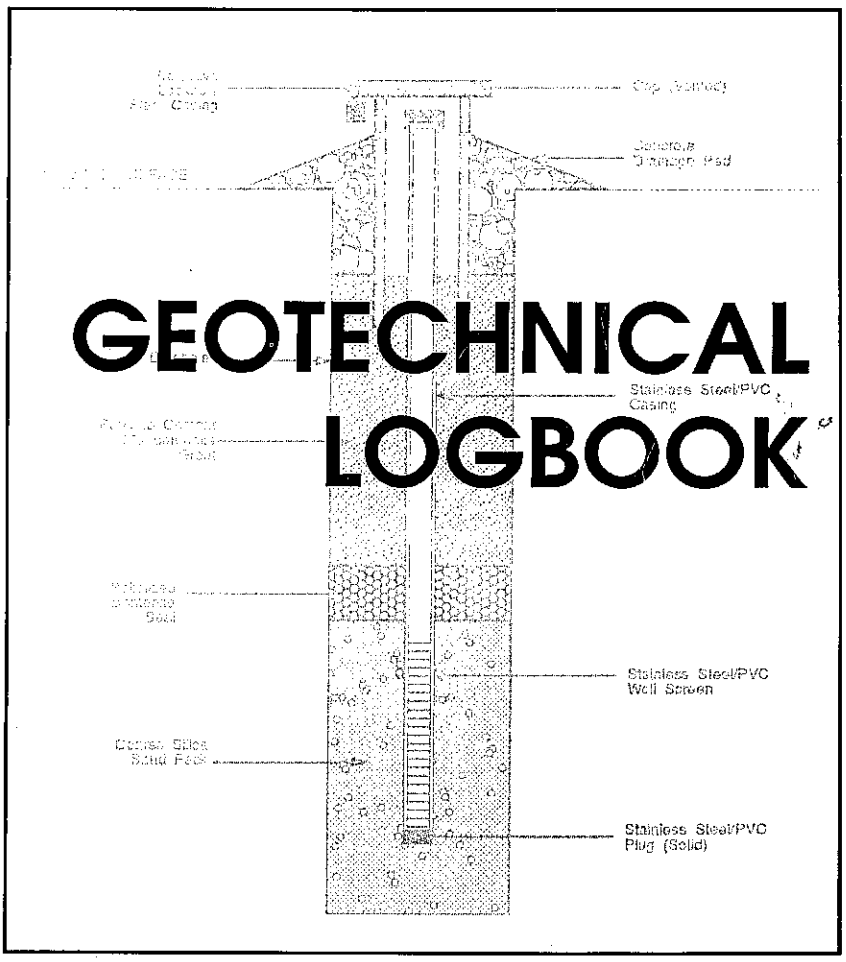
# C Borehole Logs and Field Notes

ecology and environment, inc.

International Specialists in the Environment




# GEOTECHNICAL LOGBOOK

PROJECT NUMBER:

CLIENT/SITE NAME: BLM / Helen Mine Site

DRILLING COMPANY: Test America Drilling

DATE OF FIELD ACTIVITIES: 5/7/10 →

HOLES LOGGED IN BOOK:

05/07/10 Helen Mine Site
Weather: Clear, Sunny, warm
Team: Andy Uhrig, Courtney Funk, Rebecca Jarvis
Agenda: 1) Mobilize drillers from the Contact/Sonoma to Helen Mine sites
2) Meet with BLM at Helen Mine site
0000 - meet field team at hotel lobby
0615 - Rebecca and Courtney head to Helen mine site
- Andy stays at hotel and organizes the days events
0800 - Andy heads to Helen mine site
0900 - Phone conference with Jim Petersen about activities at Helen Mine Site
- Received a call from Mike at Test Aquifer Drilling that they will be late to the Helen site due to their forklift having a flat tire. Meet with them at the bridge at 1200 instead of 1000
1030 - Arrive at bridge along the access road to Helen Mine site
- When drillers arrive they have to decide whether to cross bridge or drive through creek. I am having the bulldozer at the bridge if they need assistance.
1108 - Drillers called and said they reached the bottom of Pine Flat Road and would take a lunch and then head towards Helen Mine site ETA ~ 3 hrs
1420 - Drillers arrive at bottom of hill near the narrow bridge. CME-85 was 28,000 lbs. overweight for the 30K to 35K rated bridge
1500 - Drillers setting up on borehole 08HM-S13
1630 - Completed drilling borehole 08HM-S13
- Borehole was dry so the drillers will abandon with bentonite chips.

5/7/10

5/8/10 Helen Mine Site
Weather: Sunny, warm
Team: Andy Uhrig, 3 drillers, 1 bulldozer operator
Agenda: Drill soil borings and monitoring wells
0545 - leave hotel
0700 - Arrive at site
- Safety meeting at gate
0800 - Begin preparation to drill soil boring 02HM-SB
0838 - Begin drilling soil boring 02HM-SB
- Having drillers water ground around rig to minimize dust.
1008 - Completed drilling soil boring 02HM-SB
- Groundwater was at 30 ft bgs, base of tailings pile was 30 → 35 ft bgs.
- Borehole is being abandoned with hydrated bentonite grout.
1100 - Setting up to drill well 01HM-MW
1120 - Begin drilling well 01HM-MW
1210 - Completed drilling well 01HM-MW
- lunch for drillers
1300 - Begin installing well 01HM-MW
1350 - Completed installing well 01HM-MW
- used ~~#2/12~~ sand pack since formation contained a large amount of sand & gravel size particles.
- Mobilizing to 04HM-MW
1400 - Setting up to drill well 04HM-MW
1415 - Begin drilling well 04HM-MW
1500 - Stopped drilling well 04HM-MW, contacted gray claystone at ~19 ft bgs. We are tripping the augers and will give the borehole time to see if any water is present above the claystone.
- Mobilizing to 07HM-MW while borehole recovers.
1542 - Begin drilling 07HM-MW
1645 - Stop drilling 07HM-MW due to bit loading up. Will come back in morning and trip the augers to replace bit.

5/8/10

5/9/10 Helen Mine Site
Weather: Cool, Sunny, rain in forecast
Team: Andy Uhrig, 3 drillers, 1 bulldozer operator
Agenda: 1) Finish ~~wells~~ 07HM-MW and 04HM-MW
2) Demob CME-85 from site
3) Begin hand auger wells and borings.
0545- Leave hotel for site
0645- Arrive at site
0715- Safety meeting
0730- Prepare for days work
0815- Tripped the augers from well 07HM-MW and they were impacted with serpentinite clays. No water was present in borehole. Planning to move well location ~100 ft northwest of current borehole where seep is coming from hillside
0845- ~~Spoke~~ Spoke with Jim Petersen and got the okay to relocate well.
0855- Drillers begin drilling 07HM-MW(2)
~~Logging this hole in notes since I am out of barcodes~~
- Completed drilling well 07HM-MW(2) to 15 feet bgs. Will let ~~well~~ borehole rest and see if the water level comes up. Water can be seen seeping from adjacent hill site, so water level should be shallow.
- Moving rig to well 04HM-MW to complete installation
1000- Water level is at 10 ft bgs, however water can be see dripping from gravelly zone at 5 ft bgs. I will set screen interval 4-14 feet to cover known water producing zone and current ~~static~~ water level.
1144- Completed subsurface installation of 04HM-MW
1200- Driller take lunch
1230- Mobilize to 09HM-MW to begin hand augering borehole near creek.
- Hit refusal at 2 ft on two holes
- On 3rd hole, we reached groundwater at 30" bgs
1420- Drillers hit refusal at 60" bgs, borehole completed.
- Called Jim Petersen and Mark Longtine about drilling well 07HM-MW(2).

5/9/10

5/9/10 Helen Mine Site
Weather: Cool, Rainy, Sunny, warm, etc...
Team: Andy Uhrig, 4 drillers, 1 bulldozer operator
1500- After discussion with Mark Longtine about drilling the boreholes for well 07HM-MW we decided it would be best to complete the second borehole to 30 ft bgs, then let both boreholes sit for 24 hours to see if any water is present. If water is not present after the 24 hours we will abondon the holes ~~because wa~~ All and not continue drilling since water is not present within the serpentinite at this upgradient area of the site.
- Drillers begin drilling the second borehole from 15 ft bgs to 30 ft bgs.
1710- Completed boring 07HM-MW(2) to 30 ft bgs
- Begin demobing drill rig from site
- Bulldozer allreadly in route to bridge where the drill rig needs assistance.

5/9/10

5/10/10 Helen Mine Site
Weather: Raining, Cold, breazy
Team: 3 drillers, Andy Uhrig
Agenda: 1) Check for water in 2 soil boring for 07HM-MW
2) Install well 09HM-MW
3) Abandon 02HM-SB
4) Install well 06HM-MW
5) Work on 05HM-SB

0800 - Meet at site
- safety meeting
- Drillers are cleaning/decoming drill rig from previous weeks work.

0830 - Sent two drillers to check water in soil borings for well 07HM-MW and too haul supplies down to well 09HM-MW.

0930 - Drillers abandoned well 02HMSB

1000 - Sitting in vehicles due to heavy downpour

1030 - Talked with Jim Petersen about calling off days work due to safety concerns with heavy rain and falling rocks.

1130 - Worked stopped for day due to heavy rain
- leave site for day.

5/10/10

5/11/10 Helen Mine Site
Weather: Clear, Sunny, Cool
Team: Andy Uhrig, 4 drillers
Agenda: 1) Install well 09HM-MW
2) Hand auger and install well 06HM-MW
3) Hand auger boring 05HM-SB
4) meet with BLM at 11:00
5) Work on completing monuments
0700- Meet drillers at gate to Helen Mine
0730- Safety Meeting
- Prepare for days activities
- 2 drillers are working on constructing monuments
- 2 drillers are constructing wells
0815 - Called Jim Petersen to update him on the days agenda.
• We decided to abandon the boreholes for 07HM-MW since they ~~have~~ had not produced water in 48 hours However, this morning ~~they~~ an one of them was full of rainwater to the surface indicating it is plugged. The first borehole for 07HM-MW was covered during the storm and contained no ~~rain~~ water.
0900- Begin construction of well 09HM-MW
0945- Completed construction of well 09HM-MW
- ~~Begin~~ Continue hand augering well 06HM-MW
1030- Completed well installation of 06HM-MW
- ~~Hand~~ Had to set the screen very shallow due to an 18" dtw. Set the seal at the surface, shallower than I would have liked.
1100- Lunch for drillers
- Wait for BLM to arrive.
- BLM Arrives at Site
1300 - Completed giving BLM a tour of site and our activities
- A local land owner showed up at the site while BLM was here and he mentioned the presence of a mining building where the current parking area is and it extended down the hill to the swale/pond at the fork in the road. He also mentioned that he had removed retort bricks from the Helen Mine site.

[signature] 5/11/10

5/11/10 Helen Mine Site
Weather: Warm, sunny, breezy
1315 - Drilling reached refusal @ 3 ft bgs on soil boring 05HM-SB
- Tailings on this pile are 3" minus rock and are not practical to hand auger.
1320 - Driller continue with monument construction and site cleanup
1441 - Completed monuments for wells 09HM-MW and 06HM-MW
- Completed abandonment of boreholes for 07HM-MW using bentonite chips
- Completed abandonment of 05HM-SB
1700 - Drillers complete site cleanup and are ready to mobilize to Sonoma/contact in morning.
- leave site for day

5/11/10

5/12/10 Helen Mine Site
Weather: Warm, Sunny
Team: Andy Uhrig, 4 drillers
Agenda: 1) 3 drillers and equipment are heading back to Contact/Sonoma to finish monument construction and clean up site.
2) A. Uhrig and 1 driller will complete well development of 04HM-MW
3) A. Uhrig and 1 driller will complete monument on well 01HM-MW

0700 - Arrive at site
- Safety Meeting

0715 - 3 drillers and equipment leave site and head to Contact/Sonoma
- 1 driller begins development of 01HM-MW
- Well 04HM-MW has been starting out clean, but due to agitation during bailing, soon becomes cloudy with gray silt/mud. I believe that due to a very small seep within the well providing water that the water is washing down from the seep along the serpentinite bedrock which is a very friable silt/mud. Because of the erosive nature of the bedrock pulling excess water from the well accelerates the erosion of the bedrock. I believe bailing should cease and the well should be developed using low-flow methods to slow the erosion of the bedrock around the well.

0735 - 1 driller begins monument completion on well 01HM-MW

0830 - Monument completed on 01HM-MW
- Cleanup monument construction supplies

0930 - 1 driller mobilizes from Helen to Contact/Sonoma
- Andy Uhrig assists Courtney Funk and Rebecca Jarvis with surface soil sampling.

1100 - While demobing from Helen Mine site the surveyors arrived and needed an escort to the site. Keys were left with them and the field teams demobed from site.

[signature] 5/12/10

# Borehole Record for 01HM-MW

- Drilling Log
- Narrative Lithologic Description
- Well Development Record
- Well Development -- Parameter Measurements
- Investigation - Derived Waste Inventory Sheet

DRILLING LOG FOR 01HM-MW

Project Name Helen Mine

Site Location

Date Started/Finished 5/8/10

Drilling Company Test America

Driller's Name Dawey

Geologist's Name Andrew Uhrig

Geologist's Signature [signature]

Rig Type (s) CME-85

Drilling Method (s) HSA

Bit Size (s) 8" Auger Size (s)

Auger/Split Spoon Refusal

Total Depth of Borehole Is

Total Depth of Corehole Is

| Water Level (TOIC) | | |
|---|---|---|
| Date | Time | Level( Feet) |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Well Location Sketch

see 02HM-SB

| Depth(Feet) | Sample Number | Blows on Sampler | Soil Components Rock Profile CL SL S GR | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 1140 6 | 01HMMW05 | 3 7 10 9 | SL S GR | | | 50% | | | | Split spoon 24" |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 1150 11 | | 4 7 12 | | | | 20% | | | | Split spoon ~~24"~~ 18" |
| 12 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 15 | | | | | | | | | | |
| 1206 | | 10 50 for 5" | | | | 20% | | | | Split Spoon 24" |

**SCREENED WELL**

Lock Number _____

Inner Casing Material _____

Inner Casing Inside Diameter ____ inches

Stick-up 2 ft

GROUND SURFACE

Top of ~~Grout~~ chips ~~Ø~~ ft

Top of Seal at ~~Ø~~ AU 1 ft

Top of Sand Pack ~~3~~ AU 2 ft

Top of Screen at ~~4~~ AU 3 ft

Bottom of Screen at ~~14~~ AU 13 ft

Bottom of Hole at ~~15~~ AU 14 ft

Bottom of Sandpack at ~~15~~ AU 14

Quantity of Material Used:

Bentonite Pellets 1/2-5 gal bucket

Cement _____

Borehole _____ Inches Diameter

Cement/ Bentonite _____

Grout _____

Screen Slot Size 0.010

Screen Type slot

☒ PVC _____

☐ Stainless Steel _____

Pack Type/Size:

☒ Sand 2/12 - 4 bags

☐ Gravel _____

☐ Natural _____

**OPEN-HOLE WELL**

Stick-up _____ ft

Inner Casing Material _____

Inner Casing Inside Diameter _____ inches

Outer Casing Diameter _____ inches

Borehole Diameter _____ ft

Bedrock _____ ft

Bottom of Rock Socket/ Outer Casing _____ ft

Bottom of Inner Casing _____ ft

Corehole Diameter _____

Bottom of Corehole _____ ft

NOTE: See pages 136 and 137 for well construction diagrams

| Depth-ft. | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| 1 | | ○ | ○ | ○ |
| 2 | | ○ | ○ | ○ |
| 3 | | ○ | ○ | ○ |
| 4 | | ○ | ○ | ○ |
| 5 | Red-brown, gravelly silty sand, angular gravel | ○ | ○ | ● |
| 6 | | ○ | ○ | ● |
| 7 | | ○ | ○ | ○ |
| 8 | | ○ | ○ | ○ |
| 9 | | ○ | ○ | ○ |
| 10 | Red-brown, gravelly sandy silt, angular gravel | ○ | ○ | ● |
| 11 | | ○ | ○ | ● |
| 12 | | ○ | ○ | ○ |
| 13 | | ○ | ○ | ○ |
| 14 | | ○ | ○ | ○ |
| 15 | | ○ | ● | ● AU ● AU |

Green-brown, weathered serpentinite, very friable

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | | | See previous page | | | | | | | | |
| 17 | | | | | | | | | | | |
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| Depth(feet). | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content Dry | Moist | Wet |
|---|---|---|---|---|
| 16 | See previous pages | ○ | ○ | ○ |
| 17 | | ○ | ○ | ○ |
| 18 | | ○ | ○ | ○ |
| 19 | | ○ | ○ | ○ |
| 20 | | ○ | ○ | ○ |
| 21 | | ○ | ○ | ○ |
| 22 | | ○ | ○ | ○ |
| 23 | | ○ | ○ | ○ |
| 24 | | ○ | ○ | ○ |
| 25 | | ○ | ○ | ○ |
| 26 | | ○ | ○ | ○ |
| 27 | | ○ | ○ | ○ |
| 28 | | ○ | ○ | ○ |
| 29 | | ○ | ○ | ○ |
| 30 | | ○ | ○ | ○ |
| 31 | | ○ | ○ | ○ |
| 32 | | ○ | ○ | ○ |
| 33 | | ○ | ○ | ○ |
| 34 | | ○ | ○ | ○ |
| 35 | | ○ | ○ | ○ |
| 36 | | ○ | ○ | ○ |
| 37 | | ○ | ○ | ○ |
| 38 | | ○ | ○ | ○ |
| 39 | | ○ | ○ | ○ |
| 40 | | ○ | ○ | ○ |
| 41 | | ○ | ○ | ○ |
| 42 | | ○ | ○ | ○ |
| 43 | | ○ | ○ | ○ |
| 44 | | ○ | ○ | ○ |
| 45 | | ○ | ○ | ○ |

| Depth(feet) | Sample Number | Blows on Sampler | | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 74 | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | |

| Depth(feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content Dry | Moist | Wet |
|---|---|---|---|---|
| | | ○ | ○ | ○ |
| 46 | | ○ | ○ | ○ |
| 47 | | ○ | ○ | ○ |
| 48 | | ○ | ○ | ○ |
| 49 | | ○ | ○ | ○ |
| 50 | | ○ | ○ | ○ |
| 51 | | ○ | ○ | ○ |
| 52 | | ○ | ○ | ○ |
| 53 | | ○ | ○ | ○ |
| 54 | | ○ | ○ | ○ |
| 55 | | ○ | ○ | ○ |
| 56 | | ○ | ○ | ○ |
| 57 | | ○ | ○ | ○ |
| 58 | | ○ | ○ | ○ |
| 59 | | ○ | ○ | ○ |
| 60 | | ○ | ○ | ○ |
| 61 | | ○ | ○ | ○ |
| 62 | | ○ | ○ | ○ |
| 63 | | ○ | ○ | ○ |
| 64 | | ○ | ○ | ○ |
| 65 | | ○ | ○ | ○ |
| 66 | | ○ | ○ | ○ |
| 67 | | ○ | ○ | ○ |
| 68 | | ○ | ○ | ○ |
| 69 | | ○ | ○ | ○ |
| 70 | | ○ | ○ | ○ |
| 71 | | ○ | ○ | ○ |
| 72 | | ○ | ○ | ○ |
| 73 | | ○ | ○ | ○ |
| 74 | | ○ | ○ | ○ |
| 75 | | | | |

| Depth(feet) | Sample Number | Blows on Sampler | | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | | | | | | | | | | | | |
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| 105 | | | | | | | | | | | | |

| Depth (feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content | | |
|---|---|---|---|---|
| | | Dry | Moist | Wet |
| 77 | | ○ | ○ | ○ |
| 78 | | ○ | ○ | ○ |
| 79 | | ○ | ○ | ○ |
| 80 | | ○ | ○ | ○ |
| 81 | | ○ | ○ | ○ |
| 82 | | ○ | ○ | ○ |
| 83 | | ○ | ○ | ○ |
| 84 | | ○ | ○ | ○ |
| 85 | | ○ | ○ | ○ |
| 86 | | ○ | ○ | ○ |
| 87 | | ○ | ○ | ○ |
| 88 | | ○ | ○ | ○ |
| 89 | | ○ | ○ | ○ |
| 90 | | ○ | ○ | ○ |
| 91 | | ○ | ○ | ○ |
| 92 | | ○ | ○ | ○ |
| 93 | | ○ | ○ | ○ |
| 94 | | ○ | ○ | ○ |
| 95 | | ○ | ○ | ○ |
| 96 | | ○ | ○ | ○ |
| 97 | | ○ | ○ | ○ |
| 98 | | ○ | ○ | ○ |
| 99 | | ○ | ○ | ○ |
| 100 | | ○ | ○ | ○ |
| 101 | | ○ | ○ | ○ |
| 102 | | ○ | ○ | ○ |
| 103 | | ○ | ○ | ○ |
| 104 | | ○ | ○ | ○ |
| 105 | | ○ | ○ | ○ |

## WELL DEVELOPMENT RECORD

SITE _____ DATE _____

LOCATION _____ WELL NO. _____

_____

### MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2 (0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for $r^2h$ factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = _____ gallons.

