Voluntary Cleanup Plan

Former Burlington Northern Fueling Facility
Shelby, Montana

RECEIVED
Dept. of Environmental Quality
Remediation Division

BNSF Railway Company

DEQ - RECORD

K/J 0796021.06
August 2007
Kennedy/Jenks Consultants

VOLUNTARY CLEANUP PLAN
FORMER BURLINGTON NORTHERN FUELING FACILITY
SHELBY, MONTANA

Prepared for

BNSF RAILWAY COMPANY

Prepared by

KENNEDY/JENKS CONSULTANTS
ENGINEERS AND SCIENTISTS
32001 32nd Avenue South, Suite 100
Federal Way, Washington 98001
(253) 874-0555

K/J 0796021.06

August 2007

TABLE OF CONTENTS

PAGE NUMBER

LIST OF TABLES v

LIST OF FIGURES vi

LIST OF APPENDICES vi

1.0 INTRODUCTION 1-1

2.0 ELIGIBILITY ASSESSMENT 2-1

3.0 VOLUNTARY CLEANUP PLAN – MCA REQUIREMENTS 3-1

3.1 VCP SUBMITTAL 3-1

3.2 VCP PREPARATION 3-1

3.3 VCP COMPONENTS 3-1

3.4 REIMBURSEMENT OF REMEDIAL ACTION COSTS 3-2

3.5 PHASED CLEANUP 3-2

4.0 ENVIRONMENTAL ASSESSMENT 4-1

4.1 LEGAL DESCRIPTION AND FACILITY MAP 4-1

4.2 PHYSICAL CHARACTERISTICS 4-2
4.2.1 Topography 4-2
4.2.2 Geologic Setting and Site Soil 4-2
4.2.3 Groundwater 4-3
4.2.4 Surface Water and Drainage 4-4
4.2.5 Climatological Data 4-5
4.2.6 Site Features 4-5
4.2.7 Flora and Fauna 4-7
4.2.8 Facilities within 0.25 Mile of the Site 4-7

4.3 AREA WELLS 4-8
4.3.1 Offsite Wells 4-8
4.3.2 Onsite Wells 4-8

TABLE OF CONTENTS

		PAGE NUMBER
4.4	GROUNDWATER AND SURFACE WATER USAGE	4-9
4.4.1	Groundwater Usage	4-9
4.4.2	Surface Water Usage	4-10
4.5	OPERATIONAL HISTORY OF THE SITE	4-10
4.5.1	Site History	4-10
4.5.2	Current and Future Site Usage	4-11
4.6	SITE CHARACTERIZATION	4-11
4.6.1	September 1987 Investigation	4-12
4.6.2	June 1989 Investigation	4-12
4.6.3	April/May 2003 Investigations	4-13
4.6.4	June/July 2004 Investigation	4-14
4.6.5	July 2006 Remedial Action and confirmation Sampling Investigations	4-15
4.6.6	April 2006 Soil Investigation	4-15
4.7	SITE CHARACTERIZATION RESULTS	4-16
4.7.1	Surface Soil (0 to 2 feet bgs)	4-16
4.7.2	Subsurface Soil (Greater than 2 feet bgs)	4-15
4.7.3	Groundwater	4-22
4.8	HUMAN AND ENVIRONMENTAL EXPOSURE	4-23
4.8.1	Data Evaluation	4-25
4.8.2	Exposure Assessment	4-27
4.8.3	Toxicity Assessment	4-32
4.8.4	Risk Characterization	4-33
4.8.5	Uncertainty Assessment	4-35
4.8.6	Risk Assessment Summary	4-38
4.9	REGULATORY AND COMPLIANCE HISTORY	4-38
4.9.1	Environmental Permits	4-38
4.9.2	Facility-Specific Notifications	4-39
4.9.3	Spill Notifications	4-39
5.0	REMEDIATION PROPOSAL	5-1
5.1	EXCAVATION	5-1
5.1.1	AST Area	5-2
5.1.2	Former Fuel Pump House	5-3
5.1.3	Former Western Fueling Area	5-4
5.2	STANDARD PROCEDURES FOR REMOVAL OF PCS	5-5
5.3	WASTE MANAGEMENT	5-5

TABLE OF CONTENTS

PAGE NUMBER

5.4 SITE RECLAMATION AND LONG-TERM OPERATION AND MAINTENANCE 5-6

5.5 SCREENING AND CLEANUP LEVELS 5-6
5.5.1 Screening Levels 5-6
5.5.2 Cleanup Levels 5-7

5.6 CLEANUP REQUIREMENTS 5-7
5.6.1 Protectiveness 5-7
5.6.2 Environmental Requirements, Criteria, or Limitations (ERCLs) 5-8
5.6.3 Mitigation of Risk 5-8
5.6.4 Effectiveness and Reliability 5-9
5.6.5 Practicability and Implementability 5-9
5.6.6 Treatment or Resource Recovery Technologies 5-10
5.6.7 Cost Effectiveness 5-10

5.7 TREATABILITY STUDIES AND CONFIRMATION SAMPLING 5-11
5.7.1 Treatability Studies 5-11
5.7.2 Confirming Sampling 5-11

5.8 REMEDIAL ALTERNATIVES COMPARISON 5-11
5.8.1 Alternative 1 – No Further Action 5-13
5.8.2 Alternative 2 – Additional Excavation 5-14
5.8.3 Alternative 3 – In situ Chemical Oxidation 5-15
5.8.4 Alternative 4- Excavation and Standard Procedures 5-16

5.9 PROJECT SCHEDULE 5-17

5.10 HEALTH AND SAFETY 5-18

5.11 MINIMIZATION OF SHORT-TERM DISTURBANCES 5-18

5.12 REQUIRED PERMITS 5-18

REFERENCES R-1

TABLE OF CONTENTS

LIST OF TABLES

TABLE 1	SITE AND VICINITY PHYSICAL CHARACTERISTICS
TABLE 2	WELLS WITHIN 0.5 MILE OF THE SITE
TABLE 3	PRE-EXCAVATION SITE INVESTIGATION SOIL ANALYTICAL RESULTS – PETROLEUM HYDROCARBONS AND VOLATILE ORGANIC COMPOUNDS
TABLE 4	PRE-EXCAVATION SITE INVESTIGATION SOIL ANALYTICAL RESULTS – SEMIVOLATILE ORGANIC COMPOUNDS
TABLE 5	REMEDIATION CONFIRMATION SOIL SAMPLE ANALYTICAL RESULTS
TABLE 6	SITE INVESTIGATION SOIL ANALYTICAL RESULTS - METALS
TABLE 7	GROUNDWATER ANALYTICAL RESULTS
TABLE 8	POST-EXCAVATION SUBSURFACE SOIL ANALYTICAL RESULTS – PETROLEUM HYDROCARBONS AND VOCs
TABLE 9	OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
TABLE 10	EXPOSURE POINT CONCENTRATIONS
TABLE 11	EXPOSURE PARAMETERS FOR FUTURE ONSITE CONSTRUCTION WORKERS – SUBSURFACE SOIL
TABLE 12	TOXICITY VALUES FOR CHEMICALS OF POTENTIAL CONCERN
TABLE 13	RISK ESTIMATES
TABLE 14	PROTECTIVE SOIL CONCENTRATIONS (PSCs) AND PSC CALCULATIONS
TABLE 15	REMEDIATION ALTERNATIVES EVALUATION

TABLE OF CONTENTS

LIST OF FIGURES

FIGURE 1	SITE AND WATER SUPPLY WELL LOCATIONS
FIGURE 2	SITE FEATURES AND CHARACTERIZATION SAMPLING LOCATIONS
FIGURE 3	EXCAVATION AND CONFIRMATION SAMPLE LOCATIONS
FIGURE 4	SITE CONCEPTUAL MODEL

APPENDICES

APPENDIX A	RESUME OF QUALIFIED ENVIRONMENTAL PROFESSIONAL
APPENDIX B	VCP CONSENT AUTHORIZATION LETTER
APPENDIX C	FEMA FLOOD MAP AND ZONING MAP
APPENDIX D	AERIAL AND SITE PHOTOGRAPHS
APPENDIX E	MONTANA NATURAL HERITAGE PROGRAM REPORT
APPENDIX F	EDR REPORT
APPENDIX G	OFFSITE WELL BORING AND CONSTRUCTION LOGS
APPENDIX H	SOIL BORING, WELL CONSTRUCTION, AND TEST PIT LOGS
APPENDIX I	LABORATORY ANALYTICAL REPORTS
APPENDIX J	ENVIRONMENTAL REQUIREMENTS, CRITERIA, OR LIMITATIONS (ERCLS)

encountered in soil borings or excavations advanced to 30 feet below ground surface (bgs). Other readily available hydrogeologic information for the Shelby area does not provide an indication of the clay's total thickness.

4.2.3 Groundwater

Available hydrogeologic information for the Shelby area contains little data related to groundwater resources because developable groundwater resources suitable for domestic, commercial, or irrigation wells, if present, are likely very deep (below the Vanda Clay) and have not been exploited. Records reviewed to identify water wells in the area do not show any public or private producing wells in the topographic valley in which the site and the city of Shelby are situated. The only wells located within 0.5 mile of the site are shallow monitoring wells. Water wells that supply Shelby are located 7 miles south of the city, near the Marias River.

Site specific data has been gathered since June 2004, when Kennedy/Jenks Consultants installed six monitoring wells ranging in depth from 8 to 16 feet bgs, with the well screens set, at least partially, in the Vanda Clay. Since 2004, water has been observed in only four of the monitoring well casings at depths ranging from 2 to 14 feet bgs, with two of the wells which are located only a few feet apart exhibiting water depth differences up to 8 feet.

Although a small quantity of water has been observed in well casings, groundwater seepage has not been observed in excavations and test pits advanced at the site to depths up to 15 feet bgs. During remediation activities in 2006, for example, a small amount of water was present in the bottoms of monitoring wells SH-1 and SH-2, at approximately 7 and 14 feet bgs, while soil encountered at these same depths in nearby excavations (within a few feet of the wells) was either dry or only slightly damp. In another large excavation which remained open for several days, no groundwater or saturated soil was observed in the excavation at any time.

Based on these observations, water occurrence in onsite monitoring wells appears to be due to stormwater that infiltrates shallow permeable fill or the well screen filter packs and then settles in the clay-surrounded well screen/filter packs in the same manner as water collecting in a sump. These observations indicate that the water observed is from very small, localized, perched zones which form on top of the clay unit. Furthermore, given the low permeability of the Vanda Clay [1 x 10^{-8} centimeters per second (cm/s) (Appendix I)], it is unlikely that significant seepage of groundwater occurs in the clay unit, even under saturated conditions.

4.2.4 Surface Water and Drainage

An approximately 3-foot-wide by 2-foot-deep drainage ditch approaches the site from the west then veers northeasterly across the vacant field adjacent to the site's northwestern boundary (Figure 2). The ditch enters the railyard approximately 1,500 feet to the west of I-15 where a culvert crosses under the railroad tracks from the Shelby business district. Stormwater runoff is conveyed through the ditch during storm events. No other streams or rivers are located within .5 mile of the site. The Shel-Oole Reservoir is located approximately 1 mile to the north, and Virden Lake is located about 3 miles to the northwest (Figure 1).

Observations of the site during relatively heavy precipitation events in 2006 indicate that stormwater runoff and runon are minimal. As described below in Section 4.2.5, Shelby receives, on average, only 12 inches of precipitation per year, which primarily occurs as sporadic thundershowers during the summer. This precipitation percolates rapidly into shallow fill or collects for a short time in puddles along Central Avenue. Because storm events are relatively short and punctuated by periods of warm temperatures, runoff that collects in puddles along Central Avenue quickly evaporates

By ordinance, the City of Shelby has designated areas along the BNSF rail corridor as susceptible to flooding. A map showing potential flood hazard areas is provided in Appendix C. Available Federal Emergency Management Act (FEMA) flood insurance

rate maps for Toole County do not show flood hazard areas within Shelby corporate limits including the site.

