3.6 Conclusions and Recommendations

Environmental contamination at the West Unit does not pose an unacceptable health risk to current on-base residents, Old and New Town Galena residents, short-term workers (average case) who spend a majority of the workday outside in the immediate vicinity of the West Unit, or to future boarding school students. Risks that exceed 1 in one million for the short-term on-base worker (reasonable maximum case) and the long-term on-base worker cannot be distinguished form the risks of exposure to benzene in the air contributed by sources associated with an operating airport or from the risks of exposure to background levels of arsenic in soils.

Estimated risks for the construction worker are also slightly elevated above the threshold risk of 1 in one million. The risk estimates for the construction worker, which are driven by inhalation of benzene and incidental ingestion of arsenic in soil, are biased high. Actual risks that are attributable to the site are likely much lower.

Table 6-13
Summary of Carcinogenic Risks, Excluding Arsenic[a], for the West Unit

Scenario	Child		Adult	
	Average	Reasonable Maximum	Average	Reasonable Maximum
Current Scenarios				
Short-Term On-Base Resident	NA	NA	8E-09	2E-08
Long-Term On-Base Resident	2E-08	3E-08	3E-08	1E-08
Old Town Galena Resident	2E-09	3E-09	9E-09	3E-08
New Town Galena Resident	2E-10	2E-10	7E-10	3E-09
Short-Term On-Base Worker	NA	NA	6E-07	**4E-06**
Long-Term On-Base Worker	NA	NA	**8E-06**	**2E-05**
On-Base Construction Worker	NA	NA	**1E-06**	**3E-06**
Future Scenarios				
Boarding School Student[b]	1E-08	3E-08	NA	NA

NOTE: Risk estimates printed in bold type equal or exceed the Superfund site remediation threshold of 10^{-6} (1 in one million) for carcinogens.

NA = Not Applicable

[a]Arsenic is COPC at some source areas in the West Unit only because a background comparison could not be performed. There is no reason to suspect that concentrations of arsenic in the West Unit are elevated above background.

[b]Ages 15-18 (Grades 9-12) for the average case and ages 6-19 (Grades 1-12, plus two repeat years) for the reasonable maximum case.

Table 6-14
Summary of the Major Uncertainties Associated with the Risk Estimates

Source of Uncertainty	Impact on Risk Characterization
Chemicals of Potential Concern	
Samples representing site media	Could result in an over-or underestimate of risks if the samples do not adequately represent media at the site. However, the number and location of samples collected at the West Unit generally were sufficient to identify the area of contamination in soils and groundwater and assess the magnitude and extent of contamination.
Analytical methods used to test samples	If the analytical methods used do not apply to some chemicals that are present at the site, risks could be underestimated. Since a full suite of analytical methods was selected to test for chemicals known or suspected to be present at the site, the potential for underestimation is reduced. In some cases, different methods were used to test for the same analyte during different phases of the RI. In such cases, data from one method were selected to derive representative concentrations in a medium.
Background comparisons	Background comparisons could not be conducted for some inorganic analytes at some source areas in the West Unit because three or fewer results were available to represent the area. These analytes remained COPCs unless screened out by other means. As a result, calculated risks associated with these analytes (primarily arsenic) are probably no higher than risks of exposure to background concentrations.
Presence of pesticides	Pesticides detected at the West Unit were evaluated in the same fashion as all other COPCs. However, the pesticides result from widespread application for insect control and estimated risks from exposure to pesticides are not attributable to the West Unit.
Contamination of blanks samples	Sporadic presence of chemicals in blanks samples was accounted for in blanks comparison. Blanks data do not indicate extensive field or laboratory contaminants.
Tentatively identified compounds	Tentatively identified compounds were not reported or assessed. Most such chemicals are not known to be highly toxic.
Diesel Range Organics and Gasoline Range Organics	DRO and GRO were not evaluated in the risk assessment as groups of chemicals. The assessment addresses individual chemicals only that were speciated by chemical analysis, which includes many constituent compounds of DRO and GRO. However, some constituent compounds were not on the target analyte list. The majority of the risk associated with exposure to DRO and GRO is probably accounted for in an assessment of individual chemicals.

Table 6-14
(Continued)

Source of Uncertainty	Impact on Risk Characterization
Chemicals of Potential Concern (Continued)	
Detection Limit Adequacy	The minimum detection limit for several analytes in soil that were eliminated as COPC (because they were not detected) exceeds USEPA Region III residential soil ingestion RBCs. These include metals, PNAs, VOCs, SVOCs, and pesticides. The same is true for several metals, PNAs, VOCs, SVOCs, pesticides, and PCBs in groundwater (when compared to Region III tap water RBCs). If these analytes are in fact present at the site and were contributed to the site by site-related activities, the estimated risks for this site may be underestimated. However, since 1993 and later sampling events reported uncensored data (where an ND is reported only if there is no instrument response), the impact on the risk estimates is minimized.
Exposure Assessment	
Use of current measured concentrations to represent current and future concentrations in the exposure media	Because concentrations of chemicals in the soils and groundwater at the West Unit may decrease over time as the chemicals migrate and/or degrade, risks estimates for the current scenarios do not necessarily represent risks that will occur in the future.
Estimation of volatile emissions to the air	The methodology used to estimate volatile emissions to the air is conservative and probably results in an overestimate of risks from inhalation of benzene.
Groundwater modeling	Results of groundwater modeling are indicative of worst-case concentrations that might reach the Yukon River. Impacts are likely overestimated, including uptake by fish.
Access to site	Access to the West Unit is open. On-base residents and Galena residents are not restricted from walking onto the site. Exposure of a roaming resident was not quantified (see discussion in Section 3). If a resident spends a significant amount of time in the West Unit area, estimated risks for that resident may be underestimated.
Construction worker scenario	The exposure duration for this scenario is biased high.
Base water supply	Migration of chemicals in the groundwater of the West Unit area to base supply wells was not evaluated (see discussion in Section 3). If the contaminant plume migrates to base supply wells and the planned water treatment system does not function as designed, risks for users of the base water supply (resident and workers) may be underestimated.
Exposure parameter estimation	The standard assumptions regarding body weight, period exposed, life expectancy, and population characteristics may not be representative of any actual exposure situation. Some assumptions may underestimate risks, but most probably overestimate risk. In some cases, nonstandard assumptions were used for site-specific reasons, such as the reasonable maximum exposure duration of 70 years for Galena residents. The use of a 14-year exposure duration for the boarding school student overstates the likely duration of residence for most students.

Table 6-14
(Continued)

Source of Uncertainty	Impact on Risk Characterization
Toxicity Assessment	
Absence of toxicity values for some chemicals detected at the site	Lack of toxicity values may underestimate or risk; however, most chemicals that lack toxicity values are not very toxic or carcinogenic. Therefore, the degree of underestimation is probably low.
Use of unverified toxicity values for some chemicals	Could overestimate risk. However, chemicals with unverified toxicity values do not contribute significantly to estimated risks at the West Unit.
Bases for derivation of toxicity values	Some common sources of uncertainty in toxicity values include 1) Use of information obtained from dose-response studies conducted in laboratory animals to predict effects that are likely to occur in humans; 2) use of dose-response information from effects observed at high doses to predict adverse health effects that may occur at the low levels to which humans are likely to be exposed in the environment; 3) use of information obtained from short-term exposure studies to predict health effects in humans exposed on a long-term basis; 4) use of toxicity values that have been developed for one route of exposure and employing it under a different exposure route; and 5) use of information gathered in studies using homogeneous animal populations (inbred strains) or health human populations (occupational exposures) to predict the effects that are likely to occur in the general human population.
Absence of dermal toxicity values	Unadjusted oral toxicity values were used to evaluated dermal exposures. Since most oral values are based on administered dose and dermal exposure is quantified as an absorbed dose, risks from dermal exposure might be under-estimated. PNAs were not evaluated for dermal exposures per USEPA guidance (see discussion in Section 3). PNAs are associated with neoplasia in a variety of mammalian systems. The inability to quantify risks from dermal exposure to PNAs results in an underestimation of risks for the dermal pathway for PNAs.
Possible synergistic or antagonistic effects of exposure to multiple chemicals	Unknown impact on risk estimates. Chemical- and pathway-specific risk and hazard quotients are summed to account for possible additive effects.
Risk Characterization	
Applicability of cancer risk estimation methodology to subchronic exposure durations	The estimated intake for cancer risk estimation is averaged over a 70-year period. Exposure to higher concentrations of potential carcinogens for a short duration of time probably does not have the same effect as exposure to lower concentrations over a long duration.

On the basis of the results of the human health assessment, remedial action at the West Unit is not warranted.

6.4 Ecological Risk Assessment Results

The majority of the West Unit is contained within the dike road, with the exception of portions of Million Gallon Hill. Vegetation consists of grasses and shrubs in the manicured areas around the buildings and grasses, willows, and alders in the drainage ditches. In general, the West Unit within the dike has been graded and filled with gravel and sand limiting the area as ecological habitat. During periods of rain or snowmelt, surface water drainage occurs as sheet flow across the West Unit or as percolation into surface fill. A drainage ditch system that receives excess runoff and drains to the ditch is the western diked boundary of the Galena installation. Marshy lowlands exist west of the installation dike. Figure 6-4 shows the topography for the West Unit.

Access to the area of the West Unit east of the flood control dike is limited by perimeter fencing; however, exposure to site contaminants is possible for small mammals (such as muskrats, foxes, and rodents) through gaps in the fencing and for birds. The common raven, robin, and cliff swallows are species identified throughout the Galena Airport. Porcupine (*Erethizon dorsatum*), yellow warblers, snow bunting (*Plectrophenax nivalis*), white-crowned sparrows (*Zonothrichia leucophrys*), spotted sandpiper, and goshawk have been sighted along the dike within the bounds of the West Unit, but the frequency of these species in the West Unit is undetermined at this time (USAF, 1995e). Each source area is described separately below.

Waste Accumulation Area (SS006)—The Waste Accumulation Area is primarily mowed grass and graveled parking areas. Surface water drainage collects in a ditch west of Building 1499 and flows to the southwest to meet with the drainage ditch west of Building 1488 that flows southerly along the inside of the perimeter dike. Figure 6-4 shows the estimated area of soil contamination at the Waste Accumulation Area. This area of concern is based on detection of DRO by Method AK102.

Million Gallon Hill—Million Gallon Hill is located outside of the main dike and the Airport fence. The ground has been built up approximately 20 ft to the level of the perimeter flood control dike, and the top of Million Gallon Hill consists of a cleared, graveled area with fuel storage tanks. The slopes of this hill are vegetated primarily with balsam poplar. To the west of Million Gallon Hill, outside of the dike road, native soils and vegetation prevail. Vegetation here historically has been much thicker than within the dike, and includes wooded areas of birch, balsam poplar, and black spruce. Standing water sometimes occurs to the west of Million Gallon Hill, especially in the spring following breakup. Currently a large portion of this vegetation has been cleared as a result of drum removal activities. There is habitat for common birds and small mammals in vegetated areas adjacent to the elevated, cleared area of the top of Million Gallon Hill. Evidence of bear and moose has been noted in these vegetated areas.

Power Plant UST No. 49—Power Plant UST No. 49 is located southwest of Building 1700 in the West Unit. The area adjacent to the Power Plant UST No. 49 is primarily mowed grass and gravel. Although habitat is generally poor in the surrounding area, spotted sandpipers were sighted at the power plant by field crews in 1992. However, this habitat was not considered suitable to sustain ecological receptors and contamination was not available to receptors (i.e., surface contamination) if receptors were present intermittently. Therefore this source area was not evaluated for ecological impacts.

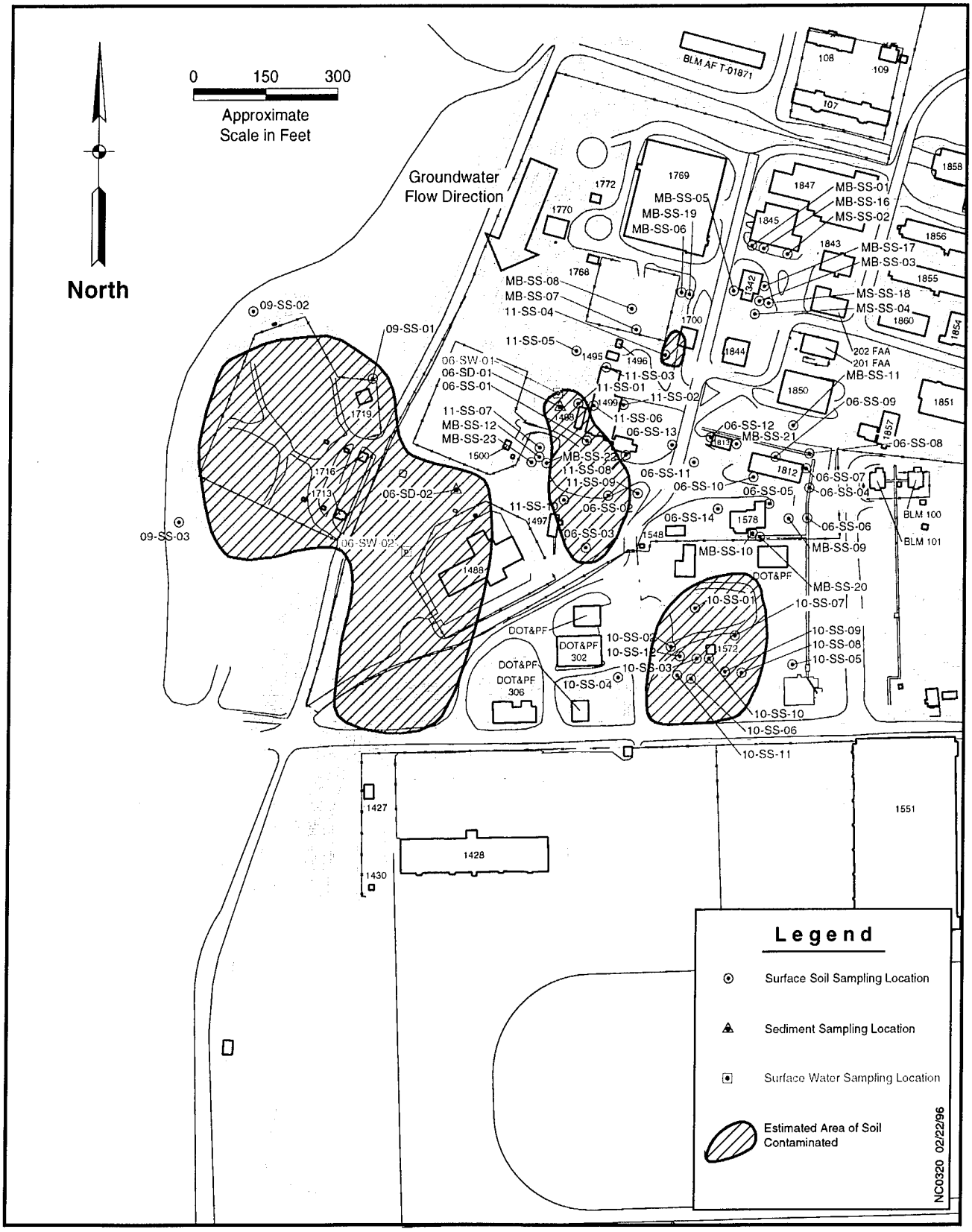


Figure 6-4. Galena Airport - West Unit

JP-4 Fillstands—The JP-4 Fillstand area is graded and contains little vegetation. Thus, ecological features at the JP-4 Fillstands are limited. Wildlife use of the area is discouraged by the machinery and industrial activity. Since there is no valuable ecological habitat in this source area, terrestrial receptors were not evaluated. However, groundwater associated with the JP-4 Fillstands was modeled to the Yukon River where it discharges into surface water. Impacts from this discharged groundwater to aquatic and semiaquatic receptors were evaluated.

Buildings 1700, 1845, and 1850—Solvent contamination in groundwater at the West Unit has been linked to Building 1845; subsurface fuel contamination is associated with Building 1700. Fuel-stained subsurface soil was discovered during recent construction of an aboveground waste oil tank to the south of Building 1850. The origin of this staining is unknown, and it appeared to be weathered. There is no valuable ecological habitat in these three source areas because they consist of gravel and paved areas. However, groundwater from beneath Building 1845 was modeled to the Yukon River where it discharges into surface water. Impacts from this discharged groundwater to aquatic and semiaquatic receptors were evaluated.

6.4.2 Chemicals of Potential Ecological Concern

Surface soil, sediment, and surface water contamination at the West Unit consists primarily of fuel-related compounds. Petroleum hydrocarbons and BTEX were present in surface soils throughout the West Unit, suggesting that spills and leaks have occurred at several locations over a period of time (Figure 6-4). Numerous samples of surface soils were taken throughout the West Unit, but only two surface water and sediment samples were taken from drainage ditches in the Waste Accumulation Area and Million Gallon Hill areas. COPECs are listed for surface soil from the Waste Accumulation Area, and Million Gallon Hill. Sediment and surface water COPECs from the drainage ditches as well as discharged groundwater are presented in Table 6-15. This table categorizes all chemicals by medium, and shows positive results that exceeded blank and background concentrations, as well as those that were not eliminated as an essential nutrient such as potassium, iron, and magnesium.

6.4.3 Exposure Assessment

Figure 6-5 shows the conceptual model for potential receptors and exposure pathways to contaminants originating at the JP4-Fillstands and Building 1845. These areas provide little ecological habitat because of industrial development, human activity, and lack of vegetation. Discharge of contaminants to the Yukon River via groundwater is the only ecological pathway considered for these source areas in this ERA. Ecological receptors evaluated for these sources were northern pike in the Yukon River, and aquatic invertebrates and spotted sandpipers on the mudflats and shoreline. Table 6-16 describes the assessment and measurement endpoints for these source areas, with methodology detailed in Section 3.2.1.

Receptors and pathways at Million Gallon Hill and the Waste Accumulation Area are shown in Figure 6-6. Ingestion of surface soils and vegetation, located in contaminated soil, represents the main routes of exposure for the species in these source areas. Ingestion of surface water and sediments in the drainage ditches also is a route of exposure for invertebrates and spotted sandpipers utilizing the semiaquatic system. Groundwater may be a route of transport of contaminants at the Yukon River, where ingestion, dermal contact, or inhalation exposure could occur. Tables 6-16 and 6-17 describe the assessment and measurement endpoints for the Million Gallon Hill and Waste

Table 6-15
Chemicals of Potential Ecological Concern at the West Unit

Chemical	Surface soil		Discharged Groundwater				Sediment	Surface Water
	1	2	1	2	3	4	5	
Metals								
Aluminum							X	
Antimony								X
Arsenic			X		X	X	X	X
Barium			X	X	X		X	X
Beryllium							X	
Cadmium	X					X		
Chromium							X	
Cobalt			X				X	X
Copper							X	
Lead	X	X	X	X	X	X	X	
Manganese			X				X	X
Mercury							X	
Molybdenum							X	
Nickel			X				X	
Selenium			X		X			
Vanadium							X	
Zinc			X				X	X
PNAs								
2-Methylnaphthalene	X	X		X	X		X	X
Acenaphthene	X	X		X			X	
Anthracene	X	X					X	
Benzo(a)anthracene	X	X					X	

Table 6-15
(Continued)

Chemical	Surface soil		Discharged Groundwater				Sediment	Surface Water
	1	2	1	2	3	4	5	
Benzo(a)pyrene	X	X					X	
Benzo(b)fluoranthene	X	X					X	
Benzo(g,h,i)perylene	X	X					X	
Benzo(k)fluoranthene	X	X					X	
Chrysene	X	X					X	
Dibenz(a,h)anthracene	X							
Fluoranthene	X	X					X	X
Fluorene	X	X		X			X	X
Indeno(1,2,3-cd)pyrene	X	X					X	
Naphthalene	X	X		X	X		X	X
Phenanthrene	X	X		X		X	X	X
Pesticides								
4,4-DDD	X	X		X	X	X	X	X
4,4-DDE	X	X		X		X	X	X
4,4-DDT	X	X	X	X	X	X	X	
Aldrin	X			X	X	X		
alpha-BHC		X	X	X	X	X	X	
beta-BHC		X	X	X	X	X		X
delta-BHC			X					X
gamma-BHC	X	X	X	X	X	X	X	
Dieldrin	X	X	X	X		X	X	
Endosulfan I	X	X			X			

Table 6-15
(Continued)

Chemical	Surface soil		Discharged Groundwater				Sediment	Surface Water
	1	2	1	2	3	4	5	
Endosulfan II	X						X	
Endosulfan sulfate	X	X	X	X		X		
Endrin	X							
Endrin aldehyde	X	X	X	X	X	X	X	
Heptachlor	X	X	X		X	X	X	
Heptachlor epoxide	X				X	X	X	X
Methoxychlor	X	X	X				X	
Dioxins								
Dibenzofuran		X		X			X	
Semi-volatiles								
2-Butanone (MEK)				X				
2-Hexanone							X	
2-Methylphenol (o-cresol)				X	X			X
4-Methylphenol/3-Methylphenol				X				
4-Methyl-2-Pentanone (MIBK)		X				X	X	
4-Methylphenol (p-cresol)					X			X
Benzoic acid	X		X		X			X
Benzyl alcohol								X
bis(2-Ethylhexyl)phthalate	X	X	X	X	X	X	X	
Dibutyl phthalate		X					X	
Phenol				X	X			X
Pyrene	X	X					X	X

Table 6-15
(Continued)

Chemical	Surface soil		Discharged Groundwater				Sediment	Surface Water
	1	2	1	2	3	4	5	
Volatiles								
1,1,2-Trichloroethane						X		
1,1-Dichloroethane				X	X	X		
1,1-Dichloroethene				X		X		
1,2-Dichloroethane			X	X	X	X		X
Acetone				X			X	
Benzene			X	X	X	X	X	X
Bromochloromethane			X	X	X	X		
Chloroethane				X				
Chloroform						X		
Chloromethane			X	X		X		
cis-1,2-Dichloroethene			X	X	X	X		
Dibromomethane			X	X				
Ethyl benzene				X	X	X	X	X
Methylene Chloride		X		X			X	
Tetrachloroethene						X		
Toluene					X		X	X
trans-1,2-Dichloroethene				X		X		
Trichloroethene				X	X	X		
Trichlorofluoromethane						X		
Vinyl Chloride			X	X		X		
Xylene				X	X		X	X

1 - Waste Accumulation Area
2 - Million Gallon Hill
3 - JP-4 Fillstands
4 - Building 1845
5 - Drainage Ditches in the West Units near Million Gallon Hill and the Waste Accumulation Area

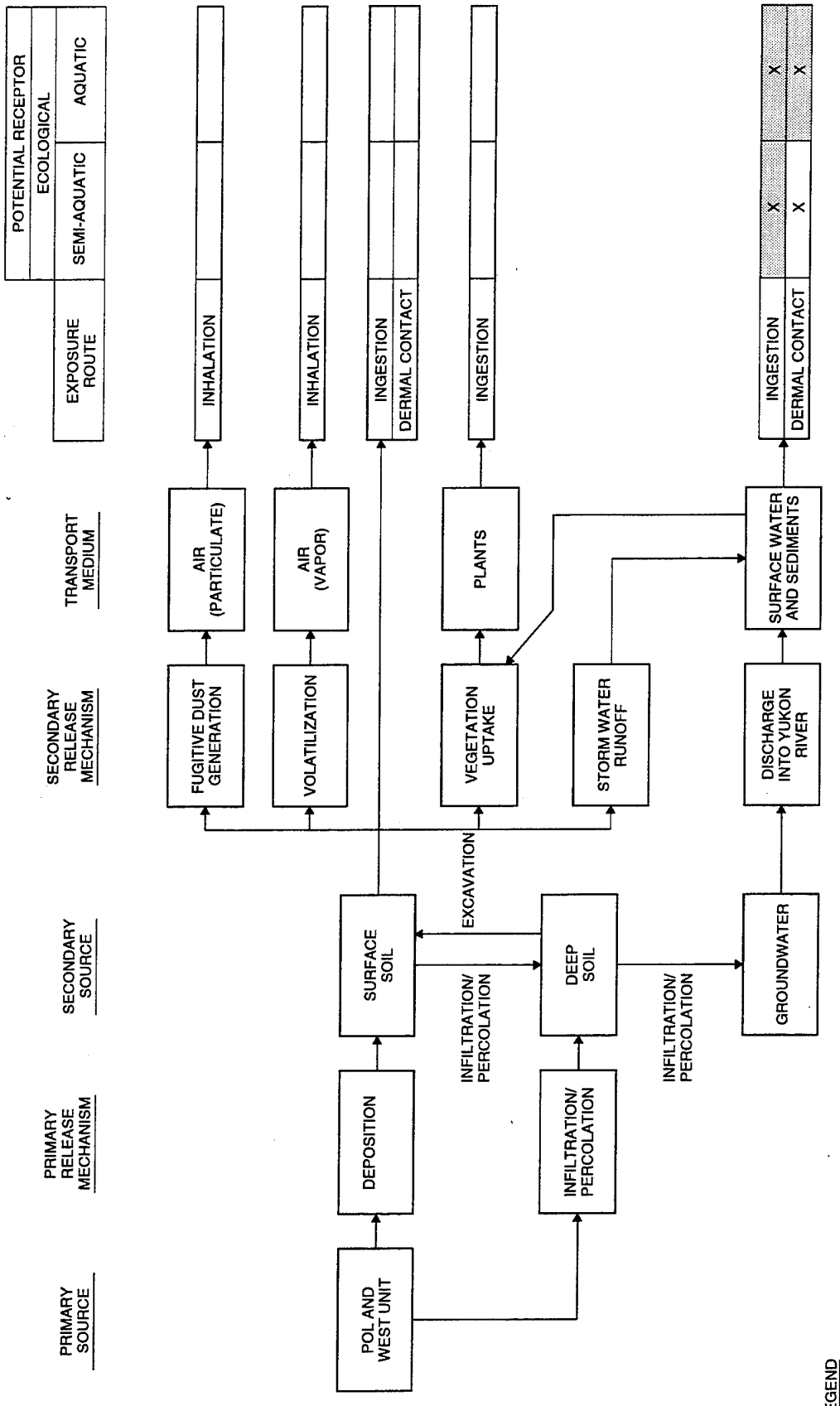


Figure 6-5.
Conceptual Site Model Showing Potential Ecological Receptors and Exposure Pathways at the West Unit (other than the Waste Accumulation Area and Million Gallon Hill)

Table 6-16
Assessment and Measurement Endpoints for the Evaluation of Surface Water[a] at the West Unit

Assessment Endpoint	Measurement Endpoint
Decrease in aquatic invertebrate productivity and local population survivorship.	AWQC for the protection of aquatic life.[b]
Decrease in spotted sandpiper productivity and survivorship.	LOAELs[c] with effects such as decreased eggshell thickness or reduced survival.
Decrease in local northern pike productivity and population survivorship in the Yukon River.	LOAELs with effects such as decreased gamete production, growth rate, or reduced survival.

[a] Individual surface water areas include the shoreline where mudflats exist part of the year. The aquatic ecosystem is the Yukon River. Modeled data for groundwater that migrated from the source areas to the mudflats and Yukon River was used.
[b] If AWQCs are unavailable (including AWQC recommended LOAELs), LC_{50} values were used.
[c] If LOAELs are unavailable, LC_{50} values were used.

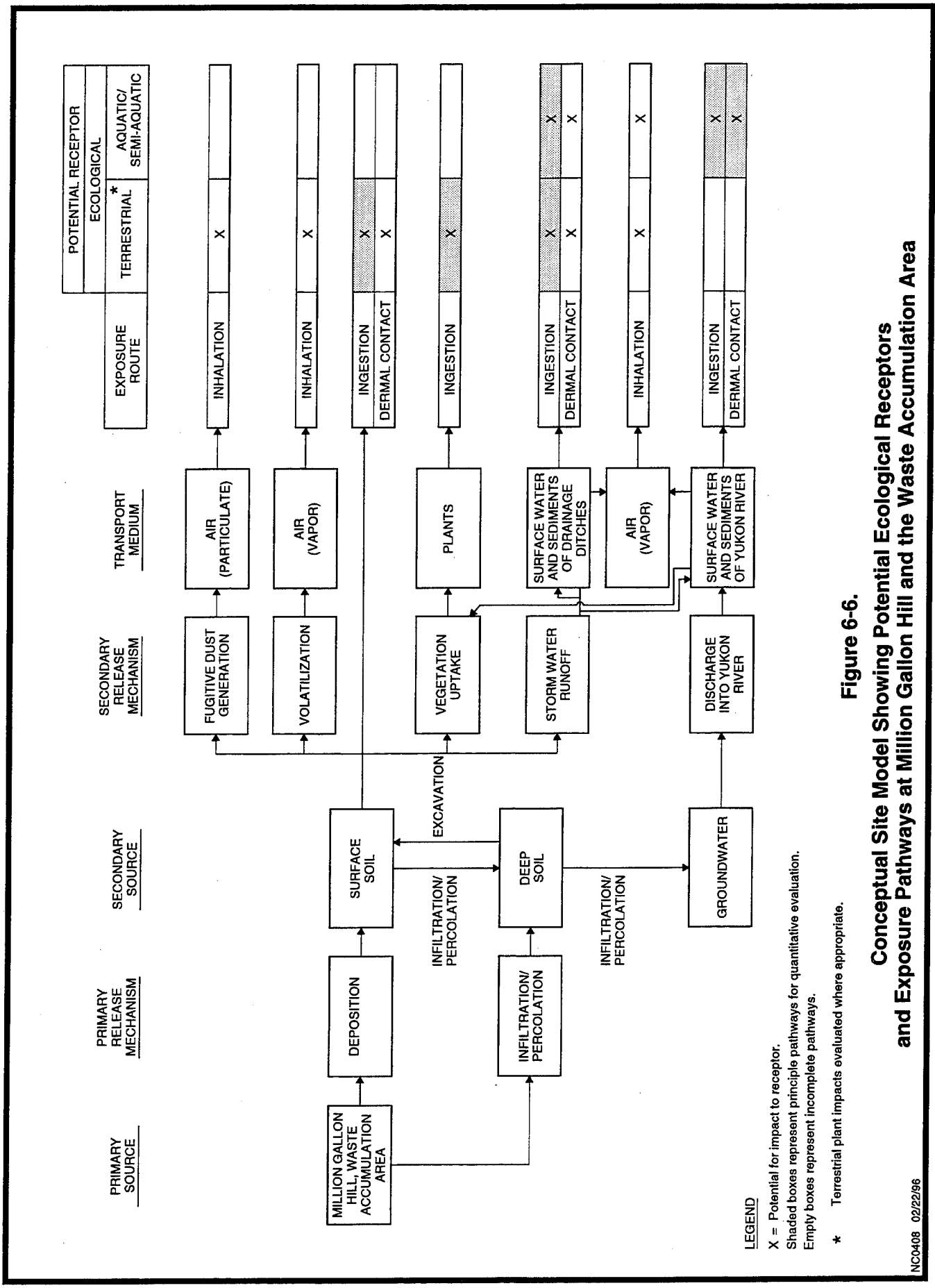


Figure 6-6.
Conceptual Site Model Showing Potential Ecological Receptors and Exposure Pathways at Million Gallon Hill and the Waste Accumulation Area

Table 6-17
Assessment and Measurement Endpoints for the Evaluation of Terrestrial Ecosystems at the West Unit

Assessment Endpoint	Measurement Endpoint
Decrease in balsam poplar and herbaceous plant survivorship.	Experimental effects such as reduced plant growth taken from available literature[1].
Decrease in terrestrial invertebrate, robin, and American kestrel productivity and local population survivorship.	LOAELs[2] with effects such as decrease in eggshell thickness or reduced survival.
Decrease in meadow vole and red fox productivity and local population survivorship.	LOAELs[2] with effects such as decrease in litter number or reduced survival.

[1] Species-specific information will be used whenever possible, but plants may have to be aggregated because there may be insufficient phytotoxicity data or plant uptake data to perform taxon-specific assessments.

[2] If LOAELs were unavailable, LD_{50} values were used.

Accumulation Area. Development of assessment and measurement endpoints is detailed in Section 3.2.1.

6.4.4 Effects Assessment

EQs were calculated for the assessment endpoint species at the West Unit. The results of this evaluation are presented in Tables 6-18 through 6-24. Supporting spreadsheets are presented in Appendix K.

6.4.5 Ecological Risk Characterization

Table 6-25 lists the EQ values greater than 1 for the aquatic and semiaquatic receptors. Table 6-26 lists the EQ values greater than 1 for the receptors associated with the drainage ditches in the West Unit. The sampling points for the drainage ditch data were taken from the Waste Accumulation and Million Gallon Hill (within the dike) areas. Table 6-27 lists the EQ values greater than 1 for the terrestrial receptors in the West Unit. These tables also provide the order of magnitude for the EQ results.

6.4.6 Uncertainty Assessment

Uncertainty occurs in almost every step of the ERA process. As stated previously, uncertainty is addressed by making intentionally biased (health conservative) assumptions so that impacts will not be underestimated. Individual assumptions are therefore conservative, but because of compounded bias, the calculated EQs are biased higher than any individual assumptions. Table 3-9 lists uncertainties associated with the ERA. Table 6-28 lists the uncertainties associated with the West Unit.

