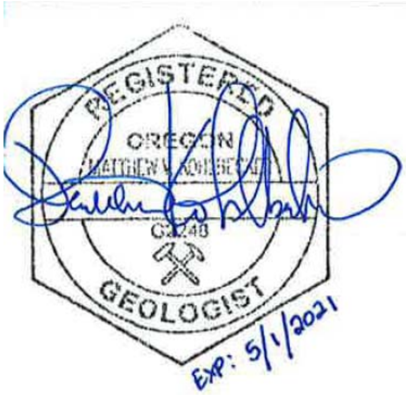
City of Bend

Stormwater Infiltration Evaluation Update

October 2020

CITY OF BEND



Prepared by:
GSI Water Solutions, Inc.
55 SW Yamhill St., Suite 300, Portland, OR, 97204

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Abbreviations and Acronyms

bgs	Below Ground Surface
COSM	Central Oregon Stormwater Manual
DEQ	Department of Environmental Quality
gpm	gallons per minute
GSI	GSI Water Solutions, Inc.
in/hr	Inches per Hour
OWRD	Oregon Water Resources Department
SWMP	Stormwater Master Plan
Tbab	Basalt of Awbrey Butte
TPD	Trips per Day
Qbn	Newberry Basalt
Qsp	Shevlin Park Tuff
Qtt	Tumalo Tuff
UIC	Underground Injection Control
UGB	Urban Growth Boundary

Executive Summary

The City of Bend (City) encourages stormwater management by infiltration and provides numerous tools to facilitate implementation of stormwater infiltration at project sites. The tools provided by the City include: (1) drainage area maps that show areas where soil conditions are favorable to infiltration and that can be used to inform infiltration strategy (e.g., using drywells or low impact development), and (2) maps of water well locations and groundwater depth, which help property owners implement infiltration projects that are protective of the City's municipal groundwater supply wells and meet requirements set forth by the Department of Environmental Quality (DEQ). The City's tools were developed about 10 to 15 years ago, and need to be updated to reflect new data generated as a part of recent infiltration projects. The tools also need to be extended to cover expansion areas and opportunity areas identified in the City's Comprehensive Plan (City of Bend, 2016), which is a guide for making land use decisions regarding future development.

The technical information that was used to develop the City's tools was documented in a stormwater infiltration evaluation report prepared by GeoEngineers in 2007. This *Stormwater Infiltration Evaluation Update* is an update to the 2007 GeoEngineers report that incorporates recent data, including: (1) data from geotechnical reports and water well installations, (2) data collected during the summer of 2020 from infiltration testing of new borings in expansion areas and opportunity areas, and (3) data collected during June 2020 as a part of testing existing Underground Injection Control (UIC) devices within the City's urban growth boundary. The information in this report will be used by the City to update mapping tools and to inform a future update of the City's 2014 Stormwater Master Plan (SWMP) and UIC permit renewal in 2023. The principle outcomes of this update are summarized in the bullets below.

- Updated Drainage Area Maps. The City's 2014 SWMP presented maps that divided the City into three Drainage Areas based on soil favorability to infiltrating or injecting stormwater and infiltration strategy (i.e., drywells, drill holes, or low impact development). This report presents updated maps that can be incorporated in the City's upcoming SWMP update and mapping tools. The updates include: (1) assigning Drainage Areas to the "expansion areas" that are identified in the City's Comprehensive Plan, and (2) refining the Drainage Areas by identifying an area of the City, corresponding with sand and gravel deposited by the Deschutes River, where infiltration projects may encounter shallow groundwater (i.e., less than ten feet below ground surface) and lower soil permeability.
- Updated Drainage Area Characteristics. This report updates Drainage Area characteristics, which are used as a planning-level tool to guide infiltration projects in the City. For example, the report provides updated estimates for exfiltration rates of drywells and drill holes in each Drainage Area based on infiltration tests documented in geotechnical reports, and provides updated information about the depth and thickness of tuff layers[1] in southwest Bend based on geotechnical reports and water well logs from the Oregon Water Resources Department (OWRD).
- UIC Ageing Evaluation. Over time, the capacity of a drywell or drill hole to infiltrate declines due to clogging with solids from stormwater. Based on drywell and drill hole capacity testing conducted over the past 10 years, we developed estimates for relative performance declines over time for the different types of infiltration devices (i.e., drywells and drill holes) and traffic categories (i.e., <1,000 vehicle trips per day [TPD] and >1,000 TPD). We found that drill holes age faster than drywells, and we found that drywells that drain streets >1,000 TPD age faster than drywells that drain streets with <1,000 TPD). Based on these findings, we recommend that the City continue to encourage the use of drywells instead

[1] Tuff is a volcanic ash that is common in the shallow subsurface soils of southwest Bend and is characterized by very low potential for infiltration.

of drill holes where possible, and we recommend that the City prioritize preventative maintenance of drywells that drain streets with >1,000 TPD.

- Updated Water Well Location Database. It is necessary to understand water well locations when implementing infiltration projects because DEQ has established setbacks between water wells and drywells/drill holes. GSI updated an existing database of water well locations in the City (which includes municipal supply wells, irrigation wells, and domestic supply wells) based on site visits conducted as part of a City reconnaissance program and records of new well installations available from the OWRD. This database update can be used by the City to update its online water well location mapping tools, to inform a future update of the City's SWMP, and to develop an updated System-Wide Assessment for DEQ, which will be required as part of the upcoming renewal of the City's UIC permit (the City's UIC permit expires on April 30, 2023).
- Potential Perched Groundwater Map. Perched groundwater occurs where groundwater accumulates on a bed or lens of low-permeability material above the regional groundwater table. It is necessary to understand areas of perched groundwater when implementing infiltration projects because DEQ has established minimum vertical separation distances between groundwater and drywells/drill holes. The City's map showing areas with the potential for perched groundwater, originally developed in 2012, was updated with information from new water well installations (from OWRD's online records) and geotechnical investigations conducted to support site development. This updated map can be used to inform a future update of the City's SWMP, and to develop an updated System-Wide Assessment for DEQ, which will be required as part of the upcoming renewal of the City's UIC permit (the City's UIC permit expires on April 30, 2023).

The main text of this document provides a high-level overview of the methods that were used to develop the primary outcomes of the update summarized in the bullets above. In-depth technical documentation is provided in the appendices that are attached to this report.

SECTION 1: **Background**

The City of Bend (City) encourages stormwater infiltration because it addresses the challenge of managing high-volume discharges from piped systems that serve large areas, recharges the groundwater system, and eliminates direct exposure of sensitive aquatic receptors to stormwater pollutants. The City's 2014 Stormwater Master Plan (SWMP), which provides strategies for managing stormwater throughout the City, facilitates implementation of infiltration projects by including soil mapping tools that identify areas where soil conditions are favorable to infiltration and that inform infiltration strategy (e.g., using drywells, drill holes, and/or low impact development). The soil mapping tools are primarily based on a geologic study prepared in 2007 by GeoEngineers (GeoEngineers, 2007), and studies of perched groundwater, water well locations, and Underground Injection Control (UIC) ageing prepared in 2011 and 2012 by GSI Water Solutions, Inc. (GSI, 2011; GSI 2012).

