SITE INVESTIGATION REPORT

KOTZEBUE FORMER IHS/BIA HOSPITAL-SCHOOL PIPELINE RELEASE

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ACRONYMS AND ABBREVIATIONS

~	approximately
>	greater than
%	percent
±	plus or minus
°C	degree(s) Celsius
°F	degree(s) Fahrenheit
µg/L	microgram(s) per liter
µS/cm	microsiemens per centimeter
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
AK	Alaska
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
Ave.	Avenue
Avg.	Average
bgs	below ground surface
BIA	Bureau of Indian Affairs
BTEX	Benzene, toluene, ethylbenzene, and xylenes
COC	Chain-of-Custody
CoC	chemicals of concern
Cumene	Isopropylbenzene
DRO	diesel-range organics
EDB	1,2-dibromoethane
EDC	1,2-dichloroethane
ESA	Environmental Site Assessment
ft	feet
GRO	gasoline-range organics
IDW	investigation-derived waste
IHS	Indian Health Service
KEA	Kotzebue Electric Association
KIC	Kikitagruk Inupiat Corporation
LOD	limit of detection
LOQ	level of quantitation

m	meter
MEK	2-Butanone
mg/kg	milligram(s) per kilogram
MIBK	4-Methyl-2-pentanone
MS/MSD	matrix spike/matrix spike duplicate
MW	Monitoring Well
MW	monitoring well
No.	Number
NOAA	National Oceanic and Atmospheric Administration
NWABSD	Northwest Arctic Borough School District
ORP	oxidation reduction potential
PAH	polycyclic aromatic hydrocarbon(s)
PAL	Project Action Limit
PCE	Tetrachloroethylene
PID	photoionization detector
POL	petroleum, oil, and lubricant
PRP	Potential Responsible Party
PSL	project screening level
PVC	polyvinyl chloride
QC	quality control
ROW	right-of-way
RRO	residual-range organics
SIM	selected ion monitoring
SOW	Scope of Work
St.	Street
TCE	trichloroethene
Temp.	Temperature
UST	underground storage tank
VOC	volatile organic compound

EXECUTIVE SUMMARY

The purpose of the 2021 and 2022 site investigation at the former Kotzebue IHS/BIA Hospital and School pipeline release site (ADEC Site File No. 410.38.025) was to determine if the previously noted groundwater impacts at the site extend to the north and potentially impact Kotzebue Sound. Additionally, the investigation included further characterization of soil impacts in/around the former pipeline and its branches.

After obtaining appropriate right-of-way (ROW) permits from the City of Kotzebue, Kuna performed 17 soil borings and installed 6 monitoring wells in October 2021. Soil samples were collected from each boring for laboratory analysis of gasoline range organics (GRO), diesel range organics (DRO), residual range organics (RRO), volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs) at depths just above the groundwater. Only one sample, SB04 (4.5-5 ft bgs) exceeded any of the Table B1 or B2 arctic zone cleanup standards (Title 18, Alaska Administrative Code (AAC) Chapter 75); DRO was detected in this sample at a concentration of 18,400 milligrams per kilogram (mg/kg), the cleanup standard is 12,500 mg/kg.

Groundwater from the newly installed monitoring wells (MW11 – MW16) was sampled in July 2022 and October 2022. Some petroleum related compounds were detected in these wells at concentrations exceeding the Table C thresholds from 18 AAC 75, including naphthalene, 1- and 2-methylnaphthalene, and 1,2,4-trimethylbenzene. Widespread petroleum related detections and exceedances were not noted. The groundwater concentrations at the northeast side of the site, near the intersection of Bison St. and Front St. (aka, Shore Ave.) may be related to a non-pipeline release or spill. Similarly, the noted groundwater impacts around MW16 (east side of Turf St.) may also be attributed to a separate spill or release.

The 2020 groundwater sampling (MW5, MW6, MW9, MW10), in conjunction with the 2022 sampling indicates that groundwater concentrations are rapidly attenuated as the groundwater moves to the north. This information, in combination with the limited detections in the Shore Ave. wells indicates that impacts to Kotzebue Sound are not likely occurring.

Recommendations for next steps for the site include the continued monitoring of the site groundwater through the existing monitoring wells on an annual basis and performing additional potential investigations of other sources in the areas of MW11/MW12 (Bison St/Front St) and MW16 (east side of Turf St.). The implementation of formal institutional controls to limit potential exposures should also be initiated to enable the site to potentially receive future closure approval from ADEC. Excavation of soils and the removal of the abandoned pipeline is not recommended due to the potential exposure risks and risks to damaging existing utilities in this area.

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1 INTRODUCTION

This Site Investigation Report describes the field activities and investigation results for the installation and sampling of new groundwater monitoring wells in the area around the former Indian Health Services (IHS) and Bureau of Indian Affairs (BIA) Hospital and School pipeline release in Kotzebue, Alaska. In conjunction with the installation of these wells, soil sampling and characterization was performed in the area around the former pipeline. The site is identified by the Alaska Department of Environmental Conservation (ADEC) Contaminated Sites Program under Site File No. 410.38.025 (Hazard ID No. 25558).

Kuna Engineering, LLC performed this site investigation and prepared this report under Contract 140A1321P0004.

1.1 PROJECT OBJECTIVES

The primary objectives for the site investigative activities are as follows:

- Determine the downgradient and side-gradient migration of fuel-impacted groundwater from the former IHS-BIA site and if the impacted groundwater extends to Kotzebue Sound or other properties.
- Determine the degree and extent of fuel-related soil impacts in the immediate vicinity of the pipeline to assess potential remedial options.

To meet the first objective, six groundwater monitoring wells were installed between the site and Kotzebue Sound: four along Shore Ave. to the north of the site, and one on each side (west and east) of the site. Groundwater from these wells was sampled to determine the presence and concentrations of petroleum hydrocarbons.

To meet the second objective, five soil borings were performed throughout the former property including in the area of the former pipeline. Soils from three of the borings for the monitoring wells were also analyzed to determine the extent and degree of potential impacts from migration of the fuel releases.

1.2 BACKGROUND INFORMATION

The BIA is identified by the ADEC as the Potential Responsible Party (PRP) for the environmental impacts resulting from the various fuel releases, spills, and leaks from the former pipeline that provided heating fuel to the BIA-IHS facilities located on the northwest side of the City of Kotzebue, AK, including the former school and hospital. Outlines of these former facilities are shown on Figure 1.

The impacted property/site is listed on ADEC's Division of Spill Prevention and Response website (Hazard ID 25558). It was formally known as the former IHS/BIA Hospital and school grounds, Tract 4A and Lots 3, 4 and 5, between Shore Avenue and 3rd Avenue (north-south) and between

Turf Street and Bison Street (east-west). The site is currently occupied by facilities/buildings operated by Maniilaq Association, Kikitagruk Inupiat Corporation (KIC), and the Northwest Arctic Borough School District (NWABSD).

The former pipeline provided #1 diesel fuel (arctic heating oil) to the school and the former hospital from a tank farm northeast of the property; the pipeline became damaged at an unknown time and leaked an unknown quantity of fuel prior to its discovery in 1980 after ADEC was notified that fuel was found seeping into the elementary school's basement. It is estimated that 100,000 to 200,000 gallons of fuel may have leaked from the fuel line over time. Currently, the former pipeline is abandoned in place.

Numerous environmental investigations and remedial actions have occurred at the site since the original discovery of the fuel in the ground. The following subsections provide a description of some of the more extensive and recent efforts that provide the general basis for this project.

1.2.1 Previous Investigations

In 2013, WHPacific Inc. (WHPacific) was contracted by Maniilaq to conduct a Phase I Environmental Site Assessment (ESA) of Lots 3 and 4 individually. These site assessments were completed in May of 2014 and included a records review of environmentally and historically relevant information. A site reconnaissance visit of the area occurred between March 26-28, 2014 and a lead-based paint survey was performed by ChemTrack Alaska Inc. (ChemTrack) on March 27. The purpose behind these assessments was to update the 2009 ESA performed by Shannon and Wilson to evaluate the environmental conditions of the Subject Properties prior to a property and building transfer from the IHS to Maniilaq. In general, these assessments were performed according to the American Society for Testing and Materials (ASTM) Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, Designation E1527-13 (ASTM E1527-13).

Following the Phase 1 ESA of the Subject Properties (Lots 3 and 4), an evaluation report concluded that the groundwater was impacted by hydrocarbon-based products from several different sources. The northeasterly groundwater flow direction likely results in the migration of the soil and groundwater impacts through the fluctuating groundwater levels and highly variable smear zone of saturated soils at the site. As a result, the overall affected soil area is likely larger than the original spill/leak site(s) (WHPacific 2015).

No drinking water or non-potable water wells exist on either Lots 3 and 4. Water and sewer services for the structures on these lots is provided through outside sources, primarily the City of Kotzebue. All current utilities on Lot 3 are buried within one conduit and there was little or no proof of previously existing utilities from historical records, but any future investigations are advised to proceed with caution.

Lot 4 contains four aboveground storage tanks (ASTs) along the northern perimeter but only two were active in 2014. All piping for the four ASTs is above ground. It is quoted in the 2014 evaluation that no other activities currently impacting the environmental degradation or risking exposure to human health, although the extent of environmental impacts required further investigation.

During 2014 and 2015, WHPacific, Inc. completed a site investigation on the properties located within Lots 3, 4, and 5 and Tract 4A, otherwise referred to as the Subject Property, further referred to as the "site." At the time of the investigation, the site was leased by several different organizations including KIC, BIA, IHS, Maniilaq, the City of Kotzebue, and the NWABSD. Included in the report is a brief background of the site's environmental concerns and a discussion about the field activities performed in 2014 and 2015, along with the analytical results, a conclusion and recommendations based on the data found.

Several activities were included in the 2014 and 2015 field events. Soil and groundwater sampling occurred in 2014 to determine the environmental hazards present throughout the site. Groundwater sampling and groundwater elevations were measured through the 2015 field activities to understand the trends in impacted groundwater concentrations and migration. Soil gas sampling also occurred in 2015 to identify and evaluate the potential risks from soil vapors within Tract 4A where the school playground is currently located. The 2014-2015 Site Investigation provides the most recent comprehensive data for the site.

Other activities performed through the 2014-2015 investigation included the digging of four test pits, performing 45 soil borings, and installing 10 groundwater monitoring wells. The soil borings were implemented in areas known to be in the proximity of the former pipeline.

For the 2015 investigation, the Project Action Limit (PAL) for the impacted soil at the site was defined from Table B1, Method Two, Arctic Zones, and the PAL for the groundwater was defined from Table C in the 18 Alaska Administrative Code (AAC) 75 Oil and Other Hazardous Substances Pollution Control. The locations that exceeded the PAL for soil and groundwater samples were along the BIA pipeline corridor on Tract 4A and northwest of the Ferguson Building in the right-of-way (ROW).

The 2015 investigation report recommendations consist of removal and proper treatment of the soils above PAL and removal of the former pipeline and the surrounding soil. The soil gas survey indicates some areas of potential exposure risks from airborne hydrocarbon fumes.

Other potential sources of contamination were found to be present aside from the BIA pipeline including former ASTs and underground storage tanks (USTs), and likely historical surface spills. Proper removal and remediation are recommended for any surface spills and out of service USTs and ASTs in order to prevent future soil and groundwater contamination.

More information is included in the investigation report such as photographs, field notes, photoionization detector (PID) readings, 2014 well diagrams/installation forms, groundwater monitoring forms, and the full analytical data reports.

The Tanana Commercial Company - Environmental Management Joint Venture completed recent site activities in two phases, including additional site characterizations, a limited removal action, and continued groundwater monitoring. The first phase, completed in July of 2020, included site characterization sampling. The second phase, performed in September and October 2020, included a limited soil removal and site-wide groundwater monitoring.

Site sampling/characterization was intended to delineate the extent of impacts on the IHS owned parcels and to determine potential human health risks from soils that may exceed appropriate ADEC cleanup levels. The limited soil removal provided for the removal of impacted soils that exceed cleanup levels on the north side of the FRF Building, in Lot 4. Groundwater monitoring activities were conducted on September 30 and October 3-4 at each of the 10 monitoring wells on the site.

Results from the 2020 site activities indicate that the groundwater is impacted throughout the site, with MW5, MW9, and MW10 having the highest petroleum related compound concentrations, and with free product encountered in wells MW1 and MW6. Continued groundwater monitoring is recommended to assess migration and attenuation trends. Tetrachloroethylene (PCE) was encountered in several of the wells; the source of this previously undetected compound is not known. Soil sampling results identified an area of diesel-range organics (DRO) impacted soil above the ADEC's migration to groundwater cleanup levels to the north of Buildings 307, 312, and 316. A second area of impacted groundwater was also identified around the FRF Building. Both areas are within Lots 3 and 4.

At least two rounds of soil vapor sampling have been performed in the school buildings over the past several years, including sampling in January 2018 (Shannon and Wilson, 2018) and in October 2020 (Rescon, 2021). In the more recent sampling, some detections of fuel related compounds were noted; with only one indoor air location (IA-04) registering detections above the appropriate action level. Some sub-slab (below the concrete slab of the building) air was also found to have fuel related compounds at concentrations above appropriate action levels.

1.3 Site Description

Kotzebue is in northwest coastal Alaska, located on the Baldwin Peninsula, about 25 miles north of the Arctic Circle in the Northwest Arctic Borough. The approximate coordinates are 66° 53' N and 162° 36' W. Kotzebue is located on a narrow spit between a lagoon and the Kotzebue Sound.

The former BIA Hospital and School, where the pipeline is terminated at, sits on Lot 5 and Tract 4A. The site around the former pipeline is relatively flat, consistent with a natural coastal tidal flat, with intermittent permafrost near the surface. The groundwater generally flows northeast toward the Kotzebue Sound. Lots 3, 4, and 5 and Tract 4A are all developed properties, with several structures and a gravel surface.

Lot 3 is currently a developed gravel lot owned by the IHS. Present on this lot is a parking lot for the Ferguson Building, several Maniilaq structures, and an AST. The structures consist of four duplex units and a multiunit apartment complex. All five structures belong to Maniilaq and used to house employees. These structures include cement walled basements with utilities running through from underneath the sidewalk. The AST supplies fuel to three boilers that produce heat for all five structures. Electric and cable/telephone utilities run overhead for the structures.

Lot 4 is a developed gravel pad also owned by the IHS. This lot contains the Ferguson Building, a parking lot, driving lanes, and an AST. The Ferguson Building is owned by Maniilaq and contains offices for Maniilaq's employees and health services for the community. The parking lot and driving lanes are mainly used by the Ferguson Building tenants. The AST supplies fuel to the facility's backup power generators, located in a shed adjacent to the tank.

