KOTZEBUE LOT M HANGAR
GROUNDWATER CHARACTERIZATION REPORT

KOTZEBUE, ALASKA

ADEC File Number: 410.38.026
ADEC Hazard ID Number: 25557

January 21, 2011
(Revision 1)

Prepared for:

Crowley Maritime Corporation
1102 SW Massachusetts Street
Seattle, Washington 98134

Prepared by:

825 W. 8th Ave.
Anchorage, AK 99501

Prepared by: ______________________
Melissa A. Pike
Environmental Scientist

Reviewed by: ______________________
Daniel J. Frank
Project Manager

- Page Intentionally Left Blank -

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

AAC............... Alaska Administrative Code
ADEC .... Alaska Department of Environmental Conservation
AK101 .... Alaska Method AK 101
AK102 .... Alaska Method AK 102
AK103 .... Alaska Method AK 103
bgs .... Below ground surface
BTEX............. Benzene, toluene, ethylbenzene, and total xylenes
°C .... Degrees Celsius
Crowley .... Crowley Petroleum Distribution, Inc.
CSM .... Conceptual site model
DO................. Dissolved oxygen
DQO .... Data quality objective
DRO .... Diesel-range organics
DTW .... Depth to groundwater
EPA............... U.S. Environmental Protection Agency
GRO .... Gasoline-range organics
LCS/LCSD..... Laboratory control sample/laboratory control sample duplicate
mg/L .... Milligrams per liter
MS/MSD........ Matrix spike/matrix spike duplicate
ND .... Non-detect
OASIS .... OASIS Environmental, Inc.
ORP .... Oxidation-reduction potential
PID .... Photoionization detector
PQL............... Practical quantitation limit
PVC............... Polyvinylchloride
QA/QC........... Quality assurance/quality control
RPD............... Relative percent difference
RRO .... Residual-range organics

- Page Intentionally Left Blank -

EXECUTIVE SUMMARY

OASIS Environmental, Inc. conducted site assessment and groundwater characterization activities at the Crowley Petroleum Distribution, Inc. Kotzebue Lot M hangar site in September 2010. This assessment was conducted to evaluate the potential petroleum hydrocarbon impact to groundwater at the Kotzebue airport as part of an Alaska Department of Environmental Conservation (ADEC) facility-wide groundwater investigation.

Site characterization activities included the installation and sampling of three permanent groundwater monitoring wells. One of the three wells was dry and not sampled.

Previous site characterization work at the facility has included the advancing of five test pits to permafrost, to a total depth of about 7 feet below ground surface in 2007. Soil samples were collected and field screened using a photoionization detector. Analytical results indicated concentrations of gasoline-range organics (GRO) and diesel-range organics (DRO) above applicable ADEC cleanup levels at test pits located at the center of the site, below the hanger, and at the southwest corner of the site. Groundwater was not encountered during the previous site characterization field event.

Groundwater analytical results indicate benzene in both wells sampled; MW-2 and MW-3, at 0.0624 milligrams per liter (mg/L) and 0.0426 mg/L, respectively, exceeded the ADEC Table C groundwater cleanup value of 0.005 mg/L for benzene. Additionally, DRO was detected in both MW-2 and MW-3 at 17.2 mg/L and 15.7 mg/L, respectively. The DRO concentrations reported are above the Table C groundwater cleanup value of 1.5 mg/L. GRO, residual-range organics, and toluene, ethylbenzene, and total xylenes were detected in both MW-2 and MW-3 but at concentrations below the ADEC Table C groundwater cleanup value. Due to the well being dry, MW-1 was not sampled.

- Page Intentionally Left Blank -

1. INTRODUCTION

This groundwater characterization report presents the results of drilling, sampling, and monitoring activities conducted by OASIS Environmental, Inc. (OASIS) in September 2010 at the Crowley Petroleum Distribution, Inc. (Crowley) Lot M hangar, located in Kotzebue, Alaska. Site assessment activities were conducted in accordance with the *Kotzebue Lot M Groundwater Characterization Work Plan*, dated September 8, 2010, as approved by the Alaska Department of Environmental Conservation (ADEC; OASIS 2010). The ADEC File Number is 410.38.026, Hazard ID Number: 25557. This report was prepared in accordance with Title 18 of the Alaska Administrative Code, Chapter 75 (18 AAC 75), Article 3, entitled *Oil and Hazardous Substance Pollution Control Regulations, Discharge Reporting, Cleanup, and Disposal of Oil and Other Hazardous Substances*, revised as of October 9, 2008 (ADEC 2008a), and *Site Characterization Work Plan and Reporting Guidance for Investigation of Contaminated Sites* (ADEC 2009b).

The primary objective of site assessment activities was to evaluate the nature and possible extent of petroleum hydrocarbon impact to groundwater at the site.

On September 24, 2010, three soil borings were advanced and completed as groundwater monitoring wells to aid in the delineation of the extent of petroleum hydrocarbon impact.

The ADEC-qualified persons conducting the sample collection activities for OASIS were Ms. Melissa Pike and Mr. Ryan Burich. Analytical data were evaluated by Mr. Robert Beckman. Data interpretation and reporting were conducted by Ms. Pike and Mr. Daniel Frank.

This document outlines the technical and analytical approaches employed during fieldwork and characterizes actual contaminants detected. This document includes site background information (Section 2); investigation activities (Section 3); site observations and analytical results (Section 4); a discussion of analytical data quality (Section 5); a conceptual site model (Section 6); conclusions (Section 7); and references (Section 8).

- Page Intentionally Left Blank -

2. SITE BACKGROUND

2.1. Site Location and Description

Kotzebue is located 550 air miles northwest of Anchorage, Alaska, and 26 miles north of the Arctic Circle on the shores of the Chukchi Sea (Figure 1). Crowley currently leases Lot M of Block 1 at the Ralph Wien Memorial Airport in Kotzebue, Alaska (Figure 2). Crowley leases the property from the Alaska Department of Transportation and Public Facility (ADOT&PF). The lot is 60 feet wide and 125 feet deep, with one hangar building, located at 66°53’23.58” north latitude and 162°36’53.75” west longitude. The southern portion of the lot (3,000 square feet) is paved. The hangar building measures approximately 31 feet wide by 42 feet deep, with hangar doors abutting the paved portion of the site. The floor of the hangar is gravel and has a thick high density poly liner located 1.5 feet below clean gravel. The liner comes up the sides of three of the four interior walls of the hangar.

2.2. Site Operations

The Lot M hangar building is currently being used to house two fueling trucks.

2.3. Previous Investigations

In October 2007, Crowley contracted OASIS to conduct initial site assessment activities as part of lease renewal criteria at the Lot M hanger site. OASIS traveled to Kotzebue and directed the advancement of five test pits to permafrost, which was encountered at about 7 feet below ground surface (bgs). Analytical results indicated concentrations of gasoline-range organics (GRO) and diesel-range organics (DRO) above applicable ADEC cleanup levels at test pits located at the center of the site, below the hanger floor, and at the southwest corner of the site (Figure 3). Groundwater was not encountered during the field event (OASIS 2007).

2.4. Geology and Hydrogeology

Kotzebue is located on a narrow spit about ½-mile wide and several miles long; it is separated from the peninsula by a brackish-water lagoon (Kotzebue Lagoon and Isaac Lake).The spit is composed of coarse-grained beach ridge deposits with lacustrine peats and silts filling the swales between ridges.

Formed by glaciers flowing westward out of the Kobuk and Selawik rivers, the 60-mile-long peninsula is comprised mainly of marine, estuarine, glaciomarine and glacial sediments. Lying 26 miles north of the Arctic Circle, the soil is in a zone of continuous permafrost (perennially frozen ground) with near-surface soils that freeze and thaw annually. The depth of freezing and thawing of the near-surface soils is dependent on the soil type, ground cover, and snow depth. Groundwater is shallow and situated above the permafrost, with small drainages and ponds that may alter groundwater flow direction (Shannon & Wilson 2009).

General lithology includes moist sandy gravel found from 0 to 5 feet bgs underlain by saturated gravelly sand to about 8 feet bgs. From 8 to 9 feet bgs, the soil is gravelly sand that is frozen and mixed with organics.

2.5. Site Characterization Objectives

Site characterization and assessment activities, described in the ADEC-approved work plan, were designed to focus on evaluation of groundwater at Crowley's Lot M hanger site located in Kotzebue, Alaska.

OASIS' approach complied with ADEC criteria for implementing this objective.

The following tasks were planned to meet this objective:

- Evaluate the vertical impact to soil by installing four soil borings using direct-push technology (Geoprobe®) and a continuous sampler to log and field screen each soil boring from the surface to groundwater.
- Convert all soil borings to permanent groundwater monitoring wells.
- Collect groundwater samples from each groundwater monitoring well to evaluate impact to groundwater at the site.
- Evaluate analytical results against ADEC cleanup levels.
- Conduct routine groundwater monitoring to evaluate plume stability.

2.6. Regulatory Standards

Analytical results are compared to relevant State of Alaska cleanup criteria. The State of Alaska, through ADEC, has established cleanup criteria for petroleum-contaminated sites. Cleanup standards are defined in 18 AAC 75, Article 3, entitled *Oil and Hazardous Substance Pollution Control Regulations, Discharge Reporting, Cleanup, and Disposal of Oil and Other Hazardous Substances* (ADEC 2008a). For this report, groundwater analysis results are evaluated against the cleanup levels listed in 18 AAC 75.345, Table C. The applicable ADEC groundwater cleanup levels are provided with the sample results on sample summary tables.

3. SITE ASSESSMENT ACTIVITIES

This section describes field activities conducted in support of the Kotzebue Lot M hangar site assessment objective. Site conditions and timing of the field work resulted in the following deviation from the work plan:

- Monitoring Well MW-1 was unable to be developed and sampled due to lack of water within the well.

The field effort for soil boring drilling and groundwater monitoring well installation was conducted in September 2010. All site groundwater monitoring wells were sampled in September 2010.

A summary of groundwater sample collection and analyses by date, time, location, and matrix is provided in Table 1. Groundwater monitoring well locations are presented in Figure 4, with survey coordinates and elevations provided in Table 2. Groundwater elevations are presented in Figure 5 and groundwater results in Figure 6. Field notes and groundwater monitoring forms are included in Appendix A. Photographic logs are included in Appendix B. Soil boring logs are included in Appendix C. The survey data generated from a land survey of new wells is included in Appendix D.

3.1. Soil Borings

Three soil borings, designated as SB01 through SB03, were drilled on September 24, 2010. The soil borings were completed as monitoring wells MW-1 though MW-3. Soil borings were drilled to a depth of 9–13 feet bgs. At each well/boring location, soil boring logs were recorded using a Borehole/Monitoring Well Construction Log form, and the soil was classified using the Unified Soil Classification System (USCS).

