



June 4, 2018

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ATTN: Laura Jacobs
Project Manager

**RE: 2017 Groundwater Monitoring and IAQ Assessment
578 Canoro Road, North Pole, Alaska**

◆
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NORTECH Environmental Engineering, Health & Safety (NORTECH) is pleased to provide the following 2017 field activities update to the ongoing release investigation at 578 Canoro Road in North Pole, Alaska. The following is a brief synopsis of the background, scope of work, methodology, field activities, sampling results with discussion including conclusions and recommendations.

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Groundwater/drinking water sampling was performed on May 16, 2017. Work included collecting groundwater parameters, and collecting analytical samples from four groundwater wells and the residence's drinking water. Figures 1 and 2 show the Site location in North Pole, Alaska. Figure 3 shows the locations of the Site monitoring wells and drinking water well.

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Table 1 summarizes drinking water results since 2008. Table 2 summarizes groundwater laboratory results and field duplicate quality control results for the 2017 event. Table 3 is a summary of historical results, including this event. Copies of the 2017 laboratory report and Alaska Department of Environmental Conservation (ADEC) Laboratory Data Review Checklist are also attached.

Background

A more detailed history of Site activities can be found in previous reports, specifically the March 16, 2007 and March 24, 2008 Characterization Reports, and update letters dated June 25, 2010 and September 28, 2012. The release occurred in late November 2006, when approximately 470 gallons of heating oil was inadvertently delivered (under pressure) into the Site's drinking water well. About 250 to 300 gallons of fuel was reportedly recovered. A large diameter recovery well was installed adjacent to the impacted well. All contaminated soil above the groundwater smear zone was removed during excavation for the recovery well installation. A temporary holding tank and replacement water system were installed to provide water for the house distribution system after the system was cleaned, flushed and tested. Laboratory results indicated the system met ADEC drinking water standards.

NORTECH conducted initial Site characterization efforts between November 2006 and March 2007 including installing seven groundwater monitoring wells. Characterization indicated the hydraulic gradient was generally west across the Site, but the heating oil appeared to be moving east. A March 2008 aquifer characterization indicated petroleum migration was controlled by confining layers sloping upward towards the north and east. A well search identified six nearby residential wells located down-



gradient. The wells were tested for drinking water standards with results indicating no wells were impacted by the release at 578 Canoro Road. No additional sampling of the off-site drinking water wells was recommended.

The 2008 report indicated free product recovery efforts focus in the vicinity of monitoring well SW5. In addition, several new shallow monitoring wells were installed to complete the delineation of dissolved benzene contamination. The shallow wells were installed east and south of the garage, including three new wells on adjacent property 580 Orion Drive. A new drinking water well was installed approximately 75 northeast of the residence in 2009. The drinking water well is screened at a depth of approximately 65 feet due to frozen silt below this depth. Subsequent periodic testing confirmed this well was not contaminated.

In January 2011, analytical samples were collected from 12 monitoring wells: SW1 through SW9, DW1, FRW2 and DW2. Most wells met the ADEC cleanup levels or suggested a decreasing trend. In March 2011, upgradient adjacent wells SW5 and FRW2 were re-sampled to ensure January 2011 results accurately reflected SW5 testing positive for contamination and FRW2 non-detect. During March re-sampling, a video inspection confirmed both wells are screened at the top of the water table, representing shallow groundwater at the same elevation only a few feet apart.

In March 2012, **NORTECH** collected analytical samples from 12 monitoring wells: SW1 through SW9, DW1, DW2 and FWR2. Each well met the ADEC cleanup levels, except SW5 which also had a decreasing trend. The former drinking water well (DWW) and culvert recovery well (CRW1) were frozen during each sampling event and samples were not collected.

In September 2012, **NORTECH** completed a report that included data from the 2011 and 2012 sampling events. The results indicated a continual decline and/or stabilization in the dissolved phase contaminant concentrations across the Site. The drinking water system was also sampled with results showing the new Site drinking water well remains clean and usable. A trend analysis of the existing groundwater sampling data (2007 through 2012) showed a significant decline in contaminant concentrations across the Site.

The 2012 report detailed the ongoing discrepancy in contaminant concentrations between SW5 (one of the original shallow direct push wells) and FRW2 (a 4" diameter, 30-foot deep well installed for product recovery). These two wells are located a few feet apart. FRW2 was installed in 2008 to more efficiently collect the free product observed in SW5. FRW2 has not had free product or exceeded the ADEC cleanup level for any contaminant of concern (COC) since installation, while SW5 has exceeded the cleanup level for some contaminants over this same period. While SW5 has shown a steady decline in contaminant concentrations since 2008, the 2012 report detailed the rationale for using the clean FRW2 data instead of the decreasing SW5 trend data for site closure evaluation due to differences in well construction and installation.

Scope of Work and Objectives

ADEC provided a letter dated November 10, 2016 outlining the data necessary to evaluate the site for closure. Based on this request **NORTECH** developed the March 2017 work plan which outlined the following activities:

- Complete groundwater sampling of SW5, FRW2, DW2, and DWW
- Sample the domestic drinking water well.



- Conduct an indoor air quality screening of the home including occupied areas, the crawlspace, garage, and outdoor air
- Report of the groundwater sampling and the IAQ assessment and evaluating the site results using ADEC's closure guidance in the context of obtaining Site closure.

Methodology

Field personnel completed groundwater sampling in general accordance with this work plan, the ADEC Field Sampling Guidance, dated March 2016 (FSG), and **NORTECH's** Lab Sampling Plan v4. Indoor air quality screening followed ADEC's 2017 Vapor Intrusion Guidance and **NORTECH's** IAQ sampling methodology. As specified in the Vapor Intrusion Guidance, a building survey (Appendix I of the Vapor Intrusion Guidance) was completed prior to the IAQ assessment.

ADEC established new groundwater cleanup levels in January 2017. The contaminants of concern (COCs) in heating oil that are affecting this site are listed in the table below:

Contaminant of Concern	2008 Cleanup levels (mg/L)	January 2016 Cleanup levels (mg/L)
Benzene	0.005	0.0046
Toluene	1.00	1.10
Ethylbenzene	0.700	0.015
Total Xylenes	10.0	0.190
Diesel Range Organics (DRO)	1.5	1.5

Field Activities

Drinking Water Sampling

The drinking water softening system was purged through the hose bib in the garage until the temperature stabilized. One primary and one duplicate were collected from this hose bib located prior to the water softening and filter equipment. Samples were submitted to SGS Environmental Services (SGS) field office in Fairbanks, Alaska and analyzed at the SGS laboratory in Anchorage, Alaska. for volatile organic compounds (VOCs) analysis by EPA Method 524.2. Laboratory results are summarized in Table 1 and are discussed in results below.

Groundwater Sampling

Each well was checked for free product using an interface probe and no free product was measured. Depth to water was measured to calculate total water volume in each well. Three to five well volumes of water from each well were purged using a Geotech peristaltic pump. During purging, water quality parameters were measured using a YSI Multi meter sensor by filling a flow-through cell connected to the pump outlet tubing. The sensor was placed in the cell and recorded conductivity, temperature, pH, dissolved oxygen, reduction/oxidation potential, and turbidity. These parameters were recorded in the field book as each well volume was purged to determine when groundwater conditions had stabilized sufficiently to collect analytical samples.

As with previous sampling events, analytical samples were collected using a peristaltic pump at a reduced flow rate to prevent entrainment of bubbles or other quality control concerns. Based on the number of samples, one field duplicate was collected for quality control purposes. Water samples were hand delivered to SGS for analyses of diesel range organics (DRO) by Method AK 102, and benzene, toluene, ethylbenzene, and total xylenes (BTEX) by EPA Method SW8021B. Laboratory results are summarized in Table 2 and discussed below.



Indoor Air Quality Assessment

A parts per billion (ppb) calibrated ppbRAE PID was used to assess air total volatile organic compounds (tVOCs) in the crawlspace, garage and occupied areas of the home. The ppbRAE was calibrated using outside ambient air as zero and 10 parts per million isobutylene gas as the span.

The crawlspace had the lowest reading in the structure at 42 ppb. The garage reading was 290 ppb and was used to store a motorcycle, gas, and other typical garage items that produce tVOCs. The kitchen and lower bathroom readings ranged from 340 to 350 ppb. The second floor loft and bedrooms ranged from 339 to 350 ppb. The crawlspace measurement was collected by lowering the ppbRAE two feet into the crawlspace with the hatch remaining open. After calibration, the ambient outside air reading fluctuated from 0 to 9 ppb. No petroleum odor was observed in any spaces in the house. No analytical air samples were collected due to near ambient background crawlspace results.

The air quality assessment and interview indicated that the residence has a heat recovery ventilation (HRV) unit that is never used. The initial assessment was performed with this unit off. To evaluate the potential impacts from the use of this unit, it was turned on and was operated for one hour. After one hour, the kitchen reading decreased to 154 ppb.

Results with Discussion

Drinking Water Sampling

The 2017 results and previous results from the drinking water well are shown in Table 1. No BTEX compound was detected during this sampling event. Chloromethane was not detected in the primary sample but was detected in the duplicate sample well below the ADEC cleanup level.

The drinking water well has been tested eight times since it was installed in 2008. No evidence of BTEX compounds or other contaminants related to the 2006 petroleum release has been observed. This is a COC not related to the heating oil release and is not considered a risk to individuals that use the water. Drinking water sampling is no longer considered necessary as outlined below in the recommendation for Site closure.

2017 Groundwater Characterization

The 2017 analytical results are summarized in Table 2 along with the field duplicate quality control summary. A summary of the historical results for each well is presented in Table 3. Both tables show the previous and current groundwater cleanup levels. The well locations and benzene concentrations are shown in Figure 4. Copies of the laboratory analytical report and the ADEC Laboratory Data Review Checklist (LDRC) are attached to this report.

