AL/OE-TR-1993-0167

ARMSTRONG LABORATORY

HEALTH RISK SURVEY FOR GALENA AIRPORT, ALASKA: AIR PATHWAY EVALUATION

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May 1994

Final Technical Report for Period 16-23 June 1993

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	May 1994	Final 16-23 June 1993

4. TITLE AND SUBTITLE

Health Risk Survey for Galena Airport, Alaska: Air Pathway Evaluation

5. FUNDING NUMBERS

6. AUTHOR(S)

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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8. PERFORMING ORGANIZATION REPORT NUMBER

AL/OE-TR-1993-0187

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Armstrong Laboratory conducted an environmental survey at Galena Airport (ARPT), Alaska, to further assess ARPT environmental emissions and provide a preliminary human health risk evaluation. This was accomplished by focusing on the on- and off-base air exposure pathways via soil gas testing and air sampling surveys. Results from these limited surveys indicate that noncarcinogenic and carcinogenic health effects from ARPT emissions should not adversely affect the health of nearby workers or residents. Air sampling-derived carcinogenic health risks for residential areas where 24-hour/day exposures are expected, ranged from 1/240,000 to 1/615,000. Where the receptors are workers exposed for only 40-hrs/wk, the actual risks are less than 1 in 347,000. Recommendations include determining the background benzene level and further evaluating areas where high benzene vapor concentrations were identified. The soil gas sampling results indicate (above 80% confidence) that locations to the north of the civilian flying services (upgradient) had greater VOC concentrations than did those samples taken to the south (downgradient), suggesting that the contamination (plume) originated in the petroleum, oil, and lubricants (POL) area and not the flightline. The relationship of higher VOC concentrations measured in soil gases upgradient was not observed in the ambient/indoor air sampling results. Recommendations include continued soil gas well surveillance throughout the POL remediation process.

14. SUBJECT TERMS

Air sampling
Soil gas

15. NUMBER OF PAGES

60

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

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LIST OF ACRONYMS

ACGIH	-	American Conference of Governmental Industrial Hygienists
AFB	-	Air Force Base
AL	-	Armstrong Laboratory (Brooks AFB, Texas)
ARPT	-	Airport
ARAR	-	Applicable or Relevant and Appropriate Requirements
AVGAS	-	Aviation Gasoline
BGL	-	Below Ground Level
BLM	-	Bureau of Land Management
BTEX	-	Benzene, Toluene, Ethyl Benzene, and Xylene
BTM	-	Bottom
CE	-	Civil Engineer
CFR	-	Code of Federal Regulations
FPTA	-	Fire Protection Training Area
GC	-	Gas Chromatograph
LOQ	-	Limit of Quantification
MCL	-	Maximum Contaminant Level (EPA Drinking water standard - mg/L)
MOGAS	-	Motor Gasoline
MS	-	Mass Spectroscopy
MW	-	Monitoring Well
NIOSH	-	National Institute for Occupational Safety and Health
OEMH	-	Environmental Sciences Branch of the Occupational Medicine Division (formerly OEMB)
OSHA	-	Occupational Safety and Health Administration
PEL	-	Permissible Exposure Limit
PID	-	Photoionizing Detector
POL	-	Petroleum, Oil, and Lubricant
PPE	-	Personal Protective Equipment

PPM	-	Parts of a Chemical per Million Parts of Air
RfC	-	Reference Concentration
RfD	-	Reference Dose
RI/FS	-	Remedial Investigation/Feasibility Study
SB	-	Soil Boring
SGPB	-	Bioenvironmental Engineering Section
TLV	-	ACGIH's Threshold Limit Values®
USAF	-	(AF) United States Air Force
US EPA	-	(EPA) United States Environmental Protection Agency
UST	-	Underground Storage Tanks
VOC	-	Volatile Organic Compound
VMB	-	Vehicle Maintenance Building
WUA	-	West Unit Area
cm/sec	-	Centimeters per Second
mg/L	-	Milligrams per Liter
$\mu g/m^3$	-	Micrograms per Cubic Meter

HEALTH RISK SURVEY FOR GALENA AIRPORT, ALASKA: AIR PATHWAY EVALUATION

INTRODUCTION

Purpose

The USAF Armstrong Laboratory/Environmental Sciences Branch (AL/OEMH) conducted an environmental health risk survey of the Galena Airport (ARPT), at the request of 11 CEOS/CEV and 3 AERMS/MGAB, Elmendorf Air Force Base (AFB), Alaska, from 16-23 June 1993. The purpose of this evaluation was to further assess ARPT environmental emissions and provide a preliminary evaluation of possible human health risks. Our primary concern was the contamination in the petroleum, oil, and lubricants (POL) area and subsequent volatilization, and the potential receptors included on-site (i.e., USAF personnel) and off-site (i.e., Old Town Galena residents) residents and workers. The focus was to evaluate volatile contaminants in the air exposure pathway.

Survey Team

Capt Wade Weisman, Mr Don Hammer, Mr Jody Wireman, TSgt Ralph Westbrook

Summary

Site Visit Activities

The survey team accomplished the following:

- Evaluated existing data to determine potential sampling locations.
- Measured soil gas concentrations using two sampling methods, both on- and off-base.
- Collected air samples on base, in and around the civilian flight services, and at nearby receptor locations (e.g., Old Town Galena).
- Accomplished air sampling with two types of sampling media and analytical techniques for benzene, toluene, ethyl benzene, and xylene (BTEX): National Institute for Occupational Safety and Health (NIOSH) and Environmental Protection Agency (EPA) recommended methods were used.

Findings

Based on the analyses of limited air sampling and soil gas test results, increases in noncarcinogenic and carcinogenic health effects from Galena ARPT emissions are within

accepted levels (1). Calculated noncarcinogenic and carcinogenic risks are presented in Table 3 and discussed in the section "Health Risk Assessment by Zone Section," page 18.

Additional findings based on the analyses were as follows:

Noncarcinogenic Exposures via Air Pathway.

Noncarcinogenic Exposures by Zone. An evaluation of ambient and occupational air sampling results (by area and zone) indicated that the combined and chemical-specific noncarcinogenic effects environmental exposures to toluene, ethyl benzene, and xylene should not adversely affect human health (Table 3). Zonal areas were created based on activities that occurred in these "zones." All samples collected in these areas were compiled to determine a "risk" associated with the zone. When the ground is mechanically disturbed (e.g., during remediation) in areas where plumes have been located, appropriate sampling methods should be used to determine if adequate personal protective equipment (PPE) is being provided. The PPE should be task- and location-specific.

Toluene Exposures. The city landfill toluene exposure levels are of concern since they may contribute to exposures to on- and off-base residents downwind of the landfill. Two other areas, NW of the Storage Tanks in Old Town Galena and N of Mark Air Express, are also of concern due to toluene exposures.

Carcinogenic Exposures (Benzene) via Air Pathway.

Benzene Health Risk Assessment by Zone. Carcinogenic risks associated with base air emissions are within accepted levels (Table 3), based on the limited survey. Benzene is the only BTEX chemical with a comparison value base on its carcinogenic effects. Air sampling results, evaluated by zone, were within EPA recommended benzene air exposure levels in the residential areas and higher in areas normally occupied by workers.

Benzene Health Risk Assessment by Sample. Benzene ambient air results were evaluated with three comparison values. Throughout Old Town Galena and in and around the entire Galena ARPT, benzene samples exceeded the most protective health comparison value recommended by the EPA. Nine areas were identified as being in the highest exposure category. The main concern with these areas is possible air transport to residential areas. A third comparison value indicated that several areas inhabited or used for recreation by Old Town Galena residents have benzene concentrations that are of concern. Areas of concern include:

- Old Town Galena community playground
- NW of Storage Tanks
- West Edge of Old Town Galena
- Galena Public Softball Field

Determining the source of the benzene air exposures for these areas is difficult, although vehicular and aircraft activity appear to be involved in each of the samples.

Petroleum, Oil and Lubricants Area and Civilian Flying Services. It is difficult to differentiate the contribution from the POL and civilian refueling operations for a number of reasons:

- variability in results
- improper/proper storage and use of petroleum-based products by the civilian air operations
- proximity of hangar openings (location of a few samples) to the apron
- vehicular traffic near sample locations

Soil-gas well samples indicate the plume may be migrating from the POL storage yard and toward the civilian flying services, which indicates that emissions in these areas are associated with the POL

February (Pre-Thaw) Survey. Indoor and ambient locations resulted in higher benzene, toluene, and ethyl benzene concentrations during the 3 AERMS/MGAB/SGPB 06-07 February sampling than during this survey, 16-21 June. This indicates that the civilian flying services may be increasing their worker's exposures in the winter months. Ambient February locations were in close proximity to building openings, differing from the June study. Portable air sampling pumps permitted more remote ambient sampling during the June survey. However, comparison between the two sampling times indicates that the main source of elevated BTEX in the air is not due to environmental contamination emanating from ARPT (i.e., POL-related chemical plume), but from other sources (i.e., vehicular).

Radian Corporation Air Modeling. It appears that the volatile organic compounds (VOCs) air emissions modeled by Radian (remedial investigation (RI) contractor) are lower than the actual emissions emanating from the ARPT. However, due to the lack of sampling data and the subsequent inability to delineate ARPT VOC emissions from those emanating elsewhere (e.g., vehicle and aircraft emissions) the Radian air modeling data can be neither validated nor invalidated.

Soil Gas - Conduit. A conduit-derived soil gas measurement taken near MW04 (Figure A2 - site ID#2) signifies that the potential for volatilization may exist for the plume located in this area. Two other measurements taken W/SW of MW04 also read above zero, at 12.5 and 12 meter units. As expected, samples taken near the POL tanks indicated that volatilization was occurring in this area and that this area is a VOC emission source.

Soil Gas Wells. The results from the soil gas wells indicate that the locations to the N/NE had greater concentrations of VOCs than did samples taken to the S/SW. This, in conjunction with the knowledge that the POL is upgradient from the civilian flying

services, suggests that the contamination (plume) originated in the POL and may extend under the civilian flying service buildings. Note that if dumping activities occurred at the civilian flying services, it would have to occur on their facilities' upgradient side due to the down gradient proximity of the tarmac flightline. Results of dumping activities may have contributed to the higher upgradient soil gas well readings.

Leaks. Active isopropanol and aviation gasoline (AVGAS) leaks in the POL area and truck refueling area were observed.

Mock-up Plane. The fire protection training area (FPTA) is in close proximity to the softball field where children play and these children may be attracted to the aircraft mock-up inside the FPTA.

GEOLOGY/HYDROLOGY AND OBSERVATIONS

Geology/Hydrology

Galena ARPT is located on an extensive alluvial floodplain along the N bank of the Yukon River. The river is totally uncontrolled with the exception of a protective levee which surrounds the base proper. There is considerable flux in water levels of the river, depending on seasonal precipitation and ice jams. Being in a broad alluvial plain, the Yukon River is subject to frequent flooding and channel migration. Much of the Yukon River at Galena has braided channels and the materials along the banks and beds are made up of silty-sand and some gravel. Almost all of it is unconsolidated and loose. Because of this, soil is easily subjected to erosion and deposition. It is also highly permeable, allowing high hydraulic conductivity to exist between the surface and ground water.

The alluvial aquifer of the Galena area consists of three main units. The upper unit immediate to the ground surface consists of a very fine-grained, poorly graded, sandy silt that contains a lot of organic matter. This unit is about 5 to 15 feet thick. In swales at the toes of the abandoned stream bed islands, sandy gravel up to 20 feet thick is common. The middle unit consists of fine grain sand ranging from 20 to 40 feet thick with gravel-sand stringers. The lower unit consists of fine-to-coarse grained, well-graded gravel and sand. Clays and silty clays are absent in the upper 60 feet of the aquifer. Permeability tests of the upper silty sand unit show hydraulic conductivities ranging from 0.00005 to 0.0001 centimeters per second (cm/sec).

Only a few shallow permafrost zones have been found and range between 25 to 40 feet below ground surface. The permafrost exists under heavily wooded areas (particularly under spruce communities), in high river terraces, under some buildings, and a pervasive frost layer was found 10 feet below ground in the levee.

