January 4, 2023 3008

Steven Bloemer
Construction Supervisor
Clackamas County Facilities Management
1710 Red Soils Ct, #200
Oregon City, Oregon

Geotechnical Infiltration Testing Letter Report
Proposed Clackamas County Fairground Infiltration Facility
Canby, Oregon

Dear Mr. Bloemer,

This letter report summarizes our infiltration testing at the proposed stormwater infiltration pond at the Clackamas County Fairground project site. These services were performed in accordance with Clackamas County Contract #5351 dated April 18th, 2022 and Amendment #1 executed November 22, 2022.

BACKGROUND

We previously prepared a Geotechnical Investigation Report (Geotechnical Report), dated June 30, 2022, for a proposed Clackamas County Fairground and Event Center (CCFEC) building. The CCFEC will be located on the Clackamas County Fairgrounds at 694 NE 4th Avenue in Canby, Oregon. Since issuing our Geotechnical Report, we were requested to perform infiltration testing to determine field measured rates to expand the existing infiltration pond north of the proposed CCFEC building. A vicinity map showing the general project location is included as Figure 1.

SUBSURFACE EXPLORATIONS

The subsurface explorations included a site reconnaissance and excavation of two test pits for infiltration testing. As part of this task, we reviewed our previous Geotechnical Report that includes a summary of regional geology from published maps and descriptions, soil conditions from Oregon Water Resources Department (OWRD) well database near the site, and our summary boring logs for boreholes performed onsite.

Site Reconnaissance. A site visit was completed on December 13th, 2022 by our Project Engineer to observe and document the general site conditions and select infiltration test locations relative to the proposed stormwater infiltration pond provided by 3J Consulting, Inc. (project civil engineer). The infiltration locations were marked for utility locates. The test locations and the footprint of the proposed stormwater pond are shown on the project site plan (Figure 2).

Test Pits. Two test pits were completed on December 19th, 2022 by Western States Soil Conservation, Inc of Hubbard, Oregon. A Staff Geologist from Landslide Technology observed test pit excavation and logged the subsurface materials while digging progressed. The test pits were advanced with a rubber tracked John Deere 50G mini-excavator. The test pits, IT-1 and IT-2, were advanced to depths of approximately 6.7 to 6.9 feet below grounds surface (bgs).

Minor to moderate sloughing of the sidewalls was observed below approximately 4 to 4.5 feet bgs in both test pits. Details of the digging and the materials encountered are provided on the Summary Test Pit Logs as Figures 3 and 4. Test Pits IT-1 and IT-2 were backfilled with excavation spoils and tamped in place with the excavator bucket in 1- to 2-foot lifts. The approximate locations of the test pits, taken with a recreation-grade GPS unit, are shown in the table below.

Table 1: Infiltration Test Pit Locations

Test Pit Designation	Latitude (°N)	Longitude (°W)
IT-1	45.269255	-122.684377
IT-2	45.269414	-122.684378

REGIONAL GEOLOGY

Geologic maps from the Oregon Department of Geology and Mineral Industries[1] (DOGAMI) and the US Geologic Survey[2] (USGS) show that the regional geology of the area consists of coarse Missoula Flood deposits. The Schlicker and Finlayson (1979) geologic map shows that the site is located within a unit map as underlain by "deltaic (flood) deposits of sand, gravel, and boulders up to 8 ft diameter; torrential cross-bedding." Similarly, O'Connor et al (2001) describes the underlying geology consisting of "bouldery, cobbly, sandy gravel fans deposited by Missoula Floods."

SUBSURFACE CONDITIONS

The subsurface materials encountered at the site were interpreted to belong to the coarse flood deposits mapped by DOGAMI and USGS. The subsurface conditions consist of sandy silt and gravel with cobbles and boulders. No firm or fresh rock was encountered. The unit is discussed further in the following section.

