Streamflow Depletion Analysis

City of Manzanita Water System Manzanita, Oregon

for **PACE Engineers, Inc.** October 8, 2018



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File No. 23092-001-00

October 8, 2018

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GEOLOGIS

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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 § 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:

<u>Scenario 1.</u> 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).

<u>Scenario 2.</u> 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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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	κ _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	т _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	KL	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	
				Review and summary of State of Oregon Water Well Reports for Sections 28 and 29 of Township 3 North and Range 10
Aquifer Thickness	b	feet	30	West.
Transmissivity	TL	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

					Streamflow De	pletion Rate ¹		
Elapsed Time ² Well Pumping Rate			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

					Streamflow De	epletion Rate ¹			
Elapsed Time ²	Well Pum	Well Pumping Rate		Scenario 1 ³			Scenario 2 ⁴		
(days)	(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

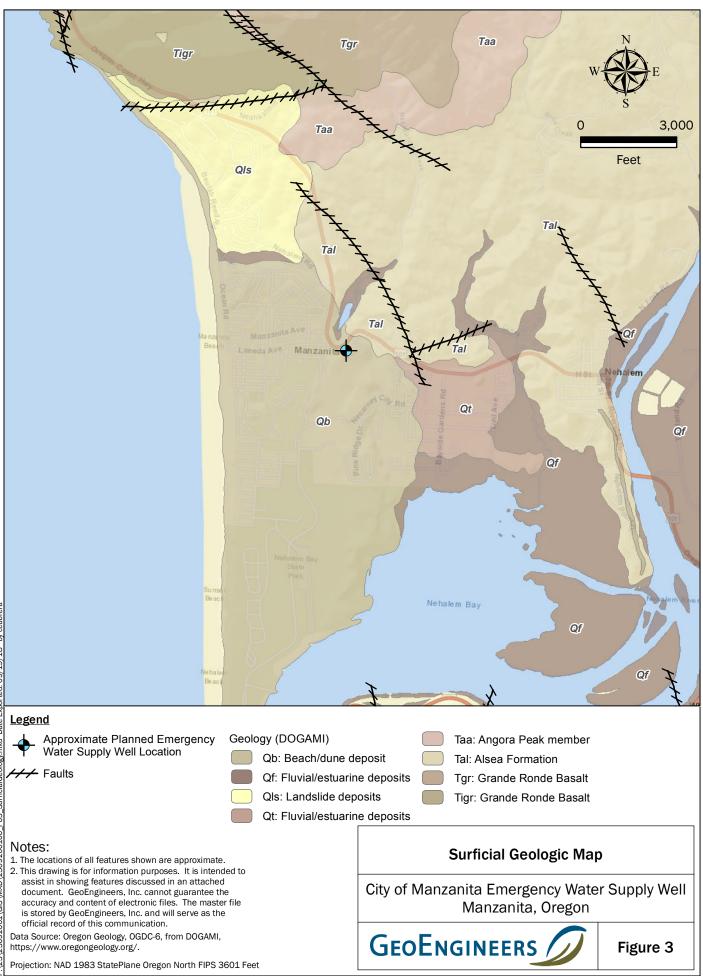


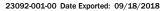


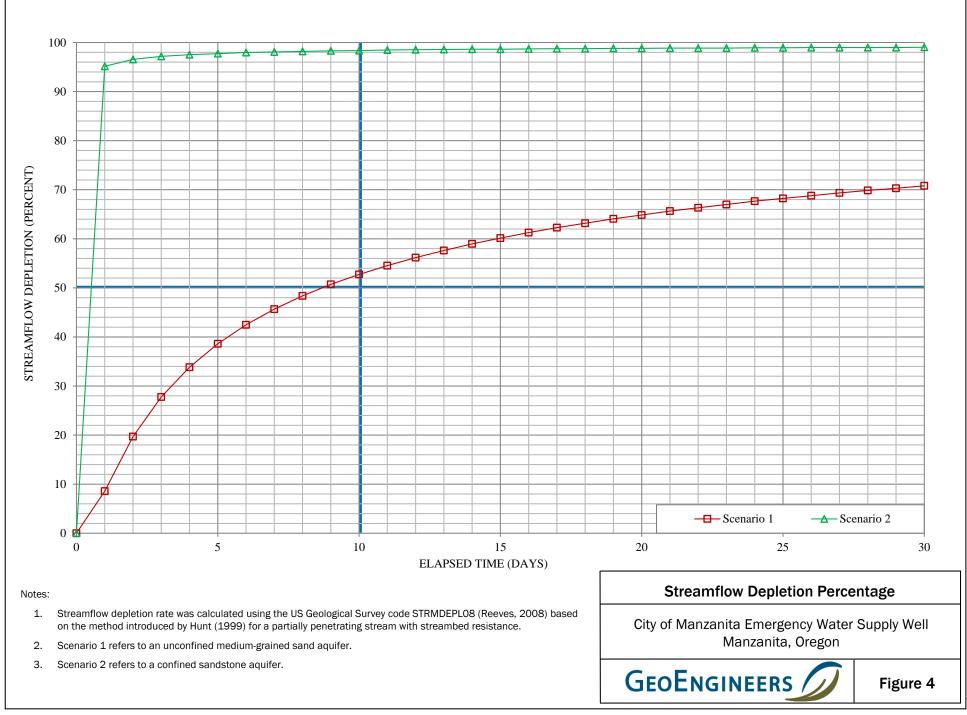




Projection: NAD 1983 StatePlane Oregon North FIPS 3601 Feet









APPENDIX A State of Oregon Geotechnical Hole Reports

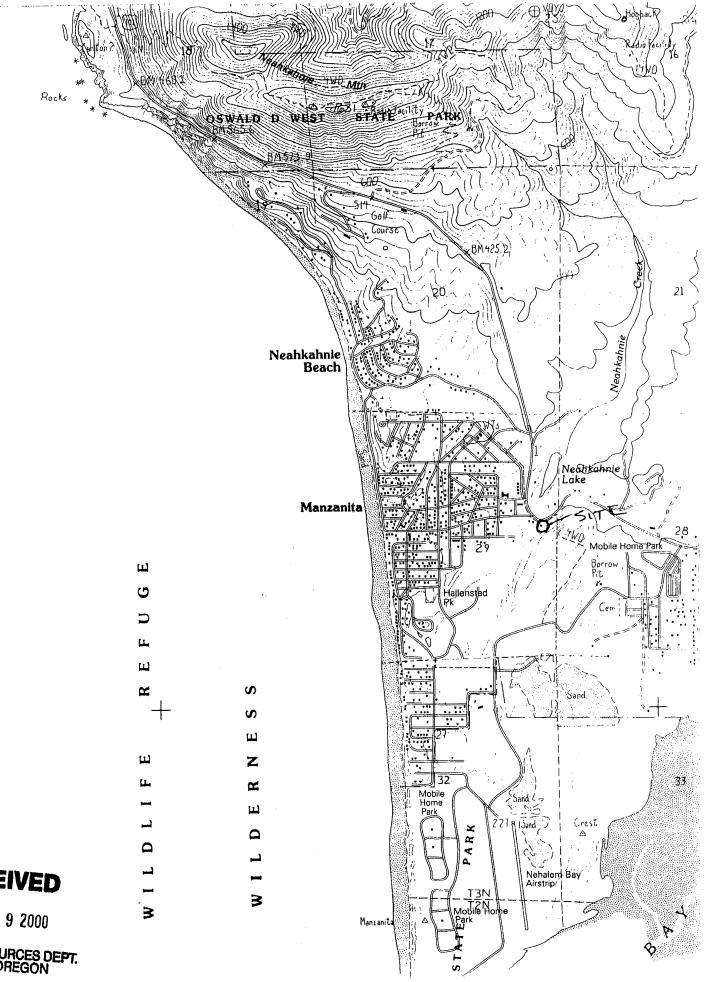
STATE OF OREGON

STATE OF OREGON GEOTECHNICAL HOLE REPORT (as required by OAR 690-240-035) 50693

Name C.	IER/PI	af '	MANZ		<u> </u>			County Thuc				Longity	de	
Address								Townshin 3	Nor	S Range	10	Longiu	E or (W WM
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(2) TYPE									Lot					
New			g 🗌 Alterat	on (repair	/reconditi	ion) 🗔 Ab	andonment		of Well (or nearest					
(3) CONS									in them (of nearest		-1			
Rotary		Hand		Hollow St	em Auger	r						-		
Rotary I							FLIGHT	, Mar	with location is	dentified i	must be	attach	ed	
(4) TYPE							1 -1 -1 -1 -1	(10) STATIC	WATER LEVE					
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· · · · ·								Mat	erial Description			From	То	SWI
(6) BOR	E HO	LE COI	STRUCT	ION:					SAND			0	40	
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•	placed	from	ft. to				- CH162	(12) ABANI	DONMENT LO					
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THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK

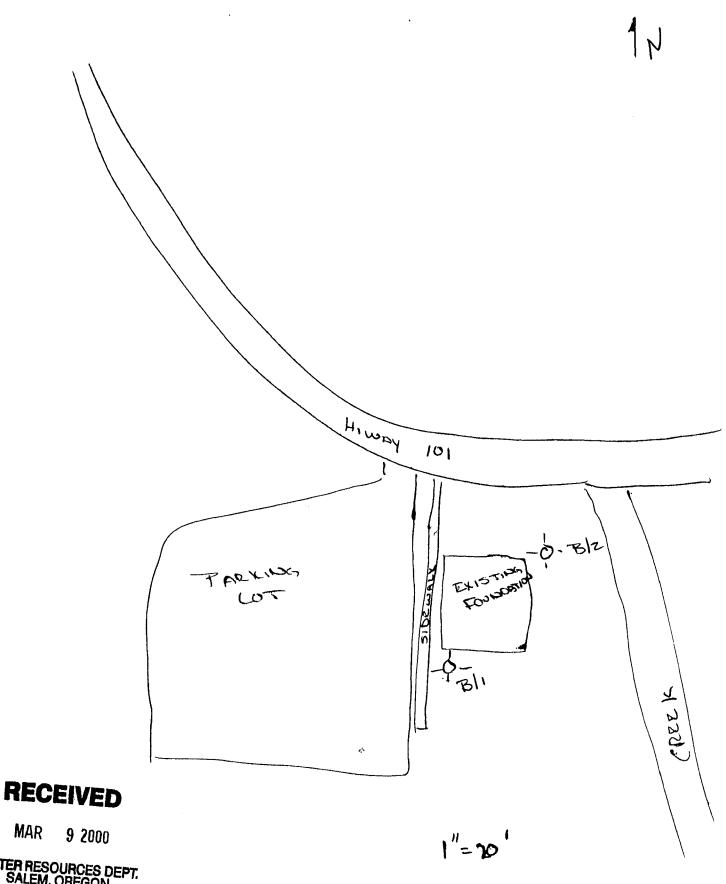
VATER RESOURCES DEPT SALEM, OREGON ORIGINAL – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER



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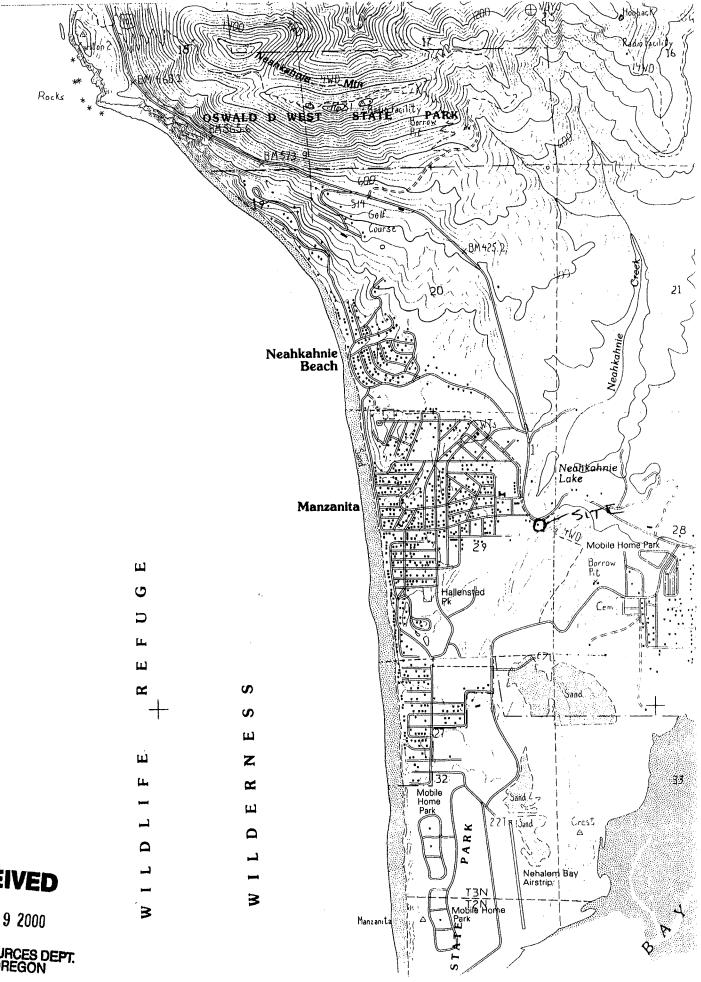
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WATER RESOURCES DEPT. SALEM, OREGON