In the years since the GeoEngineers (2007) and GSI (2011, 2012) studies were developed, additional data that support infiltration projects has become available from geotechnical site investigations and water well installations. In addition, development strategies have evolved in the past 15 years as the City has continued to grow. The City's Comprehensive Plan (City of Bend, 2016), which is a guide for making land use decisions regarding future development, identifies opportunity areas and expansion areas that were not the focus of the GeoEngineers (2007) and GSI (2012) studies. Opportunity areas are focused locations for new growth due to their location, zoning, or proximity to urban services, and expansion areas are areas for future growth outside of City limits but within the urban growth boundary (UGB). The expansion areas and opportunity areas are shown in Figure 1-1

This report is an update to the GeoEngineers (2007) and GSI (2011, 2012) studies that incorporates: (1) recent data from geotechnical reports and water well installations, (2) data collected during the summer of 2020 from infiltration testing of new borings in expansion areas and opportunity areas, and (3) data collected during June 2020 as a part of testing existing UIC devices within the City's urban growth boundary.

This section provides background information about that data that were used to develop the stormwater management strategy in the City's SWMP, and is organized as follows:

- **Section 1.1: Geologic and Hydrogeologic Setting.** Provides an overview of geology in the City of Bend, which is the basis for dividing the City into three areas based on infiltration characteristics.
- **Section 1.2: Drainage Areas.** Presents the Drainage Areas in the City of Bend, which are the foundation for informing stormwater management strategies.
- **Section 1.3: Report Purpose, Objectives, and Organization.** Describes the content of the main text (which provides an overview of infiltration characteristics, UIC ageing, and water well locations), and appendices (where technical supporting information is located).

1.1 Geologic and Hydrogeologic Setting

The City is located in the upper Deschutes Basin, an approximately 4,500 square mile area drained by the Deschutes River and its tributaries (Gannett et al., 2001). Geology in the City is complex, and is comprised of a transition zone where multiple distinct volcanic rock units with different origins and characteristics come together. The following subsections provide an overview of the surficial geology in the City organized by geographic area, including the northwest part of the City (Section 1.1.1, characterized by the basalt of Awbrey Butte), southwest part of the City (Section 1.1.2, characterized by tuff and pumice formed by Cascade volcanism), and the eastern part of the City (Section 1.1.3, characterized by basalt flows from

Newberry Volcano and local cinder cones). A surficial geologic map for the City showing the geologic units discussed in the following sections is provided in Figure 1-2.

1.1.1 Northwest Bend Geology: Awbrey Butte

Geology in the northwest part of Bend is dominated by Awbrey Butte, a small basaltic shield volcano that erupted over 4 million years ago (Sherrod et al., 2004). Infiltration tests of three UICs completed in the basalt of Awbrey Butte indicate that the unit is characterized by a relatively low permeability (GSI, 2011).

1.1.2 Southwest Bend Geology: Tuffs and Pumice

Geology in the southwest part of Bend is primarily characterized by tuff (i.e., volcanic ash) and pumice (a porous, permeable volcanic rock) originating from Cascade volcanism. Tuff is often encountered at or near ground surface, and is primarily comprised of the approximately 300,000-year-old Tumalo Tuff (Qtt) and 170,000-year-old Shevlin Park Tuff (Qsp). Tuffs can reach thicknesses of 80 feet (Tumalo Tuff) to over 150 feet (Shevlin Park Tuff). Pumice may be present beneath the tuff, and may reach thicknesses of about 35 feet (Sherrod et al., 2004). The fine-grained tuffs in Bend are unfractured and generally welded and, therefore, are characterized by a low permeability.

1.1.3 East Bend Geology: Younger Volcanics

Geology in Bend east of the Deschutes River is characterized primarily by extensive lava flows that originated from Newberry Volcano south of the City, called the Newberry Basalt (Qbn). Compared to the basalt of Awbrey Butte, the Newberry basalt is a relatively young, unweathered basalt (erupted less than 780,000 years ago) (Sherrod et al., 2004) and is highly permeable, based on the relatively rapid response (i.e., a couple days) of the water table to canals being turned on and off (Gannett et al., 2001).

1.2 Drainage Areas

In general, the surficial soils in the City originated from in-situ weathering of the geologic units with minor post-weathering transport and redeposition. Therefore, the infiltration characteristics of surficial soils in the City reflect the underlying geologic conditions. Specifically, the soils east of the Deschutes River above the Newberry Basalt are characterized as well-draining, while the tuffs in the southwest part of the City are characterized as poorly draining. Based on the geology, the City's 2014 Stormwater Master Plan (SWMP) subdivided the City into three drainage areas that correspond with the geologic units in the City. The drainage areas from the City's 2014 SWMP are shown on Figure 1-1, and are comprised of:

- Drainage Area A. Located east of the Deschutes River, Drainage Area A is primarily underlain by the Newberry Basalt (Qbn). Drainage Area A is characterized by well-draining soils.
- Drainage Area B. Located around Awbrey Butte, Drainage Area B is primarily underlain by the rocks associated with the Awbrey Butte shield volcano (Tbab). Drainage Area B is characterized by soils that are not well-draining.
- Drainage Area C. Located in the southwest part of town, Drainage Area C is primarily underlain by welded and unfractured tuff deposits. Drainage Area C generally is characterized by surficial soils that are poorly-draining, although well-draining soils may be encountered beneath the tuffs where pumice is present.

The drainage areas in Figure 1-1 are a planning tool that reflect general conditions. The feasibility of infiltration at individual sites may be different than the general conditions represented in Figure 1-1 due to: (1) heterogeneities within a drainage area (for example, well-draining sites may exist within Drainage Area C, if pumice is encountered beneath the tuff) and (2) the fact that drainage areas are based on regional-scale geologic maps, which may not reflect site-scale geology. Because of the potential for deviation from the general conditions, site-specific infiltration testing is necessary prior to implementing an infiltration project.

1.3 Report Purpose, Objectives, and Organization

The purpose of this report is to update previous studies of infiltration characteristics, UIC ageing, water well locations, and perched groundwater in Bend, to inform a future update of the City's SWMP and future renewal of the City's UIC permit. The objectives of the report are:

- Refine the City's Drainage Areas by incorporating data from: (1) approximately 50 geotechnical reports prepared since 2007 to support public works projects as well as residential, mixed use, and commercial development projects in the City and (2) infiltration testing near expansion areas and opportunity areas performed during the summer of 2020.
- Download water well logs from the Oregon Water Resources Department (OWRD) online well log database, and update maps of perched groundwater and water well locations using wells that were installed since the maps were originally developed by GSI in 2012.
- Using information collected by City staff during site visits to properties with water wells, refine the water well location maps originally prepared by GSI in 2012.
- Test the performance of twenty drywells and drill holes, compare the current performance to previous performance measurements, and evaluate UIC ageing by facility type (drywell or drill hole), traffic category (>1,000 vehicle trips per day or <1,000 vehicle trips per day), and drainage area.