### Volume of Water in Casing or Hole

| Diameter of Casing or Hole (in) | Gallons per Foot of Depth | Cubic Feet per Foot of Depth | Liter per Meter of Depth | Cubic Meters per Meter of Depth |
|---|---|---|---|---|
| 1 | 0.041 | 0.0055 | 0.509 | $0.509 \times 10^{-3}$ |
| 11/2 | 0.092 | 0.0123 | 1.142 | $1.142 \times 10^{-3}$ |
| 2 | 0.163 | 0.0218 | 2.024 | $2.024 \times 10^{-3}$ |
| 21/2 | 0.255 | 0.0341 | 3.167 | $3.167 \times 10^{-3}$ |
| 3 | 0.367 | 0.0491 | 4.558 | $4.558 \times 10^{-3}$ |
| 31/2 | 0.500 | 0.0668 | 6.209 | $6.209 \times 10^{-3}$ |
| 4 | 0.653 | 0.0873 | 8.110 | $8.110 \times 10^{-3}$ |
| 41/2 | 0.826 | 0.1104 | 10.260 | $10.260 \times 10^{-3}$ |
| 5 | 1.020 | 0.1364 | 12.670 | $12.670 \times 10^{-3}$ |
| 51/2 | 1.234 | 0.1650 | 15.330 | $15.330 \times 10^{-3}$ |
| 6 | 1.469 | 0.1963 | 18.240 | $18.240 \times 10^{-3}$ |
| 7 | 2.000 | 0.2673 | 24.840 | $24.840 \times 10^{-3}$ |
| 8 | 2.611 | 0.3491 | 32.430 | $32.430 \times 10^{-3}$ |
| 9 | 3.305 | 0.4418 | 41.040 | $41.040 \times 10^{-3}$ |
| 10 | 4.080 | 0.5454 | 50.670 | $50.670 \times 10^{-3}$ |
| 11 | 4.937 | 0.6600 | 61.310 | $61.310 \times 10^{-3}$ |
| 12 | 5.875 | 0.7854 | 72.960 | $72.960 \times 10^{-3}$ |
| 14 | 8.000 | 1.0690 | 99.350 | $99.350 \times 10^{-3}$ |
| 16 | 10.440 | 1.3960 | 129.650 | $129.650 \times 10^{-3}$ |
| 18 | 13.220 | 1.7670 | 164.180 | $164.180 \times 10^{-3}$ |
| 20 | 16.320 | 2.1820 | 202.680 | $202.680 \times 10^{-3}$ |
| 22 | 19.750 | 2.6400 | 245.280 | $245.280 \times 10^{-3}$ |
| 24 | 23.500 | 3.1420 | 291.850 | $291.850 \times 10^{-3}$ |
| 26 | 27.580 | 3.6870 | 342.520 | $342.520 \times 10^{-3}$ |
| 28 | 32.000 | 4.2760 | 397.410 | $397.410 \times 10^{-3}$ |
| 30 | 36.720 | 4.9090 | 456.020 | $456.020 \times 10^{-3}$ |
| 32 | 41.780 | 5.5850 | 518.870 | $518.870 \times 10^{-3}$ |
| 34 | 47.160 | 6.3050 | 585.680 | $585.680 \times 10^{-3}$ |
| 36 | 52.880 | 7.0690 | 656.720 | $656.720 \times 10^{-3}$ |

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 3.779 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = $12.419 \times 10^{-3}$ cubic meters per meter of depth

### INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

### FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

DESCRIPTION OF DEVELOPMENT TECHNIQUE _____

_____

_____

## WELL DEVELOPMENT - PARAMETER MEASUREMENTS

| TIME | TOTAL VOL. WITHDRAWN | | pH | COND. (µmhos/cm) | TEMP. (°C/°F) | TURB. (NTU) | COMMENTS |
|---|---|---|---|---|---|---|---|
| | GALS. | BORE VOL. | | | | | |
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DEVELOPED BY: _____

DATE _____

## INVESTIGATION-DERIVED WASTE INVENTORY SHEET

Site: _____ No. of Drums: _____

Inventory Date: _____

| Waste Source | Drum/Container ID Number | Date Generated | Contents (Solid, Liquids, etc.) | Approximate Volume | Drum Location/Comments |
|---|---|---|---|---|---|
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# Borehole Record for 02HM-SB

- Drilling Log
- Narrative Lithologic Description
- Well Development Record
- Well Development -- Parameter Measurements
- Investigation - Derived Waste Inventory Sheet

# DRILLING LOG FOR 02HM-SB

Project Name

Site Location Helen Mine

Date Started/Finished 5-8-10 / 5/8/10

Drilling Company Test America

Driller's Name Davey

Geologist's Name Andrew Uhrig

Geologist's Signature

Rig Type (s) CME-85

Drilling Method (s) HSA

Bit Size (s) 8" Auger Size (s)

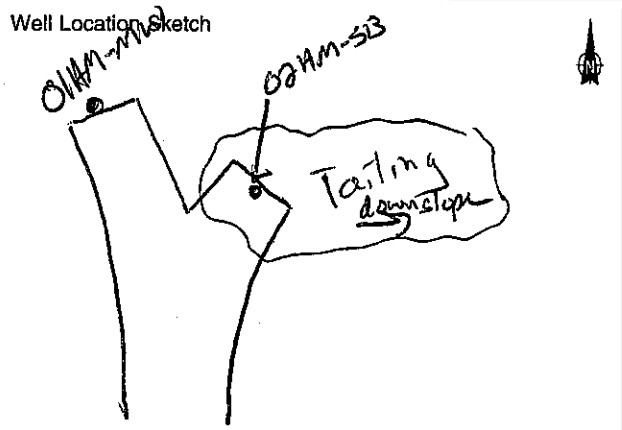
Auger/Split Spoon Refusal

Total Depth of Borehole is 35 ft bgs

Total Depth of Corehole Is

| Water Level (TOIC) | | |
|---|---|---|
| Date | Time | Level( Feet) |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Well Location Sketch




| | Depth(Feet) | Sample Number | Blows on Sampler | Soil Components Rock Profile CL SL S GR | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0838 | 1 | | | | | | | | | | |
| | 2 | | | | | | | | | | |
| | 3 | | | | | | | | | | |
| 0850 | 4 | 02HMSB02 | 1 1 3 4 | SL S GR | | | 20% | | | | Split Spoon (24") |
| | 5 | | | | | | | | | | |
| 0900 | 6 | 02HMSB05 | | | | | 100% | | | | Shelby |
| | 7 | | | | | | | | | | |
| 0905 | 8 | 02HMSB07 | | | | | 80% | | | | Shelby |
| | 9 | | | | | | | | | | |
| | 10 | | | | | | | | | | |
| 0916 | 11 | 02HMSB10 | 2 3 5 6 | SL S GR | | | 75% | | | | Split Spoon (24") |
| | 12 | | | | | | | | | | |
| | 13 | | | | | | | | | | |
| | 14 | | | | | | | | | | |
| | 15 | | | | | | | | | | |
| 0925 | | 02HMSB15 | 7 12 16 | SL S GR | | | 100% | | | | Split Spoon (24") |

**SCREENED WELL**

Stick-up _____ ft

Top of Grout _____ ft

Top of Seal at _____ ft

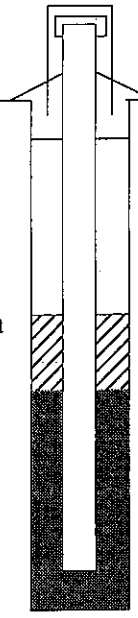
Top of Sand Pack _____ ft

Top of Screen at _____ ft

Bottom of Screen at _____ ft

Bottom of Hole at _____ ft

Bottom of Sandpack at _____



Lock Number _____

Inner Casing Material _____

Inner Casing Inside Diameter ____ inches

GROUND SURFACE

Quantity of Material Used:

Bentonite Pellets _____

Cement _____

Borehole _____ inches Diameter

Cement/ Bentonite _____

Grout _____

Screen Slot Size _____

Screen Type _____

☐ PVC _____

☐ Stainless Steel _____

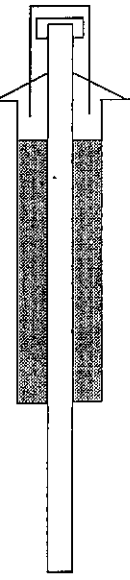
Pack Type/Size:

☐ Sand _____

☐ Gravel _____

☐ Natural _____

**OPEN-HOLE WELL**



Stick-up _____ ft

Inner Casing Material _____

Inner Casing Inside Diameter _____ inches

Outer Casing Diameter _____ inches

Borehole Diameter _____ ft

Bedrock _____ ft

Bottom of Rock Socket/ Outer Casing _____ ft

Bottom of Inner Casing _____ ft

Corehole Diameter _____

Bottom of Corehole _____ ft

NOTE: See pages 136 and 137 for well construction diagrams

| Depth-ft. | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| 1 | | ○ | ○ | ○ |
| 2 | | ○ | ○ | ○ |
| 3 | | ○ | ○ | ○ |
| 4 | pebbly sandy silt, gray color with red ~~mottling~~ stain, angular pebbles and sand (Tailings) | ● | ○ | ○ |
| 5 | | ● | ○ | ○ |
| 6 | | ○ | ○ | ○ |
| 7 | | ○ | ○ | ○ |
| 8 | | ○ | ○ | ○ |
| 9 | | ○ | ○ | ○ |
| 10 | | ○ | ○ | ○ |
| 11 | Red-brown, pebbly sandy silt, angular pebbles and sand (Tailings) | ○ | ● | ○ |
| 12 | | ○ | ● | ○ |
| 13 | | ○ | ○ | ○ |
| 14 | | ○ | ○ | ○ |
| 15 | | ○ | ○ | ○ |
| | white-red, pebbly sandy silt, angular pebbles (Tailings) | | ● | |
| | | | ● | |

| | Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16 | | | | | | | | | | | |
| | 17 | | | | | | | | | | | |
| | 18 | | | | | | | | | | | |
| | 19 | | | | | | | | | | | |
| | 20 | | | | | | | | | | | |
| 0933 | 21 | 02HMSB26 | 8 7 12 15 | | | | | 50% | | | | 24" splitspoon |
| | 22 | | | | | | | | | | | |
| | 23 | | | | | | | | | | | |
| | 24 | | | | | | | | | | | |
| | 25 | | | | | | | | | | | |
| 0940 | 26 | 02HMSB25 | 3 5 10 | | | | | 20% | | | | 18" splitspoon |
| | 27 | | | | | | | | | | | |
| | 28 | 02HMSB24 | | | | | | | | | | |
| | 29 | | | | | | | | | | | |
| | 30 | | | | | | | | | | | |
| 0945 | 31 | 02HMSB30 | 50 for 4" | | | | | 50% | | | | 24" splitspoon |
| | 32 | | | | | | | | | | | |
| | 33 | | | | | | | | | | | |
| | 34 | | | | | | | | | | | |
| | 35 | | | | | | | | | | | |
| 1000 | 36 | 02HMSB35 | 32 50 | | | | | 20% | | | | 18" splitspoon |
| | 37 | | | | | | | | | | | |
| | 38 | | | | | | | | | | | |
| | 39 | | | | | | | | | | | |
| | 40 | | | | | | | | | | | |
| | 41 | | | | | | | | | | | |
| | 42 | | | | | | | | | | | |
| | 43 | | | | | | | | | | | |
| | 44 | | | | | | | | | | | |
| | 45 | | | | | | | | | | | |

| Depth(feet). | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| 16 | | | | |
| 17 | | | | |
| 18 | | | | |
| 19 | | | | |
| 20 | red-white sandy silty gravel, angular gravel | | ● | |
| 21 | (Tailings) | | ● | |
| 22 | | | | |
| 23 | | | | |
| 24 | | | | |
| 25 | red-white gravelly sandy silt, angular gravel | | ● | |
| 26 | (Tailings) | | ● | |
| 27 | | | | |
| 28 | | | | |
| 29 | | | | |
| 30 | red-brown. gravelly sand, angular sand and gravel, very wet, | | | ● |
| 31 | fines may be washed away due to water. (Tailings) | | | ● |
| 32 | | | | |
| 33 | | | | |
| 34 | | | | |
| 35 | Brown-gray sandy gravel, angular gravel, very wet, looks | | | ● |
| 36 | like natural soils in area | | | ● |
| 37 | | | | |
| 38 | | | | |
| 39 | | | | |
| 40 | | | | |
| 41 | | | | |
| 42 | | | | |
| 43 | | | | |
| 44 | | | | |
| 45 | | | | |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 46 | | | | | | | | | | | |
| 47 | | | | | | | | | | | |
| 48 | | | | | | | | | | | |
| 49 | | | | | | | | | | | |
| 50 | | | | | | | | | | | |
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| 73 | | | | | | | | | | | |
| 74 | | | | | | | | | | | |
| 75 | | | | | | | | | | | |

| Depth(feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content Dry | Moist | Wet |
|---|---|---|---|---|
| 46 | | | | |
| 47 | | | | |
| 48 | | | | |
| 49 | | | | |
| 50 | | | | |
| 51 | | | | |
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| 70 | | | | |
| 71 | | | | |
| 72 | | | | |
| 73 | | | | |
| 74 | | | | |
| 75 | | | | |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | | | | | | | | | | | |
| 78 | | | | | | | | | | | |
| 79 | | | | | | | | | | | |
| 80 | | | | | | | | | | | |
| 81 | | | | | | | | | | | |
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| 100 | | | | | | | | | | | |
| 101 | | | | | | | | | | | |
| 102 | | | | | | | | | | | |
| 103 | | | | | | | | | | | |
| 104 | | | | | | | | | | | |
| 105 | | | | | | | | | | | |

| Depth (feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content | | |
|---|---|---|---|---|
| | | Dry | Moist | Wet |
| 77 | | ○ | ○ | ○ |
| 78 | | ○ | ○ | ○ |
| 79 | | ○ | ○ | ○ |
| 80 | | ○ | ○ | ○ |
| 81 | | ○ | ○ | ○ |
| 82 | | ○ | ○ | ○ |
| 83 | | ○ | ○ | ○ |
| 84 | | ○ | ○ | ○ |
| 85 | | ○ | ○ | ○ |
| 86 | | ○ | ○ | ○ |
| 87 | | ○ | ○ | ○ |
| 88 | | ○ | ○ | ○ |
| 89 | | ○ | ○ | ○ |
| 90 | | ○ | ○ | ○ |
| 91 | | ○ | ○ | ○ |
| 92 | | ○ | ○ | ○ |
| 93 | | ○ | ○ | ○ |
| 94 | | ○ | ○ | ○ |
| 95 | | ○ | ○ | ○ |
| 96 | | ○ | ○ | ○ |
| 97 | | ○ | ○ | ○ |
| 98 | | ○ | ○ | ○ |
| 99 | | ○ | ○ | ○ |
| 100 | | ○ | ○ | ○ |
| 101 | | ○ | ○ | ○ |
| 102 | | ○ | ○ | ○ |
| 103 | | ○ | ○ | ○ |
| 104 | | ○ | ○ | ○ |
| 105 | | ○ | ○ | ○ |

## WELL DEVELOPMENT RECORD

SITE _____ DATE _____

LOCATION _____ WELL NO. _____

_____

### MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2 (0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for $r^2h$ factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = _____ gallons.