6.4.7 Conclusions and Recommendations

Aquatic (surface water → pike)

This exposure pathway considered groundwater beneath the Waste Accumulation Area, Million Gallon Hill, Building 1845, and the JP-4-Fillstands that potentially could migrate to the Yukon River where exposure to the northern pike potentially could occur. Appendix C details the methods used in predicting the concentrations utilized in this assessment. Manganese originating from the Waste Accumulation Area was the only compound from the West Unit that resulted in an EQ exceeding 1 for the northern pike. As an AWQC was not available for manganese, an LC_{50} value for a juvenile longfin dace (*Agosia chrysogaster*, Family - *Characidae*) was used. Manganese is a natural element ubiquitously distributed in the earth's crust and waters. Concentrations range from less than 1 to 40 µg/L in neutral natural waters. Manganese has low toxicity to aquatic organisms and is an essential metal to living organisms, as numerous enzymes are activated by this element (Rouleau et al., 1995). The modeled concentration to the Yukon River was 0.0715 mg/L; however, an uncertainty factor of 3000 was applied since only an acute LC_{50} was available for the test species (measurement endpoint), which was from a different taxonomic family as the assessment endpoint species. Impacts from manganese to the northern pike are classified by the EQ to be possible (EQ = 1.65). However, owing to the conservatism built into the EQ calculations and natural dilution of the manganese in the waters of the Yukon River, manganese is not considered to pose a significant threat to the resident fish.

Semiaquatic (surface water → invertebrate → spotted sandpiper)

Table 6-25 lists the EQ values for each source area evaluated that exceed 1 and classifies them as greater than 1 (possible impacts) or greater than 10 (probable impacts). This pathway used modeled contaminate concentrations in groundwater as they were discharged to the shoreline or mudflats where they could contact invertebrates, such as insect larvae, and spotted sandpipers, which feed upon the invertebrates. It is important to note that surface water dilution was not applied to this pathway in the groundwater model (Appendix C) as it was to the pike

Table 6-18
Summary of EQ Values for Terrestrial Receptors at the Waste Accumulation Area

Chemical	EQ					
	Plant	Meadow Vole	Red Fox	Invertebrate	Robin	Kestrel
1,2-Dichloroethane	a	1.23e-06	1.86e-09	a	1.60e-04	5.70e-07
2-Methylnaphthalene	a	3.69e-02	1.71e-05	a	1.36e-02	4.17e-05
2-Methylphenol(o-cresol)	a	4.93e-06	1.56e-08	a	1.00e-05	4.63e-08
4,4'-DDD	a	1.24e-02	1.98e-04	a	8.96e+02	8.05e-01
4,4'-DDE	a	7.63e-04	1.50e-05	a	6.79e+01	6.10e-02
4,4'-DDT	a	1.67e-02	2.64e-04	a	1.20e+03	1.08e+00
4-Methylphenol(p-cresol)	a	1.63e-03	1.60e-06	a	5.52e-04	2.39e-06
Acenaphthene	a	3.75e+00	8.69e-05	a	9.32e-01	4.24e-04
Aldrin	a	1.23e-04	2.26e-06	a	4.12e-02	1.76e-03
Anthracene	a	1.10e-01	1.87e-05	a	a	a
Antimony	a	2.99e-03	1.42e-05	a	1.01e-03	3.48e-06
Arsenic	a	1.96e-02	4.41e-05	a	9.28e-02	3.74e-04
Barium	a	5.05e-03	1.72e-02	a	1.03e-02	1.17e-04
Benz(a)anthracene	a	8.11e+00	2.35e-03	a	2.36e-01	1.95e-04
Benzene	a	4.45e-04	1.69e-06	a	2.26e-02	2.09e-05
Benzo(a)pyrene	a	9.60e-01	6.01e-04	3.75e+00	7.33e-02	1.53e-04
Benzo(b)fluoranthene	a	2.70e-01	1.54e-04	a	4.38e+00	2.07e-03
Benzo(g,h,i)perylene	a	5.59e+00	3.88e-03	a	a	a
Benzo(k)fluoranthene	a	1.51e-01	8.96e-05	a	a	a
Benzoic acid	a	1.13e-01	5.70e-05	a	2.90e-01	4.42e-04
Benzyl alcohol	a	3.87e-03	3.09e-06	a	1.68e-03	6.22e-06
beta-BHC	a	1.29e-06	9.05e-09	a	1.18e-06	1.06e-08
bis(2-Ethylhexyl)phthalate	a	5.44e-04	3.92e-05	a	1.33e+00	9.03e-03
Cadmium	a	2.67e-03	1.47e-05	a	1.98e-01	2.79e-03
Chrysene	a	1.98e-01	4.85e-05	a	4.00e-01	4.25e-04
Cobalt	a	9.85e-03	1.95e-05	a	7.75e-03	4.73e-05

Table 6-18
(Continued)

Chemical	EQ					
	Plant	Meadow Vole	Red Fox	Invertebrate	Robin	Kestrel
delta-BHC	a	1.33e-06	1.59e-07	a	1.22e-06	1.10e-08
Dibenz(a,h)anthracene	a	5.31e-01	2.00e-01	a	a	a
Dieldrin	a	9.73e-02	4.92e-04	a	4.72e-01	6.31e-04
Endosulfan I	a	5.38e-04	1.15e-05	a	6.30e-04	6.01e-06
Endosulfan II	a	1.74e-04	2.54e-06	a	1.39e-04	1.33e-06
Endosulfan sulfate	a	2.78e-04	4.82e-06	a	2.65e-04	2.53e-06
Endrin	a	2.07e-03	2.77e-05	a	1.01e-02	1.36e-05
Endrin aldehyde	a	1.11e-03	1.37e-06	a	4.99e-04	6.73e-07
Ethylbenzene	a	6.00e-03	1.32e-06	a	2.37e-04	1.40e-06
Fluoranthene	a	3.99e-02	5.80e-06	a	4.86e-02	4.91e-05
Fluorene	a	8.55e-01	2.22e-04	a	a	a
gamma-BHC	a	3.25e-05	2.98e-08	a	2.90e-04	2.29e-07
Heptachlor	a	1.05e-06	2.16e-08	a	3.20e-03	4.49e-07
Heptachlor epoxide	a	4.29e-05	2.06e-07	a	1.79e-02	2.78e-06
Indeno(1,2,3-cd)pyrene	a	5.62e-02	3.90e-05	a	a	a
Lead	3.68e+00	9.91e-02	9.76e-05	a	7.43e-01	1.18e-04
Manganese	a	4.67e-03	3.23e-04	a	9.50e-03	1.85e-04
Methoxychlor	a	1.48e-05	9.12e-07	a	3.70e-04	2.79e-04
Naphthalene	a	2.42e-02	6.48e-07	a	3.73e-03	1.18e-05
Phenanthrene	a	9.65e-02	9.93e-06	1.09e+00	1.46e-02	1.25e-05
Pyrene	a	6.13e-02	1.90e-04	a	a	a
Toluene	a	3.56e-04	1.22e-06	a	7.24e-04	1.61e-05
Xylene (total)	a	4.26e-03	6.46e-06	a	8.65e-03	1.42e-04
Zinc	a	8.57e-06	1.17e-08	a	1.74e-05	2.78e-07

a = No toxicity data available.
EQ = Concentration in soil/toxicity benchmark.

Table 6-19
Summary of EQ Values for Aquatic and Semiaquatic Receptors Exposed to Groundwater from the Waste Accumulation Area

Chemical	Northern Pike	Aquatic Invertebrate	Spotted Sandpiper
1,2-Dichloroethane	5.61e-07	2.76e-06	2.42e-06
4,4'-DDT	3.93e-01	**2.42e+01**	**1.68e+02**
alpha-BHC	8.15e-03	2.70e-04	2.65e-04
Arsenic	5.01e-04	1.78e-01	**1.25e+00**
Barium	4.08e-01	8.28e-01	**2.20e+00**
Benzene	1.84e-05	3.42e-12	1.63e-11
Benzoic acid	a	a	6.32e-02
beta-BHC	1.15e-02	4.72e-04	6.00e-04
bis(2-Ethylhexyl)phthalate	4.10e-05	1.69e-04	2.01e-03
Bromochloromethane	a	a	a
Chloromethane	8.52e-07	1.93e-10	2.15e-13
cis-1,2-Dichloroethene	4.42e-04	1.25e-03	8.84e-04
Cobalt	7.63e-03	**4.10e+00**	**1.97e+02**
delta-BHC	7.01e-05	1.20e-04	9.37e-05
Dibromomethane	a	a	a
Dieldrin	6.27e-02	**3.54e+00**	7.68e-02
Endosulfan sulfate	2.38e-02	4.57e-02	4.60e-07
Endrin aldehyde	4.33e-02	6.12e-01	8.15e-05
gamma-BHC	1.43e-02	9.62e-05	7.46e-06
Heptachlor	5.34e-40	3.70e-96	3.63e-99
Lead	6.42e-02	**7.20e+00**	**6.41e+00**
Manganese	**1.65e+00**	**2.95e+03**	**5.34e+00**
Methoxychlor	6.93e-04	5.88e-03	3.60e-05
Nickel	1.21e-02	**6.48e+00**	4.13e-01
Selenium	5.89e-03	**1.79e+00**	**2.99e+00**
Vinyl Chloride	2.64e-07	4.36e-04	6.37e-04
Zinc	1.05e-03	5.62e-01	4.21e-03

a = No toxicity information available.

Table 6-20
Summary of EQ Values for Terrestrial Receptors at Million Gallon Hill

Chemical	Terrestrial Plant	Meadow Vole	EQ Red Fox	Terrestrial Invertebrate	Robin	Kestrel
1,2-Dichloroethane	a	1.23e-06	1.44e-08	a	a	4.65e-06
2-Methylnaphthalene	a	3.86e-02	1.32e-04	a	a	3.32e-04
2-Methylphenol (o-cresol)	a	4.93e-06	1.20e-07	a	a	4.93e-07
4,4'-DDD	a	1.67e-04	1.70e-06	a	2.39e-02	1.69e-01
4,4'-DDE	a	3.46e-05	3.84e-07	a	4.16e-03	4.70e-02
4,4'-DDT	a	3.78e-04	3.62e-06	a	1.66e-03	4.38e-01
4-Methyl-2-Pentanone (MIBK)	a	5.14e-05	8.79e-08	a	5.04e-01	3.91e-05
4-Methylphenol (p-cresol)	a	1.63e-03	1.24e-05	a	6.67e-01	2.41e-05
Acenaphthene	a	**1.17e+00**	1.14e-04	a	1.91e-02	1.09e-03
alpha-BHC	a	2.07e-05	5.49e-06	a	3.01e-06	4.16e-06
Anthracene	a	1.08e-02	6.82e-06	a	**1.27e+03**	a
Antimony	a	2.99e-03	1.10e-04	a	**4.48e+01**	2.70e-05
Arsenic	a	1.96e-02	3.41e-04	a	8.16e-03	3.52e-03
Barium	a	5.05e-03	1.33e-01	a	6.24e-04	1.84e-03
Benz(a)anthracene	a	**2.54e+00**	3.80e-03	a	2.28e-03	4.79e-04
Benzene	a	4.45e-04	1.31e-05	a	1.54e-03	2.38e-04
Benzo(a)pyrene	a	8.79e-01	1.82e-03	**3.42e+00**	5.84e-04	1.16e-03
Benzo(b)fluoranthene	a	**2.50e+00**	4.91e-03	a	4.96e-02	a
Benzo(g,h,i)perylene	a	**5.39e+00**	1.23e-02	a	a	a
Benzo(k)fluoranthene	a	1.92e-01	3.77e-04	a	1.60e-04	a
Benzoic acid	a	2.86e-02	2.79e-04	a	5.21e-02	5.15e-04
Benzyl alcohol	a	3.87e-03	2.39e-05	a	9.56e-04	5.32e-05
beta-BHC	a	1.49e-05	3.43e-07	2.89e-01	a	9.37e-06
bis(2-Ethylhexyl)phthalate	a	8.32e-05	4.03e-06	a	**1.30e+01**	2.64e-02
Chrysene	a	1.34e-01	1.98e-04	a	2.35e-02	2.23e-03
Cobalt	a	9.85e-03	1.51e-04	a	3.84e-05	6.00e-04
delta-BHC	a	1.33e-06	1.23e-06	a	5.92e-03	9.43e-08

Table 6-20
(Continued)

Chemical	Terrestrial Plant	Meadow Vole	EQ Red Fox	Terrestrial Invertebrate	Robin	Kestrel
Dibenzofuran	a	1.59e-01	1.60e-03	a	1.07e-02	3.00e-04
Dibutyl phthalate	a	3.35e-07	1.68e-08	a	9.21e-03	5.56e-02
Dieldrin	a	6.82e-04	4.59e-06	a	a	8.21e-05
Endosulfan I	a	2.16e-04	9.40e-06	a	1.79e-03	4.60e-05
Endosulfan sulfate	a	9.71e-04	4.21e-05	a	2.14e-02	1.68e-04
Endrin aldehyde	a	1.39e-03	8.28e-06	a	4.30e-05	1.56e-05
Ethyl benzene	a	6.00e-03	1.02e-05	a	5.84e-04	1.76e-05
Fluoranthene	a	1.66e-02	1.44e-05	a	4.96e-02	1.59e-04
Fluorene	a	5.78e-01	1.33e-03	a	a	a
gamma-BHC	a	7.26e-06	2.73e-08	**2.32e+00**	1.60e-04	8.96e-07
Heptachlor	a	6.91e-06	8.16e-08	a	5.21e-02	5.56e-05
Heptachlor epoxide	a	3.70e-05	6.76e-07	a	9.56e-04	3.11e-06
Indeno(1,2,3-cd)pyrene	a	5.50e-02	1.26e-04	a	a	a
Lead	**2.61e+01**	7.03e-01	2.16e-03	a	**1.30e+01**	7.12e-03
Manganese	a	4.67e-03	2.50e-03	a	2.35e-02	1.83e-03
Methoxychlor	a	6.22e-07	2.12e-08	a	3.84e-05	2.24e-04
Methylene chloride	a	3.55e-03	6.67e-06	1.37e-03	5.92e-03	3.95e-05
Naphthalene	a	2.72e-02	5.04e-06	5.88e-02	1.07e-02	9.47e-05
Phenanthrene	a	2.54e-02	1.82e-05	2.73e-01	9.21e-03	2.64e-05
Pyrene	a	3.21e-02	3.57e-04	a	a	a
Toluene	a	3.56e-04	9.46e-06	a	1.79e-03	1.76e-04
Xylene (total)	a	4.26e-03	4.99e-05	a	2.14e-02	1.16e-03
Zinc	a	8.57e-06	9.02e-08	a	4.30e-05	2.19e-06

a = No toxicity data available.

Table 6-21
Summary of EQ Values for Aquatic and Semiaquatic Receptors Exposed to Groundwater from Million Gallon Hill

Chemical	EQ		
	Northern Pike	Aquatic Invertebrate	Spotted Sandpiper
1,1-Dichloroethane	2.64e-08	4.87e-05	8.61e-05
1,1-Dichloroethene	3.26e-12	9.56e-10	2.04e-10
1,2-Dichloroethane	6.16e-09	1.64e-07	4.27e-07
2-Butanone (MEK)	4.86e-42	3.80e-37	4.51e-39
2-Methylnaphthalene	8.01e-01	**5.51e+03**	6.06e-01
2-Methylphenol(o-cresol)	1.85e-43	2.86e-40	4.94e-42
4,4'-DDD	3.32e-02	**6.36e+01**	**1.31e+03**
4,4'-DDE	1.55e-02	**9.11e+00**	**1.88e+02**
4,4'-DDT	5.28e-03	**2.99e+03**	**6.18e+04**
4-Methylphenol/3-Methylphenol	8.77e-05	3.09e-03	5.33e-05
Acenaphthene	9.69e-09	2.87e-05	4.58e-04
Acetone	8.71e-42	2.93e-37	2.73e-35
Aldrin	6.59e-04	2.00e-01	1.49e-02
alpha-BHC	1.06e-04	1.64e-04	4.79e-04
Barium	5.02e-03	1.75e-02	1.38e-01
Benzene	2.00e-07	2.96e-09	4.21e-08
beta-BHC	1.42e-04	1.61e-04	6.09e-04
bis(2-Ethylhexyl)phthalate	6.04e-07	4.69e-05	1.10e-02
Bromochloromethane	a	a	a
Chloroethane	a	a	a
Chloromethane	9.26e-09	1.36e-09	4.51e-12
cis-1,2-Dichloroethene	4.91e-06	3.09e-03	6.52e-03
Dibenzofuran	1.92e-15	5.69e-10	1.45e-10
Dibromomethane	a	a	a
Dieldrin	8.61e-04	5.32e-01	3.44e-02
Endosulfan sulfate	3.20e-04	1.81e-01	5.40e-06
Endrin aldehyde	5.12e-04	1.22e-01	4.85e-05
Ethylbenzene	5.21e-05	9.17e-03	9.97e-03
Fluorene	4.02e-06	5.87e-03	8.18e-04
gamma-BHC	1.62e-04	1.00e-05	2.32e-06
Heptachlor	5.81e-42	7.39e-98	2.16e-100
Heptachlor epoxide	6.70e-04	1.85e-01	5.40e-04
Lead	9.67e-04	8.00e-01	**2.12e+00**
Methylene chloride	9.47e-14	2.05e-12	3.30e-08

Table 6-21
(Continued)

Chemical	EQ		
	Northern Pike	Aquatic Invertebrate	Spotted Sandpiper
Naphthalene	1.84e-06	5.28e-03	4.95e-01
Phenanthrene	1.39e-05	4.02e-03	8.58e-02
Phenol	1.27e-79	3.69e-76	6.83e-74
Toluene	2.18e-15	3.50e-21	2.91e-19
trans-1,2-Dichloroethene	3.54e-07	3.66e-04	7.73e-04
Trichloroethene	3.62e-06	3.50e-05	5.31e-04
Vinyl Chloride	3.82e-09	2.84e-01	**1.23e+00**
Xylene (total)	2.21e-03	**3.57e+01**	**2.64e+00**

a = No toxicity information available.

Table 6-22
Summary of EQ Values for Semiaquatic Receptors in the Drainage Ditches in the West Unit

Chemical	EQ		
	Invertebrates		
	Sediment	Water	Spotted Sandpiper
1,2-Dichloroethane	a	2.08e-02	5.47e-05
2-Hexanone	a	b	2.76e-01
2-Methylnaphthalene	6.21e-01	**6.36e+02**	**8.05e+03**
2-Methylphenol(o-cresol)	a	1.47e-01	2.53e-03
4,4'-DDD	**7.40e+00**	**2.50e+02**	**1.17e+06**
4,4'-DDE	3.86e-01	**2.30e+01**	**3.48e+05**
4,4'-DDT	**7.41e+00**	b	**3.68e+05**
4-Methyl-2 Pentanone (MIBK)	a	b	6.78e-03
4-Methylphenol(p-cresol)	a	6.00e-01	1.03e-02
Acenaphthene	2.13e-04	b	3.91e-03
Acetone	a	b	2.86e-05
alpha-BHC	**7.02e+00**	b	**4.25e+01**
Aluminum	a	b	**2.48e+01**
Anthracene	a	a	a
Antimony	a	**3.67e+00**	**3.30e+01**
Arsenic	**1.34e+00**	8.42e-02	**5.07e+02**
Barium	a	5.88e-01	**1.22e+03**
Benz(a)anthracene	a	b	a
Benzene	a	1.43e-02	2.04e-01
Benzo(a)pyrene	a	b	**1.18e+00**
Benzo(b)fluoranthene	a	b	a
Benzo(g,h,i)perylene	a	b	a
Benzo(k)fluoranthene	a	b	a
Benzoic acid	a	a	**2.50e+00**
Benzyl alcohol	a	5.00e+00	3.78e-01
Beryllium	a	b	**1.60e+02**
beta-BHC	a	3.00e-02	1.14e-01
bis(2-Ethylhexyl)phthalate	4.64e-04	b	**2.70e+00**
Chromium	2.96e-01	b	**1.13e+05**
Chrysene	a	b	a
Cobalt	a	**1.60e+00**	**5.02e+02**
Copper	9.12e-01	b	**4.06e+00**
delta-BHC	a	3.88e-01	7.18e-02
Dibenzofuran	a	b	**2.45e+05**
Dibutyl phthalate	a	b	**1.83e+01**

Table 6-22
(Continued)

Chemical	EQ		
	Invertebrates		
	Sediment	Water	Spotted Sandpiper
Dieldrin	**2.72e+02**	b	**2.88e+02**
Endosulfan II	**9.51e+00**	b	5.81e-02
Endrin aldehyde	3.29e-01	b	5.78e-03
Ethylbenzene	a	1.09e-01	**7.98e+00**
Fluoranthene	a	4.52e-05	**9.36e+00**
Fluorene	a	**3.40e+01**	**3.55e+03**
gamma-BHC	**2.31e+01**	b	5.60e-01
Heptachlor	3.51e-01	b	1.92e-01
Heptachlor epoxide	**1.44e+01**	**1.13e+02**	4.75e-01
Indeno (1,2,3-cd)pyrene	a	b	a
Lead	2.57e-01	b	**2.76e+03**
Manganese	a	**4.62e+02**	**1.91e+01**
Mercury	4.93e-01	b	**5.26e+02**
Methoxychlor	6.52e-03	b	2.41e-03
Methylene chloride	a	b	4.99e-01
Molybdenum	a	b	**1.37e+03**
Naphthalene	9.19e-03	7.90e-02	**1.37e+02**
Nickel	**1.44e+00**	b	**2.34e+03**
Phenanthrene	a	2.06e-02	**1.23e+01**
Phenol	a	2.07e-02	**3.83e+00**
Pyrene	a	a	**5.34e+00**
Toluene	a	3.43e-03	**2.43e+00**
Vanadium	a	b	**8.42e+01**
Xylene (total)	a	**4.38e+01**	**1.43e+02**
Zinc	5.73e-01	1.82e-01	**1.22e+00**

a = No toxicity data available.

Table 6-23
Summary of EQ Values for Aquatic and Semiaquatic Receptors Exposed to Groundwater from Bldg. 1845

Chemical	EQ		
	Northern Pike	Aquatic Invertebrate	Spotted Sandpiper
1,1,2-Trichloroethane	5.19e-08	3.37e-05	1.08e-04
1,1-Dichloroethane	1.52e-06	1.65e-03	2.79e-04
1,1-Dichloroethene	1.19e-10	7.72e-08	1.58e-08
1,2-Dichloroethane	4.25e-09	2.76e-06	6.91e-07
4,4'-DDD	1.61e-01	**1.05e+02**	**2.08e+02**
4,4'-DDE	1.35e-02	**8.75e+00**	**1.73e+01**
4,4'-DDT	3.02e-02	**1.96e+01**	**3.88e+01**
4-Methyl-2-Pentanone(MIBK)	1.37e-41	2.65e-38	7.83e-38
Aldrin	2.33e-02	**1.51e+01**	1.09e-01
alpha-BHC	3.32e-04	6.89e-04	1.93e-04
Arsenic	1.37e-04	4.69e-01	9.46e-01
Benzene	8.65e-14	5.61e-12	7.65e-12
beta-BHC	1.47e-03	3.05e-03	1.11e-03
bis(2-Ethylhexyl)phthalate	3.87e-06	2.51e-04	5.67e-03
Bromochloromethane	a	a	a
Cadmium	1.51e-02	1.68e-01	**2.18e+01**
Chloroform	1.61e-06	1.05e-03	2.69e-04
Chloromethane	2.31e-13	1.50e-10	4.78e-14
cis-1,2-Dichloroethene	4.42e-04	**2.87e+00**	5.81e-01
Dieldrin	2.06e-02	**1.34e+01**	8.30e-02
Endosulfan sulfate	4.93e-04	3.20e-01	9.19e-06
Endrin aldehyde	3.93e-02	**2.55e+01**	9.70e-03
Ethylbenzene	1.53e-07	1.52e-05	1.59e-06
gamma-BHC	6.72e-04	2.18e-04	4.83e-06
Heptachlor	1.06e-97	6.90e-95	1.94e-98
Heptachlor epoxide	4.54e-03	**2.95e+00**	8.28e-04
Lead	5.85e-03	**3.80e+00**	9.66e-01
Phenanthrene	1.11e-05	7.22e-04	1.48e-03
Tetrachloroethene	5.31e-05	4.50e-04	5.48e-04
trans-1,2-Dichloroethene	3.14e-05	2.04e-01	4.14e-02
Trichloroethene	3.31e-04	2.15e-01	3.13e-01
Trichlorofluoromethane	a	a	a
Vinyl Chloride	2.55e-07	1.66e-02	6.91e-03

a = No toxicity information available.

Table 6-24
Summary of EQ Values for Aquatic and Semiaquatic Receptors Exposed to Groundwater from JP-4 Fillstands

Chemical	Northern Pike	Aquatic Invertebrate	Spotted Sandpiper
1,1-Dichloroethane	7.89e-09	6.49e-04	6.11e-04
1,2-Dichloroethane	2.04e-11	1.01e-06	1.39e-06
2-Methylnaphthalene	8.83e-04	**7.92e+01**	**1.72e+00**
2-Methylphenol(o-cresol)	1.07e-43	5.28e-39	4.84e-41
4,4'-DDD	6.30e-04	**3.11e+01**	**3.41e+02**
4,4'-DDT	2.26e-04	**1.12e+01**	**1.23e+02**
4-Methylphenol(p-cresol)	8.33e-25	4.11e-20	3.77e-22
Aldrin	7.99e-05	**3.95e+00**	1.57e-01
alpha-BHC	2.18e-06	3.44e-04	5.34e-04
Arsenic	5.76e-06	**1.50e+00**	**1.68e+01**
Barium	3.34e-03	**1.65e+00**	**6.93e+00**
Benzene	1.40e-07	6.92e-04	5.23e-03
Benzoic acid	a	a	8.18e-02
beta-BHC	2.92e-06	4.61e-04	9.29e-04
bis(2-Ethylhexyl)phthalate	4.09e-08	2.02e-04	3.79e-03
Bromochloromethane	a	a	a
cis-1,2-Dichloroethene	2.73e-09	1.35e-03	1.51e-03
Endosulfan I	3.72e-62	1.84e-57	2.93e-62
Endrin aldehyde	1.13e-04	**5.56e+00**	2.45e-04
Ethylbenzene	1.67e-08	1.27e-04	5.52e-05
gamma-BHC	1.52e-06	3.75e-05	4.61e-06
Heptachlor	1.29e-100	6.36e-96	9.88e-99
Heptachlor epoxide	1.19e-05	5.85e-01	9.10e-04
Lead	7.21e-05	**3.56e+00**	**5.02e+00**
Naphthalene	6.03e-09	2.98e-04	1.49e-02
Phenol	3.11e-81	1.54e-76	1.51e-74
Selenium	3.35e-05	**1.65e+00**	**4.37e+00**
Toluene	2.75e-28	1.36e-24	6.00e-23
Trichloroethene	8.71e-10	4.30e-05	3.47e-04
Xylene (total)	2.83e-06	**1.45e+01**	5.71e-01

a = No toxicity information available.

Table 6-25
EQ Values > 1 for Aquatic and Semiaquatic Receptors at the West Unit

Chemical	EQ > 1	EQ > 10
Waste Accumulation Area		
4,4'-DDT		Inv, SS
Arsenic	SS	
Barium	SS	
Cobalt	Inv	SS
Dieldren	Inv	
Lead	Inv, SS	
Manganese	Pike, SS	Inv
Nickel	Inv	
Selenium	Inv, SS	
Million Gallon Hill		
2-Methylnaphthalene		Inv
4,4'-DDD		Inv, SS
4,4'-DDE	Inv	SS
4,4'-DDT		Inv, SS
Lead	SS	
Vinyl chloride	SS	
Xylene (total)	SS	Inv
Building 1845		
4,4'-DDD		Inv, SS
4,4'-DDE	Inv	SS
4,4'-DDT		Inv, SS
Aldrin		Inv
Cadmium		SS

Table 6-25
(Continued)

Chemical	EQ > 1	EQ > 10
cis-1,2-Dichloroethene	Inv	
Dieldren		Inv
Endrin aldehyde		Inv
Heptachlor epoxide	Inv	
Lead	Inv	
JP-4 Fillstands		
2-Methylnaphthalene	SS	Inv
4,4'-DDD		Inv, SS
4,4'-DDT		Inv, SS
Aldrin	Inv	
Arsenic	Inv	SS
Barium	Inv, SS	
Endrin aldehyde	Inv	
Lead	Inv, SS	
Selenium	Inv, SS	
Xylene (total)		Inv

Inv = Aquatic invertebrate.
SS = Spotted sandpiper.

Table 6-26
EQ Values > 1 for Semiaquatic Receptors in the Drainage Ditches in the West Unit

Chemical	EQ > 1	EQ > 10
2-Methylnaphthalene		Inv-W, SS
4,4'-DDD	Inv-S	Inv-W, SS
4,4'-DDE		Inv-W, SS
4,4'-DDT	Inv-S	SS
alpha-BHC	Inv-S	SS
Aluminum		SS
Antimony	Inv-W	SS
Arsenic	Inv-S	SS
Barium		SS
Benzo(a)pyrene	SS	
Benzoic acid	SS	
Benzyl alcohol	Inv-W	
Beryllium		SS
bis(2-Ethylhexyl)phthalate	SS	
Chromium		SS
Cobalt	Inv-W	SS
Copper	SS	
Dibenzofuran		SS
Dibutyl phthalate		SS
Dieldrin		Inv-S, SS
Endosulfan II	Inv-S	
Ethylbenzene	SS	
Fluoranthene	SS	
Fluorene		Inv-W, SS
gamma-BHC		Inv-S
Heptachlor epoxide		Inv-S, Inv-W

Table 6-26
(Continued)

Chemical	EQ > 1	EQ > 10
Lead		SS
Manganese		Inv-W, SS
Mercury		SS
Molybdenum		SS
Naphthalene		SS
Nickel	Inv-S	SS
Phenanthrene		SS
Phenol	SS	
Pyrene	SS	
Toluene	SS	
Vanadium		SS
Xylene (total)		Inv-W, SS
Zinc	SS	

Inv-S = EQ for invertebrates in sediment.
Inv-W = EQ for invertebrates in water.
SS = Spotted sandpiper.

Table 6-27
EQ Values > 1 for Terrestrial Receptors in the West Unit

Chemical	EQ > 1	EQ > 10
Waste Accumulation Area		
4,4'-DDD		Robin
4-4'-DDE		Robin
4,4'-DDT	Kestrel	Robin
Acenaphthene	MV	
Antimony		Robin
Benzo(a)anthracene	MV	
Benzo(a)pyrene	Inv	
Benzo(b)fluoranthene	Robin	
Benzo(g,h,i)perylene	MV	
bis(2-Ethylhexyl)phthalate	Robin	
gamma-BHC		Inv
Lead	Plant	
Phenanthrene	Inv	
Million Gallon Hill		
Acenaphthene	MV	
Anthracene		Robin
Antimony		Robin
Benzo(a)anthracene	MV	
Benzo(b)fluoranthene	MV	
Benzo(a)pyrene	Inv	
Benzo(g,h,i)perylene	MV	
bis(2-Ethylhexyl)phthalate		Robin
gamma-BHC	Inv	
Lead		Robin, Plant

Inv = Terrestrial invertebrate.

MV = Meadow vole.

Table 6-28
Uncertainties of ERA at the West Unit

Parameter	Assumption	Uncertainty
Pathway: Surface Water → Pike		
Groundwater Migration	Groundwater beneath the POL migrates and is discharged to the Yukon River where exposure to the pike occurs.	Concentrations were modeled from the POL to the shoreline with no co-mingling or interferences. The magnitude of the uncertainty would be low, bias neutral.
	Groundwater modeling accurately estimated the concentration of COPECs in the Yukon River.	Due to restricted dilution (5 ft. from shoreline) actual concentrations that pike are exposed to are probably over-estimated. Magnitude of uncertainty would be low-high, bias high.
Assessment Endpoint Species - Pike	Pike are present in the Yukon River near Galena all year.	Pike are present in the general area, but may not be near Galena all year. The ERA assumption is conservative, uncertainty would be low, bias high.
AWQC	AWQC are protective of most aquatic life and are conservative measurement endpoints.	AWQC may be more or less conservative than necessary for the northern pike. The magnitude of the uncertainty wold be low, bias high.
Toxicity Data-Manganese	LC_{50} value for longfin dose was used as measurement endpoint. With an UF of 3000 applied to account for taxonomic differences and acute study duration, this measurement endpoint is acceptable.	The conservatism association with the UF may be low or high. The magnitude of the uncertainty would be low-high, bias high.
Pathway: Surface water → Invertebrate → Spotted Sandpiper		
Groundwater Migration	Groundwater modeling accurately estimated the concentration along the mud flats/shoreline.	No dilution, volatibility factors or attenuation was applied to these concentrations. Actual exposure concentrations are likely much lower than predicted. The magnitude of uncertainty would be low, bias high.