The 2017 sampling event indicates benzene and DRO concentrations in SW5 have decreased and are now below ADECs cleanup levels, which in the case of benzene have become more stringent. However, ethylbenzene and xylene levels now exceed the new lower ADEC cleanup levels despite a 50 percent decrease in concentrations. Each COC shows a significant decreasing trend since monitoring began.

Few other COCs were detected in these samples. Ethylbenzene and xylenes were detected in DWW at concentrations below the cleanup levels. No COCs were detected in and DW2 or FRW2, adjacent to SW5, in this sampling event.



Overall, analysis of the BTEX and DRO data through 2017 indicated that COC concentrations have decreased. The 14 groundwater monitoring wells show decreasing trends, meet 2016 updated ADEC cleanup levels or are less than the LOQ for BTEX compounds except for SW5. Data obtained from the 2017 effort show the current conditions met the pre-2016 cleanup levels. This data also indicates the remaining contamination in SW5 is not representative of groundwater conditions which was discussed in greater detail below.

QA/QC Results and Discussion

Two field duplicate sample pairs were collected and submitted blind to the laboratory. The primary and duplicate sample pair results were used to calculate the relevant percent difference (RPD). The RPD results for each duplicate pair are shown at the bottom of the respective summary Table 1 (drinking water) and Table 2 (groundwater). ADEC considers an acceptable RPD in a groundwater duplicate pair at 30% or less. If a compound was not detected in either sample, the RPD was not calculated. Non-detect results were reviewed to verify a comparable order of magnitude.

The duplicate pairs for the groundwater and drinking water samples met RPD goals, as RPD was not calculable because the samples were non-detect for each compound. **NORTECH** also reviewed the laboratory reports for other quality control issues using the ADEC Laboratory Data Review Checklist. A review of the reports did not identify any concerns that affect data usability for closure as described in this report. The checklist is included as an attachment with the laboratory report.

SW5 and FRW2 Evaluation

SW5 and FRW2 are located approximately five feet apart on the eastern side of the Site. As indicated above, SW5 was expected to be an upgradient well but free product was encountered during installation. Further aquifer characterization indicated this was due to subsurface characteristics within the saturated zone that led the petroleum to migrate horizontally while floating to the surface from the release location. FRW2 was screened for approximately 30 feet to recover product from any contaminated depth in the SW5 area. However, free product was never observed in FRW2. Dissolved contaminant concentrations have never exceeded the ADEC cleanup levels in FRW2 and no contaminants have been detected since 2009.

The 2011 sampling event was the first event in which SW5 was the only well that exceeded ADEC cleanup levels. At that time, adjacent well FRW2 was non-detect for all contaminants. Combined with concentration differences from earlier sampling events, this data suggested samples from these wells may have been from different elevations in the aquifer. A video inspection indicated both wells are screened across the top of the water table. Results in both wells were confirmed by resampling in March 2011, as well as results from March 2012 and March 2013.

The September 2012 report provides a detailed analysis of the construction and material differences between these wells. This analysis concluded the FRW2 data is more likely representative of aquifer conditions than the SW5 data due to differences in well construction and installation. The 2012 report recommended decommissioning of SW5 and removing the SW5 data from the data set to evaluate the potential for Site closure. The 2013 and 2017 data shows contaminant concentrations in SW5 continuing to decrease while no COCs are present above the detection limits in FRW2.

The 2017 results in SW5 would have met cleanup levels in place from the time of the release until late 2016. These results show a continual decrease for each COC, including an approximately 50% decrease for the two BTEX compounds that exceed the revised cleanup



levels. While the decreasing SW5 results are part of a long term positive trend in this well, the continued discrepancy between SW5 and FRW2 provides further support for discontinuing evaluation of data from SW5. Overall, the SW5 data is considered less representative than the FRW2 data that provides a clear rationale for closure of the Site.

Indoor Air Quality Assessment

A parts per billion (ppb) calibrated PID was used to assess air quality in the crawlspace and occupied areas of the home. The slightly elevated results observed in the home were due to cooking and other typical activities performed in an occupied home with no active mechanical ventilation. The crawlspace of this structure should have the highest concentrations of VOCs if vapor intrusion from a heating oil release was occurring. However, the crawlspace reading of 42 ppb was the lowest within the structure and was likely biased high because the crawlspace hatch was opened to the kitchen air. The operation of the mechanical ventilation system acted to lower the ppb concentration, most likely due to removal of cooking vapors. These results indicate that petroleum impacts to indoor air were not present at the time of the inspection. No further assessment of indoor air quality through screening or analytical sampling is recommended.

Conclusions and Recommendations

NORTECH has completed the scope of work requested by ADEC to facilitate the evaluation of this Site for closure. Based on the review of this data and the historical data for the Site, **NORTECH** has developed the following Site conclusions and recommendations:

On-Site Drinking Water Well Testing

- Drinking water results indicate released contaminants have not impacted the new drinking water well in the nine years since the well was installed
- Periodic drinking water well testing is no longer necessary

Groundwater Characterization

- Groundwater data from 2007 through 2017 show a significant decline in contaminant concentrations across the Site
 - Perimeter and downgradient wells were not sampled in 2017 after meeting the ADEC cleanup levels from 2011 through 2013
 - The wells within the release area meet the ADEC cleanup levels except for SW5
- SW5 meets the DRO and benzene cleanup levels for the first time
 - Ethylbenzene and xylenes are above the revised cleanup levels, despite decreasing approximately 50% since 2013
 - Each COC shows a decreasing trend since installation
- The 4" well FRW2 adjacent to SW5, remains non-detect for each COC
 - No COCs have been detected in the FRW2 since October 2009
 - FRW2 is believed to be more representative of this location based on well construction materials and methods
 - The groundwater data provides direct evidence that the site meets the cleanup objectives

Indoor Air Quality

- No evidence of petroleum odors has been reported in the house since the release
- Screening of the residence at the parts per billion (ppb) level showed no evidence of vapor intrusion from this release in the crawlspace
- The inhalation of indoor air pathway is incomplete



Project Management Recommendations

- Based on the letter from ADEC requesting this work, the observed site conditions indicate the Site qualifies for closure
- This report should be submitted to ADEC with a request for closure
- A decommissioning plan should be developed to document the planned removal of the monitoring wells, recovery wells, and the original drinking water well

Please contact either of the undersigned at your earliest convenience if you have any questions about the data presented in the report or the Site in general.

