Streamflow Depletion Analysis

City of Manzanita Water System
Manzanita, Oregon

for
PACE Engineers, Inc.

October 8, 2018

GeoEngineers
Earth Science + Technology

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Manzanita, Oregon

File No. 23092-001-00

October 8, 2018

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INTRODUCTION

This report presents a summary of hydrogeologic analyses related to the permitting of a planned emergency water supply well (herein designated the backup well) for the City of Manzanita, Oregon (the City). The City currently obtains its potable water from two wells situated near the Nehalem River that are operated as components of a Joint Water System with the City of Wheeler, Oregon. The City is interested in developing the backup well to increase its preparedness for a water system emergency. The planned location of the backup well is the southeast quarter of the northeast quarter of Section 29, Township 3 North, Range 10 West, approximately as shown on the Vicinity Map, Figure 1.

The design well yield for the backup well is 80 gallons per minute (gpm). The planned location of the backup well is approximately 105 feet south of Neahkahnie Creek, approximately as shown on the Well Location Map, Figure 2.

We understand that the City is interested in transferring a portion of a surface water right (Certificate No. 21707) to the backup well for groundwater use. To do so, the backup well must have a “similar” impact on Neahkahnie Creek as the original point of diversion. Per OR Rev Stat ş 540.531 (9)(b), a similar impact is defined by a streamflow depletion of at least 50 percent of the well discharge rate within 10 days of continuous pumping. In this report, streamflow depletion refers to the reduction in Neahkahnie Creek streamflow that results from backup well pumping.

SCOPE OF SERVICES

Our scope of services was presented in our revised proposal dated August 20, 2018, which was authorized by PACE Engineers, Inc. (PACE) on August 29, 2018. The purpose of our proposed hydrogeologic analyses was to estimate the depletion in Neahkahnie Creek streamflow that could result from operation of the backup well.

Our specific scope of hydrogeologic services consisted of the following:

1. Compiled and reviewed readily-available, existing information regarding hydrogeologic conditions surrounding the planned location of the backup well.
2. Conducted hydrogeologic analyses to estimate the streamflow depletion impact to Neahkahnie Creek anticipated as a result of operation of the backup well.
3. Provided a summary of our results to PACE in this report.

REVIEWED DOCUMENTS AND INFORMATION

As a basis for the hydrogeologic conceptual model and aquifer parameter estimates that support the streamflow depletion analyses described herein, GeoEngineers reviewed the following documents and information:

- PACE‘s City of Manzanita Emergency Well Feasibility Study (PACE 2017).

- Wright/Deacon & Associates, Inc.'s Geotechnical Report for the City's Proposed Water Treatment Plant (Wright/Deacon & Associates, Inc. 2000).
- The State of Oregon Department of Transportation's (ODOT's) Preliminary Plan Set for the Grading, Drainage, Structure, Paving, Signing, and Roadside Development of FFO - US101: Manzanita Ave. – Neahkahnie Creek Sec. (ODOT 2014).
- Murray, Smith & Associates' Stormwater Management Plan for FFO - US101: Manzanita Ave. – Neahkahnie Creek Sec. (Murray, Smith & Associates 2013).
- The State of Oregon Department of Geology and Mineral Industries' report describing Coastal Landforms between Tillamook Bay and the Columbia River (Lund 1972).
- The U.S. Geological Survey's Geologic Map of the Tillamook Highlands (Wells, et al. 1994).
- Water Well Reports on file with the State of Oregon for Sections 28 and 29 of Township 3 North and Range 10 West.

GEOLOGIC SETTING

The City is situated on the Pacific Coast immediately north of Nehalem Bay. Surficial geologic conditions within and surrounding the City are shown on the Surficial Geologic Map, Figure 3. Surficial geologic conditions near and within the City generally consist of Quaternary-age (deposited less than about 2.6 million years ago [MA]) beach/dune deposits, fluvial/estuarine deposits, and landslide deposits. Beach/dune deposits generally consist of Holocene-age (less than about 11,700 years ago) fine- to medium-grained sand. Fluvial/estuarine deposits generally consist of clay, silt, sand, and gravel alluvium deposited in rivers and streams (Wells et al. 1994). These Quaternary sediments are exposed at the surface throughout most of the area within the City limits, with surface elevations generally lower than Elevation 250 feet. Landslide deposits consist of poorly-sorted angular clasts of bedrock in a weathered fine-grained matrix and outcrop north of the City beginning approximately at Nehalem Road.

Stratigraphically, Quaternary sediments in the vicinity of the City are underlain by the Miocene-age (about 5 to 23 MA) Grande Ronde Formation of the Columbia River Basalt Group, the Miocene-age Angora Peak Member, and the Miocene-age/Oligocene-age (about 23 to 34 MA) Alesa Formation. The Grande Ronde Formation consists of basalt flows and interbedded sediments deposited during an extended period of volcanism that extruded a series of very fluid lava flows across Oregon, Washington, and Idaho. The Grande Ronde Formation is exposed at the surface within uplands located less than 1½ miles north of the City. The Angora Peak Member consists of deltaic and shallow marine sandstone and outcrops about one mile north of the City. The Alesa Formation consists of tuffaceous siltstone and sandstone and is exposed at the surface immediately east of the City in the area surrounding Neahkahnie Lake.

HYDROGEOLOGIC SETTING

Groundwater within the area surrounding the City primarily occurs within: (1) relatively coarse-grained Quaternary sediments; and (2) bedrock formations.

Quaternary sediments generally occur in thicknesses that can support production wells within area river valleys and along coastal areas. Aquifers within Quaternary sediments (herein designated Quaternary aquifers) are generally unconfined except where overlain by low permeability confining layers of sufficient thickness and lateral extent to truly confine the underlying aquifer. Transmissivity (a hydraulic property related to the rate of groundwater flow through a unit width of aquifer) and storativity (the ability of an aquifer to store/release water per unit change in hydraulic head) of Quaternary aquifers vary with depositional environment and are generally highest in coarse-grained fluvial deposits and lowest in fine-grained estuarine deposits. Quaternary aquifers are relatively susceptible to degradation from point and non-point sources of contamination because they frequently lack an overlying confining unit and are characterized by a shallow depth to the groundwater table. Recharge to these aquifers is primarily from precipitation, applied irrigation, septic systems, leakage from surface-water courses within losing reaches, and potentially through leakage from the adjacent bedrock aquifers. Quaternary aquifers discharge to water supply wells, underlying bedrock aquifers, gaining reaches of streams, and the Pacific Ocean.

Bedrock underlies the entire area and generally contains confined to semi-confined aquifers of relatively low transmissivity and storativity. Groundwater is most readily transmitted through primary porosity associated with relatively coarse-grained depositional environments (for example, sandstone layers of the Angora Peak Member and/or Alesa Formation) or through broken vesicular and scoriaceous interflow zones that characterize the top of individual basalt flows (for example, within the Grande Ronde Formation). Recharge to the bedrock aquifers occurs through direct precipitation, vertical infiltration from overlying unconfined aquifers, and lateral recharge from adjacent bedrock units. Bedrock aquifers discharge to water supply wells, Quaternary aquifers, gaining reaches of streams, and the Pacific Ocean.

STREAMFLOW DEPLETION ANALYSES

Target Hydrogeologic Unit

Inherent to the streamflow depletion analyses described herein is the assumption that the backup well will be in hydraulic connection with Neahkahnie Creek. That is, the backup well will be screened within/open to the hydrogeologic unit that is in hydraulic continuity with the creek (herein designated the target hydrogeologic unit). The backup well is proposed to be located approximately 105 feet southwest of and 50 feet higher in elevation than Neahkahnie Creek (Figure 2). The target hydrogeologic unit for the backup well is uncertain, based on the following:

- Geotechnical Hole Reports for geotechnical borings associated with the City Water Treatment Plant (located immediately west of the backup well) have been designated TILL 50693 and TILL 50694 by the State of Oregon and are provided in Appendix A. Information from these borings indicates that sand extends from the ground surface to a depth of at least 40 feet, which is approximately equivalent to the stage elevation of Neahkahnie Creek adjacent to the backup well. These borings do not extend deep enough to provide information regarding the composition, thickness and hydraulic properties of the target hydrogeologic unit.
- Available geotechnical exploration information associated with ODOT's FFO - US101: Manzanita Ave. project is contradictory. The reports for the borings from this project have been designated TILL 52599 through TILL 52601 by the State of Oregon and also are provided in Appendix A. The Geotechnical Hole Report for TILL 52599 indicates that sand with wood extends from 40 to 70 feet below ground surface at the time of exploration. This log suggests that unconsolidated sand likely comprises the target hydrogeologic unit. However, the Geotechnical Hole Reports for TILL 52600 and TILL 52601 indicate that siltstone was encountered at depths of 27 to 28 feet below ground surface at the time of

exploration. Borings TILL 52600 and TILL 52601 were located about 100 feet north and 130 feet east of TILL 52599, respectively. These logs suggest that the target hydrogeologic unit is comprised of sedimentary bedrock.

- No Water Well Reports on file with the State of Oregon for Sections 28 and 29 appear to be for wells located in close-enough proximity to the backup well to resolve this uncertainty.

With the goal of providing comprehensive information despite hydrogeologic uncertainty, GeoEngineers evaluated streamflow depletion rate for two target hydrogeologic unit scenarios. These include the following:

Scenario 1. The target hydrogeologic unit is assumed to be an **unconfined medium-grained sand aquifer** that is 20 feet thick. We assumed that the storage coefficient (specific yield) of the Scenario 1 aquifer is 0.2, based on typical values for unconfined aquifers provided by Driscoll (1986).