During the months of October through May, approximately the top 5 to 10 feet of soil is frozen due to the extremely cold temperatures in this high latitude region. Consequently, there is little interaction of soil gases or volatilization from either the valdose zone or ground water, respectively.

Water level surveys were conducted from July 1992 to March 1993. The hydraulic head has a wide fluctuation, but is generally 10 to 15 feet below ground level (bgl). Ground water levels were measured as low as 22 feet in July 1992 and close to the immediate surface during high river stages. Ground water gradient is approximately 0.0004 to 0.002 cm/sec, and flow is generally SW. The pH of the ground water is neutral (6.7-7.4) and the July temperature ranges from 54 to 34 degrees fahrenheit, at the surface and 20 feet bgl, respectively. Of course, the soil is generally frozen in January.

Further analysis of transmissivity, permafrost extent, and pollution plumes are currently being conducted by the Radian Corporation.

Observations

Petroleum, Oil and Lubricants Area

The POL area is on the E end of the base (excluding the runway). All diesel and motor gasoline (MOGAS) tanks are scheduled to be extracted and replaced with a million gallon tank, while the isopropanol and AVGAS tanks will remain. The isopropanol (deicing) tanks are leased by the Bureau of Land Management (BLM) from the AF through 1996.

Active isopropanol and AVGAS leaks in the POL area and truck loading facility were observed. If left unattended, either of these leaks could release more than 1,200 gallons per year. The 11 CEOS/CEV was informed of the leaks. Their policy is to shut-off the leaking line and then either repair or remove the lines/tanks or both from service. Vegetation within POL area confining berms showed signs of stress from ground saturation of product. For example, stunted growth and areas without vegetation were observed, particularly under the pipelines leading to the tanks. In addition, stressed vegetation was also observed in the truckstand area.

Fire Protection Training Area. The FPTA is close to the E end of the runway. A private operation N of the area and across the levee is suspected of contributing to the FPTA plume. Observations included improperly stored and maintained drums and tanks, and questionable activities within the facility. This area also sits in an old abandoned channel of the Yukon River that at one time flowed northward. Ground water movement is more N and S along the old filled-in channel, depending on hydraulic head of the river.

There is no berm or fence surrounding the area that was once used for fire protection training. The FPTA is in close proximity to the softball field where children play and there is a slight possibility that these children may be attracted to the aircraft mock-up inside the FPTA. The pathway of concern is potential surface soil contamination. It is recommended that the mock-up plane be removed or that a barrier fence be placed around the FPTA.

Old Town Galena

It is evident that Old Town Galena has hydrocarbon contamination. However, local sources in the town appear to be the sources of the contamination. Many storage tanks of various sizes were located throughout Old Town Galena, some noticeably emitting odors. A tour of the river bank and barge loading dock showed no visible signs of hydrocarbons. No oil slicks or sheens were present along or on the river. The river was flowing at approximately 4-5 knots. The potential groundwater contamination sources for Old Town Galena include: the ARPT, barge loading dock located W of Old Town Galena, civilian flying services/ operations, various tanks/drums throughout the town, and several fuel oil storage tanks north-centrally located in Old Town Galena.

City Landfill

The city landfill is located NW of the base in a low area, once part of an old braided channel long since abandoned by the Yukon River. It is still actively being used by civilian and governmental agencies, and is not owned by the airport. Based on the results of the air sampling, visual observation of barrels, and fact that this dump is not restricted, it is recommended that monitoring wells be installed. The purpose of installing wells is to determine whether contaminants from the landfill could impact the environment, to include water quality and human health (food chain).

AIR MONITORING

Overview

To determine sampling points and contaminants of interest for this survey, Radian Corporation (the RI/FS contractor) results from groundwater, surface water, surface soil and subsurface soil sampling, and air modeling were reviewed. The locations and results from the 06-07 February 1993 air sampling survey were also evaluated. This survey was conducted by the 3 AERMS/SGPB (Page 23, Air Sampling Section). Based on these reviews, areas of potential contaminant releases were determined and a sampling plan was developed. The goal of the sampling was to 1) provide preliminary insight about the existence of air emissions and their characteristics by performing on-site measurements during the spring thaw, when the water table is most elevated, 2) screen VOC air exposures from the release points to perform a public health risk

assessment, 3) qualitatively determine extent (spacial distribution) of the releases, 4) provide limited discernment between the releases from the Galena APRT and civilian flying service activities, 5) make available actual data to compare with the dispersion modeling calculations generated by the Radian Corporation's air modeling, and 6) serve as an additional data base for performing the evaluation of remedial alternatives.

Identification of Contaminants of Concern

The Radian Corporation results included a report of samples that exceeded the EPA regulated 1) applicable or relevant and appropriate requirements (ARARs) for soil clean-up and 2) maximum contaminant levels (MCLs) for groundwater or surface water. These results indicated that volatile organic compounds (VOCs) were present in either the surface soil, subsurface soil, surface water, or groundwater at the POL, FPTA, vehicle maintenance building (VMB), and west unit area (WUA) areas.

Chemical-specific data indicated that benzene, toluene, ethyl benzene, and xylene (BTEX) were the contaminants of interest, due to their prevalence and potentially toxic effects via the air exposure pathway. Benzene, because of its carcinogenic properties, was determined to pose the greatest potential for adverse health effects. Therefore, it was the major focal point of this survey. The remaining BTEX chemicals, were also evaluated during this survey for potential and noncarcinogenic health effects.

Air Sampling Locations (Figures 1-5) and Methods

Air sampling was conducted to quantitatively screen the BTEX chemicals throughout the Galena APRT and surrounding areas. Ambient BTEX samples were collected with calibrated pumps (DuPont Alpha® 1 and 2) that pulled air through collection media. To obtain a detection low enough for comparison with recommended benzene exposure guidelines, two samples (graphitized carbon and activated charcoal collection tubes) were taken at each site. The graphitized carbon, because of the sampling and analytical procedure, allowed for a lower detection. However, the charcoal tubes permitted samples to be taken for a longer period of time, increased the overall total of samples collected during the field study, and provided useful information for determining areas of concern (high concentrations). Approximately 28 graphitized carbon and 32 charcoal media ambient air samples were taken. Twenty-four of these air samples were taken at fixed locations inside or at the perimeter of the Galena ARPT, six locations in Old Town Galena, and one at the Landfill west of the ARPT.

Six indoor graphitized carbon and ten charcoal media samples were taken inside of three civilian flying services (Larry's Flying Service, Mark Air Express, and Frontier Flying Service), the AF Hangar, and the Civil Engineer (CE) office.

All samples were taken approximately 4 to 5 feet above the ground surface to represent the actual exposures that an individual would receive if located in the sampled area. Care was also taken to ensure that natural and man-made obstructions that could affect or alter the airflow near the sampler intake were avoided. Sample duration was approximately 8 hours for the graphitized carbon and most indoor air samples taken with charcoal tubes. The sample duration for the charcoal media ambient air and the remaining indoor air samples was 16 hours.

Sampling and analysis were performed in accordance with appropriate NIOSH and EPA sampling methods. Air samples were taken from ambient and indoor locations. The charcoal tubes were analyzed by AL/OEB. Each charcoal tube was analyzed for benzene, toluene, ethyl benzene, and xylene (BTEX) using a gas chromatograph (GC), a second column for confirmation, and a Photoionizing Detector (PID). NIOSH Method 1501 was used to evaluate each chemical.

The graphitized carbon samples were analyzed by the 11 CEOS/C hemical laboratory according to EPA Method TO2. The BTEX chemicals we hermally desorbed from the media into a GC/mass spectroscopy (MS) detection system.

Activated charcoal and graphitized carbon blanks were also analyzed to control possible sample collection, transport, and analytical errors.

Soil Gas Sampling

Direct reading instruments and sampling techniques were used to evaluate soil gas VOC levels around the POL area and the civilian flying service facilities. These screening results were taken to 1) further evaluate the extent of the plume, 2) partially determine the contaminant contributions from the civilian flying services, 3) pinpoint hot spots where chemical-specific samples should be taken, and 4) assist Radian in identifying the contaminant plume and in locating new groundwater sampling locations.

Soil gas sampling served as a VOC screening technique. The Photovac PID measures compounds that volatilize off the soils. PID results serve as an indicator that VOCs may be present. Since many organic and inorganic compounds are measured simultaneously, the results are not chemical-specific. Therefore, the results cannot be read directly from the meter in parts per million of a specific contaminant but in meter units. The PID was calibrated with isobutylene calibration gas according to the operators's manual.

Two types of sampling techniques were used during the survey. The first sampling technique involved placing a probe (a 4 foot steel conduit with a 4.5 foot steel rod occupying the hollow area of the conduit) into the ground approximately 2 feet. The rod was then removed and the soil gas entered through slots in the conduit. To allow sufficient time for the influx of soil gas, a 1-hour minimum waiting period was observed

prior to sampling. A Photovac PID was attached to a sampling tube and the tube was lowered into the conduit, 1 to 1 ½ feet below the ground surface and measurements were taken. Prior to sampling at a new location, the conduit and rod were cleaned with purified drinking water, and the PID was purged.

Soil gas samples were taken at 29 locations inside the POL and between the perimeter of the POL and the civilian flying services, using the first soil gas sampling method. The reference point (sample location) for each sample will be surveyed in. The sample locations were as follows:

- SE of POL Storage Tank area (14 samples). The first sample was taken 2 feet from the fence and 12 feet toward the road. Eight subsequent samples were taken at 25 foot intervals W of the proceeding sample (nine total samples). Five subsequent samples were taken at 10 foot intervals W of the ninth sample.

- Inside POL Storage Tank area (6 samples). The samples were collected at 25-30 foot intervals along the berm surrounding the POL area. The first sample was taken in the SE corner of the berm and subsequent samples were taken W of this point.

- POL Storage Tanks (3 samples). Samples were taken at tank numbers 1,4, and 7.

- W of MW04 (6 samples). Samples began directly S of MW04 and 5 feet N of the dirt road, and followed the roadway at varying distances.

The second type of soil gas sampling involved the use of soil gas monitoring wells installed and monitored by 11 CEOS/CEV personnel. These soil gas wells are located along the N and S sides of the civilian flying services. Eleven wells are situated on the northern and 10 on the southern side of the civilian flight line fence, for a total of 21 wells.

The sampling technique involved attaching a Teflon tube to the fitting at the bottom of the well, thus creating a seal between the screened zone and monitoring instrument. The PID sampling probe was then placed inside the tube. While the PID sampled, it created a vacuum and, therefore, only soil gases from the well were sampled. Sixteen locations were sampled on 20 June and 18 readings were made on 21 June, due to well accessibility.

Equipment Maintenance

The sampling pumps, Photovac PID, and charcoal sampling tubes were provided by the Occupational, Environment, Medical, and Industrial Hygiene (OEMI) Branch. OEMI performs maintenance on the equipment and to ensure that the equipment is in good working condition prior to its issuance. The graphitized carbon tubes were provided by 11 CEOS/CEV.

AIR SAMPLING AND SOIL GAS TESTING RESULTS

Air Sampling

This section contains the results from ambient and indoor air sampling. Prior to reviewing the results, comparison values and the selection process to determine the values are presented.

Health Risk Comparison

Combined Health Effects. To identify whether adverse health effects could result from exposure to BTEX chemicals, their combined effects were evaluated. This was accomplished by dividing the BTEX chemicals into categories: 1) carcinogenic - benzene and 2) noncarcinogenic - toluene, ethyl benzene, and xylene. Health risks from the individual chemicals are combined to determine total carcinogenic and noncarcinogenic health risks. Since benzene comparison values are based solely on its carcinogenic effects, it was not included in the noncarcinogenic health effects category. Similarly, toluene, ethyl benzene, and xylene values were not used to evaluate carcinogenic effects, because their levels are based only on noncarcinogenic health effects.