3.1.1. Field Screening

Soil borings were field screened in situ using a photoionization detector (PID). The PID was calibrated to 100 parts per million (ppm) isobutylene at the beginning of each day. In situ field screening was conducted by placing the PID probe within ½-inch of the soil contained within the soil bore core casing. In situ PID results were noted on the borehole log form for each boring (Appendix C).

3.2. Monitoring Well Installation

All soil borings were converted to monitoring wells on September 24, 2010. Monitoring well installation was performed in accordance with ADEC's *Monitoring Well Design and Construction for Investigation of Contaminated Sites* dated February 2008 (ADEC 2008b). The monitoring wells were completed as a 2-inch-diameter groundwater monitoring wells using schedule 40 polyvinylchloride (PVC) casing with a 5-foot screen section of a 0.010-inch slotted screen and threaded end caps centered (when possible) on the static water level found during the soil boring installation. The filterpack was 10/20 rounded silica sand. All monitoring wells were completed as aboveground style with a protective steel monument encased in concrete and protective bollards, as necessary.

3.2.1. Well Development

Monitoring wells were developed on September 24, 2010, after conversion from soil borings using a surge and purge technique, beginning with a gentle surging action and increasing agitation as development proceeded. The purpose of well development was to remove soil fines and establish equilibrium with the formation in which the well is installed. OASIS utilized a surge block followed by purging with a low-flow peristaltic pump to develop both wells. Well development included purging of up to ten well casing volumes. At Lot M, approximately 3 to 5.5 gallons were purged from each well. During the well development process, as purge water became visibly less turbid, the field team recorded water quality parameters including pH, dissolved oxygen (DO), temperature, and specific conductivity. MW-1 was unable to be developed due to lack of water in the well. Completed monitoring well development forms are attached with the field notes in Appendix A.

3.2.2. Monitoring Well Survey

The location, measuring point elevations, and top-of-casing elevations of the new monitoring wells were surveyed by Alaska Design Inc. on September 30, 2010. The horizontal coordinates and PVC measuring point elevations are provided in Table 2.

3.3. Groundwater Monitoring

All monitoring wells were sampled on September 25, 2010. Prior to sampling, all wells were gauged for depth to groundwater (DTW). Water was not present in MW-1; therefore, no sampling occurred at that well. No free-phase hydrocarbons were encountered during groundwater monitoring. Table 1 summarizes the water samples collected, sample locations, and requested analyses.

Table 3 presents groundwater elevation calculations for this sampling event. After collecting DTW, wells were purged using the United States Environmental Protection Agency (USEPA) low-flow technique and ADEC's (peristaltic pump and dedicated tubing) that minimizes purge volume and well draw down. Groundwater quality was monitored during well purging utilizing a YSI® water quality meter with flow-through cell rented from TTT, Inc. of Anchorage, Alaska. The YSI meter was calibrated for pH (3-point curve) prior to the start of each field day. The YSI was calibrated for all functions prior to shipment to the field.

The field team monitored and recorded in the field logbook or field form (Appendix A) successive readings for:

- pH,
- Temperature,
- Specific conductivity,
- DO; and,
- Oxidation-reduction potential (ORP).

Turbidity was not measured. Prior to sampling, a final set of groundwater quality parameters were recorded. The field team monitored for stability at each well as generally indicated by pH within ± 0.1, temperature within 0.2 degrees Celsius (°C), conductivity within 3%, and DO within ± 10%. At the two wells sampled, recovery was very slow and stability within the above guidelines was not achieved for all parameters.

After purging, samples were collected for laboratory analysis. Laboratory analytical results are discussed in Section 4.

4. SITE OBSERVATIONS AND ANALYTICAL RESULTS

This section presents a discussion of field observations and the analytical results of soil boring installation and groundwater sampling conducted in September 2010. A summary of samples collected and analyses performed is presented in Table 1 for groundwater samples. Groundwater well construction details and survey data are presented in Table 2, with groundwater elevation data presented in Table 3. Groundwater analytical results along with the regulatory standards used to evaluate the analytical data are presented in Table 4.

Laboratory analytical results and completed ADEC checklists for each sample delivery group are provided in Appendix E.

4.1. Field Observations

4.1.1. Soil Lithology Observations

Soil borings were drilled in September 24, 2010, for SB-1/MW-1 through SB-3/MW-3. Soil boring SB-1/ MW-1 consisted of 5 feet of sandy gravel underlain by 4 feet of gravelly sand. Soil boring SB-2/MW-2 consisted of 4.5 feet of sandy gravel underlain by 5 feet of sand and ½-foot frozen organics. Soil boring SB-3/MW-3 consisted of 9 feet of sandy gravel, followed by 2 feet of gravelly sand and 2 feet of sand with organics. Soil boring and well completion logs are provided in Appendix C.

4.1.2. Groundwater Table Observations

Groundwater elevation data are presented in Table 3. Groundwater was present approximately 5.8 feet below grade depending on locations. Water was not encountered upon well installation at MW-1. The flow direction of the unconfined water table aquifer appears to be to the south-southeast; however, with only two wells, this direction cannot be accurately determined. The estimated hydraulic gradient between MW-2 and MW-3 is 0.000167 feet per foot. Groundwater elevations are presented in Figure 5. Inferred groundwater contours have not been drawn. No separate-phase hydrocarbons were observed at any monitoring well.

4.1.3. Water Quality Observations

Well MW-1, located at the western side of the Lot M hangar, was dry and not sampled. Well MW-2, located to the rear of the Lot M hangar near the fence along Airport Access Road, produced groundwater that appeared amber in color, with no odors noted during purging and sampling. MW-2 and, to a lesser degree, MW-3 recharged slowly and a sample was collected prior to water quality parameters stabilizing.

Well MW-3, located at the eastern side of the Lot M hangar, produced groundwater that appeared amber in color, with no odors noted during purging and sampling.

Utilizing a YSI® water quality meter with flow-through cell, OASIS recorded pH, temperature, conductivity, DO, and ORP. The pH across the site indicated a favorable range for both aerobic and anaerobic attenuation. ORP values indicated a strong reducing environement.. DO was variable at both wells, indicating an air leak in the flow-through cell system. DO values recorded during this event are no considered usable.

4.2. Laboratory Analytical Results

4.2.1. Analytical Methods

Groundwater analytical results are summarized in Table 4. Groundwater samples were submitted to the project laboratory, TestAmerica Laboratories, Inc located in Anchorage, Alaska, in accordance with standard chain-of-custody procedures outlined in the work plan. Duplicate samples were collected at a frequency of 10% per method and matrix for quality assurance/quality control (QA/QC) purposes. All samples were preserved and stored at a temperature of 4°C ± 2°C prior to shipment to TestAmerica for laboratory analysis.

Groundwater samples were analyzed for the following site assessment target analytes using the methods specified:

- GRO/benzene, toluene, ethylbenzene, and total xylenes (BTEX; Alaska Method AK 101 [AK101]/U.S. Environmental Protection Agency [EPA] SW8260B)
- DRO/residual-range organics (RRO; Alaska Method AK 102/103 [AK102/103])

4.2.2. Groundwater Sampling Analytical Results

Groundwater was not sampled at MW-1, as groundwater was not present.

At MW-2, DRO and benzene were present at 17.2 milligrams per liter (mg/L) and 0.0624 mg/L, respectively, which were both above ADEC Table C groundwater cleanup values of 1.5 mg/L for DRO and 0.005 mg/L for benzene. GRO, ethylbenzene, and total xylenes were detected, but at concentrations below the ADEC Table C groundwater cleanup values.

At MW-3, concentrations of DRO and benzene were detected at 15.7 mg/L and 0.0426 mg/L, respectively, exceeding associated ADEC Table C groundwater cleanup values. GRO, ethylbenzene, and total xylenes were detected, but at concentrations below associated ADEC Table C groundwater cleanup values.

5. QUALITY ASSURANCE/QUALITY CONTROL

Laboratory QA/QC data associated with the analysis of project samples have been reviewed to evaluate the integrity of the analytical data generated during September 2010 groundwater investigation at the Crowley leased Lot M of Block 1 at the Ralph Wien Memorial Airport in Kotzebue, Alaska. Water samples were shipped to TestAmerica in Anchorage, Alaska, in one sample delivery group, ATI0082. Samples were collected, reported, and shipped in general accordance with the ADEC-approved work plan (OASIS 2010).

All data were validated and reviewed in accordance with appropriate EPA procedural guidance documents (EPA 2008), ADEC regulatory guidance documents (ADEC 2009a; 2009b), and the ADEC Laboratory Review Checklist (ADEC 2010a). This data review focuses on criteria for the following QA/QC parameters and their effect on the quality of data and usability: sample handling and chain-of-custody documentation; holding time compliance; field QA/QC (ambient blanks, trip blanks, field duplicate) results; laboratory QA/QC (method blanks, laboratory control samples, surrogates, matrix spike/matrix spike duplicate [MS/MSD]) results and analytical methods; method reporting limits; precision and accuracy; and completeness. In absence of other regulatory QC guidance, method- and/or standard operating procedure-specific QC limits were also utilized to apply qualifiers to the data.

Samples were tested using the following methods for the associated analytes:

- BTEX by EPA Method 8260B
- GRO by AK101
- DRO by AK102
- RRO by AK103

5.1. Sample Handling and Chain of Custody

Samples were shipped from Kotzebue to Anchorage and then hand delivered to TestAmerica in Anchorage. All sample coolers were delivered with custody seals in place, unbroken and intact. Chain of custody forms, laboratory sample receipt forms, and case narratives were reviewed to determine if any sample handling activities might affect the integrity of the samples and the quality of the associated data. All sample containers in the sample coolers were received at the laboratory intact and with proper documentation. A temperature blank was received by the lab within the specified range of 4°C ± 2°C (3.0°C). All samples were extracted, digested, and/or analyzed within the holding time criteria for the applicable analytical methods and in accordance with the work plan specifications.

5.2. Field QA/QC

Field QA/QC protocols are designed to monitor for possible contamination during collection and transport of samples collected in the field. Collection and analysis of field duplicates also facilitates an evaluation of precision that takes into account potential variables associated with sampling procedures and laboratory analyses. For this project, trip blanks and field duplicates were submitted for analysis.

5.2.1. Trip Blanks

A trip blank was prepared by the laboratory, shipped to the site with the empty sample bottles/containers, stored with sample containers during the field event, and transported with the collected samples back to the laboratory for analysis. The trip blank was placed in the same cooler as the other project volatile organics samples (GRO/BTEX). All trip blank analytes were reported non-detect (ND). Data quality and usability were not affected.

5.2.2. Field Duplicates

Out of two primary samples submitted, one field duplicate was submitted with this data set—primary sample MW2-01GW and duplicate sample MW4-01-GW. The frequency of field duplicate collection met the 10% frequency requirements specified in the work plan. The primary sample and duplicate relative percent differences (RPDs) met applicable control limits for all analytes.