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

Wet	Address POBOX 129 City MAZAN, TA State OR Zip 97130 (2) TYPE OF WORK	County Illiansey Latitude Longitude Township 3 Nor S Range 10 E or WWM Section 29 SE 1/4 1/4 Tax Lot Lot Block Subdivision
Rotary Atr Had. Ager Hold Stor Ager Rotary Mai Cable Tool Push Probe (Stork Student) (b) TYPE OF HOLE: C. Lock Tool Date (c) TYPE OF HOLE: C. Lock Tool Date (c) Unceased Permanent Stor Store Ible or square inch. Date (c) Unceased Permanent Store OF HOLE: Ground Elevation Date (c) Unceased Permanent Store OF HOLE: Ground Elevation Date (c) Uncease Permanent Store OF HOLE: Ground Elevation (d) BORE HOLE CONSTRUCTION: Secial Construction approval Bayles (Ano Depth of Completed Hole 10 or ft. Secial Construction approval Bayles (Ano Depth of Completed Hole 10 or ft. Store Filter Pack placed from	New Deepening Alteration (repair/recondition) Abandonment (3) CONSTRUCTION: Image: Construction (construction) Construction (const	Street Address of Well (or nearest address)
(i) TYPE OF HOLE: (ii) Startic Willing Construction and personandi is the is in construction and provide with the difference of the construction. Date (iii) Uncased Permanent Stope Stability Others (iii) Startic Willer RecE LOG: Date (iii) Startic Children Stope Stability Others (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece LoG: (iii) Startic Children Startic Children (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece LoG: (iii) Startic Willer Rece Miller Rece Mille	Rotary Air Hand Auger Hollow Stem Auger	
RULLASSA Autority Stope Stability Other (5) Uncased Permanel Stope Stability Other (6) UNCE OF HOLE: (7) CASINGSCREEN: Diameter From To Store: (1) Stability Other (7) CASINGSCREEN: Diameter From To Diameter From To Gauge Steel Prest (8) WELL TEST: O Atter Flowing Antesian (9) WOLL TEST: Print Gauge Steel Prest Charles (9) WELL TEST: O Atter Flowing Antesian From To Stot size O Free Flowing Antesian O Stable reported Z/24/00 Stot size O O Stable reported Charles Atter Stable reported (2) ABANDONMENT LOG: To Stable reported Charles Stable reported Charles Stot size O O Stable reported O Stable reported Stable reported (9) WELL TEST: Orage statistic reported statistics, or orage reported reported above. All work performed work reported reported above.		
United Permanent adde statuty Output (5) USE OF INDLE: Ground Elevation (6) BORE HOLE CONSTRUCTION: Ground Elevation Special Construction approval Elevation Sector (7) CASING/SCREEN: Date Stated Diameter From To Stot size Gauge Steel Platic Weided Threaded (8) WELL TEST: Date Stated Z/24/00 Date stated Z/24/00 Date Completed Z/224/00 Stot size Gow MELL TEST: Date Stated Z/24/00 Date stated Z/24/00 Date Completed Z/224/00 New Well TEST: Prom To Gauge Steel Permeability Phil OPM Profestional Certification Was water analyzed. From ft. to Prof. Profestional Certification dates reported work, and bole centruction states of the based or method work or completed during the construction dates reported work, and bole centruction and the based or method work or completed during the construction dates reported work, and bole centruction and the set of my throwledge and belief. New water analyzed. From ft. to ft. to ft. to Part Certification ft. to ft. to ft. to		