Table 6-28
(Continued)

Parameter	Assumption	Uncertainty
Exposure Concentration and Time	Invertebrates and sandpiper are exposed to the estimated concentrations at the mud flats during entire time species are on site.	Invertebrates may remain in a small geographic area and could be exposed to discharging groundwater continually, however, the spotted sandpiper is mobile and this assumption is highly conservative. The magnitude of uncertainty is low, bias high.
	The spotted sandpiper's water intake is 100% from the discharging groundwater.	The spotted sandpiper travels along the shorelines searching for food. To assume that 100% of water intake is from discharging groundwater is high conservative. The magnitude of uncertainty is low, bias high.
	The spotted sandpiper is assumed to consume only aquatic invertebrates. No attenuation or dilution in the diet is accounted for in the intake assessment.	Shoreline birds consume aquatic invertebrates, but not 100% from the same location as is assumed in this ERA. These assumptions are highly conservative. The magnitude of the uncertainty is low, bias high.
Uncertainty Factor - 2-methylnaphthalene	An uncertainty factor (UF) of 10,000 was applied to the acute LC_{50} measurement endpoint to account for taxonomical differences and study duration.	The conservatism associated with the UF may be low or high. The magnitude of the uncertainty is low-high, bias high.
AWQC	AWQC are protective of most aquatic life and are conservative measurement endpoints.	AWQC may be more or less conservative than necessary for the aquatic invertebrate. The magnitude of the uncertainty would be low, bias high.
Bioavailability of COPECs	All COPECs were assumed to be 100% bioavailable.	Bioavailability changes as physical conditions such as pH or % carbon change. This assumption is conservative. The magnitude would be low-high, bias high.
Bioconcentration Factors	Bioconcentration factors (BCF) were applied to estimated invertebrate tissue concentrations of COPECs.	BCFs can vary depending on condition of the study that determined the BCF. Applied to this ERA, they may over- or underestimate tissue concentrations. Magnitude of uncertainty is low-high, bias neutral.

Table 6-28
(Continued)

Parameter	Assumption	Uncertainty
Pathway: Soil → Plant → Meadow Vole → Red Fox		
Toxicity data	Adequate toxicity information was not available to assess impacts to plants. The site visit and modeling of contaminants through the food chain provided the assessment in this ERA for plants.	Impacts to plants could be greater or less than this ERA predicted. The uncertainty would be low-high, bias neutral.
Uncertainty factor -fluorene	An uncertainty factor (UF) of 6,000 was applied to the measurement endpoint to account for taxonomical differences and acute study duration.	The conservatism associated with the UF may be low or high. The magnitude of the uncertainty would be low-high, bias neutral.
Surface soil exposure	Surface soil samples were taken from 0-2 ft. and composited. This sample is assumed to represent the surface soil available to ecological receptors (Meadow vole).	The method may overestimate exposure concentrations, especially volatiles in the 2 ft anoxic range. The magnitude of the uncertainty would be high, bias high.
Pathway: Soil → Invertebrate → Robin → Kestrel		
Toxicity data	Adequate toxicity data was not available to assess impacts to terrestrial invertebrates. The food chain assessment provided the mechanism for evaluating contaminants through invertebrates.	Impacts to terrestrial invertebrates could be higher or lower. The uncertainty would be low-high, bias neutral.
Surface soil exposure	Surface soil samples were taken from 0-2 ft and composited. This sample is assumed to represent the surface soil available to ecological receptors (Savannah sparrow).	The method may overestimate exposure concentrations for vinyl acetate, xylene, 1,1,2,2-tetrachloroethane and 2-butanone. The magnitude of uncertainty would be high, bias low.
Use of BCFs or BAFs		
Uncertainty Factor-2,3,7,8-TCDD	LD_{50} value in bobwhite quail was the measurement endpoint. A UF of 3000 was applied to account for taxonomic differences and acute study duration.	The UF may over- or underestimate the potential impacts to the robin. The magnitude of the uncertainty is low-high, bias high.

pathway, since it was assumed that the point of discharge was the point of exposure for the assessment endpoint species. Likewise, no volatilization factor was applied to the volatile compounds (e.g., xylene). Thus, it is assumed that the assessment endpoint species are exposed orally at the point of groundwater discharge to the total concentration modeled with no attenuating factors for volatilization applied to the intake rate. These model assumptions result in very conservative EQ values. Therefore, physical and chemical properties and toxicological uncertainties relative to each chemical at each site were used to assess potential risk.

Waste Accumulation Area—4,4-DDT was the only pesticide noted to have an EQ value greater than 10 (EQ invertebrate = 24.2, EQ sandpiper = 168). Dieldrin had an invertebrate EQ of 3.54. AWQC were used to assess impacts to invertebrates and heron NOAELs were used as the toxicity benchmarks for the spotted sandpiper. Organochlorine pesticides are ubiquitous, recalcitrant, and highly lipophilic compounds that can enter the food chain easily. This lipophilic property, combined with a long half-life, results in bioaccumulation and biomagnification of the parent compound and metabolites into high trophic levels such as fish-eating birds. Because of the extensive past use of organochlorine pesticides worldwide, including 4,4-DDT and dieldrin, and the persistence of the compounds, these compounds are virtually ubiquitous and are continually being transformed and redistributed in the environment (ATSDR, 1992a). Organochlorine pesticides were used extensively at the Galena Airport for insect control. The Waste Accumulation Area does not represent a unique source for these contaminants.

Metals (arsenic, barium, cobalt, lead, manganese, nickel, and selenium) all exhibited EQ values exceeding 1 (Table 6-25) in the semi-aquatic pathway. With the exception of cobalt in the spotted sandpiper and manganese in the invertebrate, all EQ exceedances for metals in the Waste Accumulation Area were less than 10 and therefore classified as causing possible impacts. With the exception of manganese (discussed above in the aquatic pathway) and cobalt, AWQC were used as the toxicity benchmarks for the invertebrate. Avian toxicity benchmarks were difficult to locate; therefore, mammal (rat and vole) data with associated uncertainties were used to evaluate potential impacts to the spotted sandpiper. Avian data were only available for the selenium and lead evaluations. In general, the toxicity of heavy metals is governed by many physiological factors, genetic variants, and other xenobiotics present in the body. Variations in the biological concentration of heavy metals in wild birds are closely associated with feeding habits and habitats (Hussain and Kaphelia, 1990). This ERA conservatively assumes that the spotted sandpiper consumes only invertebrates; no attenuation or dilution in the diet is accounted for in the intake assessment.

The arsenic EQ for invertebrates did not exceed 1. However, the spotted sandpiper EQ for arsenic was 1.25. Arsenic is relatively mobile in the aqueous environment and cycles through water, sediment, and biota. It is widely distributed in surface and groundwater throughout the United States. Surveys of arsenic concentrations in rivers and lakes indicate most concentrations are below 10 ppb, although some samples range up to 1000 ppb (ATSDR, 1993a). The discharged arsenic concentration modeled according to Appendix C was 6.4 ppb. Bioconcentration of arsenic occurs in aquatic organisms, primarily lower invertebrates; however, biomagnification does not appear to be significant. A BCF of 9 was used in this ERA (see ecological toxicity profile in Appendix J). On the basis of the low level of arsenic present in the mudflats model, the lack of an invertebrate EQ above 1, and

natural dilution, the impact of arsenic to the ecology is expected to be minimal, to nonexistent.

Barium EQs were exceeded only by the spotted sandpiper (EQ = 2.2). Upon release to the environment, barium is most likely to partition to soils and sediments. There is some indication that barium bioconcentrates in some plants and aquatic organisms (ATSDR, 1990b); therefore, a BCF of 120 was used for this ERA. Barium has been found in surface waters at concentrations ranging from 2-380 µg/L. The discharged concentration of barium modeled according to Appendix C was 563 µg/L. On the basis of the lack of an invertebrate EQ above 1 and natural dilution, the impact of barium to the ecology is expected to be minimal, to nonexistent.

Cobalt EQs exceeded 1 for the invertebrate (EQ = 4.10) and the spotted sandpiper (EQ = 197). Similar to other metals, mobility of cobalt in waters is determined by physical factors such as pH, redox potential, and anionic concentration present in the waters. The mean cobalt concentrations in surface waters of the United States was 19 µg/L (ATDSR, 1990c). The discharged concentration of cobalt modeled according to Appendix C was 41 µg/L. Some birds may sequester metals into their eggs, which may injure developing embryos; however, a rat LD_{50} was used for the toxicity benchmark since no avian toxicity data were available. An effective concentration for a fish was used for the toxicity benchmark for the invertebrate. Due to the large degree of uncertainty for the toxicity benchmark for the sandpiper and because there is likely to be a large degree of dilution by river surface water, the impact of cobalt to site ecology is expected to be minimal.

EQs for lead were determined to be 7.20 in the invertebrate, using an AWQC as the toxicity benchmark, and 6.41 for the spotted sandpiper, using an acute dose in a day-old herring gull. The chemistry of lead is complex. In water, lead is most soluble and bioavailable under conditions of low pH; low organic carbon; low suspended sediment concentration; and low concentrations of calcium, iron, manganese, zinc, and cadmium salts. Most of the lead discharged into surface water is rapidly incorporated into sediments (Eisler, 1987a). Plants and animals may bioaccumulate lead, but biomagnification in aquatic or terrestrial food chains has not been observed. Although lead does not biomagnify, its concentration tends to increase with the age of the animal. Lead is toxic to all aquatic biota and organisms higher in the food chain. The estimated daily intake of lead for the spotted sandpiper was 0.96 mg/kg/day. A concentration of 2.0 ppm lead in the liver of birds can adversely affect some important enzymatic pathways (Hussain and Kaphalia, 1990). On the basis of the low EQ values (i.e., less than 10) for lead, natural dilution, and the propensity for lead to incorporate into sediment from the water column, impacts on the ecosystem would be low.

An EQ of 6.48 was calculated for nickel impacts on invertebrates. An EQ above 1 was not noted for the spotted sandpiper. Nickel is a natural constituent of soil, but levels vary widely depending on local geology and anthropogenic activity. Many nickel compounds are water soluble and relatively stable in aqueous solutions (ATSDR, 1991c). The discharged concentration of nickel modeled according to Appendix C was 53 µg/L. Nickel does not appear to significantly bioaccumulate in aquatic organisms. The concentration of nickel in carnivorous fish does not increase appreciably. This finding, in conjunction with the lack of bioaccumulation data in aquatic organisms and other animals, would indicate that nickel does not biomagnify in the food chain. In fact, nickel is a required trace element for growth and iron absorption (ATSDR, 1991c).

On the basis of the lack of a spotted sandpiper EQ above 1, a low EQ for the invertebrate (less than 10), the use of nickel as a required trace element in biological systems, and natural dilution of the groundwater as it contacts surface water, the impact of nickel to the ecology is expected to be minimal.

Selenium is the final contaminant detected in the Waste Accumulation Area with EQs exceeding 1. The invertebrate EQ was determined to be 1.79 and the spotted sandpiper EQ was 2.99. The discharged concentration of selenium modeled according to Appendix C was 8.9 µg/L. The chronic freshwater AWQC is 5 µg/L. Selenium concentrations in water are generally low due to its tendency to coprecipitate with sediments. In aerobic surface waters and soil solutions, the more soluble and mobile forms of selenium (selenite and selenate) may be equally present. Aquatic organisms can convert selenium to both inert and soluble forms. In aquatic systems, selenium can be bioaccumulated. Although selenium is an essential nutrient for most living organisms, it is possible for organisms to accumulate selenium to toxic levels. Conversely, selenium deficiency may also be detrimental and equally as significant as selenium poisoning (Eisler, 1987d). Results of laboratory and field investigations with fish and birds show that elevated concentrations of selenium in the diet or water were associated with reproductive abnormalities (Eisler, 1987d). It has been reported that a diet containing 20 ppm selenium caused reduced food consumption of mallard ducklings. A diet of 10 ppm did not affect gross measurements such as growth and survival of ducklings (Heinz et al., 1988). The estimated daily intake for the spotted sandpiper was 0.0019 mg/kg/day of selenium, well below the reported effects concentrations. On the basis of the low EQs (less than 10) for the invertebrate and spotted sandpiper, the low daily intake of the spotted sandpiper relative to effects concentrations, the use of selenium as a required trace element in biological systems, and natural dilution of the groundwater as it contacts surface water, the impact of selenium to the ecosystem is expected to be minimal.

Million Gallon Hill—2-Methylnaphthalene was the only PNA to have an EQ above 1 for the invertebrate (EQ = 5510). No PNAs evaluated as COPECs (2-methylnaphthalene, acenaphthene, fluorene, naphthalene, or phenanthrene) were determined to have EQs greater than 1 in the spotted sandpiper. In general, PNAs are metabolized by vertebrates and do not pose a long-term risk to the population survival of vertebrates. A large uncertainty is associated with the EQ calculation for 2-methylnaphthalene in the invertebrate since a 96-hour (acute) LC_{50} for grass shrimp was used for the measurement endpoint. Given the large uncertainty associated with the toxicity benchmark for the invertebrate EQ calculation of 2-methylnaphthalene, the lack of EQs exceeding 1 for the multiple PNAs in the invertebrate dilution effects from Yukon River surface waters, and all of the EQs for PNAs in the sandpiper were below 1, 2-methylnaphthalene does not pose a threat to the semiaquatic ecosystem at the mudflats.

Calculated EQs for 4,4-DDT, 4,4-DDE, and 4,4-DDD for the invertebrate and spotted sandpiper all exceeded 1. All EQs for these compounds, except for 4,4-DDE in the invertebrate (EQ = 9.11), exceed an EQ of 10, indicating probable impacts to the assessment endpoint species. Since organochlorine pesticides are not contaminants unique to Million Gallon Hill, organochlorine pesticides were previously discussed in the Waste Accumulation Area semiaquatic pathway. Organochlorine pesticides will be discussed further in Section 8.0 (Conclusions and Recommendations).

The sandpiper EQ for lead was calculated to be 2.12, but was below 1 for the invertebrate. Lead was previously discussed in the Waste Accumulation Area semiaquatic pathway. The spotted sandpiper daily intake of lead (0.0212 mg/kg/day) was calculated using a BCF of 42. As mentioned previously, concentrations of 2.0 ppm lead in the liver of birds can adversely affect some important enzymatic pathways (Hussain and Kaphalia, 1990). Based on the low EQ values (i.e., less than 10) for lead in the sandpiper, the absence of an EQ greater than 1 in the invertebrate, natural dilution, and the propensity for lead to incorporate into sediment from the water column, impacts upon the ecosystem would be low.

An EQ above 1 (EQ = 1.23) was calculated for vinyl chloride in the spotted sandpiper, but an EQ exceedance was not noted for the invertebrate. Vinyl chloride is expected to be highly mobile in soil and is likely to leach to groundwater. Bioconcentration is expected to be limited in aquatic organisms due to a BCF of 5.1 (ATSDR, 1993c). Based upon the low bioconcentration potential, high volatility (vapor pressure at 20°C = 2530 mmHg), and low EQ for the spotted sandpiper, there is no significant potential for adverse effects to the ecosystem at the mudflats.

Xylene was analyzed as a combination of the three possible isomers. Xylenes had an EQ of 35.7 for the invertebrate, indicating probable risk, and 2.64 for the spotted sandpiper, indicating possible risk. A 24-hour LC_{50} using goldfish as the measurement endpoint species was used as the toxicity benchmark for the invertebrate. A vole NOAEL was used for the spotted sandpiper. Both measurement endpoint tests were carried out using mixed isomers. Xylenes are single ring compounds containing two methyl groups, and are commonly found in petroleum products. Most of the xylenes released to the environment partition to the atmosphere. However, xylenes in groundwater may persist for several years. Once released to the environment, rapid oxidation of xylene isomers precludes bioconcentration into higher animal systems and therefore, bioaccumulation up the food chain is unlikely. Lower trophic levels in aquatic systems may bioconcentrate xylenes moderately (BCF range from 8-95) with a reported steady state tissue concentration after 10 days (ATSDR, 1993d). Effects of xylenes to the semiaquatic ecosystem at the mudflats would be self-limiting due to dilution and volatilization of the xylenes upon introduction to the surface. Uptake by invertebrates would be minimal. The modeled water concentration of xylene was determined to be 0.0463 mg/L at the point of discharge. A BCF factor of 80 was used to estimate invertebrate tissue concentration at 3.71 mg/kg. This concentration was used to calculate the spotted sandpiper intake of 0.48 mg/kg/day. However, this intake concentration does not account for dilution or volatilization. As shown in Table 6-31, 57.8% of the sandpiper intake would be from direct ingestion of water, which is unlikely due to volatilization. In addition, toxic effects of xylenes are most severe at high doses with inhalation as the route of exposure. It is unlikely that inhalation or ingestion of small amounts of xylenes present in water or air would pose a risk of death. Ecological damage is difficult to access, but also seems unlikely due to the physical properties of xylenes. Long term effects seem unlikely due to excretion following oral exposure. Excretion by rats, following oral doses of m-xylene, occurred in urine during the first 12 hours after dosing (ATSDR, 1993d). Thus, ecological impacts of xylene are considered to be minimal due to the low EQs, the volatile nature of xylenes, and dilution within the Yukon River surface waters.

Building 1845—4,4-DDT, 4,4-DDE, 4,4-DDD, aldrin, dieldrin, endrin aldehyde, and

heptachlor epoxide are all organochlorine pesticides or the breakdown products of organochlorine pesticides. EQs for the invertebrate ranged from 105 for 4,4-DDD to 2.95 for heptachlor epoxide. The spotted sandpiper only had EQs above 1 for 4,4-DDT (EQ = 38), 4,4-DDE (EQ = 17.3), and 4,4-DDD (208). The organochlorine pesticides are discussed in the semiaquatic pathway for the Waste Accumulation Area and combined impacts of these compounds are discussed in Section 8.0.

The EQ for lead exceeded 1 only in the invertebrate (EQ = 3.8). Lead was discussed in the semiaquatic pathway for the Waste Accumulation Area. Based on the low EQ values (i.e., less than 10) for lead, natural dilution, and the propensity for lead to incorporate into sediment from the water column, impacts upon the ecosystem would be low.

The spotted sandpiper was determined to have an EQ of 21.8 from exposure to cadmium indicating probable risk. The invertebrate EQ did not exceed 1. In aquatic environments, cadmium is more mobile than most other heavy metals. Its concentration in water is inversely related to pH and the organic matter concentration in water (Callahan et al, 1979). Bioconcentration factors for aquatic invertebrates range from 1113 to 18,000 and from 3 to 2213 for fish (ATSDR, 1991b). The 2213 factor was used in all aquatic trophic uptake calculations for this ERA. Cadmium bioaccumulates at all levels of the food chain; however, the accumulation characteristics (in organs rather than muscle tissue) in animals makes biomagnification unlikely. Although the EQ level classifies cadmium as causing probable impacts to the spotted sandpiper, dilution effects and the lack of an invertebrate EQ above 1, place the EQ value in perspective. Therefore, impacts to the ecosystem due to cadmium from this pathway are expected to be low.

The EQ for cis-1,2-dichloroethene in the invertebrate was calculated to be 2.87 indicating probable risk, but the EQ for the spotted sandpiper was determined to be below 1 (EQ = 0.580). 1,2-Dichloroethene, when released to the environment, will eventually enter the atmosphere where it is broken down. BCFs in fish range 5 to 23. 1,2-Dichloroethene does not bioconcentrate in aquatic organisms and there is little potential for biomagnification within the food chain (ATSDR, 1989c). Based upon the low bioconcentration potential, high volatility (vapor pressure at = 215 mmHg), and low EQ for the invertebrate, the potential for adverse effects to the ecosystem at the mudflats is expected to be minimal.

JP4-Fillstands—4,4-DDT, 4,4-DDD, aldrin, and endrin aldehyde are all organochlorine pesticides or the breakdown products of organochlorine pesticides. EQs for the invertebrate ranged from 31 for 4,4-DDD to 3.95 for aldrin. The spotted sandpiper had EQs above 1 for 4,4-DDT (EQ = 123), and 4,4-DDD (EQ = 341). The organochlorine pesticides are discussed in the semiaquatic pathway for the Waste Accumulation Area and combined impacts of these compounds are discussed in Section 7.2.

2-Methylnaphthalene was the only PNA to have an EQ above 1 for the invertebrate (EQ = 79.2). The calculated EQ for this compound was 1.72 for the spotted sandpiper. The only other PNA in the COPEC list for discharged groundwater from the JP-4 Fillstands was naphthalene with EQs in the invertebrate and spotted sandpiper of 0.00029 and 0.0149, respectively. In general, PNAs are metabolized by vertebrates and do not pose a long-term risk to population survival of vertebrates. A large uncertainty is associated with the EQ calculation for 2-methylnaphthalene in the invertebrate since a 96 hour (acute) LC_{50} for the grass shrimp was used for the measurement endpoint. Given the large

uncertainty associated with the toxicity benchmark for the invertebrate EQ calculation of 2-methylnaphthalene, the small EQ for the spotted sandpiper, and the dilution by Yukon River surface waters, the impact of 2-methylnaphthalene on the semiaquatic ecosystem is minimal.

Barium EQs exceeded 1 for the spotted sandpiper (EQ = 6.93) and the invertebrate (EQ = 1.65), indicating possible risk. Upon release to the environment, barium is most likely to partition to soils and sediments. There is some indication that barium bioconcentrates in some plants and aquatic organisms (ATSDR, 1990b); therefore, a BCF of 120 was used for this ERA. Barium has been found in surface waters at concentrations ranging from 2-380 µg/L (ATSDR, 1990b). The discharged concentration of barium modeled according to Appendix C was 1119.7µg/L. Based upon the low EQ values (less than 10), and natural dilution, the impact of barium to the ecosystem is expected to be low.

The EQ for lead exceeded 1 in the invertebrate (EQ = 3.56) and the spotted sandpiper (EQ = 5.02). Lead was discussed in the semiaquatic pathway for the Waste Accumulation Area. Based on the low EQ values (i.e., less than 10) for lead, natural dilution and the propensity for lead to incorporate into sediment from the water column, impacts upon the ecosystem would be low.

Selenium was calculated to have EQs exceeding 1 for both the invertebrate (EQ = 1.65) and the spotted sandpiper (EQ = 4.37). The discharged concentration of selenium modeled, according to Appendix C, was 8.2 µg/L. Selenium was discussed in the semiaquatic pathway for the Waste Accumulation Area. The estimated daily intake for the spotted sandpiper was 0.0029 mg/kg/day of selenium. Based upon the low EQs for the invertebrate and spotted sandpiper (less than 10), the low daily intake of the spotted sandpiper when compared to an effect concentration, the use of selenium as a required trace element in biological systems and natural dilution of the groundwater as it contacts surface water, the impact of selenium to the ecosystem is expected to be minimal.

The arsenic EQ was calculated to be 1.50 for the invertebrate and 16.8 for the spotted sandpiper. Arsenic is relatively mobile in the aqueous environment and cycles through water, sediment and biota. It is widely distributed in surface and groundwater throughout the United States. Surveys of arsenic concentrations in rivers and lakes indicate most concentrations are below 10 ppb, although some samples range up to 1000 ppb (ATSDR, 1993a). The discharged arsenic concentration modeled according to Appendix C was 54.0 ppb. Bioconcentration of arsenic occurs in aquatic organisms, primarily lower invertebrates; however, biomagnification does not appear to be significant (ATSDR, 1993a). A bioconcentration factor of 9 was used in this ERA. Based upon the low level of arsenic modeled to the mudflats and natural dilution, the impact of arsenic to the ecosystem is expected to be low.

Xylenes had an EQ of 14.5 for the invertebrate, but the EQ did not exceed 1 for the spotted sandpiper. Once released to the environment, rapid oxidation of xylene isomers precludes bioconcentration into higher animal systems; therefore, bioaccumulation in higher trophic levels of the food chain is unlikely. Lower trophic levels in aquatic systems may bioconcentrate xylenes moderately (BCF range from 8 to 95) (ATSDR, 1993d). Effects of xylenes to the semiaquatic ecosystem at the mudflats would be self-limiting due to dilution and volatilization of the xylenes upon introduction to the surface. Uptake of xylenes by invertebrates would be minimal. Ecological impacts

of xylene are considered to be minimal due to the low EQ in the invertebrate, absence of a spotted sandpiper EQ above 1, and the volatile nature of xylenes.

Semiaquatic (Drainage Ditch surface water and sediment → invertebrate → spotted sandpiper)

The drainage ditch system was evaluated conservatively as an aquatic environment with invertebrates and sandpipers being the assessment endpoint species. The ecosystem created by the ditches is transient and is dependent upon the rainfall and evaporation rates. Spotted sandpiper were conservatively assumed to spend six months of the year feeding exclusively on invertebrates from the drainage ditches.

Two sediment and two surface water samples were taken from the ditch system in the West Unit. These samples were taken from ditches in Million Gallon Hill and near the Waste Accumulation Area, but represent the entire West Unit. Since only two samples were available, maximum detections were used as the exposure concentration instead of the 95% UCL. As detailed in Section 3.2.4, invertebrate exposure to sediments was evaluated using sediment quality criteria (SQC). The SQC is based upon chronic AWQC and are therefore protective of all aquatic life. Table 6-26 shows the ranking of the EQs (possible versus probable risk categories) for the invertebrate and spotted sandpiper at the drainage ditches. This table distinguishes the sediment EQs from the water EQs for the invertebrate impact. Spotted sandpiper intake is defined by consumption of invertebrates and drinking water. The tissue concentration in the invertebrate was determined by multiplying BCFs with the concentrations in sediment and water where data existed (Appendix K, Table K-32 details these calculations).

EQs greater than 1 were found for organochlorine pesticides, PNAs, volatile and semivolatile compounds. Also, numerous metals resulted in EQs greater than 1 in the sediment and water samples. Table 6-26 lists all of the constituents found to have EQ values greater than 1. Table 6-31 shows the percent contribution of each media to the spotted sandpiper EQ.

The drainage ditch system collects surface water runoff from a majority of the West Unit. This runoff includes storm water containing compounds resulting from continuing operations at the West Unit and are not specific to runoff from source areas evaluated in this ERA. Much of the runoff occurring in this ditch system contains constituents resulting from vehicle traffic in the West Unit streets and parking areas. The EQ evaluations in Tables 6-26 through 6-31 are provided for information purposes only. Attributing the chemicals detected in the surface water and sediments of the ditch to specific IRP source areas is not feasible. Moreover, there is no direct evidence that the detected chemicals originated from any of the IRP sites. Therefore, a detailed discussion of toxicity and risk potentially associated with constituents in the ditch will not be performed.

Terrestrial - mammal (soil → plant → meadow vole → red fox)

This exposure pathway used surface soil data (0-2 ft) and modeled the concentration through the food chain using plant uptake factors and earthworm BAFs. When earthworm BAFs were not available, aquatic BCFs were used. The use of BCFs is overly conservative when applied to terrestrial systems because of the reduced mobility of contaminants in soils when compared to sediments. Despite on-line database searches, plant measurement endpoints that used soil uptake as the route of exposures were difficult to locate. Therefore, impacts to terrestrial plants were not adequately assessed. It was

conservatively assumed that the meadow vole consumed only plants, the red fox consumed only meadow voles and both species obtained all drinking water from the drainage ditches in the West Unit.

Waste Accumulation Area—The only measurement endpoint found for terrestrial plants was for lead. An EQ of 3.6 was calculated using a 20% reduction in plant growth as the effect in the measurement endpoint test. Lead, however, was not considered to pose any risk to the meadow vole (EQ = 0.09) since the affected area of vegetation is small when compared to available food sources for the meadow vole. On the basis of the low EQ for terrestrial plants and the lack of EQs that exceed 1 for the meadow vole or red fox, lead does not pose adverse impacts to terrestrial mammals at the Waste Accumulation Area.

Several PNAs had EQs greater than 1 in the meadow vole, but none were greater than 10. As previously mentioned, PNAs are metabolized by vertebrates and do not pose a long-term risk to the population survival of vertebrates. Numerous other PNAs were evaluated but none of the other PNAs were determined to have EQs greater than 1. On the basis of the low EQ values and potential for metabolic breakdown, the potential impacts of PNAs on terrestrial mammals in the Waste Accumulation Area are minimal.

Million Gallon Hill—EQs determined for Million Gallon Hill were similar to those for the Waste Accumulation Area, except for the plant EQ was above 10 for lead. Several PNAs had EQs greater than 1 in the meadow vole, but no EQ exceeded 1 in the red fox. Similar to waste accumulation area, potential impacts form lead and PNAs were determined to be low to minimal.

Terrestrial-bird (soil → invertebrate → robin → kestrel)

Similar to the mammal exposure pathway, the avian pathway used surface soil (0-2 ft) contaminant concentrations modeled through the food chain via earthworm BAFs. Terrestrial invertebrate toxicity information was difficult to locate, therefore terrestrial invertebrates were not completely evaluated as an assessment endpoint species. It was conservatively assumed that the robin consumed only invertebrates, the kestrel consumed only robins, and both species obtained all drinking water from the drainage ditch in the West Unit.

Waste Accumulation Area—PNAs were noted to have EQs exceeding 1 in the terrestrial invertebrate and robin, although none of the EQs exceeded 10. On the basis of the low EQ values and the potential for metabolic breakdown, the potential impacts of PNAs on avian receptors in the Waste Accumulation Area are minimal.

Organochlorine pesticides including gamma-BHC, 4,4-DDD, 4,4-DDE, and 4,4-DDT all had EQ values exceeding 1 in the avian pathway. Gamma-BHC had an EQ of 10.4 in the terrestrial invertebrate. DDT and its breakdown products had EQs exceeding 10 in the robin and 4,4-DDT had an EQ of 1.08 in the kestrel. Organochlorine pesticides were broadcast at the Galena Airport for insect control and this site does not represent an area of elevated contamination. The impacts of this class of compounds is assessed in Section 8.0 (Conclusions and Recommendations).

Bis(2-ethylhexyl)phthalate had an EQ of 1.33 in the robin at the Waste Accumulation Area. Bis(2-ethylhexyl)phthalate is ubiquitous in the environment and has low acute toxicity. However, experimental studies concluded that bis(2-ethylhexyl)phthalate is a carcinogen, and developmental toxin. Adsorption onto soils and

sediments appears to be a significant sink for phthalates. Bis(2-ethylhexyl)phthalate released to water tends to adsorb strongly to suspended particles and sediments. Residues of bis(2-ethylhexyl)phthalate have been found in the organs of terrestrial animals such as rats, rabbits, dogs, and cows. However, accumulation of bis(2-ethylhexyl)phthalate is likely to be minimized by metabolism, and extensive biomagnification of this phthalate in the food chain is not expected to occur (ATSDR, 1989a). On the basis of the low EQ and metabolic potential, the potential impacts from bis(2-ethylhexyl)phthalate on the robin are minimal.

Million Gallon Hill—Similar to the Waste Accumulation Area, PNAs were noted to have EQs between 1 and 10 in the possible risk category. EQs did not exceed 1 for any PNA in the robin or kestrel.

Organochlorine pesticides including gamma-BHC, 4,4-DDT, 4,4-DDE, and 4,4-DDD had EQ values exceeding 1. The impacts of this class of compounds have been discussed in previous sections and will be further addressed in Section 8.0 (Conclusions and Recommendations).

The robin's intake of dibutylphthalate was calculated to be 0.149 mg/kg/day with a resulting EQ of 44.8. Phthalates are ubiquitous in the environment, but their effects on wildlife are not well defined. As mentioned previously, phthalates have been found in numerous terrestrial mammals, but metabolic breakdown minimizes accumulation (ATSDR, 1989a). Similar to the Waste Accumulation Area, the potential impacts form dibutylphthate on the robin are minimal.

Dibenzofuran was determined to have an EQ of 1270 in the robin, but the kestrel EQ was 0.0003. The 95% UCL for dibenzofuran was calculated to be 0.013 mg/kg. Furans in the environment are primarily of anthropogenic origin, although trace amounts may come from forest fires. Anthropogenic sources include incineration of industrial waste, power plants which use fossil fuels, fireplaces, home heating systems, copper smelting, and cigarette smoke. Furans adsorb strongly to soils and sediment. Bioconcentration factors have been difficult to determine, but appear to be lower than other polychlorinated aromatic compounds. One possible explanation is the rapid depuration (elimination) of the chemicals from fish. Another explanation for the low bioconcentration factor is a low rate of membrane permeation of these highly hydrophobic compounds.

Soil leaching experiments indicate that furans remain strongly adsorbed in sandy soil and leaching of these compounds from soil by rainwater is not significant. The vertical movement of furans was found to be very slow. Microbial degradation of these compounds is also very slow. There is little bioaccumulation of dioxins or furans in plants from soil. Biotransfer factors for different congeners of furans was less than 1 for grazing animals (ATSDR, 1994a). The LD_{50} value for 2,3,7,8-TCDD in bobwhite quail was the measurement endpoint for the robin EQ calculation. An uncertainty factor of 3000 was applied due to taxonomic differences and acute test duration. 2,3,7,8-TCDD is the most studied and also most toxic of the dioxin class. On the basis of this highly conservative toxicity benchmark, lack of biotransfer potential and high soil sorption potential, the impacts of dibenzofuran to the robin population at Million Gallon Hill are minimal to low.

Lead had an EQ of 13 in the robin and 0.007 in the kestrel. Lead present in the soils and invertebrates was the exposure pathway for the robin at Million Gallon Hill. Plants and animals may bioaccumulate lead, but

biomagnification has not been observed. Vulnerability to lead is largely dependent on the overall health of the bird. For example, mallards on a diet of corn died within 10 to 14 days following ingestion of a single lead shot, whereas mallards fed a balanced commercial duck ration appeared outwardly normal after ingesting as many as 32 pellets of the same size (Eisler, 1987a). The 95% UCL of lead in surface soils at Million Gallon Hill was calculated to be 1306 mg/kg with an estimated robin intake of 65 mg/kg. Hatchlings of precocial species, including chickens, quail, mallards, and pheasants are relatively tolerant to moderate lead exposure, i.e., there was no effect on growth at dietary levels of 500 mg/kg or survival at 2000 mg/kg. Soils in the United States have a mean lead concentration of 20 mg/kg, but the maximum value used to calculate this mean was 700 mg/kg (Eisler, 1987a). On the basis of the EQ value of 13, and the large amount of habitat with multiple food sources providing a varied diet for the robin, the impacts to the terrestrial ecosystem would be low.