Scenario 2. The target hydrogeologic unit is assumed to be a **confined sandstone aquifer** that is 30 feet thick. We assumed that the storage coefficient of the Scenario 2 aquifer is 0.0001, based on typical values for sandstone provided by Driscoll (1986).

Minimum Hydraulic Conductivity

Our streamflow depletion analyses are predicated on the assumption that the target hydrogeologic unit will be able to support a design well yield of 80 gpm. For the above-described aquifer scenarios to support a well yield of 80 gpm, the aquifer hydraulic conductivity must meet or exceed respective minimum values. We calculated the minimum hydraulic conductivities that would support project well yield objectives using a simplified analytical model based on the Theis (1935) non-equilibrium well equation for confined aquifers. In the case of Scenario 1, the Theis (1935) values were modified using the Jacob correction for unconfined aquifers (Cooper and Jacob 1946). Maximum allowable drawdown in the aquifer immediately surrounding the backup well was assumed to be 12 feet for Scenario 1 and 15 feet for Scenario 2.

Based on the assumptions described above, the estimated minimum hydraulic conductivities necessary to support the design well yield of 80 gpm are 39 feet per day for Scenario 1 and 25 feet per day for Scenario 2. Use of these minimum hydraulic conductivity values in the below-described streamflow depletion analyses is: (1) appropriate because the project is not viable at lower hydraulic conductivities; and (2) conservative because an increase in assumed hydraulic conductivity tends to increase streamflow depletion percentage.

Analytical Method

Multiple analytical methods for estimating the depletion in streamflow resulting from groundwater pumping have been developed by researchers (Barlow and Leake 2012). These solutions generally assume the following:

- The aquifer is homogeneous, isotropic and extends infinitely away from the stream.
- The aquifer is confined, although the solutions have been extended to unconfined aquifers with the assumption that drawdown caused by pumping will be small compared to aquifer thickness.
- Water is released instantaneously from storage (that is, the effect of delayed yield is negligible).

- The stream is straight, of infinite length, and flowing at all times.
- The groundwater level in the aquifer at the stream remains above the streambed, such that the stream does not become disconnected from the underlying aquifer.
- The well is fully penetrating and pumping at a constant rate.

The most widely-used streamflow depletion solution simulates a stream penetrating the full thickness of the aquifer, with no streambed hydraulic resistance between the stream and the aquifer (Glover and Balmer 1954), and has been designated as the Glover solution. Because small streams similar to Neahkahnie Creek frequently are not fully penetrating nor in perfect hydraulic connection with the adjacent aquifer, we selected an adaptation of the Glover solution introduced by Hunt (1999) which accounts for partial penetration of the aquifer by the stream and streambed hydraulic resistance. This solution also assumes the aquifer is of infinite areal extent in the horizontal direction and not truncated by the stream.

A number of additional analytical solutions for estimating streamflow depletion have been developed by researchers (as summarized by Huang et al. 2018) to address a wide variety of specific hydrogeologic situations, including leaky aquifer conditions, layered aquifers with extensive zones of high and low permeability, stream valleys distant lateral boundaries, etc. Considering the limited amount of site-specific data available, and especially relative to the Glover solution, the modifications inherent to the Hunt (1999) solution tend to reduce the estimated streamflow depletion percentage and, therefore, offer more conservative estimates as a screening method for regulatory review and approval.

We calculated streamflow depletion rates for hydrogeologic Scenarios 1 and 2 (described above) using the Hunt (1999) solution contained within U.S. Geological Survey code STRMDEPL08 (Reeves 2008).

Each model run simulated a continuous pumping period of 30 days. We assumed that streambed conductance was equal to 50 percent of the hydraulic conductivity of the target hydrogeologic unit. The specific parameter values assumed for each analytical scenario are listed in Assumptions for Streamflow Depletion Analysis, Table 1.

Model Results

Raw program output files for the two model runs are provided in Appendix B. Results are provided in tabular form in Results of Streamflow Depletion Analysis, Table 2, provided in graphical form in Streamflow Depletion Percentage, Figure 4, and summarized by the following:

- Primarily driven by the relatively high storage coefficient inherent to unconfined aquifers, the streamflow depletion percentages estimated for Scenario 1 are less than for Scenario 2.
- After a pumping period of 10 days, streamflow depletion percentage estimated for Scenario 1 was approximately 53 percent and increased to approximately 71 percent after a pumping period of 30 days.
- After a pumping period of 10 days, streamflow depletion percentage estimated for Scenario 2 was approximately 98 percent and increased to approximately 99 percent after a pumping period of 30 days.

CONCLUSIONS

The composition, thickness and hydraulic properties of the target hydrogeologic unit are not specifically defined by the reviewed subsurface information. As such, existing data do not support a precise evaluation of the rate of streamflow depletion that will result from operation of the proposed Backup Well. For that reason, we evaluated streamflow depletion for two hydrogeologic scenarios and associated ranges in hydraulic conductivity.

Approval of the City's requested water right transfer is based on a streamflow depletion of at least 50 percent of the well discharge rate within a period of 10 days of continuous pumping. These critical values are highlighted by the blue lines shown in Figure 4. **Model results indicate that, if the project is viable and the target hydrostratigraphic unit is able to support the design well yield of 80 gpm, streamflow depletion associated with backup well operation is likely to comply with these minimum requirements.**

An increase in the precision of these analyses, if necessary to move forward with the City water right transfer, would be best accomplished by site-specific subsurface exploration and testing. This supplemental exploration, testing and analysis program, if performed, should include the following:

1. Drilling to explore the composition and thickness of the target hydrogeologic unit at the proposed location of the backup well and, if possible, adjacent to Neahkahnie Creek.
2. Hydraulic testing and analysis, which could be accomplished through: (1) Test well installation and test pumping; or (2) monitoring well installation and slug testing.
3. Revision of the streamflow depletion analysis described herein, using site-specific inputs for the target hydrogeologic unit.

LIMITATIONS

We prepared this report for use by PACE to assist in the evaluation of the depletion in Neahkahnie Creek streamflow that could result from operation of the proposed backup well. Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of hydrogeology in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Please refer to Appendix C, Report Limitations and Guidelines for Use for additional information pertaining to use of this report.

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TABLES

Table 1

Assumptions for Streamflow Depletion Analysis

City of Manzanita Emergency Water Supply Well
Manzanita, Oregon

Scenario 1 - Unconfined Sand Aquifer

Parameter	Symbol	Unit	Assumed Value	Source
Well Discharge Rate	Qw	gallons per minute	80	Pace Engineers, Inc. (2017). Page 3.
Distance from Well to Stream	d	feet	105	Pace Engineers, Inc. (2017). Figure 2.2.
Storage Coefficient	S	dimensionless	2.0E-01	Typical value for the storage coefficient (specific yield) for an unconfined, coarse-grained sedimentary aquifer provided by Driscoll (1986). Sand composition of aquifer is based on borings B-1 and B-2 from Wright/Deacon & Associates, Inc. (2000).
Hydraulic Conductivity - Minimum	K_L	feet per day	3.9E+01	Minimum calculated value that can support the design well yield (80 gallons per minute)
		feet per second	4.5E-04	
Aquifer Thickness	b	feet	20	State of Oregon Geotechnical Hole Report TILL 52599
Transmissivity	T_L	square feet per day	780	$T_L = K_L*b$
		square feet per second	9.0E-03	
Duration of Pumping	t	day	30	
Streambed Conductance	S_{cL}	feet per second	2.3E-04	50 percent of minimum hydraulic conductivity

Scenario 2 - Confined Sandstone Aquifer

Parameter	Symbol	Unit	Assumed Value	Source
Well Discharge Rate	Qw	gallons per minute	80	Pace Engineers, Inc. (2017). Page 3.
Distance from Well to Stream	d	feet	105	Pace Engineers, Inc. (2017). Figure 2.2.
Storage Coefficient	S	dimensionless	1.0E-04	Typical value for the storage coefficient of sandstone provided by Driscoll (1986).
Hydraulic Conductivity -Minimum	K_L	feet per day	2.5E+01	Minimum calculated value that can support the design well yield (80 gallons per minute)
		feet per second	2.9E-04	
Aquifer Thickness	b	feet	30	Review and summary of State of Oregon Water Well Reports for Sections 28 and 29 of Township 3 North and Range 10 West.
Transmissivity	T_L	square feet per day	750	$T_L = K_L*b$
		square feet per second	8.7E-03	
Duration of Pumping	t	day	30	
Streambed Conductance - Low	S_{cL}	feet per second	1.4E-04	50 percent of hydraulic conductivity

References:

Driscoll, F.G., 1986. Groundwater and Wells (2nd ed.), Johnson Filtration Systems, Inc., St. Paul, Minnesota, 1089p.