Chemical-Specific Health Effects. Prior to determining the combined health risks associated with the Galena ARPT, it was necessary to identify the risks associated with each specific BTEX chemical. Advisory levels were developed by using the best available risk assessment guidelines. In developing the advisory levels, conservative estimations and worst case scenarios were used. The guidelines assume that exposures continue for 24 hours a day, over a 70-year lifetime. Benzene, toluene, ethyl benzene, and hexane air exposure guidelines used for comparison (reference concentrations - RfCs) were available from the EPA (2). Xylene air exposure guidelines were not available, so levels based on the xylene maximum contaminant level (MCL) and the reference dose (RfD) were calculated. The MCL was the most protective advisory level, so it was used for comparison. To transform the MCL from mg/L to an air concentration ($\mu g/m^3$), the average adult daily intake of water (two liters) and average inhalation rate for an adult performing moderate work activities (20 m^3/day - EPA 1989) were used. It

was assumed that the xylene absorption rates are comparable regardless of route of entry. The computation was made according to the following formula:

Formula 1. (USED FOR XYLENE):
[MCL (mg/L) x 2 (L/day)] X [1 / avg inhalation rate (m3)] X [1 / percentage of year ground is not frozen]

The ground surface is frozen more than half the year. To correct for this, it was conservatively assumed that emissions from the soil only occurred 6 months per year (percentage of year ground is not frozen - Formula 1).

Benzene. Although benzene concentrations are typically not higher than other BTEX chemicals, its high toxicity makes it the chemical of greatest concern. The EPA has established benzene hazard rankings for 1 excess cancer per 10,000 people (E-4), 1 in 100,000 (E-5) and 1 in 1,000,000 (E-6) risks associated with specific ranges of airborne benzene concentrations. An excess cancer rate represents an increase in cancers (carcinomas) above the rate that is expected. For instance, if the number of cancers is expected to be 300 per 10,000 people, a 1 in 10,000 increase would raise the expected carcinomas from 300 to 301. The benzene health risk levels are as follows: E-4 - 12 $\mu g/m^3$, E-5 - 1.2 $\mu g/m^3$, E-6 - 0.12 $\mu g/m^3$. The advisory levels are doubled, E-4 = 24 $\mu g/m^3$; E-5 = 2.4 $\mu g/m^3$; E-6 = 0.24 $\mu g/m^3$, allowing twice the exposures during the nonfrozen months.

Toluene. The toluene RfC is 400 $\mu g/m^3$, assuming that exposures continue for 24 hours a day, over a 70-year lifetime. Again, to estimate the average exposures for Galena, Alaska, it was conservatively assumed that the surface ground is frozen 6 months per year. This raised the advisory level to 800 $\mu g/m^3$.

Ethyl Benzene. The ethyl benzene RfC is 1000 $\mu g/m^3$. Since exposures from groundwater sources occur only when the ground is not frozen, the comparison value was doubled. The ethyl benzene advisory level was set at 2000 $\mu g/m^3$.

Xylene. Formula 1 was applied to the xylene MCL, 10 mg/L. to obtain an air exposure advisory level. The MCL was first doubled, since the average person drinks two liters of water, and the result or allowable daily intake was 20 mg. To factor in the respiratory rate, the daily intake (20 mg) was divided by 20 m^3. The result, 1 mg/m^3 or 1000 $\mu g/m^3$, was then divided by the percentage of time the ground is not frozen (50%) to calculate the advisory level, 2000 $\mu g/m^3$.

Hexane. The n-hexane RfC is 200 $\mu g/m^3$. This value was doubled to 400 $\mu g/m^3$ for comparison, since the ground is frozen 6 months per year. Hexane was evaluated in the 3 AERMS/MGAB survey.

Occupational. Prior to evaluating industrial exposures, the results were first compared with the advisory levels mentioned previously. When evaluating occupational exposures, the most protective of the American Conference of Government Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) and Occupational Safety and Health Administration (OSHA - 29 CFR 1910.1000 and .1028) Permissible Exposure Limits (PELs) were used:

Benzene - 3250 $\mu g/m^3$ (1 ppm) and Action Level - 1625 $\mu g/m^3$
Toluene - 383000 $\mu g/m^3$ (100 ppm)
Ethyl Benzene - 441000 $\mu g/m^3$ (100 ppm)
Xylene - 441000 $\mu g/m^3$ (100 ppm)
Hexane - 176000 $\mu g/m^3$ (50 ppm)

Air Sampling Results (Tables A1 and A2 - Figures A1-5)

The results appear on Tables A1 and A2. These tables include sample location ID number, description of location, sample ID number, duration, date, BTEX chemical-specific results in micrograms of contaminant per cubic meter of air ($\mu g/m^3$), and comparison values (advisory levels).

Samples that result in less than values (e.g., < 2) indicate that the contaminant concentrations were not determined. It is inappropriate to estimate what concentrations these values represent. Therefore, activated charcoal sample results were not used for health risk evaluation, unless they 1) indicated a lower exposure than was measured with graphitized carbon (e.g., SW Larry's Flying Service) or 2) were properly quantified (e.g., City Landfill). The limit of quantification (LOQ) or reported limit for the graphitized carbon samples were 300 times more sensitive than the charcoal media samples. The LOQs for graphite carbon were 0.0113 μg for benzene, toluene, and ethyl benzene and 0.0325 μg for xylenes, while the LOQs for charcoal media were 4.06 μg (benzene), 9.95 μg (ethyl benzene and xylene) and 11.98 μg (toluene).

Petroleum, Oil, and Lubricants Area (Tables A1 and A2 - Figure A2). Benzene results from 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 (Table 1, pg 13). The nearest receptors (24 hours/day) to the POL are the on-base housing units. Near Building 1874, the closest unit, resulted in a benzene level of 0.54 $\mu g/m^3$.

Samples taken upwind from the POL area resulted in benzene measurements of 4.8 $\mu g/m^3$ (N of AVGAS tanks), 10 $\mu g/m^3$ (SE of Truckstand), and less than 13 $\mu g/m^3$ (NW of Truckstand). The 10 $\mu g/m^3$ measurement most likely reflects the transfer of petroleum products at the truckstand. However, no samples were quantified for the upwind sample location.

Table 1. POL Area Benzene and Toluene Sample Results ($\mu g/m^3$)

Upwind	Benzene	Toluene
On-base receptor (SE corner - Bldg 1874)	0.54	1.6
N of AVGAS	4.8	8.9
NW of Truckstand	*< 13	
SE of Truckstand	10 (*<13)	16
Downwind		
N of Mark Air Express	6.4	12 (*150)
NE of Bldg 1556	1.2	4.2
Old Galena Air Svc Building	3.3	6.7
Inside Larry's Flying Service (SW)	30,<3*,<11* 59,<9*,<33*	
Inside Larry's Flying Service (SE)	3.2,4.3	11,12
Inside Mark Air Express (SE)	3.1	18

* indicates samples taken with charcoal tubes

Benzene samples taken downwind from the POL resulted in concentrations of 1.2 $\mu g/m^3$ (NE of building 1556 - across dirt road) and 6.4 $\mu g/m^3$ (N of Mark Air Express - across dirt road). The lognormal mean of the up and downwind locations overlap (2.96 +/- 5.42 and 3.89 +/- 3.21), thus, it is not possible to statistically differentiate whether VOC concentrations are lower downwind (S/SW) from the POL area. Results were lognormalized, since the lognormal distribution is a good model for air quality data (4). Indoor samples are discussed in the following section (Indoor Air Sampling).

At the sample location N of Mark Air Express, the charcoal media toluene result was 150 $\mu g/m^3$, while the graphitized carbon sample result was only 4.2 $\mu g/m^3$. This suggests that daily fluctuations in contaminant concentrations may be high. These fluctuations are probably due to environmental (e.g., temperature changes and groundwater movement) and traffic pattern (e.g., automobile and aircraft) variations.

All samples for ethyl benzene, xylene, and toluene were well below their respective comparison value (Tables A1 and A2).

Indoor Air Sampling

Civilian Flying Services (Tables A1 and A2 - Figure A2). Indoor air samples were collected at Larry's Flying Service, Mark Air, and Frontier Flying Service

(Table 2). Indoor air benzene concentrations ranged from less than 3 $\mu g/m^3$ to 30 $\mu g/m^3$. Both ends of the range were measured in the SW corner of Larry's Flying Service. Benzene measurements taken in the SE corner of Larry's Flying Service (two measurements), outside the Mark Air Express owned Old Galena Air Service Building, and in the SE corner of Mark Air Express, were 3.2-4.3 $\mu g/m^3$, 3.3 $\mu g/m^3$, and 3.1 $\mu g/m^3$, respectively. These values were above the E-5 comparison value of 2.4 $\mu g/m^3$ and well below the worker allowable level of 3250 $\mu g/m^3$.

Table 2. Civilian Flying Service Benzene Results

Civilian Flying Service	Benzene ($\mu g/m^3$)
Indoor Samples	
Larry's Flying Service (SE Corner)	3.2, *<13
Larry's Flying Service (SW Corner)	30, *<11, *<3
Frontier Flying Service	*<18
Mark Air Express (SE Corner)	*<9
Outdoor Sample	
Old Galena Air Service Bldg (SW Corner)	3.3

* indicates samples taken with charcoal tubes

The only air sample collected and analyzed from the inside of Frontier Flying Service could not be quantified, at less than 18 $\mu g/m^3$. Frontier Flying Service and Mark Air Express workers should not be exposed to high levels of VOCs from the planes, environmental contamination , or both, during their daily operations, since these hangars are only used for handling packages or mail and personnel are not in the hangars for extended periods of time.

Three benzene samples were collected and analyzed from the SW Corner of Larry's Flying Service. The first sample measured 30 $\mu g/m^3$. It was both the highest benzene value measured indoors and the highest measured with graphitized carbon. The two benzene samples taken with the charcoal tubes measured less than 11 $\mu g/m^3$ and less than 3 $\mu g/m^3$. It was apparent by questioning, that only Larry's Flying Service does aircraft maintenance directly at the hangar. However, construction at the hangar entrance did not permit aircraft maintenance on the survey days. Therefore, the results we obtained may be representative of the minimum VOC exposures experienced by Larry's Flying Service workers. A contributor to the observed VOC levels at Larry's

Flying Service were two sumps/pits that are used to dump unknown materials that may have been petroleum-based. Stains were observed in both of these pits.

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 hangar openings are right on the apron and aircraft pass directly by the entrance to the hangars.

No toluene, ethyl benzene or xylene results approached their chemical-specific comparison values at these locations (Tables A1 and A2).

On-Base Indoor Samples (Tables A1 and A2 - Figure A4). The only on-base indoor samples were collected from the CE office and in the E side of building 1551 (hangar). The CE office average benzene concentration was 4.1 $\mu g/m^3$, close to outdoor sample results from the same area. This result may be due to vehicular activity from within the hangar, aircraft activity outside the hangar area, ambient exposures from area (outdoor) sources, and/or a small diesel fuel leak in the building 2 days prior to sampling. The leak was discovered and repaired within 1 day. Photoionization detector measurements taken from the confined space below the leak area resulted in a total VOC concentration below the detection limit, 0.0 meter units. The measurement taken inside the hangar was not quantified, less than 7 $\mu g/m^3$.

All toluene, ethyl benzene and xylene results were well below their chemical-specific comparison values (Tables A1 and A2).

West Unit Area (Tables A1 and A2 - Figure A3). Sample in the NW side of the ARPT were 0.33 $\mu g/m^3$ on the perimeter fence N of Building 1769 and 1.8 $\mu g/m^3$ SE of Building 1342. The perimeter measurement was taken at the fenceline between the ARPT and the nearest receptors to the N, the Bureau of Land and Management (BLM) housing area.

The only two results analyzed from the samples collected upwind and downwind from the underground storage tanks (USTs) could not be quantified. Resulting benzene measurements were less than 14 $\mu g/m^3$ at the upwind and downwind locations.

No West Unit area toluene, ethyl benzene, or xylene results approached their chemical-specific comparison values (Tables A1 and A2).

On-Base Vehicle Maintenance Building Area (Tables A1 and A2 - Figure A4). The measurement taken S of the Jet Fuel Water Separator building, had a measured

benzene concentration of 5.5 $\mu g/m^3$. This concentration may have resulted from the fueling operations that normally occur in this area. All VMB toluene, ethyl benzene, and xylene results were well below their comparison values.