Sincerely,
NORTECH

Doug Dusek,
Environmental Specialist

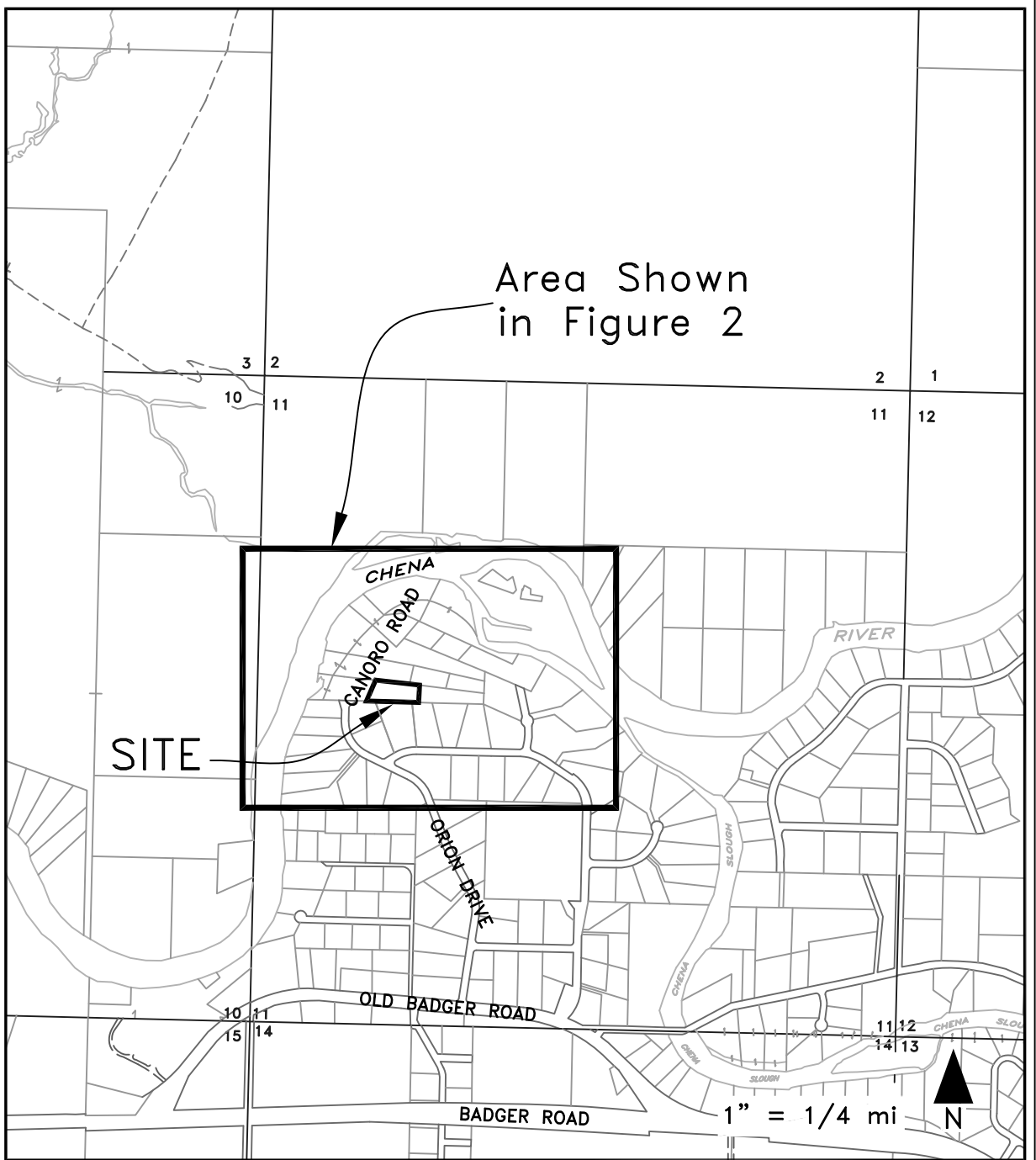
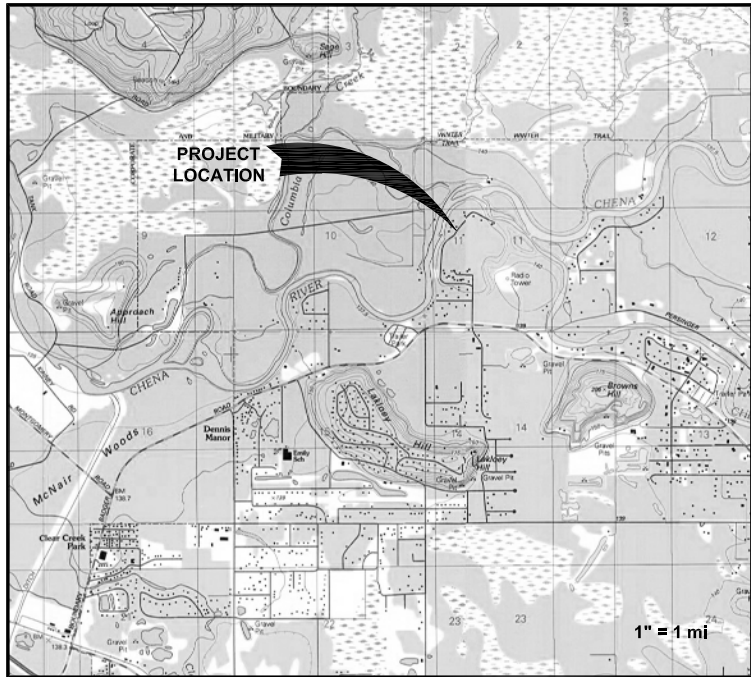
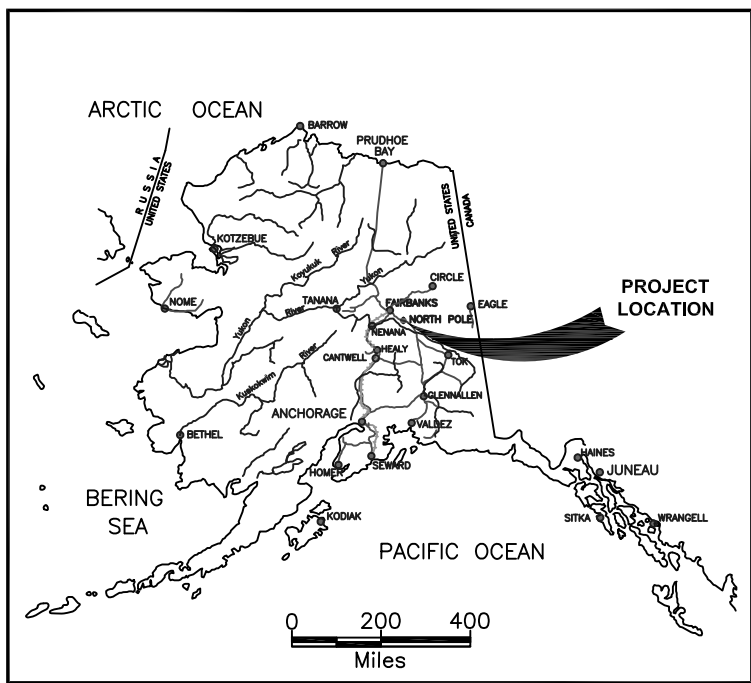
Peter Beardsley, PE
Principal, Environmental Engineer

Attachments:

Figure 1	Location Map
Figure 2	Vicinity Map
Figure 3	Site Location Map
Figure 4	Site Map
Table 1	May 2017 and Historical Drinking Water Results – Detected Analyses
Table 2	Groundwater Results – March 30, 2013
Table 3	Groundwater Results – Historical Summary

Laboratory Reports and Lab Quality Checklists
Standardized Methodologies

Attachment 1



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 5438 Shaune Dr., Juneau, Alaska 99801 907-586-6813

Location Map
 578 Canoro Road
 North Pole, Alaska

DATE: 11/27/2017	SCALE: As Shown
DESIGN: PLB	PROJECT: 06-1080
DRAWN: PLB	DWG: 061080i(01)

FIGURE
 1

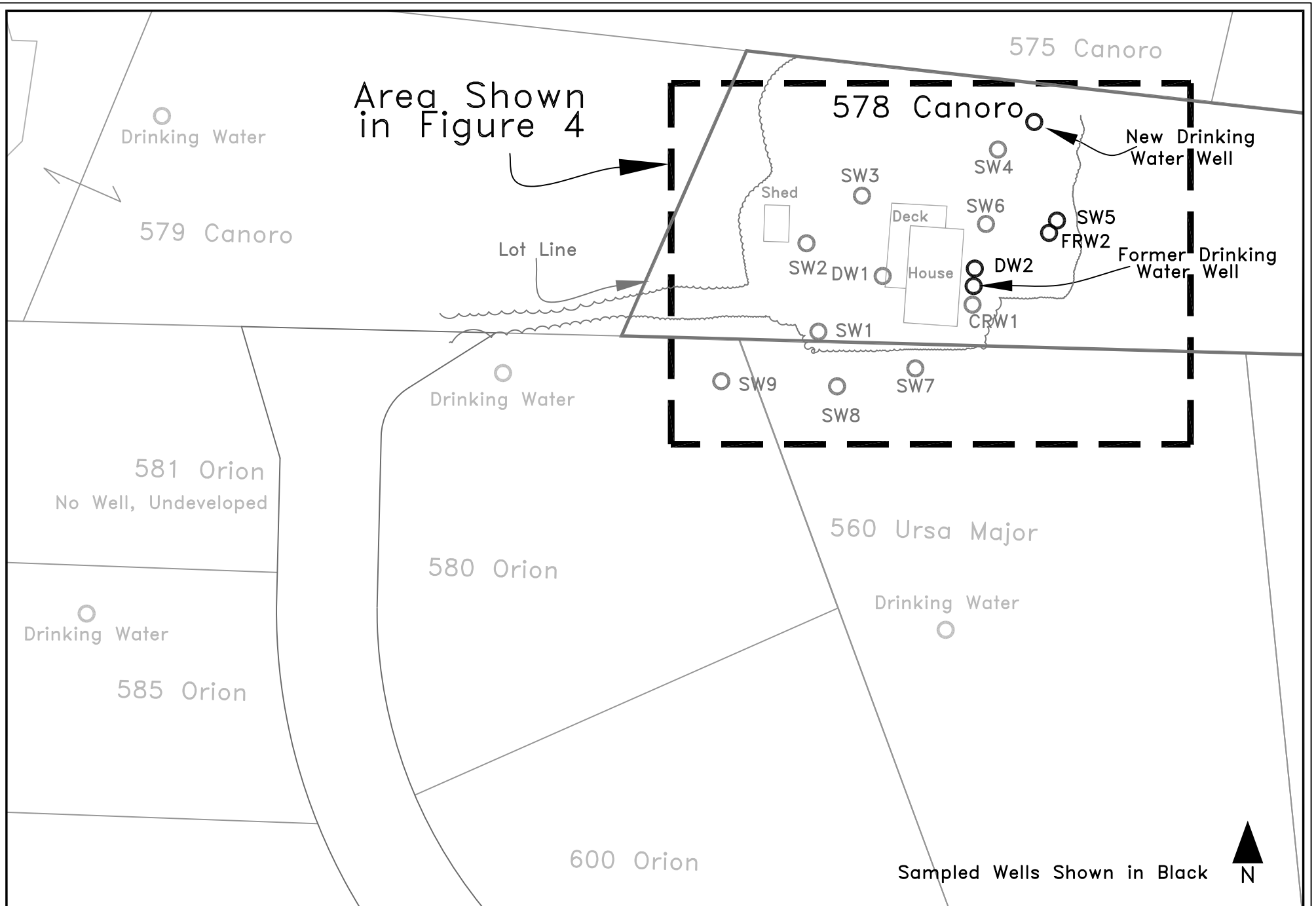


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 5438 Shaune Dr., Juneau, Alaska 99801 907-586-6813

Vicinity Map
 578 Canoro Road
 North Pole, Alaska

DATE: 11/27/2017	SCALE: 1" = 300'
DESIGN: PLB	PROJECT: 06-1080
DRAWN: PLB	DWG: 061080i(02)

FIGURE
 2



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Nearby Properties and Drinking Water Wells
 578 Canoro Road
 North Pole, Alaska

DATE: 11/27/2017

SCALE: 1" = 75'