The soil conditions encountered in the upper 4 feet of both test pits consisted of medium stiff, dark brown, slightly sandy silt. Fine roots were encountered in the upper 1.5 to 2 feet bgs of both test pits. Coarser flood deposits consisting of loose to medium dense, gray to brown, very silty, sandy gravel to silty sand from 4 feet bgs to the bottom of the test pits. The lower unit contained numerous cobbles

[1] Schlicker, H.G., Finlayson, C.T. (1979). Geology and Geologic Hazards of Northwestern Clackamas County, Oregon – Oregon Department of Geology and Mineral Industries (DOGAMI), Bulletin 99, 89p.
[2] O'Connor, J.E., Sarna-Wojcicki, A., Wozniak, K.C., Polette, D.J., and Fleck, R.J. (2001). Origin, Extent, and Thickness of Quaternary Geologic Units in the Willamette Valley, Oregon – U.S. Geological Survey (USGS), Professional Paper 1620, 51p.

and boulders up to approximately 3 feet in maximum dimension. Occasional woody roots up to approximately ½-inch diameter were encountered in IT-2.

Groundwater. Groundwater seepage or static groundwater was not observed in either test pit during our explorations. Groundwater was encountered during drilling performed in May of 2022 at approximately 14.5 to 20 feet bgs. Static groundwater was measured at approximately 18 feet bgs on October 3, 2022 in the piezometer installed at BH-1 (See our Geotechnical Report for specific details regarding the standpipe piezometer). We also reviewed water well logs on file with the Oregon Water Resources Department to estimate the depth to regional groundwater. Based on our review, regional groundwater is present at approximately 15 to 40 feet bgs.

INFILTRATION TESTING

As requested by the project team, we conducted two infiltration tests on site to assist in evaluation of the infiltration capacity of on-site soils for design of the proposed stormwater infiltration facility on the north side of the site and west of the existing stormwater facility. Testing was conducted using the open pit falling head procedure consistent with the procedure outlined for Professional Method Infiltration Testing in the Clackamas County Service District No. 1[3] (CCSD#1) Stormwater Standards – Appendix E. The test methods described in the CCSD#1 are generally consistent with other regional jurisdictions and design professionals. The general test procedure consists of the following steps: 1) excavating a test pit to the desired test depth; 2) preparing an approximately 2-foot by 2-foot wide hole at the base of the test pit for infiltration testing near proposed base of facility depth; 3) cleaning the base of the test area by removing any loose soil; 4) performing saturation phase (i.e., filling test hole with a minimum of 1-foot of water above the base of the soil to be tested and maintaining this depth of water for at least four hours); and 5) performing the infiltration test consisting of a minimum of three successive trials. For rapidly draining soils where a 1-foot head is unable to be maintained or if after filling the hole twice with 12-inches of water, the water seeps away in less than 10 minutes, the saturation phase (step 4) may be skipped.

Testing Methods and Results

The test pits were excavated into the pervious soil approximately 2.5 feet deep to a prepared testing depth approximately 6.7- to 6.9-feet bgs. A 2-foot by 2-foot excavation at the base of the pits was unable to be created due to the presence of cobbles and minor to moderate sloughing of the coarse-grained soils below approximately 4 to 4.5 feet. The test area at the base of test pit measured approximately 2 feet by 3 feet and 4 feet by 5 feet at IT-1 and IT-2, respectively. The hose from the water truck was set in a 5-gallon bucket and placed in the bottom of the test locations to help minimize disturbance of fine-grained material in the excavation while adding water.

At IT-1, a four-hour saturation period was not required because a 12-inch water head could not be maintained due to the rapidly draining soils. The flow of water into the pit ranged from approximately 10 to 20 gallons per minute (gpm) with an average of approximately 15 gpm over a time period of 15

[3] County Service District No. 1 (CCSD#1). Stormwater Standards – Appendix E Infiltration Testing Guide.

minutes. The test area at IT-2 was pre-soaked over a 4-hour period by continual controlled addition of water into the excavation to maintain a 1-foot water head. A 1-foot water head remained relatively steady with a flow rate of approximately 10 gpm based on the flow meter attached to the back of the water truck.

After the saturation period at IT-2, the hole was filled with clean water to at least 1-foot deep above the bottom of the excavation. The water surface was monitored and the drop in water level was measured over each testing increment. As water levels fall during the time-measured testing period, infiltration rates generally slow as a result of less head from the water column in the test. The diminishing rate is consistent and representative of actual infiltration of stormwater of infiltration ponds for impounded surface runoff. Field test results are summarized in Table 2 below. The manual readings for IT-1 and IT-2 are included in the infiltration test data summary in Figures 5 and 6 consistent with the requirements of CCSD#1 Stormwater Standards. In addition, we placed a vibrating wire piezometer (VWP) as a supplemental observation to measure water column height over time in the excavations. Water depth was recorded at 10-second increments electronically by a VWP throughout the test period.

