Water Solutions, Inc.

Technical Memorandum

To: Darvin Tramel – City of Canby

From: Matt Kohlbecker, RG – GSI Water Solutions
Ari Petrides, PhD – GSI Water Solutions

Cc: Gordon Munro, PE – Kennedy Jenks Consultants
Alan Flemming – Kennedy/Jenks Consultants

Date: August 29, 2013

Re: **Groundwater Protectiveness Demonstrations and Risk Prioritization for Underground Injection Control (UIC) Devices, City of Canby, Oregon**

This technical memorandum (TM) presents a Groundwater Protectiveness Demonstration (GWPD) for Underground Injection Control (UIC) devices in the City of Canby (City), Oregon (Figure 1). The GWPD was conducted to support the City's 2013 Stormwater Master Plan and UIC Water Pollution Control Facilities (WPCF) permit application.

1. Introduction

A UIC is device that infiltrates fluids into the subsurface. The City of Canby (City) owns 384 UIC devices that manage stormwater mainly from public rights-of-way (ROW) and adjacent properties in residential areas. The UICs are typically 4-foot diameter vertical structures that range from approximately 26 to 28 feet deep. The locations of the City's UICs are shown in Figure 2.

UICs are regulated by the Oregon Department of Environmental Quality (DEQ). Because the City's UICs infiltrate only stormwater from residential, commercial, and roadway areas, DEQ considers them to be Class V injection systems and regulates them under Oregon Administrative Rules (OAR) 340-044-0011(5)(d). The City applied for a UIC WPCF permit (the permit) for its UICs on December 30, 2008. In July 2012, DEQ issued a draft UIC WPCF permit template (the permit template) that will be used as the basis for developing the City's permit, which the City expects to receive in the fall of 2013.

The permit is designed to protect groundwater to its highest beneficial use. As such, the permit template stipulates that the City address UICs that are within 500 feet of a public drinking water or irrigation supply well, or inside the 2-year time of travel of a public water supply well.

Options for addressing these UICs include developing a GWPD, retrofit the UIC, or decommission the UIC. A GWPD is an evaluation of whether beneficial use of groundwater is adversely impacted by stormwater pollutants as a result of infiltration. The City has chosen to develop GWPD models to identify which UICs are protective of groundwater, and to prioritize future UIC decommissioning and retrofitting based on the GWPD and other considerations (i.e., UIC functionality and other risk factors). This TM summarizes the GWPD models, which simulate attenuation of stormwater pollutants in the subsurface (i.e., after infiltration from a UIC). Two GWPDs were conducted:

- **Unsaturated Zone GWPD**. Unsaturated zone GWPDs are based on modeling pollutant fate and transport *vertically* through the *unsaturated* soils beneath a UIC. The objective of the unsaturated zone GWPD is to calculate the vertical distance required for pollutants to attenuate to background levels (which is considered to be the method reporting limit [MRL]), called the vertical protective separation distance. If the vertical separation distance at a UIC is greater than the protective separation distance, then the UIC is demonstrated to be protective and does not need to be retrofit or decommissioned. If the vertical separation distance at a UIC is less than the protective separation distance, then groundwater protectiveness must be demonstrated using a different method, the UIC must be retrofit, or the UIC must be decommissioned.

- **Saturated Zone GWPD.** A saturated zone GWPD consists of modeling *horizontal* pollutant fate and transport through *saturated* soils. The model is used to demonstrate that that the UIC does not adversely impact groundwater users by delineating a waste management area (WMA) around the UIC. A WMA is the "area where waste or material that could become waste if released to the environment, is located or has been located" [OAR 340-040-0010(19)]. In the context of stormwater infiltration from a UIC, the WMA is the location where groundwater contains stormwater pollutants above background levels. The objective of the saturated zone GWPD is to calculate the horizontal distance required for pollutant concentrations to decline to zero. This horizontal distance replaces the default horizontal separation distance in the permit template (i.e., 500 feet or 2-year time of travel).

GWPDs have been conducted by several municipalities in Oregon, including the Cities of Gresham, Portland, Bend, Redmond, Eugene, and Milwaukie; Clackamas County Water Environment Services; and Lane County. Results of the GWPD models apply to stormwater with pollutant concentrations typical of stormwater runoff from urban ROWs, and do not apply to releases of pollutants to the environment (i.e., spills). The model results will be considered along with other relevant to groundwater protectiveness factors, permit requirements, and the City's goals and policies to develop a strategy for addressing the City of Canby's UICs.