5.3. Laboratory QA/QC

5.3.1. Method Blanks

Method blanks were analyzed concurrent with a batch of 20 or fewer primary samples for each of the analytical procedures performed for this project. Method blanks were analyzed at the required frequency, and target analytes were ND in the blanks at concentrations above the analytical reporting limit or practical quantitation limit (PQL).

5.3.2. Laboratory Control Samples/Matrix Spikes

Analysis of laboratory control samples (LCS) and LCS duplicates (LCSD) for target analytes met laboratory and project QC goals for target analytes. Precision and accuracy were evaluated by comparing field duplicates, MS/MSD, and LCS/LCSD pairs for this project. Recoveries and RPDs for all LCS/LCSD pairs were within the required limits. MS/MSD recoveries in benzene analysis were above laboratory control limits. Benzene RPDs and recovery percentages were within limits for associated LCS/LCSD samples. Data quality and usability were not affected. Recoveries and RPDs for all other QC samples were within laboratory control limits.

5.3.3. Surrogates

System Monitoring Compounds (Surrogates) are specified for organic chromatographic analytical procedures. Surrogates are compounds similar to target analytes. These compounds are added to each sample prior to collection or extraction. Subsequent surrogate recovery indicates overall method performance. Surrogate recoveries were within prescribed control limits for all field and laboratory samples.

5.3.4. Method Reporting Limits (Sensitivity)

Method reporting limits (MRLs) and PQLs met or were below established criteria specified for all analyses in the project work plan. The reporting limits were also below the ADEC-established cleanup levels.

5.4. Analytical Methods

The following sections summarize whether quality control criteria were met for each analytical method. Sample results below the method detection limits are flagged "U" or non-detect, "ND." Results between the method detection limit and the method reporting limit have been flagged "J" as estimates due to the low level of quantization. Results that are estimated due to minor QA/QC deficiencies have been flagged "J" as estimated. Results with major QA/QC deficiencies have been flagged "R" as rejected.

5.4.1. BTEX by EPA Method 8260

Quality control criteria for this method were met.

5.4.2. GRO by AK Method AK101

Quality control criteria for this method were met.

5.4.3. DRO/RRO by Method AK102/103

Quality control criteria for this method were met.

5.5. Precision and Accuracy

Precision criteria monitor analytical reproducibility. Accuracy criteria monitor agreement of measured results with "true values" established by spiking applicable samples with a known quantity of analyte or surrogate. Precision and accuracy were evaluated by comparing LCS/LCSD, MS/MSD, and field duplicate pairs for this project. Field duplicates and MS/MSD samples were collected in accordance with work plan specifications. Field duplicate RPDs met applicable control limits. Recoveries and RPDs for all LCS/LCSD samples were within required limits. Some MS/MSD samples were outside required limits; LCS/LCSD samples were within limits, however. Data quality objectives (DQOs) of an overall 90% accuracy in QC samples were met.

5.5.1. Completeness

Data completeness is defined as the percentage of usable data (usable data divided by the total possible data). The overall project completeness goal is 90%:

$$\% \text{ completeness} = \frac{\text{number of valid (i.e., non-R flagged) results}}{\text{number of possible results}}$$

All requested analyses were performed in accordance with work plan specifications. No results were qualified as unusable (i.e., "R"). Completeness for this project is 100%.

5.5.2. Representativeness

Data representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or environmental condition. The number and selection of samples were specified in the work plan and verified in the field to account accurately for site variations and sample matrices. The DQO for representativeness was met.

5.5.3. Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Data produced for this project followed applicable field sampling techniques and specific analytical methodology. The DQO for comparability was met.

5.6. Data Summary

Based upon the information provided, the data are acceptable for use. All requested analyses were performed in accordance with work plan specifications. No results were qualified as unusable (i.e., “R”). Completeness for this project is 100%. In general, the overall quality of the data was acceptable. The EPA National Functional Guidelines (EPA 2008) were used to evaluate the acceptability of the data. Overall, data quality meets DQOs established in the work plan for this project. The associated sample results are usable for the purpose of this investigation.

6. HUMAN HEALTH CONCEPTUAL SITE MODEL

A conceptual site model (CSM) has been developed for the site based on site characterization results. The CSM was developed in accordance with ADEC *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b).

The site is considered an industrial facility located on Ralph Wien Memorial Airport in Kotzebue, Alaska.

6.1. Source/Release Mechanism

The source of impact to subsurface soil and groundwater at this site is unknown. A search of site files by Crowley did not result in the discovery of a specific spill event at the Lot M hangar. Several ADEC-contaminated sites exist near this facility, within the Airport area (Figure 2). The source of impact may be past on-site petroleum hydrocarbon releases or may be due to migration of known impacted media at adjacent ADEC listed contaminated sites with documented spill histories. Without a primary media source at the Lot M site, the encountered impacts to subsurface soil and groundwater media at Lot M maybe secondarily impacted from an off-site primary source/release.

OASIS assumes that either on-site or off-site undocumented leaks, spills, or discharges have resulted in the impact of subsurface soil and groundwater media observed at the Lot M hangar site.

6.2. Route of Exposure

Contaminants identified at a source area can move from the impacted source media, though the environment, impacting secondary media including groundwater, surface water, soil, and air. Mechanisms of transport of between the source area and impacted media may include volatilization, fugitive dust, leaching, seepage, or overland water flow. Although a completed pathway may exist between impacted media and exposure media via a transportation mechanism, the exposure of receptors may not be considered significant in some cases because a contaminant may not be highly mobile, or readily dissolves or dissipates, or other site conditions reduce or eliminate the risk of actual receptor exposure. Possible pathways of exposure where site conditions indicate little or no risk are considered complete but insignificant. The following subsections detail the routes of exposure at Lot M.

6.2.1. Impacted Media

The analytical evidence presented in Section 4 indicates that subsurface soil and groundwater at Lot M are impacted by petroleum hydrocarbons at concentrations that exceed ADEC cleanup criteria. Soil contamination at the site does not include a compound considered a dermal exposure risk (ADEC 2010b [Appendix B]). However, benzene, considered a volatile of potential concern by ADEC was detected in soil and groundwater at the site is (ADEC 2010b [Appendix D]).

Surface water impacts exceeding ADEC surface water criteria (18 AAC 70) have not been documented in the area; however "pore-water" groundwater sampling conducted by Shannon and Wilson, Inc. in 2009 did find concentrations of DRO, RRO and benzene above ADEC's Table C groundwater cleanup criteria. Pore-water groundwater samples were collected from between 5 and 20 feet inland and six inches to one foot deep from both Kotzebue Lagoon and Kotzebue Sound (S & W 2009).

6.2.2. Transport Mechanisms

Subsurface soil impact has impacted groundwater via leaching. Volatilization from subsurface soil and groundwater is a possible transportation mechanism that could impact the air exposure pathway.

ADEC reports that surface water in Kotzebue Lagoon and Kotzebue Sound is impacted with DRO, RRO, and benzene. However, impact to surface water from leaching of Lot M groundwater is very unlikely because of the distance of the site to surface water and the nearness of other known impacted sites located adjacent to the S&W temporary pore-water well points. The nearest surface water to the Lot M site is across the airport apron within a depression between the apron and Runway 8/26. Kotzebue Lagoon is located 825 feet (0.15 mile) to the east, and Kotzebue Sound is located 1,425 feet (0.27 mile) to the west. Two ADEC contaminated sites lie between the Crowley Lot M site and Kotzebue Lagoon: the NANA UST site and the Northwestern Aviation site. Five ADEC contaminated sites lie between the Crowley Lot M site and Kotzebue Sound: Alaska Airlines; the former Mark Air facility; Baker Aviation; the former Mark Air Cargo facility, and the State of Alaska Department of Transportation and Public Facility site. The distance from the Lot M site to both Kotzebue Lagoon and Kotzebue Sound is considered significant enough to inhibit migration by seepage of groundwater from the Lot M site to surface water.

Additionally, impact to surface water from a site surface water run-off transportation mechanism is very unlikely. Surface water run-off from the site is not considered a viable transportation mechanism that could impact surface water because the land surface is very flat, surface water is not located near the site (no probable point of entry to surface water exists), the site is partially paved, and impacted soil is located at 2 feet bgs and deeper.

The limited amount of groundwater (one dry well) and the slow recharge of the two producing wells at the site indicate a low transmissivity aquifer located in the active layer above permafrost at about 7 feet bgs. Because of the shallow depth, the perched aquifer is expected to be frozen for 6 or months of the year. The low transmissivity and ephemeral water presence makes groundwater migration to surface water by leaching an unlikely transportation mechanism.

6.2.3. Exposure Media

Possible exposure media at the site include subsurface soil, air, and groundwater. Although impact to surface water from the Lot M site is considered unlikely, an evaluation of this pathway is included as ADEC reports surface water as impacted.

6.3. Receptors

The site is located within a secure fence maintained by Crowley and airport staff. Trespassers, subsistence users, farmers, and recreational user receptors are not expected now or in the future at the Lot M site. Possible current or future receptors include current and future site workers, future construction workers, and current and future site visitors.

Surface water is reported by ADEC to be impacted from unknown sources; surface water impacts are based on pore-water groundwater analytical results for samples collected from between 5 and 20 feet inland from a shoreline (S & W 2009). Additionally, ADEC reports the use of surface water in Kotzebue Sound for recreation (swimming). Therefore current and future recreational users of Kotzebue Sound may be exposed via surface water media.

6.4. Human Health Exposure Routes

A human health exposure routes include ingestion, inhalation, and dermal contact.

6.4.1. Exposure Pathways

Soil exposure pathways include ingestion and dermal contact. Because soil at Lot M is impacted within the top 15 feet bgs, the direct contact soil exposure pathway via incidental soil ingestion is considered complete. However, contaminants are not considered dermally absorptive, and so the soil exposure pathway by dermal absorption is not complete.

Although groundwater is not used for drinking water in Kotzebue, the ingestion of impacted groundwater is considered a complete exposure pathway as all groundwater in the State of Alaska is considered a possible future drinking water source. Exposure via the groundwater ingestion pathway is unlikely, and may be considered insignificant due to conditions present at the site: the aquifer is shallow and perched on permafrost, during most of the year ground water is frozen; the aquifer appears to be a low-producing resource as newly installed monitoring wells were found to dry or slow to recharge during low-flow purging; and, Kotzebue reportedly obtains drinking water for public distribution from a lake located 2 miles east of the site.

Ingestion of surface water is not considered a complete pathway as surface water is salt water in Kotzebue Sound and brackish in Kotzebue Lagoon.

Ingestion of wild or farmed food is not considered a complete pathway as the area is not used for hunting, fishing, or harvesting of wild or farmed food – the airport area is fenced. Additionally, no contaminant at the site is considered a potential concern for bioaccumulation (ADEC 2010 [Appendix B]).

Inhalation of both indoor air and outdoor air are considered complete pathways as benzene was detected in soil and groundwater at the site. The indoor air inhalation pathway is modified as insignificant because a high density poly liner lines the entire floor of the hanger facility.