In summary, no chemicals were found to pose significant risk to northern pike in the Yukon River. After consideration of toxic and physical properties for contaminants with EQs above 1 (Table 6-25), only dieldrin for aquatic invertebrates and DDT for both aquatic invertebrates and the spotted sandpiper were shown to have significant potential for posing risk in the Yukon River mudflats from the Waster Accumulation Area. Contaminants shown to have significant potential for risk to aquatic invertebrates and the spotted sandpiper at Million Gallon Hill are DDT, DDD, and DDE. Organochlorine pesticides potentially pose significant risk to the Yukon River mudflats from Building 1845 and the JP-4 Fillstands groundwater. For aquatic invertebrates, DDT, DDE, DDD, aldrin, dieldrin, endrin aldehyde, and heptachlor epoxide are pesticides, or their breakdown products, with EQs above 1 from exposure to groundwater from Building 1845. At the JP-4 Fillstands, DDT, DDD, aldrin, and endrin aldehyde were found to have EQs above 1. For the spotted sandpiper, DDD, DDE, and DDT and EQs above 1 from Building 1845 groundwater discharge. Groundwater from the JP-4 Fillstands had EQs above 1 for DDT and DDD in the spotted sandpiper.

The only areas of the West Unit with potential for terrestrial impacts were the Waste Accumulation Area and Million Gallon Hill. In both of these areas, EQs for DDE, DDE, and DDT were above 1 for the robin. DDT had an EQ of 1.08 in the kestrel from the Waste Accumulation Area, but this was the only risk determined for the kestrel, an upper trophic level receptor. Also in the Waste Accumulation Area, an EQ of 10.4 was calculated for gamma-BHC in the terrestrial invertebrate. This assessment shows potential for risk from these organochlorine pesticides. However, the organochlorine pesticides originating from the West Unit do not represent high concentrations relative to the Galena area in general because such chemicals were historically applied throughout the Airport for pest control. Tables 6-29 through 6-31 show the percent contribution to the EQs from the constituents with EQs above 1. This breakdown demonstrates how the organochlorine pesticides move through the food chain.

The ecology of the West Unit is limited by human industrial activities. Vegetation consists of grasses and shrubs in the manicured areas around the buildings and grasses, willows, and alders in the drainage ditches. Due to human activities, avian ecological receptors may not be located consistently in the site areas, but could travel and forage throughout the Airport area. Semiaquatic avian receptors may travel throughout the mudflats created by the Yukon River. However, these mudflats are transient and are

Table 6-29
Percent Contribution to the EQ for Terrestrial Receptors at the West Unit

Chemical	Total EQ	% EQ Soil	% EQ Water	% EQ Food
Waste Accumulation Area - Meadow Vole				
Acenaphthene	13.75	10.48	0.00	89.51
Benzo(a)anthracene	8.11	52.27	0.00	47.72
Benzo(g,h,i)perylene	5.59	78.39	0.00	21.60
Waste Accumulation Area - Robin				
4,4-DDD	896.00	2.27	0.00	97.73
4,4-DDE	67.90	2.27	0.00	97.73
4,4-DDT	1200.00	2.27	0.00	97.73
Benzo(b)fluoranthene	4.38	26.61	0.00	73.38
bis(2-Ethylhexyl)phthalate	1.33	0.20	0.00	99.79
Waste Accumulation Area - Kestrel				
4,4-DDT	1.08	10.34	0.00	89.65
Million Gallon Hill - Meadow Vole				
Acenaphthene	1.17	10.48	0.00	89.51
Benz(a)anthracene	2.54	52.27	0.00	47.72
Benzo(b)fluoranthene	2.50	66.89	0.00	33.10
Benzo(g,h,i)perylene	5.39	78.39	0.00	21.60
Million Gallon Hill - Robin				
4,4-DDD	25.9	2.27	0.06	97.66
4,4-DDE	7.20	2.27	0.02	97.7
4,4-DDT	67.2	2.26	0.00	97.73
Dibenzofuran	1270	2.26	0.00	97.73
Dibutyl phthalate	44.8	0.20	0.00	99.79
Lead	13.0	21.65	0.00	78.35

Table 6-30
Percent Contribution to the Spotted Sandpiper EQs from Ditches in the West Unit

Chemical	Total EQ	% EQ Sediment	% EQ Water	% EQ Food [a]
2-Methylnaphthalene	8050.00	0.02	0.03	99.95
4,4'-DDD	1170000.00	0.00	0.00	100.00
4,4'-DDE	348000.00	0.00	0.00	100.00
4,4'-DDT	368000.00	0.00	0.00	100.00
alpha-BHC	42.50	0.02	0.00	99.98
Aluminum	24.80	98.21	0.00	1.79
Antimony	33.00	0.00	99.86	0.14
Arsenic	507.00	2.34	1.70	95.96
Barium	1220.00	0.18	0.18	99.64
Benzo(a)pyrene	1.18	0.09	0.00	99.91
Benzoic acid	2.50	0.00	83.95	16.05
Beryllium	160.00	1.14	0.00	98.86
bis(2-Ethylhexyl)phthalate	2.70	0.38	0.00	99.62
Chromium	113000.00	0.25	0.00	99.75
Cobalt	502.00	0.54	0.33	99.12
Copper	4.06	2.15	0.00	97.85
Dibenzofuran	245000.00	0.04	0.00	99.96
Dibutyl phthalate	18.30	0.38	0.00	99.62
Dieldren	288.00	0.01	0.00	99.99
Ethylbenzene	7.98	0.15	0.64	99.21
Fluoranthene	9.36	0.06	0.06	99.88
Fluorene	3550.00	0.00	0.00	100.00
Lead	2760.00	0.52	0.00	99.48
Manganese	19.10	1.58	10.79	87.63

Table 6-30
(Continued)

Chemical	Total EQ	% EQ Sediment	% EQ Water	% EQ Food [a]
Mercury	526.00	0.34	0.00	99.66
Molybdenum	1370.00	4.37	0.00	95.63
Naphthalene	137.00	0.02	0.05	99.92
Nickel	2340.00	0.22	0.00	99.78
Phenanthrene	12.30	0.07	0.90	99.03
Phenol	3.83	0.00	84.59	15.41
Pyrene	5.34	0.32	0.29	99.39
Toluene	2.43	0.21	6.45	93.34
Vanadium	84.20	18.00	0.00	82.00
Xylene (total)	143.00	0.27	1.31	98.42
Zinc	1.22	2.66	0.31	97.03

a = The contribution to the total EQ by food for the spotted sandpiper is due to the ingestion of invertebrates.

Table 6-31
Percent Contribution to the Spotted Sandpiper EQs from Groundwater Discharging to the Mudflats

Chemical	Total EQ	% EQ Water	% EQ Food [a]
Waste Accumulation Area			
4,4-DDT	168	0.90	99.09
Arsenic	1.25	92.42	7.57
Barium	2.20	47.78	52.21
Cobalt	197	73.30	26.69
Lead	6.41	72.33	27.66
Manganese	5.34	82.93	17.06
Selenium	2.99	91.27	8.72
Million Gallon Hill			
4,4-DDD	1310	0.90	99.09
4,4-DDE	188	0.90	99.09
4,4-DDT	61800	0.90	99.09
Lead	2.12	72.33	27.66
Vinyl Chloride	1.23	95.56	4.43
Xylene	2.64	57.85	42.14
Building 1845			
4,4-DDD	208	0.90	99.09
4,4-DDE	17.3	0.90	99.09
4,4-DDT	38.8	0.90	99.09
Cadmium	21.8	4.73	95.27

Table 6-31
(Continued)

Chemical	Total EQ	% EQ Water	% EQ Food [a]
JP-4-Fillstands			
2-Methylnaphthalene	1.72	9.89	90.10
4,4-DDD	341	0.90	99.09
4,4-DDT	123	0.90	99.09
Arsenic	16.8	92.42	7.57
Barium	6.93	47.78	52.21
Lead	5.02	72.33	27.66
Selenium	4.37	91.27	8.72

[a]The contribution to the total EQ by food for the spotted sandpiper is due to the ingestion of invertebrates.

dependent upon the river level. On the basis of the EQ value in the robin, the impacts to the terrestrial ecosystem would be low.

ATTACHMENT 1

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Table 6A-1
Analytes Detected at the West Unit (Waste Accumulation Area)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
1,2-Dichloroethane	D	-	ND	ND
2-Methylnaphthalene	ND	-	D	D
4,4'-DDD	ND	-	D	D
4,4'-DDE	ND	-	D	D
4,4'-DDT	D	-	D	D
Acenaphthene	ND	-	D	ND
Acetone	D	-	D	D
Aldrin	D	-	D	D
Anthracene	ND	-	D	ND
Benz(a)anthracene	ND	-	D	D
Benzene	D	-	ND	ND
Benzo(a)pyrene	ND	-	D	D
Benzo(b)fluoranthene	ND	-	D	D
Benzo(g,h,i)perylene	ND	-	D	ND
Benzo(k)fluoranthene	ND	-	D	D
Benzoic acid	ND	-	D	D
Bromochloromethane	D	-	-	-
Chloromethane	D	-	ND	ND
Chrysene	ND	-	D	D
Dibenz(a,h)anthracene	ND	-	D	ND
Dibromomethane	D	-	-	-
Dieldrin	D	-	D	D
Endosulfan I	ND	-	D	D
Endosulfan II	D	-	D	D
Endosulfan sulfate	D	-	D	D

Table 6A-1
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
Endrin	ND	-	D	D
Endrin aldehyde	D	-	D	D
Ethylbenzene	D	-	ND	ND
Fluoranthene	ND	-	D	D
Fluorene	ND	-	D	ND
Heptachlor	D	-	D	D
Heptachlor epoxide	D	-	D	D
Indeno(1,2,3-cd)pyrene	ND	-	D	ND
Methoxychlor	D	-	D	ND
Methylene chloride	D	-	D	D
Naphthalene	ND	-	D	D
Phenanthrene	ND	-	D	D
Pyrene	ND	-	D	D
Toluene	D	-	ND	ND
Vinyl Chloride	D	-	ND	ND
Xylene (total)	D	-	ND	ND
alpha-BHC	D	-	D	D
bis(2-Ethylhexyl)phthalate	D	-	D	D
cis-1,2-Dichloroethene	D	-	-	-
delta-BHC	D	-	D	D
gamma-BHC	ND	-	D	D
Aluminum	D	-	D	D
Antimony	D	-	ND	ND
Arsenic	D	-	D	D
Barium	D	-	D	D

Table 6A-1
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
Beryllium	D	-	D	D
Cadmium	D	-	D	ND
Calcium	D	-	D	D
Chromium	D	-	D	D
Cobalt	D	-	D	D
Copper	D	-	D	D
Iron	D	-	D	D
Lead	D	-	D	D
Magnesium	D	-	D	D
Manganese	D	-	D	D
Mercury	D	-	D	D
Molybdenum	D	-	ND	ND
Nickel	D	-	D	D
Potassium	D	-	D	D
Selenium	D	-	ND	D
Silver	D	-	ND	ND
Sodium	D	-	D	D
Thallium	D	-	ND	ND
Vanadium	D	-	D	D
Zinc	D	-	D	D

D = Detect
ND = Nondetect
- = Not sampled

Table 6A-2
Analytes Detected at the West Unit (Million Gallon Hill)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
1,1-Dichloroethane	D	ND	ND	ND
1,1-Dichloroethene	D	ND	ND	ND
1,2-Dichloroethane	D	D	ND	ND
2,4-Dimethylphenol	D	ND	ND	ND
2-Butanone (MEK)	D	ND	ND	D
2-Methylnaphthalene	D	D	D	D
2-Methylphenol(o-cresol)	D	D	ND	ND
4,4'-DDD	D	D	D	D
4,4'-DDE	D	D	D	D
4,4'-DDT	D	D	D	D
4-Methyl-2-Pentanone(MIBK)	ND	ND	D	ND
4-Methylphenol(p-cresol)	D	D	ND	D
4-Methylphenol/3-Methylphenol	D	-	-	-
4-Nitrophenol	D	ND	ND	ND
Acenaphthene	D	ND	D	ND
Acetone	D	-	D	D
Aldrin	D	D	D	D
Anthracene	D	ND	D	D
Benz(a)anthracene	ND	ND	D	D
Benzene	D	D	D	D
Benzo(a)pyrene	ND	ND	D	D
Benzo(b)fluoranthene	ND	ND	D	D
Benzo(g,h,i)perylene	ND	ND	D	D
Benzo(k)fluoranthene	ND	ND	D	D
Benzoic acid	D	D	ND	D
Benzyl alcohol	ND	D	ND	ND
Bromochloromethane	D	-	-	-
Chloroethane	D	ND	ND	ND
Chloromethane	D	ND	ND	ND
Chrysene	ND	ND	D	D
Dibenzofuran	D	ND	D	ND

Table 6A-2
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
Dibromomethane	D	ND	-	-
Dibutyl phthalate	D	ND	D	D
Dieldrin	D	ND	D	D
Endosulfan I	D	D	D	D
Endosulfan II	D	D	D	D
Endosulfan sulfate	D	ND	D	D
Endrin	D	ND	ND	D
Endrin aldehyde	D	D	D	D
Ethylbenzene	D	D	ND	D
Fluoranthene	D	D	D	D
Fluorene	D	D	D	ND
Heptachlor	D	D	D	D
Heptachlor epoxide	D	D	D	ND
Indeno(1,2,3-cd)pyrene	ND	ND	D	D
Methoxychlor	ND	ND	D	ND
Methylene chloride	D	ND	D	D
Naphthalene	D	D	D	D
Phenanthrene	D	D	D	D
Phenol	D	D	ND	ND
Pyrene	D	D	D	D
Toluene	D	D	D	D
Trichloroethene	D	ND	ND	ND
Vinyl Chloride	D	ND	ND	ND
Xylene (total)	D	D	ND	D
alpha-BHC	D	D	D	ND
beta-BHC	D	D	D	D
bis(2-Ethylhexyl)phthalate	D	D	D	D
cis-1,2-Dichloroethene	D	-	ND	ND
delta-BHC	D	D	ND	D
gamma-BHC	D	D	D	ND
trans-1,2-Dichloroethene	D	ND	ND	ND

Table 6A-2
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
Aluminum	D	ND	D	D
Antimony	D	ND	ND	ND
Arsenic	D	D	D	D
Barium	D	D	D	D
Beryllium	D	ND	D	D
Cadmium	D	ND	ND	ND
Calcium	D	D	D	D
Chromium	D	ND	D	D
Cobalt	D	D	D	D
Copper	D	ND	D	D
Iron	D	D	D	D
Lead	D	ND	D	D
Magnesium	D	D	D	D
Manganese	D	D	D	D
Mercury	D	-	D	D
Molybdenum	D	ND	ND	ND
Nickel	D	ND	D	D
Potassium	D	D	D	D
Selenium	D	ND	ND	D
Silver	D	ND	ND	ND
Sodium	D	D	D	D
Thallium	D	ND	ND	ND
Vanadium	D	ND	D	D
Zinc	D	D	D	D

D = Detect
ND = Nondetect
- = Not sampled

Table 6A-3
Analytes Detected at the West Unit (Power Plant UST No. 49)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
2-Hexanone	-	-	D	ND
2-Methylnaphthalene	ND	D	D	D
4,4'-DDD	D	ND	D	D
4,4'-DDE	ND	ND	D	D
4,4'-DDT	D	D	D	D
Acetone	-	-	ND	D
Aldrin	D	D	ND	D
Benzoic acid	D	D	ND	ND
Benzyl alcohol	ND	D	ND	ND
Dibenzofuran	ND	ND	ND	D
Dieldrin	D	D	D	D
Endosulfan I	ND	D	ND	D
Endosulfan II	ND	D	D	D
Endosulfan sulfate	D	ND	D	D
Endrin aldehyde	D	D	ND	D
Ethylbenzene	ND	D	D	ND
Fluorene	ND	ND	D	D
Heptachlor	D	D	D	D
Heptachlor epoxide	ND	D	D	D
Methylene chloride	ND	ND	ND	D
Naphthalene	ND	D	D	D
Toluene	D	D	D	ND
Trichloroethene	ND	ND	ND	D
Xylene (total)	D	D	D	ND

Table 6A-3
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
alpha-BHC	ND	ND	D	D
beta-BHC	D	D	ND	D
bis(2-Ethylhexyl)phthalate	D	D	ND	D
delta-BHC	D	D	ND	ND
gamma-BHC	D	ND	D	D
Aluminum	ND	ND	D	D
Antimony	ND	D	ND	ND
Arsenic	D	D	D	D
Barium	D	D	D	D
Beryllium	ND	ND	D	D
Calcium	D	D	D	D
Chromium	ND	ND	D	D
Cobalt	D	ND	D	D
Copper	ND	ND	D	D
Iron	D	ND	D	D
Lead	D	ND	D	D
Magnesium	D	D	D	D
Manganese	D	D	D	D
Mercury	-	-	ND	D
Molybdenum	ND	ND	D	ND
Nickel	D	ND	D	D
Potassium	D	D	D	D
Selenium	D	ND	ND	ND
Sodium	D	D	D	D

Table 6A-3
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
Vanadium	ND	ND	D	D
Zinc	ND	ND	D	D

D = Detect
ND = Nondetect
- = Not sampled

Table 6A-4
Analytes Detected at the West Unit (JP-4 Fillstands)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
1,1-Dichloroethane	D	-	ND	ND
1,2-Dichloroethane	D	-	ND	ND
2,4-Dimethylphenol	D	-	ND	ND
2-Methylnaphthalene	D	-	D	D
2-Methylphenol(o-cresol)	D	-	ND	ND
4,4'-DDD	D	-	D	D
4,4'-DDE	ND	-	D	D
4,4'-DDT	D	-	D	D
4-Chloroaniline	ND	-	D	D
4-Methylphenol(p-cresol)	D	-	ND	D
Acenaphthene	ND	-	D	D
Acenaphthylene	ND	-	D	ND
Acetone	D	-	D	D
Aldrin	D	-	D	D
Anthracene	ND	-	D	D
Benz(a)anthracene	ND	-	D	D
Benzene	D	-	D	D
Benzo(a)pyrene	ND	-	D	D
Benzo(b)fluoranthene	ND	-	D	D
Benzo(g,h,i)perylene	ND	-	D	D
Benzo(k)fluoranthene	ND	-	D	D
Benzoic acid	D	-	ND	ND
Bromochloromethane	D	-	-	-
Butylbenzylphthalate	ND	-	D	D
Chrysene	ND	-	D	D
Dibenz(a,h)anthracene	ND	-	D	ND
Dibenzofuran	ND	-	D	D
Dieldrin	D	-	ND	D
Endosulfan I	D	-	ND	D
Endosulfan II	D	-	D	D

Table 6A-4
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
Endosulfan sulfate	D	-	D	D
Endrin	D	-	ND	D
Endrin aldehyde	D	-	D	D
Ethylbenzene	D	-	D	D
Fluoranthene	ND	-	D	D
Fluorene	ND	-	D	D
Heptachlor	D	-	ND	D
Heptachlor epoxide	D	-	D	D
Indeno(1,2,3-cd)pyrene	ND	-	D	D
Methylene chloride	D	-	D	D
Naphthalene	D	-	D	D
Pentachlorophenol	ND	-	D	ND
Phenanthrene	ND	-	D	D
Phenol	D	-	ND	ND
Pyrene	ND	-	D	D
Toluene	D	-	D	D
Trichloroethene	D	-	ND	ND
Xylene (total)	D	-	D	D
alpha-BHC	D	-	D	ND
beta-BHC	D	-	ND	D
bis(2-Ethylhexyl)phthalate	D	-	D	D
cis-1,2-Dichloroethene	D	-	ND	ND
delta-BHC	D	-	D	D
gamma-BHC	D	-	D	ND
Aluminum	D	-	D	D
Antimony	D	-	D	ND
Arsenic	D	-	D	D
Barium	D	-	D	D
Beryllium	D	-	ND	D
Cadmium	D	-	D	D
Calcium	D	-	D	D

Table 6A-4
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
Chromium	D	-	D	D
Cobalt	D	-	D	D
Copper	D	-	D	D
Iron	D	-	D	D
Lead	D	-	D	D
Magnesium	D	-	D	D
Manganese	D	-	D	D
Mercury	D	-	D	D
Molybdenum	D	-	ND	ND
Nickel	D	-	D	D
Potassium	D	-	D	D
Selenium	D	-	ND	D
Silver	D	-	ND	ND
Sodium	D	-	D	D
Thallium	D	-	ND	ND
Vanadium	D	-	D	D
Zinc	D	-	D	D

D= Detect
ND = Nondetect
- = Not sampled

Table 6A-5
Analytes Detected at the West Unit (Building 1845)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
1,1,2-Trichloroethane	D	-	-	ND
1,1-Dichloroethane	D	-	-	ND
1,1-Dichloroethene	D	-	-	ND
1,2-Dichloroethane	D	-	-	ND
2-Butanone (MEK)	D	-	-	ND
4,4'-DDD	D	-	-	D
4,4'-DDE	D	-	-	D
4,4'-DDT	D	-	-	D
4-Methyl-2-Pentanone(MIBK)	D	-	-	ND
Acetone	D	-	-	D
Aldrin	D	-	-	D
Benzene	D	-	-	ND
Benzoic acid	D	-	-	ND
Bromochloromethane	D	-	-	-
Chloroform	D	-	-	ND
Chloromethane	D	-	-	ND
Dibromomethane	D	-	-	-
Dieldrin	D	-	-	ND
Endosulfan I	D	-	-	ND
Endosulfan II	D	-	-	D
Endosulfan sulfate	D	-	-	D
Endrin	D	-	-	D
Endrin aldehyde	D	-	-	D
Ethylbenzene	D	-	-	ND
Heptachlor	D	-	-	D
Heptachlor epoxide	D	-	-	D
Methylene chloride	D	-	-	D
Naphthalene	D	-	-	D
Phenanthrene	D	-	-	ND
Tetrachloroethene	D	-	-	ND
Toluene	D	-	-	ND

Table 6A-5
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
Trichloroethene	D	-	-	D
Trichlorofluoromethane	D	-	-	-
Vinyl Chloride	D	-	-	ND
Xylene (total)	D	-	-	ND
alpha-BHC	D	-	-	D
beta-BHC	D	-	-	ND
bis(2-Ethylhexyl)phthalate	D	-	-	ND
cis-1,2-Dichloroethene	D	-	-	-
delta-BHC	D	-	-	D
gamma-BHC	D	-	-	D
trans-1,2-Dichloroethene	D	-	-	D
Aluminum	D	-	-	D
Antimony	D	-	-	ND
Arsenic	D	-	-	D
Barium	D	-	-	D
Beryllium	D	-	-	D
Cadmium	D	-	-	ND
Calcium	D	-	-	D
Chromium	D	-	-	D
Cobalt	D	-	-	D
Copper	D	-	-	D
Iron	D	-	-	D
Lead	D	-	-	D
Magnesium	D	-	-	D
Manganese	D	-	-	D
Mercury	D	-	-	D
Molybdenum	D	-	-	ND
Nickel	D	-	-	D
Potassium	D	-	-	D
Selenium	D	-	-	ND
Silver	D	-	-	ND

Table 6A-5
(Continued)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
Sodium	D	-	-	D
Thallium	D	-	-	ND
Vanadium	D	-	-	D
Zinc	D	-	-	D

D= Detect
ND = Nondetect
- = Not sampled

Table 6A-6
Analytes Detected at the West Unit (Building 1700)

Chemical	Groundwater	Surface Water	Surface Soil	Subsurface Soil
2-Butanone (MEK)	-	-	ND	D
2-Methylnaphthalene	-	-	D	D
2-Methylphenol(o-cresol)	-	-	ND	D
4-Chloroaniline	-	-	ND	D
4-Methyl-2-Pentanone(MIBK)	-	-	ND	D
4-Methylphenol(p-cresol)	-	-	ND	D
Acetone	-	-	ND	D
Benzene	-	-	D	D
Dibenzofuran	-	-	ND	D
Ethylbenzene	-	-	D	D
Fluorene	-	-	ND	D
Naphthalene	-	-	D	D
Phenanthrene	-	-	ND	D
Pyrene	-	-	D	ND
Toluene	-	-	D	D
Xylene (total)	-	-	D	D
bis(2-Ethylhexyl)phthalate	-	-	D	D
Arsenic	-	-	D	D
Lead	-	-	D	D

D = Detect
ND = Nondetect
- = Not sampled

Table 6B-1
Identification Criteria for Surface Soil COPCs at the West Unit (Waste Accumulation Area)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
2-Methylnaphthalene	-	-	-	-	-	YES
4,4'-DDD	-	-	-	-	-	YES
4,4'-DDE	-	-	-	-	-	YES
4,4'-DDT	-	-	-	-	-	YES
Acenaphthene	-	-	-	-	X	-
Acetone	X	-	-	-	-	-
Aldrin	-	-	-	-	-	YES
alpha-BHC	-	-	X	-	-	-
Aluminum	-	X	-	-	-	-
Anthracene	-	-	-	-	X	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Benz(a)anthracene	-	-	-	-	-	YES
Benzo(a)pyrene	-	-	-	-	-	YES
Benzo(b)fluoranthene	-	-	-	-	-	YES
Benzo(g,h,i)perylene	-	-	-	-	-	YES
Benzo(k)fluoranthene	-	-	-	-	X	-
Benzoic acid	-	-	-	-	X	-
Beryllium	-	X	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	X	-
Cadmium	-	-	-	-	X	-
Calcium	-	X	-	-	-	-
Chromium	-	X	-	-	-	-
Chrysene	-	-	-	-	X	-
Cobalt	-	X	-	-	-	-
Copper	-	X	-	-	-	-

Table 6B-1
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
delta-BHC	X	-	-	-	-	-
Dibenz(a,h)anthracene	-	-	-	-	-	YES
Dieldrin	-	-	-	-	-	YES
Endosulfan sulfate	-	-	-	-	X	-
Endosulfan II	-	-	-	-	X	-
Endosulfan I	-	-	-	-	X	-
Endrin	-	-	-	-	X	-
Endrin aldehyde	-	-	-	-	X	-
Fluoranthene	-	-	-	-	X	-
Fluorene	-	-	-	-	X	-
gamma-BHC	-	-	-	-	-	YES
Heptachlor	-	-	-	-	X	-
Heptachlor epoxide	-	-	-	-	-	YES
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	YES
Iron	-	X	-	-	-	-
Lead	-	-	-	-	-	YES
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	X	-	-	-	-	-
Methoxychlor	-	-	-	-	X	-
Methylene chloride	X	-	-	-	-	-
Naphthalene	-	-	-	-	X	-
Nickel	-	X	-	-	-	-
Phenanthrene	-	-	-	-	-	YES
Potassium	-	X	-	-	-	-
Pyrene	-	-	-	-	X	-
Sodium	-	X	-	-	-	-

Table 6B-1
(Continued)

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
Vanadium	-	X	-	-	-	-
Zinc	-	X	-	-	-	-

[a]Industinguisable from blank concentrations.
[b]Not significantly elevated above background concentrations.
[c]Detected at a frequency less than 5%.
[d]Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e]Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 6B-2
Identification Criteria for Surface Soil COPCs at the West Unit (Millon Gallon Hill)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
2-Methylnaphthalene	-	-	-	-	-	YES
4,4'-DDD	-	-	-	-	X	-
4,4'-DDE	-	-	-	-	X	-
4,4'-DDT	-	-	-	-	X	-
4-Methyl-2-Pentanone(MIBK)	-	-	-	-	X	-
Acenaphthene	-	-	-	-	X	-
Acetone	X	-	-	-	-	-
Aldrin	X	-	-	-	-	-
alpha-BHC	-	-	-	-	X	-
Aluminum	-	X	-	-	-	-
Anthracene	-	-	-	-	X	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Benz(a)anthracene	-	-	-	-	-	YES
Benzene	X	-	-	-	-	-
Benzo(a)pyrene	-	-	-	-	-	YES
Benzo(b)fluoranthene	-	-	-	-	-	YES
Benzo(g,h,i)perylene	-	-	-	-	-	YES
Benzo(k)fluoranthene	-	-	-	-	X	-
Beryllium	-	X	-	-	-	-
beta-BHC	-	-	-	-	X	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	X	-
Calcium	-	X	-	-	-	-
Chromium	-	X	-	-	-	-
Chrysene	-	-	-	-	X	-
Cobalt	-	X	-	-	-	-

Table 6B-2
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Copper	-	X	-	-	-	-
Dibenzofuran	-	-	-	-	X	-
Dibutyl phthalate	-	-	-	-	X	-
Dieldrin	-	-	-	-	X	-
Endosulfan I	-	-	-	-	X	-
Endosulfan II	X	-	-	-	-	-
Endosulfan sulfate	-	-	-	-	X	-
Endrin aldehyde	-	-	-	-	X	-
Fluoranthene	-	-	-	-	X	-
Fluorene	-	-	-	-	X	-
gamma-BHC	-	-	-	-	X	-
Heptachlor	-	-	-	-	X	-
Heptachlor epoxide	X	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	YES
Iron	-	X	-	-	-	-
Lead	-	-	-	-	-	YES
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	-	X	-	-	-	-
Methoxychlor	-	-	-	-	X	-
Methylene chloride	-	-	-	-	X	-
Naphthalene	-	-	-	-	X	-
Nickel	-	X	-	-	-	-
Phenanthrene	-	-	-	-	-	YES
Potassium	-	X	-	-	-	-
Pyrene	-	-	-	-	X	-
Sodium	-	X	-	-	-	-

Table 6B-2
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Toluene	X	-	-	-	-	-
Vanadium	-	X	-	-	-	-
Zinc	-	X	-	-	-	-

[a] Industinguisable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 6B-3
Identification Criteria for Surface Soil COPCs at the West Unit (Power Plant UST No. 49)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
2-Hexanone	-	-	-	-	-	YES
2-Methylnaphthalene	-	-	-	-	-	YES
4,4'-DDD	-	-	-	-	X	-
4,4'-DDE	-	-	-	-	X	-
4,4'-DDT	-	-	-	-	X	-
alpha-BHC	-	-	-	-	-	YES
Aluminum	-	-	-	-	-	YES
Arsenic	-	X	-	-	-	-
Barium	-	-	-	-	X	-
Beryllium	-	-	-	-	-	YES
Calcium	-	-	-	X	-	-
Chromium	-	-	-	-	X	-
Cobalt	-	-	-	-	X	-
Copper	-	-	-	-	X	-
Dieldrin	-	-	-	-	-	YES
Endosulfan II	-	-	-	-	X	-
Endosulfan sulfate	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	X	-
Fluorene	-	-	-	-	X	-
gamma-BHC	-	-	-	-	X	-
Heptachlor	-	-	-	-	X	-
Heptachlor epoxide	X	-	-	-	-	-
Iron	-	-	-	X	-	-
Lead	-	-	-	-	-	YES
Magnesium	-	-	-	X	-	-
Manganese	-	-	-	-	-	YES

Table 6B-3
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Molybdenum	-	-	-	-	X	-
Naphthalene	-	-	-	-	X	-
Nickel	-	-	-	-	X	-
Potassium	-	-	-	X	-	-
Sodium	-	-	-	X	-	-
Toluene	-	-	-	-	X	-
Vanadium	-	-	-	-	X	-
Xylene (total)	-	-	-	-	X	-
Zinc	-	-	-	X	-	-

[a] Indistinguisable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 6B-4
Identification Criteria for Surface Soil COPCs at the West Unit (JP-4 Fillstands)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
2-Methylnaphthalene	-	-	-	-	-	YES
4,4'-DDD	-	-	-	-	-	YES
4,4'-DDE	-	-	-	-	-	YES
4,4'-DDT	-	-	-	-	-	YES
4-Chloroaniline	-	-	-	-	X	-
Acenaphthene	-	-	-	-	X	-
Acenaphthylene	-	-	-	-	-	YES
Acetone	X	-	-	-	-	-
Aldrin	X	-	-	-	-	-
alpha-BHC	X	-	-	-	-	-
Aluminum	-	X	-	-	-	-
Anthracene	-	-	-	-	X	-
Antimony	-	X	-	-	-	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Benz(a)anthracene	-	-	-	-	-	YES
Benzene	-	-	-	-	X	-
Benzo(a)pyrene	-	-	-	-	-	YES
Benzo(b)fluoranthene	-	-	-	-	-	YES
Benzo(g,h,i)perylene	-	-	-	-	-	YES
Benzo(k)fluoranthene	-	-	-	-	-	YES
bis(2-Ethylhexyl)phthalate	-	-	-	-	X	-

Table 6B-4
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Butylbenzylphthalate	-	-	-	-	X	-
Cadmium	-	-	-	-	X	-
Calcium	-	X	-	-	-	-
Chromium	-	X	-	-	-	-
Chrysene	-	-	-	-	-	YES
Cobalt	-	X	-	-	-	-
Copper	-	X	-	-	-	-
delta-BHC	X	-	-	-	-	-
Dibenz(a,h)anthracene	-	-	-	-	-	YES
Dibenzofuran	-	-	-	-	X	-
Endosulfan II	-	-	-	-	X	-
Endosulfan sulfate	-	-	-	-	X	-
Endrin aldehyde	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	X	-
Fluoranthene	-	-	-	-	X	-
Fluorene	-	-	-	-	X	-
gamma-BHC	X	-	-	-	-	-
Heptachlor epoxide	X	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	YES
Iron	-	X	-	-	-	-
Lead	-	-	-	-	-	YES
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-