The report is organized into the following sections:

- **Section 1 – Background.** Provides an overview of the geologic setting in the City of Bend, the Drainage Areas that the City uses to inform stormwater management strategies, and the purpose and objectives of the report.
- **Section 2 – Drainage Areas and Infiltration Characteristics.** Refines the City's drainage areas based on geotechnical reports prepared since 2007 and infiltration tests conducted in 2020.
- **Section 3 – Underground Injection Control Ageing Evaluation.** Summarizes an analysis of UIC ageing, and evaluates the dependence of ageing on facility type, traffic category, and drainage area.
- **Section 4 – Water Well Locations and Perched Groundwater Areas.** Updates the water well location maps and areas of perched groundwater prepared by GSI in 2012.
- **Section 5 – Conclusions and Recommendations.** Provides a summary of the primary conclusions and recommendations from the report.

The main text of this report provides a high-level overview of drainage areas, UIC ageing, water well locations, and areas of perched groundwater. The appendices in the report provide in-depth technical documentation of the analyses that were conducted as a part of this work.

SECTION 2: **Updated Drainage Areas and Characteristics**

This section updates the Drainage Areas in the City's 2014 SWMP based on recent geotechnical reports, water well driller logs, and borings advanced during the summer of 2020 near opportunity areas and expansion areas in the City, and is organized as follows:

- Section 2.1 provides an overview of the information that was used to update Drainage Area characteristics (i.e., geotechnical reports, water well driller logs, and borings that were advanced during summer 2020).
- Section 2.2 provides an update to the Drainage Area Boundaries and geologic characteristics in the Drainage Areas,
- Section 2.3 provides an update to the estimated exfiltration rates for UIC devices installed within the Drainage Areas.

Supporting technical information for the updates is provided in Appendix A (review of infiltration test data from recent geotechnical reports) and Appendix B (results of drilling and infiltration testing performed during summer 2020).

2.1 Data Sources

Updates to the Drainage Areas were based on geotechnical reports prepared since 2007, water well logs downloaded from OWRD, and four borings advanced near opportunity areas and expansion areas in the City:

- Geotechnical Reports. The City provided GSI with approximately 50 geotechnical reports that were prepared to support public works projects (e.g., pedestrian bridges, stormwater improvement projects, fire stations, schools, etc.) as well as residential, mixed use, and commercial development projects in the City. Most geotechnical reports included soil logs from test pits and borings, which GSI used to refine the geology in the Drainage Areas. Twelve geotechnical reports included data from infiltration tests, which GSI used to update hydraulic properties of soils within the Drainage Areas. The geotechnical reports reviewed by GSI are listed in the Section 6 (References) of this report, and geotechnical reports with infiltration tests that GSI used to refine the Drainage Area characteristics are shown on Figure 2-1.
- OWRD Water Well Logs. GSI downloaded and evaluated 54 water well driller logs for water wells from OWRD's online well log database, some of which were included in the GeoEngineers (2007) study. The water well logs were used to refine our understanding of the depths of tuff and pumice in the southwest part of Bend (Drainage Area C).
- New Borings. The City retained Haz-Tech drilling to advance four borings near expansion areas and opportunity areas, at the locations shown in Figure 2-1. The Wallace Group logged rock core from the borings and performed infiltration tests. Table 2-1 lists the borings and summarizes the objective(s) of each boring location.

Table 2-1. Locations and Objectives of Borings Advanced During Summer 2020.

Borehole ID	Location Description	Drilling Objective(s)
ITB-01	DSL Property Expansion Area	▪ Refine understanding of drainage characteristics in an expansion area
ITB-02	North Triangle Expansion Area	▪ Refine understanding of drainage characteristics in an expansion area
ITB-03	Bend Central District Opportunity Area	▪ Refine understanding of drainage characteristics in an opportunity area ▪ Collect information in an area with multiple failing UICs [1]
ITB-04	Deschutes River Infiltration Project	▪ Collect information (infiltration rates and groundwater conditions) in an area of a potential MS4 replacement opportunity

Notes:

(1) The City has reported failing UICs near the intersections of Revere Avenue and Lytle Street, Revere Avenue and 4th Street, Olney Avenue and Second Street, Olney Avenue and 3rd Street, and Thurston Avenue and 2nd Street

ITB = Infiltration Test Boring

2.2 Updated Drainage Area Map and Geologic Characteristics

This section presents a drainage area map that has been refined based on approximately 50 geotechnical investigations in the City (Section 2.2.1), and presents updated estimates of infiltration characteristics based on infiltration testing performed since 2007 (Section 2.2.2).

2.2.1 Updated Drainage Area Map

An updated map of drainage areas in the City of Bend is provided in Figure 2-2. This map incorporates the following updates to the map in the City's 2014 SWMP:

- **Drainage Area A has been expanded to the north and east, into expansion areas where the Newberry Basalt is present.** The expansion of Drainage Area A is based on geologic observations and infiltration testing results from borings ITB-01 in the North Triangle Expansion Area and ITB-02 in the DSL Property Expansion Area. With measured hydraulic conductivities at borings ITB-01 and ITB-02 of 41.5 and over 3,600 inches per hour, respectively, the Newberry Basalt in these expansion areas appears to exhibit similar infiltration characteristics as other areas of Drainage Area A. A detailed evaluation of infiltration test data from borings ITB-01 and ITB-02 is presented in Appendix A.
- **Drainage Area C has been expanded to the west, to include the West Expansion Area.** The expansion of Drainage Area C is based on geologic mapping by Sherrod at el. (2004) and borings advanced by GeoEngineers (2006) in the nearby Shevlin Meadows subdivision, which indicate that the subsurface is characterized by extensive tuff layers. These borings confirm that infiltration strategies in the West Expansion Area will need to recognize the potential to encounter low-permeability tuff layers.
- **Hatching has been added to Drainage Area A and Drainage Area C to represent Alluvial Deposits of the Deschutes River.** The hatching was initially taken from a geologic map by Sherrod et al. (2004), and has been expanded to reflect thick accumulations of river alluvium encountered in geotechnical

investigations by Siemens and Associates (2008) and FEI (2012). Geotechnical studies indicate that the Deschutes River Alluvium may reach thicknesses of about 35 feet[2]. Infiltration tests and geotechnical studies indicate that the Deschutes River Alluvium may have different infiltration characteristics that should be taken into account for the purpose of evaluating infiltration feasibility[3].