**Volume of Water in Casing or Hole**

| Diameter of Casing or Hole (in) | Gallons per Foot of Depth | Cubic Feet per Foot of Depth | Liter per Meter of Depth | Cubic Meters per Meter of Depth |
|---|---|---|---|---|
| 1 | 0.041 | 0.0055 | 0.509 | $0.509 \times 10^{-3}$ |
| 11/2 | 0.092 | 0.0123 | 1.142 | $1.142 \times 10^{-3}$ |
| 2 | 0.163 | 0.0218 | 2.024 | $2.024 \times 10^{-3}$ |
| 21/2 | 0.255 | 0.0341 | 3.167 | $3.167 \times 10^{-3}$ |
| 3 | 0.367 | 0.0491 | 4.558 | $4.558 \times 10^{-3}$ |
| 31/2 | 0.500 | 0.0668 | 6.209 | $6.209 \times 10^{-3}$ |
| 4 | 0.653 | 0.0873 | 8.110 | $8.110 \times 10^{-3}$ |
| 41/2 | 0.826 | 0.1104 | 10.260 | $10.260 \times 10^{-3}$ |
| 5 | 1.020 | 0.1364 | 12.670 | $12.670 \times 10^{-3}$ |
| 51/2 | 1.234 | 0.1650 | 15.330 | $15.330 \times 10^{-3}$ |
| 6 | 1.469 | 0.1963 | 18.240 | $18.240 \times 10^{-3}$ |
| 7 | 2.000 | 0.2673 | 24.840 | $24.840 \times 10^{-3}$ |
| 8 | 2.611 | 0.3491 | 32.430 | $32.430 \times 10^{-3}$ |
| 9 | 3.305 | 0.4418 | 41.040 | $41.040 \times 10^{-3}$ |
| 10 | 4.080 | 0.5454 | 50.670 | $50.670 \times 10^{-3}$ |
| 11 | 4.937 | 0.6600 | 61.310 | $61.310 \times 10^{-3}$ |
| 12 | 5.875 | 0.7854 | 72.960 | $72.960 \times 10^{-3}$ |
| 14 | 8.000 | 1.0690 | 99.350 | $99.350 \times 10^{-3}$ |
| 16 | 10.440 | 1.3960 | 129.650 | $129.650 \times 10^{-3}$ |
| 18 | 13.220 | 1.7670 | 164.180 | $164.180 \times 10^{-3}$ |
| 20 | 16.320 | 2.1820 | 202.680 | $202.680 \times 10^{-3}$ |
| 22 | 19.750 | 2.6400 | 245.280 | $245.280 \times 10^{-3}$ |
| 24 | 23.500 | 3.1420 | 291.850 | $291.850 \times 10^{-3}$ |
| 26 | 27.580 | 3.6870 | 342.520 | $342.520 \times 10^{-3}$ |
| 28 | 32.000 | 4.2760 | 397.410 | $397.410 \times 10^{-3}$ |
| 30 | 36.720 | 4.9090 | 456.020 | $456.020 \times 10^{-3}$ |
| 32 | 41.780 | 5.5850 | 518.870 | $518.870 \times 10^{-3}$ |
| 34 | 47.160 | 6.3050 | 585.680 | $585.680 \times 10^{-3}$ |
| 36 | 52.880 | 7.0690 | 656.720 | $656.720 \times 10^{-3}$ |

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 3.779 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = $12.419 \times 10^{-3}$ cubic meters per meter of depth

### INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

### FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

DESCRIPTION OF DEVELOPMENT TECHNIQUE _____

_____

_____

## WELL DEVELOPMENT - PARAMETER MEASUREMENTS

| TIME | TOTAL VOL. WITHDRAWN | | pH | COND. (µmhos/cm) | TEMP. (°C/°F) | TURB. (NTU) | COMMENTS |
|---|---|---|---|---|---|---|---|
| | GALS. | BORE VOL. | | | | | |
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DEVELOPED BY: _____ DATE _____

## INVESTIGATION-DERIVED WASTE INVENTORY SHEET

Site: _____ No. of Drums: _____

Inventory Date: _____

| Waste Source | Drum/Container ID Number | Date Generated | Contents (Solid, Liquids, etc.) | Approximate Volume | Drum Location/Comments |
|---|---|---|---|---|---|
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# Borehole Record for 04HM-MW

- Drilling Log
- Narrative Lithologic Description
- Well Development Record
- Well Development -- Parameter Measurements
- Investigation - Derived Waste Inventory Sheet

# DRILLING LOG FOR 04HM-MW

Project Name Helen Mine

Site Location

Date Started/Finished 5/8/10

Drilling Company Test America

Driller's Name Davey

Geologist's Name Andrew Uhrig

Geologist's Signature [signature]

Rig Type (s) CME-85

Drilling Method (s) HSA

Bit Size (s) 8" Auger Size (s)

Auger/Split Spoon Refusal

Total Depth of Borehole Is

Total Depth of Corehole Is

| Water Level (TOIC) | | |
|---|---|---|
| Date | Time | Level( Feet) |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Well Location Sketch

| | Depth(Feet) | Sample Number | Blows on Sampler | Soil Components Rock Profile CL SL S GR | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1415 | 1 | | | | | | | | | | |
| | 2 | | | | | | | | | | |
| | 3 | | | | | | | | | | |
| | 4 | | | | | | | | | | |
| 1420 | 5 | 04HMMW05 | 8 11 | | | | 20% | | | | 24" Split Spoon |
| | 6 | | 13 45 | | | | | | | | |
| | 7 | | | | | | | | | | |
| | 8 | | | | | | | | | | |
| | 9 | | | | | | | | | | |
| 1430 | 10 | 04HMMW10 | 7 12 | | | | 100% | | | | 18" Split Spoon |
| | 11 | | 12 | | | | | | | | |
| | 12 | | | | | | | | | | |
| | 13 | | | | | | | | | | |
| | 14 | | | | | | | | | | |
| 1438 | 15 | 04HMMW15 | 8 13 50 for 2" | | | | 80% | | | | 18" Split Spoon |

**SCREENED WELL**

Stick-up 2 ft

Top of Grout Ø ft

Top of Seal at 2 ft

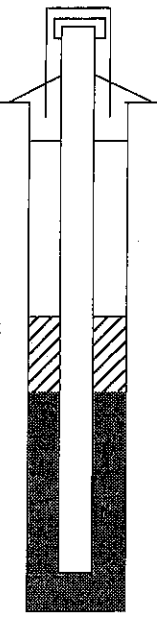
Top of Sand Pack 3 ft

Top of Screen at 4 ft

Bottom of Screen at 14 ft

Bottom of Hole at 15 ft

Bottom of Sandpack at 15



Lock Number _____

Inner Casing Material _____

Inner Casing Inside Diameter ____ inches

GROUND SURFACE

Quantity of Material Used:

Bentonite Pellets 1/2-5gal bucket

Cement _____

Borehole Diameter _____ inches

Cement/ Bentonite _____

Grout _____

Screen Slot Size 0.010

Screen Type slot

☒ PVC _____

☐ Stainless Steel _____

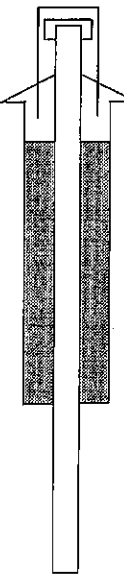
Pack Type/Size:

☒ Sand #1C 4bags

☐ Gravel _____

☐ Natural _____

**OPEN-HOLE WELL**



Stick-up _____ ft

Inner Casing Material _____

Inner Casing Inside Diameter _____ inches

Outer Casing Diameter _____ inches

Borehole Diameter _____ ft

Bedrock _____ ft

Bottom of Rock Socket/ Outer Casing _____ ft

Bottom of Inner Casing _____ ft

Corehole Diameter _____

Bottom of Corehole _____ ft

NOTE: See pages 136 and 137 for well construction diagrams

| Depth-ft. | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| 1 | | ○ | ○ | ○ |
| 2 | | ○ | ○ | ○ |
| 3 | | ○ | ○ | ○ |
| 4 | | ○ | ○ | ○ |
| 5 | | ○ | ○ | ○ |
| 6 | Gray sandy gravel w/ rock fragments, subangular gravel, angular fragments, | ○ | ● | ○ |
| 7 | | ○ | ● | ○ |
| 8 | | ○ | ○ | ○ |
| 9 | | ○ | ○ | ○ |
| 10 | | ○ | ○ | ○ |
| 11 | Gray gravelly clay, subangular gravel, very cohesive soil structure | ○ | ● | ○ |
| 12 | | ○ | ● | ○ |
| 13 | | ○ | ○ | ○ |
| 14 | | ○ | ○ | ○ |
| 15 | | ○ | ○ | ○ |
| | SAA, with large rock at bottom (fragments) | | ● | |
| | | | ● | |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | | | See previous pages | | | | | | | | |
| 17 | | | | | | | | | | | |
| 18 | | | | | | | | | | | |
| 19 | | | | | | | | | | | |
| 20 | | | | | | | | | | | |
| 21 | 04HAMW20 | 50 for 0" | | | | | 0% | | | | Split spoon |
| 22 | | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | | | | | | | | | | | |
| 25 | | | | | | | | | | | |
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| 44 | | | | | | | | | | | |
| 45 | | | | | | | | | | | |

| Depth(feet). | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| 16 | See previous pages | | | |
| 17 | | | | |
| 18 | Dense gravel (Hard drilling) | | | |
| 19 | | | | |
| 20 | cuttings are gray claystone | | | |
| 21 | no core recovery, likely gray claystone | | | |
| 22 | | | | |
| 23 | | | | |
| 24 | | | | |
| 25 | | | | |
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| 43 | | | | |
| 44 | | | | |
| 45 | | | | |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 46 | | | | | | | | | | | |
| 47 | | | | | | | | | | | |
| 48 | | | | | | | | | | | |
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| 73 | | | | | | | | | | | |
| 74 | | | | | | | | | | | |
| 75 | | | | | | | | | | | |

| Depth(feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content Dry | Moist | Wet |
|---|---|---|---|---|
| 46 | | | | |
| 47 | | | | |
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| 71 | | | | |
| 72 | | | | |
| 73 | | | | |
| 74 | | | | |
| 75 | | | | |

| Depth(feet) | Sample Number | Blows on Sampler | | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | | | | | | | | | | | | |
| 78 | | | | | | | | | | | | |
| 79 | | | | | | | | | | | | |
| 80 | | | | | | | | | | | | |
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| 103 | | | | | | | | | | | | |
| 104 | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | |

| Depth (feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content | | |
|---|---|---|---|---|
| | | Dry | Moist | Wet |
| 77 | | ○ | ○ | ○ |
| 78 | | ○ | ○ | ○ |
| 79 | | ○ | ○ | ○ |
| 80 | | ○ | ○ | ○ |
| 81 | | ○ | ○ | ○ |
| 82 | | ○ | ○ | ○ |
| 83 | | ○ | ○ | ○ |
| 84 | | ○ | ○ | ○ |
| 85 | | ○ | ○ | ○ |
| 86 | | ○ | ○ | ○ |
| 87 | | ○ | ○ | ○ |
| 88 | | ○ | ○ | ○ |
| 89 | | ○ | ○ | ○ |
| 90 | | ○ | ○ | ○ |
| 91 | | ○ | ○ | ○ |
| 92 | | ○ | ○ | ○ |
| 93 | | ○ | ○ | ○ |
| 94 | | ○ | ○ | ○ |
| 95 | | ○ | ○ | ○ |
| 96 | | ○ | ○ | ○ |
| 97 | | ○ | ○ | ○ |
| 98 | | ○ | ○ | ○ |
| 99 | | ○ | ○ | ○ |
| 100 | | ○ | ○ | ○ |
| 101 | | ○ | ○ | ○ |
| 102 | | ○ | ○ | ○ |
| 103 | | ○ | ○ | ○ |
| 104 | | ○ | ○ | ○ |
| 105 | | ○ | ○ | ○ |

## WELL DEVELOPMENT RECORD

SITE _____ DATE _____

LOCATION _____ WELL NO. _____

_____

### MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2 (0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for $r^2h$ factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = _____ gallons.

### Volume of Water in Casing or Hole

| Diameter of Casing or Hole (in) | Gallons per Foot of Depth | Cubic Feet per Foot of Depth | Liter per Meter of Depth | Cubic Meters per Meter of Depth |
|---|---|---|---|---|
| 1 | 0.041 | 0.0055 | 0.509 | $0.509 \times 10^{-3}$ |
| 11/2 | 0.092 | 0.0123 | 1.142 | $1.142 \times 10^{-3}$ |
| 2 | 0.163 | 0.0218 | 2.024 | $2.024 \times 10^{-3}$ |
| 21/2 | 0.255 | 0.0341 | 3.167 | $3.167 \times 10^{-3}$ |
| 3 | 0.367 | 0.0491 | 4.558 | $4.558 \times 10^{-3}$ |
| 31/2 | 0.500 | 0.0668 | 6.209 | $6.209 \times 10^{-3}$ |
| 4 | 0.653 | 0.0873 | 8.110 | $8.110 \times 10^{-3}$ |
| 41/2 | 0.826 | 0.1104 | 10.260 | $10.260 \times 10^{-3}$ |
| 5 | 1.020 | 0.1364 | 12.670 | $12.670 \times 10^{-3}$ |
| 51/2 | 1.234 | 0.1650 | 15.330 | $15.330 \times 10^{-3}$ |
| 6 | 1.469 | 0.1963 | 18.240 | $18.240 \times 10^{-3}$ |
| 7 | 2.000 | 0.2673 | 24.840 | $24.840 \times 10^{-3}$ |
| 8 | 2.611 | 0.3491 | 32.430 | $32.430 \times 10^{-3}$ |
| 9 | 3.305 | 0.4418 | 41.040 | $41.040 \times 10^{-3}$ |
| 10 | 4.080 | 0.5454 | 50.670 | $50.670 \times 10^{-3}$ |
| 11 | 4.937 | 0.6600 | 61.310 | $61.310 \times 10^{-3}$ |
| 12 | 5.875 | 0.7854 | 72.960 | $72.960 \times 10^{-3}$ |
| 14 | 8.000 | 1.0690 | 99.350 | $99.350 \times 10^{-3}$ |
| 16 | 10.440 | 1.3960 | 129.650 | $129.650 \times 10^{-3}$ |
| 18 | 13.220 | 1.7670 | 164.180 | $164.180 \times 10^{-3}$ |
| 20 | 16.320 | 2.1820 | 202.680 | $202.680 \times 10^{-3}$ |
| 22 | 19.750 | 2.6400 | 245.280 | $245.280 \times 10^{-3}$ |
| 24 | 23.500 | 3.1420 | 291.850 | $291.850 \times 10^{-3}$ |
| 26 | 27.580 | 3.6870 | 342.520 | $342.520 \times 10^{-3}$ |
| 28 | 32.000 | 4.2760 | 397.410 | $397.410 \times 10^{-3}$ |
| 30 | 36.720 | 4.9090 | 456.020 | $456.020 \times 10^{-3}$ |
| 32 | 41.780 | 5.5850 | 518.870 | $518.870 \times 10^{-3}$ |
| 34 | 47.160 | 6.3050 | 585.680 | $585.680 \times 10^{-3}$ |
| 36 | 52.880 | 7.0690 | 656.720 | $656.720 \times 10^{-3}$ |

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 3.779 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = $12.419 \times 10^{-3}$ cubic meters per meter of depth

### INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

### FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

DESCRIPTION OF DEVELOPMENT TECHNIQUE _____

_____

_____

## WELL DEVELOPMENT - PARAMETER MEASUREMENTS

| TIME | TOTAL VOL. WITHDRAWN | | pH | COND. (µmhos/cm) | TEMP. (°C/°F) | TURB. (NTU) | COMMENTS |
|---|---|---|---|---|---|---|---|
| | GALS. | BORE VOL. | | | | | |
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DEVELOPED BY: _____ DATE _____

## INVESTIGATION-DERIVED WASTE INVENTORY SHEET

Site: _____ No. of Drums: _____

Inventory Date: _____

| Waste Source | Drum/Container ID Number | Date Generated | Contents (Solid, Liquids, etc.) | Approximate Volume | Drum Location/Comments |
|---|---|---|---|---|---|
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# Borehole Record for 05HM-5B

- Drilling Log
- Narrative Lithologic Description
- Well Development Record
- Well Development -- Parameter Measurements
- Investigation - Derived Waste Inventory Sheet

DRILLING LOG FOR 05HM-SB

Project Name Helen Mine

Site Location

Date Started/Finished 5/11/10

Drilling Company Test America

Driller's Name Davey

Geologist's Name Andrew Uhrig

Geologist's Signature

Rig Type (s) Hand Auger

Drilling Method (s)

Bit Size (s) Auger Size (s) 6"

Auger/Split Spoon Refusal

Total Depth of Borehole Is 3'

Total Depth of Corehole Is

| Water Level (TOIC) | | |
|---|---|---|
| Date | Time | Level( Feet) |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Well Location Sketch

| Depth(Feet) | Sample Number | Blows on Sampler | Soil Components Rock Profile CL SL S GR | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | 05HMSB03 | | GR,S,SL | | | | | | | Hand auger sample |
| 4 | | | | | | | | | | |
| 5 | | | refusal @ 3 ft bgs due to large | | | | | | | |
| 6 | | | rocks and caving of borehole. | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
| 12 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 15 | | | | | | | | | | |

315

**SCREENED WELL**

Stick-up _____ ft

Top of Grout _____ ft

Top of Seal at _____ ft

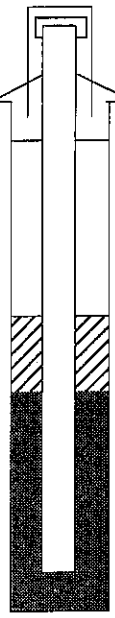
Top of Sand Pack _____ ft

Top of Screen at _____ ft

Bottom of Screen at _____ ft

Bottom of Hole at _____ ft

Bottom of Sandpack at _____



Lock Number _____

Inner Casing Material _____

Inner Casing Inside Diameter ____ inches

GROUND SURFACE

Quantity of Material Used:

Bentonite Pellets _____

Cement _____

Borehole _____ inches Diameter

Cement/ Bentonite _____

Grout _____

Screen Slot Size _____

Screen Type _____

☐ PVC _____

☐ Stainless Steel _____

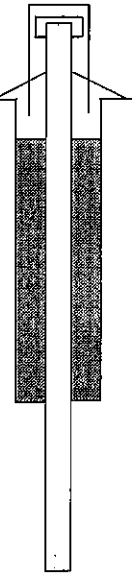
Pack Type/Size:

☐ Sand _____

☐ Gravel _____

☐ Natural _____

**OPEN-HOLE WELL**



Stick-up _____ ft

Inner Casing Material _____

Inner Casing Inside Diameter _____ inches

Outer Casing Diameter _____ inches

Borehole Diameter _____ ft

Bedrock _____ ft

Bottom of Rock Socket/ Outer Casing _____ ft

Bottom of Inner Casing _____ ft

Corehole Diameter _____

Bottom of Corehole _____ ft

NOTE: See pages 136 and 137 for well construction diagrams

| Depth-ft. | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| 1 | Redbrown, cobbly silty sandy gravel, angular to | ○ | ● | ○ |
| 2 | subangular gravel and cobbles. No organics | ○ | ● | ○ |
| 3 | | ○ | ○ | ○ |
| 4 | | ○ | ○ | ○ |
| 5 | | ○ | ○ | ○ |
| 6 | | ○ | ○ | ○ |
| 7 | | ○ | ○ | ○ |
| 8 | | ○ | ○ | ○ |
| 9 | | ○ | ○ | ○ |
| 10 | | ○ | ○ | ○ |
| 11 | | ○ | ○ | ○ |
| 12 | | ○ | ○ | ○ |
| 13 | | ○ | ○ | ○ |
| 14 | | ○ | ○ | ○ |
| 15 | | ○ | ○ | ○ |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | | | | | | | | | | | |
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| 45 | | | | | | | | | | | |

| Depth(feet). | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content | | |
|---|---|---|---|---|
| | | Dry | Moist | Wet |
| 16 | | | | |
| 17 | | | | |
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| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
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| 74 | | | | | | | | | | | |
| 75 | | | | | | | | | | | |

| Depth(feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content Dry | Moist | Wet |
|---|---|---|---|---|
| 46 | | | | |
| 47 | | | | |
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| 72 | | | | |
| 73 | | | | |
| 74 | | | | |
| 75 | | | | |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | | | | | | | | | | | |
| 78 | | | | | | | | | | | |
| 79 | | | | | | | | | | | |
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| 104 | | | | | | | | | | | |
| 105 | | | | | | | | | | | |

| Depth (feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content | | |
|---|---|---|---|---|
| | | Dry | Moist | Wet |
| 77 | | ○ | ○ | ○ |
| 78 | | ○ | ○ | ○ |
| 79 | | ○ | ○ | ○ |
| 80 | | ○ | ○ | ○ |
| 81 | | ○ | ○ | ○ |
| 82 | | ○ | ○ | ○ |
| 83 | | ○ | ○ | ○ |
| 84 | | ○ | ○ | ○ |
| 85 | | ○ | ○ | ○ |
| 86 | | ○ | ○ | ○ |
| 87 | | ○ | ○ | ○ |
| 88 | | ○ | ○ | ○ |
| 89 | | ○ | ○ | ○ |
| 90 | | ○ | ○ | ○ |
| 91 | | ○ | ○ | ○ |
| 92 | | ○ | ○ | ○ |
| 93 | | ○ | ○ | ○ |
| 94 | | ○ | ○ | ○ |
| 95 | | ○ | ○ | ○ |
| 96 | | ○ | ○ | ○ |
| 97 | | ○ | ○ | ○ |
| 98 | | ○ | ○ | ○ |
| 99 | | ○ | ○ | ○ |
| 100 | | ○ | ○ | ○ |
| 101 | | ○ | ○ | ○ |
| 102 | | ○ | ○ | ○ |
| 103 | | ○ | ○ | ○ |
| 104 | | ○ | ○ | ○ |
| 105 | | ○ | ○ | ○ |

## WELL DEVELOPMENT RECORD

SITE _____ DATE _____

LOCATION _____ WELL NO. _____

_____

### MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2(0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for $r^2h$ factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = _____ gallons.

