Nikiski Groundwater Study

Revised

Final Report

April 2015

DOWL

KENAI PENINSULA BOROUGH

NIKISKI GROUNDWATER STUDY REPORT

REVISED

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LIST OF ACRONYMS

CERCLA......Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DEC..State of Alaska Department of Environmental Conservation
DEM...Digital Elevation Model
DNR .... State of Alaska Department of Natural Resources
GIS ....Geographic Information System
GPS .... global positioning system
IDW.. inverse distance weighted
KPB .... Kenai Peninsula Borough
OSK.. Offshore Systems Kenai
study area ....project boundaries
USCS...Unified Soil Classification System
USGS ....United States Geological Survey
UTM...Universal Transverse Mercator
WELTS .... Well Log Tracking System

GLOSSARY

Aquifer – The saturated part of geologic materials capable of yielding significant water to wells or springs.

Confined Aquifer – Those aquifers with which an impermeable layer of dirt or rock prevents water from seeping into the aquifer from the ground surface located directly above; instead, water seeps into the aquifer from further locations where the impermeable layer is not present.

Groundwater – Water held underground in soil or in pores and crevices in rock.

Institutional Controls (IC) – A set of conditions which may be applied to a site known to contain environmental contamination by the Alaska Department of Environmental Conservation. These conditions may restrict or prohibit activities, place monitoring requirements, require engineering controls, or otherwise prescribe required activities. ICs are specific to the conditions of each site.

Lithology – The general physical characteristics of a sediment deposit or rock formation; a layer within a sediment deposit with distinct physical characteristics.

Piezometric Surface – The hypothetical surface defined by the level to which water in a confined aquifer rises in observation wells. In practice, the piezometric surface is mapped by interpolation between groundwater measurements taken from wells accessing a confined aquifer.

Stadial – The known interval of an ice age.

Stratification – The arrangement of sedimentary rocks in distinct layers (strata), each layer representing the sediment deposited over a specific period.

Unconfined Aquifer – Those aquifers whose physical structure allows surface water to seep directly into them and water is free to migrate.

EXECUTIVE SUMMARY

DOWL completed a groundwater study under contract with the Kenai Peninsula Borough for the central Niksiki area. The region has a long history of oil and gas development and is home to a variety of support industries. As a result, the area has subsequently experienced a variety of contamination events. Concerns over contaminant migration potential and a need to better understand local aquifers, including their stratification and flow direction, led to the initiation of this study.

DOWL completed a review of available records and performed a field survey to provide data for the creation of a working subsurface model. The results of the study produced a three-dimensional geological model of the area and determined two main aquifers provide source water for area wells. The deeper aquifer appears to be at least partially confined beneath a layer of silt and clay (commonly observed between 50 and 75 feet elevation) and the aquifer is continuous, at depth, beneath the study area. This aquifer appears to be closely connected hydrologically and displays a fairly consistent hydraulic gradient with general flow from the southeast to the northwest. Above the confining layer is a less well understood unconfined aquifer. It does not appear to be strongly connected hydrologically across the study area. This upper aquifer displays a general trend from east to west but contains local variations in flow direction (likely due to preferential flow paths in the sediment). The upper aquifer flow direction also appears to be susceptible to localized drawdown pumping effects. Additionally, several of the wells in the study access smaller isolated, perched aquifers. Contaminants reaching the lower aquifer will likely be transported in the general flow direction (southeast to northwest) of the aquifer. Contaminants isolated in the upper aquifer may be transported in the general flow direction of the upper aquifer (east to west), but are susceptible to being drawn into the depression of the groundwater surface created by actively pumping wells nearby.

1.0 INTRODUCTION

1.1 Project Purpose

DOWL was contracted by the Kenai Peninsula Borough (KPB) to conduct a groundwater modeling study in the central Nikiski area (Figure 1). The area of focus is approximately bounded by Cook Inlet to the North at the Offshore Systems Kenai (OSK) dock, to the west along the eastern property line of Nikiski High School, the McGahan Industrial Airpark to the south, and the eastern boundary is approximated by the western property line of the AIMM Technologies monofill site (Figure 2). The study area has a history of documented environmental contamination related to industrial processes, illegal dumping, and unauthorized industrial waste disposal and the KPB has concerns with the impacts of the sites on Borough property, private property, and overall business development within the region.

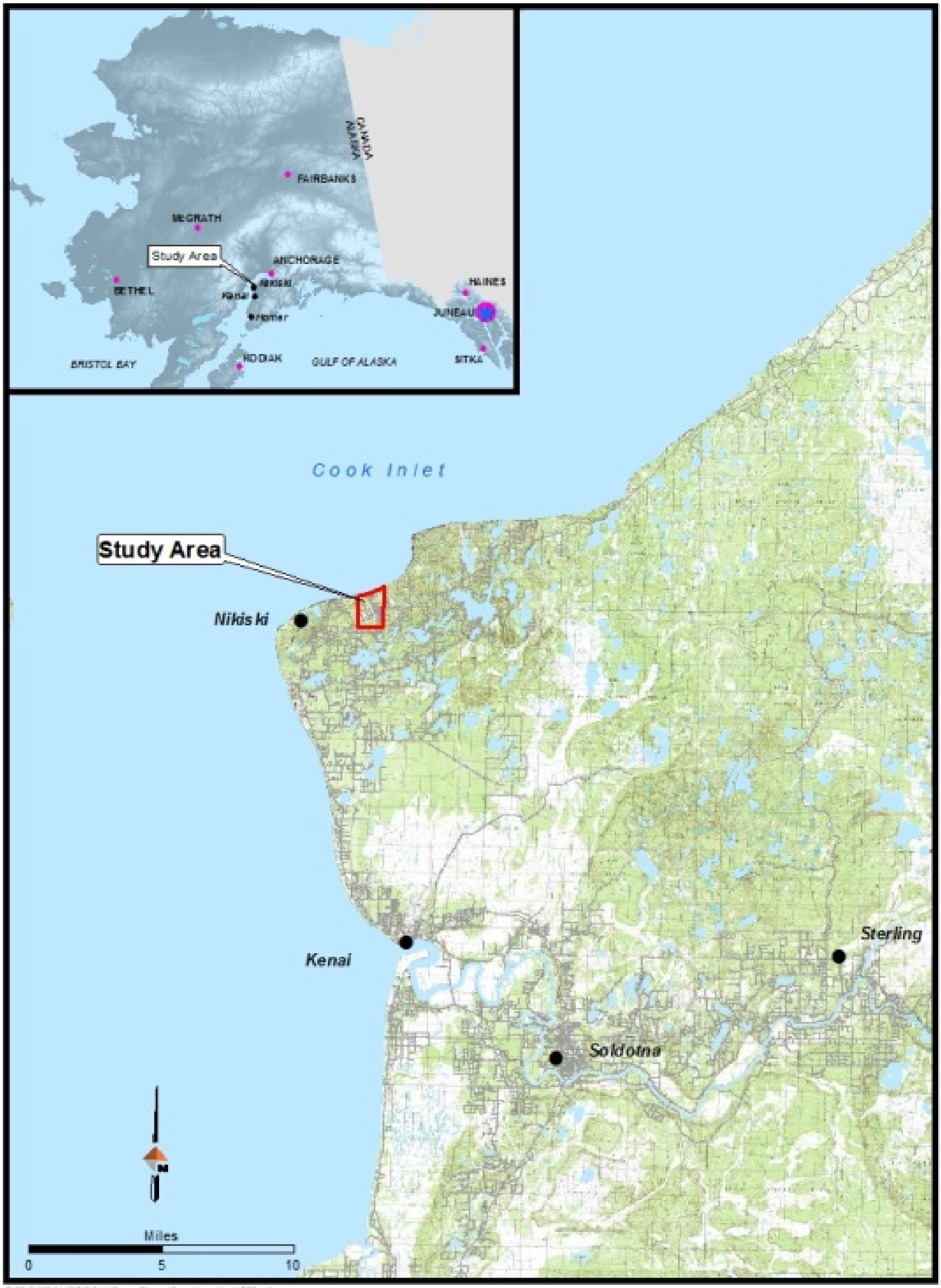

Figure 1: Location and Vicinity Map

Figure 2: Project Study Area

Several investigations of contaminated sites have occurred within the study area over the last 30 years. Many of the studies have concluded additional information is needed regarding the flow of groundwater in the area to determine the potential effects of contamination on the surrounding community.

The goal of the study is to better understand groundwater flow, movement, and depth in the central Nikiski area through subsurface characterization and groundwater modeling. DOWL staff identified local aquifers and sub-surface water migration patterns through an examination of existing water wells, monitoring wells, geotechnical boring logs, other environmental records and documentation, and a field survey of existing wells. The DOWL survey was performed to provide a common datum for surface and groundwater elevations, and to measure groundwater depths over a short interval of time to minimize the effects of seasonal changes and precipitation events in groundwater levels. The field study and record review provided necessary data for the construction of groundwater model indicating the likely direction of flow within area aquifers.

Although numerous contaminated sites in the study area have generated multiple reports with site-specific data, they do not equate to a comprehensive characterization of the subsurface conditions in Nikiski. However, these reports proved invaluable to developing such a subsurface characterization as they provide detailed descriptions of particular sites' lithography, soils, and aquifers.

1.2 General Setting

The study area contains a mixture of residential, commercial, and industrial development, in addition to large swaths of mostly undeveloped land. Development is primarily centered along the Kenai Spur Highway, with some additional industrial facilities located at the north end of the study area along Nikishka Beach Road, where OSK maintains a port facility.

The terrain of the southern half of the study area is relatively flat with some rolling topography, and generally slopes to the south. The northern portion of the study area is characterized by steeper slopes and rolling topography, with an overall slope to the north which becomes very abrupt as it approaches Cook Inlet and quickly falls toward the water. Kenai Peninsula is free of permafrost.

1.2.1 Geologic Setting

Nikiski lies on the western side of the Kenai Peninsula and within the Nikishka Lowland, a part of the Kenai Lowland physiographic sub-province bordering Cook Inlet. The present topography is the product of Quaternary Glaciation, primarily deposited during the innermost Killey Stadial during the Naptowne Glaciation (approximately 18,500 to 17,500 years before present). The glacial deposits beneath Nikiski are between 500 to 750 feet thick. These sediments are commonly interlayered and are unconsolidated or poorly consolidated (i.e., the particles are not closely arranged or cemented together). Underlying the glacial deposits is the Kenai Group, which is composed mainly of non-marine Tertiary sedimentary deposits of the Cook Inlet Basin (Reger et al., 2007).

The geological surface of the study site is composed predominately of two types of glacial deposits. These deposits are mapped in Figure 3 and described in greater detail in Appendix D, Technical Discussion. The northwest corner of the site is composed of glacial moraine material. This is recognized in the landscape by the ridgeline running approximately northeast-southwest on which the Old Nikiski Airstrip was previously located.

Figure 3: Surface Deposits within the Study Area

These sediments were deposited by the melting of a glacial ice sheet during the innermost Killey Stadial. This type of glacial deposit typically consists of rocks having a wide variety of particle sizes (clay, silt, sand, gravel, cobbles, and boulders) mixed together and lacks stratification. These deposits contain large proportions of silt and clay. Therefore, permeability is generally low in this type of deposit and water flow tends to follow paths established when glacial ice was present and glacial meltwater flowed over, under, or through the deposit. The depth of the glacial moraine deposit is unknown and it is underlain by varying glacial deposits.

The surface material in the rest of the study area is composed of proximal outwash, proglacial lakes, and associated fluvial deposits. These deposits are created by the meltwater streams and lakes which occurred across the plain below the terminus of an advancing or receding glacier. They are commonly composed of stratified layers of sand, gravel, silt, and clay. Water flow in these deposits may vary greatly over short distances. Additionally, layers of clay or silt may create impermeable layers in which groundwater may be trapped above or below.

1.3 Summary of Public Involvement

Known and potential contamination of groundwater within the Nikiski area as a whole, and the project study area specifically, is of great interest to the local community. The oil and gas industry has a long history of operations within the Cook Inlet area of the Kenai Peninsula and these efforts have resulted in a variety of contaminated soils and water issues over the last 50 years. Concern over past contamination and its migration through groundwater serving local potable water wells was the impetus for this project and as such, an effort was conducted to inform the community of the specific work occurring within the area and to solicit public assistance through access to any private water wells which may be present within the project boundaries.

Public participation in the form of access to private property and wells was necessary for the collection of field data required to produce the project models. As such, multiple outreach efforts were conducted to inform the local community about the project plan and goals. Table 1 highlights the efforts to reach out to the community to discuss the project and obtain access to local wells. Appendix A contains copies of public involvement documents including press releases, handouts, mailers, and news articles.

Table 1: Summary of Public Outreach Efforts

Type	Date	Notice
Project Kickoff Meeting	10/16/2014	Flyer announcing meeting in lobby of local post office.
Newspaper Article	10/30/2014	Peninsula Clarion story about project and November 3rd meeting based on press release by DOWL.
Public Information Meeting	11/3/2014	Rachel Steer, Zach Huff, and Emily Creely attended the November 3 Nikiski Community Council Meeting. Approximately 60 residents attended. DOWL staff provided an informal presentation of the project and then allowed the public to ask questions.
Radio Interview[1]	11/4/2014	KSRM Radio interview with project team members discussing the nature and objective of project (*DOWL HKM Gathering Nikiski Groundwater Data*).
Newspaper Article	11/6/14	Peninsula Clarion story about project and need for Nikiski residents to participate, based on information from November 3rd meeting.
Radio Interview[1]	11/7/2014	KSRM Radio interview with project team members discussing the nature and objective of project (*Groundwater Surveyors Looking for Participants by November 14*).
Radio Interview[1]	11/12/2014	KSRM Radio interview with project team members discussing the nature and objective of project (*Nikiski Well Surveyors will be Out this Weekend*).
Radio Interview[1]	11/20/2014	KSRM Radio interview with project team members discussing the nature and objective of project (*Nikiski Well Surveyors get Plethora of Data*).
Public Information Meeting	3/23/2015	Paul Pribyl, Zach Huff, and Emily Creely are to attend the March 23 Nikiski Community Council Meeting where they will make a presentation sharing the results of the study.

[1] http://radiokenai.net/

2.0 DATA SOURCES AND METHODS

2.1 Data Sources

Source data was obtained through public records research and field survey efforts. A review of public records was performed early in the project and allowed the creation of an initial project database. After the initial data collection effort, it was determined several of the data points represented the same wells creating duplicates; duplicates were consolidated and/or eliminated as necessary. This initial database then provided the foundation for the field survey efforts.

2.1.1 Public Records

A public records search was conducted of potential data sources within the defined study area and the immediate vicinity. Public records sources included the United States Geological Survey (USGS), the Alaska Department of Environmental Conservation (DEC), and the Alaska Department of Natural Resources (DNR).

2.1.1.1 USGS

The USGS maintains a national level database[2], the National Water Information System: Mapper, which provides information on select wells, including location of the well (latitude and longitude in degrees, minutes, and seconds), the depth of the well, and limited water elevation and/or water quality information. Much of the data within the study area is of limited value due to the lack of precision in the well locations and the date of data collection, which is often twenty or more years old. This limited information was useful for initially identifying wells within the study area and as cross-reference for other collected data identifying well locations. Within the study area, this database identified 33 wells. A complete list of USGS data for the study area is available in Appendix B.

The USGS National Water Information System: Mapper was used to roughly check a variety of wells previously reviewed and/or surveyed by USGS. The record data is coarse, but served as an

[2] http://maps.waterdata.usgs.gov/mapper/index.html

approximate check against other well records for bore depths. Much of the USGS data provides depth of water and approximate groundwater elevations, but due to the dates of the surveys (ranging from 1968 to 1991), these values were only useable as approximations.

The majority of the historical water elevation data consists of single point observation periods and does not provide information on groundwater variability in the area over seasons or annual periods. Only one site within the project study area was observed by the USGS over a multi-year period and provides some insight into local variability.

USGS site ID number 604323151190301 (State of Alaska Department of Transportation and Public Facilities Maintenance Yard, 51150 Island Lake Road) records provide data on 28 measurements of the groundwater depth for this single well. The data was recorded over two distinct periods from February 27, 1970 to June 23, 1972 and May 20, 1977 to December 29, 1978. The collected data reflects a groundwater variance of approximately eight feet, though two outlier measurements are noted as being taken at times of recent pumping activity. Removing the outlier measurements, the variation in water levels is approximately 4.5 feet. This information was valuable in confirming aquifer fluctuation over time for the study area.

2.1.1.2 DNR

The DNR maintains a publicly accessible database of wells registered with their Division of Mining, Land, and Water. The Well Log Tracking System (WELTS) database provides a searchable system with links to individual well records. The records for each well vary in quality and detail, but often include well logs with basic lithology as logged by the well driller. These documents typically include scanned copies of original drilling logs and initial production (drawdown) information.

WELTS data was the primary source documentation used for creation of the models as it provided lithology, of varying quality, for a number of wells. Table 2 summarizes the individual wells identified through the WELTS database; drilling logs obtained through WELTS are available in Appendix B. Well logs were evaluated and a qualitative score was assessed for each record; scores ranged from one (great quality and reliable information) to three (poor quality and unreliable information). These qualitative scores were used to resolve discrepancies, outliers,

and inconsistencies in the groundwater models development. Additional details on how qualitative scores were determined and applied to records can be found in section 2.2, Subsurface Geology.

Figure 4 identifies WELTS data point locations within the project study area and the immediate vicinity.

Table 2: Summary of WELTS Data from the Study Area

DOWL Project Well ID	WELTS ID	Useable Lithology	Test Hole/ Well Depth (*ft*)	Completion Date	Qualitative Score
Admirality 1	16842	No	84	1962	—
ArnDock 1	19292	Yes	182	5/16/1968	2
ArnDock 2	19796	Yes	31	12/16/1966	2
ArnDock 3	19797	Yes	41	12/21/1966	2
ArnDock 4	21647	Yes	186	6/11/1991	2
ArnDock 5	21648	Yes	257	5/21/1991	2
ArnDock 6	16599	No	159	5/00/1968	2
Arness 1	19818	Yes	138	9/18/1988	2
BakerRd 1	16845	Yes	119	Unknown	2
Bernice 1	16843	Yes	132	Unknown	2
Charlie 1	34201	Yes	145	10/5/2005	2
CIP 9	14100	Yes	140	4/4/1984	3
CIP 10	19790	Yes	168	4/4/1984	3
CIP 11	23912	Yes	155	5/23/1990	3
Contro 1	16848	No	96	4/00/1967	—
Diamond 1	15089	Yes	213	3/26/1983	2
Diamond 2	17552	No	300+	Unknown	—
FirstBaptist 1	16382	Yes	87	8/27/1963	3
Halco 1	19792	Yes	140	1/17/1986	2
JW 1	17313	Yes	103	10/3/1986	3
JW 2	17419	Yes	107	11/14/1983	2
Mazie 1	16847	Yes	92	8/1/1996	3
Mazie 2	364	Yes	70	1/20/1971	2
MBC 1	16844	Yes	295	3/27/1959	2
MCG 9	19100	Yes	86.5	3/16/1989	1
MCG 10	19101	Yes	56	3/17/1989	1
MCG 11	19105	Yes	96	3/23/1989	1
MCG 12	19099	Yes	55	3/25/1989	1
MCG 13	19103	Yes	91	3/28/1989	1
MCG 14	19102	Yes	85	3/29/1989	1
MCG 15	19104	Yes	40	3/30/1989	1
MCG 16	19106	Yes	60	4/1/1989	1
MCG 17	19098	Yes	187	1/00/1990	1
MCG 20	19791	Yes	152	10/14/1987	2
Nair 1	19506	Yes	97	5/19/1990	1
NorFab 1	18166	Yes	138	10/23/1989	2
OilSal 1	19793	Yes	55	2/13/1977	2
Oren 1	16841	No	224	1961	—
Porter 1	14658	Yes	105	8/4/1977	2
School 1	1335	Yes	197	4/16/1986	2
School 2	19795 17600	Yes	170	5/2/1988	2
Village 1	27711	No	136.0	12/21/1976	3
Village 2	27712	Yes	137.0	8/10/1977	2

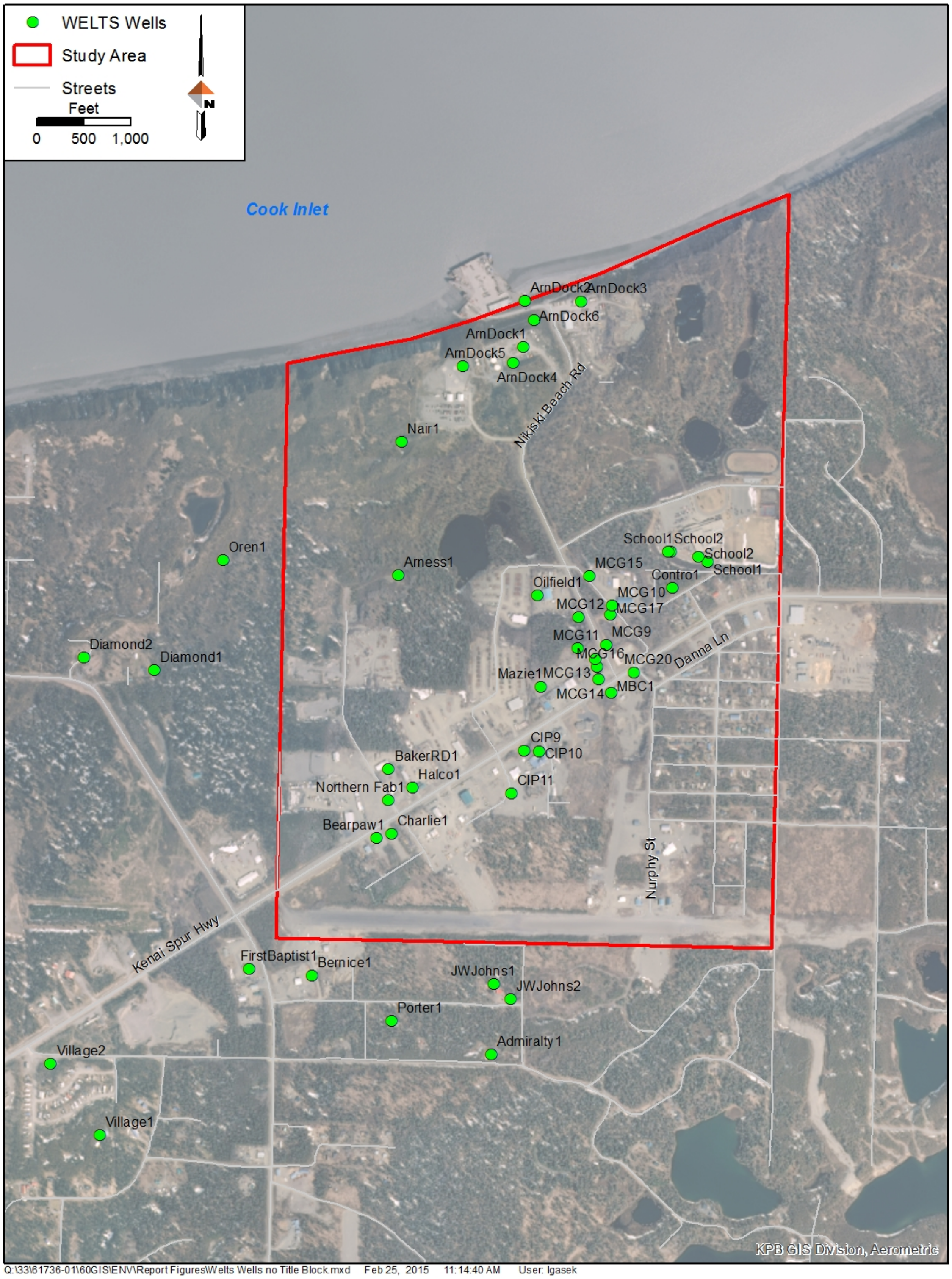

Figure 4: Locations of WELTS records.

2.1.1.3 ADEC

The Central Cook Inlet region has a long history of oil and gas development projects dating back to the 1950s and the first successful commercial oil production project, the Swanson River Field. Oil and gas development in the immediate area has included the Tesoro Kenai refinery, the ConocoPhillips liquid natural gas plant, and a variety of oil field services companies with shops and other associated industry support facilities located within and surrounding the study area. The activities of the oil and gas industry, including associated support services and other commercial activities within the area, have resulted in multiple sites with documented environmental contamination.

The DEC maintains a Contaminated Sites Program Database[3] which was consulted to identify known contaminated sites within the study area. DEC records for contaminated sites can provide additional background information, including previously completed study reports and the existence of monitoring wells associated with a site. Additionally, the database provides historical and contextual information on the known extent of contamination within the study area. This database identified 13 known contaminated sites with the following statuses: nine "cleanup complete", two "cleanup complete – institutional controls", and two "active". ADEC-documented sites within the study area are summarized in Table 3 and Figure 5.

[3] http://dec.alaska.gov/spar/csp/db_search.htm

Table 3: DEC Contaminated Sites within the Study Area

Map Id	Site Name	Status	Description of Contamination	Year of Initial DEC Action
1	Petro Marine Services - Arness Dock	Cleanup Complete	Diesel	1991
2	Nikiski Airstrip	Cleanup Complete – Institutional Controls	Oily waste, drums, unknown waste, garbage	1988
3	Arness Septage	Active	Drag-reducing agent, non-domestic wastewater and oil	1980
4	Baker Oil Tools	Active	Trichloroethene	2012
5	Tesoro Land & Marine Rental Co.	Cleanup Complete	Petroleum, waste oil	1990
6	Hallco Building	Cleanup Complete	Diesel	1989
7	Silvertip Storage Yard	Cleanup Complete	Waste oilfield chemicals	1988
8	Cook Inlet Processing - Nikiski 1	Cleanup Complete	petroleum	1994
9	Cook Inlet Processing - Nikiski 2	Cleanup Complete	Diesel	2002
10	Cook Inlet Processing Miller Est.	Cleanup Complete	Diesel, used oil, hydraulic fluid	1995
11	McGahan Utilities	Cleanup Complete – Institutional Controls	Tetrachloroethylene	1988
12	Nikiski Fire Department #2	Cleanup Complete	Diesel	1991
13	Steve's Chevron	Cleanup Complete	Diesel	1991

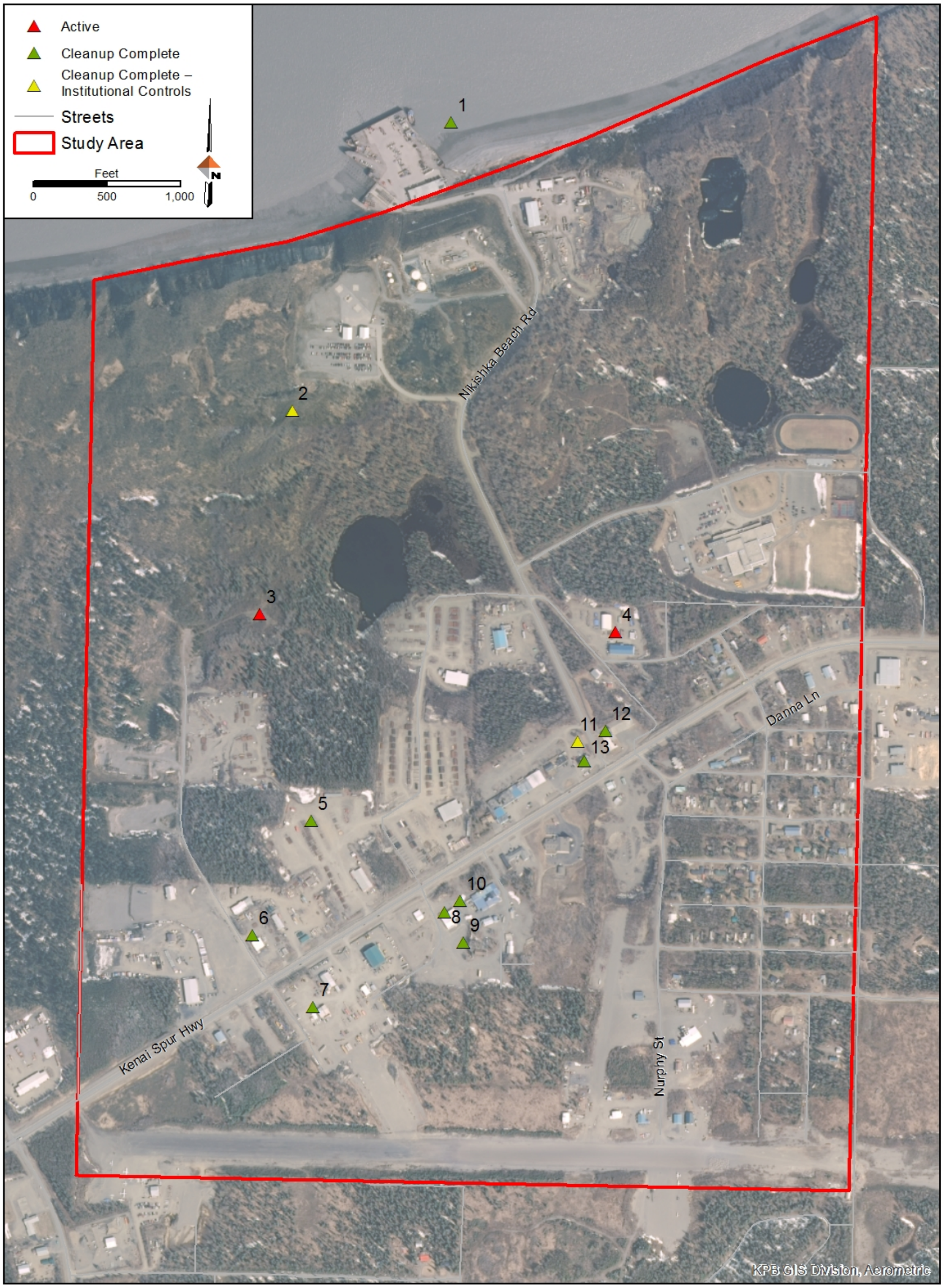

Figure 5: Contaminated Sites within the Project Study Area as Recorded by DEC

Data was obtained with the help of ADEC staff in Soldotna. DOWL staff spent one day in the Soldotna DEC office (October 2, 2014) reviewing the paper files for sites and copying pertinent records for use. Most of the 13 contaminated sites within the study area provided limited information from previously conducted assessments and studies; previous measurements and surveys are not generally available for monitoring wells. However, four sites yielded data from multiple years due to required monitoring: Arness Disposal, Nikiski Airstrip, Baker Oil Tools, and McGahan Utilities. These sites are summarized in Appendix B. Additionally, pre-project development permitting requirements for the AIMM monofill site yielded survey and groundwater elevation data.

Discrepancies in previous survey data, ambiguous techniques, and the reproduction of previously produced survey data further limited the usefulness of the available information.

2.1.2 Field Survey

DOWL collected field measurements of wells within the study area and the immediate surrounding area, including well location (longitude, latitude, and elevation of the ground surface and well casing) and depth to water. The survey data provided a record of well locations and a common datum (elevation) for comparing groundwater depths. Field survey efforts were completed between November 15 and 17, 2014 and captured data for 60 wells and four lakes. Figure 6 shows wells where data was collected during field efforts.

See Appendix C for the Surveyor's Report, including the results of field activities.

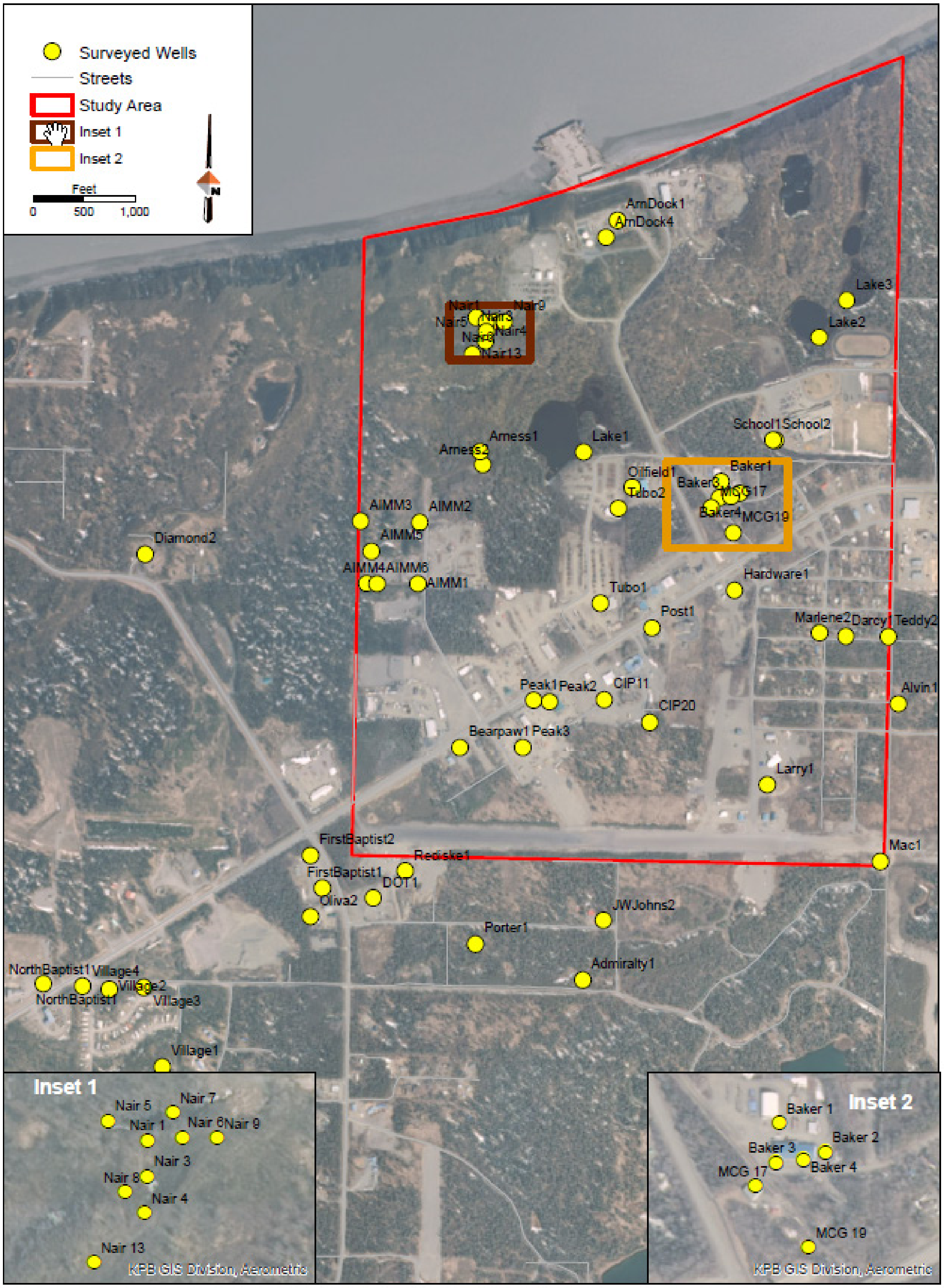

Figure 6: Field Survey Locations

2.1.2.1 Terrestrial Survey

Horizontal and vertical control was established using Real Time Kinematic Global Positioning System (GPS) survey equipment. A temporary control point was established within the study area and the GPS base unit was stationed at this location to record a static position. A roving unit in communication with the base unit was used to collect the horizontal and vertical positions of each well. Following field collection efforts, the data was processed and normalized. Processed horizontal coordinates (latitude and longitude) and vertical (elevation) data both have a margin of error of +/- 0.1 feet.

2.1.2.2 Groundwater Measurements

The depths of groundwater were measured with a Ravensgate Model 200 sonic water level meter. The meter operates by emitting a series of acoustical pulses and measuring the time it takes for the sound to return to the meter after reflecting off of the surface of the water. Use of the sonic meter provided depth to water measurements typically accurate within one to two tenths of a foot. This level of accuracy was considered sufficient as: the tool would prevent the potential for cross-contamination between wells, real or perceived; the quality of the available lithology data typically only provided a wide spread between stratigraphic layers (making exact depths unnecessary); and, well measurement accuracy would be consistent across all measured wells. The data collected was not intended to meet additional data needs beyond this study nor other agency or organizational protocols.

Measurements provided by the sonic meter may not provide the absolute consistency and accuracy traditional down-hole equipment is capable of producing. Although measurements were repeated to verify depth readings, equipment in wells, changes in casing size, misaligned casing, and other obstructions, can affect the accuracy of depth data. (Down-hole equipment requiring contact with the water was not used for the survey due to community concerns in general and the desire to not create any possibility of cross-contamination between either water wells or monitoring wells.) The sonic meter was always transported in its protective case and required no maintenance.

The meter was calibrated and measurements were verified prior to the field work commencing in Nikiski. Sonic meter temperature was set to 32 degrees Fahrenheit on day 1 and 40 degrees Fahrenheit on days 2 and 3 (ambient air temperature was at or below freezing during the time of survey, but downhole temperatures were not known). This change was initiated following consideration of downhole temperatures which were not known, but were reasonably believed to be slightly warmer than ambient air temperatures during the time of the survey.

The following list provides a general summary of the procedures and protocols typically employed for measuring water depths while conducting field activities:

1. Remove well cap or service port plug;
2. Remove excessive wiring from casing when required;
3. Use 6" casing adapter which allows for measurement from top of casing (location of terrestrial survey point) on water wells (older wells not employing a sanitary seal did not require the adapter as the well head cap was not removed and a service port was used allowing direct insertion of the meter's probe);
4. Use 2" PVC adapter on monitoring wells and correct measurement for 0.4" extension (the adapter was frequently required to reach PVC risers set beneath the top of monument boxes);
5. All measurements were repeated at least twice per well to confirm the results, which included removal of the meter from the well casing and subsequent reinsertion and measurement;
6. The riser pipe was used as the point of measurement for terrestrial survey on monitoring wells; and
7. Reassemble the well head as necessary.

2.1.2.3 Field Data Reconciliation and Quality Control

An initial field review of the data produced showed consistencies in areas where it might be expected, for example:

- Darcy 1, Marlene 2, Teddy 1, and Alvin 1 are residential wells located within a few hundred yards of each other and showed only a couple feet of differential in water elevation, in spite of a nearly 40’ difference in surface elevation;

- Village 1, 2, and 4 showed less than 0.5’ of differential in water elevation for three wells also located within a few hundred yards of each other; and

- Porter 10, 20, and 30 showed 1’ of differential in water elevation for three wells located several hundred yards apart.

Following the field survey efforts, data was input and processed for initial review. Data processing included applying appropriate correction factors to the survey data and converting depth to groundwater measurements to elevations using the common datum. Well locations and associated bore logs were confirmed at this time, allowing for final input into the modeling software. A quality control analysis was performed on the processed data, using existing records of known well measurements. This round of quality control review was limited due to the few records available for the surveyed sites.

2.2 Subsurface Geology

The subsurface geology of the study area was determined through examination of publicly available well and test boring logs. No new borings were conducted for this study. The quality of the lithology logs varies greatly as they were completed by multiple people with varying ranges of expertise in soils identification. Additionally, the logs used in the subsurface investigation spanned 50 years, ranging from the 1960s to present day, making the possibility of altered ground elevations at well head locations likely for some of the data points. As such, the depths observed at the time of drilling may not accurately reflect current surface conditions at the site.

A quality assessment criterion was developed to classify the perceived quality of each log. Logs with a higher quality assessment rating were given preference in making interpretations regarding the subsurface geology. The log quality assessment criterion is as follows:

1. A log was assigned a quality value of "1" if it was created by a professional engineering firm or drilling company perceived to have a high level of expertise, sampling of material was conducted at frequent intervals, and the exact location of the boring is identifiable.

2. A log was assigned a quality value of "2" if it was recorded by a drilling company with a perceived intermediate level of expertise, the lithology changes were documented to a fairly precise interval (changes of less than approximately three to five feet were recorded), and the location of the boring is known exactly or with a high degree of certainty.

3. A log was assigned a quality value of "3" if the level of expertise of the individual recording the boring could not be determined or was perceived as low, the lithology changes were recorded in non-precise intervals (changes of less than approximately three to five feet were not recorded), and/or the location of the boring is not known exactly or with a high degree of certainty

The study site is located in an area composed of glacial deposits which can vary greatly over short distances. In the northwest corner of the study area, silty sands and gravels are common in the glacial moraine material. In the remainder of the study area, clean sands and gravels are interbedded with lenses of clay, silt, and silty sands and gravels. There is a clay and silt layer commonly observed at an elevation of approximately 75 to 100 feet within the study area. This layer separates the upper, unconfined aquifer from the lower confined aquifer. The general subsurface geology at the study site is in agreement with regional trends described by Freethey and Scully, 1980, Anderson and Jones, 1972, and Glass, 1996.

2.2.1 Groundwater Aquifers

An aquifer is defined as the saturated part of geologic materials capable of yielding significant water to wells or springs. In the Nikiski area, the geologic material is composed of unconsolidated glacial sediments and the water moves through small openings between grains of the material (clay, silt, sand, gravel, and cobbles).

An unconfined aquifer is one in which the upper surface of the aquifer is the water table, all permeable rocks below the water table are saturated, and the pressure of the water table is equal

to atmospheric pressure. A perched aquifer is an isolated lens (pocket) of water not connected to a larger aquifer system. A perched aquifer may sit on an impermeable layer such as clay. Wells in perched aquifers have the potential to be pumped dry as the water resource is not connected to a larger aquifer system capable of recharging the reservoir. A confined aquifer is one separated from the earth's surface by an impermeable layer, such as clay or hard/tight silt, preventing the upward flow of water and confining the water beneath a distinctly separating layer. Water in a confined aquifer may be under additional pressure, and, where the aquifer is tapped by a well, the water surface will rise in the well above the top of the confining layer. It is possible to have all three types of aquifers layered within a single vertical column.

The majority of the wells in the study area utilize two main aquifers in the Nikiski area. There is an upper unconfined aquifer separated from a lower confined aquifer by an impermeable to semi-impermeable layer of clay and silt. These aquifers are referred to within this report as the upper or upper unconfined aquifer and the lower or lower confined aquifer. The remaining wells are located in scattered and disconnected perched aquifers. Regionally, a third deeper, confined aquifer is believed to be present beneath a clay layer approximately 100 feet thick, but none of the wells identified in this study are believed to be accessing this deeper third aquifer based on interpretation of available information. A generalized schematic of the subsurface geology below the study site is shown in Figure 7.

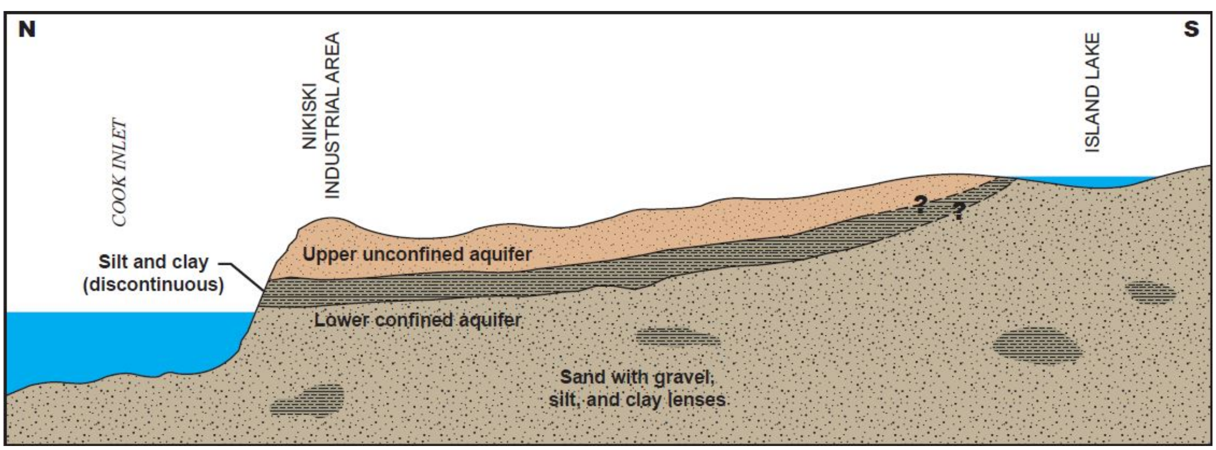

Figure 7: Generalized Geology and Aquifer Schematic in the North Nikiski Area. (Vertical Distance is Greatly Exaggerated).

Interpretation of which aquifer each well is accessing was accomplished by examining the well construction lithology logs and the subsurface geology model. At well locations where lithology logs were not available, the aquifer classification was determined by extrapolating the interpretation of nearby wells with similar groundwater elevations, or by using the projected aquifer surface modeled for each aquifer. If the modeled surface correctly predicted the measured groundwater elevation in an unknown well, it was assigned/grouped with the relevant aquifer in future revisions of the modeled groundwater surface. These techniques are discussed in greater detail in section 3.2 Mapping and Modeling and Appendix D, Technical Discussion.

2.3 Mapping and Modeling

Subsurface lithology mapping and modeling is the process in which two-dimensional lithology data (well lithology logs) is extrapolated to form a three-dimensional conceptual model of the subsurface of the study area. The three-dimensional subsurface geology model can then be used to help interpret the groundwater survey measurements and ultimately create a model of the groundwater system.

The lithology and groundwater models were created using a combination of geographic information system (GIS) mapping software and RockWorks subsurface modeling software. RockWorks is a subsurface visualization software package capable of creating maps, logs, cross-sections, solid three-dimensional models, and topographic surfaces through the interpolation and extrapolation of user supplied data.

2.3.1 Lithology Model

The lithology model was created based on the project geologist's *interpretation* of the available public well logs. Each sediment division identified within the logs was translated into a common Unified Soil Classification System (USCS) category; the USCS is a soil classification system used by geologists and engineers to describe the particle size distribution and texture of sediments. These classifications were then grouped into four sediment classes based on the general permeability of the sediments most relevant to the flow of groundwater. The four classifications used are (listed from greatest permeability to least): clean gravel and sands, silty gravel and sands, silt, and clay.

The geographic location of each lithology log was determined through field surveying, geographic information recorded on the logs, information or maps created during previous investigations, location data stored in DEC and USGS databases, or from the more general method of the official rectangular subdivision of public lands system (a system in which locations are recorded by quartering sections of the town ship and range system). The location of each log was plotted using a GIS mapping application and the latitude and longitude recorded in the well database created in Excel. These locations were then transferred to RockWorks for use in creating the lithology model.

Lithology divisions within logs are recorded in terms of depth from surface. To create a three-dimensional subsurface model, the elevation of the ground surface at the location of the log must be known. This information is often not accurately obtained and/or recorded at the time of the test boring or well installation and cannot be accurately known without surveying. The ground elevation for logs which were not surveyed during this study or during previous investigations required an elevation estimate derived from external data.

2.3.1.1 Topographic Surface Model

In order to estimate the ground elevation at the location of the lithology logs without survey data, a topographic model of the ground surface was created for the study area. DOWL was provided with a Digital Elevation Model (DEM) model of the study area from the KPB in the form of a GIS raster layer. The data used to generate the DEM was collected through a previous Laser Imaging Detection and Ranging (LIDAR) survey. The elevation data contained within the GIS raster layer was then translated into RockWorks and a three-dimensional surface was created. This surface can be seen in Figure 8.

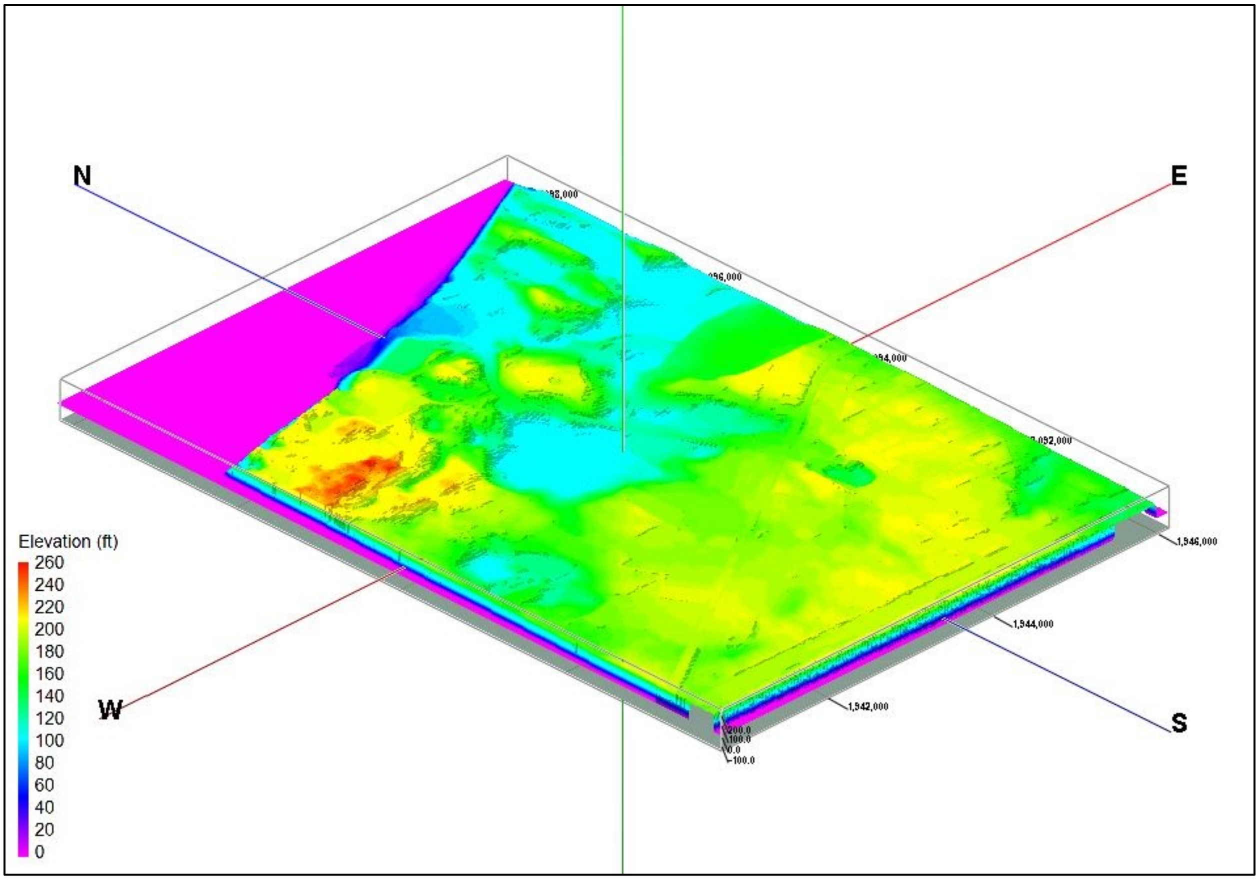

Figure 8: Topographic Elevation Model

2.3.1.2 Subsurface Solid Model

Once all of the test boring and well logs had been translated into one of the four lithology groups discussed above, and geographic location and elevation data was assigned, the logs were plotted in three-dimensional space. The distribution of logs within the model can be seen in Figure 98 (an aerial photo of the study area was applied the topographic surface for reference) and the lithology log data is tabulated in Appendix D: Technical Discussion.

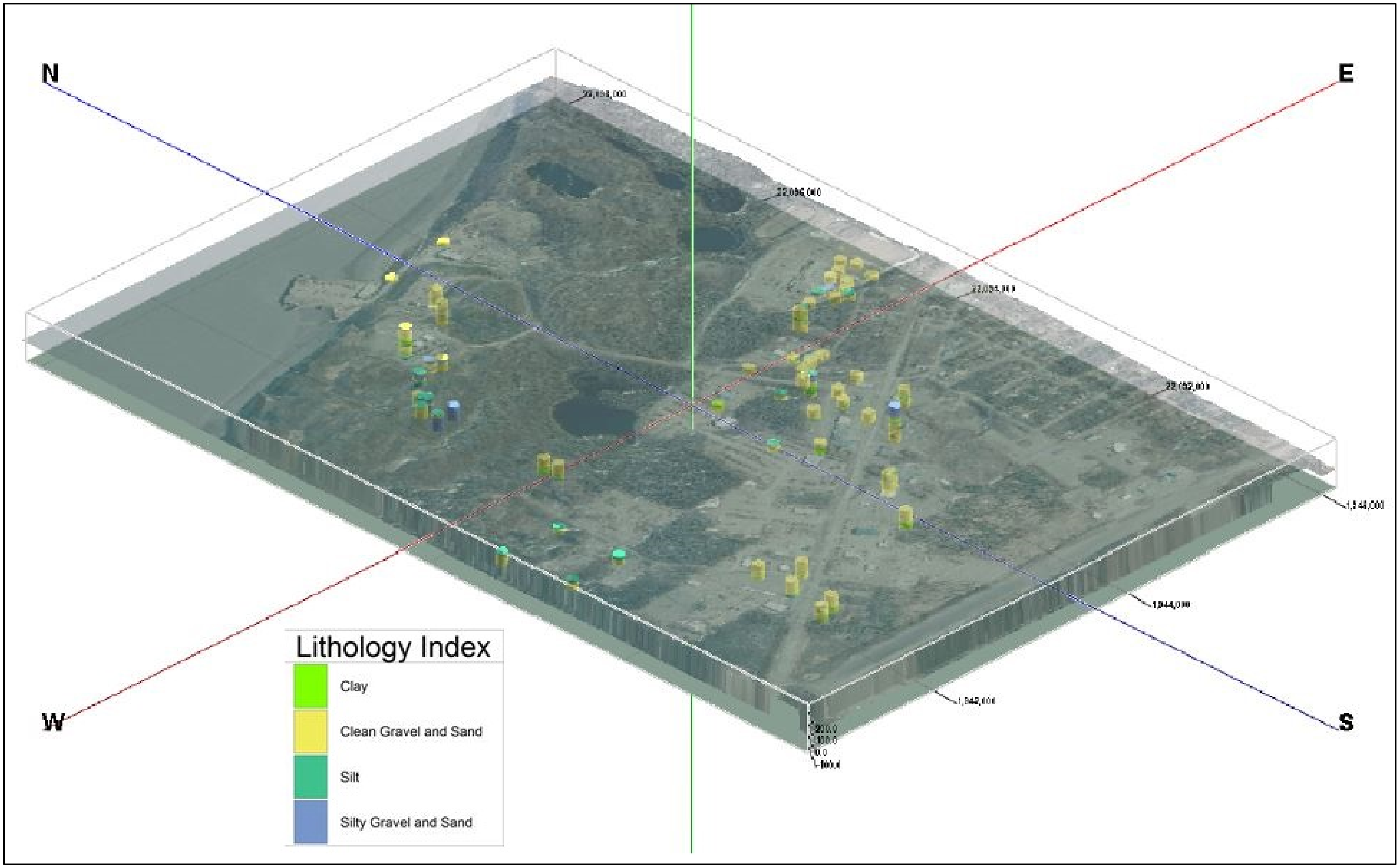

Figure 9: Lithology Log Distribution with Aerial Photograph Draped Over Topographic Elevation Model

A solid model was then generated from the lithology logs through application of a horizontal lithology blending function. The lithology blending algorithm assigns a lithology type to unknown locations by looking outward horizontally from each lithology type in each borehole and in search circles of ever-increasing diameter. It assigns the space immediately surrounding each borehole (50-foot radius) the closest lithology value. It then moves out by an additional 50 feet, and assigns the next circle of lithology values, effectively "bleeding" the lithology type outward from the wells in a horizontal fashion. The software continues in this manner until the program encounters interpolated locations already assigned lithologies. The resulting model from this step can be seen in Figure 10. It is important to note that within glacial deposits, such as those composing the study area, the confidence of the horizontal projection decreases with distance from the control points (i.e. the well lithology logs). Model confidence is discussed in further detail in Appendix D, Technical Discussion.

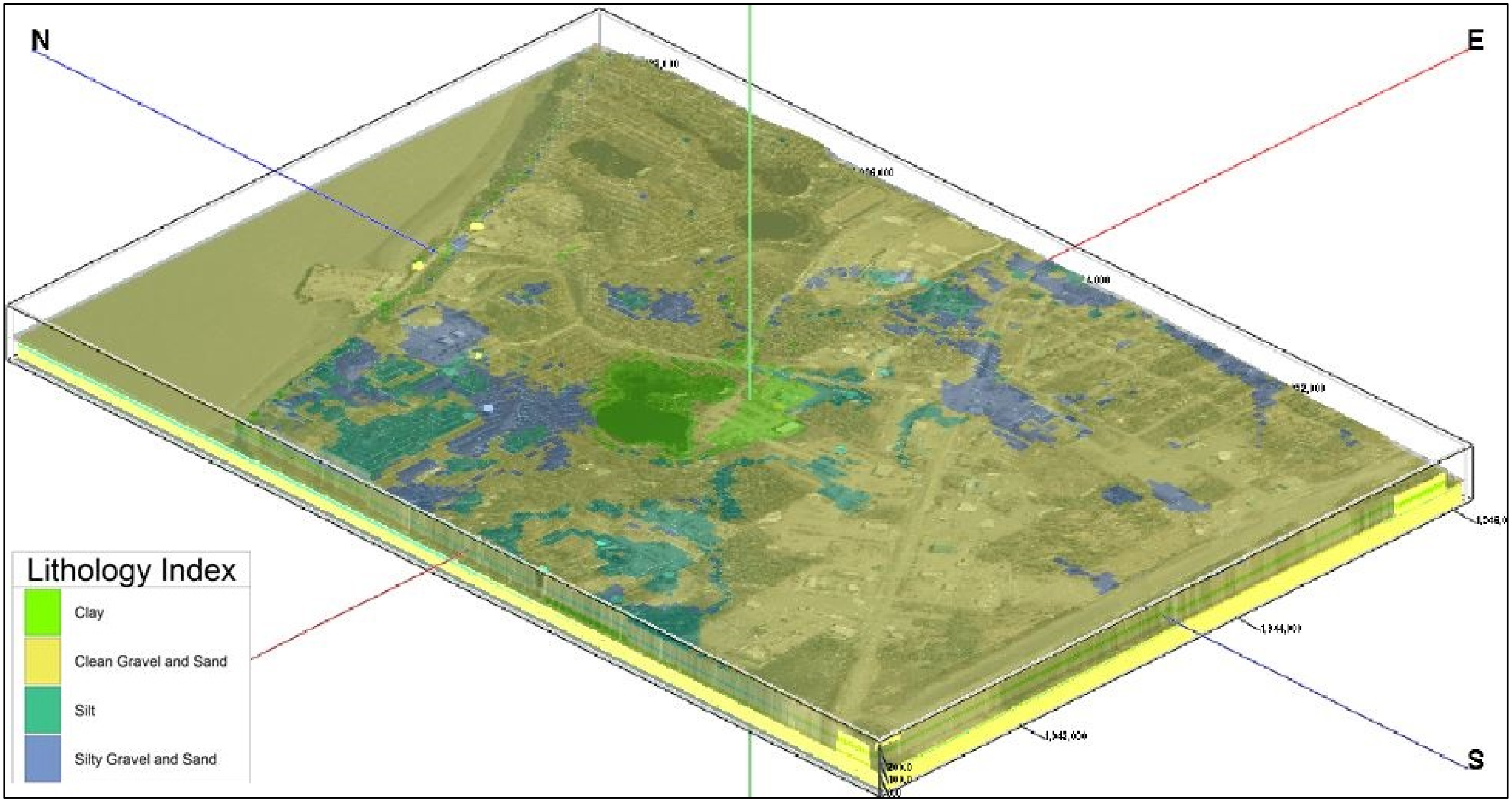

Figure 10: Lithology Solid Model with Aerial Photograph

2.3.1.3 Solid Model Filtering

One limitation of this solid model lithology blending method is lithologies near the bottom of deep test borings will be projected for great distances across the study area when another horizontal control point (test boring) is not encountered. This generates a misleading model of the subsurface. To control how far lithologies are projected horizontally near the base of the wells, an additional three-dimensional surface was created to filter out the misleading data. This filtering surface was created from the elevations of the bottom of the test borings (this surface can be seen in Appendix D, Technical Discussion). This can be thought of as slicing the bottom of the model off in a "connect-the-dots" fashion from the base of each well. The upper surface of the model is controlled by the topographic elevation model discussed in Section 2.3.1.1. The lithology model resulting from this step is seen in Figure 11.