Lot 5 belongs to KIC; this property was transferred to KIC in 1997 from the IHS. It contains a large, fenced industrial area with a building (No. 314) historically associated with the former hospital. This building stores various petroleum products, chemicals and equipment. The fenced area is also used by KIC and Maniilaq as storage for vehicles, equipment, Conex boxes, fuel tanks, a stockpile of soil berms, and a telecom utility easement. The fuel tanks were formerly used to fuel the former hospital but are now marked "out of service." Outside of the fenced area is a portion of a parking lot on the east corner of the overall lot, and on the west end are driving lanes outside of the Ferguson Building.

Tract 4A is the largest parcel (11.52 acres) in this area and is owned by the NWAB. This lot encompasses the school grounds with the elementary, middle, and high school buildings, two playgrounds, the NWABSD office building, a maintenance area for school vehicles and equipment, and a few other school district buildings. An access road and a utility right-of-way runs through the northwest side of the lot as well as a portion of the fuel pipeline that is potentially identified as the primary former leak location. On the southwest side of the lot, several portions of the pipeline exist with junctions and branch lines servicing the school buildings and the former hospital's fuel tanks.

1.3.1 Climate

Kotzebue lies within the dry, subarctic, transitional climate of Alaska and is generally characterized by long, snowy and very cold winters, and short, mild summers. Daily temperature variations are low to minimal throughout the year with an annual normal of 11.6 degrees Fahrenheit (°F) and a minimum normal of 8.0°F in October, with frequent winds, low humidity and limited cloud cover. From 1991 to 2020, average temperatures (January through July) ranged from -0.7 to 56.6°F, with an annual mean temperature of 25.3°F. Temperature extremes recorded from 1930 to 2013 ranged from -58°F to 85°F. Annual precipitation from 1991 to 2020 averaged 11.36 inches per year, although precipitation may vary considerably according to local topography. The wettest months are July and August, which receive an average of 1.6 to 2.13

inches of rain, whereas the driest months of March, April, and May receive less than 1 inch of rain per month on average (National Oceanic and Atmospheric Administration [NOAA] 2020). Table 1 provides a summary of annual climate data.

Table 1. Kotzebue Climate Summary

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Climate Data Kotzebue Airport, Alaska from 1991 to 2020 *(NOAA, May 2020)*													
Avg. Max. Temp. (°F)	5.8	9.9	10.4	25.1	40.3	54.5	61.4	57.8	48.8	32.1	17.2	9.9	31.1
Avg. Min. Temp. (°F)	-7.2	-4.5	-4.8	10.0	28.5	43.0	51.8	48.9	39.9	24.1	6.9	-2.7	19.5
Avg. Precipitation. (in.)	0.62	0.85	0.52	0.56	0.44	0.60	1.60	2.13	1.42	1.07	0.82	0.73	11.36
Avg. Snowfall (in.)	9.4	13.1	6.4	4.7	1.2	0	0	0	0.6	5.9	11.0	11.9	64.2

Notes: See Acronyms and Abbreviations for definitions.

1.3.2 Geology and Hydrogeology

The former BIA Hospital/School pipeline, abandoned in place, is located along the School Utility Road and the school playground south of the Kotzebue Sound. According to Dorava and Brekken (1995), the bedrock on the Baldwin Peninsula is deep and is covered by surficial materials ranging from 150 meters (m) to 750 m thick. This surficial material contains a sequence of marine and glacial deposits visible as sea cliffs. The organic rich soils near Kotzebue, where permafrost is present, have a maximum layer of approximately 1-5 m depth. Soils are alternately wet and dry, typically dark-gray and mottled, due to variations in temperatures and precipitation. The prime silt loam soils are settled on deep silty alluvium. According to Dorava and Brekken (1995), the continuous permafrost influences the groundwater recharge and flow and acts as an impermeable layer to underlying geologies. In the areas where permafrost is absent, the groundwater is hydraulically connected to the Kotzebue Sound and susceptible to saltwater intrusion. The groundwater discharges into the sound to the west, as well as the lagoon to the east and wetlands throughout the area. The groundwater is typically at sea level below the ground surface. The groundwater contains chloride at depths of 25 m and 80 m deep.

Groundwater in the areas adjacent to or near the Kotzebue Sound are tidally influenced; the tide fluctuates roughly 1 foot at most (NOAA 2022). Although the tidal fluctuations are fairly low, Kotzebue Sound is heavily influenced by storm surges, winter ice buildup, and spring ice melts. These fluctuations historically caused flooding that likely also impacted groundwater levels. The installation of the sea wall on the north side of Shore Ave. has decreased the flood risks and reduced the groundwater interactions south of the sea wall. The low specific conductivity as measured in the wells (values in the hundreds of microsiemens per centimeter µS/cm versus Kotzebue Sound measurement of ~7,000 µS/cm in July 2022) is one indication of this isolation. Note that it is likely that some groundwater-Sound interactions still may occur, especially when sea levels rise enabling the seawater to potentially travel under the sea wall.

2 Regulatory Criteria

This project included the collection of soil and groundwater samples. The primary chemicals of concern (CoC) are typical petroleum related compounds likely attributed to the pipeline fuel releases; these include:

- Gasoline range organics (GRO)
- Diesel range organics (DRO)
- Polynuclear aromatic hydrocarbons (PAH)
- Residual range organics (RRO)
- Benzene, toluene, ethylbenzene, and xylenes (BTEX) and other volatile organic compounds (VOCs)

Previous investigations have also detected non-petroleum related VOCs, including trichloroethene, chloroform, and tetrachloroethylene (aka, perchloroethylene, PCE) in both soils and groundwater.

The applicable project screening levels, based on Alaska cleanup standards are identified in Table 2.

Table 2. Project Screening Levels

Analyte	Soil Project Screening Level (mg/kg) [1]	Groundwater Project Screening Level (µg/L) [2]
Fuels and BTEX		
GRO	2200	2,200
DRO	1500	1,500
RRO	1100	1,100
Benzene	16	4.6
Toluene	8000	1,100
Ethylbenzene	72	15
Xylenes (total)	190	190
PAHs		
1-Methylnaphthalene	310	11
2-Methylnaphthalene	420	36
Acenaphthene	6300	530
Acenaphthylene	3100	260
Anthracene	31000	43
Benz[a]anthracene	20	0.3
Benzo[a]pyrene	2	0.25
Benzo[b]fluoranthene	20	2.5

Table 2. Project Screening Levels

Analyte	Soil Project Screening Level (mg/kg) [1]	Groundwater Project Screening Level (µg/L) [2]
Benzo[g,h,i]perylene	3100	0.26
Benzo[k]fluoranthene	200	0.8
Chrysene	2000	2
Dibenzo[a,h]anthracene	2	0.25
Fluoranthene	4200	260
Fluorene	4200	290
Indeno[1,2,3-cd]pyrene	20	0.19
Naphthalene	42	1.7
Phenanthrene	3100	170
Pyrene	3100	120
VOCs		
2-Butanone (MEK)	53000	5,600
Bromobenzene	410	62
Bromodichloromethane	5.3	1.3
Bromoform	340	33
Bromomethane	15	7.5
n-Butylbenzene	6800	1,000
sec-Butylbenzene	14000	2,000
tert-Butylbenzene	14000	690
Carbon disulfide	1600	810
Carbon tetrachloride	13	4.6
Chlorobenzene	370	78
Chloroform	5.8	2.2
Chloromethane	250	190
1,2-Dibromoethane (EDB)	0.62	0.075
Dibromochloromethane	140	8.7
Dibromomethane	45	8.3
1,2-Dichlorobenzene	2300	300
1,3-Dichlorobenzene	2000	300
1,4-Dichlorobenzene	31	4.8
Dichlorodifluoromethane	220	200
1,1-Dichloroethane	67	28
1,2-Dichloroethane (EDC)	8	1.7
1,2-Dichloropropane	25	8.2
cis-1,3-Dichloropropene	30	4.7
Hexachlorobutadiene	14	1.4
2-Hexanone	380	38

Table 2. Project Screening Levels

Analyte	Soil Project Screening Level (mg/kg) [1]	Groundwater Project Screening Level (µg/L) [2]
Isopropylbenzene (Cumene)	2500	450
4-Methyl-2-pentanone (MIBK)	69000	6,300
Methylene chloride	630	110
Methyl-t-butyl ether	970	140
Naphthalene	42	1.7
Styrene	8100	1,200
1,1,1,2-Tetrachloroethane	30	5.7
1,1,2,2-Tetrachloroethane	8.8	0.76
1,2,3-Trichlorobenzene	110	7
1,2,4-Trichlorobenzene	66	4
1,1,1-Trichloroethane	160000	8,000
1,1,2-Trichloroethane	2.3	0.41
Trichlorofluoromethane	41000	5,200
1,2,3-Trichloropropane	0.089	0.0075
1,2,4-Trimethylbenzene	400	56
1,3,5-Trimethylbenzene	360	60
Trichloroethylene	7.1	2.8
Vinyl acetate	2100	410
Vinyl chloride	0.69	0.19

Notes: See Acronyms and Abbreviations for definitions.

[1] Unless otherwise noted, soil PSLs are the cleanup levels as listed in 18 AAC 75.341, Tables B1 and B2 for arctic zone soils (ADEC 2021).

[2] Unless otherwise noted, groundwater PSLs are the cleanup levels as listed in 18 AAC 75.345, Table C.

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3 FIELD ACTIVITIES

Project activities were performed according to the procedures and methods outlined in the ADEC-approved Work Plan (Kuna 2021). The field activities included the performance of soil borings for both the collection of soil samples and the subsequent installation of groundwater monitoring wells. Well development and sampling were performed through several site visits. A timeline for the completed field activities is as follows:

- October 2021 – Mobilized to Kotzebue and completed 16 soil borings and installed six monitoring wells. Unfortunately, the newly installed wells could not be developed and sampled due to the cold conditions and the field crew demobilized.
- June 2022 – Mobilized to Kotzebue to attempt to develop and sample previously installed monitoring wells; unfortunately, the wells remained frozen, and the field crew demobilized.
- July 2022 – Mobilized to Kotzebue and developed and sampled the monitoring wells.
- October 2022 – Mobilized to Kotzebue and sampled the monitoring wells.

In general, the following provides an overview of the major activities performed through these site visits:

- During the October 2021 site visit, the site was inspected for evidence of recent spills or other releases and any potential impacts. The location of each existing groundwater monitoring well was verified, and the condition of the wells was noted. The former pipeline, existing utilities, and the city ROWs around the wells were pinpointed and marked (with the help of City personnel) to site the exact locations for the groundwater monitoring wells and soil borings. A detailed review of the site was also performed to verify the continued presence or status of any USTs located within Lot 4A. The locations of these tanks are shown on Figure 1; no locations changed from the locations as identified in the work plan (Kuna 2021).
- Soil borings were performed to collect the soil samples for field screening and laboratory analysis at locations along/surrounding the former pipeline to assess the degree and extent of impacted soils around this pipeline. Soil samples were also collected from the borings performed for the installation of each groundwater monitoring well. The specific locations of the soil borings along the former pipeline were determined in the field after identifying any impeding utilities.
- Six groundwater monitoring wells were installed at the locations as specified on Figure 2. The locations of these wells were field determined based on the ROW limits and any impeding utilities.

- Groundwater samples were collected from the newly installed groundwater monitoring wells and submitted for laboratory analysis. Field parameters and groundwater elevations were also recorded for each well.

The following sections describe the specific approach and field sampling methods that were used for the activities described above. In general, all field activities and sampling followed applicable ADEC sampling guidance (ADEC 2019) and the methods included in the approved work plan (Kuna 2021). Some variances in the sampling approach or methods occurred in response to field conditions; these variances were documented in the field notes and included in this report. Significant variances were discussed and approved by ADEC prior to the completion of the sampling. These are described in the following subsections.

3.1 Permit Applications

Prior to the soil borings and the installation of the monitoring wells, Kuna prepared and submitted a City of Kotzebue ROW application. This application was necessary to permit the installation of the monitoring wells in the Shore Ave. right-of-way and along the edge of Bison Street and Turf Street. Following a meeting of the Planning Department in September 2021, the City of Kotzebue provided the permit; a copy of the ROW permits for each of the monitoring wells is provided in Appendix A.

3.2 Site Inspection

Upon arrival to the site in October 2021, the City of Kotzebue and Kotzebue Electric Association (KEA) assisted in locating existing buried utilities and the City ROW boundaries. Any utilities around the former pipeline were also identified and marked to ensure the safe performance of the soil borings in this area. Locations of the utilities, particularly along/within School Utility Driver are shown on Figure 3.

The locations of the existing groundwater monitoring wells were verified to confirm their status and condition. To the extent possible, groundwater elevations were measured in each well, also noting the presence/depth of any free product or sheens in these wells.

3.3 Groundwater Monitoring Well Installations

After the ROW and utilities were marked, borings for each well were performed using the Geoprobe 6620DT drilling rig. The cores for each boring were continuously screened using the PID. PID readings provide a general assessment on the degree of petroleum impacts in the soils around the groundwater monitoring wells.

One soil sample from each boring was collected for laboratory analysis. The soils sampled were from the six-inch depth interval just above the water table (i.e., saturated soils as noted through observation of the cores and the depths identified in the nearby groundwater monitoring wells). The soil samples were collected for the analyses as identified in Table 3.

Groundwater monitoring wells were installed according to a common design, consisting of a two-inch diameter well completed with a flush-mount finish and installed to a depth of approximately 10 feet (ft) below the ground surface (bgs). Each well was constructed using a polyvinyl chloride (PVC) casing, with a five-foot screened section at the bottom of the well. The screen slot size is a 0.01-in and is surrounded by a sand filter pack, using #20 sand. A locking well cap was installed at the top of the well just below the flush-mount cover.

3.4 Well Development, Purging, and Groundwater Sampling

As noted, the development and sampling of the wells did not occur immediately after the well construction; cold weather and snow prevented this activity from occurring in October 2021. The wells were developed/purged in July 2022 to restore the natural hydraulic conductivity and remove any sediment buildup in the well. The well development also removed stagnant water to ensure the samples are representative of the local groundwater conditions. The development goal was to reach static water quality conditions. All well development water was contained as investigative derived waste (IDW) and subsequent sampling/analysis was performed to guide in proper waste disposal (see subsequent section).

Groundwater sampling at each well was conducted two to three hours before and after low tide to minimize the influence of high tide and higher water level. Samples were collected with a QED 1.75-inch pneumatic bladder pump and dedicated tubing using low-flow methods. Pump intakes were set approximately 1 foot below the depth to water. Field water quality parameters were monitored using a YSI 556 multiparameter meter with a flow-through cell; measurements were recorded until parameters were stable. Water quality parameters were considered stable when at least four parameters (including temperature) had successive stable readings, collected four minutes apart. Drawdown during purging did not exceed 0.3 ft. Field water quality parameters and sampling notes were recorded on groundwater purging and sampling logs (Appendix F).

Prior to the purging of each well for sampling, the water levels were measured. Times were also noted to correlate with known tide levels for the Kotzebue Sound. Water levels and field water quality parameters are summarized in Table 7. Tide levels during the sampling events are also included in the table.