While we do not recommend changes to the boundaries between Drainage Areas, we note that the data from geotechnical reports indicate that boundaries are not necessarily sharp and distinct. For example, test pits excavated by the Wallace Group (2016a) report weathered Tuff to up to 10 feet below ground surface (bgs), overlying Newberry basalt in Drainage Area A (specifically, at a site located at the intersection of NW Wall Street and NW Olney Avenue).

2.2.2 Drainage Area Characteristics

The following sections provide additional detail about the characteristics of each Drainage Area, based on information from the 2007 GeoEngineers Drainage Area report (GeoEngineers, 2007), geotechnical reports received by the City from 2006 to 2019 to support development projects (see Appendix A), and infiltration tests performed by the Wallace Group during the summer of 2020 in future expansion areas where no infiltration data is available (see Appendix B).

Drainage Area A

Located east of the Deschutes River, Drainage Area A is primarily underlain by the well-draining Newberry Basalt (Qbn). The Newberry Basalt is relatively unweathered and contains numerous fracture zones (GeoEngineers, 2007) and, in some areas, lava tubes (Greely and Corcoran, 1971). It is common for up to 14 feet of fill and/or native sand with gravel to be encountered between ground surface and the top of competent Newberry Basalt[4,5].

In general, Drainage Area A is characterized by a high infiltration rates. Hydraulic conductivities range from about 1 inch per hour to over 3,700 inches per hour, with the low end of the range typical of the sand and the high end of the range typical of fractured zones (see Appendix A for a compilation of infiltration rates and hydraulic conductivities in Drainage Area A). Note that in some areas of Drainage Area A, the Newberry Basalt may be absent at ground surface. These areas are denoted by the blue hatching in Figure 2-2, which correspond to the Deschutes River Alluvium and basalt of Pilot Butte. In these areas, the drainage characteristics may deviate from the general characteristics in Drainage Area A.

Drainage Area B

Located in the northwest portion of the City, Drainage Area B is comprised primarily of the basalt of Awbrey Butte (Tbab), which are deeply-weathered, Pliocene Age basalt flows (Mimura, 1992). GeoEngineers (2007)

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[2] Alluvium thickness was about 35 feet in Wallace Group (2011, 2015), over 20 feet in Siemens and Associates (2008), and over 10 feet in FEI (2012).

[3] Infiltration testing by the Wallace Group (2020) indicated that permeability of the Deschutes River Alluvium is about an order of magnitude less than native alluvial material overlying the Newberry Basalt (see test results from Carlson Geotech [2019]) and is at least two orders of magnitude less than the Newberry Basalt (see test results from Wallace Group [2020]). Details are provided in Appendix A. In addition, as explained in Section 3, perched groundwater may be encountered in the Deschutes River Alluvium.

[4] See CH2M Hill (2012), Shannon and Wilson (2012), GeoPacific Engineering, Inc. (2015), FEI (2015), Carlson Geotech (2015a), Carlson Geotech (2015b), Carlson Geotech (2016), PBS (2016), AGE (2017), Carlson Geotech (2017a), Carlson Geotech (2017b), Wallace Group (2016b), Wallace Group (2017), Wallace Group (2018a), Carlson Geotech (2019a), Carlson Geotech (2019b).

[5] In one instance, over 21 feet of fill was encountered at a site (Wallace Group, 2016c).

indicates that the rocks in Drainage Area B are characterized by a slightly lower permeability than the rocks in Drainage Area A, which is supported by infiltration test data compiled in GSI (2011).

Drainage Area C

Shallow soils in Drainage Area C is comprised of tuffaceous sedimentary rocks and tuffs that are characterized by a low hydraulic conductivity and are generally not favorable to infiltration. However, infiltration may be feasible using drill holes if the tuff layer is penetrated and more porous material (i.e., pumice, basalt, or sediments) is encountered beneath the tuff. Table A-7 in Appendix A summarizes the depths of tuff by quarter-quarter section in Drainage Area C, based on geotechnical reports and water well driller logs.

2.3 Hydraulic Conductivity and Estimated Exfiltration Rates

The estimated hydraulic conductivities and exfiltration rates within each of the drainage areas is summarized on Table 2-2. Note that the hydraulic conductivities and exfiltration rates in Drainage Area A have been updated from the GeoEngineers (2007) estimates[6] based on a review of geotechnical reports prepared from 2008 to 2019, and based on infiltration testing conducted during the summer of 2020 (see Appendix A for details). Specifically, the estimated exfiltration rates in Drainage Area A are about twice as large as the exfiltration rates presented in GeoEngineers (2007), which was estimated based on typical values of hydraulic conductivity for young basalt in the scientific literature. In Drainage Area B and Drainage Area C, the hydraulic conductivities and exfiltration rates are unchanged from GeoEngineers (2007) because no new infiltration tests were available for these drainage areas (GeoEngineers [2007] also used the scientific literature to estimate hydraulic conductivity in Drainage Area B and Drainage Area C).

Table 2-2. Infiltration Performance in Drainage Areas.

Drainage Area	Description	Hydraulic Conductivity [1,2] (in/hr)	Drywell Exfiltration Rate (ft^3/s)	Drill Hole Exfiltration Rate (ft^3/s)
A	Newberry Basalt	6.2	0.18	0.020
B	Older basalt of Awbrey Butte	1.4	0.04	0.004
C	Tuffaceous Sedimentary Rocks and Tuff	0.14	0.004	0.0004

Notes
(1) Geometric mean of measured hydraulic conductivity values in Drainage Area A (see Appendix A for details).
(2) See Table 2 of GeoEngineers (2007). Typical for the rock type in the drainage area, based on values in Freeze and Cherry (1979).
in/hr = inches per hour
ft^3/s = cubic feet per second

The hydraulic conductivities and exfiltration estimates for Drainage Area A in Table 2-2 are representative of native sands above the Newberry Basalt and fresh Newberry Basalt; the estimates are not representative of fill material or Deschutes River Alluvium.

[6] See Table 2 of GeoEngineers (2007) for the original exfiltration estimates.

SECTION 3: **Underground Injection Control Ageing Evaluation**

Over time, a UIC's capacity to infiltrate stormwater declines due to clogging with solids in stormwater, which is called "ageing" in this report. An understanding of the rate of decline is helpful for the City's implementation of stormwater infiltration projects, and for the City's prioritization of maintenance activities. Some facility types (i.e., drywells or drill holes) may perform better than others over time and should be encouraged by the City for infiltration projects. In addition, the City may prioritize UIC rehabilitation activities based on relative rates of UIC ageing (for example, if UICs that drain streets with ≥1,000 vehicle trips per day (TPD) age faster than UICs that drain streets with <1,000 TPD, then the City may prioritize maintenance activities for UICs draining streets with ≥1,000 TPD) to preserve capacity over time.