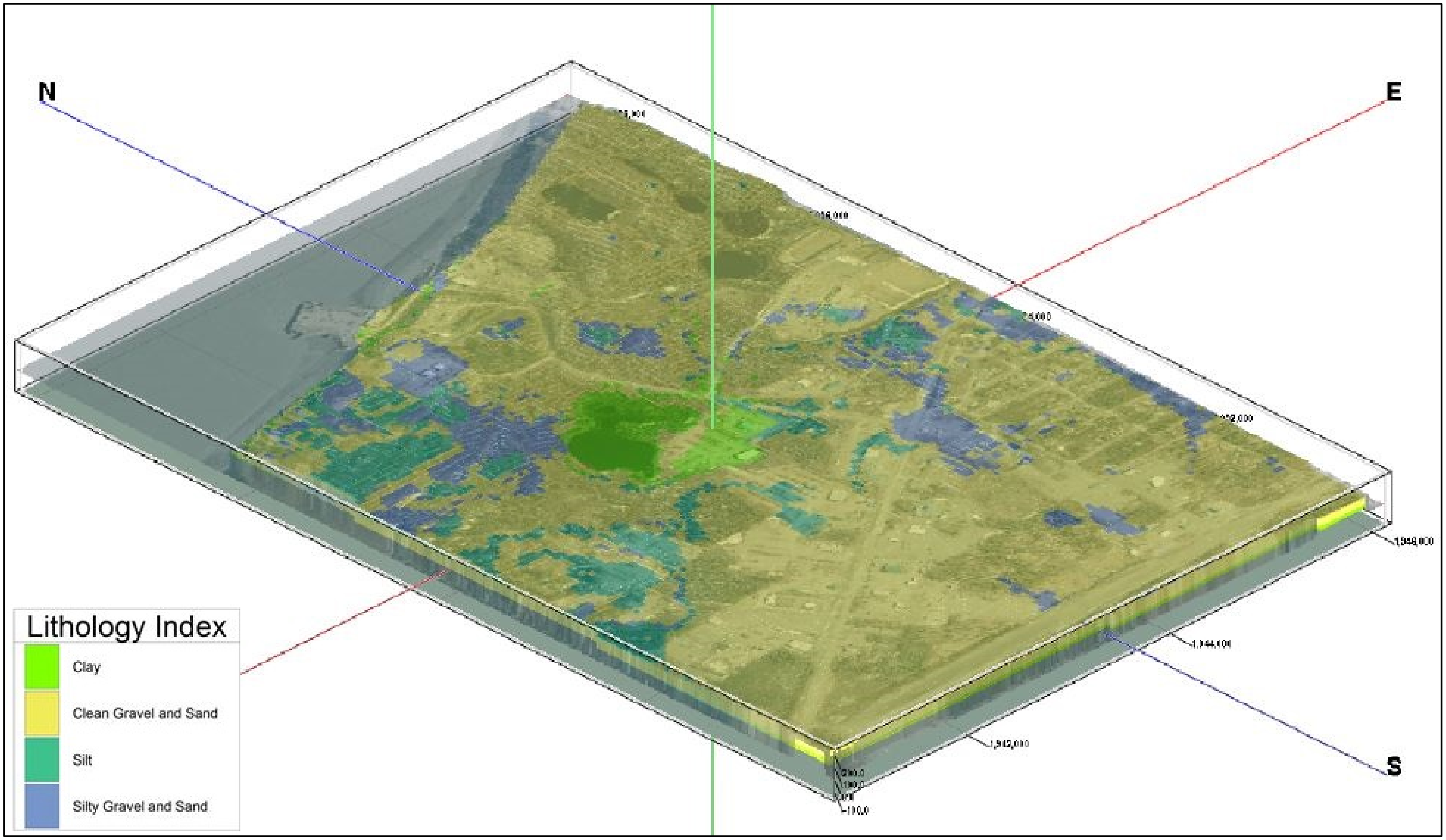

Figure 11: Lithology Solid Model Base Filtered

2.3.1.4 Geologic Cross-sections

Geologic cross-sections are two-dimensional projections of the subsurface. They are vertical "slices" of the geology beneath the grounds surface. For this project, geologic cross-sections were created by taking slices of the lithology solid model. The locations of the cross-sections presented within this report were chosen in areas of the study area where: a) there is a high density of well logs; b) cross-sections pass through and illustrate the subsurface near areas of interest (contaminated sites); and c) differences in aquifer water elevations are illustrated. Additionally, measured groundwater elevations are shown on the cross-sections. This aided interpreting which aquifer individual wells are likely utilizing. The cross-section location map, individual cross-sections, and discussion are located in Appendix D.

2.3.1.5 Limitations and Confidence

The subsurface geologic model was limited by the quality and geographic distribution of the data. Drill logs used for the subsurface model varied in level of detail and perceived expertise of the person creating the log. Logs with a higher qualitative assessment rating (discussed in Section 2.2, Subsurface Geology) were used to make subsurface determinations in areas where multiple interpretations are possible. The geographic distribution of the well logs is another limiting factor of the subsurface model. Glacial deposits can vary over short distances. The confidence in the model decreases the further the model is extrapolated from the data input, i.e., model confidence is greater the nearer a point is to a well log. The average minimum distance between wells is 434 feet and the wells are not evenly distributed (the wells occur in groups near each other), so it is possible the model is not capturing or displaying all of the subsurface trends and details.

3.0 RESULTS

3.1 Subsurface Geology and Groundwater Aquifers

The subsurface lithology was found to consist of complex interbedded glacial deposits, i.e., interbedded layers and lenses of gravel, sand, silt, clay, and gravel-sand-silt-clay mixtures. This creates an environment where groundwater occurs in perched, unconfined, and confined aquifers.

A clay and silt layer was commonly observed in the well logs at an elevation between 50 and 75 feet. This layer is interpreted to be a confining layer between two aquifers: an unconfined aquifer (above the clay and silt layers) and a confined aquifer (below the clay and silt layer). The data does not demonstrate conclusively if the confining layer is “leaky” or not.

3.1.1 Groundwater Models

After creation of the lithology model and examination of the well lithology logs, the aquifer each well is likely utilizing was determined. The interpretation of which aquifer each well is accessing is shown in Table 4 and discussion of well inclusion can be found in Appendix D, Technical Discussion. Once each well was assigned to an aquifer, interpolation techniques were applied to the measured groundwater elevations to generate groundwater surface contour maps for each aquifer. The groundwater surface contours were then used to determine probable groundwater flow directions.

Table 4: Groundwater Elevations and Interpreted Aquifers

Site Name	Well ID	Casing/Riser Elevation	Depth to Water (*ft*)	Water Elevation	Interpreted Aquifer
AIMM Monofill	AIMM 1	149.98	56.8	93.18	Upper
	AIMM 2	137.94	44.8	93.14	Upper
	AIMM 3	171.80	79	92.8	Upper
	AIMM 4	161.44	68.6	92.84	Upper
	AIMM 5	161.35	60.4	100.95	Perched*
	AIMM 6	154.76	57.8	96.96	Perched*
Arness Disposal	Arness 1	191.44	109.2	82.24	Lower
	Arness 2	185.51	107.2	78.31	Lower
Arness Dock	ArnDock 4	144.38	98.5	45.88	Perched
	ArnDock 1	144.15	45.4	98.75	Perched/Upper
Baker Oil Tools	Baker 1	132.07	35.2	96.87	Upper
	Baker 2	133.74	35.3	98.44	Upper
	Baker 3	132.89	35.6	97.29	Upper
	Baker 4	136.63	42.3	94.33	Upper
Bear Paw Coffee Shop	BearPaw 1	187.31	100.5	86.81	Lower
Cook Inlet Processing	CIP 9	184.67	11.4	173.27	Perched
	CIP 20	179.73	93	86.73	Lower
	CIP 11	183.59	97.8	85.79	Lower
Darcy	Darcy 1	192.78	106.5	86.28	Lower
Diamond	Diamond 2	214.44	144.6	69.84	Lower
DOT&PF	DOT 1	187.78	94.8	92.98	Lower
First Baptist Church of Nikiski	FirstBaptist 1	181.76	91.7	90.06	Lower
	FirstBaptist 2	180.99	94.1	86.89	Lower
Hardware Store	Hardware 1	176.39	91.7	84.69	Lower
Lake	Lake 1	N/A	N/A	98.07	Upper
	Lake 2	N/A	N/A	96.48	Upper
	Lake 3	N/A	N/A	97.8	Upper
	Lake 4	N/A	N/A	192.66	Perched
Larry Miller	Larry 1	190.94	95.1	95.84	Lower
Marhenke Res	Alvin 1	155.84	66	89.84	Lower
	Teddy 1	174.78	85.9	88.88	Lower
Marlene Res	Marlene 2	191.86	105.5	86.36	Lower

Site Name	Well ID	Casing/Riser Elevation	Depth to Water (*ft*)	Water Elevation	Interpreted Aquifer
Mack McGahan Residence	Mack 1	147.18	38.3	108.88	Lower
McGahan Utilities	MCG 17	138.03	55.3	82.73	Lower
	MCG 19	138.62	44.9	93.72	Upper
Nikiski Airstrip	Nair 1	193.89	89.4	104.49	Perched/Upper
	Nair 3	195.55	95.5	100.05	Perched/Upper
	Nair 4	213.06	121	92.06	Perched/Upper
	Nair 5	194.43	95.8	98.63	Perched/Upper
	Nair 6	204.51	111.7	92.81	Perched/Upper
	Nair 7	195.28	N/A	N/A	Unknown
	Nair 8	215.75	N/A	N/A	Unknown
	Nair 9	215.97	120.5	95.47	Perched/Upper
	Nair 13	220.20	124.5	95.7	Perched/Upper
North Kenai Baptist Church	NorthBaptist 1	170.02	87.5	82.52	Lower
Oilfield Salvage	OilSal 1	130.23	36.3	93.93	Upper
Oliva	Oliva 2	174.18	84.4	89.78	Lower
Peak Oilfield Services	Peak 1	185.66	100.1	85.56	Lower
	Peak 2	186.20	100.4	85.8	Lower
	Peak 3	188.70	101.5	87.2	Lower
Porter Road	JWJohns 2	187.02	88.9	98.12	Lower
	Admirality 1	186.36	87.2	99.16	Lower
	Porter 1	185.44	86.8	98.64	Lower
Post Office	Post 1	187.32	102.2	85.12	Lower
Rediske	Rediske 1	183.63	92.5	91.13	Lower
Nikiski High School	School 1	158.52	77.5	81.02	Lower
	School 2	159.94	77.8	82.14	Lower
Tuboscope	Tubo 1	176.26	92.9	83.36	Lower
	Tubo 2	128.81	34.9	93.91	Upper
Village Trailer Court	Village 1	176.74	90.1	86.64	Lower
	Village 2	147.94	63.8	84.14	Lower
	Village 3	155.98	54.7	101.28	Perched
	Village 4	156.02	71.8	84.22	Lower

**Note: Data suspect due to potential damage or other obstruction to monitoring well resulting in likely false groundwater depth measurement.*

3.1.2 Results Summary

Two distinct aquifers were determined to be present beneath the study area. The deeper aquifer appears to be at least partially confined beneath a layer of silt and clay (commonly observed between 50 and 75 feet elevation) and is continuous, at depth, beneath the study area. This aquifer appears to be well connected hydrologically and displays a fairly consistent hydraulic gradient with general flow from the southeast to northwest. Above the confining layer is another less understood aquifer. This upper aquifer does not appear to be well connected hydrologically across the study area. It has a very general trend from east to west but has local variations in flow direction (likely due to preferential flow paths in the sediment). The upper aquifer flow direction also appears to be susceptible to localized drawdown pumping effects.

3.1.2.1 Lower Aquifer

The lower aquifer is the confined aquifer and interpreted to be present, at depth, across the study area. Thirty four (34) of the wells surveyed with groundwater measurements are interpreted to be accessing the lower aquifer. The data supports the lower aquifer being well connected hydrologically and the piezometric surface (the level of the groundwater table in a confined aquifer, once allowed to rise past the confining layer) displays a generally consistent slope and directional trend. The piezometric surface/groundwater table of the lower aquifer was generated through interpolation of measured groundwater elevations in wells interpreted to be accessing the lower aquifer. A natural neighbor interpolation function was selected for the interpolation technique (Kriging interpolation was also conducted and generated very similar results; see Appendix D, Technical Discussion). The piezometric surface/groundwater table of the lower aquifer provides an indication of the direction of groundwater flow. The interpolated groundwater surface fitted with 5 foot contours and groundwater flow directions can be seen in Figure 12.

Figure 12: Lower Aquifer Groundwater Contours and Flow Directions

3.1.2.2 Upper Aquifer

The remaining 26 of the surveyed wells and four lakes are interpreted to be accessing the upper unconfined aquifer or perched aquifers. The upper aquifer is likely comprised of multiple bodies of groundwater with varying degrees of hydraulic connectivity; for the purposes of this report, this system of aquifers is referred to as the upper or unconfined aquifer. When the groundwater elevations of the surveyed wells and lake surfaces of the upper aquifer wells in the central study area are modeled together, conflicting groundwater contours are resultant. For example, the groundwater contours (0.5 feet intervals) generated through natural neighbor interpolation suggests irrational groundwater flow directions and are shown in Figure 13.

Figure 13: Upper Aquifer Natural Neighbor Conflicting Groundwater Model

The result of this model suggests: a) the upper aquifer is not well hydrologically connected and that preferential flow patterns are present in the subsurface; b) some of the wells are accessing perched isolated aquifers; and/or c) not enough data is available to accurately capture the characteristics of the upper aquifer.

Assuming the remaining wells (those not accessing the confined aquifer) are not accurately representing continuous groundwater gradients, it is appropriate to analyze each grouping of well data individually. The wells were divided between the AIMM monofill site, the Nikiski Airstrip site, and Baker Oil Tools area. The groundwater table at each of these sites was then modeled individually.

3.1.2.3 AIMM Monofill Site

Four (4) surveyed welled and groundwater measurements were used to create the groundwater contour map for the AIMM Monofill site. The groundwater measurements from monitoring wells five and six were not including in the analysis as the measured groundwater elevations were anomalous (they are interpreted to be obstructions or constrictions of the well casing creating a false reading in the sonic meter). The data indicates a generally westward groundwater flow direction. The flow direction and groundwater gradient are in general agreement with the results of Weston Solutions, 2012.

A Kriging interpolation method was appropriate for generation of the groundwater contours (0.08 feet per contour) and the resultant contours and groundwater flow direction are shown in Figure 14.

Figure 14: AIMM Monofill Groundwater Contours and Flow Direction

3.1.2.4 Nikiski Airstrip Area

The Nikiski Airstrip is located on glacial moraine material. Isolated, perched aquifers are common in moraine material due to the heterogeneous blend of gravel, sand silt, and clay of the material. Groundwater measurements at the Nikiski Airstrip suggest many of the wells are accessing disconnected or poorly connected perched aquifers or lenses of water; groundwater elevations varied as much as 8 feet between wells approximately 175 feet apart. Additionally, several of the groundwater measurements are at a higher elevation than the regional aquifers, indicating they may be perched aquifers isolated from the larger systems. Previous studies at the Nikiski Airstrip also documented a large range of groundwater elevations for the site as well, and it has been suggested all groundwater flows north towards a small seep observable in the bluffs north of the site. Our data suggests it is possible some of the water entering the moraine as precipitation also drains to the south of the site.

An inverse distance weighted (IDW) interpolation technique best represents the groundwater elevations at the Nikiski Airstrip site. The resultant contours (2 feet per contour) and groundwater flow directions are shown in Figure 15. The groundwater flow direction indicators are dashed to indicate the possible flow direction; however, it is not clear if the lenses of water are hydrologically connected.

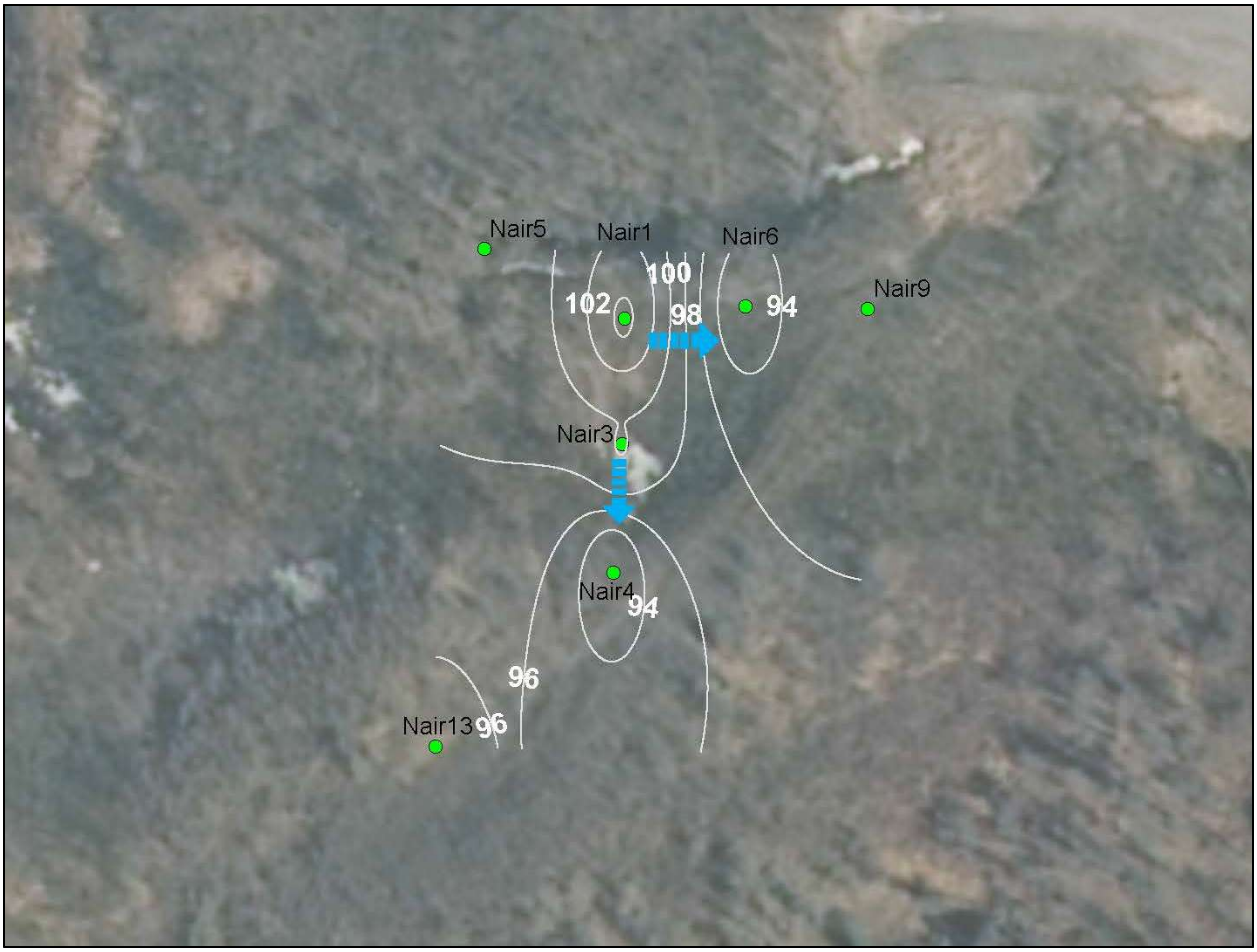

Figure 15: Niksiki Airstrip Groundwater Contours and Potential Flow Directions

3.1.2.5 Baker Oil Tools Site

The Baker Oil Tools Site includes the area from Baker Oil Tools west to the TuboScope and Oil Field Salvage sites. Most of the surveyed and measured wells in this area are interpreted to be accessing the upper aquifer (except MCG17). The general trend in groundwater flow is from east to west. The data shows a depression in the groundwater table around well Baker 4. This is a production well believed to have been pumping prior to well measurements, resulting in a discontinuity in the data. Although the well was turned off before groundwater measurements were taken, it does not appear enough time was allowed for the groundwater table to equilibrate and a pumping drawdown effect is captured in the data. In spite of this, it appears the overall trend (flow from east to west) is still preserved. This finding is in general agreement with groundwater gradients reported by Ahtna, 2014, which documented two groundwater gradients

to the northwest and southwest. An inverse distance weighted interpolation technique best represents the groundwater conditions at the time of measurement and the resultant contours (1 foot contours) and groundwater flow directions are shown in Figure 16. Smaller dashed arrows in the figure represent groundwater flow directions interpreted to be created by localized drawdown by pumping while the natural trend is shown with the larger arrow.

Figure 16: Baker Oil Tools Area Groundwater Contours and Flow Directions

3.1.2.6 Limitations and Confidence

The largest limitation for the aquifer modeling is the interpretation of which aquifer was accessed by each well. This interpretation was largely dependent on the availability of well lithology logs. In the event a surveyed and measured well did not have accompanying lithology data, the interpretation of which aquifer each well was accessing was accomplished by examining nearby well groundwater elevations. For example, in the Nikiski Village Trailer Court area, two of the surveyed wells had lithology logs which suggested they were accessing the

lower aquifer. A third well had no lithology data but similar groundwater elevation, so it was assumed to be accessing the lower aquifer as well. A fourth well had no lithology data but had a drastic difference in groundwater elevation (greater than 12 feet), so it was assumed this well was accessing a separate perched aquifer. In the event a surveyed and measured well did not have accompanying lithology data and no nearby comparable wells, the interpretation was based on projected groundwater gradients of the modeled aquifers. For example, the Diamond and Hangar 1 wells have no nearby comparable wells. A lower aquifer model was created without their groundwater elevations included and the modeled projected surface was compared to the measured level. If the projection was close to the measured value (within 2 feet), the well was interpreted to be part of the modeled aquifer and included in updated renditions of the model.

The groundwater analysis and modeling revealed several problematic areas for the interpretation of the known contaminant history and future. Around the Arness site, the data suggests the two wells are screened and accessing the lower aquifer below a confining layer, but the contaminant source was located on or near the surface as shallow buried waste. The fact the contaminant is detectable in water samples from the well suggests: a) the confining layer between the upper aquifer and lower aquifer is discontinuous and may be leaking down into the lower aquifer at the Arness site; b) wells on site may not be sealed properly and contaminant is draining down the well from the upper levels to the groundwater below; and/or c) the Arness wells are accessing an isolated aquifer not well understood due to lack of nearby wells and data.

Analysis from this study and previous studies suggests the hydraulic gradient in the upper aquifer near the Baker Oil Tools site is very susceptible to pumping. This limits how accurate projections of the natural groundwater gradient can be without a well-organized effort to coordinate a shutdown of all nearby pumps for a long enough time period to allow the groundwater to equilibrate and groundwater measurements to then be made. Additionally, it suggests the natural groundwater gradient in the area may not be as important on influencing the contaminate transport direction as the local drawdown effect of nearby pumping.

4.0 ADDITIONAL STUDIES AND RECOMMENDATIONS

Data collection for this project was limited to existing lithology records made available to the project team and collection of field measurements including well location and water depths. This methodology was determined to be a cost effective solution for the task of producing generalized groundwater flow models, but it does contain limitations inherent to using data of limited detail and varying quality. As such, further efforts could be conducted to refine the accuracy of the model, expand or narrow the geographic area encompassed within the model, and/or generate additional models with alternative objectives.

In recognition of limited financial resources, any further efforts should be tailored to clearly defined goals determined by the KPB to best serve residents and industries within the study area. In this section, several of the potential additional studies and actions are discussed. Table 54 summarizes the potential studies envisioned by DOWL for consideration by the KPB. Additional studies focused on the goals of the KPB may take the form of a combination of the following activities.

Table 5: A Summary of Potential Additional Studies and Actions

Recommended Action	Cost	Description
Public Education Campaign	$5,000 - $10,000	Provides well owners information on how they can better protect their water wells. Informs well owners on how to test drinking water and what tests should be examining for…
Datalogger Installation	$4,000 - $10,000	Install dataloggers to record groundwater elevations for extended periods of time around areas of interest. This would provide information on localized flow variation and could provide background data for drawdown testing.
Drawdown Testing	$8,000 - $12,000	Pumping tests can be conducted on wells near contaminated sites to determine the influence of well pumping on the groundwater flow direction and to determine aquifer analytical characteristics.
Installation of Monitoring Wells	$10,000 - $30,000	Install additional monitoring wells on KPB property neighboring the Arness Disposal site and/or the former laundry on Nikishka Beach Road. This would provide additional lithology, assist in on-going monitoring efforts, and further define the extent of contamination.
Tracer Identification and Testing	$15,000 - $30,000	Identify chemical signature specific to one or both aquifers and sample wells throughout the study area for each signature. This information would confirm the conclusions of the model.
Additional Survey Data	$15,000 - $30,000	Collect additional round(s) of measurements from the study area to further refine the model and provide insight on seasonal fluctuations in the water table.
Expand the Study Area	$25,000 - $75,000	Expand the study area to the south and/or west to include areas with higher residential densities. This would provide a larger picture of groundwater movements in the area and assist in determining areas potentially at risk of groundwater contamination.
Plume Identification/Modeling	$75,000 - $100,000	Plume identification would be a combined effort of several of the techniques listed above, as well as additional efforts and testing to create a contaminant fate and transport model to determine the extent of contamination and the ultimate fate of the hazardous materials.

4.1 Additional Studies

The following subsections contain recommendations for potential future studies should additional funding be made available. Each option is discussed in terms of what sort of action would be involved, the likely benefits the information would provide, and a general cost estimate. Cost estimates provide a probable cost associated with performing the stated tasks, though refinement of sampling size or analysis may be tailored to some degree based on available funding.

4.1.1 Public Education Campaign

As this study was in large part driven by concerns over water quality by area residents, a public outreach and education campaign about how well owners can better protect and test their water supply would likely aid in alleviating community concerns.

Many of the wells in the study area were observed to not use modern sanitary seals or concrete aprons as preventive measures to protect them from surficial contamination, were placed on flat terrain, or only had a short length of well casing rising above the surrounding ground surface. Contamination from surface water, whether it be hydrocarbon products or bacteria carried in runoff water, can be easily transmitted to source water through migration along the well casing. The DEC and other environmental agencies suggest the following tips for wellhead protection:

- Ensure the ground around the wellhead is sloped to drain away from the well for at least 10 feet in all directions to ensure there is no standing water at the wellhead;
- Leave a minimum of two feet of well casing “stickup” above the surrounding ground surface;
- Installation of a concrete apron around the well casing;
- Don’t pile snow, leaves, or other materials around the well;
- Installation of a proper wellhead sanitary seal (not just a well cap) to minimize or prevent insect or airborne debris from entering the well casing;

- Dispose of hazardous products (e.g., motor oil, solvents, antifreeze, etc.) properly;
- Limit the use of chemicals, fertilizers, pesticides, and other hazardous products; and
- Properly maintain septic systems.

Water testing for contamination can be cost prohibitive as testing prices can range from $40 for basic bacterial testing into several hundred dollars for more exhaustive chemical contamination tests. Identification of likely contaminants, as determined from previous DEC studies and water testing, could be provided to well owners to limit costs through tailored testing parameters. Public outreach efforts could include a combination of local advertisement, targeted mailings to area well owners, and/or community meetings. Additional resources, if available, could be used to establish a grant program to reduce the financial costs associated with individual well testing based on KPB determined guidelines.

Estimated Cost: $5,000 – $10,000

4.1.2 Datalogger Installation

Groundwater dataloggers are devices installed into a groundwater monitoring well and left in place for a period of time. During this time, they collect groundwater level measurements automatically and the measurements are stored within the device. This data is then retrieved and analyzed to obtain continuous groundwater elevation measurements at a location. Dataloggers could be installed within wells around areas of interest to capture seasonal variation and localized aquifer variation created through groundwater pumping. This can be a cost effective solution to obtain groundwater measurements within wells where accurate location data obtained through professional survey already exists. Additionally, dataloggers can provide background data prior to conducting further aquifer tests such as drawdown testing and plume identification/modeling.

Estimated Cost: $4,000 – $10,000 (per well installation)

4.1.3 Drawdown Testing

Drawdown is a side effect of well pumping and the time lag associated with well recharge. As water is pulled from a well by pumping, water at the surface of the aquifer exhibits a depression due to the time required for water to migrate through the geological material. Drawdown creates a localized change in flow direction of the aquifer towards the pumping well. This can influence the transport direction of contaminates within the groundwater.

Drawdown testing consist of measuring the static level of water, pumping the well for a period of time, measuring the depth of the water immediately following pumping, and then measuring the time required for the water level to return to its previous static level. Additionally, at least one additional well (screened within the same aquifer and within the range of influence of the pumping well) is also used as an observational well. The drawdown should be measured at an observation well located approximately one to two times the saturated thickness of the aquifer away from the pumped well. Groundwater elevation measurements are obtained from this well during the test. Drawdown testing can be used to determine hydraulic parameters (e.g. transmissivity and storage coefficient) and the area influenced by the pumping well.

There are several limitations to drawdown testing requiring consideration. To accurately capture the aquifer characteristics, it is preferable the pumping well is screened entirely through the thickness of the aquifer. This is unlikely for most of the wells within the study area. Another limiting aspect is the pumping of other nearby wells must be coordinated with the testing so other wells are not influencing the measurements at the well being studied or the observation well(s). Drawdown pump tests are generally conducted for approximately 24 hours in a confined aquifer and 72 hours in an unconfined aquifer. However, some conclusions can be reached concerning the area of influence of a pumping well without the above stated limitations being met. If background data is collected through the installation of dataloggers prior to conducting the pumping tests, many of the effects of nearby pumping wells can be identified and accounted for in the drawdown analysis.

The data obtained from drawdown pump tests could be used to determine the likelihood of contaminates being transported away from known contamination areas to areas of actively pumping wells and the rates contaminates can flow through the aquifers.

Estimated Cost: $8,000 – $12,000 (per well tested)

4.1.4 Installation of Additional Monitoring Wells

As the primary sources of contamination most concerning to area residents are related to the Arness Disposal site and the former drycleaner/laundry located on Nikishka Beach Road, additional monitoring wells could be installed on neighboring KPB properties. Using the groundwater model created through this study, new monitoring wells could be located in areas of likely contaminant migration.

This is particularly true near the Arness Disposal site. The groundwater model developed during this study suggests the lower aquifer groundwater flow direction at the Arness Site to be from southeast to northwest (away from populated areas of the study site), but the groundwater measurements indicate a possible flow direction to the south. However, the two wells currently on the site are not sufficient to confidently capture the localized aquifer conditions and groundwater flow. Additionally, the detection of contaminates (leached from the surface) within the monitoring wells at the Arness Site (even though the well logs suggest the well is screen within the confined aquifer) suggests the installation of additional monitoring wells would be beneficial to assess potential connection between the two aquifers.

Installation of additional monitoring wells would provide valuable lithology data and groundwater elevations, allowing for further refinement of the existing model. Additionally, the new monitoring wells would provide access for on-going water sampling and testing efforts. Installation of monitoring wells should be conducted by an environmental professional.

Cost Estimate: $10,000 – $15,000 (per well)

4.1.5 Tracer Identification and Testing

It was noted by the DEC Contaminated Sites Program that an exploratory well was drilled near the McGahan Utilities well and a lower aquifer (presumably the confined aquifer described in

detail within this report) was identified, beneath the existing aquifer being used by the utility[4]. The exploratory work was completed in an effort to seek out a different water source for the utility in response to contamination within the existing well. The new aquifer was deemed not a suitable source of water for the utility due to high, naturally occurring iron concentrations. These iron concentrations may be present throughout the aquifer and make for a suitable chemical identifier which could be tested for in water sampling of other area wells to confirm conclusions reached in this report and to further expand the data set. Further analysis of previous water quality testing investigations may reveal additional geochemical markers for each aquifer.

The benefit of this analysis is water samples could potentially be tested only for the unique marker(s) which would lower the costs of water testing and provide a quick indication of vulnerability of a well to contamination within its source aquifer. This would be particularly useful in wells without lithology data to assess aquifer utilization. If a well is shown to be accessing an aquifer containing contaminates and is located down-gradient from the contaminant, further testing may be warranted. If a well is shown to be accessing an aquifer without contamination or up-gradient from contamination, no further testing may be deemed necessary. Additionally, the presence of a specific aquifer tracer in a well screened within another aquifer (where the tracer is not normally found), would suggest localized “leaking” or transmission between aquifers at/near that location.

Estimated Cost: $15,000 – $30,000

4.1.6 Additional Survey Data

Conducting an additional round or multiple rounds of well measurements could provide further insight into groundwater migration and would allow for further refinement of the model. The results of this study provide grounds to distinguish which aquifer a majority of the wells within the study area are accessing. Additional survey and groundwater measurements could focus on specific aquifer characteristics around areas of interest. For example, the study area of future measurements could be focused only on wells in the upper aquifer in the area of the former

[4] http://dec.alaska.gov/Applications/SPAR/PublicMVC/CSP/SiteReport/478

laundry facility. Ideally, the survey would consist of successive measurements at the same wells spaced over a period of time (e.g., every 8 hours for 2 days). This would generate a snapshot of how the upper aquifer gradient changes while different users utilize the resources. Successive rounds of data collection would be quicker as well locations have been recorded. The results of this method would be more clearly understood with greater community involvement, such as documenting the duration the pumps are active and the rate at which they pump. Analysis of the resulting data would likely reveal how pumping locally affects the aquifer and should still capture the larger trend of the regional aquifer flow direction. This is an alternative to aquifer drawdown testing not requiring coordination for the shutdown of well pumps, but would not yield the same analytical aquifer characteristics obtainable through coordinated drawdown testing.

Estimated Cost: $15,000 – $30,000

4.1.7 Plume Identification/Modeling

Contaminant plume identification, including the extents of migration and prediction of future migration direction, could be achieved through a combination of the above described methods. Analytical aquifer characteristics would need to be determined through pump testing, slug tests, and/or laboratory permeability tests on collected subsurface soil samples. Careful coordination between groundwater users in the area would be needed to make accurate conclusions.

Additional monitoring wells would likely need to be installed down-gradient from known contaminate sources for sampling and groundwater measurements. Installation of additional groundwater monitoring wells may also produce the necessary lithology information to determine if anisotropic conditions (preferential flow paths) are present within the aquifer. Water sampling from all known and suspected contaminated wells would need to be conducted to establish contamination gradients within the aquifer. These tests would determine the necessary variables needed to construct a plume model in a standard groundwater contaminate modeling software (e.g., ModFlow).

This effort would produce risk horizons for area wells based on the direction of flow, the permeability of localized soils, the concentrations of contaminants, and would serve as the basis for conducting geochemical fate and transport modeling of the contaminants.

Cost Estimate: $75,000 – $100,000

4.2 Recommendations for Future Actions

The recommendations listed here need to be evaluated in terms of the KPB's priorities and funding availability. The recommended responses listed below are based on our interpretations presented within this report. Many of the possible actions have been presented in the proceeding section, and all alternatives should be considered in relation to the goals of the KPB. Our recommendations are based on a combination of the above actions and are here listed from the most passive response (least expensive) to the most proactive approach in relation to the known contaminated sites.

4.2.1 Area Wide Monitoring

The results of this study suggest groundwater in both the lower and upper aquifers flows away from population centers within the study area. The upper aquifer appears to be more susceptible to localized pumping affects. The McGahan public utility is known to be accessing contaminated water and is actively treating all water drawn from the aquifer to a safe level. As it is doing so, it is effectively working to pump and treat the contaminated aquifer, and may also be restricting the transport of the contaminants across natural gradients. The DEC water testing program has shown contaminant levels in the vicinity are decreasing.

Further studies, such as drawdown testing and additional survey efforts described above in Section 4.1, could help determine if other wells in the area are at risk, as well as the area of influence (drawdown and aquifer gradient changes) of active wells. Installation of groundwater dataloggers in monitoring wells in the area around the known contaminate sites could also be a cost effective measure to continue monitoring the groundwater flow directions. This would help

elicit localized aquifer variation due to pumping and usage and could also capture seasonal variations.

4.2.2 The Arness Disposal Site – Proactive Monitoring

The current monitoring well array and available subsurface data does not appear to be sufficient to fully understand the localized subsurface and aquifer characteristics near the Arness Disposal site. If an understanding of the subsurface characteristics is desired; at least one additional monitoring well should be installed. It is likely multiple monitoring wells would be necessary to fully characterize the conditions at the site. The priority should be placement of an additional monitoring well to the southwest of monitoring well one and to the west of monitoring well two. Each additional monitoring well could be installed successively at later times, with each location ultimately determined based on knowledge gleaned from previous efforts.

The installation of the monitoring well(s) should be supervised and logged by an environmental professional and location(s) of the installed monitoring well(s) should be surveyed by a professional licensed surveyor. Soil and water samples should be tested for contaminates during the installation of the well(s). Water levels encountered while drilling should be carefully documented. The investigation should be conducted in such a manner as to test the hypothesis of whether the wells are accessing confined, unconfined, or perched aquifer(s). If a layer of clay is observed in the boring and an aquifer is observed below the clay layer, the first monitoring well should be screened below the clay layer. A bentonite plug should be placed at the elevation of the clay layer in the monitoring well annulus to prevent the upward or downward migration of water around the monitoring well. The second monitoring well should be installed in the same manner. If a third monitoring well is to be installed, it should be drilled to the elevation above the clay layer (in close proximity to one of the new monitoring wells), and screened above the clay layer alone.

The installation (and subsequent measuring and sampling) of these wells could show the localized groundwater flow direction around the Arness Disposal site and could illuminate the relationship between the contaminants and the aquifers.

4.2.3 Baker Area Wells – Proactive Monitoring

The upper aquifer is the contaminated aquifer in the area around Baker Oil Tools. The contamination source at Baker Oil Tools has been documented by the DEC to be four Class V injection wells connected to interior floor drains on site. To understand the likelihood of known contaminants being transported to other neighboring wells, it is recommended a series of successive groundwater measurements be taken at area wells screened within the upper aquifer spaced over a period of time (e.g., every 8 hours for 2 days) or the installation of dataloggers within selected monitoring wells. Efforts could be made to work with local groundwater users to have the duration and rate of any active pumping be recorded during a predetermined interval to isolate the effects of each pumping well. This data could then be analyzed to determine the localized aquifer flow trends and the area of influence of actively pumping wells in the areas. If possible, a coordinated effort should be made to arrange a shutdown of neighboring pumps for an interval long enough to conduct pumping tests to determine some of the aquifers analytical characteristics. This type of study would likely provide the data necessary to interpret the likelihood of contaminant transport to area wells.

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APPENDIX A

Public Involvement

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NIKISKI ENVIRONMENTAL STUDY PROJECT KICKOFF

Please join us!

Thursday,
October 16, 2014
6:00 p.m.
Nikiski Middle/High School

A project kickoff will be held at Nikiski Middle/ High School in the library on Thursday, October 16th at 6:00 p.m. to discuss a new project to study the subsurface conditions of the central Nikiski area.

The community is invited to come learn about the project and ask questions.

The goal of this project is to better understand subsurface conditions and develop a conceptual model of the groundwater between the McGahan airstrip and the coast, and between Prather Street and Marhenke Street.

The Kenai Peninsula Borough has contracted DOWL HKM to conduct the study, and a representative from both the borough and DOWL HKM will host the meeting.

For more information, contact:

Dan Mahalak, KPB Project Manager

(907) 224-9515

or

DOWL HKM Project Manager

907-562-2000

DOWL HKM

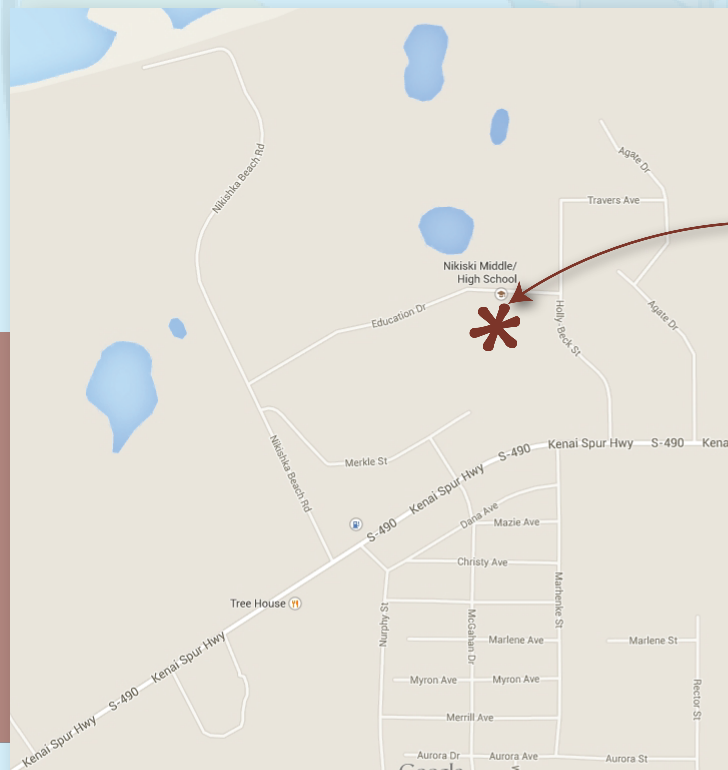
NIKISKI ENVIRONMENTAL STUDY

PROJECT KICKOFF

Please join us for a project kickoff to discuss a new project to study the subsurface conditions of the central Nikiski area.

Thursday, October 16, 2014

Nikiski Middle/High School



Meeting Location: Nikiski Middle/ High School is located on Education Drive between Holly-Beck Street and Nikishka Beach road.

Project Kickoff

October 16, 2014

NIKISKI ENVIRONMENTAL STUDY

A project kickoff will be held at Nikiski Middle/ High School in the library on Thursday, October 16th at 6:00 p.m. to discuss a new project to study the subsurface conditions of the central Nikiski area.

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Dan Mahalak, KPB Project Manager
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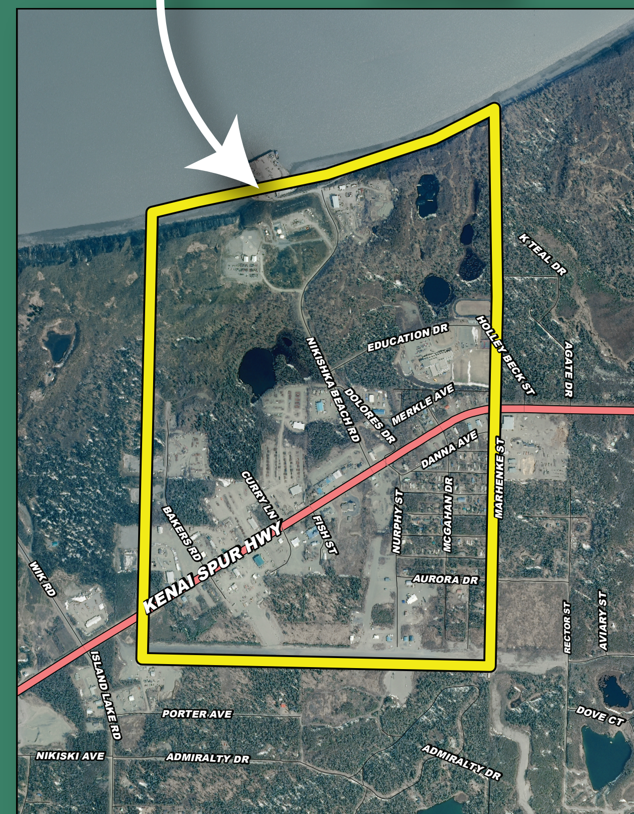
Project Study Area



DOWL HKM

Please join us!

Kenai Peninsula Borough
Attn: Dan Mahalak
144 North Binkley Street
Soldotna, AK 99669

First Name Last Name
Street Address
State, City Zip

Nikiski Environmental Study
Project Kickoff Agenda

1. *Introductions*

- Dan Mahalak, Kenai Peninsula Borough Project Manager
- Emily Creely, DOWL HKM Project Manager

2. *Project Background and Status*

- Development of grant
- Project Goal
- Status of Project and Schedule

3. *Questions*

4. *Discussion*

To receive project information, please provide your name and an email or postal address:

Name: ______________________________

Address: ______________________________

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Comments/Questions

TO: KENAI PENINSULA CLARION

NIKISKI ENVIRONMENTAL STUDY | FOR IMMEDIATE RELEASE | OCTOBER 21, 2014

Project managers for a study that aims to document groundwater movement in Nikiski are asking for help to identify private wells that Nikiski residents will allow to be surveyed. The study covers the area between McGahan airstrip and the dock, and between Prather Street and Marhenke Street, and is funded by a legislative grant. Additionally, project managers are asking the public for information about their wells to assist in the study.

The borough has contracted DOWL HKM to conduct the study, which is in its early stages and is expected to be complete by Spring 2015. The end result will be a conceptual model of the groundwater in the Central Nikiski area through subsurface modeling and mapping.

“This study doesn’t include water quality data, but rather the measurement of the groundwater table,” said borough project manager Dan Mahalak. “Before any assessment of contamination can happen, basic information about subsurface conditions is needed and we need a fact-based picture of the aquifers.

DOWL HKM is currently working with available data taken from monitoring wells, well logs from drillers and existing reports, but large portions of the study area lack any data.

“The groundwater aquifers are variable between seasons as well as years, and we need more consistent information so our next step is to survey the wells and measure groundwater levels at the same time so that we’re comparing apples to apples,” said Mahalak. “We need help from residents and businesses to do this.”

Mahalak explained that he and DOWL HKM project manager Emily Creely are looking to survey private wells to get an accurate recording of the ground surface, and also measure the water elevation.

“We don’t need to touch anyone’s water -- we have a meter that uses sonic technology to determine the depth of groundwater,” said Creely. “More information from south of the Kenai Spur Highway is needed as information from that portion of the study area is just not there.”

Once DOWL HKM geologists finish surveying the location and static water level in all accessible wells, then the depth and extent of groundwater aquifers can be estimated. Using

specialized software, the dataset will result in subsurface maps to conceptualize groundwater flow depth and direction. A report summarizing the findings and resulting recommendations will be released in March.

Surveyors are planning to conduct their portion of the project before mid-November, so any residents willing to allow their wells to be used in the model, should contact Emily Creely in the within two weeks at 907-562-2000 or ecreely@dowlhkm.com. For more information about the project, contact Dan Mahalak at DMahalak@kpb.us or (907) 224-9515.

Nikiski water study underway

Posted: October 30, 2014 - 8:39pm | Updated: October 30, 2014 - 8:45pm

File photo contributed by the Alaska Department of Environmental Conservation The Arness Septage Site in Nikiski, shown here from the air in September 1985. The site was contaminated with thousands of gallons of oil and other industry wastes.

By Rashah McChesney

Peninsula Clarion

In addition to Alaska LNG project managers, and planners from Trans-Foreland Pipeline Company, Nikiski landowners will soon have another group of surveyors knocking on their doors as contractors from DOWL HKM begin testing area wells.

The study, which will cover an area between the McGahan Industrial Park, the AIMM Monofill site, the Cook Inlet and the eastern property line of Nikiski High School, was contracted by the borough in response to community concerns about contaminated sites in Nikiski. The hydrogeological study will not include water quality testing. Rather DOWL HKM surveyors will be documenting groundwater movement and generate a model for the Kenai Peninsula Borough.

"They have been tasked with building a model, so that we can figure out — if a contaminant was introduced at "x" location, what it would mean to the aquifers in the area — where the contaminant would go, how fast it would be able to get to another place," said Kenai Peninsula Borough Capital Projects Director Kevin Lyon.

Currently, employees from DOWL HKM are gathering publicly available water movement data from area monitoring wells, well logs from drillers, and existing reports. Among those to be studied are six groundwater-monitoring wells installed by AIMM Technologies as part of its permitting process with the Alaska Department of Environmental Conservation.

Study organizers are also looking for help from area residents.

"Large portions of the study area lack any data," said borough project manager Dan Mahalak.

Borough and DOWL HKM employees will be at the Nov. 3 Nikiski Community Council Meeting to give a brief presentation on the project, Mahalak said.

To test the well, surveyors will not need to touch a resident's water, Lyon said.

"We can sound it from the top, just like a sonar, and then we can read the water levels there," he said. "If we can get ahold of their well log, so we know the pump setting, what the pipe was and where the water was, that will work."

The borough's $119,970 contract with DOWL HKM will eat up most of the $150,000 state money the borough received in 2013 for the project. The funds were part of a capital budget reappropriation written by State Rep. Mike Chenault, R-Nikiski.

When the money was requested, Kenai Peninsula Borough Mayor Mike Navarre said he had heard from a number of Nikiski residents after the history of a site near the AIMM Monofill known as the Arness Septage Site was revealed. The site was the subject of a six-part Peninsula Clarion investigation that revealed at least 4,200 gallons of oil-contaminated waste, sludge and other pollutants were dumped on the land in the early 1980s.

Study organizers said having more wells to test would better the final model.

"We just really want people to come out and help us get the data so we can put it together," Lyon said. "If we don't have data points, we really aren't going to have a good data set."

Once surveyors are done with the field research portion of the project, DOWL HKM will generate subsurface maps to conceptualize groundwater flow, depth and direction, according to a project media release. A report summarizing the findings and recommendations is scheduled to be released in March, according to the release.

Surveyors are planning to finish their field research in November, so any residents willing to volunteer their wells for testing should contact DOWL HKM's Emily Creely at 907-562-2000 or at ecreely@dowlhkm.com.

Clarion file material was used in this article.

Rashah McChesney can be reached at rashah.mcchesney@peninsulaclarion.com

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Company seeks private wells for Nikiski water testing

Surveyors to generate a model of groundwater movement near Arness Septage site

Posted: November 6, 2014 - 8:49pm | Updated: November 6, 2014 - 9:28pm

Alaska Department of Environmental Conservation file photo An Alaska Department of Environmental Conservation staff member secures a chain to an unearthed 40-foot pipe used at the Arness Septage Site. The pipe was installed on the land previous to a 1979 permit seeking to expand the facility, including a 21-tank system, to hold petroleum products, drilling muds and other sludge. That permit was not approved, but in the late 1980s, DEC excavated more than 4,200 gallons of oily waste at the site in addition to hundreds of barrels containing various oil industry wastes.

By Rashah McChesney

Peninsula Clarion

Darcy McCaughey and her family live in the middle of an area in Nikiski that will soon be the subject of a groundwater modeling study.

So, when the company that will undertake the study gave a presentation at a recent community council meetings, McCaughey was one of the first to volunteer her drinking water well for testing.

At least four other private landowners in the area have given hydrologists and geologists with DOWL HKM, the company contracted by the Kenai Peninsula Borough to track groundwater movement in the area. Their data will be added to a model that, thus far, has about 140 other sources of data, according to project geologists.

Eventually, the mode should show groundwater flow, depth and direction in an area of Nikiski that has long been speculated to contain several sources of groundwater contamination.

"There's a lot of uproar over water," McCaughey said. "Often people are willing to talk and they aren't willing to help. I'm just doing my little part to help people figure it all out."

A lot of the talk about the groundwater quality in Nikiski was rekindled when Texas-based AIMM Technologies proposed and ultimately built a waste disposal site on a 1.5 acre plot that will store up to 10 million gallons of petroleum drilling waste at the end of Halliburton Drive.

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- Coming Clean Part 6: 'When all the cards were dealt'
- Photo slideshow: Arness Septage site

During the 15 month process of getting the project permitted, area residents expressed concern that the site would join or affect a neighboring piece of land known as the Arness Septage site. At the septage site, Alaska Department of Environmental Conservation officials have said that at least 4,200 gallons of oil-contaminated waste, sludge and other pollutants were improperly stored.

No one knows the extent of the pollution and how much of it got into the groundwater.

The Arness Septage site is included in the area to be surveyed. In addition, data from six wells built by AIMM Technologies are to be included in the model. However, project planners stressed that they would not be testing for pollutants.

“This study is not to show whether there is contamination in the area,” said DOWL HKM Public Involvement Manager Rachel Steer during the Monday meeting. “This study could be used in the future to determine where contaminants have traveled, but this is the first step that you need to do to be able to do anything else.”

The Kenai Peninsula Borough and DOWL HKM are still seeking landowners in the area. DOWL HKM Environmental Specialist Emily Creely said project managers need to have landowner permission by Friday Nov. 14. Surveyors will be out collecting data from Nov. 18-21, she said. The company plans to have the study completed by the spring of 2015.

“The key is to do all that survey work within a short period of time so it’s consistent. Groundwater levels change from season to season,” Steer said.

The company has been examining well logs and previous studies conducted in the area, to supplement the model.

No one is sure exactly how many wells are in the area of land between the McGahan Industrial Park, the AIMM Monofill site, the Cook Inlet and the eastern property line of Nikiski High School, Creely said.

The borough’s $119,970 contract with DOWL HKM will eat up most of the $150,000 of state money the borough received in 2013 for the project. The funds were part of a capital budget reappropriation written by State Rep. Mike Chenault, R-Nikiski.

Project organizers encouraged Nikiski residents to contact them for the non-invasive well testing which involves no contact with the water, they said during the community council meeting.

“We can sound it from the top, just like a sonar, and then we can read the water levels there,” said Kenai Peninsula Borough Capital Projects director Kevin Lyon during a previous interview. “If we can get ahold of their well log, so we know the pump setting, what the pipe was and where the water was, that will work.”

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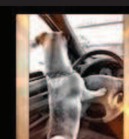


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Steer said she hoped to get as much data as possible to improve the resulting model and organizers encouraged residents at the community meeting to spread the word about the project.

At least one resident, owner of Charlie's Pizza Steve Chamberlain, said he wanted to see more done with testing the water rather than spending money to determine how it moved. Chamberlain has been a vocal proponent of further testing in the area. The walls of his pizza shop were plastered with local newspaper articles, photos and DEC documentation of a polluted site in the area when the Clarion published a six-part series investigating a contaminated site in Nikiski in 2012.

"Some of that money should be put toward actual analytical testing of the water," he said during the community council meeting. "After we get done with this study we still won't know where pollution is and where it isn't."

Reach Rashah McChesney at Rashah.mcchesney@peninsulaclarion.com

NIKISKI GROUNDWATER STUDY
FACT SHEET

The Kenai Peninsula Borough has hired DOWL HKM to study groundwater in central Nikiski and develop a model showing groundwater flow, depth, and direction. This study does not include identification of contaminated areas, but rather the measurement of the groundwater table. Basic information about subsurface conditions is needed before any future assessment of contamination can happen. The study started in October 2014 and is expected to be complete by Spring 2015.

Is this project related to the LNG project?

No.

Will this project test contamination in the groundwater?

This study does not include identification of contaminated areas, but rather the measurement of the groundwater table. Basic information about subsurface conditions is needed before any future assessment of contamination can happen.

Why do you need my well information?

There is a large portion of the study area that does not have any public information available.

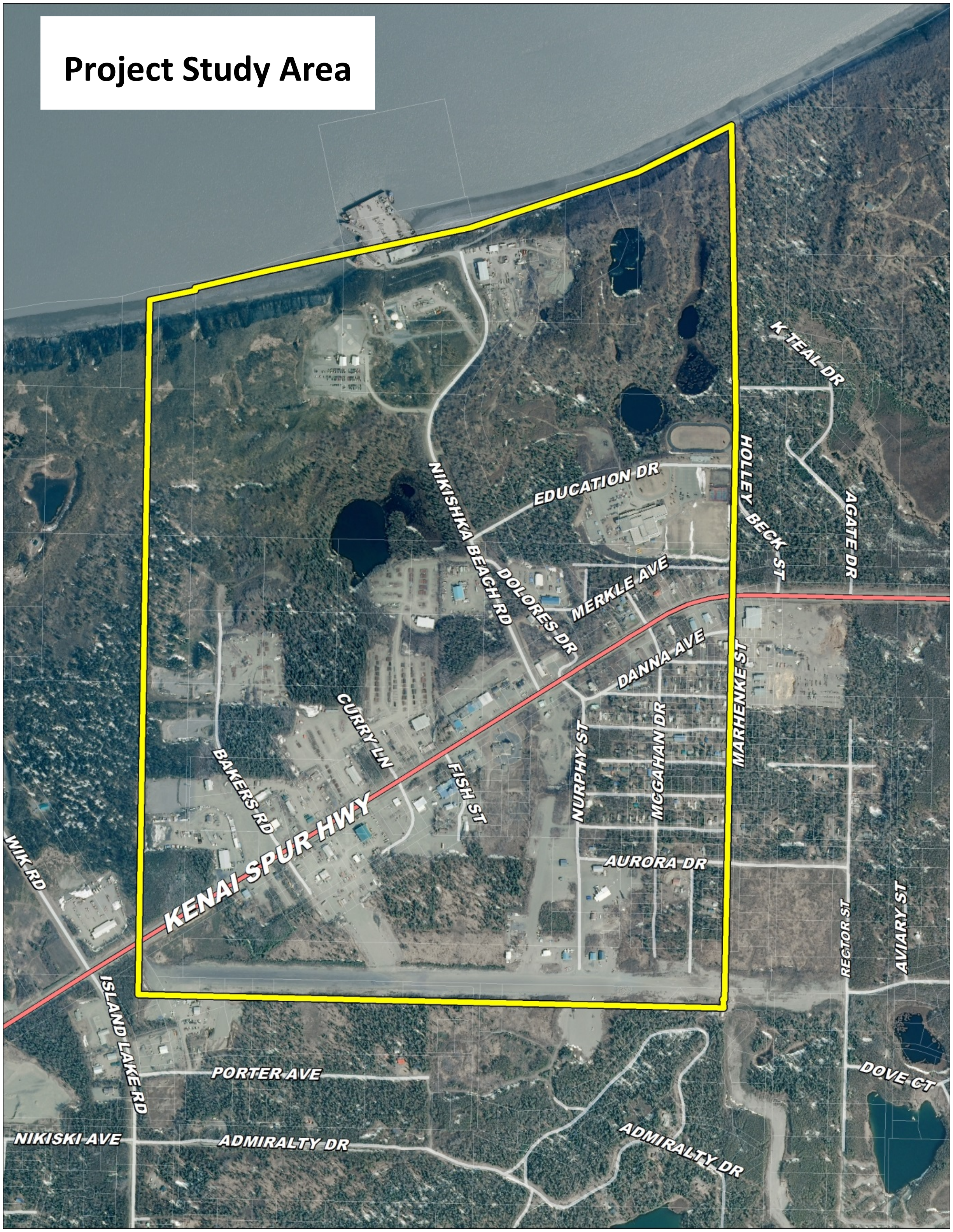
If I let you survey my well, could it impact my water?

No. Measuring water elevation will not require any physical contact with well water as the project team will use sonic technology to determine the depth of groundwater.

PROJECT GEOLOGISTS ARE LOOKING FOR ADDITIONAL WELL DATA AND THEY NEED YOUR HELP!