### Volume of Water in Casing or Hole

| Diameter of Casing or Hole (in) | Gallons per Foot of Depth | Cubic Feet per Foot of Depth | Liter per Meter of Depth | Cubic Meters per Meter of Depth |
|---|---|---|---|---|
| 1 | 0.041 | 0.0055 | 0.509 | $0.509 \times 10^{-3}$ |
| 11/2 | 0.092 | 0.0123 | 1.142 | $1.142 \times 10^{-3}$ |
| 2 | 0.163 | 0.0218 | 2.024 | $2.024 \times 10^{-3}$ |
| 21/2 | 0.255 | 0.0341 | 3.167 | $3.167 \times 10^{-3}$ |
| 3 | 0.367 | 0.0491 | 4.558 | $4.558 \times 10^{-3}$ |
| 31/2 | 0.500 | 0.0668 | 6.209 | $6.209 \times 10^{-3}$ |
| 4 | 0.653 | 0.0873 | 8.110 | $8.110 \times 10^{-3}$ |
| 41/2 | 0.826 | 0.1104 | 10.260 | $10.260 \times 10^{-3}$ |
| 5 | 1.020 | 0.1364 | 12.670 | $12.670 \times 10^{-3}$ |
| 51/2 | 1.234 | 0.1650 | 15.330 | $15.330 \times 10^{-3}$ |
| 6 | 1.469 | 0.1963 | 18.240 | $18.240 \times 10^{-3}$ |
| 7 | 2.000 | 0.2673 | 24.840 | $24.840 \times 10^{-3}$ |
| 8 | 2.611 | 0.3491 | 32.430 | $32.430 \times 10^{-3}$ |
| 9 | 3.305 | 0.4418 | 41.040 | $41.040 \times 10^{-3}$ |
| 10 | 4.080 | 0.5454 | 50.670 | $50.670 \times 10^{-3}$ |
| 11 | 4.937 | 0.6600 | 61.310 | $61.310 \times 10^{-3}$ |
| 12 | 5.875 | 0.7854 | 72.960 | $72.960 \times 10^{-3}$ |
| 14 | 8.000 | 1.0690 | 99.350 | $99.350 \times 10^{-3}$ |
| 16 | 10.440 | 1.3960 | 129.650 | $129.650 \times 10^{-3}$ |
| 18 | 13.220 | 1.7670 | 164.180 | $164.180 \times 10^{-3}$ |
| 20 | 16.320 | 2.1820 | 202.680 | $202.680 \times 10^{-3}$ |
| 22 | 19.750 | 2.6400 | 245.280 | $245.280 \times 10^{-3}$ |
| 24 | 23.500 | 3.1420 | 291.850 | $291.850 \times 10^{-3}$ |
| 26 | 27.580 | 3.6870 | 342.520 | $342.520 \times 10^{-3}$ |
| 28 | 32.000 | 4.2760 | 397.410 | $397.410 \times 10^{-3}$ |
| 30 | 36.720 | 4.9090 | 456.020 | $456.020 \times 10^{-3}$ |
| 32 | 41.780 | 5.5850 | 518.870 | $518.870 \times 10^{-3}$ |
| 34 | 47.160 | 6.3050 | 585.680 | $585.680 \times 10^{-3}$ |
| 36 | 52.880 | 7.0690 | 656.720 | $656.720 \times 10^{-3}$ |

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 3.779 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = $12.419 \times 10^{-3}$ cubic meters per meter of depth

### INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

### FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

DESCRIPTION OF DEVELOPMENT TECHNIQUE _____

_____

_____

## WELL DEVELOPMENT - PARAMETER MEASUREMENTS

| TIME | TOTAL VOL. WITHDRAWN | | pH | COND. (µmhos/cm) | TEMP. (°C/°F) | TURB. (NTU) | COMMENTS |
|---|---|---|---|---|---|---|---|
| | GALS. | BORE VOL. | | | | | |
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DEVELOPED BY: _____ DATE _____

## INVESTIGATION-DERIVED WASTE INVENTORY SHEET

Site: _____ No. of Drums: _____

Inventory Date: _____

| Waste Source | Drum/Container ID Number | Date Generated | Contents (Solid, Liquids, etc.) | Approximate Volume | Drum Location/Comments |
|---|---|---|---|---|---|
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# Borehole Record for 06HM-MW

- Drilling Log
- Narrative Lithologic Description
- Well Development Record
- Well Development -- Parameter Measurements
- Investigation - Derived Waste Inventory Sheet

# DRILLING LOG FOR 06HM-MW

Project Name

Site Location

Date Started/Finished 5/9/10 → 5/11/10

Drilling Company Test America

Driller's Name Davey

Geologist's Name Andrew Uhrig

Geologist's Signature

Rig Type (s) Hand Auger

Drilling Method (s)

Bit Size (s) Auger Size (s) 6"

Auger/Split Spoon Refusal

Total Depth of Borehole Is 4ft

Total Depth of Corehole Is

| Water Level (TOIC) | | |
|---|---|---|
| Date | Time | Level( Feet) |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Well Location Sketch

| Depth(Feet) | Sample Number | Blows on Sampler | Soil Components Rock Profile CL SL S GR | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
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| 14 | | | | | | | | | | |
| 15 | | | | | | | | | | |

48
-38
100

48
-32
16

**SCREENED WELL**

Stick-up 2 ft

Top of Grout _____ ft

Top of Seal at Ø ft

Top of Sand Pack 8" ~~ft~~

Top of Screen at ~~12 ft~~ 12" in

Bottom of Screen at 4 ft

Bottom of Hole at 4 ft

Bottom of Sandpack at 4 ft

Lock Number _____

Inner Casing Material _____

Inner Casing Inside Diameter ____ inches

GROUND SURFACE

Quantity of Material Used:

Bentonite Pellets _____

Cement _____

Borehole _____ inches Diameter

Cement/ Bentonite _____

Grout _____

Screen Slot Size _____

Screen Type D10

☑ PVC _____

☐ Stainless Steel _____

Pack Type/Size:

☒ Sand #2/12

☐ Gravel _____

☐ Natural _____

**OPEN-HOLE WELL**

Stick-up _____ ft

Inner Casing Material _____

Inner Casing Inside Diameter _____ inches

Outer Casing Diameter _____ inches

Borehole Diameter _____ ft

Bedrock _____ ft

Bottom of Rock Socket/ Outer Casing _____ ft

Bottom of Inner Casing _____ ft

Corehole Diameter _____

Bottom of Corehole _____ ft

NOTE: See pages 136 and 137 for well construction diagrams

| Depth-ft. | DTW = 16" NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content Dry | Moist | Wet |
|---|---|---|---|---|
| 1 | Gray Cobbly silty sandy Gravel, with organics, | ○ | ○ | ● |
| 2 | Cobbles rounded to sub rounded, gravel angular to subrounded | ○ | ○ | ● |
| 3 | | ○ | ○ | ○ |
| 4 | | ○ | ○ | ○ |
| 5 | | ○ | ○ | ○ |
| 6 | | ○ | ○ | ○ |
| 7 | | ○ | ○ | ○ |
| 8 | | ○ | ○ | ○ |
| 9 | | ○ | ○ | ○ |
| 10 | | ○ | ○ | ○ |
| 11 | | ○ | ○ | ○ |
| 12 | | ○ | ○ | ○ |
| 13 | | ○ | ○ | ○ |
| 14 | | ○ | ○ | ○ |
| 15 | | ○ | ○ | ○ |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | | | | | | | | | | | |
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| 45 | | | | | | | | | | | |

| Depth(feet). | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content | | |
|---|---|---|---|---|
| | | Dry | Moist | Wet |
| 16 | | ○ | ○ | ○ |
| 17 | | ○ | ○ | ○ |
| 18 | | ○ | ○ | ○ |
| 19 | | ○ | ○ | ○ |
| 20 | | ○ | ○ | ○ |
| 21 | | ○ | ○ | ○ |
| 22 | | ○ | ○ | ○ |
| 23 | | ○ | ○ | ○ |
| 24 | | ○ | ○ | ○ |
| 25 | | ○ | ○ | ○ |
| 26 | | ○ | ○ | ○ |
| 27 | | ○ | ○ | ○ |
| 28 | | ○ | ○ | ○ |
| 29 | | ○ | ○ | ○ |
| 30 | | ○ | ○ | ○ |
| 31 | | ○ | ○ | ○ |
| 32 | | ○ | ○ | ○ |
| 33 | | ○ | ○ | ○ |
| 34 | | ○ | ○ | ○ |
| 35 | | ○ | ○ | ○ |
| 36 | | ○ | ○ | ○ |
| 37 | | ○ | ○ | ○ |
| 38 | | ○ | ○ | ○ |
| 39 | | ○ | ○ | ○ |
| 40 | | ○ | ○ | ○ |
| 41 | | ○ | ○ | ○ |
| 42 | | ○ | ○ | ○ |
| 43 | | ○ | ○ | ○ |
| 44 | | ○ | ○ | ○ |
| 45 | | ○ | ○ | ○ |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
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| 74 | | | | | | | | | | | |
| 75 | | | | | | | | | | | |

| Depth(feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content | | |
|---|---|---|---|---|
| | | Dry | Moist | Wet |
| 46 | | | | |
| 47 | | | | |
| 48 | | | | |
| 49 | | | | |
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| 73 | | | | |
| 74 | | | | |
| 75 | | | | |

| Depth(feet) | Sample Number | Blows on Sampler | | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | | | | | | | | | | | | |
| 78 | | | | | | | | | | | | |
| 79 | | | | | | | | | | | | |
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| 103 | | | | | | | | | | | | |
| 104 | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | |

| Depth (feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content | | |
|---|---|---|---|---|
| | | Dry | Moist | Wet |
| 77 | | ○ | ○ | ○ |
| 78 | | ○ | ○ | ○ |
| 79 | | ○ | ○ | ○ |
| 80 | | ○ | ○ | ○ |
| 81 | | ○ | ○ | ○ |
| 82 | | ○ | ○ | ○ |
| 83 | | ○ | ○ | ○ |
| 84 | | ○ | ○ | ○ |
| 85 | | ○ | ○ | ○ |
| 86 | | ○ | ○ | ○ |
| 87 | | ○ | ○ | ○ |
| 88 | | ○ | ○ | ○ |
| 89 | | ○ | ○ | ○ |
| 90 | | ○ | ○ | ○ |
| 91 | | ○ | ○ | ○ |
| 92 | | ○ | ○ | ○ |
| 93 | | ○ | ○ | ○ |
| 94 | | ○ | ○ | ○ |
| 95 | | ○ | ○ | ○ |
| 96 | | ○ | ○ | ○ |
| 97 | | ○ | ○ | ○ |
| 98 | | ○ | ○ | ○ |
| 99 | | ○ | ○ | ○ |
| 100 | | ○ | ○ | ○ |
| 101 | | ○ | ○ | ○ |
| 102 | | ○ | ○ | ○ |
| 103 | | ○ | ○ | ○ |
| 104 | | ○ | ○ | ○ |
| 105 | | ○ | ○ | ○ |

## WELL DEVELOPMENT RECORD

SITE _____ DATE _____

LOCATION _____ WELL NO. _____

_____

### MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2 (0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for $r^2h$ factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = _____ gallons.

### Volume of Water in Casing or Hole

| Diameter of Casing or Hole (in) | Gallons per Foot of Depth | Cubic Feet per Foot of Depth | Liter per Meter of Depth | Cubic Meters per Meter of Depth |
|---|---|---|---|---|
| 1 | 0.041 | 0.0055 | 0.509 | $0.509 \times 10^{-3}$ |
| 11/2 | 0.092 | 0.0123 | 1.142 | $1.142 \times 10^{-3}$ |
| 2 | 0.163 | 0.0218 | 2.024 | $2.024 \times 10^{-3}$ |
| 21/2 | 0.255 | 0.0341 | 3.167 | $3.167 \times 10^{-3}$ |
| 3 | 0.367 | 0.0491 | 4.558 | $4.558 \times 10^{-3}$ |
| 31/2 | 0.500 | 0.0668 | 6.209 | $6.209 \times 10^{-3}$ |
| 4 | 0.653 | 0.0873 | 8.110 | $8.110 \times 10^{-3}$ |
| 41/2 | 0.826 | 0.1104 | 10.260 | $10.260 \times 10^{-3}$ |
| 5 | 1.020 | 0.1364 | 12.670 | $12.670 \times 10^{-3}$ |
| 51/2 | 1.234 | 0.1650 | 15.330 | $15.330 \times 10^{-3}$ |
| 6 | 1.469 | 0.1963 | 18.240 | $18.240 \times 10^{-3}$ |
| 7 | 2.000 | 0.2673 | 24.840 | $24.840 \times 10^{-3}$ |
| 8 | 2.611 | 0.3491 | 32.430 | $32.430 \times 10^{-3}$ |
| 9 | 3.305 | 0.4418 | 41.040 | $41.040 \times 10^{-3}$ |
| 10 | 4.080 | 0.5454 | 50.670 | $50.670 \times 10^{-3}$ |
| 11 | 4.937 | 0.6600 | 61.310 | $61.310 \times 10^{-3}$ |
| 12 | 5.875 | 0.7854 | 72.960 | $72.960 \times 10^{-3}$ |
| 14 | 8.000 | 1.0690 | 99.350 | $99.350 \times 10^{-3}$ |
| 16 | 10.440 | 1.3960 | 129.650 | $129.650 \times 10^{-3}$ |
| 18 | 13.220 | 1.7670 | 164.180 | $164.180 \times 10^{-3}$ |
| 20 | 16.320 | 2.1820 | 202.680 | $202.680 \times 10^{-3}$ |
| 22 | 19.750 | 2.6400 | 245.280 | $245.280 \times 10^{-3}$ |
| 24 | 23.500 | 3.1420 | 291.850 | $291.850 \times 10^{-3}$ |
| 26 | 27.580 | 3.6870 | 342.520 | $342.520 \times 10^{-3}$ |
| 28 | 32.000 | 4.2760 | 397.410 | $397.410 \times 10^{-3}$ |
| 30 | 36.720 | 4.9090 | 456.020 | $456.020 \times 10^{-3}$ |
| 32 | 41.780 | 5.5850 | 518.870 | $518.870 \times 10^{-3}$ |
| 34 | 47.160 | 6.3050 | 585.680 | $585.680 \times 10^{-3}$ |
| 36 | 52.880 | 7.0690 | 656.720 | $656.720 \times 10^{-3}$ |

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 3.779 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = $12.419 \times 10^{-3}$ cubic meters per meter of depth

### INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

### FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

DESCRIPTION OF DEVELOPMENT TECHNIQUE _____

_____

_____

## WELL DEVELOPMENT - PARAMETER MEASUREMENTS

| TIME | TOTAL VOL. WITHDRAWN | | pH | COND. (µmhos/cm) | TEMP. (°C/°F) | TURB. (NTU) | COMMENTS |
|---|---|---|---|---|---|---|---|
| | GALS. | BORE VOL. | | | | | |
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DEVELOPED BY: _____

DATE _____

## INVESTIGATION-DERIVED WASTE INVENTORY SHEET

Site: _____ No. of Drums: _____

Inventory Date: _____

| Waste Source | Drum/Container ID Number | Date Generated | Contents (Solid, Liquids, etc.) | Approximate Volume | Drum Location/Comments |
|---|---|---|---|---|---|
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# Borehole Record for 07HM-MW

- Drilling Log
- Narrative Lithologic Description
- Well Development Record
- Well Development -- Parameter Measurements
- Investigation - Derived Waste Inventory Sheet

# DRILLING LOG FOR 02HM-MW

Project Name Helen Mine

Site Location

Date Started/Finished 5/8/10

Drilling Company Test America

Driller's Name Davey

Geologist's Name Andrew Uhrig

Geologist's Signature

Rig Type (s) CME-85

Drilling Method (s) HSA

Bit Size (s) 8" Auger Size (s)

Auger/Split Spoon Refusal

Total Depth of Borehole Is

Total Depth of Corehole Is

| Water Level (TOIC) | | |
|---|---|---|
| Date | Time | Level( Feet) |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Well Location Sketch

| | Depth(Feet) | Sample Number | Blows on Sampler | Soil Components Rock Profile CL SL S GR | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1542 | 1 | | | | | | | | | | |
| | 2 | | | | | | | | | | |
| | 3 | | | | | | | | | | |
| | 4 | | | | | | | | | | |
| | 5 | | | | | | | | | | |
| 1556 | 6 | 02HMMW05 | 12 27 26 | | | | 100% | | | | 18" Split Spoon |
| | 7 | | | | | | | | | | |
| | 8 | | | | | | | | | | |
| | 9 | | | | | | | | | | |
| | 10 | | | | | | | | | | |
| 1603 | 11 | 02HMMW10 | 6 11 20 | | | | 100% | | | | 18" Split Spoon |
| | 12 | | | | | | | | | | |
| | 13 | | | | | | | | | | |
| | 14 | | | | | | | | | | |
| | 15 | | | | | | | | | | |
| 1617 | | 02HMMW15 | 33 26 35 | | | | 100% | | | | 18" Split Spoon |

**SCREENED WELL**

Stick-up _____ ft

Top of Grout _____ ft

Top of Seal at _____ ft

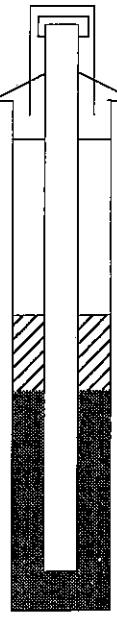
Top of Sand Pack _____ ft

Top of Screen at _____ ft

Bottom of Screen at _____ ft

Bottom of Hole at _____ ft

Bottom of Sandpack at _____



Lock Number _____

Inner Casing Material _____

Inner Casing Inside Diameter ____ inches

GROUND SURFACE

Quantity of Material Used:

Bentonite Pellets _____

Cement _____

Borehole _____ inches Diameter

Cement/ Bentonite _____

Grout _____

Screen Slot Size _____

Screen Type _____

☐ PVC _____

☐ Stainless Steel _____

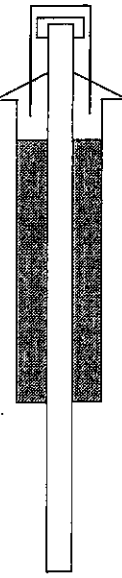
Pack Type/Size:

☐ Sand _____

☐ Gravel _____

☐ Natural _____

**OPEN-HOLE WELL**



Stick-up _____ ft

Inner Casing Material _____

Inner Casing Inside Diameter _____ inches

Outer Casing Diameter _____ inches

Borehole Diameter _____ ft

Bedrock _____ ft

Bottom of Rock Socket/ Outer Casing _____ ft

Bottom of Inner Casing _____ ft

Corehole Diameter _____

Bottom of Corehole _____ ft

NOTE: See pages 136 and 137 for well construction diagrams

| Depth-ft. | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| | Brown-gray silty sandy gravel | ○ | ○ | ○ |
| 1 | | ○ | ○ | ○ |
| 2 | | ○ | ○ | ○ |
| 3 | | ○ | ○ | ○ |
| 4 | | ○ | ○ | ○ |
| 5 | Green weathered Serpentinite, very friable, | ○ | ● | ○ |
| 6 | angular black rock fragments at bottom | ○ | ● | ○ |
| 7 | | ○ | ○ | ○ |
| 8 | | ○ | ○ | ○ |
| 9 | | ○ | ○ | ○ |
| 10 | | ○ | ● | ○ |
| 11 | SAA | ○ | ● | ○ |
| 12 | | ○ | ○ | ○ |
| 13 | | ○ | ○ | ○ |
| 14 | | ○ | ○ | ○ |
| 15 | | ○ | ● | ○ |
| | SAA | | ● | |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | | | See previous page | | | | | | | | |
| 17 | | | | | | | | | | | |
| 18 | | | | | | | | | | | |
| 19 | | | | | | | | | | | |
| 20 | | | | | | | | | | | |
| 21 | 07MMW26 | 37 50for4" | | | | | 75% | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | | | | | | | | | | | |
| 25 | | | | | | | | | | | |
| 26 | 07MMW25 | | | | | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | Borehole abandoned on 5/11/10 due to no water | | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |
| 31 | | | | | | | | | | | |
| 32 | | | | | | | | | | | |
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| 43 | | | | | | | | | | | |
| 44 | | | | | | | | | | | |
| 45 | | | | | | | | | | | |

| Depth(feet). | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content Dry | Moist | Wet |
|---|---|---|---|---|
| 16 | See previous page | | | |
| 17 | | | | |
| 18 | | | | |
| 19 | | | | |
| 20 | | | | |
| 21 | SAA | | | |
| 22 | | | | |
| 23 | | | | |
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| 44 | | | | |
| 45 | | | | |