6.4.2. Additional Exposure Pathways

Additional exposure pathways relevant to the Lot M site include dermal exposure to contaminants in groundwater and surface water; inhalation of volatile compounds in tap water; and inhalation of fugitive dust. Direct contact with sediment is not currently considered an additional exposure pathway for this site.

6.4.2.1. Dermal exposure

Dermal exposure may occur and be considered a complete exposure pathways if:

- Climate permits recreational use of water for swimming;
- Climate permits exposure to groundwater during activities, such as construction; and,
- Groundwater or surface water is used for household purposes such as bathing or cleaning.

ADEC reports that surface water is used for swimming and other recreational activities, therefore the dermal exposure pathway could be considered complete, or in need of further evaluate. Because it is not reasonable to expect impact at Lot M to be the source of impact in surface water, and because cold temperatures will greatly limit the time a swimmer or bather would be in the water, or that a hunter or other recreational user would not be fully covered and therefore protected from exposure, the surface water dermal exposure pathway is considered insignificant.

Groundwater exposure from construction activities is considered unlikely and therefore no further evaluation is deemed necessary.

Although unlikely, groundwater could be used in the future for household purposes or bathing. However, a future groundwater use scenario is considered insignificant at the airport because the actual use of groundwater is not a reasonably expected source of tap or drinking water.

Surface water could be used for bathing, however the cold temperature of the water and that the water is salt water makes this an unlikely use; therefore exposure by this route is considered insignificant.

6.4.2.2. Inhalation of Volatile Compounds in Tap Water

If groundwater at the site is utilized in the future for household activities such as showering, laundry, and dish washing, and as benzene was found in groundwater, an inhalation exposure pathway from tap water is complete. However, given site groundwater conditions, this pathway is considered insignificant, and no further evaluation is needed in relation to the Lot M site.

Surface water is salt water and so an inhalation exposure pathway of violates in surface water as tap water is not complete as surface water is salt water and would not be used as tap water.

6.4.2.3. Inhalation of Fugitive Dust

At Lot M, soil was not found to be impacted within the first two feet, eliminating the potential for ingestion by fugitive dust

Receptors and completed pathways are presented in the ADEC CSM checklist and graphic CSM provided in Appendix F.

7. CONCLUSIONS

Site characterization activities were conducted in September 2010 to evaluate the nature and extent of petroleum hydrocarbon impact to subsurface soil and groundwater at Crowley's hangar facility in Kotzebue, Alaska. Characterization activities included the installation, development, and sampling of three groundwater monitoring wells at the site. One of the three wells was dry and not sampled.

7.1. Conclusions

Groundwater analytical results indicate petroleum hydrocarbon impact at MW-2 and MW-3. At both wells, the concentration of benzene exceeded ADEC's Table C groundwater cleanup levels at 0.0624 mg/L and 0.0426 mg/kg, respectively. Additionally, DRO was reported above the ADEC Table C groundwater cleanup level at 17.2 mg/L in MW-2 and 15.7 mg/L in MW-3.

The source of impact at these two wells is unknown.

- Page Intentionally Left Blank -

8. REFERENCES

Alaska Department of Environmental Conservation (ADEC). 2008a. Alaska Administrative Code*, Title 18, Environmental Conservation Chapter 75, Oil and Other Hazardous Substances Pollution Control.* ADEC, Juneau, Alaska, October 9.

———. 2008b. *Monitoring Well Design and Construction for Investigation of Contaminated Sites*. ADEC Division of Spill Prevention and Response Contaminated Sites Program. Juneau, Alaska. November.

———. 2009a. *Environmental Laboratory Data and Quality Assurance Requirements, Technical Memorandum*, ADEC Division of Spill Prevention and Response. Contaminated Sites Program. Juneau, Alaska. March.

———. 2009b. *Site Characterization Work Plan and Reporting Guidance for Investigation of Contaminated Sites*. September 23.

———. 2010a. *Laboratory Data Review Checklist, Version 2.7,* ADEC Division of Spill Prevention and Response, Contaminated Sites Program form, downloaded from: http://dec.alaska.gov/spar/guidance.htm#methods. January.

———. 2010b. *Draft Guidance on Developing Conceptual Site Models,* ADEC Division of Spill Prevention and Response, Contaminated Sites Program, Juneau, Alaska. Human Health Scoping and Graphic Forms downloaded from: http://www.dec.state.ak.us/spar/guidance.htm#csp. October.

EMCON. 1998. Letter Regarding Underground Storage Tank Closures. October 21.

OASIS Environmental, Inc. (OASIS). 2007. Letter Report *Kotzebue Lot M Hangar Site Assessment Report* . November 7.

———. 2010. *Former Newhalen Tank Farm Groundwater Characterization Work Plan.* OASIS, Anchorage, Alaska. August 10.

Shannon & Wilson, Inc. 2009. Pore-Water Sampling Report Ralph Wien Memorial Airport Kotzebue Alaska, June.

U.S. Environmental Protection Agency (EPA). 2008. *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 540/R-94/012).

- Page Intentionally Left Blank -

TABLES

- Page Intentionally Left Blank -

TABLE 1: GROUNDWATER SAMPLE COLLECTION SUMMARY
2010 KOTZEBUE LOT M HANGAR GROUNDWATER CHARACTERIZATION REPORT
CROWLEY MARITIME COMPANY
KOTZEBUE, ALASKA

Location	Sample No. 10-KLOTM-:	Duplicate	Sample Date	Sample Time	Laboratory Analyses			
					GRO (AK 101)	DRO (AK 102)	RRO (AK 103)	BTEX (EPA 8260)
MW-1	MW1-01GW		NS	NS	✓	✓	✓	✓
MW-2	MW2-01GW		09/25/10	1456	✓	✓	✓	✓
MW-3	MW3-01GW		09/25/10	1405	✓	✓	✓	✓
MW-4	MW4-01GW	✓	09/25/10	1515	✓	✓	✓	✓
Trip Blank	TB-01GW		09/25/10	800	✓	--	--	✓

Key:

AK = Alaska

BTEX = Benzene, toluene, ethylbenzene, xylenes

DRO = Diesel-range organics

EPA = United States Environmental Protection Agency

GRO = Gasoline-range organics

GW= Groundwater

NS = Not sampled. Dry well.

RRO = Residual-range organics

TB = Trip Blank

TABLE 2: WELL CONSTRUCTION AND SURVEY DETAILS
2010 KOTZEBUE LOT M HANGAR GROUNDWATER CHARACTERIZATION REPORT
CROWLEY MARITIME COMPANY
KOTZEBUE, ALASKA

Well ID	Installation Date	Well Construction Details							Land Survey Details				Initial DTW (ft. bgs)
		Casing Diameter (inches)	Depth to Top of Screen (ft. bgs)	Depth to Bottom of Screen (ft. bgs)	Screen Length (ft.)	Total Depth (ft. bgs)	Top of Screen (BTOC)	Bottom of Screen (BTOC)	Northing[1]	Easting[1]	Measuring Point Elevation[2]	Ground Surface Elevation[2]	
September 2010 Groundwater Monitoring Wells													
MW-1	9/24/2010	2	3.00	8.00	5.00	8.00	5.50	10.50	4712045.52	1554346.11	13.30	10.70	dry
MW-2	9/24/2010	2	3.00	8.00	5.00	8.00	5.51	10.51	4712090.97	1554372.42	13.21	10.70	5.25
MW-3	9/24/2010	2	5.00	10.00	5.00	10.00	7.80	12.80	4712028.19	1554381.15	14.10	11.30	5.45

Notes:

(1) Alaska State Plan Zone 7, NAD83

(2) Top of (PVC) pipe elev's are at black mark; NAVD88 Elevation.

Key:

-- = None measured/not applicable

bgs = Below ground surface

BTOC = Below top of casing, a.k.a. below measuring point

DTW = Depth to water

ft. = Feet

MP = Measuring Point (a.k.a. PVC Elevation/TOC)

TABLE 3: GROUNDWATER ELEVATION DATA
2010 KOTZEBUE LOT M HANGAR GROUNDWATER CHARACTERIZATION REPORT
CROWLEY MARITIME COMPANY
KOTZEBUE, ALASKA

Well ID	Measuring Point Elevation[1]	Top of Screen (BTOC)	Bottom of Screen (BTOC)	Gauge Date	Depth from Well MP		Groundwater Elevation	Groundwater Elevation within Screening Interval?
					Depth to Product	Depth to Water		
September 2010 Groundwater Monitoring Wells								
MW-1	13.30	5.50	10.50	9/25/2010	--	Dry	Dry	Dry
MW-2	13.21	5.51	10.51	9/25/2010	--	7.4	5.81	Yes
MW-3	14.10	7.80	12.80	9/25/2010	--	8.30	5.80	Yes

Notes:

All measurements are in units of feet.

[1] Top of (PVC) pipe elev's are at black mark; NAVD88 Elevation.

Key:

-- = None measured/not applicable

BTOC = Below top of casing, a.k.a. below measuring point

MP = Measuring Point (a.k.a. PVC Elevation/TOC)

TABLE 4: GROUNDWATER SAMPLE ANALYTICAL RESULTS SUMMARY
2010 KOTZEBUE LOT M HANGAR GROUNDWATER CHARACTERIZATION REPORT
CROWLEY MARITIME COMPANY
KOTZEBUE, ALASKA

Location:	ADEC Groundwater Cleanup Values[1]	MW1	MW2	MW-2 (Duplicate)	MW-3	Trip Blank
Sample Number (10-KLOTM-):		MW1-01GW	MW2-01GW	MW4-01GW	MW3-01GW	TB-01GW
Sample Date:		9/25/2010	9/25/2010	9/25/2010	9/25/2010	9/25/2010
ADEC Fuels (AK101, AK102, AK103; mg/L)						
Gasoline-Range Organics	2.2	NS	0.78	0.884	0.378	ND (0.05)
Diesel-Range Organics	1.5	NS	**<u>17.2</u>**	**<u>15.1</u>**	**<u>15.7</u>**	--
Residual-Range Organics	1.1	NS	0.947	0.952	0.827	--
VOCs (EPA 8260; mg/L)						
Benzene	0.005	NS	**<u>0.0624</u>**	**<u>0.0665</u>**	**<u>0.0426</u>**	ND (0.0002)
Toluene	1	NS	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
Ethylbenzene	0.7	NS	0.0486	0.0539	0.00179	ND (0.001)
m,p-Xylenes	-	NS	0.0931	0.108	0.034	ND (0.002)
o-Xylene	-	NS	0.00178	0.00195	ND (0.001)	ND (0.001)
Total Xylenes	10	NS	0.095	0.11	0.034	ND (0.003)

<u>Notes:</u>

Detected results above ADEC groundwater cleanup values are bolded and underlined.