CONTACT EMILY CREELY TO ARRANGE A WELL MEASUREMENT:

907-562-2000 • ECREELY@DOWLHKM.COM



Project Contacts:

Emily Creely, DOWL HKM, 907-562-2000, ecreely@dowlhkm.com

Dan Mahalak, Kenai Peninsula Borough, 907-244-9515, dmahalak@kpb.us

APPENDIX B

Publicly Available Records

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No.	Site Number	Site Name	Latitude[1]	Longitude[1]	Well Depth[2]	Surface Elevation[3]	Other Data
1	604430151181801	SB00801236ACCD1 004	60^0 44'30"	151^0 18'06"	41.0	88.1	None immediately available
2	604430151181802	SB00801236BDDD2 001	60^0 44'30"	151^0 18'18"	31	50	None immediately available
3	604445151181601	SB00801236CAAA1 002	60^0 44'28"	151^0 18'16"	159	115.0	Groundwater depth: 86.0' bgs, 29.0' above NGVD, 5/1/1968
4	604423151181801	SB00801236CAAA2 002	60^0 44'23"	151^0 18'18"	182	148.5	Groundwater depth: 101.0' bgs, 47.5' above NGVD, 5/16/1968
5	604422151181901	SB00801236CAAD1 006	60^0 44'22"	151^0 18'19"	186	147.7	Groundwater depth: 101.0' bgs, 46.7' above NGVD, 6/11/1991
6	604423151183101	SB00801236CABD1 007	60^0 44'23"	151^0 18'31"	257	200.2	None immediately available
7	604416151183701	SB00801236CACC1 005	60^0 44'16"	151^0 18'37"	93.6	189	Groundwater depth: 86.0' bgs, 103.0' above NGVD, 5/31/1990
8	604401151184401	SB00701201BBAA1 023	60^0 44'01"	151^0 18'44"	137	148	Groundwater depth: 120.0' bgs, 28.0' above NGVD, 9/15/1988
9	604402151181301	SB00701201ABBB1 021	60^0 44'2"	151^0 18'13"	55	115	Groundwater depth: 40.0' bgs, 75.0' above NGVD, 2/13/1977
10	604410151174601	SB00801236DDBC2 003	60^0 44'10"	151^0 17'46"	169	115	Groundwater depth: 80.0' bgs, 35.0' above NGVD, 5/2/1988
11	604409151193001	SB00801236DDBC1 003	60^0 44'09"	151^0 17'42"	197	115	Groundwater depth: 105.0' bgs, 10.0' above NGVD, 4/16/1986
12	604402151180101	SB00701201ABBA1 013	60^0 44'02"	151^0 18'01"	40	86	Groundwater depth: 39.0' bgs, 47.0' above NGVD, 3/30/1989
13	604359151175601	SB00701201ABAC1 015	60^0 43'59"	151^0 17'56"	55	90	Groundwater depth: 43.0' bgs, 47.0' above NGVD, 3/17/1989
14	604359151175501	SB00701201AABB1 001	60^0 43'59"	151^0 17'55"	96	129	Water Quality Samples, 9/7/1967
15	604357151180501	SB00701201ABBD1 017	60^0 43'57"	151^0 18'05"	55	94	Groundwater depth: 43.0' bgs, 51.0' above NGVD, 3/25/1989
16	604357151175601	SB00701201ABAC2 015	60^0 43'57"	151^0 17'56"	97	90	Groundwater depth: 44.0' bgs, 46.0' above NGVD, 4/13/1981
17	604356151175601	SB00701201ABDB3 014	60^0 43'56"	151^0 17'56"	174	90	Groundwater depth: 58.0' bgs, 32.0' above NGVD, 12/11/1989
18	604355151175801	SB00701201ABDB1 014	60^0 43'55"	151^0 17'58"	85	122	Groundwater depth: 74.0' bgs, 48.0' above NGVD, 3/16/1989
19	604354151180101	SB00701201ABCA1 016	60^0 43'54"	151^0 18'01"	96	131	Groundwater depth: 91.0' bgs, 40.0' above NGVD, 3/23/1989
20	604354151180001	SB00701201ABDB2 014	60^0 43'54"	151^0 18'00"	N/A	134	None immediately available
21	604352151180101	SB00701201ABDC2 012	60^0 43'52"	151^0 18'01"	N/A	134	None immediately available
22	604352151175901	SB00701201ABDC1 012	60^0 43'52"	151^0 17'59"	85	137	Groundwater depth: 75.0' bgs, 62.0' above NGVD, 3/29/1989
23	604351151175201	SB00701201ABDD1 011	60^0 43'51"	151^0 17'52"	152	139	Groundwater depth: 94.0' bgs, 45.0' above NGVD, 10/14/1987
24	604343151181302	SB00701201ACCB2 007	60^0 43'43"	151^0 18'13"	168	180	None immediately available
25	604342151181301	SB00701201ACCB1 007	60^0 43'42"	151^0 18'13"	140	180	None immediately available
26	604344151182301	SB00701201BDDA1 002	60^0 43'44"	151^0 18'23"	295	168	None immediately available
27	604341151184701	SB00701201BCDA1 005	60^0 43'41"	151^0 18'47"	119	175	Groundwater depth: 106.3' bgs, 68.7' above NGVD, 7/14/1977
28	604330151184001	SB00701201BDCC1 002	60^0 43'39"	151^0 18'40"	140	139	Groundwater depth: 112.5' bgs, 26.5' above NGVD, 1/17/1986
29	604337151184501	SB00701201BCDD1 019	60^0 43'37"	151^0 18'45"	138	156	Groundwater depth: 103.3' bgs, 52.7' above NGVD, 10/24/1989
30	604330151185001	SB00701201CBAC1 018	60^0 43'30"	151^0 18'50"	125	156	Groundwater depth: 108.0' bgs, 75.0' above NGVD, 5/9/1989
31	604323151190301	SB00701201CCBA1 004	60^0 43'23"	151^0 19'03"	132	171	Groundwater depth: 28 measurments between 1970-1979, 99.0-107.0' bgs, 72.0-64.0' above NGVD
32	604350151180902	SB00701201ABCC2 006	60^0 43'50"	151^0 18'09"	70	160	Groundwater depth: 20.0' bgs, 140.0' above NGVD, 1/1/1971
33	604350151180901	SB00701201ABCC1 06	60^0 43'50"	151^0 18'09"	90	160	Groundwater depth: 20.0' bgs, 140.0' above NGVD, 1/1/1971

Data taken from: http://maps.waterdata.usgs.gov/mapper/index.html

Notes:

[1] Latitude and Longitude based on NAD27

[2] Well Depths are given as feet Beneath Ground Surface (BGS)

[3] Elevations based on NGVD29

USGS Data Surveyed Wells

Study Area

Streets

N

Feet

0 500 1,000

Nikiski Groundwater Study
USGS NWIS Data Points

Nikiski, Alaska

DOWL

February 26, 2015

Figure 1

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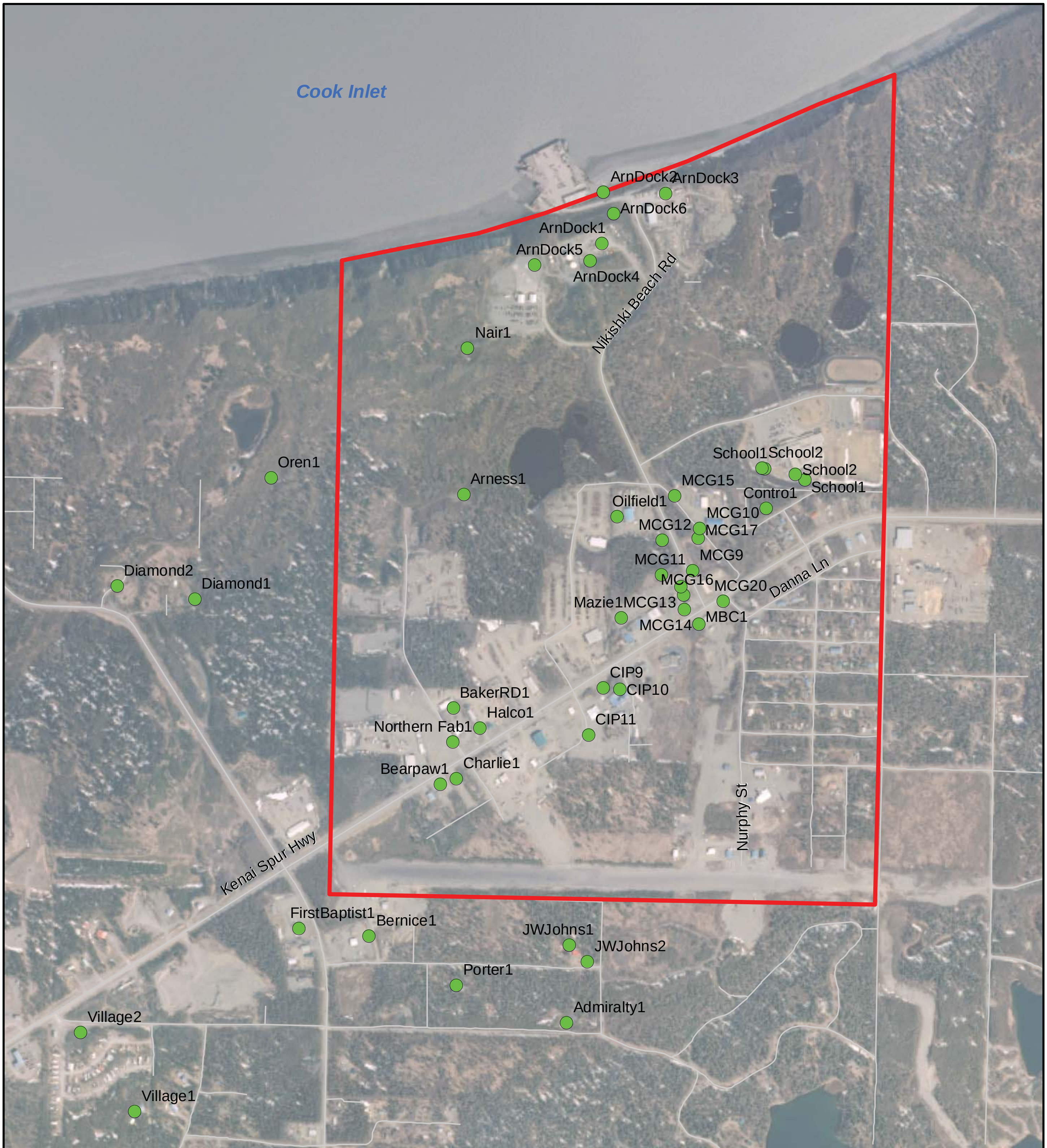
Project Well ID	Welts ID	Useable Lithology	Bore Depth (*ft*)	Completion Date	Qualitative Score
Admirality 1	16842	No	84	1962	--
ArnDock 1	19292	Yes	182	5/16/1968	2
ArnDock 2	19796	Yes	31	12/16/1966	2
ArnDock 3	19797	Yes	41	12/21/1966	2
ArnDock 4	21647	Yes	186	6/11/1991	2
ArnDock 5	21648	Yes	257	5/21/1991	2
ArnDock 6	16599	No	159	5/00/1968	2
Arness 1	19818	Yes	138	9/18/1988	2
BakerRd 1	16845	Yes	119	Unknown	2
Bernice 1	16843	Yes	132	Unknown	2
Charlie 1	34201	Yes	145	10/5/2005	2
CIP 9	14100	Yes	140	4/4/1984	3
CIP 10	19790	Yes	168	4/4/1984	3
CIP 11	23912	Yes	155	5/23/1990	3
Contro 1	16848	No	96	4/00/1967	--
Diamond 1	15089	Yes	213	3/26/1983	2
Diamond 2	17552	No	300+	Unknown	--
FirstBaptist 1	16382	Yes	87	8/27/1963	3
Halco 1	19792	Yes	140	1/17/1986	2
JW 1	17313	Yes	103	10/3/1986	3
JW 2	17419	Yes	107	11/14/1983	2
Mazie 1	16847	Yes	92	8/1/1996	3
Mazie 2	364	Yes	70	1/20/1971	2
MBC 1	16844	Yes	295	3/27/1959	2
MCG 9	19100	Yes	86.5	3/16/1989	1
MCG 10	19101	Yes	56	3/17/1989	1
MCG 11	19105	Yes	96	3/23/1989	1
MCG 12	19099	Yes	55	3/25/1989	1
MCG 13	19103	Yes	91	3/28/1989	1
MCG 14	19102	Yes	85	3/29/1989	1
MCG 15	19104	Yes	40	3/30/1989	1
MCG 16	19106	Yes	60	4/1/1989	1
MCG 17	19098	Yes	187	1/00/1990	1
MCG 20	19791	Yes	152	10/14/1987	2
Nair 1	19506	Yes	97	5/19/1990	1
NorFab 1	18166	Yes	138	10/23/1989	2
OilSal 1	19793	Yes	55	2/13/1977	2
Oren 1	16841	No	224	1961	
Porter 1	14658	Yes	105	8/4/1977	2
School 1	1335	Yes	197	4/16/1986	2
School 2	19795/ 17600	Yes	170	5/2/1988	2
Village 1	27711	No	136.0	12/21/1976	3
Village 2	27712	Yes	137.0	8/10/1977	2

Note - Logs less than or equal to depth of 30 feet omitted

Note - Log Quality Assesment:

Rating Number	Description
1	Great Quality, Reliable Information
2	Good Quality, Acceptable Information
3	Poor Quality, Unreliable Information



WELTS Wells

Study Area

Streets

N

Feet

0 500 1,000

Nikiski Groundwater Study
DNR WELTS Data Points

Nikiski, Alaska

DOWL

February 26, 2015

Figure 2

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Admirality 1
WELTS 16842

WRD Exp. (GW)
April 1966

Locatet

Well No. 16842

#3

WELL SCHEDULE

U. S. DEPT. OF THE INTERIOR — GEOLOGICAL SURVEY — WATER RESOURCES DIVISION

HEA 6-14

MASTER CARD

Record by Chase — Source of data Owner — Date 2-14-68 — Map Kenai C-4

State Alaska — 60 — County (or town) Kenai — EQ

Latitude: 60 43 12 N — Longitude: 151 18 19 — Sequential number: 1

Lat-long accuracy: 2 — T. 7 S, R 12 W Sec 1, SW ¼, SW ¼, SE ¼ SEWARD B & M

Local well number: SB00701201DCCC — Other number:

Local use: 003 — 10535 — Owner or name: James Robnett

Owner or name: JAMES ROBNETT — Address: N. Kenai, old C... rai

Ownership: (C) County, (F) Fed Gov't, (M) City, (N) Corp or Co, (P) Private, (S) State Agency, (W) Water Dist — P

Use of water: (A) Air cond, (B) Bottling, (C) Comm, (D) Dewater, (E) Power, (F) Fire, (H) Dom, (I) Irr, (M) Med, (N) Ind, (P) P S, (R) Rec, (S) Stock, (T) Instit, (U) Unused, (V) Repressure, (W) Recharge, (X) Desal-P S, (Y) Desal-other, (Z) Other — H

Use of well: (A) Anode, (D) Drain, (G) Seismic, (H) Heat Res, (O) Obs, (P) Oil-gas, (R) Recharge, (T) Test, (U) Unused, (W) Withdraw, (X) Waste, (Z) Destroyed — W

DATA AVAILABLE: Well data O — Freq. W/L meas.: — Field aquifer char.

Hyd. lab. data:

Qual. water data; type:

Freq. sampling: — Pumpage inventory: yes no, period:

Aperture cards: yes

Log data:

WELL-DESCRIPTION CARD

SAME AS ON MASTER CARD — Depth well: 84' ft — 84 — Meas. rept accuracy — 6

Depth cased; (first perf.) ft — Casing type: Steel; Diam. 6 in — 6

Finish: (C) porous concrete, (F) gravel w. (perf.), (G) gravel w. (screen), (H) horiz. gallery, (O) open end, (P) perf., (S) screen, (T) sd. pt., (W) shored, (X) open hole, (Z) other — O

Method Drilled: (A) air rot, (B) bored, (C) cable, (D) dug, (H) hyd rot., (J) jetted, (P) air percussion, (R) reverse rotary, (T) trenching, (V) driven, (W) drive wash, (Z) other — C

Date Drilled: 1962 — 962 — Pump intake setting: 82' ft — 82

Driller: Bernie Marsh (name), (address)

Lift (type): (A) air, (B) bucket, (C) cent, (J) jet, (L) multiple (cent.), (M) multiple (turb.), (N) none, (P) piston, (R) rot, (S) submerg, (T) turb, (Z) other — S — Deep / Shallow

Power (type): diesel, elec, nat gas, gasoline, hand, LP gas, wind; H.P. 5 — Trans. or meter no.

Descrip. MP — ft above/below LSD . Alt. MP

Alt. LSD: 150 — Accuracy: (source) 6 (4)

Water Level ft above/below MP; Ft above/below LSD — Accuracy:

Date meas: — Yield: gpm — Method determined

Drawdown: ft — Accuracy: — Pumping period hrs

QUALITY OF WATER DATA: Iron ppm — Sulfate ppm — Chloride ppm — Hard. ppm

Sp. Conduct K x 10^6 — Temp. °F — Date sampled

Taste, color, etc.

Well No. 3 SB7-12-1 DCCC/3

AIMM 1
MW-1

WESTON SOLUTIONS

MONITORING WELL INSTALLATION REPORT

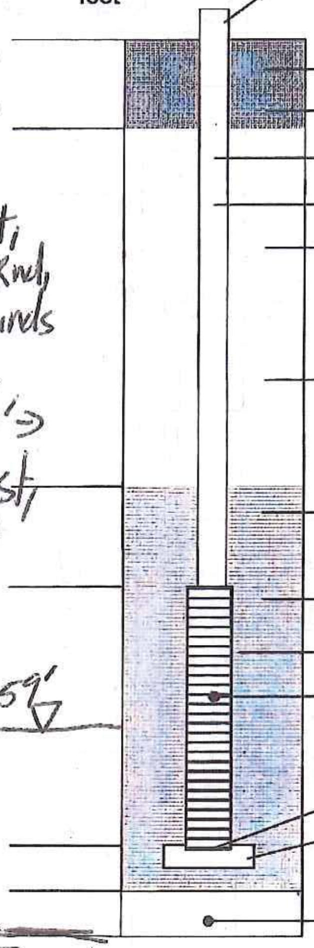
Project Name:	Vikiski Landfill	Well No.:	MW-Ø1
Project No.:	14830.003.001.8888	Observer:	A. Pennino
Date/Time:	5/16/11 0900	Drilling Method:	Hollow-Stem Auger CME-75

Soil Log

0'
-Silt, Br, 5% Gravels ½"->1" Well Rnd, Some sands (<10%), Slt. Mst.

20'
Higher Gravel Content, 25-30% ¼"->2"+ Well Rnd, Fine Drk Brn/Grey Sands & Silt, Cuttings are consistent from 20'-> 67' BGS. Slt. Mst. No odor or PID evidence of contamination.

Depth of Components in feet



Stick up (feet) 2.5'
Approximate ground surface elevation (feet)
Diameter of borehole (inches) ~10"
Type of surface seal Bentonite
I.D. of riser pipe (inches) ~2"
Type of riser pipe ~Schedule 40 PVC
Type of backfill around riser Bentonite
Type of well seal Bentonite
Type of sand Silica Sand
Length of top screen blank 10 feet
Screen size and type 10 Slot Schedule 40
Water level 62.36'
Length of bottom screen blank 10 feet
Length of end cap 3"
Type of backfill material Sand

Remarks: Sand - 67'->56', Bentonite - 56'-3', Pea Gravel - 3'-> Surface
Concrete surface completion.

Amount of Materials:			
Sand	6 Bags x 50#	Monument	~3' Height Steel
Cement	Surface Only	Riser	10' Sections x 6
Bentonite pellets	18 bags x 50#	Screen	10' Section x 1
Bentonite/Volclay		Other	~Pea Gravel at surface => 3' BGS

AIMM 2
MW-2

WESTON SOLUTIONS

MONITORING WELL INSTALLATION REPORT

Project Name: Nikiski Landfill
Project No.: 14830.003.001.8888
Date/Time: 5/17/11 1345 1716

Well No.: MW-Ø2
Observer: A. Pennino
Drilling Method: Hollow-Stem Auger CME-75

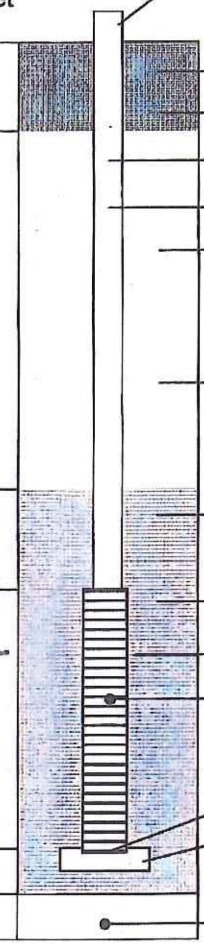
Soil Log

Depth of Components in feet

0' — Silt, Br, 5% Gravels 1/2"-1" Well Rnd, Some Sand (40%) Slt. Mst

10' — Higher Gravel Content, 25%-30%, 1/4"-2"+" Well Rnd, Fine drk brn/Grey sands Few silt (<10%). Cuttings are consistent from 10'->58' BGS. Slt Mst, No odor or PID evidence of contamination. 49'

58'



Stick up (feet) 2.5'
Approximate ground surface elevation (feet)
Diameter of borehole (inches) ~10"
Type of surface seal Bentonite
I.D. of riser pipe (inches) 2"
Type of riser pipe Schedule 40 PVC
Type of backfill around riser Bentonite
Type of well seal Bentonite
Type of sand Silica Sand
Length of top screen blank 10 feet
Screen size and type 10 Slot Schedule 40
Water level 52.71
Length of bottom screen blank 10 feet
Length of end cap ~3"
Type of backfill material Sand

Remarks: Sand -> 58'->47'; Bentonite -> 47'-4'; Pea Gravel -> 4'-Surface

Amount of Materials:
Sand 6 Bags x 50#
Cement Surface Only
Bentonite pellets 15 Bags x 50#
Bentonite/Volclay

Monument 2.5' Steel
Riser 10' Sections x 5
Screen 10' Section x 1
Other -Pea Gravel at Surface -> 4' BGS

AIMM 3
MW-3

WESTON SOLUTIONS

MONITORING WELL INSTALLATION REPORT

Project Name: Nikiski Landfill
Project No.: 14830.003.001.8888
Date/Time: 5/18/11 0800
7

Well No.: MWØ3
Observer: A. Pennino
Drilling Method: Hollow-Stem Auger CME-75

Soil Log | Depth of Components in feet

0' — 10': Silt, Br, 5% Gravels 1/4"-1/2" well Rnd Some Sand (<10%), Slt. Mst

10': Higher Gravel Content, 25-30% 1/4"→2"+ Well Rnd, Fine drk Br/grey sands, few silt (<10%). Cuttings are consistent from 10'→96', Slt. Mst, No odor or PID evidence of contamination.

80' ▽

7]
96'

Stick up (feet) 2.5'
Approximate ground surface elevation (feet)
Diameter of borehole (inches) ~10"
Type of surface seal Bentonite
I.D. of riser pipe (inches) 2"
Type of riser pipe Schedule 40 PVC
Type of backfill around riser Bentonite
Type of well seal Bentonite
Type of sand Silica Sand
Length of top screen blank 10 feet
Screen size and type
Water level
Length of bottom screen blank
Length of end cap
Type of backfill material

Remarks: Sand → 96'-85', Bentonite - 85'-4', Pea Gravel - 4' - Surface
Concrete surface completion.

Amount of Materials:
Sand 6 Bags x 50#
Cement Surface Only
Bentonite pellets 16 Bags x 50#
Bentonite/Volclay

Monument 2.5' Steel
Riser 9 x 10' Sections
Screen 1 x 10' Section
Other

AIMM 4
MW-4
Page 1

WESTON SOLUTIONS
Restoring Resource Efficiency

Boring Location ID:	
Project Name: ~~Triple North Geotech Investigation~~	
Site Location: ~~Beluga River Unit~~	
Project Number: ~~12700.084.001.0010~~	
Start/End Date: 10/12/11 — 10.21	Driller's Name: DARREN VANDEHEY Logged By: ~~J. Graner~~
Start/End Time: 10/12/11 - 16:58 OFF SITE -	Drilling Contractor: Discovery Drilling PM: J. Peterson
Initial W. Level: Longitude:	Drilling Method: SH/CG Total Depth:
Borehole Dia.: Latitude:	Cutting Disposal: Down HOLE Backfill: 10/20

Collected Sample IDs/Analysis: —
HAMMER = 340 lb
S. SPOON = 2.5 Ø

Depth (ft)	Blow Counts (per 0.5 ft)	Recovered/Driven (ft) 24"	Hydrocarbon Odor (Y/N)	Hydrocarbon Staining (Y/N)	Sample ID	Time	Sample Interval	USCS Code	Graphic Log	Lithologic Description (color, type, size, moisture, density, particle shape, other)	Gravel	Sand	Fines
SRF (A)	1, 2, 3, 7	20"	N	N	N/A	10:35		OL, OL, OL, SP		BRN. W/ORGANICS. (DRY) ↓ GRAY SILT/W SAND (DRY)	— ↓	20, 20, 40	80, 80 ↓, 60
2 (B)	15, 19, 24, 36	23"	N	N	N/A	10:45		SP, GM, GM, GM		BRWN SAND W/GRAVEL - SILT (DRY); GRAY SAND W/ GRAVEL 1-2" LRG AG - SILT; " " " " " (DRY)	20, 30, 20 ↓	60, 60, 60 ↓	20, 20, 20 ↓
4 (C)	9, 21, 24, 21	24"	N	N	N/A	10:50		CL, GP ↓		~~[illegible]~~ CLAY BRWN. W/ORGANICS; BRWN/GRAY SAND W/ GRAVEL 1"-2" AG ↓; GRAY CL (3" @ BTM. SPOON) (DRY)	~~30~~, 30 ↓	~~60~~, 60 ↓	~~10~~ - 70% Fi, 10 ↓
6 (D)	4, 20, 24, 27	24"	N	N	N/A	11:00	6-8	GM, GP ↓		BRWN. SAND W/ GRVL - SILT (MOIST); SAND W/ GRVL - SILT (MOIST) ↓ ↓	30, 20 ↓	50, 70 ↓	20, 10 ↓
8 (E)	4, 13, 12, 13	24"	N	N	N/A	11:24	8-10	GW ↓		BRWN. WELL GRADED SAND W/GRAVEL SMALL AG < 3/4" (MOIST) ↓	10	90	—
10 (F)	7, 11, 12, 11	20"	N	N	N/A	11:31	10-12	GM, GP ↓		BRWN SILT W/SAND (MOIST); SAND W/GRVL POORLY GRD. (MOIST) ~3/4 AG	10, 40 ↓	40, 60 ↓	50, — ↓
12 (G)	6, 7, 8, 10	24"	N	N	N/A	11:42	12-14	GP, SP, SP, SW		BRWN /SAND W/ GRAVEL, (MOIST) SMALL GRVL - SILT; BRWN. POORLY GRADED SAND W/ GRVL - SILT; FINE WELL GRADED SAND W/SILT (MOIST) NO GRVL.	30, 20, 20, —	60, 70, 70, 80	10, 10, 10, 20
14										DIRECT BORE TO ▽ 5' STICKS.			
15													

AIMM 4
MW-4
Page 2

WESTON SOLUTIONS
Restoring Resource Efficiency

Boring Location ID: ____ Page 2 of 3
Project Name: Triple North Geotech Investigation
Site Location: Beluga River Unit
Project Number: 12700.084.001.0010

Collected Sample IDs/Analysis: Page __ of __
AUGER ~~FALLINGS~~ CUTTINGS ID

Depth (ft)	Blow Counts (per 0.5 ft)	Recovered/ Driven (ft)	Hydrocabon Odor (Y/N)	Hydrocarbon Staining (Y/N)	Sample ID	Time	Sample Interval	USCS Code	Graphic Log	Lithologic Description (color, type, size, moisture, density, particle shape, other)	Gravel	Sand	Fines
20							20-25			SAND / ~~SILT~~ w/ GRVL 3/4" – GRVL w/ SAND No FINES	80	20	~~10~~
25										SAND / ~~SILT~~ w/ GRVL 3/4" – GRVL w/ SAND 3	80	20	~~10~~
										COBBIE LARG < 4"	80	15	5
30										-3/4" GRVL w/ SAND - ~~SILT~~	80	20	–
35										T-2" GRVL w/ SAND	80	20	-
										-3/4 GRVL w/ SAND	80	20	–
40										<3/4-3" GRVL w/ SAND ↓	80	20	–
45										<3/4" GRVL w/ SAND ↓	80	20	
50										<3/4" GRVL w/ SAND ↓	80	20	
55										<3/4" GRVL w/SAND ↓	80	20	
60										<3/4" GRVL w/ SAND ↓	80	20	
65										<3/4" GRVL w/ SAND ↓	80	20	
70													

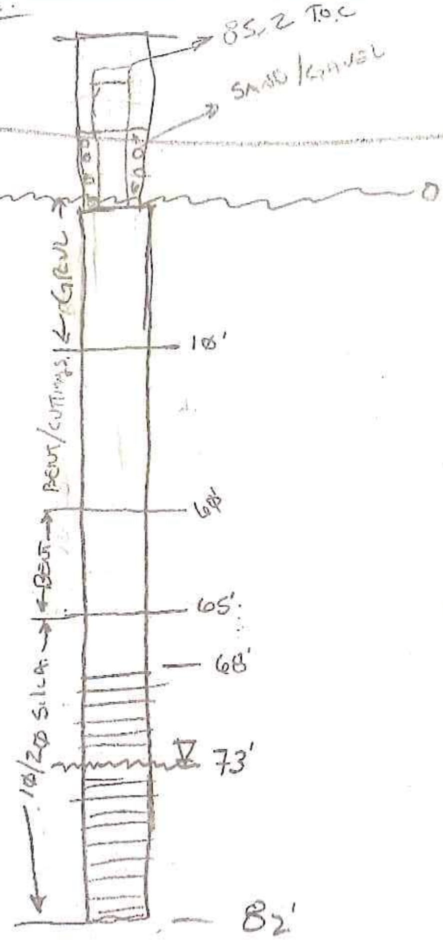
AIMM 4
MW-4
Page 3

WESTON SOLUTIONS
Restoring Resource Efficiency

Boring Location ID: ______ Page 3 of 3
Project Name: Triple North Geotech Investigation
Site Location: Beluga River Unit
Project Number: 12700.084.001.0010

Collected Sample IDs/Analysis: Page __ of __

Depth (ft)	Blow Counts (per 0.5 ft)	Recovered/ Driven (ft)	Hydrocabon Odor (Y/N)	Hydrocarbon Staining (Y/N)	Sample ID	Time	Sample Interval	USCS Code	Graphic Log	Lithologic Description (color, type, size, moisture, density, particle shape, other)	Grain Size Distribution (%) Gravel	Sand	Fines
70								GP		2-3" AG GRVL w/ Little SAND	90	10	—
	∇	73'						SW		∇ SW			
75										SAND w/ GRVL.			
80		2'4"	N	N	N/A	13:55	80-82	SW		DRIVE SPLIT SPOON TO GET ∇ (WET) 80'-80'10" — SW		100%	
								GP		80'10" — 82' — GP — POOR GRD. GRVL w/ SAND	90	10'	
82										BTM.			



ArnDock 1
Welts 19292

KRAXBERGER DRILLING
Rt. 2 Box 905
SOLDOTNA, ALASKA 99669
(907) 262-4720

Kraxberger Drilling Co. Well Drilling Log

Well owner: OffshoreSystems   Driller: BJ   Completion: 5/16/68

Builder: Foss Tug   City: Nth Kenai

Road/Area: Arness Dock

Legal 1: ______   Legal2: PAD 3 WELL

Depth: 162   Casing length: 162   Diameter: 8   Rig type: CT

Static level: 101   Yield: 530.0   Finish of well: .035 Screen 139-154

0-101 grv,sand,rocks,boulders

107-111 clay

115-131 coarse sand

133-137 good water bear/ sand

139-141 good water bear/sand

149-162 coarse sand

Test pumped @ 530-540 gpm for 16 hrs

.020 Screen 154-159

101-107 sand & gravel

111-115 fine heaving sand

131-133 coarse gravel

137-139 coarse gravel

141-149 coarse water gravel

Developed screen 39 hrs

1/24/86 - added 20' 8" casing

TOTAL DEPTH NOW APPROX. 182'

SMALL WELL FOR TIM ARNESS RESIDENCE ON DOCK LEVEL AT BASE OF BLUFF. WELL NO LONGER EXISTS.

19796

Source DEC - Soldotna "McGahan File"

12/29/88

ArnDock 2
WELTS 19796

Kraxberger Drilling Co. Well Drilling Log

Well owner: Arness Dock   Driller: F   Completion: 12/16/66

Builder: Jim Arness   City: Nth Kenai

Road/Area: Nth Rd /Arness Dock

Legal 1: ______   Legal2: Arness Dock

Depth: 31   Casing length: 33   Diameter: 6   Rig type: CT

Static level: Yield/GPM 20.0   Finish of well: perforate 20-23

0-20 dry sand & gravel

23-27 sandy clay

perforated 20-23ft

20-23 water gravel

27-31 water sand

SB 8-12-36 BDDD2-1
604430151181802

Source: DEC-Soldotna
'McGahan File'
19797

ArnDock 3
WELTS 1979

Kraxberger Drilling Co. Well Drilling Log

Well owner: ~~Arness Dock~~ Offshore Systems Driller: F Completion: 12/12/66

Builder: Jim Arness City: Nth Kenai

Road/Area: Arness Dock

Legal 1: PAD 2 OFFICE WELL aka Well #4 Legal2: Arness Dock

Depth: 41	Casing length: 43	Diameter: 6	Rig type: CT
Static level:	Yield/GPM 20.0	Finish of well: perforate 15-18'	

0-15 dry rocks & gravel

18-27 silty sand water gravel

35-41 sand & gravel

perforate 15-18 5 rows 6 per

15-18 water gravel

27-35 clay

SB 8-12-36 ACCD1-4
60430151181801

21647

ArnDock 4
WELTS 21647

Kraxberger Drilling Co. Well Drilling Log

Well owner: Offshore Systems - Kenai   Driller: RRK   Completion: 6/11/91

Builder: ______   City: Nth Kenai

Road/Area: Arness Dock Rd   Elev. = 147.7' MSL

Legal 1: Well #2   Legal2: ______

Depth: 186   Casing length: 189   Diameter: 8   Rig type: AR

Static level: 101   Yield/GPM 550.   Finish of well: 25' JS screen 161-186

0-22 dirty sand & gravel

22-43 dirty sand,grv,rocks

43-50 loose dirty sand & gravel

50-61 loose grv,sand & rocks

61-64 sand

64-95 loose sand & gravel

95-97 wet sand & gravel

97-99 sticky gray clay

99-107 silty wet sand

107-115 clean wet sand

115-165 sand,gravel,water

165-186 coarse sand & water

186 silt,sand,water,wood,coal

Set .030 screen 161-166

.025 screen 166-171

.020 screen 171-181

.018 screen 181-186

Developed screen for 24hrs

SB 8-12-36 CAAD 1-6
6044221511181901

21648

ArnDock 5
WELTS 21648

Kraxberger Drilling Co. Well Drilling Log

Well owner: Offshore Systems, Kenai Driller: SLK Completion: 5/21/91

Builder: ______ City: Nth Kenai

Road/Area: Arness Dock Rd ELEV. = 200.2' MSL

Legal 1: WELL #3 Legal2: ______

Depth: 257 Casing length: 259 Diameter: 8 Rig type: AR

Static level: Yield/GPM Finish of well: ______

0-2 gravel

2-10 gravel,silt & clay

10-15 sand,gravel & rocks

15-17 sand

17-96 sand,gravel & rock

96-108 gravel & clay

108-125 clay

125-131 sand & gravel

131-145 clay

145-152 silt,gravel & clay

11 152-167 sand & gravel(20gpm)

167-172 clay

13 172-178 water sand coarse.020

178-200 water sand.008(20-30gpm)

200-209 blue clay,silt,coal

209-220wet sand,silt,coal

220-227 flowing sand & silt

227-238 fine water sand(15-20gpm)

19 238-257 silt,sand & water

DRILL & CASE ONLY

NOT DEVELOPED OR USED

SB 8-12-36 CABD 1-7

60442315118310

FORM NO 9-1904-A

SITE NO. SB-8-12-36-CAAA 1-2

16599 600

U.S. DEPT. OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
GROUND WATER SITE INVENTORY
SITE SCHEDULE

AK-10117

Recorded by Anderson — Date 2-15-77

transcribed by Lundell

ArnDock 6
WELTS 16599

Check One: ✓ English ___ Metric Units

GENERAL SITE DATA (0)

Site Ident No: 604445151186001 — RG Number: R-0 — Transaction: T- (A) D M V (add, delete, modify, verified)

Site-Type: 2- C D H I M P T (W) (collector, drain, sinkhole, connector, multiple well, pond, tunnel or shaft, well) — Data Reliability: 3- C (U) L M (field checked, unchecked, location not accurate, minimal data) — Reporting Agency: 4- USGS

Project No.: 5- — District: 6- 02 — State: 7- 02 — County (or town): 8- 120

Latitude: 9- 604428 (deg min sec) — Longitude: 10- 1511816 (deg min sec) — Lat-Long Accuracy: 11- S F (T) M (sec, 5 sec, 10 sec, Min)

Local Number: 12- SB00801236CAAA1 002 — Land Net Loc.: 13- NENESW S 36 T 008N R 012W S (1/4 1/4 1/4 section, township, range, merid)

KENAI C-4 — 63360

Location Map: 14- NORTHKKENAIKKRM — Scale: 15- 63360 (63360 written over another value)

Altitude: 16- 115 — Method of Measurement: 17- A L (M) (altimeter, level, map) — Accuracy: 18- 5

Topo Setting: 19- D C E F H K L Ø P S (T) U V W (depression, stream channel, dunes, flat, hilltop, sink, swamp, offshore, pediment, hillside, terrace, undulating, valley flat, upland draw) — Hydrologic Unit (OWDC): 20- 19050002

Date of First Construction/Completion: 21- 05/00/1968 (month day year) — Use of Site: 23- A D E G H Ø M P R S T U (W) X Z (anode, drain, geothermal, seismic, heat, observation, mine, oil or gas, recharge, repressure, test, unused, withdrawal, waste, destroyed)

Use of Water: 24- A B (C) D E F H I M N P R S T U Y Z (air cond., bottling, commercial, dewater, power, fire, domestic, irrigation, medicinal, industrial, public supply, recreation, stock, institution, unused, desal, other)

Secondary Water Use: 25- — Tertiary Use of Water: 26- — Depth of Hole: 27- 159 — Depth of Well: 28- 159 — Source of Depth Data①: 29- D

Water Level: 30- 86 — Date Measured: 31- 05/00/1968 (month day year) — Source①: 33- D

Method of Measurement: 34- A C E G H L M R S T V Z (airline, calibrated airline, estimated, pressure gage, calibrated pressure gage, geophysical logs, manometer, reported, steel tape, electric tape, calibrated electric tape, other)

273= Y

Site Status: 37- D F G H Ø P R S T V X Z (dry, flowing, nearby flowing, nearby recently flowing, obstruction, pumping, recently pumped, nearby pumping, nearby recently pumped, foreign substance, surface water effects, other)

Source of Geohydrologic Data①: 36- D — Pump Used: 35- (no) — Measuring Point: 266- — Measuring Point Date: 267- / / (month day year)

OWNER IDENTIFICATION (1)

R-158 — T- (A) D M (add, delete, modify) — Date of Ownership: 159 # 05/00/1968 (month day year)

Name: Last 161- FOSS LAUNC — First 162- H. & TUG CO — Middle Initial 163-

OTHER SITE IDENTIFICATION NUMBERS (1)

R-189 — T- (A) D M (add, delete, modify) — Ident 190 # 002 — Assigner 191- AKMP

New Card Same R & T — Ident 190 # 10117 — Assigner 191- AKRG

190 # UNCONSOL * — 191 = CONFINED *

SITE VISIT DATA (1)

R-186 — T- A D M (add, delete, modify) — Date of Visit 187# / / (month day year) — Name of Person 188-

FIELD WATER QUALITY MEASUREMENTS (1)

R-192 — T- A D M (add, delete, modify) — Date 193 # / / (month day year) — Geohydrologic Unit 195 #

New Card Same R thru 195

Temperature 196# 00010 — Degrees C 197-

Conductance 196# 00095 — µ Mhos 197-

Other (STORET) Parameter 196# — Value 197-

Other (STORET) Parameter 196# — Value 197-

FOOT NOTES:

① Source of Data Codes:

S D Ø A R L G Z (reporting agency, driller, owner, other gov't, other reported, logs, geologist, other)

REMARK	DATE	INITIALS
AKRG OK	RAL	2-15-77
HEADER N	5-77	wt
WATER LEVEL N	5-77	wt
KEY PUNCH Y	5-77	wt
PRINT OUT OK'D	8-78	BTB

SB8-12-36-CAAA1-2

Arness 1
WELTS 19818

ARNESS DISPOSAL
SITE EXISTING
MONITOR WELL
MW 1

WELTS 19818

Kraxberger Drilling Co. Well Drilling Log

Well owner: Hart-Crowser   Driller: AAK   Completion: 9/15/88

Builder: Arness Disposal Site   City: Nth Kenai

Road/Area: Behind Baker /North Rd

Legal 1: ______   Legal2: ______

Depth: 138   Casing length: 48   Diameter: 6   Rig type: AR

Static level: 120   Yield/GPM   Finish of well: PVC 4" .010 scr 117-137

0-14 gravel,sand & rocks

14-21 sand & gravel

21-55 loose gravel,sand & rocks

55-56 rock

56-91 loose grave,sand & rock

91-95 tight silt,sand & gravel

95-105 loose gravel sand & rock

105-107 clay,sand & gravel

107-119 damp sand & gravel

119-123 wet silt & sand

123-124 clay

124-134 wet silt,sand & gravel

134-138 water sand & gravel

47'6" steel casing (3'6" above gr

20' screen & 120'PVC casing

A-8136   SEPTEMBER 1988

FIGURE 4A

ARNESS DISPOSAL SITE
MONITOR WELL MW 2

SHEET 2

Arness 2
MW-2

W S & S CO.
WATER SYSTEMS & SERVICE CO.
47360 EMERALD AVE.
KENAI, ALASKA 99611
907-776-8066

ECOWATER SYSTEMS
SINCE 1925.

Arness Disposal Site Monitor Well #2

Lot	Block	Subdivision	Borough	Section Qtrs.	Section	Township	Range	Meridian
			Kenai Peninsula		1	7N	12W	Seward

Well Owner:
Peggy Arness
46095 Arness Road
Kenai, Alaska 99611

Well Depth:
Depth of Hole 131 ft
Depth of Casing 111 ft

Date Of Completion: 7 / 9 / 13

Well Data:

Depth: From	To	Material, Type, Color
0	13	Gravel / Rocks / Sand
13	19	Sand / Gravel / Rocks
19	23	Rocks
23	68	Gravel / Rocks / Sand
68	72	Clay / Rocks
72	74	Gravel
74	83	Clay / Rocks
83	88	Clay
88	94	Gravel / Rocks / Clay
94	107	Gravel / Rocks / Sand
107	125	Clay / Gravel / Sand / Water
125	131	Gravel / Rocks / Water

Depths Measured From: X Casing Top ____ Ground Surface
Casing 2.5' above ground level

Depth to Static Water Level: 113 ft

Method of Drilling: X Air Rotary ____ Cable Tool ____ Other

Use of Well: ____ Domestic X Monitor ____ Public ____ Other

Casing Size: 6 in. to 111 ft
Type: Welded Steel ____ in. to ____ ft

Well Intake Opening Type: ____ Open End X Screened ____ Open Hole

Screen Type: PVC diam. 4 in.
Slot Size .010 Length 20 ft
Screen set at 111' to 131'

Grout Type: ____
Volume Used ____ Depth to Top ____

Development Method: Air, Pump

Draw Down Test & Yield: 0 ft of Draw Down 9 gpm
Tested with 1.5 hp pump. Depth of 120' from top of casing

Thank you for choosing Water Systems & Service for your water well needs.

Tom Dyer
Authorized Representative

7/9/13
Date

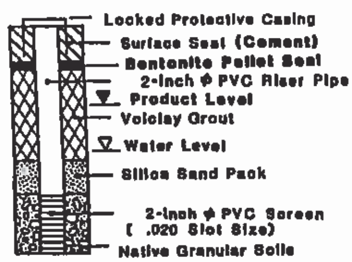
Arness 3
BH-1

Boring Log BH-1

Geologic Log

Depth in Feet	Approximate Ground Surface Elevation in Feet	Sample
5	Brown Sandy Gravel, GP, loose, wet to saturated, slight septage odor. Very small recovery, redrive at 6.5 feet.	S-1, S-1A
	Strong septage odor in cuttings at 9.0 feet.	
15	Brown to grey Sandy Gravel, GP, wet, loose, mild septage odor.	S-2
20	Very tough drilling, 22.0 to 24.0 feet.	
30	Grey-brown Sandy Gravel, GP, moist to wet, medium dense, no unusual odor.	S-3
35	Bottom of Boring - 30.5 feet Completed 9-13-88 No free water observed ATD Backfilled with drill cuttings.	

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50. Thermal State column.



Nominal 8-Inch Borehole

NOTES:

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level is for date indicated and may vary with time of year. ATD:At Time of Drill
3. Refer to Figure A-1 for explaination of symbo

HARTCROWSER

A-8136 September 1988

FIGURE 5

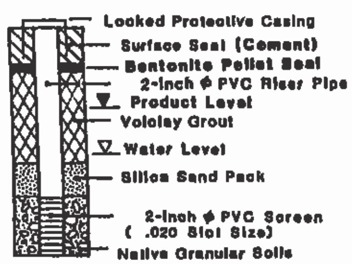
Arness 4
BH-2

Boring Log BH-2

Geologic Log

Depth in Feet	Approximate Ground Surface Elevation in Feet	Sample
5	Brown Gravelly Sand, SP, moist, loose no unusual odor.	S-1
10	Cuttings change to grey sand at 8 feet with slight to moderate petroleum odor.	
15	Grey Sandy Gravel, GP, moist, medium dense, mild sweet odor.	S-2
25	Very gravelly drilling at 27 feet.	
30	Grey Sandy Gravel, GP, moist, very dense with cobbles. Very small recovery. Redrive at 32.5 feet. Recovery contained large broken rock fragments, no unusual odor.	S-3, S-3A
35	Bottom of Boring - 33.5 feet Completed 9-13-88 No free water observed ATD Backfilled with drill cuttings.	

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50. Columns: Depth in Feet; Thermal State.



Nominal 8-Inch Borehole

NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level is for date indicated and ma vary with time of year. ATD:At Time of Dril
3. Refer to Figure A-1 for explaination of symbc

HARTCROWSER

A-8136 September 1988
FIGURE 6

Arness 5
BH-3

Boring Log BH-3

Geologic Log

Depth in Feet	Thermal State	Approximate Ground Surface Elevation in Feet	Sample
5		Brown Gravelly Sand, SP, damp to moist, loose to medium dense, no unusual odor	S-1
10		Grey sandier cutting with some gravel between 7 and 10 feet.	
15		Brown Sandy Gravel, GP, damp, medium dense, no unusual odor.	S-2
20–25		Very slow cobbly drilling 23 to 30 feet.	
30		Brown-grey Sandy Gravel, GP, moist, medium dense with no unusual odor.	S-3
35		Bottom of Boring - 31.0 feet Completed 9-13-88 No free water observed ATD Backfilled with drill cuttings.	

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Nominal 8-inch Borehole

NOTES:
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level is for date indicated and may vary with time of year. ATD:At Time of Drillir
3. Refer to Figure A-1 for explaination of symbols

HARTCROWSER

A-8136 September 1988
FIGURE 7

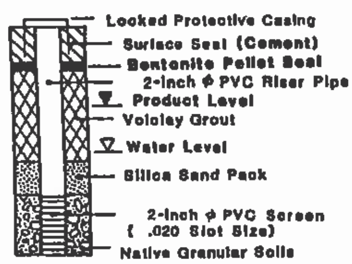
Arness 6
BH-4

Boring Log BH-4

Geologic Log

Depth in Feet | Thermal State | Approximate Ground Surface Elevation in Feet | Sample

Depth in Feet	Description	Sample
0	Brown Sandy Silt, ML, dry to moist	
	Brown Gravelly Sand, SP, with cobbles.	
5	Brown Sandy Gravel, GP, moist, medium dense, no unusual odor.	S-1
	Grey sandier cuttings 6 to 13 feet.	
10	Slight to moderate petroleum odor in cuttings at 11 feet.	
15	Brown Sandy Gravel, GP, moist, medium dense, no unusual odor.	S-2
20		
	Tough cobbly drilling 22 to 26 feet.	
25		
30	Brown Sandy Gravel, GP, moist to wet, medium dense well rounded 1/4 inch to 3/8 inch pea gravel. No unusual odor.	S-3
35	Bottom of Boring - 30.5 feet Completed 9-13-88 No free water ATD Backfilled with drill cuttings.	
40		
45		
50		



Nominal 8-inch Borehole

NOTES:

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level is for date indicated and may vary with time of year. ATD:At Time of Drilli
3. Refer to Figure A-1 for explaination of symbol

HARTCROWSER

A-8136 September 1988

FIGURE 8

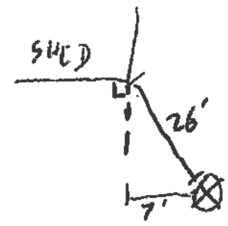
Baker 1
BHI-MW-1

Ahtna Engineering — WELL CONSTRUCTION LOG

PROJECT NUMBER:	WELL NUMBER:	SHEET:
20275,002	BHI-MW-01	1 of 1

PROJECT NAME	DHI NiKuKi	SITE	—
CLIENT	Baker Hughes	SCIENTIST	DRANN/DOBSON
DATE	5/14/14	WEATHER	SUNNY 60°F
DRILLING COMPANY	GeoTek	RIG TYPE	Geoprobe 8040 DT
BORING SIZE	7"	DRILLING METHOD	HSA
TOTAL DEPTH	44'	WELL TYPE	pre-pack
NORTHING		DEPTH TO GW	
EASTING		ELEVATION	

LOCATION SKETCH/EXTRA FIELD NOTES:
[surface condition, ie. Asphalt, grass]



DEPTH (FEET)	FIELD ILLUSTRATION	WELL INSTALLATION INFO	SOIL DESCRIPTION
0		Pea Gravel native soil	
5			
10		Bentonite	
15			
20			
25		slough/native soil	
30		Bentonite	
35		Sand	
40			
45			

WELL DATA

Monument Type: Flush Mount

Surface Seal: ______

Stickup Height: n/a

2 -inch Schedule PVC Well Casing

Screened Interval: 34-44'

.01 " Slotted Screen

Other:

31 - Sand
28-31 - Bent
20-28 Sluff
5-20 Bent

Baker 2
BHI-MW-02

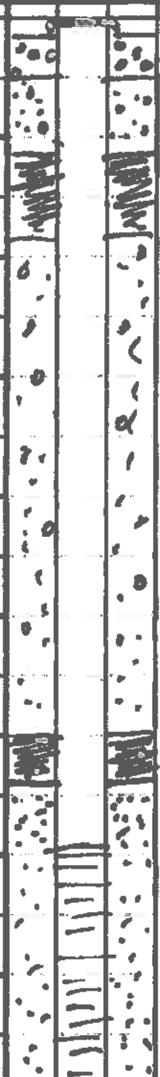
Ahtna Engineering

WELL CONSTRUCTION LOG

PROJECT NUMBER:	WELL NUMBER:	SHEET:
20275.002	BHI-MW 02	1 of 1

PROJECT NAME	BHI Nikiski	SITE	
CLIENT	Baker Hughes	SCIENTIST	Dobson/Brann
DATE	5/14/14	WEATHER	Sunny 60°F
DRILLING COMPANY	GeoTEK	RIG TYPE	Geoprobe 8040 DT
BORING SIZE	7"	DRILLING METHOD	HSA
TOTAL DEPTH	44.5'	WELL TYPE	Pre-pack
NORTHING		DEPTH TO GW	
EASTING		ELEVATION	

LOCATION SKETCH/EXTRA FIELD NOTES:
[surface condition, ie. Asphalt, grass]
N

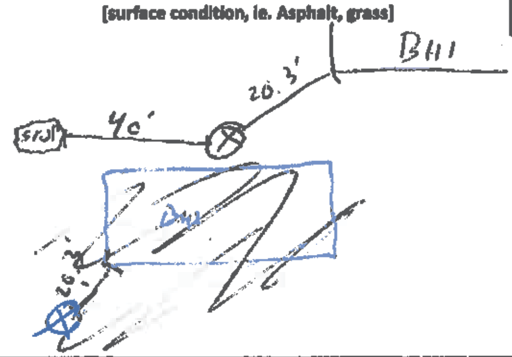
DEPTH (FEET)	FIELD ILLUSTRATION	WELL INSTALLATION INFO	SOIL DESCRIPTION	WELL DATA
0		Pea Gravel		Monument Type: Flush Mount
		Native soil		Surface Seal:
5		Bentonite		Stickup Height: n/a
10				2 -inch Schedule PVC Well Casing
				Screened Interval: 44.5 - 34.5'
15		Native Sand/Sluff		.01 " Slotted Screen
20				Other:
				Sand 32 - 34.5'
25				Bentonite 30 - 32'
				Native sluff 9 - 30'
30		Bentonite (hydrated)		Bentonite 6 - 9'
		Sand		
35				
40		Screen		
45				

Baker 3
BHI-MW-3

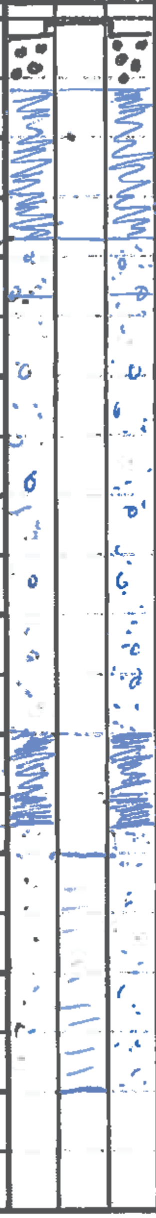
Ahtna Engineering	WELL CONSTRUCTION LOG	PROJECT NUMBER: 20275.002	WELL NUMBER: BHI-MW2	SHEET: 1 of 1

PROJECT NAME	BHI Nikiski CF	SITE	
CLIENT	BAKER HUGHES	SCIENTIST	DOBSON/BROWN
DATE	5/14	WEATHER	SUNNY
DRILLING COMPANY	GeoTek	RIG TYPE	GeoProbe 8040 DT
BORING SIZE	7" OD	DRILLING METHOD	HSA
TOTAL DEPTH	45'	WELL TYPE	PRE-PACK 0.10 SLOT
NORTHING		DEPTH TO GW	
EASTING		ELEVATION	

LOCATION SKETCH/EXTRA FIELD NOTES: [surface condition, ie. Asphalt, grass] N



DEPTH (FEET)	FIELD ILLUSTRATION	WELL INSTALLATION INFO	SOIL DESCRIPTION
0		Pea Gravel	
5		Bentonite	
15		Native soil	
25			
		Bentonite	
35			
		Sand/screen	
45			



WELL DATA

Monument Type: Flush mount

Surface Seal: ______

Stickup Height: N/A

2 -Inch Schedule PVC Well Casing

Screened Interval: 35'-45' BGS

0.10 " Slotted Screen - SS OUTER SCREEN

Other:

Colorado SAND 33'-45' BGS
BENTONITE 30'-33' BGS
NATIVE BACKFILL/SLUFF 8'-30' BGS
BENTONITE - 3'-8' BGS
BACKFILL -

Baker 8
SB-01
Page 1

Ahtna Engineering

Boring Number: SB-01
Project Number: 20275.002

Project Name Nikiski	**Recovery Device** Macro Core	**X/Y Coordinates** 2461924.27409/1407550.31941
Site Completions Facility	**Device Diameter** N/A	**X/Y Datum** NAD83(2011) AK State Plane 4
Client Baker Hughes	**Sample Method** Macro Core	**Ground Elevation** 136.02
Field Scientist/Engineer Tim Dobson	**# of Samples** 3	**Elevation Datum** NAVD88 Geoid 12A US ft
Date 5/12/2014	**Drilling Company** GeoTek	**Extra Field Notes:**
Weather	**Rig Type** Geoprobe 8040	
Total Depth 45 feet bgs	**Hammer Drop & Weight** N/A	
Boring Size 2.25 -inch	**Associated Points** N/A	

ColorTec 133LL (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						0			
0.0	14-BHI-SB01-01-SO		ND	Concrete. SANDY GRAVEL WITH SILT (GW-GM); brown; medium dense; moist.					
0.0				SANDY GRAVEL (GW); brown; dense; moist.		5			
0.0						10			
0.0	14-BHI-SB01-04-SO		ND			15			
0.0						20			
0.0				FINE SAND (SP). SANDY GRAVEL (GW); brown; dense; moist.		25			
0.0						30			
						35			

Baker 8
SB-01
Page 2

Ahtna Engineering

Boring Number: SB-01
Project Number: 20275.002

Project Name Nikiski
Site Completions Facility
Client Baker Hughes
Field Scientist/Engineer Tim Dobson
Date 5/12/2014
Weather
Total Depth 45 feet bgs
Boring Size 2.25 -inch

Recovery Device Macro Core
Device Diameter N/A
Sample Method Macro Core
# of Samples 3
Drilling Company GeoTek
Rig Type Geoprobe 8040
Hammer Drop & Weight N/A
Associated Points N/A

X/Y Coordinates 2461924.27409/1407550.31941
X/Y Datum NAD83(2011) AK State Plane 4
Ground Elevation 136.02
Elevation Datum NAVD88 Geoid 12A US ft
Extra Field Notes:

ColorTec 133LL (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						35			
0.0				SANDY GRAVEL (GW); brown; dense; moist. *(continued)*					
						40			
0.0	14-BHI-SB01-09-SO		0.0074	GRAVELLY SAND (SW); brown; dense; wet.			∇		
						45			

End of Boring: 45 feet bgs.

Ahtna Engineering

Boring Number: SB-02
Project Number: 20275.002

Project Name Nikiski
Site Completions Facility
Client Baker Hughes
Field Scientist/Engineer Tim Dobson
Date 5/12/2014
Weather
Total Depth 45 feet bgs
Boring Size 2.25 -Inch

Recovery Device Macro Core
Device Diameter N/A
Sample Method Macro Core
# of Samples 3
Drilling Company GeoTek
Rig Type Geoprobe 8040
Hammer Drop & Weight N/A
Associated Points N/A

X/Y Coordinates 2461934.07451/1407590.11501
X/Y Datum NAD83(2011) AK State Plane 4
Ground Elevation 136.03
Elevation Datum NAVD88 Geoid 12A US ft
Extra Field Notes:

ColorTec 133LL (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						0			
0.0	14-BHI-SB02-01-SO		ND	Concrete. SANDY GRAVEL (GW); brown; dense; moist.		5			
0.0						10			
0.0						15			
0.0	14-BHI-SB02-04-SO		ND			20			
0.0						25			
0.0						30			
0.0						35			

Baker 9
SB-02
Page 1

Ahtna Engineering

Boring Number: SB-02
Project Number: 20275.002

Project Name	Nikiski	Recovery Device	Macro Core	X/Y Coordinates	2461934.07451/1407590.11501
Site	Completions Facility	Device Diameter	N/A	X/Y Datum	NAD83(2011) AK State Plane 4
Client	Baker Hughes	Sample Method	Macro Core	Ground Elevation	136.03
Field Scientist/Engineer	Tim Dobson	# of Samples	3	Elevation Datum	NAVD88 Geoid 12A US ft
Date	5/12/2014	Drilling Company	GeoTek	Extra Field Notes:	
Weather		Rig Type	Geoprobe 8040		
Total Depth	45 feet bgs	Hammer Drop & Weight	N/A		
Boring Size	2.25 -Inch	Associated Points	N/A		

ColorTec 133LL (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						35			
0.0				SANDY GRAVEL (GW); brown; dense; moist. *(continued)*					
				FINE TO MEDIUM SAND (SP); brown; dense; moist.		40	∇		
0.0	14-BHI-SB02-09-SO		0.0098	SANDY GRAVEL (GW); brown; dense; moist.		45			

End of Boring: 45 feet bgs.

Data Template: AES DATA TEMPLATE.GDT Library: M:\AES0 AK ENVIRONMENTAL GROUP\GINT\AES LIBRARY.GLB Project File: M:\AES\PROJECT FILES - REORGANIZED\BAKER_HUGHES_20275001_NIKISKI_TOOL_SHOP\10_FIELD REPORTS\BORING LOGS\NIKISKI.GPJ

Baker 10
SB-03
Page 1

Ahtna Engineering

Boring Number: SB-03
Project Number: 20275.002

Project Name	Nikiski	**Recovery Device**	Macro Core	**X/Y Coordinates**	2461918.54143/1407634.19772
Site	Completions Facility	**Device Diameter**	N/A	**X/Y Datum**	NAD83(2011) AK State Plane 4
Client	Baker Hughes	**Sample Method**	Macro Core	**Ground Elevation**	135.91
Field Scientist/Engineer	Tim Dobson	**# of Samples**	4	**Elevation Datum**	NAVD88 Geoid 12A US ft
Date	5/13/2014	**Drilling Company**	GeoTek	**Extra Field Notes:**	
Weather		**Rig Type**	Geoprobe 8040		
Total Depth	45 feet bgs	**Hammer Drop & Weight**	N/A		
Boring Size	2.25 -inch	**Associated Points**	N/A		

ColorTec 1331LL (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						0			
0.0	14-BHI-SB03-01-SO		ND	Concrete. SANDY GRAVEL WITH SILT (GW); brown; medium dense; moist.		5			
0.0				GRAVELLY SAND WITH SILT (SW); brown; dense; moist.		10			
0.0						15			
0.0	14-BHI-SB03-04-SO 14-BHI-SB03-05-SO		ND	SANDY GRAVEL WITH SILT (GW); brown; dense; moist.		20			
0.0				GRAVELLY SAND WITH SILT (SW); brown; dense; moist.		25			
0.0				SANDY GRAVEL WITH TRACE SILT (GW); brown; dense; moist.		30			
0.0				FINE TO MEDIUM SAND (SP); brown; moist.		35			

Baker 10
SB-03
Page 2

Ahtna Engineering

Boring Number: SB-03
Project Number: 20275.002

Project Name	Nikiski	**Recovery Device**	Macro Core	**X/Y Coordinates**	2461918.54143/1407634.19772
Site	Completions Facility	**Device Diameter**	N/A	**X/Y Datum**	NAD83(2011) AK State Plane 4
Client	Baker Hughes	**Sample Method**	Macro Core	**Ground Elevation**	135.91
Field Scientist/Engineer	Tim Dobson	**# of Samples**	4	**Elevation Datum**	NAVD88 Geoid 12A US ft
Date	5/13/2014	**Drilling Company**	GeoTek	**Extra Field Notes:**	
Weather		**Rig Type**	Geoprobe 8040		
Total Depth	45 feet bgs	**Hammer Drop & Weight**	N/A		
Boring Size	2.25 -Inch	**Associated Points**	N/A		

ColorTec 133LL (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						35			
0.0				SANDY GRAVEL (GW); brown; moist to wet.		40			
0.0	14-BHI-SB03-10-SO		0.058			45	∇		

End of Boring: 45 feet bgs.

Ahtna Engineering

Boring Number: SB-04
Project Number: 20275.002

Project Name Nikiski
Site Completions Facility
Client Baker Hughes
Field Scientist/Engineer Tim Dobson
Date 5/13/2014
Weather
Total Depth 45 feet bgs
Boring Size 2.25 -inch

Recovery Device Macro Core
Device Diameter N/A
Sample Method Macro Core
# of Samples 4
Drilling Company GeoTek
Rig Type Geoprobe 8040
Hammer Drop & Weight N/A
Associated Points BHI-MW-01

X/Y Coordinates 2461918.07848/1407701.36253
X/Y Datum NAD83(2011) AK State Plane 4
Ground Elevation 135.49
Elevation Datum NAVD88 Geoid 12A US ft
Extra Field Notes:

ColorTec 133LL (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						0			
	14-BHI-SB04-01-SO		ND	SANDY GRAVEL WITH SILT (GW); brown; medium dense; moist.		5			Native Soil
0.0				SANDY GRAVEL WITH SILT (GW); brown; medium dense; wet.		10			
0.0				SILT (MH); brown; medium stiff; wet. SANDY GRAVEL WITH SILT (GW); brown; dense; moist.		15			Bentonite
0.0	14-BHI-SB04-04-SO		0.0045			20			
0.0						25			Native Soil
0.0						30			Bentonite
0.0						35			Sand Screened Interval

Baker 11
SB-04
Page 2

Ahtna Engineering

Boring Number: SB-04
Project Number: 20275.002

Project Name	Nikiski	**Recovery Device**	Macro Core	**X/Y Coordinates**	2461918.07848/1407701.36253
Site	Completions Facility	**Device Diameter**	N/A	**X/Y Datum**	NAD83(2011) AK State Plane 4
Client	Baker Hughes	**Sample Method**	Macro Core	**Ground Elevation**	135.49
Field Scientist/Engineer	Tim Dobson	**# of Samples**	4	**Elevation Datum**	NAVD88 Geoid 12A US ft
Date	5/13/2014	**Drilling Company**	GeoTek	**Extra Field Notes:**	
Weather		**Rig Type**	Geoprobe 8040		
Total Depth	45 feet bgs	**Hammer Drop & Weight**	N/A		
Boring Size	2.25 -inch	**Associated Points**	BHI-MW-01		

ColorTec 1331L (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						35			
0.0	14-BHI-SB04-08-SO		0.093	SANDY GRAVEL WITH SILT (GW); brown; dense; moist. *(continued)*					
	14-BHI-103-GW	43		SANDY GRAVEL WITH SILT (GW); brown; dense; wet.		40	∇		Screened Interval
						45			

End of Boring: 45 feet bgs.