07HM-MW(2)

| | Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 46 | | | | | | | | | | | |
| | 47 | | | | | | | | | | | |
| | 48 | | | S4S/GR | | | | | | | | |
| | 49 | | | | | | | | | | | |
| | 50 | | | | | | | | | | | |
| 5 | 51 | | | | | | | | | | | |
| 0916 | 52 | 07HMMW05B | 18 17 20 | Bedrock | | | | 100% | | | | 18" split spoon |
| | 53 | | | | | | | | | | | |
| | 54 | | | | | | | | | | | |
| | 55 | | | | | | | | | | | |
| 10 | 56 | | | | | | | | | | | |
| 0925 | 57 | 07HMMW10B | 11 14 17 | Bedrock | | | | | | | | 18" split spoon |
| | 58 | | | | | | | | | | | |
| | 59 | | | | | | | | | | | |
| | 60 | | | | | | | | | | | |
| 15 | 61 | | | | | | | | | | | |
| | 62 | no sample | 50 for 1" | Bedrock | | | | 5% | | | | 18" split spoon |
| | 63 | | | | | | | | | | | |
| | 64 | | | | | | | | | | | |
| | 65 | | | | | | | | | | | |
| 20 | 66 | | | | | | | | | | | |
| 1540 | 67 | 07HMMW20B | 44 50 for 0" | Bedrock | | | | 75% | | | | 18" split spoon |
| | 68 | | | | | | | | | | | |
| | 69 | | | | | | | | | | | |
| | 70 | | | | | | | | | | | |
| 25 | 71 | | | | | | | | | | | |
| 1600 | 72 | no sample (Slider) | NA | | | | | 100% | | | | 18" split spoon |
| | 73 | | | | | | | | | | | |
| | 74 | | | | | | | | | | | |
| | 75 | | | | | | | | | | | |

| Depth(feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| 0 46 | brown-gray silty sandy gravel, angular gravels and sands | | ● | |
| 47 | | | ● | |
| 48 | | | | |
| 49 | | | | |
| 50 | | | | |
| 5 51 | | | | |
| 52 | Green weathered serpentinite with angular fragments of black rock. Moderately friable. Moisture in sample bag. | | ● | |
| 53 | | | ● | |
| 54 | | | | |
| 55 | | | | |
| 10 56 | | | | |
| 57 | | | | |
| 58 | | | | |
| 59 | | | | |
| 60 | | | | |
| 15 61 | | | | |
| 62 | Very dense bedrock, not enough material for sample | ● | | |
| 63 | | ● | | |
| 64 | | | | |
| 65 | | | | |
| 20 66 | | | | |
| 67 | Green weathered serpentinite, very friable, dry | ● | | |
| 68 | | ● | | |
| 69 | | | | |
| 70 | | | | |
| 25 71 | | | | |
| 72 | | | | |
| 73 | | | | |
| 74 | | | | |
| 75 | | | | |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 ~~77~~ | | | | | | | | | | | |
| 1707 ~~78~~ | | 20 37 50 for 5" | | | | | 90% | | | | |
| ~~79~~ | | | | | | | | | | | |
| 80 | | | Borehole abandoned on 5/11/10 due to no water present | | | | | | | | |
| 81 | | | | | | | | | | | |
| 82 | | | | | | | | | | | |
| 83 | | | | | | | | | | | |
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| 104 | | | | | | | | | | | |
| 105 | | | | | | | | | | | |

| Depth (feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| 30 ~~77~~ | SAA | ● | ○ | ○ |
| ~~78~~ | | ● | ○ | ○ |
| ~~79~~ | | ○ | ○ | ○ |
| 80 | | ○ | ○ | ○ |
| 81 | | ○ | ○ | ○ |
| 82 | | ○ | ○ | ○ |
| 83 | | ○ | ○ | ○ |
| 84 | | ○ | ○ | ○ |
| 85 | | ○ | ○ | ○ |
| 86 | | ○ | ○ | ○ |
| 87 | | ○ | ○ | ○ |
| 88 | | ○ | ○ | ○ |
| 89 | | ○ | ○ | ○ |
| 90 | | ○ | ○ | ○ |
| 91 | | ○ | ○ | ○ |
| 92 | | ○ | ○ | ○ |
| 93 | | ○ | ○ | ○ |
| 94 | | ○ | ○ | ○ |
| 95 | | ○ | ○ | ○ |
| 96 | | ○ | ○ | ○ |
| 97 | | ○ | ○ | ○ |
| 98 | | ○ | ○ | ○ |
| 99 | | ○ | ○ | ○ |
| 100 | | ○ | ○ | ○ |
| 101 | | ○ | ○ | ○ |
| 102 | | ○ | ○ | ○ |
| 103 | | ○ | ○ | ○ |
| 104 | | ○ | ○ | ○ |
| 105 | | ○ | ○ | ○ |

## WELL DEVELOPMENT RECORD

SITE _____ DATE _____

LOCATION _____ WELL NO. _____

_____

### MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2(0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for $r^2h$ factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = _____ gallons.

### Volume of Water in Casing or Hole

| Diameter of Casing or Hole (in) | Gallons per Foot of Depth | Cubic Feet per Foot of Depth | Liter per Meter of Depth | Cubic Meters per Meter of Depth |
|---|---|---|---|---|
| 1 | 0.041 | 0.0055 | 0.509 | $0.509 \times 10^{-3}$ |
| 11/2 | 0.092 | 0.0123 | 1.142 | $1.142 \times 10^{-3}$ |
| 2 | 0.163 | 0.0218 | 2.024 | $2.024 \times 10^{-3}$ |
| 21/2 | 0.255 | 0.0341 | 3.167 | $3.167 \times 10^{-3}$ |
| 3 | 0.367 | 0.0491 | 4.558 | $4.558 \times 10^{-3}$ |
| 31/2 | 0.500 | 0.0668 | 6.209 | $6.209 \times 10^{-3}$ |
| 4 | 0.653 | 0.0873 | 8.110 | $8.110 \times 10^{-3}$ |
| 41/2 | 0.826 | 0.1104 | 10.260 | $10.260 \times 10^{-3}$ |
| 5 | 1.020 | 0.1364 | 12.670 | $12.670 \times 10^{-3}$ |
| 51/2 | 1.234 | 0.1650 | 15.330 | $15.330 \times 10^{-3}$ |
| 6 | 1.469 | 0.1963 | 18.240 | $18.240 \times 10^{-3}$ |
| 7 | 2.000 | 0.2673 | 24.840 | $24.840 \times 10^{-3}$ |
| 8 | 2.611 | 0.3491 | 32.430 | $32.430 \times 10^{-3}$ |
| 9 | 3.305 | 0.4418 | 41.040 | $41.040 \times 10^{-3}$ |
| 10 | 4.080 | 0.5454 | 50.670 | $50.670 \times 10^{-3}$ |
| 11 | 4.937 | 0.6600 | 61.310 | $61.310 \times 10^{-3}$ |
| 12 | 5.875 | 0.7854 | 72.960 | $72.960 \times 10^{-3}$ |
| 14 | 8.000 | 1.0690 | 99.350 | $99.350 \times 10^{-3}$ |
| 16 | 10.440 | 1.3960 | 129.650 | $129.650 \times 10^{-3}$ |
| 18 | 13.220 | 1.7670 | 164.180 | $164.180 \times 10^{-3}$ |
| 20 | 16.320 | 2.1820 | 202.680 | $202.680 \times 10^{-3}$ |
| 22 | 19.750 | 2.6400 | 245.280 | $245.280 \times 10^{-3}$ |
| 24 | 23.500 | 3.1420 | 291.850 | $291.850 \times 10^{-3}$ |
| 26 | 27.580 | 3.6870 | 342.520 | $342.520 \times 10^{-3}$ |
| 28 | 32.000 | 4.2760 | 397.410 | $397.410 \times 10^{-3}$ |
| 30 | 36.720 | 4.9090 | 456.020 | $456.020 \times 10^{-3}$ |
| 32 | 41.780 | 5.5850 | 518.870 | $518.870 \times 10^{-3}$ |
| 34 | 47.160 | 6.3050 | 585.680 | $585.680 \times 10^{-3}$ |
| 36 | 52.880 | 7.0690 | 656.720 | $656.720 \times 10^{-3}$ |

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 3.779 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = $12.419 \times 10^{-3}$ cubic meters per meter of depth

### INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

### FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

DESCRIPTION OF DEVELOPMENT TECHNIQUE _____

_____

_____

## WELL DEVELOPMENT - PARAMETER MEASUREMENTS

| TIME | TOTAL VOL. WITHDRAWN | | pH | COND. (µmhos/cm) | TEMP. (°C/°F) | TURB. (NTU) | COMMENTS |
|---|---|---|---|---|---|---|---|
| | GALS. | BORE VOL. | | | | | |
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DEVELOPED BY: _____

DATE _____

## INVESTIGATION-DERIVED WASTE INVENTORY SHEET

Site: _____ No. of Drums: _____

Inventory Date: _____

| Waste Source | Drum/Container ID Number | Date Generated | Contents (Solid, Liquids, etc.) | Approximate Volume | Drum Location/Comments |
|---|---|---|---|---|---|
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# Borehole Record for 08HM ~~MW~~ AM SB

- Drilling Log
- Narrative Lithologic Description
- Well Development Record
- Well Development -- Parameter Measurements
- Investigation - Derived Waste Inventory Sheet

# DRILLING LOG FOR 08HM-SB

Project Name

Site Location Helen Mine

Date Started/Finished 5-7-10

Drilling Company Test America

Driller's Name Dave

Geologist's Name Andrew Uhrig

Geologist's Signature

Rig Type (s) CME-85

Drilling Method (s) Auger

Bit Size (s) 8 Auger Size (s)

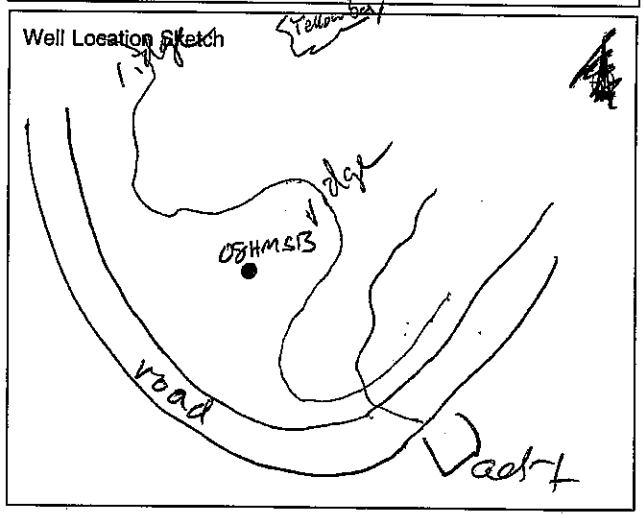
Auger/Split Spoon Refusal

Total Depth of Borehole Is 30ft

Total Depth of Corehole Is

| Water Level (TOIC) | | |
|---|---|---|
| Date | Time | Level( Feet) |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Well Location Sketch




| Time | Depth(Feet) | Sample Number | Blows on Sampler | Soil Components Rock Profile CL SL S GR | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | ~~HNU/OVA (ppm)~~ Hg µg/m3 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1520 | 1 | | | | | | | | | | |
| | 2 | | | | | | | | | | |
| | 3 | | | | | | | | | | |
| 1540 | 4 | 08HMSB04 | 18 16 15 | SL SGR | | | 20% | | | Ø | Split Spoon |
| | 5 | | | | | | | | | | |
| | 6 | | | | | | 50% | | | | Shelby |
| | 7 | | | | | | | | | | |
| | 8 | | | | | | Ø% | | | | Shelby |
| | 9 | | | | | | | | | | |
| | 10 | | | | | | | | | | |
| 1600 | 11 | 08HMSB10 | 42 50 for 4" | | | | | | | Ø | Split Spoon |
| | 12 | | | | | | | | | | |
| | 13 | | | | | | | | | | |
| | 14 | | | | | | | | | | |
| | 15 | | | | | | | | | | |
| 1605 | | 08HMSB15 | 50 for 4" | | | | 10% | | | Ø | Split Spoon |

**SCREENED WELL**

Stick-up _____ ft

Top of Grout _____ ft

Top of Seal at _____ ft

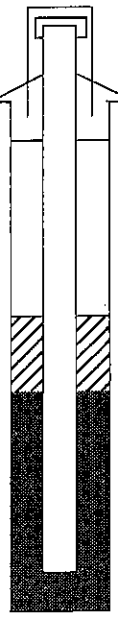
Top of Sand Pack _____ ft

Top of Screen at _____ ft

Bottom of Screen at _____ ft

Bottom of Hole at _____ ft

Bottom of Sandpack at _____



Lock Number _____

Inner Casing Material _____

Inner Casing Inside Diameter ____ inches

GROUND SURFACE

Quantity of Material Used:

Bentonite Pellets _____

Cement _____

Borehole _____ inches Diameter

Cement/ Bentonite _____

Grout _____

Screen Slot Size _____

Screen Type _____

☐ PVC _____

☐ Stainless Steel _____

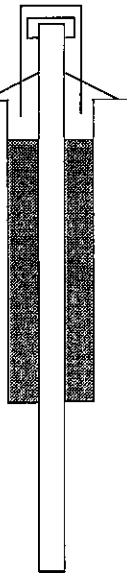
Pack Type/Size:

☐ Sand _____

☐ Gravel _____

☐ Natural _____

**OPEN-HOLE WELL**



Stick-up _____ ft

Inner Casing Material _____

Inner Casing Inside Diameter _____ inches

Outer Casing Diameter _____ inches

Borehole Diameter _____ ft

Bedrock _____ ft

Bottom of Rock Socket/ Outer Casing _____ ft

Bottom of Inner Casing _____ ft

Corehole Diameter _____

Bottom of Corehole _____ ft

NOTE: See pages 136 and 137 for well construction diagrams

| Depth-ft. | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| 1 | | ○ | ○ | ○ |
| 2 | | ○ | ○ | ○ |
| 3 | | ○ | ○ | ○ |
| 4 | Silty Sandy Gravel w/ rock fragments, light gray color, angular sands and gravel | ● | ○ | ○ |
| 5 | | ● | ○ | ○ |
| 6 | | ○ | ○ | ○ |
| 7 | | ○ | ○ | ○ |
| 8 | | ○ | ○ | ○ |
| 9 | | ○ | ○ | ○ |
| 10 | Gray-Green, weathered serpentinite, very friable, crumbles into Sandy Silt | ○ | ○ | ○ |
| 11 | | ● | ○ | ○ |
| 12 | | ● | ○ | ○ |
| 13 | | ○ | ○ | ○ |
| 14 | | ○ | ○ | ○ |
| 15 | | ● | ○ | ○ |

SAA

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | | See previous page | | | | | | | | | |
| 17 | | | | | | | | | | | |
| 18 | | | | | | | | | | | |
| 19 | | | | | | | | | | | |
| 20 | | 50 for 4" | | | | | 0% | | | N/A | no recovery |
| 21 | | | | | | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | | | | | | | | | | | |
| 25 | | 50 for 4" | | | | | 0% | | | N/A | no recovery |
| 26 | | | | | | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | | | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | | 50 for 3" | | | | | 25% | | | 0 | |
| 31 | 08HMSB30 | | | | | | | | | | |
| 32 | | | | | | | | | | | |
| 33 | | | | | | | | | | | |
| 34 | | | | | | | | | | | |
| 35 | | | | | | | | | | | |
| 36 | | | | | | | | | | | |
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| 38 | | | | | | | | | | | |
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| 40 | | | | | | | | | | | |
| 41 | | | | | | | | | | | |
| 42 | | | | | | | | | | | |
| 43 | | | | | | | | | | | |
| 44 | | | | | | | | | | | |
| 45 | | | | | | | | | | | |

1630

| Depth(feet). | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| 16 | See Previous pages | ● | ○ | ○ |
| 17 | | ○ | ○ | ○ |
| 18 | | ○ | ○ | ○ |
| 19 | | ○ | ○ | ○ |
| 20 | | ○ | ○ | ○ |
| 21 | No recovery @ 20 ft bgs | ○ | ○ | ○ |
| 22 | | ○ | ○ | ○ |
| 23 | | ○ | ○ | ○ |
| 24 | | ○ | ○ | ○ |
| 25 | | ○ | ○ | ○ |
| 26 | No Recovery @ 25 ft bgs | ○ | ○ | ○ |
| 27 | | ○ | ○ | ○ |
| 28 | | ○ | ○ | ○ |
| 29 | | ○ | ○ | ○ |
| 30 | | ○ | ○ | ○ |
| 31 | SAA | ● | ○ | ○ |
| 32 | | ● | ○ | ○ |
| 33 | | ○ | ○ | ○ |
| 34 | | ○ | ○ | ○ |
| 35 | | ○ | ○ | ○ |
| 36 | | ○ | ○ | ○ |
| 37 | | ○ | ○ | ○ |
| 38 | | ○ | ○ | ○ |
| 39 | | ○ | ○ | ○ |
| 40 | | ○ | ○ | ○ |
| 41 | | ○ | ○ | ○ |
| 42 | | ○ | ○ | ○ |
| 43 | | ○ | ○ | ○ |
| 44 | | ○ | ○ | ○ |
| 45 | | ○ | ○ | ○ |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 46 | | | | | | | | | | | |
| 47 | | | | | | | | | | | |
| 48 | | | | | | | | | | | |
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| 74 | | | | | | | | | | | |
| 75 | | | | | | | | | | | |

| Depth(feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content Dry | Moist | Wet |
|---|---|---|---|---|
| | | ○ | ○ | ○ |
| 46 | | ○ | ○ | ○ |
| 47 | | ○ | ○ | ○ |
| 48 | | ○ | ○ | ○ |
| 49 | | ○ | ○ | ○ |
| 50 | | ○ | ○ | ○ |
| 51 | | ○ | ○ | ○ |
| 52 | | ○ | ○ | ○ |
| 53 | | ○ | ○ | ○ |
| 54 | | ○ | ○ | ○ |
| 55 | | ○ | ○ | ○ |
| 56 | | ○ | ○ | ○ |
| 57 | | ○ | ○ | ○ |
| 58 | | ○ | ○ | ○ |
| 59 | | ○ | ○ | ○ |
| 60 | | ○ | ○ | ○ |
| 61 | | ○ | ○ | ○ |
| 62 | | ○ | ○ | ○ |
| 63 | | ○ | ○ | ○ |
| 64 | | ○ | ○ | ○ |
| 65 | | ○ | ○ | ○ |
| 66 | | ○ | ○ | ○ |
| 67 | | ○ | ○ | ○ |
| 68 | | ○ | ○ | ○ |
| 69 | | ○ | ○ | ○ |
| 70 | | ○ | ○ | ○ |
| 71 | | ○ | ○ | ○ |
| 72 | | ○ | ○ | ○ |
| 73 | | ○ | ○ | ○ |
| 74 | | ○ | ○ | ○ |
| 75 | | | | |

| Depth(feet) | Sample Number | Blows on Sampler | | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | | | | | | | | | | | | |
| 78 | | | | | | | | | | | | |
| 79 | | | | | | | | | | | | |
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| 100 | | | | | | | | | | | | |
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| 102 | | | | | | | | | | | | |
| 103 | | | | | | | | | | | | |
| 104 | | | | | | | | | | | | |
| 105 | | | | | | | | | | | | |

| Depth (feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content | | |
|---|---|---|---|---|
| | | Dry | Moist | Wet |
| 77 | | ○ | ○ | ○ |
| 78 | | ○ | ○ | ○ |
| 79 | | ○ | ○ | ○ |
| 80 | | ○ | ○ | ○ |
| 81 | | ○ | ○ | ○ |
| 82 | | ○ | ○ | ○ |
| 83 | | ○ | ○ | ○ |
| 84 | | ○ | ○ | ○ |
| 85 | | ○ | ○ | ○ |
| 86 | | ○ | ○ | ○ |
| 87 | | ○ | ○ | ○ |
| 88 | | ○ | ○ | ○ |
| 89 | | ○ | ○ | ○ |
| 90 | | ○ | ○ | ○ |
| 91 | | ○ | ○ | ○ |
| 92 | | ○ | ○ | ○ |
| 93 | | ○ | ○ | ○ |
| 94 | | ○ | ○ | ○ |
| 95 | | ○ | ○ | ○ |
| 96 | | ○ | ○ | ○ |
| 97 | | ○ | ○ | ○ |
| 98 | | ○ | ○ | ○ |
| 99 | | ○ | ○ | ○ |
| 100 | | ○ | ○ | ○ |
| 101 | | ○ | ○ | ○ |
| 102 | | ○ | ○ | ○ |
| 103 | | ○ | ○ | ○ |
| 104 | | ○ | ○ | ○ |
| 105 | | ○ | ○ | ○ |

## WELL DEVELOPMENT RECORD

SITE _____ DATE _____

LOCATION _____ WELL NO. _____

_____

### MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2 (0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for $r^2h$ factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = _____ gallons.