Table 2: Infiltration Test Results

Infiltration Test Number	Location	Depth (feet)	Soil Description	Field Measured Infiltration Rate[1] (inches/hour)
IT-1	South side of proposed infiltration pond (see Site Plan)	6.9	Very silty, sandy, fine to coarse GRAVEL, numerous cobbles and boulders (up to 2-ft in dimension)	>40
IT-2	North side of proposed infiltration pond (see Site Plan)	6.7	Silty SAND, numerous gravel and cobbles, scattered small boulders (up to 3-ft in dimension)	17

Notes:

[1] Appropriate factors should be applied to the field-measured infiltration rate, based on the design methodology and specific system used.

The infiltration rates shown in Table 2 were calculated from the field-measured infiltration testing and represent short-term measured rates. The calculated infiltration rate at IT-1 exceeds 40-inches per hour, but CCSD#1 recommends a maximum design infiltration rate of 20-inches per hour. The calculated infiltration rate at IT-2 is based on a combination of manual readings and piezometer data and represents an average rate over the testing period.

RECOMMENDATIONS AND CONCLUSIONS

Successful design and implementation of stormwater infiltration systems, and whether a system is suitable for a development depend on several site-specific factors. Stormwater infiltration systems are

generally best suited for sites having sandy or gravelly soil with saturated hydraulic conductivities greater than 2 inches per hour such as those encountered below approximately 4 feet at this site.

Based on the generally sandy/gravelly soil conditions encountered at the test site, and measured infiltration rates exceeding 2 inches per hour, it is our opinion that stormwater infiltration is feasible at this site as a means of stormwater management, provided soil types and infiltration values are confirmed during facility installation. For the proposed site, we recommend the calculated infiltration rate at IT-2 shown in Table 2 be used for facility design using an appropriate factor of safety.

Appropriate correction factors should also be applied by the project civil engineer to account for long-term infiltration parameters. From a geotechnical perspective, we recommend a factor of safety (correction factor) of at least 2 be applied to the field-measured infiltration values shown in Table 2 to account for potential soil variability with depth and location within the area tested. This is the minimum required factor of safety allowed in the CCSD#1 Stormwater Standards for open pit falling head tests. In addition, the stormwater system design engineer should determine and apply appropriate remaining correction factor values, or factors of safety, to account for repeated wetting and drying that occur in this area, degree of in-system filtration, variability that may be present in the on-site soil, frequency and type of system maintenance, vegetation, potential for siltation and bio-fouling, etc., as well as system design correction factors for overflow or redundancy, and base and facility size.

Actual depths, lateral extent and estimated infiltration rates can vary from the values presented above. We recommend that the design infiltration values be confirmed by performing field testing during installation. Field testing/confirmation during construction is often required in large or long systems or other situations where soil conditions may vary within the area where the system is constructed. The results of this field testing might necessitate that the infiltration locations be modified to achieve the design infiltration rate.

The infiltration flow rate of a focused stormwater system typically diminishes over time as suspended solids and precipitates in the stormwater slowly clog the void spaces between the soil particles or cake on the infiltration surface. The serviceable life of a stormwater system can be extended by pre-filtering or with on-going accessible maintenance. Eventually, most systems will fail and will need to be replaced or have media regenerated or replaced. We recommend that infiltration systems include an overflow that is connected to a suitable discharge point.

CLOSING

We appreciate the opportunity to assist Clackamas County with this challenging project. If you have any questions please call us at (503) 452-1100.

Sincerely,

LANDSLIDE TECHNOLOGY
A Division of Cornforth Consultants, Inc.