Project File: M:\AES\PROJECT FILES - REORGANIZED\BAKER_HUGHES_20275001_NIKISKI_TOOL_SHOP\10_FIELD REPORTS\BORING LOGS\NIKISKI.GPJ Library: M:\AES\10 AK ENVIRONMENTAL GROUP\GINT\AES LIBRARY.GLB Data Template: AES DATA TEMPLATE.GDT

Baker 12
SB-05
Page 1

Ahtna Engineering

Boring Number: SB-05
Project Number: 20275.002

Project Name Nikiski
Site Completions Facility
Client Baker Hughes
Field Scientist/Engineer Tim Dobson
Date 5/13/2014
Weather
Total Depth 45 feet bgs
Boring Size 2.25 -inch

Recovery Device Macro Core
Device Diameter N/A
Sample Method Macro Core
# of Samples 5
Drilling Company GeoTek
Rig Type Geoprobe 8040
Hammer Drop & Weight N/A
Associated Points BHI-MW-02

X/Y Coordinates 2462034.85326/1407515.21258
X/Y Datum NAD83(2011) AK State Plane 4
Ground Elevation 133.77
Elevation Datum NAVD88 Geoid 12A US ft
Extra Field Notes:

ColorTec 133LL (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						0			
	14-BHI-SB05-01-SO		ND	SANDY GRAVEL WITH SILT (GW); brown; medium dense; moist.		5			Native Soil
0.0				SANDY GRAVEL WITH SILT (GW); brown; dense; moist.		10			Bentonite
0.0						15			
0.0	14-BHI-SB05-04-SO 14-BHI-SB05-05-SO		0.010 0.0071			20			Native Soil
0.0						25			
0.0						30			
0.0				FINE TO MEDIUM SAND WITH TRACE GRAVEL AND SILT (SP); brown to gray; dense; moist.		35			Bentonite Sand Screened Interval

Baker 12
SB-05
Page 2

Ahtna Engineering

Boring Number: SB-05
Project Number: 20275.002

Project Name	Nikiski	**Recovery Device**	Macro Core	**X/Y Coordinates**	2462034.85326/1407515.21258
Site	Completions Facility	**Device Diameter**	N/A	**X/Y Datum**	NAD83(2011) AK State Plane 4
Client	Baker Hughes	**Sample Method**	Macro Core	**Ground Elevation**	133.77
Field Scientist/Engineer	Tim Dobson	**# of Samples**	5	**Elevation Datum**	NAVD88 Geoid 12A US ft
Date	5/13/2014	**Drilling Company**	GeoTek	**Extra Field Notes:**	
Weather		**Rig Type**	Geoprobe 8040		
Total Depth	45 feet bgs	**Hammer Drop & Weight**	N/A		
Boring Size	2.25 -inch	**Associated Points**	BHI-MW-02		

ColorTec 133LL (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						35			
0.0				GRAVELLY SAND WITH TRACE SILT (SW); brown; moist.					
	14-BHI-106-GW	2.9				40	∇		Screened Interval
	14-BHI-SB05-10-SO		0.024	GRAVEL WITH SILT (GW); brown; wet.		45			

End of Boring: 45 feet bgs.

Baker 13
SB-06
Page 1

Ahtna Engineering

Boring Number: SB-06
Project Number: 20275.002

Project Name Nikiski	**Recovery Device** Macro Core	**X/Y Coordinates** 2461873.92623/1407499.205
Site Completions Facility	**Device Diameter** N/A	**X/Y Datum** NAD83(2011) AK State Plane 4
Client Baker Hughes	**Sample Method** Macro Core	**Ground Elevation** 134.66
Field Scientist/Engineer Tim Dobson	**# of Samples** 5	**Elevation Datum** NAVD88 Geoid 12A US ft
Date 5/14/2014	**Drilling Company** GeoTek	**Extra Field Notes:**
Weather	**Rig Type** Geoprobe 8040	
Total Depth 45 feet bgs	**Hammer Drop & Weight** N/A	
Boring Size 2.25 -inch	**Associated Points** BHI-MW-03	

ColorTec 133LL (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						0			
	14-BHI-SB06-01-SO		ND	GRAVELLY SAND (SW); brown; medium dense; moist.					Pea Gravel
0.0						5			Bentonite
				SILT (MH); brown; wet.					
				GRAVELLY SAND WITH SILT (SW); brown; dense; moist.		10			
0.0									
						15			
0.0	14-BHI-SB06-04-SO		ND	SANDY GRAVEL WITH SILT (GW); brown; dense; moist.					
						20			Native Soil
0.0									
						25			
0.0									
						30			
0.0									Bentonite
				Granite Boulder.					Sand
						35			

Baker 13
SB-06
Page 2

Ahtna Engineering

Boring Number: SB-06
Project Number: 20275.002

Project Name Nikiski
Site Completions Facility
Client Baker Hughes
Field Scientist/Engineer Tim Dobson
Date 5/14/2014
Weather
Total Depth 45 feet bgs
Boring Size 2.25 -inch

Recovery Device Macro Core
Device Diameter N/A
Sample Method Macro Core
# of Samples 5
Drilling Company GeoTek
Rig Type Geoprobe 8040
Hammer Drop & Weight N/A
Associated Points BHI-MW-03

X/Y Coordinates 2461873.92623/1407499.205
X/Y Datum NAD83(2011) AK State Plane 4
Ground Elevation 134.66
Elevation Datum NAVD88 Geoid 12A US ft
Extra Field Notes:

ColorTec 133LL (ppm)	ANALYTICAL SAMPLES	GROUNDWATER ANALYTICAL TCE (ug/L)	SOIL ANALYTICAL TCE (mg/kg)	SOIL DESCRIPTION AND NOTES	SOIL GRAPHIC	DEPTH (ft)	WATER LEVEL	WELL GRAPHIC	WELL DESCRIPTION
						35			
0.0				SANDY GRAVEL WITH SILT (GW); brown; dense; moist to wet. *(continued)*			⊻		
	14-BHI-101-GW	0.67							
	14-BHI-102-GW	0.69				40			Screened Interval
0.0	14-BHI-SB06-09-SO		0.0056			45			

End of Boring: 45 feet bgs.

Project File: M:\AES\PROJECT FILES - REORGANIZED\BAKER_HUGHES_20275001_NIKISKI_TOOL_SHOP\10_FIELD REPORTS\BORING LOGS\NIKISKI.GPJ Library: M:\AES\0 AK ENVIRONMENTAL GROUP\GINT\AES LIBRARY.GLB Data Template: AES DATA TEMPLATE.GDT

BakerRd 1
WELTS 16845

WATER WELL DRILLERS LOG

DO NOT FILL IN

Drilling Co. FRANK KRAXBERGER DRILLING STAR ROUTE SOLDATNA, ALASKA

USGS No. ____

Driller Frank Kraxberger

Area ____

Well Owner Baker Tool

Use of Well Shop

Location (address of: Township, Range, & Section (if known); distance from road:

Nth Kenai near Hunger Hut

Size of Casing 6 Depth of Hole ___ feet. Cased to 119 feet.

Static water level 105 feet (~~above~~) (below) land surface. Finish of well

(check one) Open end ( ): Screen (✓): Perforated ( ).

Describe screen or perforations: 15,000 114 to 119

Well pumping test at 5 gallons per (~~hr~~) (min) for 4 hours with ____ feet of drawdown from static level.

Remarks ____

WELL LOG

Depth in feet from ground surface	Give details of formations penetrated, size of material, color, and hardness.
0 to 58	loose sand & gravel
50 to 60	very hard
60 to 99	dry sand & gravel
99 to 101	water sand with a little water
101 to 111	blue clay
111 to 119	water gravel
to	
to	SB7-12-1BCDA1-5
to	
to	
to	
to	
to	
to	
to	
to	

SB 7-12-1 BCDA 1-5

BearPaw 1
No WELTS

BEAR PAW COFFEE SHOP & DELI
Nikiski, Ak.

STRATA WELL LOG

2' to 90'	-	gravel
90' to 95'	-	gravel with clay
96' to 100'	-	water vein with washed sand & gravel
100' to 117'	-	gravel & clay
117' to 124'	-	water strata
124' to 128'	-	red clay
128' to 134'	-	good sand, gravel & lots of water

16843

Bernice 1
WELTS 16843

Well No. 7-12-1-4

Latitude-longitude 60, 43, 23 (N) 151, 19, 03 - 1
d m s d m s

HYDROGEOLOGIC CARD

SAME AS ON MASTER CARD (1–19) | Physiographic Province: | 2 9 (20–21) | Section:

C (22) | Drainage Basin: | 8 0 B (23–25) | Subbasin: | C (26)

Topo of well site: (D) depression, (C) stream channel, (E) dunes, (F) flat, (H) hilltop, (K) sink, (L) swamp, (O) offshore, (P) pediment, (S) hillside, (T) terrace, (U) undulating, (V) valley flat | 27 U

MAJOR AQUIFER: system, series | Q G (28–29) | aquifer, formation, group | 0 U (30–31)

Lithology: | R (32–33) | Origin: | O (34) | Aquifer Thickness: ft

Length of well open to: ft (35–37) | 5 (38–40) | Depth to top of: ft (41–43)

MINOR AQUIFER: system, series (44–45) | aquifer, formation, group (46–47)

Lithology: (48–49) | Origin: (50) | Aquifer Thickness: ft

Length of well open to: ft (51–53) | (54–56) | Depth to top of: ft (57–59)

Intervals Screened: 5' #40 slot from 126'6" to 131'6"

Depth to consolidated rock: ft (60–63) | Source of data: (64)

Depth to basement: ft (65–68) | Source of data: (69)

Surficial material: (70–71) | Infiltration characteristics: (72)

Coefficient Trans: gpd/ft (73–75) | Coefficient Storage: (76–78)

Coefficient Perm: gpd/ft^2; Spec cap: gpm/ft; Number of geologic cards: (79)

0-101 Sand & gravel - dry
101-102 Sand & gravel w/ seepage less than 1gpm
102-120 Silty sand w/ blue clay w/ coal
120-122 Silty sand w/ coal
122-123 Silty sand & gravel heaving w/ H_2O 3-4 gpm
123-125 Sand & gravel w/ H_2O heaving
125-126 Silty sand w/ coal w/ H_2O coal dia = 4"
126-131.5 Sand & gravel w/ H_2O clean
131.5-132 Sandy blue clay

		1	
0			

Well No. AK-10784

SB 7 12 1 CCBA

GPO 857-700

Charlie 1
WELTS 34201

W S & S CO.

WATER SYSTEMS & SERVICE CO.

47360 EMERALD AVE.
KENAI, ALASKA 99611
907-776-8066

ECOWATER SYSTEMS SINCE 1925.

Lot	Block	Subdivision	Borough	Section Qtrs.	Section	Township	Range	Meridian
2	2	Nikishka Sub						

Well Owner:
Steve & Jennifer Chamberlain
P.O. Box 8186
Nikiski, Alaska 99635

Well Depth:
Depth of Hole 145 ft
Depth of Casing 140 ft

Date Of Completion: 10 / 05/ 05

Well Data:

Depth: From	To	Material, Type, Color
0	15	Bury Pit
15	98	Sand / Gravel
98	121	Clay
121	135	Clay / Rocks
135	145	Sand / Gravel

< .5 ppm Iron
6.9 PH
6 Grains Hardness

Depths Measured From: X Casing Top ____ Ground Surface

Depth to Static Water Level: 110 ft

Method of Drilling: X Air Rotary ____ Cable Tool ____ Other

Use of Well: ____ Domestic ____ Monitor X Public ____ Other

Casing Size: 6 in. to 140 ft; ____ in. to ____ ft

Well Intake Opening Type: ____ Open End X Screened ____ Open Hole

Screen Type: S.S. diam. 6 in.
Slot Size 12 Length 5 ft

Grout Type: Enviro Plug #8
Volume Used 100 lbs Depth to Top 10'

Development Method: Air, Pump, Bailing

Draw Down Test & Yield: 8 ft of Draw Down 20 gpm

Thank you for choosing Water Systems & Service for your water well needs.

Tom Dyer
Authorized Representative

10/05/05
Date

Attachment E

WS & S Co.

WATER SYSTEMS & SERVICE

Rt. 1, Box 1517 Kenai, Alaska 99611

CIP 9
Well No. 1
WELTS 14100

14100

April 4, 1984

for well #1 located on Lot 2, Nikishka Subd No. 2

COOK INLET PROCESSING
Fish Avenue
Nikishka, AK 99635

#1

Attn: Carl Summers

Dear Carl:

Per your request last evening we are submitting the following well log on Well #1 on the cannery located on Fish Avenue in Nikishka, Alaska:

0 to 2 feet topsoil
2 to 90feet gravel
90 to 140 feet sand
135 to 140 feet screen set in sand formation

A submersible pump with a rating of 5 h.p. was set as requested and the well yields 70 gpm.

We thank you for choosing our company to serve your water needs. If you have any questions or problems please don't hesitate to call.

Sincerely,

Kenneth D. Dyer
Owner

kd/dd

LAS 18787

N51 W41

SE NE SE NW

LAS 18787

N51 W41

SENESENW

NIKISHKA #2 L2 B1

BDAC ← CORRECT LOCATION

refer to LAS 6640

567-12-1 ACB 1-7

19790

CIP 10
Well No. 2
WELTS 19790

WS & S Co.

WATER SYSTEMS & SERVICE

Rt. 1, Box 1517 Kenai, Alaska 99611.

Dated this 4th day of April, 19 84.

L02B01 Nikiska Sub 2

COOK INLET PROCESSING
FISH AVENUE
NIKISHKA, AK

Dear Mr. Carl Summers:

The following is a well log which is located on Well #2
Lot ______ Block ______, ______
Subdivision; being physically located on ______
FISH AVENUE.
As you have requested said well to be drilled, we are submitting the following information:

0	to	2	feet	topsoil
2	to	90	feet	gravel
90	to	168	feet	sand
158	to	168	feet	screen set in sand formation
	to		feet	

A submersible pump with a rating of 5 h.p. was set as requested and the well yields 100 gpm.

We thank you for choosing our company to serve your needs. If you have any questions or problems please don't hesitate to call.

Sincerely,

Kenneth D. Dyer
Owner

kd/dd

LOCAL NO. SB7-12-1 ACCB2-7
SITE ID 604343151181302
NK 20

Cook Inlet Processing Well that is approved by ADEC as Class B well. Received from Kenny Dier. 1/89

PDH 1/23/89

CIP 11
Well No. 3
WELTS 23912

23912

WS & S Co.

WATER SYSTEMS & SERVICE

Rt. 1, Box 1517 Kenai, Alaska 99611

Dated this 23 day of May, 19 80

MR. Cook Inlet Processing
P. O. Box 8163
Nikiski, Alaska 99635

#3

Dear MR. Cook Inlet Processing

The following is a well log which is located on Lot ______
Block ______ Well # 3 ______
subdivision, located in the Kenai Recording District.
As you have requested said well to be drilled, we are submitting the following information regarding your well:

0 to	95 feet	Large Rock - Gravel & Sand
95 to	126 feet	Clay - Grey
126 to	132 feet	Large Rock - Gravel & Sand
132 to	137 feet	Clay
137 to	153 feet	Sand

Static Water - 105'

A submersible pump with a rating of 15 h.p. was set as requested and the well yield has the capacity of 150 gpm W/ 20' Draw Dow g.p.m. A screen was/XXXXXXX set as requested or required.
15' of # 16 screen was set at 138' to 153'.

We thank you for choosing Water Systems and Service to servu your water well needs. If you have any further questions or problems, please don't hesitate to call.

Sincerely,

Kenneth D. Dyer

Kenneth D. Dyer

cj/kd

LAS 18787

LOG B1 N44 W45 SESESENW

NIKISKA #3 1, 7N, 12W, SM

BDDD

SB7-12-1BDDD

WILLIAUER FILE

FORM NO 9-1904-A

SITE NO. SB-7-12-1-AABB1-1
AK-10533

16848

Contro 1
WELTS 16848

Recorded by Feathy / Still

U.S. DEPT. OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
GROUND WATER SITE INVENTORY
SITE SCHEDULE

Date Dec 16, 1976

Check One ✓ English ___ Metric Units

GENERAL SITE DATA (0)

Mod.

Site Ident No 604359151175501 | RG Number R-0 | Transaction T- (A) D M V (add, delete, modify, verified)

Site-Type 2- C D H I M P T (W) (collector, drain, sinkhole, connector, multiple, pond, tunnel or shaft, well) | Data Reliability 3- C (U) L M (field checked, unchecked, location not accurate, minimal data) | Reporting Agency 4- USGS

Project No. 5- | District 6- 02 | State 7- 02 | County (or town) N. Kenai 8- 120

Latitude 9- 604359 | Longitude 10- 1511755 | Lat-Long Accuracy 11- S F (T) M

Local Number 12- SB00701201AABB1 001 | Land Net Loc. 13- NE NW NE S 01 T 007N R 012W S (W E)

Location Map 14- ~~NORTH KENAI 3 KBM~~ KENAI C-4 | Scale 15- ~~6000~~ 63360

Altitude 16- 129 | Method of Measurement 17- A L (M) (altimeter, level, map) | Accuracy 18- 5

Topo Setting 19- D C E F H K L Ø P S T (U) V W (depression, stream channel, dunes, flat, hilltop, sink, swamp, offshore, pediment, hillside, terrace, undulating, valley flat, upland draw) | Hydrologic Unit (OWDC) 20- 19050002

Date of First Construction/Completion 21- 04/00/1967 | Use of Site 23- A D E G H Ø M P R S T U (W) X Z (anode, drain, geothermal, seismic, heat reserv., observation, mine, oil or gas, recharge, repress, test, unused, withdrawal, waste, destroyed)

Use of Water 24- A B C D E F H I M N (P) R S T U Y Z (air cond., bottling, commercial, dewater, power, fire, domestic, irrigation, medicinal, industrial, public supply, recreation, stock, institution, unused, desal, other)

Secondary Water Use 25- | Tertiary Use of Water 26- | Depth of Hole 27- 96. | Depth of Well 28- 96. | Source of Depth Data 29- Ø

Water Level 30- | Date Measured 31- / / (month day year) | Source 33- | Delete 30, 31, 33, 34

Method of Measurement 34- A C E G H L M R S T V Z (airline, calibrated airline, estimated, pressure gage, calibrated pressure gage, geophysical logs, manometer, reported, steel tape, electric tape, calibrated electric tape, other)

Site Status 37- D F G H Ø P R S T V X Z (dry, flowing, nearby flowing, nearby recently flowing, obstruction, pumping, recently pumped, nearby pumping, nearby recently pumped, foreign substance, surface water effects, other) | 273 = Y *

Source of Geohydrologic Data 36- | Pump Used 35- (no) | Measuring Point 266- | Measuring Point Date 267- / / (month day year)

REMARK	DATE	INITIALS
04	1-77	owf
04	1-77	owf
~~OAW~~	4-77	owf
Y	5-77	pmg
	6/78	KJB

AKRG | SEARCH | WATER USE | KEY PUNCH | PRINT OUT CKD

OWNER IDENTIFICATION (1)

R-158 | T- (A) D M (add, delete, modify) | Date of Ownership 159 # 04/00/1967 (month day year) | D/- Kenny Carver

Name: Last 161- MCGAHAN | First 162- MAC | Middle Initial 163-

OTHER SITE IDENTIFICATION NUMBERS (1)

R-189 | T- (A) D M (add, delete, modify) | Ident ~~190# 9543~~ * ~~191- LAB~~ delete

Ident 190 # 001 | Assigner 191- AKMP

New Card Same R & T | Ident 190 # 10533 | Assigner 191- AKRG

190# 10542 * 191= LAB

SITE VISIT DATA (1)

R-186 | T- (A) D M (add, delete, modify) | Date of Visit 187# 09/07/1967 (month day year) | Name of Person 188- STILL P.

FIELD WATER QUALITY MEASUREMENTS (1)

R-192 | T- (A) D M (add, delete, modify) | Date 193 # 09/07/1967 (month day year) | Geohydrologic Unit 195 #

New Card Same R thru 196 | Temperature 196# 0,0,0,1,0 | Degrees C 197- 7.0

Conductance 196# 0,0,0,9,5 | µ Mhos 197-

Other (STORET) Parameter 196# | Value 197-

Other (STORET) Parameter 196# | Value 197-

FOOT NOTES:

① Source of Data Codes:

S D Ø A R L G Z (reporting agency, driller, owner, other gov't, other reported, logs, geologist, other)

SB 7-12-1AABB1-1

Diamond 1
WELTS 15089

15089

DAILY DRILLING LOG

B. SPIRES
WELL DRILLING & PUMP SERVICE
RT. 1 - BOX 22 KENAI, ALASKA 99611

Legal Description PARCIAL # 012-390-10
Lot 1 HOSON Subdv - plat # 80-98
Filed 3d Judicial District
Kenai AK.

OWNER OF LAND Ted R. & MARY ANN K Morse
ADDRESS BOX 8112 KENAI AK 99611
WELL—SITE See Above
DATE—STARTED
DATE—ENDED 3/26/83

DEPTH OF WELL 213 feet
STATIC LEVEL OF WATER FT. 71
DRAW DOWN FT. UNKNOWN
GALS. PER HR. 3000
KIND OF CASING 4"

KIND OF FORMATION:

FROM	FT. TO	FT.	FROM	FT. TO	FT.
0	2	Top Soil			
2	75	Gravel & Boulders			
75	96	SAND			
96	117	BLUE CLAY			
117	202	SAND			
202	205	COAL Bed & SAND			
205	225	SAND			
225	234	SILT			

Note - This well is directional drilled North & EAST X 1/4" IN 4 feet, IN starting the first piece of pipe which was 20' long

MISCL. INFORMATION: We could not find any gravel sufficent for a well without A Sand screen past 75 ft The reason for not setting the screen at 202 was that we were not sure the cason could be pulled - we brought the T3 Ingersall Rig in - put the casing hammer on the well & pulled it back in order to set the 4" X 5' #10 slot SS Sand Screen The screen is set below the COAL Bed - The well developed to 60 gal per min max - 40 gal per min min.

DRILLER'S NAME Billy A Spires

Diamond 2
WELTS 17552

17552

APPLICATION FOR EVALUATION OF ON-SITE
WATER AND WASTEWATER DISPOSAL SYSTEMS

LSE 203' (KPB 1:6000; 10' CI)

1. Legal Description: LOTS 3, 4, & (5) HOBSON S/D
Street Location: WIK ROAD - NORTH KENAI

2. Property Owner: GARY & BETTY HOBSON
Address: P.O.BOX 251, KENAI Phone: 283-3775

3. Name of Buyers: CATHERINE SEBALD
Address: P.O. BOX 3621, KENAI Phone: 776-5165

4. Lending Institution: 1ST NATIONAL BANK of ANCH
Address: P.O. BOX 4070, KENAI Phone: 283-3585

5. Agents (for buyer): BELUGA REALTY - RANDY ERNST
(for seller): BELUGA REALTY - RANDY ERNST

Check List
1. Comp. App.
a) Owner sign
b) Bank sign
2. Agent's Name
3. Current As-built Survey ✓
4. Current Water Sample
5. Photo of Well ✓
6. Well log

REQUESTED INFORMATION

Single Family Residence: (✓) Number of Bedrooms: 3
Multiple Family Residence: ( ) Number of Bedrooms:

WATER SYSTEM

Water Source: Individual Single Family Well (✓) Other ( )

If other, please explain:

Well depth: 300 FT Feet Depth to Static Water Level: 35 FEET

Cased to: 300 FT + Feet Casing Size: 6" Inches

Date Drilled: UNKNOWN Artesian? Static Level: N/A
Flowing GPM: N/A

Drilled by: UNKNOWN

Horizontal distance from the well to the nearest septic tank: 150 Feet

Horizontal distance from the well to the nearest oil or fuel storage tank: N/A Feet
(NO FUEL STORAGE) - ALL ELECTRIC) FOR HEAT OR AUTO)

587-12-2 RECD 1-8
6043521519 5101

304=PD 16832

FirstBaptist 1
WELTS 16832

GEOHYDROLOGIC UNIT DESCRIPTIONS (1)

R-90 * | T- (A) D M * (add, delete, modify) | Entry No 256 # * | Depth to Top 91- 85. * | Depth to Bottom 92- . *

Unit Identifier 93- 110QRNR * | Lithology 96- GRVL * | Lithologic Modifier 97- *

AQUIFER DATA (2)

R-94 * | T- (A) D M * (add, delete, modify) | Geohydrologic Unit Entry No 256 # 1 *

Date 95 # 08/27/1963 * (month day year) | Water Level 126- 85. * | % Water Contributed 132- 100 *

GEOHYDROLOGIC UNIT DESCRIPTIONS (1)

R-90 * | T- A D M * (add, delete, modify) | Entry No 256 # * | Depth to Top 91- . * | Depth to Bottom 92- . *

Unit Identifier 93- * | Lithology 96- * | Lithologic Modifier 97- *

AQUIFER DATA (2)

R-94 * | T- A D M * (add, delete, modify) | Geohydrologic Unit Entry No 256 # *

Date 95 # / / * (month day year) | Water Level 126- . * | % Water Contributed 132- *

PERTINENT REMARKS

R-183 * | T- A * (add) | 185- ` '*

New Card Same R&T | 185- ` '*

185- ` '*

NOTES: Log

0-85 gravel

85-87 gravel w/ water

MAP LOCATION: PLOTTED ON BOTH KENAI C-4 AND N. KENAI 3 KBM.

U. S. GOVERNMENT PRINTING OFFICE : 1976 O - 213-137

SB 7-12-2DDAA1-1

Halco 1
WELTS 19792

19792

WATER WELL DRILLING
AND PUMP SUPPLY AND RE

WATER WELL RECORD
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURES
Division of Geological & Geophysical Surveys

JIM HOOVER (907) 776-8443 P. O. BOX 1292
Owner KENAI, ALASKA 99611

Location SW¼ SE¼ NW¼ Sec 1
T7NR12W .SM

LOCATION OF WELL (Please complete either 1a, 1b or 1c.)

Drilling Permit No. ______
A.D.L. No. ______

1a. Borough	Subdivision	Lot	Block	1b. ¼ qtrs. __of__of__of__	Section No.	Township N☐ S☐	Range E☐ W☐	Meridian

1c. DISTANCE AND DIRECTION FROM ROAD INTERSECTIONS
Northroad mile 28
owner Gilman L. Hall - ~~Po Box 8149~~
Street Address and Area of Well Location ~~Nikiski~~ 99635

3. OWNER OF WELL: Hallco
Address: Box 8149
Nikiski Ak 99635

2. WELL LOG

Material Type	Feet Below Surface Top	Bottom
Sand & gravel	0	102
wet clay w/ Rock	102	108
Clay + Rock some wet	108	114
Broken rock + gravel	114	130
Sand + gravel water Bearing	130	140

4. WELL DEPTH: (final) 140 ft.

5. DATE OF COMPLETION 1 - 17 - 86

6. ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug
☐ Auger ☐ Jetted ☐ Bored ☐ Other:

7. USE: ☐ Domestic ☐ Public Supply ☐ Industry
☐ Irrigation ☐ Recharge ☒ Commerical
☐ Test Well ☐ Other: ______

8. CASING: ☐ Threaded ☒ Welded
diam. 6 in. to 133 ft. Depth Weight 17 lbs./ft.
diam. ____ in. to ____ ft. Depth Stickup 2 ft.

9. FINISH OF WELL:
Type: sandscreen Diameter: 6
Slot/Mesh Size: 5' 4/10th 3' 6/6th Length: 8'
Set between 133 ft. and 140 ft.
Backfilling ______ Gravel pack ______

10. STATIC WATER LEVEL: 112½ ft. 1/17/86 Date
☐ Above or ☒ Below land surface
Equipment used: ______

11. PUMPING LEVEL below land surface and YIELD
____ ft. after ____ hrs. pumping 55 gpm
____ ft. after ____ hrs. pumping ____ g

12. GROUTING Well Grouted: ☐ Yes ☒ No
Material: ☐ Neat Cement ☐ Other: ______

13. PUMP: (if available) HP ______
Length of Drop Pipe ____ ft. capacity ____
☐ Subm. ☐ Jet ☐ Centrifical ☐ Other

14. REMARKS:

15. Water Temperature ____ ° ☐ F ☐ C

SITE ID 604330151184001

LOCAL NO. SB 7-12-1BDCC1-20

16. WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief;

Northland Drilling
Registered Business Name

AA4201
Contract License Number

Address: PO Box 1292 Kenai Alaska 99611

Signed: Maralee M Hoover Date: 1-17-86
Authorized Representative

WATER WELL DRILLING
AND PUMP SUPPLY AND REPAIR

(907) 776-8443 P. O. BOX 1292
KENAI, ALASKA 99611

WATER WELL RECORD 17313
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURES
Division of Geological & Geophysical Surveys

JW 1
WELTS 17313

Drilling Permit No.:
A.D.L. No.:

1. LOCATION OF WELL (Please complete either 1a, 1b or 1c.)

1a. through	Subdivision	Lot	Block	1b.	1/4 qtrs.	Section No.	Township N/S	Range E/W	Meridian
	Johns Sub	28			—of—of—of—				

1c. DISTANCE AND DIRECTION FROM ROAD INTERSECTIONS
1st rd past Hiway Dist go 1/4 mile
Turn left on Kodiak St. end of Rd.
Street Address and Area of Well Location

3. OWNER OF WELL: J.W. Johns
Address: PO Box 7139
776-5235 N. Kiski Ak 99635

2. WELL LOG

Material Type	Feet Below Surface Top	Bottom
Top Soil	0	1
sand and gravel	1	103
with Big Bolders		

4. WELL DEPTH: (final) 103 ft.
5. DATE OF COMPLETION 10-3-86

6. ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug
☐ Auger ☐ Jetted ☐ Bored ☐ Other:

7. USE: ☒ Domestic ☐ Public Supply ☐ Industry
☐ Irrigation ☐ Recharge ☐ Commerical
☐ Test Well ☐ Other:

8. CASING: ☐ Threaded ☒ Welded
diam. 6 in. to ____ ft. Depth Weight 17 lbs./ft.
diam. ____ in. to ____ ft. Depth Stickup 2 ft.

9. FINISH OF WELL:
Type: open Bottom Diameter: 6
Slot/Mesh Size: ____ Length: ____
Set between ____ ft. and ____ ft.
Backfilling ____ Gravel pack ____

10. STATIC WATER LEVEL: 90 ft. 10/3/86 Date
☐ Above or ☒ Below land surface
Equipment used:

11. PUMPING LEVEL below land surface and YIELD
____ ft. after ____ hrs. pumping 10 g.p.m.
4 ft. after 4 hrs. pumping 7 g.p.m.

12. GROUTING Well Grouted: ☐ Yes ☒ No
Material: ☐ Neat Cement ☐ Other:

13. PUMP: (if available) HP 1/2
Length of Drop Pipe 99 ft. capacity 10 g.p.m.
☒ Subm. ☐ Jet ☒ Centrifical ☐ Other

14. REMARKS:

15. Water Temperature ____ ° ☐ F ☐ C

SB 7-12-1 CDAC 1-9
6043191511822301

16. WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief;

Northland Drilling AAJ201
Registered Business Name Contract License Number
Address: PO Box 1292 Kenai, Alaska 99611
Signed: Maralee M. Harris Date: 10-3-86
Authorized Representative

Form 02-WWR (11/81) Copy Distribution: WHITE - State DGGS, PINK - Driller, CANARY - Customer

NORTHLAND DRILLING
WATER WELL DRILLING
AND PUMP SUPPLY AND REPAIR

(907) 776-8443 P. O. BOX 1292
KENAI, ALASKA 99611

WATER WELL RECORD 17419P
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURES
Division of Geological & Geophysical Surveys

JW 2
WELTS 17419

Drilling Permit No.
A.D.L. No.

(Please complete either Ia, Ib or Ic.)

Borough	Subdivision	Lot	Block	Ib. ¼ qtrs.	Section No.	Township N/S	Range E/W	Meridian
	Johns	1		__of__of__of__				

Ic. DISTANCE AND DIRECTION FROM ROAD INTERSECTIONS
off Island lake rd.
Street Address and Area of Well Location

3. OWNER OF WELL: J W Johns
Address: Boston Coast

2. WELL LOG

Material Type	Feet Below Surface Top	Bottom
Back fill	0	8
sand & gravel	8	65
sand gravel w/clay hard	65	90
sand gravel loose	90	94
sand gravel water	94	107

4. WELL DEPTH: (final) 107 ft.

5. DATE OF COMPLETION 11-14-83

6. ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug ☐ Auger ☐ Jetted ☐ Bored ☐ Other:

7. USE: ☒ Domestic ☐ Public Supply ☐ Industry ☐ Irrigation ☐ Recharge ☐ Commerical ☐ Test Well ☐ Other:

8. CASING: ☐ Threaded ☒ Welded
diam. 6 in. to 107 ft. Depth Weight 17 lbs./ft.
diam.___in. to___ft. Depth Stickup 2 ft.

9. FINISH OF WELL:
Type: open Bottom Diameter: 6
Slot/Mesh Size: Length:
Set between ___ ft. and ___ ft.
Backfilling ___ Gravel pack ___

10. STATIC WATER LEVEL: 91 ft. 11/14/83 Date
☐ Above or ☒ Below land surface
Equipment used:

11. PUMPING LEVEL below land surface and YIELD
___ ft. after ___ hrs. pumping 20 g.p.m.
___ ft. after ___ hrs. pumping ___ g.p.m.

12. GROUTING Well Grouted: ☐ Yes ☒ No
Material: ☐ Neat Cement ☐ Other:

13. PUMP: (If available) HP unknown
Length of Drop Pipe ___ ft. capacity ___ g.p.m.
☒ Subm. ☐ Jet ☐ Centrifical ☐ Other

14. REMARKS: for duplex

15. Water Temperature ___° ☐ F ☐ C

USGS Local No. 6043181511 2701

SB 7-12-1 CDAD 1-10

16. WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief;

Northland Drilling
Registered Business Name

AA4201
Contract License Number

Address: PO Box 1292 Kenai Ak 99611

Signed: Maralee M. Hoover
Authorized Representative

Date: 11-14-83

Form 02-VWR (11/81)

Copy Distribution. WHITE - State DGGS, PINK - Driller, CANARY - Customer

NORTHLAND DRILLING
WATER WELL DRILLING
AND PUMP SUPPLY AND REPAIR

JIM HOOVER (907) 776-8443 P. O. BOX 1292
Owner KENAI, ALASKA 99611

WATER WELL RECORD
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURES
Division of Geological & Geophysical Surveys

18326 S

Keller 1
WELTS 18326

Drilling Permit No. ______
A.D.L. No. ______

LOCATION OF WELL (Please complete either Ia, Ib or Ic.)

Ia. Borough	Subdivision	Lot	Block	Ib. ¼ qtrs.	Section No.	Township	Range	Meridian
	Rector	2	3	—of—of—of—		N ☐ S ☐	E ☐ W ☐	

Ic. DISTANCE AND DIRECTION FROM ROAD INTERSECTIONS
Behind Aroura Height

Street Address and Area of Well Location

3. OWNER OF WELL: Vern Keller
Address: Box 7025
776-8506 Nikiski AK 99635

2. WELL LOG

Material Type	Feet Below Surface Top	Bottom
Over Burden	0	8
Sand & gravel	8	53
Mostly fine sand		

4. WELL DEPTH: (final) 53 ft.

5. DATE OF COMPLETION 10-23-85

6. ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug ☐ Auger ☐ Jetted ☐ Bored ☐ Other:

7. USE: ☒ Domestic ☐ Public Supply ☐ Industry ☐ Irrigation ☐ Recharge ☐ Commerical ☐ Test Well ☐ Other: ______

8. CASING: ☐ Threaded ☒ Welded
diam. 6 in. to 53 ft. Depth Weight 17 lbs./ft.
diam. ___ in. to ___ ft. Depth Stickup 2 ft.

9. FINISH OF WELL:
Type: open Bottom Diameter: 6
Slot/Mesh Size: ______ Length: ______
Set between ______ ft. and ______ ft.
Backfilling ______ Gravel pack ______

10. STATIC WATER LEVEL: 35 ft. 10/23/85 Date
☐ Above or ☒ Below land surface
Equipment used: ______

11. PUMPING LEVEL below land surface and YIELD
___ ft. after ___ hrs. pumping 16 g.p.m.
___ ft. after ___ hrs. pumping ___ g.p.m.

12. GROUTING Well Grouted: ☐ Yes ☒ No
Material: ☐ Neat Cement ☐ Other: ______

13. PUMP: (if available) HP ______
Length of Drop Pipe ___ ft. capacity ___ g.p.m.
☐ Subm. ☐ Jet ☐ Centrifical ☐ Other

14. REMARKS:

15. Water Temperature ___° ☐ F ☐ C

16. WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief;

Northland Drilling
Registered Business Name

AA4201
Contract License Number

Address: Box 1292 Kenai Ak 99611

Signed: Maralee M Hoover
Authorized Representative

Date: 10-23-85

5B7-11-6BCDA1-8
604341151165301

Form 02-WWR (11/81) Copy Distribution: WHITE - State DGGS, PINK - Driller, CANARY - Customer

Mazie 1
WELTS 16847

1/20/89
J.T. to PDH
16847

0-5 ~ Topsoil
5-40 Dry gravel
40-80 Blue clay
80-83 - Water bearing gravel
83-92 - Clay silt

8" well perforated
8 rings perforation

83-80'

1/4" perforation
well pumped 620 gpm
10 hrs. w/ 1" drawdown

Herb Johnson for Kenny Carver 8/1966

* The McGahan Well No. 1 well log as read to Jane TonKin by Dee Rappe on 1/20/89 by telephone. The well log is reported to have been recorded by Herb Johnson, the welldriller for Kenny Carver, and is dated 8/1966.

PDHorwath
1/23/89

507-12-1 ARCC 1-6
6043501511809

MBC 1
WELTS 16844

9-063
(December 1949)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

McGrahan
16844 S

No.

WELL LOG

OTHER NOS.
SB 7-12-1-BDDA1-2

State Alaska County Subarea Kenai (North)

Owner McGrahan 1N 12W -1

Location Mile 16, Beach Road

Drilled by Penn Jersey (Al Schackle) Address

Date Casing diam. Land-surf. alt.

Source of data Log

(Enter type of well, perforations, yield, and drawdown at end of log)

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	Dug hole	30	30
	Brown clay and gravel	55	85
	Sandy clay	5	90
	Gravelly clay	21	111
	Sand little water	2	113
	Sandy blue clay	22	135
	Mixed gravel, sand, some water	1	136
	Fine sand	4	140
	Sandy gravel some water	1	141
	Quicksand	154	295
	Total Depth - 295 feet		

SB 7-12-1BDDA1-2
604344151182301

RECORD BY P.R.Lord DATE 3-27-59 SHEET OF

U. S. GOVERNMENT PRINTING OFFICE 16—61587-1

MCG 9
MW-1
WELTS 19100

Boring Log and Construction Data for Well MW-1

Approx. Surface Elev.– 122

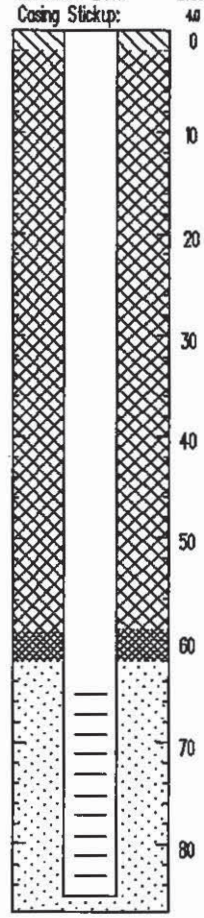
Depth in Feet	Soil Description	Sample	Total PCE Field GC (ppb)	Total PCE EPA 8010 (ppb)
0–7	Brown Sand SP, moist, trace gravel, no odor or discoloration.	S-1	TRACE	
7–20	Brown Sandy Gravel GP, moist, no odor or discoloration.	S-2	TRACE	
		S-3	TRACE	
20–33	Brown Gravelly Sand SP, moist, no odor or discoloration.	S-4	2.8	
		S-5	1.1	
		S-6	1.5	
33–42	Brown Sand SP, moist, with some gravel, no odor or discoloration. 1/2 in. layer of dark brown silt/organic(?) material at 35 ft., faint sweet odor.	S-7	11	ND
		S-8	4.1	
42–60	Brown Gravelly Sand SP, moist, no odor or discoloration.	S-9	4.1	
		S-10	3.3	
		S-11	3.1/2.6	
		S-12	6.1	
60–68	Brown Sandy Gravel GP, moist, no odor or discoloration.	S-13	26	ND
68–86.5	Brown Sand SP, wet to saturated, no odor or discoloration. (Water level: ATD; 4/1/89)	S-14	17	7.1
		S-15	53/64	
		S-16	85	

Total depth of hole 86.5 ft. on 3/16/89 at 18:15. Water at 74 ft. ATD.

<10ppb TCA and 215 ppb PCE in groundwater by EPA 502.2 on 4/1/89.

Well Design

Completion Type: A
Reference Elev.: 124.49
Casing Stickup: 4.0



NOTES:

1. Soil descriptions are interpretative and actual changes may be gradual.
2. Water level is for date indicated and may vary with time of year. (ATD – At Time of Drilling)

HARTCROWSER
A-8143 July 1989
Figure A-6

MCG 10
MW-2
WELTS 19101

Boring Log and Construction Data for Well MW-2

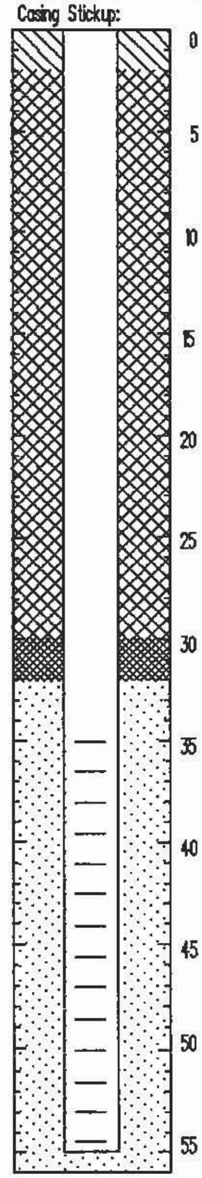
Approx. Surface Elev.– 90

Depth in Feet	Soil Description	Water Level	Sample	Total PCE Field GC (ppb)	Total PCE EPA 8010 (ppb)
0	Brown Gravelly Sand SP, moist no odor or discoloration.				
5	Brown-Gold Silt ML, moist, no odor.		S-1	ND	
10	Brown Sand SP, trace to some gravel, moist to saturated, no odor or discoloration.		S-2	ND	
15			S-3	ND	
20			S-4	ND	
25	Brown Sandy Gravel GP, moist to wet, no odor or discoloration.		S-5	ND	
30			S-6	TRACE	
35		3/31/89	S-7	ND	
40		ATD	S-8	ND	
45			S-9	ND	ND
50			*		
55			S-10	ND/ND	
60	Total depth of hole 56.0 ft. on 3/17/89 at 16:45. Water level 43 ft. ATD.				

1.3 ppb TCA and <1 ppb PCE in groundwater by EPA 502.2 on 3/31/89.

Well Design

Completion Type: F
Reference Elev.: 90.24
Casing Stickup:



NOTES:

1. Soil descriptions are interpretative and actual changes may be gradual.
2. Water level is for date indicated and may vary with time of year. (ATD – At Time of Drilling)

HARTCROWSER
A-8143 July 1989
Figure A7

MCG 11
MW-3
WELTS 19105

Boring Log MW-3

Approx. Surface Elev.– 131

Depth in Feet	Soil Description
0	Brown Sandy Gravel GP, frozen Non .
	Brown Silty Gravel GP, frozen to dry.
	Brown Sandy Gravel GP, moist, no odor or discoloration.
10	
	Brown Gravelly Sand SP, dry to moist, trace silt to 20 ft.
20	1 in. layer dark brown clayey silt at 20.6 ft.
	2 in. layer dark brown clayey silt at 26 ft.
30	
40	Brown Sandy Gravel GP, moist to wet, no odor or discoloration.
	Brown Sand SP, moist with some gravel, no odor.
50	Increasing gravel 55 to 65 ft.
60	Dark brown silt seam at 62 ft.
70	
	Olive Silt ML, damp, very dense, trace sand, non-plastic, no odor.
80	Gray Silt ML to Gray Silty Clay CL moist to damp, stiff, trace to some sand, plastic.
90	Gray to Green Gray Silt ML, moist, interbedded with fine gray Sand SP, saturated. (ATD)
100	Total depth of hole 96.0 ft. on 3/23/89 at 19:20. Backfill with grout. Free water at 91.0 ft. ATD

Sample	Total PCE Field GC (ppb)	Total PCE EPA 8010 (ppb)
S-1	600	62.3
S-2	56	
S-3	24	
S-4	410	
S-5	740/655	15.5
S-6	79	
S-7	44	
S-8	81	
S-9	70	
S-10	51	
S-11	264	ND
S-12	30	
S-13	130	43.3
S-14	9	
S-15	8.6	
S-16	4.0	
S-17	5.5	
S-18	ND	
S-19	ND	
S-20		
S-21		

NOTES:

1. Soil descriptions are interpretative and actual changes may be gradual.
2. Water level is for date indicated and may vary with time of year. (ATD – At Time of Drilling)

HARTCROWSER
A-8143 July 1989
Figure A-12

MCG 12
MW-4
WELTS 19099

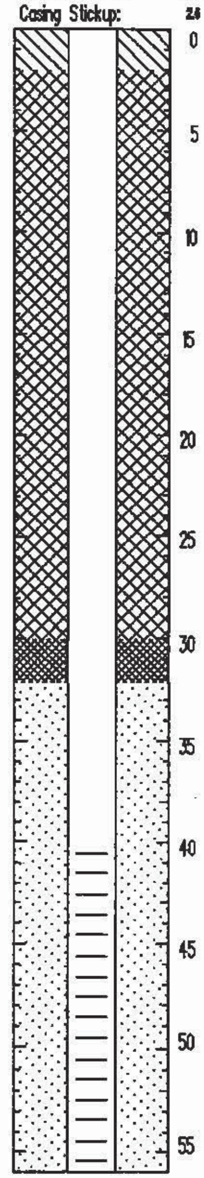
Boring Log and Construction Data for Well MW-4

Approx. Surface Elev.- 94

Depth in Feet	Soil Description	Sample	Total PCE Field GC (ppb)	Total PCE EPA 8010 (ppb)
0	Brown Organic Silt OL, with layers of rust, decaying wood, coal, etc, damp to moist, slight garbage odor.			
5		S-1	ND	
~8	Brown Sand SP, moist to damp, with increasing gravel content, no odor or discoloration.			
10		S-2	ND	
15		S-3	ND	
20		S-4	ND	
25		S-5	ND	
30	Brown Sandy Gravel GP, damp, no odor or discoloration.	S-6	ND	
33	Drilling halted due to boulder at 33 ft. Redrill 5 ft. north to 38 ft., hit boulder. Redrill to 15 ft. hit boulder. Redrill 27 ft.west and 15 ft. north.			
39	Brown Sand SP, dry to damp becoming saturated at 43 ft., no odor.			
40		S-7	ND	
41	2 in. ash layer at 41 ft.			
43	ATD ▽ / 3/31/89 ▽			
45		S-8	TRACE/ TRACE	
55		S-9	TRACE	ND
55	Total depth of hole 55.0 ft. on 3/25/89 at 13:15. Water level 43 ft. ATD.			

Well Design

Completion Type: A
Reference Elev.: 93.57
Casing Stickup: 2.6



<1 ppb TCA and <1 ppb PCE in groundwater by EPA 502.2 on 3/31/89.

NOTES:

1. Soil descriptions are interpretative and actual changes may be gradual.

2. Water level is for date indicated and may vary with time of year. (ATD - At Time of Drilling)

HARTCROWSER
A-8143 July 1989
Figure A-9

MCG 13
TH-1
WELTS 19103

Boring Log TH-1

Approx. Surface Elev.– 134

Brown Sand SP, frozen Nbn, no odor or discoloration.

Brown Sandy Gravel GP, moist, no odor.

Brown Sandy Silt ML, with interlayers of fine sand at 20.8 ft.

Brown Gravelly Sand SP, moist to damp, no odor or discoloration.

Brown Sand SP-SW, moist, some gravel, trace silt, no odor or discoloration.

Brown-Gray Silt ML, moist, interbedded with fine Sand SP, dry to damp, slight odor at 75 ft., no discoloration.

Brown Sand SP, moist to damp, no odor or discoloration.

Total depth of hole 91.0 ft. on 3/28/89 at 18:00. No water ATD.

Sample	Total PCE Field GC (ppb)	Total PCE EPA 8010 (ppb)
S-1	66	ND
S-2	40	
S-3	16	
S-4	82	ND
S-5	300/385	
S-6	210	
S-7	590	TRACE
S-8	73	
S-9	600	4.0
S-10	460	
S-11	600	ND
S-12	770/580	
S-13	36	
S-14	530	ND
S-15	38	ND
S-16	1.8	
S-17	TRACE	
S-18	2.0	
S-19	ND	

NOTES:

1. Soil descriptions are interpretative and actual changes may be gradual.
2. Water level is for date indicated and may vary with time of year. (ATD – At Time of Drilling)

HARTCROWSER
A-8143 July 1989
Figure A-10

MCG 14
TH-2
WELTS 19102

Boring Log and Construction Data for Well TH-2

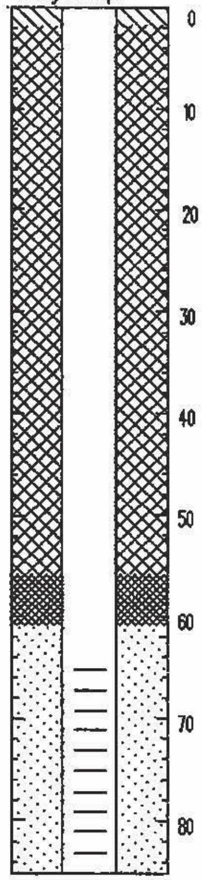
Approx. Surface Elev.- 137

Depth in Feet	Soil Description	Sample	Total PCE Field GC (ppb)	Total PCE EPA 8010 (ppb)
0	Brown Sand to Gravelly Sand SP, frozen Nbn.	S-1	ND	
		S-2	ND	
10	Brown Gravelly Sand SP, damp.	S-3	ND	
	Rust colored silt seam at 15 ft.	S-4	ND/ND	
20		S-5	ND	
	Brown Sandy Gravel GP, moist, no odor or discoloration.	S-6	ND	
30		S-7	ND	
		S-8	TRACE/ TRACE	
40		S-9	TRACE	
	Brown Gravelly Sand SP, moist, no odor or discoloration.	S-10	1.6	
50		S-11	1.9	
	Occasional cobbles.	S-12	1.5	
60		S-13	3.0	
		S-14	4.7	
70	Dark Brown Organic Silt at 71 ft., 3/4 in. thick, no odor or discoloration. (Water level: 4/1/89; ATD)	S-15	13	ND
		S-16	TRACE	
80	Brown Sand SP, interlayered with Brown to Gray Brown Clay CL, saturated, no odor or discoloration.	S-17	1.0	ND
90	Total Depth of hole 85 ft. on 3/29/89 at 10:00. Water level at 75 ft. ATD.			
100				

1.4 ppb TCA and 2.0 ppb PCE in groundwater by EPA 502.2 on 4/1/89.

Well Design

Completion Type: F
Reference Elev.: 136.85
Casing Stickup:



NOTES:

1. Soil descriptions are interpretative and actual changes may be gradual.
2. Water level is for date indicated and may vary with time of year. (ATD - At Time of Drilling)

HARTCROWSER
A-8143 July 1989
Figure A-8

MCG 15
TH-3
WELTS 19104

Boring Log TH-3

Approx. Surface Elev.– 86

Depth in Feet	Soil Description	Sample	Total PCE Field GC (ppb)	Total PCE EPA 8010 (ppb)
0	Brown Gravelly Sand SP, frozen to 7 ft. then moist.			
5		S-1	ND	
7.5	2-3 in. thick Silt layer at 7.5 ft., wood chips in cuttings.			
10		S-2	ND	
15		S-3	ND/ND	
20	Brown Sand SP, trace gravel, moist, no odor or discoloration.	S-4	ND	
25	Brown Sandy Gravel GP, damp to moist.	S-5	ND	
30		S-6	ND	
35		S-7	ND	ND
39	Saturated at 39 ft. (ATD)			
40	Total depth of hole 40.0 ft. on 3/30/89 at 13:45. Water level 39 ft. ATD.	S-8	ND	ND

NOTES:

1. Soil descriptions are interpretative and actual changes may be gradual.
2. Water level is for date indicated and may vary with time of year. (ATD – At Time of Drilling)

HARTCROWSER
A-8143 July 1989
Figure A-11

MCG 16
TH-4
WELTS 19106

Boring Log TH-4

Approx. Surface Elev.– 134

Depth in Feet	Soil Description	Sample	Total PCE Field GC (ppb)	Total PCE EPA 8010 (ppb)
0	Brown Sandy Silt ML, frozen Nbn, no odor or discoloration.	S-1	170	
5	Brown Sand Gravel GP, frozen Nbn to 7.5 ft. then moist to damp, no odor or discoloration.	S-2	28	
10		S-3	52	
15	Occasional cobbles and boulders, 12 ft. to 20 ft.	S-4	44	
20		S-5	35	ND
25	Brown Gravelly Sand SP, moist with occasional cobbles.	S-6	39	
30	Boulder at 30 ft., redrill 15 ft. east.	S-9	48	TRACE
	6 in. thick Brown Sandy Silt at 31 ft., moist to wet no odor or discoloration.	S-10	160	7.7
35		S-11	150	
40		S-12	67	
45		S-13	150	TRACE
50		S-14	72	
55	Brown Gravelly Sand, SP, wet, trace silt.	S-15	170	7.3
60		S-16	120/140	TRACE

Total depth of hole 60.0 ft. on 4/1/89 at 11:40. Drilling halted as hole too crooked to continue. No water ATD.

NOTES:

1. Soil descriptions are interpretative and actual changes may be gradual.
2. Water level is for date indicated and may vary with time of year. (ATD – At Time of Drilling)

HARTCROWSER
A-8143 July 1989
Figure A-13

MCG 17
WELTS 19098
Page 1

LOG OF BORING W-1

Equipment: Cable Tool
Elevation: --
Date Drilled: 10/21-11/27/89

% Passing #200	OVM (ppm)	Depth (ft)	Samples	Description
		0		BROWN SANDY GRAVEL (GP) medium dense, moist, (Fill)
		5		BROWN SILT (ML) medium stiff, moist, with trace sand
		10		BROWN SILTY SANDY GRAVEL (GM) medium dense to dense, moist; becoming dense at 9 feet
		15		
		20		water production, possibly perched water; boulder encountered at 20 feet
		25		sands becoming coarse, gravel 1/2 to 1-1/2-inch
		30		
	0	35	X	becoming very dense at 35 feet
		40		casing driving more easily below 43 feet
		45		▽ water level during drilling
		50		BROWN SILTY SAND (SM) dense, wet, with gravels and fine to medium sands, sand heaving in casing
		55		
	0	60	X	BROWN SANDY GRAVEL (GP) dense, wet, with many cobbles to 4-inches
		65		fine sands heaving in casing
		70		
		75		silt content increasing
	0	80	X	BROWN SILTY SANDY GRAVEL (GM) dense, wet, fine sand in casing heaving

Harding Lawson Associates
Engineers, Geologists & Geophysicists

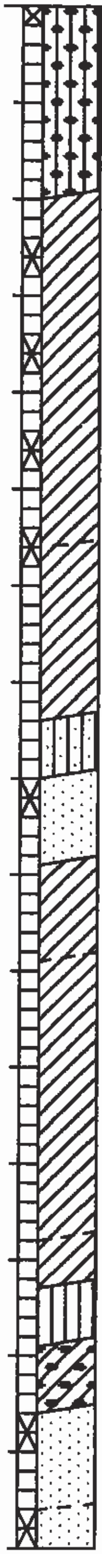
Log of Boring W-1
Nikiski Investigative Test Well
Nikiski, Alaska

PLATE 2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	5535,018.08	AW	1/90		

MCG 17
WELTS 19098
Page 2

LOG OF BORING W-1(Cont)



Notes	% Passing #200	OVM (ppm)	Depth (ft)	Description
		0	80	BROWN SILTY SANDY GRAVEL (Cont)
			85	
			90	GRAY SILTY CLAY (CL) stiff, moist, with some gravels and fine sand
		0		
			95	
		0		becoming very stiff, with some thin sand lenses at 97 feet
			100	
		0		bottom of 10-inch diameter casing at 102.5 feet
			105	
		0		
			110	becoming very stiff, moist, with gray sand (SP) medium dense, moist, lenses up to 3-inches thick
			115	becoming stiff water encountered during drilling at 117 feet GRAY SILTY SAND (SM) medium dense, wet
NOTE: Below 117 feet, log completed using Mark Jungmann's daily drilling report		NA	120	GRAY SAND (SP) medium dense, wet
			125	GRAY SILTY CLAY (CL) stiff, moist, with sand lenses
			130	GRAY CLAY (CL) stiff, moist
			135	
			140	becoming very stiff at 140 feet
			145	GRAY GRAVELLY CLAY (CL) stiff, moist GRAY CLAYEY SILT (ML) stiff, moist, with trace sand
			150	GRAY CLAYEY GRAVEL (GC) dense, moist, with trace silt water encountered during drilling at 153 feet
	6.0	NA	155	GRAY-BROWN SILTY SAND (SP-SM) dense, wet, with trace gravel
	3.7	NA	160	GRAY-BROWN SAND (SP) dense, wet

HLA

Harding Lawson Associates
Engineers, Geologists & Geophysicists

Log of Boring W-1(Cont)

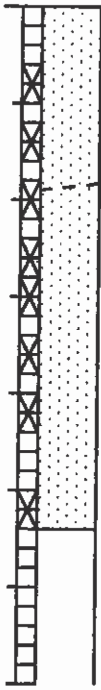
Nikiski Investigative Test Well
Nikiski, Alaska

PLATE 3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	5535,018.08	AW	1/90		

LOG OF BORING W-1(Cont)

% Passing #200	OVM (ppm)	Depth (ft)	Description
		160	GRAY-BROWN SAND (Cont)
3.9	NA		
3.7	NA	165	
8.9	NA	170	GRAY-BROWN SILTY SAND (SP-SM) dense, wet, with trace gravel and coal fragments
5.2	NA		
10.3	NA	175	color change to brown, becoming finer grained
	NA		
	NA	180	becoming finer grained at 180.0 feet
	NA	185	very fine grained at 185.0 feet
		190	
		200	



NA = Not Analyzed

NOTE: % Passing #200 may not be representative of actual conditions because samples were collected via the sand pump.