1.1 Objectives

The objectives of this TM are:

- Locate water wells in the City, and the number of UICs that are within the default setbacks to water wells that are specified within the permit template (500 feet of a water well or the 2-year time of travel).

- Determine the depth to seasonal high groundwater in the City, and UICs that intersect the seasonal high water table.

- Present technical documentation for the unsaturated zone and saturated zone GWPD models, and identify the protective vertical and horizontal separation distances for the City's UICs.
- Identify whether each UIC is protective of groundwater, based on the protective separation distances calculated by the GWPD models and the City's internal risk management goals.

The main text of this TM provides an overview of the UIC system and GWPD models. Additional technical details are provided in Attachment A (technical documentation for determining depth to seasonal high groundwater and water well locations), Attachment B (technical documentation for the unsaturated zone GWPD model), and Attachment C (technical documentation for the saturated zone GWPD model).

2. Geology and Hydrogeology

Input parameters for the GWPD models are based on the physical characteristics of the soils in Canby. This section summarizes the geologic and hydrogeologic characteristics of the soils with the objective of informing model input parameters.

2.1 Geology

The City's UICs are located in the coarse-grained facies of the catastrophic flood deposits (unit Qfc), shown on the geologic map in Figure 2. Locally, the Qfc is identified as the Canby fan by Piper (1942). The Canby fan is an alluvial fan originating from an erosional gap near the City of Oregon City. During the catastrophic floods that occurred approximately 13,000 to 15,000 years ago, a flow restriction downstream of the current location of the City of Portland caused floodwaters to backflow south into the Willamette Valley and spill southward into Canby and Wilsonville (O'Conner et al., 2001).

Locally, the Qfc consists of an up to 120 feet thick bouldery, sandy gravel that is capped with several feet of sand and silt (O'Conner et al., 2001). Shallow (i.e., approximately 20 feet deep) borings advanced as a part of geotechnical investigations in Canby indicate that the shallow unsaturated zone ranges from a coarse gravel with trace silt and sand to a silty, sandy gravel (Northwest Geotech, 2006a, 2006b, 2006c; Geotech Solutions, 2004; GeoDesign, 2007). Interbedded silty, sandy gravel lenses are noted within the coarse gravels in some of the shallow logs (GeoDesign, 2007). Well driller logs for monitoring wells and geotechnical holes indicate that below 20 feet, the unsaturated zone is primarily sand and gravel with layers of "gravelly silts" (CLAC 57878) and "clay layers" (CLAC 1529) (note that the "clays" on well driller logs are most likely silts because there are few true clays in the Portland basin, and silts are easily mistaken for clays).

2.2 Hydrogeology

A map showing groundwater elevation in the Qfc unit is provided in Figure 3. Groundwater flows toward the Willamette and Molalla Rivers, and away from topographic highs in the east and north areas of town. A map of depth to seasonal high groundwater, which is used for evaluating whether a UIC has sufficient protective vertical separation distance, is provided in Figure 4.

Technical documentation for development of the water level maps is provided in Attachment A. Hydrogeologic properties of unsaturated zone and saturated zone soils are summarized in Table 1 (unsaturated zone) and Table 4 (saturated zone), and are discussed in detail in Attachment B (unsaturated zone soils) and Attachment C (saturated zone soils).

3. Water Well Locations and Setbacks Between UICs and Water Wells

Water wells in the City were located based on the Oregon Water Resources Department (OWRD) online water rights database and the OWRD online well log query. A UIC and water well location map is provided in Figure 5. Technical documentation of the methods used to located water wells is provided in Attachment A.

Based on the permit template, UICs within 500 feet of a water well or the 2-year time of travel must be addressed with a GWPD, be retrofit, or be decommissioned. The 2-year time-of-travel zone (DEQ, 2012) or 500 foot buffer for each water well is shown in Figure 5 to indicate the default setback conditions in the permit template. A total of 189 UICs (shown in green in Figure 5) is within the default setbacks between UICs and water wells, and need to be addressed.