### Volume of Water in Casing or Hole

| Diameter of Casing or Hole (in) | Gallons per Foot of Depth | Cubic Feet per Foot of Depth | Liter per Meter of Depth | Cubic Meters per Meter of Depth |
|---|---|---|---|---|
| 1 | 0.041 | 0.0055 | 0.509 | $0.509 \times 10^{-3}$ |
| 11/2 | 0.092 | 0.0123 | 1.142 | $1.142 \times 10^{-3}$ |
| 2 | 0.163 | 0.0218 | 2.024 | $2.024 \times 10^{-3}$ |
| 21/2 | 0.255 | 0.0341 | 3.167 | $3.167 \times 10^{-3}$ |
| 3 | 0.367 | 0.0491 | 4.558 | $4.558 \times 10^{-3}$ |
| 31/2 | 0.500 | 0.0668 | 6.209 | $6.209 \times 10^{-3}$ |
| 4 | 0.653 | 0.0873 | 8.110 | $8.110 \times 10^{-3}$ |
| 41/2 | 0.826 | 0.1104 | 10.260 | $10.260 \times 10^{-3}$ |
| 5 | 1.020 | 0.1364 | 12.670 | $12.670 \times 10^{-3}$ |
| 51/2 | 1.234 | 0.1650 | 15.330 | $15.330 \times 10^{-3}$ |
| 6 | 1.469 | 0.1963 | 18.240 | $18.240 \times 10^{-3}$ |
| 7 | 2.000 | 0.2673 | 24.840 | $24.840 \times 10^{-3}$ |
| 8 | 2.611 | 0.3491 | 32.430 | $32.430 \times 10^{-3}$ |
| 9 | 3.305 | 0.4418 | 41.040 | $41.040 \times 10^{-3}$ |
| 10 | 4.080 | 0.5454 | 50.670 | $50.670 \times 10^{-3}$ |
| 11 | 4.937 | 0.6600 | 61.310 | $61.310 \times 10^{-3}$ |
| 12 | 5.875 | 0.7854 | 72.960 | $72.960 \times 10^{-3}$ |
| 14 | 8.000 | 1.0690 | 99.350 | $99.350 \times 10^{-3}$ |
| 16 | 10.440 | 1.3960 | 129.650 | $129.650 \times 10^{-3}$ |
| 18 | 13.220 | 1.7670 | 164.180 | $164.180 \times 10^{-3}$ |
| 20 | 16.320 | 2.1820 | 202.680 | $202.680 \times 10^{-3}$ |
| 22 | 19.750 | 2.6400 | 245.280 | $245.280 \times 10^{-3}$ |
| 24 | 23.500 | 3.1420 | 291.850 | $291.850 \times 10^{-3}$ |
| 26 | 27.580 | 3.6870 | 342.520 | $342.520 \times 10^{-3}$ |
| 28 | 32.000 | 4.2760 | 397.410 | $397.410 \times 10^{-3}$ |
| 30 | 36.720 | 4.9090 | 456.020 | $456.020 \times 10^{-3}$ |
| 32 | 41.780 | 5.5850 | 518.870 | $518.870 \times 10^{-3}$ |
| 34 | 47.160 | 6.3050 | 585.680 | $585.680 \times 10^{-3}$ |
| 36 | 52.880 | 7.0690 | 656.720 | $656.720 \times 10^{-3}$ |

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 3.779 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = $12.419 \times 10^{-3}$ cubic meters per meter of depth

### INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

### FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

DESCRIPTION OF DEVELOPMENT TECHNIQUE _____

_____

_____

## WELL DEVELOPMENT - PARAMETER MEASUREMENTS

| TIME | TOTAL VOL. WITHDRAWN | | pH | COND. (µmhos/cm) | TEMP. (°C/°F) | TURB. (NTU) | COMMENTS |
|---|---|---|---|---|---|---|---|
| | GALS. | BORE VOL. | | | | | |
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DEVELOPED BY: _____ DATE _____

## INVESTIGATION-DERIVED WASTE INVENTORY SHEET

Site: _____ No. of Drums: _____

Inventory Date: _____

| Waste Source | Drum/Container ID Number | Date Generated | Contents (Solid, Liquids, etc.) | Approximate Volume | Drum Location/Comments |
|---|---|---|---|---|---|
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# Borehole Record for 09HM-MW

- Drilling Log
- Narrative Lithologic Description
- Well Development Record
- Well Development -- Parameter Measurements
- Investigation - Derived Waste Inventory Sheet

DRILLING LOG FOR 09HM-MW

Project Name Helen Mine

Site Location

Date Started/Finished 5/9/10

Drilling Company Test America

Driller's Name Davey

Geologist's Name Andrew Uhrig

Geologist's Signature

Rig Type (s) Hand Auger

Drilling Method (s)

Bit Size (s) Auger Size (s) 4" thru 6"

Auger/Split Spoon Refusal

Total Depth of Borehole Is 54"

Total Depth of Corehole Is

| Water Level (TOIC) | | |
|---|---|---|
| Date | Time | Level( Feet) |
| | | |
| | | |
| | | |
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| | | |
| | | |

Well Location Sketch

250

| Depth(Feet) | Sample Number | Blows on Sampler | Soil Components Rock Profile CL SL S GR | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |
| 7 | | | | | | | | | | |
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| 11 | | | | | | | | | | |
| 12 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 15 | | | | | | | | | | |

4/
59
-36
18

**SCREENED WELL**

Stick-up 2 ft

Top of Grout _____ ft

Top of Seal at Ø ft

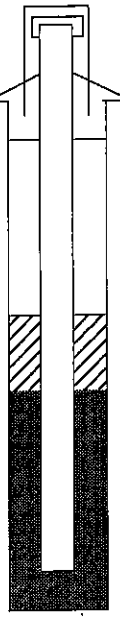
Top of Sand Pack 12 ft

Top of Screen at 18 ft

Bottom of Screen at 54" ft

Bottom of Hole at 54" ft

Bottom of Sandpack at 54"



Lock Number _____

Inner Casing Material _____

Inner Casing Inside Diameter ____ Inches

GROUND SURFACE

Quantity of Material Used:

Bentonite Pellets _____

Cement _____

Borehole Diameter _____ inches

Cement/ Bentonite _____

Grout _____

Screen Slot Size _____

Screen Type 0.010

☒ PVC Slot

☐ Stainless Steel

Pack Type/Size:

☒ Sand #2/12

☐ Gravel _____

☐ Natural _____

**OPEN-HOLE WELL**

Stick-up _____ ft

Inner Casing Material _____

Inner Casing Inside Diameter _____ inches

Outer Casing Diameter _____ inches

Borehole Diameter _____ ft

Bedrock _____ ft

Bottom of Rock Socket/ Outer Casing _____ ft

Bottom of Inner Casing _____ ft

Corehole Diameter _____

Bottom of Corehole _____ ft

NOTE: See pages 136 and 137 for well construction diagrams

| Depth-ft. | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content: Dry | Moist | Wet |
|---|---|---|---|---|
| 1 | Red-brown, Silty Sandy Gravel | ● | ○ | ○ |
| 2 | | ○ | ● | ○ |
| 3 | DTW=30" | ○ | ○ | ● |
| 4 | | ○ | ○ | ○ |
| 5 | Green serpentinite w/ cobble sized rock fragments | ○ | ○ | ○ |
| 6 | (Not Bedrock) | ○ | ○ | ○ |
| 7 | | ○ | ○ | ○ |
| 8 | | ○ | ○ | ○ |
| 9 | | ○ | ○ | ○ |
| 10 | | ○ | ○ | ○ |
| 11 | | ○ | ○ | ○ |
| 12 | | ○ | ○ | ○ |
| 13 | | ○ | ○ | ○ |
| 14 | | ○ | ○ | ○ |
| 15 | | ○ | ○ | ○ |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | | | | | | | | | | | |
| 17 | | | | | | | | | | | |
| 18 | | | | | | | | | | | |
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| 45 | | | | | | | | | | | |

| Depth(feet). | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content | | |
|---|---|---|---|---|
| | | Dry | Moist | Wet |
| 16 | | | | |
| 17 | | | | |
| 18 | | | | |
| 19 | | | | |
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| 44 | | | | |
| 45 | | | | |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 46 | | | | | | | | | | | |
| 47 | | | | | | | | | | | |
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| 74 | | | | | | | | | | | |
| 75 | | | | | | | | | | | |

| Depth(feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content Dry | Moist | Wet |
|---|---|---|---|---|
| 46 | | | | |
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| 72 | | | | |
| 73 | | | | |
| 74 | | | | |
| 75 | | | | |

| Depth(feet) | Sample Number | Blows on Sampler | Soil Components CL SL S GR | Rock Profile | Penetration Times | Run Number | Core Recovery | RQD | Fracture Sketch | HNu/OVA (ppm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | | | | | | | | | | | |
| 78 | | | | | | | | | | | |
| 79 | | | | | | | | | | | |
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| 103 | | | | | | | | | | | |
| 104 | | | | | | | | | | | |
| 105 | | | | | | | | | | | |

| Depth (feet) | NARRATIVE LITHOLOGIC DESCRIPTION | Moisture Content | | |
|---|---|---|---|---|
| | | Dry | Moist | Wet |
| 77 | | ○ | ○ | ○ |
| 78 | | ○ | ○ | ○ |
| 79 | | ○ | ○ | ○ |
| 80 | | ○ | ○ | ○ |
| 81 | | ○ | ○ | ○ |
| 82 | | ○ | ○ | ○ |
| 83 | | ○ | ○ | ○ |
| 84 | | ○ | ○ | ○ |
| 85 | | ○ | ○ | ○ |
| 86 | | ○ | ○ | ○ |
| 87 | | ○ | ○ | ○ |
| 88 | | ○ | ○ | ○ |
| 89 | | ○ | ○ | ○ |
| 90 | | ○ | ○ | ○ |
| 91 | | ○ | ○ | ○ |
| 92 | | ○ | ○ | ○ |
| 93 | | ○ | ○ | ○ |
| 94 | | ○ | ○ | ○ |
| 95 | | ○ | ○ | ○ |
| 96 | | ○ | ○ | ○ |
| 97 | | ○ | ○ | ○ |
| 98 | | ○ | ○ | ○ |
| 99 | | ○ | ○ | ○ |
| 100 | | ○ | ○ | ○ |
| 101 | | ○ | ○ | ○ |
| 102 | | ○ | ○ | ○ |
| 103 | | ○ | ○ | ○ |
| 104 | | ○ | ○ | ○ |
| 105 | | ○ | ○ | ○ |

## WELL DEVELOPMENT RECORD

SITE _____ DATE _____

LOCATION _____ WELL NO. _____

_____

### MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2 (0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for $r^2h$ factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = _____ gallons.

### Volume of Water in Casing or Hole

| Diameter of Casing or Hole (in) | Gallons per Foot of Depth | Cubic Feet per Foot of Depth | Liter per Meter of Depth | Cubic Meters per Meter of Depth |
|---|---|---|---|---|
| 1 | 0.041 | 0.0055 | 0.509 | $0.509 \times 10^{-3}$ |
| 11/2 | 0.092 | 0.0123 | 1.142 | $1.142 \times 10^{-3}$ |
| 2 | 0.163 | 0.0218 | 2.024 | $2.024 \times 10^{-3}$ |
| 21/2 | 0.255 | 0.0341 | 3.167 | $3.167 \times 10^{-3}$ |
| 3 | 0.367 | 0.0491 | 4.558 | $4.558 \times 10^{-3}$ |
| 31/2 | 0.500 | 0.0668 | 6.209 | $6.209 \times 10^{-3}$ |
| 4 | 0.653 | 0.0873 | 8.110 | $8.110 \times 10^{-3}$ |
| 41/2 | 0.826 | 0.1104 | 10.260 | $10.260 \times 10^{-3}$ |
| 5 | 1.020 | 0.1364 | 12.670 | $12.670 \times 10^{-3}$ |
| 51/2 | 1.234 | 0.1650 | 15.330 | $15.330 \times 10^{-3}$ |
| 6 | 1.469 | 0.1963 | 18.240 | $18.240 \times 10^{-3}$ |
| 7 | 2.000 | 0.2673 | 24.840 | $24.840 \times 10^{-3}$ |
| 8 | 2.611 | 0.3491 | 32.430 | $32.430 \times 10^{-3}$ |
| 9 | 3.305 | 0.4418 | 41.040 | $41.040 \times 10^{-3}$ |
| 10 | 4.080 | 0.5454 | 50.670 | $50.670 \times 10^{-3}$ |
| 11 | 4.937 | 0.6600 | 61.310 | $61.310 \times 10^{-3}$ |
| 12 | 5.875 | 0.7854 | 72.960 | $72.960 \times 10^{-3}$ |
| 14 | 8.000 | 1.0690 | 99.350 | $99.350 \times 10^{-3}$ |
| 16 | 10.440 | 1.3960 | 129.650 | $129.650 \times 10^{-3}$ |
| 18 | 13.220 | 1.7670 | 164.180 | $164.180 \times 10^{-3}$ |
| 20 | 16.320 | 2.1820 | 202.680 | $202.680 \times 10^{-3}$ |
| 22 | 19.750 | 2.6400 | 245.280 | $245.280 \times 10^{-3}$ |
| 24 | 23.500 | 3.1420 | 291.850 | $291.850 \times 10^{-3}$ |
| 26 | 27.580 | 3.6870 | 342.520 | $342.520 \times 10^{-3}$ |
| 28 | 32.000 | 4.2760 | 397.410 | $397.410 \times 10^{-3}$ |
| 30 | 36.720 | 4.9090 | 456.020 | $456.020 \times 10^{-3}$ |
| 32 | 41.780 | 5.5850 | 518.870 | $518.870 \times 10^{-3}$ |
| 34 | 47.160 | 6.3050 | 585.680 | $585.680 \times 10^{-3}$ |
| 36 | 52.880 | 7.0690 | 656.720 | $656.720 \times 10^{-3}$ |

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 3.779 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = $12.419 \times 10^{-3}$ cubic meters per meter of depth

### INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

### FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____
WELL DEPTH (TD) _____
COLOR _____
ODOR _____
CLARITY _____

DESCRIPTION OF DEVELOPMENT TECHNIQUE _____

_____

_____

## WELL DEVELOPMENT - PARAMETER MEASUREMENTS

| TIME | TOTAL VOL. WITHDRAWN | | pH | COND. (µmhos/cm) | TEMP. (°C/°F) | TURB. (NTU) | COMMENTS |
|---|---|---|---|---|---|---|---|
| | GALS. | BORE VOL. | | | | | |
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DEVELOPED BY: _____ DATE _____

## INVESTIGATION-DERIVED WASTE INVENTORY SHEET

Site: _____ No. of Drums: _____

Inventory Date: _____

| Waste Source | Drum/Container ID Number | Date Generated | Contents (Solid, Liquids, etc.) | Approximate Volume | Drum Location/Comments |
|---|---|---|---|---|---|
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## SOIL AND SEDIMENT CLASSIFICATION

### GRAIN-SIZE SCALE (Modified Wentworth Scale)

| phi | mm | inches | U.S. Standard Sieve Series | Grade Name | | |
|---|---|---|---|---|---|---|
| -12 | 4096 | 161.3 | | | | |
| | | | | very large | | |
| -11 | 2048 | 80.6 | | | | |
| | | | | large | | |
| -10 | 1024 | 40.3 | | | Boulders | |
| | | | | medium | | |
| -9 | 512 | 20.2 | | | | |
| | | | | small | | |
| -8 | 256 | 10.1 | | | | |
| | | | | large | | |
| -7 | 128 | 5.0 | | | Cobbles | |
| | | | | small | | GRAVEL |
| -6 | 64 | 2.52 | 63 mm | | | |
| | | | | very coarse | | |
| -5 | 32 | 1.26 | 31.5 mm | | | |
| | | | | coarse | | |
| -4 | 16 | 0.63 | 16 mm | | | |
| | | | | medium | Pebbles | |
| -3 | 8 | 0.32 | 8 mm | | | |
| | | | | fine | | |
| -2 | 4 | 0.16 | No. 5 | | | |
| | | | | very fine | | |
| -1 | 2 | 0.08 | No. 10 | | | |
| | | | | very coarse | | |
| 0 | 1 | 0.04 | No. 18 | | | |
| | | | | coarse | Sand | SAND |
| +1 | 0.500 | | No. 35 | | | |
| | | | | medium | | |
| +2 | 0.250 | | No. 60 | | | |
| | | | | fine | | |
| +3 | 0.125 | | No. 120 | | | |
| | | | | very fine | | |
| +4 | 0.062 | | No. 230 | | | |
| | | | | coarse | | |
| +5 | 0.031 | | | | Silt | |
| | | | | medium | | |
| +6 | 0.016 | | | | | |
| | | | | fine | | |
| +7 | 0.008 | | | | | MUD |
| | | | | very fine | | |
| +8 | 0.004 | | | | | |
| | | | | coarse | | |
| +9 | 0.002 | | | | | |
| | | | | medium | | |
| +10 | 0.001 | | | | | |
| | | | | fine | | |
| +11 | 0.0005 | | | | | |
| | | | | very fine | | CLAY SIZE |
| +12 | 0.00025 | | | | | |

### PROPORTIONS USED IN DESCRIBING SOILS

Trace - Particles are present but estimated to be less than 5%
Few - 5 to 10%
Little - 15 to 25%
Some - 30 to 45%
Mostly - 50 to 100%

i.e.: Sand with a trace of silt = .95% Sand, <5% Silt

(When sampling gravelly soils with a standard split spoon, the true percentage of gravel is often not recovered due to relatively small sample diameter.)