Table 6B-4
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Naphthalene	-	-	-	-	X	-
Nickel	-	X	-	-	-	-
Pentachlorophenol	-	-	-	-	-	YES
Phenanthrene	-	-	-	-	-	YES
Potassium	-	X	-	-	-	-
Pyrene	-	-	-	-	X	-
Sodium	-	X	-	-	-	-
Toluene	-	-	-	-	X	-
Vanadium	-	X	-	-	-	-
Xylene (total)	-	-	-	-	X	-
Zinc	-	-	-	X	-	-

[a] Indistinguisable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 6B-5
Identification Criteria for Surface Soil COPCs at the West Unit (Building 1700)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
2-Methylnaphthalene	-	-	-	-	-	YES
Arsenic	-	-	-	-	-	YES
Benzene	-	-	-	-	-	YES
bis(2-Ethylhexyl)phthalate	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	X	-
Lead	-	-	-	-	-	YES
Naphthalene	-	-	-	-	X	-
Pyrene	-	-	-	-	X	-
Toluene	-	-	-	-	X	-
Xylene (total)	-	-	-	-	X	-

[a] Indistinguisable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 6C-1
Identification Criteria for Subsurface Soil COPCs at the West Unit (Waste Accumulation Area)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
2-Methylnaphthalene	-	-	-	-	-	YES
4,4'-DDD	-	-	-	-	X	-
4,4'-DDE	-	-	-	-	X	-
4,4'-DDT	-	-	-	-	X	-
Acetone	-	-	-	-	X	-
Aldrin	-	-	-	-	X	-
alpha-BHC	X	-	-	-	-	-
Aluminum	-	X	-	-	-	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Benz(a)anthracene	-	-	-	-	X	-
Benzo(a)pyrene	-	-	-	-	-	YES
Benzo(b)fluoranthene	-	-	-	-	X	-
Benzo(k)fluoranthene	-	-	-	-	X	-
Benzoic acid	-	-	-	-	X	-
Beryllium	-	X	-	-	-	-
beta-BHC	-	-	-	-	X	-
bis(2-Ethylhexyl)phthalate	X	-	-	-	-	-
Calcium	-	X	-	-	-	-
Chromium	-	X	-	-	-	-
Chrysene	-	-	-	-	X	-
Cobalt	-	X	-	-	-	-
Copper	-	X	-	-	-	-
delta-BHC	X	-	-	-	-	-
Dieldrin	X	-	-	-	-	-
Endosulfan II	X	-	-	-	-	-
Endosulfan sulfate	X	-	-	-	-	-

Table 6C-1
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Endosulfan I	X	-	-	-	-	-
Endrin aldehyde	X	-	-	-	-	-
Endrin	-	-	-	-	X	-
Fluoranthene	-	-	-	-	X	-
gamma-BHC	X	-	-	-	-	-
Heptachlor	X	-	-	-	-	-
Heptachlor epoxide	X	-	-	-	-	-
Iron	-	X	-	-	-	-
Lead	-	X	-	-	-	-
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	-	X	-	-	-	-
Methylene chloride	X	-	-	-	-	-
Naphthalene	-	-	-	-	X	-
Nickel	-	X	-	-	-	-
Phenanthrene	-	-	-	-	-	YES
Potassium	-	X	-	-	-	-
Pyrene	-	-	-	-	X	-
Selenium	-	-	-	X	-	-
Sodium	-	X	-	-	-	-
Vanadium	-	X	-	-	-	-
Zinc	-	X	-	-	-	-

[a] Indistinguisable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 6C-2
Identification Criteria for Subsurface Soil COPCs at the West Unit (Million Gallon Hill)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
2-Butanone (MEK)	-	-	-	-	X	-
2-Methylnaphthalene	-	-	-	-	-	YES
4,4'-DDD	-	-	-	-	X	-
4,4'-DDE	-	-	-	-	X	-
4,4'-DDT	-	-	-	-	X	-
4-Chloroaniline	-	-	-	-	X	-
4-Methylphenol(p-cresol)	-	-	-	-	X	-
Acenaphthylene	-	-	-	-	-	YES
Acetone	X	-	-	-	-	-
Aldrin	X	-	-	-	-	-
Aluminum	-	X	-	-	-	-
Anthracene	-	-	-	-	X	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Benz(a)anthracene	-	-	-	-	-	YES
Benzene	-	-	-	-	X	-
Benzo(a)pyrene	-	-	-	-	-	YES
Benzo(b)fluoranthene	-	-	-	-	-	YES
Benzo(g,h,i)perylene	-	-	-	-	-	YES
Benzo(k)fluoranthene	-	-	-	-	X	-
Benzoic acid	-	-	-	-	X	-
Beryllium	-	X	-	-	-	-
beta-BHC	X	-	-	-	-	-

Table 6C-2
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
bis(2-Ethylhexyl)phthalate	-	-	-	-	X	-
Calcium	-	X	-	-	-	-
Chromium	-	X	-	-	-	-
Chrysene	-	-	-	-	X	-
Cobalt	-	X	-	-	-	-
Copper	-	X	-	-	-	-
delta-BHC	X	-	-	-	-	-
Dibenz(a,h)anthracene	-	-	-	-	-	YES
Dibutyl phthalate	-	-	-	-	X	-
Dieldrin	X	-	-	-	-	-
Endosulfan II	X	-	-	-	-	-
Endosulfan sulfate	X	-	-	-	-	-
Endosulfan I	X	-	-	-	-	-
Endrin	X	-	-	-	-	-
Endrin aldehyde	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	X	-
Fluoranthene	-	-	-	-	X	-
Heptachlor	X	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	YES
Iron	-	X	-	-	-	-
Lead	-	X	-	-	-	-
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	-	X	-	-	-	-

Table 6C-2
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Methylene chloride	-	-	-	-	X	-
Naphthalene	-	-	-	-	X	-
Nickel	-	X	-	-	-	-
Nitrobenzene	-	-	-	-	X	-
Phenanthrene	-	-	-	-	-	YES
Potassium	-	X	-	-	-	-
Pyrene	-	-	-	-	X	-
Selenium	-	-	-	X	-	-
Sodium	-	X	-	-	-	-
Toluene	-	-	-	-	X	-
Vanadium	-	X	-	-	-	-
Xylene (total)	-	-	-	-	X	-
Zinc	-	X	-	-	-	-

[a] Indistinguisable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 6C-3
Identification Criteria for Subsurface Soil COPCs at the West Unit (Power Plant UST No. 49)

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
2-Methylnaphthalene	-	-	-			YES
4,4'-DDD	-	-	-	-	X	-
4,4'-DDE	-	-	-	-	X	-
4,4'-DDT	-	-	-	-	X	-
Acetone	X	-	-	-	-	-
Aldrin	-	-	-	-	X	-
alpha-BHC	-	-	-	-	-	YES
Aluminum	-	-	-	-	-	YES
Arsenic	-	-	-	-	-	YES
Barium	-	-	-	-	X	-
Beryllium	-	-	-	-	-	YES
beta-BHC	-	-	-	-	X	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	X	-
Calcium	-	-	-	X	-	-
Chromium	-	-	-	-	X	-
Cobalt	-	-	-	-	X	-
Copper	-	-	-	X	-	-
Dibenzofuran	-	-	-	-	X	-
Dieldrin	-	-	-	-	-	YES
Endosulfan I	-	-	-	-	X	-
Endosulfan II	-	-	-	-	X	-
Endosulfan sulfate	-	-	-	-	X	-
Endrin aldehyde	-	-	-	-	X	-
Fluorene	-	-	-	-	X	-
gamma-BHC	-	-	-	-	-	YES
Heptachlor	-	-	-	-	X	-
Heptachlor epoxide	-	-	-	-	-	YES

Table 6C-3
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Iron	-	-	-	X	-	-
Lead	-	-	-	-	-	YES
Magnesium	-	-	-	X	-	-
Manganese	-	-	-	-	-	YES
Mercury	X	-	-	-	-	-
Methylene chloride	-	-	-	-	X	-
Naphthalene	-	-	-	-	X	-
Nickel	-	-	-	-	X	-
Potassium	-	-	-	X	-	-
Sodium	-	-	-	X	-	-
Trichloroethene	-	-	-	-	X	-
Vanadium	-	-	-	-	X	-
Zinc	-	-	-	X	-	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 6C-4
Identification Criteria for Subsurface Soil COPCs at the West Unit (JP-4 Fillstands)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
1,1,2,2-Tetrachloroethane	-	-	-	-	-	YES
2-Butanone (MEK)	-	-	-	-	X	-
2-Methylnaphthalene	-	-	-	-	-	YES
2-Hexanone	-	-	-	-	-	YES
4,4'-DDD	-	-	-	-	-	YES
4,4'-DDE	-	-	-	-	X	-
4,4'-DDT	-	-	-	-	-	YES
4-Chloroaniline	-	-	-	-	X	-
4-Methylphenol(p-cresol)	-	-	-	-	X	-
Acenaphthene	-	-	-	-	X	-
Acetone	-	-	-	-	X	-
Aldrin	-	-	-	-	X	-
Aluminum	-	X	-	-	-	-
Anthracene	-	-	-	-	X	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Benz(a)anthracene	-	-	-	-	X	-
Benzene	-	-	-	-	-	YES
Benzo(a)pyrene	-	-	-	-	-	YES
Benzo(b)fluoranthene	-	-	-	-	-	YES
Benzo(g,h,i)perylene	X	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	X	-
Beryllium	-	X	-	-	-	-
beta-BHC	-	-	-	-	X	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	X	-
Butylbenzylphthalate	-	-	-	-	X	-

Table 6C-4
Continued

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Cadmium	-	X	-	-	-	-
Calcium	-	X	-	-	-	-
Chlorobenzene	-	-	-	-	X	-
Chromium	-	X	-	-	-	-
Chrysene	-	-	-	-	X	-
Cobalt	-	X	-	-	-	-
Copper	-	X	-	-	-	-
delta-BHC	-	-	-	-	X	-
Dibenzofuran	-	-	-	-	X	-
Dieldrin	-	-	-	-	X	-
Endosulfan sulfate	-	-	-	-	X	-
Endosulfan I	X	-	-	-	-	-
Endosulfan II	X	-	-	-	-	-
Endrin aldehyde	-	-	-	-	X	-
Endrin	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	X	-
Fluoranthene	-	-	-	-	X	-
Fluorene	-	-	-	-	X	-
Heptachlor	X	-	-	-	-	-
Heptachlor epoxide	X	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	X	-	-	-	-	-
Iron	-	X	-	-	-	-
Isophorone	-	-	-	-	X	-
Lead	-	X	-	-	-	-
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-

Table 6C-4
Continued

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Mercury	X	-	-	-	-	-
Methoxychlor	-	-	-	-	X	-
Methylene chloride	-	-	-	-	X	-
Naphthalene	-	-	-	-	X	-
Nickel	-	X	-	-	-	-
Phenanthrene	-	-	-	-	-	YES
Potassium	-	X	-	-	-	-
Pyrene	-	-	-	-	X	-
Selenium	-	-	-	X	-	-
Sodium	-	X	-	-	-	-
Toluene	-	-	-	-	X	-
Vanadium	-	X	-	-	-	-
Xylene (total)	-	-	-	-	X	-
Zinc	-	X	-	-	-	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 6C-5
Identification Criteria for Subsurface Soil COPCs at the West Unit (Building 1845)

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
2-Methylnaphthalene	-	-	-	-	-	YES
4,4'-DDD	-	-	-	-	-	YES
4,4'-DDE	-	-	-	-	X	-
4,4'-DDT	-	-	-	-	-	YES
Acetone	X	-	-	-	-	-
Aldrin	X	-	-	-	-	-
alpha-BHC	-	-	-	-	X	-
Aluminum	-	-	-	-	-	YES
Arsenic	-	-	-	-	-	YES
Barium	-	-	-	-	X	-
Beryllium	-	-	-	-	-	YES
Calcium	-	-	-	X	-	-
Chromium	-	-	-	-	X	-
Cobalt	-	-	-	-	X	-
Copper	-	-	-	X	-	-
delta-BHC	X	-	-	-	-	-
Endosulfan sulfate	X	-	-	-	-	-
Endosulfan II	X	-	-	-	-	-
Endrin	X	-	-	-	-	-
Endrin aldehyde	-	-	-	-	X	-
gamma-BHC	X	-	-	-	-	-
Heptachlor	X	-	-	-	-	-
Heptachlor epoxide	X	-	-	-	-	-
Iron	-	-	-	X	-	-
Lead	-	-	-	-	-	YES
Magnesium	-	-	-	X	-	-

Table 6C-5
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Manganese	-	-	-	-	-	YES
Mercury	X	-	-	-	-	-
Methoxychlor	-	-	-	-	X	-
Methylene chloride	-	-	-	-	X	-
Naphthalene	-	-	-	-	X	-
Nickel	-	-	-	-	X	-
Potassium	-	-	-	X	-	-
Sodium	-	-	-	X	-	-
trans-1,2-Dichloroethene	-	-	-	-	X	-
Trichloroethene	-	-	-	-	X	-
Vanadium	-	-	-	-	X	-
Zinc	-	-	-	X	-	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 6C-6
Identification Criteria for Subsurface Soil COPCs at the West Unit (Building 1700)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
2-Butanone (MEK)	X	-	-	-	-	-
2-Methylnaphthalene	-	-	-	-	-	YES
2-Methylphenol(o-cresol)	-	-	-	-	X	-
4-Chloroaniline	-	-	-	-	X	-
4-Methyl-2-Pentanone (MIBK)	-	-	-	-	X	-
4-Methylphenol(p-cresol)	-	-	-	-	X	-
Acetone	-	-	-	-	X	-
Arsenic	-	-	-	-	-	YES
Benzene	-	-	-	-	-	YES
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	YES
Dibenzofuran	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	X	-
Fluorene	-	-	-	-	X	-
Lead	-	-	-	-	-	YES
Naphthalene	-	-	-	-	X	-
Phenanthrene	-	-	-	-	-	YES
Toluene	-	-	-	-	X	-
Xylene (total)	-	-	-	-	X	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III Residential Soil RBC.
- = Not eliminated through this criterion.

Table 6D-1
Identification Criteria for Groundwater COPCs at the West Unit (Waste Accumulation Area)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [a]	Risk-Based Screen [e]	COPC
1,2-Dichloroethane	-	-	-	-	-	YES
4,4'-DDT	X	-	-	-	-	-
Acetone	X	-	-	-	-	-
Aldrin	X	-	-	-	-	-
alpha-BHC	-	-	-	-	-	YES
Aluminum	-	X	-	-	-	-
Antimony	X	-	-	-	-	-
Arsenic	-	X	-	-	-	-
Barium	-	X	-	-	-	-
Benzene	-	-	-	-	-	YES
Beryllium	X	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	YES
Bromochloromethane	-	-	-	-	-	YES
Cadmium	X	-	-	-	-	-
Calcium	-	X	-	-	-	-
Chloromethane	-	-	-	-	-	YES
Chromium	X	-	-	-	-	-
cis-1,2-Dichloroethene	-	-	-	-	X	-
Cobalt	-	X	-	-	-	-
Copper	-	X	-	-	-	-
delta-BHC	X	-	-	-	-	-
Dibromomethane	-	-	-	-	-	YES
Dieldrin	-	-	-	-	-	YES
Endosulfan II	-	-	-	-	X	-
Endosulfan sulfate	-	-	-	-	X	-
Endrin aldehyde	-	-	-	-	X	-

Table 6D-1
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [a]	Risk-Based Screen [e]	COPC
Ethylbenzene	X	-	-	-	-	-
Heptachlor	-	-	-	-	-	YES
Heptachlor epoxide	X	-	-	-	-	-
Iron	-	X	-	-	-	-
Lead	-	X	-	-	-	-
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	X	-	-	-	-	-
Methoxychlor	-	-	-	-	X	-
Methylene chloride	X	-	-	-	-	-
Molybdenum	X	-	-	-	-	-
Nickel	X	-	-	-	-	-
Potassium	-	X	-	-	-	-
Selenium	X	-	-	-	-	-
Silver	X	-	-	-	-	-
Sodium	-	-	-	X	-	-
Thallium	X	-	-	-	-	-
Toluene	X	-	-	-	-	-
Vanadium	X	-	-	-	-	-
Vinyl Chloride	-	-	-	-	-	YES
Xylene (total)	X	-	-	-	-	-
Zinc	-	-	-	X	-	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III tap water RBC.
- = Not eliminated through this criterion.

Table 6D-2
Identification Criteria for Groundwater COPCs at the West Unit (Million Gallon Hill)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
1,1-Dichloroethane	-	-	-	-	X	-
1,1-Dichloroethene	-	-	-	-	-	YES
1,2-Dichloroethane	-	-	-	-	-	YES
2,4 Dimethylphenol	-	-	X	-	-	-
2-Butanone (MEK)	-	-	-	-	-	YES
2-Methylnaphthalene	-	-	-	-	-	YES
2-Methylphenol(o-cresol)	-	-	-	-	X	-
4,4'-DDD	-	-	-	-	-	YES
4,4'-DDE	-	-	-	-	-	YES
4,4'-DDT	-	-	-	-	-	YES
4-Methylphenol(p-cresol)	-	-	-	-	-	YES
4-Methylphenol/3-Methylphenol	-	-	-	-	X	-
4-Nitrophenol	-	-	-	-	X	-
Acenaphthene	-	-	-	-	X	-
Acetone	-	-	-	-	-	X
Aldrin	-	-	-	-	-	YES
alpha-BHC	-	-	-	-	-	YES
Aluminum	X	-	-	-	-	-
Antimony	X	-	-	-	-	-
Anthracene	-	-	X	-	-	-
Arsenic	-	X	-	-	-	-
Barium	-	-	-	-	-	YES
Benzene	-	-	-	-	-	YES
Benzoic acid	-	-	-	-	X	-
Beryllium	-	X	-	-	-	-

Table 6D-2
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
beta-BHC	-	-	-	-	-	YES
Bromochloromethane	-	-	-	-	-	YES
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	YES
Cadmium	-	X	-	-	-	-
Calcium	-	X	-	-	-	-
Chloroethane	-	-	-	-	X	-
Chloromethane	-	-	-	-	-	YES
Chromium	-	X	-	-	-	-
cis-1,2-Dichloroethene	-	-	-	-	-	YES
Cobalt	-	X	-	-	-	-
Copper	X	-	-	-	-	-
delta-BHC	-	-	-	-	X	-
Dibenzofuran	-	-	-	-	-	YES
Dibromomethane	-	-	-	-	-	YES
Dibutyl phthalate	-	-	-	-	X	-
Dieldrin	-	-	-	-	-	YES
Endosulfan I	-	-	X	-	-	-
Endosulfan sulfate	-	-	-	-	X	-
Endosulfan II	X	-	-	-	-	-
Endrin	-	-	X	-	-	-
Endrin aldehyde	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	-	YES
Fluoranthene	-	-	X	-	-	-
Fluorene	-	-	-	-	X	-
gamma-BHC	-	-	-	-	-	YES
Heptachlor epoxide	-	-	-	-	-	YES

Table 6D-2
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Heptachlor	-	-	-	-	-	YES
Iron	-	-	-	-	-	YES
Lead	-	-	-	-	-	YES
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	-	X	-	-	-	-
Methylene chloride	-	-	-	-	-	YES
Molybdenum	X	-	-	-	-	-
Naphthalene	-	-	-	-	-	YES
Nickel	-	X	-	-	-	-
Phenanthrene	-	-	-	-	-	YES
Phenol	-	-	-	-	X	-
Potassium	-	X	-	-	-	-
Pyrene	-	-	X	-	-	-
Selenium	-	X	-	-	-	-
Silver	-	X	-	-	-	-
Sodium	-	-	-	X	-	-
Thallium	X	-	-	-	-	-
Toluene	-	-	-	-	-	YES
trans-1,2-Dichloroethene	-	-	-	-	X	-
Trichloroethene	-	-	-	-	-	YES
Vanadium	X	-	-	-	-	-
Vinyl Chloride	-	-	-	-	-	YES
Xylene (total)	-	-	-	-	-	YES
Zinc	-	X	-	-	-	-

Table 6D-2
(Continued)

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III tap water RBC.
- = Not eliminated through this criterion.

Table 6D-3
Identification Criteria for Groundwater COPCs at the West Unit (Power Plant UST No. 49)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
4,4'-DDD	X	-	-	-	-	-
4,4'-DDT	-	-	-	-	-	YES
Aldrin	X	-	-	-	-	-
Arsenic	-	-	-	-	-	YES
Barium	-	-	-	-	-	YES
Benzoic acid	-	-	-	-	X	-
beta-BHC	-	-	-	-	-	YES
bis(2-Ethylhexyl)phthalate	X	-	-	-	-	-
Calcium	-	-	-	X	-	-
Cobalt	-	-	-	-	X	-
delta-BHC	-	-	-	-	X	-
Dieldrin	-	-	-	-	-	YES
Endosulfan sulfate	X	-	-	-	-	-
Endrin aldehyde	X	-	-	-	-	-
gamma-BHC	-	-	-	-	-	YES
Heptachlor	X	-	-	-	-	-
Iron	-	-	-	-	-	YES
Lead	-	-	-	-	-	YES
Magnesium	-	-	-	X	-	-
Manganese	-	-	-	-	-	YES
Nickel	-	-	-	-	X	-
Potassium	-	-	-	X	-	-
Selenium	-	-	-	X	-	-
Sodium	-	-	-	X	-	-
Toluene	X	-	-	-	-	-
Xylene (total)	X	-	-	-	-	-

Table 6D-3
(Continued)

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequently less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III tap water RBC.
- = Not eliminated through this criterion.

Table 6D-4
Identification Criteria for Groundwater COPCs at the West Unit (JP-4 Fillstands)

Chemical	Blanks Comparison[a]	Background Comparison[b]	Low Frequency[c]	Essential Nutrient[d]	Risk-Based Screen[e]	COPC
1,1-Dichloroethane	-	-	-	-	X	-
1,2-Dichloroethane	-	-	-	-	-	YES
2,4-Dimethylphenol	-	-	-	-	X	-
2-Methylnaphthalene	-	-	-	-	-	YES
2-Methylphenol(o-cresol)	-	-	-	-	X	-
4,4'-DDD	-	-	-	-	X	-
4,4'-DDT	-	-	-	-	X	-
4-Methylphenol(p-cresol)	-	-	-	-	X	-
Acetone	X	-	-	-	-	-
Aldrin	-	-	-	-	-	YES
alpha-BHC	-	-	-	-	-	YES
Aluminum	X	-	-	-	-	-
Antimony	X	-	-	-	-	-
Arsenic	-	-	-	-	-	YES
Barium	-	-	-	-	-	YES
Benzene	-	-	-	-	-	YES
Benzoic acid	-	-	-	-	X	-
Beryllium	X	-	-	-	-	-
beta-BHC	-	-	-	-	-	YES
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	YES
Bromochloromethane	-	-	-	-	-	YES
Cadmium	X	-	-	-	-	-

Table 6D-4
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Calcium	-	X	-	-	-	-
Chromium	X	-	-	-	-	-
cis-1,2-Dichloroethene	-	-	-	-	X	-
Cobalt	-	X	-	-	-	-
Copper	X	-	-	-	-	-
delta-BHC	X	-	-	-	-	-
Dieldrin	X	-	-	-	-	-
Endosulfan II	X	-	-	-	-	-
Endosulfan sulfate	X	-	-	-	-	-
Endosulfan I	-	-	-		X	-
Endrin	X	-	-	-	-	-
Endrin aldehyde	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	X	-
gamma-BHC	-	-	-	-	-	YES
Heptachlor epoxide	-	-	-	-	-	YES
Heptachlor	-	-	-	-	-	YES
Iron	-	-	-	-	-	YES
Lead	-	-	-	-	-	YES
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	X	-	-	-	-	-
Methylene chloride	X	-	-	-	-	-

Table 6D-4
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Molybdenum	X	-	-	-	-	-
Naphthalene	-	-	-	-	-	YES
Nickel	-	X	-	-	-	-
Phenol	-	-	-	-	X	-
Potassium	-	X	-	-	-	-
Selenium	-	-	-	X	-	-
Silver	X	-	-	-	-	-
Sodium	-	-	-	X	-	-
Thallium	X	-	-	-	-	-
Toluene	X	-	-	-	-	-
Trichloroethene	-	-	-	-	-	YES
Vanadium	X	-	-	-	-	-
Xylene (total)	-	-	-	-	X	-
Zinc	-	X	-	-	-	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III tap water RBC.
- = Not eliminated through this criterion.

Table 6D-5
Identification Criteria for Groundwater COPCs at the West Unit (Building 1845)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
1,2-Dichloroethane	-	-	-	-	-	YES
1,1-Dichloroethane	-	-	-	-	X	-
1,1-Dichloroethene	-	-	-	-	-	YES
1,1,2-Trichloroethane	-	-	-	-	-	YES
2-Butanone (MEK)	X	-	-	-	-	-
4-Methyl-2-Pentanone (MIBK)	-	-	-	-	X	-
4,4'-DDD	-	-	-	-	-	YES
4,4'-DDE	-	-	-	-	-	YES
4,4'-DDT	-	-	-	-	-	YES
Acetone	X	-	-	-	-	-
Aldrin	-	-	-	-	-	YES
alpha-BHC	-	-	-	-	-	YES
Aluminum	X	-	-	-	-	-
Antimony	X	-	-	-	-	-
Arsenic	-	-	-	-	-	YES
Barium	-	X	-	-	-	-
Benzene	-	-	-	-	-	YES
Benzoic acid	-	-	-	-	X	-
Beryllium	-	X	-	-	-	-
beta-BHC	-	-	-	-	-	YES
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	YES
Bromochloromethane	-	-	-	-	-	YES
Cadmium	-	-	-	-	-	YES
Calcium	-	X	-	-	-	-
Chloroform	-	-	-	-	-	YES

Table 6D-5
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Chloromethane	-	-	-	-	-	YES
Chromium	X	-	-	-	-	-
cis-1,2-Dichloroethene	-	-	-	-	-	YES
Cobalt	-	X	-	-	-	-
Copper	X	-	-	-	-	-
delta-BHC	X	-	-	-	-	-
Dibromomethane	X	-	-	-	-	-
Dieldrin	-	-	-	-	-	YES
Endosulfan sulfate	-	-	-	-	X	-
Endosulfan I	X	-	-	-	-	-
Endosulfan II	X	-	-	-	-	-
Endrin	X	-	-	-	-	-
Endrin aldehyde	-	-	-	-	X	-
Ethylbenzene	-	-	-	-	X	-
gamma-BHC	-	-	-	-	-	YES
Heptachlor	-	-	-	-	-	YES
Heptachlor epoxide	-	-	-	-	-	YES
Iron	-	X	-	-	-	-
Lead	-	-	-	-	-	YES
Magnesium	-	X	-	-	-	-
Manganese	-	X	-	-	-	-
Mercury	-	-	-	-	X	-
Methylene chloride	X	-	-	-	-	-
Molybdenum	-	X	-	-	-	-
Naphthalene	-	-	-	-	X	-
Nickel	-	X	-	-	-	-

Table 6D-5
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	Risk-Based Screen [e]	COPC
Phenanthrene	-	-	-	-	-	YES
Potassium	-	X	-	-	-	-
Selenium	X	-	-	-	-	-
Silver	X	-	-	-	-	-
Sodium	-	-	-	X	-	-
Tetrachloroethene	-	-	-	-	-	YES
Thallium	-	X	-	-	-	-
Toluene	X	-	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	-	YES
Trichloroethene	-	-	-	-	-	YES
Trichlorofluoromethane	-	-	-	-	X	-
Vanadium	X	-	-	-	-	-
Vinyl Chloride	-	-	-	-	-	YES
Xylene (total)	X	-	-	-	-	-
Zinc	-	X	-	-	-	-

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations.
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
[e] Maximum detected concentration lower than one-tenth the USEPA Region III tap water RBC.
- = Not eliminated through this criterion.

Table 6E-1
Identification Criteria for Surface Water COPECs at the West Unit (Million Gallon Hill)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	COPEC
1,2-Dichloroethane	-	-	-	-	YES
2-Methylnaphthalene	-	-	-	-	YES
2-Methylphenol(o-cresol)	-	-	-	-	YES
4,4'-DDD	-	-	-	-	YES
4,4'-DDE	-	-	-	-	YES
4,4'-DDT	X	-	-	-	-
4-Methylphenol(p-cresol)	-	-	-	-	YES
Aldrin	X	-	-	-	-
alpha-BHC	X	-	-	-	-
Arsenic	-	-	-	-	YES
Barium	-	-	-	-	YES
Benzene	-	-	-	-	YES
Benzoic acid	-	-	-	-	YES
Benzyl alcohol	-	-	-	-	YES
beta-BHC	-	-	-	-	YES
bis(2-Ethylhexyl)phthalate	X	-	-	-	-
Calcium	-	-	-	X	-
Cobalt	-	-	-	-	YES
delta-BHC	X	-	-	-	-
Endosulfan II	X	-	-	-	-
Endosulfan I	X	-	-	-	-
Endrin aldehyde	X	-	-	-	-
Ethylbenzene	-	-	-	-	YES
Fluoranthene	-	-	-	-	YES
Fluorene	-	-	-	-	YES
gamma-BHC	X	-	-	-	-

Table 6E-1
(Continued)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	COPEC
Heptachlor epoxide	-	-	-	-	YES
Heptachlor	X	-	-	-	-
Iron	-	-	-	X	-
Magnesium	-	-	-	X	-
Manganese	-	-	-	-	YES
Naphthalene	-	-	-	-	YES
Phenanthrene	-	-	-	-	YES
Phenol	-	-	-	-	YES
Potassium	-	-	-	X	-
Pyrene	-	-	-	-	YES
Sodium	-	-	-	X	-
Toluene	-	-	-	-	YES
Xylene (total)	-	-	-	-	YES
Zinc	-	-	-	-	YES

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
- = Not eliminated through this criterion.

Table 6E-2
Identification Criteria for Surface Water COPECs at the West Unit (Power Plant UST No. 49)

Chemical	Blanks Comparison [a]	Background Comparison [b]	Low Frequency [c]	Essential Nutrient [d]	COPEC
2-Methylnaphthalene	-	-	-	-	YES
4,4'-DDT	X	-	-	-	-
Aldrin	X	-	-	-	-
Antimony	-	-	-	-	YES
Arsenic	-	-	-	-	YES
Barium	-	-	-	-	YES
Benzoic acid	-	-	-	-	YES
Benzyl alcohol	-	-	-	-	YES
beta-BHC	-	-	-	-	YES
bis(2-Ethylhexyl)phthalate	X	-	-	-	-
Calcium	-	-	X	-	-
delta-BHC	-	-	-	-	YES
Dieldrin	X	-	-	-	-
Endosulfan II	X	-	-	-	-
Endosulfan I	X	-	-	-	-
Endrin aldehyde	X	-	-	-	-
Ethylbenzene	-	-	-	-	YES
Heptachlor	X	-	-	-	-
Heptachlor epoxide	X	-	-	-	-
Magnesium	-	-	X	-	-
Manganese	-	-	-	-	YES
Naphthalene	-	-	-	-	YES
Potassium	-	-	X	-	-
Sodium	-	-	X	-	-
Toluene	-	-	-	-	YES
Xylene (total)	-	-	-	-	YES

Table 6E-2
(Continued)

[a] Indistinguishable from blank concentrations.
[b] Not significantly elevated above background concentrations
[c] Detected at a frequency less than 5%.
[d] Estimated maximum daily intake less than the Recommended Dietary Allowance (RDA).
- = Not eliminated through this criterion.

Table 6F-1
Statistical Summary of Values Used in the Human Health Risk Assessment for Surface Soil at the West Unit (Waste Accumulation Area)

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
Metals					
Lead [a]	20/20	8.52e+02	1.01e+02	2.15e+02	**1.84e+02**
PNAs					
2-Methylnaphthalene [b]	1/6	2.10e-02	9.94e-03	7.68e-03	**1.63e-02**
Benz(a)anthracene	5/6	7.60e-01	2.31e-01	2.89e-01	**4.68e-01**
Benzo(a)pyrene	5/6	5.20e-01	2.09e-01	2.01e-01	**3.75e-01**
Benzo(b)fluoranthene	5/6	5.20e-01	2.25e-01	2.12e-01	**4.00e-01**
Benzo(g,h,i)perylene [b]	3/6	2.30e-01	1.29e-01	7.93e-02	**1.94e-01**
Dibenz(a,h)anthracene	3/6	1.70e-01	7.26e-02	6.33e-02	**1.25e-01**
Indeno(1,2,3-cd)pyrene	3/6	2.50e-01	1.02e-01	8.90e-02	**1.75e-01**
Phenanthrene [b]	4/6	7.70e-01	1.90e-01	2.97e-01	**6.53e-01**
Pesticides					
4,4'-DDE	25/26	1.95e+00	2.19e-01	4.46e-01	**3.49e-01**
4,4'-DDD	26/26	3.78e+01	2.13e+00	7.39e+00	**4.61e+00**
4,4'-DDT	25/25	8.19e+01	5.04e+00	1.64e+01	**6.17e+00**
Aldrin	6/26	6.20e-02	4.46e-03	1.32e-02	**8.89e-03**
Dieldrin	16/26	4.90e-01	8.64e-02	1.54e-01	**2.15e-01**
gamma-BHC	3/26	7.14e-02	3.62e-03	1.40e-02	**8.31e-03**
Heptachlor epoxide	9/26	1.05e-02	1.03e-03	2.14e-03	**1.41e-03**

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK Model was used to calculate risk from lead.
[b] No toxicity data available.