3.5 Soil Borings and Sampling

In addition to the groundwater sampling, soil samples were collected from locations directly adjacent to the former BIA pipeline, as well as one soil sample from the borings performed for each of the six new monitoring well locations (as described above). According to task 3 of the project/contract Scope of Work (SOW) (BIA 2021), the degree and extent of the soil impacts in the immediate vicinity of the pipeline were assessed on Tract 4A and Lot B, with the objective to determine the quantity of impacted soil that may require removal should the pipeline be removed (in the future). Direct push soil borings were used for this assessment. Samples were collected along the pipeline or at every junction or pipeline end, as shown in Figure 3. Each boring was performed to depths just below the water table, or approximately five to seven feet bgs. Cores from each boring were continuously analyzed/screened via PID for petroleum impacts. Samples from the depth intervals (six inches) from each boring core with the highest PID readings were collected for the laboratory analyses.

A total of 15 soil borings were advanced using a Geoprobe 6620DT direct push drill rig at the former HIS/BIA hospital site. The first three proposed soil boring sites (SB-1, SB-2, SB-3-2021) were not drilled due to concerns about unmarked utility lines; this is further described in the subsequent deviations section of this report. Borings were advanced at or as close as possible to proposed locations and were moved only to accommodate underground utilities or property boundaries. The borings were advanced to make observations, conduct field screening, and collect analytical soil samples. Each boring was documented on a Soil Boring Log (Appendix D), which included a description of soil lithology, moisture/depth to groundwater observations, visual and olfactory observations, associated samples, and PID results. The borings were logged continuously for geological profiling purposes and to identify potentially contaminated intervals using PID field screening.

Table 3. Soil Boring, Monitoring Well, and Sample Summary

Boring/ Monitoring Well Identification	Total Boring Depth (ft bgs)	Date Performed	Depth to Groundwater (ft bgs)	Well Screen Interval (ft bgs)	Samples Collected
SB04-2021	8	10/24/21	6	N/A	1 soil sample (4.5-5 feet)
SB05-2021	6	10/24/21	4.5	N/A	1 soil sample (4.5-5 feet)
SB06-2021	8	10/23/21	5	N/A	1 soil sample (4.5-5 feet)
SB07-2021	10	10/24/21	6	N/A	1 soil sample (5.5-6 feet)
SB08-2021	8	10/24/21	7	N/A	1 soil sample (6-7 feet)
SB09-2021	10	10/24/21	6.5	N/A	1 soil sample (5.5-6.5 feet)
SB10-2021	8	10/24/21	6	N/A	1 soil sample (5.5-6 feet)
SB11-2021	10	10/23/21	6.5	N/A	1 soil sample (5.5-6.5 feet)
SB12-2021	10	10/24/21	6	N/A	1 soil sample (5.5-6 feet)
SB13-2021	9	10/23/21	7	N/A	1 soil sample (6-7 feet)
SB14-2021	6	10/23/21	4.5	N/A	1 soil sample (4-5 feet)
SB14a-MW11-2021	6	10/23/21	4.5	2.8-7.8	1 soil sample (4.5-5.5 feet) 2 GW samples (7/31; 10/5)
SB15-MW12-2021	10	10/22/21	6.31	5.8-10.8	1 soil sample (7-8 feet bgs) 2 GW samples (7/31; 10/5)
SB16-MW13-2021	10	10/22/21	6.46	5.0-10.0	1 soil sample (4.5-5 feet) 2 GW samples (7/31; 10/5)
SB17-MW14-2021	11	10/22/21	6.33	5.5-10.5	1 soil sample (5.5-6 feet) 2 GW samples (7/31; 10/5)
SB18-MW15-2021	10	10/22/21	7.91	5.5-10.5	1 soil sample (6-7 feet) 1 GW sample (10/5)
SB19-MW16-2021	10	10/22/21	4.5-5	3.5-8.5	1 soil sample (4-5 feet) 2 GW samples (7/31; 10/5)

3.6 Work Plan Deviations

Soil borings SB1, SB2, and SB3 were not drilled due to utility conflicts in the planned locations. A deviation notice (Field Change Notice) was submitted to BIA and ADEC for the elimination of these boring/sampling locations. A copy of the approved notice is provided in Appendix B. As noted above, the locations of the potential interfering utilities around the northwest side of the school are shown on Figure 3.

In the July 2022 sampling event, a vehicle was parked over well MW15; unfortunately, a resident in the adjacent house was not available to move the vehicle and a sample was not obtained.

3.7 Decontamination

Non-dedicated, down-well sampling equipment was decontaminated between wells, including all stainless-steel bladder pump components, the water level meter, and the interface probe. The pumps were appropriately disassembled for the decontamination process. Similarly, soil sampling and drilling equipment including drilling cores, sampling spoons, and bowls were also decontaminated between each boring location. Decontamination procedures included an Alconox wash and deionized water rinse. Disposable tubing and the Macro-Core liners (for the soil borings) were used for sampling efforts.

3.8 Waste Management

IDW generated during the three field events included soil cuttings, purge and decontamination water, and solid wastes such as nitrile gloves and paper towels. These wastes were managed as follows:

- *Solid wastes.* For each of the three events, these were placed in garbage bags and disposed as typical solid waste which is finally disposed at the City of Kotzebue landfill.
- *Decon and purge water.* This was containerized in a drum and sampled for waste characterization purposes. The results for this water are summarized in Table 6 and included in Appendix G. No analytes were detected at concentrations above the levels of quantitation (LOQs) in this water. The drum is currently stored outside and likely frozen. It will be surface disposed once it melts in spring/early summer 2023.
- *Soil cuttings.* Soils from the borings and well installations were containerized in 5-gal drums labeled according to each boring/well. Separate requests for disposal were submitted to ADEC for these materials according to the detected compounds in each boring; copies of the disposal approvals are provided in Appendix C:
    - *Cuttings with low/no detects* (Appendix C-1). Cuttings from borings SB07, SB10, SB12, SB17, and SB18 had low-level or no detections of just petroleum (non-chlorinated) compounds that enabled these materials to be disposed in the Kotzebue Landfill, per the approval from ADEC.
    - *Cuttings with higher levels of detections* (Appendix C-2). Cuttings from borings SB05, SB06, SB08, SB09, SB11, SB13, SB14a, SB16, and SB19 had detections of petroleum compounds that could not be disposed in the Kotzebue landfill and therefore required transport back to Anchorage for disposal. These materials were disposed with Anchorage Sand and Gravel (Alaska Soil Recycling). This disposal occurred in July 2022.
    - *Cuttings with potential chlorinated compound detections* (Appendix C-3). The potential detection of trichlorofluoromethane (R-11 refrigerant) in borings SB04, SB14, and SB15 (see Table 5) meant these soils could not be immediately managed

by Alaska Soil Recycling. The initial detection in these borings was at concentrations below the LOQ (above the limit of detection, LOD). Additional sampling, performed in July 2022, demonstrated that these soils did not contain any chlorinated compounds (results provided in Appendix G and Table 5). The approved and completed transport form is provided in Appendix C-3. These soils were disposed appropriately by U.S. Ecology.

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4 Investigation Results

The section summarizes and provides discussion of notable observations and analytical soil and groundwater sampling results from the site investigation at the Former IHS/BIA Hospital-School.

4.1 Soil Sampling Results

Field screening and analytical data from soil sampling are summarized in the following subsections.

4.1.1 Geology

The sixteen soil borings performed around the former BIA school and hospital generally encountered unconsolidated gravel, sand, and silt materials to their final depth. This material is consistent with the general fill materials used throughout the Kotzebue area to enable construction within the area. Peat and organic material were intermittently encountered at a general depth of four feet bgs (SB08; SB12; SB19). Minimal ice or permafrost was encountered. Foam insulation was encountered in SB14 at three feet bgs, indicating that this area had previously been disturbed. The foam encountered in SB14 coupled with the known utilities in the area around SB01, SB02, and SB03 led to the elimination of these three borings. City of Kotzebue personnel also had significant concerns related to these three boring locations and the potential for damage to these utilities.

4.1.2 Field Screening

To provide a qualitative understanding of the potential fuel related impacts in the site soils, PID field screening measurements and visual/olfactory field observations are documented on the soil boring logs in Appendix D. A strong petroleum, oil, and lubricant (POL) odor was noted in borings SB05, SB06, SB08, SB09, SB14, and SB19. The petroleum odor was generally associated with sandy material in proximity to the groundwater table. The elevated PID results were observed two feet or more below ground surface. Table 4 provides a summary of the PID readings. As noted, only a few of the borings had PID readings above 50 and those generally are found in areas immediately adjacent to the pipeline and at the location to the west of Bison Street (SB14). Where PID readings are above 50, the greater values are generally located at the deeper depths and in soils near the zone where groundwater is periodically in contact with the soil. It is important to note that the PID results were not used as any form of an action level, but rather to simply provide qualitative information on the general presence/absence of impacts.

4.1.3 Soil Analytical Results

Complete soil analytical results are included in Appendix G; samples with concentrations of specific compounds above the applicable project screening level (PSLs) are shown on Figure 4 and highlighted in Table 5. None of the soil had individual VOC or PAH analyte detections that exceeded their respective arctic zone soil cleanup levels (i.e., the PSLs), as identified in the prior section.

While many of the soil boring samples detected DRO and RRO, only one of the 18 samples had an exceedance. DRO was detected in SB04 (4.5-5 ft bgs) at a concentration of 18,400 milligrams per kilogram (mg/kg); the PSL is 12,500 mg/kg.

Table 4. Soil Boring PID Readings

Borehole ID	Depth (ft bgs)	PID Reading
SB04-2021	0-2	10.2
	2-4	13.5
	4-5	16
SB05-2021	0-2	19.7
	2-4	149
	4-5	324.6
SB06-2021	0-2	0.1
	2-4	0.3
	4-6	297
SB07-2021	0-2	9.9
	2-4	8.7
	4-5	7.2
SB08-2021	0-2	8.1
	2-4	6.5
	4-5	16
SB09-2021	0-2	12.7
	2-5	8.8
	5-7	171
	7-9	27.7
SB10-2021	0-2	9.7
	2-4	13.6
	4-6	10.6
SB11-2021	0-2	13
	2-4	7.7
	4-5	11.3
	5-7	9.6
SB12-2021	0-2	4.2
	2-4	6
	4-5	6.8
SB13-2021	0-2	11.2
	2-4	12.8
	4-5	10
SB14-2021	0-2	2.3
	2-4	8
	4-5	159
SB14a-2021	0-2	76.9
	2-4	149
	4-5	450
SB15-2021	0-2	0.4
	2-4	0.4
	4-6	0.4
	6-8	308
	8-10	197
SB16-2021	0-2	0.2
	2-4	0.2
	4-6	0.2
	6-8	2
	8-10	5
SB17-2021	0-2	0.2
	2-4	0.2
	4-6	0.4
	6-8	0.5
	8-10	0.4
SB18-2021	0-2	0.4
	2-4	0.5
	4-6	0.3
	6-8	0.8
	8-10	0.7
SB19-2021	0-2	0.5
	2-4	28
	4-6	5.5
	6-8	23

Note: Color coding is as follows:
Green – detections from 0 – 5; Yellow – 5 – 100; Orange – 100 – 300; Red – above 300

4.2 Groundwater Investigation Results

Two rounds of groundwater samples were collected in 2022: in late July and in early October. The results from these samples are summarized in the following subsections.

4.2.1 Groundwater Quality Field Parameters

The final water quality measurements from the purging of each well are summarized in Table 6. Water levels were recorded in each sampling event with the water level tape; these measurements are also provided in Table 7.

4.2.2 Groundwater Analytical Results

Groundwater samples were obtained from each well during both sampling events (July and October 2022). Samples were kept on ice and under Chain-of-Custody (COC) procedures for delivery to the laboratory, SGS North America Inc. in Anchorage, Alaska. The following subsections highlight the results from the analyses performed. Table 6 provides a summary of the analytical results for both sampling events.

For both the July and October 2022 sampling events the samples arrived at the laboratory with temperatures exceeding the acceptable range for VOC samples. The standard temperature is set at 6°C; however, the recorded temperatures for the June and July samples were 12.7°C and 15°C, respectively. It is important to consider the potential impacts of elevated temperatures on these samples:

- Increased volatility: Higher temperatures can enhance the volatility of VOCs, causing them to evaporate at a faster rate.
- Compound degradation: Elevated temperatures can lead to the degradation of target compounds, potentially altering their concentrations.
- Container leakage: The increased pressure within sample containers under higher temperatures can increase VOCs release/leakage.

Consequently, the higher, out-of-range temperatures may lead to an underestimation of VOC concentrations from these specific sampling events.

4.2.2.1 Polycyclic Aromatic Hydrocarbons

For the July 2022 sample results, only one well (MW16) had any PAH results above the PSLs: 1-methylanaphthalene at 45.7 micrograms per liter µg/L, where the PSL is 11 µg/L; and 2-methylnaphthalene at 44.5 µg/L where the PSL is 36 µg/L.

For the October results, 1-methylnaphthalene and 2-methylnaphthalene continued to have concentrations above the PSLs in MW16 (58.1 and 69.4 µg/L respectively). The sample from well MW13 had concentrations for these compounds above the PSLs (43.2 and 46.5 µg/L respectively). Wells MW11 and MW12 also had detections of 1-methylnaphthalene above the PSLs (11.1 and 57.4 respectively).

4.2.2.2 GRO, DRO, RRO

While each of the six wells had detections of GRO, DRO, and/or RRO in one or both 2022 sampling events, none of the results was above the PSLs for these composite analyses.

4.2.2.3 Volatile Organic Compounds

For the July and October sampling all six wells, except MW15, detected naphthalene at concentrations above the PSL (1.7 µg/L). In both sampling events, MW13 had benzene concentrations (July: 5.39 µg/L and Oct: 9.08 µg/L) above the PSL (4.6 µg/L). Chloroform, a potential laboratory artifact, was detected in either July and/or October in 5 of the 6 wells (MW11, MW12, MW13, MW14, and MW15) at concentrations exceeding the PSL (2.2 µg/L). Wells MW16, MW13, and MW12 had detections of 1,2,4-trimethylbenzene above its PSL (60 µg/L) in October and MW16 also detected this compound above the PSL in July (84.4 µg/L). The sample from well MW12 had detections of 1,3,5-trimethylbenzene in both July and October (66.7 and 89.4 µg/L) above the PSL (60 µg/L). The July sample from MW16 also detected trichloroethylene (TCE) at a concentration (6.06 µg/L) above the PSL (2.8 µg/L). This was the only detection above the LOQ for TCE or any other of the typical chlorinated solvents in any of the groundwater samples. Several other VOCs were detected in the groundwater samples at concentrations below their respective PSLs, including dichlorodifluoromethane and trichlorofluoromethane; both compounds are refrigerants (aka, R-11 and R-12) that were commonly used in many refrigeration units until the past few years.