Fire Protection Training Area (Tables A1 and A2 - Figure A5). The graphitized carbon samples collected in the FPTA resulted in benzene concentrations of 0.14 $\mu g/m^3$ SE of the FPTA and 0.20 $\mu g/m^3$ NW (upwind) of the FPTA and S of a local business. In addition, no toluene, ethyl benzene, or xylene results approached their chemical-specific comparison values.

The fire protection training area (FPTA) BTEX results were below all other results, including samples taken in residential areas. Thus, it does not appear that VOCs are being emitted into the air at concentrations that could result in adverse effects. The sample collected to the NW of the FPTA was only 0.20 $\mu g/m^3$. This value is relatively low compared to other BTEX measurements; however, it should be noted that there is a private operation upwind and upgradient (N) of the FPTA. This private operation may be a contributor to the FPTA plume or could be producing its own plume. The operation and the area surrounding it contains a number of storage tanks, refueling operations, and a large maintenance building. The sample taken during this survey suggests that further sampling of various media may not be warranted N of the FPTA. However, ongoing groundwater and soil sampling may indicate otherwise.

Residential Areas (Receptor Locations)(Tables A1 and A2 - Figure A1). Only one residential area sample location result approached a comparison value (Old Town Galena - oil storage tanks). All ethyl benzene, xylene, and all other toluene results were well below their respective comparison values. Benzene results are discussed in the following sections.

Galena Public Softball Field (Figure A5). The graphitized carbon sample taken in the community softball field located approximately 100 yards NE of the FPTA, resulted in a benzene concentration of 2.2 $\mu g/m^3$. This result and results from the FPTA indicate that BTEX exposures via inhalation were greater near the softball field than at the FPTA located SW (downwind) and near the private operation located W of the softball field. High concentrations in the softball field may be attributed to vehicular activities, since this area was a relatively high traffic due to area softball tournaments.

Old Town Galena (Figure A1). Air samples were taken at various locations throughout Old Town Galena, located SE of the ARPT. These samples were taken to evaluate BTEX levels. The potential groundwater contamination sources for Old Town Galena include: the ARPT, barge loading dock located W of Old Town Galena, civilian flying services/operations, and several fuel oil storage tanks north-centrally located in Old Town Galena. The graphitized carbon benzene concentrations in these areas ranged from 0.22 $\mu g/m^3$ SE of the Galena storage tanks to 2.0 $\mu g/m^3$ in the playground area. The highest levels monitored were taken near dirt roads that transect

the city. This suggests that vehicular activities are responsible for the majority of VOC exposures in Old Town Galena.

The only charcoal sample quantified was taken NW of the storage tanks. Toluene was measured at 130 $\mu g/m^3$ and no other chemicals were quantified. The high toluene measurement may be due to vehicular activity; however, its proximity to the tanks suggests that the tanks may have been a source for the toluene. A conflicting result from the graphitized carbon sample (1.6 $\mu g/m^3$ toluene) reflects a large variability in day-to-day toluene concentrations.

On-Base Housing Area (Figure A2). The nearest receptors to the POL are the on-base housing units (Table 2, Page 14) Building 1874, the closest unit, resulted in a benzene level of 0.54 $\mu g/m^3$.

Bureau of Land Management Housing Area (Figure A3). The benzene sample from the northwestern side of the ARPT were 0.33 $\mu g/m^3$. This was a perimeter measurement and was taken at the fenceline between the ARPT and the Bureau of Land Management (BLM) housing area. The BLM housing area is located to the NW of the ARPT, upwind from potential on-base sources.

City Landfill (Figure A3). The measurement taken in the landfill, located W of the ARPT property, resulted in a benzene concentration of 110 $\mu g/m^3$ and a toluene concentration of 380 $\mu g/m3$. Ethyl benzene and xylene, although not quantified were below their recommended comparison levels. Both the benzene and toluene concentrations may be attributed to vehicular activity and the inability to prevent access. Unlimited access makes it quite possible to dump unwanted materials (including fuel oils) into the landfill. The landfill is used jointly by the AF, the state, and residents of Galena.

Health Risk Assessment

Sample Media Selection. The purpose of the graphitized carbon was to obtain quantified results and the activated charcoal samples were taken to qualitatively evaluate and support the graphitized carbon findings. Graphitized carbon or activated charcoal samples that result in "less than" values or "not detected" (e.g., < 2 or ND) indicate that the contaminant concentrations were not determined. It is inappropriate to estimate what concentrations these values represent. Therefore, activated charcoal sample results were not used for health risk evaluation, unless they 1) indicated that exposures measured with graphitized carbons may have been high (e.g., SW Larry's Flying Service) or 2) were properly quantified (e.g., City Landfill). Proper quantification occurred in areas with relatively high concentrations of BTEX chemicals (above 100 $\mu g/m^3$).

Health Risk Assessment by Zone. To evaluate the health effects of specific chemicals, as well as their combined effects, the sample locations were divided into four zones. Zone One (Figure A1) includes the sample locations in and around Old Town

Galena, Zone Two (Figure A2) the POL and civilian flying services, Zone Three (Figures A3 and A4) the W side of the Galena ARPT, and the sample locations in and around the FPTA were considered Zone Four (Figure A5). Evaluations of results by contaminant and sample location appear in sections to follow.

Health effects from the various zones were determined by completing a series of steps. First, chemical-specific results from each zone were lognormalized and averaged to determine their geometric mean ($mean_G$) to account for anticipated environmental distributions. The resulting values were then compared to their chemical-specific advisory levels. By adding associated risks, both the combined carcinogenic and combined noncarcinogenic health effects were evaluated. Combined carcinogenic effects were based on benzene levels, since it is the only BTEX chemical with potential carcinogenic effects. To determine the combined effects of noncarcinogens, the following formula was used:

Formula 2.
Combined Effects Value = a/advisory $level_T$ + b/advisory $level_E$ + c/advisory $level_X$, where:

a - average lognormal result for toluene
b - average lognormal result for ethyl benzene
c - average lognormal result for xylene
Advisory Levels - comparison values used for evaluation
T - toluene
E - ethyl benzene
X - xylene

If the Combined Effects Value is less than one, then the combined effects of the three chemicals should not pose any increased health threat due to the measured compounds.

Example (Zone Two):
toluene $mean_G$ = 11.21 $\mu g/m^3$, ethyl benzene $mean_G$ = 1.5 $\mu g/m^3$, xylene $mean_G$ = 5.17 $\mu g/m^3$

Combined Effects Value =
(11.21 $\mu g/m^3$)/(800 $\mu g/m^3$) + (1.5 $\mu g/m^3$)/(2000 $\mu g/m^3$) + (5.17 $\mu g/m^3$)/(2000 $\mu g/m^3$) = 0.018

Since 0.018 is less than one, individuals located in Zone Two should not experience increased noncarcinogenic health effects related to their toluene, ethyl benzene, and xylene air exposures.

The results from the various zones (Table 3) indicate that BTEX-related noncarcinogenic health effects should not occur. Both chemical-specific toluene, ethyl benzene, xylene, and combined effects results were well below their respective advisory levels. Combined effects values (total) ranged from 0.003 to 0.018, well below one.

Table 3. Carcinogenic and Noncarcinogenic Health Risks By Zone

Carcinogenic Risk[1]		Noncarcinogenic Risks[2]			
Zone	Benzene	Toluene	Ethyl Benzene	Xylene	Total
One	1 in 240,000	0.005	0.000	0.001	0.007
Two	1 in 69,000	0.014	0.001	0.003	0.018
Three	1 in 147,000	0.004	0.001	0.002	0.007[3]
Four	1 in 615,000	0.001	0.000	0.001	0.003

1 - Benzene is the only BTEX chemical used to determine carcinogenic risks (results are in excess carcinomas per specified number of people - e.g., 1 excess carcinoma per 240,000 people).
2 - If the value is less than one (1) adverse health effects should not occur.
3 - Including the landfill results increases the toluene health risk to 0.008 and the total risk to 0.011.

The carcinogenic (benzene) health risks ranged from 1 excess carcinoma per 69,000 people (Zone Two) to 1 in 615,000 (Zone Four). These values indicate marginal to increased health risks. Areas where 24-hour, 70-year exposures are expected (Zones One and Four), health risk results were marginal. Generally, health risks accepted by the public health community are between the 1 in 100,000 and 1,000,000 risk levels (1). Since Zones One and Four are 1 in 240,000 and 1 in 615,000, respectively, it is relatively safe to conclude that there is not an increased health hazard caused by benzene air exposures. Note that conservative assumptions were used to determine the health risks, and that actual risks associated with the results from this survey are likely to be less. In addition, regional studies conducted by the Agency for Toxic Substances and Disease Registry (ATSDR) indicate that the median background benzene levels range from 0.16 ppb (0.51 $\mu g/m^3$) in remote areas to 0.47 ppb (1.50 $\mu g/m^3$) in rural areas (3). This translates to an increased cancer risk due to background benzene air exposures of 1 in 432,000 and 1 in 172,000, respectively. However, median background benzene levels were not determined for the Galena area during this study and none are

available from other sources, and the amount of air sampling data obtained is limited. The background benzene level should be determined and a further evaluation should be made in areas where high benzene concentrations were identified in the next section (Health Risk Assessment Based on Benzene Air Exposure Results). This will determine whether the estimated health risks are conservative.

The health risk is above accepted levels for residential populations at Zone Two. However, the receptors are workers exposed to ambient BTEX air emissions for durations of 8 hours per day, 40 hours per week. Therefore, actual health risks associated with benzene are 1 in 347,000 instead of the 24-hour residential health risk value of 1 in 69,000. In addition, remedial efforts to remove contaminate plumes and diesel and MOGAS tanks are currently underway, which should lessen emissions. If a more sensitive population made use of this area (e.g., children or elderly) or current receptor exposures were continuous (24 hours per day, 7 days a week, for a lifetime), risks associated with the area would be of greater concern.

Differentiation between sample results taken up and downwind from potential emission sources were evaluated by zone. Since the upwind and downwind results (+/- one standard deviation) overlapped, no further statistical evaluations were completed. Samples that are currently being collected by 11 CEOS/CEV may provide enough samples to perform a statistical analysis of the up and downwind locations at the POL/civilian flying services area (Zone Two).

Health Risk Assessment Based on Benzene Air Exposure Results. The benzene concentrations throughout Old Town Galena and in and around the entire Galena ARPT were close to or exceeded the E-6 (representing a one in a million increase risk) comparison value of 0.24 $\mu g/m^3$. In fact, only three samples were below the 0.24 $\mu g/m^3$ comparison value: SE of the FPTA (0.14 $\mu g/m^3$), NW of the FPTA (0.20 $\mu g/m^3$), and SE of storage tanks in Old Town Galena (0.22 $\mu g/m^3$). This suggests that the background concentration approaches, if not exceeds, the E-6 comparison value; elevated levels due to anthropometric-related activities in the entire area surrounding Galena. Therefore, it is more appropriate to use the E-5 comparison value to identify the areas/sources that increased the background levels. Samples that were at or above the E-5 comparison value of 2.4 $\mu g/m^3$ appear in Table 4.

These areas are above the EPA E-5 levels, although receptors are not subjected to these levels for 24-hour periods. Workers will typically be the receptors in these areas and only in the civilian flying services and the CE office do they regularly perform 8-hour shifts. The main concern about these areas is the possibility that air containing benzene might be transported to residential areas, thereby, increasing the benzene concentration in areas where individuals are exposed everyday for 24-hour periods (e.g., children and elderly).