4.2.5 Climatological Data

The Shelby area is designated as semiarid with annual precipitation averaging approximately 12 inches. The period of highest rainfall is typically between May and August when average air temperatures range from 48.6 degrees Fahrenheit (°F) to 79.8 °F, and storms consist of localized thunder showers. During the winter, average temperatures range from 8.4 °F to 34 °F. The average annual snowfall is approximately 23 inches, with most snowfall occurring between January and March. Westerly wind is common throughout the year, with gusts often reaching 50 miles per hour (Weather Underground 2006).

4.2.6 Site Features

The Shelby railyard and depot are currently used for locomotive crew changes, switching operations, and Amtrak passenger traffic. Onsite structures include the depot, a small brick building formerly used as a diesel fuel pump house, a portable trailer used as an office, a cargo container used for equipment storage, three communication towers, and several tracks. Concrete supports and the northern abutment of the I-15 overpass are also present in the western half of the site. Former site structures reportedly included a water tower, a water softening plant, and a small carpentry shop.

Numerous underground utilities are present west of the depot, including natural gas lines, water mains, electrical cables, and fiber optic cables. A trunk-line fiber optic cable that supports international border crossings to the north and most cable communications in the city of Shelby are present in the approximate center of the site (Figure 3).

Former and existing site features related or potentially related to former fueling operations include the following:

described in this VCP. Based on the locations of other facilities identified by EDR, it is unlikely that they have affected site soil and groundwater conditions.

4.3 AREA WELLS

An environmental assessment described in this section must include the location of any wells located on the site or on areas within a ½-mile radius of the site and a description of the use of those wells [MCA Section 75-10-734(2)(c)].

4.3.1 Offsite Wells

According to current records maintained by the Montana Department of Natural Resources and Conservation (DNRC) and Bureau of Mines and Geology Groundwater Information Center, 30 monitoring wells are located within approximately 0.5 mile of the site. The nearest water supply well reported by the DNRC is located approximately 1 mile northeast of the site in Section 22 and appears to be used for irrigation. The city of Shelby reportedly obtains its water supply from wells located near the Marias River, approximately 7 miles south of the city. Offsite well locations are shown on Figure 1, and construction details for the wells are summarized in Table 2. Copies of well logs obtained from the DNRC are provided in Appendix G.

4.3.2 Onsite Wells

Six monitoring wells have been constructed onsite in the locations shown on Figure 2. The depths of the wells range from 7 to 16 feet, with the well screens ranging from 3 to 5 feet long. As described above, groundwater encountered in the wells appears to be due to infiltration of stormwater runoff into surface soil and shallow fill around the well casings and not due to lateral migration into the deeper portions of the screens. Boring/construction logs for onsite monitoring wells are provided in Appendix H.

4.4 GROUNDWATER AND SURFACE WATER USAGE

An environmental assessment described in this section must include a description of the current and reasonably anticipated future use of onsite ground and surface water [MCA Section 75-10-734(2)(d)].

4.4.1 Groundwater Usage

The lack of water supply wells in the vicinity of Shelby suggests that groundwater is not a practical water supply source in the area. Although a small quantity of water has been encountered in site monitoring wells, these small volumes appear to be due primarily to infiltrated stormwater and do not indicate the presence of a practical source for either drinking or irrigation. Furthermore, because the site is to remain a railyard for the foreseeable future, there are no plans for exploration or use of deeper groundwater sources, if present.

Administrative Rules of Montana (ARM) Chapter 17.30.1006 classifies groundwater based on natural specific conductance measured at 25 degrees Celsius (°C). Although only a small quantity of water has been recovered from site monitoring wells, which readily purge dry and cannot produce a sustained yield, specific conductance of the water was measured at one of the wells during one sampling event. In July 2004, the specific conductance measured at monitoring well SH-1 [with minimal purging (approximately 0.2 gallons)] was 3,460 microSiemens per centimeters (µS/cm). Based on this specific conductance value, groundwater at the site would be classified as Class III as defined in Administrative Rules of Montana (ARM) 17.30.1006. [Note: Class III groundwaters are those groundwaters with a natural specific conductance greater than 2,500 µS/cm and less than or equal to 15,000 µS/cm at 25 °C.

4.4.2 Surface Water Usage

As described above, surface water near the site consists only of intermittent flows in a small stormwater drainage ditch in the vacant field to the northwest. Shel-Oole Reservoir (located north of Shelby) is reportedly used for recreation and drinking water Virden Lake, located approximately 3 miles northwest of the site, is used for recreation.

4.5 OPERATIONAL HISTORY OF THE SITE

An environmental assessment described in this section must include a description of the operational history of the facility, including ownership, and the current use of the facility, including any readily available aerial photographs from within the State of Montana [MCA Section 75-10-734(2)(e)].

This section summarizes the history of the site based on a review of available records, historical maps, and aerial photographs. Kennedy/Jenks Consultants reviewed MDOT aerial photographs of the site and surrounding vicinity for the years 1961, 1968, and 1977. MDOT and other photographs taken by Kennedy/Jenks Consultants are presented in Appendix D.

4.5.1 Site History

In 1892, the Great Northern Railway (GN) established Shelby Junction while extending its standard gauge railroad westward from Havre. Initially, the railyard consisted of a depot located approximately 500 feet east of the current depot building. With the exception of the former and current depot buildings, relatively few other structures have been built throughout the railyard's history because of its limited uses including locomotive crew changes, passenger loading, switching, and fueling (Kennedy/Jenks Consultants 1987). Station maps indicate that the only other significant historical structures on or adjacent to the site boundary included a small carpentry shop, a water tower, and the approximately 50-foot-diameter AST west of I-15.

4.6.4 June/July 2004 Investigations

Seven soil borings (GP-32 and SH-1 through SH-6) were advanced at the site in June 2004 using direct-push drilling techniques. Soil boring GP-32 was advanced north of the eastern end of the western fueling stanchion area to a depth of 8 feet bgs. Six of the borings, SH-1 through SH-6, were completed as monitoring wells ranging in depth from 8 to 16 feet bgs. The wells were constructed using 0.75-inch diameter, 0.010-inch slotted, PVC well screens pre-packed with size 10/20 silica sand and wrapped with stainless-steel wire mesh. PVC blank casing was installed from the top of each screen to the ground surface and sealed within the 2-inch diameter well boring using hydrated bentonite granules. Cast-iron, flush-mounted well monuments set in Portland cement were placed around the riser pipes, extending from 1 foot bgs to the ground surface. A licensed land surveyor surveyed the well locations and casing elevations. Locations of the monitoring wells and boring GP32 are shown on Figure 2.

Continuous soil samples obtained from the 2-inch diameter well borings and boring GP-32 were field tested for organic vapor using a PID and observed for the presence of sheens.

In July 2004, groundwater samples were collected from wells SH-1, SH-2, SH-3, and SH-5. The wells were not purged because very little water was present in the casings and did not recharge at a sufficient rate. Field parameters including pH, temperature, specific conductance, dissolved oxygen, and oxidation-reduction (redox) potential were measured at well SH-1. Groundwater samples were not collected from wells SH-4 and SH-6 because the wells were dry at the time of sampling. The groundwater samples were submitted to NCA for EPH screen and VPH/MBTEXN analysis by Montana EPH screen and VPH Methods. Sufficient volumes of water for further analyses were not available.

boring GP-21 (Figure 2)] are not described because the facility is being addressed by others.

- No odors or stains were observed in test pits TP-6 and TP-7, advanced near the western end of the former fueling stanchion platform.

- In 2003, samples from soil borings GP-5, GP-6, GP-10, GP-15, and GP-20 were analyzed using EPH screen analysis. No EPH were detected.

4.7.3 Groundwater

Perched groundwater (potentially related to localized stormwater infiltration) has been observed in only four of six onsite monitoring wells (SH-1, SH-2, SH-4, and SH-5) at depths up to 14 feet bgs. However, as discussed above, the source of water observed in some of the wells appears to be downward vertical migration from surface fill materials. This interpretation is based on the large variations in the depth of observed well casing water and observations of excavations at the site wherein no groundwater was encountered, even after the excavations remained open for a period of days. Therefore, groundwater analytical results discussed below may be representative of conditions in the shallow fill and not necessarily representative of conditions at the apparent depth of water in the wells. Furthermore, it appears that the shallow saturated zone conditions represented by individual groundwater analytical results are localized to within only a few feet of each well casing.

One round of groundwater monitoring was conducted at the site in July 2004, which included collection of samples from wells SH-1, SH-2, SH-4, and SH-5. Purging of the wells prior to sampling was either limited or not conducted because of the extremely slow rate of recharge to the well casings. The results of groundwater analysis are summarized below and in Table 7.

- Monitoring well SH-1 is 7 feet deep with a well screen extending between 2 and 7 feet bgs. The upper 2 feet of the well screen is positioned in coarse-grained

fill materials. The bottom 3 feet is surrounded by clay. When the well was sampled in July 2004, the depth to water prior to sampling was 2 feet bgs. The EPH screen concentration detected in the water sample was 7.52 milligrams per liter (mg/L). Other results included a total VPH concentration of 0.167 mg/L, a naphthalene concentration of 1.4 micrograms per liter (µg/L), and a C9-C18 aliphatics concentration of 0.366 mg/l.

- Monitoring well SH-2, located approximately 10 feet west of SH-1, is 15 feet deep and screened entirely within the Vanda Clay between 12 and 15 feet bgs. At the time of sampling, the depth to water in the well was approximately 12 feet bgs. The EPH screen concentration detected in the SH-2 sample was 0.752 mg/L. Fractionated EPH/VPH and MBTEXN were not detected.

- Monitoring well SH-4 next to the southwestern corner of the former fuel pump house building is 8 feet deep and screened between 2 and 7 feet bgs. At the time of sampling in 2004, the depth to water in the well was 5 feet bgs. The sample contained an EPH screen concentration of 1.07 mg/L. No fractionated EPH/VPH or MBTEXN compounds were detected.

- Monitoring well SH-5, located approximately 10 feet west of SH-4, is 16 feet deep and screened between 13 and 16 feet bgs. At the time of sampling, the depth to water in the well was approximately 13 feet bgs. No petroleum hydrocarbon compounds were detected in the groundwater sample.

4.8 HUMAN AND ENVIRONMENTAL EXPOSURE

An environmental assessment described in this section must include a description of the human and environmental exposure to releases or threatened releases of hazardous or deleterious substances at the facility based upon the current use of the facility and adjacent properties and any reasonably anticipated future uses of the facility [MCA Section 75-10-734(2)(i)].