Table 6F-2
Statistical Summary of Values Used in the Human Health Risk Assessment for Surface Soil at the West Unit (Million Gallon Hill)

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
Metals					
Lead [a]	5/5	2.08e+03	4.25e+02	9.25e+02	**1.31e+03**
PNAs					
2-Methylnaphthalene [b]	2/5	4.10e-02	1.55e-02	1.64e-02	**3.11e-02**
Benz(a)anthracene	2/5	2.13e-01	7.09e-02	7.97e-02	**1.47e-01**
Benzo(a)pyrene	2/5	**3.21e-01**	8.64e-02	1.33e-01	3.43e-01
Benzo(g,h,i)perylene [b]	2/5	2.36e-01	6.83e-02	9.43e-02	**1.87e-01**
Benzo(b)fluoranthene	2/5	**7.17e-01**	1.62e-01	3.11e-01	3.70e+00
Indeno(1,2,3-cd)pyrene	2/5	2.60e-01	7.06e-02	1.06e-01	**1.72e-01**
Phenanthrene [b]	2/5	2.26e-01	9.54e-02	7.36e-02	**1.64e-01**

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK Model was used to calculate risk from lead.
[b] No toxicity data available.

Table 6F-3
Statistical Summary of Values Used in the Human Health Risk Assessment for Surface Soil at the West Unit (Power Plant UST No. 49)

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
Metals					
Aluminum	2/2	**1.10e+04**	1.04e+04	9.19e+02	1.45e+04
Beryllium	2/2	**2.80e-01**	2.65e-01	2.12e-02	3.60e-01
Lead [a]	4/4	**4.32e+01**	3.43e+01	1.49e+01	5.19e+01
Manganese (food)	2/2	**4.40e+02**	4.25e+02	2.12e+01	5.20e+02
PNAs					
2-Methylnaphthalene [b]	2/2	**2.40e+01**	1.21e+01	1.69e+01	8.74e+01
Pesticides					
alpha-BHC	1/1	**1.60e-02**	1.60e-02	0.00e+00	0.00e+00
Dieldrin	1/1	**8.80e-03**	8.80e-03	0.00e+00	0.00e+00
Semivolatiles					
2-Hexanone [b]	1/2	**1.40e+00**	1.24e+00	2.20e-01	2.23e+00

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK Model was used to calculate risk from lead.
[b] No toxicity data available.

Table 6F-4
Statistical Summary of Values Used in the Human Health Risk Assessment for Surface Soil at the West Unit (JP-4 Fillstands)

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
Metals					
Lead [a]	14/14	5.30e+01	2.65e+01	1.43e+01	**3.33e+01**
PNAs					
2-Methylnaphthalene [b]	7/14	7.50e-01	1.63e-01	2.36e-01	**4.84e-01**
Acenaphthylene	4/14	4.80e-01	9.03e-02	1.66e-01	**1.69e-01**
Benz(a)anthracene	10/14	1.40e+01	2.05e+00	5.06e+00	**4.45e+00**
Benzo(a)pyrene	11/14	1.30e+01	1.93e+00	4.69e+00	**3.61e+00**
Benzo(b)fluoranthene	11/14	1.30e+01	1.93e+00	4.69e+00	**5.05e+00**
Benzo(g,h,i)perylene [b]	11/14	6.70e+00	1.02e+00	2.41e+00	**2.16e+00**
Benzo(k)fluoranthene	11/14	1.30e+01	1.93e+00	4.69e+00	**4.15e+00**
Chrysene	11/14	1.60e+01	2.38e+00	5.77e+00	**4.50e+00**
Dibenz(a,h)anthracene	4/14	3.10e+00	4.81e-01	1.11e+00	**1.01e+00**
Indeno(1,2,3-cd)pyrene	10/14	6.60e+00	1.00e+00	2.37e+00	**1.77e+00**
Phenanthrene [b]	10/14	1.70e+01	2.47e+00	6.16e+00	**4.94e+00**
Pesticides					
4,4'-DDD	6/6	1.00e+00	4.51e-01	4.28e-01	**8.02e-01**
4,4'-DDE	6/6	5.00e-01	1.11e-01	1.93e-01	**3.73e-01**
4,4'-DDT	6/6	2.40e+00	7.40e-01	9.33e-01	**2.40e+00**
Semivolatiles					
Pentachlorophenol	2/14	1.20e+00	8.50e-01	2.68e-01	**9.77e-01**

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK Model was used to calculate risk from lead.
[b] No toxicity data available.

Table 6F-5
Statistical Summary of Values Used in the Human Health Risk Assessment for Surface Soil at the West Unit (Building 1700)

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
Metals					
Arsenic	3/3	**8.09e+00**	7.51e+00	5.75e-01	8.48e+00
Lead[a]	2/2	**7.68e+01**	4.75e+01	4.14e+01	2.32e+02
PNAs					
2-Methylnaphthalene[b]	1/1	**4.40e-02**	4.40e-02	0.00e+00	0.00e+00
Volatiles					
Benzene	1/1	**6.60e+00**	6.60e+00	0.00e+00	0.00e+00

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration. However, if the detection frequency is 1/1 and the 95% UCL equals zero, the maximum detected concentration was used in the risk assessment.

[a] USEPA IEUBK Model was used to calculate risk from lead.
[b] No toxicity data available.

Table 6G-1
Statistical Summary of Values Used in the Human Health Risk Assessment for Subsurface Soil at the West Unit (Waste Accumulation Area)

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
PNAs					
2-Methylnaphthalene [a]	1/5	4.30e-02	2.31e-02	1.23e-02	**3.48e-02**
Benzo(a) pyrene	1/5	2.60e-02	1.16e-02	8.85e-03	**2.01e-02**
Phenanthrene[a]	1/5	3.10e-02	1.44e-02	9.65e-03	**2.36e-02**

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] No toxicity data available.

Table 6G-2
Statistical Summary of Values Used in the Human Health Risk Assessment for Subsurface Soil at the West Unit (Million Gallon Hill)

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
PNAs					
2-Methylnaphthalene [a]	2/8	1.65e-01	4.84e-02	5.38e-02	**9.89e-02**
Acenaphthylene [a]	1/8	1.10e-02	5.57e-03	3.93e-03	**8.21e-03**
Benz(a)anthracene	2/8	1.20e-01	2.57e-02	3.84e-02	**4.12e-02**
Benzo(a)pyrene	3/8	3.60e-01	5.81e-02	1.22e-01	**1.24e-01**
Benzo(b)fluoranthene	3/8	4.70e-01	7.88e-02	1.60e-01	**2.78e-01**
Benzo(g,h,i)perylene [a]	1/8	1.00e-01	5.43e-02	3.22e-02	**7.59e-02**
Dibenz(h,h)anthracene	1/8	5.70e-02	3.13e-02	1.69e-02	**4.26e-02**
Indeno(1,2,3-cd)pyrene	2/8	1.20e-01	2.57e-02	3.84e-02	**4.12e-02**
Phenanthrene [a]	3/8	1.50e-01	3.20e-02	5.01e-02	**1.33e-01**

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] No toxicity data available.

Table 6G-3
Statistical Summary of Values Used in the Human Health Risk Assessment for Subsurface Soil at the West Unit (Power Plant UST No. 49)

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
Metals					
Aluminum	2/2	**9.90e+03**	9.50e+03	5.66e+02	1.20e+04
Arsenic	2/2	**1.00e+01**	9.30e+00	9.90e-01	1.37e+01
Beryllium	2/2	**3.10e-01**	3.00e-01	1.41e-02	3.63e-01
Lead [a]	2/2	**9.50e+00**	9.40e+00	1.41e-01	1.00e+01
Manganese	2/2	**3.70e+02**	3.40e+02	4.24e+01	5.29e+02
Pesticides					
alpha-BHC	1/2	**1.10e-02**	5.82e-03	7.33e-03	3.85e-02
Dieldrin	1/2	**1.20e-02**	1.18e-02	2.52e-04	1.29e-02
gamma-BHC	1/2	**5.00e-02**	2.68e-02	3.27e-02	1.73e-01
Heptachlor epoxide	2/2	**1.20e-02**	6.18e-03	8.23e-03	4.29e-02
PNA					
2-Methylnaphthalene [b]	1/2	**1.50e+01**	1.35e+01	2.08e+00	2.28e+01

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK model was used to calculate risk from lead.
[b] No toxicity data available.

Table 6G-4
Statistical Summary of Values Used in the Human Health Risk Assessment for Subsurface Soil at the West Unit (JP-4 Fillstands)

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
PNAs					
2-Methylnaphthalene[a]	9/16	1.30e+02	1.20e+01	3.29e+01	**2.64e+01**
Benzo(a)pyrene	5/16	3.80e-02	9.23e-03	1.08e-02	**2.27e-02**
Benzo(b)fluoranthene	5/16	9.90e-02	1.93e-02	2.29e-02	**2.93e-02**
Phenanthrene[a]	6/16	2.61e-01	4.51e-02	8.51e-02	**1.00e-01**
Pesticides					
4,4'-DDD	9/10	**2.90e-01**	8.37e-02	1.05e-01	1.41e+00
4,4'-DDT	9/10	**3.70e-01**	8.39e-02	1.20e-01	1.67e+00
Semi-Volatiles					
2-Hexanone[a]	1/17	1.20e-01	5.84e-02	3.40e-02	**7.27e-02**
Volatiles					
1,1,2,2-Tetrachloroethane	1/17	2.60e+00	1.11e+00	7.79e-01	**1.44e+00**
Benzene	7/17	6.60e+01	5.20e+00	1.61e+01	**1.20e+01**

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] No toxicity data available.

Table 6G-5
Statistical Summary of Values Used in the Human Health Risk Assessment for Subsurface Soil at the West Unit (Building 1845)

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
Metals					
Aluminum	2/2	**9.80e+03**	9.45e+03	4.95e+02	1.17e+04
Arsenic	2/2	**9.30e+00**	8.75e+00	7.78e-01	1.22e+01
Beryllium	2/2	**2.60e-01**	2.35e-01	3.54e-02	3.93e-01
Lead [a]	2/2	**8.10e+00**	7.40e+00	9.90e-01	1.18e+01
Manganese (food/dust)	2/2	**4.80e+02**	4.25e+02	7.78e+01	7.72e+02
Pesticides					
4,4'-DDT	2/2	**3.70e+00**	1.85e+00	2.61e+00	1.35e+01
4,4'-DDD	2/2	**1.00e+01**	5.00e+00	7.07e+00	3.66e+01
PNAs					
2-Methylnaphthalene [b]	1/2	**1.10e-01**	5.55e-02	7.70e-02	4.00e-01

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK model was used to calculate risk from lead.
[b] No toxicity data available.

Table 6G-6
Statistical Summary of Values Used in the Human Health Risk Assessment for Subsurface Soil at the West Unit (Building 1700)

Chemical Name	Detection Frequency	Max Detect mg/kg	Mean mg/kg	Standard Deviation	95% UCL mg/kg
Metals					
Arsenic	3/3	**8.23e+00**	6.36e+00	1.96e+00	9.66e+00
Lead [a]	3/3	**1.90e+01**	1.31e+01	7.95e+00	2.65e+01
PNAs					
2-Methylnaphthalene [b]	3/3	**5.67e+01**	3.05e+01	2.78e+01	7.73e+01
Phenanthrene [b]	2/3	**7.36e-01**	4.47e-01	3.72e-01	1.07e+00
Semi-Volatile					
bis(2-Ethylhexyl)phthalate	3/3	**2.29e+01**	8.89e+00	1.23e+01	2.95e+01
Volatile					
Benzene	3/3	**6.80e+01**	3.00e+01	3.47e+01	8.85e+01

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK model was used to calculate risk from lead.
[b] No toxicity data available.

Table 6H-1
Statistical Summary of Values Used in the Human Health Risk Assessment for Groundwater at the West Unit (Waste Accumulation Area)

Chemical Name	Detection Frequency	Max Detect mg/L	Mean mg/L	Standard Deviation	95% UCL mg/L
Pesticides					
alpha-BHC	1/4	1.73e-05	1.03e-05	4.90e-06	**1.62e-05**
Dieldrin	2/4	**9.10e-06**	6.20e-06	3.20e-06	9.90e-06
Heptachlor	1/4	2.50e-06	1.50e-06	9.00e-07	2.50e-06
Semi-volatile					
bis(2-Ethylhexyl)phthalate	2/4	**1.60e-03**	9.47e-04	7.16e-04	1.79e-03
Volatiles					
1,2-Dichloroethane	1/2	**1.18e-03**	9.44e-04	3.34e-04	2.44e-03
Benzene	2/2	**3.90e-04**	3.60e-04	4.24e-05	5.49e-04
Bromochloromethane [a]	1/1	**1.83e-02**	1.83e-02	0.00e+00	0.00e+00
Chloromethane	2/2	**6.80e-04**	3.85e-04	4.17e-04	2.25e-03
Dibromomethane [a]	1/2	**2.20e-04**	1.21e-04	1.40e-04	7.45e-04
Vinyl Chloride	1/2	**2.00e-05**	1.59e-05	5.80e-06	4.16e-05

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] No toxicity data available.

Table 6H-2
Statistical Summary of Values Used in the Human Health Risk Assessment for Groundwater at the West Unit (Million Gallon Hill)

Chemical Name	Detection Frequency	Max Detect mg/L	Mean mg/L	Standard Deviation	95% UCL mg/L
Metals					
Barium	22/22	1.10e+00	5.35e-01	3.10e-01	**6.49e-01**
Iron	19/22	1.30e+02	4.03e+01	4.40e+01	**5.64e+01**
Lead [a]	17/22	2.00e-02	5.00e-03	6.54e-03	**7.40e-03**
Pesticides					
4,4'-DDD	11/33	5.52e-04	2.57e-05	9.62e-05	**5.41e-05**
4,4'-DDE	9/33	7.91e-05	6.70e-06	1.69e-05	**1.16e-05**
4,4'-DDT	13/33	3.20e-05	5.80e-06	9.30e-06	**9.90e-06**
Aldrin	10/33	5.30e-05	4.70e-06	9.60e-06	**7.60e-06**
alpha-BHC	5/33	1.90e-04	1.39e-05	3.72e-05	**2.49e-05**
beta-BHC	8/33	1.50e-04	9.40e-06	2.85e-05	**1.78e-05**
Dieldrin	15/33	4.60e-05	7.60e-06	8.00e-06	**9.90e-06**
gamma-BHC	15/33	2.10e-04	1.85e-05	4.67e-05	**2.03e-05**
Heptachlor epoxide	20/33	2.70e-05	5.20e-06	6.90e-06	**7.30e-06**
Heptachlor	11/33	4.80e-05	4.90e-06	1.11e-05	**8.20e-06**
PNAs					
2-Methylnaphthalene	10/35	4.74e+00	2.73e-01	9.20e-01	**5.36e-01**
Naphthalene	11/35	2.57e+00	1.67e-01	5.11e-01	**3.13e-01**
Phenanthrene	6/35	3.84e-02	3.73e-03	7.42e-03	**5.85e-03**
Semi-volatiles					
2-Butanone (MEK)	2/10	3.36e-01	3.61e-02	1.05e-01	**9.72e-02**
4-Methylphenol(p-cresol)	3/25	1.60e-01	2.16e-02	3.05e-02	**2.93e-02**
bis(2-Ethylhexyl)phthalate	20/35	1.50e-02	2.74e-03	4.56e-03	**6.78e-03**
Dibenzofuran	3/35	2.77e-02	6.31e-03	5.33e-03	**8.95e-03**
Volatiles					
1,2-Dichloroethane	2/10	7.00e-04	1.25e-04	2.04e-04	**2.43e-04**
1,1-Dichloroethene	1/10	7.00e-05	4.30e-05	2.64e-05	**5.83e-05**
Acetone	10/10	7.56e-01	1.07e-01	2.44e-01	**2.49e-01**
Benzene	10/10	**3.38e+00**	4.11e-01	1.05e+00	7.73e+00
Bromochloromethane [b]	8/8	1.97e-02	1.69e-02	2.24e-03	**1.84e-02**
Chloromethane	3/10	4.80e-02	6.28e-03	1.53e-02	**1.51e-02**

Table 6H-2
(Continued)

Chemical Name	Detection Frequency	Max Detect mg/L	Mean mg/L	Standard Deviation	95% UCL mg/L
cis-1,2-Dichloroethene	5/10	2.80e-02	3.94e-03	8.74e-03	**1.71e-02**
Dibromomethane [b]	3/10	6.00e-02	8.11e-03	1.93e-02	**1.93e-02**
Ethylbenzene	6/10	3.61e-01	5.29e-02	1.13e-01	**1.18e-01**
Volatiles (cont.)					
Methylene chloride	10/10	6.00e-02	8.50e-03	1.93e-02	**1.97e-02**
Toluene	10/10	1.29e+00	1.33e-01	4.07e-01	**3.69e-01**
Trichloroethene	3/10	1.23e-02	1.37e-03	3.84e-03	**3.60e-03**
Vinyl Chloride	1/10	1.30e-04	8.63e-05	3.54e-05	**1.07e-04**
Xylene (total)	15/21	9.90e+00	9.45e-01	2.54e+00	**1.90e+00**

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK model was used to calculate risk from lead.
[b] No toxicity data available.

Table 6H-3
Statistical Summary of Values Used in the Human Health Risk Assessment for Groundwater at the West Unit (Power Plant UST No. 49)

Chemical Name	Detection Frequency	Max Detect mg/L	Mean mg/L	Standard Deviation	95% UCL mg/L
Metals					
Arsenic	1/2	**5.00e-03**	3.22e-03	2.51e-03	1.44e-02
Barium	2/2	**4.40e-01**	3.20e-01	1.70e-01	1.08e+00
Iron	1/2	**2.60e+00**	1.55e+00	1.48e+00	8.17e+00
Lead [a]	1/2	**1.80e-02**	1.31e-02	6.97e-03	4.42e-02
Manganese (water)	1/2	**3.00e+01**	2.14e+01	1.22e+01	7.58e+01
Pesticides					
4,4'-DDT	2/2	**2.10e-05**	1.60e-05	7.10e-06	4.76e-05
beta-BHC	2/2	**4.40e-05**	2.36e-05	2.89e-05	1.53e-04
Dieldrin	1/2	**9.40e-06**	7.40e-06	2.80e-06	1.99e-05
gamma-BHC	1/2	**4.90e-05**	4.07e-05	1.17e-05	9.29e-05

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK model was used to calculate risk from lead.

Table 6H-4
Statistical Summary of Values Used in the Human Health Risk Assessment for Groundwater at the West Unit (JP-4 Fillstands)

Chemical Name	Detection Frequency	Max Detect mg/L	Mean mg/L	Standard Deviation	95% UCL mg/L
Metals					
Arsenic	5/7	4.22e-02	1.73e-02	1.72e-02	**2.99e-02**
Lead [a]	7/7	2.00e-02	5.93e-03	7.33e-03	**1.13e-02**
Iron	7/7	1.50e+02	5.28e+01	5.59e+01	**9.39e+01**
Barium	7/7	9.40e-01	6.10e-01	2.69e-01	**8.07e-01**
Pesticides					
Aldrin	2/8	1.73e-05	1.09e-05	6.00e-06	**1.49e-05**
Heptachlor epoxide	4/8	5.10e-06	3.20e-06	1.70e-06	**4.30e-06**
Heptachlor	4/8	8.20e-06	1.70e-06	3.00e-06	**3.70e-06**
alpha-BHC	1/8	2.20e-05	1.58e-05	3.50e-06	**1.81e-05**
beta-BHC	4/8	4.30e-05	2.46e-05	1.34e-05	**3.36e-05**
gamma-BHC	2/8	1.91e-05	6.10e-06	5.50e-06	**9.80e-06**
PNAs					
2-Methylnaphthalene	2/9	4.60e-02	7.94e-03	1.44e-02	**1.35e-02**
Naphthalene	4/9	8.50e-02	1.14e-02	2.80e-02	**2.88e-02**
Semi-volatile					
bis(2-Ethylhexyl)phthalate	5/9	1.84e-01	2.17e-02	6.09e-02	**5.94e-02**
Volatiles					
1,2-Dichloroethane	1/2	**4.30e-04**	3.60e-04	9.92e-05	8.03e-04
Trichloroethene	1/2	**1.51e-03**	1.36e-03	2.07e-04	2.29e-03
Bromochloromethane [b]	4/4	1.96e-02	1.76e-02	1.56e-03	**1.94e-02**
Benzene	2/2	**8.29e-02**	4.16e-02	5.84e-02	3.02e-01

Bold numbers indicate the value used in the risk assessment, which was the lower of either the UCL or the maximum detected concentration.

[a] USEPA IEUBK model was used to calculate risk from lead.
[b] No toxicity data available.

Table 6H-5
Statistical Summary of Values Used in the Human Health Risk Assessment for Groundwater at the West Unit (Building 1845)

Chemical Name	Detection Frequency	Max Detect mg/L	Mean mg/L	Standard Deviation	95% UCL mg/L
Metals					
Arsenic	4/6	1.32e-02	7.52e-03	3.75e-03	**1.06e-02**
Cadmium (water)	4/7	8.40e-03	3.32e-03	2.94e-03	**5.48e-03**
Lead [a]	7/7	1.70e-02	8.41e-03	5.73e-03	**1.26e-02**
Pesticides					
4,4'-DDD	5/9	3.10e-03	3.79e-04	1.02e-03	**2.57e-03**
4,4'-DDE	6/9	1.60e-04	2.26e-05	5.20e-05	**5.29e-05**
4,4'-DDT	8/9	5.60e-04	1.01e-04	1.88e-04	**2.00e-04**
Aldrin	4/9	6.13e-05	9.20e-06	1.97e-05	**4.74e-05**
alpha-BHC	4/9	4.41e-05	9.20e-06	1.34e-05	**1.54e-05**
beta-BHC	2/9	2.84e-04	6.61e-05	8.49e-05	**1.18e-04**
Dieldrin	4/9	3.44e-05	7.80e-06	1.18e-05	**1.99e-05**
gamma-BHC	5/9	1.11e-04	2.15e-05	3.42e-05	**3.34e-05**
Heptachlor epoxide	2/9	2.57e-05	7.60e-06	7.30e-06	**1.70e-05**
Heptachlor	3/9	4.67e-05	5.50e-06	1.54e-05	**1.51e-05**
PNA					
Phenanthrene	1/10	6.90e-04	3.93e-04	2.22e-04	**5.21e-04**
Semi-volatile					
bis(2-Ethylhexyl)phthalate	6/10	1.60e-01	1.78e-02	5.00e-02	**2.16e-02**
Volatiles					
1,2-Dichloroethane	4/4	**1.18e-03**	9.95e-04	1.87e-04	1.22e-03
1,1-Dichloroethene	2/4	**5.65e-03**	1.50e-03	2.77e-03	1.05e-02
1,1,2-Trichloroethane	1/4	**1.26e-03**	9.23e-04	5.75e-04	1.60e-03
Benzene	3/4	**6.40e-04**	2.05e-04	2.91e-04	7.93e-04
Bromochloromethane [b]	3/3	**2.13e+00**	7.22e-01	1.22e+00	5.41e+01
Chloroform	2/4	**1.96e-03**	5.84e-04	9.20e-04	3.15e-03
Chloromethane	2/4	5.30e-04	2.47e-04	2.27e-04	**5.14e-04**
cis-1,2-Dichloroethene	2/4	2.66e+00	6.65e-01	1.33e+00	**2.23e+00**
Tetrachloroethene	1/4	3.30e-04	1.69e-04	1.28e-04	**3.20e-04**
trans-1,2-Dichloroethene	1/4	**1.85e-01**	1.25e-01	6.28e-02	1.99e-01
Trichloroethene	3/4	**7.55e+00**	1.91e+00	3.76e+00	5.70e+02
Vinyl Chloride	1/4	7.60e-04	4.22e-04	2.74e-04	**7.44e-04**

Bold numbers indicate the value used in the risk assessment, which was lower of either the UCL or themaximum detected concentration.

[a] USEPA IEUBK model was used to calculate risk from lead.
[b] No toxicity data available.

Table 6I-1
Summary of Statistical Values Used in the Ecological Risk Assessment for Surface Soils at the Waste Accumulation Area

Chemical Name	Detection Frequency	Max Detect (mg/kg)	Mean (mg/kg)	Standard Deviation	UCL (mg/kg)
2-Methylnaphthalene	1/6	0.021	0.010	0.008	0.016
4,4'-DDD	26/26	37.8	2.133	7.391	4.610
4,4'-DDE	25/26	1.95	0.219	0.446	0.349
4,4'-DDT	25/25	81.9	5.037	16.352	6.167
Acenaphthene	1/6	0.045	0.035	0.011	0.043
Aldrin	6/26	0.062	0.004	0.013	0.009
Anthracene	4/6	0.25	0.063	0.098	0.502
Benz(a)anthracene	5/6	0.76	0.231	0.289	0.468
Benzo(a)pyrene	5/6	0.52	0.209	0.201	0.375
Benzo(b)fluoranthene	5/6	0.52	0.225	0.212	0.400
Benzo(g,h,i)perylene	3/6	0.23	0.129	0.079	0.194
Benzo(k)fluoranthene	5/6	0.52	0.217	0.226	0.403
Benzoic acid	1/6	0.078	0.044	0.030	0.068
Cadmium	4/6	0.51	0.310	0.221	0.491
Chrysene	5/6	0.91	0.288	0.338	0.566
Dibenz(a,h)anthracene	3/6	0.17	0.073	0.063	0.125
Dieldrin	16/26	0.49	0.086	0.154	0.215
Endosulfan I	8/26	0.036	0.003	0.008	0.005
Endosulfan II	4/26	0.01	0.001	0.001	0.001
Endosulfan sulfate	5/26	0.01	0.001	0.001	0.002
Endrin	13/26	0.199	0.011	0.039	0.024
Endrin aldehyde	12/26	0	0.001	0.001	0.001
Fluoranthene	5/6	1.4	0.377	0.542	1.320
Fluorene	1/6	0.042	0.022	0.016	0.036
Heptachlor	10/26	0	0.000	0.000	0.000
Heptachlor epoxide	9/26	0.011	0.001	0.002	0.001
Indeno(1,2,3-cd)pyrene	3/6	0.25	0.102	0.089	0.175
Lead	20/20	852	100.910	215.307	184.200
Methoxychlor	4/26	0.01	0.001	0.002	0.002
Naphthalene	1/6	0.012	0.004	0.005	0.008
Phenanthrene	4/6	0.77	0.190	0.297	0.653

Table 6I-1
(Continued)

Chemical Name	Detection Frequency	Max Detect (mg/kg)	Mean (mg/kg)	Standard Deviation	UCL (mg/kg)
Pyrene	5/6	1.3	0.396	0.508	0.814
bis(2-Ethylhexyl)phthalate	6/6	1.6	0.361	0.609	0.861
gamma-BHC	3/26	0.071	0.004	0.014	0.008

Table 6I-2
Summary of Statistical Values Used in the Ecological Risk Assessment for Surface Soils at the West Unit (Million Gallon Hill)

Chemical Name	Detection Frequency	Mean (mg/kg)	Standard Deviation	UCL (mg/kg)	Max Detect (mg/kg)
2-Methylnaphthalene	2/5	0.016	0.016	0.031	0.041
4,4'-DDD	4/4	0.0368	0.015	0.054	0.046
4,4'-DDE	4/4	0.0094	0.0047	0.015	0.014
4,4'-DDT	4/4	0.0743	0.056	0.14	0.15
4-Methyl-2-Pentanone (MIBK)	1/6	0.00098	0.0005	0.0014	0.0017
Acenaphthene	1/5	0.0068	0.007	0.014	0.0187
Anthracene	1/5	0.0277	0.022	0.049	0.0609
Benz(a)anthracene	2/5	0.071	0.08	0.147	0.213
Benzo(a)pyrene	2/5	0.086	0.132	0.343	0.321
Benzo(b)fluoranthene	2/5	0.161	0.31	3.7	0.717
Benzo(g,h,i)perylene	2/5	0.068	0.094	0.187	0.236
Benzo(k)fluoranthene	2/5	0.161	0.31	0.51	0.717
Chrysene	2/5	0.109	0.16	0.38	0.396
Dibenzofuran	1/5	0.011	0.002	0.013	0.0146
Dibutyl phthalate	1/5	0.019	0.0087	0.028	0.0266
Dieldrin	1/4	0.00094	0.0005	0.0015	0.0013
Endosulfan I	1/4	0.0016	0.0003	0.002	0.0018
Endosulfan sulfate	3/4	0.0036	0.00298	0.007	0.0074
Endrin aldehyde	3/4	0.00062	0.0007	0.0015	0.0017
Fluoranthene	2/5	0.139	0.152	0.54	0.403
Fluorene	1/5	0.011	0.006	0.017	0.0166
Heptachlor	3/4	0.0007	0.0009	0.0017	0.0018
Indeno(1,2,3-cd)pyrene	2/5	0.071	0.106	0.17	0.26
Lead	5/5	424.8	925.29	1307	2080
Methoxychlor	1/4	0.000053	0	0	0.00008
Methylene chloride	4/6	0.014	0.0199	0.03	0.054
Naphthalene	1/5	0.017	0.0059	0.022	0.021
Phenanthrene	2/5	0.095	0.074	0.164	0.226
Pyrene	1/5	0.302	0.129	0.424	0.435
alpha-BHC	2/4	0.00087	0.0004	0.0013	0.0013
beta-BHC	2/4	0.00107	0.0016	0.0029	0.0034

Table 6I-2
(Continued)

Chemical Name	Detection Frequency	Mean (mg/kg)	Standard Deviation	UCL (mg/kg)	Max Detect (mg/kg)
bis(2-Ethylhexyl)phthalate	1/5	0.1005	0.033	0.131	0.129
gamma-BHC	3/4	0.001	0.0007	0.0019	0.0017

Table 6I-3
Summary of Statistical Values Used in the Ecological Risk Assessment for Surface Water at the West Unit

Chemical Name	Sample No. O6-SW-01-01 (mg/kg)	Sample No. O6-SW-02-01 (mg/kg)	Max Detect (mg/kg)
1,2-Dichloroethane		0.00042	0.00042
2-Methylnaphthalene	0.0019	0.07	0.07
2-Methylphenol		0.022	0.022
4,4'-DDD		0.00025	0.00025
4,4'-DDE		0.000023	0.000023
4-Methylphenol (p-cresol)		0.09	0.09
Antimony	0.11		0.11
Arsenic	0.0049	0.016	0.016
Barium	0.32	0.4	0.4
Benzene		0.076	0.076
Benzoic acid	0.0082	0.068	0.068
Benzyl alcohol	0.0019	0.0075	0.0075
beta-BHC	0.000027	0.00003	0.00003
Cobalt		0.016	0.016
delta-BHC	0.000031		0.000031
Ethylbenzene	0.00036	0.003	0.00036
Fluoranthene		0.00018	0.00018
Fluorene		0.0034	0.0034
Heptachlor epoxide		0.00043	0.00043
Manganese	3.2	6	6
Naphthalene	0.0017	0.049	0.049
Phenanthrene		0.0013	0.0013
Phenol		0.053	0.053
Pyrene		0.00021	0.00021

Table 6I-3
(Continued)

Chemical Name	Sample No. O6-SW-01-01 (mg/kg)	Sample No. O6-SW-02-01 (mg/kg)	Max Detect (mg/kg)
Toluene	0.0011	0.06	0.06
Xylenes (total)	0.0087	0.057	0.057
Zinc		0.02	0.02

Note: Samples identified in USAF 1995c.