DESIGN: PLB

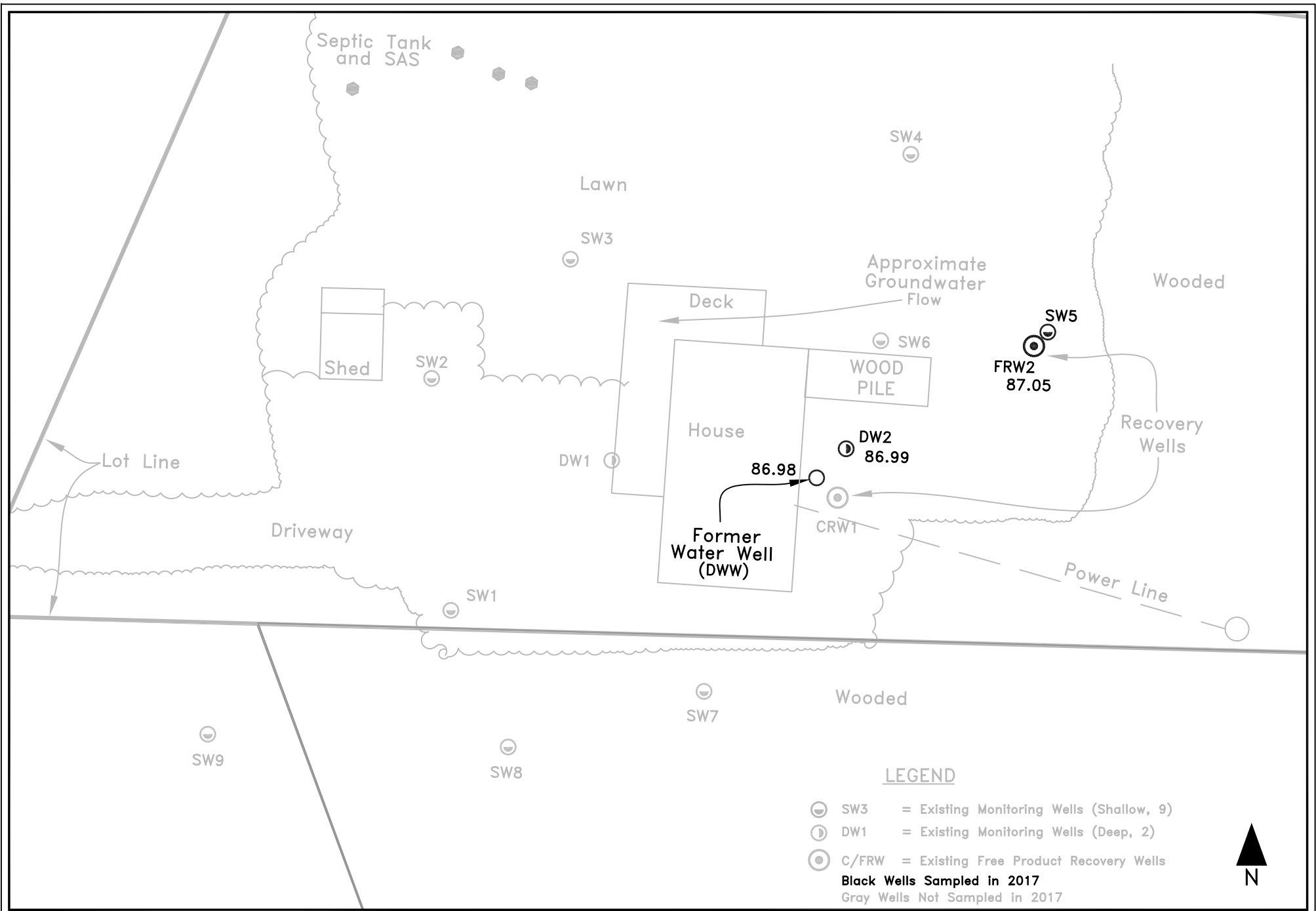
PROJECT: 06-1080

DRAWN: PLB

DWG: 061080i(03)

FIGURE

3



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2017 Sample Locations and Groundwater Elevations
 578 Canoro Road
 North Pole, Alaska

DATE: 11/27/2017	SCALE: 1" = 30'
DESIGN: PLB	PROJECT: 06-1080
DRAWN: PLB	DWG: 061080i(04)

FIGURE
 4

Attachment 2

Table 1
May 2017 and Historical Drinking Water Results - Detected Analytes

Sampling Date	Sample ID	Benzene	Toluene	Ethyl-benzene	Total Xylenes	Chloro-methane
	Units	mg/L	mg/L	mg/L	mg/L	mg/L
2016 ADEC Cleanup Limits		0.0046	1.10	0.015	0.190	0.190
Pre-2016 ADEC Cleanup Limits		0.005	1.0	0.7	10	0.066
3/8/2008	BALL-DWW-1	0.0005U	0.0005U	0.0005U	0.001U	0.0005U
3/8/2008	BALL-DWW-2*	0.0005U	0.0005U	0.0005U	0.001U	0.0005U
4/8/2008	[BALL-]DW-01	0.000440J	0.00183J	0.000150J	0.000800J	0.0005U
4/8/2008	[BALL-]DW-02*	0.00063	0.00268	0.000210J	0.000940J	0.000220J
6/3/2008	BALL-DWW1	0.0005U	0.0005U	0.0005U	0.001U	0.0005U
6/3/2008	BALL-DWW2*	0.0005U	0.0005U	0.0005U	0.001U	0.0005U
9/18/2008	BALL-DWW1	0.0005U	0.0005U	0.0005U	0.001U	0.0005U
9/18/2008	BALL-DWW2*	0.0005U	0.0005U	0.0005U	0.001U	0.0005U
1/28/2011	IN1	0.0005U	0.00082	0.0005U	0.001U	0.0005U
1/28/2011	IN2*	0.0005U	0.00071	0.0005U	0.001U	0.0005U
3/23/2012	NDW1	0.0005U	0.00059	0.0005U	0.001U	NA
3/23/2012	NDW2*	0.0005U	0.00067	0.0005U	0.001U	NA
3/30/2013	TW1	0.0005U	0.00186	0.0005U	0.00063	0.0005U
3/30/2013	TW2*	0.0005U	0.00127	0.0005U	0.001U	0.0005U
5/16/2017	DWW1	0.0005U	0.0005U	0.0005U	0.001U	0.0005U
5/16/2017	DWW2*	0.0005U	0.0005U	0.0005U	0.001U	0.004

Notes:

- U Analyte not detected at the listed detection limit
 Shade Analyte detected in concentration below the ADEC Cleanup level
 X.XX U Analyte(s) not detected at specified limit of quantitation (LOQ)
 X.XX J Measured concentration below LOQ, value estimated by laboratory
 * Blind duplicate sample
 NA Not Analyzed

Duplicate Pair Quality Control Summaries - 2013 Samples

Sample ID	DWW1	DWW2*	Average	Difference	RPD
Analyte	mg/L	mg/L	mg/L	mg/L	%
B	ND	ND	NA	NA	NA
T	ND	ND	NA	NA	NA
E	ND	ND	NA	NA	NA
X	ND	ND	NA	NA	NA

Notes:

- NA The calculation is not applicable.
 RPD Relative percent difference as described in the lab data review checklist
 ND Analyte not detected

Table 2
Groundwater Results - May 5, 2017

Sample ID	Benzene	Toluene	Ethyl-benzene	Total Xylenes	DRO
Units	mg/L	mg/L	mg/L	mg/L	mg/L
Pre-2016 ADEC Limits	0.005	1.0	0.7	10	1.5
2016 ADEC Limits	0.0046	1.10	0.015	0.190	1.5
SW5	0.001	0.001	0.163	0.656	1.47
DW2	0.0005U	0.0010U	0.0010U	0.0020U	0.588U
DWW	0.0005U	0.0010U	0.002	0.004	0.566U
FRW1 Dup of FRW2	0.0005U	0.0010U	0.0010U	0.002U	0.556U
FRW2	0.0005U	0.001U	0.001U	0.002U	0.556U

Notes:

DRO

Diesel range organics

U

Analyte not detected at the listed limit of quantitation (LOQ)

Shade

Analyte detected in concentration below the 2016 ADEC Cleanup level

Bold

Analyte detected at concentration exceeding the ADEC Cleanup level

2017 Quality Control Summary

Sample ID	FRW1	FRW2	RPD
Analyte	mg/L	mg/L	%
B	ND	ND	NA
T	ND	ND	NA
E	ND	ND	NA
X	ND	ND	NA
DRO	ND	ND	NA

Notes:

NA

The calculation is not applicable.