(a) DB OF HOLE. Ground Elevation (b) BORE HOLE CONSTRUCTION: Ground Elevation Special Construction approval BVes (ZNo Depth of Completed Hole 40 ft.) Material Description Diameter From To Material Prom S ¹ O 40 East Chross Science S ² O 40 East Chross Science Size of pack Material Description Prom Diameter From To Gauge Steel Platic Weided Threaded Casing: Diameter From To Gauge Steel Platic Weided Threaded Screen: Diameter From To Gauge Steel Platic Weided Threaded Screen: Diameter Chrons To Gauge Steel Platic Weided Threaded Screen: Diameter Chrons To Gauge Steel Platic Weided Threaded Screen: Dinto Steel Chrons To Gauge Steel <td< td=""><td></td><td></td></td<>		
GNOTER (6) BORE HOLE CONSTRUCTION: Special Construction approval By Yes (No Depth of Completed Hole 10 ft. Diameter From To (6) BORE HOLE CONSTRUCTION: Special Construction approval By Yes (No Depth of Completed Hole 10 ft. (6) BORE HOLE CONSTRUCTION: Special Construction approval By Yes (No Depth of Completed Hole 10 ft. (7) CASING/SCREEN: Diameter From To Gauge Steel Diameter From To Gauge Steel (8) WELLTEST Porm Baller (8) WELLTEST Prom (9) WELLTEST (9) WELLTEST (10) No Pricesional Certification (10) Astard analyzed. From (11) No (12) ABANDONMENT LOG: Treaction (12) ABANDONMENT LOG: Date started (12) ABANDONMENT LOG: Date started Conductivity (13) MELLTEST (14) No Mether (15) No (16) WELLTEST (17) No (18) Wether (18) Wether (19) No <		
6) BORE HOLE CONSTRUCTION: Special Construction approval Eyes (2/No Depth of Completed Hole 4/O, f., HOLE Diameter From To Seckil placed from 0, fl, to 40, fl, Material Exerct 1/O, fl, Size of pack (7) CASING/SCREEN: Diameter From To Size	NEOTTCH	
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Special Construction approval By Yes (2) No Depth of Completed Hole=0 ft. HOLE SEAL Diameter From To Material Prom To Backfill placed from	(6) BORE HOLE CONSTRUCTION:	BROWN GAND 0 40
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Distribution ft. Size of pack Filter Pack placed from ft. Size of pack O' CASING/SCREEN: Material Description From To SacBor Pour Oisameter From To Gauge Steel Plastic Welded Threaded Casing: Image: Image: <thimage:< th=""></thimage:<>		Date Started Date completes
Casing:		
Slot size		
Slot size		
Pump Bailer Air Flowing Artesian PermeabilityYieldGPM GPM (to be signed by a licensed water supply or monitoring well constructor, or Ore registered geologist or civil engineer). ConductivityPH F/C Perthermatical flow foundft. Temperature of waterPF/C Perthermatical flow foundft. I accept responsibility for the construction dates reported above. All 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. By whom?No ft. toft. License or Registration Number 10.45 Remarks: Signed WatureDate Z/ZS MAR 9 2000 Affiliation SEE		Date started 22400 Date Completed 22400
PermeabilityYieldGPM GPM ConductivityPH PH		Professional Certification
Temperature of water PF/C Pepth artesian flow foundft. Temperature of water PF/C Pepth artesian flow foundft. Was water analysis done? No Phase and the second and the second actor reported above. All 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. By whom?	PermeabilityYield GPM	registered geologist or civil engineer).
Temperature of water		I accept responsibility for the construction, alteration, or abandonment work
Was water analysis done? Image: Constraint of the set of my knowledge and belief. By whom?		performed during the construction dates reported above. All work performed
By whom? Image: Constraint of the cons	Was water analysis done?	standards. This report is true to the best of my knowledge and belief.
RECEIVED Signed Warm Cum Date Z/25 MAR 9 2000	By whom?	1045
MAR 9 2000		
MAR 9 2000	Remarks:	Signed Date Z/25
	RECEIVED	Affiliation USE
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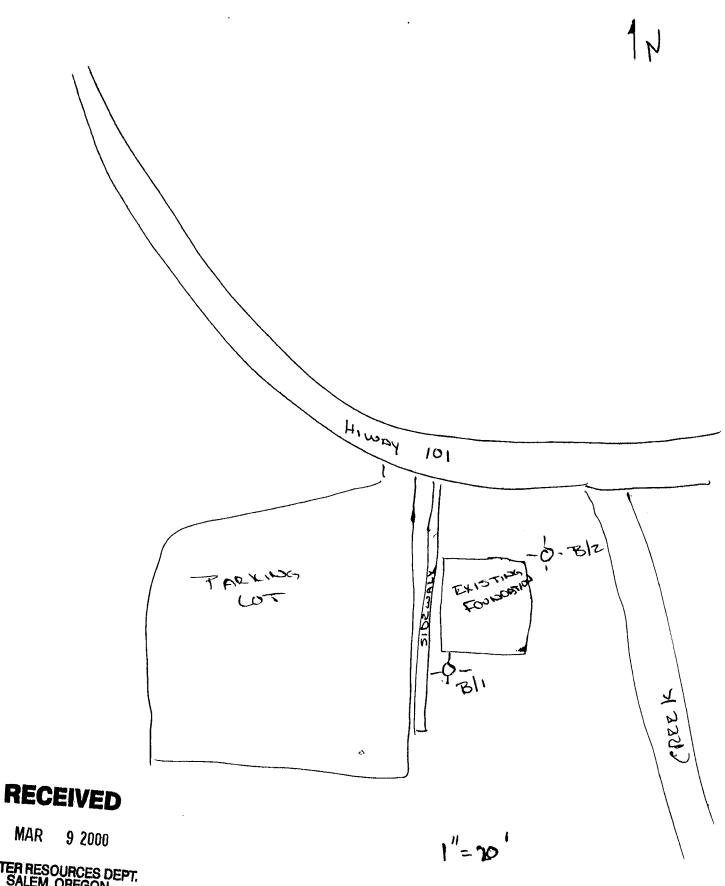
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WATER RESOURCES DEPT. SALEM, OREGON