Table 6I-4
Summary of Statistical Values Used in the Ecological Risk Assessment for Sediment at the West Unit

Chemical Name	Sample No. O6-SD-01-01 (mg/kg)	Sample No. O6-SD-02-01 (mg/kg)	Max Detect (mg/kg)
2-Hexanone	1.4		1.4
2-Methylnaphthalene	24		24
4,4'-DDD	0.057	0.046	0.057
4,4'-DDE	0.017	0.005	0.017
4,4'-DDT		0.018	0.018
4-Methyl-2-pentanone		0.00054	0.00054
Acenaphthalene		0.0051	0.0051
Acetone		0.0023	0.0023
alpha-BHC	0.016	0.00041	0.016
Aluminum	11000	8200	11000
Anthracene		0.0067	0.0067
Arsenic	11	8.7	11
Barium	200	160	200
Benzo(a)anthracene		0.039	0.039
Benzene		0.00045	0.00045
Benzo(a)pyrene		0.0079	0.0079
Benzo(b)fluoranthene		0.033	0.033
Benzo(g,h,i)perylene		0.029	0.029
Benzo(k)fluoranthene		0.013	0.013
Beryllium	0.28	0.21	0.28
bis(2-Ethylhexyl)phthalate		0.12	0.12
Chromium	24	18	24
Chrysene		0.019	0.019

Table 6I-4
(Continued)

Chemical Name	Sample No. O6-SD-01-01 (mg/kg)	Sample No. O6-SD-02-01 (mg/kg)	Max Detect (mg/kg)
Cobalt	13	10	13
Copper	31	21	31
Dibenzofuran		0.012	0.012
Dibutyl phthalate		0.026	0.026
Dieldrin	0.0088	0.001	0.0088
Endosulfan II	0.031	0.00097	0.031
Endrin aldehyde		0.00023	0.00023
Ethylbenzene	0.35		0.35
Fluoranthene		0.09	0.09
Fluorene	2.6	0.013	2.6
gamma-BHC	0.015	0.00086	0.015
Heptachlor	0.0016	0.000018	0.0016
Heptachlor epoxide	0.0012	0.000048	0.0012
Indeno(1,2,3-cd)pyrene		0.022	0.022
Iron	23000	18000	23000
Lead	12	10	12
Manganese	440	360	440
Mercury		0.074	0.074
Methoxychlor		0.000078	0.000078
Methylene chloride		0.0031	0.0031
Molybdenum	5		5
Naphthalene	10	0.021	10
Nickel	30	23	30

Table 6I-4
(Continued)

Chemical Name	Sample No. O6-SD-01-01 (mg/kg)	Sample No. O6-SD-02-01 (mg/kg)	Max Detect (mg/kg)
Phenanthrene		0.047	0.047
Pyrene		0.11	0.11
Toluene	1	0.00085	1
Vanadium	38	29	38
Xylenes (total)	5.8		5.8
Zinc	86	66	86

Note: Samples identified in USAF 1995c.

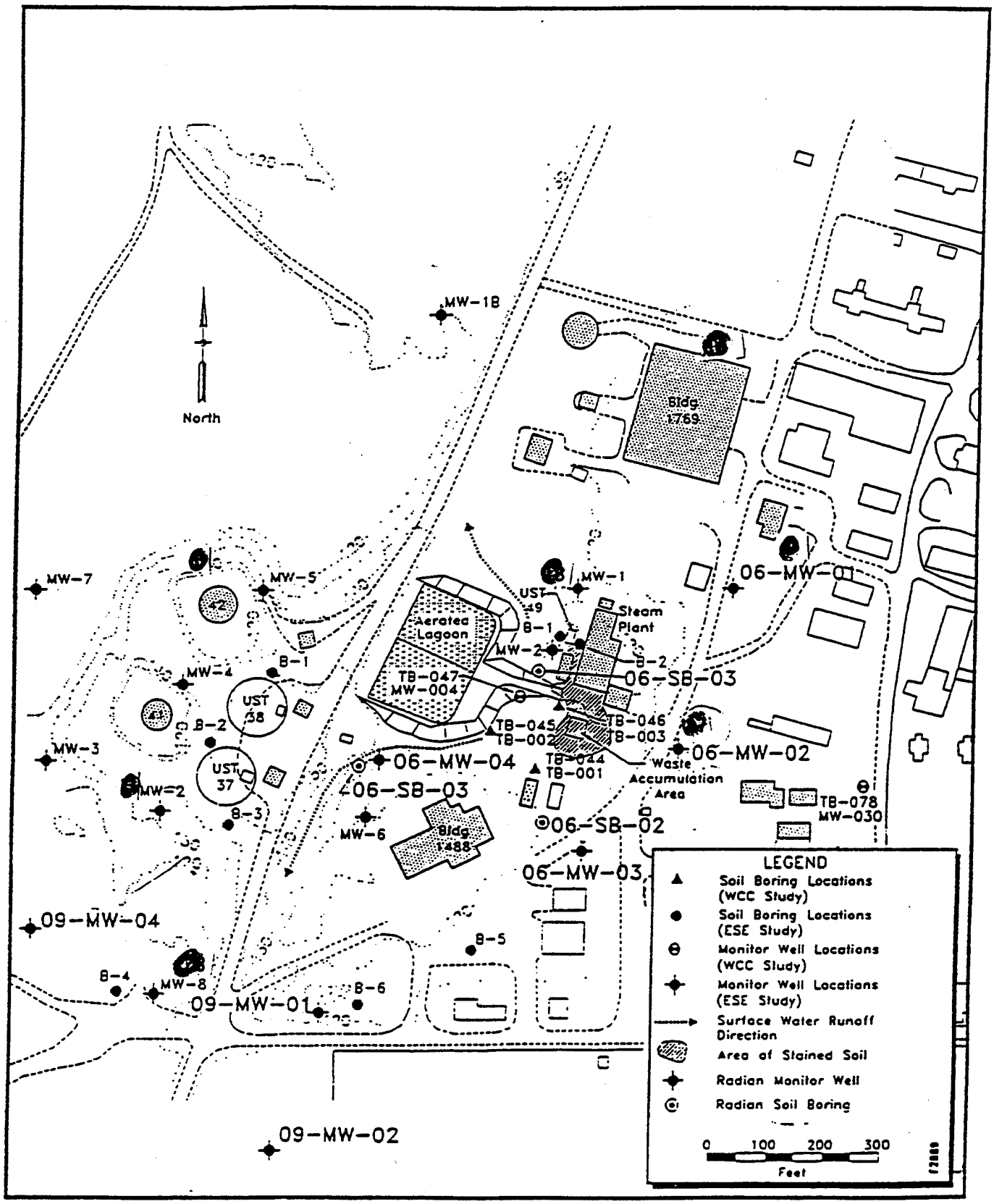


Figure 6A-1. Approximate Air Ssample Locations in the West Unit (USAF, 1994b)

Section 7
COMBINED IMPACTS

The POL Tank Farm and the West Unit are located adjacent to each other on the west side of the installation. The FPTA is less than two miles away on the east side of the installation. Additive impacts are considered in Section 7.1 for the human health assessment and in Section 7.2 for the ecological assessment.

7.1 Human Health Assessment

For the human health assessment, combined impacts of individual exposure scenarios and individual sites are evaluated.

7.1.1 Exposure Scenario Combinations

Combinations of exposure pathways make up a defined exposure scenario. It is sometimes possible that one individual can be exposed to site-related contaminants by the pathways represented in more than one exposure scenario. Exposure scenario combinations that are possible and were addressed include the following:

1. Child and adult Galena resident (to represent an individual who is born in Galena and continues to live there through adulthood);

2. On-base resident and on-base worker (to represent an individual who lives and works on base); and

3. Construction workers at individual sites (to represent construction workers who work at more than one site during different time periods).

Child and Adult Galena Resident

If the child scenario is added to the adult scenario for Galena residents, the average case represents an individual born in Galena who resides there for 31 years (6 + 25 years) and the reasonable maximum case represents a 76 year exposure duration (6 + 70 years). Combined child plus adult scenario cancer risk estimates for Old Town Galena residents are as follows:

	Average	Reasonable Maximum
FPTA	7E-10	2E-09
POL Tank Farm	6E-08	2E-07
West Unit	1E-08	3E-08

These risk estimates are well below levels of concern. Combined noncancer hazard indices are also well below levels of concern. Combined risk estimates for New Town Galena residents are lower than those for Old Town Galena.

On-Base Resident and On-Base Worker—It is likely that many on-base residents also work on-base. Adding the risks estimated for the on-base resident to that estimated for the on-base worker will overstate the risks for the resident who works on base because it is assumed that the resident is exposed for 24 hours/day to contaminants in the air medium at the location of the residences. However, because the estimated risks for the long-term on-base resident are several orders of magnitude lower than the estimated risks for the long-term on-base worker at all three sites, combined risk estimates are the same as the estimated risks for the worker.

Construction Workers—Combined cancer risk estimates for a construction worker who works at each of the three sites during different time periods total 7E-05 for the average case (which assumes a 3 month construction

project at each site) and 1E-04 for the reasonable maximum case (which assumes a 6 month construction project at each site). Estimated cancer risks for the construction worker at the FPTA and the West Unit are at least an order of magnitude lower than those estimated at the POL Tank Farm; therefore, the combined risks are essentially the same as the POL Tank Farm estimates. Combined noncancer hazard indices do not exceed 1.

7.1.2 Site Combinations

Media that might receive contributions of contaminants from the different sites at the same location include ambient air, groundwater, and surface water in the Yukon River.

Ambient Air—Each of the three sites contributes volatile and dust emissions to the air that were modeled to residential and boarding school student receptor locations. Risk estimates for the individual sites considered only the contribution of that site. Estimated combined cancer risks from inhaling contaminants in the ambient air from all three sites are as follows:

	Average	Reasonable Maximum
Short-term On-Base Resident (adult)	5E-08	1E-07
Long-term On-Base Resident (adult)	2E-07	7E-07
Old Town Galena Resident (adult)	6E-08	2E-07
New Town Galena Resident (adult)	4E-09	2E-08
Boarding School Student (student)	4E-07	1E-06

Combined cancer risks for the air pathway remain lower than 1 in one million for all residential scenarios and was equal to 1 in one million in the reasonable maximum case for the boarding school student scenario. However, this risk estimate is based almost entirely (98%) on exposure at the POL Tank Farm. Combined hazard indices for the air pathway for all scenarios remain lower than 1. Air pathway estimates for the worker scenarios were not combined; presumably the ambient air directly above a site is more heavily impacted by emissions to the air from that site than it is by emissions from a more distant site.

Groundwater—Several of the groundwater contaminant plumes from source areas within the West Unit have commingled and groundwater modeling considered the contribution of each source together (e.g., groundwater at the Waste Accumulation Area and Power Plant UST No. 49). However, it is unlikely that groundwater plumes from the FPTA, the POL Tank Farm, and the West Unit will commingle to any great extent before discharging to the Yukon River. Commingling of groundwater plumes from the West Unit and POL Tank Farm might occur but it is unlikely to significantly increase groundwater concentrations at any one location. Even if the plumes do commingle, the implications to identified receptors are minimal. There are no existing wells in areas downgradient of the West Unit and POL Tank Farm, nor are there likely to be wells installed in the future that draw from the shallow groundwater. Therefore, the combined impact of the three sites on groundwater quality is not evaluated.

Surface Water—Groundwater that flows under each of the sites discharges to the Yukon River. It is possible that discharges that occur at an upstream site will commingle with the discharges from other sites. The modeling that was performed takes additive impacts into account. Concentrations that are predicted in the river include the contribution of the individual site plus the contribution of upstream sites or

source areas. For example, the estimated concentrations in the river attributed to the Million Gallon Hill source area in the West Unit actually include the contributions of other source areas in the West Unit, the POL Tank Farm, and the FPTA. Consequently, additive impacts on the surface water in the river and uptake by fish have already been addressed.

7.2 Ecological Assessment

Combined impacts for ecological receptors may occur in two ways: through exposures to a receptor by more than one pathway (e.g., ingestion of soils and ingestion of food items) and/or through exposures of a receptor to contaminants at more than one IRP site.

7.2.1 Combined Pathways

Exposures to trophic exposure pathways are evaluated on a site specific basis for the FPTA, POL Tank Farm, and the West Unit in Sections 4.4, 5.4, and 6.4, respectively. Results of these assessments are summarized here and exposures from multiple sites is also detailed.

FPTA—For the FPTA, EQs were derived that considered multiple pathways for the kestrel (ingestion of soil and savannah sparrows), red fox (ingestion of soil and meadow voles), meadow vole (ingestion of soil and plants), savannah sparrow (ingestion of soil and invertebrates), and spotted sandpiper (ingestion of water and invertebrates). The relative contribution of each pathway for each species is shown in Tables 4-25 and 4-26. One primary pathway of exposure was considered for terrestrial plants (exposure to soils), terrestrial and aquatic invertebrates (exposure to soils and surface waters, respectively), and the northern pike (exposure to surface water). Thus, combining pathways was applicable for these species.

No potential risks were obtained for FPTA plants and terrestrial invertebrates, and for higher trophic level consumers such as the red fox and the kestrel. Through evaluation of the toxicity data and physical properties of the contaminants with EQs above 1 in the context of the FPTA, it was determined that only dioxin and fluorene have potential for risk to the meadow vole. Dioxin had an EQ in the possible risk range ($1 < EQ < 10$), and fluorene had an EQ in the probable risk range ($EQ > 10$). The potential risk from dioxin was primarily from soil ingestion (93.9 percent); the potential risk from fluorene was primarily from ingestion of food (plants, 85.9 percent). After consideration of toxic and physical properties for contaminants with EQs above 1 for the savannah sparrow, it was determined that only DDT, its breakdown products, and dioxin showed potential for risk. DDT and its breakdown products were in the probable risk range, and dioxin was in the possible risk range. Potential risk from all of these chemicals was primarily from consumption of food (97.7% contribution to total EQ from invertebrates).

For the aquatic and semiaquatic pathways, no potential risks were obtained for the pike. Aquatic invertebrates were evaluated with AWQCs for the protection of aquatic life and EQs in the possible risk range were derived for dieldrin, heptachlor epoxide, and lead. An EQ in the probable risk range was derived for DDT. For the spotted sandpiper, an EQ was derived that estimated the potential for risk from exposure to contaminants from the ingestion of groundwater discharged at the Yukon River mudflats and food ingestion pathways. The percent contribution of each of these pathways to this EQ is presented in Table 4-25. DDT exhibited probable risk to the sandpiper with 99% contribution from the food ingestion pathway. Lead exhibited possible risk with 72.3% contribution from the water ingestion pathway.

It should be noted that pesticides (DDT, dieldrin, and heptachlor epoxide) were historically broadcast throughout the Airport for pest control, and therefore, the FPTA does not represent an isolated area of high concentrations.

POL Tank Farm—Combined pathways were used to assess risk for the spotted sandpiper from potential POL Tank Farm groundwater discharge to surface waters of the Yukon River. The relative contributions of potential risks due to water ingestion and aquatic invertebrate ingestion are presented in Table 5-22. Single pathways were used to evaluate impacts to aquatic invertebrates and the northern pike because only risk from exposure to groundwater discharge was considered important.

Toxic, chemical, and physical effects in the context of the Yukon River for those chemicals with EQs greater than 1 were evaluated for all assessment endpoints. For the northern pike, no significant potential for risk from POL Tank Farm groundwater discharge was determined. Chemicals that were considered to pose potential risk to aquatic invertebrates and the spotted sandpiper were DDT, 2-methylnaphthalene, lead, and thallium. DDT, 2-methylnaphthalene, and thallium exhibited EQs in the probable risk range, whereas the EQ for lead was in the possible risk range. For the spotted sandpiper, these EQs combined effects from ingestion of surface waters and aquatic invertebrates. Table 5-22 shows that potential risks were primarily due to ingestion of invertebrates, except for thallium and lead where ingestion of surface water was the primary pathway.

Organochlorine pesticides historically were used over the entire Airport for insect control and the POL Tank Farm does not represent a unique area of contamination. Dilution and adsorption to sediments can attenuate the assessment endpoint species' exposure to lead and thallium. On the basis of the transient nature of the mudflats as an ecosystem, and the dilution of the constituents as they enter surface water, the population impacts of groundwater from the POL Tank Farm at the mudflats is minimal.

West Unit—Combined pathways for the West Unit were used to assess risk for the Waste Accumulation Area, Million Gallon Hill, Building 1845, and JP-4 Fillstands groundwater discharge impacts to the spotted sandpiper at the Yukon River mudflats. The contributions to potential risks due to water ingestion and aquatic invertebrate ingestion were combined in the EQ evaluation (Table 6-26). Single pathways were considered for assessment of impacts to aquatic invertebrates and the northern pike because only risk from exposure to groundwater discharge was considered important for evaluation.

No chemicals were found to pose significant risk to northern pike in the Yukon River. After consideration of toxic and physical properties for contaminants with EQs above 1 (Table 6-25), only dieldrin for aquatic invertebrates and DDT for both invertebrates and the spotted sandpiper were shown to have significant potential for posing risk in the Yukon River mudflats from groundwater originating from the Waste Accumulation Area. The EQ for dieldrin was in the possible risk category and the EQs for DDT were in the probable risk category. The combined impacts of water ingestion and invertebrate ingestion were assessed for the spotted sandpiper. Table 6-30 shows that 99% of the potential risk was from ingestion of invertebrates. This assessment shows potential for risk to these pesticides. However, the pesticides originating from the Waste Accumulation Area do not represent high concentrations relative to the Galena area in general because such chemicals were historically applied for pest control.

Contaminants shown to have significant potential for risk to aquatic invertebrates and the spotted sandpiper at Million Gallon Hill are DDT, DDE, and DDD. The assessment of potential risk for these chemicals for the sandpiper included evaluation of ingestion of surface water and ingestion of aquatic invertebrates. Table 6-30 shows that 99% of the potential risk was from ingestion of invertebrates. Consideration of toxic and physical properties for other Million Gallon Hill contaminants with EQs above 1 (Table 6-25) indicates that these chemicals are not likely to pose significant risk to assessment endpoints at the Yukon River mudflats.

Organochlorine pesticides from Bldg. 1845 and the JP-4 Fillstands groundwater potentially pose significant risk to aquatic invertebrates and the spotted sandpiper at the Yukon River mudflats. For the aquatic invertebrates, DDT, DDE, DDD, aldrin, dieldrin, endrin aldehyde, and heptachlor epoxide are pesticides with EQs above 1 for groundwater discharge from Bldg. 1845, and for the JP-4 Fillstands, DDT, DDD, aldrin, and endrin aldehyde are groundwater discharge chemicals with EQs above 1. For the spotted sandpiper, DDD, DDE, and DDT, are pesticides with EQs above 1 for groundwater discharge from Bldg. 1845, and for the JP-4 Fillstands, DDT, DDD, are groundwater discharge chemicals with EQs above 1. The assessment of potential risk for these chemicals for the sandpiper included evaluation of ingestion of surface water and ingestion of aquatic invertebrates. Table 6-30 shows that 99% of the potential risk form pesticides was from ingestion of invertebrates. Consideration of toxic and physical properties for other Million Gallon Hill contaminants with EQs above 1(Table 6-25) indicates that these chemicals are not likely to pose significant risk to assessment endpoints at the Yukon River mudflats.

The only areas of the West Unit with potential for terrestrial impacts (population survivorship and productivity) were the Waste Accumulation Area and Million Gallon Hill. In each of these areas, EQs were derived that considered multiple pathways for the kestrel (ingestion of soil, water, and robins), fox (ingestion of soil, water, and meadow voles), meadow vole (ingestion of soil, water, and plants), and robin (ingestion of soil, water, and invertebrates). The relative contribution of each pathway is given in Table 6-28. One primary pathway of exposure was considered for terrestrial plants (exposure to soils) and terrestrial invertebrates (exposure to soils).

In both of these terrestrial areas of the West Unit, EQs for DDD, DDE, and DDT were above 1 for the robin. DDT had an EQ of 1.08 in the kestrel from the waste accumulation area, but this was the only risk determined for the kestrel, an upper trophic level receptor. Also in the Waste Accumulation Area, an EQ of 10.4 was calculated for gamma-BHC in the terrestrial invertebrate.

7.2.2 Site Combinations

Sites with multiple source areas, such as the Galena Airport, have the potential for receptor exposure to more than one source area. Sections 4.4, 5.4, and 6.4,4 estimate the potential for risk to assessment endpoints at individual IRP sites. As described above, risk due to combinations of pathways have been considered in these estimates. This section estimates the potential for combined risk for receptor exposure to multiple sites.

For ecological receptors, the primary factors that affect exposure to multiple source areas are home range (mobility) and habitat availability. For most soil and sediment invertebrates and plants, multiple site exposure is precluded due to relative immobility. Species

with relatively small home ranges are less likely to encounter multiple sites than are species with large home ranges. Moreover, even if home range size makes it possible for encounters of multiple sites, when the appropriate habitat is not available, it is not likely that multiple exposures will occur. The potential for multiple exposures was evaluated for the assessment endpoints at each IRP source area and is summarized below.

The FPTA is approximately 1.5 miles from the terrestrial ecological areas of concern at the West Unit (Waste Accumulation Area and Million Gallon Hill). For terrestrial receptors all species except the fox and the kestrel have home ranges that would preclude frequent encounters with both the West Unit sites and the FPTA. The kestrel has a home range of approximately 499 acres (Appendix I), and the home range for the fox is approximately 1771 acres (Appendix I). Thus, strictly evaluating home range size indicates that these species easily would have access to any area of the Airport, assuming the center of their home range was within the Airport or near the Airport.

Available habitat for these two species is of better quality at the FPTA than at the West Unit. The FPTA is located in the large grasslands that surround the eastern runway areas, and there are areas of trees and shrubs along the perimeter dike to the north, east, and south. The dike area provides cover, nesting, and foraging sites for the fox. The dike provides cover and nesting sites for the kestrel. The grassland areas and edges of the wooded areas are good foraging areas for both species, although less so when the grasses are mowed frequently. These same habitat types are found at the Waste Accumulation Area, but Million Gallon Hill contains only wooded slopes and cleared, formerly wooded areas at the base of the hill that will presumably returned to wooded areas as taiga wetland. Thus, Million Gallon Hill offers little habitat for the kestrel because there are no open vegetated areas (e.g., grasslands) for foraging. Overall, the abundance of habitat is much less in both areas, the grassy area of the Waste Accumulation Area is mowed frequently reducing habitat value, and the degree of human disturbance is greater at the West Unit. Moreover, it is important to note for the fox that there is higher quality habitat outside of the Airport in undisturbed areas; thus further decreasing the likelihood of combined utilization of the FPTA and West Unit Areas. For the kestrel, utilization of infrequently mowed grasslands in areas of human activity is common. However, the degree of human activity still can influence occurrence. Habitat available outside of the airport for the kestrel is not as abundant as for the fox; nevertheless, there are many open fields and woodland edge habitats available, further reducing the likelihood of combined use of the FPTA and West Unit areas.

At the FPTA, there were no EQ values indicating possible risk to the red fox or the kestrel. At the Waste Accumulation area and Million Gallon Hill, there was no potential for risk to the red fox. The EQ for the kestrel at the Waste Accumulation area indicated possible risk. However, as explained above, the habitat at the Waste Accumulation area is of less quality for the kestrel than other available areas. Therefore, given the limited acreage of fox and kestrel habitat for West Unit source areas, the lack of habitat for the kestrel at Million Gallon Hill, the higher quality habitat at the FPTA, the availability of habitat outside of the Airport, and the lack of EQs in the possible risk category, it is unlikely that there is a significant degree of combined risk due to multiple source area utilization for these assessment endpoints.

Combine utilization for terrestrial assessment endpoints of Million Gallon Hill and the

Waste Accumulation Area is possible for the red fox, meadow vole, and robin because the source areas are adjacent to each other and the assessment endpoint home range sizes would allow contact with both source areas. As explained above, the kestrel is not likely to occur at Million Gallon Hill, precluding combined site impacts. No EQs were in the possible risk category for the red fox. Combined use of these sites for such a species that has a very large home range is likely to be minimal compared to the total habitat, thus, minimizing the potential for combined use to cause potential risk.

For the meadow vole, EQs indicated possible risk for acenaphthene, benzo(a)anthracene, benzo(a)flouranthene, and benzo(g,h,i)perylene at Million Gallon Hill. All of these chemicals also showed possible risk, except benzo(b)flouranthene, at the Waste Accumulation Area. As explained in Section 6.4, risk to voles from PNAs at these sites in minimal due to the relatively low concentrations and the ability of vertebrates to readily metabolize these compounds. It is not likely that combined use of the Waste Accumulation Area and Million Gallon Hill would appreciably increase the potential for risk.

Combined site impacts to robins at the Waste Accumulation Area and Million Gallon Hill are possible for DDT, DDE, and DDD, which exhibited EQs above 1 for both sites. These chemicals were applied historically in the Galena area for pest control, and their presence at these two sites does not represent areas of elevated concentrations

Multiple site exposure for aquatic and semiaquatic species is possible for those species utilizing multiple groundwater discharge areas. Groundwater discharge to surface waters of the Yukon River were modeled for the FPTA, POL Tank Farm, Waste Accumulation Area, Million Gallon Hill, JP-4 Fillstands, and Bldg.1845. Groundwater discharge for the FPTA is approximately 1.5 miles up stream from the discharge points for the remaining sites (Appendix C). Potential combined site impacts to Yukon River aquatic invertebrates at the FPTA discharge point is not likely. Also, it is not likely that potential migration of contaminants at the FPTA discharge point would significantly affect invertebrates 1.5 mile down stream at the POL Tank Farm and source areas of the West Unit discharge points because of the low concentrations at the FPTA discharge point and subsequent dilution that would occur in route down stream.

There is a potential for combined impacts to aquatic invertebrates at the POL Tank Farm and source areas of the West Unit groundwater discharge points to Yukon River mudflats because these are either overlapping or adjacent to each other (Appendix C). The primary area of combined impacts is in the area of discharge for the Waste Accumulation Area, JP-4 Fillstands, and Bldg. 1845, because these source areas potentially could discharge in approximately the same area along the Yukon River. After consideration of toxic and physical properties and dilution effects of the river on chemicals with EQs greater than 1, it was determined that organochlorine pesticides were the primary chemicals that may pose potential risk to invertebrates of the mudflats (Section 6.4.7). The potential additive effects of the source areas discharging groundwater to the same vicinity was not considered in the groundwater model (Appendix C). Thus, the effect on potential mudflat concentrations is uncertain. However, the possible combined effects of the source areas potentially creating a larger area of potential contamination than any one source area would create increases the likelihood of invertebrate contact with contaminants, and thus, potential risk.

For the spotted sandpiper, utilization of the mudflats at the FPTA groundwater discharge point in conjunction with the discharge points of the POL Tank Farm and the West Unit areas is likely to be minimal because of the small home range size of the sandpiper (approximately 2.5 acres). Wading bird species with larger home ranges potentially could forage in both areas. However, the abundance of other wetland and mudflat habitat in the area reduces probability of combined use of these areas.

There is a significant likelihood of combined use by the spotted sandpiper of the POL Tank Farm and source areas of the West Unit groundwater discharge points (mudflats) because these are either overlapping or adjacent to each other (Appendix C). After consideration of toxic and physical properties and dilution effects of the river on chemicals with EQs greater than 1, it was determined that organochlorine pesticides were the primary chemicals that may pose potential risk to wading bird such as sand pipers at the mudflats (Section 6.4.7). As stated above, the potential additive effects of the source areas discharging groundwater to the same vicinity was not considered in the groundwater model (Appendix C). Thus, the effect on potential mudflat concentrations is uncertain. However, the possible combined effects of the source areas potentially creating a larger area of potential contamination than any one source area would create increases the likelihood of wading bird contact with contaminants, and thus, potential risk. However, the abundance of locally available wetland habitat for foraging would reduce the magnitude of a potential combined use effect.

Combined impacts from all groundwater discharge sources is possible for the northern pike because individuals of this species can range over large areas. However, the only EQ indicating possible risk to pike was the EQ for manganese. It was determined that this metal is not likely to pose risk due to dilution effects and the fact that it is an essential metabolic element. Thus, given that all other EQs were below 1 and that the exposure concentrations modeled did not account for dilution, impacts to the northern pike from combined sources would be minimal (productivity and population survivorship would not be reduced).

Section 8
CONCLUSIONS AND RECOMMENDATIONS

8.1 Human Health Assessment

For each scenario addressed in this risk assessment, the carcinogenic risk was estimated on a chemical-by-chemical basis for each relevant pathway of exposure. The estimated cancer risk was summed for each chemical associated with a specific pathway to determine total risk by pathway. To determine the total exposure scenario risk, total risks for all pathways were summed. A similar procedure was performed to determine the total noncancer HI for each exposure scenario.

The USEPA Superfund site remediation goal set forth in the NCP designates a cancer risk of 10^{-4} (1 in 10,000) to 10^{-6} (1 in one million). This range is designed to be protective of human health and to provide flexibility for consideration of other factors in risk management decisions. In effect, risks that are less than 10^{-6} are generally considered negligible. Risks that are greater than 10^{-4} are usually considered sufficient justification for undertaking remedial action. Risks in the intermediate range between these two values can be considered acceptable on a case-by-case basis. The State of Alaska plans to use a cancer risk level of 10^{-5} (1 in 100,000) in making risk management decisions (USAF, 1996b).

The HQ is not a statistical probability of a noncarcinogenic effect occurring. If the exposure level exceeds the appropriate toxicity value (i.e., the HQ is greater than one), there may be cause for concern regarding the potential noncarcinogenic effects. The Superfund site remediation goal for noncarcinogens is a total HI of 1 for chemicals with similar toxic endpoints.

Table 8-1 summarizes the chemicals and exposure pathways that contribute an estimated cancer risk greater than 1 in one million at the FPTA, POL Tank Farm, and the West Unit. The table specifies the applicable exposure scenario, the chemical-specific risk estimate and percent of the total risk, and provides summary comments to place the risk estimate in perspective. Of the numerous chemicals detected in environmental media at the three sites, only two chemicals pose an estimated risk in excess of 1 in one million: benzene at all three sites and arsenic in the West Unit. Estimated noncancer hazard indices are below 1, the Superfund site remediation goal for noncarcinogens, for all scenarios at all three sites. An evaluation of combined impacts indicates that combining scenarios (e.g., child and adult), or adding individual site contributions to media at the same location, does not substantially increase the estimated cancer risks or noncancer hazard indices.

Risks associated with residual petroleum at the sites are addressed by quantifying risks for individual chemicals that are components of the residual petroleum. The results of the risk assessment can be used to evaluate the need to remediate DRO and GRO, but are not intended to be used to establish alternate cleanup levels for DRO and GRO. Remediation issues related to DRO, GRO, and free product are to be addressed outside of the risk assessment.

It should be noted that the risk estimates presented address risks associated with the IRP sites under investigation and do not include risk associated with airport operations.

8.1.1 Fire Protection Training Area

Estimated incremental cancer risks for all scenarios except the long-term on-base worker (reasonable maximum case) and construction

Table 8-1
Chemicals and Pathways that Contribute Estimated Cancer Risks Greater Than 1 in One Million

Chemical	Exposure Pathway	Exposure Scenario	Chemical-Specific Risk Estimate (% of Total Risk)	Comments
Fire Protection Training Area				
Benzene	Inhalation of volatile emissions from subsurface soils brought to the surface by construction-related excavations	On-Base Construction Worker - Average - Reasonable Maximum	 3E-06 (100%) 5E-06 (97%)	The methodology used to estimate volatile emissions to the air is conservative and probably results in an overestimate of risks from inhalation of benzene. Moreover, since construction is unlikely to occur at the FPTA, estimated risks for the construction worker scenario do not represent a current or likely future population. The exposure duration for this scenario is biased high.
POL Tank Farm				
Benzene	Inhalation of volatile emissions from subsurface soils.	Short-term On-Base Worker (Reasonable Maximum) Long-Term On-Base Worker - Average - Reasonable Maximum	2E-06 (97%) 3E-06 (95%) 9E-06 (97%)	The methodology used to estimate volatile emissions to the air is conservative and probably results in an overestimate of risks from inhalation of benzene. Measured concentrations of benzene in the ambient air at the POL Tank Farm are higher than the estimated concentration from volatilization from subsurface soils. It is possible that the contribution of benzene emissions from contaminated soils is minor when compared with other sources related to operation of an airport. The construction worker exposure duration is biased high. The reasonable maximum boarding school student exposure duration is also biased high. The reasonable maximum boarding school student exposure duration is also biased high.
	Inhalation of volatile emissions from subsurface soils brought to the surface by construction-related excavations.	On-Base Construction Worker - Average - Reasonable Maximum	6E-05 (100%) 1E-04 (100%)	
	Inhalation of volatile emissions from subsurface soils.	Boarding School Student (Reasonable Maximum)	1E-06 (90%)	

Table 8-1
(Continued)

Chemical	Exposure Pathway	Exposure Scenario	Chemical-Specific Risk Estimate (% of Total Risk)	Comments
West Unit				
Benzene	Inhalation of volatile emissions from surface and subsurface soils at Bldg. 1700.	Short-Term On-Base Worker (Reasonable Maximum)	3E-06 (58%)	The methodology used to estimate volatile emissions to the air is conservative and probably results in an overestimate of risks from inhalation of benzene. The construction worker exposure duration is biased high.
		Long-Term On-Base Worker - Average - Reasonable Maximum	 5E-06 (38%) 2E-05 (58%)	
	Inhalation of volatile emissions from subsurface soils brought to the surface by construction-related excavations.	On-Base Construction Worker (Reasonable Maximum)	2E-06 (48%)	
Arsenic	Incidental ingestion of arsenic in surface soils.	Long-Term On-Base Worker - Average - Reasonable Maximum	 3E-06 (26%) 3E-06 (14%)	Arsenic is a COPC in surface soil at Bldg. 1700 and in the subsurface soil at the Power Plant UST No. 49, Bldg. 1845, and Bldg. 1700 only because there were three or fewer results at these locations in these media and a statistical comparison with background concentrations could not be performed. Maximum detected concentrations at these areas are well below both the background UTL and 95% UCL for arsenic. There is no known reason to suspect that arsenic at Bldg. 1700, Bldg. 1845, or the Power Plant UST No. 49 might be elevated above background; there is no known or suspected source for arsenic at these locations.
	Incidental ingestion of arsenic in surface and subsurface soils.	On-Base Construction Worker (Reasonable Maximum)	1E-06 (28%)	
	Dermal contact with arsenic in surface soil.	Long-Term On-Base Worker - Average - Reasonable Maximum	 2E-06 (16%) 3E-06 (14%)	

worker (average and reasonable maximum cases) are below 1 in one million, considered the *de minimis*, or level of negligible risk. Estimated risk for the reasonable maximum long-term worker equals 1 in one million. The cancer risks estimated for the construction worker exceed 1 in one million but are well below the high end of the Superfund risk range goal of 1 in 10,000.