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Table 2

Results of Streamflow Depletion Analyses

City of Manzanita Emergency Water Supply Well

Manzanita, Oregon

Elapsed Time [2]	Well Pumping Rate		Streamflow Depletion Rate [1]					
			Scenario 1 [3]			Scenario 2 [4]		
(days)	(gpm)	(cfs)	(gpm)	(cfs)	(percent)	(gpm)	(cfs)	(percent)
0	0	0.000	0	0.00	0.0	0	0.00	0.0
1	80	0.178	6.9	0.0153	8.6	76.1	0.1696	95.2
2	80	0.178	15.8	0.0351	19.7	77.2	0.1721	96.6
3	80	0.178	22.2	0.0495	27.8	77.7	0.1732	97.2
4	80	0.178	27.1	0.0603	33.8	78.0	0.1738	97.5
5	80	0.178	30.9	0.0688	38.6	78.2	0.1742	97.7
6	80	0.178	34.0	0.0757	42.5	78.4	0.1746	98.0
7	80	0.178	36.5	0.0814	45.7	78.5	0.1748	98.1
8	80	0.178	38.7	0.0862	48.4	78.6	0.1750	98.2
9	80	0.178	40.6	0.0904	50.7	78.6	0.1752	98.3
10	80	0.178	42.2	0.0940	52.7	78.7	0.1753	98.4
11	80	0.178	43.6	0.0972	54.5	78.8	0.1755	98.5
12	80	0.178	44.9	0.1001	56.2	78.8	0.1756	98.5
13	80	0.178	46.1	0.1027	57.6	78.9	0.1757	98.6
14	80	0.178	47.2	0.1051	59.0	78.9	0.1758	98.6
15	80	0.178	48.1	0.1072	60.1	78.9	0.1758	98.6
16	80	0.178	49.0	0.1092	61.3	79.0	0.1759	98.7
17	80	0.178	49.8	0.1110	62.3	79.0	0.1760	98.7
18	80	0.178	50.5	0.1126	63.2	79.0	0.1760	98.7
19	80	0.178	51.3	0.1142	64.1	79.0	0.1761	98.8
20	80	0.178	51.9	0.1156	64.9	79.0	0.1761	98.8
21	80	0.178	52.5	0.1170	65.6	79.1	0.1762	98.9
22	80	0.178	53.1	0.1182	66.3	79.1	0.1762	98.9
23	80	0.178	53.6	0.1194	67.0	79.1	0.1762	98.9
24	80	0.178	54.1	0.1206	67.7	79.1	0.1763	98.9
25	80	0.178	54.6	0.1216	68.2	79.1	0.1763	98.9
26	80	0.178	55.0	0.1226	68.8	79.2	0.1764	99.0
27	80	0.178	55.5	0.1236	69.3	79.2	0.1764	99.0

Elapsed Time [2] (days)	Well Pumping Rate		Streamflow Depletion Rate [1]					
			Scenario 1 [3]			Scenario 2 [4]		
	(gpm)	(cfs)	(gpm)	(cfs)	(percent)	(gpm)	(cfs)	(percent)
28	80	0.178	55.9	0.1245	69.9	79.2	0.1764	99.0
29	80	0.178	56.2	0.1253	70.3	79.2	0.1764	99.0
30	80	0.178	56.6	0.1262	70.8	79.2	0.1765	99.0

Notes:

[1] Streamflow depletion rate was calculated using the US Geological Survey code STRMDEPL08 (Reeves, 2008) based on the method introduced by Hunt (1999) for a partially penetrating stream with streambed resistance.

[2] Elapsed time refers to the duration of continuous pumping in the planned emergency water supply well.

[3] Scenario 1 refers to an unconfined medium-grained sand aquifer. The minimum hydraulic conductivity estimated to support a well yield of 80 gallons per minutes (gpm) is 39 feet per day.

[4] Scenario 2 refers to a confined sandstone aquifer. The minimum hydraulic conductivity estimated to support a well yield of 80 gpm is 39 feet per day.

cfs = cubic feet per second; K = hydraulic conductivity

FIGURES

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Feet

Notes:

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2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2016

Projection: NAD 1983 UTM Zone 10N

Vicinity Map

City of Manzanita Emergency Water Supply Well
Manzanita, Oregon

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Figure 1

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Legend

- Approximate Planned Emergency Water Supply Well Location
- Neahkahnie Creek

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Data Source: ESRI

Projection: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Well Location Map

City of Manzanita Emergency Water Supply Well
Manzanita, Oregon

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Figure 2

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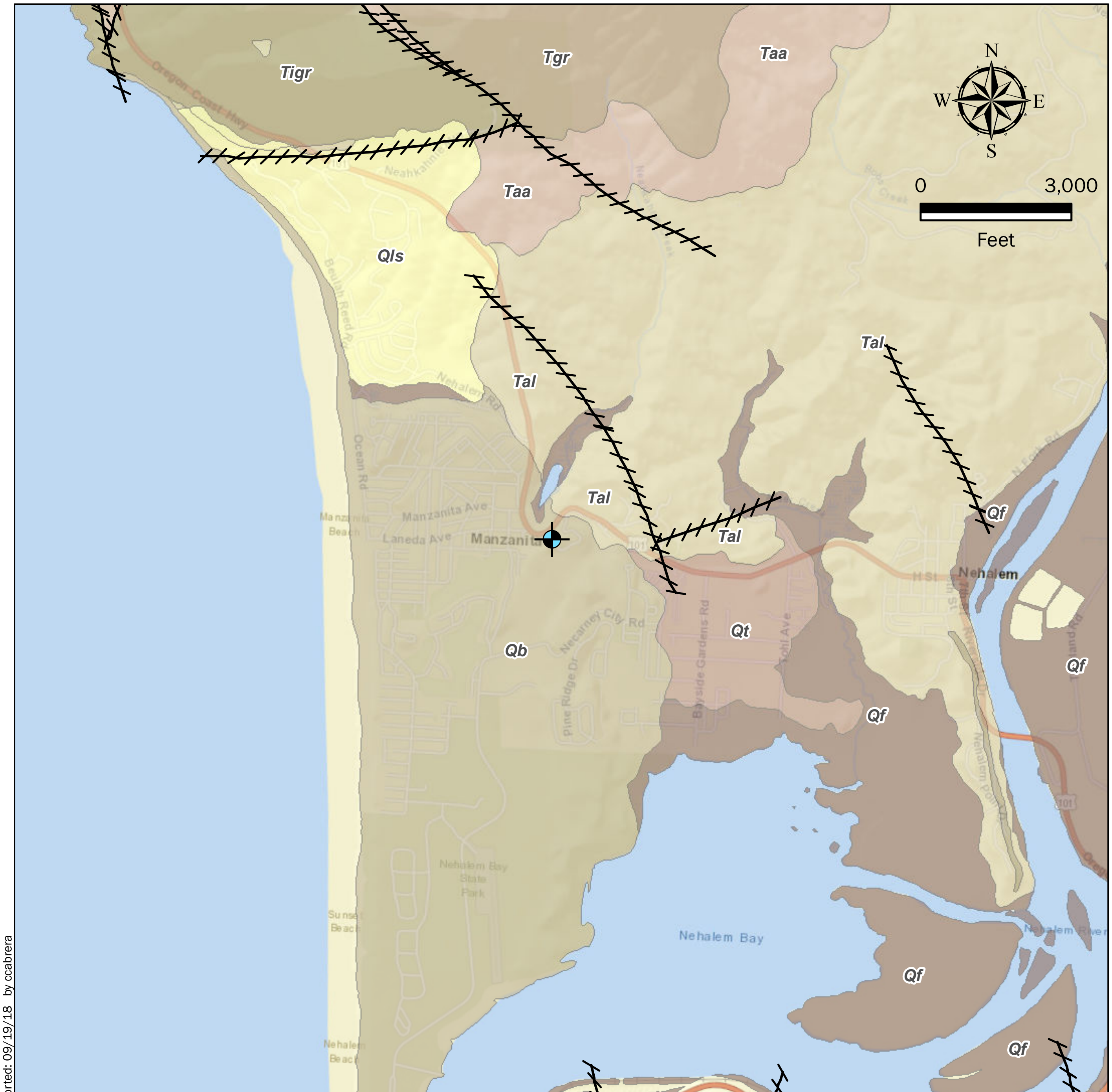


Legend

Approximate Planned Emergency Water Supply Well Location

Faults

Geology (DOGAMI)

- Qb: Beach/dune deposit
- Qf: Fluvial/estuarine deposits
- Qls: Landslide deposits
- Qt: Fluvial/estuarine deposits
- Taa: Angora Peak member
- Tal: Alsea Formation
- Tgr: Grande Ronde Basalt
- Tigr: Grande Ronde Basalt

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Oregon Geology, OGDC-6, from DOGAMI, https://www.oregongeology.org/.