[1] 18 AAC 75.345, Table C

<u>Key:</u>

-- = Not applicable

ADEC = Alaska Department of Environmental Conservation

mg/L = Milligrams per liter

ND = Analyte not detected above the method reporting limit

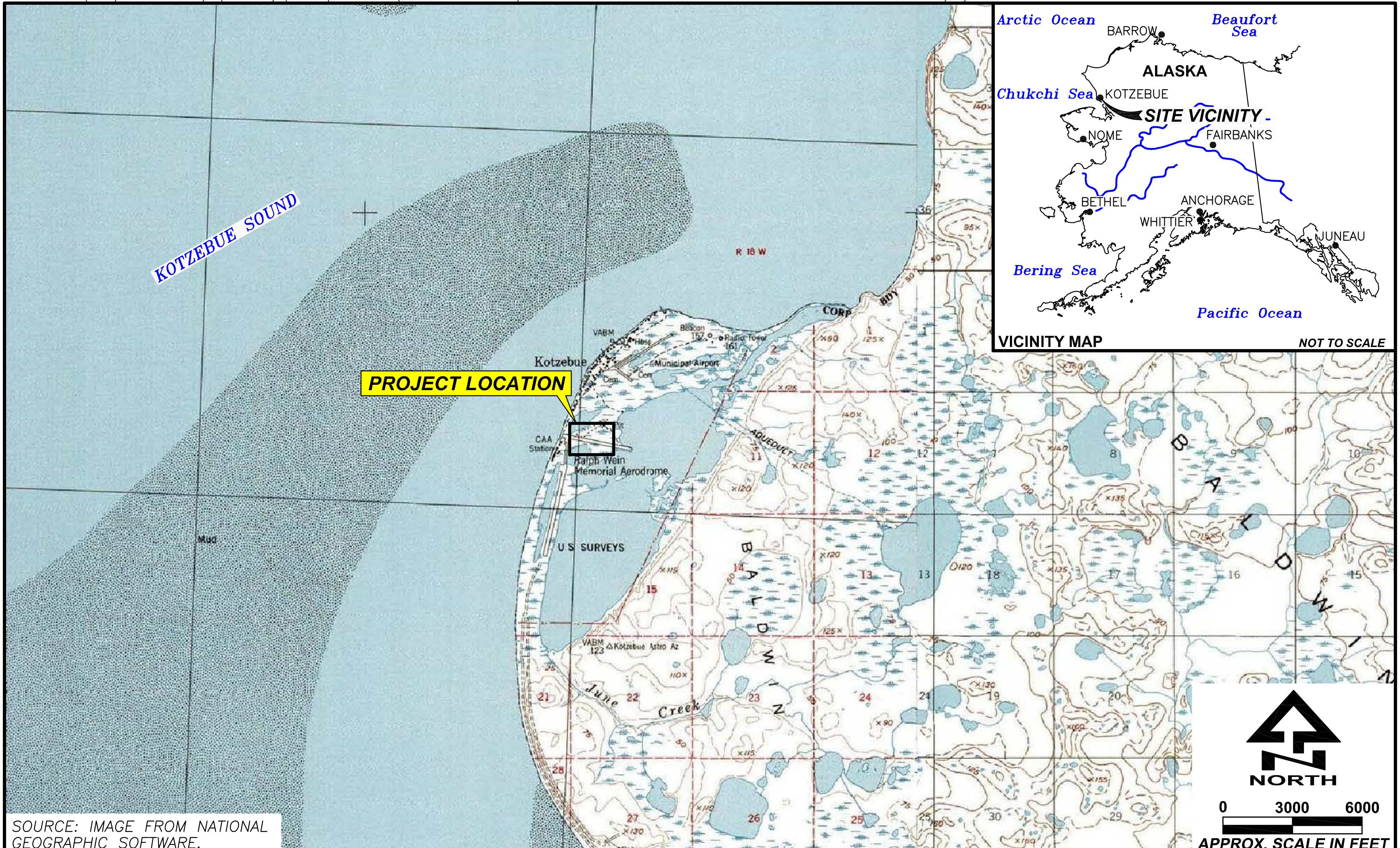
NS = Not sampled. Dry well.

VOC = Volatile organic compound

FIGURES

- Page Intentionally Left Blank -

PATH: V:\Project Drawings\Crowley\Kotz\10 Kotz\10 Kot Gwm Rpt FILE: 465-012-KZ-GWM-RPT-F1.DWG PLOTTED: 12/7/10.



SOURCE: IMAGE FROM NATIONAL GEOGRAPHIC SOFTWARE.

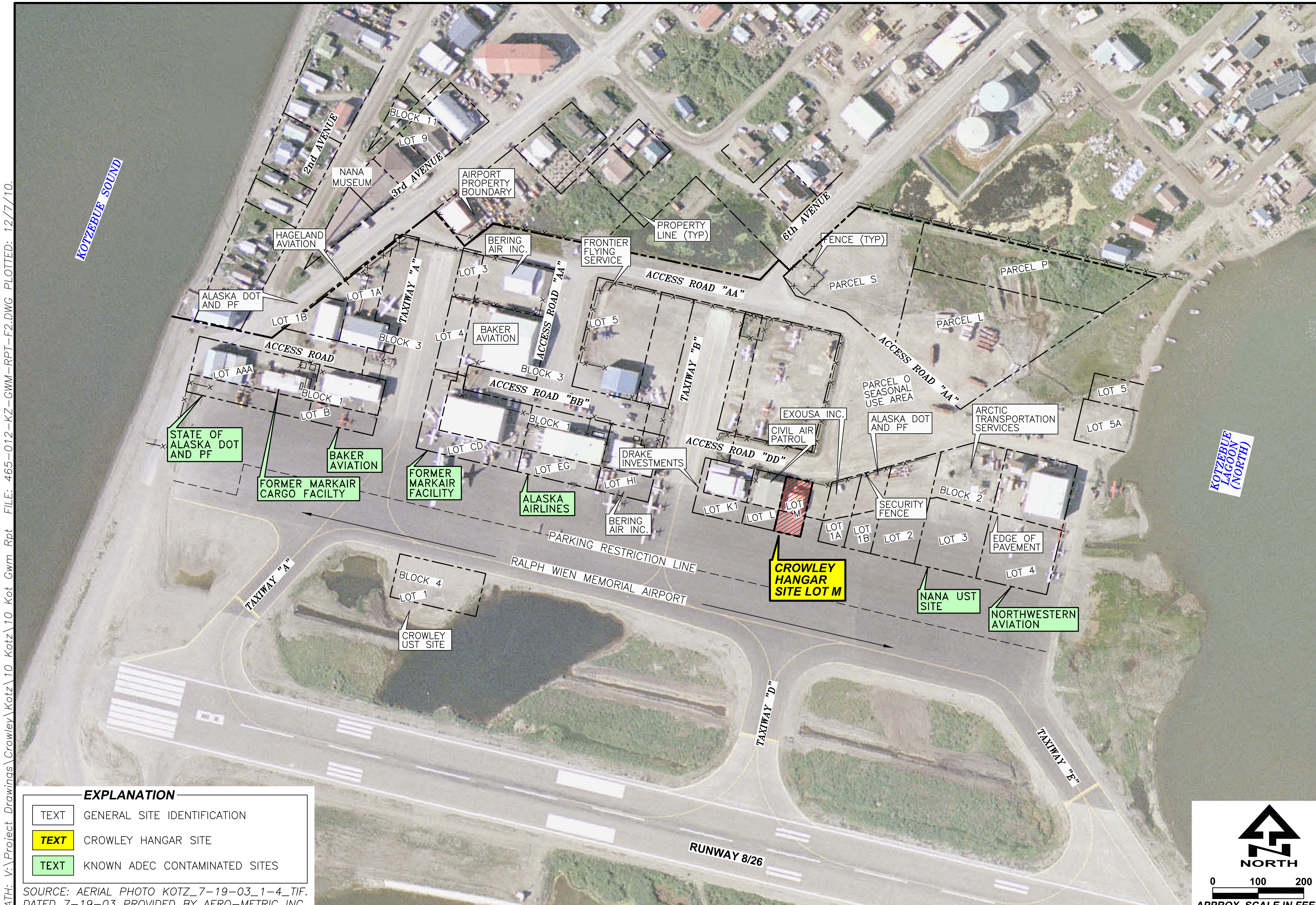
oasis ENVIRONMENTAL

DATE: DEC. 2010
CHKD: M.A.P.
DRAWN: C.L.H.
PROJ. No.: 465-012
825 W. 8th Ave., Anchorage, AK 99501, (907) 258-4880

SITE LOCATION MAP

KOTZEBUE LOT M HANGAR
2010 GROUNDWATER CHARACTERIZATION REPORT
CROWLEY MARITIME CORPORATION
Kotzebue, Alaska

FIGURE
1



PATH: V:\Project Drawings\Crowley\Kotz\10 Kotz Gwm Rpt FILE: 465-012-KZ-GWM-RPT-F2.DWG PLOTTED: 12/7/10.