ND

Analyte not detected

RPD

Relative percent difference

Table 3
Groundwater Results - Historical Summary

Well ID	Date	Benzene	Toluene	Ethyl-benzene	Total Xylenes	DRO
Units		mg/L	mg/L	mg/L	mg/L	mg/L
ADEC Limits 2016		0.0046	1.1	0.015	0.19	1.5
ADEC Limits Pre-2016		0.005	1	0.7	10	1.5
DW1	Feb-07	0.0005U	0.00245	0.002U	0.00813	0.319U
	Jul-07	0.0005U	0.002U	0.002U	0.002U	0.324U
Dup Sample	Jul-07	0.0005U	0.002U	0.002U	0.002U	0.319U
	Aug-08	0.00741	0.0020U	0.00794	0.0059	0.400U
	Nov-08	0.000798	0.0020U	0.00209	0.0040U	0.357U
	Oct-09	0.00589	0.0020U	0.0237	0.0160	0.769U
	Jan-11	0.00102	0.0020U	0.002U	0.00209	0.714U
	Mar-12	0.0005U	0.0010U	0.0010U	0.0030U	0.0006U
	Mar-13	0.0005U	0.0010U	0.0010U	0.0020U	0.706U
Sampling Discontinued	May-17	NT	NT	NT	NT	NT
DW2	Feb-07	0.117	0.698	0.269	1.639	15.0
Field Duplicate	Feb-07	0.113	0.702	0.277	1.667	8.6
	Jul-07	0.0452	0.416	0.209	1.253	19.3
	Aug-08	0.00273	0.002U	0.022	0.06656	0.766
Field Duplicate	Aug-08	0.00283	0.00282	0.0202	0.06256	0.71
	Nov-08	0.0005U	0.00208	0.00752	0.01609	0.621
Field Duplicate	Nov-08	0.0005U	0.002U	0.00706	0.01548	0.637
	Oct-09	0.0005U	0.0020U	0.00518	0.0084	0.714U
Field Duplicate	Oct-09	0.0005U	0.0020U	0.00527	0.01081	0.784U
	Jan-11	0.0005U	0.0020U	0.00269	0.0079	2.24
	Mar-12	0.0005U	0.0010U	0.00147	0.00285	0.600U
	Mar-13	0.0005U	0.0010U	0.0010U	0.0020U	0.730
	May-17	0.0005U	0.0010U	0.0010U	0.0020U	0.588U
SW1	Feb-07	0.0005U	0.002U	0.002U	0.002U	0.326U
	Jul-07	0.00982	0.002U	0.00864	0.0550	0.333U
	Aug-08	0.00287	0.0020U	0.00895	0.00876	0.357U
Field Duplicate	Aug-08	0.00233	0.0020U	0.00736	0.00743	0.400U
	Nov-08	0.00938	0.0020U	0.0296	0.0258	0.357U
Field Duplicate	Nov-08	0.00866	0.002U	0.0283	0.0248	0.357U
	Oct-09	0.00397	0.0020U	0.0129	0.0121	0.714U
Field Duplicate	Oct-09	0.00504	0.002U	0.0194	0.0176	0.784U
	Jan-11	0.00164	0.0020U	0.00762	0.0040U	0.714U
	Mar-12	0.00081	0.0010U	0.0010U	0.0030U	0.600U
	Mar-13	0.0005U	0.0010U	0.0010U	0.0020U	0.600U
Sampling Discontinued	May-17	NT	NT	NT	NT	NT
SW2	Feb-07	0.0005U	0.002U	0.002U	0.002U	0.333U
	Jul-07	0.0005U	0.002U	0.002U	0.002U	0.324U
	Aug-08	0.00137	0.0020U	0.0020U	0.0040U	0.357U
	Nov-08	0.00485	0.0020U	0.0020U	0.0040U	0.357U
	Oct-09	0.00115	0.0020U	0.0020U	0.0040U	0.714U
	Jan-11	0.0005U	0.0020U	0.0020U	0.0040U	0.714U
	Mar-12	0.0005U	0.0010U	0.0010U	0.0030U	0.600U
	Mar-13	0.0005U	0.0010U	0.0010U	0.0020U	0.600U

Table 3
Groundwater Results - Historical Summary

Well ID	Date	Benzene	Toluene	Ethyl-benzene	Total Xylenes	DRO
Units		mg/L	mg/L	mg/L	mg/L	mg/L
ADEC Limits 2016		0.0046	1.1	0.015	0.19	1.5
SW3	Feb-07	0.0005U	0.002U	0.002U	0.002U	0.313U
	Jul-07	0.0005U	0.002U	0.002U	0.002U	0.313U
	Aug-08	0.000648	0.0020U	0.0020U	0.0040U	0.357U
	Nov-08	0.00327	0.0020U	0.0020U	0.0040U	0.357U
	Oct-09	0.00060	0.0020U	0.0020U	0.0040U	0.714U
	Jan-11	0.0005U	0.0020U	0.0020U	0.0040U	0.714U
	Mar-12	0.0005U	0.0010U	0.0010U	0.0030U	0.600U
	Mar-13	0.0005U	0.0010U	0.0010U	0.0020U	0.600U
Sampling Discontinued	May-17	NT	NT	NT	NT	NT
SW4	Feb-07	0.0005U	0.002U	0.002U	0.00238	0.326U
	Jul-07	0.0005U	0.002U	0.002U	0.002U	0.316U
	Aug-08	0.0005U	0.0020U	0.0020U	0.0040U	0.357U
	Nov-08	0.00350	0.0020U	0.00372	0.0040U	0.357U
	Oct-09	0.00142	0.0020U	0.00393	0.00339	0.769U
	Jan-11	0.00067	0.0020U	0.002U	0.00265	0.714U
	Mar-12	0.0005U	0.0010U	0.0010U	0.0030U	0.600U
	Mar-13	0.0005U	0.0010U	0.0010U	0.0020U	0.667U
Sampling Discontinued	May-17	NT	NT	NT	NT	NT
SW5	Feb-07	0.466	1.670	0.767	4.400	2320
	Jul-07	Not sampled due to free product depth (>0.03 feet)				
	Aug-08	0.00955	0.673	0.310	1.876	5.70
	Nov-08	0.0846	0.587	0.308	1.865	2.08
	Oct-09	0.0776	0.497	0.319	1.836	1.75
	Jan-11	0.0429	0.443	0.319	1.884	21.3
	Mar-11	0.0218	0.304	0.279	1.569	9.84
	Mar-12	0.0297	0.259	0.291	1.816	2.19
Field Duplicate	Mar-12	0.0294	0.257	0.288	1.804	2.18
	Mar-13	0.00917	0.0779	0.279	1.729	1.7
	May-17	0.00100	0.001	0.163	0.656	1.47
SW6	Aug-08	0.000939	0.0020U	0.0020U	0.00581	0.400U
	Nov-08	0.0170	0.0020U	0.0273	0.0833	0.385U
	Oct-09	0.00609	0.0020U	0.0659	0.0500	0.714U
	Jan-11	0.00477	0.0020U	0.0536	0.0596	0.714U
Field Duplicate	Jan-11	0.00484	0.0020U	0.054	0.0602	0.714U
	Mar-12	0.00109	0.0010U	0.0278	0.0265	0.600U
	Mar-13	0.0005U	0.0010U	0.021	0.023	0.667U
Sampling Discontinued	May-17	NT	NT	NT	NT	NT
SW7	Aug-08	0.0005U	0.0020U	0.0020U	0.0040U	0.400U
	Nov-08	0.000734	0.0020U	0.0020U	0.0040U	0.357U
	Oct-09	0.0005U	0.0020U	0.0020U	0.0040U	0.714U
	Jan-11	0.0005U	0.0020U	0.0020U	0.0040U	0.714U
	Mar-12	0.0005U	0.0010U	0.0010U	0.0030U	0.600U
Field Duplicate	Mar-12	0.0050U	0.0010U	0.0010U	0.0030U	0.600U
	Mar-13	0.0005U	0.0010U	0.0010U	0.0020U	0.600U
Sampling Discontinued	May-17	NT	NT	NT	NT	NT

Table 3
Groundwater Results - Historical Summary

Well ID	Date	Benzene	Toluene	Ethyl-benzene	Total Xylenes	DRO	
Units		mg/L	mg/L	mg/L	mg/L	mg/L	
ADEC Limits 2016		0.0046	1.1	0.015	0.19	1.5	
SW8	Aug-08	0.0005U	0.0020U	0.0020U	0.0040U	0.400U	
	Nov-08	0.00127	0.0020U	0.00897	0.00764	0.357U	
	Oct-09	0.0005U	0.0020U	0.00655	0.005710	0.714U	
	Jan-11	0.0005U	0.0020U	0.00322	0.0040U	0.714U	
	Mar-12	0.0005U	0.0010U	0.0010U	0.0030U	0.600U	
	Mar-13	0.0005U	0.0010U	0.0010U	0.0020U	0.600U	
Sampling Discontinued	May-17	NT	NT	NT	NT	NT	
SW9	Aug-08	0.00848	0.0020U	0.00901	0.0523	0.513U	
	Nov-08	0.00730	0.0020U	0.0153	0.01893	0.357U	
	Oct-09	0.00353	0.0020U	0.0211	0.0135	0.769U	
	Jan-11	0.00179	0.0020U	0.0122	0.0040U	0.714U	
	Field Duplicate	Jan-11	0.00184	0.0020U	0.0125	0.0040U	0.714U
	Mar-12	0.00098	0.0010U	0.00162	0.0030U	0.600U	
Field Duplicate	Mar-13	0.0005U	0.0010U	0.0010U	0.0020U	0.600U	
	Mar-13	0.0005U	0.0010U	0.0010U	0.0020U	0.600U	
	Mar-13	0.0005U	0.0010U	0.0010U	0.0020U	0.600U	
CRW1	Jul-07	0.0005U	0.002U	0.002U	0.002U	1.10	
	Aug-08	0.0005U	0.0020U	0.0020U	0.0040U	0.400U	
	Nov-08	0.0005U	0.0020U	0.0020U	0.0040U	0.358	
	Oct-09	0.0005U	0.0020U	0.0020U	0.0040U	0.400U	
	Jan-11	Frozen no sample					
	Mar-12	Frozen no sample					
	Mar-13	Frozen no sample					
Sampling Discontinued	May-17	NT	NT	NT	NT	NT	
FRW2	Aug-08	0.0005U	0.0020U	0.0020U	0.01042	0.574	
	Nov-08	0.0005U	0.0020U	0.0020U	0.0040U	0.357U	
	Oct-09	0.0005U	0.0020U	0.0020U	0.01042	0.714U	
	Jan-11	0.0005U	0.0020U	0.0020U	0.0040U	0.714U	
	Mar-11	0.0005U	0.0020U	0.0020U	0.0040U	0.800U	
	Mar-12	0.0005U	0.0010U	0.0010U	0.0030U	0.600U	
	Mar-13	0.0005U	0.0010U	0.0010U	0.002U	0.659U	
	May-17	0.0005U	0.0010U	0.0010U	0.002U	0.556U	
	Dup (FRW1)	May-17	0.0005U	0.0010U	0.0010U	0.002U	1.556U
DWW (Old Well)	Jul-07	0.00321	0.110	0.120	0.644	14.4	
	Aug-08	0.00209	0.0020U	0.036	0.10545	0.658	
	Nov-08	0.00154	0.0020U	0.0309	0.07455	0.860	
	Oct-09	0.0005U	0.0020U	0.0124	0.02276	0.769U	
	Jan-11	Frozen no sample					
	Mar-12	Frozen no sample					
	Mar-13	0.0005U	0.0010U	0.007	0.016	0.632U	
	Field Duplicate	Mar-13	0.0005U	0.0010U	0.007	0.015	0.652U
	May-17	0.0005U	0.0010U	0.002	0.004	0.652U	

Notes:

U

Analyte not detected at the listed detection limit

Shade

Analyte detected in concentration below the ADEC Cleanup level

Bold

Analyte detected in concentration exceeding the ADEC Cleanup level

When duplicate sample values are greater than primary sample values, duplicate sample values are used.