### Soil Density from Standard Penetration Test (ASTM D1586)

| Granular Soils | Cohesive Soils |
|---|---|
| 0 - 10: Loose | 0 -4: Soft |
| 10 - 30: Medium Dense | 4 - 8 : Medium Stiff |
| 30 - 50:Dense | 8 - 15 : Stiff |
| Over 50: Very Dense | 15 - 30 : Very Stiff |

### CLASSIFICATION CHART(United Soil Classification System)

| MAJOR DIVISIONS | | | |
|---|---|---|---|
| | GRAVELS (More than 1/2 of coarse fraction > No. 4 sieve size) | GW | Well-graded gravels or gravel-sand mixtures,little or no fines |
| | | GP | Poorly graded gravels or gravel-sand mixtures little or no fines |
| | | GM | Silty gravels, gravel-sand-silt mixture |
| | | CC | Clayey gravels, gravel-sand-clay mixtures |
| | SANDS (More than 1/2 of coarse fraction < No. 4 sieve size) | SW | Well-graded sands or gravelly sands, little or no fines |
| | | SP | Poorly graded sands or gravelly sands, little or no fines |
| | | SM | Silty sands, sand-silt mixtures |
| | | SC | Clayey sands, sand clay mixtures |
| | SILTS AND CLAYS LL< 50 | ML | Inorganic silts, and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity |
| | | CL | Inorganic clays, of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays |
| | | OL | Organic silts and organic clays of low plasticity |
| | SILTS AND CLAYS LL> 50 | MH | Inorganic silts, micaceous or diatamaceous, fine sandy or silty soils, elastic silts |
| | | CH | Inorganic clays of high plasticity, fat clays |
| | | OH | Organic clays of medium to high plasticity, organic silty clays, organic silts |
| | HIGHLY ORGANIC SOILS | Pt | Peat and other highly organic soils |

## ASTM CRITERIA FOR DESCRIBING SOIL

### Criteria for Describing Angularity of Coarse-Grained Particles

| Description | Criteria |
|---|---|
| Angular | Particles have sharp edges and relatively plane side with unpolished surfaces |
| Subangular | Particles are similar to angular description but have rounded edges |
| Subrounded | Particles have nearly plane sides but have well-rounded corners and edges |
| Rounded | Particles have smoothly curved side and no edges |

### Criteria for Describing Dilatancy

| Description | Criteria |
|---|---|
| None | No visible change in the specimen. |
| Slow | Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing. |
| Rapid | Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing. |

### Criteria for Describing Toughness

| Description | Criteria |
|---|---|
| Low | Only slight pressure is required to roll the thread near the plastic limit . The thread and the lump are weak and soft. |
| Medium | Medium pressure is required to roll the thread to near plastic limit. The thread and the lump have medium stiffness. |
| High | Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness. |

### Criteria for Describing Dry Strength

| Description | Criteria |
|---|---|
| None | The dry specimen crumbles into powder with mere pressure of handling |
| Low | The dry specimen crumbles into powder with some finger pressure |
| Medium | The dry specimen breaks into pieces or crumbles with considerable finger pressure |
| High | The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface. |
| Very High | The dry specimen cannot be broken between the thumb and shard surface |

### Criteria for Describing Structure

| Description | Criteria |
|---|---|
| Stratified | Alternating layers of varing material or color with layers at least 6 mm thick; note thickness. |
| Laminated | Alternating layers of varying materials or color with the layers less than 6 mm thick; note thickness. |
| Fissured | Breaks along definite planes of fracture with little resistance to fracturing. |
| Slickensided | Fracture planes appear polished or glossy, sometimes striated. |
| Blocky | Cohesive soil that can be broken down into small angular lumps which resist further breakdown. |
| Lensed | Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness. |
| Homo-geneous | Same color and appearance throughout. |

## CRITERIA FOR DESCRIBING SOIL (Cont.)

### Criteria for Describing the Reaction with HCl

| Description | Criteria |
|---|---|
| None | No visible reaction |
| Weak | Some reaction, with bubbles forming slowly |
| Strong | Violent reaction, with bubbles forming immediately |

### Criteria for Describing Consistency

| Description | Criteria |
|---|---|
| Very Soft | Thumb will penetrate soil more than 1 inch (25 mm) |
| Soft | Thumb will penetrate soil about 1 inch (25 mm) |
| Firm | Thumb will indent soil about 1/4 inch (6 mm) |
| Hard | Thumb will not indent soil but readily indented with thumbnail |
| Very Hard | Thumbnail will not indent soil |

### Criteria for Describing Cementation

| Description | Criteria |
|---|---|
| Weak | Crumbles or breaks with handling or little finger pressure |
| Moderate | Crumbles or breaks with considerable finger pressure |
| Strong | Will not crumble or break with finger pressure |

### Criteria for Describing Particle Shape

The particle shape shall be described as follows where length, width, and thickness refer to greatest, intermediate, and least dimensions of a particle, respectively (see page 104 ).

| | |
|---|---|
| Flat | Particles with width/thickness ratio > 3 |
| Elongated | Particles with length/width ratio > 3 |
| Flat and Elongated | Particles meet criteria for both flat and elongated |

### Criteria for Describing Plasticity

| Description | Criteria |
|---|---|
| Nonplastic | A 1/8 inch (3 mm) thread cannot be rolled at any water content. |
| Low | The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit. |
| Medium | The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit. |
| High | It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit. |

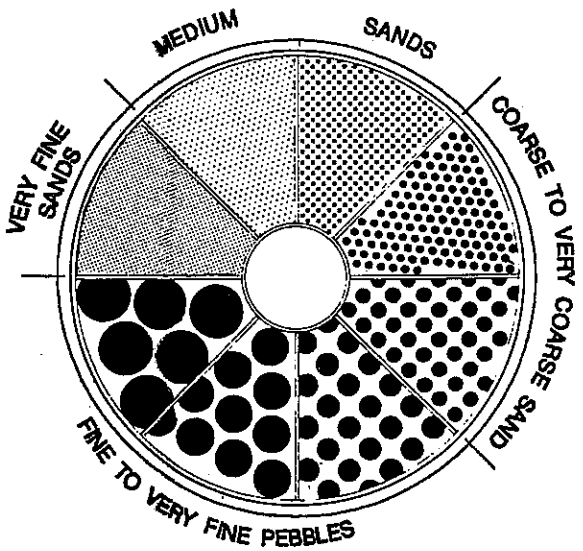
### Identification of Inorganic Fine-Grained Soils from Manual Tests

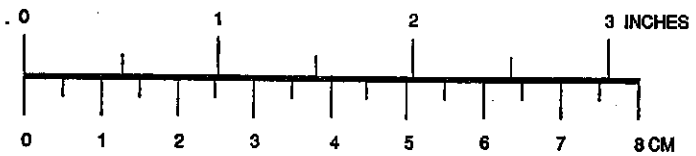
| Soil Symbol | Dry Strength | Dilatancy | Toughness |
|---|---|---|---|
| ML | None to low | Slow to rapid | Low or thread cannot be formed |
| CL | Medium to high | None to slow | Medium |
| MH | Low to medium | None to slow | Low to medium |
| CH | High to very high | None | High |

### Criteria for Describing Moisture Condition

| Description | Criteria |
|---|---|
| Dry | Absence of moisture, dusty, dry to the touch |
| Moist | Damp but no visible water |
| Wet | Visible free water, usually soil is below water table |

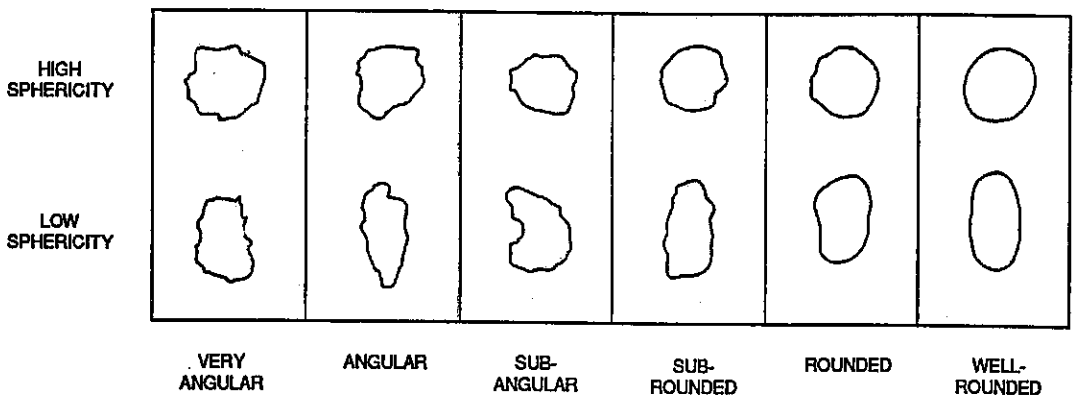
## GRAPH FOR DETERMINING SIZE OF SEDIMENTARY PARTICLES




COBBLES RANGE FROM 6.4 TO 25.6 cm (~ 2.5 TO 10.1 INCHES)
BOULDERS ARE LARGER THAN 25.6 cm (>10.1 INCHES)

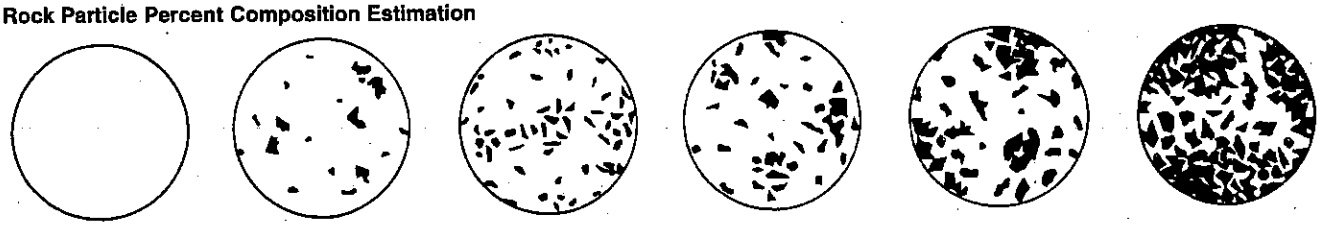
## SEDIMENT PARTICLE SHAPES



## ROCK DESCRIPTIVE TERMS

| Term | | Defining Characteristics | |
|---|---|---|---|
| Hardness | Soft | Scratched by fingernail | |
| | Medium Hard | Scratched easily by penknife | |
| | Hard | Difficult to scratch with a penknife | |
| | Very Hard | Cannot be scratched by penknife | |
| Weathering | Fresh | Rock is unstained. May be fractured, but discontinuities are not stained. | |
| | Slighty | Rock is unstained. Discontinuities show some staining on the surfaces of rocks, but discoloration does not penetrate rock mass. | |
| | Moderate | Discontinuity surfaces are stained. Discoloration may extend into rock along discontinuity surfaces. | |
| | High | Individual rock fragments are thoroughly stained and may be crumbly. | |
| | Severe | Rock appears to consist of gravel-sized fragments in a "soil" matrix. Individual fragments are thoroughly discolored and can be broken with fingers. | |
| Bedding Planes | Laminated | < .04 in. | < 1 mm |
| | Parting | .04 in. - .24 in. | 1mm - 6mm |
| | Banded | .24 in. - 1in. | 6 mm - 3 cm |
| | Thin | 1 in. - 4 in. | 3 cm - 9.1 cm |
| | Medium | 4 in. - 12 in. | 9.1 cm - 30.5 cm |
| | Thick | 12 in.- 36 in. | 30.5 cm - 1m |
| | Massive | > 36 in. | > 1 m |
| Joints and Fracture Spacing | Very close | < 2 in. | < 5.1 cm |
| | Close | 2 in. - 1ft. | 5.1 - 30.5 cm |
| | Moderately close | 1ft. - 3 ft. | 30.5 cm - 91.4 cm |
| | Wide | 3 ft. - 10 ft. | 91.4 cm - 3 M |
| | Very wide | > 10 ft. | > 3 M |
| Voids | Porous | Smaller than a pinhead. Their presence is indicated by the degree of absorbency. | |
| | Pitted | Pinhead size to a 1/4 inch. If only thin walls separate the individual pits, the core may be described as honeycombed. | |
| | Vug | 1/4 inch to the diameter of the core. The upper limit will vary with core size. | |
| | Cavity | Larger than the diameter of the core. | |

**Rock Particle Percent Composition Estimation**



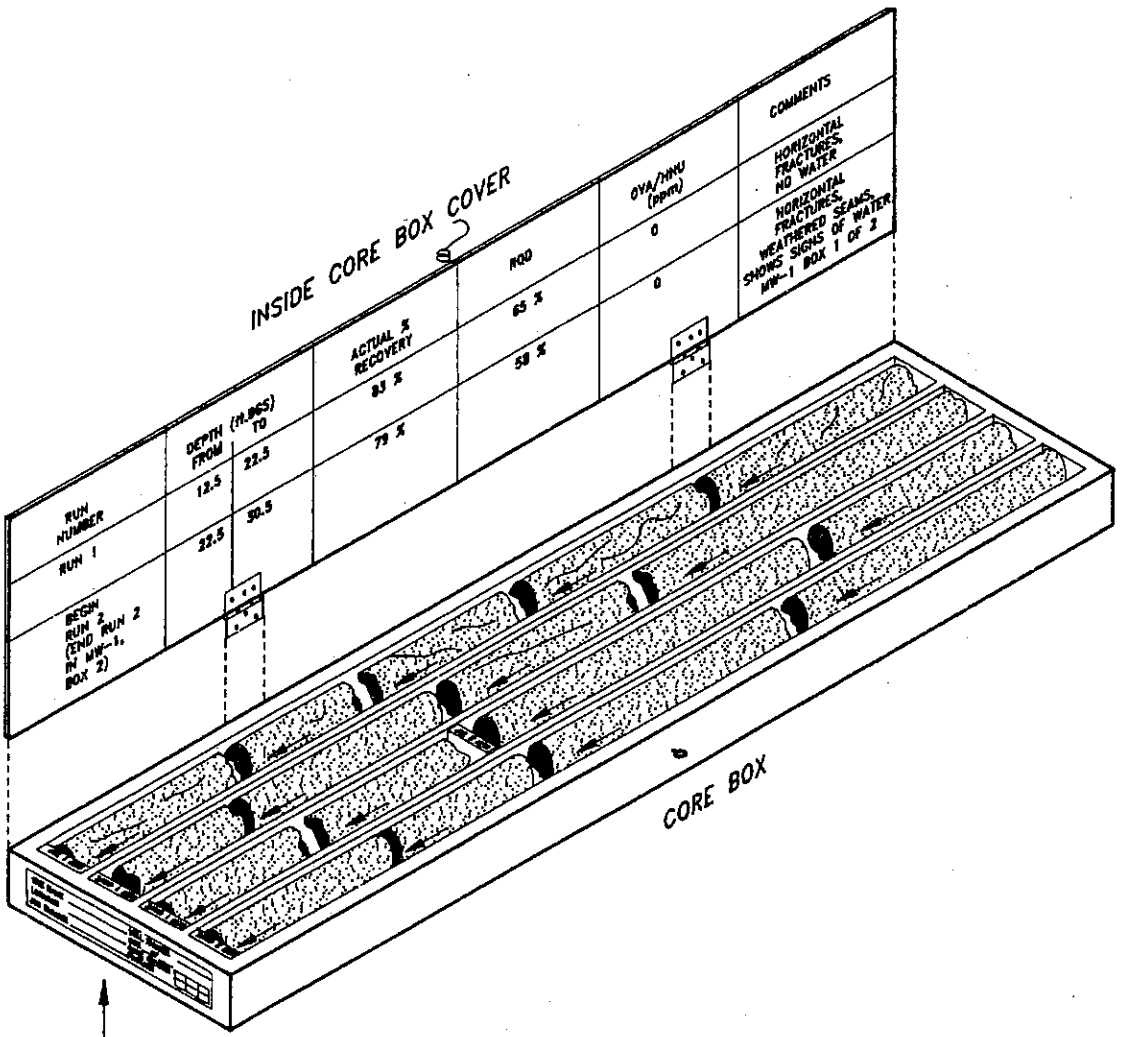
0% 5% 10% 15% 25% 50%

FORMS: CORE-BOX-BX11

ABC LANDFILL
SYRACUSE, NEW YORK
XA-6022

MONITORING WELL MW-1
BOX 1 OF 2
CORE RUN 1 12.5'-22.5'
BEGINNING CORE RUN 2 22.5' - 30.5'

EXAMPLE: OUTSIDE CORE BOX COVER




RECORD THIS INFORMATION ON EACH END PANEL

| | | | |
|---|---|---|---|
| SITE NAME | _____ | WELL NUMBER | _____ |
| LOCATION | _____ | BOX ___ OF ___ | |
| JOB NUMBER | _____ | CORES # | |
| | | FOOTAGE | |

SIDE PANELS

ecology and environment

COREBOX DETAIL

## ROCK CORE HANDLING AND COREBOX PACKING

NOTES:

1. HANDLING OF CORE – THE TOP OF THE CORE SHALL BE PLACED AT THE BACK LEFT CORNER OF THE CORE BOX. THE REMAINING CORE SHALL BE PLACED TO THE RIGHT OF THE PRECEDING SECTION. THE CORE BOX SHALL BE FILLED IN THIS MANNER MOVING TO THE FRONT SECTIONS OF THE BOX AS NEEDED. THE BEGINNING OF EACH RUN SHALL BE MARKED ON THE CORE AND ALSO NOTED WITH A MARKED WOODEN BLOCK.

2. CORE LABELING – THE TOP OF THE CORE WILL BE SHOWN ON EACH PIECE OF CORE WITH AN ARROW WRITTEN IN A BLACK WATERPROOF MARKER. THE ARROW WILL INDICATE WHICH END OF THE CORE IS NEARER GROUND SURFACE.

   OTHER MARKS MADE ON CORES MAY INCLUDE:
   - MECHANICAL BREAKS
   - DRILLING FOOTAGES

3. CORE LOSS – MISSING SECTIONS OF CORE WILL BE SHOWN BY WOODEN SPACER BLOCKS. THE SITE GEOLOGIST WILL INSERT THE SPACER INTO THE COREBOX IN PLACE OF THE MISSING SECTION. THE SPACER SHOULD INDICATE THE RUN NUMBER AND FOOTAGE OF THE MISSING CORE.

4. CORE BOX LABELING – INCLUDE THE FOLLOWING:

   OUTER CORE BOX COVER

   TOP LEFT: PROJECT NAME
   CITY, STATE
   PROJECT NUMBER

   LOWER RIGHT: MONITORING WELL (MW1)
   (EXAMPLE) BOX 1 OF 2
   CORE RUN 1 12.5'–22.5'
   BEGINNING CORE RUN 2 22.5' – 30.5'

   BOTH OUTSIDE PANELS

   SITE NAME _____ WELL NUMBER _____
   LOCATION _____ BOX ___ OF ___
   JOB NUMBER _____ CORE # [ ] [ ] [ ]
   FOOTAGE [ ] [ ] [ ]

   INSIDE CORE BOX COVER

   THE FOLLOWING COLUMNS WILL BE RECORDED ON THE INSIDE CORE BOX COVER.

| RUN NUMBER | DEPTH (FT. BGS) | | ACTUAL % RECOVERY | RQD | OVA/HNU (ppm) | COMMENTS |
|---|---|---|---|---|---|---|
| | FROM | TO | | | | |
| | | | | | | |
| | | | | | | |

   ONE ROW REGARDING THE ABOVE INFORMATION WILL BE RECORDED FOR EACH CORE RUN OR PARTIAL CORE RUN CONTAINED WITHIN THE COREBOX.