Table 4. Benzene Values Above 2.4 $\mu g/m^3$
(E-5 Comparison Value)

Location	Benzene Results ($\mu g/m^3$)
1. N of Mark Air Express (POL area)	6.4
2. N of AVGAS Tanks (POL area)	4.8
3. SE of Truckstand	10
4. S of Jet Fuel Water Separator Building	5.5
5. SW of Mark Air Express (Old Galena Service Bldg)	3.3
6. Larry's Flying Service (three samples)	3.2, 4.3, 30
7. SE Corner of Mark Air Express	3.1
8. CE office	4.1
9. Landfill	110

To further evaluate the transport of benzene and to better determine the areas of concern (emission sources), a new comparison level was developed based on half the E-5 comparison value. This level is important because of day-to-day variability of the data, the fact that the surveys screened BTEX chemicals for only a few days (limiting the accuracy of the results), and that it also provides a secondary list of areas that may adversely affect human health. Areas where benzene results were equal to or exceeded half the E-5 comparison value, 1.2 $\mu g/m^3$, appear in Table 5.

Table 5. Benzene Values Above 1.2 $\mu g/m^3$
(Half of the E-5 Comparison Value)

Location	Benzene Results ($\mu g/m^3$)
1. NE of Building 1556, across dirt road (POL area)	1.2
2. Softball Field (Galena Public)	2.2
3. SE of Building 1342	1.8
4. W of Old Town Galena	1.2
5. NW of Storage Tanks (Old Town Galena)	1.6
6. NW of Playground (Old Town Galena)	2.0

These benzene concentrations are greater than values of concern based on a 24-hour/day 70-year exposure scenario. Based on a comparison of sample results with occupational guidelines, carcinogenic risks related to benzene vapor inhalation in nonresidential areas number 1, 3, and 5 should not increase the overall cancer risk.

Potential areas of concern include the playground, area NW of Storage Tanks, West Edge of Old Town Galena, and the Galena Public Softball Field. It is difficult to determine the source of the benzene air exposures for any of these areas. Vehicular and aircraft activity appear to be likely sources. This is especially true in the Galena playground and softball field samples where results in the surrounding areas were lower, although other possible emission sources (e.g., dumping and drum storage in the area) were not fully evaluated.

Health Risk Assessment Based on Toluene Air Exposure Results. The toluene comparison level used for this report is 800 $\mu g/m^3$ (Page 11). All graphitized carbon sample results were well below this comparison level. The highest value, 59 $\mu g/m^3$, was taken inside Larry's Flying Service. However, samples taken with charcoal media resulted in airborne toluene concentrations of 130 $\mu g/m^3$ NW of Storage Tanks in Old Town Galena, 150 $\mu g/m^3$ N of Mark Air Express, and 380 $\mu g/m^3$ in the landfill. Duplicate graphitized carbon toluene results from the same sample locations (NW of Storage Tanks in Old Town Galena and north of Mark Air Express) were 5.0 $\mu g/m^3$ and 12 $\mu g/m^3$, respectively. The landfill was not sampled with graphitized carbon.

The landfill toluene exposure levels do not pose a health problem, since no residences (receptors) appear to be located in close proximity to the landfill. Activities at the landfill are infrequent, short in duration, and normally performed as part of a workday by experienced personnel. An increase in the overall background toluene (and benzene) concentrations, associated with landfill emissions, is of concern. This could, subsequently, increase the exposures to on- and off-base residents downwind and down gradient from the landfill.

The other two areas, NW of the Storage Tanks in Old Town Galena and N of Mark Air Express, are also areas of concern even though their values are equal to or slightly less than a quarter the comparison toluene level, 800 $\mu g/m^3$. The location N of Mark Air Express may be a concern to on-base workers and possibly to the civilian flying service workers or patrons. Toluene results from other locations around the POL and civilian flying services indicate that there should be no increased health risks associated with toluene exposures. During remedial activities, mechanical disturbances of soil (e.g., digging) may release toluene vapors and increase remedial worker exposures.

A charcoal media toluene sample taken NW of the Storage Tanks in Old Town Galena indicates that this area may also potentiate adverse health effects. The receptors would be the nearby community. A contrasting graphitized carbon toluene result from the same location, 5.0 $\mu g/m^3$, and low toluene results from samples taken approximately 150 yards SE of this sample (charcoal, < 15 $\mu g/m^3$, and graphitized

carbon, 3.4 $\mu g/m^3$) suggest that toluene should not pose a public health threat. It is, however, recommended that possible toluene sources in Old Town Galena be identified.

Health Risk Assessment Based on Ethyl Benzene, Xylene and Occupational Air Exposures. All ethyl benzene and xylene results were well below recommended exposure guidelines. Also, no BTEX concentrations approached their respective occupational exposure limits. When mechanical disturbances (e.g., drilling during remediation) occur in areas where plumes have been located, appropriate sampling methods should be used to determine if adequate personal protective equipment (PPE) is being provided. The PPE should be task- and location-specific.

3 AERMS/MGAB/SGPB February Sampling Results

Several benzene, toluene, and ethyl benzene results (hexane was evaluated instead of xylene) were greater during the 06-07 February sampling (Table 8, Appendix) than during this survey, 16-21 June. This is an indication that the civilian flying services may be increasing their worker's exposures in the winter months, perhaps the result of decreased fresh-air intake (e.g., closing the doors and increasing the amount of air being recirculated in the air). Another factor that altered the values of the June survey was the lack of aircraft maintenance and activities on the survey days. From the February results it appears that surrounding areas (e.g., outside of Mark Air Express) are also increased by work activities and procedures performed during the winter months. The air outside of Mark Air Express, for example, had measured toluene concentrations of 20 $\mu g/m^3$ while the results of toluene samples measured outside of Mark Air Express ranged from 3.3 $\mu g/m^3$ to 12 $\mu g/m^3$ during the June survey.

Hexane was also evaluated during the February survey. The outside and inside results were below both the hexane abient and occupational exposure comparison levels.

Soil Gas Results

The following two sections discuss the results from the soil gas readings taken with the conduit and soil gas well methods. The detector used in this survey, Photovac PID, 1) was calibrated with isobutylene, 2) measures both organic and inorganic chemicals, and 3) does not specifically identify the chemicals that are being measured. Since many organic and inorganic chemicals are concurrently being measured and the suspected contaminants are not isobutylene, the results are reported as meter units.

Conduit Soil Gas Results (Table A3)

Of the 29 conduit soil gas sample locations around the POL area, only eight locations resulted in PID readings above 0.0 meter units. This does not mean that those areas

that measured 0.0 meter units are free from contamination, since one meter unit for a given chemical (e.g., BTEX chemicals) may be well above its VOC health exposure guideline. The purpose of sampling was to identify areas of concern. The results are not to be compared to any environmental exposure limits.

The eight results above 0.0 meter units included an area near an isopropanol leak, near MW04, three samples near Tanks number 1, 4, and 7, and one measurement taken inside and two measurements taken outside the Galena ARPT perimeter fence. The only measurement in the vicinity of the isopropanol tanks was taken near a leak. The recorded value was 3.9 meter units. The ARPT has a comprehensive POL area maintenance program, which stipulates that either immediate maintenance occur or that the leaking area be shut-down prior to tank removal. Maintenance of the leaking isopropanol pipe should alleviate the potential for human health concerns.

It is known that a VOC plume exists under the POL area. A measurement taken near MW04, 0.9 meter units, signifies that the potential for volatilization may exist for the region of the plume in this area. Two other measurements taken W/SW of MW04 also read above zero, at 12.5 and 12 meter units.

The samples taken near Tanks number 1, 4, and 7 resulted in readings of 25, 50, and 75 meter units, respectively. These results are to be expected, because of the past and current operations in the POL. As a result, it can be said that these areas around the POL tanks are VOC emission sources.

Six readings were taken at locations S (downgradient) of the POL tanks. Only one of the results was above 0.0 meter units, at 0.2 meter units. The area between the POL tanks and the MW04 soil gas locations did not have many readings above zero, because these measurements were made at higher elevations and, thus, farther away from the groundwater and contaminant plume.

Soil Gas Well Results

Measurements were made at 16 (20 June) and 18 (21 June) of the 21 soil gas wells installed by 11 CEOS/CEV (Table A4). Results from the soil gas readings ranged from 3.3 to greater than 2500 meter units. Samples were taken at nine locations S of the civilian flight line fence and at seven (20 June) and nine (21 June) locations N of this fence. Most of the samples were taken S or N of the buildings, thus, the results were separated into the two areas for statistical evaluation. The results are presented in Table 6.

Results were lognormalized, since the lognormal distribution is a good model for environmental data (3). The results indicate that the locations to the N (upgradient) had greater concentrations of VOCs than did samples taken to the S (down gradient). This, in conjunction with the knowledge that the POL is upgradient from the civilian flying

Table 6. Soil Gas Well Results - Statistical Analysis

Statistic	20 June South	20 June North	21 June South	21 June North
Summation of results	3821.9	7353.3	2523.8	4416.1
Mean	424.7	1050.5	280.4	490.7
Natural Log (ln) summation	41.36	41.2	36.26	48.57
Mean (ln)	4.60	5.88	4.03	5.40
Standard Deviation (ln)	1.18	2.30	1.76	1.53
Pooled Variance	3.06		2.71	
t-score t comparison value (two-sided)	-1.45 +/- 1.383 t = .90		-3.52 +/- 2.921	t = .995

services, suggests that the contamination (plume) originated in the POL. From the small number of samples collected it was evident with 80% confidence that the results were greater to the N on 20 June and increased to 99% confidence on 21 June. One factor influencing the greater confidence observed on 21 June was the additional samples collected on that day.

The 11 CEOS/CEV is currently taking BTEX soil gas measurements with graphitized carbon at the well locations.

Comparison of Air Sampling and Soil Gas Results (Zone Two - Figure A2)

Conduit and well soil gas results indicate that soils near MW04 and the region north (upgradient) of the civilian flight line fence contain elevated levels of VOCs. Readings ranged from 148 to greater than 2500 meter units N of Mark Air, Larry's Flying Service, and Mark Air Express. Contrastingly, S and W of these sample locations ranged from 4.3 to 68.5 meter units.

The relationship of higher VOC concentrations measured upgradient, was not observed in the ambient/indoor air sampling results. The samples taken closest to MW04 (upgradient) resulted in benzene concentrations of 6.4 and 1.2 $\mu g/m^3$. Samples collected downwind from MW04, including those taken inside the civilian flying services,

ranged from 3.1 to 30 $\mu g/m^3$. The geometric mean of the upgradient and downgradient samples were 2.77 +\- 3.95 $\mu g/m^3$ and 4.41 +\- 3.38 $\mu g/m^3$, respectively. No correlation between soil gas and ambient air results can be made. Current soil gas and ambient air monitoring by 11 CEOS/CEV may allow statistical evaluation of the POL/civilian flying services area.

RECOMMENDATIONS

- Continue surveillance of the soil gas wells during and after remediation of the POL area.

- Conduct air monitoring with EPA strategies (quantitative air sampling) downwind from the remedial activities (i.e., at civilian flying services) to ensure that the receptor population is not adversely affected by the POL. To further delineate the airborne benzene exposures emanating from Galena ARPT, extended sampling periods (5-10 samples/location) will have to be conducted.

- Install monitoring wells in the landfill to help identify if a plume originates from this source and, if so, to quantify what impact it has on the Yukon River and area ground water. A monitoring well may be needed N of the FPTA to delineate between contamination emanating from the FPTA and possible contamination emanating from the civilian facility located to the N.

- Ensure that all pipelines and tanks are periodically inspected, and leaks are repaired promptly.

- Remove the mock-up plane from the fire training area.

- Provide AL/OEMH the findings from the ongoing Radian and 11 CEOS/CEV surveys.

REFERENCES

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2. Environmental Protection Agency. "Risked-Based Concentration Table, First Quarter 1994". USEPA Region III. Philadelphia, PA. January 1994.

3. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Benzene, Atlanta, Georgia, April 1993.