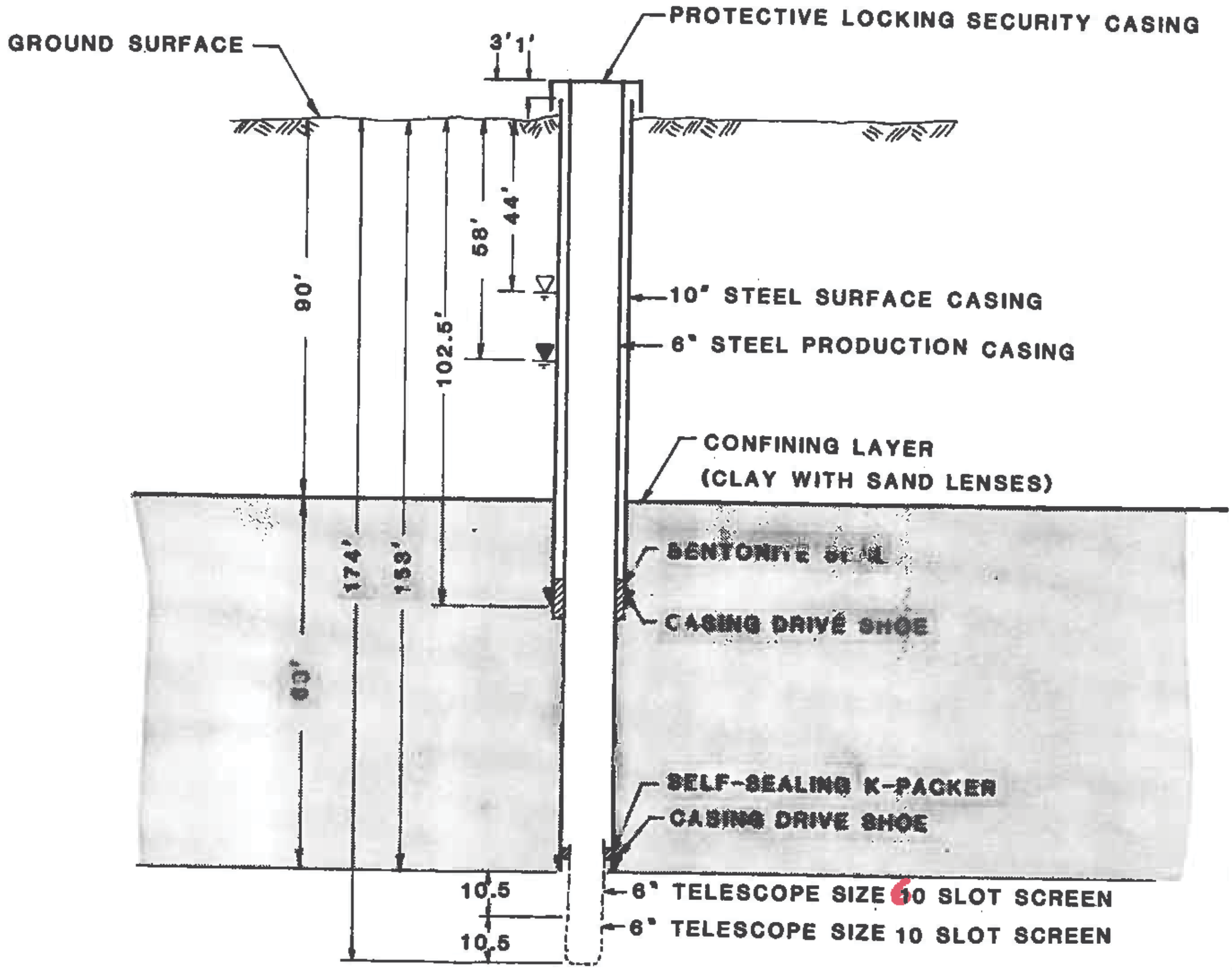
Harding Lawson Associates
Engineers, Geologists & Geophysicists

Log of Boring W-1(Cont)
Nikiski Investigative Test Well
Nikiski, Alaska

PLATE 4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	5535,018.08	AW	1/90		

MCG 17
WELTS 19098



∇ APPROXIMATE WATER LEVEL IN UNCONFINED AQUIFER DURING DRILLING ON 10/29/89

▼ MEASURED WATER LEVEL IN WELL ON 12/11/89

Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Well Completion Detail
Nikiski Investigative Test Well
Nikiski, Alaska

PLATE
6

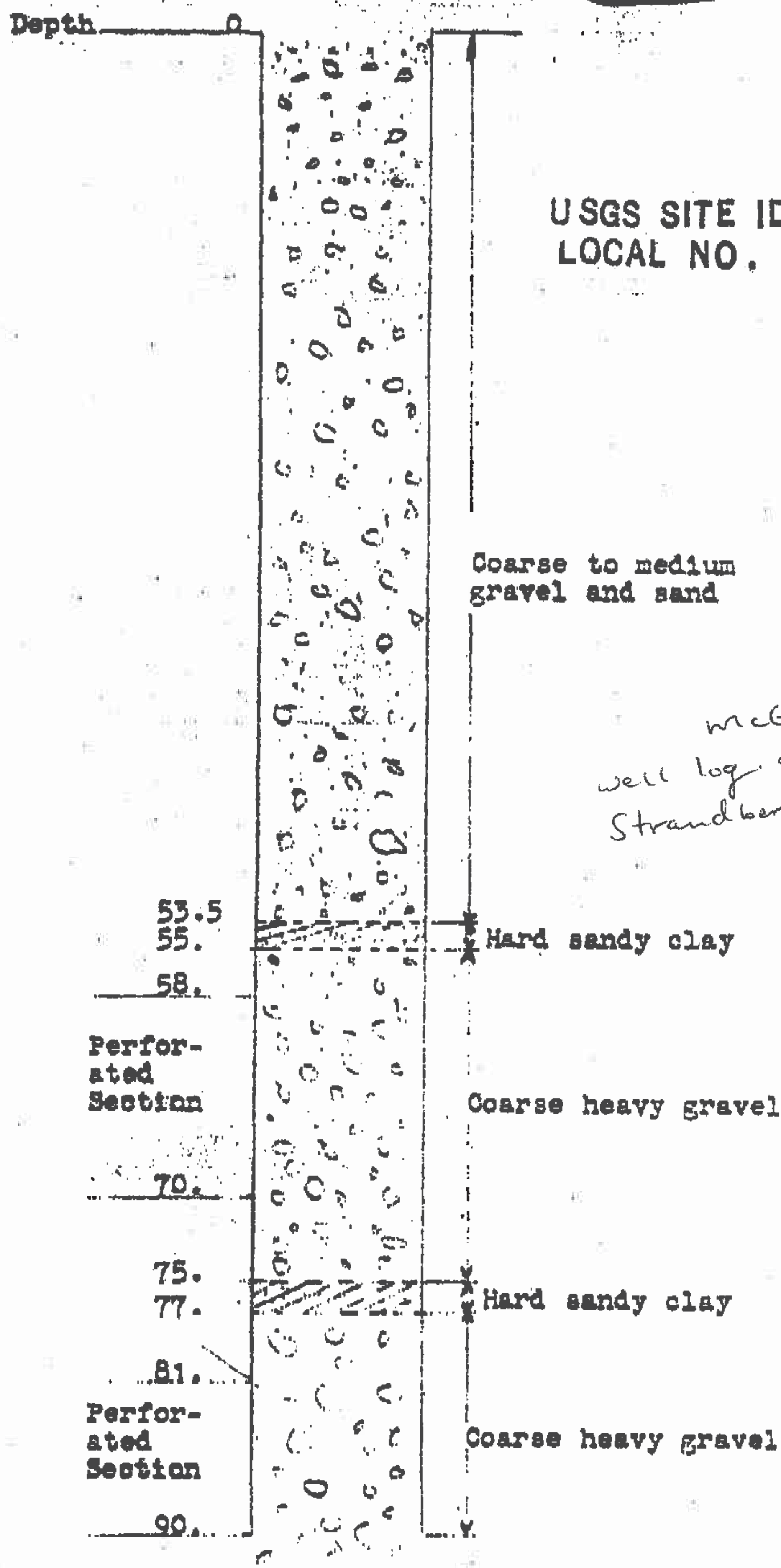
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
CS	5535,018.08	AW	1/90		

BY .... DATE 1/20/71 SUBJECT McGahan Utilities, I...
CHKD. BY ..... DATE .... Water System
Exhibit E Well "A"

SHEET NO ..... OF .....
JOB NO. .....

MCG 18
Well A (#1)
No WELTS

USGS SITE ID 604350151181301
LOCAL NO. SB00701201ABCC1 006



ADL # 040305

McGahan Utilities Well No 1 well log as prepared by Mr. Odin Strandberg 1/23/89 PDW

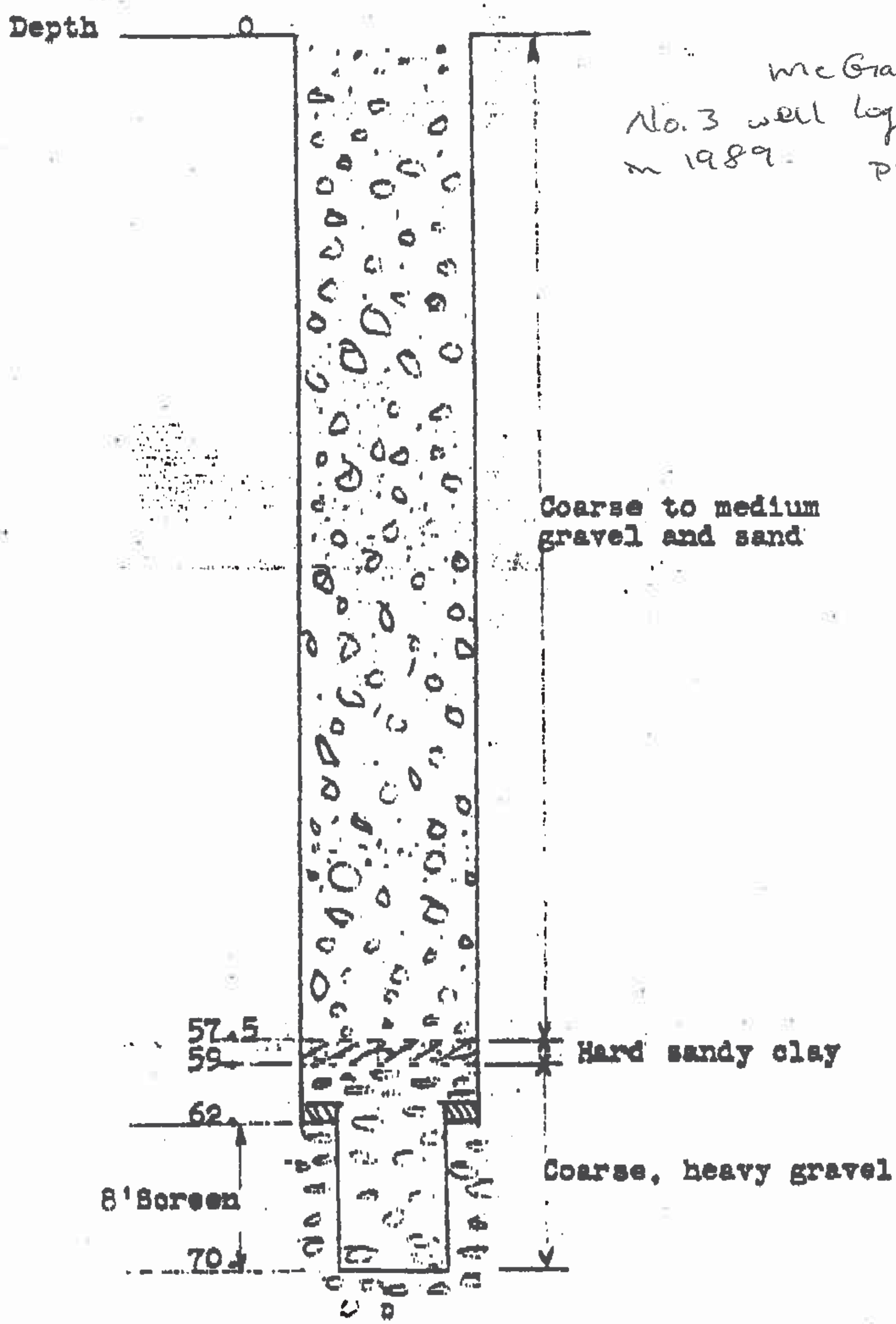
BY ... DATE 11/20/ SUBJECT McGahan Utilities Water System Exhibit B (Well "B") | SHEET NO. ... OF ... | Book ...

CHKD. BY EGS DATE ... | JOB NO. ...

MCG 19
Well B (#3)
No WELTS

USGS SITE ID 604350151181302
LOCAL NO. SB00701201ABCC2 006

McGahan Utilities well No. 3 well log. Well is not in use in 1989. PDH 1/23/89



MCG 20
WELTS 19791

19791

WS & S Co.

WATER SYSTEMS & SERVICE

Rt. 1, Box 1517 Kenai, Alaska 99611

Dated this 14th day of Oct, 1987

Mr. NORKEN CORPORATION
P.O. BOX 7459
NIKISKI, AK 99635

Dear Mr Johnson

The following is a well log which is located on ~~Lot~~ TRACT ~~Block~~ "A" McGAHAN TRACTS Subdivision, located in the Kenai Recording District. As you have requested said well to be drilled, we are submitting the following information regarding your well:

0	to	45	feet	Gravel
45	to	50	feet	Coal
50	to	60	feet	Sand Gravel
60	to	80	feet	Clay
80	to	152	feet	Sand Gravel

94' - S.W.L

A submersible pump with a rating of _____ h.p. was set as requested and the well yield has the capacity of 100 GPM + g.p.m. A screen was/~~wasn't~~ set as requested or required.

We thank you for choosing Water Systems and Service to serve your water well needs. If you have any further questions or problems, please don't hesitate to call.

Sincerely,

Kenneth D. Dyer

Kenneth D. Dyer

cj/kd

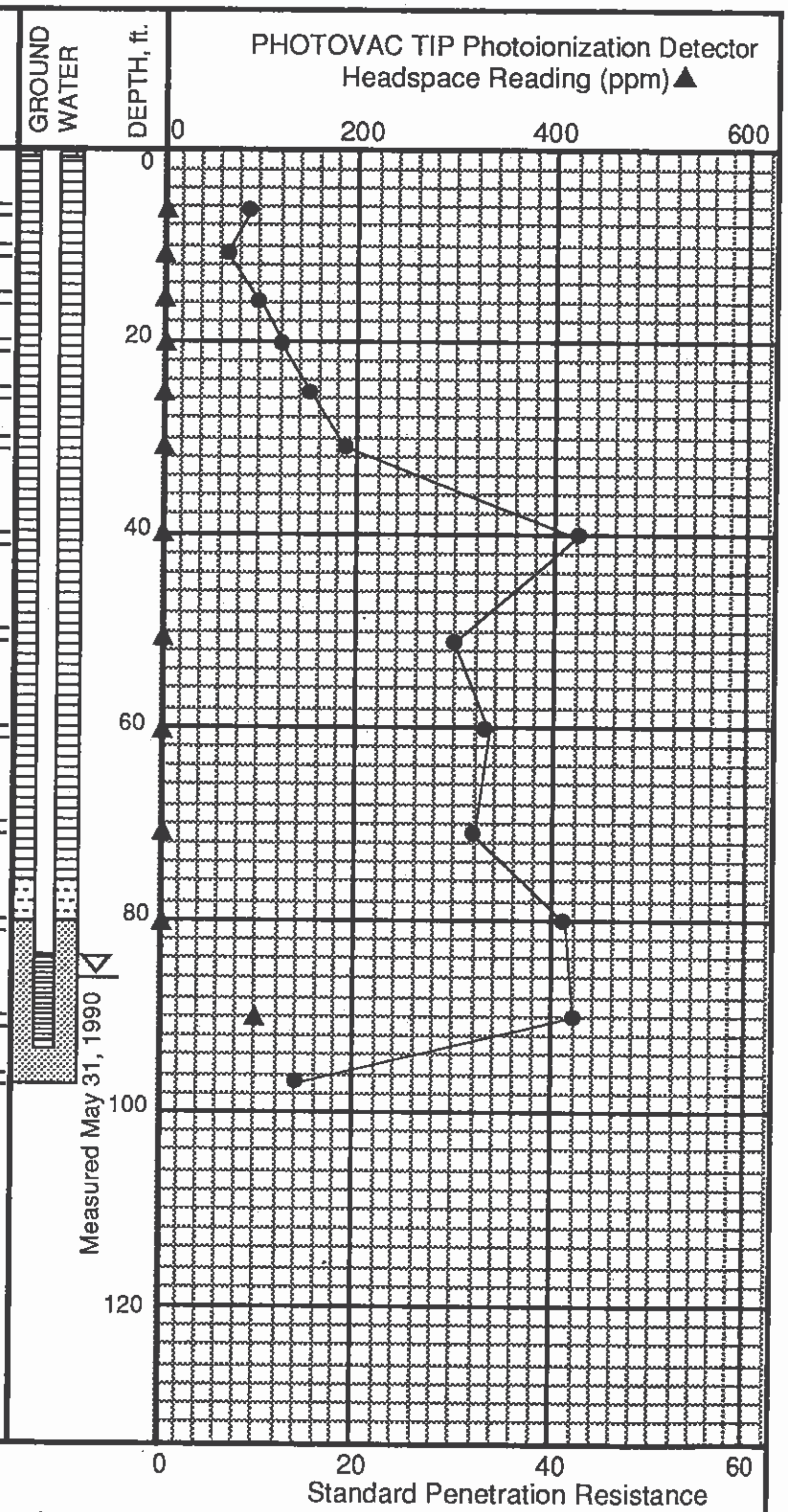
RECEIVED FEB 26 1988

LOCAL NO. SB 7-12-1 ABDD 1-11
SITE ID 604351151176201

Nair 1
Nik-90-1
WELTS 19506

Surface Elevation: Assumed 100 ft.

SOIL DESCRIPTION	DEPTH, ft.	SAMPLES
Loose, gray-brown, clean, sandy GRAVEL		S-1
Same		S-2
Medium dense, gray-brown, clean, slightly gravelly to gravelly SAND	14	S-3
Same		S-4
Same		S-5
Same		S-6
Dense, gray-brown, clean, sandy GRAVEL	36	S-7
Gray-brown, clean, sandy GRAVEL		S-8
Gray-brown, clean, sandy GRAVEL		S-9
Gray-brown, clean, sandy GRAVEL		S-10
Gray-brown, clean, sandy GRAVEL		S-11
Medium dense to dense, gray, clean gravelly SAND; wet at 88.5 feet	87.5	S-12
Bottom of Boring Completed 5/19/90	97.0	S-13



LEGEND

- B Bulk sample
- 3" O.D. split spoon sample
- 3" O.D. thin-wall sample
- * Sample not recovered
- Frozen
- Impervious seal
- Water level
- Slotted pipe

MONITORING WELL DETAILS

2-INCH PVC PIPE IN STEEL MONUMENT; TOTAL LENGTH: 96.34'; STICKUP: 2.7'; MACHINE CUT, 0.020" SLOTS; SLOTTED PIPE: 83.79' TO 93.31'; #8-12 SAND: 80.5' TO 90.5'; BENTONITE: 76.5' TO 80.5'; VOLCLAY GROUT: 1.5' TO 76.5'; NATURAL CAVE: NONE; CEMENT GROUT: 0.0-1.5'; PADLOCK: #2001

NOTE: The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.

Nikiski Airstrip
Alaska Dept. of Environmental Conservation
Anchorage, Alaska

LOG OF BORING NIK-90-1

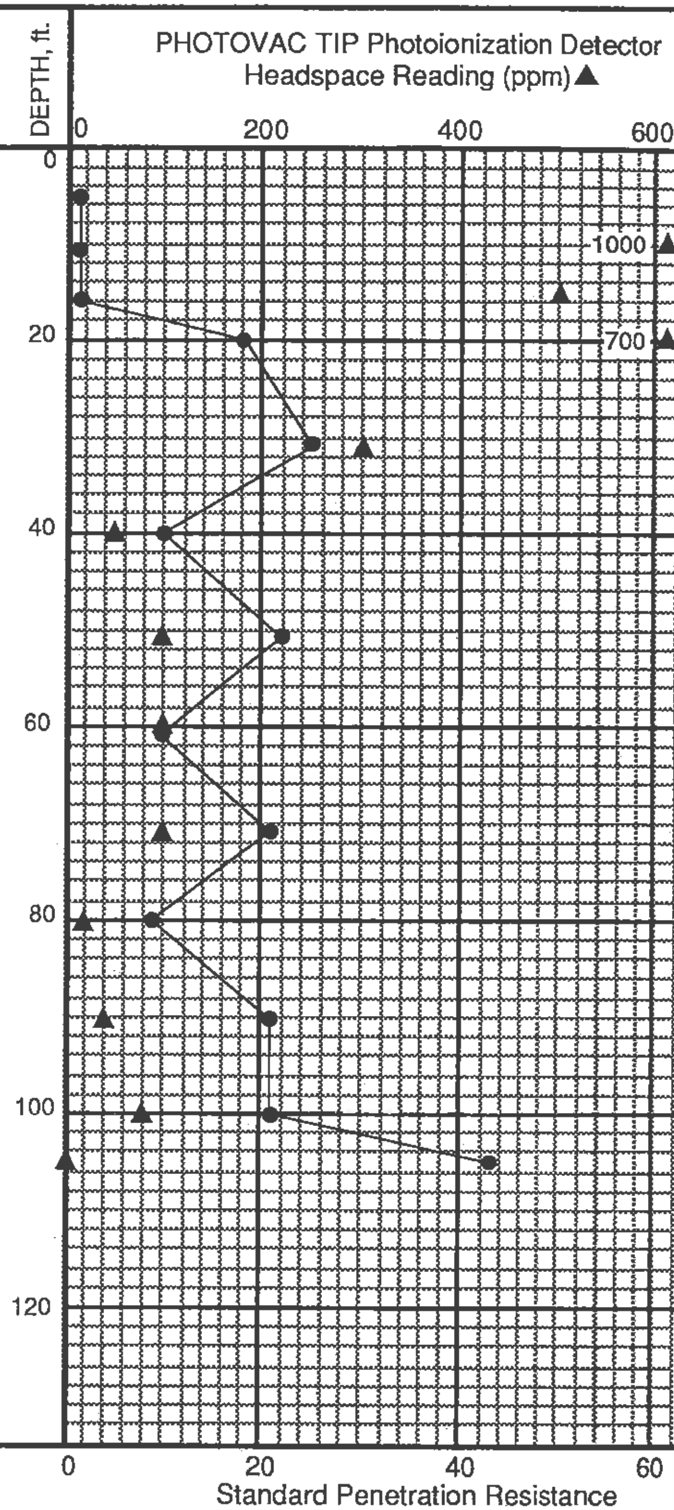
September 1990 X-283

SHANNON & WILSON, INC.
Geotechnical Consultants

Fig. 3

Nair 2
Nik-90-2
No WELTS

SOIL DESCRIPTION Surface Elevation: Not Surveyed	DEPTH, ft.	SAMPLES	GROUND WATER
Very soft, brown, slightly gravelly to gravelly SILT with organics; hydrocarbon stained soils and odor		S-1	No groundwater encountered during drilling
Same		S-2	
Same		S-3	
Very stiff, brown SILT with organics; hydrocarbon stained soils and odor	20	S-4	
Same		S-5	
Medium dense, brown, clean, sandy GRAVEL; hydrocarbon odor	36	S-6	
Medium dense, gray-brown, silty SAND	44	S-7	
Same		S-8	
Medium dense, gray-brown, silty SAND interlayered with gray, sandy SILT		S-9	
Same		S-10	
Same		S-11	
Dense, gray, clean, sandy GRAVEL; trace hydrocarbon odor	95	S-12	
Stiff, gray-brown, slightly gravelly, clayey SILT	104	S-13	
Bottom of Boring Completed 5/20/90	106		



LEGEND

- B Bulk sample
- 3" O.D. split spoon sample
- 3" O.D. thin-wall sample
- * Sample not recovered
- Frozen
- Impervious seal
- Water level
- Slotted pipe

MONITORING WELL DETAILS

2-INCH PVC PIPE IN STEEL MONUMENT; TOTAL LENGTH: Not Installed; STICKUP: NA; MACHINE CUT, 0.020" SLOTS; SLOTTED PIPE: NA; #8-12 SAND: NA; BENTONITE: NA; VOLCLAY GROUT: 0.0 TO 106'; NATURAL CAVE: NONE; CEMENT GROUT: NA; PADLOCK: NA

NOTE: The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.

Nikiski Airstrip
Alaska Dept. of Environmental Conservation
Anchorage, Alaska

LOG OF BORING NIK-90-2

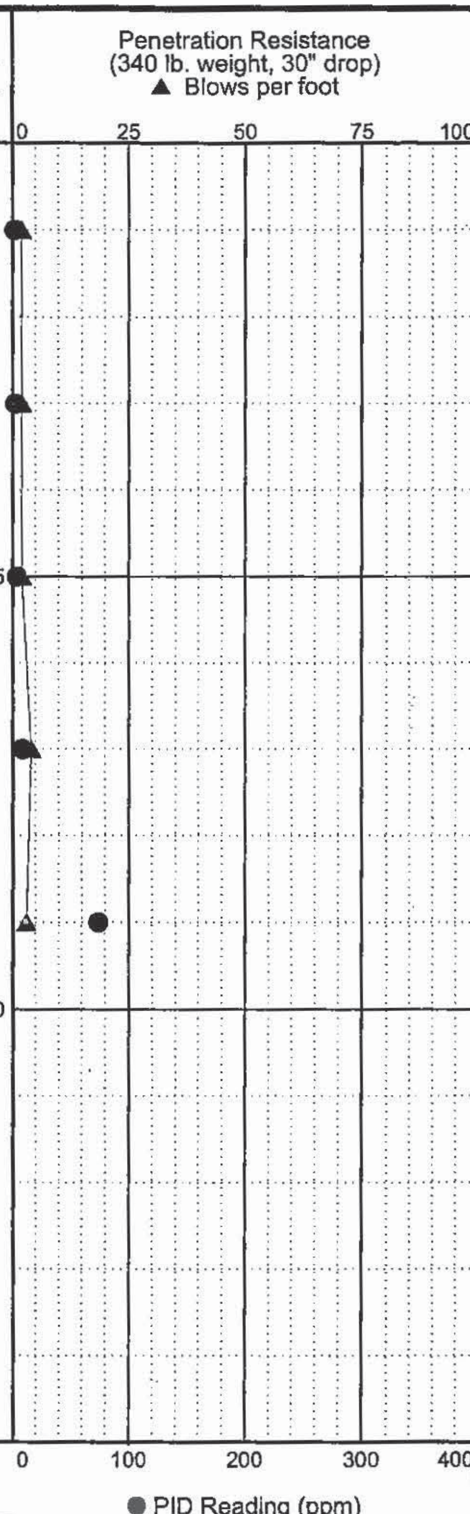
September 1990 X-283

SHANNON & WILSON, INC.
Geotechnical Consultants

Fig. 4

Nair 15
B-1
No WELTS

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Very loose, brown, slightly gravelly, SAND; moist; trace of organics.			S1		
Very loose, brown, slightly silty, sandy GRAVEL; moist; trace of organics and slight hydrocarbon odor.	2.0		S2		
Soft, brown, slightly gravelly, sandy SILT; moist to wet; trace organics and slight hydrocarbon odor.	4.0		S3	Groundwater Not Encountered During Drilling on 5/10/04	5
			S4		
Hyrdocarbon odor			S5		
Bottom of Boring Boring Completed 5/10/04	10.0				10



LEGEND

* Sample Not Recovered

Ⅲ 3" O.D. Split Spoon Sample

⊻ Ground Water Level At Time Of Drilling

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B1

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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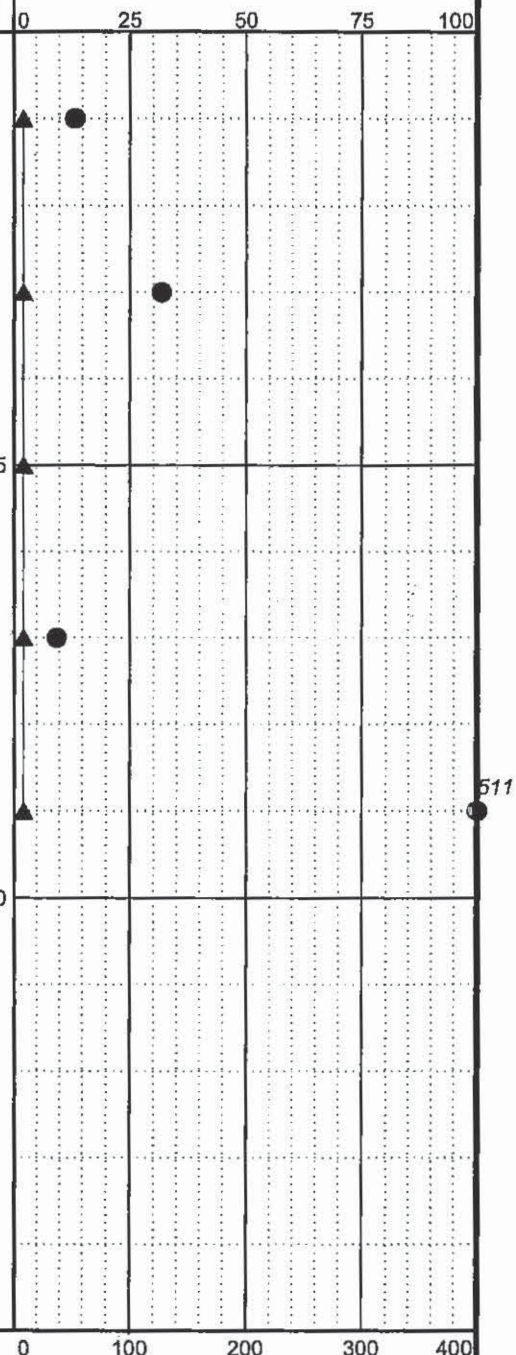
ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 16
B-2
No WELTS

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.	Penetration Resistance (340 lb. weight, 30" drop) ▲ Blows per foot
Soft, brown, slightly sandy, gravelly SILT; moist to wet; trace of organics; slight hydrocarbon odor.			S1, S2, S3 *, S4, S5	Groundwater Not Encountered During Drilling on 5/10/04	5	
	10.0				10	
Bottom of Boring Boring Completed 5/10/04						



LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample
Ground Water Level At Time Of Drilling

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B2

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

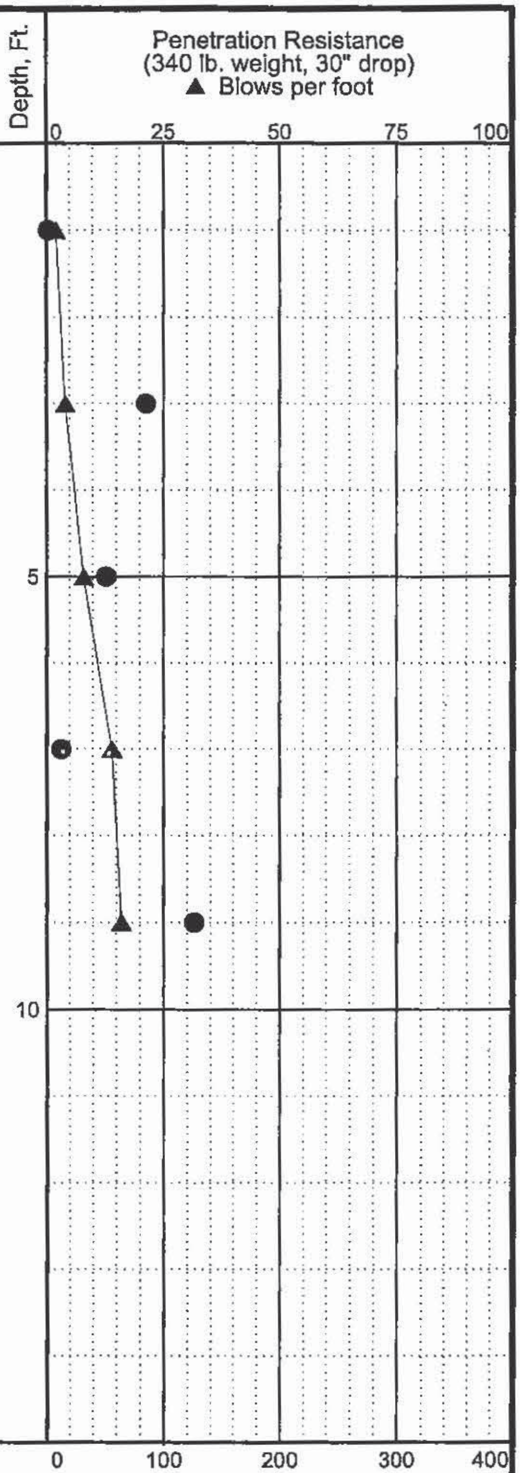
B-2

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 17
B-3
No WELTS

MATERIAL DESCRIPTION	Depth, Ft.	Samples
Very loose, brown, silty, sandy GRAVEL; moist.		S1
Soft to medium stiff, brown, sandy, gravelly SILT; moist.	2.0	S2
Loose, brown to gray, silty, sandy GRAVEL; moist.	4.0	S3
Medium dense, brown to gray, slightly silty, gravelly SAND; moist; slight hydrocarbon odor.	6.0	S4
Medium dense, brown to gray, slightly silty, sandy GRAVEL; moist; slight hydrocarbon odor.	8.0	S5
Bottom of Boring Boring Completed 5/10/04	10.0	

Ground Water: Groundwater Not Encountered During Drilling on 5/10/04



LEGEND

* Sample Not Recovered

3" O.D. Split Spoon Sample

Ground Water Level At Time Of Drilling

● PID Reading (ppm)

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B3

June 2004 | 32-1-16819-004

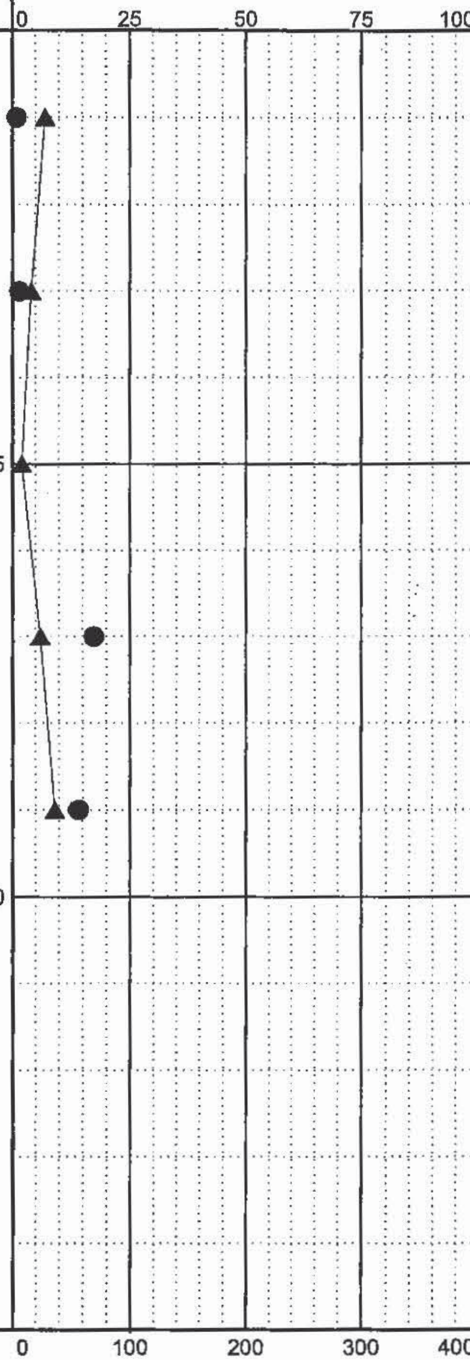
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

B-3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 18
B-4
No WELTS

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Loose, brown, sandy, silty GRAVEL; moist; trace of organics.			S1	Groundwater Not Encountered During Drilling on 5/10/04	
Soft to medium stiff, brown, sandy, gravelly SILT; trace of organics.	2.0		S2, S3 *, S4		5
Loose, brown, slightly sandy, silty GRAVEL; moist; slight hydrocarbon odor.	8.0		S5		
Bottom of Boring Boring Completed 5/10/04	10.0				10



LEGEND

* Sample Not Recovered

Ground Water Level At Time Of Drilling

3" O.D. Split Spoon Sample

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B4

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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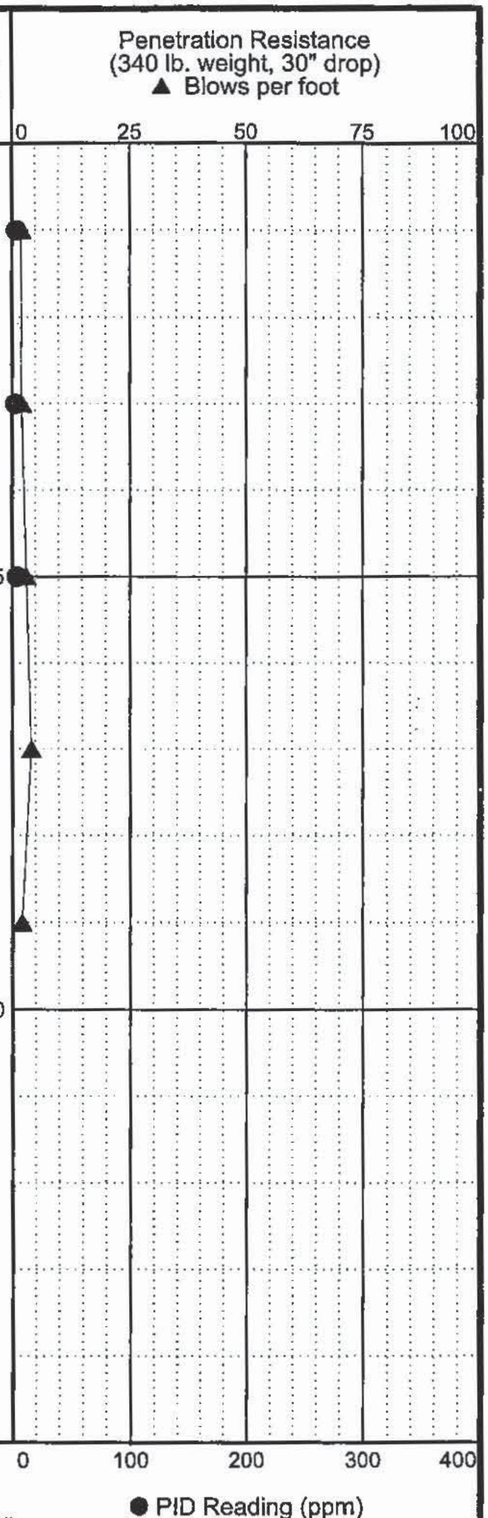
ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 19
B-5
No WELTS

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Soft, brown, slightly gravelly, sandy SILT; moist; trace of organics; slight hydrocarbon odor.			S1 S2 S3 S4 * S5 *	Groundwater Not Encountered During Drilling on 5/10/04	5
Bottom of Boring Boring Completed 5/10/04	10.0				10



LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample
Ground Water Level At Time Of Drilling

NOTES

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2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B5

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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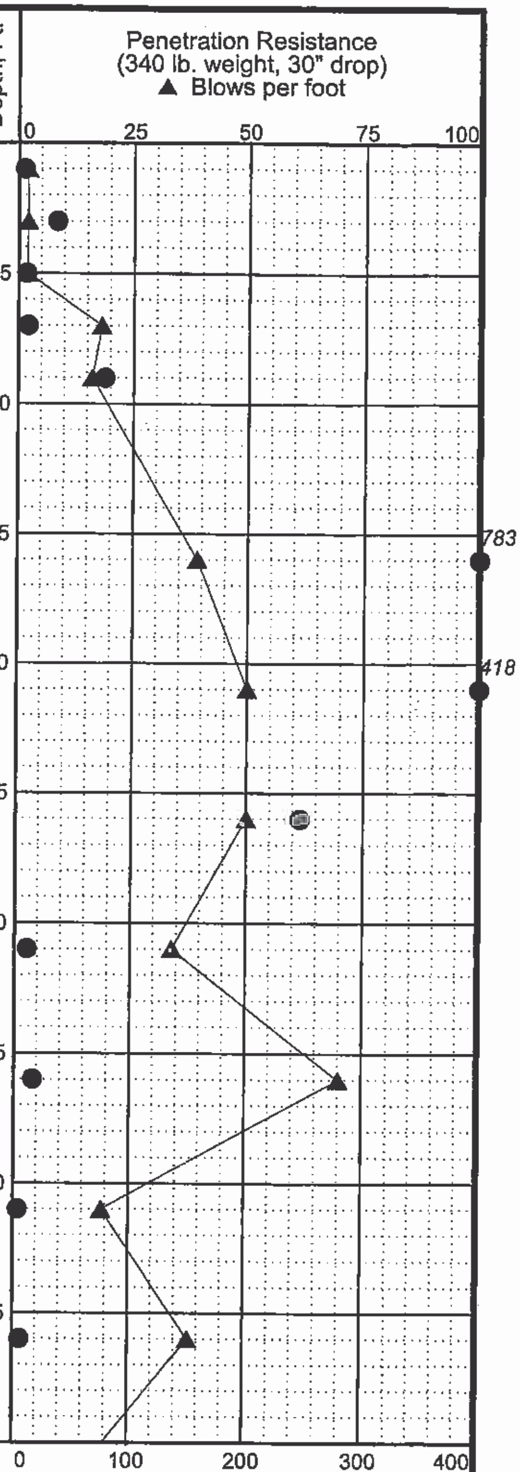
ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 20
B-6
Page 1

MATERIAL DESCRIPTION	Depth, Ft.	Samples
Soft, brown, slightly gravelly, sandy SILT; trace of organics. Slight hydrocarbon odor.		S1, S2, S3
Medium dense, brown, silty, gravelly SAND; moist; slight hydrocarbon odor.	6.0	S4, S5
Medium dense, brown to gray, silty, sandy GRAVEL; moist; slight hydrocarbon odor.	9.5	
Dense, brown to gray, silty, sandy GRAVEL, trace of cobbles; moist; slight hydrocarbon odor.	15.0	S6, S7, S8, S9, S10
Medium dense, brown to gray, slightly silty SAND; moist.	40.0	S11
Dense, brown to gray, slightly silty, sandy GRAVEL, trace of cobbles; moist.	45.0	S12

CONTINUED NEXT PAGE

Symbol | Ground Water | Depth, Ft.



LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample

Surface Seal
Solid Casing and Annular Seal
Well Casing and Filter Sand
Cuttings Backfill
Ground Water Level At Time Of Drilling
Static Water Level

NOTES

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2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B6

June 2004 | 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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Sheet 1 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 20
B-6
Page 2

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Medium dense, brown to gray, slightly silty, gravelly SAND; moist.	50.0		S13		
Medium dense, brown to gray, slightly silty, sandy GRAVEL; moist.	55.0		S14		55
Medium dense, brown to gray, silty, gravelly SAND; moist.	60.0		S15		60
Dense to very dense, brown to gray, silty, sandy GRAVEL; moist.	65.0		S16		65
			S17		70
Trace of cobbles			S18		75
			S19		80
			S20		85
Slight hydrocarbon and solvent odor.			S21		90
			S22	5/18/2004	95

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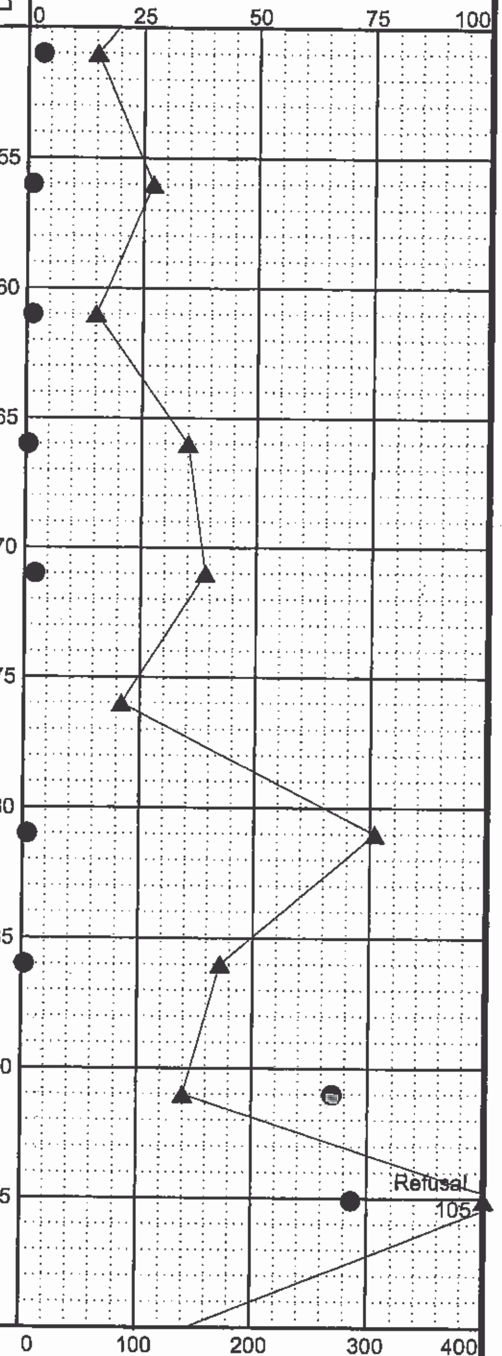
Penetration Resistance
(340 lb. weight, 30" drop)
▲ Blows per foot



● PID Reading (ppm)

LEGEND

- * Sample Not Recovered
- 3" O.D. Split Spoon Sample
- Surface Seal
- Solid Casing and Annular Seal
- Well Casing and Filter Sand
- Cuttings Backfill
- Ground Water Level At Time Of Drilling
- Static Water Level

NOTES

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2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B6

June 2004 32-1-16819-004

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Geotechnical and Environmental Consultants

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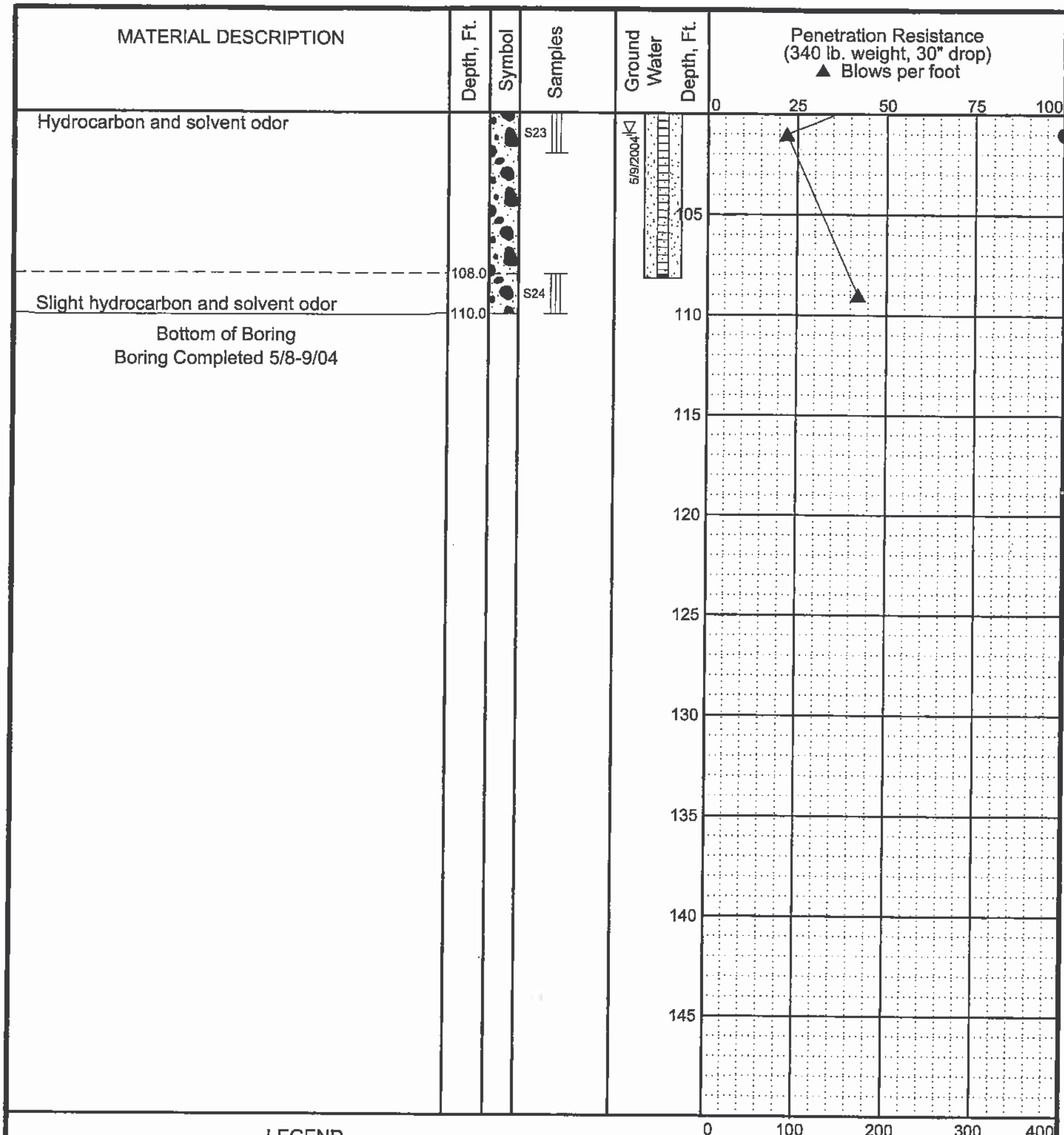
Sheet 2 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04



LEGEND

- * Sample Not Recovered
- 3" O.D. Split Spoon Sample
- Surface Seal
- Solid Casing and Annular Seal
- Well Casing and Filter Sand
- Cuttings Backfill
- Ground Water Level At Time Of Drilling
- Static Water Level

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B6

June 2004 | 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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Sheet 3 of 3

Nair 22
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Page 1

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Stiff, brown, slightly gravelly, sandy SILT; moist.			S1		5
Medium dense, brown, gravelly, silty SAND; moist.	10.0		S2		10
			S3		15
Trace of cobbles			S4		20
Dense, brown, sandy, silty GRAVEL; moist.	25.0		S5		25
			S6		30
Dense, brown, silty, gravelly SAND; moist.	35.0		S7		35
Very dense, brown, silty, sandy GRAVEL, trace of cobbles; moist.	40.0		S8		40
Medium dense, brown, gravelly, silty SAND; moist.	45.0		S9		45

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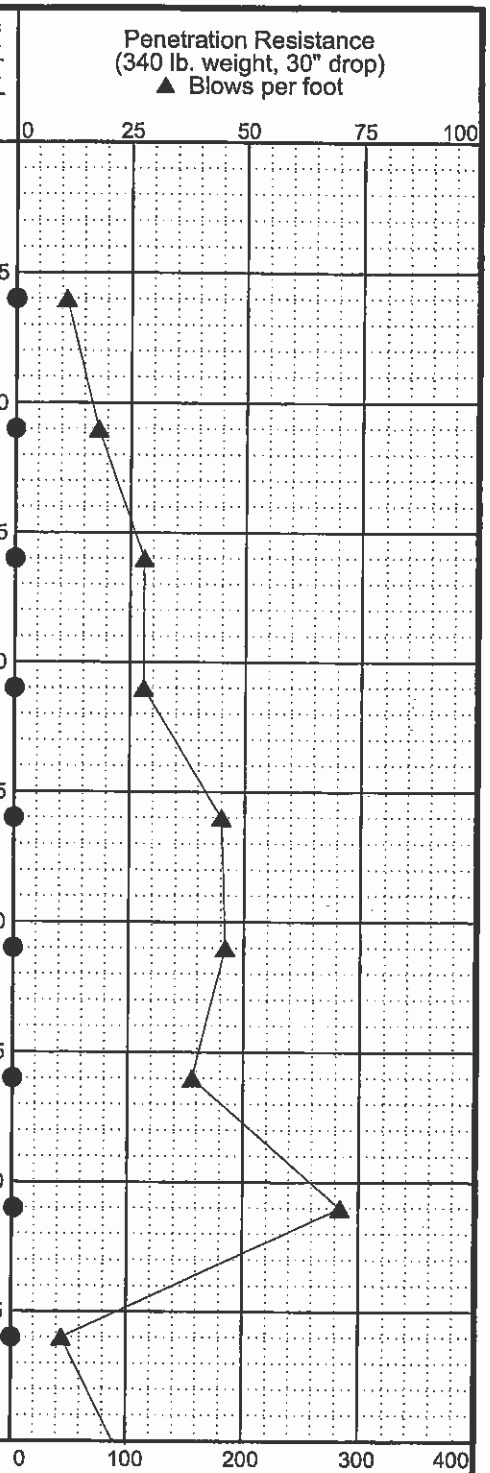

LEGEND

- * Sample Not Recovered
- Ⅲ 3" O.D. Split Spoon Sample
- Surface Seal
- Solid Casing and Annular Seal
- Well Casing and Filter Sand
- Cuttings Backfill
- ▽ Ground Water Level At Time Of Drilling
- ▼ Static Water Level

NOTES

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2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B15

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
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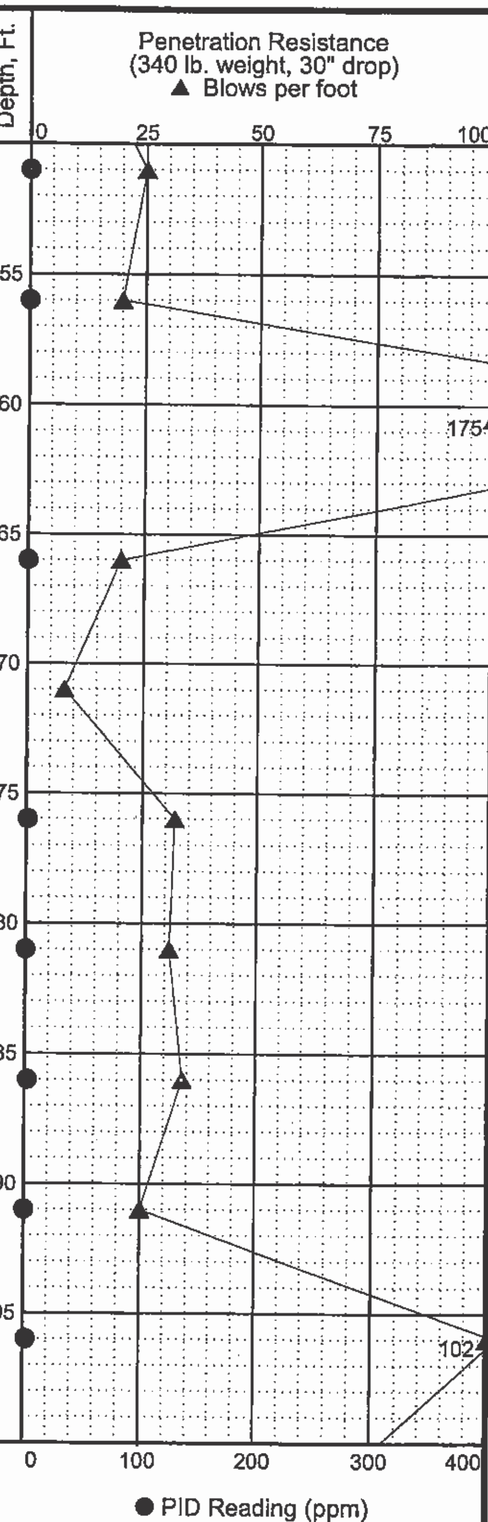
Sheet 1 of 3

Nair 22
B-15
Page 2

MATERIAL DESCRIPTION	Depth, Ft.	Samples
Medium dense, brown to gray, slightly silty, sandy GRAVEL, trace of cobbles; moist.	50.0	S10
Medium dense, brown to gray, slightly silty, gravelly SAND; moist.	55.0	S11, S12*
Medium dense to dense, brown, slightly silty, sandy GRAVEL; moist.	65.0	S13, S14*
Very stiff, brown, slightly sandy, gravelly SILT; moist. Slightly gravelly.	76.0	S15, S16, S17, S18
Very dense, brown to gray, silty, sandy GRAVEL, trace of cobbles; moist.	95.0	S19



CONTINUED NEXT PAGE

LEGEND

- * Sample Not Recovered
- 3" O.D. Split Spoon Sample
- Surface Seal
- Solid Casing and Annular Seal
- Well Casing and Filter Sand
- Cuttings Backfill
- Ground Water Level At Time Of Drilling
- Static Water Level

NOTES

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2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B15

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 22
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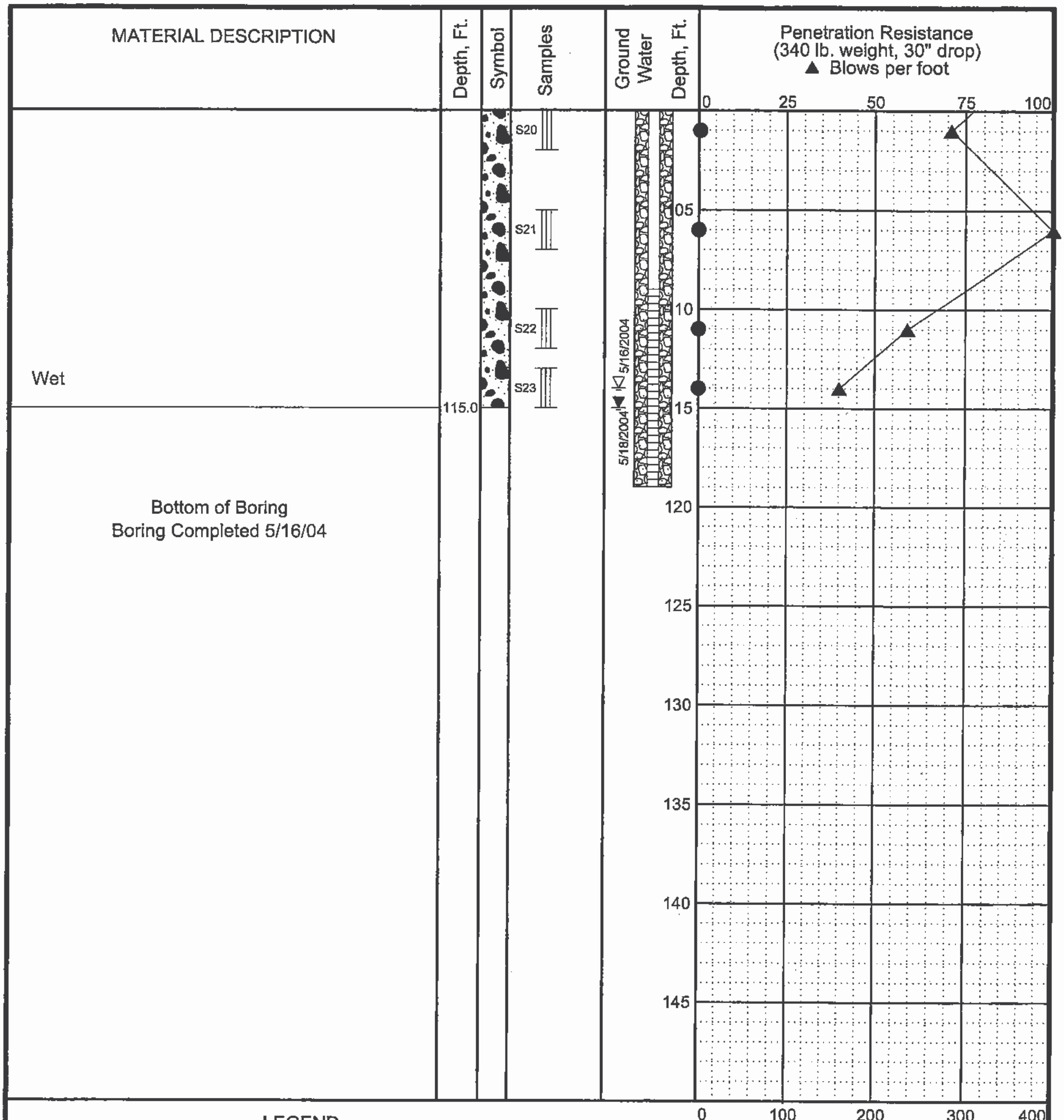
Page 3



LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample

Surface Seal
Solid Casing and Annular Seal
Well Casing and Filter Sand
Cuttings Backfill
Ground Water Level At Time Of Drilling
Static Water Level

NOTES

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3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B15

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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Sheet 3 of 3

Nair 23
B-16
Page 1

MATERIAL DESCRIPTION

Medium dense, brown, silty, sandy GRAVEL, trace of cobbles; moist; trace of organics.

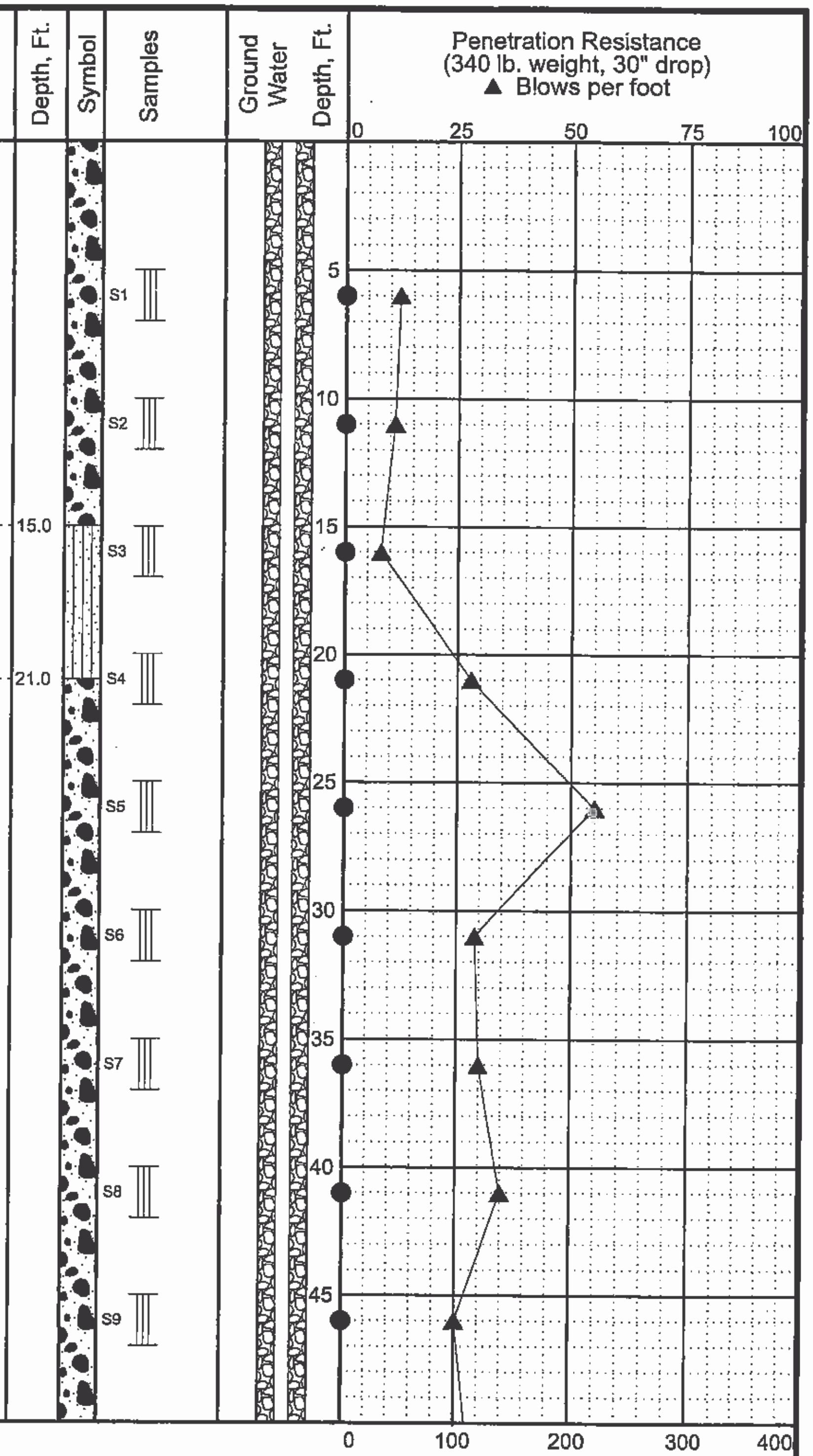
15.0

Stiff to very stiff, brown, slightly gravelly, sandy SILT; moist.