Projection: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

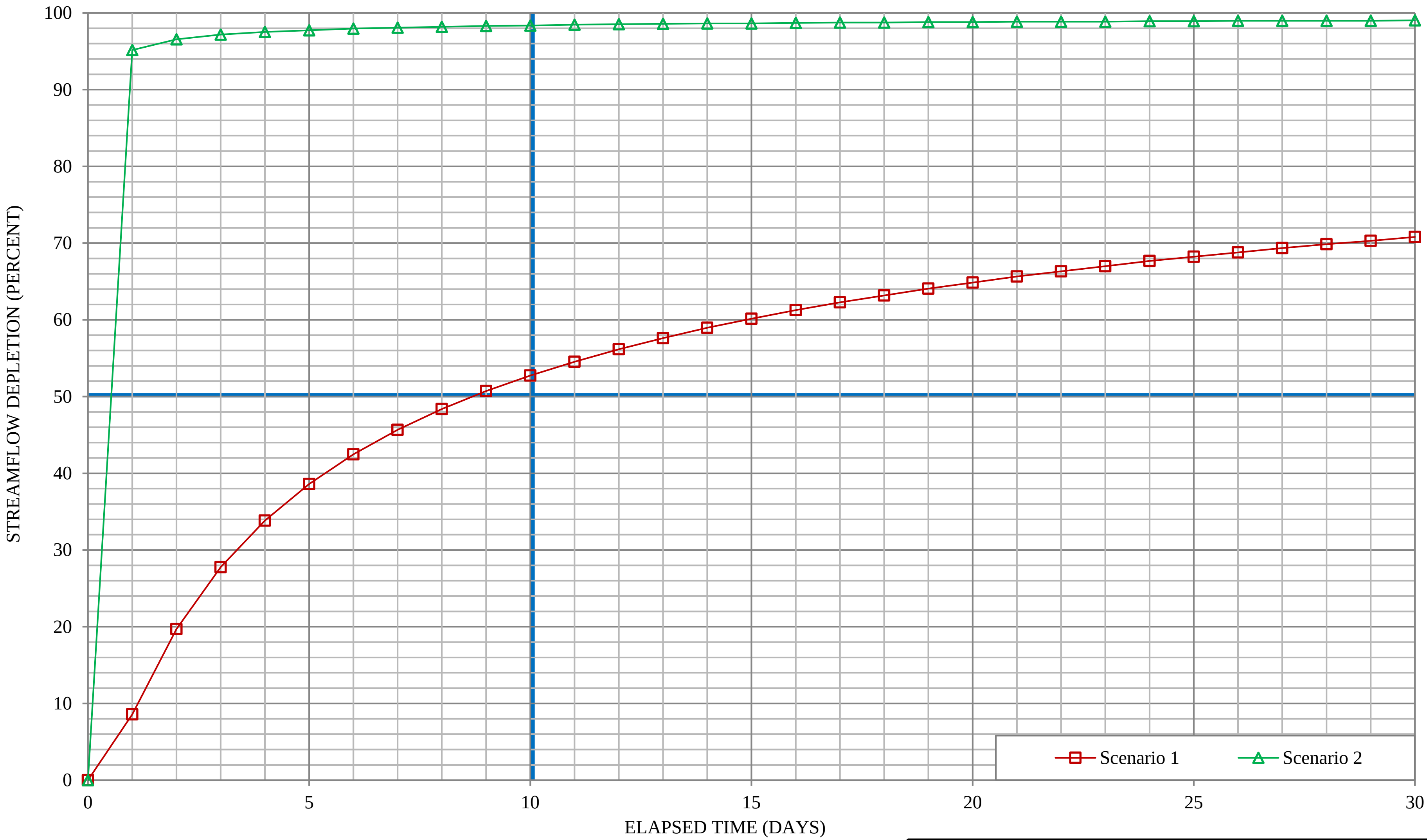
Surficial Geologic Map

City of Manzanita Emergency Water Supply Well
Manzanita, Oregon

GeoEngineers

Figure 3

P:\23\23092001\GIS\MXD\2309200100_F03_SurficialGeology.mxd Date Exported: 09/19/18 by ccabrera



Notes:

1. Streamflow depletion rate was calculated using the US Geological Survey code STRMDEPL08 (Reeves, 2008) based on the method introduced by Hunt (1999) for a partially penetrating stream with streambed resistance.
2. Scenario 1 refers to an unconfined medium-grained sand aquifer.
3. Scenario 2 refers to a confined sandstone aquifer.

Streamflow Depletion Percentage	
City of Manzanita Emergency Water Supply Well Manzanita, Oregon	
GeoEngineers	Figure 4

APPENDICES

GeoEngineers

APPENDIX A
State of Oregon Geotechnical Hole Reports

STATE OF OREGON
GEOTECHNICAL HOLE REPORT
(as required by OAR 690-240-035)

TILL 50693

(1) OWNER/PROJECT: Hole Number B/1

Name CITY OF MANZANITA

Address PO BOX 129

City MANZANITA State OR Zip 97130

(2) TYPE OF WORK

[X] New [ ] Deepening [ ] Alteration (repair/recondition) [ ] Abandonment

(3) CONSTRUCTION:

[ ] Rotary Air [ ] Hand Auger [ ] Hollow Stem Auger

[ ] Rotary Mud [ ] Cable Tool [ ] Push Probe [X] Other SOLID FLIGHT

(4) TYPE OF HOLE:

[X] Uncased Temporary [ ] Cased Permanent

[ ] Uncased Permanent [ ] Slope Stability [ ] Other

(5) USE OF HOLE:

GEOTECH

(6) BORE HOLE CONSTRUCTION:

Special Construction approval [ ] Yes [X] No Depth of Completed Hole 40 ft.

HOLE			SEAL			
Diameter	From	To	Material	From	To	Sacks or pounds
5"	0	40	BENT CHIPS	0	40	8

Backfill placed from 40 ft. to 0 ft. Material BENT CHIPS

Filter Pack placed from ___ ft. to ___ ft. Size of pack ___

(7) CASING/SCREEN:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:					[ ]	[ ]	[ ]	[ ]
					[ ]	[ ]	[ ]	[ ]
					[ ]	[ ]	[ ]	[ ]
					[ ]	[ ]	[ ]	[ ]
Screen:					[ ]	[ ]	[ ]	[ ]
					[ ]	[ ]	[ ]	[ ]

N/A

Slot size

(8) WELL TEST:

[ ] Pump [ ] Bailer [ ] Air [ ] Flowing Artesian

Permeability ___ Yield ___ GPM ___

Conductivity ___ PH ___

Temperature of water ___ °F/C Depth artesian flow found ___ ft.

Was water analysis done? [ ] Yes [ ] No

N/A

By whom?

Depth of strata analyzed. From ___ ft. to ___ ft.

Remarks:

(9) LOCATION OF HOLE by legal description:

County TILLAMOOK Latitude ___ Longitude ___

Township 3 (N) or S Range 10 E or (W) WM.

Section 29 SE 1/4 NE 1/4

Tax Lot ___ Lot ___ Block ___ Subdivision ___

Street Address of Well (or nearest address)

Map with location identified must be attached

(10) STATIC WATER LEVEL: N/A

___ ft. below land surface Date ___

Artesian pressure ___ lb. per square inch. Date ___

(11) SUBSURFACE LOG:

Ground Elevation

Material Description	From	To	SWL
BROWN SAND	0	40	

Date Started 2/24/00 Date Completed 2/24/00

(12) ABANDONMENT LOG:

Material Description	From	To	Sacks or Pounds
BENT CHIPS	40	0	8

Date started 2/24/00 Date Completed 2/24/00

Professional Certification

(to be signed by a licensed water supply or monitoring well constructor, or Oregon registered geologist or civil engineer).

I accept responsibility for the construction, alteration, or abandonment work performed during the construction dates reported above. All work performed during this time is in compliance with Oregon's geotechnical hole construction standards. This report is true to the best of my knowledge and belief.

License or Registration Number 10459

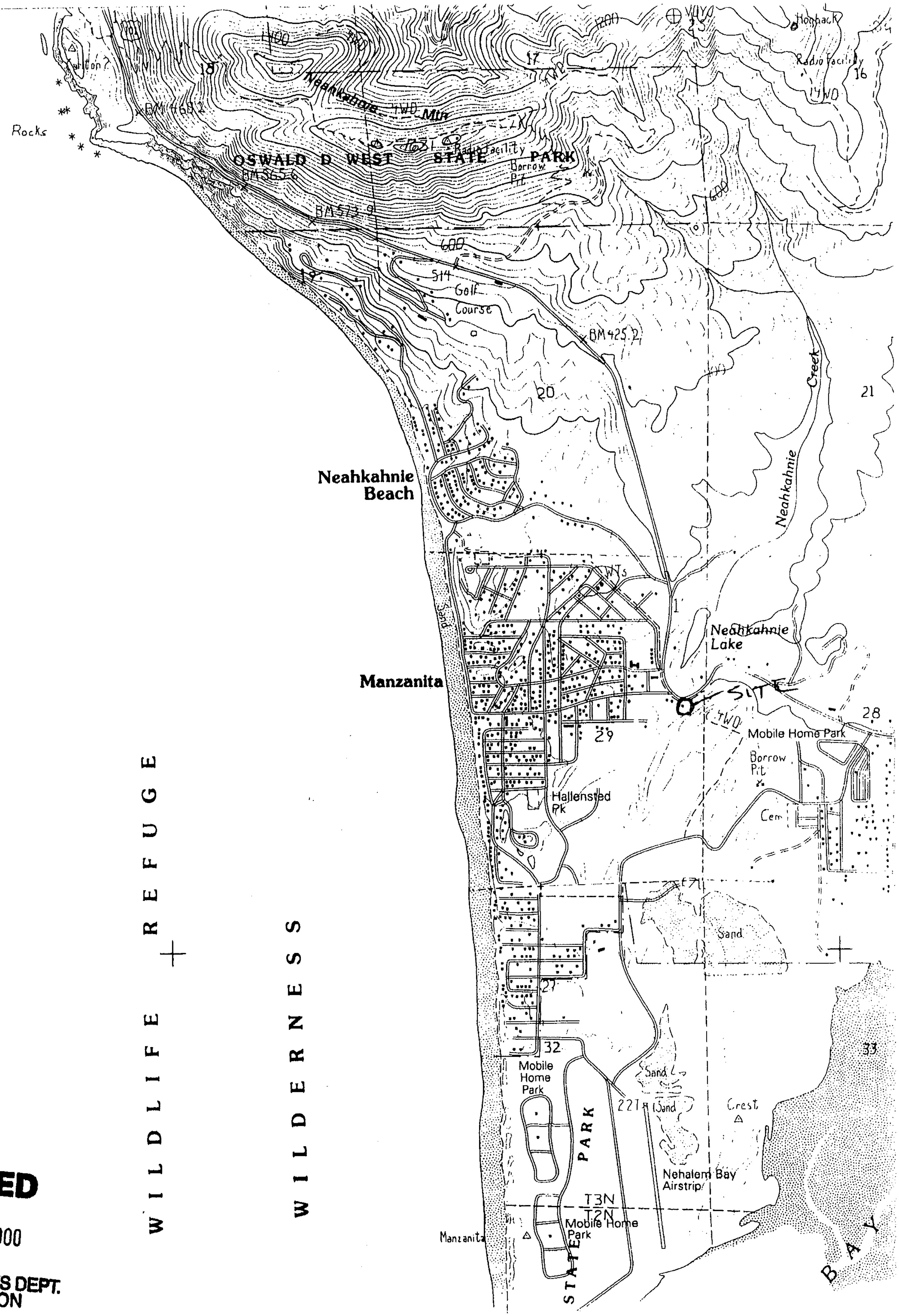
Signed Warren C [signature] Date 2/25/00