4. Gilbert, Richard O. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold, New York, 1987.

APPENDIX
(Tables and Figures)

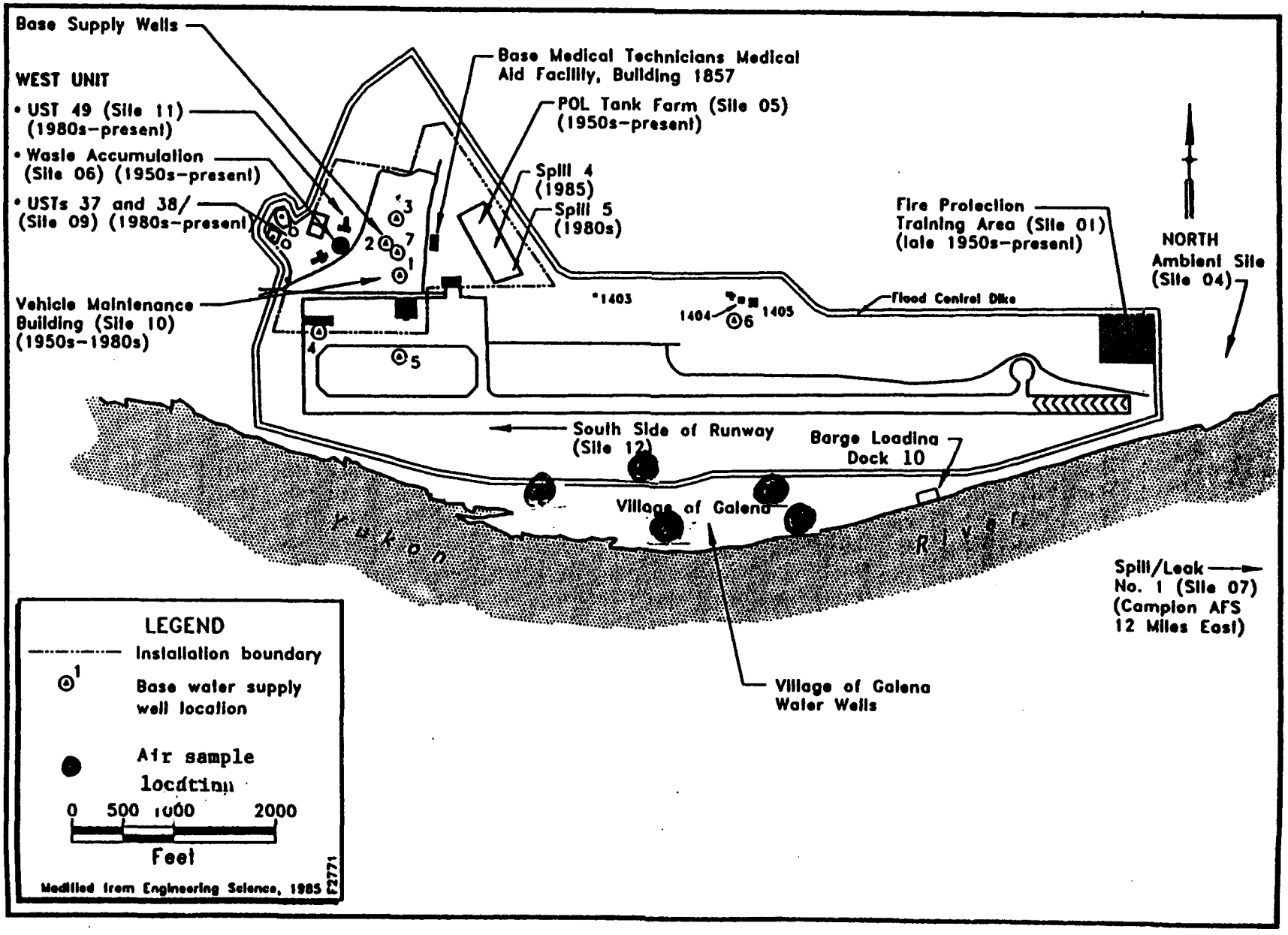

Figure A1. Old Town Galena Approximate Sample Locations (ZONE 1)

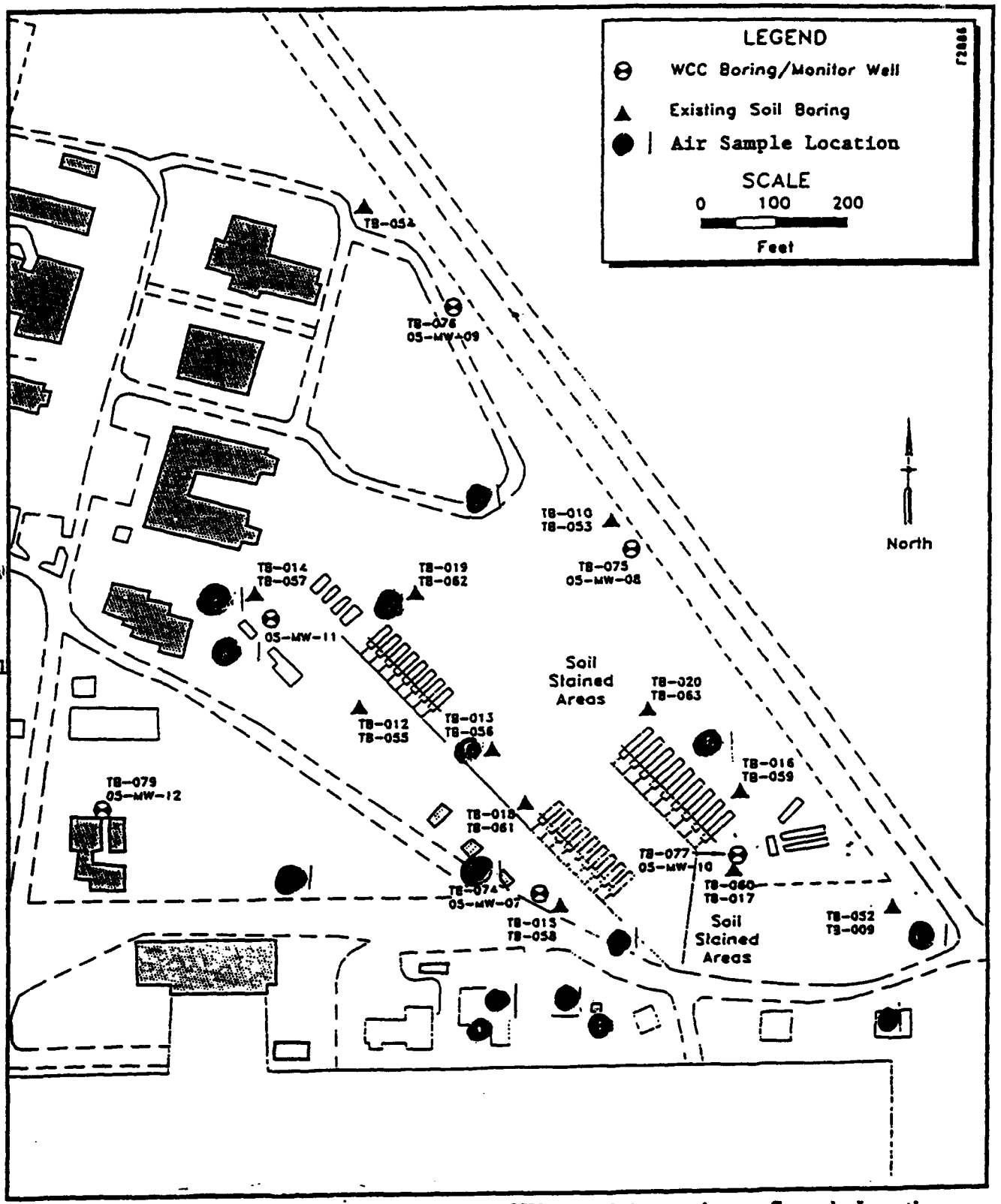

Figure A2. The POL Storage Tank Area (ST05) and Approximate Sample Locations, Galena AFS, Alaska (ZONE 2)

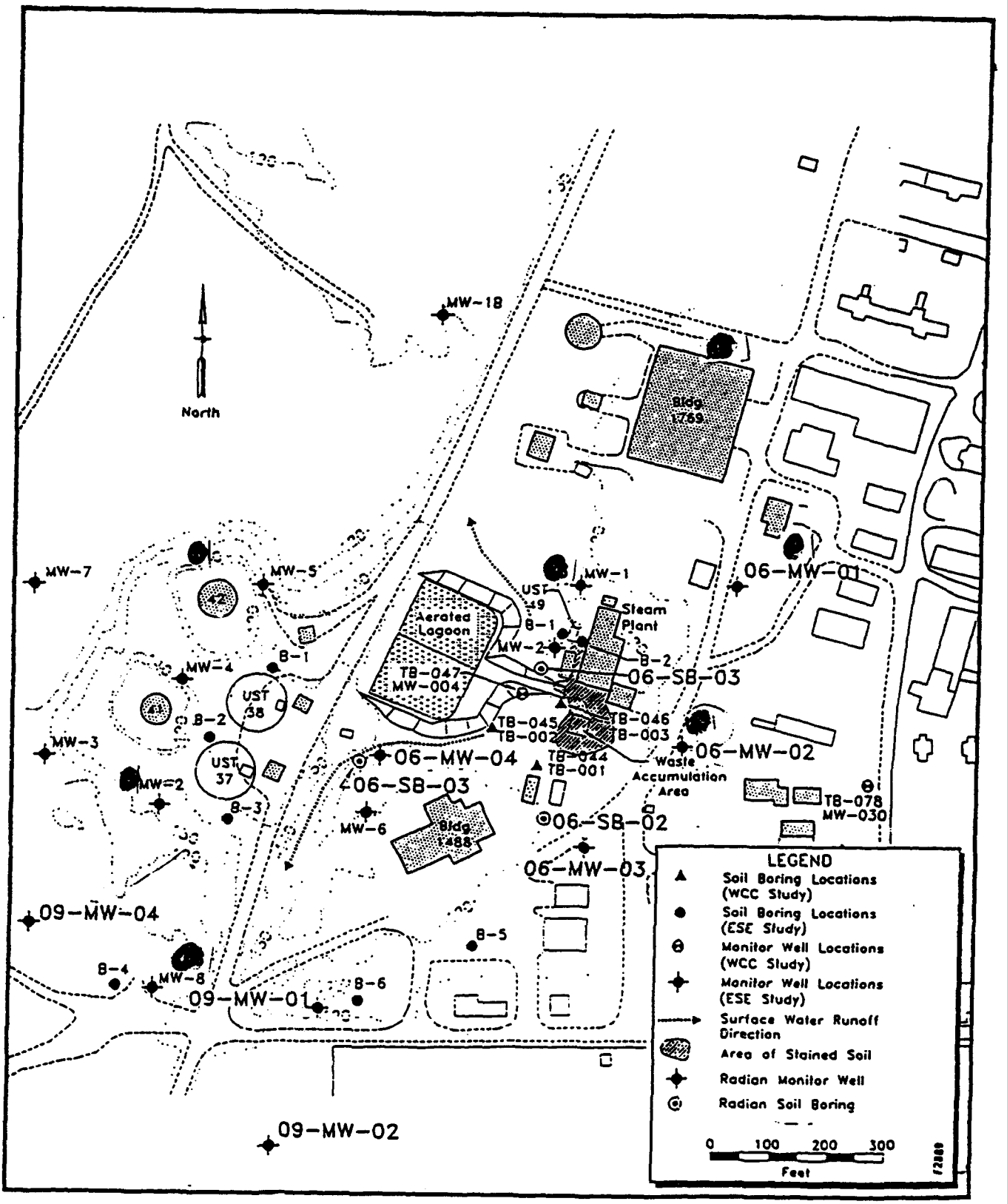

Figure A3. The West Unit Area (Sites ST09, ST11, and SS06) and Approximate Sample Locations, Galena AFS, Alaska (ZONE 3)