4. Groundwater Protectiveness Demonstrations

This section provides an overview of the unsaturated zone (Section 4.1) and saturated zone (Section 4.2) GWPD models. Detailed technical documentation for input parameters, the governing equations, and conservative assumptions for the GWPD are provided in Attachment B (unsaturated zone GWPD) and Attachment C (saturated zone GWPD).

Both models simulate pollutant fate and transport over time based on user-provided input parameters. During transport in the subsurface, pollutant concentrations are reduced by microbial action (biodegradation), dispersion, and sorption on aquifer solids. The objective of the modeling was to calculate the vertical and horizontal transport distances necessary to attenuate pollutants to below zero (i.e., MRL). Pollutant fate and transport are simulated for organic pollutants pentachlorophenol (PCP); di(2-ethylhexyl)phthalate (DEHP); benzo(a)pyrene; and the metal lead. These pollutants are among the most mobile, toxic, and environmentally persistent in their respective chemical classes (GSI, 2008), and are the most likely pollutants in their respective chemical classes to exceed regulatory standards for stormwater at UICs (Kennedy/Jenks, 2009).

4.1 Unsaturated Zone GWPD

The unsaturated zone GWPD model simulates pollutant fate and transport in soils below the bottom of the UIC and above the seasonal high groundwater table. The model is based on the 1-dimensional (1-D) advection dispersion equation, and is implemented in a Microsoft Excel spreadsheet. Model input parameters are summarized in Table 1 (soil properties) and Table 2 (pollutant properties). The input parameters for the unsaturated zone GWPD are varied to evaluate two scenarios for pollutant fate and transport: (1) the average scenario, which is represented by the central tendency or expected mean value of the input parameter, and (2) the reasonable maximum scenario, which is an upper bound on what could occur, but is considered unlikely to occur because of compounding conservatism.

Table 3 presents the minimum protective vertical separation distances under the average and reasonable maximum scenarios of the unsaturated zone GWPD model. The average scenario represents most reasonably likely conditions, and is used for regulatory compliance. Pollutant selected for modeling included those that are consistently present in stormwater and represent a cross section of chemical types. PCP migrates farther than the other pollutants that were modeled because it is more mobile in the environment. Therefore, the protective vertical separation distance at City UICs is conservatively based on PCP. Under the average scenario, the minimum protective vertical separation distance is 1.4 feet. However, GSI recommends adding 1.1 feet to the model-calculated vertical separation distance to account for natural variation of seasonal groundwater high elevations over time[1]. Therefore, GSI recommends using a protective separation distance of 2.5 feet for the minimum separation distance at vertical UICs.

The reasonable maximum scenario represents the worst-case conditions, and is characterized by compounding conservatism of input variables. The purpose of the reasonable maximum scenario is to evaluate model sensitivity, and it is not used for regulatory compliance. As is shown in Table 3, the protective separation distances under the worst-case "reasonable maximum scenario" are larger than the protective separation distances under the most likely "average scenario."

4.2 Saturated Zone GWPD

The saturated zone GWPD simulates pollutant fate and transport in saturated soils below the water table. The conceptual model for the saturated zone GWPD assumes that the UIC intersects the seasonal high groundwater table such that the UIC extends 5 feet below the water table. The saturated zone GWPD model is based on a conservative, 3-D numerical groundwater model (MODFLOW) that is coupled with a pollutant fate and transport model (MT3D) to simulate pollutant attenuation by dilution, dispersion, biodegradation, and retardation. Model input parameters are summarized in Table 4 (soil properties) and Table 5 (pollutant properties).

Table 6 presents the protective horizontal separation distances based on the saturated zone GWPD model. PCP migrates farther than the other pollutants that were modeled because it is more mobile and persistent in the environment. Therefore, the protective horizontal separation distance at City UICs is conservatively based on PCP. The protective horizontal separation distance is 267 feet.

[1] The protective vertical separation distance is a separation from the seasonal high groundwater elevation. However, the seasonal high groundwater elevation fluctuates annually. The factor of safety accounts for these annual fluctuations in seasonal groundwater high, and was calculated using a prediction interval. A prediction interval contains a specified percent of the data from a distribution. For example, the upper 90 percent prediction interval for seasonal high groundwater elevation at a well contains 90 percent of the observed seasonal groundwater highs.