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5 DATA QUALITY ASSURANCE AND QUALITY CONTROL

Each of the three field events documented in this report were overseen by an ADEC-qualified environmental professional (Norm Straub). Standard quality control (QC) samples were collected and submitted to the laboratory along with field samples including field duplicates (collected at a frequency of roughly 10 percent) and matrix spike/matrix spike duplicate (MS/MSD) samples. Standard blank samples, including both field/equipment blanks and trip blanks were also collected and analyzed.

In general, the overall project data quality was acceptable. However, some analyses and analytes may have specific issues as noted below:

- The level of detection for 1,2,3-trichloropropane in both the groundwater sample analyses (July and October 2022) were above the respective PSL for this compound (0.0075 µg/L).
- 2-methylnaphthalene analyses for the October 2021 collected soil samples via Method 8270D-SIM had QC issues for samples SB19, SB06, SB14, SB15, SB14a, SB09, SB08, SB08 (duplicate), SB05, and SB04. The elevated concentrations in these samples is potentially influenced by matrix interferences as documented in the lab report; surrogate recovery levels fell outside of the acceptable range.
- 2-methylnaphthalene analyses for the MW11, MW12, MW13, MW14, and MW16 October 2022 collected groundwater samples had noted surrogate recovery QC issues. Like the soil samples, the elevated concentrations in these samples is potentially influenced by matrix interferences as documented in the lab report; surrogate recovery levels fell outside of the acceptable range.
- Several brominated and chlorinated compounds were noted with either matrix, calibration, or surrogate recovery concerns. While this presents potential quantification concerns for these compounds, the site's history as a former diesel leak/release does not present significant concern for the presence of these compounds.
- The coolers received at the laboratory for the July and October 2022 sample events exceeded the temperature standard, as noted in the Results (Section 4.2.2.3). This is most impactful to the interpretation of the VOC samples. While the VOC samples were preserved with hydrochloric acid to protect sample integrity by preventing microbial degradation and inhibiting chemical reactions that could alter the VOCs composition, the preservation does not have the same inhibitory effect on volatilization as colder temperatures would. Consequently, there is a possibility of underestimating the concentrations of VOCs in these groundwater samples. However, it is expected that the compounds in the degraded spill residue for this old diesel spill site will have lower

volatilization rates, diminishing the influence of temperature on sample integrity. The primary contaminants of concern at this site are PAHs, DRO, and RRO.

ADEC Data Quality Review Checklists for each of the lab reports are provided in Appendix H. For the purposes of this investigation, all the collected data is deemed usable for site characterization purposes and understanding the general trends and potential next steps.

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6 Results and Discussion

This section presents a discussion of the results from this investigation, in context with results from the prior investigations and the site setting and geology. The conceptual model informs potential data gaps and recommendations for future actions at the site.

6.1 Potential Receptors and Pathways

Potential receptors and receptor pathways that may exist in the area around the former pipeline include the following:

- Ecological receptors in Kotzebue Sound that may be exposed to impacted groundwater, including various marine plant, microbiological, and animal species. This pathway may also include individuals, including subsistence harvesters, that may be consuming any of these species.
- Individuals with residences near the former pipeline, where soils and/or groundwater may be off-gassing certain VOCs into the atmosphere of these residences.
- Students, workers, or other intermittent visitors in the buildings around the former pipeline where soils and/or groundwater may be off-gassing certain VOCs into the atmosphere of these buildings.
- Workers or other individuals exposed to either surface or subsurface soils when excavations are performed around the former pipeline.
- Individuals with residential drinking water wells located in the area around the former pipeline.

A further discussion of each potential pathway is provided in the following subsections.

6.1.1 Kotzebue Sound Receptors

The arctic nature of the site and the presence of permafrost below the shallow water table limits the overall discharge of groundwater to Kotzebue Sound. Additionally, the presence of the sea wall along Front Street provides a further impedance to significant groundwater flow from the south to the north and to the Sound. However, a connection between area groundwater and the Sound was documented via the historic sheens noted in the Sound and cannot be definitively ruled out via the current understanding of the site.

The results from the monitoring well sampling performed through the 2022 investigation indicate that minimal overall groundwater impacts are present in the area immediately south of the sea wall. In the four wells located along Shore Ave. (MW12 – MW15), only a few compounds had detections above the PSLs. While these detections may indicate the possibility of impacted groundwater flow into the Sound, the intermittent and seasonal nature of this flow and the low concentrations present a minimal risk of impacts to any Sound-based receptors.

6.1.2 VOC Off-Gas Receptors

VOCs by-nature have low vapor pressures and therefore can volatilize to develop high gaseous concentrations when the soils are in contact with air in confined spaces, such as buildings. Several prior studies have included soil-gas monitoring and have not found widespread petroleum related soil concentrations that can be definitively attributed to the former pipeline and/or at consistently high concentrations that may necessitate further action. Based on both the PID measurements and the concentrations of VOCs and PAHs in the soil or groundwater in the areas included in this investigation, the off-gas rates and subsequent concentrations are not high enough to present significant concerns. Off-gassing from soils or groundwater in other areas of the site (on other sides of the school) may not be definitively ruled out as potential pathways.

6.1.3 Worker Exposure

This investigation was primarily focused on impacts to groundwater and the relationship between impacted soils and groundwater. Soil samples for laboratory analysis were generally collected from soils at deeper depths (below four feet bgs) where only deeper foundation or utility excavations would be performed. However, the PID measurements from soils at shallower depths provide an indication of potential aggregate VOC concentrations. In general, the PID measurements for the shallower soils are low values that indicate potential and not indicative of VOC concentrations that may present worker risks. Additionally, the semi-frozen nature of the soils further minimizes the potential generation of dust, eliminating this potential pathway.

Despite the low exposure risk for workers performing excavations in pipeline-affected soils, the potential exposure to other more susceptible individuals, such as children in the school area should not be discounted and any excavations should be appropriately monitored and minimized.

6.1.4 Private/Public Well Water Exposure

No shallow public or private water wells exist in the area around the former pipeline.

6.2 Soil Conceptual Model

Several potential observations can be developed based on the soil results from this investigation and the prior investigations. These observations include:

- Numerous utilities are known to exist in the area around the former pipeline, presenting significant challenges for both soil sampling and any potential removal of impacted soils or removal of the former pipeline.

- Shallow soils both near the former pipeline and downgradient (along Shore Ave.) may not be impacted by petroleum compounds based on indicative PID measurements; natural attenuation of any compounds in these soils may have occurred.
- Some VOCs and PAHs are detected in the deeper soils near the groundwater-soil interface in limited locations around the site, however none of these detections are above the applicable PSLs. Only DRO is detected in one sample (SB04) at a concentration exceeding its PSL.
- Deeper soils in the area downgradient (towards Kotzebue Sound) from the pipeline are not impacted by fuel related compounds.
- Soils in the areas on the branch pipelines and at the south end of the main pipeline (near the teacher housing) have limited detections above applicable PSLs; borings SB09 and SB08 have some fuel related impacts at depth (>5 ft bgs), with concentrations of DRO (5,160 and 3,870 mg/kg respectively) above its applicable PSL (1,500 mg/kg).
- A pocket of impacted soil may exist in the MW11 area, on the northwestern end of Bison Street. These impacts may be attributed to another spill or release. Prior investigations, including the 2020 investigation and limited removal action (2021 TCC-EM JV) identified higher concentrations in this area and a small amount of soil was removed in the area east of MW11 (north of FRF Building). This removal area is up and sidegradient of MW11 and MW12, respectively.

These observations inform the recommendations for the next potential investigation and/or remedial steps for the area. These results are also related to the groundwater observations as described in the following subsection.

6.3 Groundwater Conceptual Model

Observations related to the groundwater results from this investigation and prior groundwater investigations are identified as follows:

- Groundwater depths generally increase through the summer/fall; higher groundwater levels are experienced early in the summer when snow melt/runoff and infiltration is high.
- Groundwater flow is generally to the north, towards Kotzebue Sound.
- Dissolved oxygen and oxidation reduction potential (ORP) values in the groundwater in the six monitoring wells changed seasonally; lower values in the fall may be indicative of lower groundwater flow and greater uptake of dissolved oxygen by microorganisms in the groundwater through the summer.
- Although the sea wall on the north side of Shore Ave. has likely limited the interactions between the site groundwater and Kotzebue Sound, some interactions may still periodically occur. However, historically (before the sea wall construction) a greater degree of connection likely existed, that would have resulted in the flushing of the

subsurface soils and groundwater by tidal and storm surges. This may have washed much of the released fuel to the Sound over time.

- Limited compounds are detected at concentrations above the applicable PSLs in the groundwater to the north of the site and near its potential discharge into Kotzebue Sound. The migration of potentially impacted groundwater to Kotzebue Sound is therefore limited and further inhibited by the sea wall (as described above).
- Groundwater in the areas around and downgradient of the high soil concentrations as noted above also have concentrations of the same compounds above PSLs, such as 1-methylnaphthalene in SB14a and SB15 and wells MW11 and MW12. Other spills/releases may have contributed to the groundwater concentrations in this area. The presence of chloroform in these two wells (MW11 and MW12) may also be indicative of another spill/release and the degradation of the refrigerant (R-12, dichlorodifluoromethane) in the soil sample from SB14a may be contributing to the chloroform detection. The foam insulation noted in boring SB14 may be a source of R-12; some insulation materials used R-12 in their manufacture (Taylor 1987).
- Groundwater upgradient and east of the former pipeline (MW16) is impacted by fuel related compounds above the applicable PSLs. This may not be directly attributed to releases from the former pipeline. This impacted groundwater may also be slowly migrating towards the east end of the former pipeline, in the area where proposed borings were unable to be performed.
- The 2022 results are generally consistent with the groundwater results as measured in 2020 (TCC-EM JV LLC); chloroform was detected on the east side of the site in 2020 and is also detected at similar concentrations in the MW11/MW12 wells at northeast end of the site. DRO and RRO groundwater detections in the area around the pipeline in 2020 (MW5, MW6, MW9, MW10) are rapidly attenuated as the groundwater moves north; neither analyte is detected at concentrations exceeding the PSLs in the groundwater along Shore Ave. (MW13, MW14, MW15). Chloroform is a compound found in many locations and can be related to the discharge of chlorinated water or wastewaters (Ivahneko and Zogorski, 2006).

These observations inform the recommendations for the next potential investigation and/or remedial steps for the groundwater around the area.

6.4 Data Gaps and Uncertainties

Additional observations and conclusions related to the site soils and groundwater require additional data that includes the following:

- The status of the soils around the east end of the former pipeline are unknown. The numerous utilities in this area prevented soil borings and the collection of soil samples. While this presents a datagap for the soils in this portion of the pipeline, any potential remedial steps in this area would also be restricted due to the utilities present.

- Current groundwater quality in the area at the south end of the site is unknown; the one existing well at this end of the site (MW2) was not sampled through this investigation. Similarly, wells in the center of the site, MW3, MW4, and MW8 were not sampled either. However, soil in this area of the site does not have widespread impacts above the applicable PSLs and does not have any known receptors. This datagap does not negatively impact the ability to recommend potential future steps for the overall site.
- Other spills/releases may be contributing to the groundwater and/or soil impacts in the area at the west/northwest of the site (MW11/MW12 area) and the east of the site (MW16). Additional sampling around these areas may aid in the identification or delineation of other sources.

Future sampling or investigation activities at the site should consider these data gaps. Future activity recommendations are provided in the following section.

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7 RECOMMENDATIONS AND NEXT STEPS

This section presents potential recommendations for next steps for the site. These include the following:

- *Continued groundwater monitoring.* Annual monitoring of the groundwater at the site, including the Front Street wells (MW12-MW15), sidegradient wells (MW11, MW16), and interior wells (MW1 – MW10). This monitoring will confirm the continued attenuation of the groundwater impacts noted in the wells along/near the pipeline (MW5, MW6, MW9, and MW10). Should funding be limited, the sampling of the interior wells may be limited to a less frequent basis and some wells may be eliminated, such as MW3 and MW8. It is important to note that none of the wells are currently recommended for decommissioning/abandonment; all of the wells should be maintained until formal site closure is achieved. Continued monitoring is further justified due to previously noted sample temperature exceedances from 2022 samples. Future sampling will verify prior sample results.

- *Potential investigation of other spills/sources.* The elevated concentrations noted in the soils and groundwater around MW11 and MW16 may be attributed to non-pipeline related sources. Delineating the specific source and extent of these sources should be pursued through additional soil borings performed in a methodical approach in these areas.

- *Development of formal institutional controls.* Managing future risks related to the noted impacts to soil and groundwater requires the implementation of specific control measures such as formal prohibitions on excavation in certain areas and/or placement of additional cover materials (to minimize exposure to affected surface soils). Formal measures to also prevent the installation of shallow groundwater wells may also be implemented. The BIA will need to work with both the Northwest Arctic Borough School District, City of Kotzebue, and landowners in the area to implement these controls. An environmental covenant is necessary for ADEC to officially recognize institutional controls.

It is important to note that removal of the former pipeline and excavation of any affected soils is not recommended. Potential impacts to utilities present immediately adjacent to the main trunk of the pipeline (along School Utility Rd.) present significant challenges to any excavation; these utilities could be easily severed or otherwise damaged (see Figure 3). Additionally, the school facilities located south of the pipeline have significant traffic from children and others that may be exposed to impacted soils in the pipeline area should excavation occur.

Pending the evaluation of the other potential spills and/or sources of soil and groundwater impacts and following the performance of two-to-three more rounds of monitoring, the BIA may be able to discuss the formal closure options for the site; many of the ADEC closure requirements may be achieved following this additional monitoring (ADEC 2020).

Recommendations are not provided for the management of any potential soil gas concerns. The analysis and evaluation of soil gas and potential risks to indoor air quality is not included in the scope of this project.