Tygh N. Gianella, P.E.
Project Engineer

Wade N. Osborne, P.E.
Senior Associate Engineer

ATTACHMENTS:

Figure 1 – Vicinity Map

Figure 2 – Project Site Plan

Figure 3 – Summary Test Pit Log for IT-1

Figure 4 – Summary Test Pit Log for IT-2

Figure 5 – Infiltration Test Data for IT-1

Figure 6 – Infiltration Test Data for IT-2

LIMITATIONS IN THE USE AND INTERPRETATION OF THIS GEOTECHNICAL REPORT

Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical letter report was prepared for the use of the Owner in the design of the subject facility and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive test pit logs or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory borings and test pits are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory borings and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

The Summary Test Pit Logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the excavations progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

The test pit logs and related information depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at these test pit locations. Also, the passage of time may result in a change in the soil conditions at these test pit locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the test pit logs, boring logs, or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, borings or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report; nor can our firm be responsible for any construction activity on sites other than the specific site referred to in this report.

L:\01-Technical\3000\3008 - Clackamas Fairgrounds Building\60-Drafting\GIS\MXD\Fig1_VicinityMap.mxd - JCM

SCALE: 1 INCH = 1000 FEET

0 500 1,000 2,000 Feet

Basemap derived from ESRI imagery

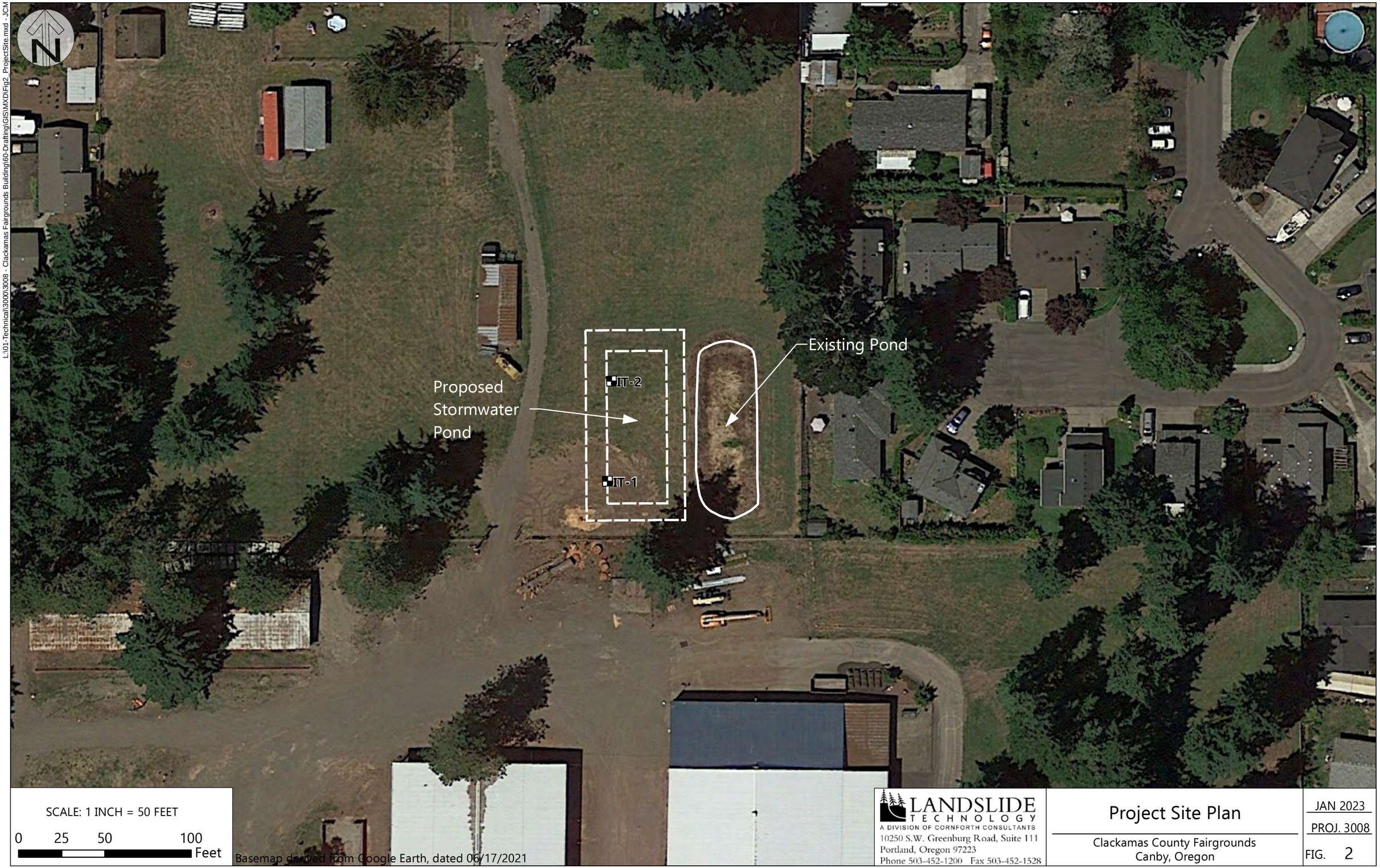
LANDSLIDE TECHNOLOGY
A DIVISION OF CORNFORTH CONSULTANTS
10250 S.W. Greenburg Road, Suite 111
Portland, Oregon 97223
Phone 503-452-1200 Fax 503-452-1528