Attachment 3

Laboratory Data Review Checklist

Completed by:	Doug Dusek		
Title:	Envirnmental Professional	Date:	Nov 20, 2017
CS Report Name:	Canoro Road	Report Date:	Jun 1, 2017
Consultant Firm:	Nortech		
Laboratory Name:	SGS	Laboratory Report Number:	1137642
ADEC File Number:	100.38.217	ADEC RecKey Number:	

1. Laboratory

a. Did an ADEC CS approved laboratory receive and perform all of the submitted sample analyses?

Yes No NA (Please explain.) Comments:

b. If the samples were transferred to another "network" laboratory or sub-contracted to an alternate laboratory, was the laboratory performing the analyses ADEC CS approved?

Yes No NA (Please explain) Comments:

Samples were not transferred.

2. Chain of Custody (COC)

a. COC information completed, signed, and dated (including released/received by)?

Yes No NA (Please explain) Comments:

b. Correct analyses requested?

Yes No NA (Please explain) Comments:

3. Laboratory Sample Receipt Documentation

a. Sample/cooler temperature documented and within range at receipt ($4^{\circ} \pm 2^{\circ} \text{C}$)?

Yes No NA (Please explain) Comments:

Samples were 0.2 degrees

b. Sample preservation acceptable - acidified waters, Methanol preserved VOC soil (GRO, BTEX, Volatile Chlorinated Solvents, etc.)?

Yes No NA (Please explain) Comments:

c. Sample condition documented - broken, leaking (Methanol), zero headspace (VOC vials)?

Yes No NA (Please explain) Comments:

d. If there were any discrepancies, were they documented? - For example, incorrect sample containers/preservation, sample temperature outside of acceptance range, insufficient or missing samples, etc.?

Yes No NA (Please explain) Comments:

e. Data quality or usability affected? (Please explain)

Comments:

NA

4. Case Narrative

a. Present and understandable?

Yes No NA (Please explain) Comments:

b. Discrepancies, errors or QC failures identified by the lab?

Yes No NA (Please explain) Comments:

SW-5 and SW-6 AK101 - BFB (surrogate) recoveries do not meet QC criteria (biased high) due to matrix interference.

c. Were all corrective actions documented?

Yes No NA (Please explain) Comments:

d. What is the effect on data quality/usability according to the case narrative?

Comments:

Affects only AK101 results, 8021 results unaffected

5. Samples Results

a. Correct analyses performed/reported as requested on COC?

Yes No NA (Please explain)

Comments:

b. All applicable holding times met?

Yes No NA (Please explain)

Comments:

c. All soils reported on a dry weight basis?

Yes No NA (Please explain)

Comments:

Water Samples

d. Are the reported PQLs less than the Cleanup Level or the minimum required detection level for the project?

Yes No NA (Please explain)

Comments:

e. Data quality or usability affected? (Please explain)

Comments:

No

6. QC Samples

a. Method Blank

i. One method blank reported per matrix, analysis and 20 samples?

Yes No NA (Please explain)

Comments:

ii. All method blank results less than PQL?

Yes No NA (Please explain)

Comments:

iii. If above PQL, what samples are affected?

Comments:

iv. Do the affected sample(s) have data flags? If so, are the data flags clearly defined?

Yes No NA (Please explain) Comments:

v. Data quality or usability affected? (Please explain)

Comments:

NA

b. Laboratory Control Sample/Duplicate (LCS/LCSD)

i. Organics - One LCS/LCSD reported per matrix, analysis and 20 samples? (LCS/LCSD required per AK methods, LCS required per SW846)

Yes No NA (Please explain) Comments:

ii. Metals/Inorganics - One LCS and one sample duplicate reported per matrix, analysis and 20 samples?

Yes No NA (Please explain) Comments:

iii. Accuracy - All percent recoveries (%R) reported and within method or laboratory limits? And project specified DQOs, if applicable. (AK Petroleum methods: AK101 60%-120%, AK102 75%-125%, AK103 60%-120%; all other analyses see the laboratory QC pages)

Yes No NA (Please explain) Comments:

524.2 - LCS recovery for bromomethane (143%) is outside of QC criteria and This analyte was not detected above

iv. Precision - All relative percent differences (RPD) reported and less than method or laboratory limits? And project specified DQOs, if applicable. RPD reported from LCS/LCSD, MS/DMSD, and or sample/sample duplicate. (AK Petroleum methods 20%; all other analyses see the laboratory QC pages)

Yes No NA (Please explain) Comments:

v. If %R or RPD is outside of acceptable limits, what samples are affected?

Comments:

This analyte was not detected above the LOQ in the associated samples.

vi. Do the affected samples(s) have data flags? If so, are the data flags clearly defined?

Yes No NA (Please explain) Comments:

vii. Data quality or usability affected? (Please explain) Comments:

Not affected

c. Surrogates - Organics Only

i. Are surrogate recoveries reported for organic analyses - field, QC and laboratory samples?

Yes No NA (Please explain) Comments:

ii. Accuracy - All percent recoveries (%R) reported and within method or laboratory limits? And project specified DQOs, if applicable. (AK Petroleum methods 50-150 %R; all other analyses see the laboratory report pages)

Yes No NA (Please explain) Comments:

iii. Do the sample results with failed surrogate recoveries have data flags? If so, are the data flags clearly defined?

Yes No NA (Please explain) Comments:

iv. Data quality or usability affected? (Use the comment box to explain.)

Comments:

d. Trip Blank - Volatile analyses only (GRO, BTEX, Volatile Chlorinated Solvents, etc.): Water and Soil

i. One trip blank reported per matrix, analysis and for each cooler containing volatile samples? (If not, enter explanation below.)

Yes No NA (Please explain.) Comments:

ii. Is the cooler used to transport the trip blank and VOA samples clearly indicated on the COC? (If not, a comment explaining why must be entered below)

Yes No NA (Please explain.) Comments:

Trip blanks with Cooler with VOCS

iii. All results less than PQL?

Yes No NA (Please explain.)

Comments:

iv. If above PQL, what samples are affected?

Comments:

v. Data quality or usability affected? (Please explain.)

Comments:

e. Field Duplicate

i. One field duplicate submitted per matrix, analysis and 10 project samples?

Yes No NA (Please explain.)

Comments:

ii. Submitted blind to lab?

Yes No NA (Please explain.)

Comments:

iii. Precision - All relative percent differences (RPD) less than specified DQOs?
(Recommended: 30% water, 50% soil)

$$RPD (\%) = \frac{\text{Absolute Value of: } (R_1 - R_2)}{((R_1 + R_2)/2)} \times 100$$

Where R_1 = Sample Concentration

R_2 = Field Duplicate Concentration

Yes No NA (Please explain.)

Comments:

Both were below LOQ for BTEX

iv. Data quality or usability affected? (Use the comment box to explain why or why not.)

Yes No NA (Please explain.)

Comments:

f. Decontamination or Equipment Blank (if applicable)

Yes No NA (Please explain)

Comments:

NA

i. All results less than PQL?

Yes No NA (Please explain)

Comments:

ii. If above PQL, what samples are affected?

Comments:

iii. Data quality or usability affected? (Please explain.)

Comments:

7. Other Data Flags/Qualifiers (ACOE, AFCEE, Lab Specific, etc.)

a. Defined and appropriate?

Yes No NA (Please explain)

Comments:

No other data flags

Reset Form

Attachment 4



**Groundwater Laboratory Sampling Plan
STANDARDIZED METHODOLOGY
(Version 2)
February 2017**

Laboratory Sampling Plan

This document describes the laboratory sampling plan for existing monitoring wells and sampling points at a project site. In general, laboratory sampling will be conducted to provide additional data at an existing site with a history of laboratory results. This will typically include sampling of the source area, an up gradient location, and a downgradient location. The specific locations and rationales will be described in the site-specific work plan.

Groundwater sampling

NORTECH will collect laboratory groundwater samples in general accordance with the ADEC 2016 Field Sampling Guidance document (adopted by reference for sampling guidance, 18 AAC 78 regulations). Existing groundwater wells will be purged and sampled using low-flow techniques. Purging will consist of three to five well volumes and/or until the suspended silt is minimized and field parameters, including dissolved oxygen, pH, ORP, and conductivity, have stabilized. One sample will be collected from each groundwater sampling well/point. At least one field duplicate will be collected for every ten samples submitted per analysis, and per sampling day.

Groundwater samples will be collected directly into clean glassware provided by the laboratory and immediately placed in a cooler with ice prior to transportation under chain-of-custody to the laboratory. A minimum of one trip blank will accompany each set of volatile samples submitted to the lab.

Contaminants of Concern

The contaminants of concern (COC) for the groundwater sampling program will be detailed in the site specific work plan. The most common contaminants of concern in the Fairbanks area are petroleum fractions, including gasoline range organics (GRO), diesel range organics (DRO), residual range organics (RRO), and benzene, toluene, ethylbenzene, and xylenes (BTEX).

Specific laboratory analyses and cleanup levels for these COCs are as follows:

Contaminant of Concern	Analysis Method	Groundwater
GRO	AK101	2.2 mg/L
DRO	AK102	1.5 mg/L
RRO	AK103	1.1 mg/L
Benzene	EPA 8021	0.0046 mg/L
Toluene	EPA 8021	1.1 mg/L
Ethylbenzene	EPA 8021	0.015 mg/L
Total Xylenes	EPA 8021	0.190 mg/L
Polycyclic Aromatic Hydrocarbons	EPA 8270 SIM	Refer to Table C, Groundwater Cleanup Levels

NORTECH plans to use SGS Environmental Services in Anchorage, Alaska as the analytical laboratory for all laboratory samples needed for this project. SGS is an ADEC approved laboratory.