Groundwater elevation measurements from State of Oregon observation well CLAC 54227 (located in T3S R1W Section 24DD) were downloaded from the OWRD online groundwater elevation database. The period of record for CLAC 54227 is 1998 to 2012, and the well completed in the Qfc. The seasonal high groundwater elevation for each calendar year was identified, and one-sided nonparametric prediction interval was calculated using Equation 3.11 in Helsel and Hirsch (2002). Data from a calendar year was used only if data from February through May were available, which is when the seasonal groundwater high typically occurs. Also, data from 1999 through 2001 was excluded from the analysis because water levels appear to be outliers from the remainder of the data. The prediction interval for CLAC 54227 was 1.1 feet greater than their median seasonal high groundwater elevations. Therefore, annual variation in seasonal high groundwater elevations is expected to be within 1.1 feet (LANE 8029) of the median seasonal high groundwater elevation 90 percent of the time. The measure of safety was conservatively chosen to be 1.1 feet.

5. Conclusion and Recommendations

The GWPD models indicate that UICs are protective if they meet at least one of the following two conditions: (1) vertical separation distance between the UIC and seasonal high groundwater is more than 2.5 feet or (2) horizontal separation distance between a UIC and water well is more than 267 feet. UICs that do not meet one of these two conditions must be retrofit, decommissioned, or demonstrated to be protective using a different method.

Relative risk posed by UICs in the City is summarized in Table 7, and shown in Figure 6. UICs are classified according to the following risk categories:

- **Red = High Risk.** The following types of UICs are designated as high risk:
  - UICs that do not have the horizontal or vertical criteria for protectiveness. Specifically, the vertical separation distance is less than 2.5 feet and horizontal separation distance is less than 267 feet at these UICs.
  - UICs that drain areas where the stormwater potentially has a high pollutant load (UIC E-8, which is located near the garbage and grit dumpster at the wastewater treatment plant, and UIC E-11, which is located near a vehicle wash bay at the motor pool).

  A total of six high-risk UICs were identified.

- **Yellow = Moderate Risk.** These UICs are protective because they have more than 267 feet of horizontal separation distance; therefore, DEQ does not require decommissioning or retrofit of these UICs. However, because these are wet feet UICs, they are considered to pose a higher risk to groundwater and are candidates for retrofit. Wet-feet UICs were identified using two methods: (1) information provided by the public works staff indicating that the UICs contained water (Darvin Tramel, personal communication, May 6, 2013), and (2) comparison of UIC depth to the depth to seasonal high groundwater in Figure 4 (i.e., UIC depth is greater than depth to seasonal high groundwater at wet-feet UICs).

  The method used to identify wet-feet UICs is provided in Table 7. A total of six wet-feet UICs were identified on the basis of information provided by the public works staff, and 20 UICs were identified on the basis of the depth to seasonal high groundwater map. GSI recommends site visits to the wet-feet UICs identified during April (the time of seasonal high groundwater) to confirm that they are wet-feet UICs.

- **Green = Low Risk.** UICs that meet at least one of the two conditions for protectiveness listed above. At these UICs, the vertical separation distance is greater than 2.5 feet or horizontal separation distance is greater than 267 feet.

A total of six high-risk and 26 moderate-risk UICs were identified. The high-risk and moderate-risk UICs are located primarily along Northwest 3rd Avenue and North Holly, North Pine, and Northeast 10th, and the wastewater treatment plant. The high-risk UICs may be addressed by retrofit, decommissioning, or an alternative GWPD, which may include:

- Demonstration to DEQ that the nearby water well is no longer being used for domestic purposes, or has been decommissioned.

- Demonstration that the UIC is outside of the capture zone of the water well (a capture zone is the area of groundwater that drains to a UIC).
- Demonstration that the water well is constructed in a manner that is protective against stormwater infiltration (i.e., based on the locations of the well seal and well screen).

References

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Tables

Table 1

Unsaturated Zone GWPD Model Input Parameters – Soil Properties

City of Canby

Input Parameter	Units	Average Scenario	Reasonable Maximum Scenario	Data Source and Location of Technical Documentation
Total Porosity (η)	-	0.325	0.325	Midrange porosity for a gravel, Freeze and Cherry (1979) Table 2.4. Appendix B, Section 2.1.1.
Effective Porosity (η_e)	-	0.20	0.20	In the range of specific yields for a gravel (Johnson, 1967). Appendix B, Section 2.1.1.
Bulk Density (ρ_b)	g/cm^3	1.79	1.79	Calculated by equation 8.26 in Freeze and Cherry (1979). Appendix B, Section 2.1.2.
Dispersivity (α)	m/d	5% of transport distance	5% of transport distance	Calculated based on Gelhar (1985). Appendix B, Section 2.1.3.
Pore Water Velocity (v)	m/d	0.42	0.73	Based on 8 specific capacity tests at water wells conducted at water wells that are less than 50 feet deep. Average scenario uses the median of permeability measurements, reasonable maximum scenario uses the 95% UCL on the mean of permeability measurements. Appendix B, Section 2.1.4.