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TABLES

TABLE 5

Summary of Soil Analytical Results

	AK Cleanup Stds (mg/kg)	Sample/Well No. (results in ug/kg, unless specified)																			
		MW16-SB19	MW15-SB18	MW14-SB17	SB06	SB14	MW12-SB15	MW13-SB16	MW11-SB14A	SB12	SB10	SB11	SB09	SB07	SB08	SB08 (dup)	SB13	SB05	SB04	IDW-01 (7/30/22)	IDW-01 (10/25/21)
PAHs																					
1-Methylnaphthalene	310	328	13.3 U	13.0 U	8010	13200	4480	13.4 U	15300	12.9 U	13.4 U	20.8 J	1550	12.9 U	8080	10500	13.5 U	26000	32100		732
2-Methylnaphthalene	420	36.7	13.3 U	13.0 U	213 J	10600	783	13.4 U	10200	12.9 U	13.4 U	16.9 J	141 U	12.9 U	5160	7390	13.5 U	29400	24300		422
Acenaphthene	6300	18.8 J	13.3 U	13.0 U	678	552 J	497 J	13.4 U	527	12.9 U	13.4 U	13.9 U	142 J	12.9 U	383	491	13.5 U	885	1470		35.8
Acenaphthylene	3100	13.6 U	13.3 U	13.0 U	258 U	362 U	329 U	13.4 U	131 U	12.9 U	13.4 U	13.9 U	141 U	12.9 U	141 U	146 U	13.5 U	333 U	292 U		13.4 U
Anthracene	31000	13.6 U	13.3 U	13.0 U	258 U	362 U	329 U	13.4 U	131 U	12.9 U	13.4 U	13.9 U	141 U	12.9 U	141 U	146 U	13.5 U	333 U	292 U		13.4 U
Benzo(a)Anthracene	20	13.6 U	13.3 U	13.0 U	258 U	362 U	329 U	13.4 U	131 U	12.9 U	13.4 U	13.9 U	249 J	12.9 U	141 U	146 U	13.5 U	333 U	20.2 J		13.4 U
Benzo[a]pyrene	2	13.6 U	13.3 U	13.0 U	258 U	362 U	329 U	13.4 U	131 U	12.9 U	13.4 U	13.9 U	220 J	12.9 U	141 U	146 U	13.5 U	333 U	15.7 J		13.4 U
Benzo[b]Fluoranthene	20	13.6 U	13.3 U	13.0 U	258 U	362 U	329 U	13.4 U	131 U	12.9 U	13.4 U	13.9 U	413	12.9 U	141 U	146 U	13.5 U	333 U	21.0 J		13.4 U
Benzo[g,h,i]perylene	3100	13.6 U	13.3 U	13.0 U	258 U	362 U	329 U	13.4 U	131 U	12.9 U	13.4 U	13.9 U	221 J	12.9 U	141 U	146 U	13.5 U	333 U	10.2 J		13.4 U
Benzo[k]fluoranthene	200	13.6 U	13.3 U	13.0 U	258 U	362 U	329 U	13.4 U	131 U	12.9 U	13.4 U	13.9 U	180 J	12.9 U	141 U	146 U	13.5 U	333 U	14.6 U		13.4 U
Chrysene	2000	13.6 U	13.3 U	13.0 U	258 U	362 U	329 U	13.4 U	131 U	12.9 U	13.4 U	13.9 U	351	12.9 U	141 U	146 U	13.5 U	333 U	36.1		13.4 U
Dibenzo[a,h]anthracene	2	13.6 U	13.3 U	13.0 U	258 U	362 U	329 U	13.4 U	131 U	12.9 U	13.4 U	13.9 U	141 U	12.9 U	141 U	146 U	13.5 U	333 U	14.6 U		13.4 U
Fluoranthene	4200	13.6 U	13.3 U	13.0 U	258 U	362 U	329 U	13.4 U	131 U	12.9 U	13.4 U	13.9 U	443	12.9 U	141 U	146 U	13.5 U	333 U	14.6 U		13.4 U
Fluorene	4200	29.7	13.3 U	13.0 U	2210	1470	1090	13.4 U	1390	12.9 U	13.4 U	13.9 U	344	12.9 U	796	1050	13.5 U	2650	4140		93.7
Indeno[1,2,3-c,d] pyrene	20	13.6 U	13.3 U	13.0 U	258 U	362 U	329 U	13.4 U	131 U	12.9 U	13.4 U	13.9 U	206 J	12.9 U	141 U	146 U	13.5 U	333 U	8.03 J		13.4 U
Naphthalene	42	35.7	10.6 U	10.4 U	426	1600	323 J	10.7 U	1510	10.4 U	10.8 U	8.45 J	113 U	10.3 U	281	372	10.8 U	6430	6400		69
Phenanthrene	3100	8.86 J	13.3 U	13.0 U	2620	1150	987	13.4 U	989	12.9 U	13.4 U	13.9 U	520	12.9 U	1470	1770	13.5 U	3280	4290		80.4
Pyrene	3100	13.6 U	13.3 U	13.0 U	332 J	362 U	273 J	13.4 U	131 U	12.9 U	13.4 U	13.9 U	905	12.9 U	119 J	144 J	13.5 U	238 J	537		11.7 J
Alaska Petroleum Composites (results in mg/kg)																					
GRO	1400	12.2	2.81 U	1.84 U	53.3	109	7.13	1.89 J	68.4	5.27	2.62 J	1.32 J	27.2	0.981 J	50.8	62	2.22 J	149	81.1		15.2
DRO	12500	271	10.7 U	10.3 U	7640	10600	9590	10.8 U	5300	10.2 J	16.7 J	10.7 J	3870	10.3 U	5160	5530	591	9300	**18400**		374
RRO	13700	54.0 U	53.5 U	51.5 U	144	202 J	289 J	54.0 U	211 U	52.0 U	54.5 U	56.5 U	85.0 J	51.0 U	96.7 J	121	53.5 U	213 U	585 U		130
VOCs (results in ug/kg)																					
1,1,1,2-Tetrachloroethane	30	33.0 U	22.4 U	14.7 U	20.1 U	21.6 U	14.1 U	13.8 U	10.7 U	10.4 U	13.9 U	13.4 U	14.2 U	9.80 U	14.4 U	17.1 U	14.6 U	133 U	14.7 U	11.8 U	17.4 U
1,1,1-Trichloroethane	160000	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
1,1,2,2-Tetrachloroethane	8.8	3.30 U	2.25 U	1.47 U	2.01 U	2.17 U	1.41 U	1.38 U	1.07 U	1.04 U	1.39 U	1.34 U	1.42 U	0.980 U	1.44 U	1.71 U	1.46 U	13.3 U	1.47 U	1.18 U	1.74 U
1,1,2-Trichloroethane	2.3	1.65 U	1.13 U	0.735 U	1.00 U	1.09 U	0.705 U	0.690 U	0.535 U	0.525 U	0.690 U	0.670 U	0.710 U	0.491 U	0.720 U	0.855 U	0.730 U	6.65 U	0.735 U	0.590 U	0.870 U
1,1-Dichloroethane	67	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
1,1-Dichloroethene	67	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
1,1-Dichloropropene		41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
1,2,3-Trichlorobenzene	110	165 U	113 U	73.5 U	101 U	109 U	70.5 U	69.0 U	53.5 U	52.5 U	69.0 U	67.0 U	71.0 U	49.1 U	72.0 U	85.5 U	73.0 U	665 U	73.5 U	59.0 U	87.0 U
1,2,3-Trichloropropane	0.089	3.30 U	2.25 U	1.47 U	2.01 U	2.17 U	1.41 U	1.38 U	1.07 U	1.04 U	1.39 U	1.34 U	1.42 U	0.980 U	1.44 U	1.71 U	1.46 U	13.3 U	1.47 U	1.18 U	1.74 U
1,2,4-Trichlorobenzene	66	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
1,2,4-Trimethylbenzene	400	165 U	113 U	73.5 U	101 U	1890	70.5 U	69.0 U	1300	52.5 U	69.0 U	67.0 U	71.0 U	49.1 U	72.0 U	85.5 U	73.0 U	10800	2360	59.0 U	95.5 J
1,2-Dibromo-3-chloropropane		165 U	113 U	73.5 U	101 U	109 U	70.5 U	69.0 U	53.5 U	52.5 U	69.0 U	67.0 U	71.0 U	49.1 U	72.0 U	85.5 U	73.0 U	665 U	73.5 U	59.0 U	87.0 U
1,2-Dibromoethane	0.62	2.48 U	1.69 U	1.11 U	1.51 U	1.63 U	1.05 U	1.03 U	0.805 U	0.785 U	1.03 U	1.00 U	1.06 U	0.735 U	1.08 U	1.28 U	1.10 U	9.95 U	1.10 U	0.885 U	1.30 U
1,2-Dichlorobenzene	2300	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
1,2-Dichloroethane	8	3.30 U	2.25 U	1.47 U	2.01 U	2.17 U	1.41 U	1.38 U	1.07 U	1.04 U	1.39 U	1.34 U	1.42 U	0.980 U	1.44 U	1.71 U	1.46 U	13.3 U	1.47 U	1.18 U	1.74 U
1,2-Dichloropropane	25	16.5 U	11.3 U	7.35 U	10.1 U	10.9 U	7.05 U	6.90 U	5.35 U	5.25 U	6.90 U	6.70 U	7.10 U	4.91 U	7.20 U	8.55 U	7.30 U	66.5 U	7.35 U	5.90 U	8.70 U
1,3,5-Trimethylbenzene	360	41.2 U	28.1 U	18.4 U	4120	2700	12.3 J	17.3 U	3720	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	396	490	18.2 U	6460	3520	14.8 U	200
1,3-Dichlorobenzene	2000	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
1,3-Dichloropropane	25	16.5 U	11.3 U	7.35 U	10.1 U	10.9 U	7.05 U	6.90 U	5.35 U	5.25 U	6.90 U	6.70 U	7.10 U	4.91 U	7.20 U	8.55 U	7.30 U	66.5 U	7.35 U	5.90 U	8.70 U
1,4-Dichlorobenzene	31	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
2,2-Dichloropropane		41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
2-Butanone (MEK)	53000	412 U	281 U	184 U	252 U	271 U	176 U	173 U	134 U	131 U	173 U	168 U	178 U	123 U	181 U	214 U	182 U	1660 U	184 U	148 U	217 U
2-Chlorotoluene		41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
2-Hexanone	380	198 U	135 U	88.5 U	121 U	130 U	84.5 U	83.0 U	64.0 U	63.0 U	83.0 U	80.5 U	85.0 U	59.0 U	86.5 U	103 U	87.5 U	795 U	88.0 U	71.0 U	104 U
4-Chlorotoluene		33.0 U	22.4 U	14.7 U	20.1 U	21.6 U	14.1 U	13.8 U	10.7 U	10.4 U	13.9 U	13.4 U	14.2 U	9.80 U	14.4 U	17.1 U	14.6 U	133 U	14.7 U	11.8 U	17.4 U
4-Isopropyltoluene		132 U	90.0 U	59.0 U	80.5 U	399	56.5 U	55.5 U	231	41.9 U	55.5 U	53.5 U	120	39.3 U	107 J	159	58.5 U	3590	1800	47.3 U	98.6 J
4-Methyl-2-pentanone (MIBK)	69000	412 U	281 U	184 U	252 U	271 U	176 U	173 U	134 U	131 U	173 U	168 U	178 U	123 U	181 U	214 U	182 U	1660 U	184 U	148 U	217 U

TABLE 5

Summary of Soil Analytical Results

	AK Cleanup Stds (mg/kg)	Sample/Well No. (results in ug/kg, unless specified)																			
		MW16-SB19	MW15-SB18	MW14-SB17	SB06	SB14	MW12-SB15	MW13-SB16	MW11-SB14A	SB12	SB10	SB11	SB09	SB07	SB08	SB08 (dup)	SB13	SB05	SB04	IDW-01 (7/30/22)	IDW-01 (10/25/21)
Acetone	1.0×10^5	412 U	281 U	184 U	252 U	271 U	176 U	173 U	134 U	131 U	173 U	168 U	178 U	123 U	181 U	214 U	182 U	1660 U	184 U	148 U	217 U
Benzene	16	20.6 U	14.1 U	9.20 U	12.6 U	13.6 U	8.80 U	8.65 U	6.70 U	6.55 U	8.65 U	8.35 U	8.90 U	6.15 U	9.00 U	10.7 U	9.10 U	83.0 U	9.15 U	7.40 U	10.9 U
Bromobenzene	410	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
Bromochloromethane		41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
Bromodichloromethane	5.3	3.30 U	2.25 U	1.47 U	2.01 U	2.17 U	1.41 U	1.38 U	1.07 U	1.04 U	1.39 U	1.34 U	1.42 U	0.980 U	1.44 U	1.71 U	1.46 U	13.3 U	1.47 U	1.18 U	1.74 U
Bromoform	340	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
Bromomethane	15	33.0 U	22.4 U	14.7 U	20.1 U	21.6 U	14.1 U	13.8 U	10.7 U	10.4 U	13.9 U	13.4 U	14.2 U	9.80 U	14.4 U	17.1 U	14.6 U	133 U	14.7 U	11.8 U	17.4 U
Carbon disulfide	1600	165 U	113 U	73.5 U	101 U	109 U	70.5 U	69.0 U	53.5 U	52.5 U	69.0 U	67.0 U	71.0 U	49.1 U	72.0 U	85.5 U	73.0 U	665 U	73.5 U	59.0 U	87.0 U
Carbon tetrachloride	13	20.6 U	14.1 U	9.20 U	12.6 U	13.6 U	8.80 U	8.65 U	6.70 U	6.55 U	8.65 U	8.35 U	8.90 U	6.15 U	9.00 U	10.7 U	9.10 U	83.0 U	9.15 U	7.40 U	10.9 U
Chlorobenzene	370	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
Chloroethane	29000	330 U	225 U	147 U	201 U	217 U	141 U	138 U	107 U	105 U	139 U	134 U	142 U	98.0 U	144 U	171 U	146 U	1325 U	147 U	118 U	174 U
Chloroform	5.8	9.90 U	6.75 U	4.42 U	6.05 U	6.50 U	4.22 U	4.14 U	3.21 U	3.14 U	4.15 U	4.02 U	4.26 U	2.94 U	4.33 U	5.10 U	4.37 U	39.8 U	4.40 U	3.54 U	5.20 U
Chloromethane	250	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
Dibromochloromethane	140	8.25 U	5.60 U	3.67 U	5.05 U	5.40 U	3.52 U	3.46 U	2.67 U	2.62 U	3.46 U	3.35 U	3.55 U	2.46 U	3.61 U	4.27 U	3.65 U	33.1 U	3.67 U	2.96 U	4.34 U
Dibromomethane	45	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
Dichlorodifluoromethane	220	165 U	113 U	73.5 U	101 U	1500	70.5 U	69.0 U	53.5 U	52.5 U	69.0 U	67.0 U	71.0 U	49.1 U	72.0 U	85.5 U	73.0 U	665 U	73.5 U	59.0 U	87.0 U
Ethylbenzene	72	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	22.4 J	14.8 U	21.7 U
Freon-113	16000	165 U	113 U	73.5 U	101 U	109 U	70.5 U	69.0 U	53.5 U	52.5 U	69.0 U	67.0 U	71.0 U	49.1 U	72.0 U	85.5 U	73.0 U	665 U	73.5 U	59.0 U	87.0 U
Hexachlorobutadiene	14	33.0 U	22.4 U	14.7 U	20.1 U	21.6 U	14.1 U	13.8 U	10.7 U	10.4 U	13.9 U	13.4 U	14.2 U	9.80 U	14.4 U	17.1 U	14.6 U	133 U	14.7 U	11.8 U	17.4 U
Isopropylbenzene (Cumene)	2500	41.2 U	28.1 U	18.4 U	25.1 U	35.2 J	17.6 U	17.3 U	27	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	169 J	81.1	14.8 U	21.7 U
Methyl-t-butyl ether	970	165 U	113 U	73.5 U	101 U	109 U	70.5 U	69.0 U	53.5 U	52.5 U	69.0 U	67.0 U	71.0 U	49.1 U	72.0 U	85.5 U	73.0 U	665 U	73.5 U	59.0 U	87.0 U
Methylene chloride	630	165 U	113 U	73.5 U	101 U	109 U	70.5 U	69.0 U	53.5 U	52.5 U	69.0 U	67.0 U	71.0 U	49.1 U	72.0 U	85.5 U	73.0 U	665 U	73.5 U	59.0 U	87.0 U
Naphthalene	42	85.7	28.1 U	18.4 U	765	981	154	42.8	1440	13.1 U	17.3 U	17.1 J	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	6240	6710	14.8 U	212
P & M -Xylene	57	82.5 U	56.0 U	36.8 U	50.5 U	39.0 J	35.3 U	34.5 U	40.9 J	26.2 U	34.6 U	33.5 U	35.5 U	24.6 U	36.0 U	42.7 U	36.5 U	544 J	229	29.6 U	43.4 U
Styrene	8100	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
Tetrachloroethene	140	20.6 U	14.1 U	9.20 U	12.6 U	13.6 U	8.80 U	8.65 U	6.70 U	6.55 U	8.65 U	8.35 U	8.90 U	6.15 U	9.00 U	10.7 U	9.10 U	83.0 U	9.15 U	7.40 U	10.9 U
Toluene	8000	41.2 U	28.1 U	18.4 U	79.5	18.4 J	17.6 U	12.1 J	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	521	14.8 U	21.7 U
Trichloroethene	7.1	16.5 U	11.3 U	7.35 U	10.1 U	10.9 U	7.05 U	6.90 U	5.35 U	5.25 U	6.90 U	6.70 U	7.10 U	4.91 U	7.20 U	8.55 U	7.30 U	66.5 U	7.35 U	5.90 U	8.70 U
Trichlorofluoromethane	980	82.5 U	56.0 U	36.8 U	50.5 U	54.0 U	22.2 J	34.5 U	16.3 J	26.2 U	34.6 U	33.5 U	35.5 U	24.6 U	36.0 U	42.7 U	36.5 U	332 U	55.0 J	29.6 U	43.4 U
Vinyl acetate	2100	165 U	113 U	73.5 U	101 U	109 U	70.5 U	69.0 U	53.5 U	52.5 U	69.0 U	67.0 U	71.0 U	49.1 U	72.0 U	85.5 U	73.0 U	665 U	73.5 U	59.0 U	87.0 U
Vinyl chloride	0.69	1.32 U	0.900 U	0.590 U	0.805 U	0.865 U	0.565 U	0.555 U	0.428 U	0.419 U	0.555 U	0.535 U	0.570 U	0.393 U	0.575 U	0.685 U	0.585 U	5.30 U	0.585 U	0.473 U	0.695 U
Xylenes (total)	710	124 U	84.0 U	55.0 U	75.5 U	77.4 J	53.0 U	52.0 U	81.6	39.3 U	52.0 U	50.0 U	53.5 U	36.9 U	54.0 U	64.0 U	54.5 U	696 J	596	44.4 U	65.0 U
cis-1,2-Dichloroethene	270	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
cis-1,3-Dichloropropene	30	20.6 U	14.1 U	9.20 U	12.6 U	13.6 U	8.80 U	8.65 U	6.70 U	6.55 U	8.65 U	8.35 U	8.90 U	6.15 U	9.00 U	10.7 U	9.10 U	83.0 U	9.15 U	7.40 U	10.9 U
n-Butylbenzene	6800	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
n-Propylbenzene	5200	41.2 U	28.1 U	18.4 U	25.1 U	47.7 J	17.6 U	17.3 U	29.4	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	169 J	72.6	14.8 U	21.7 U
o-Xylene	710	41.2 U	28.1 U	18.4 U	18.6 J	38.5 J	17.6 U	17.3 U	40.7	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	153 J	367	14.8 U	21.7 U
sec-Butylbenzene	14000	41.2 U	28.1 U	18.4 U	25.1 U	391	17.6 U	17.3 U	134	13.1 U	17.3 U	16.8 U	61.1	12.3 U	18.1 U	21.4 U	18.2 U	1190	226	14.8 U	21.7 U
tert-Butylbenzene	14000	41.2 U	28.1 U	18.4 U	74.4	67.7	17.6 U	17.3 U	58.6	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	118	14.8 U	21.7 U
trans-1,2-Dichloroethene	2700	41.2 U	28.1 U	18.4 U	25.1 U	27.1 U	17.6 U	17.3 U	13.4 U	13.1 U	17.3 U	16.8 U	17.8 U	12.3 U	18.1 U	21.4 U	18.2 U	166 U	18.4 U	14.8 U	21.7 U
trans-1,3-Dichloropropene	30	20.6 U	14.1 U	9.20 U	12.6 U	13.6 U	8.80 U	8.65 U	6.70 U	6.55 U	8.65 U	8.35 U	8.90 U	6.15 U	9.00 U	10.7 U	9.10 U	83.0 U	9.15 U	7.40 U	10.9 U