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WATER RESOURCES DEPT. SALEM, OREGON

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TILL 52599

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

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7/28/2016

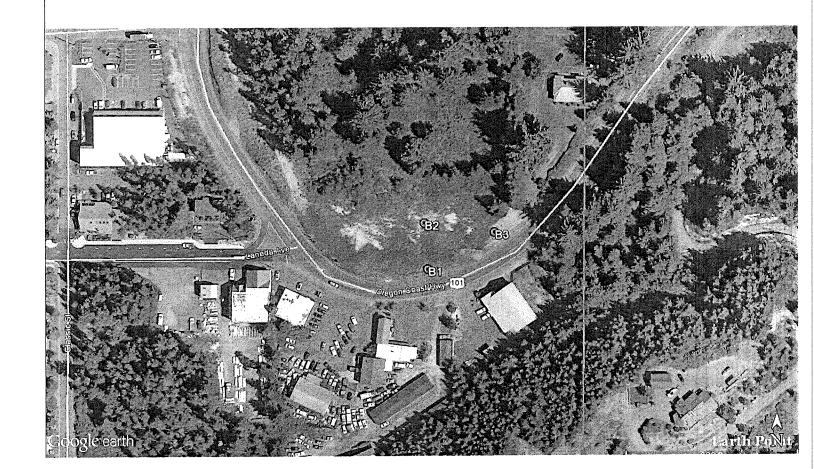
(1) OWNER/PROJECT Hole Number <u>B1</u>	
PROJECT NAME/NBR: 1-1073/LRL-2015-003	(9) LOCATION OF HOLE (legal description)
First Name Last Name	County <u>TILLAMOOK</u> Twp 3.00 N N/S Range 10.00 W E/W WM
Company ODOT	Sec 29 SE 1/4 of the NE 1/4 Tax Lot ROW
Address 350 WEST MARINA DR	Tax Map Number Lot Lat ° " or 45.71921944 DMS or DD
City ASTORIA State OR Zip 97103	Lat 01 43.71921944
(2) TYPE OF WORK X New Deepening X Abandonment	Long ' ' or123.92719444 DMS or DD
	36723 PACIFIC COAST SCENIC BYWAY NEHALEM, OR 97131
Alteration (repair/recondition)	
(3) CONSTRUCTION	(10) STATIC WATER LEVEL
Rotary Air Hand Auger Hollow stem auger	Date SWL(psi) + SWL(ft)
Rotary Mud Cable Push Probe	Existing Well / Predeepening
Other	Flowing Artesian?
(4) TYPE OF HOLE:	WATER BEARING ZONES Depth water was first found
	SWL Date From To Est Flow SWL(psi) + SWL(ft)
Uncased Temporary OCased Permanent	
OUncased Permanent OSlope Stablity	
Other	
Other:	
(5) USE OF HOLE	(11) SUBSURFACE LOG Ground Elevation
	Material From To
GEOTECHNICAL	Top Soil, Fill - Brown Silt, Rock, Wood 0 30
	Brown Silt 30 40
	Sand with Wood 40 70
(6) BORE HOLE CONSTRUCTION Special Standard Attach copy	
Depth of Completed Hole 70.00 ft. BORE HOLE SEAL sacks/	
Dia From To Material From To Amt Ibs	
4 0 70 Bentonite Chips 0 15 2 S	
Bentonite Grout 15 70 2 S	
	Date Started 7/15/2016 Completed 7/15/2016
Backfill placed from ft. to ft. Material	(12) ABANDONMENT LOG:
Filter pack from ft. to ft. Material Size	sacks/
	Material From To Amt Ibs Bentonite Chips 0 15 2 S
(7) CASING/SCREEN	Bentonite Grout 15 70 2 S
Casing Screen Dia + From To Gauge Stl Plstc Wld Thrd	
(8) WELL TESTS	Date Started 7/15/2016 Completed 7/15/2016
O Pump O Bailer O Air O Flowing Artesian	Date Started <u>7/15/2016</u>
Yield gal/min Drawdown Drill stem/Pump depth Duration(hr)	Professional Certification (to be signed by an Oregon licensed water or
	monitoring well constructor, Oregon registered geologist or professional engineer).
Temperature °F Lab analysis Yes By	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
Supervising Geologist/Engineer	- standards. This report is true to the best of my knowledge and belief.
Water quality concerns? Yes (describe below) TDS amount From To Description Amount Units	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:

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

Map of Hole



TILL 52599

7/28/2016

TILL 52600

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

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7/28/2016

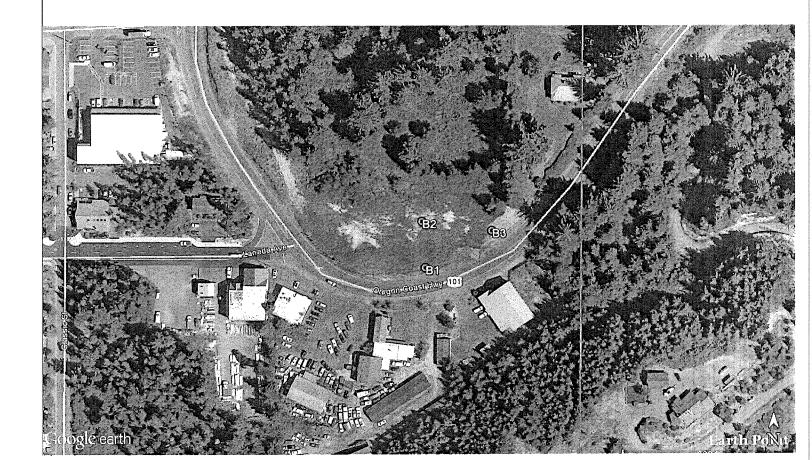
(1) OWNERPROJECT Note Norther B2 PROJECT NAME/INJRL2015400		
Constant Constant <td< th=""><th>(1) OWNER/PROJECT Hole Number <u>B2</u></th><th></th></td<>	(1) OWNER/PROJECT Hole Number <u>B2</u>	
High Name	PROJECT NAME/NBR: 1-1073/LRL-2015-003	
Company GOLT Size 23 SE 112 of the NB In the ND City ASTORIA Size 0R Zip 9710.3 DMS or DD City ASTORIA Size 0R Zip 9710.3 DMS or DD City ASTORIA Size 0R Zip 9710.3 DMS or DD City ASTORIA Size 0R Zip 9710.3 DMS or DD City ASTORIA Illeration (repair/recondition) Size 23 Size 212222 DMS or DD City ASTORIA Illeration (repair/recondition) Size 23 Size 127232722222 DMS or DD Construction Alteration (repair/recondition) Size 23 Size 1272372722222 DMS or DD Size Construction Hollow stein sager Size 23 Size 127237272222 DMS or DD Coher Holey Size 24 Size 127237272222 DMS or DD Size 23 Size 127237272222 Coher Deat Swillpin Size 24 Size 12723727272727 DMS or DD Coher Deat Swillpin Coher Size 24 Size 127237272727 DMS or DD Coher Deat Swillpin Size 24 Size 127237272 DMS or DD Size 127237272727 Coher Difference Coher Difference Coher Differencoher Coh	First Name Last Name	County TILLAMOOK Twp 3.00 N N/S Range 10.00 W E/W WM
Address Site OR Zip Total (S) Distribution (equiviex condition) City ASTORIA Site OR Total (S) Distribution (equiviex condition) City Alteration (equiviex condition) Site ONE Distribution (equiviex condition) City Alteration (equiviex condition) Site One Distribution (equiviex condition) City Alteration (equiviex condition) Site Distribution (equiviex condition) City Alteration (equiviex condition) Site Distribution (equiviex condition) City Condition Condition Site Site Oher Oher Distribution Site Site City Unseed Tempony Cased Permanent Dispose Site Dispose Site Other Oher Tot Site Site City Site Condition Site Site City Site Site Site Site City Site Site Site Site Dispose Site Condition Site Site Site		Sec 29 SE 1/4 of the NE 1/4 Tax Lot ROW
City ASTORIA Suite OR Zip 97103 City ASTORIA Suite OR Zip 97103 City TYPE OF WORK X Weet Construction (transition (transitant)))))))))))))))))))))))))))))))))))	Address 350 WEST MARINA DR	Lat ° ' OF 45 71044167 DMS of DD
(2) TYPE OF WORK New		Long OF OF DMS or DD
(a) CONSTRUCTION (b) CONSTRUCTION (c) Rotary Air (c) Rotary Air (c) NONTRUCTION (c) Rotary Air (c) TYPE OF HOLE: (c) Uncased Permanent (c) BORE HOLE (c) BORE HOLE (c) BORE HOLE (c) Permition (C) In (c) CasingGesCREEN (c) Permit	(2) TVPE OF WORK New Deepening Abandonment	Street address of hole (Nearest address
(3) CONSTRUCTION Rotary Mut Hollow sitem auger Rotary Mut Cable Other Date SWL/pei + SWL/(1) External Wall Prodepenning Other Divesced Temponary Other Stope Stabilay Other Other (5) USE OF HOLE Stope Stabilay (6) BORE HOLE CONSTRUCTION Special Standard Attuent copy (7) CASING/SCREEN SEAL Packfil plexed from ft. Material (7) CASING/SCREEN State Yish galment Dire description Yish galment Dire description Yish galment The mark manual description Yish galment The mark manual description Yish galment Dire description Yish galment <td< td=""><td></td><td></td></td<>		
Notary Air Baland Auger Plob/set marger (4) TYPE OF HOLE: (b) Uncased Temporary Caced Permanent (b) Uncased Temporary Caced Permanent (c) USE OF HOLE (c) Deter CHNICAL (c) Deter TechNICAL (c) BORE HOLE CONSTRUCTION Special Standard Attract a From To a from <td< td=""><td></td><td></td></td<>		
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Onler		
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Other	\mathbf{O}	
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(a) (b) (c) (Casing Screen Dia + From To Gauge Stl Plstc Wld Thrd	
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Pump Bailer Air Flowing Artesian Yield gal/min Drawdown Drill stem/Pump depth Duration(hr)		
Pump Bailer Air Flowing Artesian Yield gal/min Drawdown Drill stem/Pump depth Duration(hr)		
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Pump Bailer Air Flowing Artesian Yield gal/min Drawdown Drill stem/Pump depth Duration(hr)		
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monitoring well constructor, Oregon registered geologist or professional engineer). Temperature °F Lab analysis Yes By Supervising Geologist/Engineer	Yield gal/min Drawdown Drill stem/Pump depth Duration(hr)	Professional Certification (to be signed by an Oregon heensed water or
Temperature °F Lab analysis Yes By Supervising Geologist/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. Water quality concerns? Yes (describe below) TDS amount From To Description Amount Units First Name WILLIAM 'BRAD' Last Name WRIGHT		
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Water quality concerns? Yes (describe below) TDS amount standards. This report is the to the best of the		during this time is in compliance with Oregon geotechnical hole construction
From To Description Amount Units License/Registration Number 1772 Date 7/28/2016 First Name WILLIAM 'BRAD' Last Name WRIGHT		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