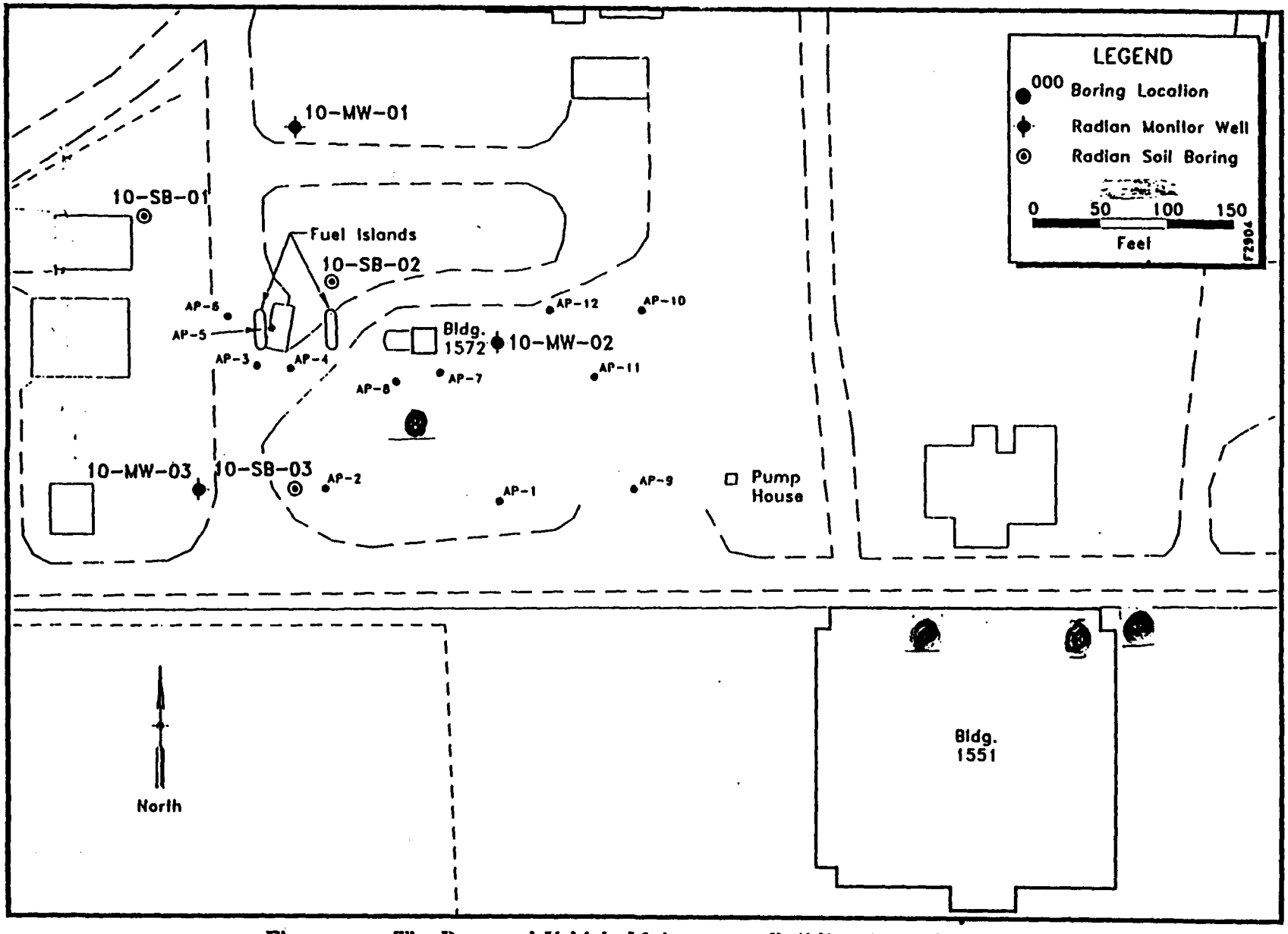

Figure A4. The Proposed Vehicle Maintenance Building Area (Site 10) and Approximate Sample Locations, Galena AFS, Alaska (ZONE 3 cont.)

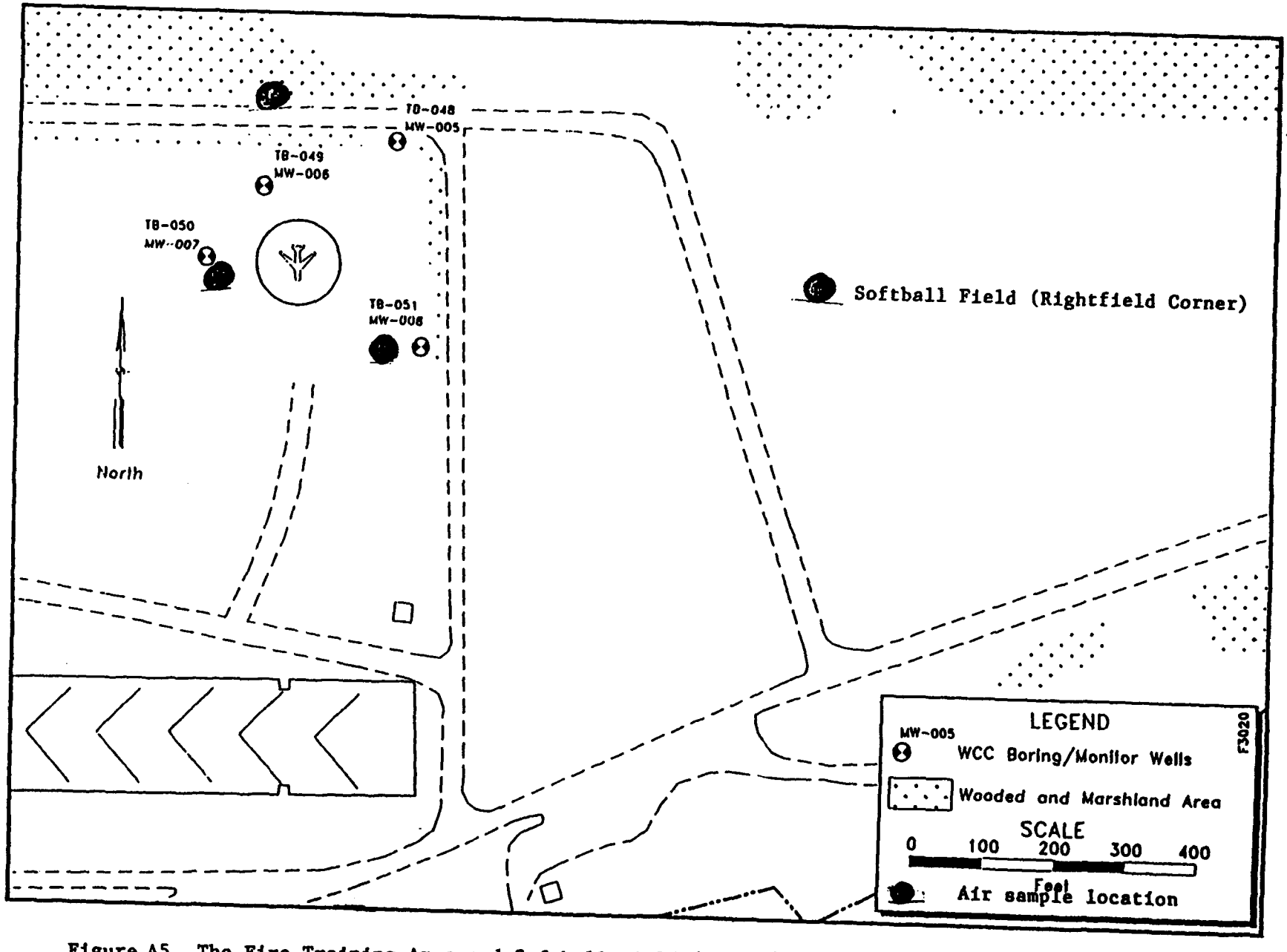

Figure A5. The Fire Training Area and Softball Field (Galena) (ZONE 4)

Comparison Values used for the Health Assessment

Contaminant	Environmental ($\mu g/m^3$)	Occupational ($\mu g/m^3$)
Benzene	E-6* = 0.24 E-5 = 2.4 E-4 = 24	3250 (Action Level- 1625)
Toluene	E-6 = 800	383000
Ethyl Benzene	E-6 = 2000	441000
Xylene	E-6 = 2000	441000
Hexane	E-6 = 400	176000

* E-6 is equivalent to one excess cancer(benzene) or illness (other contaminants) per million people. E-5 = 1 in 100,000 and E-4 = 1 in 10,000.

Table A1. Air Monitoring Results - Graphitized Carbon
Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) Screen
Galena AP, Alaska 20-21 June 1993

Indoor (I) or Ambient (A)/Date	Map ID Number[1]	Sample Location/ ID Number[2]	Duration (min)	Benzene ($\mu g/m^3$)	Toluene ($\mu g/m^3$)	Ethyl Benzene ($\mu g/m^3$)	Total Xylene ($\mu g/m^3$)
A/200693	1	Outside Fence - SW of POL area/13	456	NA	NA	NA	NA
A/200693	2	Outside POL fence - across street from Mark Air/7	514	6.4	12	0.8	3.2
A/200693	3	Outside Fence - across dirt road and NE of Bldg 1556/24	276	1.2	4.2	ND 1.3	ND 3.9
A/200693	25	W of MW04/5	460	NA	NA	NA	NA
A/210693	30	E of Diesel Tanks (POL)/30	463	NA	NA	NA	NA
A/200693	14	SE of AVGAS and NW of MOGAS tanks (POL)/15	381	NA	NA	NA	NA
A/200693	5	N of AVGAS tanks (POL)/3	483	4.8	8.9	1.4	6.3
A/200693	16	NW of Truckstand/18	410	NA	NA	NA	NA
A/200693	17	SE of Truckstand/2	500	10	16	3.7	19
A/200693	4	SE corner of Bldg 1874/9 & 14	484 405	0.54 NA	1.6 NA	ND 0.69 NA	ND 2.1 NA

Indoor (I) or Ambient (A)/Date	Map ID Number[1]	Sample Location/ ID Number[2]	Duration (min)	Benzene ($\mu g/m^3$)	Toluene ($\mu g/m^3$)	Ethyl Benzene ($\mu g/m^3$)	Total Xylene ($\mu g/m^3$)
A/200693	29	SE of FTA/12	520	0.14	ND 0.65	ND 0.65	ND 2.0
A/200693	12	NW of FTA - S of local business/11	519	0.20	0.58	ND 0.64	ND 2.0
A/200693	13	Softball Field/10	500	2.2	3.8	0.71	3.2
A/210693	15	N of Bldg 1769 - on Perimeter Fence (APRT/BLM)/25	457	0.33	1.1	ND 0.4	ND 1.2
A/200693	9	SE of Bldg 1342/23	276	1.8	4.6	ND 1.2	3.6
A/200693	27	SW of Bldg 1813/28	493	NA	NA	NA	NA
A/200693	8	S of Jet Fuel Water Separator Bldg/19	410	5.5	13	1.2	5.0
A/200693	6	NW of UST 38/16	420	NA	NA	NA	NA
A/200693	7	SW of UST 37/17	422	NA	NA	NA	NA
A/200693	22	West of Old Town Galena/22	411	1.2	6.3	ND 0.82	ND 2.5
A/200693	21	NW of Storage Tanks/Old Town Galena)/21	425	1.6	5.0	ND 0.76	ND 2.3
A/200693	20	SE of Storage Tanks (Old Town Galena)/20	429	0.22	3.4	ND 0.78	ND 2.4

Indoor (I) or Ambient (A)/Date	Map ID Number[1]	Sample Location/ ID Number[2]	Duration (min)	Benzene ($\mu g/m^3$)	Toluene ($\mu g/m^3$)	Ethyl Benzene ($\mu g/m^3$)	Total Xylene ($\mu g/m^3$)
A/20069	23	NW of Playground (central Old Town Galena)/4	443	2.0	3.9	ND 0.69	ND 2.1
A/210693	J	SW Corner of Gymnasium/32	473	0.85	2.5	ND 0.71	ND 2.2
A/210693	19	S of Wildlife Refuge Bldg - Old Town Galena (Shoreline)/29	468	1.5	3.6	ND 0.72	2.2
A/200693	10	Barge Loading Dock/1	455	ND 0.8	ND 0.8	ND 0.8	ND 2.3
A/210693	F	NE of Bldg 1551 - on fence/35	474	NA	NA	NA	NA
A/210693 & 200693	H	SW of Mark Air Express (Old Galena Air Service Bldg)/36 & 8	421 485	NA 3.3	NA 6.7	NA 0.66	NA 2.7
I/210693	C	Larry's Flying Service - SW Corner/26	529	*30	*59	9.9	41
I/200693 & 210693	A	Larry's Flying Service - SE Corner/6 & 33	494 529	3.2 4.3	11 12	0.83 1.1	3.6 5.0
I/210693	D	SE Corner Mark Air Express/34	418	3.1	18	0.87	3.7
I/210693	B	Frontier Flying Service/27	410	NA	NA	NA	NA
I/210693	G	Inside of CE office/31	540	4.1	13	3.9	16

NA - Sample could not be analyzed due to technical difficulties (instrument fell out of calibration).
ND - Chemical-specific concentration could not be quantified.
1 - Map I.D. Numbers are used to identify sample location, Figures 1-5.
2 - I.D. Numbers were reported for each sample prior to releasing samples for analysis and for chain-of-custody purposes.