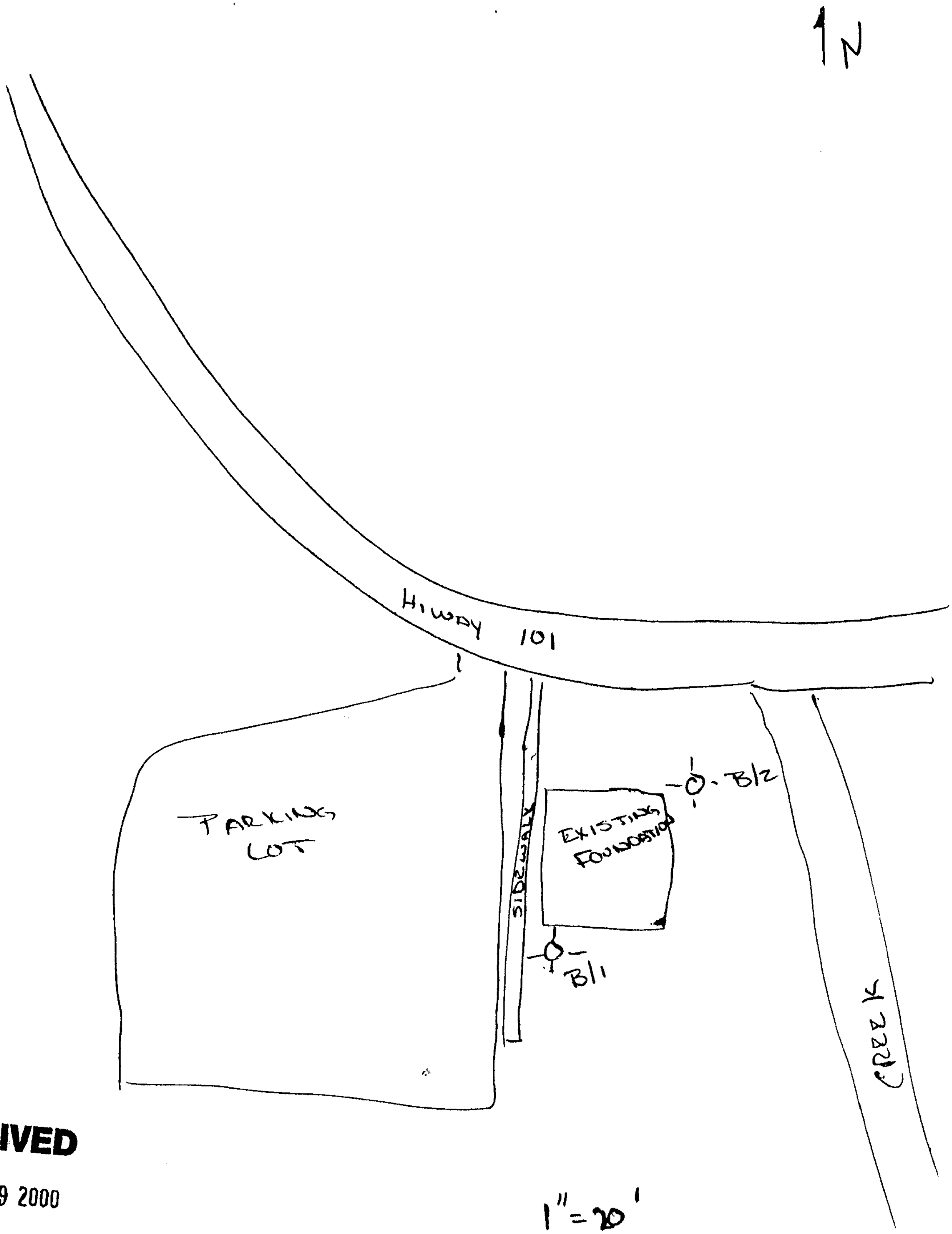
Affiliation USF

RECEIVED
MAR 9 2000
WATER RESOURCES DEPT
SALEM, OREGON

THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK

ORIGINAL – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER


Neahkahnie Mtn
OSWALD WEST STATE PARK
Rocks
Radio Facility
Borrow Pit
Hogback
BM 468.2
BM 565.6
BM 573.9
1400
1200
1631
4WD
600
514
Golf Course
BM 425.2
17
18
16
19
20
21
Neahkahnie Creek
Neahkahnie Beach
Manzanita
Sand
WTs
Neahkahnie Lake
SITE
28
29
Mobile Home Park
Borrow Pit
Cem
Hallensted Pk
Sand
27
32
Mobile Home Park
221
Crest
33
STATE PARK
Nehalem Bay Airstrip
T3N
T2N
Mobile Home Park
Manzanita
BAY
WILDLIFE REFUGE
WILDERNESS


N
HIWAY 101
PARKING LOT
SIDEWALK
EXISTING FOUNDATION
B/2
B/1
CREEK
1"=20'

TILL
50694

STATE OF OREGON
GEOTECHNICAL HOLE REPORT
(as required by OAR 690-240-035)

(1) OWNER/PROJECT: Hole Number B/2
Name CITY OF MANZANITA
Address PO BOX 129
City MAZANITA State OR Zip 97130

(2) TYPE OF WORK
[X] New [ ] Deepening [ ] Alteration (repair/recondition) [ ] Abandonment

(3) CONSTRUCTION:
[ ] Rotary Air [ ] Hand Auger [ ] Hollow Stem Auger
[ ] Rotary Mud [ ] Cable Tool [ ] Push Probe [X] Other SOLID FLIGHT

(4) TYPE OF HOLE:
[X] Uncased Temporary [ ] Cased Permanent
[ ] Uncased Permanent [ ] Slope Stability [ ] Other

(5) USE OF HOLE:
GEOTECH

(6) BORE HOLE CONSTRUCTION:
Special Construction approval [ ] Yes [X] No Depth of Completed Hole 40 ft.

HOLE			SEAL			
Diameter	From	To	Material	From	To	Sacks or pounds
5"	0'	40'	BENT CHIPS	0	40'	8

Backfill placed from 0 ft. to 40 ft. Material BENT CHIPS
Filter Pack placed from ____ ft. to ____ ft. Size of pack ____

(7) CASING/SCREEN:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:					[ ]	[ ]	[ ]	[ ]
					[ ]	[ ]	[ ]	[ ]
			N/A		[ ]	[ ]	[ ]	[ ]
					[ ]	[ ]	[ ]	[ ]
Screen:					[ ]	[ ]	[ ]	[ ]
					[ ]	[ ]	[ ]	[ ]

Slot size ____

(8) WELL TEST:
[ ] Pump [ ] Bailer [ ] Air [ ] Flowing Artesian
Permeability ____ Yield ____ GPM ____
Conductivity ____ PH ____
Temperature of water ____ °F/C Depth artesian flow found ____ ft.
Was water analysis done? [ ] Yes [ ] No N/A
By whom? ____
Depth of strata analyzed. From ____ ft. to ____ ft.
Remarks:

(9) LOCATION OF HOLE by legal description:
County TILLAMOOK Latitude ____ Longitude ____
Township 3 (N) or S Range 10 E or (W) WM.
Section 29 SE 1/4 NE 1/4
Tax Lot ____ Lot ____ Block ____ Subdivision ____
Street Address of Well (or nearest address) ____

Map with location identified must be attached

(10) STATIC WATER LEVEL: N/A
____ ft. below land surface. Date ____
Artesian pressure ____ lb. per square inch. Date ____

(11) SUBSURFACE LOG:
Ground Elevation ____

Material Description	From	To	SWL
BROWN SAND	0	40'	

Date Started 2/24/00 Date Completed 2/24/00

(12) ABANDONMENT LOG:

Material Description	From	To	Sacks or Pounds
BENT CHIPS	40	0	8

Date started 2/24/00 Date Completed 2/24/00

Professional Certification
(to be signed by a licensed water supply or monitoring well constructor, or Oregon registered geologist or civil engineer).