Indoor Air Quality Standardized Methodology Version 4, December 2014

Objective and Management

NORTECH Indoor Air Quality (IAQ) standardized assessment methodology is developed to comply with currently applicable regulations utilizing standard industrial hygiene practices designed for the anticipation, recognition, evaluation, and control of those factors or stressors arising in or from the workplace that may cause sickness, impaired health and well-being, or significant discomfort among workers or citizens of the community. Qualified personnel with current certifications and experience conduct field assessment inspection and sampling efforts. All work completed is managed, reviewed and signed off on by a board Certified Industrial Hygienist (CIH) or Professional Engineer.

Scope of Work

NORTECH provides a variety of Indoor Air Quality (IAQ) Assessment services as necessary to meet project specific needs cost effectively. **NORTECH's** standard methodology for the assessment of indoor air quality (IAQ) is intended to provide for professional assessment of indoor air quality as outlined and as further detailed in the project specific scope of work. The standard indoor air quality assessment includes a review of background materials and concerns, interviews with mgmt., maintenance and concerned occupants as well as a visual inspection by a qualified and experienced assessor. Based on this information a sampling and analysis plan can be developed to verify the assessment hypothesis. The standard addresses the following indoor air quality methods:

- Visual and Multi-Sensorial Assessment
- HVAC Measurements
- Assessment and Monitoring, including
 - Standard IAQ parameters,
 - Temp, Humidity, Carbon Monoxide (CO), Carbon Dioxide (CO₂)
 - Contaminants of Concern
 - Volatile Organic Compounds
 - Lead
 - Odor
 - Allergens
 - Fungal
 - Wastewater
- Identifying Adverse Associated Conditions
- Development and Implementation of a Sampling and Analysis Plan
 - Worst Case
 - Air, Wipe, Bulk, Grab and Real Time
 - Bacterial
- Interpretation of Results

The assessor evaluates and verifies that the assessment has been conducted to fulfill the project specific specified scope of work and thoroughly test the hypothesis. If there are critical data gaps, additional assessments may be conducted. Typically there can be restrictions on the scope of work and other limitations including but not limited to seasonal conditions, prior damage, undisclosed areas, willful non-disclosure, and inaccessible areas. In the case of non-fungal contamination, additional actions outside of the scope of this standard are warranted.

References

General IAQ inspection observations are evaluated in accordance with criteria contained in

- ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality
- ANSI/ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy
- American Industrial Hygiene Association (AIHA) Guideline 3-2004 for the evaluation of mold in buildings

Methodology

The Indoor Air Quality assessments involve informal interviews with knowledgeable individuals, as well as a site inspection and sampling of conditions present in an effort to determine current conditions that could be a cause of the symptoms reported. The following indoor air quality methods and standard industrial hygiene methods of anticipation, recognition, evaluation, and control of those factors or stressors arising in or from the workplace that may cause sickness, impaired health and well-being, or significant discomfort among workers or citizens of the community can be utilized.

Visual Inspection

The visual inspection is completed of all accessible areas with specific focus on the HVAC systems, potential health impacts related to inadequate outdoor air contribution, presence or potential for bioaerosols (such as visual presence of mold, bugs or nuisance particulates) to be integrated into the HVAC system, and poor air distribution for the HVAC system to the respective areas. This preliminary IAQ evaluation does not typically provide quantitative measurement of HVAC airflows. Instead, the objective is to assess the HVAC system visually in qualitative terms. No destructive testing or inspection of hidden spaces is undertaken. Information collected during the inspections include visible signs of water damage, mold, as well as a general review of building construction and HVAC mechanical systems configuration and operation.

Exposure Sampling

The goal for exposure sampling is to collect samples during the highest or “worst case” exposure periods.

Standard Indoor Air Quality (IAQ) Parameters

Standard IAQ parameters including carbon dioxide (CO₂), carbon monoxide (CO), temperature, and relative humidity can be monitored real time and graphed over the sampling period with IAQ monitors. Each meter electronically measures all parameters and has the capability to store data for long term assessments. The preferred sampling period is over 5-7 days in order to monitor diurnal, work week and weekend effects to IAQ. Results are compared to ANSI/ASHRAE Standard 55-2010.

Although there are some differences between IAQ experts and industry references, the general consensus is that ideal indoor conditions for most people include temperatures in the range of 69 to 76°F and relative humidity between 40% and 60%. Instead of controlling outside air based on mixed air temperature, it is recommended that the system provide an average of 20 cubic feet per minute of fresh air per occupant. Indoor carbon dioxide (CO₂) concentrations of 750 to 850 parts per million (ppm) or less usually indicate an adequate amount of fresh outside air. Indoor carbon monoxide (CO) concentrations should be no greater than outdoor concentrations, which are usually 0-2 ppm in rural locations. The EPA has set a limit for outdoor air of 9 ppm averaged over an 8-hour period for the protection of health-compromised persons. OSHA

standard for occupational CO exposure is 50 ppm with an action level of 30 ppm for 8-hour time weighted average. Monitoring of these IAQ parameters is recommended to verify conditions as well as modifications implemented.

Total Volatile Organic Compounds (TVOC)

A parts per billion (ppb) photoionization gas detector (PID), can be used to monitor IAQ Total Volatile Organic Compound (TVOC) concentrations. The hand held PIDs provide real-time monitoring data for organic vapors in a semi-quantitative way. It cannot distinguish between individual chemical constituents (such as benzene, formaldehyde, isopropyl alcohol, etc.), but it can identify whether organic vapors are present down to approximately 1 part per billion (ppb), and it gives a relative expression of concentration. The PID can be used to identify areas of higher TVOC concentrations and, depending on the levels, a future monitoring site for potential toxin or irritant exposures. The PID is calibrated in accordance with the manufacturer's recommendations with an isobutylene 100 ppm standard gas.

Recommended guidelines for TVOC concentrations is ideally less than 200 ppb with levels between 200-3,000 ppb capable of causing irritation and discomfort. While some references suggest office/work levels should be less than 1300 ppb, other international sources consider TVOC levels above 500 ppb to be poor with higher concentrations creating greater concerns.

Factors such as temperature, dust, relative humidity, smoking habits, and age of individuals have a synergistic effect on individual response (Molhave 1985; 1990). Although individuals will react differently to VOC exposures, concentrations exceeding 3,000 ppb are significant and symptoms are prevalent. There is a potential for sensitization to chemicals with repeat or acute exposure. Reactions can be experienced by sensitized individuals when exposed to even low concentrations of VOC's (Ashford and Miller, 1991). TVOC symptoms and chemical inhalation may include irritation of eyes, nose, and throat, respiratory difficulties, nausea, headaches, fatigue, drowsiness (Hudnell et al., 1990).

Volatile Organic Compounds (VOC)

Lined, evacuated 6-liter canisters commonly referred to as Summa canisters can be used to collect a grab or integrated TVOC sample that the laboratory can analyze with gas chromatography to determine individual constituents. Each summa is equipped with regulators that can be requested to obtain a grab or integrated sample over time as required by the project specific sampling and analysis plan. The laboratory analysis method is typically EPA method TO15 capable of identifying approximately 50-75 primary VOCs down to the parts per billion (ppb) range.

Allergens

Dust mites, cockroaches, cats, and dogs can generate allergens that are known to cause allergic reactions and respiratory diseases in sensitive people. Dust mites are nearly impossible to see with the naked eye. Cockroaches are often hidden in dark places. Allergens from cats and dogs may be carried into buildings by cat and dog owners. Samples collected from visible dust suspected of having target allergens are analyzed by a qualified laboratory using an Enzyme Linked Immunosorbent Assay (ELISA). ELISA is a multiple step quantitation of antigens using antibodies and enzymes which uniquely interact with the allergens.

Fungi/Mold

Being ubiquitous, mold (a type of fungus) is found in outdoor and indoor environments. Air samples are collected as representative of occupant respiratory exposure levels while wipes, bio swabs or tape lift of visible dust are collected to evaluate visible settled dust and as a

measure of cleanliness. Bulk samples of visible mold amplification sites are collected and analyzed to determine the species and genus of mold observed.

Wipes, bioswabs and/or clear tape can be used to lift visible accumulations of dust off a known area of horizontal surfaces. The bulk and dust samples are microscopically analyzed for fungal spores and fungal structures at the genus level as well as other IAQ particulates present. Fungal/mold spores measured in dust provide an assessment of fungal/mold deposition on work areas over time as well as the fungal/mold cleanliness of the visible dust present. Depending on sampling method, samples collected may be microscopically analyzed and/or cultured on specific media.

NORTECH uses the Air-O-Cell method for non-viable air sample analysis for fungal particulates. The method allows for the rapid collection and analysis of fungal particulates and also a wide range of non-biological aerosols. The method pumps known volumes of air through a slit inertial impactor at high velocity and collects particulates on a 37 mm Air-O-Cell spore trap cassettes sticky slide that is subsequently microscopically examined.

The microscopic analysis of Air-O-Cell cassettes includes identification of mold particulates to genus level and the concentration and rank order of the molds identified. The method does not distinguish viable or non-viable fungal particulate. The microscopic analysis can quantify up to 300 different particulate fractions such as pollen, insect parts, dander (skin cells), hair, debris, dust and (non-asbestos) fibers. Enumeration of non-fungal particulate is often useful for identifying non-fungal concerns as well as housekeeping and maintenance issues.

One or more outdoor or background non-complaint air samples are collected concurrently with complaint area samples for comparative purposes. Counts of airborne fungal parts are evaluated for their ability to affect individuals through the respiratory exposure path. Air and dust samples are evaluated for total fungal structure counts, toxicity of fungal varieties identified, and comparison to background, non-complaint areas. See Standardized Moisture/Fungal Assessment Methodologies for additional information.