Notes

g/cm^3 = grams per cubic centimeter

m/d = meters per day

95% UCL = 95% Upper Confidence Limit on the mean, based on the 95% H-UCL, which assumes a lognormal distribution of K

(-) = input parameter units are dimensionless

Table 2

Unsaturated Zone GWPD Model Input Parameters – Pollutant Properties

City of Canby

Input Parameter	Units	Pollutant	Average Scenario	Reasonable Maximum Scenario	Data Source and Location of Technical Documentation
Initial Concentration	µg/L	PCP	10	10	Action Level in City of Eugene UIC WPCF Permit
		DEHP	60	60	Action Level in City of Gresham UIC WPCF Permit
		B(a)P	2	2	Action Level in City of Eugene UIC WPCF Permit
		Lead	500	500	Action Level in City of Eugene UIC WPCF Permit
Organic Carbon Partitioning Coefficient (K_{oc})	L/Kg	PCP	703	703	EPA (1996), assuming a pH of 6.6 based on groundwater pH measured at USGS observation wells. Appendix B, Section 2.3.1.
		DEHP	12,200	12,200	Calculated based on equations in Roy and Griffin (1985). Appendix B, Section 2.3.1.
		B(a)P	282,185	282,185	
Distribution Coefficient (K_d)	L/Kg	PCP	5.4	1.0	Calculated based on Equation 5.12 in Watts (1998). Appendix B, Section 2.3.2.
		DEHP	94.4	16.7	Calculated based on Equation 5.12 in Watts (1998). Appendix B, Section 2.3.2.
		B(a)P	2,184	387	Calculated based on Equation 5.12 in Watts (1998). Appendix B, Section 2.3.2.
		Lead	1,200,000	535,000	
Half Life (h)	d	PCP	31.4	49.9	Literature values. Appendix B, Section 2.3.3.
		DEHP	46.2	69.3	Literature values. Appendix B, Section 2.3.3.
		B(a)P	533	2,666	Literature values. Appendix B, Section 2.3.3.
Retardation Factor (R)	-	PCP	30.9	6.3	Calculated based on Equation (9.14) in Freeze and Cherry (1979). Appendix B, Section 2.3.4.
		DEHP	521	93	
		B(a)P	12,022	2,129	
		Lead	6,600,000	2,900,000	

Notes

d = days

L/Kg = Liters per Kilogram

mg/L = micrograms per liter

DEHP = di(2-ethylhexyl) phthalate

(-) = input parameter units are dimensionless

PCP = pentachlorophenol

B(a)P = benzo(a)pyrene

H = horizontal UIC

V = vertical UIC

Table 3

Unsaturated Zone GWPD - Protective Vertical Separation Distances

City of Canby

Pollutant	MRL (µg/L)	Minimum Protective Vertical Separation Distance (feet)		
		Average Scenario	Reasonable Maximum Scenario	Recommended Value [3]
Lead [1]	0.1	< 0.1	< 0.1	2.5
Benzo(a)pyrene	0.01	< 0.1	< 0.1	
PCP	0.04	1.4	11.4	
DEHP	1	< 0.1	0.66	

Notes:

MRL = method reporting limit

µg/L = micrograms per liter

PCP = pentachlorophenol

DEHP = di(2-ethylhexyl)phthalate

[1] Metals transport simulations are longer than 12.80 days because metals do not biodegrade over time. Metals transport simulations assume 1000 years of transport at 12.80 days per year = 12,800 days of transport.

[2] The vertical separation distance in the unsaturated zone that is necessary for pollutant concentrations to attenuate to below the method reporting limit.