TABLE 2

WELLS WITHIN 0.5 MILE OF THE SITE
BN Shelby Site

Map ID	GWIC[a] ID	DNRC[b] Water Right	Well Owner/Well Name	Location	Well Use	Total Depth (feet)	Screen Interval (feet bgs)	Well Diameter (in.)	Screen Description	Static Water Depth (feet)	Driller	Date Completed
1	125369	NA[c]	MOORE TRUCK STOCK - SHELBY	32N 02W 21 DD	Monitoring	16	--[d]	2	.02 SLOT SCREEN	1	BOLAND	14-Nov-91
1	125370	NA	MOORE TRUCK STOP - SHELBY	32N 02W 21 DD	Monitoring	16	--	2	.02 SLOT SCREEN	1	BOLAND	14-Nov-91
1	135043	NA	MOORES TRUCK STOP SPTO-01 * 3	32N 02W 21 DDC	Monitoring	12	--	--	--	--	--	7-Oct-92
1	135045	NA	MOORES TRUCK STOP SPTO-01 * 4	32N 02W 21 DDC	Monitoring	12	--	--	--	--	--	7-Oct-92
1	135046	NA	MOORES TRUCK STOP SPTO-01 * 5	32N 02W 21 DDC	Monitoring	12	--	--	--	--	--	7-Oct-92
1	135047	NA	MOORES TRUCK STOP SPTO-01 * 6	32N 02W 21 DDC	Monitoring	12	--	--	--	--	--	7-Oct-92
1	135049	NA	MOORES TRUCK STOP SPTO-01 * 7	32N 02W 21 DDC	Monitoring	12	--	--	--	--	--	7-Oct-92
1	135050	NA	MOORES TRUCK STOP SPTO-01 * 8	32N 02W 21 DDC	Monitoring	15	--	--	--	--	--	7-Oct-92
1	135051	NA	MOORES TRUCK STOP SPTO-01 * 9	32N 02W 21 DDC	Monitoring	13	--	--	--	--	--	7-Oct-92
1	135052	NA	MOORES TRUCK STOP SPTO-01 * 10	32N 02W 21 DDC	Monitoring	13	--	--	--	--	--	7-Oct-92
1	135054	NA	MOORES TRUCK STOP SPTO-01 * 11	32N 02W 21 DDC	Monitoring	25	--	--	--	--	--	7-Oct-92
1	135055	NA	MOORES TRUCK STOP SPTO-01 * 12	32N 02W 21 DDC	Monitoring	13	--	--	--	--	--	7-Oct-92
2	159444	NA	SHELBY SIGN 6TH AVE FRONT ST	32N 02W 21 DDD	Monitoring	23.5	--	--	--	--	LLOYD	9-Sep-96
3	180411	NA	MT SALINITY CONTROL ASSOC SPTO-11 #1	32N 02W 22 CCAA	Monitoring	20	--	--	--	--	JV RL	7-Sep-99
3	180410	NA	MT SALINITY CONTROL ASSOC SPTO-11 #2	32N 02W 22 CCAA	Monitoring	15	--	--	--	--	JV RL	7-Sep-99
3	180409	NA	MT SALINITY CONTROL ASSOC SPTO-11 #3	32N 02W 22 CCAA	Monitoring	20	--	--	--	--	JV RL	7-Sep-99
3	180408	NA	MT SALINITY CONTROL ASSOC SPTO-11 #4	32N 02W 22 CCAA	Monitoring	20	--	--	--	--	JV RL	7-Sep-99
3	180407	NA	MT SALINITY CONTROL ASSOC SPTO-11 #5	32N 02W 22 CCAA	Monitoring	7	--	--	--	--	JV RL	7-Sep-99
3	180406	NA	MT SALINITY CONTROL ASSOC SPTO-11 #6	32N 02W 22 CCAA	Monitoring	15	--	--	--	--	JV RL	7-Sep-99
3	220304	NA	MT SALINITY CONTROL ASSOC SPTO-11 Well 1	32N 02W 22 CCAA	Monitoring	20	--	--	steel	--	--	25-May-05
3	220305	NA	MT SALINITY CONTROL ASSOC SPTO-11 Well 4	32N 02W 22 CCAA	Monitoring	20	--	--	steel	--	--	25-May-05
3	220307	NA	MT SALINITY CONTROL ASSOC SPTO-11 Well 7	32N 02W 22 CCAA	Monitoring	20	--	--	steel	--	--	25-May-05
3	220308	NA	MT SALINITY CONTROL ASSOC SPTO-11 Well 8	32N 02W 22 CCAA	Monitoring	20	--	--	steel	--	--	25-May-05
4[e]	88811	62742	KLEINERT WILLIAM	32N 02W 22 DBA	Irrigation	40	--	4	--	14	Drilco	1-Jan-86
5	162892	NA	TOOLE COUNTY SHOP - MW-1	32N 02W 27 CC	Monitoring	14	--	2	020 SLOT	4.3	OKEEFE	12-Sep-96
5	162886	NA	TOOLE COUNTY SHOP - MW-2	32N 02W 27 CC	Monitoring	14	--	2	020 SLOT	4.7	OKEEFE	12-Sep-96
5	162891	NA	TOOLE COUNTY SHOP - MW-3	32N 02W 27 CC	Monitoring	14	--	2	020 SLOT	4.3	OKEEFE	12-Sep-96
6	173736	NA	MT SALINITY CONTROL ASSOC *SPTO-05 #1	32N 02W 27	Monitoring	19	--	--	SLOTTED	--	JV SB	21-Oct-97
7	173835	NA	MT SALINITY CONTROL ASSOC * SPTO-08 #1	32N 02W 27 BC	Monitoring	13	--	--	SCREEN	--	SB & RL	17-Nov-98
7	173836	NA	MT SALINITY CONTROL ASSOC *SPTO-08 #2	32N 02W 27 BC	Monitoring	13	--	--	SCREEN	--	SB & RL	17-Nov-98
7	173837	NA	MT SALINITY CONTROL ASSOC *SPTO-08 #3	32N 02W 27 BC	Monitoring	13	--	--	SCREEN	--	SB & RL	17-Nov-98

Notes

(a) Ground-Water Information Center, Montana Bureau of Mines and Geology

(b) Montana Department of Natural Resources and Conservation, Water Rights List

(c) NA = Not Applicable

(d) "--"denotes information not available in well records

(e) This well is located outside of the ½ mile radius. The well is included because it is the only water supply well identified within one mile of the site

TABLE 7

GROUNDWATER ANALYTICAL RESULTS
BN Shelby Site

Well Location	SH-1	SH-2	SH-4	SH-5
Well Depth (feet)	7	15	8	16
VPH[a] (mg/L)[b]				
C5-C8 Aliphatics	<0.020[c]	<0.050	<0.050	<0.100
C9-C12 Aliphatics	**0.0802**	<0.050	<0.050	<0.100
C9-C10 Aromatics	**0.0819**	<0.050	<0.050	<0.100
Total VPH	**0.167**	<0.050	<0.050	<0.100
MBTEXN[a] (µg/L)[d]				
Benzene	<0.500	<1.25	<1.25	<2.50
Toluene	<0.500	<1.25	<1.25	<2.50
Ethylbenzene	<0.500	<1.25	<1.25	<2.50
Total xylenes	<1.00	<2.50	<2.50	<5.00
Methyl-t-butyl-ether	<1.00	<2.50	<2.50	<5.00
Naphthalene	**1.4**	<2.50	<2.50	<5.00
EPH Screen[e] (mg/L)	**7.52**	**0.787**	**1.07**	<2.31
EPH[f] (mg/L)				
C9-C18 Aliphatics	**0.366**	<0.568	<0.806	NA[g]
C19-C36 Aliphatics	<0.338	<0.568	<0.806	NA
C11-C22 Aromatics	<0.338	<0.568	<0.806	NA
Total EPH	<1.01	<1.70	<2.42	NA

Notes:

(a) Groundwater samples were analyzed for volatile petroleum hydrocarbons (VPH) and methyl-t-butyl-ether, benzene, toluene, ethylbenzene, xylenes, and naphthalene (MBTEXN) by the Massachusetts Department of Environmental Protection (MADEP) VPH Method.

(b) mg/L = milligrams per liter.

(c) "<" indicates that the analyte was not detected at a concentration greater than the specified laboratory reporting limit.

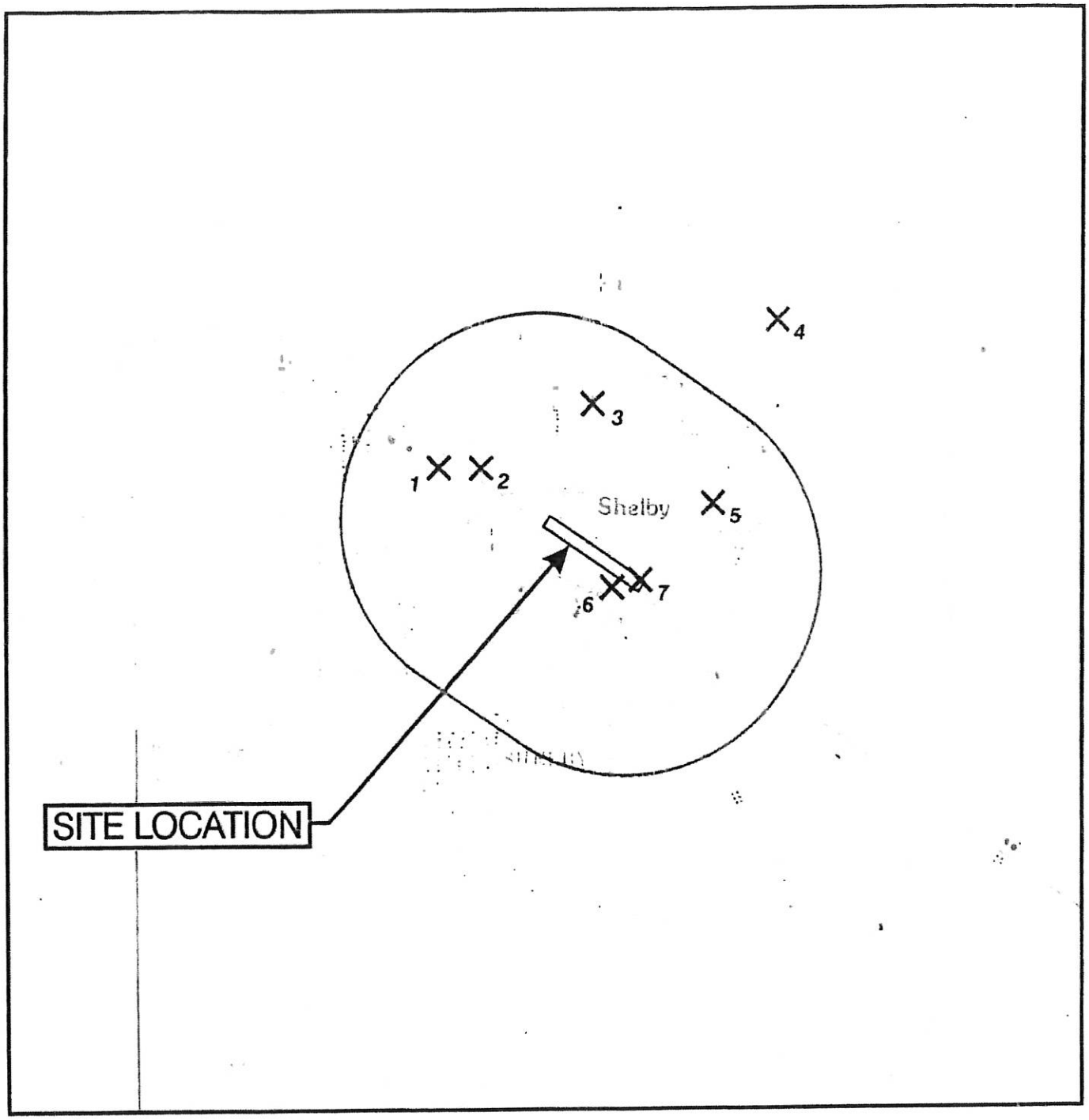
(d) µg/L = micrograms per liter.

(e) Groundwater samples were screened for extractable petroleum hydrocarbons (EPH) using modified EPA Method 8015. The EPH screening method is a screening technique for EPH analysis via the Montana Method. Higher detection limits for both EPH analyses (screen and MADEP Method) were reported for all samples as the required water volume for these analyses could not be collected from the wells.

(f) Groundwater samples were analyzed for EPH by the MADEP EPH Method. (Also see footnote e.)

(g) "NA" = Not analyzed.

Detected concentrations are shown in bold.