For the long-term worker scenario, inhalation of benzene that volatilizes from subsurface soil contributes the largest percentage (46%) of the total reasonable maximum risk estimate. Likewise, in the construction worker scenario, inhalation of benzene that volatilizes from the subsurface soil when it is brought to the surface by construction-related excavations (conservative modeling assumption) contributes the majority (100% for the average case and 97% for the reasonable maximum case) of the risk. Risks associated with exposure to all other chemicals are negligible. Estimated noncancer hazard indices are well below 1 for all scenarios.

The construction worker scenario assumes that a worker will work in the immediate vicinity of the FPTA for 8 hours/day, 5 days/week for 3 to 6 months and that soil excavation/moving activities will occur over this time period. Moreover, the emissions calculation assumes that all subsurface soils containing benzene will be exposed and essentially become surface soils. If construction involving soil excavation were assumed to occur over a less than 3-month period, and if it were assumed that excavations involved less than 50% of the contaminated soil rather than 100%, the reasonable maximum estimate for the construction worker would decrease to less than 1 in one million. Note also that its location at the east end of the runway precludes building construction activity at the FPTA as long as Galena Airport is operating. The entire FPTA site is within the airport's building restriction line (see Figure 2-2 in Section 2).

The estimated annual average concentration of benzene in the air at the FPTA from volatilization from subsurface soil is 0.29 $\mu g/m^3$. Assuming excavation activities that expose the subsurface soil, the estimated concentration of benzene in the air during construction work is 130 $\mu g/m^3$. These estimated air concentrations are substantially lower than both the OSHA PEL of 3,200 $\mu g/m^3$ and the proposed ACGIH TLV of 960 $\mu g/m$ for worker exposure to benzene.

If the subsurface soils are left undisturbed, risks posed by the FPTA are negligible for all human populations that might encounter site-related contaminants. On the basis of the results of the human health assessment, remedial action at the FPTA is not warranted as long as the airport remains operational or the land use remains industrial.

8.1.2 POL Tank Farm

The estimated incremental cancer risks for the long-term on-base worker and construction worker scenarios are greater than 1 in one million but do not exceed the high end of the Superfund risk range goal for carcinogens (1 in 10,000). The reasonable maximum cancer risk estimates for the short-term on-Base worker and boarding school student slightly exceed 1 in one million. Estimated cancer risks for all other scenarios at the POL Tank Farm are below 1 in one million. Estimated noncancer hazard indices are below 1 for all scenarios.

Inhalation of benzene that volatilizes from the subsurface soil contributes the majority (90-97%) of the risk for the short- and long-term on-base worker and boarding school student, and virtually 100% of the risk for the construction worker. The estimated annual average concentration of benzene in the air at the POL Tank

Farm from volatilization from subsurface soils is 4.2 $\mu g/m^3$. Assuming excavation activities that expose the subsurface soils, the estimated concentration of benzene in the air during construction work is 2700-2800 $\mu g/m^3$.

Air sampling conducted by the USAF in and around the entire Galena Airport indicates that elevated levels of benzene due to anthropogenic-related activities exist in the entire area surrounding Galena. Benzene results in the POL area ranged from 0.54 $\mu g/m^3$ to 10 $\mu g/m^3$ upwind and 1.2 to 30 $\mu g/m^3$ downwind (USAF, 1994b). The air sample results may be due to refueling operations, vehicular traffic, and aircraft activity, in addition to any contribution from benzene contaminated soils. It is not possible to differentiate the sources contributing to the measured concentrations of benzene in the air. It is possible that the contribution of benzene emissions from contaminated soils is minor compared to sources related to the operation of an airport. Risks that slightly exceed 1 in one million for the long-term on-Base worker cannot be distinguished from the risks of exposure to benzene in the air contributed by other sources. Eliminating the risk associated with volatilization from the soils in all likelihood would not substantially reduce the risk of benzene exposure for the on-Base worker.

As discussed above for the FPTA, the emission estimates for benzene from subsurface soil during construction work are likely biased high. Actual risks to a worker excavating soils in the POL area are probably much lower. Moreover, the estimated benzene concentration from volatilization from subsurface soil is well below the proposed ACGIH TLV and OSHA's PEL for worker exposure to benzene. Although the estimated concentration of benzene in air during construction work slightly exceeded the ACGIH TLV, the TLV is designed to be protective of long-term worker exposure. In the construction worker scenario, the estimated high air concentrations are only expected to occur for a few weeks to a few months.

On the basis of the results of the human health assessment, remedial action at the POL Tank Farm is not warranted.

8.1.3 West Unit

Estimated incremental cancer risks for the on-base residents, Old and New Town Galena residents, and boarding school students are below 1 in one million. The average and reasonable maximum cancer risk estimate for the short-term on-base worker and the construction worker either equal or slightly exceed 1 in one million. The average and reasonable maximum cancer risk estimates for the long-term on-base worker equal and slightly exceed 1 in 100,000, respectively. None of the estimates exceeds the high end of the Superfund risk range goal (1 in 10,000). Estimated noncancer hazard indices are below 1 for all scenarios.

Similar to the other two sites, inhalation of benzene that volatilizes from soils (primarily from surface and subsurface soil at Bldg. 1700 and from subsurface soil at the JP-4 Fillstands) contributes the highest percentage of the estimated risk for the worker scenarios. The above discussions on estimated and measured benzene concentrations at the installation, the ACGIH TLV and OSHA PEL, and the methodology used to estimate benzene emissions during construction work, also apply to the West Unit.

However, in the West Unit, risks higher than 1 in one million are also attributable to incidental ingestion of and dermal contact with soils containing arsenic. Arsenic is a COPC in surface soil at Bldg. 1700 and in the subsurface soil at the Power Plant UST No. 49, Bldg. 1845, and Bldg. 1700 only because there were three or fewer results at these locations in these

media and a statistical comparison to background concentrations could not be performed. The maximum detected concentrations of arsenic in soils at these locations are well below both the background UTL and 95% UCL for arsenic in surface and subsurface soils. There is no reason to suspect that concentrations of arsenic at Bldg. 1700, Bldg. 1845, or the Power Plant UST No. 49 might be elevated above background. There is no known or suspected source for arsenic at these locations. Indeed, if risks for the same scenarios were computed using the background 95% UCL concentrations, risk due to contact with arsenic at the background location would be higher than the corresponding risk estimates at the West Unit.

Estimated risks for the West Unit scenarios cannot be distinguished from the risks of exposure to benzene in the air contributed by sources associated with an operating airport or from the risks of exposure to background levels of arsenic in soils. Therefore, on the basis of the results of the human health assessment, remedial action at the West Unit is not warranted.

8.2 Ecological Assessment

For each assessment endpoint species addressed in the ecological assessment, EQs were estimated on a chemical-specific basis. A high EQ does not necessarily mean theat the local population of that species is at risk. Therefore, using the EQs, the ecological significance of potential impacts was also evaluated.

A weight-of-evidence analysis of potential effects on assessment endpoint species was conducted by reviewing the physical, chemical, ecological, and toxicological properties of the COPECs with EQs above 1. More specifically these properties included:

- Physical and chemical properties:
  - environmental persistence;
  - mobility;
  - degradation products; and
  - bioavailability to ecological receptors.
- Toxicological properties:
  - toxic effects to wildlife;
  - likelihood of metabolism;
  - metabolic products; and
  - excretion time.
- Ecosystem properties:
  - ecosystem type;
  - ecosystem use;
  - habitat quality; and
  - habitat use.

On the basis of both the EQ values and the weight-of-evidence evaluation, each COPEC with an EQ value greater than 1 was rated for potential to cause local population impacts. This population impacts rating (high, medium, or low) provides the initial guidance for the decision-making process.

Figures 8-1 through 8-6 summarize the weight-of-evidence findings for local populations of the assessment endpoint species of this ERA.

8.2.1 Fire Protection Training Area

Risk to plants, terrestrial invertebrates, red fox, and kestrel were determined to be minimal. Through evaluation of the toxicity data and physical properties of the contaminants with EQs above 1 in the context of the FPTA, it was determined that only dioxin and fluorene have potential for risk to the meadow vole. The available habitat at the FPTA is small when compared to the surrounding area. Due to

FIRE PROTECTION TRAINING AREA
Potential Local Population Impacts

	LOW	MEDIUM	HIGH
Savannah Sparrow			
DDT		⊢—×—⊣	
DDE		⊢—×—⊣	
DDD		⊢—×—⊣	
Dioxin		⊢—×—⊣	
Meadow Vole			
Dioxin	×		
Fluorene	×		
Aquatic Invertebrates			
DDT	×		
Dieldrin	×		
Heptachlor epoxide	×		
Lead	×		
Thallium	×		
Spotted Sandpiper			
DDT	×		
Lead	×		

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Figure 8-1

POL TANK FARM
Potential Local Population Impacts

	LOW	MEDIUM	HIGH
Aquatic Invertebrates			
DDT	X		
DDE	X		
DDD	X		
Thallium	X		
Lead	X		
Spotted Sandpiper			
DDT	X		
DDE	X		
DDD	X		
Thallium	X		
Lead	X		

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Figure 8-2

WEST UNIT
Potential Local Population Impacts

Waste Accumulation Area

	LOW	MEDIUM	HIGH
Aquatic Invertebrates			
DDT	X		
Dieldrin	X		
Lead	X		
Spotted Sandpiper			
DDT		⊢—X—⊣	
Lead	X		
Terrestrial Invertebrates			
gamma-BHC	X		
Robin			
DDT		⊢—X—⊣	
DDE		⊢—X—⊣	
DDD		⊢—X—⊣	
Lead	X		
Kestrel			
DDT	⊢—X—⊣		

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Figure 8-3

WEST UNIT
Potential Local Population Impacts

Million Gallon Hill

	LOW	MEDIUM	HIGH
Aquatic Invertebrates			
DDT		×	
DDE	×		
DDD		×	
Spotted Sandpiper			
DDT		⊢—×—⊣	
DDE		⊢—×—⊣	
DDD		⊢—×—⊣	
Lead	×		
Terrestrial Invertebrates			
gamma-BHC	×		
Robin			
DDT		⊢—×—⊣	
DDE		⊢—×—⊣	
DDD		⊢—×—⊣	
Dibenzofuran	×		
Lead	×		
Kestrel			
DDT	⊢—×—⊣		

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Figure 8-4

WEST UNIT
Potential Local Population Impacts

Building 1845

	LOW	MEDIUM	HIGH
Aquatic Invertebrates			
DDD	×		
DDE	×		
DDT	×		
Aldrin	×		
Dieldrin	×		
Endrin aldehyde	×		
Heptachlor epoxide	×		
Lead	×		
Spotted Sandpiper			
DDT		⊢—×—⊣	
DDE		⊢—×—⊣	
DDD		⊢—×—⊣	
Cadmium	×		

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Figure 8-5

WEST UNIT
Potential Local Population Impacts

JP4-Fillstands

	LOW	MEDIUM	HIGH
Aquatic Invertebrates			
DDD	X		
DDT	X		
Aldrin	X		
Dieldrin	X		
Endrin aldehyde	X		
Barium	X		
Lead	X		
Selenium	X		
Arsenic	X		
Spotted Sandpiper			
DDD		X	
DDT		X	
Arsenic	X		
Barium	X		
Lead	X		
Selenium	X		

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Figure 8-6

sporadic human activity, the affected area does not represent a high quality habitat. On the basis the size of the affected area relative to useable local habitat and the occasional human activity at the site, the population impacts are determined to be low. If surface soils remained in place, the local population of meadow voles would not be adversely impacted.

After consideration of toxic and physical properties for contaminants with EQs above 1 for the savannah sparrow, it was determined that DDT, its breakdown products, and dioxin showed potential for risk. The grassy open field of the FPTA provides a unique habitat for the savannah sparrow. This field is also an area of breeding for the savannah sparrow. If the surface soils remained in place, risk to the savannah sparrow population from DDT, its breakdown products, and dioxin showed potential for risk. The grassy open field of the FPTA provides an unique habitat for the savannah sparrow. This field is also an area of breeding for the savannah sparrow. If the surface soils remained in place, risk to the savannah sparrow population from DDT, its breakdown products and dioxin is medium to high. However, DDT was historically broadcast throughout the Airport, and the FPTA does not represent a unique source of DDT.

For the aquatic and semiaquatic pathways, potential risks to the pike were minimal. DDT, dieldrin, heptachlor epoxide, and lead had EQ levels greater than 1 for the aquatic invertebrate. The spotted sandpiper had EQs greater than 1 for lead and DDT. The mudflats represent a transient habitat and is dependent upon the level of the Yukon River. Groundwater modeling did not account for volatilization, dilution, or binding of the constituent to sediment. Organochlorine pesticides, including DDT, were historically broadcast throughout the Airport for pest control, and the FPTA does not represent a unique source of DDT. In surface waters, lead quickly binds to sediments. On the basis of the dilution effects, and transient nature of the ecosystem, the potential local population impacts to the spotted sandpiper and aquatic invertebrates is minimal to low.

8.2.2 POL Tank Farm

Toxicity, chemical, and physical effects in the context of the Yukon River for those chemicals with EQs exceeding 1 were evaluated for all assessment endpoints. For the pike, it was determined that there was no significant potential for risk from POL Tank Farm groundwater discharge.

For the aquatic invertebrates and the spotted sandpiper, organochlorine pesticides, lead, and thallium potentially could impact these populations adversely. However, organochlorine pesticides historically were used over the entire Airport for insect control and the POL Tank Farm does not represent a unique area of contamination. Dilution and adsorption to sediments can attenuate the assessment endpoint species' exposure to lead and thallium. On the basis of the transient nature of the mudflats as an ecosystem, and the dilution of the constituents as they enter surface water, the population impacts of groundwater from the POL Tank Farm at the mudflats are minimal to low.

8.2.3 West Unit

In summary, no chemicals were found to pose significant risk to northern pike in the Yukon River. After consideration of toxic and physical properties for contaminants with EQs above 1 (Table 6-25), only dieldrin for aquatic invertebrates and DDT for both aquatic invertebrates and the spotted sandpiper were shown to have significant potential for posing risk in the Yukon River mudflats from the Waster Accumulation Area. Contaminants shown to have significant potential for risk to aquatic inverte-

brates and the spotted sandpiper at Million Gallon Hill are DDT, DDD, and DDE. Organochlorine pesticides potentially pose significant risk to the Yukon River mudflats from Bldg. 1845 and the JP-4 Fillstands groundwater. For aquatic invertebrates, DDT, DDE, DDD, aldrin, dieldrin, endrin aldehyde, and heptachlor epoxide are pesticides, or their breakdown products, with EQs above 1 from exposure to groundwater from Bldg. 1845. For the JP-4 Fillstands, DDT, DDD, aldrin, and endrin aldehyde were found to have EQs above 1. For the spotted sandpiper, DDD, DDE, and DDT had EQs above 1 from Bldg. 1845 groundwater discharge. Groundwater from the JP-4 Fillstands had EQs above 1 for DDT and DDD in the spotted sandpiper.

The only areas of the West Unit with potential for terrestrial impacts were the Waste Accumulation Area and Million Gallon Hill. In both of these areas, EQs for lead, DDE, DDD, and DDT were above 1 for the robin. Dibenzofuran was noted to have an EQ above 1 in the robin at Million Gallion Hill. DDT had an EQ of 1.08 in the kestrel from the Waste Accumulation Area, but this was the only risk determined for the kestrel, an upper trophic level receptor. In the terrestrial invertebrate, gamma-BHC had an EQ above 1 in Million Gallon Hill and above 10 in the Waste Accumulation Area. This assessment shows potential for risk from these organochlorine pesticides. However, the organochlorine pesticides originating from the West Unit do not represent high concentrations relative to the Galena area in general because such chemicals were historically applied throughout the Airport for pest control.

The ecology of the West Unit is limited by human industrial activities. Vegetation consists of grasses and shrubs in the manicured areas around the buildings and grasses, willows, and alders in the drainage ditches. Due to human activities, avian ecological receptors may not be located consistently in the site areas, but could travel and forage throughout the Airport area. Semiaquatic avian receptors may travel throughout the mudflats created by the Yukon River. However, these mudflats are intermittent and are dependent upon the river level. On the basis of the EQ value in the robin, the impacts to the terrestrial ecosystem would be low.

Section 9
ACRONYMS/ABBREVIATIONS AND DEFINITIONS

9.1 Acronyms/Abbreviations

AA	Atomic Absorption
AB	Ambient Blank
ACGIH	American Conference of Governmental Industrial Hygienists
ACQUIRE	Aquatic Information Retrieval
ADEC	Alaska Department of Environmental Conservation
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
AFS	Air Force Station
AH	Aromatic Hydrocarbons
ARAR	Applicable or Relevant and Appropriate Requirements
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criteria
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
bgl	below ground level
BLM	Bureau of Land Management
BRA	Baseline Risk Assessment
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CAA	Civil Aeronautics Authority

CAG	(U.S.) EPA Carcinogenic Assessment Group
CAS	Chemical Abstract Service Registry Number
CAT	Catalytic Hydrocarbon
CDC	Centers for Disease Control
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response Compensation and Liability Act (Superfund)
cfs	cubic feet per second
CLP	Contract Laboratory Program
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CRAVE	Carcinogen Risk Assessment Verification Endeavor
CTDSA	Control Tower Drum Storage Area, South
DI	Daily Intake
DL	Detection Limit
DNAPL	Dense, Nonaqueous Phase Liquid
DoD	(U.S.) Department of Defense
DoT	(U.S.) Department of Transportation
DPT	Direct Push Technology
DQO	Data Quality Objective
DRO	Diesel Range Organics
EAC	Effective Air Concentration
EB	Equipment Blank

EC	Environmental Concentration
ECAO	Environmental Criteria and Assessment Office
EE/CA	Engineering Evaluation/Cost Analysis
EQ	Ecological Effects Quotient
ER-L	Effects Range-Low
ER-M	Effects Range-Medium
ERA	Ecological Risk Assessment
FAA	Federal Aviation Administration
FID	Flame Ionization Detector
FFA	Federal Facilities Agreement
FPTA	Fire Protection Training Area
FS	Feasibility Study
GC	Gas Chromatograph
gpd	gallons per day
gpm	gallons per minute
GRO	Gasoline Range Organics
HAD	Health Assessment Document
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
HR	Home Range
HSDB	Hazardous Substances Dat Base

ICAP	Inductively Coupled Argon Plasma
IEUBK	Integrated Exposure Uptake Biokinetic Model
IR	Infrared
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
K_{oc}	Organic Carbon Partition Coefficient
K_{ow}	Octanol-Water Partition Coefficient
LC_{50}	Lethal Concentration (50%)
LD_{50}	Lethal Dose (50%)
LCL	95% Lower Confidence Limit
LNAPL	Light, Nonaqueous Phase Liquid
LOAEL	Lowest Observed Adverse Effect Level
MB	Method Bank
mcf	million cubic feet
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/kg	milligram/kilogram
mg/L	milligram/liter
MSL	Mean Sea Level
NA	Not Available
NCP	National Contingency Plan
ND	Not Detected

NFRAP	No Further Response Action Planned
NIOSH	National Institute for Occupational Safety and Health
NIPDWR	National Interim Primary Drinking Water Regulations
NOAA	National Oceanographic and Atmospheric Administration
NOAEL	No Observed Adverse Effects Level
NOEL	No Observed Effect Level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NT	Not Tested
OAQPS	Office of Air Quality Planning and Standards
OSHA	Occupational Safety and Health Administration
PA/SI	Preliminary Assessment/Site Investigation
PCB	Polychlorinated Biphenyl
PEL	Permissible Exposure Limit
PID	Photoionization Detector
PNA	Polynuclear Aromatic Hydrocarbon
POL	Petroleum, Oil, and Lubricants
ppb	parts per billion
ppm	parts per million
PRG	Preliminary Remediation Goal
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control

QL	Quantitation Limit
RAGS	Risk Assessment Guidance for Superfund
RAS	Routine Analytical Services
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RDA	Recommended Daily Allowance
RfC	Reference Concentration for Chronic Exposure
RfC_s	Reference Concentration for Subchronic Exposure
RfD	Reference Dose for Chronic Exposure
RfD_s	Reference Dose for Subchronic Exposure
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	Reporting Limit
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RPM	Remedial Project Manager
SAB	Science Advisory Board
SARA	Superfund Amendments and Reauthorization Act
SAS	Special Analytical Services
SDI	Subchronic Daily Intake
SEAM	Superfund Exposure Assessment Manual
SF	(Cancer) Slope Factor

SGB	Sergeant General Bioenvironmental Engineering
SI	Site Investigation
SQC	Sediment Quality Criteria
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TB	Toxicity Benchmark
TB	Trip Blank
TCE	Trichloroethene
TCL	Target Compound List
TEF	Toxicity Equivalency Factor
TIC	Tentatively Identified Compound
TLV	Threshold Limit Value
TPH	Total Petroleum Hydrocarbons
UCL	95% Upper Confidence Limit
UF	Uptake Factor
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	Underground storage tank

UTL Upper Tolerance Limit

VOC Volatile Organic Compound

µg/kg microgram/kilogram

µg/L microgram/liter

WIMS-ES Work Information Management System—Environmental Subsystem

Multiplication Factor		Prefix	Symbol
1,000,000	$= 10^{6}$	mega-	M
1,000	$= 10^{3}$	kilo-	k
100	$= 10^{2}$	hecto-	h
10	$= 10^{1}$	deka-	da
0.1	$= 10^{-1}$	deci-	d
0.01	$= 10^{-2}$	centi-	c
0.001	$= 10^{-3}$	milli-	m
0.000 001	$= 10^{-6}$	micro-	u
0.000 000 001	$= 10^{-9}$	nano-	n
0.000 000 000 001	$= 10^{-12}$	pico-	p
ppm (parts per million)	= mg/kg, µg/g, ng/mg, pg/µg, mg/L, µg/mL, ng/µL		
ppb (parts per billion)	= µg/kg, ng/g, pg/mg, µg/L, ng/mL, pg/µL		
ppt (parts per trillion)	= ng/kg, pg/g, ng/L, pg/mL		

9.2 Definitions

Absorbed Dose	The amount of a substance penetrating the exchange boundaries of an organism after contact. Absorbed dose is calculated from the intake and the absorption efficiency. It usually is expressed as mass of a substance absorbed into the body per unit body weight per unit time (e.g., mg/kg-day).
Administered Dose	The mass of a substance given to an organism and in contact with an exchange boundary (e.g., gastrointestinal tract) per unit body weight per unit time (e.g., mg/kg-day).
Analytes	The chemicals for which a sample is analyzed.
Applied Dose	The amount of a substance given to an organism, especially through dermal contact.
Bioavailability	The degree to which a substance becomes available to the target tissue after administration or exposure.
Bioconcentration Factor (BCF)	Provides a measure of the extent of chemical partitioning at equilibrium between a biological medium such as fish tissue or plant tissue and an external medium such as water. The higher the BCF, the greater the accumulation in living tissue is likely to be.
Cancer Risk	Incremental probability of an individual's developing cancer over a lifetime as a result of exposure to a potential carcinogen.
Carcinogen	An agent capable of inducing a cancer response.
Chemicals of Potential Concern	Chemicals that are potentially site related and whose data are of sufficient quality for use in the quantitative risk assessment.
Chronic Daily Intake (CDI)	Exposure expressed as mass of a substance contacted per unit body weight per unit time, averaged over a long period of time (as a Superfund program guideline, seven years to a lifetime).
Chronic Reference Dose (RfD) or Reference Concentration (RfC)	An estimate (with uncertainty spanning as much as three orders of magnitude) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. Chronic RfDs or RfCs are specifically developed to be protective for long-term exposure to a compound (as a Superfund program guideline, seven years to lifetime).
Common Laboratory Contaminants	Certain organic chemicals (considered by EPA to be acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters) that are commonly used in the laboratory and thus may be introduced into a sample from laboratory cross-contamination, not from the site.

Contract Laboratory Program (CLP)	Analytical program developed for Superfund waste site samples to fill the need for legally defensible analytical results supported by a high level of quality assurance and documentation.
Contact Rate	Amount of medium (e.g., groundwater, soil) contacted per unit time or event (e.g., liters of water ingested per day).
Contract-Required Quantitation Limit (CRQL)	Chemical-specific levels that a CLP laboratory must be able to routinely and reliably detect and quantitate in specified sample matrices. May or may not be equal to the reported quantitation limit of a given chemical in a given sample.
Critical Effect	The first adverse effect, or its known precursor, that occurs as the dose rate increases.
Detection Limit (DL)	The lowest amount that can be distinguished from the normal "noise" of an analytical instrument or method.
Diffusivity	The movement of a molecule in a liquid or gas medium as a result of differences in concentration. It is used to calculate the dispersive component of chemical transport. The higher the diffusivity, the more likely a chemical is to move in response to concentration gradients.
Dose-response Evaluation	The process of quantitatively evaluating toxicity information and characterizing the relationship between the dose of a contaminant administered or received and the incidence of adverse health effects in the exposed population. From the quantitative dose-response relationship, toxicity values are derived that are used in the risk characterization step to estimate the likelihood of adverse effects occurring in humans at different exposure levels.
Exposure	Contact of an organism with a chemical or physical agent. Exposure is quantified as the amount of the agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut) and available for absorption.
Exposure Assessment	The determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of exposure.
Exposure Event	An incident of contact with a chemical or physical agent. An exposure event can be defined by time (e.g., day, hour) or by the incident (e.g., eating a single meal of contaminated fish).
Exposure Parameters	Variables used in the calculation of intake (e.g., exposure duration, inhalation rate, average body weight).

Exposure Pathway	The course a chemical or physical agent takes from a source to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (e.g., air) or media (in cases of intermedia transfer) also is included.
Exposure Point	A location of potential contact between an organism and a chemical or physical agent.
Exposure Route	The way a chemical or physical agent comes in contact with an organism (i.e., by ingestion, inhalation, dermal contact).
Feed-to-Milk/Beef Transfer Coefficients	The ratio of the chemical concentration in milk/beef (in mg/kg) to the daily intake of the chemical (in mg/day).
Hazard Identification	The process of determining whether exposure to an agent can cause an increase in the incidence of a particular adverse health effect (e.g., cancer, birth defect) and whether the adverse health effect is likely to occur in humans.
Hazard Index (HI)	The sum of more than one hazard quotient for multiple substances and/or multiple exposure pathways. The HI is calculated separately for chronic, subchronic, and shorter duration exposures.
Hazard Quotient (HQ)	The ratio of a single substance exposure level over a specified time period (e.g., subchronic) to a reference dose for that substance derived from a similar exposure period.
Henry's Law Constant	Provides a measure of the extent of chemical partitioning between air and water at equilibrium. The higher the Henry's Law constant, the more likely a chemical is to volatilize than to remain in the water.
Intake	A measure of exposure expressed as the mass of a substance in contact with the exchange boundary per unit body weight per unit time (e.g., mg chemical/kg-day). Also termed the normalized exposure rate; equivalent to administered dose.
Integrated Risk Information System (IRIS)	A USEPA data base containing verified RfDs and slope factors and up-to-date health risk and USEPA regulatory information for numerous chemicals. IRIS is USEPA's preferred source for toxicity information for Superfund.
K_{oc}	Provides a measure of the extent of chemical partitioning between organic carbon and water at equilibrium. The higher the K_{oc}, the more likely a chemical is to bind to soil or sediment than to remain in water.

K_d	Provides a soil- or sediment-specific measure of the extent of chemical partitioning between soil or sediment and water, unadjusted for dependence upon organic carbon. To adjust for the fraction of organic carbon present in soil or sediment (f_{oc}), use $K_d = K_{oc} \times f_{oc}$. The higher the K_d, the more likely a chemical is to bind to soil or sediment than to remain in water.
K_{ow}	Provides a measure of the extent of chemical partitioning between water and octanol at equilibrium. The greater the K_{ow}, the more likely a chemical is to partition to octanol than to remain in water. Octanol is used as a surrogate for lipids (fat), and K_{ow} can be used to predict bioconcentration in aquatic organisms.
Lifetime Average Daily Intake	Exposure expressed as mass of a substance contacted per unit body weight per unit time, averaged over a lifetime.
Lowest Observed Adverse Effect Level (LOAEL)	In dose-response experiments, the lowest exposure level at which there are statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group.
Maximum Contaminant Level (MCL)	A legally enforceable maximum concentration allowable for a chemical in drinking water.
Media-specific Half-life	Provides a relative measure of the persistence of a chemical in a given medium, although actual values can vary greatly depending on site-specific conditions. The greater the half-life, the more persistent a chemical is likely to be.
Nondetects (NDs)	Chemicals that are not detected in a particular sample above a certain limit, usually the quantitation limit for the chemical in that sample. Nondetects may be indicated by a "U" data qualifier.
No Observed Adverse Effect Level (NOAEL)	In dose-response experiments, an exposure level at which there are no statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered to be adverse or precursors to specific adverse effects. In an experiment with more than one NOAEL, the regulatory focus is primarily on the highest one, leading to the common usage of the term NOAEL to mean the *highest* exposure level without adverse effect.
No Observed Effect Level (NOEL)	In dose-response experiments, an exposure level at which there are no statistically or biologically significant increases in the frequency or severity of *any* effect between the exposed population and its appropriate control.
Off site	Off-base areas not controlled by the Air Force that are not likely the original source of contamination.

On site	On-base areas controlled by the Air Force that are likely sources of contamination.
Plant Uptake Factors	The ratio of the chemical concentration in the plant tissue to the chemical concentration in the soil.
Positive Data	Analytical results for which measurable concentrations (i.e., above a reporting limit) are reported. May have data qualifiers attached (except a U, which indicates a nondetect).
Quality Assurance Project Plan (QAPP)	Describes the policy, organization, functional activities, and quality assurance and quality control protocols necessary to achieve data quality objectives dictated by the intended use of the data (*RI/FS guidance*).
Quantitation Limit (QL)	The lowest level at which a chemical can be accurately and reproducibly quantitated.
Reference Dose (RfD)	The USEPA's preferred toxicity value for evaluating noncarcinogenic effects resulting from exposures at Superfund sites. See specific entries for chronic RfD and subchronic RfD. The acronym RfD, when used without other modifiers, either refers generically to all types of RfDs or specifically to chronic RfDs; it never refers specifically to subchronic RfDs.
Reporting Limit (RL)	Defined as the sample quantitation limit: the lowest level at which a chemical can be accurately and reproducibly quantitated.
Risk	The probability of injury, disease, or death under specific circumstances.
Risk Assessment	The determination of the kind and degree of hazard posed by an agent, the extent to which a particular group of people has been or may be exposed to the agent, and the present or potential health risk that exists due to the agent.
Routine Analytical Services (RAS)	The set of CLP analytical protocols that are used to analyze most Superfund site samples. These protocols are provided in USEPA Statements of Work for the CLP (*SOW for inorganics, SOW for organics*) and must be followed by every CLP laboratory.
Slope Factor (SF)	A plausible upperbound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upperbound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.
Solubility	An upper limit on a chemical's dissolved concentration in water at a specified temperature. Aqueous concentrations in excess of solubility may indicate sorption onto sediments, the presence of solubilizing chemicals such as solvents, or the presence of a nonaqueous phase liquid.

Special Analytical Services (SAS)	Nonstandardized analyses conducted under the CLP to meet user requirements that cannot be met using RAS, such as shorter analytical turnaround time, lower detection limits, and analysis of nonstandard matrices or non-TCL compounds.
Subchronic Daily Intake (SDI)	Exposure expressed as mass of a substance contacted per unit body weight per unit time, averaged over a portion of a lifetime (as a Superfund program guideline, two weeks to seven years).
Subchronic Reference Dose (RfD_s) or Reference Concentration (RfC_s)	An estimate (with uncertainty spanning as much as three orders of magnitude) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a portion of a lifetime (as a Superfund program guideline, two weeks to seven years).
Target Analyte List (TAL)	Developed by USEPA for Superfund site sample analyses. The TAL is a list of 23 metals plus total cyanide routinely analyzed using RAS.
Target Compounds List (TCL)	Developed by USEPA for Superfund site sample analyses. The TCL is a list of analytes (34 volatile organic chemicals, 65 semivolatile organic chemicals, 19 pesticides, 7 polychlorinated biphenyls, 23 metals, and total cyanide) routinely analyzed using RAS.
Threshold Limit Values (TLVs)	Refers to airborne concentrations of substances and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects.
Toxicity Value	A numerical expression of a substance's dose-response relationship that is used in risk assessments. The most common toxicity values used in Superfund program risk assessments are reference doses (for noncarcinogenic effects) and slope factors (for carcinogenic effects).
Unit Risk	The upperbound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 μg/L in water or 1 $\mu g/m^3$ in air.
Vapor Pressure	The pressure exerted by a chemical vapor in equilibrium with its solid or liquid form at any given temperature. It is used to calculate the rate of volatilization of a pure substance from a surface or in estimating a Henry's Law constant for chemicals with low water solubility. The higher the vapor pressure, the more likely a chemical is to exist in a gaseous state.
Weight-of-Evidence Classification	An USEPA classification system for characterizing the extent to which the available data indicate that an agent is a *human* carcinogen. Recently, USEPA has developed weight-of-evidence classification systems for some other kinds of toxic effects, such as developmental effects.

Section 10
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