1. Soil standards are from Table B1 or Table B2 of 18 AAC 75 (ADEC, February 2023).

TABLE 6
Summary of Groundwater Analytical Results

	Sample/Well No. (results in ug/L)														AK Cleanup Stds (ug/L)
	MW16		MW15	MW14		MW13		MW12		EB-01	MW11		MW11D	IDW	
	7/31/22	10/5/22	10/5/22	7/31/22	10/5/22	7/31/22	10/5/22	7/31/22	10/5/22	7/31/22	7/31/22	10/5/22	7/31/22	10/5/22	
PAHs															
1-Methylnaphthalene	**45.7**	**58.1**	0.0249	0.0250 U	0.00640 U	6.81	**43.2**	1.2	**57.4**	0.0535	0.0240 U	**11.1**	0.0240 U		11
2-Methylnaphthalene	**44.5**	**69.4**	0.0156	0.0250 U	0.00640 U	0.957	**46.5**	0.0245 U	1.75	0.0448 J	0.0240 U	6.75	0.0240 U		36
Acenaphthene	0.609	0.408	0.00665 U	0.0250 U	0.00640 U	0.331	0.229	0.502	0.344	0.0245 U	0.0240 U	0.842	0.0240 U		530
Acenaphthylene	0.0250 U	0.00640 U	0.00665 U	0.0250 U	0.00640 U	0.0255 U	0.00650 U	0.0245 U	0.00650 U	0.0245 U	0.0240 U	0.00660 U	0.0240 U		260
Anthracene	0.0250 U	0.00640 U	0.00665 U	0.0250 U	0.00640 U	0.0255 U	0.00650 U	0.0245 U	0.00650 U	0.0245 U	0.0240 U	0.00660 U	0.0240 U		43
Benzo(a)Anthracene	0.0250 U	0.00640 U	0.00665 U	0.0250 U	0.00640 U	0.0255 U	0.00650 U	0.0245 U	0.00650 U	0.0245 U	0.0240 U	0.00660 U	0.0240 U		0.3
Benzo[a]pyrene	0.0100 U	0.00255 U	0.00266 U	0.0100 U	0.00255 U	0.0102 U	0.00261 U	0.00980 U	0.00261 U	0.00980 U	0.00960 U	0.00263 U	0.00960 U		0.25
Benzo[b]Fluoranthene	0.0250 U	0.00640 U	0.00665 U	0.0250 U	0.00640 U	0.0255 U	0.00650 U	0.0245 U	0.00650 U	0.0245 U	0.0240 U	0.00660 U	0.0240 U		2.5
Benzo[g,h,i]perylene	0.0250 U	0.00640 U	0.00665 U	0.0250 U	0.00640 U	0.0255 U	0.00650 U	0.0245 U	0.00650 U	0.0245 U	0.0240 U	0.00660 U	0.0240 U		0.26
Benzo[k]fluoranthene	0.0250 U	0.00640 U	0.00665 U	0.0250 U	0.00640 U	0.0255 U	0.00650 U	0.0245 U	0.00650 U	0.0245 U	0.0240 U	0.00660 U	0.0240 U		0.8
Chrysene	0.0250 U	0.00640 U	0.00665 U	0.0250 U	0.00640 U	0.0255 U	0.00650 U	0.0245 U	0.00650 U	0.0245 U	0.0240 U	0.00660 U	0.0240 U		2
Dibenzo[a,h]anthracene	0.0100 U	0.00255 U	0.00266 U	0.0100 U	0.00255 U	0.0102 U	0.00261 U	0.00980 U	0.00261 U	0.00980 U	0.00960 U	0.00263 U	0.00960 U		0.25
Fluoranthene	0.0250 U	0.00640 U	0.00665 U	0.0250 U	0.00640 U	0.0255 U	0.00650 U	0.0245 U	0.00650 U	0.0245 U	0.0240 U	0.00660 U	0.0240 U		260
Fluorene	0.894	0.817	0.00665 U	0.0250 U	0.00640 U	0.621	0.685	0.819	0.907	0.0245 U	0.0240 U	2.18	0.0240 U		290
Indeno[1,2,3-c,d] pyrene	0.0250 U	0.00640 U	0.00665 U	0.0250 U	0.00640 U	0.0255 U	0.00650 U	0.0245 U	0.00650 U	0.0245 U	0.0240 U	0.00660 U	0.0240 U		0.19
Naphthalene	**34.3**	**47.7**	0.0253 J	0.0500 U	0.0127 U	0.805	**58.7**	0.0490 U	0.831	0.0320 J	0.0481 U	**1.99**	0.0481 U		1.7
Phenanthrene	0.0500 U	0.153	0.0133 U	0.0500 U	0.0127 U	0.0510 U	0.158	0.0490 U	0.219	0.0490 U	0.0481 U	0.408	0.0481 U		170
Pyrene	0.0250 U	0.00640 U	0.00665 U	0.0250 U	0.00640 U	0.0255 U	0.00650 U	0.0245 U	0.00650 U	0.0245 U	0.0240 U	0.00660 U	0.0240 U		120
Alaska Petroleum Composites (results and standards in mg/L)															
GRO	0.412	0.467	0.0500 U	0.0500 U	0.0500 U	0.226	0.365	0.495	0.569	0.0500 U	0.295	0.213	0.305	0.0500 U	2,200
DRO	7.37	13	0.779	1.82	3.47	9.97	16	14.6	17.3	0.300 U	17.2	4.36	16.5		1,500
RRO	1.03	1.35	0.482 J	1.01	1.07	1.64	2.05	2.15	1.88	0.212 J	1.63	0.708	1.63		1,100
VOCs															
1,1,1,2-Tetrachloroethane	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	5.7
1,1,1-Trichloroethane	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	8,000
1,1,2,2-Tetrachloroethane	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.76
1,1,2-Trichloroethane	0.200 U	0.200 U	0.200 U	0.200 U	0.200 U	0.200 U	0.200 U	0.200 U	0.200 U	0.200 U	0.200 U	0.200 U	0.200 U	0.200 U	0.41
1,1-Dichloroethane	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	28
1,1-Dichloroethene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	280
1,1-Dichloropropene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	
1,2,3-Trichlorobenzene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	7
1,2,3-Trichloropropane	**0.500 U**	**0.500 U**	**0.500 U**	**0.500 U**	**0.500 U**	**0.500 U**	**0.500 U**	**0.500 U**	**0.500 U**	**0.500 U**	**0.500 U**	**0.500 U**	**0.500 U**	0.500 U	0.0075
1,2,4-Trichlorobenzene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	4
1,2,4-Trimethylbenzene	**84.4**	**111**	0.390 J	0.330 J	0.320 J	32.7	**69.7**	54.2	**65.1**	0.500 U	18.8	15.9	18.8	0.500 U	56
,2-Dibromo-3-chloropropan	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	
1,2-Dibromoethane	0.0375 U	0.0375 U	0.0375 U	0.0375 U	0.0375 U	0.0375 U	0.0375 U	0.0375 U	0.0375 U	0.0375 U	0.0375 U	0.0375 U	0.0375 U	0.0375 U	0.075
1,2-Dichlorobenzene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	300
1,2-Dichloroethane	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	280
1,2-Dichloropropane	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	8.2
1,3,5-Trimethylbenzene	21	29.4	0.500 U	0.500 U	0.500 U	21.7	48.6	**66.7**	**89.4**	0.500 U	46.6	41.8	46.5	0.500 U	60

TABLE 6
Summary of Groundwater Analytical Results

	Sample/Well No. (results in ug/L)														AK Cleanup Stds (ug/L)
	MW16		**MW15**	**MW14**		**MW13**		**MW12**		**EB-01**	**MW11**		**MW11D**	**IDW**	
	7/31/22	**10/5/22**	**10/5/22**	**7/31/22**	**10/5/22**	**7/31/22**	**10/5/22**	**7/31/22**	**10/5/22**	**7/31/22**	**7/31/22**	**10/5/22**	**7/31/22**	**10/5/22**	
1,3-Dichlorobenzene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	300
1,3-Dichloropropane	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	8.2
1,4-Dichlorobenzene	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	4.8
2,2-Dichloropropane	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	
2-Butanone (MEK)	5.00 U	68.3	5.00 U	5.00 U	5.00 U	5.00 U	3.15 J	5.00 U	6.93 J	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5,600
2-Chlorotoluene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	
2-Hexanone	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	38
4-Chlorotoluene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	
4-Isopropyltoluene	4.81	16.5	0.500 U	0.500 U	0.360 J	2.2	13.7	5.15	19.8	0.500 U	7.24	8.82	1.29	0.500 U	
4-Methyl-2-pentanone (MIBK)	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	6,300
Benzene	2.03	2.77	0.200 U	0.200 U	0.41	**5.39**	**9.08**	1.54	2.47	0.200 U	0.200 U	0.4	0.200 U	0.200 U	4.6
Bromobenzene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	62
Bromochloromethane	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	
Bromodichloromethane	0.250 U	0.250 U	4.85	0.250 U	0.52	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	1.3
Bromoform	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	33
Bromomethane	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	3.00 U	7.5
Carbon disulfide	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	810
Carbon tetrachloride	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	4.6
Chlorobenzene	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	78
Chloroethane	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	21,000
Chloroform	0.510 J	0.590 J	**51**	1.06	**8.53**	1.02	**2.63**	**3.35**	**7.49**	0.500 U	1.04	**3.25**	1.03	0.500 U	2.2
Chloromethane	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	190
Dibromochloromethane	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	8.7
Dibromomethane	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	8.3
Dichlorodifluoromethane	52.5	106	1.7	2.93	4.79	10.9	10.8	3.44	7.99	0.500 U	2.28	13	2.27	0.500 U	200
Ethylbenzene	3.52	4.34	0.500 U	0.500 U	0.500 U	2.83	5.43	3.89	5.08	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	15
Freon-113	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	10,000
Hexachlorobutadiene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	1.4
Isopropylbenzene (Cumene)	7.16	8.78	0.500 U	0.500 U	0.500 U	2.89	7.11	2.29	2.73	0.500 U	0.430 J	0.480 J	0.440 J	0.500 U	450
Methyl-t-butyl ether	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	140
Methylene chloride	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	110
Naphthalene	**66.6**	**88.6**	0.670 J	**5.16**	**2.4**	**55.8**	**127**	**44.3**	**42.9**	**3.69**	**38.9**	**19.6**	**40**	0.500 U	1.7
P & M -Xylene	11.4	15	1.00 U	1.00 U	1.00 U	6.81	13.5	11.1	12.9	1.00 U	1.71 J	1.14 J	1.71 J	1.00 U	*190*
Styrene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	1,200
Tetrachloroethene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	41
Toluene	2.74	2.99	0.500 U	0.500 U	0.500 U	1.15	1.16	0.730 J	0.720 J	0.500 U	0.380 J	0.500 U	0.370 J	0.500 U	1,100
Trichloroethene	**6.06**	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	2.8
Trichlorofluoromethane	265	707	6.01	11.9	16.9	62.8	48.3	27.7	31.8	0.500 U	11.5	14.9	11.5	0.500 U	5,200
Vinyl acetate	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	410
Vinyl chloride	0.0750 U	0.0750 U	0.0750 U	0.0750 U	0.0750 U	0.0750 U	0.0750 U	0.0750 U	0.0750 U	0.0750 U	0.0750 U	0.0750 U	0.0750 U	0.0750 U	0.19
Xylenes (total)	33.3	41.8	1.50 U	1.50 U	1.50 U	8.63	15.3	24.1	26.8	1.50 U	4.19	2.71 J	4.18	1.50 U	190