This section summarizes an evaluation of UIC ageing based on infiltration testing of existing drywells and drill holes during the summer of 2020, and is organized as follows:

- Section 3.1 discusses methods used to evaluate the ageing of drywells and drill holes in the City of Bend, and
- Section 3.2 provides the results of the UIC ageing evaluation.

Detailed technical documentation of the testing methods and statistical analysis of the testing results is provided in Appendix C.

3.1 Methods

The City provided GSI with data from approximately 150 infiltration tests of drywells and drill holes that were conducted by City staff from 2010 to 2019. The City's infiltration tests were performed in general accordance with methods in Appendix 4B of the Central Oregon Stormwater Manual (COSM) (COIC, 2010).

GSI filtered the list of 150 UIC tests down to 41 UICs, based on data quality and the length of time since the test was performed (i.e., recent tests were eliminated from consideration because the effects of ageing were less likely to be as pronounced as with older tests), as discussed in Appendix C. GSI and City staff selected 20 of the 41 UICs for re-testing, using methods to ensure that the UICs representing different facility types (drywells and drill holes), traffic categories (<1,000 TPD and ≥1,000 TPD) and drainage areas in the City were selected for testing, as summarized in Table 3-1. The locations of the UICs that were re-tested in June 2020 are shown on Figure 3-1.

Table 3-1. Overview of UICs Re-Tested During Summer 2020

Drainage Area	Number of UICs Tested	Facility Type	Traffic Category
Drainage Area A	9	6 drywells 3 drill holes	2 from >1,000 TPD 7 from <1,000 TPD
Drainage Area B	4	3 drywells 1 drill holes	1 from >1,000 TPD 3 from <1,000 TPD
Drainage Area C	7	4 drywells 3 drill holes	2 from >1,000 TPD 5 from <1,000 TPD
Total	20	13 drywells 7 drill holes	5 from >1,000 TPD 15 from <1,000 TPD

Notes
TPD = trips per day

GSI re-tested the UICs in June 2020 in general accordance with methods in Appendix 4B of the COSM, replicating the flow and head conditions during the previous tests to the extent possible. GSI evaluated UIC ageing by creating plots of declines in infiltration rate over time, and tabulating infiltration rate decline statistics (i.e., minimum, maximum, median, and average). An in-depth discussion of the methods used to select the 20 UICs for re-testing, conduct the infiltration tests, and evaluate the infiltration testing data is provided in Appendix C.

3.2 Results

Plots of performance declines over time for each evaluated category (facility type, drainage areas, and traffic categories) are provided in Figure 3-2 (drywells and drill holes), Figure 3-3 (Drainage Area), and Figure 3-4 (traffic category). A statistical summary of performance declines over time for each evaluated category is provided in Table 3-2 (drywells and drill holes), Table 3-3 (Drainage Area), and Table 3-4 (traffic category). The average performance decline in the following tables is calculated from the regression line shown in the figures. Note that the total number of tests performed in the tables and plots may not add up to 20 because results from some tests were excluded from the analysis due to data quality issues. Specifically, some infiltration tests indicated that UIC performance had increased over time (see Appendix C for an explanation of possible causes for this observation)[7]. In addition, note that the evaluation of performance decline by traffic category and drainage area was performed for drywells only because the categories did not have an equal weighting of drywells and drill holes (see Table 3-1). Detailed documentation of results from the UIC ageing evaluation is provided in Appendix C.

Note that, for a given category (e.g., drywells and drill holes in Table 3-2), performance declines on a percentage basis and on a gallons per minute basis do not necessarily exhibit the same magnitude of decline. For example, in Table 3-2, the drywell category and the drill hole category experienced about the same *maximum* performance decline on a percentage basis, but drill holes experience a larger *maximum* performance decline on a gallons per minute basis. These differences between performance declines on a percentage and gallons per minute basis are related to the initial performance of a UIC; for example, a performance decline of 10% would be 1 gallon per minute (gpm) for a UIC with a baseline performance of 10 gpm, or alternatively, a performance decline of 10% would be 10 gpm for a UIC with a baseline performance of 100 gpm.

Table 3-2. Performance Declines[1] Over Time for Drywells and Drill Holes.

Facility Type	Number of Tests	Minimum Performance Decline (% / gpm per year)	Median Performance Decline (% / gpm per year)	Average Performance Decline (% / gpm per year)	Maximum Performance Decline (% / gpm per year)
Drywell	10	0.2% / 0.2 gpm	1.6% / 1.2 gpm	2.9% / 2.0 gpm	8.7% / 8.9 gpm
Drill Hole	5	0.8% / 0.7 gpm	7.3% / 7.0 gpm	6.0% / 6.8 gpm	8.5% / 13.2 gpm

Notes
(1) Reported performance declines are based on the falling head tests reported in Table C-5 of Appendix C.
gpm = gallons per minute

[7] Observed increases in performance may be the result of the inability to replicate previous test conditions, particularly during the constant head portion of the test, which has more variables that must be accounted for and managed (i.e., maintaining a constant flow rate and head). Maintaining a constant flow rate is particularly challenging when potable water during testing is provided by a fire hydrant, which is characterized by a fluctuating flow rate due to fluctuating system pressures. Other possible explanations for increases in UIC performance could be unreported reconditioning that occurred between the original test and the June 2020 test, or measurement inaccuracies.

Table 3-3. Performance Declines[1] Over Time for Drywells By Drainage Area.

Drainage Area	Number of Tests	Minimum Performance Decline (% / gpm per year)	Median Performance Decline (% / gpm per year)	Average Performance Decline (% / gpm per year)	Maximum Performance Decline (% / gpm per year)
Drainage Area A	4	0.5% / 0.9 gpm	2.4% / 1.7 gpm	3.5% / 3.3 gpm	8.7% / 8.9 gpm
Drainage Area B	2	0.2% / 0.2 gpm	3.8% / 0.2 gpm	3.8% / 0.2 gpm	7.4% / 0.2 gpm
Drainage Area C	4	1.4% / 0.4 gpm	1.6% / 1.4 gpm	1.8% / 1.5 gpm	2.5% / 3.0 gpm

Notes
(1) Reported performance declines are based on the falling head tests reported in Table C-6 of Appendix C.
gpm = gallons per minute

Table 3-4. Performance Declines[1] Over Time for Drywells by Traffic Category.