Vicinity Map

Clackamas County Fairgrounds
Canby, Oregon

JAN 2023
PROJ. 3008
FIG. 1

L:\01-Technical\3000\3008 - Clackamas Fairgrounds Building\60-Drafting\GIS\MXD\Fig2_ProjectSite.mxd - JCM



SCALE: 1 INCH = 50 FEET

0 25 50 100 Feet

Basemap derived from Google Earth, dated 06/17/2021

LANDSLIDE TECHNOLOGY
A DIVISION OF CORNFORTH CONSULTANTS
10250 S.W. Greenburg Road, Suite 111
Portland, Oregon 97223
Phone 503-452-1200 Fax 503-452-1528

Project Site Plan

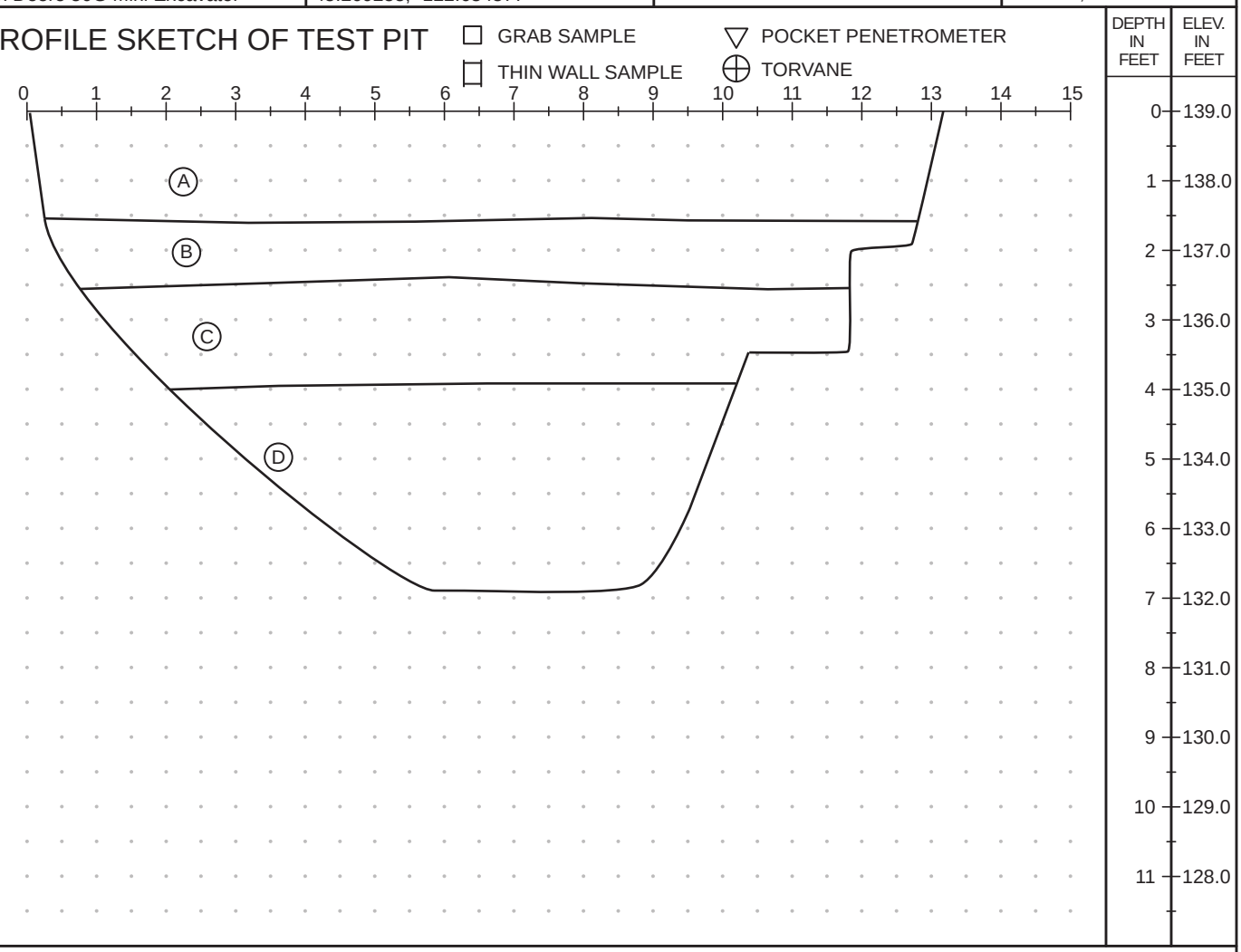
Clackamas County Fairgrounds
Canby, Oregon