LEGEND

X2 APPROXIMATE LOCATION OF OFFSITE WELL BASED ON DNRC WELL LOGS

½-MILE RADIUS FROM SITE BOUNDARY

0 1000 2000

APPROXIMATE SCALE IN FEET

N

REFERENCE

USGS 7.5' TOPOGRAPHIC QUADRANGLES
LEDGER NW (1967), NAISMITH (1967), SHELBY (1986),
AND VIRDEN (1986), MONTANA

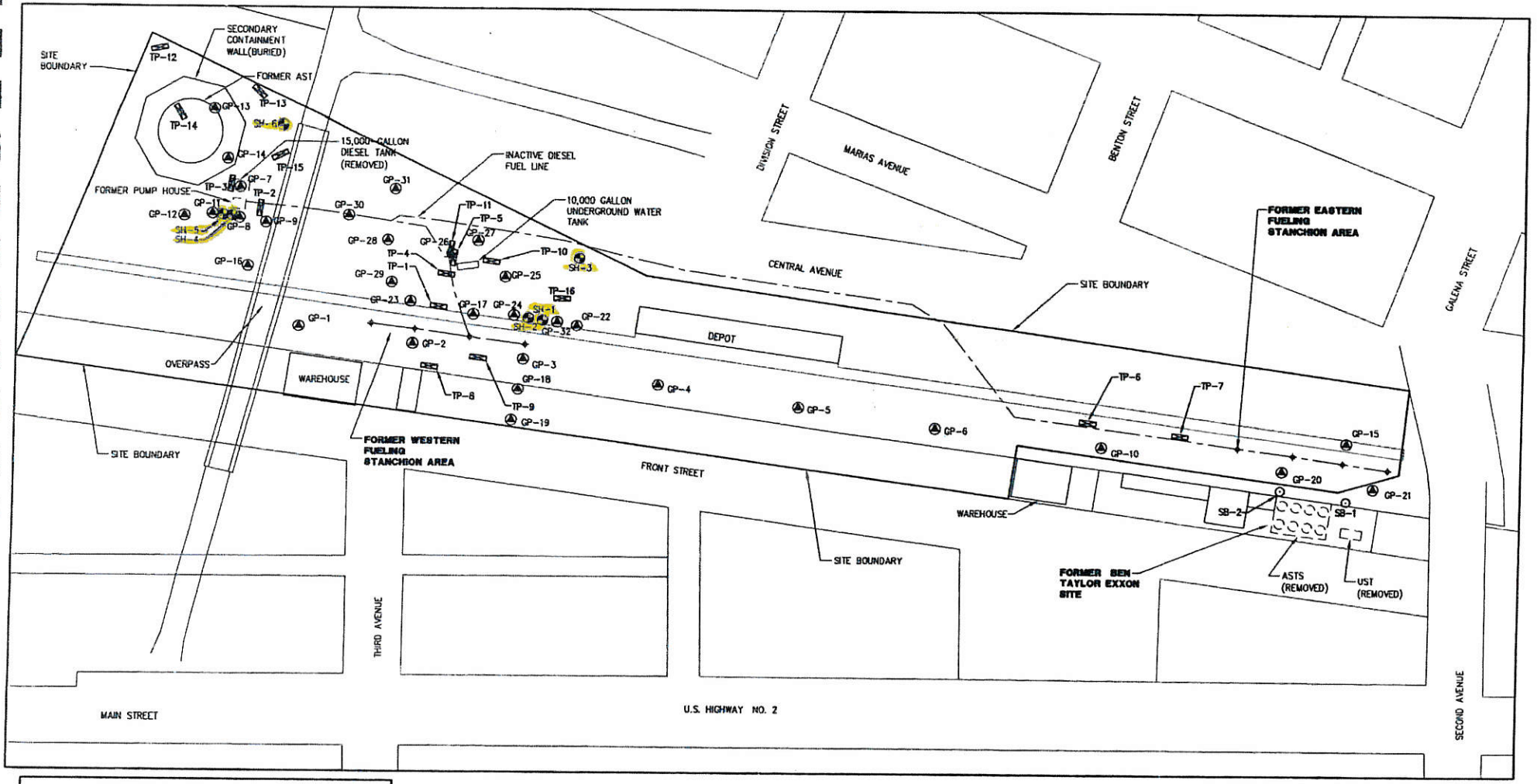
Kennedy/Jenks Consultants

BURLINGTON NORTHERN FUELING FACILITY
SHELBY, MT

SITE AND WATER SUPPLY WELL LOCATIONS

0796021.06/VCP/P07SK001

FIGURE 1



LEGEND:

⏃	SOIL CORING LOCATION
TP-7	TEST PIT LOCATION
SB-1	SOIL BORING LOCATION
SH-5	MONITORING WELL LOCATION
⌖	FORMER FUELING STANCHION LOCATION

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. REFERENCE: GREAT NORTHERN RAILWAY, JUNE 1979, SHELBY NO. 1 STATION PLAT, TOOLE COUNTY, MONTANA

0 50 100
APPROXIMATE SCALE IN FEET

N

Kennedy/Jenks Consultants

BURLINGTON NORTHERN FUELING FACILITY
SHELBY, MT

SITE FEATURES AND CHARACTERIZATION SAMPLING LOCATIONS

0796021.06\VCP\P06SK002

FIGURE 2

Project BN Site Shelby, MT **TEST PIT** 1 Sh 1 of 1

Date 9/16/87 Location _____ Ground Elevation _____

Total Depth 8½ Contractor TOM ROE & SON

Equipment Used Case 1080 Logged by M P [illegible]

Remarks _____

Elev. Feet	Depth Feet	Sample Type & No. / Depth Range	Stratigraphy	Description & Comments
				RED ROCK - BALLAST 0-½'
	1			
	2			FILL [illegible] - SANDY GRAV[illegible] ½'-7½'
	3			
	4			STRONG DIESEL ODOR 5'-7½'
	5			
	6	▽		
	7			8" CLAY SEWER [illegible] 7½'
	8			BROWN CLAY - MOIST
				8½" BOTTOM OF EXCAVATION
				NOTE:
				EXCAVATED ALONG SEWER
				[illegible]
				[illegible] - 3' [illegible]
				[illegible]
				ALSO [illegible] TWO [illegible] (DE[illegible])

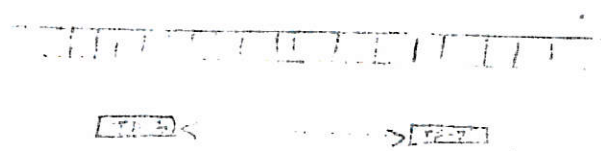
Test Pit Plan

Groundwater

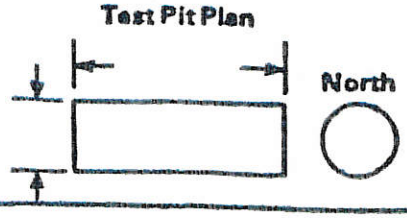
Date	Time (Hours After Completion)	Depth (Feet)

Project GN **Site** Shelby **TEST PIT** 7 **Sh** 1 **of** 1
Date 9/16/87 **Location** E of Depot - 100 ft E of TP-6 **Ground Elevation**
Total Depth 7 **Contractor** TOM RDE
Equipment Used Case 1080 **Logged by** M P Kapala
Remarks

Elev. Feet	Depth Feet	Sample Type & No. / Depth Range	Stratigraphy	Description & Comments
				0-1½ Misc Fill (Red Rock - 6"/Sandy Gravel)
	1			
	2			1½-3½ Clay/[illegible] with [illegible]
	3			
	4			
	5			3½-7 Grey/black clay - Very Plastic
	6			• No odor
	7			• No [illegible]
	8			



Test Pit Plan



Groundwater

Date	Time (Hours After Completion)	Depth (Feet)

Project BN Site Shelby **TEST PIT 8** Sh ___ of ___

Date 9/16/87 Location 20' South of Tracks - Across from TP-1 Ground Elevation ___

Total Depth 6 Contractor Tom Roe

Equipment Used CASE 580 Logged by M. P. Kapalka

Remarks ___

Elev. Feet	Depth Feet	Sample Type & No. / Depth Range	Stratigraphy	Description & Comments
	1			0-2½ Sand Gravel Fill
	2			2½-3½ Cinders mixed with gravel Water flowing in at 2'8" through cinder layer Faint odor(?) at bottom of cinder
	3			
	4			3½-6½ Grey Black Clay high Plasticity
	5			
	6			6½ Bottom of Excavation
	7			

Test Pit Plan

North

Groundwater		
Date	Time (Hours After Completion)	Depth (Feet)

Kennedy/Jenks/Chilmark

Project BW Site Shelby **TEST PIT** 9 Sh 1 of 1

Date 9/16/87 Location 50' East of TP-8 South of tracks Ground Elevation

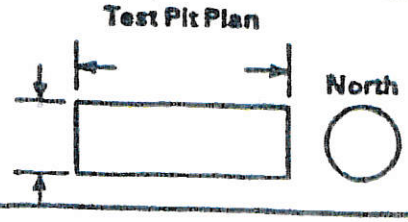
Total Depth 6' Contractor TOM ROE

Equipment Used Case 580 Logged by M P Kapalal

Remarks

Elev. Feet	Depth Feet	Sample Type & No. / Depth Range	Stratigraphy	Description & Comments
	1			0-3½' Rubble/sandy gravel with [illegible] and burned wood.
	2			
	3			3½-3¾' Cinders - Water flowing
	4	▽		3¾-6 Black sandy clay Moderately plastic Odor (Not typical of diesel)
	5			
	6			6' Bottom of [illegible]

Test Pit Plan



Groundwater

Date	Time (Hours After Completion)	Depth (Feet)

Kennedy/Jenks/Chilt

Project BN Site Shelby **TEST PIT** TP-10 Sh 1 of 1

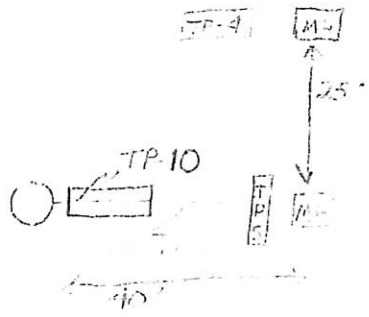
Date 9/14/87 Location Alona Sewer Trench Ground Elevation

Total Depth 9' Contractor TOM POE

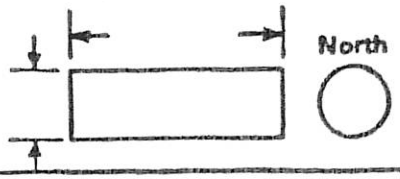
Equipment Used Case 1080 Logged by M P Kapala

Remarks

Elev. Feet	Depth Feet	Sample Type & No. / Depth Range	Stratigraphy	Description & Comments
	1			0-1 Red Rock
	2			1-4 Sandy Gravel - some stones to 1½"
	3			
	4			
	5			4-9 Grey/Black Clay - No odor Moderate Plastic
	6			
	7			Sewer at ≈ 8½ feet
	8			Fill is clay
	9			BOTTOM OF EXCAVATION



Test Pit Plan



Groundwater		
Date	Time (Hours After Completion)	Depth (Feet)

Well Completion Logs

Boring & Well Construction Log

Kennedy/Jenks Consultants

BORING LOCATION: 126 FT W OF DEPOT, 5 FT N OF WALK	DRILLER: E. HANDL
DRILLING COMPANY: ATLATL, INC	DRILL BIT(S) SIZE: 2 1/4" O.D.
DRILLING METHOD(S): GEOPROBE CORING	ISOLATION CASING: N/A — FROM N/A TO N/A FT
BLANK CASING: 0.75 inch Schd 40 PVC	FROM 0 TO 2 FT
SLOTTED CASING: 0.010 inch Slotted Schd 40 PVC	FROM 2 TO 7 FT
SIZE AND TYPE OF FILTER PACK: 20/40 Mesh Sand	FROM 1.6 TO 8 FT
SEAL: Bentonite Granules	FROM 0.5 TO 1.6 FT
GROUT: Concrete	FROM 0 TO 0.5 FT

Well Name: SH-1	
Project Name: BNSF-Shelby	
Project Number: 0496021.06	
ELEVATION AND DATUM	TOTAL DEPTH: 8.0 ft. bgs
DATE STARTED: 6/16/04	DATE COMPLETED: 6/16/04
INITIAL WATER DEPTH (FT): N/A	STATIC WATER ELEV (FT): N/A
LOGGED BY: M. GIBSON	
SAMPLING METHODS: 1.5" ID MACROCORE w/ ACETATE LINER	WELL COMPLETION: ■ SURFACE HOUSING; □ STAND PIPE ____ FT.