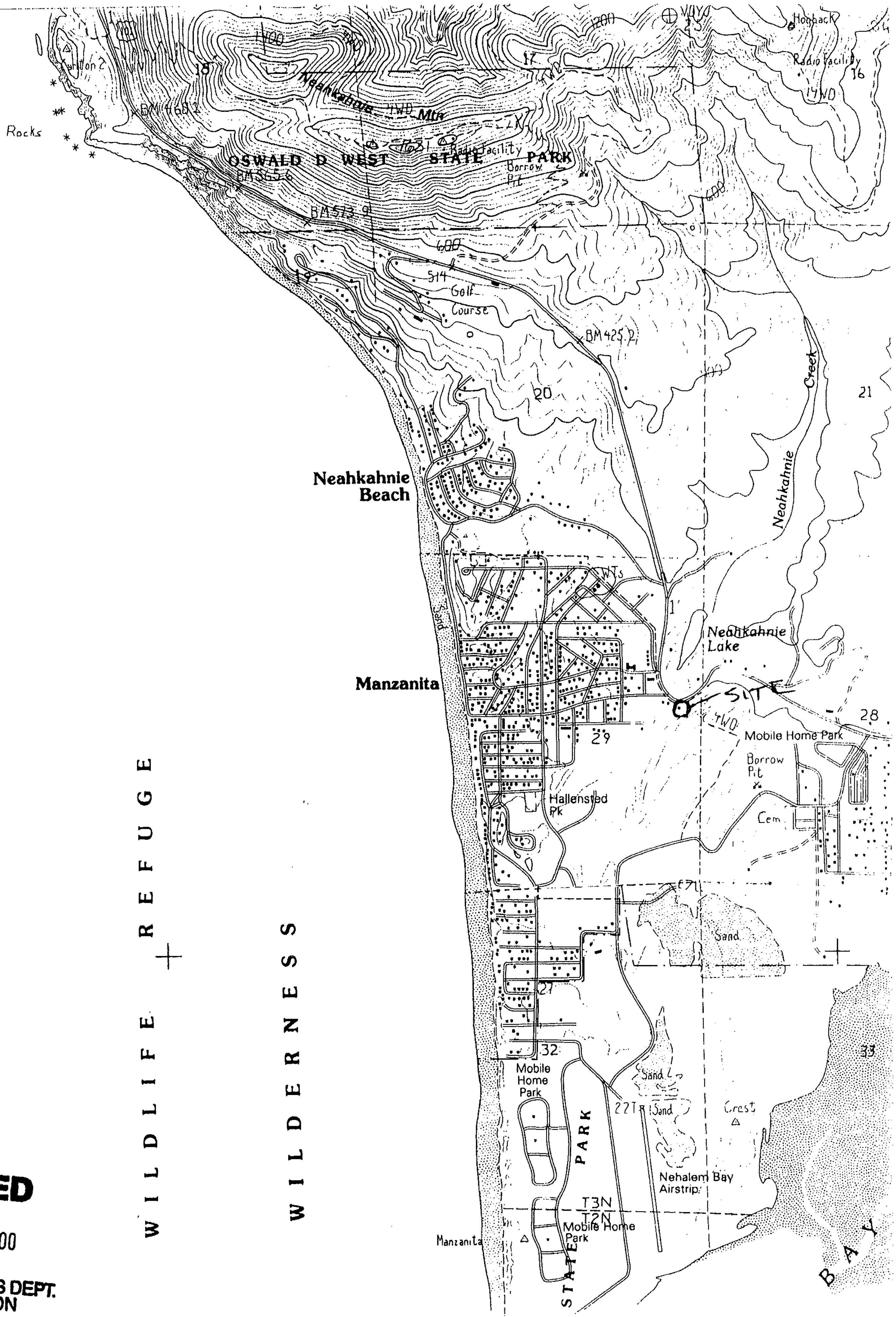
I accept responsibility for the construction, alteration, or abandonment work performed during the construction dates reported above. All work performed during this time is in compliance with Oregon's geotechnical hole construction standards. This report is true to the best of my knowledge and belief.

License or Registration Number 10459
Signed [signature] Date 2/25/00
Affiliation USE

RECEIVED
MAR 9 2000
WATER RESOURCES DEPT.
SALEM, OREGON

THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK

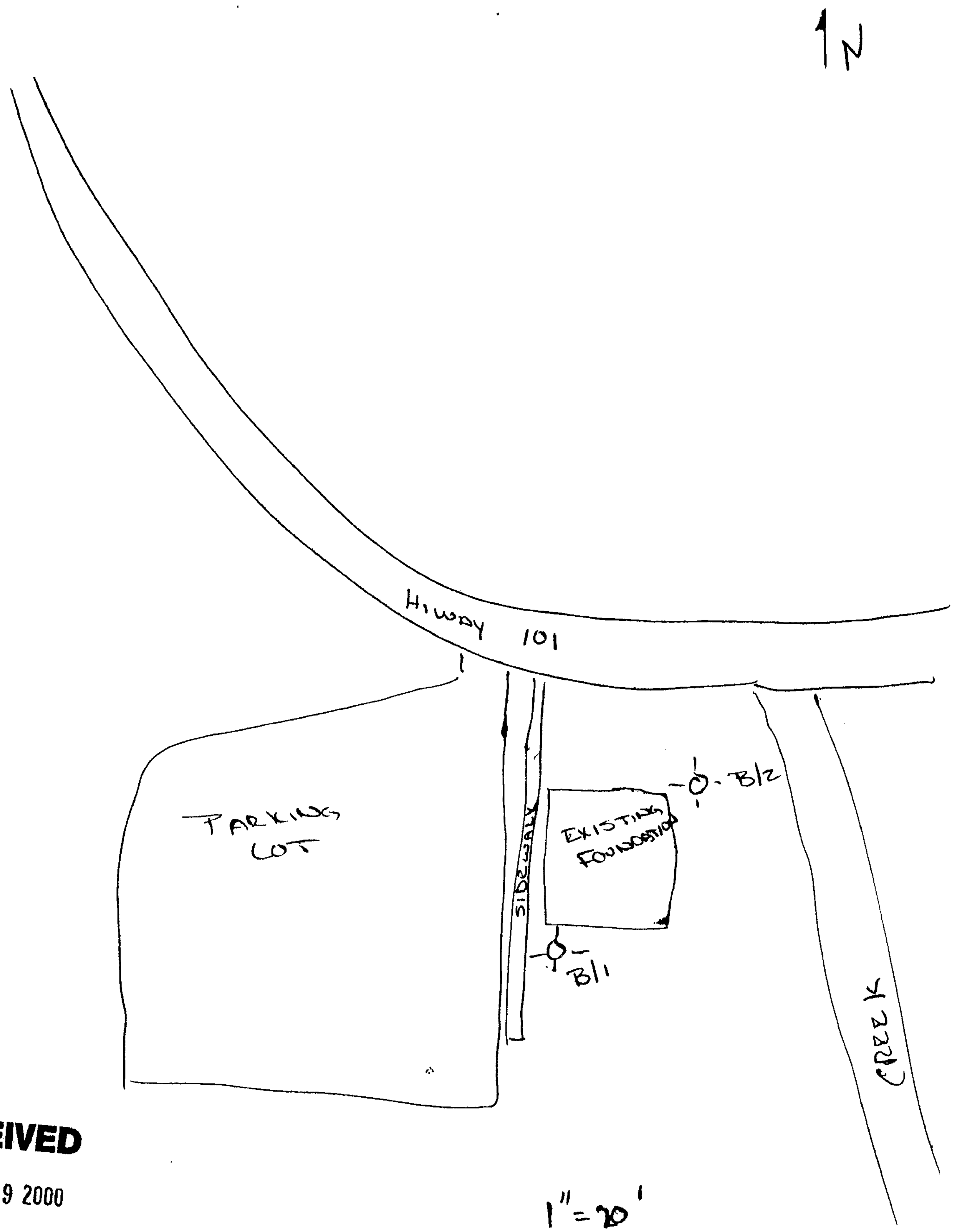
ORIGINAL – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER



RECEIVED

MAR 9 2000

WATER RESOURCES DEPT.
SALEM, OREGON


N
HIWAY 101
PARKING LOT
SIDEWALK
EXISTING FOUNDATION
B/2
B/1
CREEK
1"=20'

TILL 52599

STATE OF OREGON
GEOTECHNICAL HOLE REPORT
(as required by OAR 690-240-0035)

7/28/2016

(1) OWNER/PROJECT

Hole Number B1

PROJECT NAME/NBR: 1-1073/LRL-2015-003

First Name ______ Last Name ______

Company ODOT

Address 350 WEST MARINA DR

City ASTORIA State OR Zip 97103

(2) TYPE OF WORK

[X] New [ ] Deepening [X] Abandonment
[ ] Alteration (repair/recondition)

(3) CONSTRUCTION

[ ] Rotary Air [ ] Hand Auger [ ] Hollow stem auger
[X] Rotary Mud [ ] Cable [ ] Push Probe
[ ] Other ______

(4) TYPE OF HOLE:

(●) Uncased Temporary ( ) Cased Permanent
( ) Uncased Permanent ( ) Slope Stablity
( ) Other
Other: ______

(5) USE OF HOLE

GEOTECHNICAL

(6) BORE HOLE CONSTRUCTION

Special Standard [ ] (Attach copy)

Depth of Completed Hole 70.00 ft.

BORE HOLE			SEAL				
Dia	From	To	Material	From	To	Amt	sacks/ lbs
4	0	70	Bentonite Chips	0	15	2	S
			Bentonite Grout	15	70	2	S
				\			

Backfill placed from ______ ft. to ______ ft. Material ______
Filter pack from ______ ft. to ______ ft. Material ______ Size ______

(7) CASING/SCREEN

Casing	Screen	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd

(8) WELL TESTS

( ) Pump ( ) Bailer ( ) Air ( ) Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration(hr)

Temperature ______ °F Lab analysis [ ] Yes By ______

Supervising Geologist/Engineer ______

Water quality concerns? [ ] Yes (describe below) TDS amount ______

From	To	Description	Amount	Units

(9) LOCATION OF HOLE (legal description)

County TILLAMOOK Twp 3.00 N N/S Range 10.00 W E/W WM

Sec 29 SE 1/4 of the NE 1/4 Tax Lot ROW

Tax Map Number ______ Lot ______

Lat ___° ___' ___" or 45.71921944 DMS or DD

Long ___° ___' ___" or -123.92719444 DMS or DD

( ) Street address of hole (●) Nearest address

36723 PACIFIC COAST SCENIC BYWAY NEHALEM, OR 97131

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Predeepening			[ ]	
Completed Well			[ ]	

Flowing Artesian? [ ]

WATER BEARING ZONES

Depth water was first found ______

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(11) SUBSURFACE LOG

Ground Elevation ______

Material	From	To
Top Soil, Fill - Brown Silt, Rock, Wood	0	30
Brown Silt	30	40
Sand with Wood	40	70

Date Started 7/15/2016 Completed 7/15/2016

(12) ABANDONMENT LOG:

Material	From	To	Amt	sacks/ lbs
Bentonite Chips	0	15	2	S
Bentonite Grout	15	70	2	S

Date Started 7/15/2016 Completed 7/15/2016

Professional Certification (to be signed by an Oregon licensed water or monitoring well constructor, Oregon registered geologist or professional engineer).