Smoke Tubes

Smoke tubes may be used to evaluate the air movement within the facility.

Moisture Content

Moisture content of inspected building materials are measured in % moisture collected with either a contact surface or penetrating pin model of moisture meters. Both meters have adjustments for different material substrate. Concentrations below 5% are considered background or dry. Less than 14% moisture is considered acceptable and incapable of supporting fungal/mold growth. Moisture concentrations above 18% moisture will support mold growth on building material cellulose substrates at suitable temperatures. The in between range of 14-18% moisture is considered the marginal area capable of supporting fungal growth under some high relative humidity conditions.

Other Particulates

Industrial processes can generate a number of particles that impact employee health. These solids can take the form of dusts, metals, aerosols, mold spores, ultrafine particles, or other irritating materials. In order to pinpoint an indoor particulate problem, real-time monitors can be used to measure particulate concentrations.

A real time data logging environmental monitor can be used for measurement of particulates utilizing a light scattering particle counting technology. The instrument is zero calibrated to the

manufacturer's recommendations pre and post the data logging session. Results are reported in milligrams per cubic meter (mg/m³) of particulates. While different fractions may be monitored based on the field equipment selected the most common size range reported is 10 micrometers to below 1 micrometer in size (diameter).

Air quality can be measured for specific contaminants of concern identified for the project.

Ultrafine Particulates

A TSI P-Trak Ultrafine Particle Counter (P-Trak) can be used to measure the number of ultrafine particles per cubic centimeter. Ultrafine particulates are defined as particles less than 1 micron in size. The ultrafine sub-micron particulate size is representative of combustion engine exhaust and/or photocopier carbon. This technique is used to identify and locate indoor particulate sources or relative particle concentration that would point to a more specific problem. The unit of measure for this instrument is particulates per cubic centimeter. The unit is zero calibrated to the manufacturer's recommendations prior to use.

Hydrogen Sulfide

Real time field levels of Hydrogen Sulfide can be monitored with a handheld PPB RAE parts per billion electronic H₂S meter for detection of hydrogen sulfide gas.

Lead

Field tests to determine best potential for lead wipe sampling of surface dust conditions are performed in accordance with NIOSH 7702, using a Thermo Fisher NITON XLp-303A (XRF), X-Ray fluorescent spectrum analyzer, providing EPA accepted real-time on-site sample results at detectable levels of lead at mg/cm². Laboratory analysis of lead dust wipes are performed by EMSL Laboratory in San Leandro, CA with National Lead Laboratory Accreditation Program (NLLAP) certification through the Environmental Lead Accreditation Program (ELLAP) under the ISO17025 umbrella of AIHA-LAP-LLC. Analysis for lead in wipes were performed by Atomic Absorption Spectroscopy (AAS) Analytical Method(s): USEPA SW 846-7000B: 7420-Pb AAS-FL, RL <10ug/sample).

Area concentration of lead contaminant is considered a mass of lead per unit area of the total sample, sometimes called "loading". This is independent of the volume (or thickness) of the sample analyzed. This unit of quantification is typically encountered in measuring paint by portable X-Ray fluorescence instruments and laboratory techniques. The HUD regulatory level is 1.0 mg/cm² or 1 000 ug/cm². Area concentration (loading) is also used to describe settled leaded dust levels in ug/ft² (micrograms of lead per square foot of surface area). 200 ug/ft² equals 1.85 mg/m² (milligrams of lead per square meter).

One cannot convert from ppm or % by weight to area concentration (mg/cm²) as measured by an X-Ray fluorescence instrument in any predictable way unless the total mass per unit area of the sample is known. One reason is that the dilution factor of adding more non-leaded paint or dust layers over an existing leaded one will not change the area concentration. However, adding additional layers will change the % by weight. The area concentration is independent of the thickness of the multiple layers. The XRF determines the lead mass per unit area as measured by X-Ray emission from a lead layer (mg/cm²). The weight percent method measures the percent of lead in the bulk paint films and dusts by determining the weight of lead in the total sample.

For this reasoning, the XRF unit is used solely to determine best potential and least potential surfaces for lead wipe testing, allowing for a best target approach assessment of lead

contaminated surfaces within the area to be wipe sampled and sent to the lab for appropriate method of laboratory analysis.

The lead dust wipe collection is performed using laboratory supplied lead wipe collection medium consisting of a 5"x7-3/4" cloth wipe saturated with water, Polyorbate 20, Methylparaben, Propylparaben and sealed within a 2"x2" sterile packet. NITRILE gloves are worn during removal of sampling medium from each packet and throughout the wipe sampling effort. A disposable 144 sq. inch template is utilized to demark each sample collection location. Each template and NITRILE gloves are disposed and replaced with new prior to each sequential sample collected to assure cross contamination from one sample site to another does not occur. Each wipe is placed within the template and, using palm and fingertip force and wiped in an overlapping manner with strokes from top to bottom and right to left, as well as upper left diagonally to lower right and vice versa in the same manner, and circular strokes both diagonally and horizontally from left to right within the template, top to bottom, to assure all surface within the template are adequately wiped. Following the same procedure each sample is collected by the same sampler and placed in a sterile 3x5 ziplock baggie. Each sample is labeled with area, surface type, and sequential sample numeration that is recorded on a standard chain of custody form that accompanies the samples via overnight delivery to the laboratory performing the analysis.

The results are compared with the following EPA/HUD Dust-Lead Hazard criteria for low income housing:

- 40 micrograms per square foot (ug/ft²) on uncarpeted floors,
 - may also be applied to table tops and chairs;
- 250 ug/ft² on interior window sills (accessible to a child);
- 800 ug/ft² for window troughs
 - areas inaccessible to children,
 - may also be applied at ceilings and above ceiling grids, and mechanical spaces

Wastewater

Surface samples of building materials suspected of being contaminated with wastewater are collected with sterile swabs in Butterfield solution of a known area, typically an area of 1 in². Coliform bacteria are not typically found on building materials. As a result, no background samples are typically collected and the background level are presumed to be zero.

Surface samples are cultured by the Quantitray method for bacterial growth and included analysis for *Escherichia coli* (*E. coli*), *Enterococcus* spp (any species present in the genus *Enterococcus*) and total coliform (an indicator organism of bacterial contamination present in a sample). The Laboratory analysis is conducted by a laboratory accredited by the American Association for Laboratory Accreditation and the American Industrial Hygiene Association. There are no established state or federal standards for coliform bacteria on building materials. Results are analyzed in accordance with accepted industry standards.

Air Sampling

Summa Canisters – (SC - TO-15) - Primary VOCs and QA Correlation. EPA method TO-15 is used to analyze for approximately 50-75 primary VOCs down to the parts per billion (ppb) range. Tentatively Identified Compounds are identified with a search of the spectral library of compounds to find a match.

Sorbent Tube - (ST - EPA Method) IP-1B – Primary and Secondary VOCs. Sorbent tube samples are collected by USEPA IP-1B and ASTM D 6196 for VOC analysis including 4-

phenylcyclohexane (4-PCH) 4-PCH which is screened/analyzed due to suspect carpets and fabrics containing styrene butadiene rubber (1,3-Butadiene and Styrene were indicated in first VOC sample event). For compounds not included in the internal GC/MS calibration database, identification of Tentatively Identified Compounds (TICs) are made by comparison with a National Institute of Standards (NIST) general mass spectral library.

Sorbent Tube - (ST - Non-EPA) Proprietary Method AS002-HS. Sorbent tube samples are collected for analysis by a proprietary non-EPA, method AS002 – HS for VOCs. This method is used for comparison with the EPA IP-1B method and provided detection of 255 secondary compounds by semi quantitative methods.

Aldehydes (ST – EPA) Sorbent tubes are collected for EPA method analysis IP-6A and ASTM D 5197-03, targeting aldehyde compounds.

Tedlar Bag (TB) Samples – Acids and Isocyanates Tedlar bag for analysis by proprietary method TB002-IR for acids and Isocyanates. This method is reported to expand the number of detectable compounds by up to 380 additional compounds by semi quantitative methods.

Odor Threshold

Though not an enforceable legal standard, Odor Thresholds for Chemicals with Established Occupational Health Standards, published by The American Industrial Hygiene Association is referenced for comparison. Many compounds have odors that can be detected by the human nose or cause individual discomfort well below enforceable occupational exposure limits.

HVAC Measurements.

HVAC systems are measured to verify air flows (supply and return) as well as pressure conditions. Duct work air volume flow rates are measured by employing a TSI Accubalance hood velocitometer to determine volumes of supply and return air and to detect if positive pressure is being maintained in individual rooms. Air velocities are measured with a VelociCalc Plus, Model 8386 Industrial Ventilation velocity meter to determine fresh air make up being provided by the HVAC.

Applicability and Limitations

Current regulatory requirements and common sense necessitates professional management of contaminants in an occupied building in order to properly manage Indoor Air Quality (IAQ) and notify occupants of conditions present. However, it is important to understand that no matter how comprehensive (or expensive) the project assessment effort, it cannot be expected to uncover or identify all concerns in a non-invasive assessment. Hidden hazards and unknown conditions may still exist. The assessment efforts provided are based on information provided and requested. **NORTECH** has performed the work, made the findings, and proposed the recommendations in accordance with industrial hygiene practice standard of care. The data should be considered representative of the time of the assessment. Changes in the conditions of the assessed area will occur with the passing of time. In the event that additional concerns are identified, supplementary follow up services and sampling may be required.

NORTECH has based its conclusions and recommendations on our current understanding of regulatory policies. The regulations are constantly changing, including the interpretations by the regulating agencies. The data in this report should be considered representative of the time of the assessment and monitoring. If changes in regulations or their interpretation occur, then **NORTECH** reserves the right to amend or revise conclusions and/or recommendations.