SAMPLES TYPE	RECOV (FEET)	PENETR. RESIST. BLOWS/6	DEPTH (FEET)	SAMPLE NUMBER	WELL CONSTRUCTION	PID	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
SS	3			7/21/04		12.9		GM	**Silty GRAVEL with sand (Fill)** reddish brown, silty gravel fill, grades to dark gray with cinders, moist, iridescent sheen or petroleum-like odor observed at 2.6 ft
SS	4		5			13 16.4 0.2		CL	**Lean CLAY** dark olive brown, some carbonaceous streaking, firm to stiff, moderate plasticity, moist to wet, iridescent sheen or petroleum-like odor decreases at 6 ft

NOTES

1. Iridescent sheen or petroleum-like odor observed from 2.6 ft to 6 ft bgs.
2. Monitoring well completed adjacent to GP-24
3. Shallow clustered monitoring well completed adjacent to SH-2

KJ PNW 0496021.05 WELLS.GPJ KJ PNW.GDT 10/12/05

F-40 1
(6-87) (3-88) (8-90)

Boring & Well Construction Log

Kennedy/Jenks Consultar

BORING LOCATION: 126 FT W OF DEPOT, 5 FT N OF WALK	Well Name: SH-2
DRILLING COMPANY: ATLATL, INC	DRILLER: E. HANDL
DRILLING METHOD(S): GEOPROBE CORING	DRILL BIT(S) SIZE: 2 1/4" O.D.
ISOLATION CASING: 3 1/4 Steel Rod	FROM 0 TO 6 FT
BLANK CASING: 0.75 inch Schd 40 PVC	FROM 0 TO 12 FT.
SLOTTED CASING: 0.010 inch Slotted Schd 40 PVC	FROM 12 TO 15 FT.
SIZE AND TYPE OF FILTER PACK: 20/40 Mesh Sand	FROM 11 TO 15 FT.
SEAL: Bentonite Granules	FROM 1 TO 11 FT.
GROUT: Concrete	FROM 0 TO 1 FT.
Project Name: BNSF-Shelby	
Project Number: 0496021.06	
ELEVATION AND DATUM	TOTAL DEPTH: 15.0 ft. bgs
DATE STARTED: 6/16/04	DATE COMPLETED: 6/16/04
INITIAL WATER DEPTH (FT): N/A	STATIC WATER ELEV. (FT): N/A
LOGGED BY: M. GIBSON	
SAMPLING METHODS: NOT SAMPLED	WELL COMPLETION: ■ SURFACE HOUSING ☐ STAND PIPE____ FT

SAMPLES TYPE	RECOV (FEET)	PENETR. RESIST. BLOWS/6	DEPTH (FEET)	SAMPLE NUMBER	WELL CONSTRUCTION	PID	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
								GM	**Silty GRAVEL with sand (Fill)** reddish brown, silty gravel fill, grades to dark gray with cinders, moist, iridescent sheen or petroleum-like odor observed at 2.6 ft .
			5					CL	**Lean CLAY** dark olive brown, some carbonaceous streaking, firm to stiff, moderate plasticity, moist to wet, iridescent sheen or petroleum-like odor decreases at 6 ft
			10	7/21/04					
			15					CL/ CH	**Lean to Fat CLAY** yellowish brown, soft, high plasticity

NOTES

1. Lithologic descriptions use information from GP-24 and SH-1
2. 3 1/4 inch steel conductor casing set to 6 ft bgs. Advance borehole to depth with 2 1/4 inch drive rod with expendable tip.
3. Iridescent sheen or petroleum-like odor observed in SH-1 from 2.6 ft to 6 ft bgs.
4. Deep clustered monitoring well completed adjacent to SH-1.

KJ PNW 0496021.06 WELLS.GPJ KJ PNW.GDT 10/12/05

F-40.1
(6-87) (3-88) (6-90)

Boring & Well Construction Log

Kennedy/Jenks Consultan

BORING LOCATION: 129 FT W OF DEPOT, 42 FT N OF WALK	
DRILLING COMPANY: ATLATL, INC	DRILLER: E. HANDL
DRILLING METHOD(S): GEOPROBE CORING	DRILL BIT(S) SIZE: 2 1/4" O.D
ISOLATION CASING: N/A	FROM N/A TO N/A FT
BLANK CASING: 0.75 inch Schd 40 PVC	FROM 0 TO 2 FT.
SLOTTED CASING: 0.010 inch Slotted Schd 40 PVC	FROM 2 TO 7 FT.
SIZE AND TYPE OF FILTER PACK: 20/40 Mesh Sand	FROM 1.5 TO 8 FT.
SEAL: Bentonite Granules	FROM 0.5 TO 1.5 FT
GROUT: Concrete	FROM 0 TO 0.5 FT

Well Name	SH-3
Project Name	BNSF-Shelby
Project Number	0496021.06
ELEVATION AND DATUM	TOTAL DEPTH: 8.0 ft. bgs
DATE STARTED: 6/16/04	DATE COMPLETED: 6/16/04
INITIAL WATER DEPTH (FT): N/A	
LOGGED BY: M. GIBSON	
SAMPLING METHODS: 1.5" ID MACROCORE w/ ACETATE LINER	WELL COMPLETION: ■ SURFACE HOUSING; □ STAND PIPE_____ FT.

SAMPLES TYPE	RECOV (FEET)	PENETR. RESIST. BLOWS/6"	DEPTH (FEET)	SAMPLE NUMBER	WELL CONSTRUCTION	PID	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
								GM	**Silty GRAVEL with sand (Fill)** brown, silty angular gravel fill, damp
SS	3.7					0.1			**Lean CLAY** dark olive brown, some carbonaceous streaking, firm to stiff, low plasticity increasing to moderate plasticity at 6.2 ft, moist to wet, no iridescent sheen or petroleum-like odor observed
						0.1			
SS	4		5			0.1		CL	2 inch yellowish orange clay lenses at 1.0 and 1.7 ft
						0.1			

NOTES
1. No iridescent sheen or petroleum-like odor observed in borehole.
2. Shallow monitoring well located downgradient of SH-1/SH-2 well cluster.
3. Well was dry on 7/21/04.

KJ PNW 0496021.06 WELLS.GPJ KJ PNW.GDT 10/12/05

F-40 1
(6-87) (3-88) (8-90)

Boring & Well Construction Log

Kennedy/Jenks Consultan

BORING LOCATION: 10 FT S OF SW CORNER OF PUMPHOUSE	
DRILLING COMPANY: ATLATL, INC	DRILLER: E. HANDL
DRILLING METHOD(S): GEOPROBE CORING	DRILL BIT(S) SIZE: 2 1/4" O.D.
ISOLATION CASING: N/A	FROM N/A TO N/A FT.
BLANK CASING: 0.75 inch Schd 40 PVC	FROM 0 TO 2 FT.
SLOTTED CASING: 0.010 inch Slotted Schd 40 PVC	FROM 2 TO 7 FT.
SIZE AND TYPE OF FILTER PACK: 20/40 Mesh Sand	FROM 1.5 TO 8 FT.
SEAL: Bentonite Granules	FROM 0.5 TO 1.5 FT.
GROUT: Concrete	FROM 0 TO 0.5 FT.

Well Name	SH-4
Project Name	BNSF-Shelby
Project Number	0496021.06
ELEVATION AND DATUM	TOTAL DEPTH: 8.0 ft. bgs
DATE STARTED: 6/17/04	DATE COMPLETED: 6/17/04
INITIAL WATER DEPTH (FT): N/A	STATIC WATER ELEV. (FT): N/A
LOGGED BY: M. GIBSON	
SAMPLING METHODS: 1.5" ID MACROCORE w/ ACETATE LINER	WELL COMPLETION: ■ SURFACE HOUSING ☐ STAND PIPE ____ FT.

SAMPLES TYPE	RECOV (FEET)	PENETR. RESIST. BLOWS/6	DEPTH (FEET)	SAMPLE NUMBER	WELL CONSTRUCTION	PID	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
SS	3.5					ND		CL/ ML	**Sandy silty CLAY (Fill)** olive brown, reworked clay to silty clay with fine to medium angular gravel, with well graded sand from 0.7 to 1.4 ft, moist
						0.4			**Lean CLAY** olive brown, some carbonaceous streaking, with whitish clay infilling (root traces), firm to stiff, moderate plasticity, moist to wet, slight iridescent sheen or petroleum-like odor from 4 to 5.5 ft
SS	4		5	7/21/04		3.1		CL	
						0.4			
						0.1			softer from 5.5 to 7 ft

NOTES

1. Slight iridescent sheen or petroleum-like odor observed from 4.0 ft to 5.5ft bgs.
2. Monitoring well completed adjacent to GP-8 and GP-11.
3. Shallow clustered monitoring well completed adjacent to SH-5.

KJ PNW 0496021.06 WELLS.GPJ KJ PNW.GDT 10/12/05

F-40 1
(6-87) (3-88) (8-90)

Boring & Well Construction Log

Kennedy/Jenks Consultant

BORING LOCATION: 10 FT S OF SW CORNER OF PUMPHOUSE		Well Name: SH-5	
DRILLING COMPANY: ATLATL, INC	DRILLER: E. HANDL	Project Name: BNSF-Shelby	
DRILLING METHOD(S): GEOPROBE CORING	DRILL BIT(S) SIZE: 2 1/4" O.D.	Project Number: 0496021.06	
ISOLATION CASING: 3 1/4 Steel Rod	FROM 0 TO 7 FT.	ELEVATION AND DATUM	TOTAL DEPTH: 16.0 ft. bgs
BLANK CASING: 0.75 inch Schd 40 PVC	FROM 0 TO 13.1 FT.	DATE STARTED: 6/17/04	DATE COMPLETED: 6/17/04
SLOTTED CASING: 0.010 inch Slotted Schd 40 PVC	FROM 13.1 TO 16.1 FT.	INITIAL WATER DEPTH (FT): N/A	STATIC WATER ELEV (FT): N/A
SIZE AND TYPE OF FILTER PACK: 20/40 Mesh Sand	FROM 12 TO 16.1 FT	LOGGED BY: M. GIBSON	
SEAL: Bentonite Granules	FROM 1 TO 12 FT	SAMPLING METHODS: NOT SAMPLED	WELL COMPLETION: ■ SURFACE HOUSING □ STAND PIPE_____ FT.
GROUT: Concrete	FROM 0 TO 1 FT		

SAMPLES TYPE	SAMPLES RECOV (FEET)	SAMPLES PENETR. RESIST. BLOWS/6	DEPTH (FEET)	SAMPLE NUMBER	WELL CONSTRUCTION	PID	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
			0					CL/ ML	**Sandy silty CLAY (Fill)** olive brown, reworked clay to silty clay with fine to medium angular gravel, with well graded sand from 0.7 to 1.4 ft, moist
			5					CL	**Lean CLAY** olive brown, some carbonaceous streaking, with whitish clay infilling (root traces), firm to stiff, moderate plasticity, moist to wet, slight iridescent sheen or petroleum-like odor from 4 to 5.5 ft softer from 5.5 to 7 ft
			10						
			15		7/21/04				

NOTES

1. Lithologic descriptions use information from GP-8, GP-11 and SH-4.
2. 3 1/4 inch steel conductor casing set to 7 ft bgs. Advance borehole to depth with 2 1/4 inch drive rod with expendable tip.
3. Iridescent sheen or petroleum-like odor observed in SH-4 from 4.0 ft to 5.0 ft bgs.
4. Deep clustered monitoring well completed adjacent to SH-4.