5. CORE BOX STORAGE – CORE BOXES FROM ALL SITE WELLS WILL BE MOVED FROM WELLHEADS ON A REGULAR BASIS AND STORED IN A DESIGNATED AREA. THIS LOCATION SHOULD BE IN AN AREA WHERE THE CORE BOXES WILL BE UNDISTURBED. WHEREVER POSSIBLE, THE COREBOX STORAGE AREA SHOULD BE INDOORS.

## ROCK QUALITY DESIGNATION AND FRACTURE FREQUENCY

Core borings are a useful means of obtaining information about the quality of rock mass. The recoverable core indicates the character of the intact rock and the number and character of the natural discontinuities.

Another quantitative index that has proved useful in logging NX core is a rock quality designation (RQD) developed by Deere (1963). The RQD is a modified core recovery percentage in which all the pieces of sound NX core over 4 inches long are counted as recovery. The length of the core run is the distance to the nearest tenth of a foot from the corrected depth of the hole at the end of the previous run to the corrected depth of the hole at the end of subject run. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. The RQD is a more general measure of the core quality than the fracture frequency. Core loss, weathered and soft zones, as well as fractures, are accounted for in this determination. The RQD provides a preliminary estimate of the variation of the in situ rock mass properties from the properties of the "sound" portion of the rock core. Thus, a general estimate of the behavior of the rock mass can be made. An RQD approaching 100 percent denotes an excellent quality rock mass with properties similar to that of an intact specimen. RQD values ranging from 0 to 50 percent are indicative of a poor quality rock mass having a small fraction of the strength and stiffness measured for an intact specimen.

RQD (Rock Quality Designation)

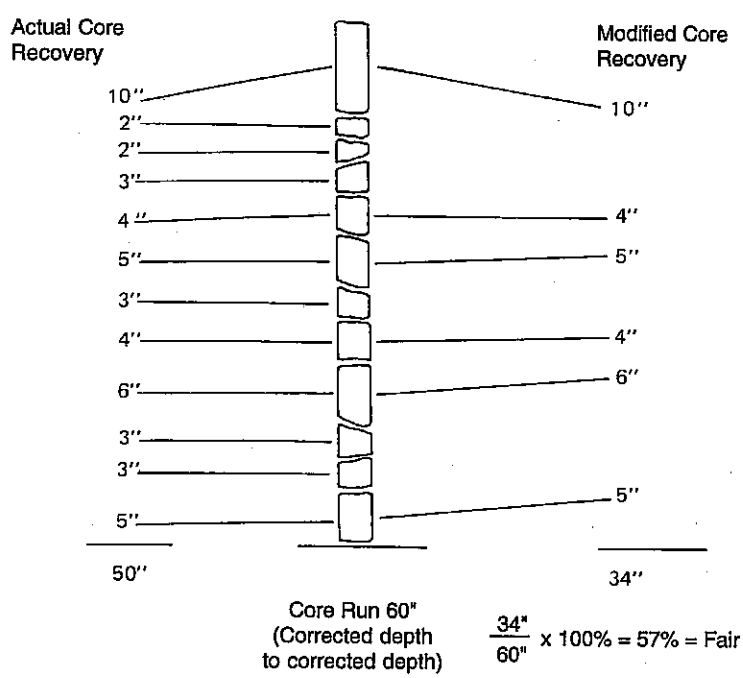
| | |
|---|---|
| 0 - 25 | Very Poor |
| 25 - 50 | Poor |
| 50 - 75 | Fair |
| 75 - 90 | Good |
| 90 - 100 | Excellent |

An example of determining the RQD from a core run of 60 inches measured from corrected depth to corrected depth is given in diagram below. For this particular case, the core recovery was 50 inches and the modified core recovery was 34 inches. This yields an RQD of 57 percent, classifying the rock mass in the fair category.

Problems arise in the use of RQD for determining the in situ rock mass quality. The RQD evaluates fractures in the core caused by the drilling process, as well as in natural fractures previously existing in the rock mass. For example, when the core hole penetrates a fault zone or a joint, additional breaks may form that, although not natural fractures, are caused by natural planes of weakness existing in the rock mass. These fresh breaks occur during drilling and handling of the core and are not related to the quality of the rock mass. The skill of the driller will affect the amount of breakage and the core loss that occurs. Poor drilling techniques will "penalize" the rock by lowering its apparent quality. It is difficult to distinguish between drilling breaks and those natural and incipient fractures that reflect the quality of the rock mass. In certain instances, it may be advisable to include all fractures when estimating RQD. Obviously, some judgment is involved in core logging.

Another problem with the use of the RQD index is that the determinations are not sensitive to the tightness of the individual joints, whereas in some instances, the in situ deformation modulus may be strongly affected by the average joint opening.

### RQD OF A SINGLE CORE RUN




Typical calculation of RQD of a single core run. Note that the run is calculated from corrected depth to corrected depth.

## CEMENT AND GROUT MIXTURES, ANNULAR SPACE, AND CONVENIENT CONVERSION FACTORS

| CEMENT MIX PER ONE - NO. 94 CEMENT SACK | | | | |
|---|---|---|---|---|
| MIXING WATER | | VOLUME OF SLURRY | | DENSITY |
| gal | $ft^3$ | gal | $ft^3$ | $g/cm^3$ |
| 5.2 * | .70 | 8.8 | 1.2 | 1.9 |
| 6 | .80 | 9.7 | 1.3 | 1.8 |
| 7 | .94 | 10.5 | 1.4 | 1.7 |

Table values reflect the cement mixture obtained using one 94 lb sack of API Class A/Portland Type I cement (one cubic foot) with specified volume of water.

The addition of bentonite to cement requires that the amount of water also be increased. 5.3 % water by weight should be added for each 1.0% of bentonite by weight added.

* This is the minimum volume of water needed to hydrolize one 94 lb. sack of cement (neat cement slurry)

### ANNULAR VOLUME

ANNULAR VOLUME FORMULA (gallons)

$$V = (d_2^2 - d_1^2)(D)(.041)$$

V = Volume (gallons)

$d_2$ = Diameter of borehole (inches)

$d_1$ = Casing O.D. (inches)

D = Depth of drilled hole to fill (feet)

### ANNULAR VOLUME CHART (cubic feet/linear feet)*

| | Borehole Diameter (O.D.) | | | | |
|---|---|---|---|---|---|
| Casing (I.D) | 6" | 7" | 8" | 9" | 10" |
| 2" | .17 | .24 | .32 | – | – |
| 4" | – | .16 | .24 | .33 | – |
| 6" | – | – | .11 | .20 | .31 |

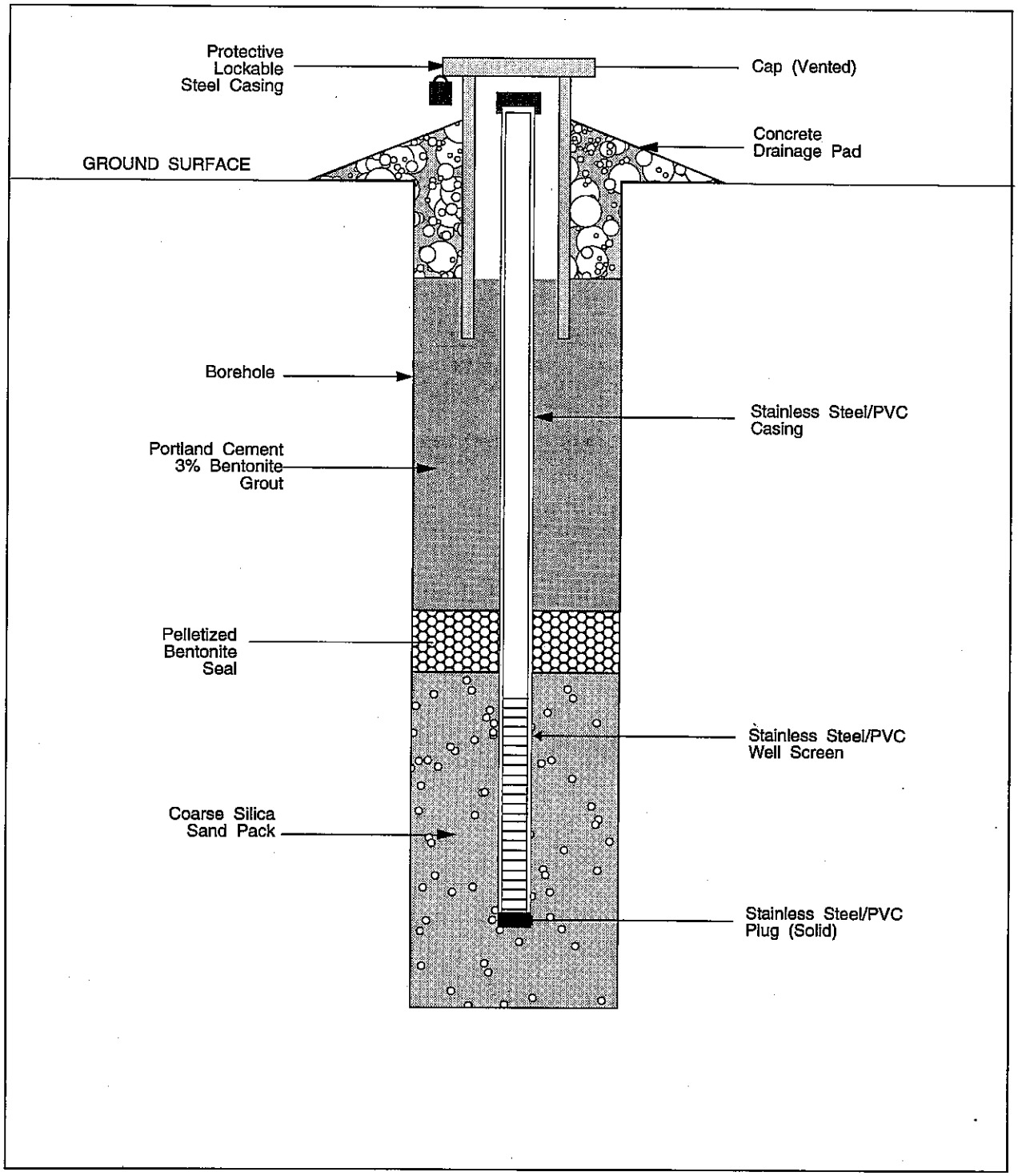
Note: Add extra cement/grout to account for seepage or loss due to voids around drill hole.

### GENERAL INFORMATION

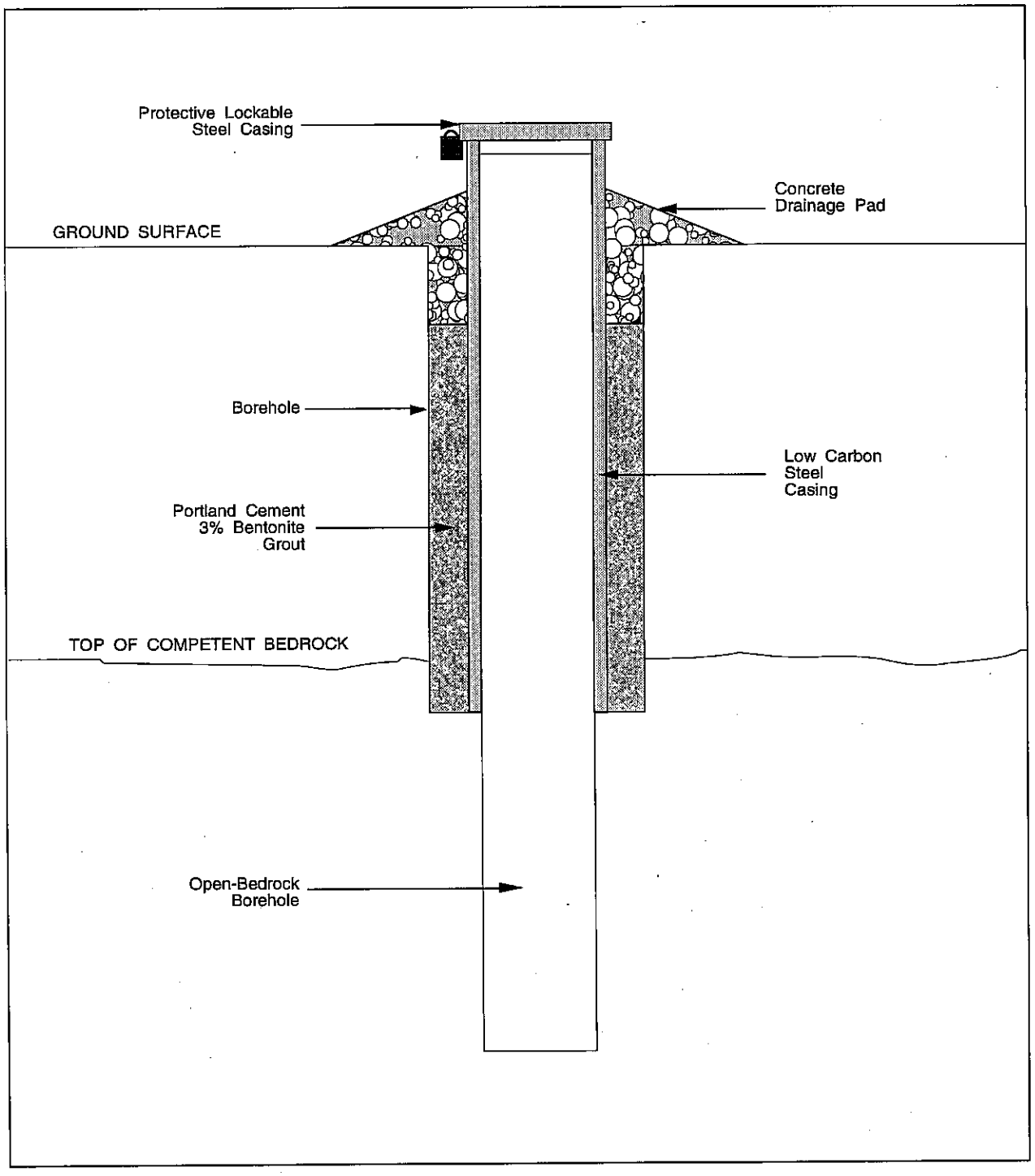
| CONVERSION FACTOR | | |
|---|---|---|
| Multiply | By | To Obtain |
| Cubic feet | 7.4805 | Gallons (U.S.) |
| Gallons | 0.1337 | Cubic feet |

| CEMENT - ONE SACK | |
|---|---|
| Weight | 94 lbs. |
| Volume | 7.48 gallons<br>1.0 $ft^3$ |
| Density | 3.15 $g/cm^3$ |

| WATER | |
|---|---|
| Density - | 8.32 lbs./gallons |
| | 62.23 lbs/ $ft^3$ |
| | 1.0 gallons/$cm^3$ |

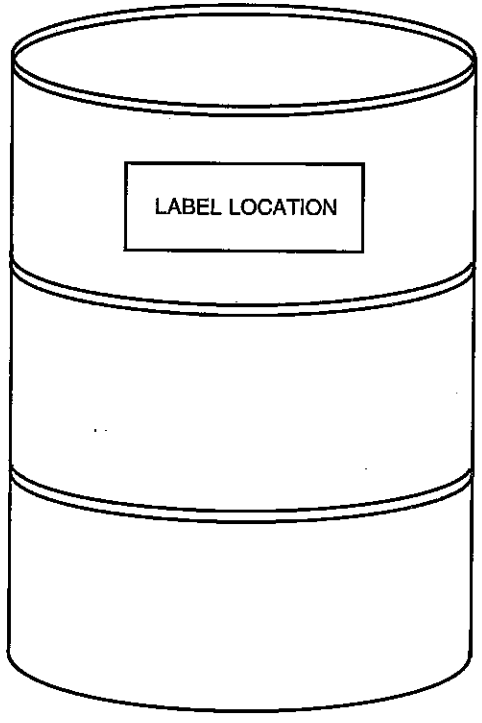



**TYPICAL SCREENED MONITORING WELL CONSTRUCTION**




**TYPICAL OPEN-HOLE MONITORING WELL CONSTRUCTION**

## INVESTIGATION-DERIVED WASTE DRUM/CONTAINER PACKING AND LABELING




- Record applicable information on each drum (see Note No. 2)
- Labeling should be located on the upper 1/3 of the drum
- Label drum using an enamel paint stick

**EXAMPLE LABEL**

| | |
|---|---|
| SITE NAME. . . . . | ABC LANDFILL |
| DATE . . . . . | JAN. 2,1991 |
| MATERIAL . . . . . | DRILL CUTTINGS (100% SOLID) |
| DRUM ID. NUMBER . . . . . | DRUM NO.3 |
| SOURCE OF MATERIAL . . . . | MONITORING WELL 2 (30'-36') |
| SITE CONTRACTOR . . . . . | ECOLOGY AND ENVIRONMENT |

1. WASTE DRUM/CONTAINER PACKING

Wastes from separate sources should not be mixed into a single drum whenever possible. Drums should not be overpacked. Particular care should be taken to leave enough headspace to account for the expansion due to freezing of liquids containing water as it is not unusual for drums to remain onsite for several months or more. Care should be taken to keep the outsides of the drum free from investigation-derived wastes. Drums with bungholes (DOT 17-E) should be filled only with liquids. Drums with open tops (DOT 17-H) may be filled with liquids or solids. Be sure to properly fit the gasket on a 17-H drum when filling with liquids.

Lids should be placed on drums and be securely fastened with the retainer loop. Retainer loops are most easily put onto drums by starting at one end and working over the drum/lid lip. Care should be taken to visually inspect this seal. An improper seal will result in drum leakage regardless of how tight the nut-bolt fastener is tightened. The retainer loop may require gentle tapping around its circumference to seal properly. Finally, secure the retainer loop with the nut and bolt fastener. The nut and bolt assembly should be facing downward.

2. DRUM/CONTAINER LABELING

Waste drums should be clearly labeled using a enamel paint stick. The following information should be recorded directly on the drum face.

- Site name
- Date when material was generated
- Matrix (soil, water, personal protective gear, precentage of solids,liquids, etc.)
- Drum ID number
- Source of material and depth where applicable
- Ecology & Environment, Inc.

Additional material may include:

- Listing of hazardous substances known to be within (acetone, hexane, methanol, etc.)
- Expected concentration of materials (low, medium, high)
- Warnings/cautions for next party opening drum

All labeling should be done on the side of the drum. Duct tape should not be used to label drums. Writing should be done directly on the drum itself.

3. DRUM/CONTAINER STORAGE AND HANDLING

Investigation-derived waste should be left on site unless previously directed otherwise by the E&E Project Manager. Filled drums, particularily soils or waters should be left in the place where they are filled. Field crews should not attempt to lift, roll, or otherwise move drums at a site. Moving drums without the proper equipment can easily cause personal injuries, damage to the drum, and/or to the work site. Therefore if the drums need to be moved to a central repository, arrangements should be made for the appropriate equipment to be used.

4. DRUM/CONTAINER NUMBERING

Drum numbers should be consecutive.

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