21.0

Medium dense, brown, slightly silty, sandy GRAVEL; moist.

Trace of cobbles.



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LEGEND

- * Sample Not Recovered
- 3" O.D. Split Spoon Sample
- Surface Seal
- Solid Casing and Annular Seal
- Well Casing and Filter Sand
- Cuttings Backfill
- Ground Water Level At Time Of Drilling
- Static Water Level

NOTES

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4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B16

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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Sheet 1 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 23
B-16
Page 2

MATERIAL DESCRIPTION

Trace of cobbles.

Trace of cobbles.

Medium dense, brown, gravelly, silty SAND; moist.

Trace of cobbles.

Trace of cobbles.

Dense, brown to gray, slightly silty, sandy GRAVEL, trace of cobbles; moist.

Very dense, brown to gray, slightly silty, sandy GRAVEL, trace of cobbles; moist to wet.

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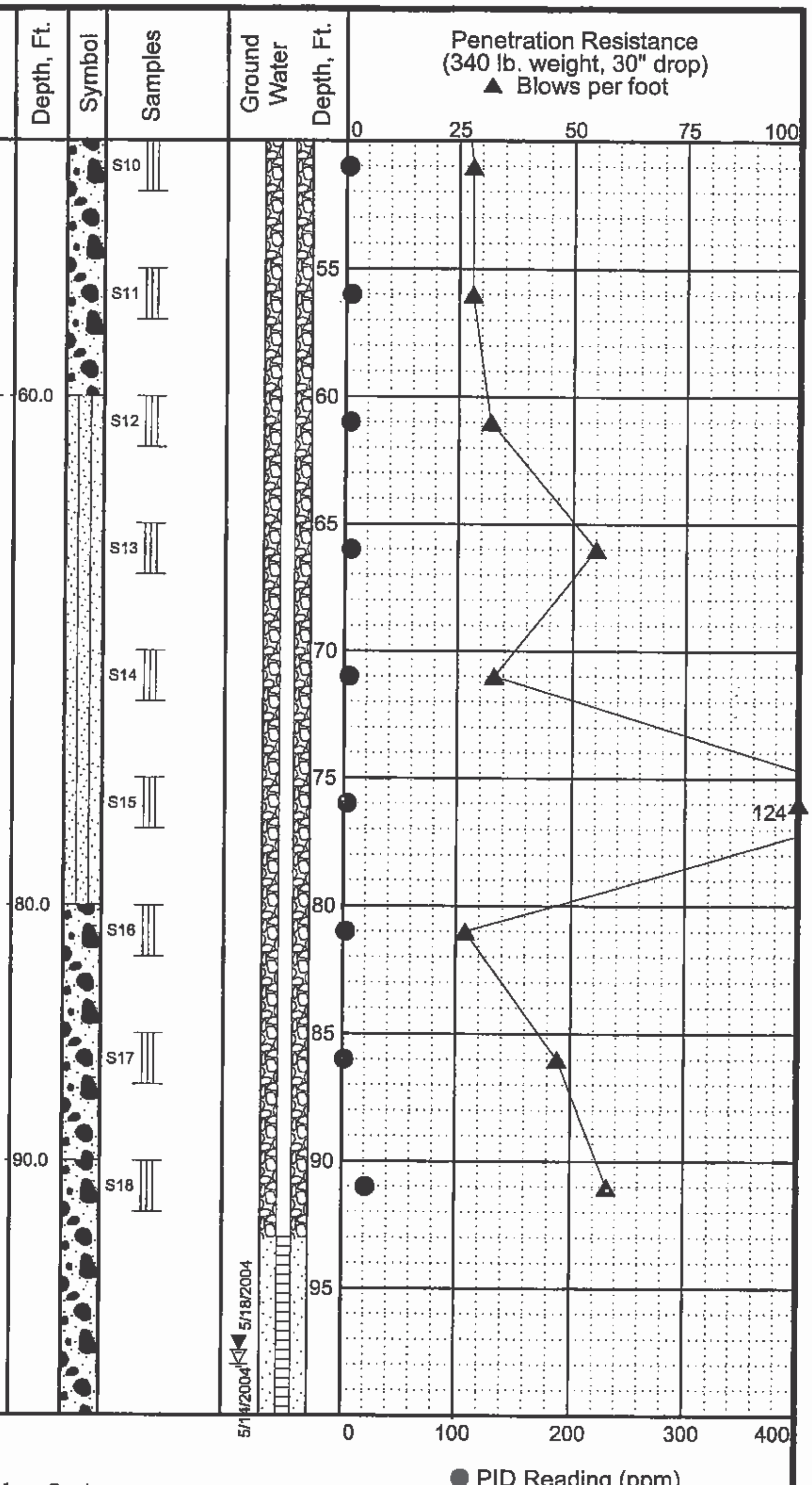

LEGEND

- * Sample Not Recovered
- 3" O.D. Split Spoon Sample
- Surface Seal
- Solid Casing and Annular Seal
- Well Casing and Filter Sand
- Cuttings Backfill
- Ground Water Level At Time Of Drilling
- Static Water Level

NOTES

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4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B16

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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Sheet 2 of 3

Nair 23
B-16
Page 3

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.	Penetration Resistance (340 lb. weight, 30" drop) ▲ Blows per foot (0 25 50 75 100)
	103.0					
Bottom of Boring Boring Completed 5/14/04					105	
					110	
					115	
					120	
					125	
					130	
					135	
					140	
					145	

0 100 200 300 400

● PID Reading (ppm)

LEGEND

- * Sample Not Recovered
- 3" O.D. Split Spoon Sample
- Surface Seal
- Solid Casing and Annular Seal
- Well Casing and Filter Sand
- Cuttings Backfill
- ▽ Ground Water Level At Time Of Drilling
- ▼ Static Water Level

NOTES

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Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B16

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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Sheet 3 of 3

Nair 24
B-17
Page 1

MATERIAL DESCRIPTION	Depth, Ft.	Samples
Very loose, brown, sandy, silty GRAVEL; moist.		S1
Stiff, brown, slightly gravelly, sandy SILT; moist; trace of organics.	10.0	S2
Loose, brown, silty, sandy GRAVEL; moist.	15.0	S3
Stiff, brown, slightly gravelly, sandy SILT; moist.	20.0	S4
Medium dense, brown, gravelly, silty SAND; moist.	25.0	S5
Medium dense, brown to gray, slightly silty, sandy GRAVEL; moist.	30.0	S6
Loose, brown to gray, silty, gravelly SAND; moist.	35.0	S7
Medium dense, brown to gray, slightly silty, sandy GRAVEL; moist to wet.	40.0	S8, S9

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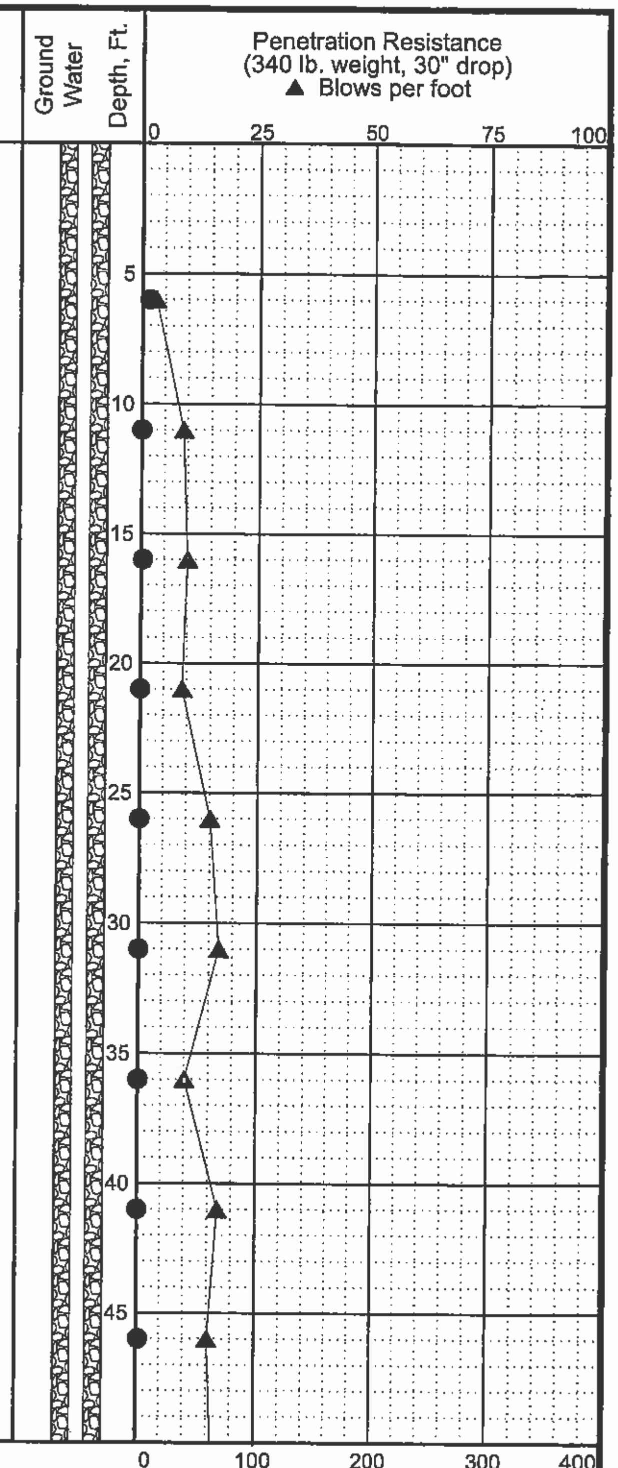

LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample

Surface Seal
Solid Casing and Annular Seal
Well Casing and Filter Sand
Cuttings Backfill
Ground Water Level At Time Of Drilling
Static Water Level

NOTES

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3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B17

June 2004 | 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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Sheet 1 of 3

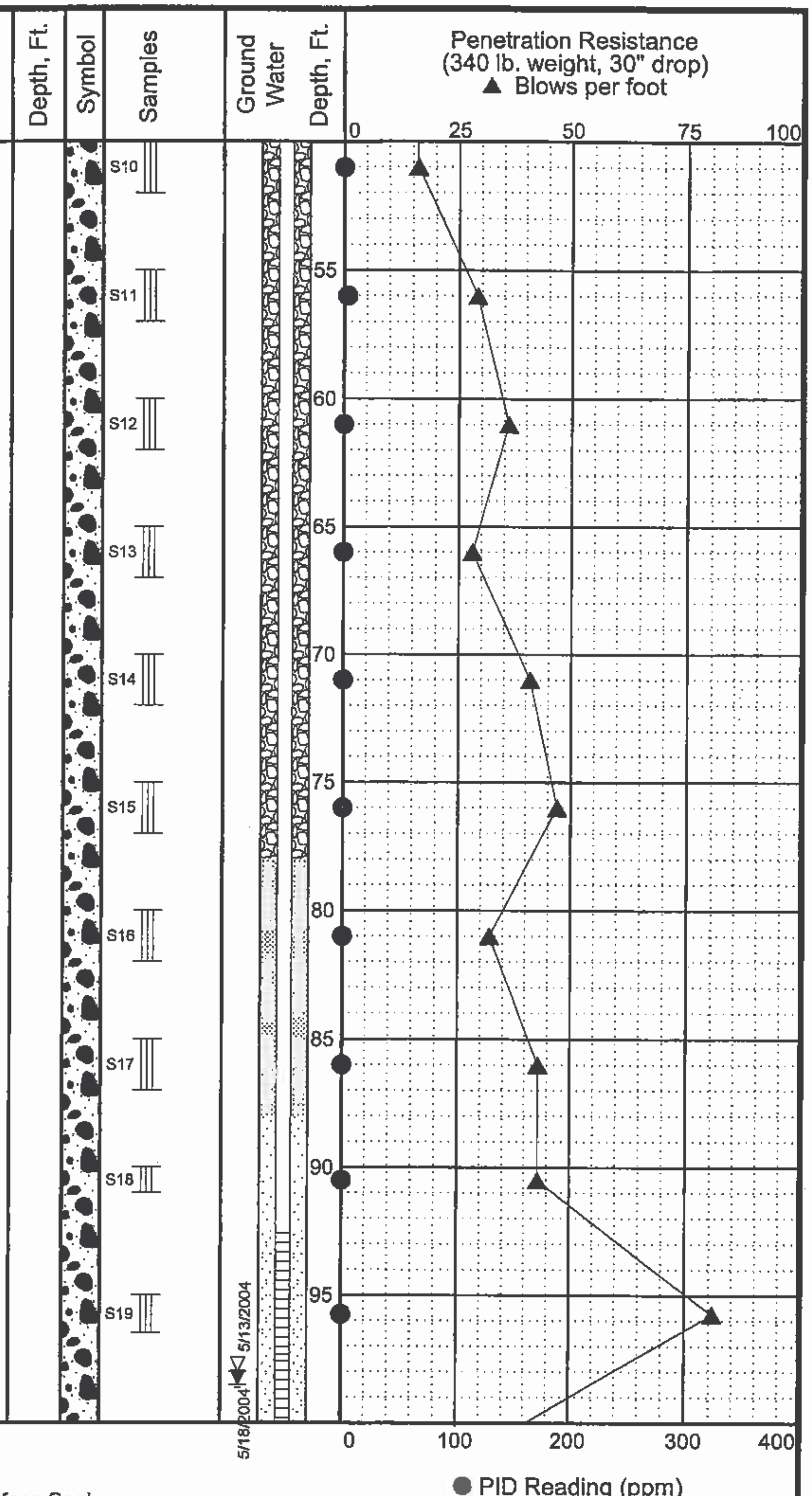
ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 24
B-17
Page 2

MATERIAL DESCRIPTION

Trace of cobbles to bottom of boring.

CONTINUED NEXT PAGE



LEGEND

- * Sample Not Recovered
- 3" O.D. Split Spoon Sample
- Surface Seal
- Solid Casing and Annular Seal
- Well Casing and Filter Sand
- Cuttings Backfill
- Ground Water Level At Time Of Drilling
- Static Water Level

NOTES

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Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B17

June 2004 | 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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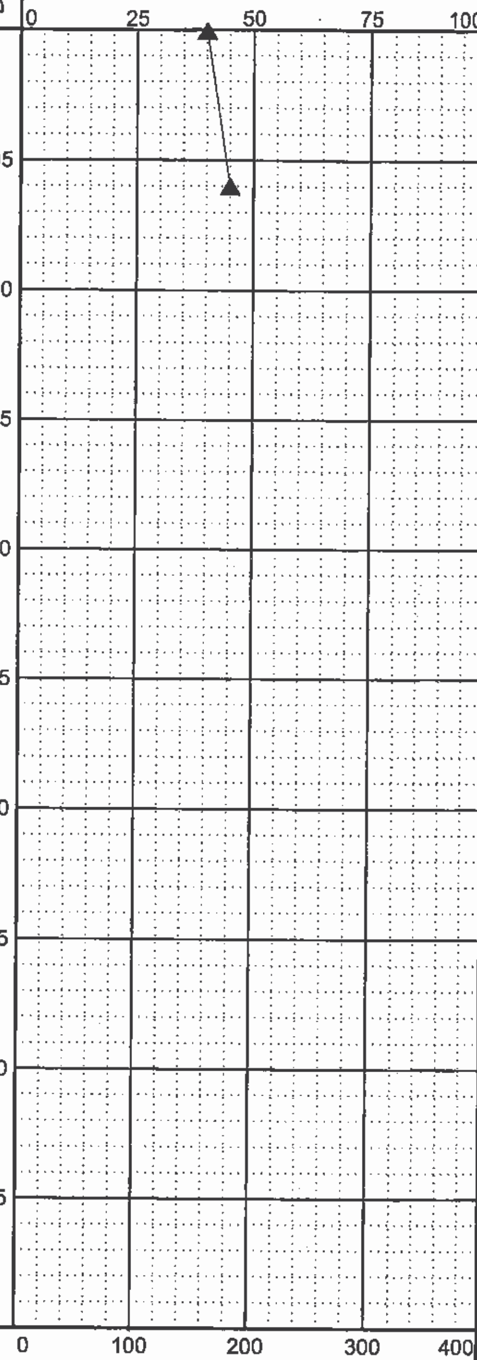
Sheet 2 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 24
B-17
Page 3

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Wet.			S20		
			S21		105
	108.0				
Bottom of Boring Boring Completed 5/13/04					110

Penetration Resistance
(340 lb. weight, 30" drop)
▲ Blows per foot



● PID Reading (ppm)

LEGEND

- * Sample Not Recovered
- 3" O.D. Split Spoon Sample
- Surface Seal
- Solid Casing and Annular Seal
- Well Casing and Filter Sand
- Cuttings Backfill
- Ground Water Level At Time Of Drilling
- Static Water Level

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B17

June 2004 32-1-16819-004

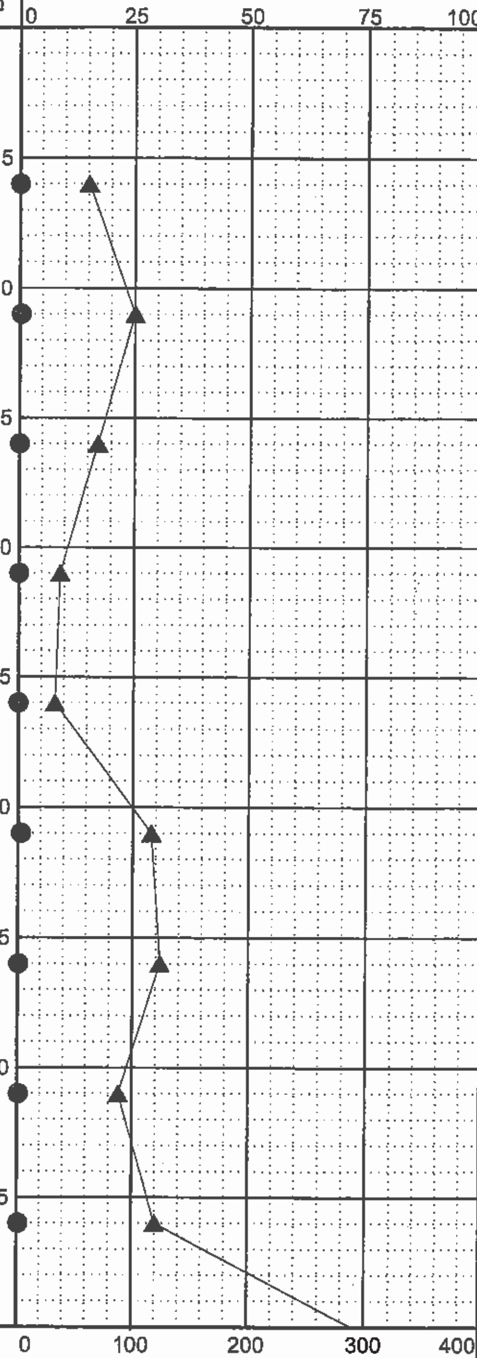
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

B-10
Sheet 3 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 25
B-18
Page 1

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Loose to very dense, brown, silty, sandy GRAVEL; moist; trace of organics.			S1	Groundwater Not Encountered During Drilling on 5/10-12/04	5
			S2		10
			S3		15
			S4		20
			S5		25
Intermittent cobbles to 122 ft. bgs.			S6		30
			S7		35
			S8		40
			S9		45



CONTINUED NEXT PAGE

LEGEND

- * Sample Not Recovered
- 3" O.D. Split Spoon Sample
- Ground Water Level At Time Of Drilling

NOTES

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4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B18

June 2004 — 32-1-16819-004

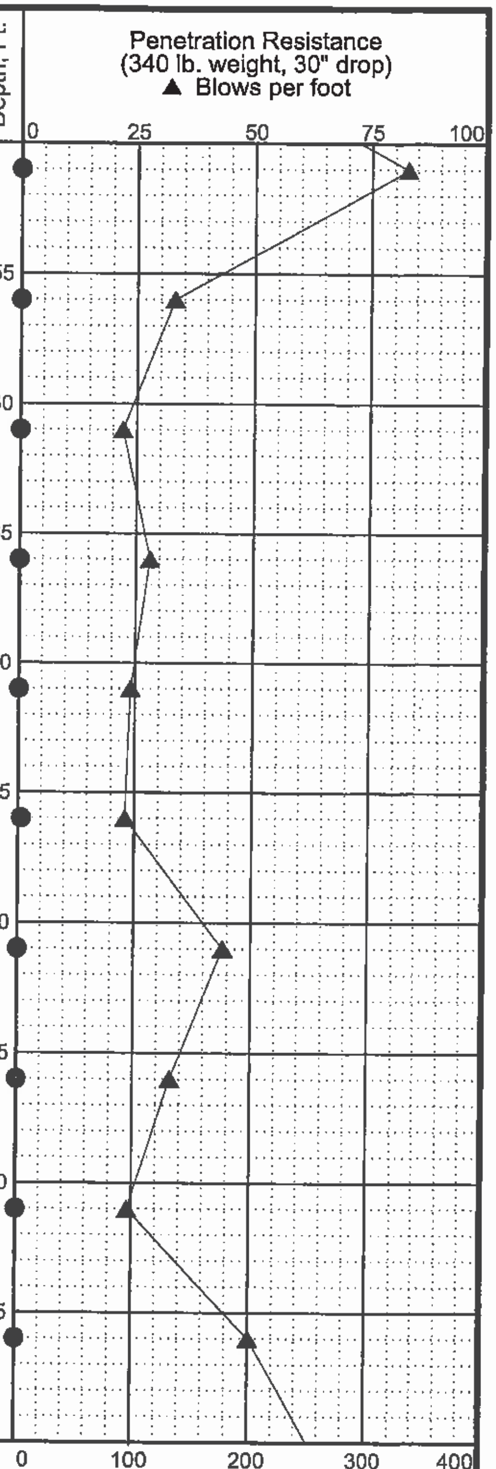
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

B-11
Sheet 1 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 25
B-18
Page 2

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
			S10		
			S11		55
			S12		60
Medium dense, brown, slightly silty, sandy GRAVEL; moist.	65.0		S13	Groundwater Not Encountered During Drilling on 5/10-12/04	65
			S14		70
			S15		75
			S16		80
			S17		85
			S18		90
			S19		95



CONTINUED NEXT PAGE

LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample
Ground Water Level At Time Of Drilling
● PID Reading (ppm)

NOTES

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Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B18

June 2004 32-1-16819-004

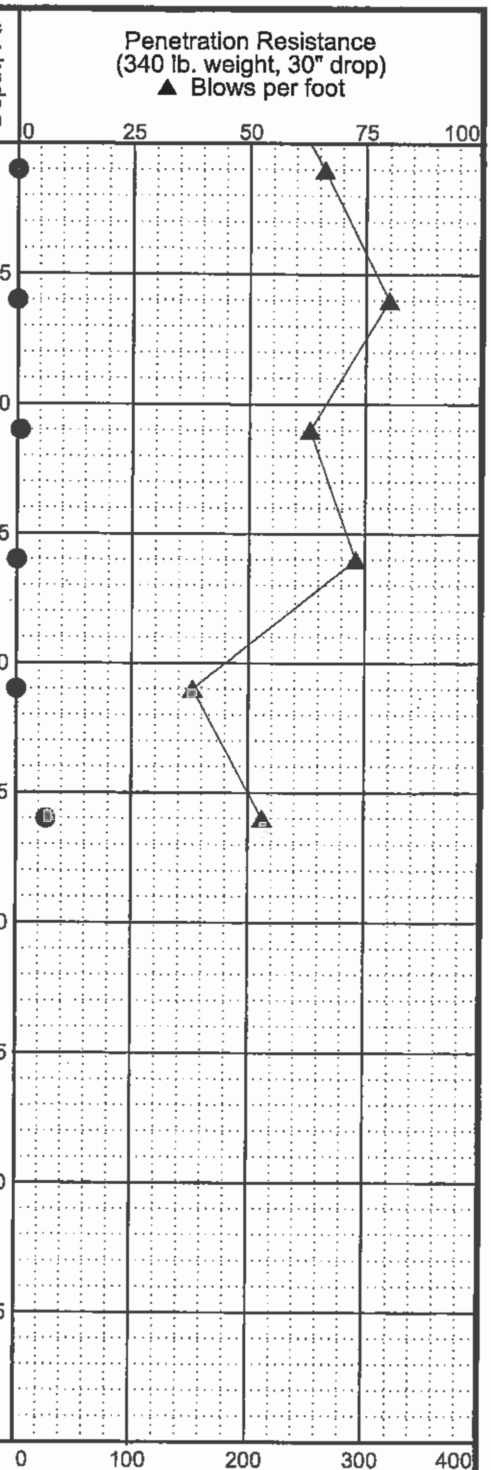
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

B-11
Sheet 2 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 25
B-18
Page 3

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
			S20	Groundwater Not Encountered During Drilling on 5/10-12/04	
			S21		105
			S22		110
			S23		115
			S24		120
Very dense, brown to gray, slightly silty, gravelly SAND; moist.	125.0		S25		125
Bottom of Boring Boring Completed 5/10-12/04	130.0				130
					135
					140
					145



LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample
Ground Water Level At Time Of Drilling

NOTES

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Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B18

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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Sheet 3 of 3

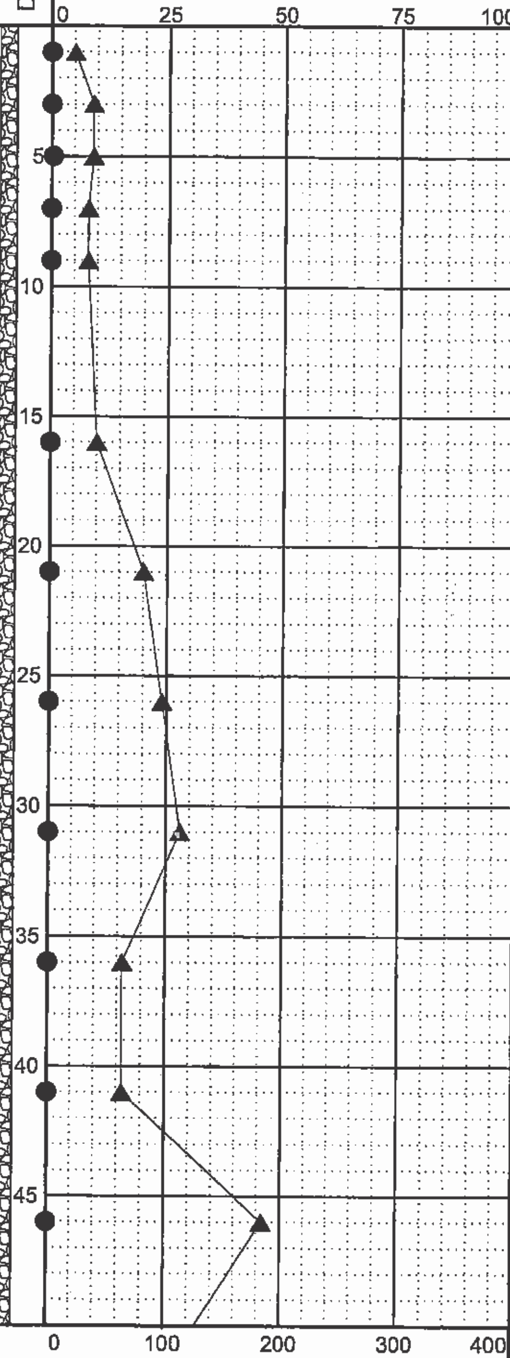
ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 26
B-19
Page 1

MATERIAL DESCRIPTION	Depth, Ft.	Samples
Medium stiff, brown, slightly gravelly, sandy SILT; moist; trace organics.		S1
Loose, brown, slightly gravelly, silty SAND; moist; trace organics.	2.0	S2, S3
Loose to medium dense, brown, slightly gravelly, silty SAND; moist.	6.0	S4, S5, S6, S7
Medium dense to dense, brown, silty, sandy GRAVEL; moist to wet. Trace of cobbles between 20 and 35 ft.	25.0	S8, S9, S10, S11 *, S12

CONTINUED NEXT PAGE

Ground Water



LEGEND

* Sample Not Recovered
Ⅲ 3" O.D. Split Spoon Sample

Surface Seal
Solid Casing and Annular Seal
Well Casing and Filter Sand
Cuttings Backfill
Ground Water Level At Time Of Drilling
Static Water Level

NOTES

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4. USC letter symbol based on visual classification.

Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B19

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

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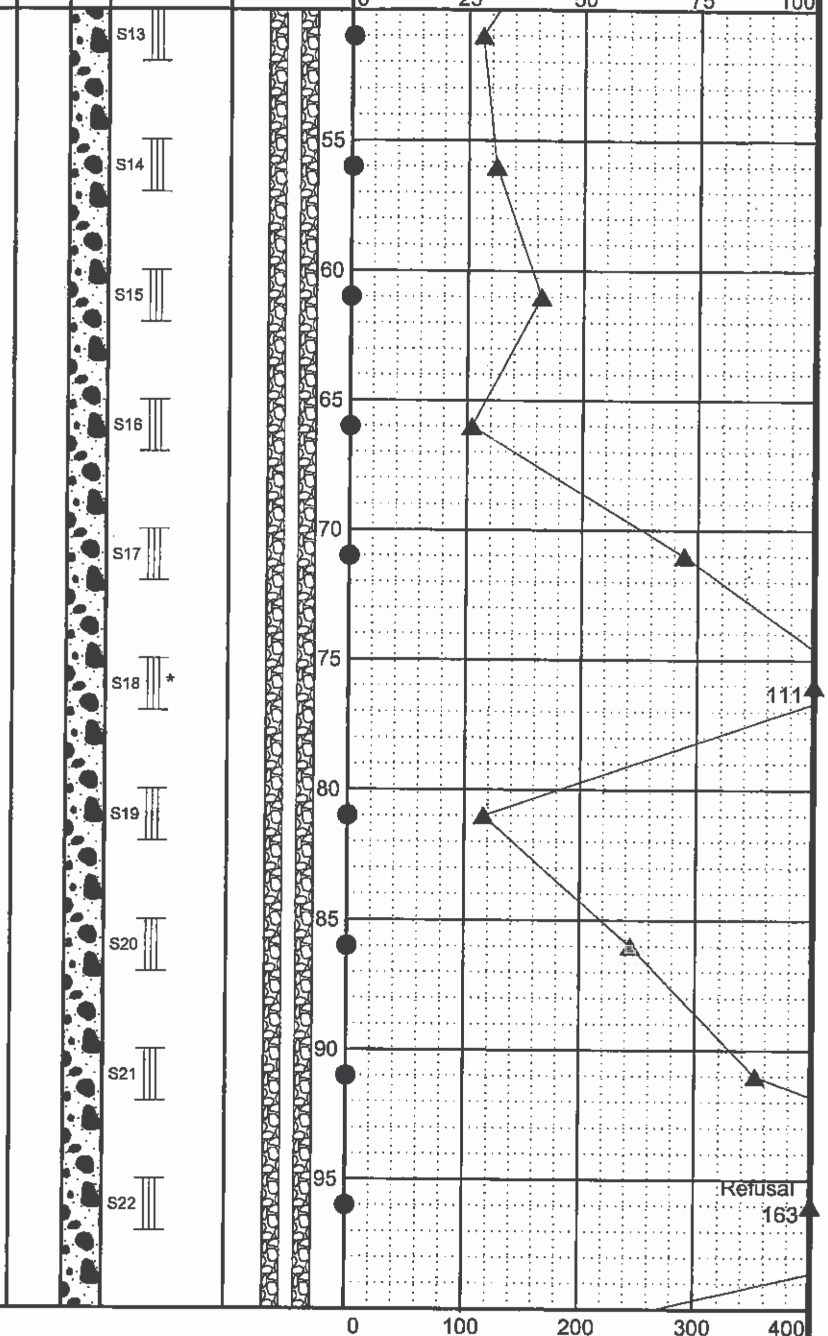
Sheet 1 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

MATERIAL DESCRIPTION | Depth, Ft. | Symbol | Samples | Ground Water | Depth, Ft. | Penetration Resistance (340 lb. weight, 30" drop) ▲ Blows per foot

Trace of cobbles between 60 and 65 ft.

Trace of cobbles between 90 and 125 ft.



CONTINUED NEXT PAGE

LEGEND

- * Sample Not Recovered
- 3" O.D. Split Spoon Sample
- Surface Seal
- Solid Casing and Annular Seal
- Well Casing and Filter Sand
- Cuttings Backfill
- Ground Water Level At Time Of Drilling
- Static Water Level

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Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B19

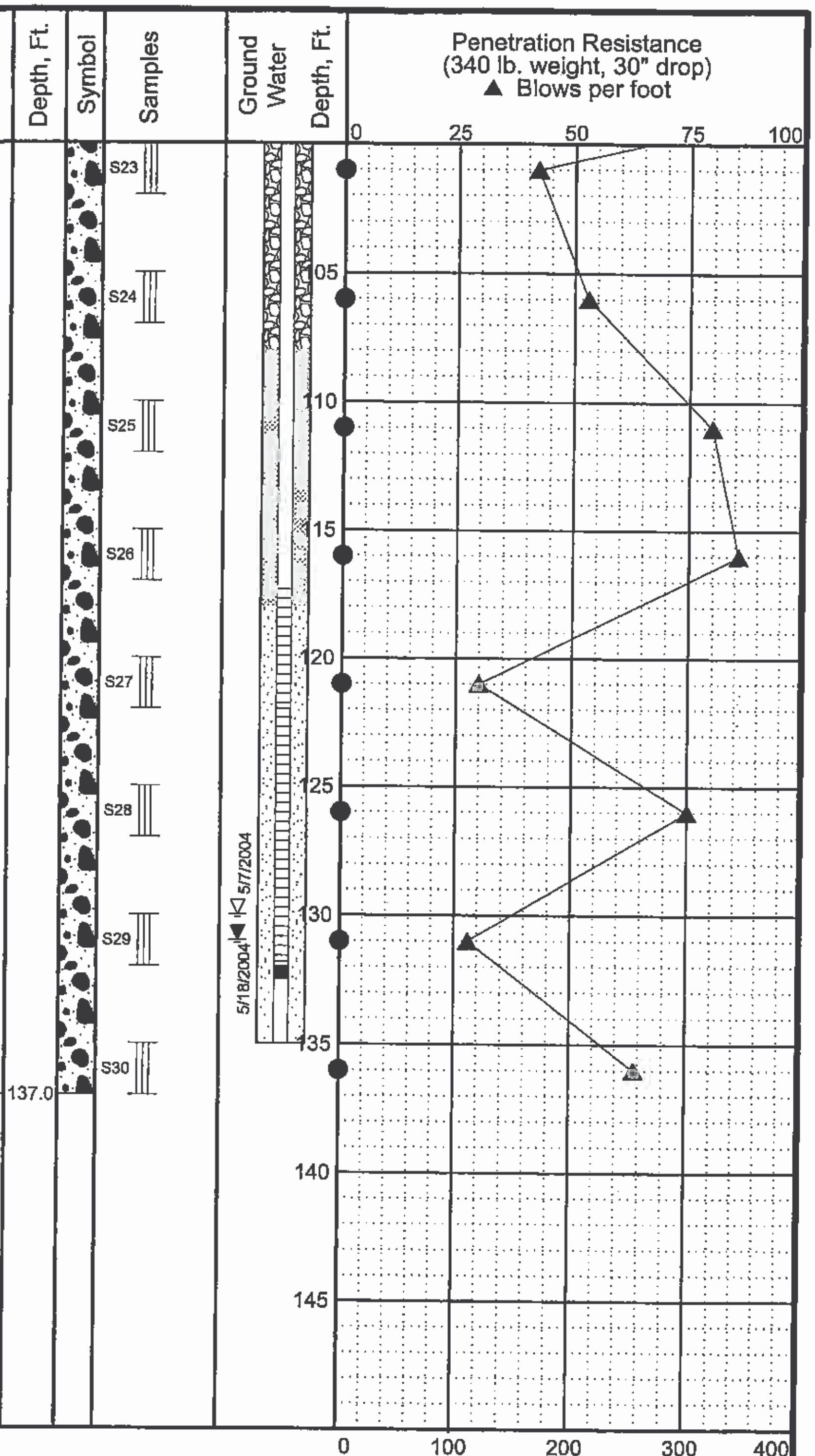
June 2004 | 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

B-12
Sheet 2 of 3

Nair 26
B-19
Page 3

MATERIAL DESCRIPTION



Bottom of Boring
Boring Completed 5/6-7/04

LEGEND

*	Sample Not Recovered
Ⅲ	3" O.D. Split Spoon Sample
	Surface Seal
	Solid Casing and Annular Seal
	Well Casing and Filter Sand
	Cuttings Backfill
▽	Ground Water Level At Time Of Drilling
▼	Static Water Level

NOTES

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Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B19

June 2004 32-1-16819-004

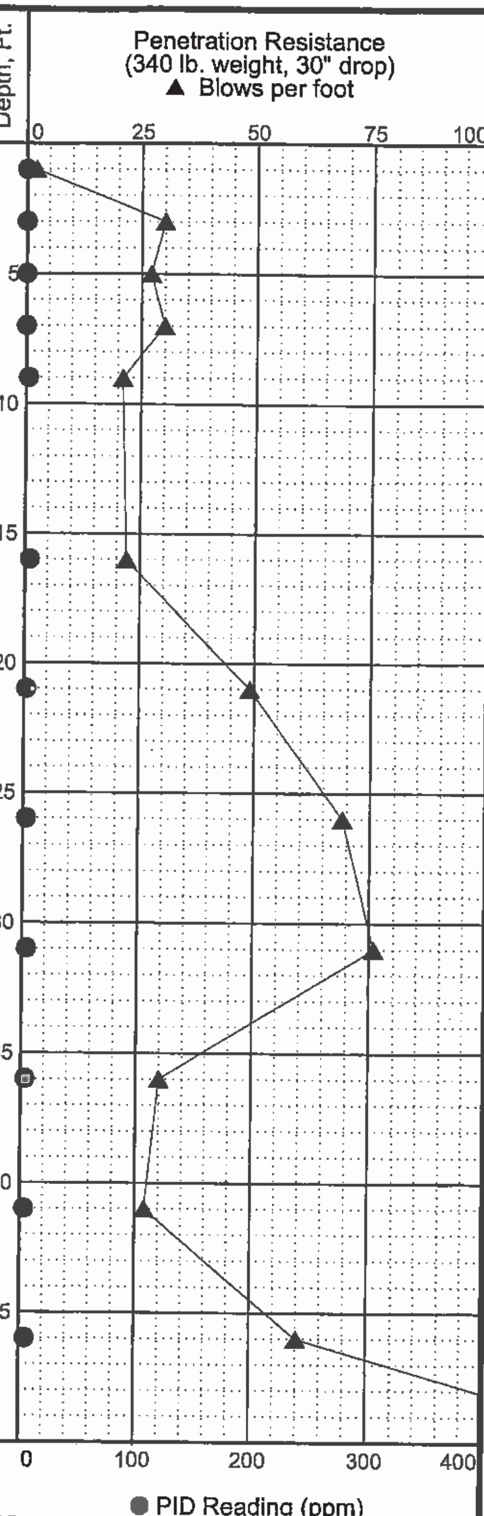
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

B-12
Sheet 3 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 27
B-20
Page 1

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Soft, brown, slightly gravelly SILT; moist; trace of organics.			S1		
Medium dense to dense, brown, slightly silty, sandy GRAVEL; moist.	2.0		S2, S3, S4, S5, S6, S7, S8, S9, S10	Groundwater Not Encountered During Drilling on 5/4-6/04	5, 10, 15, 20, 25, 30, 35
Medium dense, brown, slightly silty, gravelly SAND; moist.	40.0		S11		40
Very dense, brown, slightly silty, sandy GRAVEL, trace of cobbles; moist.	45.0		S12		45



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LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample
Ground Water Level At Time Of Drilling

NOTES

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Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B20

June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

B-13
Sheet 1 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 27
B-20
Page 2

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
			S13		
Medium dense to very dense, brown, slightly silty, sandy GRAVEL; moist.	55.0		S14		55
			S15		60
			S16	Groundwater Not Encountered During Drilling on 5/4-6/04	65
Sample number S17 not collected.			S18		70
			S19		75
			S20		80
			S21		85
			S22		90
			S23		95

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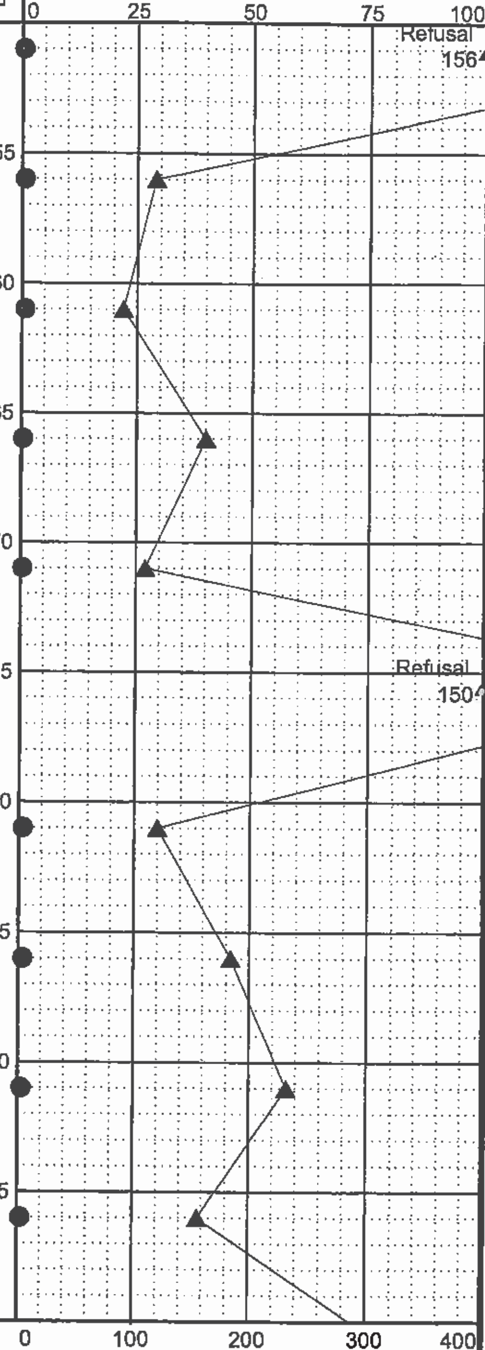

LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample
Ground Water Level At Time Of Drilling

NOTES

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Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B20

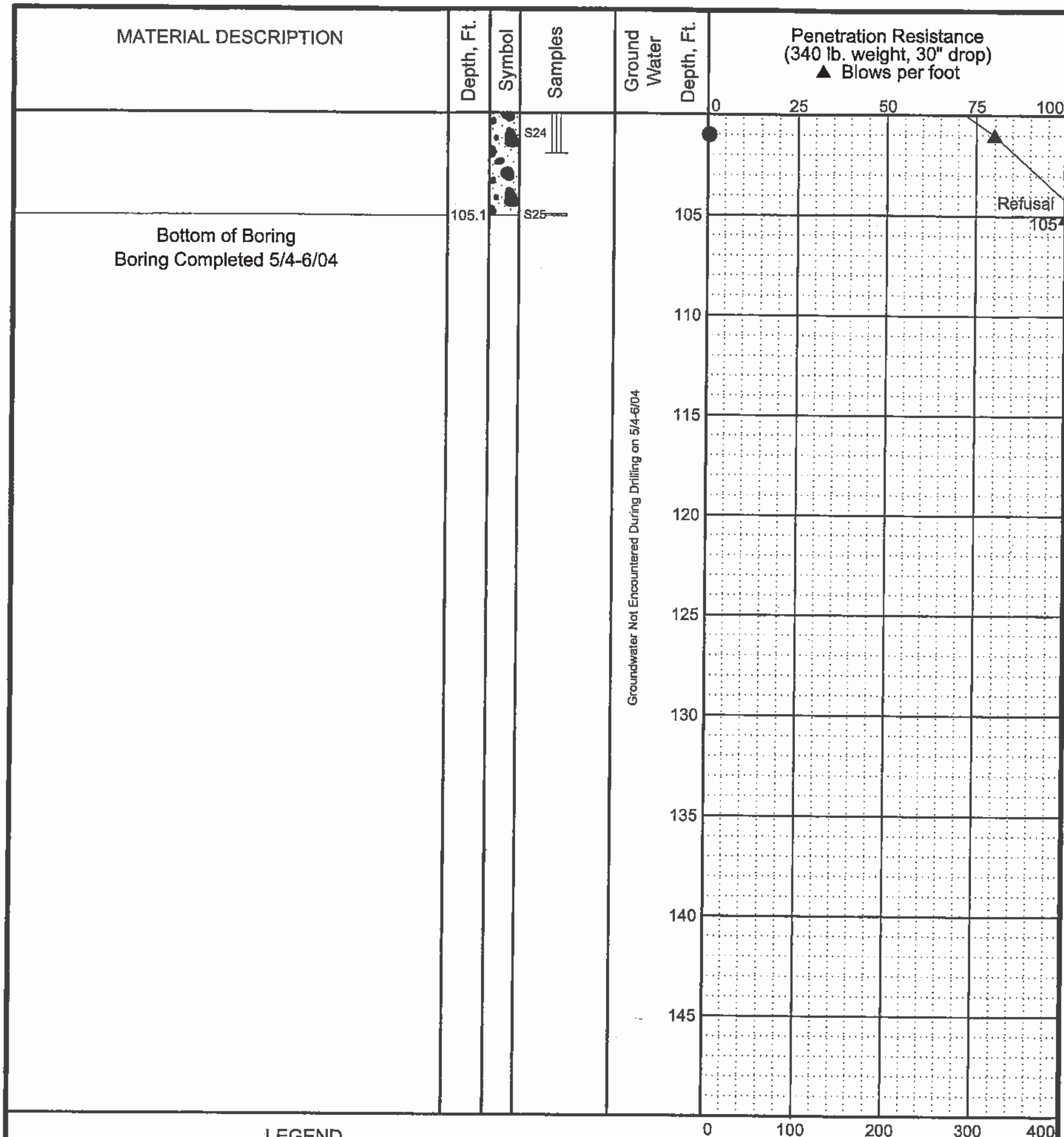
June 2004 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

B-13
Sheet 2 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

Nair 27
B-20
Page 3



LEGEND

* Sample Not Recovered
3" O.D. Split Spoon Sample
Ground Water Level At Time Of Drilling

NOTES

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Nikiski Airstrip
Nikiski, Alaska

LOG OF BORING B20

June 2004 | 32-1-16819-004

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

B-13
Sheet 3 of 3

ENVIRONMENTAL LOG 16819.GPJ S&W GEO1.GDT 7/7/04

NorFab 1
WELTS 18166

18166

NORTHLAND DRILLING
WATER WELL DRILLING
AND PUMP SUPPLY AND REPAIR

JIM HOOVER (907) 776-8443 P. O. BOX 1292
Owner KENAI, ALASKA 99611

national water well association

THE AMERICAN TRADITION — THIS BUSINESS IS CONSUMER PREFERRED

LOCATION OF WELL (Please complete either 1a, 1b or 1c.)

1a. Borough	Subdivision	Lot	Block	1b. 1/4 qtrs. — of — of — of —	Section No.	Township N☐ S☐	Range E☐ W☐	Meridian

1c. DISTANCE AND DIRECTION FROM ROAD INTERSECTIONS
On North Road
SW 1/4 SW 1/4 NW 1/4 & PORTION OF SE 1/4 SW 1/4 NW 1/4
16.59 Ac.
Street Address and Area of Well Location

3. OWNER OF WELL: Northern Fabrication
Address: PO Box 7259
776-5533 Nikiski, AK 99635

2 WELL LOG

Material Type	Feet Below Surface Top	Bottom
gravel & sand	0	105
Wet gravel & sand	105	112
wet clay w/ sand	112	117
sandy silt little rock	117	134
gravel w/ fine sand	134	138

4. WELL DEPTH: (final) 138 ft.

5. DATE OF COMPLETION 10-23-89

6. ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug ☐ Auger ☐ Jetted ☐ Bored ☐ Other:

7. USE: ☐ Domestic ☐ Public Supply ☒ Industry ☐ Irrigation ☐ Recharge ☐ Commerical ☐ Test Well ☐ Other: ______

8. CASING: ☐ Threaded ☐ Welded
diam. 6 in. to 134 ft. Depth Weight 17 lbs./ft.
diam. ____ in. to ____ ft. Depth Stickup 2 ft.

9. FINISH OF WELL: Casing @ 134 1/2
Type: Sand screen Diameter: 6
Slot/Mesh Size: 30TH Length: 5'
Set between 134 ft. and 138 ft.
Backfilling ______ Gravel pack ______

10. STATIC WATER LEVEL: 105' 4" ft. 10/24/89 Date
☐ Above or ☒ ~~Below land surface~~ from top of CASING
Equipment used: ______

11. PUMPING LEVEL below land surface and YIELD
____ ft. after ____ hrs. pumping ____ g.p.m.
____ ft. after ____ hrs. pumping ____ g.p.m.

12. GROUTING Well Grouted: ☐ Yes ☒ No
Material: ☐ Neat Cement ☐ Other: ______

13. PUMP: (if available) HP ______
Length of Drop Pipe ____ ft. capacity ____ g.p.m.
☐ Subm. ☐ Jet ☐ Centrifical ☐ Other

14. REMARKS:

15. Water Temperature ____° ☐ F ☐ C

60 43 37 15/1845 01
SB 7-12-1 BCDD1-19

16. WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief;

Northland Drilling
Registered Business Name

AA4201
Contract License Number

Address: PO Box 7174 Nikiski Alaska 99635

Signed: Maralee Smith-Hoover
Authorized Representative

Date: 10-23-89

NORTHLAND DRILLING
WATER WELL DRILLING
AND PUMP SUPPLY AND REPAIR

NorthBaptist 1
No WELTS

WATER WELL RECORD
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURES
Division of Geological & Geophysical Surveys

JIM HOOVER
Owner
(907) 776-8443
P. O. BOX 1292
KENAI, ALASKA 99611

Drilling Permit No.:
A.D.L. No.:

LOCATION OF WELL (Please complete either Ia, Ib or Ic.)

Ia. Borough	Subdivision	Lot	Block	Ib. 1/4 qtrs. __of__of__of__	Section No.	Township N☐ S☐	Range E☐ W☐	Meridian

Ic. DISTANCE AND DIRECTION FROM ROAD INTERSECTIONS
North Road
Church
Street Address and Area of Well Location

3. OWNER OF WELL: Carrigan Const
Address: PO Box 3315
776-8625 Kenai, Alaska 99611

2. WELL LOG

Material Type	Feet Below Surface Top	Bottom
sandy gravel w/ Rock	0	80
Clay	80	100
Rocks clay water	100	110
dirty sand & gravel dirty w/clay	110	125
water sand & gravel	125	131
sand + water	131	140

4. WELL DEPTH: (final) 140 ft.

5. DATE OF COMPLETION 6-28-86

6. ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug ☐ Auger ☐ Jetted ☐ Bored ☐ Other:

7. USE: ☒ Domestic ☐ Public Supply ☐ Industry ☐ Irrigation ☐ Recharge ☐ Commercial ☐ Test Well ☐ Other:

8. CASING: ☐ Threaded ☒ Welded
diam. ___ in. to ___ ft. Depth Weight 6 lbs./ft.
diam. ___ in. to ___ ft. Depth Stickup 2 ft.

9. FINISH OF WELL:
Type: Sandscreen Diameter: 6
Slot/Mesh Size: 10TH Length: 5'
Set between 135 ft. and 140 ft.
Backfilling ___ Gravel pack ___

10. STATIC WATER LEVEL: 94 ft. 6/28/86 Date
☐ Above or ☒ Below land surface
Equipment used:

11. PUMPING LEVEL below land surface and YIELD
140 ft. after ___ hrs. pumping 65 g.p.m.
___ ft. after ___ hrs. pumping ___ g.p.m.

12. GROUTING Well Grouted: ☐ Yes ☒ No
Material: ☐ Neat Cement ☐ Other:

13. PUMP: (if available) HP ___
Length of Drop Pipe ___ ft. capacity ___ g.p.m.
☐ Subm. ☐ Jet ☐ Centrifical ☐ Other

14. REMARKS:

15. Water Temperature ___ ° ☐ F ☐ C

16. WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief;

Northland Drilling
Registered Business Name
AA4201
Contract License Number
Address: PO Box 1292 Kenai, Alaska 99611
Signed: Marlee M Hoover
Authorized Representative
Date: 6-28-86

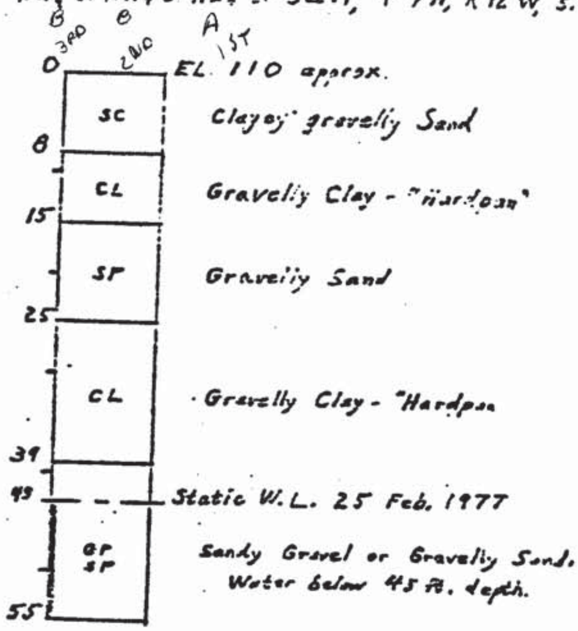
Form.02-WWR (11/81) Copy Distribution: WHITE - State DGGS, PINK - Driller, CANARY - Customer

19793

W .L - OIL FIELD SALVAG NC.

Test on [illegible] parcel of property ([illegible] description, in NW¼ of NW¼ of NE¼ of Sec. 1, T 7 N, R 12 W, S. M.

ABB



Well was drilled in Feb. 1977. No data on development, production rate, or drawdown.

LOCAL NO. SB 7-12-1 ABB B1-21
SITE ID 340402-1511813-01

Oren 1
WELTS 16841

in header file

16841

SITE NO. SB-7-12-2-AABA1-4

AK- 10716

U.S. DEPT. OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
GROUND WATER SITE INVENTORY
SITE SCHEDULE

Recorded by Freethey/Anderson

Date Dec 20 1976

326

Check One ✓ English ___ Metric Units

GENERAL SITE DATA (0)

Site Ident No 6044021511929 01 | RG Number R=0 * | Transaction T- (A) D M V * (add, delete, modify, verified)

Site-Type 2= C D H I M P T (W) * (collector, drain, sinkhole, connector, multiple, pond, tunnel or shaft, well) | Data Reliability 3= C (U) L M * (field checked, unchecked, location not accurate, minimal data) | Reporting Agency 4= USGS *

Project No. 5= * | District 6= 02 * | State 7= 02 * | County (or town) 8= 120 *

Latitude 9= 604402 * (deg min sec) | Longitude 10= 1511929 * (deg min sec) | Lat-Long Accuracy 11= S F (T) M * (sec, 5 sec, 10 sec, Min)

Local Number 12= SB00701202AABA1 004 * | Land Net Loc. 13= NW NE NE S 02 T 007N R 012W S * (1/4 1/4 1/4 section, township, range, merid)

Location Map 14= KENAI C-4 (~~NORTH KENAI 3 KBM~~) * | Scale 15= 63360 (~~6000~~) *

Altitude 16= 145. * | Method of Measurement 17= A L (M) * (altimeter, level, map) | Accuracy 18= 5 *

Topo Setting 19= D C E F H K L Ø P S T (U) V W * (depression, stream channel, dunes, flat, hilltop, sink, swamp, offshore, pediment, hillside, terrace, undulating, valley flat, upland draw) | Hydrologic Unit (OWDC) 20= 19050002 *

Date of First Construction/Completion 21= 00/00/1961 * (month day year) | Use of Site 23= A D E G H Ø M P R S T U (W) X Z * (anode, drain, geothermal, seismic, heat reserv., observation, mine, oil or gas, recharge, repress, test, unused, withdrawal, waste, destroyed)

Use of Water 24= A B C D E F (H) I M N P R S T U Y Z * (air cond., bottling, commercial, dewater, power, fire, domestic, irrigation, medicinal, industrial, public supply, recreation, stock, institution, unused, desal, other)

Secondary Water Use 25= * | Tertiary Use of Water 26= * | Depth of Hole 27= 224. * | Depth of Well 28= 224. * | Source of ① Depth Data 29= *

Water Level 30= . * | Date Measured 31= / / * (month day year) | Source ① 33= *

Method of Measurement 34= A C E G H L M R S T V Z * (airline, calibrated airline, estimated, pressure gage, calibrated pressure gage, geophysical logs, manometer, reported, steel tape, electric tape, calibrated electric tape, other)

273= Y

Site Status 37= D F G H Ø P R S T V X Z * (dry, flowing, nearby flowing, nearby recently flowing, obstruction, pumping, recently pumped, nearby pumping, nearby recently pumped, foreign substance, surface water effects, other)

Source of Geohydrologic Data ① 36= * | Pump Used 35= * (no) | Measuring Point 266= . * | Measuring Point Date 267= / / * (month day year)

OWNER IDENTIFICATION (1)

R = 158 * | T- (A) D M * (add, delete, modify) | Date of Ownership 159 # 00/00/1961 * (month day year)

Name: Last 161= HUDSON * | First 162= OREN * | Middle Initial 163= B *

OTHER SITE IDENTIFICATION NUMBERS (1)

190# 12715 * 191= LAB *

R = 189 * | T- (A) D M * (add, delete, modify) | Ident 190 # 004 * | Assigner 191= AK MP *

New Card Same R & T | Ident 190 # 10716 * | Assigner 191= AKRG *

SITE VISIT DATA (1)

R = 186 * | T- A D M * (add, delete, modify) | Date of Visit 187# / / * (month day year) | Name of Person 188= *

FIELD WATER QUALITY MEASUREMENTS (1)

R = 192 * | T- (A) D M * (add, delete, modify) | Date 193 # 06/04/1969 * (month day year) | Geohydrologic Unit 195 # *

New Card Same R thru 195

Temperature 196# 0,0,0,1,0 * | Degrees C 197= 7.0 *

Conductance 196# 0,0,0,9,5 * | μ Mhos 197= 110. *

Other (STORET) Parameter 196 # * | Value 197= . *

Other (STORET) Parameter 196 # * | Value 197= . *

FOOT NOTES:

① Source of Data Codes:

S D Ø A R L G Z (reporting agency, driller, owner, other gov't, other reported, logs, geologist, other)

Left margin: OK OK NY Y; GWF 1-77; QWF 1-77; LWF 5-77; GWJ 5-77; BSB 8-78; AKRG HEADER; HB 3-31-77

Right margin: SB 7-12-2 AABA 1-4

14658

Porter 1
WELTS 14658

WELL CONSTRUCTION LOG

Drilling Co. Northland Drilling USGS no. ______

Driller Jim Hoover Type of rig Cable Date well completed 8-4-77

Well owner Bob Porter Nearest community N.K.

Well location: (address & legal description) Off Island Lake rd Northland

Location sketch or remarks: w/in alignment part property: NE1/4 SE1/4 SW1/4 SW1/4 Sec. 1, T7N, R 12W, SM

N04
W61

Depth of well 103 ft. Casing: depth 104-5 ft. diam. 6 in.

Static water level 91 ft. (above, **below**) land surface. Date 8-4-77

Finish of well: (**open-end**, screen, perforated, open-hole, other) ______

Describe intervals and size: ______

Well yield tested by (pumping, bailing, air) at 23 gal/min.

or 4 hours with ______ ft. of drawdown from static level.