FIGURE 2

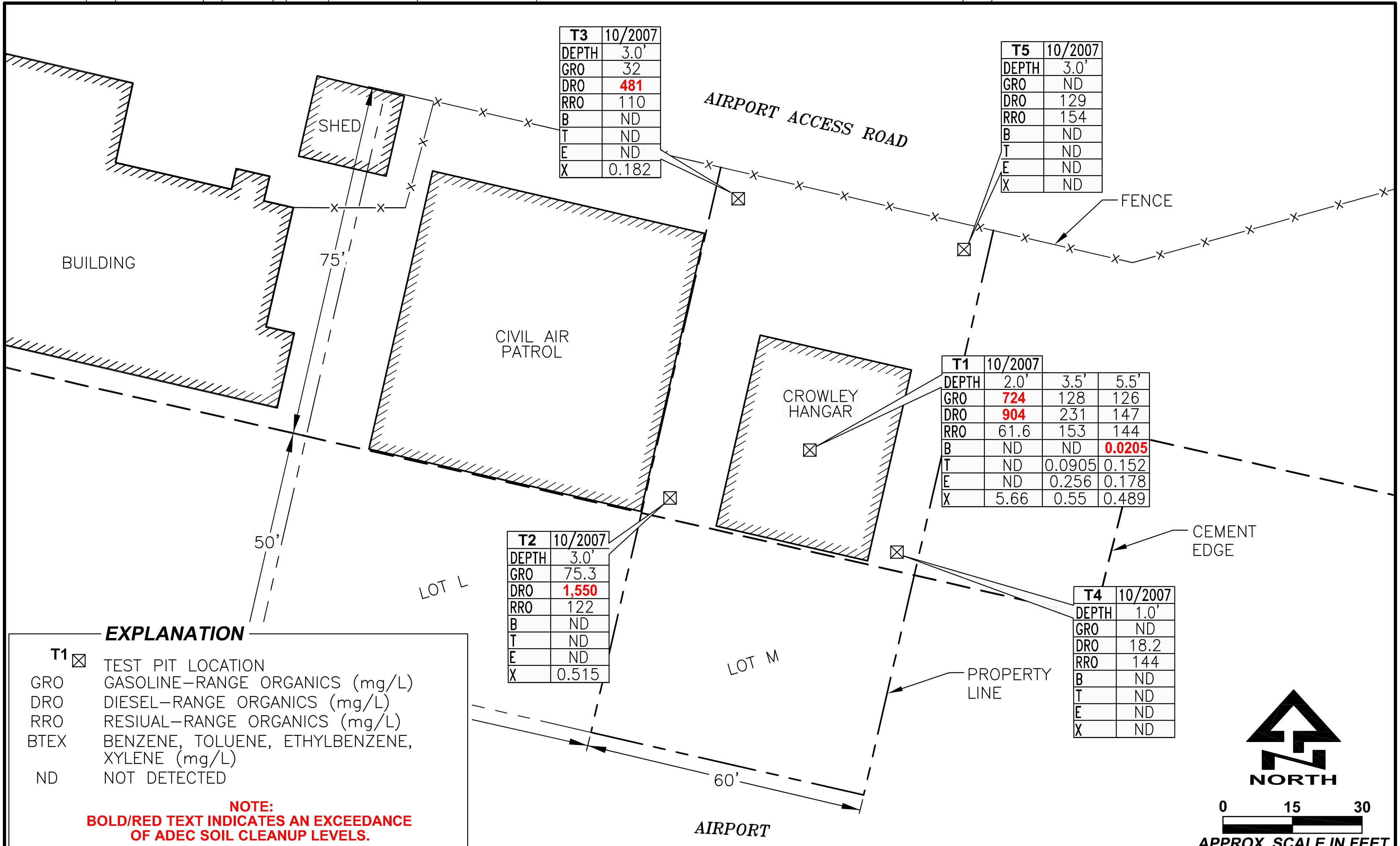
SITE PLAN

KOTZEBUE LOT M HANGAR
2010 GROUNDWATER CHARACTERIZATION REPORT
CROWLEY MARITIME CORPORATION
Kotzebue, Alaska

DATE: DEC. 2010
CHKD: M.A.P.
DRAWN: C.L.H.
PROJ. No.: 465-012

oasis ENVIRONMENTAL
825 W. 8th Ave., Anchorage, AK 99501, (907) 258-4880

PATH: V:\Project Drawings\Crowley\Kotz\2010 Kotz\10 Kot Gwm Rpt FILE: 465-012-KOT-GWM-RPT-F3.DWG PLOTTED: 1/12/11.



T3	10/2007
DEPTH	3.0'
GRO	32
DRO	**481**
RRO	110
B	ND
T	ND
E	ND
X	0.182

T5	10/2007
DEPTH	3.0'
GRO	ND
DRO	129
RRO	154
B	ND
T	ND
E	ND
X	ND

T1	10/2007		
DEPTH	2.0'	3.5'	5.5'
GRO	**724**	128	126
DRO	**904**	231	147
RRO	61.6	153	144
B	ND	ND	**0.0205**
T	ND	0.0905	0.152
E	ND	0.256	0.178
X	5.66	0.55	0.489

T2	10/2007
DEPTH	3.0'
GRO	75.3
DRO	**1,550**
RRO	122
B	ND
T	ND
E	ND
X	0.515

T4	10/2007
DEPTH	1.0'
GRO	ND
DRO	18.2
RRO	144
B	ND
T	ND
E	ND
X	ND

EXPLANATION

T1 ⊠	TEST PIT LOCATION
GRO	GASOLINE-RANGE ORGANICS (mg/L)
DRO	DIESEL-RANGE ORGANICS (mg/L)
RRO	RESIUAL-RANGE ORGANICS (mg/L)
BTEX	BENZENE, TOLUENE, ETHYLBENZENE, XYLENE (mg/L)
ND	NOT DETECTED

NOTE:
BOLD/RED TEXT INDICATES AN EXCEEDANCE OF ADEC SOIL CLEANUP LEVELS.

oasis ENVIRONMENTAL

DATE: JAN. 2011
CHKD: M.A.P.
DRAWN: C.L.H.
PROJ. No.: 465-012

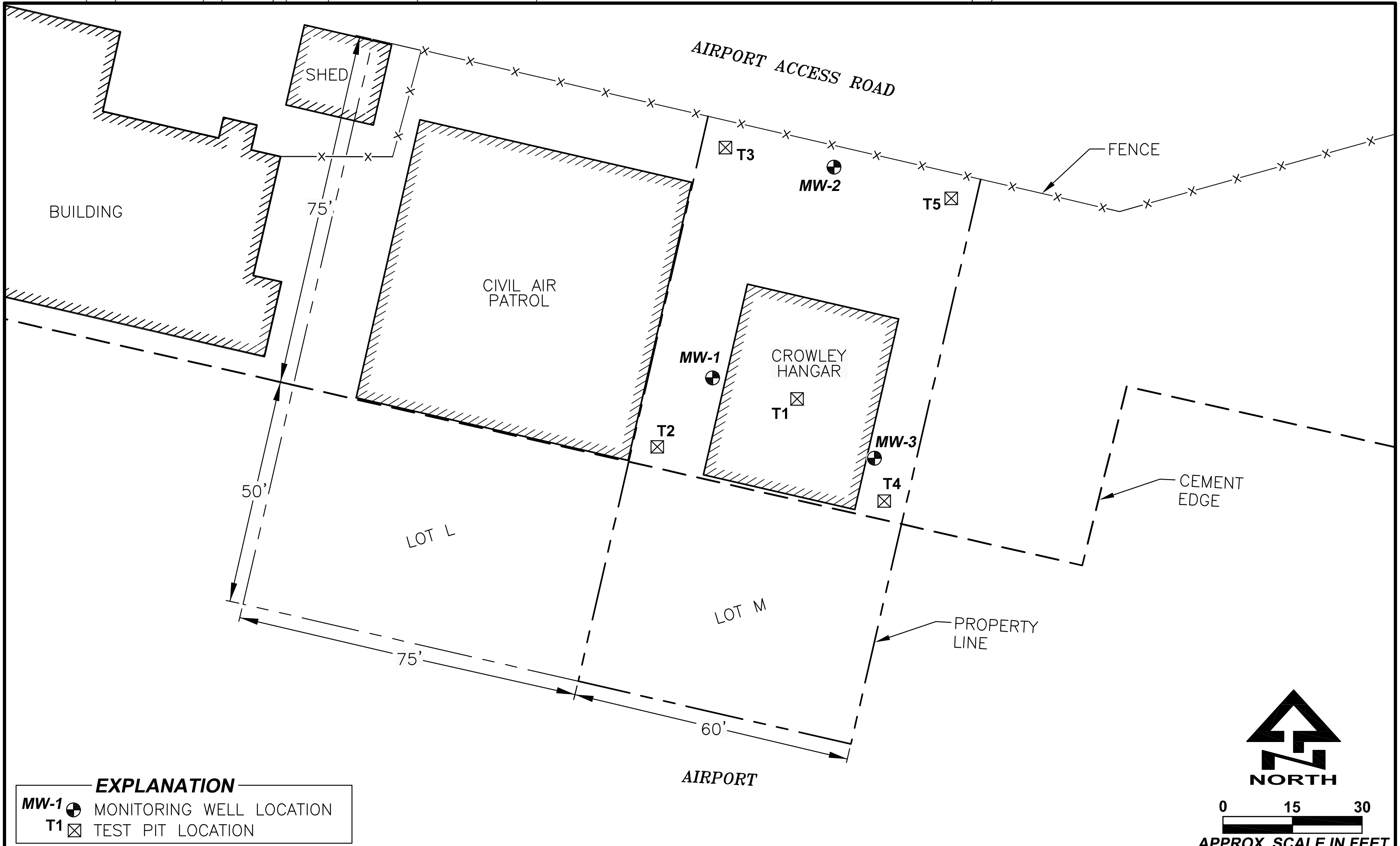
825 W. 8th Ave., Anchorage, AK 99501, (907) 258-4880

2007 TEST PIT ANALYTICAL RESULTS

KOTZEBUE LOT M HANGAR
2010 GROUNDWATER CHARACTERIZATION REPORT
CROWLEY MARITIME CORPORATION
Kotzebue, Alaska

FIGURE 3

PATH: V:\Project Drawings\Crowley\Kotz\2010 Kotz\10 Kot Gwm Rpt FILE: 465-012-KOT-GWM-RPT-F4.DWG PLOTTED: 12/7/10.



oasis ENVIRONMENTAL

DATE: DEC. 2010
CHKD: M.A.P.
DRAWN: C.L.H.
PROJ. No.: 465-012

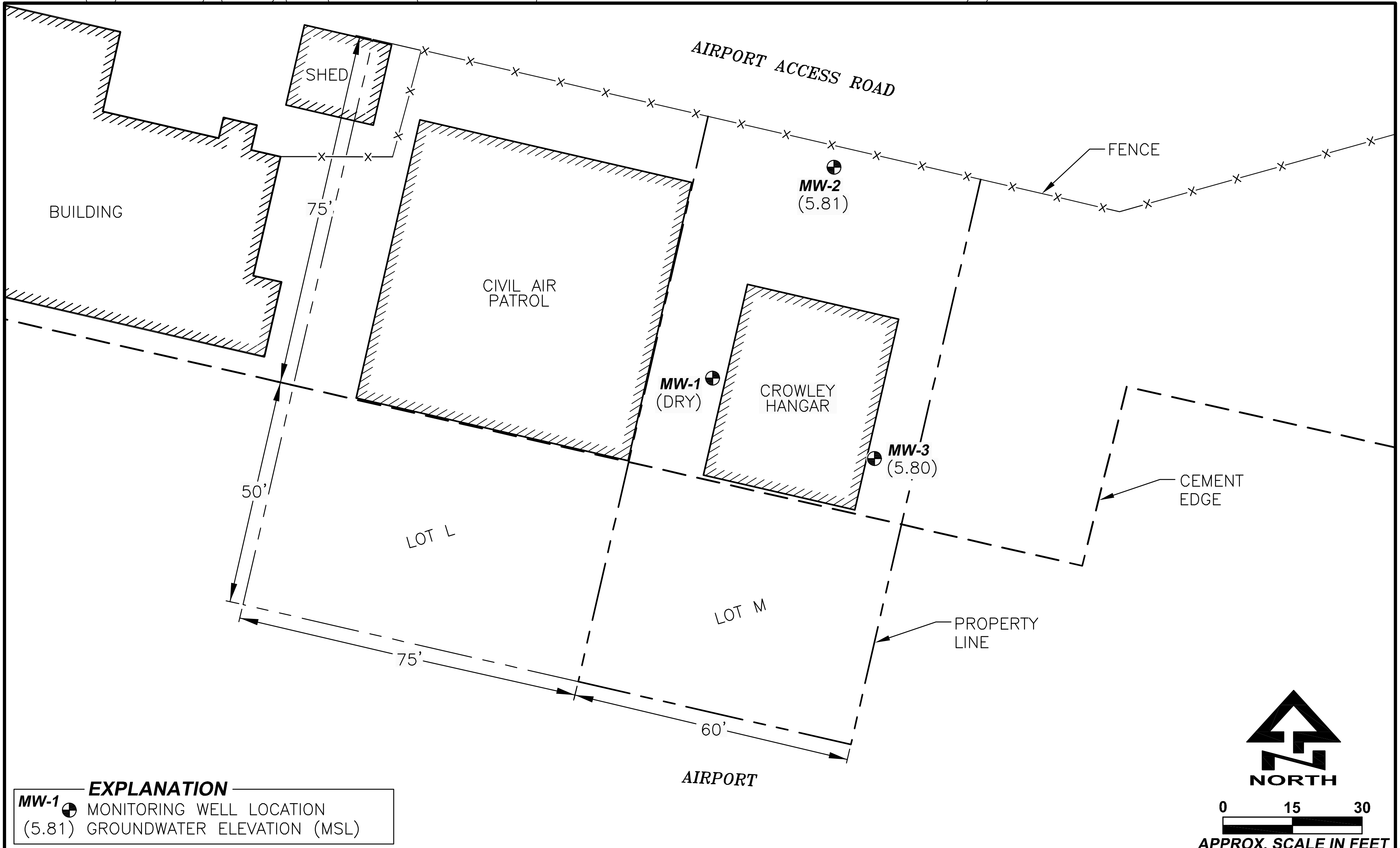
825 W. 8th Ave., Anchorage, AK 99501, (907) 258-4880