I accept responsibility for the construction, deepening, alteration, or abandonment work performed during the construction dates reported above. All work performed during this time is in compliance with Oregon geotechnical hole construction standards. This report is true to the best of my knowledge and belief.

License/Registration Number 1772 Date 7/28/2016

First Name WILLIAM 'BRAD' Last Name WRIGHT

Affiliation WESTERN STATES SOIL CONSERVATION, INC.

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK

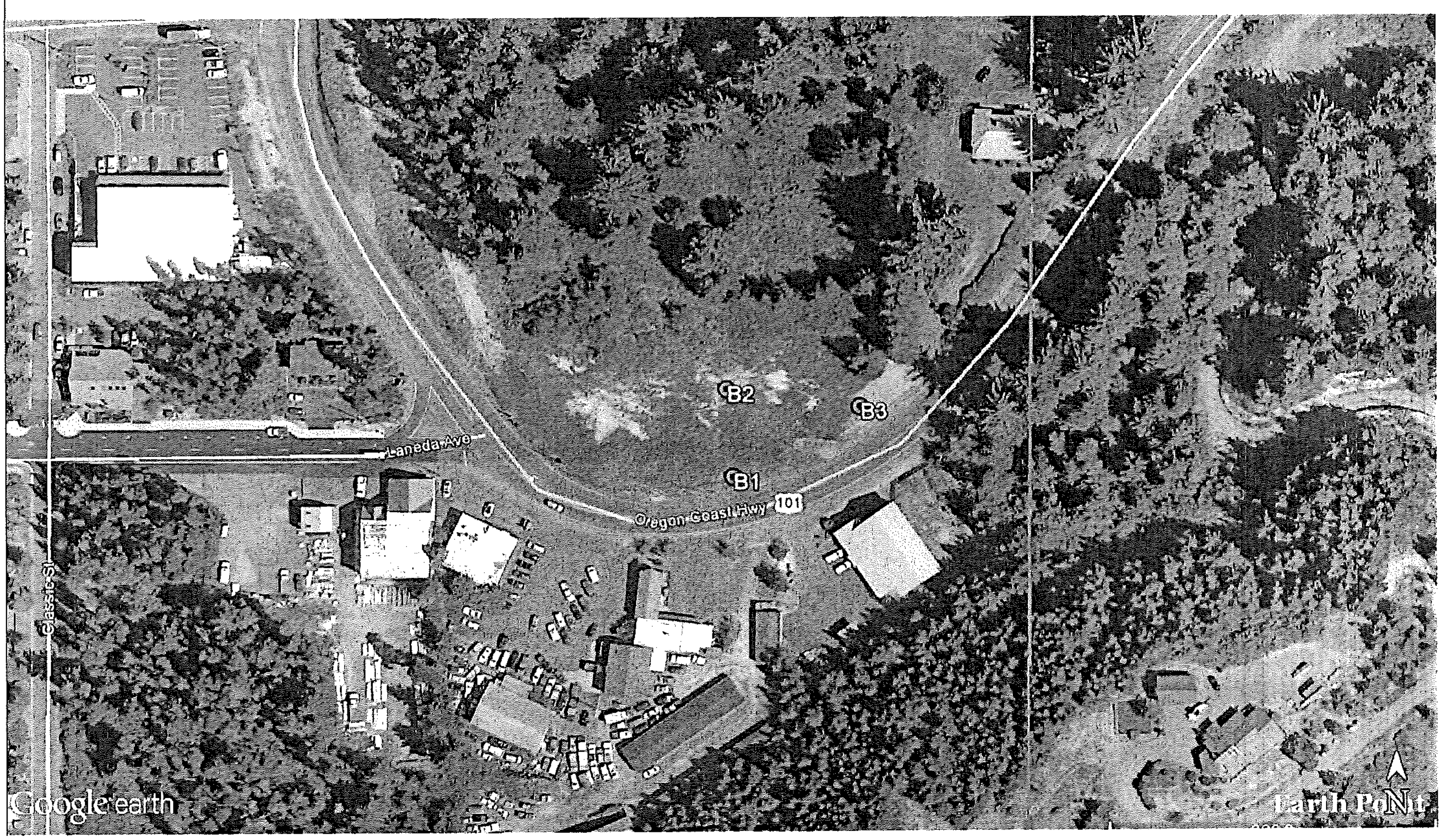
Form Version:

GEOTECHNICAL HOLE REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

TILL 52599

7/28/2016

Map of Hole



TILL 52600

STATE OF OREGON
GEOTECHNICAL HOLE REPORT
(as required by OAR 690-240-0035)

7/28/2016

(1) OWNER/PROJECT

Hole Number: B2

PROJECT NAME/NBR: 1-1073/LRL-2015-003

First Name: Last Name:
Company: ODOT
Address: 350 WEST MARINA DR
City: ASTORIA State: OR Zip: 97103

(2) TYPE OF WORK

[X] New [ ] Deepening [X] Abandonment
[ ] Alteration (repair/recondition)

(3) CONSTRUCTION

[ ] Rotary Air [ ] Hand Auger [ ] Hollow stem auger
[X] Rotary Mud [ ] Cable [ ] Push Probe
[ ] Other

(4) TYPE OF HOLE:

(●) Uncased Temporary ( ) Cased Permanent
( ) Uncased Permanent ( ) Slope Stablity
( ) Other
Other:

(5) USE OF HOLE

GEOTECHNICAL

(6) BORE HOLE CONSTRUCTION

Special Standard [ ] (Attach copy)

Depth of Completed Hole 40.00 ft.

BORE HOLE Dia	From	To	SEAL Material	From	To	Amt	sacks/lbs
4	0	40	Bentonite Chips	0	40	7	S

Backfill placed from ft. to ft. Material
Filter pack from ft. to ft. Material Size

(7) CASING/SCREEN

Casing	Screen	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd

(8) WELL TESTS

( ) Pump ( ) Bailer ( ) Air ( ) Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration(hr)

Temperature °F Lab analysis [ ] Yes By

Supervising Geologist/Engineer

Water quality concerns? [ ] Yes (describe below) TDS amount

From	To	Description	Amount	Units

(9) LOCATION OF HOLE (legal description)

County: TILLAMOOK Twp: 3.00 N N/S Range: 10.00 W E/W WM
Sec: 29 SE 1/4 of the NE 1/4 Tax Lot: ROW
Tax Map Number Lot
Lat ° ' " or 45.71944167 DMS or DD
Long ° ' " or -123.92722222 DMS or DD

( ) Street address of hole (●) Nearest address

36723 PACIFIC COAST SCENIC BYWAY NEHALEM, OR 97131

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Predeepening				
Completed Well				

Flowing Artesian? [ ]

WATER BEARING ZONES

Depth water was first found

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(11) SUBSURFACE LOG

Ground Elevation

Material	From	To
Top Soil	0	2
Brown Silt	2	15
Gray Silty Sand	15	20
Gray Sand, Wood	20	28
Gray Hard Siltstone	28	40

Date Started 7/15/2016 Completed 7/15/2016

(12) ABANDONMENT LOG:

Material	From	To	Amt	sacks/lbs
Bentonite Chips	0	40	7	S

Date Started 7/15/2016 Completed 7/15/2016

Professional Certification (to be signed by an Oregon licensed water or monitoring well constructor, Oregon registered geologist or professional engineer).

I accept responsibility for the construction, deepening, alteration, or abandonment work performed during the construction dates reported above. All work performed during this time is in compliance with Oregon geotechnical hole construction standards. This report is true to the best of my knowledge and belief.

License/Registration Number: 1772 Date: 7/28/2016

First Name: WILLIAM 'BRAD' Last Name: WRIGHT
Affiliation: WESTERN STATES SOIL CONSERVATION, INC.

GEOTECHNICAL HOLE REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

TILL 52600

7/28/2016

Map of Hole

TILL 52601

7/28/2016

STATE OF OREGON
GEOTECHNICAL HOLE REPORT
(as required by OAR 690-240-0035)

(1) OWNER/PROJECT

Hole Number B3

PROJECT NAME/NBR: 1-1073/LRL-2015-003

First Name ______ Last Name ______

Company ODOT

Address 350 WEST MARINA DR

City ASTORIA State OR Zip 97103

(2) TYPE OF WORK

[X] New [ ] Deepening [X] Abandonment
[ ] Alteration (repair/recondition)

(3) CONSTRUCTION

[ ] Rotary Air [ ] Hand Auger [ ] Hollow stem auger
[X] Rotary Mud [ ] Cable [ ] Push Probe
[ ] Other ______

(4) TYPE OF HOLE:

(•) Uncased Temporary ( ) Cased Permanent
( ) Uncased Permanent ( ) Slope Stablity
( ) Other
Other: ______

(5) USE OF HOLE

GEOTECHNICAL

(6) BORE HOLE CONSTRUCTION

Special Standard [ ] (Attach copy)

Depth of Completed Hole 45.00 ft.