JAN 2023
PROJ. 3008
FIG. 2

LANDSLIDE TECHNOLOGY
A DIVISION OF CORNFORTH CONSULTANTS
10250 S.W. Greenburg Road, Suite 111
Portland, Oregon 97223
Phone 503-452-1100 Fax 503-452-1528

PROJECT LOCATION: Canby, OR	BY: JCM	DATE: 12/19/22	TEST PIT NO.: IT-1
JOB NUMBER: 3008	CK: TNG	DATE: 12/28/22	START TIME: 08:22 DATE: 12/19/22 / FINISH TIME: 11:00 DATE: 12/19/22
CLIENT: Clackamas County	WEATHER: Cloudy/Scattered Rain		
EQUIPMENT & CONTRACTOR: Western States / Dustin John Deere 50G Mini Excavator	TEST PIT LOCATION: Clackamas County Fairgrounds 45.269255, -122.684377	SAMPLING METHODS: N/A	ELEVATION & DATUM: 139.0 ft., WGS 1984

PROFILE SKETCH OF TEST PIT



SOIL DESCRIPTIONS:

SURFACE CONDITIONS: Grass Cover

Ⓐ MEDIUM STIFF, dark brown, slightly sandy SILT; sand is medium to fine, rounded, light brown to gray; moist, non-plastic to low plasticity; numerous organics (fine roots)

Ⓑ MEDIUM STIFF, dark brown, slightly sandy SILT; trace clay; moist, low plasticity; becomes lighter brown with depth to approximately 3.7'; numerous organics (roots)

Ⓒ STIFF, dark brown, slightly sandy to sandy SILT; numerous sub-rounded, brown to gray, gravels and cobbles; trace clay; moist, non-plastic

Ⓓ LOOSE to MEDIUM DENSE, gray to brown, very silty, sandy GRAVEL; numerous cobbles and boulders up to approximately 2.0 feet in maximum dimension; gravel is fine to coarse; moist, non-plastic

Note: No samples collected. Infiltration test performed approximately 6.9 feet below ground surface.