SITE DETAIL

KOTZEBUE LOT M HANGAR
2010 GROUNDWATER CHARACTERIZATION REPORT
CROWLEY MARITIME CORPORATION
Kotzebue, Alaska

FIGURE 4

PATH: V:\Project Drawings\Crowley\Kotz\2010 Kotz\10 Kot Gwm Rpt FILE: 465-012-KOT-GWM-RPT-F5DWG PLOTTED: 12/7/10.



oasis ENVIRONMENTAL

DATE: DEC. 2010
CHKD: M.A.P.
DRAWN: C.L.H.
PROJ. No.: 465-012

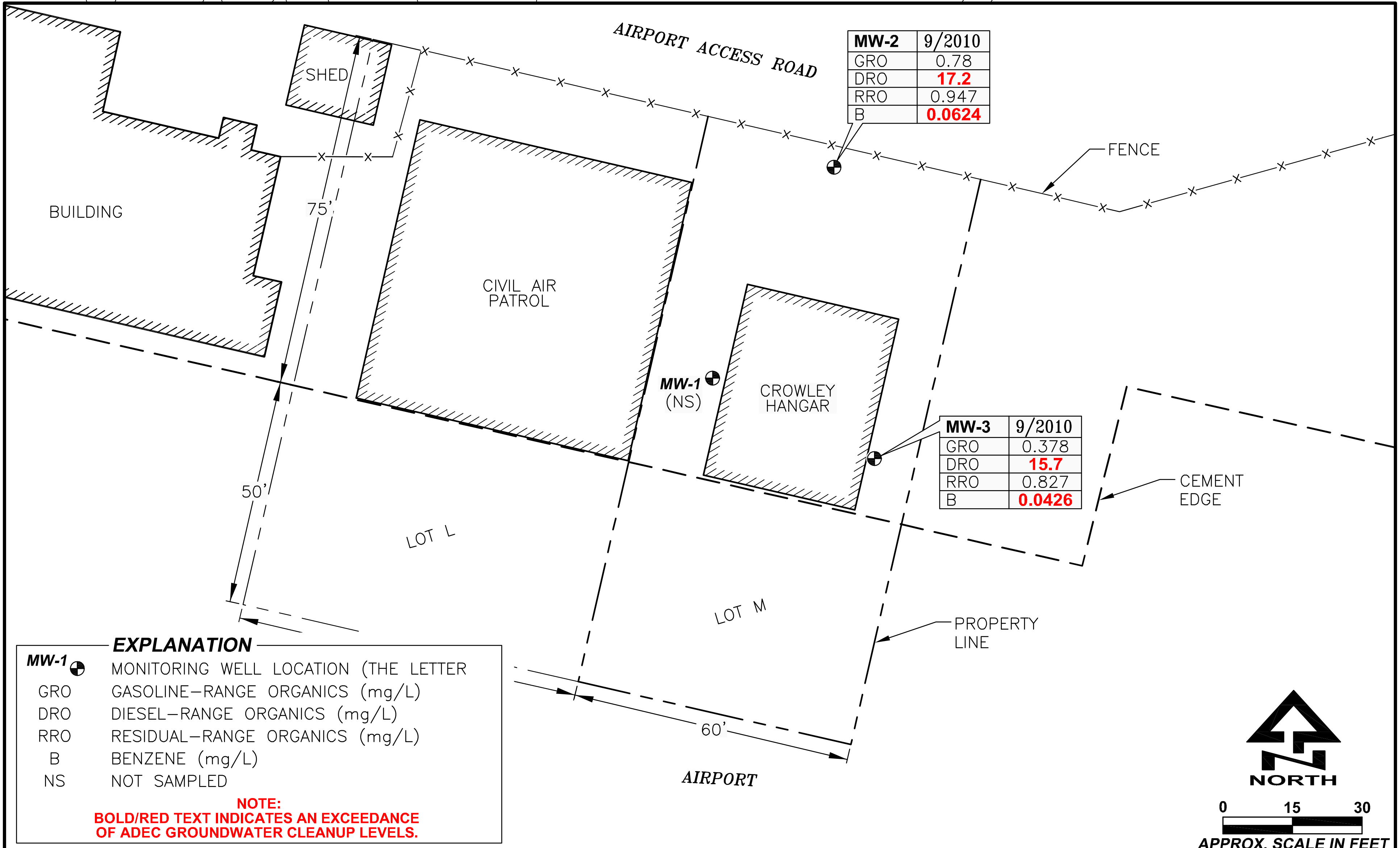
825 W. 8th Ave., Anchorage, AK 99501, (907) 258-4880

2010 GROUNDWATER ELEVATIONS

KOTZEBUE LOT M HANGAR
2010 GROUNDWATER CHARACTERIZATION REPORT
CROWLEY MARITIME CORPORATION
Kotzebue, Alaska

FIGURE
5

PATH: V:\Project Drawings\Crowley\Kotz\2010 Kotz\10 Kot Gwm Rpt FILE: 465-012-KOT-GWM-RPT-F6.DWG PLOTTED: 1/12/11.



MW-2	9/2010
GRO	0.78
DRO	**17.2**
RRO	0.947
B	**0.0624**

MW-3	9/2010
GRO	0.378
DRO	**15.7**
RRO	0.827
B	**0.0426**

EXPLANATION

MW-1	MONITORING WELL LOCATION (THE LETTER
GRO	GASOLINE–RANGE ORGANICS (mg/L)
DRO	DIESEL–RANGE ORGANICS (mg/L)
RRO	RESIDUAL–RANGE ORGANICS (mg/L)
B	BENZENE (mg/L)
NS	NOT SAMPLED

NOTE:
BOLD/RED TEXT INDICATES AN EXCEEDANCE OF ADEC GROUNDWATER CLEANUP LEVELS.

oasis ENVIRONMENTAL

DATE: JAN. 2011
CHKD: M.A.P.
DRAWN: C.E.H.
PROJ. No.: 465–012

825 W. 8th Ave., Anchorage, AK 99501, (907) 258–4880

2010 GROUNDWATER ANALYTICAL RESULTS

KOTZEBUE LOT M HANGAR
2010 GROUNDWATER CHARACTERIZATION REPORT
CROWLEY MARITIME CORPORATION
Kotzebue, Alaska

FIGURE 6

APPENDIX A

Field Notes

- Page Intentionally Left Blank -

APPENDIX B

Photographic Log

- Page Intentionally Left Blank -

APPENDIX C

Borehole and Monitoring Well Installation Logs

- Page Intentionally Left Blank -

APPENDIX D

Survey Data/Map

- Page Intentionally Left Blank -

APPENDIX E

TestAmerica Analytical Results
ADEC Data Review Checklists

- Page Intentionally Left Blank -

APPENDIX F

ADEC Conceptual Site Model Human Health Scoping Form and Graphic

- Page Intentionally Left Blank -

Print Form

Human Health Conceptual Site Model
Scoping Form

Site Name: KOTZEBUE LOT M HANGAR

File Number: 410.38.026

Completed by: D.Frank; OASIS Environmental, Inc.

Introduction
The form should be used to reach agreement with the Alaska Department of Environmental Conservation (DEC) about which exposure pathways should be further investigated during site characterization. From this information, summary text about the CSM and a graphic depicting exposure pathways should be submitted with the site characterization work plan and updated as needed in later reports.

General Instructions: Follow the italicized instructions in each section below.

1. General Information:

Sources *(check potential sources at the site)*

- ☐ USTs
- ☐ ASTs
- ☒ Dispensers/fuel loading racks
- ☐ Drums
- ☒ Vehicles
- ☐ Landfills
- ☐ Transformers
- ☒ Other: migration from other nearby contaminated sites

Release Mechanisms *(check potential release mechanisms at the site)*

- ☒ Spills
- ☒ Leaks
- ☒ Direct discharge
- ☐ Burning
- ☐ Other:

Impacted Media *(check potentially-impacted media at the site)*

- ☐ Surface soil (0-2 feet bgs*)
- ☒ Subsurface soil (>2 feet bgs)
- ☒ Air
- ☐ Sediment
- ☒ Groundwater
- ☒ Surface water
- ☐ Biota
- ☐ Other:

Receptors *(check receptors that could be affected by contamination at the site)*

- ☐ Residents (adult or child)
- ☒ Commercial or industrial worker
- ☒ Construction worker
- ☐ Subsistence harvester (i.e. gathers wild foods)
- ☐ Subsistence consumer (i.e. eats wild foods)
- ☒ Site visitor
- ☐ Trespasser
- ☒ Recreational user
- ☐ Farmer
- ☐ Other:

* bgs - below ground surface

2. Exposure Pathways: *(The answers to the following questions will identify complete exposure pathways at the site. Check each box where the answer to the question is "yes".)*

a) Direct Contact -

1. Incidental Soil Ingestion

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site-specific basis.) ☒

If the box is checked, label this pathway complete: Complete

Comments:

2. Dermal Absorption of Contaminants from Soil

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site specific basis.) ☒

Can the soil contaminants permeate the skin (see Appendix B in the guidance document)? ☐

If both boxes are checked, label this pathway complete: Incomplete

Comments:

no contaminant is listed in Appendix B

b) Ingestion -

1. Ingestion of Groundwater

Have contaminants been detected or are they expected to be detected in the groundwater, or are contaminants expected to migrate to groundwater in the future? ☒

Could the potentially affected groundwater be used as a current or future drinking water source? Please note, only leave the box unchecked if DEC has determined the ground-water is not a currently or reasonably expected future source of drinking water according to 18 AAC 75.350. ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

Considered an insignificant pathway as it is not a reasonably expected future source of drinking water.