DRILLER'S MATERIAL LOG

Depth below land surface in feet	Give description of strata penetrated (size of material, color, hardness of drilling, and water content)
0 to 1	Back fill
1 to 2	Top soil
2 to 10	clay w/ gravel
10 to 20	clean gravel
20 to 30	gravel w/ clay Hard
30 to 50	Gravel & Sand
50 to 74	Hard pan
74 to 78	Loose Sand & gravel
78 to 92	Hard pan
92 to 103	Loose gravel water
to	
to	
to	
to	
to	
to	
to	
to	
to	
to	
to	
to	
to	

SO 7-12-1 CCDA F-8
604315 151/8 4601

22459

Rector 1
WELTS 22459

WS & S Co.

WATER SYSTEMS & SERVICE

Rt. 1, Box 1517 Kenai, Alaska 99611

Well Log 4-15-80

Fred Rector

1-2 Top Soil

2-34 Gravel

34-53' Gravel w/Water

Possible Water Production - 15 GPM

1/2 H/P Pump - 10 GPM

Thank You

R.O. Dugas

LOCAL NO. SB 7-11-6 BCDD

SITE ID

NK 21

1335

School 1
Well No. 1
WELTS 1335

Krauberger Drilling Co. Well Drilling Log

Well owner: Nikiski High School Driller: ARK Completion: 4/16/86

Builder: Kenai Pensuile Boro City: Nth Kenai

Road/Area: Nth Road

Legal 1: ______ Legal2: # 1

Depth: 197	Casing length: 199	Diameter: 6	Rig type: AR
Static level: 105	Yield/GPM 300.	Finish of well: JS screen 173-197 ft	

.020Js screen 173-187

0-3 topsoil & clay

9-11 cemented sand & grv

91-94 grey clay

98-111 sandy clay

117-132 wet silt,sand,coal,clay

136-170 sand,grv,coal & wood

185-197 water gravel

We cut off 42.4' of 6" casing &

added 42.4' of 8"pittless 3"

weld on 158' from bottom

.040 187-192/.060 192-197

3-9 sand & gravel

11-91 sand & gravel

94-98 wet sand

111-117 wet sans

132-136 wet sand & gravel

170-185 clean water sand & grv

197 dirty water sand,grv,coal

SB 8-12-36 DDBC 1-3

Nikiski High School Well #1 Well Log.

1/89

PDH. 1/23/89

19795

School 2
Well No. 2
WELTS 19795

Kreuberger Drilling Co. Well Drilling Log

Well owner: NHS

Driller: ARK

Completion: 5/2/88

Builder: Boro

City: Niskiski

Road/Area: Nth Road

Legal 1: ______________

Legal2: ______________

Depth: 169	Casing length: 172	Diameter: 8	Rig type: AR
Static level: 80	Yield/GPM 200.	Finish of well: 25'JS screen 144-169	

0-63 sand & gravel

63-67 grey clay

67-70 wet sand

70-84 sandy clay

84-104 wet sand,silt,coal,clay

104-142wet sand,grv,coal,wood

142-170 clean water sand & grv

170 water sand,grv,coal,wood

Set 25' 8" screen welded to 8"

144 to 169ft pumped est. 200 to

300 gpm

LOCAL NO. SB 8-12-36 DDBC 2-3

SITE ID 604410151174601

NK 18

Nikiski High School Well #2 well log. 1/89

PDA 1/23/89

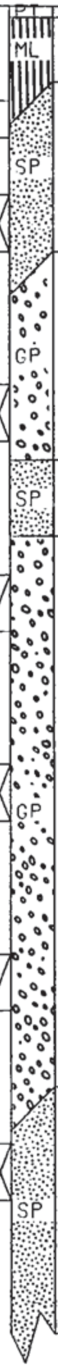
School 3
TB-1
Page 1

TEST BORING 1

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)
~3 (grab sample)		7	T=51	
~6		6	T=47	15
~11		6	T=46	10
~16		6		22
~21		3	T=47	31
~26		4		30
~31		3	T=48	32

FROST DEPTH



Description	DEPTH
PEAT, SURFACE ORGANICS	0.3
F4, BROWN SANDY SILT, PLASTIC, WET, STIFF	2.0
NFS, BROWN GRAVELLY SAND WITH ABOUT 40% GRAVEL TO 1" AND GENERALLY LESS THAN 5% SILT, DAMP, MEDIUM DENSE 2" STRATUM OF PLASTIC BROWN SILT	6.5
NFS, BROWN SANDY GRAVEL TO 1.5", ABOUT 55-60% GRAVEL AND GENERALLY LESS THAN 5% SILT BUT THERE ARE SOME THIN STRATUM OF MORE SILTY GRAVEL, LOOSE, DAMP	12.0
NFS, BROWN GRAVELLY SAND WITH GENERALLY LESS THAN 5% SILT, DAMP, MEDIUM DENSE	14.0
NFS, BROWN SANDY GRAVEL TO 2", ABOUT 55% GRAVEL AND GENERALLY LESS THAN 5% SILT, DAMP, MEDIUM DENSE	28.5
NFS, BROWN POORLY GRADED GRAVELLY SAND WITH ABOUT 35% GRAVEL TO 1" AND GENERALLY LESS THAN 5% SILT, DAMP, DENSE	35.0

KEY
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PI = PLASTIC INDEX
PP = POCKET PENETROMETER (TSF)
TV = TORVANE (TSF)
☐ = GRAB SAMPLE
◪ = SPT SAMPLE
[S] = SHELBY TUBE-PUSHED
☒ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL
T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS
LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 3

School 3
TB-1
Page 2

TEST BORING 1 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH	DESCRIPTION	DEPTH
35		2	T=50	47	SP	NFS, BROWN POORLY GRADED GRAVELLY SAND WITH ABOUT 35% GRAVEL TO 1" AND GENERALLY LESS THAN 5% SILT, DAMP, DENSE	38.0
40		3		45	GP	NFS, BROWN SANDY GRAVEL WITH ABOUT 50% GRAVEL TO 2"+, GENERALLY LESS THAN 5% SILT, DAMP, MEDIUM DENSE	44.0
45		4		42	SP	NFS, BROWN POORLY GRADED GRAVELLY SAND WITH ABOUT 80% SAND AND LESS THAN 5% SILT, DAMP, MEDIUM DENSE	45.5
50		2		78	GP	NFS, BROWN SANDY GRAVEL WITH ABOUT 40% SAND AND LESS THAN 5% SILT, GRAVEL TO 2", DAMP, VERY DENSE	
55		4		142			
60		3		50/3"			60.8
65							
70							

TEST BORING COMPLETED 6/13/85
NO GROUNDWATER OBSERVED WHILE DRILLING
PVC STANDPIPE INSTALLED
NO GROUNDWATER OBSERVED ON 6/24/85

KEY
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DOWL ENGINEERS
LOG OF BORING
LOGGED BY T BARBER
W.O. D51921
FIGURE 4

School 4
TB-2
Page 1

TEST BORING 2

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH
3		7	T=42		
5		6	T=50	26	
10		4	T=51	31	
15		8	T=56	28	
20		4	T=51	33	
25		3	T=62	45	
30		4	T=55	26	
35		3	T=49	50/3"	

Symbol	Description	DEPTH
PT	SURFACE ORGANICS	0.3
ML	F4, REDDISH BROWN SANDY SILT, NONPLASTIC, WET, FIRM	1.5
SP	NFS, BROWN GRAVELLY SAND WITH ABOUT 25% GRAVEL TO 1.3" AND GENERALLY LESS THAN 5% SILT, SOME THIN LAYERS OF SILTY SAND UP TO 1", DAMP, MEDIUM DENSE	7.0
GP	NFS, BROWN SANDY GRAVEL WITH ABOUT 35% SAND AND GENERALLY LESS THAN 5% SILT, SUBROUNDED GRAVEL TO 3", DAMP, MEDIUM DENSE. 1/8-1/4" REDDISH BROWN PEAT LENSE, WET (at about 15 ft)	35.0

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DOWL ENGINEERS
LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 5

School 4
TB-2
Page 2

TEST BORING 2 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH		DEPTH
35						NFS. BROWN SANDY GRAVEL WITH ABOUT 35% SAND AND GENERALLY LESS THAN 5% SILT. SUBROUNDED GRAVEL TO 3". DAMP. MEDIUM DENSE (GP)	
40		9	T=49	32			
							43.0
45		4	T=56	82		NFS. BROWN GRAVELLY SAND WITH ABOUT 35% GRAVEL TO 3". OCCASIONAL COBBLES TO 8". GENERALLY LESS THAN 5% SILT. DAMP. VERY DENSE (SP)	
50		3	T=51	62/6"			
55		6	T=53	73/9"			
							57.0
60		4	T=50	52		NFS. BROWN SANDY GRAVEL WITH ABOUT 45% SAND AND GENERALLY LESS THAN 5% SILT. SUBROUNDED GRAVEL TO 1.5". DAMP. VERY DENSE (GP)	
							60.5
65							
70							

TEST BORING COMPLETED 6/13/85
NO GROUNDWATER OBSERVED WHILE DRILLING
PVC STANDPIPE INSTALLED
NO GROUNDWATER OBSERVED ON 6/24/85

KEY
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☒ = 2.5" I.D. SPOON SAMPLE
340# WEIGHT, 30" FALL
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DOWL ENGINEERS
LOG OF BORING
LOGGED BY T BARBER
W.O. D51921

FIGURE 6

School 5
TB-3
Page 1

TEST BORING 3

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

Symbol	Description	Depth
PT	SURFACE ORGANICS	0.3
ML	F4, BROWN SANDY SILT, NONPLASTIC, TRACE OF ORGANICS, WET, FIRM	1.0
SP	NFS, BROWN GRAVELLY SAND, POORLY GRADED, ABOUT 25% GRAVEL TO 1.5". GENERALLY LESS THAN 5% SILT, DAMP, MEDIUM DENSE	7.0
GP	NFS, BROWN SANDY GRAVEL, POORLY GRADED, SUBROUNDED GRAVEL TO 2", DAMP, MEDIUM DENSE TO DENSE. OCCASIONAL COBBLES DETECTED BY DRILL ACTION	35.0

DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH
	5	T=44		
	8	T=48	22	
	3	T=43	28	
	3		37	
	3	T=45	34	
	3		35	
	4	T=43	28	
	2	T=48	39	

DEPTH (FEET): 0, 5, 10, 15, 20, 25, 30, 35

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☐ = GRAB SAMPLE
◩ = SPT SAMPLE
[S] = SHELBY TUBE-PUSHED
☒ = 2.5" I.D. SPOON SAMPLE
340# WEIGHT, 30" FALL
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DOWL ENGINEERS
LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 7

TEST BORING 3 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH	DESCRIPTION	DEPTH
35						NFS, BROWN SANDY GRAVEL, POORLY GRADED, SUBROUNDED GRAVEL TO 2", DAMP, MEDIUM DENSE TO DENSE. OCCASIONAL COBBLES DETECTED BY DRILL ACTION (GP)	
40		3	T=44	36			
							43.0
45		4		54		NFS, BROWN GRAVELLY SAND, POORLY GRADED, ABOUT 25% GRAVEL TO 1.3", GENERALLY LESS THAN 5% SILT, DAMP, VERY DENSE (SP)	
							46.0
						NFS, BROWN SANDY GRAVEL WITH SUBROUNDED GRAVEL TO 2" AND ABOUT 40% SAND, GENERALLY LESS THAN 5% SILT DAMP, MEDIUM DENSE TO VERY DENSE (GP)	
50		4	T=47	100/7"		ABOUT 3/4" STRATUM OF VOLCANIC ASH	
55		3	T=57	52			
60		2	T=50	19			60.5
65							
70							

TEST BORING COMPLETED 6/14/85
NO GROUNDWATER OBSERVED WHILE DRILLING
PVC STANDPIPE INSTALLED
NO GROUNDWATER OBSERVED ON 6/24/85

KEY
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340# WEIGHT, 30" FALL
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DOWL ENGINEERS
LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 8

School 6
TB-4
Page 1

TEST BORING 4

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

Depth (feet)	Symbol	Description
0 – 0.4	PT	SURFACE ORGANICS
0.4 – 1.3	ML	F4, BROWN SANDY SILT, WET, FIRM
1.3 – 12.0	SP	NFS, BROWN GRAVELLY SAND WITH ABOUT 20% GRAVEL TO 1.2" AND GENERALLY LESS THAN 5% SILT, DAMP, MEDIUM DENSE 3" OF SANDY SILT, NONPLASTIC 4" OF F4 BROWN SANDY SILT
12.0 – 31.0	GP	NFS, BROWN SANDY GRAVEL TO 1.2", ABOUT 40% SAND AND GENERALLY LESS THAN 5% SILT, DAMP, DENSE 3" OF F2 BROWN SILTY SAND
31.0 – 35.0	SP SM	NFS, BROWN GRAVELLY SAND WITH GRAVEL TO 1", DAMP, DENSE

Approx. Depth (feet)	Dry Density (PCF)	Moisture Content (%)	Other Tests	N (Blows/Ft)	Sample Type
3		6	T=40		Grab
5		10	T=48	20	SPT
10		11	T=43	10	2.5" I.D. Spoon
15		4		34	SPT
20		2	T=46	20	2.5" I.D. Spoon
25		2	T=57	34	SPT
30		4	T=47	32	2.5" I.D. Spoon
35		4	T=53	32	SPT

Frost Depth: (none shown)

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⧄ = SPT SAMPLE
[S] = SHELBY TUBE-PUSHED
⊠ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL
T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS
LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 9

School 6
TB-4
Page 2

TEST BORING 4 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH	DESCRIPTION	DEPTH
35					SP SM	NFS, BROWN GRAVELLY SAND WITH GRAVEL TO 1", DAMP, DENSE	37.0
40		3	T=47	26		NFS, BROWN SANDY GRAVEL, POORLY GRADED, ABOUT 35% SAND AND GENERALLY LESS THAN 5% SILT, SUBROUNDED GRAVEL TO 2", DAMP, DENSE TO VERY DENSE	
45		4	T=52	84			
50		2	T=54	47	GP		
55		2	T=53	69			
60		4		50/6"			59.5
65							
70							

TEST BORING COMPLETED 6/14/85
NO GROUNDWATER OBSERVED WHILE DRILLING
PVC STANDPIPE INSTALLED
NO GROUNDWATER OBSERVED ON 6/24/85

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340# WEIGHT, 30" FALL
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DOWL ENGINEERS
LOG OF BORING
LOGGED BY T BARBER
W.O. D51921

FIGURE 10

School 7
TB-5
Page 1

TEST BORING 5

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH
2.5		6	T=43		
4.5		4	T=52	32	
10		3	T=46	18	
15		4		27	
20		3	T=49	14	
25		4	T=52	38	
30		4	T=48	32	
35		3		32	

Symbol	Description	DEPTH
PT	SURFACE ORGANICS	0.5
ML	F4, BROWN SANDY SILT, TRACE OF ORGANICS, WET, FIRM	1.5
SM	F2, BROWN SILTY SAND, ABOUT 20% SUBROUNDED GRAVEL TO 1/2" AND ABOUT 15% SILT, DAMP, DENSE	3.5
SP	NFS, BROWN GRAVELLY SAND WITH ABOUT 30% SUBROUNDED GRAVEL TO 1" AND GENERALLY LESS THAN 5% SILT, DAMP, DENSE	8.0
GP GM	NFS, BROWN SANDY GRAVEL WITH ABOUT 30% SAND AND 5-10% SILT, SUBROUNDED GRAVEL TO 2"+, DAMP TO WET, MEDIUM DENSE TO DENSE	31.0
GP	NFS, BROWN SANDY GRAVEL WITH ABOUT 45% SUBROUNDED GRAVEL TO 2"+ AND OCCASIONAL COBBLES, GENERALLY LESS THAN 5% SILT, DAMP, DENSE	35.0

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☒ = 2.5" I.D. SPOON SAMPLE
340# WEIGHT, 30" FALL
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DOWL ENGINEERS

LOG OF BORING

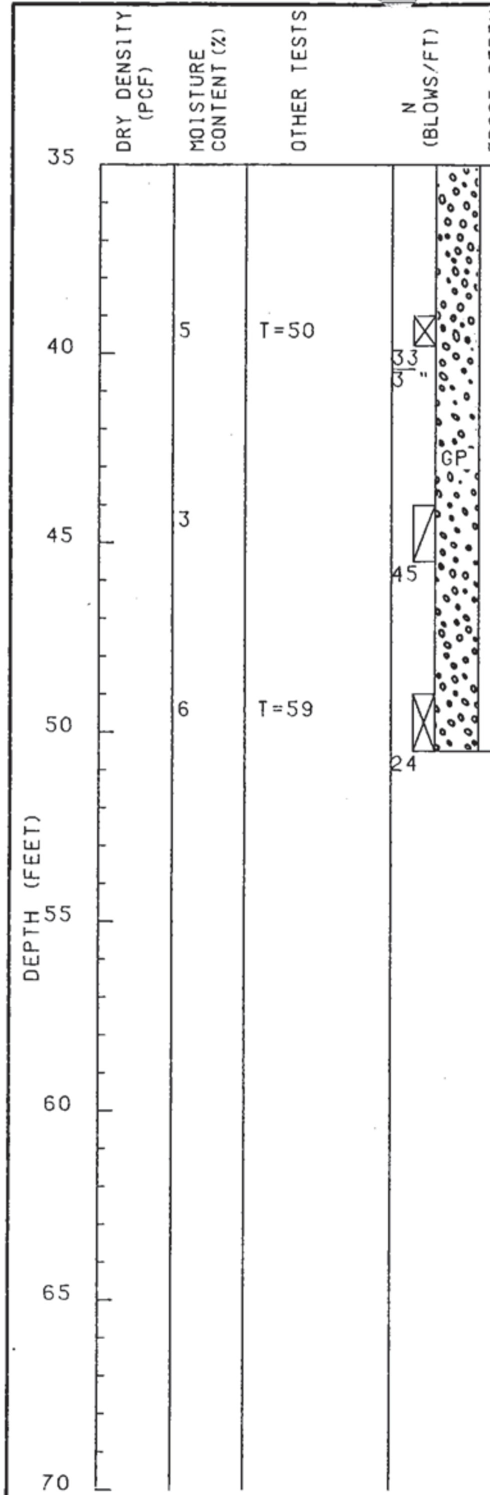
LOGGED BY T BARBER
W.O. D51921

FIGURE 11

School 7
TB-5
Page 2

TEST BORING 5 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=



DEPTH

NFS, BROWN SANDY GRAVEL WITH ABOUT 45% SUBROUNDED GRAVEL TO 2"+ AND OCCASIONAL COBBLES, GENERALLY LESS THAN 5% SILT, DAMP, DENSE

50.5

TEST BORING COMPLETED 6/14/85
NO GROUNDWATER OBSERVED WHILE DRILLING
PVC STANDPIPE INSTALLED
NO GROUNDWATER OBSERVED ON 6/24/85

KEY

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340# WEIGHT, 30" FALL
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DOWL ENGINEERS

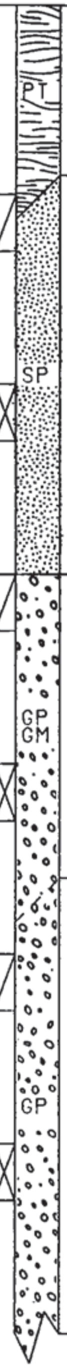
LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 12

TEST BORING 6

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=



DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH	DESCRIPTION	DEPTH
0						BROWN PEAT, WET, SOFT	
5		4		23		NFS, BROWN POORLY GRADED GRAVELLY SAND, ABOUT 35% SUBROUNDED GRAVEL TO 1.5", GENERALLY LESS THAN 5% SILT, DAMP, MEDIUM DENSE	4.5
10		4	T=49	12		1/2" BROWN TO PINK VOLCANIC ASH OR PEAT, PLASTIC	
15		4	T=50	25		NFS, BROWN POORLY GRADED SANDY GRAVEL TO 1.5", WITH ABOUT 5-10% SILT AND 35% SAND, WET, MEDIUM DENSE	15.0
20		5	T=46	26			
25		3		27		NFS, BROWN POORLY GRADED SANDY GRAVEL, SUBROUNDED GRAVEL TO 2", ABOUT 40% SAND AND GENERALLY LESS THAN 5% SILT, DAMP, MEDIUM DENSE	23.0
30		4	T=42	24		8" GREY FINE POORLY GRADED SAND, WET, LOOSE	
35							35.0

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☐ = GRAB SAMPLE
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[S] = SHELBY TUBE-PUSHED
☒ = 2.5" I.D. SPOON SAMPLE
340# WEIGHT, 30" FALL
T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS
LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 13

School 8
TB-6
Page 2

TEST BORING 6 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH		DEPTH
35		5		52	GP	NFS, BROWN POORLY GRADED SANDY GRAVEL, SUBROUNDED GRAVEL TO 2", ABOUT 40% SAND AND GENERALLY LESS THAN 5% SILT, DAMP, MEDIUM DENSE	38.0
40		9	T=45 MA FIG.70 FC	45	SP	NFS, GREY POORLY GRADED SAND WITH SOME GRAVELLY ZONES, GENERALLY ABOUT 10% GRAVEL TO 1" AND LESS THAN 5% SILT, DAMP, MEDIUM DENSE; 1/4" GREY TO BROWN PLASTIC SILT, WET, STIFF	
45		6	T=50	63			48.0
					GP	SANDY GRAVEL WITH OCCASIONAL COBBLES, DENSE	50.0

TEST BORING COMPLETED 6/17/85
NO GROUNDWATER OBSERVED WHILE DRILLING
PVC STANDPIPE INSTALLED
NO GROUNDWATER OBSERVED ON 6/24/85

DEPTH (FEET): 35, 40, 45, 50, 55, 60, 65, 70

KEY
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PI = PLASTIC INDEX
PP = POCKET PENETROMETER (TSF)
TV = TORVANE (TSF)
☐ = GRAB SAMPLE
◪ = SPT SAMPLE
[S] = SHELBY TUBE-PUSHED
☒ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL
T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS
LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 14

School 9
TB-7
Page 1

TEST BORING 7

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

Sample depth (ft)	Dry density (PCF)	Moisture content (%)	Other tests	N (blows/ft)	Symbol	Description	Depth
					PT	SURFACE ORGANICS	0.5
					ML	F4, LIGHT BROWN SANDY SILT	2.0
~2.5		8	T=37		SP	NFS, BROWN POORLY GRADED GRAVELLY SAND WITH ABOUT 20% SUBROUNDED GRAVEL TO 1", DAMP, MEDIUM DENSE	8.0
~5		7	T=52	28			
~10		6	T=44	18	GP	NFS, BROWN SANDY GRAVEL, POORLY GRADED, SUBROUNDED GRAVEL TO 3" WITH OCCASIONAL COBBLES, ABOUT 45% SAND AND GENERALLY LESS THAN 5% SILT, WET, MEDIUM DENSE	12.0
~15		5	T=46	29		NFS, BROWN SANDY GRAVEL WITH SUBROUNDED GRAVEL TO 3" AND OCCASIONAL COBBLES, GENERALLY ABOUT 30% SAND AND ABOUT 5% SILT, WET, DENSE	27.0
~20		2	T=49	49	GP GM		
~25				46			
~30		4	T=49	22	GP	NFS, BROWN SANDY GRAVEL, POORLY GRADED SUBROUNDED GRAVEL TO 2" WITH ABOUT 35% SAND AND GENERALLY LESS THAN 5% SILT, WET, DENSE	33.0
~35		4	T=51	79/7"			35.0

DEPTH (FEET): 0, 5, 10, 15, 20, 25, 30, 35

KEY
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☐ = GRAB SAMPLE
◪ = SPT SAMPLE
[S] = SHELBY TUBE-PUSHED
☒ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL
T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS
LOG OF BORING

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W.O. D51921

FIGURE 15

School 9
TB-7
Page 2

TEST BORING 7 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH		DEPTH
35					SP	NFS, BROWN POORLY GRADED GRAVELLY SAND WITH ABOUT 35% SUBROUNDED GRAVEL TO 2". OCCASIONAL COBBLES AND GENERALLY LESS THAN 5% SILT. DAMP, DENSE TO VERY DENSE	
40		3	T=45 MA FIG.71	27			
45		4	T=59	55			
50		8	T=50 MA FIG.72	52			50.5
						TEST BORING COMPLETED 6/18/85 NO GROUNDWATER OBSERVED WHILE DRILLING PVC STANDPIPE INSTALLED NO GROUNDWATER OBSERVED ON 6/24/85	
55							
60							
65							
70							

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◪ = SPT SAMPLE
[S] = SHELBY TUBE-PUSHED
☒ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL
T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS
LOG OF BORING

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FIGURE 16

School 10
TB-8
Page 1

TEST BORING 8

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH	SOIL	DESCRIPTION	DEPTH
0						PT	BROWN PEAT, WET, SOFT	3.0
						ML	F4, LIGHT BROWN SANDY SILT, NONPLASTIC, DAMP, FIRM	4.0
5		11	T=52	6		SP SM	NFS, REDDISH BROWN POORLY GRADED SAND WITH ABOUT 20% GRAVEL TO 1/2" AND ABOUT 10% SILT, DAMP, LOOSE	6.5
10		5	T=47 MA FIG.73	12		GW	NFS, BROWN SANDY GRAVEL TO 2", SUBROUNDED, WITH ABOUT 35% SAND AND ABOUT 2% SILT, WET, MEDIUM DENSE	12.0
15		3	T=49	15		GP	NFS, BROWN SANDY GRAVEL TO 2", SUBROUNDED, WITH ABOUT 40% SAND AND GENERALLY LESS THAN 5% SILT, WET, MEDIUM DENSE TO DENSE	
20		4	T=51	13				
25		2	T=52	23				
30		3	T=49 MA FIG.74	39				
35		4		64				35.0

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TV = TORVANE (TSF)
☐ = GRAB SAMPLE
◪ = SPT SAMPLE
S = SHELBY TUBE-PUSHED
☒ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL
T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS
LOG OF BORING

LOGGED BY T BARBER
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FIGURE 17

School 10
TB-8
Page 2

TEST BORING 8 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH	DESCRIPTION	DEPTH
35							37.0
40		4	T=51	26		SP — NFS, BROWN POORLY GRADED GRAVELLY SAND WITH ABOUT 35% GRAVEL TO 2" AND GENERALLY LESS THAN 5% SILT, FINE SAND, DAMP, DENSE	45.0
45		7	T=55	45		GP — NFS, BROWN SANDY GRAVEL TO 3" WITH OCCASIONAL COBBLES, DAMP, DENSE	49.1
50				50/1"		TEST BORING COMPLETED 6/18/85 NO GROUNDWATER OBSERVED WHILE DRILLING PVC STANDPIPE INSTALLED NO GROUNDWATER OBSERVED ON 6/24/85	
55							
60							
65							
70							

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⊠ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL
T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS
LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 18

TEST BORING 9

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH
0					
		10	T=35		
5		6	T=50	28	
10		7	T=45	36	
15		6	T=48	39	
20		4		42/6"	
25		3	T=59	38	
30		3		42	
35				50/3"	

Symbol	Description	Depth
PT	SURFACE ORGANICS	0.7
ML	F4, LIGHT BROWN SANDY SILT, NONPLASTIC, WET, FIRM	2.0
SP SM	NFS/F2, BROWN GRAVELLY SAND WITH ABOUT 25% GRAVEL TO 1.5" AND ABOUT 10% SILT, DAMP, MEDIUM DENSE	3.5
SP	NFS, BROWN POORLY GRADED GRAVELLY SAND, ABOUT 20% SUBROUNDED GRAVEL TO 1.5" AND GENERALLY LESS THAN 5% SILT, DAMP, MEDIUM DENSE	11.0
GP GM	NFS/F1, BROWN SANDY GRAVEL, POORLY GRADED, SUB-ROUNDED GRAVEL TO 2"+, ABOUT 35% SAND AND GENERALLY ABOUT 10% SILT, DAMP, DENSE	17.0
GM	F1, BROWN SILTY GRAVEL WITH ABOUT 30% SAND AND 15% SILT, SUBROUNDED GRAVEL TO 3", WET, DENSE	21.5
SP SM	NFS, BROWN GRAVELLY SAND WITH ABOUT 40% SUBROUNDED GRAVEL TO 2" AND ABOUT 5% SILT, DAMP, DENSE	26.0
GP GM	NFS, BROWN SANDY GRAVEL WITH ABOUT 45% SAND AND ABOUT 5% SILT, SUBROUNDED GRAVEL TO 2"+, DAMP, DENSE	32.0
		35.0

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☐ = GRAB SAMPLE
◪ = SPT SAMPLE
[S] = SHELBY TUBE-PUSHED
☒ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL
T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS

LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 19

School 11
TB-9
Page 2

TEST BORING 9 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH	SYMBOL	DESCRIPTION	DEPTH
35						GP	NFS, BROWN SANDY GRAVEL, POORLY GRADED, SUBROUNDED GRAVEL TO 2"+, ABOUT 45% SAND AND GENERALLY LESS THAN 5% SILT, ACCASIONAL COBBLES, DAMP, DENSE	36.0
		3	T=53	29		SP	NFS, BROWN GRAVELLY SAND WITH ABOUT 35% SUBROUNDED GRAVEL TO 2" AND GENERALLY LESS THAN 5% SILT, DAMP, DENSE	40.5
40							TEST BORING COMPLETED 6/17/85 NO GROUNDWATER OBSERVED WHILE DRILLING PVC STANDPIPE INSTALLED NO GROUNDWATER OBSERVED ON 6/24/85	
45								
50								
55								
60								
65								
70								

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T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS

LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 20

School 12
TB-10
Page 1

TEST BORING 10

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH	DESCRIPTION	DEPTH
0–6.5					PT	FILL, BROWN PEAT, WET, SOFT PIECES OF WOOD	6.5
6.5–21.5		11	T=49	41	SP SM	NFS, BROWN POORLY GRADED GRAVELLY SAND WITH ABOUT 30% GRAVEL TO 1.7" AND 5-10% SILT, DAMP, DENSE	
		8	T=45	14			
		13	T=51	46			21.5
21.5–31.5		7	T=48	45	GP GM	NFS, BROWN SANDY GRAVEL WITH ABOUT 40% SAND AND 5% SILT, SUBROUNDED GRAVEL TO 3" AND OCCASIONAL COBBLES, WET, DENSE	
		3	T=54	83			31.5
31.5–35.0		4	T=48	33	SP	NFS, BROWN POORLY GRADED GRAVELLY SAND WITH ABOUT 35% SUBROUNDED GRAVEL TO 1" AND GENERALLY LESS THAN 5% SILT, WET, DENSE	35.0

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DOWL ENGINEERS
LOG OF BORING

LOGGED BY T BARBER
W.O. D51921

FIGURE 21

School 12
TB-10
Page 2

TEST BORING 10 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH		DEPTH
35–40		6		41		SP — NFS, BROWN POORLY GRADED GRAVELLY SAND WITH ABOUT 35% SUBROUNDED GRAVEL TO 1" AND GENERALLY LESS THAN 5% SILT, WET, DENSE	40.0

TEST BORING COMPLETED 6/17/85
NO GROUNDWATER OBSERVED WHILE DRILLING
PVC STANDPIPE INSTALLED
NO GROUNDWATER OBSERVED ON 6/24/85

Depth scale: 35, 40, 45, 50, 55, 60, 65, 70

KEY
MA = MECHANICAL ANALYSIS
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PI = PLASTIC INDEX
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TV = TORVANE (TSF)
☐ = GRAB SAMPLE
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☒ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL
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DOWL ENGINEERS
LOG OF BORING
LOGGED BY T BARBER
W.O. D51921
FIGURE 22

School 13
TB-11
Page 1

TEST BORING 11

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH
3		8	T=37		
6		5	T=45	45	
11		4	T=50 MA FIG.75	18	
16		4	T=45	45	
21		5	T=43	19	
26		1	T=46	52	
31		7	T=45	56	

DEPTH	DESCRIPTION	SYMBOL
0.4	BROWN PEAT, WET, SOFT	PT
1.7	F4, LIGHT BROWN SANDY SILT, NONPLASTIC, WET, FIRM	ML
14.5	NFS, BROWN POORLY GRADED GRAVELLY SAND WITH ABOUT 30% SUBROUNDED GRAVEL TO 1.5" AND GENERALLY LESS THAN 5% SILT, DAMP, DENSE	SP
32.0 / 35.0	NFS, BROWN SANDY GRAVEL WITH ABOUT 35% SAND AND ABOUT 5% SILT, SUBROUNDED GRAVEL TO 2" AND OCCASIONAL COBBLES, DAMP, DENSE	GP GM

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⧄ = SPT SAMPLE
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DOWL ENGINEERS
LOG OF BORING
LOGGED BY T BARBER
W.O. D51921

FIGURE 23

School 13
TB-11
Page 2

TEST BORING 11 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH	DESCRIPTION	DEPTH
35		2		50/1"	GP	NFS, BROWN SANDY GRAVEL WITH ABOUT 40% SAND AND LESS THAN 5% SILT, SUBROUNDED GRAVEL TO 1.5", WET, VERY DENSE	37.0
40		3		20	GP GM	NFS, BROWN SANDY GRAVEL WITH ABOUT 35% SAND AND 5% SILT, SUBROUNDED GRAVEL TO 2" AND OCCASIONAL COBBLES, WET, DENSE	41.5

TEST BORING COMPLETED 6/19/85
NO GROUNDWATER OBSERVED WHILE DRILLING
PVC STANDPIPE INSTALLED
NO GROUNDWATER OBSERVED ON 6/24/85

Depth scale: 35, 40, 45, 50, 55, 60, 65, 70

KEY
MA = MECHANICAL ANALYSIS
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☐ = GRAB SAMPLE
⧄ = SPT SAMPLE
[S] = SHELBY TUBE-PUSHED
☒ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL
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DOWL ENGINEERS
LOG OF BORING

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FIGURE 24

School 14
TB-12
Page 1

TEST BORING 12

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH
	10	T=39		
	6	T=47	35	
	3	T=46	64	
	4	T=50	29	
	4	T=52 MA FIG.76 FC	21	
	9	T=46	25	
	4	T=52	67	

Description	DEPTH
BROWN PEAT, WET, SOFT	0.3
F4, BROWN SANDY SILT WITH FINE SAND, WET, STIFF	2.0
NFS, BROWN POORLY GRADED GRAVELLY SAND, WITH ABOUT 25% SUBROUNDED GRAVEL TO 1" AND 5% SILT, DAMP, MEDIUM DENSE	7.5
NFS, BROWN GRAVELLY SAND WITH ABOUT 45% GRAVEL TO 2" AND GENERALLY LESS THAN 5% SILT, OCCASIONAL COBBLES, DAMP, DENSE	12.0
NFS, BROWN POORLY GRADED SANDY GRAVEL WITH ABOUT 40% SAND AND GENERALLY LESS THAN 5% SILT. OCCASIONAL COBBLES, DAMP, DENSE	18.0
NFS, BROWN WELL GRADED SANDY GRAVEL WITH ABOUT 30% SAND AND GENERALLY LESS THAN 5% SILT, SUB-ROUNDED GRAVEL TO 2"+, WET, MEDIUM DENSE	23.0
NFS, BROWN POORLY GRADED SAND WITH UP TO 20% GRAVEL TO 2" AND GENERALLY LESS THAN 5% SILT, DAMP, MEDIUM DENSE. LARGE COBBLE OR BOULDER BY DRILL ACTION	33.0
	35.0

DEPTH (FEET): 0, 5, 10, 15, 20, 25, 30, 35

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☐ = GRAB SAMPLE
◪ = SPT SAMPLE
[S] = SHELBY TUBE-PUSHED
☒ = 2.5" I.D. SPOON SAMPLE 340# WEIGHT, 30" FALL
T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS
LOG OF BORING

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FIGURE 25

School 14
TB-12
Page 2

TEST BORING 12 (CONT'D)

LOCATION=SEE TEST BORING LOCATION MAP
ELEVATION=

DEPTH (FEET)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	OTHER TESTS	N (BLOWS/FT)	FROST DEPTH		DEPTH
35		3		37		GP — NFS, BROWN POORLY GRADED SANDY GRAVEL WITH ABOUT 40% SAND AND GENERALLY LESS THAN 5% SILT, GRAVEL TO 2"+, WET, DENSE	
40		3	T=51	30			41.5

TEST BORING COMPLETED 6/18/85
NO GROUNDWATER OBSERVED WHILE DRILLING
PVC STANDPIPE INSTALLED
NO GROUNDWATER OBSERVED ON 6/24/85

Depth scale: 35, 40, 45, 50, 55, 60, 65, 70

KEY
MA = MECHANICAL ANALYSIS
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☐ = GRAB SAMPLE
◪ = SPT SAMPLE
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☒ = 2.5" I.D. SPOON SAMPLE
340# WEIGHT, 30" FALL
T = SAMPLE TEMPERATURE (°F) PROBABLY AFFECTED BY SAMPLING PROCEDURE

DOWL ENGINEERS
LOG OF BORING

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FIGURE 26

Village 1
WELTS 27711

01/30/92 17:25 002 27711

696-0078

SB-7-12-11-ABBB1-4

what was originally ... is now well L. Snyder 2-7-78

FORM NO 9-1904-A

LSel. 138'

SITE NO. AK-10134

U.S. DEPT. OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
GROUND WATER SITE INVENTORY
SITE SCHEDULE

Recorded by Feathy/Still

Date Dec. 21, 1976

Check One: ✓ English — Metric Units

GENERAL SITE DATA (8)

Site Ident No: 604259151200401
Site Type: W
Data Reliability: U
Reporting Agency: USGS
District: 02
State: 02
County (or town): 122
Latitude: 604308
Longitude: 1512008
Lat-Long Accuracy: T
Local Number: SB00701211ABBB1 004
Land Net Loc.: NWNWNE 11 T007N R012W S
Location Map: KENAI C-1 NORTH KENAI 5 KAM
Scale: 63360
Altitude: 130
Method of Measurement: M
Accuracy: 5
Topo Setting: U
Hydrologic Unit (OWDC): 19050002
Date of First Construction/Completion: 08/00/1967
Use of Site: W
Use of Water: P
Depth of Hole: 136
Depth of Well: 136
Source of Depth Data: D
Water Level: 68.61
Date Measured: 07/14/1977
Source: R
Method of Measurement: R
Site Status: —
Measuring Point: 1.8
Measuring Point Date: 07/14/1977

273= Y

REMARK	DATE	INITIALS
OK	3-77	gdf
N	5-77	
N	5-77	
Y	5-77	
	2-78	LJE

AKRG / HEADER / WATER LEVEL / KEY PUNCH / PRINT OUT CKD

OWNER IDENTIFICATION (1)

Date of Ownership: 08/00/1967
Name: Last: WILKISKI VL; First: TRLR CRT

OTHER SITE IDENTIFICATION NUMBERS (1)

Ident: 004 — Assignor: AKMP
Ident: 10134 — Assignor: AKRG

SITE VISIT DATA (1)

Date of Visit: 09/07/1967
Name of Person: STILL P.

R=186* T=A # 186#2-07-14-1977* 188=COHEN,P

FIELD WATER QUALITY MEASUREMENTS (1)

Temperature: 0,0,0,1,0
Conductance: 0,0,0,0,5

KPB
LSel. 138'

Roy Gloss, RA, Bonnie

FOOT NOTES:
① Source of Data Codes: reporting, driller, owner, other gov't., other agency, ... reported, logs, geologist, other

70 hold 7/23/91
4.55 cut

65.45 BMP
-1.8 mp
63.65 water level below LSD

SB-7-12-11-ABBB1-4

01/30/92 17:27

LSel. 164'

005 27712

SB 7-12-11 ABDB 1-17

Village 2
WELTS 27712

WELL CONSTRUCTION LOG

Drilling Co. Frontier Prospecting Drilling USGS no. ______

Driller Scotty Type of rig rotary Date well completed 7/11/77

Well owner Geo Bakke & Otto Dahl Nearest community ______

Well location; (address & legal description) 11th Kenai Lakes — Location sketch or remarks

Nikiski Lake Ct

Depth of well 137 ft. Casing: length 120 ft. diam. 6 in.

Static water level 94 ft. (above, below) land surface. Date ______

Finish of well: (open-end, screen, perforated, open-hole, other) ______

Describe intervals and size: ______

Well yield tested by (pumping, bailing, air) at 60 gal/min.

for ______ hours with ______ ft. of drawdown from static level.

DRILLER'S MATERIAL LOG

Depth below land surface in feet	Give description of strata penetrated (size of material, color, hardness of drilling, and water content)
0 to 1	Top soil & clay
1 to 76	sand & gravel
76 to 84	rocky clay
84 to 108	clay
108 to 120	rocky clay
120 to 137	water sand & gravel
to	
to	
to	
to	
to	
to	
to	
to	
to	
to	
to	
to	
to	
to	
to	
to	

SB 7-12-11 ABDB 1-17

Village X
No WELTS

Well no: SB 007 012 11 BADA2; map no. 4
Owner: Nikiski Village Trailer Court
Driller: Thorn Drilling

Sand and gravel	75	75
Silt, sandy, water-bearing	11	86
Clay, blue	23	99
Silt, blue, water-bearing	11	110
Clay, sand, and gravel	7	117
Pea gravel, water-bearing	2	119
Silt, clay, and sand	6	125
Silt, sand, water-bearing	2	127
Sand, coarse, and pea gravel	3	130
Gravel, cemented, dry	1	131
Gravel and sand, water-bearing	2	133
Gravel, cemented, some water	5	138
Pea gravel, loose, water-bearing	1	139
Gravel and sand	4	143

No. 20 slot screen 128 to 133 ft.
No. 30 slot screen 133 to 138 ft.

No.	Name	Hazard ID	File Number	Status	Institutional or Other Controls	Longitude	Latitude	Address	Description/Summary
1	Petro Marine Serivces - Arness Dock	664	2323.38.023	Cleanup Complete	Advance approval required to transport soil or groundwater off-site.	-151.307778	60.742222	52500 Nikishka Beach Road	Open valve allowed 4,130 gallons of diesel to escape diked area. 3,845 gallons were recovered by vacuum truck. Site closure approved in July 2005.
2	Nikiski Airstrip	669	2323.38.001	Cleanup Complete - Institutional Controls	Deed Notice; groundwater Monitoring	-151.313599	60.736805	Near Arness Dock Road	Oily wastes, Bunker C fuel, drums containing unknown waste, and garbage disposed of in pits adjacent to abandoned airstrip near Nikiski. Preliminary investigation revealed two likely disposal pits on west side of airstrip. Initial cleanup was completed in 1981 and 1985, though there is no clear documentation cleanup was adquate. Multiple monitoring wells have been installed at the site and continue to undergo periodic testing.
3	Arness Septage	176	2323.38.004	Active	None	-151.314658	60.733005	Mile 26.1 North Kenai Spur Highway, 3/8mi NW	Dave Brown of MAR Enterprises is believed to have dupmed 56 drums of Drag Reducing Agent and unknown quantity of other (oily) wastes on the property. Additional drums have been removed from site. Contamintated soils were landspread over approximately three acres to aid in decomposition. Two groundwater monitoring wells have been installed on site.
4	Baker Oil Tools - Delores Drive	25935	2323.38.055	Active	Advance approval required to transport soil or groundwater off-site.	-151.301163	60.732812	51950 Dolores Drive	A September 2012 area wide drinking water investigation conducted by DEC of on-site drinking water systems detected tricloroethene (TCE) in a sample collected at Baker Oil Tools exceeding DEC groundwater cleanup criteria. Additional investigations indicate an on-site piping system may have contributed to the site's contamination.
5	Tesoro Land & Marine Rental Company	1015	2323.38.31	Cleanup Complete	None	-151.312568	60.729177	51605 Kenai Spur Highway (Mile 26.5 North Kenai Spur Highway)	Lube oil, gas, and diesel compounds found above and below ground at site. Other associated contaminants found in soils. The site had been used to clean and maintian drilling equipment. Site was sold to Homco in approximately 1990. Site closure approved in April 1994.
6	Hallco Building	659	2323.38.011	Cleanup Complete	Advance approval required to transport soil or groundwater off-site.	-151.314703	60.727042	51530 Bakers Road (Mile 26.1 North Kenai Spur Highway)	Diesel contamination discovered during 9/6/1989 site visit. Contaminated soils were addressed in a DEC approved manner, primarily disposal off-site at an approved location. Site Closure approved in July 1992.
7	Silvertip Storage Yard	462	2320.38.049	Cleanup Complete	Advance approval required to transport soil or groundwater off-site.	-151.312343	60.725720	Mile 26 North Kenai Road (Near Halliburton Drive)	250+ drums of oilfield waste chemicals leaked and spilled in August 1985 affecting less then 1 acre. No groundwater contamination was identified. Site closure approved in October 1989.
8	Cook Inlet Processing - Nikiski 1	1524	2323.38.007	Cleanup Complete	Advance approval required to transport soil or groundwater off-site.	-151.307440	60.727532	51643 Fish Street (Mile 26.5 North Kenai Spur Highway)	Overfilling of a holding tank created petroleum product contaminated soils. Stockpiled soils shipped to Anchorage. Institutional controls removed in February 2014.
9	Cook Inlet Processing - Nikiski 2	3931	2323.38.008	Cleanup Complete	Advance approval required to transport soil or groundwater off-site.	-151.306700	60.726984	51590 Curry Lane (Mile 26.5 North Kenai Spur Highway)	Diesel Range Organics (DRO) discovered during site assessment. One soil stockpile approved for spreading on site and one soil stockpile shipped to Anchorage for thermal remidiation. Site Closure approved in October 2004.
10	Cook Inlet Processing Miller Est.	2072	2323.38.009	Cleanup Complete	Advance approval required to transport soil or groundwater off-site.	-151.306839	60.727750	Curry Lane (Mile 26.7 North Kenai Spur Highway)	Stained soils found on site likely to have originated from diesel, used oil, and hydraulic fluid leaking and dumping. Stained soil excavated. Site closure approved in May 1996.
11	McGahan Utilities	478	2323.38.019	Cleanup Complete - Institutional Controls	Excavation/soil movement restrictions	-151.302511	60.730758	KPB Parcel ID 01208047	Site was contaminated by former laundromat/dry cleaner located behind Cheveron station. Contamination was detected in the McGahan Public Water Systen in November 1988. A carbon treatment system was installed in the public water well and a monitoring well was completed on the neighboring fire station property. No further remedial action is planned, though long-term monitoring will continue.
12	Nikiski Fire Department #2	23471	2323.26.007	Cleanup Complete	Advance approval required to transport soil or groundwater off-site.	-151.301476	60.730972	51849 Kenai Spur Highway (Mile 26.75 Kenai Spur Highway)	While removing one 1,500 gallon underground diesel storage tank, DRO contaminated soils were encountered. Approximately 3 cubic yards of contaminated soil was excavated, stockpiled, and landspread at Nikiski Fire Station #1. Site assessment indicates remaining contamination is below cleanup guidelines. Site closure approved in July 1992.
13	Steve's Chevron - Nikiski, Alaska Oil Sales	23121	2323.26.010	Cleanup Complete	Advance approval required to transport soil or groundwater off-site.	-151.302268	60.730400	51835 North Kenai Spur Highway	During the removal of two 8,000 gallon and one 4,000 gallon underground storage tanks, detectable lab readings were encountered around the fill spout of a diesel tank, but they were below DEC cleanup level B. Site closure aproved in December 1991.

Information obtained from: http://www.arcgis.com/home/webmap/viewer.html?webmap=315240bfbaf84aa0b8272ad1cef3cad3

Site Status

- Active
- Cleanup Complete
- Cleanup Complete – Institutional Controls
- Study Area
- Streets

Feet
0 500 1,000

N

Nikiski Groundwater Study
DEC Contaminated Sites

Nikiski, Alaska

DOWL

February 26, 2015 | Figure 3

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Summary of Primary DEC Contaminated Sites in Study Area

Arness Disposal Site

The Arness Disposal Site was identified by the Alaska Department of Environmental Conservation (DEC) in 1985. The property located at the north end of Halliburton Drive/Bakers Road was leased to an operator who ran the site as a septage disposal site from 1979 to 1984. Bilge water, oily waste water, and septage were processed at the location. Alaska Environmental Industries (AEI) operated the site beginning in 1982 and offered service to oil exploration, production, and development companies. AEI is believed to have disposed of a variety of chemical and oil field waste products at the Arness site, including a variety of hydrocarbons and solvents. The site was shut down following the discovery by DEC and an initial cleanup effort was undertaken which included removal of containers, burning of drum contents, excavation and removal of some contaminated soils to an off-site location, and the excavation and spreading (land farming) of other contaminated soils on site. Additionally, one monitoring well was installed for groundwater testing purposes in 1988.

The site has been the subject of intermittent DEC review, testing, and directives for further clean-up efforts. A second monitoring well was installed in 2013. Since the discovery of the extensive waste dumping at the site, several investigative reports and studies have been conducted on the property, including efforts conducted by the property owner (Peggy Arness) in recent years to complete remediation of the site as desired by DEC.

Some of the reports generated about this site include:

- CERCLA[1] Preliminary Assessment Arness Property, by Tryck, Nyman and Hayes, November 1987;
- Site Assessment Arness Disposal Site, by HartCrowser, October 1988 (Revised January 1989);
- Waste Handling and Disposal Case Study, by Doreen Sullivan-Garcia, December 1990;
- Groundwater Sampling and Monitoring Well Survey, by HartCrowser, November 1992;
- Arness Disposal Site, Limited Additional Site Investigation Report of Findings, by Alaska Consulting and Environmental Engineering, October 2013;
- DEC Spill Response and Prevention: http://www.dec.alaska.gov/spar/csp/sites/arness.htm; and
- DEC Contaminated Sites Program: http://dec.alaska.gov/Applications/SPAR/PublicMVC/CSP/SiteReport/176.

Nikiski Airstrip

The old Nikiski Airstrip is an abandoned airstrip located at the northwest end of Nikishka Beach Road, immediately adjacent to the Offshore Systems Kenai (OSK) heliport. The site was used as airstrip from the 1960's through the 1980's. Two separate areas adjacent to the airstrip have been identified as having been used as an un-permitted solid waste disposal sites for many years, with wastes such as crushed rums and oily rags being prevalent. One of the pits was used to dispose of bunker C fuel (or other weathered petroleum products), believed to be the primary source of site contamination. The property is now owned by the KPB.

This contaminated site has been the subject of cleanup and monitoring efforts for more than two decades. Initial efforts focused on the removal of solid waste and the free standing petroleum products in 1985 (BGES, 2006). A portion of the oil and contaminated soil was removed from the pit and spread on site in a process known as "land-farming". (Shannon & Wilson 1990) Later efforts consisted of identifying the extent of the contamination, the installation of monitoring wells, and soils and groundwater testing for contaminants.

[1] Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA); also frequently referred to as "Superfund"

In 1986, OSK constructed a heliport facility over the northern disposal pit. Since this time, the focus on monitoring efforts has been on the southern disposal pit, located approximately 650 feet southwest of the gated access to the OSK property.

Some of the reports generated for this site include:

- Soil and Groundwater Assessment Nikiski Airstrip, by Shannon & Wilson, September 1990;
- Additional Site Characterization Nikiski Airstrip, by Shannon & Wilson, June 2004;
- Former Nikiski Airstrip Groundwater Sampling, by BGES, Inc., June 2006; and
- DEC Contaminated Sites Program: http://dec.alaska.gov/Applications/SPAR/PublicMVC/CSP/SiteReport/669.

McGahan Utilities

In September of 1988, contaminants were discovered in water produced by the McGahan Public Utility water system which served approximately 150 residences and businesses in the area at the time. The DEC initiated testing and assessment of the water system and immediate surrounding area to identify the extent of the contamination. In 1989, the DEC contracted with HartCrowser for additional investigation and analysis, including soil and water sampling, the installation of monitoring wells, and a workover of the existing well Number One (video logging and cleaning of the casing and well screen). (HartCrowser, 1989) HartCrowser concluded the source of contamination was the former laundromat and dry cleaner located at the northwest corner of Kenai Spur Highway and Nikishka Beach Road, behind Steve's Chevron.

The laundry facility was believed to have initially processed general laundry generated by oilfield activities and eventually added dry cleaning services (HartCrowser, 1989). Wastewater generated by the facility was pumped to an on-site disposal facility to the north of the building, with overflow being discharged to the drainage ditch located along the west side of Nikishka Beach Road. Eventually, wastewater overflow was directed to the bluff along the north side of the property and discharged into the wooded area and down slope.

An exploratory well was drilled in 1989 to assess whether a different water source (aquifer) could provide production water for the utility. A deeper aquifer was tapped and deemed suitable as a source for the utility, but due to high naturally occurring concentrations of iron, the utility

decided against using the deeper aquifer and instead chose to treat the existing water source in the shallower aquifer.

Site remediation and cleanup activities have not occurred to date due to the complexity and difficulty associated with in-situ actions. Monitoring of the site continues.

Some of the reports generated about this site include:

- Groundwater Quality Evaluation McGahan Water System Service Area, by HartCrowser, July 1989;
- Groundwater Investigation Nikiski Investigative Test Well, by Harding Lawson Associates, March 1990; and
- DEC Contaminated Sites Program: http://dec.alaska.gov/Applications/SPAR/PublicMVC/CSP/SiteReport/478.

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APPENDIX C

Survey Records

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NIKISKI ENVIRONMENTAL STUDY

NIKISKI, ALASKA

SURVEYING REPORT

Prepared for:

Alaska Department of Environmental Conservation
43335 Kalifornsky Beach Road Suite 11
Soldotna, Alaska 99501

Prepared by:

DOWL HKM
4041 B Street
Anchorage, Alaska 99503
(907) 562-2000

DOWL HKM Project Number 1133.61736.01

December 2014

NIKISKI ENVIRONMENTAL STUDY PROJECT

TABLE OF CONTENTS

Page

LIST OF ACRONYMS

GPS .... Global Positioning System

RTK... Real Time Kinematic GPS

NIKISKI ENVIRONMENTAL STUDY PROJECT

SURVEY SUMMARY

1.0 INTRODUCTION

This project consisted of locating monitoring wells and drinking water wells in Nikiski, Alaska.

2.0 HORIZONTAL CONTROL SUMMARY

A field survey was performed by DOWL HKM between November 15th, 2014 and November 17th, 2014 by of A. Willie Stoll, PLS. Static Global Positioning System (GPS) observations were taken on a new control point to position this project. Static GPS measurements were submitted to the NGS OPUS utility for processing, producing a NAD83 (2011) (EPOCH 2010.0000) position to locate the site features from.

Positions for all of the site features were performed using Real Time Kinematic (RTK) GPS. Relative positions for all features located have location accuracy better than 0.1-feet.

3.0 VERTICAL CONTROL SUMMARY

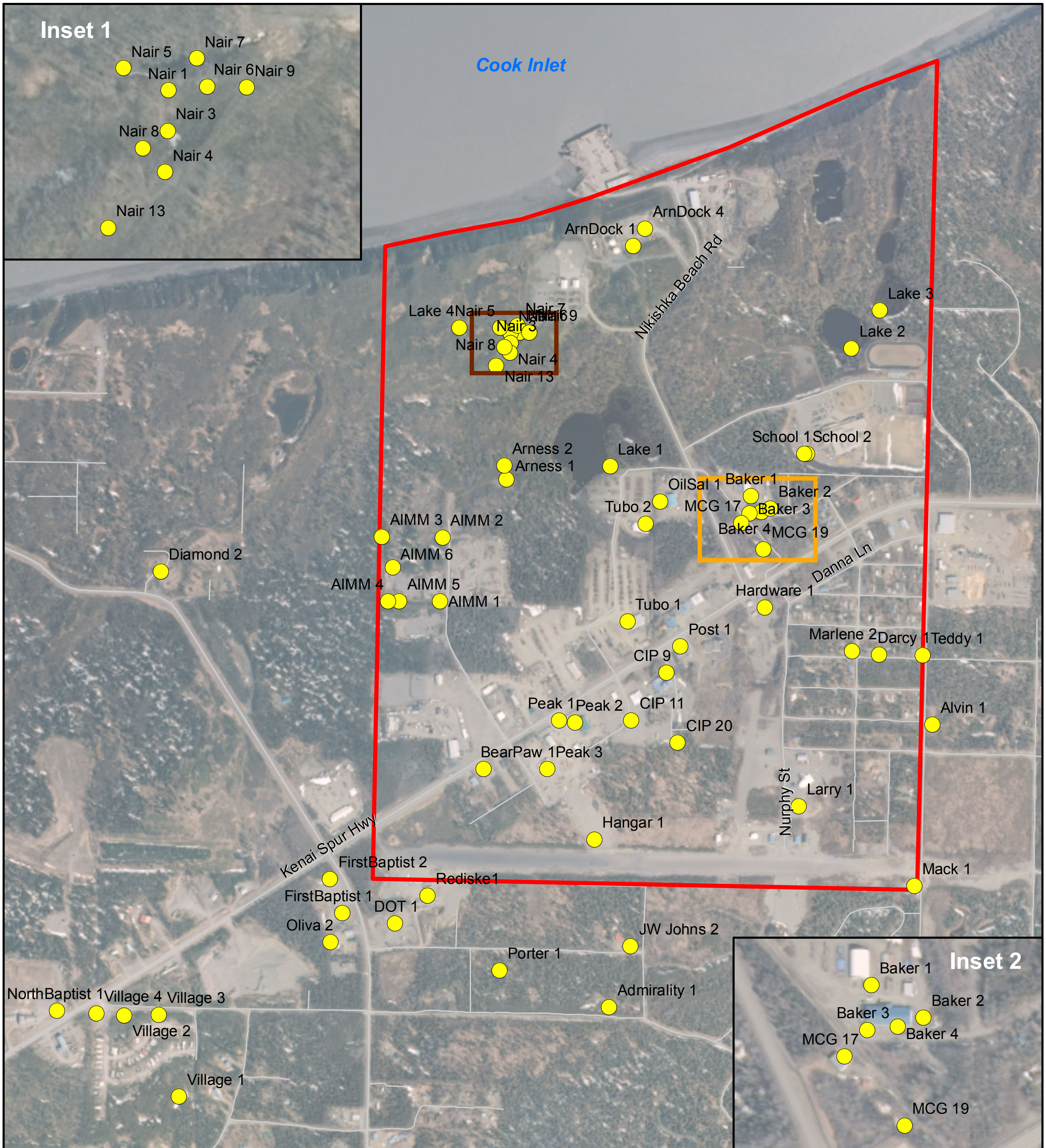
Elevations are NAVD88 as determined by Geoid 12A. Elevations were determined using RTK GPS. Relative elevations for all features located have location accuracy better than 0.1-feet.

4.0 SURVEYOR'S CERTIFICATION

I, A. William Stoll, Alaska Land Surveyor #12041, do hereby certify that the information contained herein is the result of work performed by me or by others working under our direct supervision.