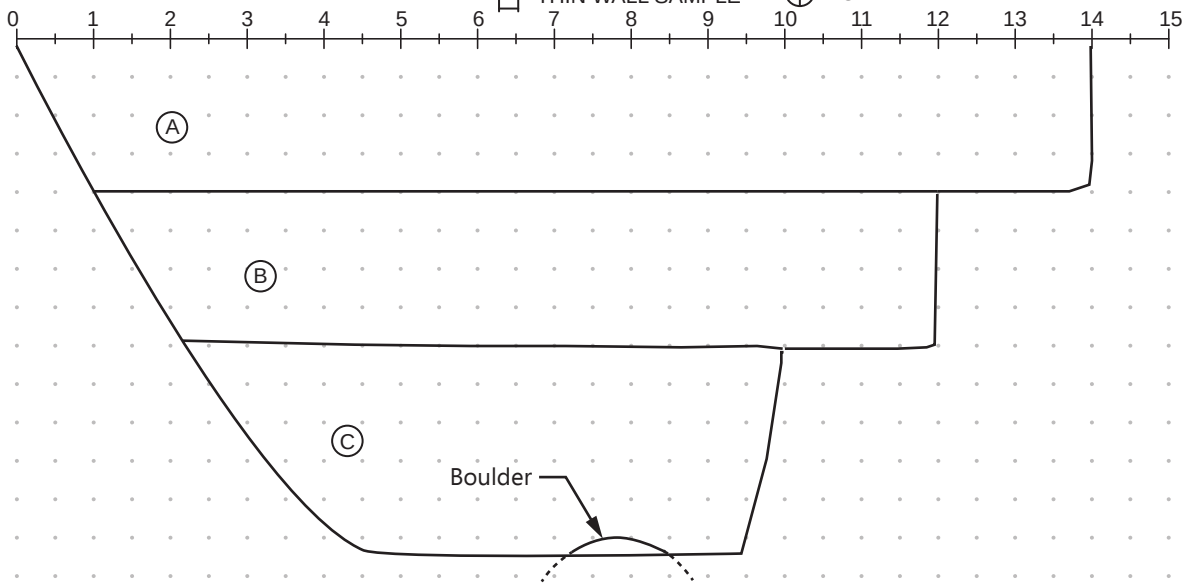
FIGURE NUMBER: 3

LANDSLIDE TECHNOLOGY
A DIVISION OF CORNFORTH CONSULTANTS
10250 S.W. Greenburg Road, Suite 111
Portland, Oregon 97223
Phone 503-452-1100 Fax 503-452-1528

PROJECT LOCATION: Canby, OR	BY: JCM	DATE: 12/19/22	TEST PIT NO.: IT-2
JOB NUMBER: 3008	CK: TNG	DATE: 12/28/22	START TIME: 10:01 DATE: 12/19/22 / FINISH TIME: 4:45 DATE: 12/19/22
CLIENT: Clackamas County	WEATHER: Cloudy/Scattered Rain		
EQUIPMENT & CONTRACTOR: Western States / Dustin, John Deere 50G Mini Excavator	TEST PIT LOCATION: Clackamas County Fairgrounds, 45.269414, -122.684378	SAMPLING METHODS: N/A	ELEVATION & DATUM: 139.0 ft., WGS 1984

PROFILE SKETCH OF TEST PIT

GRAB SAMPLE | THIN WALL SAMPLE | POCKET PENETROMETER | TORVANE



DEPTH IN FEET	ELEV. IN FEET
0	139.0
1	138.0
2	137.0
3	136.0
4	135.0
5	134.0
6	133.0
7	132.0
8	131.0
9	130.0
10	129.0
11	128.0

SOIL DESCRIPTIONS:

SURFACE CONDITIONS: Grass Cover

(A) MEDIUM STIFF, dark brown, slightly sandy SILT; sand is medium to fine, rounded, light brown to gray; moist, non-plastic to low plasticity; numerous organics (fine roots)

(B) MEDIUM STIFF, dark brown, slightly sandy SILT; trace clay; moist, low plasticity; becomes lighter brown with depth to approximately 3.7'; numerous organics (roots)

(C) LOOSE to MEDIUM DENSE, light brown to gray, silty SAND; numerous subrounded, light gray to brown, gravels and cobbles; scattered boulders (approximately 3 feet maximum dimension) encountered at 6.5' bgs; sand is medium coarse; non-plastic; occasional woody roots up to approximately 0.5"

Note: No samples collected. Infiltration test performed approximately 6.7 feet below ground surface.