Traffic Category	Number of Tests	Minimum Performance Decline (% / gpm per year)	Median Performance Decline (% / gpm per year)	Average Performance Decline (% / gpm per year)	Maximum Performance Decline (% / gpm per year)
<1,000 TPD	6	0.2% / 0.2 gpm	1.7% / 0.9 gpm	2.9% / 1.5 gpm	7.7% / 3.0 gpm
≥1,000 TPD	4	0.5% / 0.2 gpm	4.4% / 0.7 gpm	4.5% / 2.6 gpm	8.7% / 8.9 gpm

Notes
(1) Reported performance declines are based on the falling head tests reported in Table C-7 of Appendix C.
gpm = gallons per minute
TPD = trips per day

3.3 Conclusions and Recommendations

The UIC ageing database is currently limited in size, which subsequently inhibits our understanding of ageing trends. However, the preliminary dataset suggests that UIC ageing is influenced by multiple site-specific variables including facility type, drainage areas, and traffic category. Despite the limited size and understanding of the dataset, several preliminary trends emerged based on our evaluation of UIC ageing:

- Drywells and Drill Holes (Figure 3-2). As shown on Figure 3-2, drill hole performance declines faster than drywell performance. Specifically, drill hole performance declines generally range from about 60 percent to 80 percent after about 10 years of infiltration, and drywell performance declines generally range from less than a percent to about 30 percent after 10 years of infiltration. This trend is also evidence on an average basis, as drill holes were characterized by average performance declines of 6.0 percent per year based on the regression line in Figure 3-2, while drywells were characterized by average performance declines of 2.9 percent per year based on the regression line in Figure 3-2. The faster ageing of drill holes may be caused by the lower level of pretreatment typically installed at drill holes, or their smaller sidewall area which would make them more susceptible to clogging over time (drill holes are six-inch diameter devices while drywells are typically four-foot diameter devices).
- Drainage Areas (Figure 3-3). Drywells located in Drainage Areas A and B age faster than drywells located in Drainage Area C (specifically, drywells in Drainage Areas A and B were characterized by average performance declines of 3.5 to 3.8 percent per year based on the regression lines in Figure 3-3, while

drywells in Drainage Area C were characterized by average performance declines of 1.8 percent per year based on the regression line in Figure 3-3). The faster ageing of drywells in Drainage Areas A and B is poorly understood at the time of this report, and may be due to other variables (e.g., traffic category).

- **Traffic Categories (Figure 3-4).** Drywells that drain streets with ≥1,000 TPD age slightly faster than drywells that drain streets with <1,000 TPD (specifically, drywells draining ≥1,000 TPD streets were characterized by average performance declines of 4.5 percent per year based on the regression line in Figure 3-4, while drywells draining <1,000 TPD streets were characterized by average performance declines of 2.9 percent per year based on the regression line in Figure 3-4). The slightly faster ageing of drywells on ≥1,000 TPD streets is likely related to higher rates of sediment loading to the drywell.

Based on this evaluation of UIC ageing, we recommend that:

- **Maintenance Activities.** For UIC maintenance, because drill holes appear to age faster than drywells, and because drywells that drain streets with ≥1,000 TPD appear to age faster than drywells that drain streets with <1,000 TPD, we recommend that the City prioritize preventative maintenance activities for UICs on drill holes, and on UICs that drain streets with ≥1,000 TPD.
- **Facility Types.** Drywells are less susceptible to performance declines over time than drill holes. As such, we recommend that the City encourage stormwater management using drywells when feasible at a site. In addition, we recommend prioritizing pretreatment retrofits at drill holes.
- **Future UIC Testing.** The UIC ageing evaluation in this report represents a snapshot of performance declines over about 10 years of infiltration (i.e., the evaluation compared two UIC performance tests, separated by 10 years, at the same UIC). As such, there is uncertainty about performance declines over longer time intervals (e.g., whether performance continues to decline in a linear fashion or whether performance declines are nonlinear). We recommend that:
  - The City continue to collect updated infiltration testing data about every five years to refine the understanding of performance decline trends. The tested UICs should include the 20 UICs that were tested in June 2020, as well as other previously-tested UICs chosen so that the City can develop snapshots of performance at different time intervals (e.g., 5 years, 10 years, 15 years, etc.).
  - Future testing should replicate, to the extent possible, the flow and head conditions of previous tests, to minimize the effect of head-dependent test results and to allow comparison to existing infiltration tests.
  - Future testing and UIC ageing evaluations should consider other factors that likely influence the rate and magnitude of ageing, such as the type of pretreatment.

The future UIC testing will improve confidence in relationships between ageing and facility type, traffic category, and drainage area. In addition, future UIC testing may inform appropriate safety factors that are stipulated in the COSM as a part of UIC design.

SECTION 4: **Water Well Locations and Perched Groundwater Areas**

This section provides an update of a GSI (2012) analysis of water well locations and potential perched groundwater areas in the City of Bend. Understanding water well locations and areas of perched groundwater is important for siting UICs so that they are in compliance with DEQ requirements for horizontal setbacks from water wells and vertical separation distances from groundwater. The information in this section can be used by the City to update its online water well location mapping tools, and to develop an updated System-Wide Assessment for DEQ, which will be required as part of the upcoming renewal of the City's UIC permit (the City's UIC permit expires on April 30, 2023). This section is organized as follows:

- Section 4.1 provides background on the City's water well location database and perched groundwater delineations (which were initially developed in 2012), and
- Section 4.2 provides updated maps of water well locations and perched groundwater based on the City's water well reconnaissance program and records from OWRD's online water well database.

4.1 Background

In order to protect drinking water resources from pollutants in infiltrated stormwater, DEQ has developed requirements for horizontal setbacks between UICs and water wells and vertical setbacks between UICs and seasonal high groundwater. Specifically, DEQ requires that UICs be located a horizontal distance of 500 feet from water wells[8] and a vertical distance of at least 5 feet from the seasonal high groundwater[9]. Because the regional groundwater table in Bend is deep (typically 250 to 600 feet bgs based on regional water table elevation maps from Gannett et al., [2001]), it is unlikely for UICs to have inadequate vertical separation from the regional water table. However, UICs may have inadequate vertical separation from perched groundwater, which occurs at shallower depths and occurs when groundwater accumulates on low-permeability geologic units (e.g., cemented gravels, silts and clays, or basalt flow interiors). The City originally developed maps of water well locations and perched groundwater in the City as a requirement of the City's UIC Water Pollution Control Facilities (WPCF) permit that was issued to the City on May 14, 2013. The original water well location database and potential perched groundwater area delineations were developed based on information obtained from well logs from OWRD on November 14, 2011. Currently, these maps are used as a planning-level tool to site drywells and drill holes in the City.

4.2 Updates to Water Well Locations and Potential Perched Groundwater Delineations

Since the initial development of the City's water well location database and potential perched groundwater delineations in 2011, water wells have been installed, altered, and decommissioned, and the City has conducted a field reconnaissance program to improve the accuracy of water well locations. The following subsections update the City's water well location database (Section 4.2.1) and perched groundwater delineations (Section 4.2.2) based on the City's field reconnaissance program and OWRD records of water wells installed after 2011.

[8] See OAR 340-044-0018(3)(a)(E)
[9] See OAR 340-044-0018(3)(a)(H)

4.2.1 Water Well Locations

The updated inventory of water well locations is shown on Figure 4-1, and an updated table of the water wells is provided in Table D-1 of Appendix D. The following bullets document the methods and results of the City's water well location database update.