KJ PNW 0496021.06 WELLS.GPJ KJ PNW.GDT 10/12/05

F-40.1
(6-87) (3-88) (8-90)

Boring & Well Construction Log

Kennedy/Jenks Consultants

BORING LOCATION: 120 FT N OF S SIDE OF PUMPHOUSE, 60 FT W OF OVERPASS	Well Name: SH-6
DRILLING COMPANY: ATLATL, INC	DRILLER: E. HANDL — Project Name: BNSF-Shelby
DRILLING METHOD(S): GEOPROBE CORING	DRILL BIT(S) SIZE: 2 1/4" O.D. — Project Number: 0496021.06
ISOLATION CASING: N/A	FROM N/A TO N/A FT.
BLANK CASING: 0.75 inch Schd 40 PVC	FROM 0 TO 2 FT.
SLOTTED CASING: 0.010 inch Slotted Schd 40 PVC	FROM 2 TO 7 FT.
SIZE AND TYPE OF FILTER PACK: 20/40 Mesh Sand	FROM 1.5 TO 8 FT.
SEAL: Bentonite Granules	FROM 0.5 TO 1.5 FT.
GROUT: Concrete	FROM 0 TO 0.5 FT.

ELEVATION AND DATUM	TOTAL DEPTH: 8.0 ft. bgs
DATE STARTED: 6/17/04	DATE COMPLETED: 6/17/04
INITIAL WATER DEPTH (FT): N/A	
LOGGED BY: M. GIBSON	
SAMPLING METHODS: 1.5" ID MACROCORE w/ ACETATE LINER	WELL COMPLETION: ■ SURFACE HOUSING ☐ STAND PIPE_____ FT.

SAMPLES TYPE	RECOV (FEET)	PENETR. RESIST. BLOWS/6"	DEPTH (FEET)	SAMPLE NUMBER	WELL CONSTRUCTION	PID	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
SS	3.5					ND		CL/ML	**Silty CLAY** olive brown and dusky yellowish brown, some plant fragments, firm to stiff, low plasticity, moist
						ND			**Lean CLAY** dark olive brown, some carbonaceous streaking, with whitish clay infilling (root traces), stiff, low to moderate plasticity, moist to wet, no iridescent sheen or petroleum-like odor observed
SS	4		5			ND		CL	softer from 6.2 to 7.4 ft

NOTES
1. No iridescent sheen or petroleum-like odor observed in borehole.
2. Shallow monitoring well located downgradient of SH-4/SH-5 well cluster.
3. Well was dry on 7/21/04.

KJ PNW 0496021.08 WELLS.GPJ KJ PNW.GDT 10/12/05

F-40 1
(6-87) (3-88) (8-90)

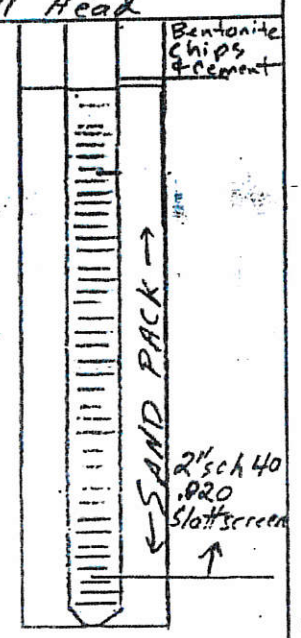
...ah, Rge...
...e County
...at Falls

BOLAND DRILLING COMPANY
SOIL BORING LOG AND WELL CONSTRUCTION RECORD

084454

Client	Neil Consultants, Inc.	Project I.D.	
Site	Shelby, MT - Moore Truck Stop	Well I.D.	#1
Boring I.D.	#1	Date Installed	11-14-91
Geologist/Engineer	Joe Murphy	Date Grouted	11-14-91
Drilling Method	Auger	Casing Material	2" sch 40 PVC
Sampling Method	Split spoon	Screen Material	2" sch 40 .020 slott
Date Started	11-14-91	Casing Interval	0'-1'
Date Completed	11-14-91	Screened Interval	1'-15'
Driller	Chris Boland MWC042	Sump Installed?	No
Borehole Diameter (in.)	8"	Well Depth (ft)	16'
Depth Drilled (ft)	16'	TOC Elevation (ft)	
Ground Elevation (ft)		Water Level (ft)	1'
Depth to Water (ft)	1'	Date Measured	11-14-91
Date Measured	11-14-91		

DEPTH (feet)	SAMPLE	BLOWS/FOOT	% REC.	HNu/OVA (ppm)	LITHOLOGIC DESCRIPTION	SOIL CLASS	GRAPHIC LOG	WELL DIAGRAM
0					0'-1' Gravel & Sand - Brown			Flush Mount Well Head
					1'-6' Sand, some gravel & Clay Brown & Gray			
5								
					6'-16' Sandy Clay - Gray			
10								
15								
20					CC			



MULTI.POT

INTERS PLUS • 727-3414

M:1253 104

32N Rge 2W
- County
ut Falls

BOLAND DRILLING COMPANY

SOIL BORING LOG AND WELL CONSTRUCTION RECORD

084455

Page 1 of 1

Client	Neil Consultants Inc.
Site	Shelby, MT - Maverick Truck Stop
Boring I.D.	#2
Geologist/Engineer	Joe Murphy
Drilling Method	Auger
Sampling Method	Split spoon
Date Started	11-14-91
Date Completed	11-14-91
Driller	Chris Boland (MWC042
Borehole Diameter (in.)	8"
Depth Drilled (ft)	16'
Ground Elevation (ft)	
Depth to Water (ft)	1'
Date Measured	11-14-91

Project I.D.	
Well I.D.	#2
Date Installed	11-14-91
Date Grouted	11-14-91
Casing Material	2" sch 40 PVC
Screen Material	2" sch 40 .020 slott
Casing Interval	0' - 1'
Screened Interval	1' - 15'
Sump Installed?	No
Well Depth (ft)	16'
TOC Elevation (ft)	
Water Level (ft)	1'
Date Measured	11-14-91

DEPTH (feet)	SAMPLE	BLOWS/FOOT	% REC.	HNu/OVA (ppm)	LITHOLOGIC DESCRIPTION	SOIL CLASS	GRAPHIC LOG	WELL DIAGRAM
0					0'-1' Gravel & Sand			Flush Mount Well Head
					1'-6' Sand, some gravel & clay - Brown & Gray			Bentonite Chips & Cement
5								
					6'-16' Sandy Clay - Gray			← SAND PACK →
10								
								2" sch 40 .020 Slott Screen ↑
15								
					CC			
20								

MULTI.POT

PRINTERS PLUS • 727-3414

M: 125370

101 32N 2W 22 DBA File No. 62742-g4.1.P

Form No. 603 (R 6-84)

Shelby NOV 19 1986

WELL LOG REPORT

Toole

State law requires that this form be filed by the water well driller within 60 days after completion

030677

MONTANA DEPT. OF NATURAL RESOURCES & CONSERVATION

1. WELL OWNER
Name William Kleinert

2. CURRENT MAILING ADDRESS
310 5th St. No
Shelby, Mt 59474

3. WELL LOCATION
County Toole
Township 32 (N)/S Range 2 E(W)
NE ¼ NW ¼ SE ¼ Section 22
Lot 15 Block 3
Subdivision Green-up/city of Shelby

4. PROPOSED USE Domestic ☐ Stock ☐ Irrigation ☒
Other ☐ specify

5. DRILLING METHOD ____ cable, ____ bored,
X forward rotary, ____ reverse rotary, ____ jetted,
____ other (specify)

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations ~~X~~ and/or Screen X Kind Size	From (feet)	To (feet)
7 7/8	10.4 pd 4" steel	+18"	-10	010 NWP	-10	-40
↓	4" PVC F480	-10	-40			

Was casing left open end? X Yes ____ No
Was a packer or seal used? X Yes ____ No
If so, what material Bentonite
Was the well gravel packed? X Yes ____ No
Was the well grouted? X Yes ____ No
To what depth? 10'
Material used in grouting Bentonite + puddled clay
Well head completion: Pitless adapter ____ Yes X No
Top of casing 12 in. or greater above grade X Yes ____ No

7. WHAT IS THE TEMPERATURE OF THE WATER?
45 Degrees Fahrenheit
☐ Measured ☒ Estimated

8. WATER LEVEL
Static water level 14 feet below land surface
If flowing; closed-in pressure ____ psi
____ gpm
Controlled by: ____ valve, ____ reducers,
____ other, (specify)

9. WELL TEST DATA X pump ____ bailer
____ other, (specify)
Pumping water level below land surface:
25 ft. after 12 hrs. pumping 5 gpm
____ ft. after ____ hrs. pumping ____ gpm

10. WAS WELL PLUGGED OR ABANDONED? ____ Yes X No
If yes, how?

11. DATE COMPLETED 10/8/86

12. WELL LOG

Depth (ft.) From	To	Formation
0	10	clay
10	22	sandy clay w/ sand lenses
22	31	sandy clay
31	38	sand
38	40	sandy clay

(use separate sheet if necessary)

13. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
10/8/86
Date
Montana Drilco
Firm Name
Box 674 WSS, Mt 59645
Address
[signature] 475
Signature License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION DNRC
32 SOUTH EWING HELENA, MONTANA 59620 444-6610

DEPARTMENT COPY
DRILLER: Please give this copy to the well owner to complete reverse side.
OWNER: Complete reverse side of Form 602 and send to DNRC.

8881 106

page 1 of 1

124900

PROJECT	TOOLE COUNTY SHOP SHELBY, MT	LOCATION:	5' E of SE corner of Quonset Building.
JOB NO.:	196-71	SURFACE ELEVATION	3271.74
DRILLING METHOD:	MOBILE B-61 HOLLOW STEM AUGER -8" diam.	GROUNDWATER DEPTH:	▽ 3.5 9/12/96 ▼ 4.2 10/7/96
DRILLER:	O'KEEFE-J.GRAHAM	DATE STARTED:	9/12/96
LOGGED BY:	R.BROWN	DATE COMPLETED:	9/12/96

Toole

CC

DEPTH (FT)	MATERIAL SYMBOL	SAMPLE* TYPE	PENETRATION RESISTANCE (BLOWS/FT)	MATERIAL CLASSIFICATION AND DESCRIPTION	ANALYTICAL RESULTS: HEADSPACE (ppm)	URO (ppm)	GRO (ppm)	BTEX (ppm)		MONITORING WELL LOG
				FILL, Clayey Gravel with Sand, medium dense to dense, slightly moist, brown.						8"Flush-mtd manhole cover in concrete.
1.5				Sandy Fat CLAY, stiff, moist, dark brown.						
		LSS	9							3/8" Bentonite chip seal-1.5' to 3.5'.
3.5				Silty SAND, loose, saturated, brown. Several coarse grained lenses to 6.0'.						
5		LSS	5							
6.0				Fat CLAY, soft, saturated, caliche, rust in fractures, blocky structure, grey.						
7.0		LSS	3	Sandy Lean CLAY, soft, saturated, brown.						2" PVC with 0.020" slot size and Filtersock to reduce fines.
8.0				Fat CLAY, soft, saturated, grey.						
8.5				Silty SAND, loose, saturated, brown.						
9.5		LSS	5	Fat CLAY, soft, saturated, grey.						
10										
10.8				Silty SAND, loose, saturated, brown.						10-20 graded Silica sand surrounding slotted pipe section-3.5-14'
				Bottom of MW-1 at 14.0'.						
15										
20										

*SAMPLE TYPE KEY:
- SSS - STANDARD SPLIT SPOON (SPT)
- LSS - LARGE SPLIT SPOON
- CS - CONTINUOUS SAMPLER
- GS - GRAB SAMPLE
- COMP COMPOSITE SAMPLE

REMARKS

M. 162892

LOG OF BORING MW-2

page 1 of 1

SDNUOW 01

PROJECT	TOOLE COUNTY SHOP SHELBY, MT	LOCATION	5' N & 67' E of SE corner of Shop Office. (124913)
JOB NO	196-71	SURFACE ELEVATION:	3271.34
DRILLING METHOD:	MOBILE B-61 HOLLOW STEM AUGER -8" diam.	GROUNDWATER DEPTH:	▽ 4.5 9/12/96 ▼ 4.7 10/7/96
DRILLER:	O'KEEFE-J.GRAHAM	DATE STARTED	9/12/96
LOGGED BY:	R.BROWN	DATE COMPLETED:	9/12/96