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 52600

7/28/2016

Map of Hole



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

TILL 52601

7/28/2016

(1) OWNER/PROJECT Hole Number B3	
PROJECT NAME/NBR: 1-1073/LRL-2015-003	(9) LOCATION OF HOLE (legal description)
First Name Last Name	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
Company ODOT	Sec 29 SE 1/4 of the NE 1/4 Tax Lot ROW Tax Map Number Lot Lot
Address 350 WEST MARINA DR	Lat ° ′ ″ or 45.71939722 DMS or DD
City ASTORIA State OR Zip 97103	Long " or -123.92675000 DMS or DD
(2) TYPE OF WORK 🗙 New Deepening 🗙 Abandonment	Street address of hole Nearest address
Alteration (repair/recondition)	36723 PACIFIC COAST SCENIC BYWAY NEHALEM, OR 97131
(3) CONSTRUCTION Rotary Air Hand Auger Hollow stem auger Rotary Mud Cable Push Probe	(10) STATIC WATER LEVEL Date SWL(psi) + SWL(ft)
Other	Existing Well / Predeepening Completed Well
(4) TYPE OF HOLE:	WATER BEARING ZONES Flowing Artesian? Depth water was first found
	SWL Date From To Est Flow SWL(psi) + SWL(ft)
Uncased Temporary Cased Permanent Ouncased Permanent Slope Stablity	
Other	
Other:	
(5) USE OF HOLE	(11) SUBSURFACE LOG Ground Elevation
	Material From To
GEOTECHNICAL	Top Soil 0 2
	Brown Silt 2 10
	Brown Sand 10 20 Sand, Silt (Wet/Soft) 20 23
(C) PODE HOLE CONSTRUCTION Gradied The Los	
(6) BORE HOLE CONSTRUCTION Special Standard Attach copy Depth of Completed Hole 45.00 ft.	Gray Siltstone 27 45
BORE HOLE SEAL sacks/	
Dia From To Material From To Amt Ibs	
4 0 45 Bentonite Chips 0 45 7 S	
	Date Started 7/21/2016 Completed 7/21/2016
Backfill placed from ft. to ft. Material	(12) ABANDONMENT LOG:
Filter pack from fl. to fl. Material Size	sacks/ Material From To Amt Ibs
(7) CASING/SCREEN	Bentonite Chips 0 45 7 S
Casing Screen Dia + From To Gauge Stl Plstc Wld Thrd	
70X W/ELL TESTS	
(8) WELL TESTS	Date Started 7/21/2016 Completed 7/21/2016
Yield gal/min Drawdown Drill stem/Pump depth Duration(hr)	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
Temperature °F Lab analysis Yes By	work performed during the construction dates reported above. All work performed
Supervising Geologist/Engineer	during this time is in compliance with Oregon geotechnical hole construction standards. This report is true to the best of my knowledge and belief.
Water quality concerns? Yes (describe below) TDS amount	•
From To Description Amount Units	License/Registration Number 1772 Date 7/28/2016
	First Name WILLIAM 'BRAD' Last Name WRIGHT
	Affiliation WESTERN STATES SOIL CONSERVATION, INC.

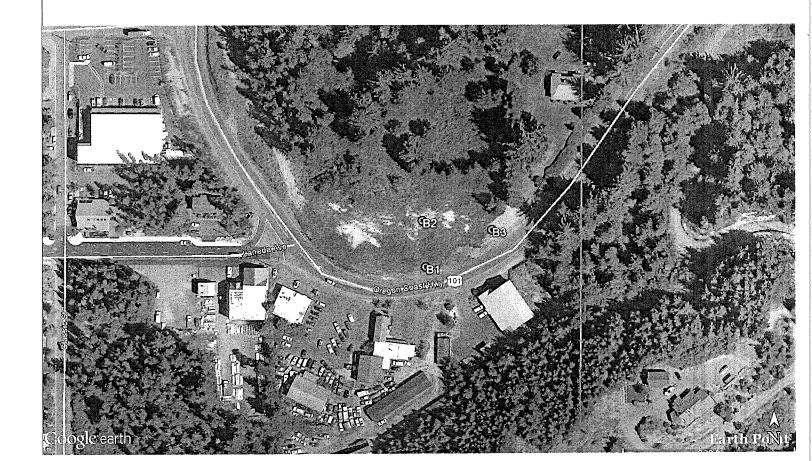
ORIGINAL - WATER RESOURCES DEPARTMENT THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

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

TILL 52601

7/28/2016

Map of Hole



APPENDIX B STRMDEPL08 Output

Manz_Sc1_Min K_80 gpm_Hunt 99.out

*****	****
*	*
* **** U.S. GEOLOGICAL SURVEY ****	*
*	*
* *** STRMDEPL08: PROGRAM OUTPUT ***	*
*	*
* ONE-DIMENSIONAL MODEL OF STREAMFLOW DEPLETIO	N *
*	*
* BY WELLS, BASED ON ANALYTICAL SOLUTIONS	*
*	*
* DEVELOPED BY JENKINS (1968) AND HANTUSH (1965) *
*	*
* MODIFIED TO INCLUDE HUNT (1999, 2003) SOLUTIO	NS *
*	*
* 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

	PUMPING RATE	STREAMFLOW DEPLETION
DAY	(cubic	feet per second)
 2019010100	0.1780	0.0153
2019010100	0.1780	0.0351
2019010200	0.1780	0.0495
2019010300	0.1780	0.0603
2019010400	0.1780	0.0688
2019010500	0.1780	0.0757
2019010000	0.1780	0.0814
2019010700	0.1780	0.0862
2019010900	0.1780	0.0904
2019010900	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

Manz_Sc2_Min K_80 gpm_Hunt 99.out

*		*
*	**** 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	k
*		*

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

DAV		STREAMFLOW DEPLETION
DAY	(CUD1C	feet per second)
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.

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.