FIGURE NUMBER: 4

LANDSLIDE TECHNOLOGY
A DIVISION OF CORNFORTH CONSULTANTS
10250 S.W. Greenburg Road, Suite 111
Portland, Oregon 97223
Phone 503 452 1200 Fax 503 452 1528

Job No.: 3008
Project: Clackamas County Fairgrounds
Location: Canby, Oregon
Tested by: Justin McCarley

Standard Falling Head Test Field Log

Test Hole No.: IT-1
Depth to bottom of hole (ft): 6.9
Approximate dimension of bottom of hole (ft): 2x3
Test Method: Open Pit Falling Head
Date of Testing: 12/19/2022

Depth	Soil Texture
0 to 1.5'	MEDIUM STIFF, dark brown, slightly sandy SILT; moist, sand is medium to fine, rounded, light brown to gray; non-plastic, numerous organics (roots)
1.5' to 2.4'	MEDIUM STIFF, dark brown, slightly sandy SILT; trace clay, moist, soil becomes lighter with depth, low-plasticity, numerous organics (roots)
2.4' to 3.7'	STIFF, dark brown, slightly sandy to sandy SILT; trace clay, moist, non-plastic, numerous gravel and cobbles, sub-rounded, brown to gray
3.7' to 6.9'	LOOSE TO MEDIUM DENSE, gray to brown, very silty, sandy, GRAVEL, numerous cobbles and boulders up to 2' in maximum dimension, gravel is fine to coarse, moist

Time of Day	Time Interval (min)	Total Time (min)	Depth to Water from Top of Pit (feet)	Dist. Interval (inches)	Infiltration (inches/hr)	Notes/Remarks
9:42:00 AM	0	0	-	-	-	Initial test (Saturation) - flow ~10 gallons per minute (gpm)
9:47:00 AM	5	5	-	-	-	flow ~20 gpm into hole
9:52:00 AM	5	10	-	-	-	flow ~15 gpm into hole
9:57:00 AM	5	15	-	-	-	Unable to build water head; test terminated

LANDSLIDE TECHNOLOGY
A DIVISION OF CORNFORTH CONSULTANTS
10250 S.W. Greenburg Road, Suite 111
Portland, Oregon 97223
Phone 503-452-1200 Fax 503-452-1528

Job No.: 3008
Project: Clackamas County Fairgrounds
Location: Canby, Oregon
Tested by: Justin McCarley

Standard Falling Head Test Field Log

Test Hole No.: IT-2
Depth to bottom of hole (ft): 6.7
Approximate dimension of bottom of hole (ft): 4x5
Test Method: Open Pit Falling Head
Date of Testing: 12/19/2022

Depth	Soil Texture
0 to 2.0'	MEDIUM STIFF, dark brown, slightly sandy SILT; moist, sand is medium to fine, rounded, light brown to gray; non-plastic, numerous organics (roots)
2.0' to 3.8'	MEDIUM STIFF, dark brown, slightly sandy SILT; trace clay, moist, soil becomes lighter with depth, low-plasticity, numerous organics (roots)
3.8' to 6.7'	LOOSE TO MEDIUM DENSE, light brown to gray, silty SAND, numerous gravel to cobbles, subrounded, gray to light brown, sand is medium, scattered boulders (approximately 3 feet maximum dimension) encoutered at 6.5', occasional roots up to 0.5"

Time of Day	Time Interval (min)	Total Time (min)	Depth to Water from Top of Pit (feet)	Dist. Interval (inches)	Infiltration (inches/hr)	Notes/Remarks
10:50:00 AM	0	0	-	-	-	Initial test (Saturation) - head remains constant with flow ~10 gallons per minute throughout saturation.
2:50:00 PM	240	240	-	-	-	
2:55:00 PM	0	0	5.50			Test #1
3:05:00 PM	10	10	5.80	3.60	21.6	
3:15:00 PM	10	20	6.10	3.60	21.6	
3:25:00 PM	10	30	6.30	2.40	14.4	
3:30:00 PM	5	35	6.40	1.20	14.4	
3:35:00 PM	0	0	5.70			Test #2
3:45:00 PM	10	10	6.00	3.60	21.6	
3:55:00 PM	10	20	6.20	2.40	14.4	
4:05:00 PM	10	30	6.40	2.40	14.4	
4:13:00 PM	0	0	5.70			Test #3
4:23:00 PM	10	10	6.00	3.60	21.6	
4:33:00 PM	10	20	6.30	3.60	21.6	
4:38:00 PM	5	25	6.40	1.20	14.4	