BORE HOLE Dia	From	To	SEAL Material	From	To	Amt	sacks/lbs
4	0	45	Bentonite Chips	0	45	7	S

Backfill placed from ______ ft. to ______ ft. Material ______
Filter pack from ______ ft. to ______ ft. Material ______ Size ______

(7) CASING/SCREEN

Casing	Screen	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd

(8) WELL TESTS

( ) Pump ( ) Bailer ( ) Air ( ) Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration(hr)

Temperature ______ °F Lab analysis [ ] Yes By ______

Supervising Geologist/Engineer ______

Water quality concerns? [ ] Yes (describe below) TDS amount ______

From	To	Description	Amount	Units

(9) LOCATION OF HOLE (legal description)

County TILLAMOOK Twp 3.00 N N/S Range 10.00 W E/W WM

Sec 29 SE 1/4 of the NE 1/4 Tax Lot ROW

Tax Map Number ______ Lot ______

Lat ___° ___' ___" or 45.71939722 DMS or DD

Long ___° ___' ___" or -123.92675000 DMS or DD

( ) Street address of hole (•) Nearest address

36723 PACIFIC COAST SCENIC BYWAY NEHALEM, OR 97131

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Predeepening				
Completed Well				

Flowing Artesian? [ ]

WATER BEARING ZONES

Depth water was first found ______

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(11) SUBSURFACE LOG

Ground Elevation ______

Material	From	To
Top Soil	0	2
Brown Silt	2	10
Brown Sand	10	20
Sand, Silt (Wet/Soft)	20	23
Gray Silt	23	27
Gray Siltstone	27	45

Date Started 7/21/2016 Completed 7/21/2016

(12) ABANDONMENT LOG:

Material	From	To	Amt	sacks/lbs
Bentonite Chips	0	45	7	S

Date Started 7/21/2016 Completed 7/21/2016

Professional Certification (to be signed by an Oregon licensed water or monitoring well constructor, Oregon registered geologist or professional engineer)

I accept responsibility for the construction, deepening, alteration, or abandonment work performed during the construction dates reported above. All work performed during this time is in compliance with Oregon geotechnical hole construction standards. This report is true to the best of my knowledge and belief.

License/Registration Number 1772 Date 7/28/2016

First Name WILLIAM 'BRAD' Last Name WRIGHT

Affiliation WESTERN STATES SOIL CONSERVATION, INC.

GEOTECHNICAL HOLE REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

TILL 52601

7/28/2016

Map of Hole

APPENDIX B
STRMDEPL08 Output

```
**************************************************
*                                                *
*         ****  U.S. GEOLOGICAL SURVEY  ****     *
*                                                *
*         *** STRMDEPL08: PROGRAM OUTPUT ***     *
*                                                *
*    ONE-DIMENSIONAL MODEL OF STREAMFLOW DEPLETION  *
*                                                *
*       BY WELLS, BASED ON ANALYTICAL SOLUTIONS  *
*                                                *
*   DEVELOPED BY JENKINS (1968) AND HANTUSH (1965)  *
*                                                *
*   MODIFIED TO INCLUDE HUNT (1999, 2003) SOLUTIONS *
*                                                *
*            VERSION 1.0, JUNE, 2008            *
*                                                *
**************************************************


  Manzanita Emergency Water Supply Well, Scenario 1 Minimum K, Hunt (199


                 SUMMARY OF INPUT DATA
                 ---------------------

   WELL IDENTIFIER:                     Backup Well
   WELL DISTANCE TO STREAM (XWELL):     0.105D+03 feet
   TRANSMISSIVITY:                      0.900D-02 square feet per second
   STORATIVITY:                         0.200D+00
   STREAMBANK CODE (ISOLN):             2 (partially penetrating stream with
resistance, Hunt 1999)
   STREAMBED CONDUCTANCE:               0.230D-03 feet per second
   INITIAL TIME (INTIME):                  0 days
   INITIAL PUMPING RATE (QWINIT):       0.178D+00 cubic feet per second
   NUMBER OF PUMPING STEPS (NPD):         30
   TIME STEP FOR PUMPING  (DELT):       0.100D+01 days


                         RESULTS
                         -------


   STREAMFLOW DEPLETION AT BEGINNING OF ANALYSIS:
              0.0000 cubic feet per second
```

Manz_Sc1_Min K_80 gpm_Hunt 99.out

DAY	PUMPING RATE (cubic feet per second)	STREAMFLOW DEPLETION (cubic feet per second)
---	------------	--------------------
2019010100	0.1780	0.0153
2019010200	0.1780	0.0351
2019010300	0.1780	0.0495
2019010400	0.1780	0.0603
2019010500	0.1780	0.0688
2019010600	0.1780	0.0757
2019010700	0.1780	0.0814
2019010800	0.1780	0.0862
2019010900	0.1780	0.0904
2019011000	0.1780	0.0940
2019011100	0.1780	0.0972
2019011200	0.1780	0.1001
2019011300	0.1780	0.1027
2019011400	0.1780	0.1051
2019011500	0.1780	0.1072
2019011600	0.1780	0.1092
2019011700	0.1780	0.1110
2019011800	0.1780	0.1126
2019011900	0.1780	0.1142
2019012000	0.1780	0.1156
2019012100	0.1780	0.1170
2019012200	0.1780	0.1182
2019012300	0.1780	0.1194
2019012400	0.1780	0.1206
2019012500	0.1780	0.1216
2019012600	0.1780	0.1226
2019012700	0.1780	0.1236
2019012800	0.1780	0.1245
2019012900	0.1780	0.1253
2019013000	0.1780	0.1262

```
 *****************************************************
 *                                                   *
 *          ****  U.S. GEOLOGICAL SURVEY  ****       *
 *                                                   *
 *          *** STRMDEPL08: PROGRAM OUTPUT ***       *
 *                                                   *
 *     ONE-DIMENSIONAL MODEL OF STREAMFLOW DEPLETION *
 *                                                   *
 *        BY WELLS, BASED ON ANALYTICAL SOLUTIONS    *
 *                                                   *
 *    DEVELOPED BY JENKINS (1968) AND HANTUSH (1965) *
 *                                                   *
 *    MODIFIED TO INCLUDE HUNT (1999, 2003) SOLUTIONS *
 *                                                   *
 *             VERSION 1.0, JUNE, 2008              *
 *                                                   *
 *****************************************************


  Manzanita Emergency Water Supply Well, Scenario 2 Minimum K, Hunt (199


                  SUMMARY OF INPUT DATA
                  ---------------------

   WELL IDENTIFIER:                       Backup Well
   WELL DISTANCE TO STREAM (XWELL):       0.105D+03 feet
   TRANSMISSIVITY:                        0.870D-02 square feet per second
   STORATIVITY:                           0.100D-03
   STREAMBANK CODE (ISOLN):               2 (partially penetrating stream with
resistance, Hunt 1999)
   STREAMBED CONDUCTANCE:                 0.140D-03 feet per second
   INITIAL TIME (INTIME):                    0 days
   INITIAL PUMPING RATE (QWINIT):         0.178D+00 cubic feet per second
   NUMBER OF PUMPING STEPS (NPD):           30
   TIME STEP FOR PUMPING  (DELT):         0.100D+01 days


                          RESULTS
                          -------



   STREAMFLOW DEPLETION AT BEGINNING OF ANALYSIS:
             0.0000 cubic feet per second
```

Manz_Sc2_Min K_80 gpm_Hunt 99.out

DAY	PUMPING RATE	STREAMFLOW DEPLETION
	(cubic feet per second)	
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2019010100	0.1780	0.1696
2019010200	0.1780	0.1721
2019010300	0.1780	0.1732
2019010400	0.1780	0.1738
2019010500	0.1780	0.1742
2019010600	0.1780	0.1746
2019010700	0.1780	0.1748
2019010800	0.1780	0.1750
2019010900	0.1780	0.1752
2019011000	0.1780	0.1753
2019011100	0.1780	0.1755
2019011200	0.1780	0.1756
2019011300	0.1780	0.1757
2019011400	0.1780	0.1758
2019011500	0.1780	0.1758
2019011600	0.1780	0.1759
2019011700	0.1780	0.1760
2019011800	0.1780	0.1760
2019011900	0.1780	0.1761
2019012000	0.1780	0.1761
2019012100	0.1780	0.1762
2019012200	0.1780	0.1762
2019012300	0.1780	0.1762
2019012400	0.1780	0.1763
2019012500	0.1780	0.1763
2019012600	0.1780	0.1764
2019012700	0.1780	0.1764
2019012800	0.1780	0.1764
2019012900	0.1780	0.1764
2019013000	0.1780	0.1765

APPENDIX C
Report Limitations and Guidelines for Use

APPENDIX C
REPORT LIMITATIONS AND GUIDELINES FOR USE [1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Hydrogeologic Services Are Performed For Specific Purposes, Persons and Projects

This report has been prepared for use by PACE Engineers, Inc. This report may be made available in its entirety to others for information only. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a hydrogeologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each hydrogeologic study is unique, each hydrogeologic report is unique, prepared solely for the specific client and project site. No one except PACE Engineers, Inc. should rely on this report without first conferring with GeoEngineers. This report should not be applied for any purpose or project except the one originally contemplated.

A Hydrogeologic Report Is Based On a Unique Set of Project-Specific Factors

This report has been prepared for the City of Manzanita's proposed emergency water supply well. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This hydrogeologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

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[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

Most Hydrogeologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

A Hydrogeologic Report Could Be Subject To Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a hydrogeologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or hydrogeology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

GeoEngineers