TABLE 6
Summary of Groundwater Analytical Results

	Sample/Well No. (results in ug/L)														AK Cleanup Stds (ug/L)
	MW16		**MW15**	**MW14**		**MW13**		**MW12**		**EB-01**	**MW11**		**MW11D**	**IDW**	
	7/31/22	**10/5/22**	**10/5/22**	**7/31/22**	**10/5/22**	**7/31/22**	**10/5/22**	**7/31/22**	**10/5/22**	**7/31/22**	**7/31/22**	**10/5/22**	**7/31/22**	**10/5/22**	
cis-1,2-Dichloroethene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	36
cis-1,3-Dichloropropene	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	4.7
n-Butylbenzene	3.12	0.500 U	0.500 U	0.500 U	0.500 U	0.960 J	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	1,000
n-Propylbenzene	7.2	9.54	0.500 U	0.500 U	0.500 U	3.07	8.88	1.43	2.11	0.500 U	0.500 U	0.470 J	0.500 U	0.500 U	660
o-Xylene	21.8	26.8	0.500 U	0.500 U	0.500 U	1.82	1.76	13	14	0.500 U	2.48	1.57	2.47	0.500 U	*190*
sec-Butylbenzene	5.47	7.4	0.500 U	0.500 U	0.500 U	1.88	4.59	1.72	2.28	0.500 U	0.730 J	1.56	0.740 J	0.500 U	2,000
tert-Butylbenzene	0.710 J	0.840 J	0.500 U	0.500 U	0.500 U	0.560 J	0.980 J	0.990 J	1.3	0.500 U	0.520 J	0.660 J	0.520 J	0.500 U	690
trans-1,2-Dichloroethene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.540 J	0.330 J	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	360
trans-1,3-Dichloropropene	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	4.7

Notes:

Gray highlighted cells indicate no standards exist for this compound. Italicized results indicate standard is for total xylenes.

Bolded values indicate concentrations above the standards.

J = value is above the limit of detection (LOD), but below the limit of quantitation (LOQ) and the result is estimated.

U = result is undetected (value is below the LOQ; LOQ value is provided)

Cleanup standards are the Table C values from 18 AAC 75 (Feb 2023)

TABLE 7
GROUNDWATER FIELD MEASUREMENTS

Parameter	*MW11*		*MW12*		*MW13*		*MW14*		*MW15*		*MW16*	
	7/31/2022	***10/5/2022***	***7/31/2022***	***10/5/2022***	***7/31/2022***	***10/5/2022***	***7/30/2022***	***10/5/2022***	***7/30/2022***	***10/5/2022***	***7/30/2022***	***10/5/2022***
Groundwater Depth (ft bgs)	2.93	4.04	6.17	6.31	5.75	6.27	6.3	6.26	No sample	5.82	2.6	3.76
Low Tide (ft AMSL)	-0.04 (6:08 PM)	0.07 (11:29 AM)	-0.04 (6:08 PM)	0.07 (11:29 AM)	-0.04 (6:08 PM)	0.07 (11:29 AM)	-0.04 (5:33 PM)	0.07 (11:29 AM)	-0.04 (5:33 PM)	0.07 (11:29 AM)	-0.04 (5:33 PM)	0.07 (11:29 AM)
High Tide (ft AMSL)	0.66 (10:14 AM)	0.38 (4:57 PM)	0.66 (10:14 AM)	0.38 (4:57 PM)	0.66 (10:14 AM)	0.38 (4:57 PM)	0.68 (9:46 AM)	0.38 (4:57 PM)	0.68 (9:46 AM)	0.38 (4:57 PM)	0.68 (9:46 AM)	0.38 (4:57 PM)
Temperature (°C)	7.19	4.6	3.89	1.7	3.83	3.7	4.7	3.6	No sample	1.8	5.18	3.77
pH	6.7	7	6.89	6.84	7.04	7.05	7.13	6.99	No sample	7.33	6.92	6.78
Conductivity (mS/cm)	668	753	573	646	610	900	720	739	No sample	781	822	755
Oxidation-Reduction Potential (mV)	-51.3	1	-25.3	5.5	-14.3	7.6	98.8	21.9	No sample	24	-45.2	21.6
Dissolved Oxygen (mg/L)	1.11	0.53	1.81	0.23	3.41	0.15	6.12	0.28	No sample	0.11	3.7	0.34

Notes: Tide information is from NOAA, www.tidesandcurrents.noaa.gov

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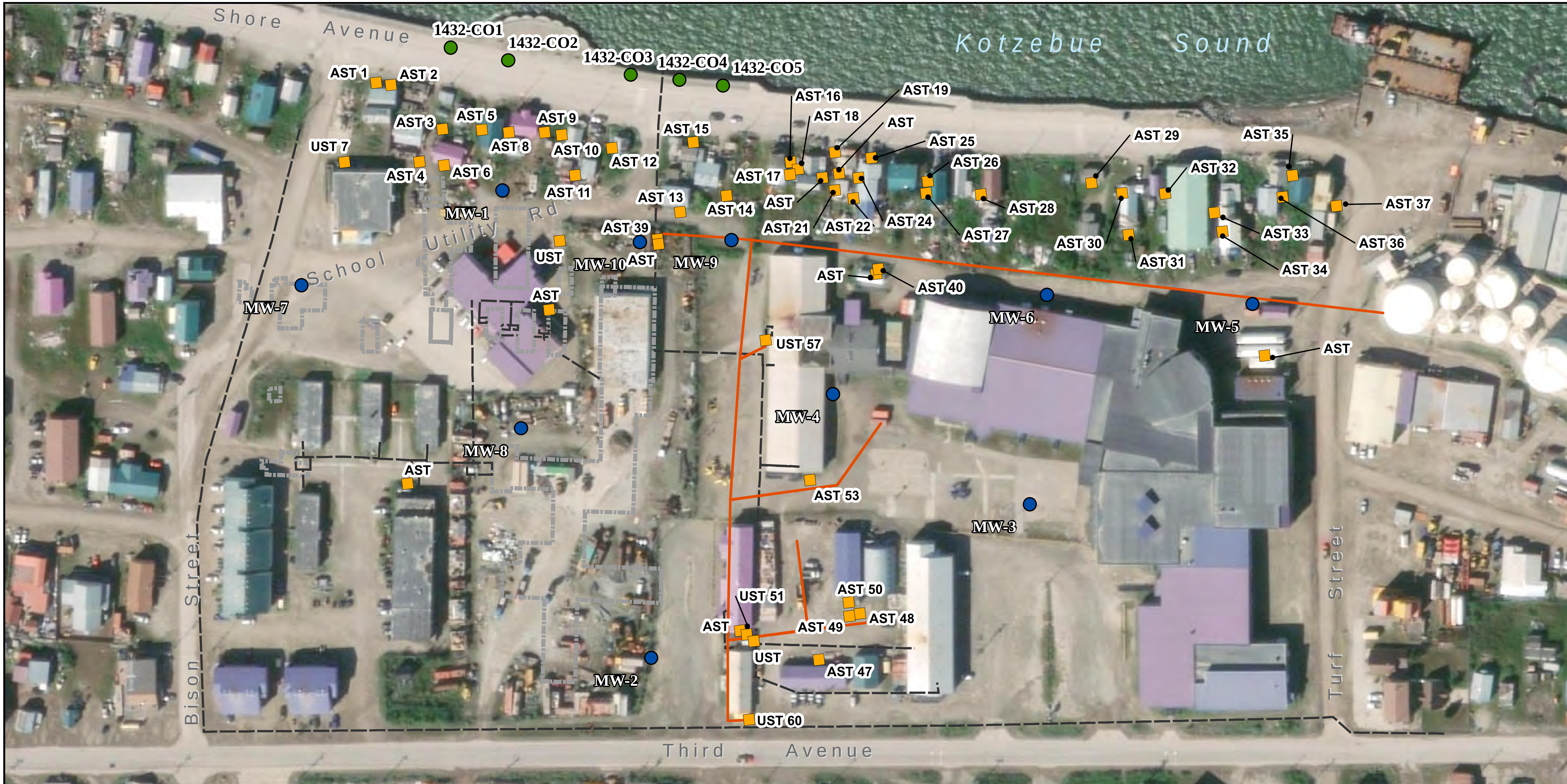
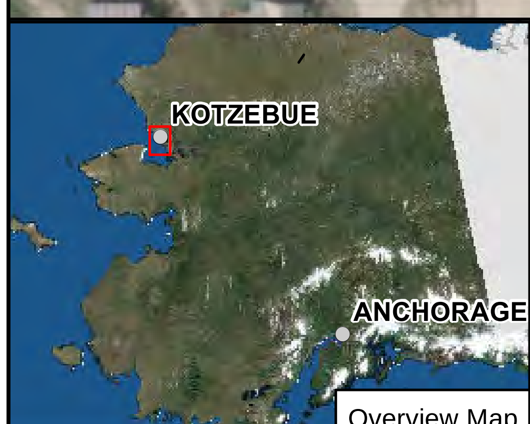
FIGURES





Legend

- Existing Groundwater Monitoring Wells
- Former Water Sample Locations
- Fuel Storage Tanks
- BIA Pipeline
- Historic Utility Corridors
- Former BIA Structures

1 in = 125 ft

N

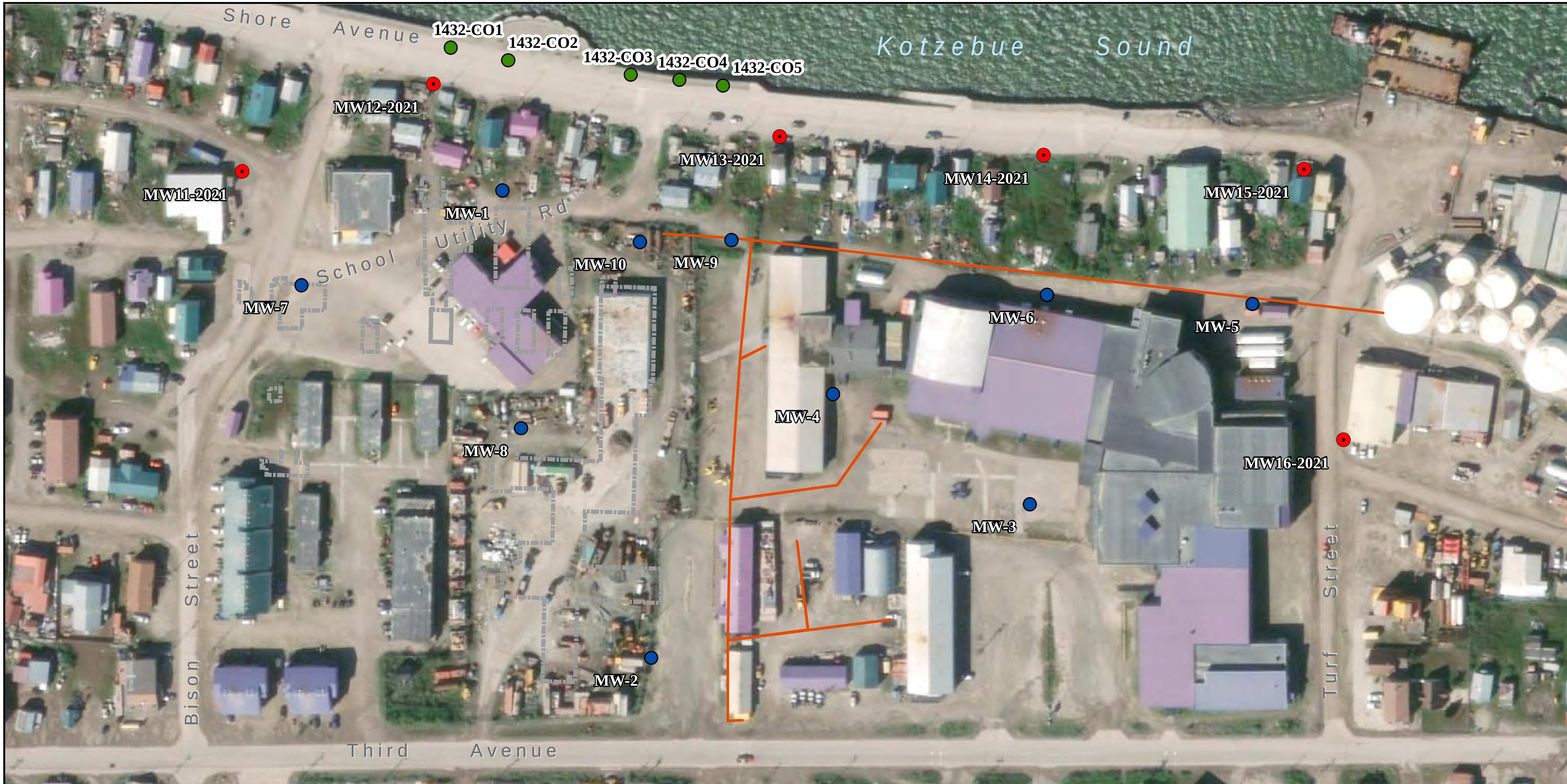
0 90 180 360 Feet

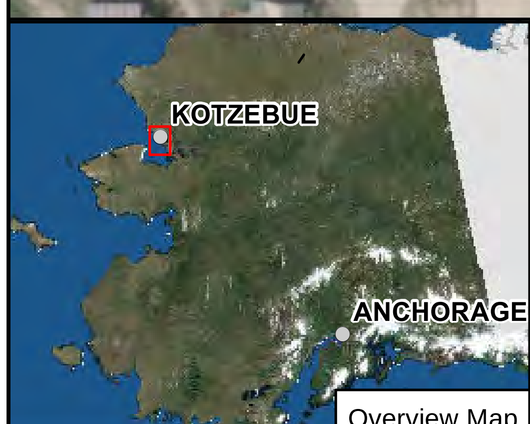
Notes:
1. Coordinate system is NAD 83 UTM Zone 4N, Unit: Meters
2. Background imagery is from AGC Imagery, 2020.