Toole

CC

DEPTH (FT)	MATERIAL SYMBOL	SAMPLE* TYPE	PENETRATION RESISTANCE (BLOWS/FT)	MATERIAL CLASSIFICATION AND DESCRIPTION	ANALYTICAL RESULTS: HEADSPACE (ppm)	URO (ppm)	GRO (ppm)	BTEX (ppm)		MONITORING WELL LOG
				FILL, Clayey GRAVEL with Sand, dense, slightly moist, brown.						8"Flush-mtd manhole cover in concrete.
1.5		LSS	11	Sandy Fat CLAY with Gravel, stiff, moist, moderately strong petroleum odor with black discoloration.						3/8" Bentonite chip seal-1.5' to 3.6'.
5		LSS	2	Silty SAND, loose, saturated, strong petroleum odor with heavy black discoloration. Alternating layers of silty sand and fat clay-0.5 to 1.0' thick- down to 7.0'						
7.0		LSS	4	Fat CLAY, soft, saturated, caliche, slight odor-decreases rapidly with depth, grey brown. Interbedded soft sandy clay layers to 14'.						2" PVC with 0.020" slot size and Filtersock to reduce fines.
10		LSS	8							10-20 graded Silica sand surrounding slotted pipe section 3.6-14'
				Bottom of MW-2 at 14.0'.						
15										
20										

*SAMPLE TYPE KEY:
- SSS STANDARD SPLIT SPOON (SPT)
- LSS LARGE SPLIT SPOON
- CS CONTINUOUS SAMPLER
- GS GRAB SAMPLE
- COMP COMPOSITE SAMPLE

REMARKS

Page 4 of 4 Mill 0788 108

Toole CC

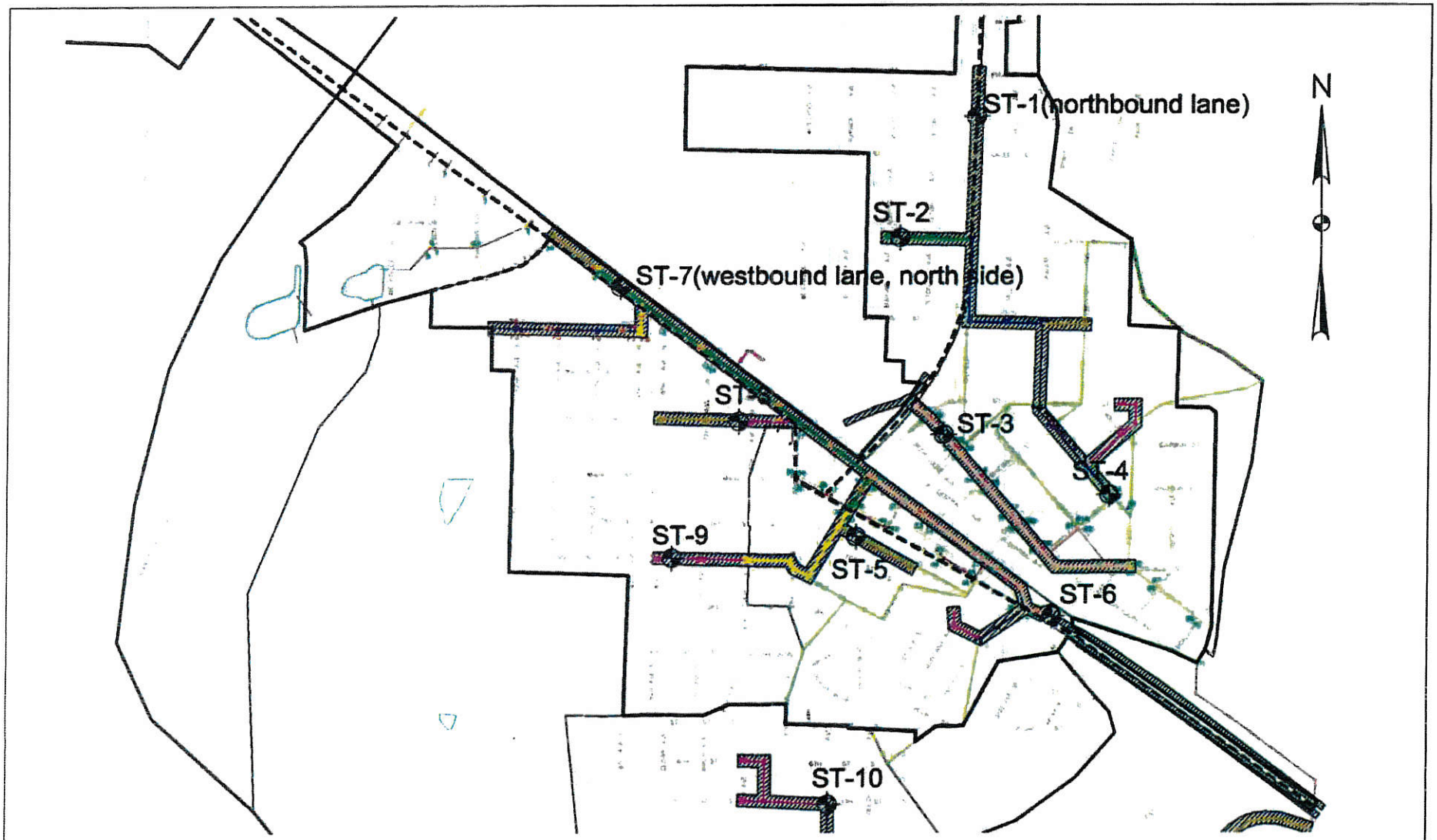
PROJECT	TOOLE COUNTY SHOP SHELBY, MT	LOCATION:	8' N & 193' E of SE corner of Shop Office.
JOB NO.	196-71	SURFACE ELEVATION:	3271.10
DRILLING METHOD:	MOBILE B-61 HOLLOW STEM AUGER -8" diam.	GROUNDWATER DEPTH:	▼ 4.8 9/12/96 ▼ 4.3 10/7/96
DRILLER:	O'KEEFE-J.GRAHAM	DATE STARTED:	9/12/96
LOGGED BY:	R.BROWN	DATE COMPLETED:	9/12/96

DEPTH (FT)	MATERIAL SYMBOL	SAMPLE* TYPE	PENETRATION RESISTANCE (BLOWS/FT)	MATERIAL CLASSIFICATION AND DESCRIPTION	ANALYTICAL RESULTS: HEADSPACE (ppm)	URO (ppm)	GRO (ppm)	BTEX (ppm)	MONITORING WELL LOG
0.5				FILL, Poorly-Graded GRAVEL Surfacing.					8"Flush-mtd manhole cover in concrete.
2.0				FILL, Sandy Fat CLAY, very stiff, moist, debris, dark brown.					
		LSS	10	Fat CLAY, stiff, very moist, dark brown.					3/8" Bentonite chip seal-1.5' to 3.6'.
				becomes soft at 4.0' with thin sandy lenses.					
5		LSS	2	Poody-Graded SAND, very loose, saturated, brown.					
6.0				Fat CLAY, soft, saturated, rust in fractures, blocky structure, caliche/gypsum crystals, grey.					
		LSS	3	Interbedded sandy layers to 14.0'.					2" PVC with 0.020" slot size and Filtersock to reduce fines.
10		LSS	6						10-20 graded Silica sand surrounding slotted pipe section 3.6-14'
				Bottom of MW-3 is 14.0'.					
15									
20									

*SAMPLE TYPE KEY:
- SSS - STANDARD SPLIT SPOON (SPT)
- LSS - LARGE SPLIT SPOON
- CS - CONTINUOUS SAMPLER
- GS - GRAB SAMPLE
- COMP COMPOSITE SAMPLE

REMARKS

M.16 2891



SK GEOTECHNICAL

BORING LOCATION SKETCH
Stormwater Improvements
Shelby, Montana

Drawn by:	E. Niebler	Date	10/2/14
Project:	14-3255G		
Scale:	None		FIGURE
Sheet	1 of 1		

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3255G
UTILITY GEOTECHNICAL EVALUATION
Proposed Stormwater Improvements
Shelby, Montana

BORING: **ST-1**
LOCATION:
See Boring Location Sketch

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 8/26/14 | SCALE: 1" = 3'

Elev.	Depth	Symbol	Description of Materials	BPF	WL MC	qp*	Remarks
3296.0	0.0						
3295.5	0.5		FILL: Asphalt Pavement (6 1/2" thick).				Elevations: Provided by KLJ.
			FILL: Clayey Gravel with Sand, fine- to coarse-grained, brown, moist, loose. (Base Course)	7	4.4		
3294.0	2.0	CL	SANDY LEAN CLAY, low to medium plasticity, trace gravels, brown, moist, medium. (Alluvium)	6	4.8		
3292.5	3.5	CL	LEAN CLAY with SAND, medium plasticity, trace gravels, brown, moist to wet, soft. (Alluvium)	2	14.6		Pipe Invert 3290.6
3289.5	6.5	SC	CLAYEY SAND, fine-grained, brown, wet, very loose. (Alluvium)	4	12.1		
3287.0	9.0	GM	SILTY GRAVEL with SAND, fine- to coarse-grained, multi-colored, waterbearing, loose. (Alluvium)	7	14.2		An open triangle in the water level (WL) column indicates the depth at which groundwater was first observed while drilling.
3285.0	11.0	CL CH	LEAN to FAT CLAY, medium to high plasticity, brown, waterbearing, soft. (Alluvium)	3	20.3		
				2	21.5		
3280.5	15.5		END OF BORING				*qp=pocket penetrometer estimate of unconfined compressive strength, tons per square foot.

Water down 11.3' with 11.5' of hollow-stem auger in the ground.

Water down 9' with 14' of hollow-stem auger in the ground.

Water not observed to dry cave-in depth of 6.7' immediately after withdrawal of auger.

Boring then backfilled.

Several days may be necessary for groundwater to stabilize in these types of clay soils.

BORING BPF WL-MC QP* 3255.GPJ LAGNNN06.GDT 10/9/14

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3255G
UTILITY GEOTECHNICAL EVALUATION
Proposed Stormwater Improvements
Shelby, Montana

BORING: **ST-2**
LOCATION:
See Boring Location Sketch

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 8/26/14 | SCALE: 1" = 3'

Elev.	Depth	Symbol	Description of Materials	BPF	WL MC	qp	Remarks
3287.3	0.0						
3286.8	0.5		FILL: Asphalt Pavement (6 1/2" thick).				Boring moved 2' north.
		CL	LEAN CLAY, medium plasticity, trace salts, dark brown, moist to wet, very soft to medium. (Alluvium)	6	16.5	4+	
				4	20.4	2½	
			-trace gravels	5	15.9	2½	
							Pipe Invert 3281.4
				3	20.6	1½	
				2	19.9		
			-some sand seams	WH	23.0		
3271.8	15.5			2	22.0		
			END OF BORING				
			Water not observed with 14' of hollow-stem auger in the ground.				
			Water not observed to dry cave-in depth of 5' immediately after withdrawal of auger.				
			Waterbearing soils observed below 11' while drilling.				
			Boring then backfilled.				
			Several days may be necessary for groundwater to stabilize in these types of clay soils.				