[3] "Recommended Value" is based on PCP, which migrates further than the other pollutants that were modeled. The Recommeded Value was calculated by adding the minimum protective vertical separation distance for PCP under the average scenario (1.4 feet) to a safety measure of 1.1 feet. The safety measure accounts for uncertainties in the seasonal high groundwater elevation contour map and natural variation of seasonal high groundwater elevations over time.

Table 4

Saturated Zone GWPD Model Input Parameters – Soil Properties

City of Canby

Input Parameter	Units	Base Model and DB Sensitivity Runs	Data Source and Location of Technical Documentation
Total Porosity (η)	-	0.325	Midrange porosity for a gravel, Freeze and Cherry (1979) Table 2.4. Appendix C, Section 2.4.1.
Effective Porosity (η_e)	-	0.20	Range of specific yields for a gravel in Johnson (1967). Appendix C, Section 2.4.1.
Hydraulic Conductivity (K)	ft/d	26.6	Median hydraulic conductivity calculated from well tests available on OWRD well logs in the Missoula Flood Deposits (Qfc) Appendix C, Section 2.4.1.
Hydraulic Gradient (h)	ft/ft	0.011	Based on groundwater elevation contour map in the City of Canby
Bulk Density (ρ_b)	g/cm^3	1.79	Calculated by equation 8.26 in Freeze and Cherry (1979). Appendix B, Section 2.1.2.
Longitudinal Dispersivity (α_L)	ft	17.93	Calculated using Xu and Eckstein (1995). aL = (3.28)(0.83)[log(Lp/3.28)]2.414. A transport distance (L_p) of 500 feet was used in the calculation). Appendix C, Section 2.4.1.
Transverse Dispersivity (y-direction)	ft	5.92	Calculated using EPA (1986). $a_T = 0.33(a_L)$. Appendix C, Section 2.4.1.
Vertical Dispersivity (z-direction)	ft	1.79	Calculated using EPA (1986). $a_v = 0.10(a_L)$. Appendix C, Section 2.4.1.

Notes

g/cm^3 = grams per cubic centimeter

ft/d = feet per day

ft = feet

DB Sensitivity Runs = Drainage Basin Sensitivity Runs

(-) = input parameter units are dimensionless

Table 5

Saturated Zone GWPD Model Input Parameters – Pollutant Properties

City of Canby

Input Parameter	Units	Pollutant	Base Model - Near Vertical UIC	Base Model - Distal From Vertical UIC	Data Source and Location of Technical Documentation
Initial Concentration	µg/L	PCP	10	10	Action Level in City of Eugene UIC WPCF Permit
		DEHP	60	60	Action Level in City of Gresham UIC WPCF Permit
		B(a)P	2	2	Action Level in City of Eugene UIC WPCF Permit
		Lead	500	500	Action Level in City of Eugene UIC WPCF Permit
Organic Carbon Partitioning Coefficient (K_{oc})	L/Kg	PCP	703	703	EPA (1996), assuming a pH of 6.6 from USGS monitoring wells. Appendix B, Section 2.3.1.
		DEHP	12,200	12,200	Calculated based on equations in Roy and Griffin (1985). Appendix B, Section 2.3.1.
		B(a)P	282,185	282,185	
Distribution Coefficient (K_d)	L/Kg	PCP	8.2	1.3	Calculated based on Equation 5.12 in Watts (1998). Appendix B, Section 2.3.2.
		DEHP	142	22.3	Calculated based on Equation 5.12 in Watts (1998). Appendix B, Section 2.3.2.
		B(a)P	3,293	515	Calculated based on Equation 5.12 in Watts (1998). Appendix B, Section 2.3.2.
		Lead	1,000,000	1,000,000	
Half Life (h)	d	PCP	46	46	Literature values. Appendix C, Section 2.4.2.
		DEHP	10	10	Literature values. Appendix C, Section 2.4.2.
		B(a)P	587	587	Literature values. Appendix C, Section 2.4.2.
Retardation Factor (R)	-	PCP	74	6.95	Calculated based on Equation (9.14) in Freeze and Cherry (1979). Appendix B, Section 2.3.4.
		DEHP	1,260	124	
		B(a)P	29,471	2,800	
		Lead	5,500,000	5,500,000	