2. Ingestion of Surface Water

Have contaminants been detected or are they expected to be detected in surface water, or are contaminants expected to migrate to surface water in the future? ☒

Could potentially affected surface water bodies be used, currently or in the future, as a drinking water source? Consider both public water systems and private use (i.e., during residential, recreational or subsistence activities). ☐

If both boxes are checked, label this pathway complete: Incomplete

Comments:

surface water is salt water, not available as a drinking water source.

3. Ingestion of Wild and Farmed Foods

Is the site in an area that is used or reasonably could be used for hunting, fishing, or harvesting of wild or farmed foods? ☐

Do the site contaminants have the potential to bioaccumulate (see Appendix C in the guidance document)? ☐

Are site contaminants located where they would have the potential to be taken up into biota? (i.e. soil within the root zone for plants or burrowing depth for animals, in groundwater that could be connected to surface water, etc.) ☐

If all of the boxes are checked, label this pathway complete: Incomplete

Comments:

c) Inhalation-

1. Inhalation of Outdoor Air

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site specific basis.) ☒

Are the contaminants in soil volatile (see Appendix D in the guidance document)? ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

benzene

2. Inhalation of Indoor Air

Are occupied buildings on the site or reasonably expected to be occupied or placed on the site in an area that could be affected by contaminant vapors? (within 30 horizontal or vertical feet of petroleum contaminated soil or groundwater; within 100 feet of non-petroleum contaminted soil or groundwater; or subject to "preferential pathways," which promote easy airflow like utility conduits or rock fractures) ☒

Are volatile compounds present in soil or groundwater (see Appendix D in the guidance document)? ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

Considered insignificant due to poly liner lining the entire underside of the hanger.

3. **Additional Exposure Pathways:** *(Although there are no definitive questions provided in this section, these exposure pathways should also be considered at each site. Use the guidelines provided below to determine if further evaluation of each pathway is warranted.)*

Dermal Exposure to Contaminants in Groundwater and Surface Water

Dermal exposure to contaminants in groundwater and surface water may be a complete pathway if:

- o Climate permits recreational use of waters for swimming.
- o Climate permits exposure to groundwater during activities, such as construction.
- o Groundwater or surface water is used for household purposes, such as bathing or cleaning.

Generally, DEC groundwater cleanup levels in 18 AAC 75, Table C, are assumed to be protective of this pathway.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

ADEC indicates recreational use of surface water and potential impact to surface water based on pore-water groundwater sampling. Surface water at the site has not been evaluated against ADEC surface water criteria found in 18 AAC 70. Surface water has not been directly sampled. Future users of groundwater may use water for drinking or household purposes, although this is considered insignificant as groundwater at the site is not a reasonably expected future source.

Inhalation of Volatile Compounds in Tap Water

Inhalation of volatile compounds in tap water may be a complete pathway if:

- o The contaminated water is used for indoor household purposes such as showering, laundering, and dish washing.
- o The contaminants of concern are volatile (common volatile contaminants are listed in Appendix D in the guidance document.)

Generally, DEC groundwater cleanup levels in 18 AAC 75, Table C, are assumed to be protective of this pathway.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Groundwater is not used, but could be used. This pathway is considered insignificant because the actual use of groundwater at the site is not considered reasonable. Surface water is salt water and so an inhalation exposure pathway of violates in surface water as tap water is not complete.

Inhalation of Fugitive Dust

Inhalation of fugitive dust may be a complete pathway if:

- Nonvolatile compounds are found in the top 2 centimeters of soil. The top 2 centimeters of soil are likely to be dispersed in the wind as dust particles.
- Dust particles are less than 10 micrometers (Particulate Matter - PM_{10}). Particles of this size are called respirable particles and can reach the pulmonary parts of the lungs when inhaled.
- Chromium is present in soil that can be dispersed as dust particles of any size.

Generally, DEC direct contact soil cleanup levels in Table B1 of 18 AAC 75 are protective of this pathway because it is assumed most dust particles are incidentally ingested instead of inhaled to the lower lungs. The inhalation pathway only needs to be evaluated when very small dust particles are present (e.g., along a dirt roadway or where dusts are a nuisance). This is not true in the case of chromium. Site specific cleanup levels will need to be calculated in the event that inhalation of dust containing chromium is a complete pathway at a site.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

At Lot M, soil was not found to be impacted within the first two feet, eliminating the potential for ingestion by fugitive dust

Direct Contact with Sediment

This pathway involves people's hands being exposed to sediment, such as during some recreational, subsistence, or industrial activity. People then incidentally ingest sediment from normal hand-to-mouth activities. In addition, dermal absorption of contaminants may be of concern if the the contaminants are able to permeate the skin (see Appendix B in the guidance document). This type of exposure should be investigated if:

- Climate permits recreational activities around sediment.
- The community has identified subsistence or recreational activities that would result in exposure to the sediment, such as clam digging.

Generally, DEC direct contact soil cleanup levels in 18 AAC 75, Table B1, are assumed to be protective of direct contact with sediment.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

4. Other Comments *(Provide other comments as necessary to support the information provided in this form.)*

APPENDIX A

BIOACCUMULATIVE COMPOUNDS OF POTENTIAL CONCERN

Organic compounds are identified as bioaccumulative if they have a BCF equal to or greater than 1,000 or a log K_{ow} greater than 3.5. Inorganic compounds are identified as bioaccumulative if they are listed as such by EPA (2000). Those compounds in Table B-1 of 18 AAC 75.341 that are bioaccumulative, based on the definition above, are listed below.

Aldrin	DDT	Lead
Arsenic	Dibenzo(a,h)anthracene	Mercury
Benzo(a)anthracene	Dieldrin	Methoxychlor
Benzo(a)pyrene	Dioxin	Nickel
Benzo(b)fluoranthene	Endrin	PCBs
Benzo(k)fluoranthene	Fluoranthene	
Cadmium	Heptachlor	Pyrene
Chlordane	Heptachlor epoxide	Selenium
Chrysene	Hexachlorobenzene	Silver
Copper	Hexachlorocyclopentadiene	Toxaphene
DDD	Indeno(1,2,3-c,d)pyrene	Zinc
DDE		

Because BCF values can relatively easily be measured or estimated, the BCF is frequently used to determine the potential for a chemical to bioaccumulate. A compound with a BCF greather than 1,000 is considered to bioaccumulate in tissue (EPA 2004b).

For inorganic compounds, the BCF approach has not been shown to be effective in estimating the compound's ability to bioaccumulate. Information available, either through scientific literature or site-specific data, regarding the bioaccumulative potential of an inorganic site contaminant should be used to determine if the pathway is complete.

The list was developed by including organic compounds that either have a BCF equal to or greater than 1,000 or a log K_{ow} greater than 3.5 and inorganic compounds that are listed by the United States Environmental Protection Agency (EPA) as being bioaccumulative (EPA 2000).

The list was developed by including organic compounds that either have a BCF equal to or greater than 1,000 or a log K_{ow} greater than 3.5 and inorganic compounds that are listed by the United States Environmental Protection Agency (EPA) as being bioaccumulative (EPA 2000). The BCF can also be estimated from a chemical's physical and chemical properties. A chemical's octanol-water partitioning coefficient (K_{ow}) along with defined regression equations can be used to estimate the BCF. EPA's Persistent, Bioaccumulative, and Toxic (PBT) Profiler (EPA 2004) can be used to estimate the BCF using the K_{ow} and linear regressions presented by Meylan et al. (1996). The PBT Profiler is located at http://www.pbtprofiler.net/. For compounds not found in the PBT Profiler, DEC recommends using a log K_{ow} greater than 3.5 to determine if a compound is bioaccumulative.

APPENDIX B

VOLATILE COMPOUNDS OF POTENTIAL CONCERN

A chemical is identified here as sufficiently volatile and toxic for further evaluation if the Henry's Law constant is 1 x 10^{-5} atm-m^3/mol or greater, the molecular weight is less than 200 g/mole (EPA 2004a), and the vapor concentration of the pure component posed an incremental lifetime cancer risk greater than 10^{-6} or a non-cancer hazard quotient of 0.1, or other available scientific data indicates the chemical should be considered a volatile. Chemicals that are solid at typical soil temperatures and do not sublime are generally not considered volatile.

Acetone	Mercury (elemental)
Benzene	Methyl bromide (Bromomethane)
Bis(2-chloroethyl)ether	Methyl chloride (Chloromethane)
Bromodichloromethane	Methyl ethyl ketone (MEK)
Bromoform	Methyl isobutyl ketone (MIBK)
n-Butylbenzene	Methylene bromide
sec-Butylbenzene	Methylene chloride
tert-Buytlbenzene	**1-Methylnaphthalene**
Carbon disulfide	**2-Methylnaphthalene**
Carbon tetrachloride	Methyl *tert*-butyl ether (MTBE)
Chlorobenzene	**Naphthalene**
Chlorodibromomethane (Dibromochloromethane)	Nitrobenzene
Chloroethane	n-Nitrosodimethylamine
Chloroform	**n-Propylbenzene**
2-Chlorophenol	**Styrene**
1,2-Dichlorobenzene	1,1,2,2-Tetrachlorethane
1,3-Dichlorobenzene	Tetrachloroethylene (PCE)
1,4-Dichlorobenzene	**Toluene**

Dichlorodifluoromethane	1,2,4-Trichlorobenzene
1,1-Dichloroethane	1,1,1-Trichloroethane
1,2-Dichloroethane	1,1,2-Trichloroethane
1,1-Dichloroethylene	Trichloroethane
cis-1,2-Dichloroethylene	2,4,6-Trichlorophenol
trans-1,2-Dichloroethylene	1,2,3-Trichloropropane
1,2-Dichloropropane	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)
1,3-Dichloropropane	Trichlorofluoromethane (Freon-11)
Ethylbenzene	**1,2,4-Trimethylbenzene**
Ethylene dibromide (1,2-Dibromoethane)	**1,3,5-Trimethylbenzene**
Hexachlorobenzene	Vinyl acetate
Hexachloro-1,3-butadiene	Vinyl chloride (Chloroethene)
Hexachlorocyclopentadiene	**Xylenes (total)**
Hexachloroethane	GRO (see note 3 below)
Hydrazine	DRO (see note 3 below)
Isopropylbenzene (Cumene)	RRO (see note 3 below)

Notes:

1. Bolded chemicals should be investigated as volatile compounds when petroleum is present. If fuel containing additives (e.g., 1,2-dichloroethane, ethylene dibromide, methyl *tert*-butyl ether) were spilled, these chemicals should also be investigated.
2. If a chemical is not on this list, and not in Tables B of 18 AAC 75.345, the chemical has not been evaluated for volatility. Contact the ADEC risk assessor to determine if the chemical is volatile.
3. At this time, ADEC does not require evaluation of petroleum ranges GRO, DRO, or RRO for the indoor air inhalation (vapor intrusion) pathway.