BORING BPF WL-MC QP 3255.GPJ LAGNNN06.GDT 10/9/14

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3255G
UTILITY GEOTECHNICAL EVALUATION
Proposed Stormwater Improvements
Shelby, Montana

BORING: **ST-3**
LOCATION: See Boring Location Sketch

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 8/27/14 | SCALE: 1" = 3'

Elev.	Depth	Symbol	Description of Materials	BPF	WL MC	qp	Remarks
3278.0	0.0						
3277.5	0.5		FILL: Asphalt Pavement (6" thick).				Boring moved 7' north.
		CL	SANDY LEAN CLAY, medium plasticity, trace gravels, dark brown, moist to wet, soft to medium. (Alluvium)	8	17.7		
				4	13.1	2¼	Bulk bag sample 2'-6' LL=38, PL=15, PI=23 P_{200}=57.1%
				3	18.8	2¼	
				5	20.2	2¼	Pipe Invert 3270.4
				8	21.6	1½	
3266.5	11.5	CL ML	SILTY CLAY with SAND, slightly plastic, dark brown, wet to waterbearing, rather soft. (Alluvium)	4	22.7		
					▽		
				5	21.3		
3262.5	15.5		END OF BORING				
			Water down 13.7' with 14' of hollow-stem auger in the ground.				
			Water not observed to dry cave-in depth of 9' immediately after withdrawal of auger.				
			Boring then backfilled.				
			Several days may be necessary for groundwater to stabilize in these types of clay soils.				

BORING BPF WL-MC QP 3255.GPJ LAGNNN06.GDT 10/9/14

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3255G
UTILITY GEOTECHNICAL EVALUATION
Proposed Stormwater Improvements
Shelby, Montana

BORING: **ST-4**
LOCATION:
See Boring Location Sketch

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 8/27/14 | SCALE: 1" = 3'

Elev.	Depth	Symbol	Description of Materials	BPF	WL MC	qp	Remarks
3273.4	0.0						
3272.9	0.5		FILL: Asphalt Pavement (6 1/2" thick).				
		CL	LEAN CLAY, medium plasticity, some FeOx stains, dark brown, moist, medium to rather stiff. (Alluvium)	9	19.1	3½	
3270.9	2.5						
		SC	CLAYEY SAND, fine-grained, brown, moist to wet, very loose. (Alluvium)	8	6.0	2	
				3	16.9		
							Pipe Invert 3267.3
3266.4	7.0				18.6		
			LEAN to FAT CLAY with SAND, medium to high plasticity, trace salts, dark brown, wet to waterbearing, very soft to soft. (Alluvium)	1	▽	1½	
		CL CH	-with salts	3	22.7	1¼	
				2	23.0		
3257.9	15.5			5	22.9		
			END OF BORING				

Waterbearing soils observed at about 8' while drilling.

Water down 9' immediately after withdrawal of auger.

Water not observed to wet cave-in depth of 9.6' immediately after withdrawal of auger.

Boring then backfilled.

Several days may be necessary for groundwater to stabilize in these types of clay soils.

BORING BPF WL-MC QP 3255.GPJ LAGNNN06.GDT 10/9/14

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3255G
UTILITY GEOTECHNICAL EVALUATION
Proposed Stormwater Improvements
Shelby, Montana

BORING: **ST-5**
LOCATION:
See Boring Location Sketch

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 8/27/14 | SCALE: 1" = 3'

Elev.	Depth	Symbol	Description of Materials	BPF	WL MC	qp	Remarks
3299.7	0.0						
3299.4	0.3		FILL: Asphalt Pavement (3" thick).				Boring moved 16' west and 13' south.
		GC	FILL: Clayey Gravel, fine- to coarse-grained, multi-colored, moist, loose. (Base Course)	7	5.9		
3297.2	2.5		LEAN to FAT CLAY with SAND, medium to high plasticity, dark brown, moist to wet, rather soft to rather stiff. (Alluvium)	9	21.0	3	
				5	21.9	2¼	
				9	20.8	½	Possible waterbearing soils at 7'.
		CL CH		5	22.1	¼	
			-some sand seams	5	21.2		
					▽		
				8	24.5		Pipe Invert 3285.0
3282.7	17.0		SHALE BEDROCK, very thinly bedded, dark gray, highly weathered to decomposed, moderately hard hardness.	50-3"	9.9		
3279.9	19.8		END OF BORING - Auger Refusal	50-3"	16.3		
			Water down 18' with 17.5' of hollow-stem auger in the ground.				
			Waterbearing soils observed at 13 1/2' while drilling.				
			Water down 15.5' immediately after withdrawal of auger.				
			Water not observed to wet cave-in depth of 15.5' immediately after withdrawal of auger.				
			Boring then backfilled.				

BORING BPF WL-MC QP 3255.GPJ LAGNNN06.GDT 10/9/14

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3255G
UTILITY GEOTECHNICAL EVALUATION
Proposed Stormwater Improvements
Shelby, Montana

BORING: **ST-5** **(cont.)**
LOCATION:
See Boring Location Sketch

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 8/27/14 | SCALE: 1" = 3'

Elev.	Depth	Symbol	Description of Materials	BPF	WL MC	qp	Remarks
3275.7	24.0		Several days may be necessary for groundwater to stabilize in these types of clay soils.				

BORING BPF WL-MC QP 3255.GPJ LAGNNN06.GDT 10/9/14

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3255G
UTILITY GEOTECHNICAL EVALUATION
Proposed Stormwater Improvements
Shelby, Montana

BORING: **ST-6**
LOCATION: See Boring Location Sketch

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 8/26/14 | SCALE: 1" = 3'

Elev.	Depth	Symbol	Description of Materials	BPF	WL MC	qp	Remarks
3278.0	0.0		FILL: 3" topsoil and root zone over Clayey Sand, fine-grained, trace roots, brown, moist, loose.	8	6.5		Boring moved 7' south.
3276.5	1.5		FILL: Poorly Graded Gravel with Sand, fine- to coarse-grained, brown, moist, loose.	9	3.0		
3274.0	4.0		LEAN CLAY with SAND, medium plasticity, trace gravels and salts, brown, wet to waterbearing, very soft to rather soft. (Alluvium)	5	17.5 ▽		Pipe Invert 3271.9
				2	19.5	¼	
				WH	23.3	< ¼	LL=36, PL=18, PI=18 P_{200}=74.2%
			-some sand seams				
		CL		WH	22.0		
				2	26.0		
				4	21.4	1½	
3257.5	20.5		END OF BORING Water down 6' with 9' of hollow-stem auger in the ground. Water observed at 7' to wet cave-in depth of 7.5' immediately after withdrawal of auger. Boring then backfilled.				Several days may be necessary for groundwater to stabilize in these types of clay soils.

BORING BPF WL-MC QP 3255.GPJ LAGNNN06.GDT 10/9/14

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3255G
UTILITY GEOTECHNICAL EVALUATION
Proposed Stormwater Improvements
Shelby, Montana

BORING: **ST-7**
LOCATION:
See Boring Location Sketch

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 8/26/14 | SCALE: 1" = 3'

Elev.	Depth	Symbol	Description of Materials	BPF	WL MC	qp	Remarks
3286.5	0.0						
3286.0	0.5		FILL: Asphalt Pavement (6" thick).				
			FILL: Clayey Gravel with Sand, fine- to coarse-grained, dark brown, moist, medium dense. (Base Course)	30	5.0		
				18	6.5		
3282.5	4.0						Pipe Invert 3282.6
			LEAN to FAT CLAY with SAND, medium to high plasticity, dark brown, wet, soft to medium. (Alluvium)	7	21.4	1½	
				6	24.1	1½	
		CL CH	-some sand seams	3	21.8 ▽	½	
				6	24.4		
3271.0	15.5			4	24.8	½	
			END OF BORING				

Waterbearing soils observed at about 10' while drilling.

Water not observed with 14' of hollow-stem auger in the ground.

Water not observed immediately after withdrawal of auger.

Water not observed to dry cave-in depth of 4 1/2' immediately after withdrawal of auger.

Boring then backfilled.

Several days may be necessary for groundwater to stabilize in these types of clay soils.

BORING BPF WL-MC QP 3255.GPJ LAGINN06.GDT 10/9/14

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3255G
UTILITY GEOTECHNICAL EVALUATION
Proposed Stormwater Improvements
Shelby, Montana

BORING: **ST-8**
LOCATION:
See Boring Location Sketch

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 8/27/14 | SCALE: 1" = 3'

Elev.	Depth	Symbol	Description of Materials	BPF	WL MC	qp	Remarks
3292.7	0.0						
			FILL: Asphalt Pavement (9" thick).				
3291.9	0.8		FILL: Clayey Gravel with Sand, fine- to coarse-grained, brown, moist, medium dense. (Base Course)	20	7.3		
				11	7.1		Bulk bag sample 2'-6' LL=34, PL=17, PI=17 P_{200}=40.3%
3289.7	3.0		SANDY LEAN CLAY, medium plasticity, dark brown, moist to wet, very soft to rather soft. (Alluvium)				Pipe Invert 3288.7
				4	12.4		
				2	21.5	½	
		CL	-waterbearing below 8 1/2'		▽		
				2	24.7	¾	
			-some sand seams	WH	28.0		
				5	22.1		
3277.2	15.5		END OF BORING				
			Water not observed with 14' of hollow-stem auger in the ground.				
			Water not observed immediately after withdrawal of auger.				
			Waterbearing soils observed below 8 1/2' while drilling.				
			Boring then backfilled.				
			Several days may be necessary for groundwater to stabilize in these types of clay soils.				

BORING BPF WL-MC QP 3255.GPJ LAGNNN06.GDT 10/9/14

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3255G
UTILITY GEOTECHNICAL EVALUATION
Proposed Stormwater Improvements
Shelby, Montana

BORING: **ST-9**
LOCATION:
See Boring Location Sketch

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 8/27/14 | SCALE: 1" = 3'

Elev.	Depth	Symbol	Description of Materials	BPF	WL MC	qp	Remarks
3341.7	0.0						
3341.4	0.3		FILL: Asphalt Pavement (3" thick).				
			FILL: Clayey Gravel, fine- to coarse-grained, brown, moist, very loose to loose. (Base Course)	8	7.9		
3339.2	2.5	CL CH	LEAN to FAT CLAY, medium to high plasticity, brown, moist, medium to rather stiff. (Alluvium)	5	10.7	2½	
				6	21.7	2	Pipe Invert 3336.4
			-trace salts, some FeOx staining	11	22.0	2½	
			-some sand seams	9	20.9	2¾	
				10	22.9		
3326.2	15.5			13	20.5		
			END OF BORING				

Water not observed with 14' of hollow-stem auger in the ground.

Water not observed immediately after withdrawal of auger.

Water not observed to dry cave-in depth of 7.7' immediately after withdrawal of auger.

Boring then backfilled.

Several days may be necessary for groundwater to stabilize in these types of clay soils.

BORING BPF WL-MC QP 3255.GPJ LAGNNN06.GDT 10/9/14

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3255G
UTILITY GEOTECHNICAL EVALUATION
Proposed Stormwater Improvements
Shelby, Montana

BORING: **ST-10**
LOCATION:
See Boring Location Sketch

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 8/27/14 | SCALE: 1" = 3'

Elev.	Depth	Symbol	Description of Materials	BPF	WL MC	qp	Remarks
3412.5	0.0						
3411.8	0.7	OL	Topsoil and root zone (8" thick).				
		SM	SILTY SAND, fine-grained, with roots, light brown, moist, medium dense. (Alluvium)	12	4.8		
3410.5	2.0	CL ML	SANDY SILTY CLAY, slightly plastic, trace gravels, light brown, moist, very stiff to stiff. (Alluvium)	18	7.3	4+	
				14	5.6	4+	
3407.0	5.5	CL	SANDY LEAN CLAY, low plasticity, trace gravels, brown, moist, stiff to very stiff. (Alluvium)	19	16.0		Pipe Invert 3404.7
				15	18.2	4+	
3402.0	10.5		END OF BORING				

Water not observed with 9' of hollow-stem auger in the ground.

Water not observed immediately after withdrawal of auger.

Water not observed to dry cave-in depth of 5' immediately after withdrawal of auger.

Boring then backfilled.

Several days may be necessary for groundwater to stabilize in these types of clay soils.

BORING BPF WL-MC QP 3255.GPJ LAGNNN06.GDT 10/9/14