* Comparison Values used to evaluate health hazards associated with chemical-specific sample results:

	Environmental ($\mu g/m^3$)	Occupational ($\mu g/m^3$)
Benzene	E-6 = 0.24, E-5 = 2.4, E-4 = 24	3250 (Action Level - 1625
Toluene	800	383000
Ethyl Benzene	2000	441000
Xylene	2000	441000

Table A2. Air Monitoring Results - Activated Charcoal Media
Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) Screen
Galena AP, Alaska 16-21 June 1993

Indoor (I) or Ambient (A)/Date	Map ID Number[1]	Sample Location/ ID Number[2]	Duration (min)	Benzene ($\mu g/m^3$)	Toluene ($\mu g/m^3$)	Ethyl Benzene ($\mu g/m^3$)	Total Xylene ($\mu g/m^3$)
A/160693	1	Outside Fence - SE of POL area/17	120	<138	<414	<345	<345
A/160693	2	Outside POL fence - N of Mark Air/18	993	<20	**150**	<50	<50
A/160693 & 180693	3	Outside Fence - across dirt road and NE of Bldg 1556/20 & 39	993 1500	<17 <13	<52 <40	<43 <33	<43 <33
A/160693 & 170693	25	W of MW04/21 & 30	979 1233	<20 <19	<61 <57	<51 <47	<51 <47
A/180693 & 200693	30	E of Diesel Tanks (POL)/44 & 53	1518 724	<13 <70	<39 <210	<33 <175	<33 <175
A/160693 & 200693	14	SE of AVGAS and NW of MOGAS tanks (POL)/10 & 50	220 404	<111 <330	<333 <990	<278 <825	<278 <825
A/180693	16	NW of Truckstand/42	1491	<13	<40	<34	<34
A/180693	17	SE of Truckstand/41	1501	<13	<40	<33	<33
A/160693	4	SW corner of Bldg 1874/11	1020	<17	<50	<42	<42
A/160693	11	SW of FTA/14	1417	<14	<42	<35	<35

Indoor (I) or Ambient (A)/Date	Map ID Number[1]	Sample Location/ ID Number[2]	Duration (min)	Benzene ($\mu g/m^3$)	Toluene ($\mu g/m^3$)	Ethyl Benzene ($\mu g/m^3$)	Total Xylene ($\mu g/m^3$)
A/160693	26	NE of Bldg 1851/16	938	<21	<64	<53	<53
A/170693	K	N of FTA/24	1291	<16	<46	<39	<39
A/170693	12	NW of FTA - S of local business/25	1296	<15	<46	<39	<39
A/170693	13	Softball Field/26	1053	<19	<57	<47	<47
A/180693	15	N of Bldg 1769 - on Perimeter Fence (APRT/BLM)/40	1491	<13	<40	<34	<34
A/160693	9	SE of Bldg 1342/13	929	<20	<59	<49	<49
A/180693	27	SW of Bldg 1813/38	1490	<13	<40	<34	<34
A/160693	8	S of Jet Fuel Water Separator Bldg/12	1017	<20	<59	<49	<49
A/180693	6	NW of UST 38/36	1466	<14	<41	<34	<34
A/180693	7	SW of UST 37/35	1459	<14	<41	<34	<34
A/180693	21	NW of Storage Tanks (Old Town Galena)/32	1330	<15	**130**	<38	<38
A/180693	20	SE of Storage Tanks (Old Town Galena)/33	1347	<15	<44	<37	<37
A/190693	23	NW of Playground (central Old Town Galena)/47	1141	<7	<21	<18	<18

Indoor (I) or Ambient (A)/Date	Map ID Number[1]	Sample Location/ ID Number[2]	Duration (min)	Benzene ($\mu g/m^3$)	Toluene ($\mu g/m^3$)	Ethyl Benzene ($\mu g/m^3$)	Total Xylene ($\mu g/m^3$)
A/180693	19	S of Wildlife Refuge Bldg - Old Town Galena (Shoreline)/37	1474	<14	<42	<35	<35
A/160693	10	Barge Loading Dock/15	944	<21	<63	<53	<53
A/190693	F	NE of Bldg 1551 - on fence/48	1028	<8	<23	<19	<19
A/170693	H	Mark Air Express (Old Galena Air Service Bldg)/29	187	<41	<124	<103	<103
I/170693	I	Landfill/22	1293	**110**	**380**	<39	<39
I/170693 I 170693	C	Larry's Flying Service - SW Corner/23 & 27	1315 360	**<3** **<11**	<9 <33	<7 <28	<7 <28
I/170693 & 180693	A	Larry's Flying Service - SE Corner/28 &49	180 465	<44 <17	<133 <52	<111 <43	<111 <43
I/170693	D	SE Corner Mark Air Express/31	424	<9	<28	<24	<24
I/180693	B	Frontier Flying Service/34	1087	<18	<55	<46	<46
I/190693 & 210693	E	E side of Bldg 1551 (hangar area)/46 & 52	958 540	<8 <247	<25 <741	<21 <617	<21 <617
I/210693	G	Inside of CE office/45 & 51	978 280	<8 <143	<25 <429	<21 <357	<21 <357

1 - Map I.D. Numbers are used to identify sample location, Figures 1-5.
2 - I.D. Numbers were reported for each sample prior to releasing samples for analysis and for chain-of-custody purposes.
Bolded Results were used in the health risk assessment.

Less than (<) signs indicate that the chemical-specific concentration could not be quantified.

* Comparison Values used to evaluate health hazards associated with chemical-specific sample results:

	Environmental ($\mu g/m^3$)	Occupational ($\mu g/m^3$)
Benzene	E-6 = 0.24, E-5 = 2.4, E-4 = 24	3250 (Action Level - 1625
Toluene	800	383000
Ethyl Benzene	2000	441000
Xylene	2000	441000

Table A3. Conduit Soil Gas Results
16-19 June 1993
Galena Airport, Alaska

Sample Location/Number	* Results (meter units)	Sample Location/Number	* Results (meter units)
1. 12' from corner of fence and 12' toward road (SE side of the POL)	0.0	16. 60' South of #15	0.0
2. 25' West of #1	0.0	17. 25" NW of #16	0.2
3. 25' West of #2	0.0	18. 25' NW of #17	0.0
4. 25' West of #3	0.0	19. 30' NW of #18	0.0
5. 25' West of #4 (near isopropanol leak)	3.9	20. 25' NW of #19	0.0
6. 25' West of #5	0.0	21. Near Tank #1	843 max; 25 steady
7. 25' West of #6	0.0	22. Near Tank #4	1071 max; 50 steady
8. 25' West of #7	0.0	23. Near tank #7	1487 max; 65 stady
9. 25' West of #8	0.0	24. S of MW04 and 5' N of dirt road	0.0
10. 10' West of #9	0.0	25. 25' West of #24	12.5
11. 10' West of #10	0.0	26. 25' SW of #25	0.0
12. 10' West of #11 (Definite fuel smell - near MW04)	0.9	27. 40' West of #25	12 max

Sample Location/Number	* Results (meter units)	Sample Location/Number	* Results (meter units)
13. 10' West of #12	0.0	28. 75' SW of #27	0.0
14. 10' West of #13	0.0	29. 50' South of #28	0.0
15. On berm between MOGAS tanks and road	0.0		

* Meter units and not parts per million (ppm) must be used to express results, since the PID was calibrated with isobutylene and the resulting instrument response is not chemical-specific.

Table A4. Soil Gas Well Results
20-21 June 1993
Galena Airport, Alaska

Sample Location	Date/Time[1]	Max20[2] (Meter Units)[3]	Max[4] (Meter Units)[3]	Comments
A1	200693 NA 210693 1955	302 197	3.3 55.6	No Comment (NC) NC
B2	200693 NA 210693 1910	189 36	11.3 21	NC NC
C3	200693 NA 210693 1915	79.5 79	55.2 68	Water in hole Moist
D4	200693 NA 210693 1918	35.0 53.7	34.2 46	Wet Wet
E5	200693 NA 210693 1921	347 364	332 364	Moist Max of 419 at 1.5 Meter Units
F6	200693 NA 210693 1932	199 39	55.2 36	Dry NC
G7	200693 NA 210693 1935	58.9 29	5.0 4.3	NC Bottom of well (soil) is claylike
H8	200693 NA 210693 NA	-- --	-- --	No access due to bulldozer
I9	200693 NA 210693 1938	199 2300	196 1928	Very Wet Very Wet

Sample Location	Date/Time[1]	Max20[2] (Meter Units)[3]	Max[4] (Meter Units)[3]	Comments
J10	200693 NA 210693 1944	1352 74	1344 31.5	Very Wet Very Wet
K11	200693 NA 210693 1946	1789 78	1789 25	Wet Wet
L12	200693 NA 210693 NA	-- --	-- --	Water in well on both days - no evaluations
M13	200693 NA 210693 NA	-- --	-- --	Well not located
N14	200693 NA 210693 2028	360 978	360 450	Well Pluged (both days), Switched PIDs (200693)
O15	200693 NA 210693 2022	1843 1132	1660 963	No Water NC
P16	200693 NA 210693 2019	2290 1204	2290 1178	No Water NC
Q17	200693 NA 210693 2012	>2500 1347	>2500 1347	No Water NC
R18	200693 NA 210693 2010	1010 164	336 148	No Water NC
S19	200693 NA 210693 2006	730 219	204 189	No Water Moist
T20	200693 NA 210693 1958	-- 119	-- 68.5	Not Sampled Well Plugged

Sample Location	Date/Time[1]	Max20[2] (Meter Units)[3]	Max[4] (Meter Units)[3]	Comments
U21	200693 NA 210693 2003	-- 65	-- 17	Not Sampled Wet

1. (NA) Samples were taken in the afternoon, but exact times were not recorded on 20 Jun.
2. Value measured after 20 seconds of sampling.
3. Meter units and not parts per million (ppm) were used to express results, since the PID was calibrated with isobutylene and the resulting instrument response is not chemical-specific.
4. Maximum value measured during the 20-second sampling interval.

(NC) Indicates that no comment was made -- Indicates that no sample was taken

Table A5. 3 AERMS/MGAB Air Monitoring Results - Activated Charcoal Media
Benzene, Toluene, Ethyl Benzene, and Hexane (BTEX) Screen
Galena AP, Alaska 06-07 February 1993

Indoor (I) or Ambient (A) or Personal (P)	Sample Location	Benzene ($\mu g/m^3$)	Toluene ($\mu g/m^3$)	Ethyl Benzene ($\mu g/m^3$)	Hexane ($\mu g/m^3$)
A	Mark Air Porch	<1	20	<3	<3
A	Base Service Station	<1	10	<3	<3
I	Base Fire Station	40	310	10	30
I	Frontier Flying Svc	20	280	40	20
I	Larry's Flying Svc	<4 <3	90 80	<10 <7	<10 <7
P	A1C Phi Dang	<21 <4	40 <12	<53 <10	<53 <10

* Comparison Values used to evaluate health hazards associated with chemical-specific sample results:

	Environmental ($\mu g/m^3$)	Occupational ($\mu g/m^3$)
Benzene	E-6 = 0.24, E-5 = 2.4, E-4 = 24	3250 (Action Level - 1625
Toluene	800	383000
Ethyl Benzene	2000	441000
Hexane	400	176000

Less than (<) signs indicate that the chemical-specific concentration could not be quantified.