- The City provided GSI with the current version of its water well location database by email on July 31, 2020. This database was originally finalized on November 14, 2011, by GSI (2012), but has been modified by the City over time based on researching site plans and field-verifying well locations.
- GSI accessed the OWRD well log database and downloaded well logs for water wells constructed since November 14, 2011 and also within one quarter section of the City's UGB[10]. GSI downloaded the well logs and located them by the best available location information[11]. A total of 10 water wells were added to the database.
- GSI also made the following changes to the City's water well location database:
  - Location data was updated for 1 previously identified water well based on reviewing site documents (e.g., historical plans available online from OWRD).
  - Construction information was updated for 3 previously identified water wells. The updated construction information was associated with the wells being deepened.

4.2.2 Potential Perched Groundwater Areas

The potential perched groundwater areas are shown on Figure 4-2. To refine delineations of potential perched groundwater areas, a review of the following data sources was completed:

- OWRD's online database of well logs (as of July 11, 2020) for any wells or boreholes installed after November 14, 2011.
- Geotechnical investigations completed after November 14, 2011 (specifically Siemens and Associates (2008) and FEI (2012)).
- DEQ Cleanup Program historic and ongoing cleanup site Environmental Cleanup Site Information (ECSI) database records.

An updated map of potential perched groundwater areas in the City is provided in Figure 4-2. This map is identical to the GSI (2012) perched groundwater map with the exception of perched groundwater around the Old Mill District. The area of perched groundwater around the Old Mill District was expanded to encompass the extent of the Deschutes River Alluvium geologic unit and observations from geotechnical investigations discussed in Section 2. The presence of perched groundwater in this formation is likely a combination of leakage from the Deschutes River and/or un-lined canals and also the comparatively low permeability of the Deschutes River Alluvium formation (see Section 2.2.1). While this area has limited water level data from water wells, geotechnical investigations[12] and DEQ Cleanup Program records[13] indicate that zones of perched groundwater at depths of less than ten feet are common throughout this area, and are increasingly prevalent towards the Deschutes River. Note that the areas of perched groundwater in Figure 4-2 is a planning-level tool that is not intended to represent conditions at all sites (e.g., site-scale conditions may result in the absence of perched groundwater in an area where Figure 4-2 identified perched groundwater as

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[10] Per the methods and search criteria outlined in GSI, 2012, an additional quarter section was included in the water well search to account for possible wells just outside of the UGB boundary but potentially within 500 feet of a City-owned UIC.
[11] Wells were located based on the best available location information, which includes the following subsets of location data (listed in decreasing location accuracy): latitudes and longitudes; City tax lot numbers; street addresses; ¼-¼ section; ¼-section; or section.
[12] See Siemens and Associates (2008) and FEI (2012)
[13] See ECSI Site ID's 1451 (Daw Forest Products Co.) and 1600 (Former Shevlin Hixon Hill)

being present). For example, boring ITB-04 was advanced in Deschutes River alluvium and no perched groundwater was encountered (see boring location in Figure 2-1).

4.3 Conclusions and Recommendations

The following conclusions and recommendations are provided for the City's database of water well locations and map of potential perched groundwater areas:

- Water Well Locations: A database of water well locations in the City (which includes municipal supply wells, irrigation wells, and domestic supply wells) was updated based on new well installations since November 14, 2011. An updated map of the water well locations is provided in Figure 4-1.

  It is necessary to understand water well locations when implementing UIC projects because DEQ has established setback requirements between water wells and drywells/drill holes. This water well database update can be used by the City to update its online water well location mapping tools, and to develop an updated System-Wide Assessment for DEQ, which will be required as part of the upcoming renewal of the City's UIC permit (the City's UIC permit expires on April 30, 2023).

- Potential Perched Groundwater Areas: Perched groundwater occurs where groundwater accumulates on a bed or lens of low-permeability material above the regional groundwater table. The City's map showing areas with the potential for perched groundwater, originally developed in 2012, was updated with information from new water well installations (from OWRD's online records) and geotechnical investigations conducted to support site development. An updated map showing areas of the City with the potential for perched groundwater is provided in Figure 4-2.

  It is necessary to understand areas of perched groundwater when implementing UIC projects because DEQ has established minimum vertical separation distances between groundwater and drywells/drill holes. This updated delineation of perched groundwater areas can be used to update the City's mapping to help the community better understand injection depth options and to develop an updated System-Wide Assessment for DEQ, which will be required as part of the upcoming renewal of the City's UIC permit (the City's UIC permit expires on April 30, 2023).

SECTION 5: **Conclusions and Recommendations**

The following sections present the primary conclusions of this stormwater infiltration evaluation update, which will be used as part of an upcoming revision to the City's SWMP.

5.1 Updated Drainage Area Map

The City's 2014 SWMP divided the City into three Drainage Areas based on the favorability of soils to infiltrating stormwater and infiltration strategy (i.e., drywells, drill holes, or low impact development). An updated map of Drainage Areas in the City of Bend is provided in Figure 2-2, which can be incorporated in the City's mapping tools and the upcoming SWMP update. The map updates the Drainage Areas in the City's 2014 SWMP by: (1) expanding drainage area delineations into expansion areas identified in the City's comprehensive plan (i.e., Drainage Area A is extended to the north and east, and Drainage Area C is expanded to the west into the West Expansion Area) and (2) delineating the Deschutes River Alluvium, where lower soil permeability and saturated conditions may be encountered.

The drainage areas in Figure 2-2 are intended as a planning tool that reflect general conditions. The feasibility of infiltration at individual sites may be different than the general conditions represented in Figure 2-2 due to: (1) heterogeneities within a drainage area (for example, well-draining sites may exist within Drainage Area C, if pumice is encountered beneath the tuff) and (2) the fact that boundaries between the drainage areas are neither sharp nor distinct (i.e., drainage areas are based on regional-scale geologic maps, which may not reflect site-scale geology, and geologic boundaries may be transitional in nature). Because of the potential for deviation from the general conditions, site-specific infiltration testing is necessary prior to implementing an infiltration project.

5.2 Updated Drainage Area Characteristics (Exfiltration Rates and Tuff Depth/Thickness)

This report updates Drainage Area characteristics, which are used as a planning-level tool to guide infiltration projects in the City. Updated estimates for exfiltration rates of drywells and drill holes in each Drainage Area are provided in Table 2-2, and updated information about the depth and thickness of tuff layers[14] in southwest Bend are provided in Table A-7 of Appendix A. These exfiltration rates and information about tuff depths are intended for planning purposes and not for design; site-specific exploration and testing should be performed to inform infiltration facility feasibility and design.