The information in this map is for planning purposes only and is not to be used as a legal document.

Historical Environmental Investigation Activities
2021-2022 Environmental Investigation Activities
Former IHS/BIA Hospital-School Pipeline Release
Kotzebue, AK

Date: 12/2/2022	Approved: JCR/MLN	Figure: 1
Job No. 165.030390		
File Name: 030390_OTZ Groundwater Monitoring Workplan_Fig1		





Legend

- New Groundwater Monitoring Wells
- Existing Groundwater Monitoring Wells
- Former Water Sample Locations
- BIA Pipeline
- Former BIA Structures

1 in = 125 ft

N

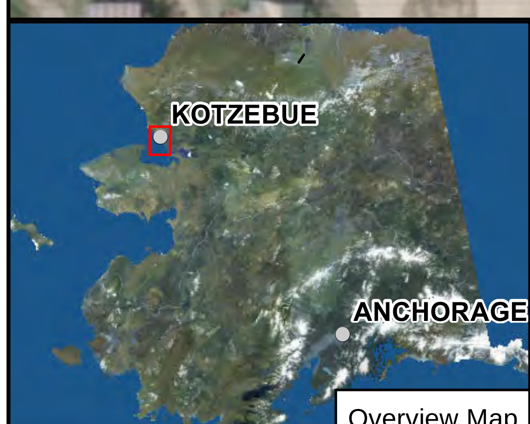
0 90 180 360 Feet

Notes:
1. Coordinate system is NAD 83 UTM Zone 4N, Unit: Meters
2. Background imagery is from AGC Imagery, 2020.

The information in this map is for planning purposes only and is not to be used as a legal document.

Monitoring Well Location Map
2021-2022 Environmental Investigation Activities
Former IHS/BIA Hospital-School Pipeline Release
Kotzebue, AK

Date: 12/2/2022	Approved: JCR/MLN	Figure: 2
Job No. 165.030390		
File Name: 030390_OTZ Groundwater Monitoring Workplan_Fig2		



Legend

- 2021 Soil Borings
- Fuel Storage Tanks
- BIA Pipeline
- Former BIA Structures

Utility Line Type

- Electric/Telephone
- Fuel Line
- Sewer
- Sewer Force Main
- Water

1 in = 125 ft

0 90 180 360 Feet

N

Notes:
1. Coordinate system is NAD 83 UTM Zone 4N, Unit: Meters
2. Background imagery is from AGC Imagery, 2020.
3. Utility line locations are digitized from DCRA Community Map, 2013; locations are approximate.

The information in this map is for planning purposes only and is not to be used as a legal document.

2021-2022 Soil Boring Location Map
Former IHS/BIA Hospital-School Pipeline Release
Kotzebue, AK

Date: 3/10/2023	Approved: JCR/MLN	Figure: 3
Job No. 165.030390		
File Name: 030390_OTZ Groundwater Monitoring Workplan_Fig3		

Legend

- 2021 Soil Borings (SB)
- Former Pipeline
- Former BIA Structures

1 in = 125 ft

0 90 180 360 Feet

Notes:

1. Coordinate system is NAD 83 UTM Zone 4N, Unit: Meters
2. Background imagery is from AGC Imagery, 2020.
3. Acronyms and Abbreviations: Diesel Range Organics (DRO), Below Ground Surface (BGS).
4. All concentrations are in mg/kg
5. Only compounds with exceedances of the Table B1 or B2 soil cleanup levels (for Arctic zone soils) from Title 18 Chapter 75 of the Alaska Administrative Code are shown. Table provides these cleanup thresholds:
6. Soil Borings and samples collected 10/22-10/24/21

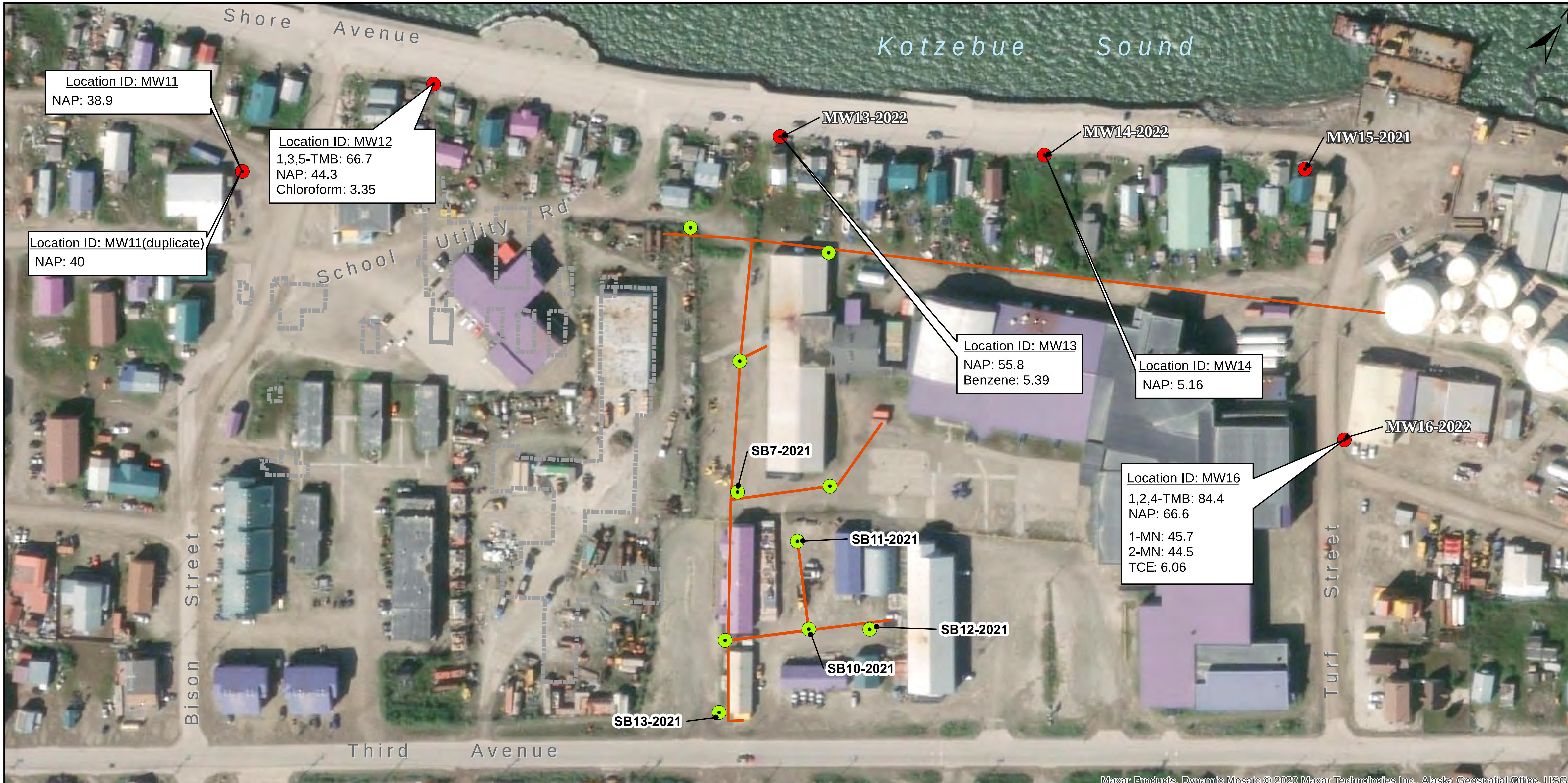
Compound	Cleanup Standard (mg/kg)
DRO	12,500

2021 Soil Exceedances
2021-2022 Environmental Investigation Activities
Former IHS/BIA Hospital-School Pipeline Release
Kotzebue, AK

Date:	Approved:	Figure:
2/21/2023	JCR/MLN	4

Job No. 165.030390

File Name: OTZ Groundwater Monitoring Workplan_Fig4update



Legend

- Groundwater Monitoring Wells (MW)
- Soil Borings (SB)
- Former Pipeline
- Former BIA Structures

1 in = 125 ft

0 90 180 360 Feet

Notes:

1. Coordinate system is NAD 83 UTM Zone 4N, Unit: Meters
2. Background imagery is from AGC Imagery, 2020.
3. Acronyms and Abbreviations: 1,2,4-Trimethylbenzene (1,2,4-TMB), 1,3,5-Trimethylbenzene (1,3,5-TMB), Naphthalene (NAP), 1-methylnaphthalene (1-MN), 2-methylnaphthalene (2-MN), Benzo[b]Fluoranthene (Benzo [b] F, Trichloroethene (TCE), Dichlorodifluoromethane (DCDFM)
4. All concentrations are in ug/L
5. Only compounds with exceedances of the Table C groundwater cleanup standards from Title 18 Chapter 75 of the Alaska Administrative Code are shown.
6. Samples obtained on July 30-31,2022

Compound	Cleanup Standard (ug/L)
1-MN	11
2-MN	36
1,2,4-TMB	56
1,3,5-TMB	60
Nap	1.7
DRO	1500
Benzene	4.6
DCDFM	200
Benzo [b] F	2.5
TCE	2.8
Chloroform	2.2

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July 2022 Groundwater Exceedances
2021-2022 Environmental Investigation Activities
Former IHS/BIA Hospital-School Pipeline Release
Kotzebue, AK

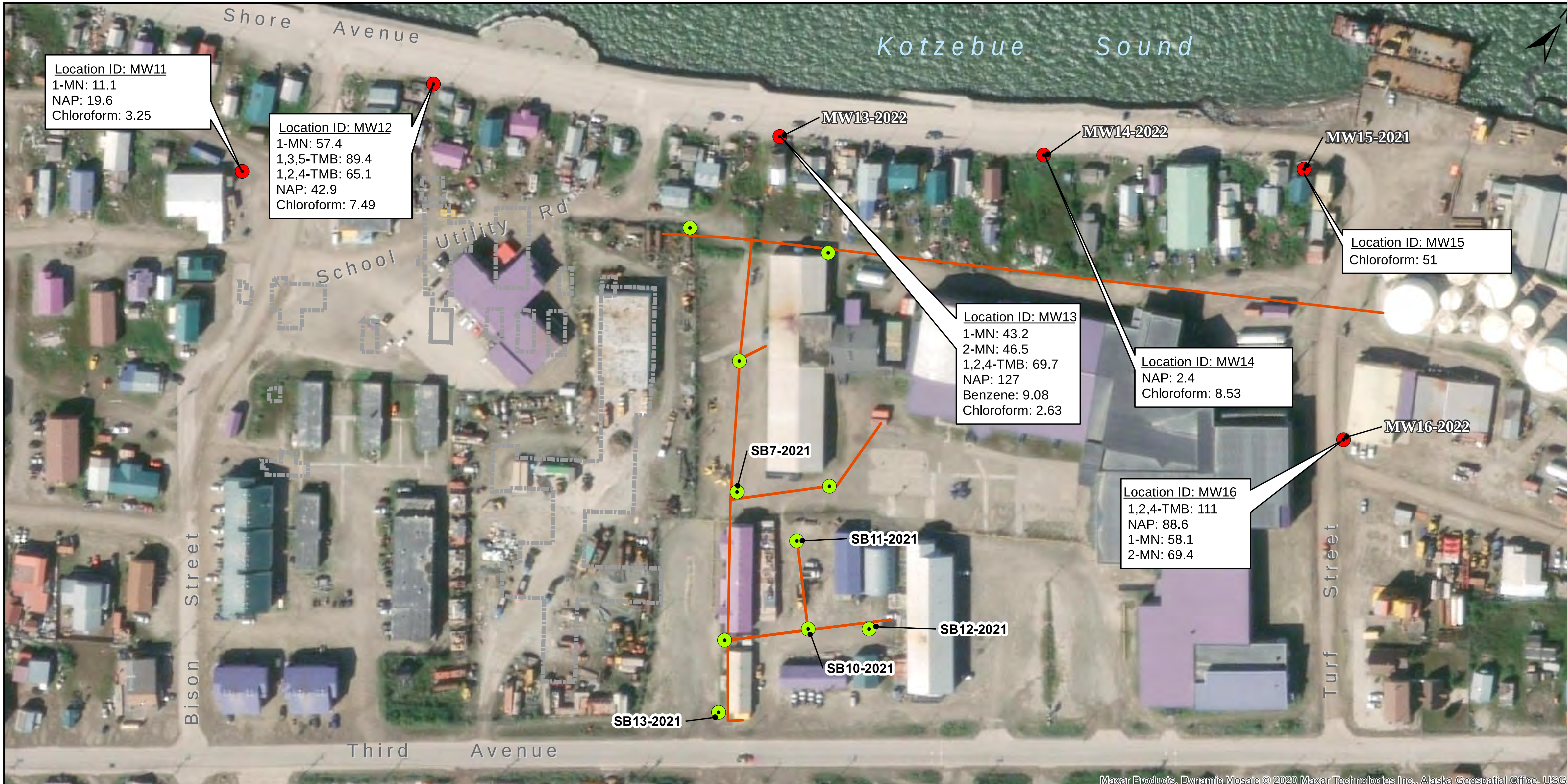
Date: 2/21/2023

Approved: JCR/MLN

Job No. 165.030390

File Name: 030390_OTZ Groundwater Monitoring Workplan_Fig5

Figure: 5



Legend

Groundwater Monitoring Wells (MW)

Soil Borings (SB)

Former Pipeline

Former BIA Structures

1 in = 125 ft

0 90 180 360 Feet

Notes:

1. Coordinate system is NAD 83 UTM Zone 4N, Unit: Meters
2. Background imagery is from AGC Imagery, 2020.
3. Acronyms and Abbreviations: 1,2,4-Trimethylbenzene (1,2,4-TMB), 1,3,5-Trimethylbenzene (1,3,5-TMB), Naphthalene (NAP), 1-methylnaphthalene (1-MN), 2-methylnaphthalene (2-MN), Benzo[b]Fluoranthene (Benzo [b] F, Trichloroethene (TCE), Dichlorodifluoromethane (DCDFM)
4. All concentrations are in ug/L
5. Only compounds with exceedances of the Table C groundwater cleanup standards from Title 18 Chapter 75 of the Alaska Administrative Code are shown.
6. Samples obtained on October 5, 2022

Compound	Cleanup Standard (ug/L)
1-MN	11
2-MN	36
1,2,4-TMB	56
1,3,5-TMB	60
Nap	1.7
DRO	1500
Benzene	4.6
DCDFM	200
Benzo [b] F	2.5
TCE	2.8
Chloroform	2.2

October 2022 Groundwater Exceedances

2021-2022 Environmental Investigation Activities
Former IHS/BIA Hospital-School Pipeline Release
Kotzebue, AK

Date: 2/21/2023

Approved: JCR/MLN

Job No. 165.030390

File Name: OTZ Groundwater Monitoring Workplan_Fig6

Figure: 6