Notes

d = days

L/Kg = Liters per Kilogram

mg/L = micrograms per liter

DEHP = di(2-ethylhexyl) phthalate

(-) = input parameter units are dimensionless

PCP = pentachlorophenol

B(a)P = benzo(a)pyrene

Table 6

Saturated Zone GWPD -- Protective Horizontal Separation Distance

City of Canby

Pollutant	Minimum Protective Horizontal Separation Distance (feet)
Lead	5
Benzo(a)pyrene	33
PCP	267
DEHP	67

Notes:

DEHP = di(2-ethylhexyl)phthalate

PCP = pentachlorophenol

Table 7

Relative Risk at UICs

City of Canby

UIC ID	UIC Address	Vertical Separation Distance (feet)	Distance to Nearest Water Well (feet)	Nearest Water Well ID
High Risk				
D-63	N Pine and NE 10th	< 0.0 [1]	69.1	CLAC 12047
None	NE 2nd and N Ivy	-8.05	233.6	CLAC 12792
None	NW 3rd and N Holly	-11.29	83.8	CLAC 9668
D-48	NW 3rd and N Holly	-10.83	144	CLAC 9668
E-8	1480 NE Territorial (WWTP)	6.9	1109	Cert 55066
E-11	1490 NE Territorial (PW Complex)	9.0	626	Cert 55066
Moderate Risk				
D-28	NW 11th Ave and N Pine St	< 0.0 [1]	278	CLAC 12047
D-35	NW 14th Ave and N Oak St	< 0.0 [1]	295	CLAC 9703
D-31	NW 10th Ave and N Oak St	< 0.0 [1]	408	CLAC 12047
D-26	NW 12th Ave and N Pine St	< 0.0 [1]	574	CLAC 12047
D-23	NW 13th Ave and N Pine St	< 0.0 [1]	617	CLAC 9675
F-7	N Birch and Territorial	< 0.0 [1]	684	Claim GR2913
None	NW 2nd Ave. and N Ivy St.	-8.14 [2]	272.01	C12792
A-62	SW 2nd Ave	-0.52 [2]	304.05	C12048
D-54	NE 4th Ave and N Juniper St	-0.49 [2]	415.20	C12266
D-55	NW 4th Ave and N Ivy St	-5.24 [2]	439.93	C12792
D-64	NE 3rd Ave and N Juniper St	-2.22 [2]	446.20	C12792
X-1	S Hazel Dell Way and S Sequoia Py	-13.91 [2]	527.48	C12103
X-2	S Hazel Dell Way and S Sequoia Py	-13.40 [2]	544.42	C12103
None	NE 1st Ave and N Ivy St	-6.86 [2]	556.65	C12792
None	S Hazel Dell Way and S Sequoia Py	-13.50 [2]	570.37	C12103
None	S Hazel Dell Way and S Sequoia Py	-13.82 [2]	582.14	Cert 30448
B-18	N Baker St and N 8th Way	-12.85 [2]	624.82	Inchoate T7068
X-3	S Sequoia Parkway	-11.78 [2]	640.45	C12103
None	NE 1st Ave	-4.91 [2]	647.97	C12792
B-19	N Baker St and N 8th Way	-9.92 [2]	704.36	Inchoate T7068
D-27	NE 12th Way	-1.14 [2]	708.36	C12047
C-44	S Knott Ct and S Knott St	-0.05 [2]	726.39	C64610
X-5	S Sequoia Parkway	-6.00 [2]	788.46	C12104
X-4	S Sequoia Parkway	-10.02 [2]	789.50	C12103
None	N Baker Drive	-25.77 [2]	930.90	C12038
C-1	SE 3rd Avenue and S Knott St	-1.93 [2]	1004.26	C12048