Well ID	Welts ID	Northing	Easting	Ground Elevation	Casing/Riser Elevation	Depth to Water (*ft*)	Water Elevation	Date and Time of Survey
AIMM 1	N/A	2461025.95	1404521.22	147.48	149.98	56.8	93.18	11/17/2014 13:41
AIMM 2	N/A	2461634.29	1404544.20	135.31	137.94	44.8	93.14	11/17/2014 14:03
AIMM 3	N/A	2461646.31	1403957.93	168.66	171.80	79.0	92.80	11/17/2014 13:58
AIMM 4	N/A	2461027.09	1404022.24	158.86	161.44	68.6	92.84	11/17/2014 13:50
AIMM 5	N/A	2461025.49	1404124.49	158.87	161.35	60.4	100.95	11/17/2014 13:47
AIMM 6	N/A	2461347.40	1404063.88	152.60	154.76	57.8	96.96	11/17/2014 13:55
Arness 1	19818	2462328.21	1405138.43	188.29	191.44	109.2	82.24	11/17/2014 14:52
Arness 2	N/A	2462198.60	1405161.00	183.16	185.51	107.2	78.31	11/17/2014 14:49
ArnDock 4	21647	2464611.33	1406491.12	141.75	144.38	98.5	45.88	11/17/2014 11:01
ArnDock 1	19292	2464443.54	1406379.64	141.86	144.15	45.4	98.75	11/17/2014 10:50
Baker 1	N/A	2462035.06	1407515.07	132.59	132.07	35.2	96.87	11/15/2014 11:33
Baker 2	N/A	2461917.82	1407701.51	134.22	133.74	35.3	98.44	11/15/2014 11:44
Baker 3	N/A	2461873.91	1407499.57	133.42	132.89	35.6	97.29	11/15/2014 11:36
Baker 4	N/A	2461885.75	1407610.40	134.27	136.63	42.3	94.33	11/15/2014 11:08
BearPaw 1	N/A	2459410.07	1404937.88	185.51	187.31	100.5	86.81	11/17/2014 11:24
CIP 9	14100	2460335.26	1406698.37	182.01	184.67	11.4	173.27	11/16/2014 10:00
CIP 20	N/A	2459661.09	1406808.96	177.39	179.73	93.0	86.73	11/16/2014 10:27
CIP 11	23912	2459880.71	1406362.00	181.31	183.59	97.8	85.79	11/16/2014 10:36
Darcy 1	N/A	2460509.57	1408744.81	190.60	192.78	106.5	86.28	11/16/2014 12:12
Diamond 2	17552	2461314.03	1401833.39	212.62	214.44	144.6	69.84	11/15/2014 13:27
DOT 1	N/A	2457927.37	1404084.67	187.23	187.78	94.8	92.98	11/17/2014 11:48
FirstBaptist 1	16382	2458025.19	1403578.90	178.09	181.76	91.7	90.06	11/17/2014 12:37
FirstBaptist 2	N/A	2458347.83	1403462.39	178.42	180.99	94.1	86.89	11/17/2014 12:47
Hardware 1	N/A	2460961.31	1407647.69	174.06	176.39	91.7	84.69	11/16/2014 13:24
Lake 1	N/A	2462324.77	1406156.64	98.07	N/A	N/A	98.07	11/15/2014 15:14
Lake 2	N/A	2463456.62	1408482.71	96.48	N/A	N/A	96.48	11/15/2014 14:52
Lake 3	N/A	2463823.63	1408753.42	97.80	N/A	N/A	97.80	11/15/2014 15:00
Lake 4	N/A	2463659.89	1404704.71	192.66	N/A	N/A	192.66	11/16/2014 16:09
Larry 1	N/A	2459051.55	1407973.03	188.89	190.94	95.1	95.84	11/15/2014 18:00
Alvin 1	N/A	2459839.07	1409260.15	153.36	155.84	66.0	89.84	11/16/2014 12:48
Teddy 1	N/A	2460504.19	1409163.93	172.89	174.78	85.9	88.88	11/16/2014 13:02
Marlene 2	N/A	2460542.83	1408483.23	189.92	191.86	105.5	86.36	11/16/2014 12:26
Mack 1	N/A	2458285.25	1409083.44	144.99	147.18	38.3	108.88	11/15/2014 18:15
MCG 17	19098	2461777.99	1407416.88	134.30	138.03	55.3	82.73	11/15/2014 12:18
MCG 19	N/A	2461527.29	1407633.38	139.37	138.62	44.9	93.72	11/15/2014 12:31
Nair 1	19506	2463604.70	1405200.08	191.76	193.89	89.4	104.49	11/17/2014 16:28
Nair 3	N/A	2463513.13	1405198.10	193.65	195.55	95.5	100.05	11/17/2014 16:44
Nair 4	N/A	2463419.26	1405192.06	211.05	213.06	121.0	92.06	11/17/2014 16:47
Nair 5	N/A	2463655.29	1405097.86	192.02	194.43	95.8	98.63	11/17/2014 16:32
Nair 6	N/A	2463613.37	1405288.15	202.77	204.51	111.7	92.81	11/17/2014 16:21
Nair 7	N/A	2463677.63	1405264.37	194.14	195.28	N/A	N/A	11/17/2014 16:39
Nair 8	N/A	2463473.78	1405141.50	213.71	215.75	N/A	N/A	11/17/2014 16:53
Nair 9	N/A	2463611.53	1405377.42	213.15	215.97	120.5	95.47	11/17/2014 17:06
Nair 13	N/A	2463292.55	1405062.54	218.36	220.20	124.5	95.70	11/17/2014 17:00

Well ID	Welts ID	Northing	Easting	Ground Elevation	Casing/Riser Elevation	Depth to Water (*ft*)	Water Elevation	Date and Time of Survey
NorthBaptist 1	N/A	2457081.75	1400831.52	168.09	170.02	87.5	82.52	11/16/2014 17:07
OilSal 1	19793	2461980.90	1406638.33	129.48	130.23	36.3	93.93	11/17/2014 11:13
Oliva 2	N/A	2457740.95	1403463.61	171.53	174.18	84.4	89.78	11/17/2014 12:12
Peak 1	N/A	2459876.41	1405665.72	185.80	185.66	100.1	85.56	11/17/2014 13:08
Peak 2	N/A	2459860.67	1405821.98	184.23	186.20	100.4	85.80	11/17/2014 13:20
Peak 3	N/A	2459410.88	1405555.48	185.22	188.70	101.5	87.20	11/17/2014 13:25
JWJohns 2	17419	2457704.48	1406352.98	185.01	187.02	88.9	98.12	11/16/2014 13:49
Admirality 1	16842	2457118.31	1406147.87	186.04	186.36	87.2	99.16	11/16/2014 14:08
Porter 1	14658	2457473.25	1405091.23	183.85	185.44	86.8	98.64	11/16/2014 16:49
Post 1	N/A	2460589.60	1406829.91	185.20	187.32	102.2	85.12	11/15/2014 13:10
Rediske 1	N/A	2458193.84	1404398.07	181.41	183.63	92.5	91.13	11/15/2014 17:33
School 1	1335	2462443.41	1408054.85	155.21	158.52	77.5	81.02	11/17/2014 9:48
School 2	19795 17600	2462446.83	1408027.09	156.85	159.94	77.8	82.14	11/17/2014 9:51
Tubo 1	N/A	2460834.05	1406324.02	174.69	176.26	92.9	83.36	11/17/2014 17:31
Tubo 2	N/A	2461770.75	1406501.36	127.65	128.81	34.9	93.91	11/17/2014 17:41
Village 1	27711	2456257.14	1402004.05	175.87	176.74	90.1	86.64	11/15/2014 14:31
Village 2	27712	2457035.59	1401479.14	146.66	147.94	63.8	84.14	11/15/2014 14:04
Village 3	N/A	2457045.00	1401810.48	153.59	155.98	54.7	101.28	11/15/2014 14:17
Village 4	N/A	2457056.08	1401210.16	153.78	156.02	71.8	84.22	11/15/2014 13:53



2014 DOWL Surveyed Wells

Streets

Study Area

Inset 1

Inset 2

Feet

0 500 1,000

N

Service Layer Credits: KPB GIS Division, Aerometric

Nikiski Groundwater Study
2014 DOWL Surveyed Wells

Nikiski, Alaska

DOWL

February 26, 2015

Figure 1

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APPENDIX D

Technical Discussion

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1.0 INTRODUCTION

This technical appendix is intended to supplement the information presented in the body of the report and provides additional discussion, figures, and data; it is presented to help illustrate methods and interpretations use, and conclusions reached in the study.

User note: The headings and associated section numbers here are not presented in numerical order, but instead correspond to the relevant headings and section numbers used within the body of the report. Sections numbers with an "X" are original to this appendix.

1.2 General Setting

1.2.1 Geologic Setting

The overall geologic setting of the site is discussed within the main body of text. Here, further geologic information relevant to the interpretation of the subsurface is presented. Figure 1 shows the Freethey and Scully, 1980, geological map (the approximate study area is shown in red). The accompanying geologic unit descriptions of the two units comprising the study area follow the figure.

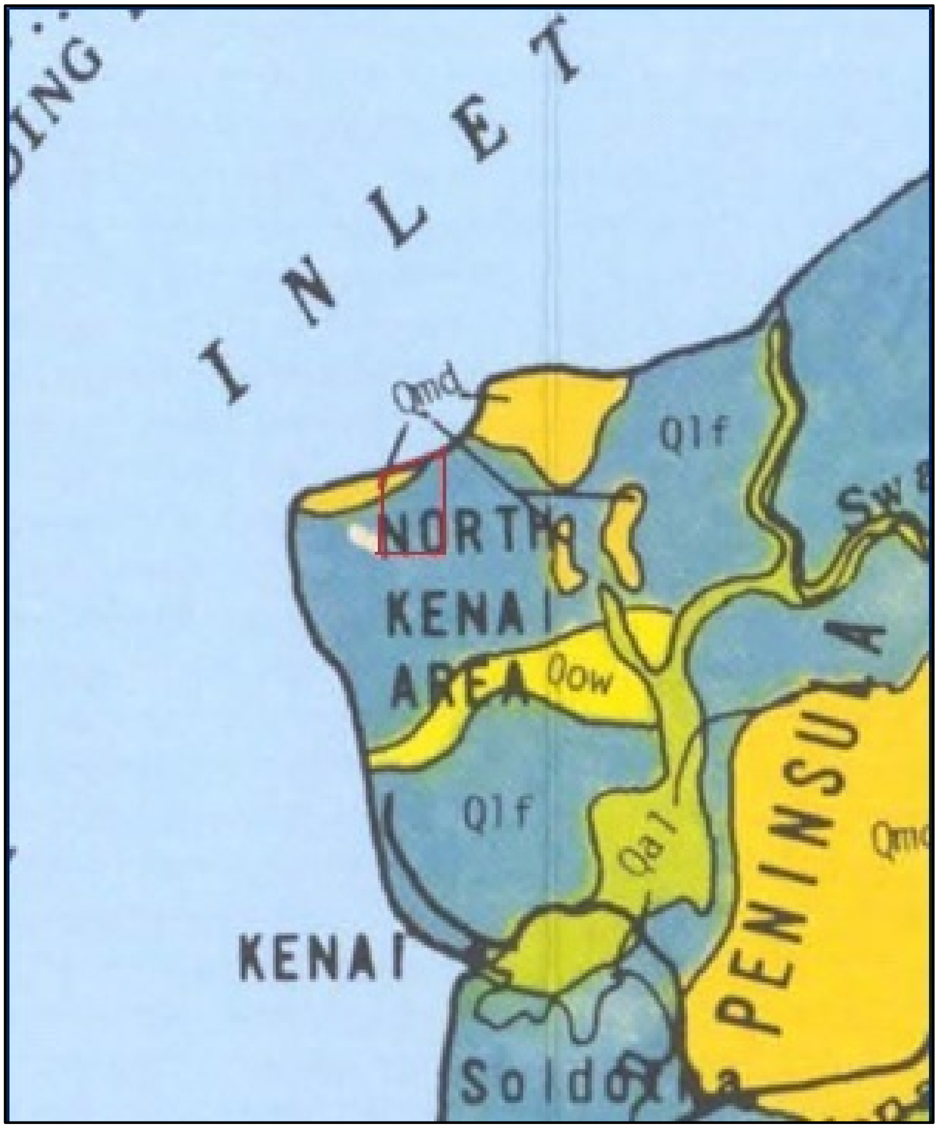


Figure 1: Geological Map of the North Kenai/Nikiski Area

A) Qmd – Moraines and other unsorted glacial drift

Lithology: Heterogeneous blend of gravel, sand, silt, and clay, with discontinuous lenses consisting of largely well-sorted material.

Landforms and Occurrence: Forms hummocky terrain with muskeg- and marsh-filled depressions; in places, these are extensively dissected by post-glacial erosional processes.

Surface Drainage, Infiltration, and Permeability: Surface drainage is moderate to good on slopes and poor in depressions. Infiltration is poor to good depending on soil texture

and grain size. Permeability is poor to good depending on the concentration of fine-grained materials.

Potential for Groundwater Use: Groundwater potential ranges from poor to moderate depending on grain size of underlying material, saturated thickness, and the availability of groundwater recharge. Typical domestic wells are finished in relatively shallow lenses of coarse-grained material which yields enough water for the average required household supply. Few large yield wells have been drilled in areas underlain by this material type.

B) Qlf – Proglacial lake and associated fluvial deposits

Lithology: Heterogeneous mixtures of silt, sand, and gravel, interlayered with more homogeneous deposits of silt and clay (lake deposition) and sand and gravel (fluvial deposition).

Landforms and Occurrence: Forms channeled and terraced high grounds, and marsh- and muskeg-covered flat areas, typically in the lowest parts of the basin.

Surface Drainage, Infiltration, and Permeability: Surface drainage is poor due to low relief; numerous lakes, marshes, and swamps are typical. Infiltration is poor to good depending on soil texture and type of surficial deposits present. Permeability is good in coarse-grained strata and poor in fine-grained strata.

Potential for Groundwater Use: Groundwater potential is moderate to good where surficial materials are coarse grained and thick. Many domestic wells are less than 100 feet in depth. Confined aquifers at greater depths have a potential to yield volumes large enough to be suitable for use as public supplies.

1.2.X Climate and Long Term Groundwater Elevation Variations

Frequently, long-term trends in absolute groundwater elevations can be correlated to precipitation and climatic trends in a region. Absolute groundwater elevations generally do not alter the hydraulic gradients observed. However, examination of regional climate is often useful in understanding groundwater observations.

Nikiski is located in a transitional climate zone between the relatively mild maritime climate of Gulf of Alaska, and the dry, cold, and continental climate of interior Alaska. Kenai is the nearest community to Nikiski where historical climate data is available. The climatological data presented in Tables 1 and 2 for Kenai and the immediate vicinity (from 1981 to 2010) were taken from a range of sources including the Department of Commerce, Community, and Economic Development Community Database, the National Weather Service, and the Kenai Peninsula Borough.

Table 1: General Climate Data for Kenai and Surrounding Areas

Measurement Type	Value
Mean Annual Precipitation	20 in
Mean Annual Snowfall	60 in
Mean Maximum Temperature (July)	60°F
Mean Maximum Temperature (January)	25°F
Mean Minimum Temperature (July)	47°F
Mean Minimum Temperature (January)	8°F
Average Summer Temperature	51°F
Average Winter Temperature	17°F

Table 2: Average Monthly Temperatures and Precipitation in the Project Study Area.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Temperature (*°F*)	13	17	24	35	45	51	55	54	47	34	22	17
Precipitation (*in*)	1.07	0.91	0.81	0.64	0.95	1.09	1.75	2.62	3.31	2.66	1.69	1.45

Natural variability in groundwater elevations is likely for the given study area, but the extent of seasonal and annual variations is not known. Commonly, groundwater levels are lower during period of February through April than during May through August period; however, high and low water levels can occur in any month. Some wells in the region show medium-term trends of approximately five years in length generally following trends in precipitation, while others indicate no correlation between precipitation and groundwater levels. Few wells show long-term (greater than 10 years) trends in water levels (Glass, 1996). The cause of long-term groundwater

fluctuations is not understood for wells not following trends in precipitation, but the effects of these variations reinforce the importance of conducting groundwater measurements over a brief time period for the production of a groundwater model. This information was used to confirm historical groundwater measurements would be inadequate for the scope of this project in determining groundwater flow directions.

2.0 DATA SOURCES AND METHODS

2.3 Mapping and Modeling

2.3.1 Lithology Model

Much of the methods used to create the RockWorks lithology model are discussed in the main body of the text but, additional information concerning the model is presented here.

The lithology model was created using the Universal Transverse Mercator (UTM) Projection WGS-84 (NAD-83) in UTM Zone 5 (Northern Hemisphere). The UTM provides a two dimensional Cartesian coordinate system for locations, independent of vertical position. Table 3 presents the three-dimensional grid constraints assigned to the model.

Table 3: UTM Grid Constraints Used in the RockWorks Model

	Minimum	Maximum	Grid Size (*ft*)	Nodes
Easting (*ft*)	1,940,708.72	1,946,141.79	50.0	110
Northing (*ft*)	22,090,095.85	22,098,133.91	50.0	162
Elevation (*ft*)	-150.0	263.0	1.0	414

Each sediment division within the well log was classified into a common Unified Soil Classification System (USCS) lithology groups. These classifications were then grouped into four sediment classes based on the general permeability of the sediments. The four classifications used in the lithology model and their associated USCS classes are presented in Table 4.

Table 4: Lithology Classifications and their Associated Sediment Classes.

Associated USCS Lithologies	Sediment Classes
GW, GP, SW, SP	Clean Sands and Gravels
GM, GC, SM, SC	Silty Sands and Gravels
ML, MH	Silt
CL, CH	Clay

2.3.1.2 Subsurface Solid Model

In order to create the subsurface model, interpolation between well log lithologies was necessary. The interpolation function used for the RockWorks subsurface solid model was Horizontal Lithoblending. It assigns the solid model voxel nodes (grid spaces) by looking outward, horizontally from each borehole in search circles of ever-increasing diameter. It first assigns the voxels immediately surrounding each borehole the closest lithology value. (Lithology "G" values are declared in the active Lithology table. Each Lithology “G” value corresponds to each one of the lithology classification groups.) It then moves out by a voxel, and assigns the next "circle" of voxels the closest lithology value. It continues in this manner until the program encounters a voxel already assigned (presumably from another borehole), in which case it skips the node assignment step. Once all nodes are assigned, the searching and assigning is terminated. This method results in "lithozones" around each borehole which can end abruptly when the zone from a neighboring borehole is encountered. To generate a more realistic representation where lithology zones tend to blend together with neighboring zones, randomized blending was applied. An example a subsurface model with and without randomized blending is shown in Figure 2.

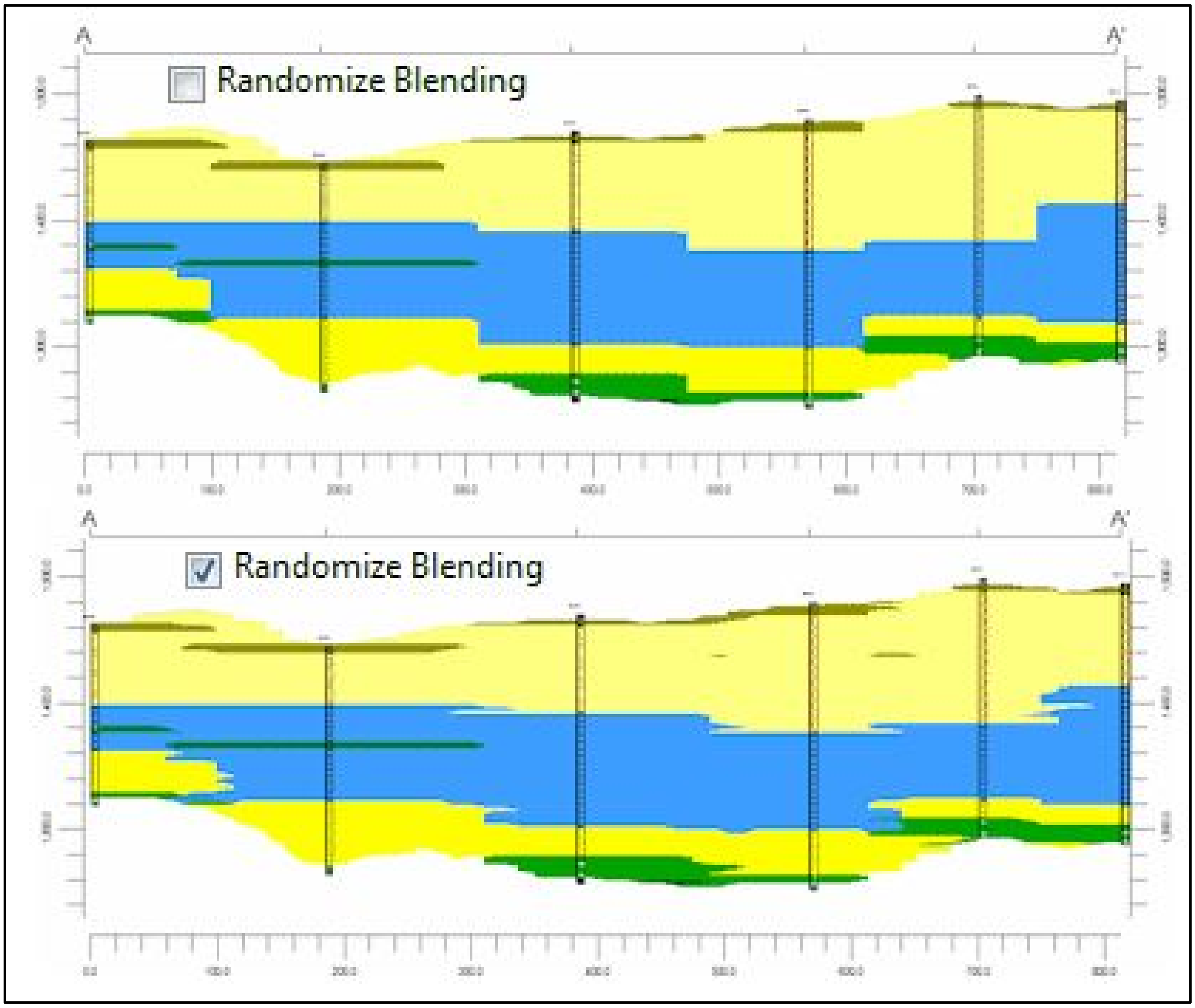


Figure 2: Subsurface Model Example Portraying the Difference between Randomized and Non-randomized Blending.

2.3.1.3 Solid Model Filtering

Glacial deposits are highly variable (often over short geographic distances). The interpolation of the model lithology data continues outward horizontally until it encounters a grid space or voxel which has already been assigned. In some instances, this means the model will continue to project a lithology layer indefinitely if another borehole is not present in the direction of the projection. As a result of this, in deeper wells, the deepest lithologies may be projected across the entire study area since there are no other wells containing lithologies at this depth. This is highly unlikely to be realistic in the geologic setting of the study area and would present false data. To limit the presence of these false projections, a filtering surface was created to remove this data. This surface was created by calculating the elevation of the base of the well (the

elevation of the well minus the total depth of the well) and then applying an inverse distance weighted function. Figure 3 shows the resulting surface which defines the elevations of the base of the model.

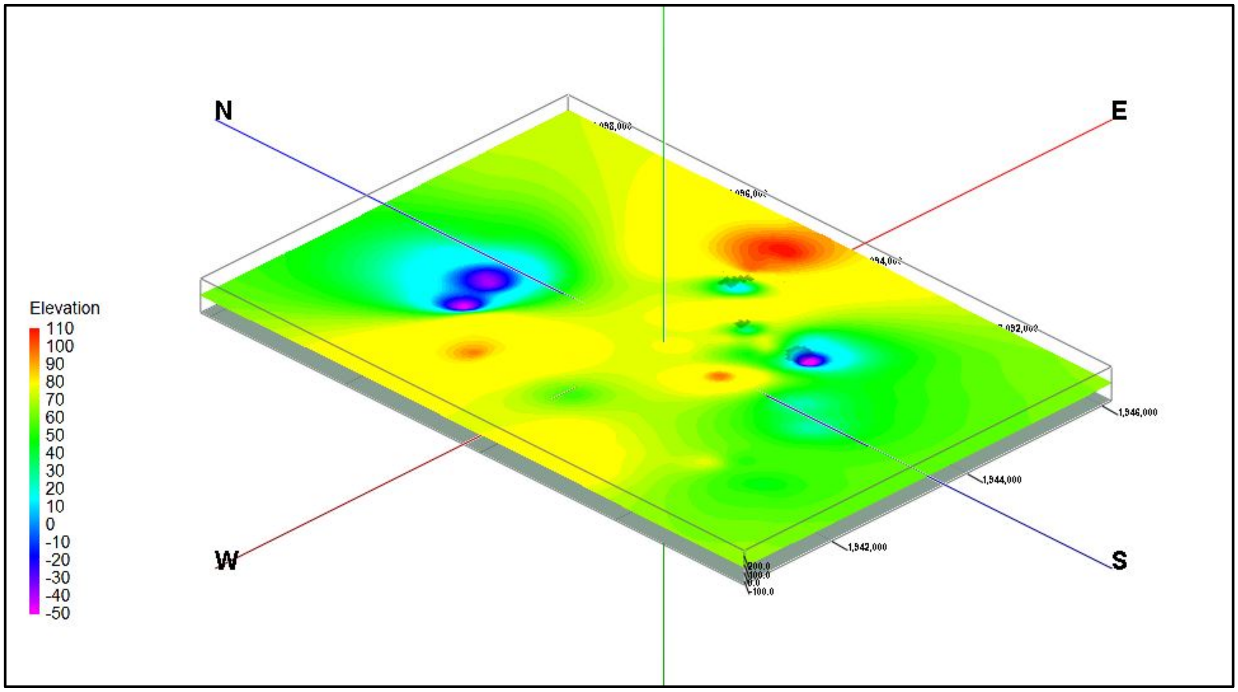


Figure 3: The Resulting Base Surface Elevation Created by Applying Filters

2.3.1.4 Geologic Cross-sections

Within elevations where lithology data is available, lithologies can still vary over horizontal distances. The average minimum distance between wells is 434 feet, meaning our high confidence zone is within approximately 430 feet of each boring, since this is the average distance between control points, and confidence decreases with increasing distance from each well. A visualization showing the approximate high confidence zone (within 500 feet of well logs) is shown below in Figure 4.

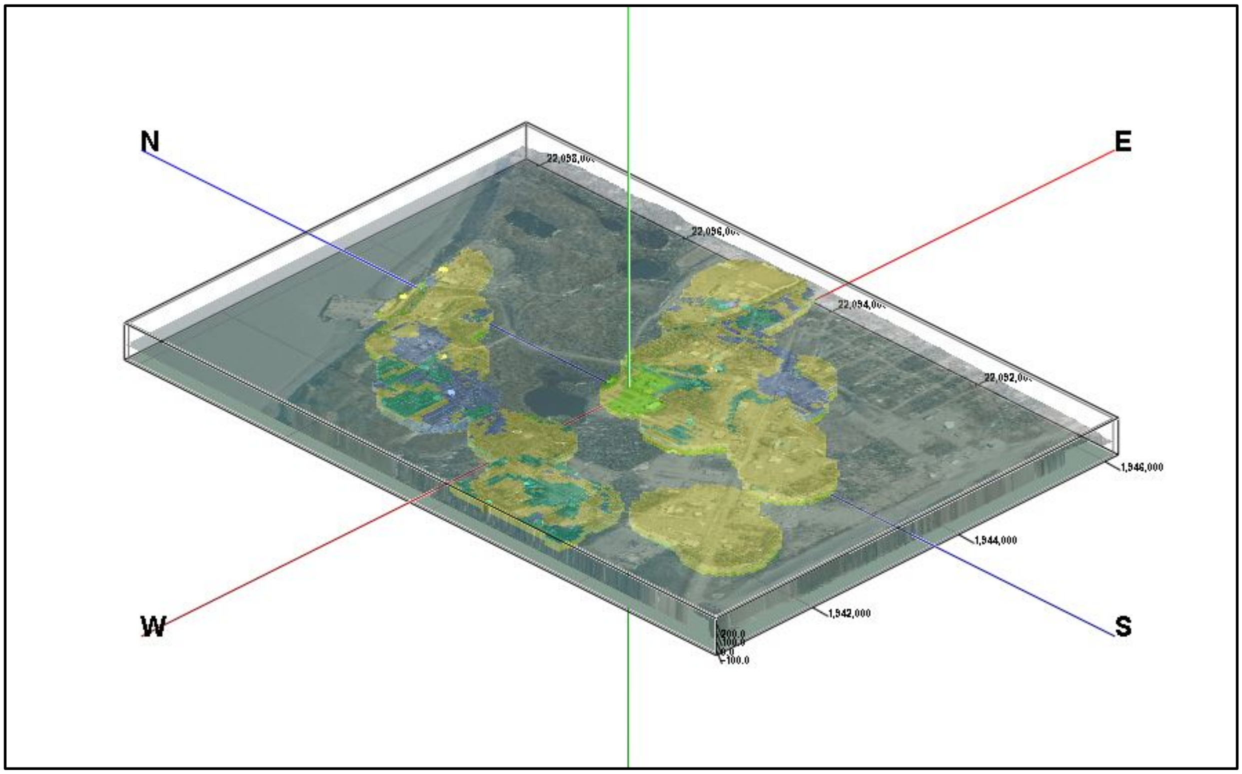


Figure 4: The Approximate Confidence Zone Based on 500-Foot Projections from Well Logs

The locations of cross-sections were selected within these high confidence areas and where: a) there is a high density of well logs; b) cross-sections pass through and illustrate the subsurface near areas of interest (contaminated sites); and, c) differences in aquifer water elevations are illustrated.

The cross-section location map (Figure 5) and individual cross-sections are presented below. The cross-section figures (Figures 6 through 8) show model lithology (lithology classification groups) based on well log records, measured water elevations (when collected during field survey efforts), surface elevations, and model base elevations. Discussion of each cross-section follows after the cross-section figure.

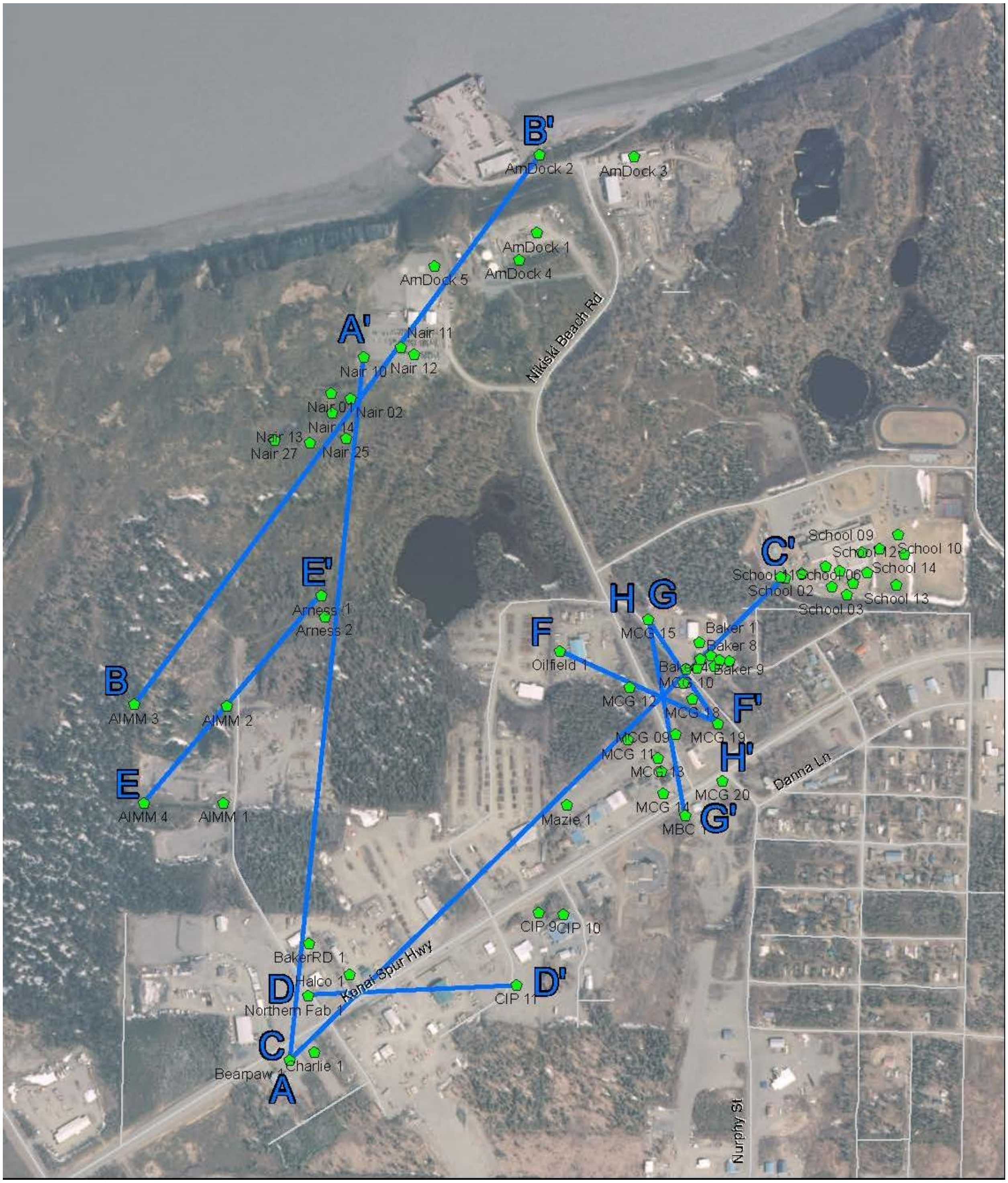
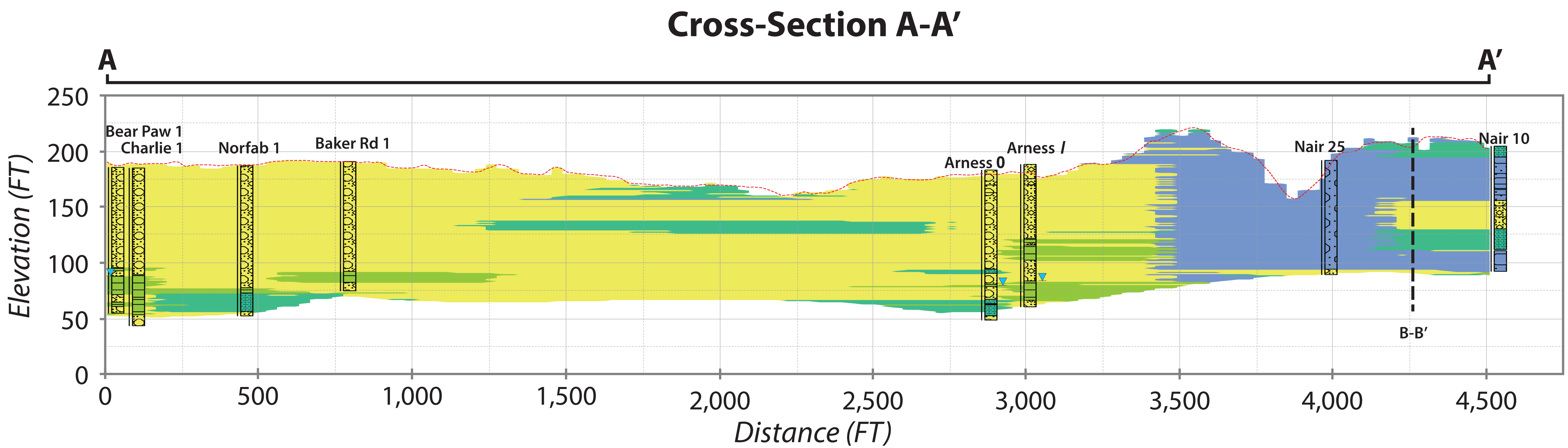
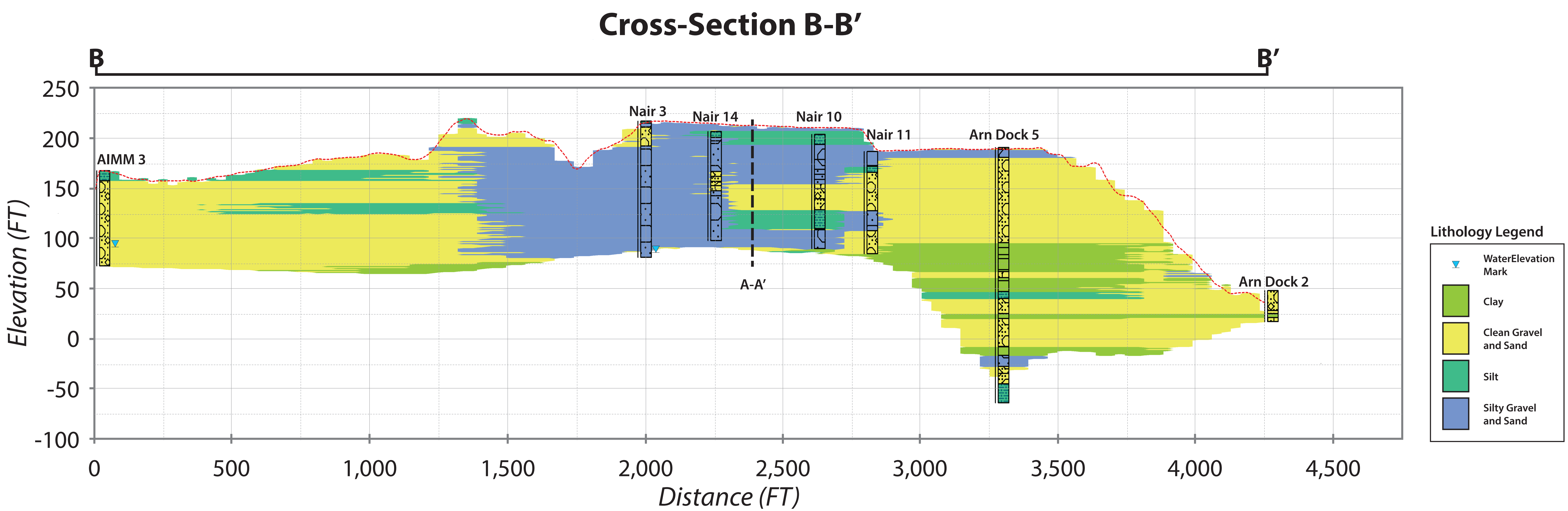


Figure 5: Cross-section Location Map

Figure 6: Cross-sections A-A' and B-B'





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Cross-section A-A’: Cross-section A-A’ (Figure 6) displays approximately 4,500 linear feet of the subsurface model between the BearPaw 1 and Nair10 wells. Additionally, the lithology logs of Charlie 1, Norfab 1, BakerRd 1, Arness 1, Arness 2, and Nair 25 are shown.

Besides Nair 25 and Nair 10, all of the wells are screened below a significant clay and/or silt layer and are interpreted to be accessing the lower confined aquifer. Nair 25 and Nair 20 are located in the glacial moraine material. This material can be identified by the blue/purple color in the cross-section coinciding with the highest surface elevation shown. These wells are interpreted to be accessing the upper unconfined aquifer or perched/isolated aquifers.

Cross-section B-B’: Cross-section B-B’ (Figure 6) displays approximately 4,250 linear feet of the subsurface model between the AIMM 3 and ArnDock 2 wells. Additionally, the lithology logs of Nair 3, Nair 14, Nair 10, Nair 11, and ArnDock 5 are also shown.

The AIMM 3 well is screened in clean gravels and sands and is interpreted to be utilizing the upper unconfined aquifer. All of the Nair wells are located in the silt rich sediments within the glacial moraine material and are interpreted to be using the upper unconfined aquifer or perched/isolated aquifers. ArnDock 5 is screened very deep relative to other wells in the study area. The well is drilled through a cleaner portion of the glacial moraine material and through several significant clay and silt layers. This well appears to be screened within the lower confining aquifer.

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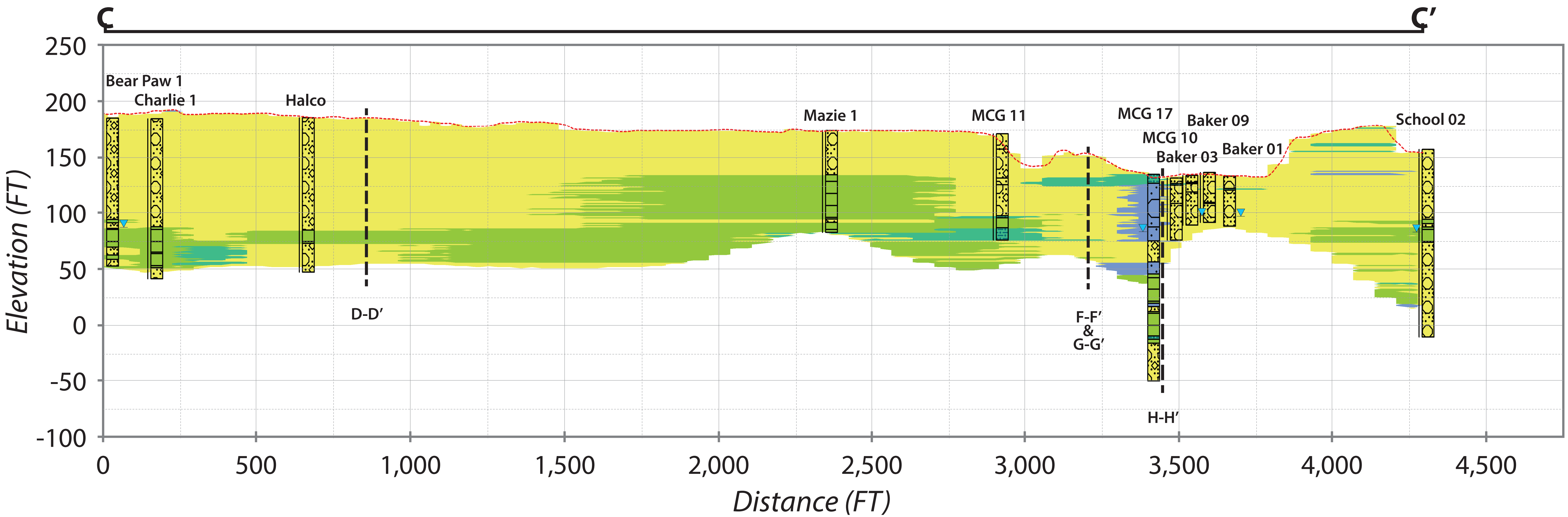
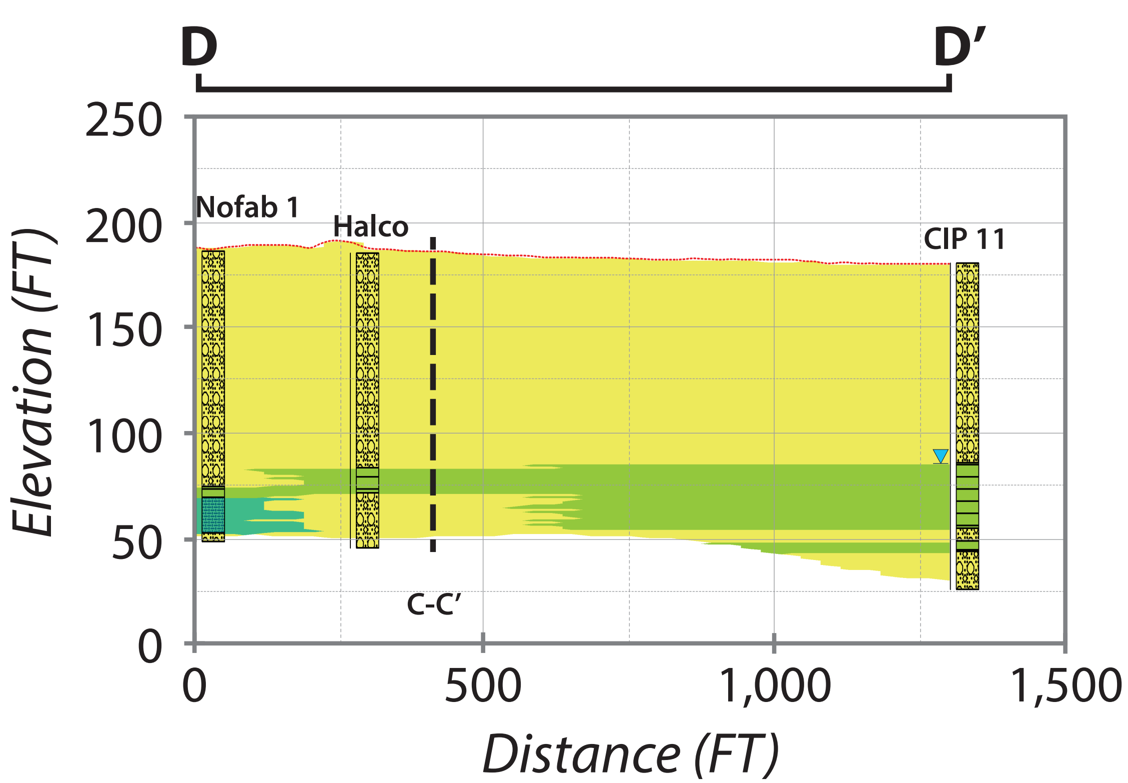
Figure 7: Cross-sections C-C', D-D', and E-E'

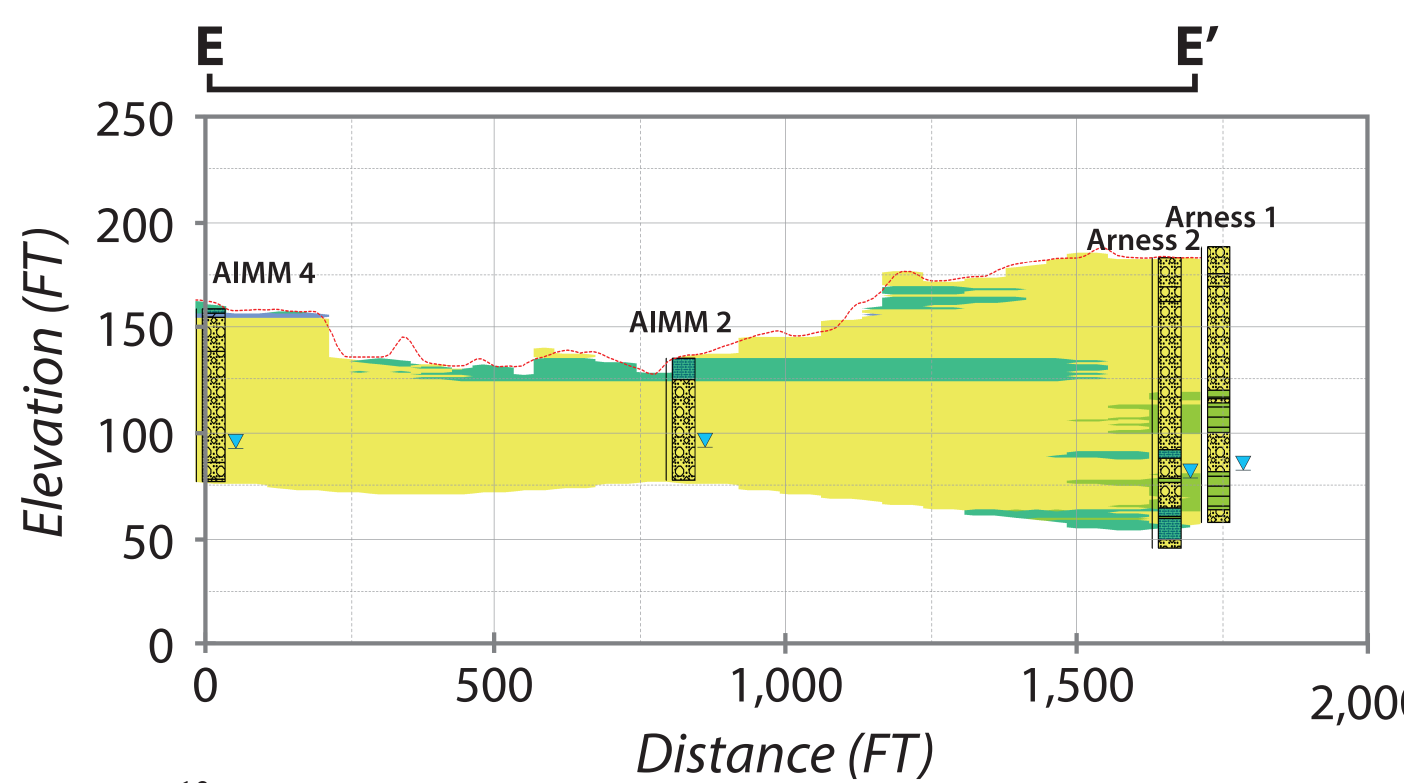
Cross-section C-C’

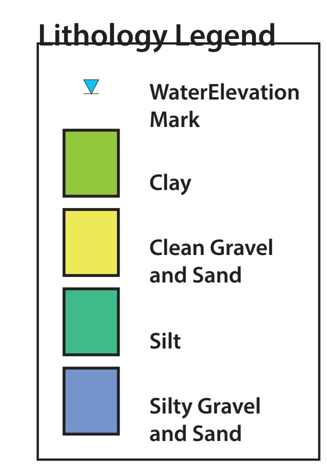


Cross-section D-D’



Cross-section E-E’





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Cross-section C-C’: Cross-section C-C’ (Figure 7) displays approximately 4,300 linear feet of the subsurface model between the BearPaw1 and School 02 wells. Additionally, the lithology logs of Charlie 1, Halco, Mazie 1, MCG 11, MCG 17, MCG 10, Baker 03, Baker 09, and Baker 01 are shown.

The BearPaw 1, Charlie 1, Halco, MCG 17, and the School 02 wells are screened below a significant clay and/or silt layer and are interpreted to be accessing the lower confined aquifer. The MCG 10, Baker 03, Baker 09, and Baker 01 wells are screened within clean gravels and sands are interpreted to be using the upper aquifer. It is unclear which aquifer the Mazie1 and MCG 11 wells are accessing since they appear to be screened in thin lenses of sand, silt and gravel contained within clay layers.

Cross-section D-D’: Cross-section D-D’ (Figure 7) displays approximately 1,300 linear feet of the subsurface model between the Norfab 1 and CIP 11 wells. Additionally, the lithology log of Halco is shown.

The Norfab 1, Halco, and CIP 11 wells are all screened below a significant clay and/or silt layer and are interpreted to be accessing the lower confined aquifer. The Peak 1 and Peak 2 wells (not shown in cross section due to lack of lithology logs) have been assumed to be screened below the clay layer and accessing the same aquifer based on measured water levels.

Cross-section E-E’: Cross-section E-E’ (Figure 7) displays approximately 1,700 linear fear of the subsurface model between the AIMM 4 and Arness 2 wells. Additionally, the lithology logs of AIMM 2 and Arness 1 are shown.

The AIMM 4 and AIMM 2 logs are screened at an elevation of approximately 75 to 65 feet in clean gravels and sands and the lithology logs do not show the presence of the significant clay or silt layer commonly observed between 50 and 75 feet elevation. Had these wells been drilled deeper, the clay layer may have been encountered. These wells are interpreted to be accessing the upper unconfined aquifer. The Arness wells are screened below a significant clay and silt layer and are interpreted to be to be accessing the lower confined aquifer.

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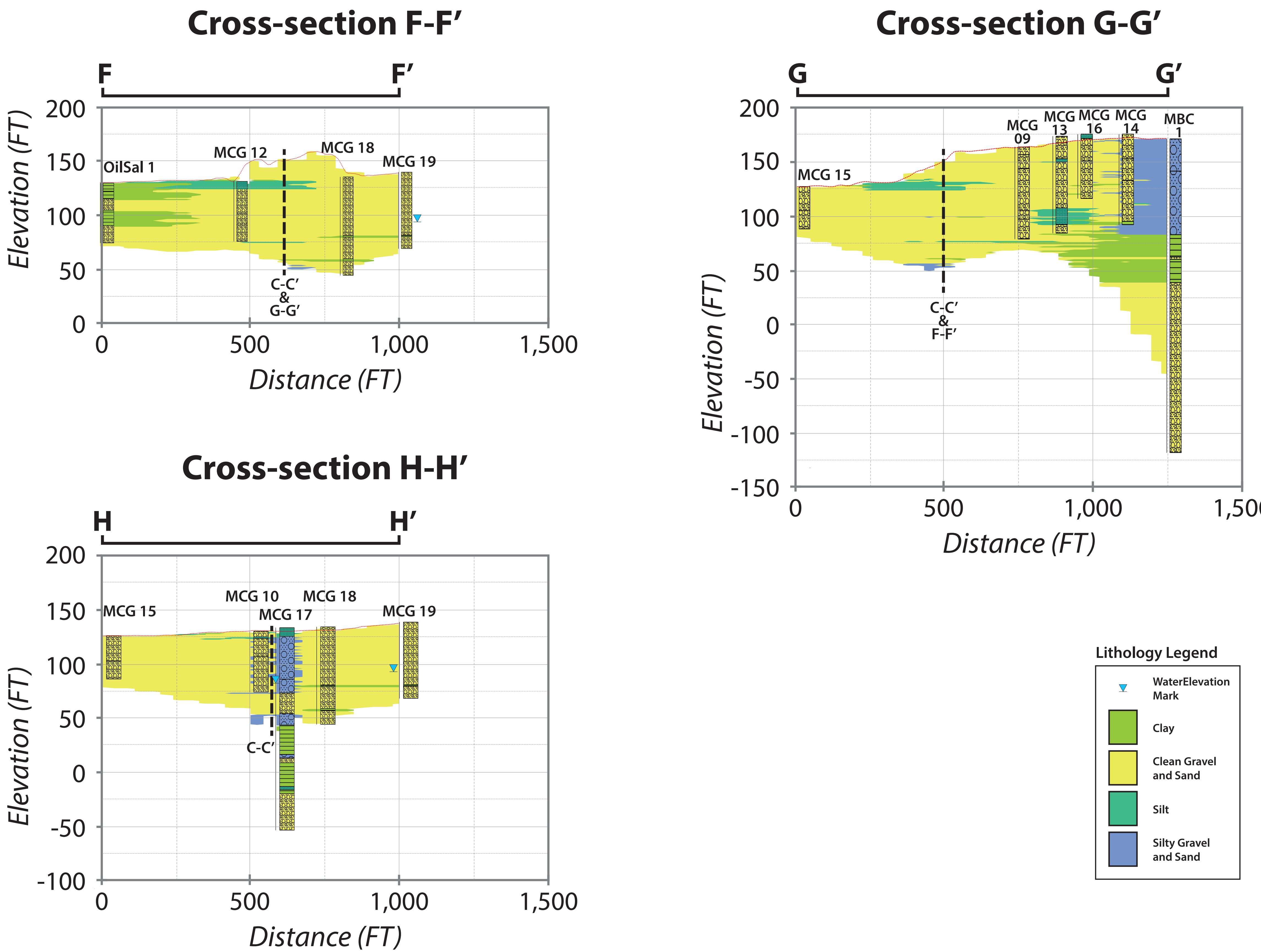
Figure 8: Cross-sections F-F', G-G', and H-H'



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Cross-section F-F’: Cross-section F-F’ (Figure 8) displays approximately 1,000 linear feet of the subsurface model between the OilSal 1 and MCG 19 wells. Additionally, the lithology logs of MCG 12 and MCG 18 are shown.

All of the wells shown are screened in clean gravels and sands and do not show the silt and clay layer commonly observed at approximately 50 to 75 feet elevation. Significant clay layers are present in the OilSal 1 lithology logs but they are at a higher elevation and are interpreted to be isolated lenses of clay not connected to the area wide clay layer interpreted to be separating the upper and lower aquifers. All of the wells in this cross-section are interpreted to be accessing the upper unconfined aquifer.

Cross-section G-G’: Cross-section G-G’ (Figure 8) displays approximately 1,250 linear feet of the subsurface model between the MCG 15 and MBC 1 wells. Additionally, the lithology logs of MCG 09, MCG 13, MCG 16, and MCG 14 are shown.

None of the logs displayed in this cross-section had groundwater measurements taken during the field survey. This cross-section does illustrate the deepest well encounters a significant clay layer at an elevation of roughly 50 to 75 feet, while the rest of the wells are not drilled deep enough to encounter the clay layer. Also of note, is the MBC 1 well log shows during the time of drilling, all of the sand beneath the clay layer is “quicksand”, indicating complete saturation of the soils.

Cross-section H-H’: Cross-section H-H’ (Figure 8) displays approximately 1,000 linear feet of the subsurface model between MCG 15 and MCG 19. Additionally, the lithology logs of MCG 10, MCG 17, and MCG 18 are shown.

All of the wells shown in this cross-section, besides MCG 17, are screened in the upper, unconfined aquifer. MCG 17 is screened below significant clay layers. There is an approximate 10 foot elevation difference between the groundwater measurement in MCG 17 and MCG 19. This is due to the wells accessing different aquifers.

3.0 RESULTS

3.1.1 Groundwater Models

Creation of the groundwater models required identifying which aquifer each well is accessing. This was done by examining the subsurface model and the lithology well data available, as previously discussed in the cross-section narrative. However, there are wells in which no lithology data is available. To determine which aquifer these well are accessing, alternative methods were used.

In the event a surveyed and measured well did not have accompanying lithology data, the interpretation of which aquifer each well was accessing was accomplished by examining nearby well groundwater elevations. For example, in the Nikiski Village Trailer Court area, two of the surveyed wells had lithology logs suggesting they are accessing the lower aquifer. A third well had no lithology data but similar groundwater elevation, so it was assumed to be accessing the lower aquifer as well. A fourth well had no lithology data but had a drastic difference in groundwater elevation (greater than 12 feet), so it was assumed this well was accessing a separate perched aquifer.

In the event a surveyed and measured well did not have accompanying lithology data and no nearby comparable wells, the interpretation was based on projected groundwater gradients of the modeled aquifers. For example, the Diamond 2 well has no nearby comparable wells. A lower aquifer model was created without its groundwater elevation included and the modeled projected surface was compared to the measured level. If the projection was close to the measured value (within 2 feet), the well was interpreted to be part of the modeled aquifer and included in future renditions of the model.

To illustrate this process, a groundwater model generated without the Diamond 2 well included is shown below in Figure 9. Where the Diamond 2 well is located, the model predicts the measured groundwater elevation to be approximately 70 to71 feet and within the lower, confined aquifer, based on the projected groundwater surface gradient. The measured groundwater level within the Diamond 2 well was 69.8 feet.

Figure 6: Groundwater Contour Model Predicting the Groundwater Elevation of the Diamond 2 Well

This supports the Diamond 2 well is indeed accessing the lower aquifer, even without available lithology data to draw the conclusion. The Diamond 2 well was included in future revisions of the lower aquifer model. This iterative process was repeated for other wells for which lithology data was not available. In other words, wells were subtracted and added to the model in different revisions to see how the model behaved and predicted groundwater elevations at the well

revisions to see how the model behaved and predicted groundwater elevations at the well locations without lithology data; where the aquifer models accurately predicted a groundwater elevation of a well, it was inferred to be accessing the modeled aquifer.

The interpolation of measured groundwater elevations is the mathematical process of predicting unknown values from a limited number of sample data points. There are many different mathematical methods to interpolate surfaces. The assumption making interpolation a viable option is spatially distributed objects are spatially correlated; in other words, things close together tend to have similar characteristics. Common interpolation methods used for modeling groundwater are Inverse Distance Weighted (IDW), Kriging, Natural Neighbor, and Spline. Each method has different advantages in different situations and applications.
Some of the variables which influence which method is most appropriate are the distribution of data points (clumped together or evenly spread out), the need or desire for the calculated surface to perfectly go through measured data points, or the need to project a surface beyond the geographic distribution of data points. It is often up the project geologist or hydrologist to choose the appropriate method believed to most accurately represent the realistic scenario of the modeled aquifer. For this project, natural neighbor (sometimes called nearest neighbor) methods and Kriging methods generated the most realistic representation of the study area aquifers. Discussion of the various interpolation methods is available in most groundwater texts and many professional papers. A visualization of how the different surfaces generated through Kriging, Natural Neighbor, and IDW (those used within this study) interpolation methods vary is shown in Figure 10.

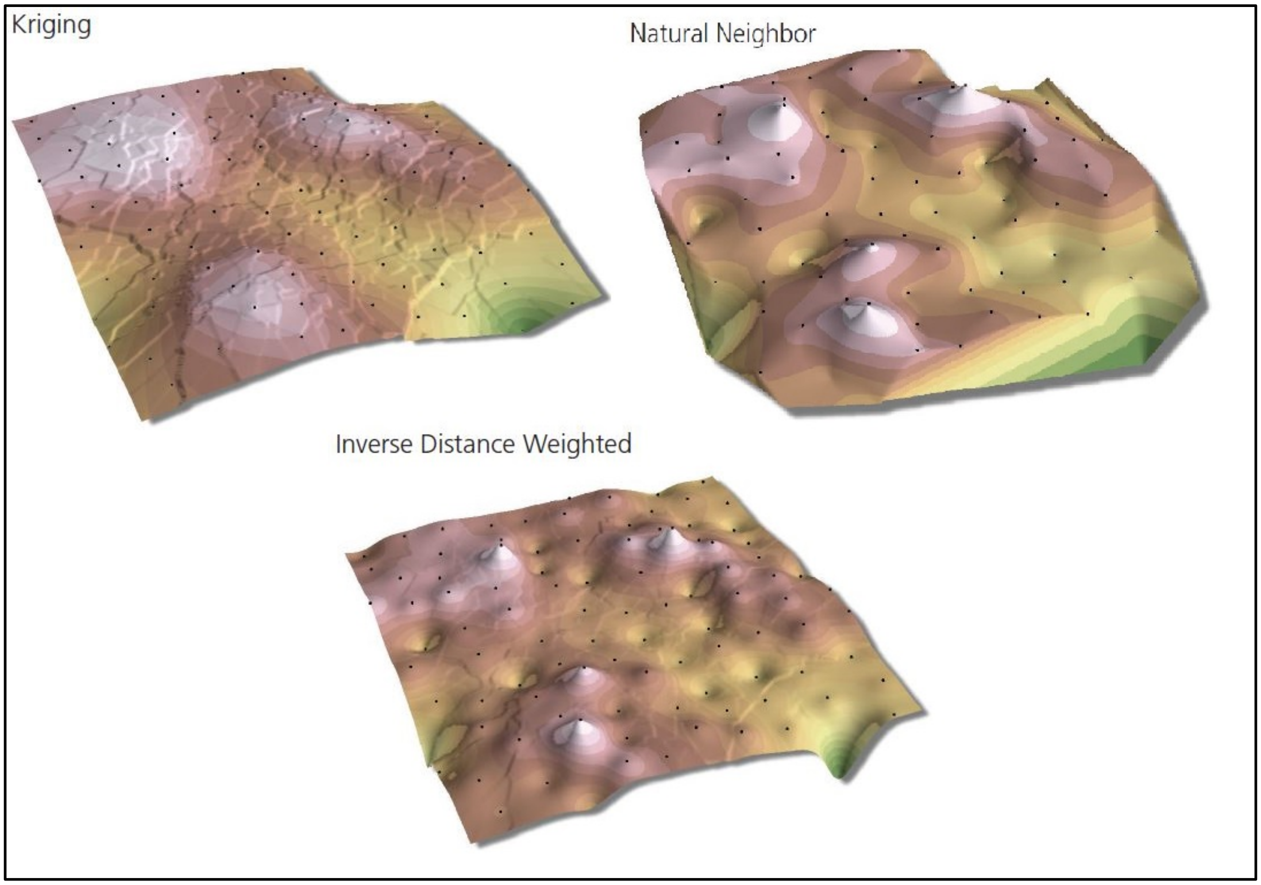

Figure 7: A Visualization of Different Interpolation Methods employed in the Study

Creating aquifer models using varying interpolation methods is a way to test the reliability of the model. Confidence increases if an aquifer is modeled using multiple interpolation methods and all interpolation methods generate similar trends. An example of this is shown below, where the same aquifer data input was used in a Kriging (Figure 11) and natural neighbor (Figure 12) interpolation method. While the details of the aquifer contours vary slightly, the overall trend is present in both resultant models.

Figure 8: Kriging Interpolation Method Contours

Figure 9: Natural Neighbor Interpolation Method Contours

4.0 REFERENCES

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