Notes

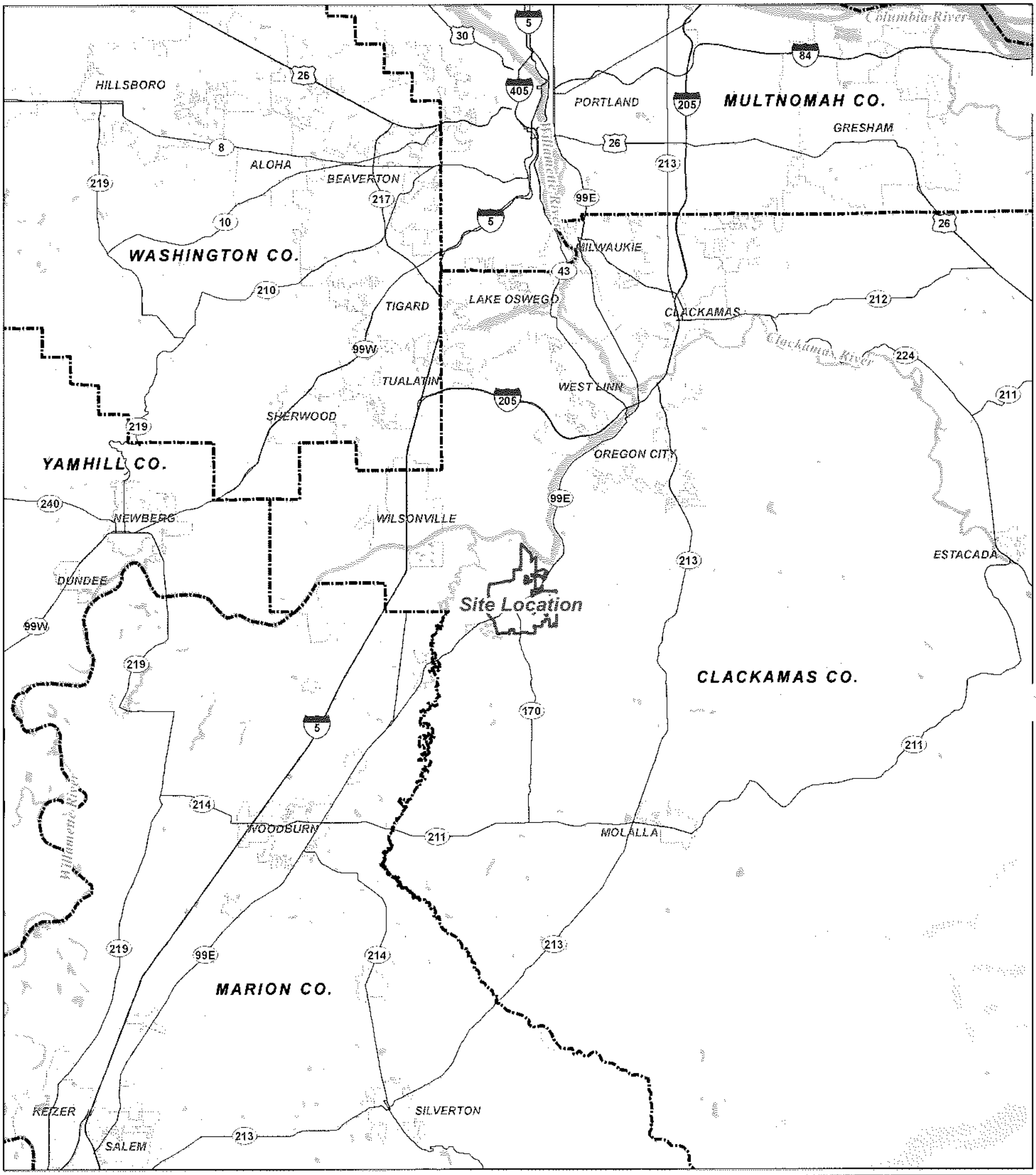
[1] Wet feet conditions based on observations by City public works department

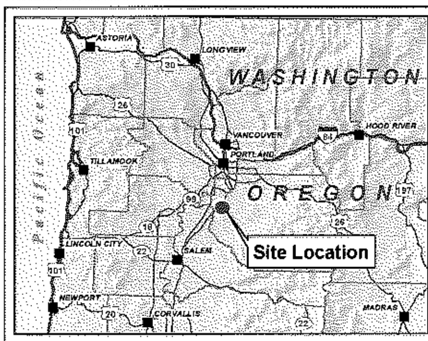
[2] Wet feet conditions based on depth to seasonal high grounwater map

Water Solutions, Inc.

P:\Portland\390-Kennedy_Jenks\002-Canby_Risk_Model\Reports-Memos\TABLES\Main Text\TABLE 7 - RISK AT UICS

Figures





LEGEND

- Site Location
- Cities
- Counties
- Highways
- Major Waterbodies

MAP NOTES:
Date: August 28, 2013
Data Sources: METRO RLIS, USGS, ESRI

0 2.5 5
Miles

N

FIGURE 1

Site Location

City of Canby
Groundwater Protectiveness Demonstration

GSI Water Solutions, Inc.