5.3 UIC Ageing Evaluation

Over time, the capacity of a drywell or drill hole to infiltrate declines due to clogging with solids from stormwater, called "UIC ageing" in this report. Based on drywell and drill hole capacity testing conducted over the past 10 years, we developed estimates for relative performance declines over time for the different types of infiltration devices (i.e., drywells and drill holes) and traffic categories (i.e., <1,000 vehicle trips per day and ≥1,000 vehicle trips per day):

- **Drywells and Drill Holes.** Drill hole performance declines faster than drywell performance. Specifically, drill hole performance declines generally range from about 60 percent to 80 percent after about 10 years of infiltration, and drywell performance declines generally range from less than a percent to about 30 percent after 10 years of infiltration. This trend is also evidence on an average basis, as drill holes

[14] Tuff is a volcanic ash that is common in the shallow subsurface soils of southwest Bend and is characterized by very low potential for infiltration.

were characterized by average performance declines of 6.0 percent per year, while drywells were characterized by average performance declines of 2.9 percent per year. The faster ageing of drill holes may be caused by the lower level of pretreatment typically installed at drill holes, or their smaller sidewall area which would make them more susceptible to clogging over time (drill holes are six-inch diameter devices while drywells are typically four-foot diameter devices).

- **Traffic Categories.** Drywells that drain streets with ≥1,000 TPD age slightly faster than drywells that drain streets with <1,000 TPD (specifically, drywells draining ≥1,000 TPD streets were characterized by average performance declines of 4.5 percent per year, while drywells draining <1,000 TPD streets were characterized by average performance declines of 2.9 percent per year.

Based on this evaluation of UIC ageing, we recommend that: (1) the City prioritize preventative maintenance activities on drill holes, and on UICs that drain streets with ≥1,000 TPD, which exhibit more rapid performance declines, and (2) the City encourage stormwater management using drywells when feasible at a site given that they appear to be less susceptible to performance declines than drill holes.

5.4 Updated Water Well Location Database

It is necessary to understand water well locations when implementing infiltration projects because DEQ has established setbacks between water wells and drywells/drill holes. A database of water well locations in the City (which includes municipal supply wells, irrigation wells, and domestic supply wells) was updated based on site visits conducted as part of a City reconnaissance program and records of new well installations available from OWRD. An updated map of the water well locations is provided in Figure 4-1. This water well database update can be used by the City to update its online water well location mapping tools, and to develop an updated System-Wide Assessment for DEQ, which will be required as part of the upcoming renewal of the City's UIC permit (the City's UIC permit expires on April 30, 2023).

5.5 Updated Potential Perched Groundwater Map

Perched groundwater occurs where groundwater accumulates on a bed or lens of low-permeability material above the regional groundwater table. It is necessary to understand areas of perched groundwater when implementing infiltration projects because DEQ has established requirements for minimum vertical separation distances between groundwater and drywells/drill holes. The City's map showing areas with the potential for perched groundwater, originally developed in 2012, was updated with information from new water well installations (from OWRD's online records) and geotechnical investigations conducted to support site development. An updated map showing areas of the City with the potential for perched groundwater is provided in Figure 4-2. This updated map can be used to update the City's mapping to help the community better understand injection depth options and to develop an updated System-Wide Assessment for DEQ, which will be required as part of the upcoming renewal of the City's UIC permit (the City's UIC permit expires on April 30, 2023).

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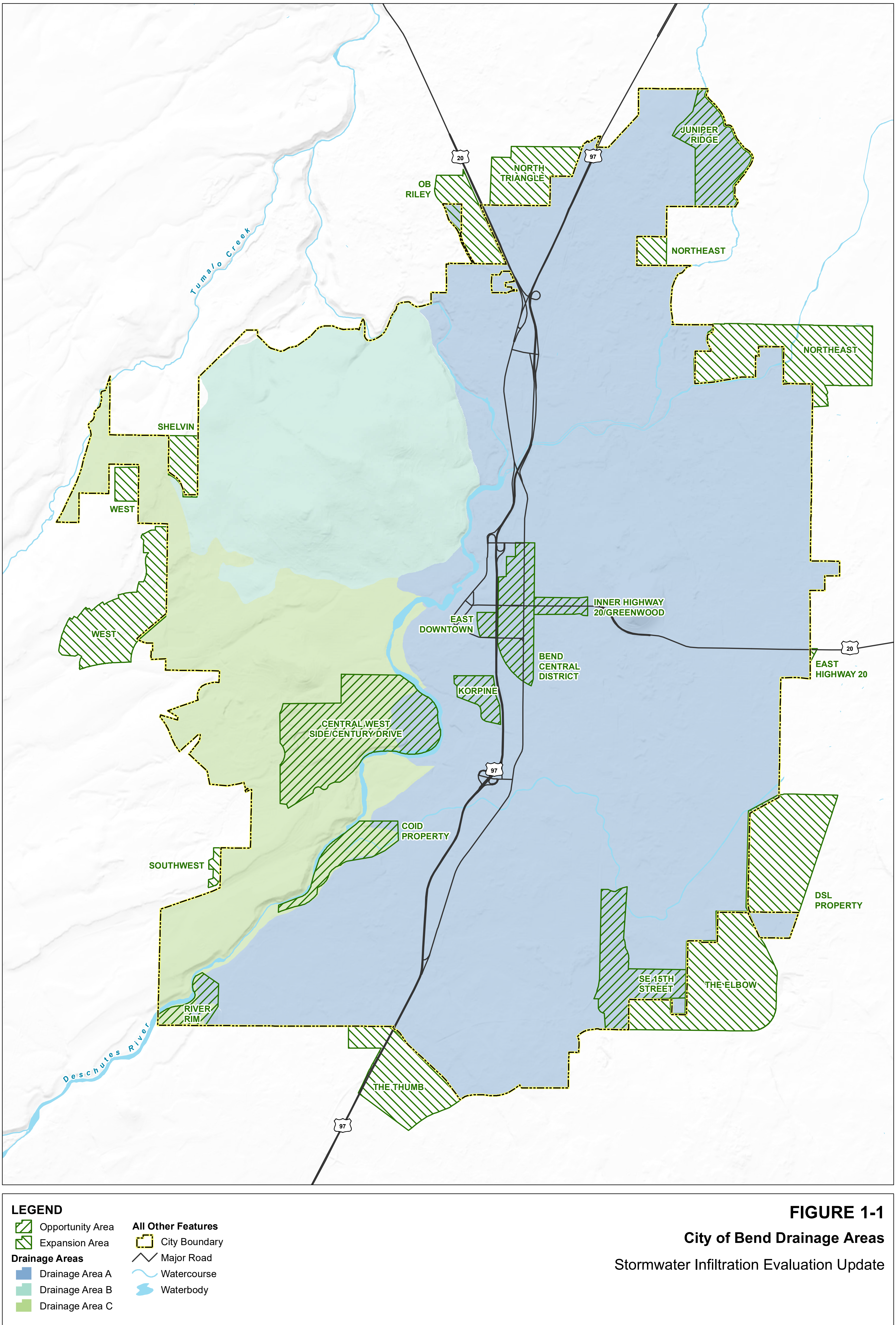


FIGURE 1-1

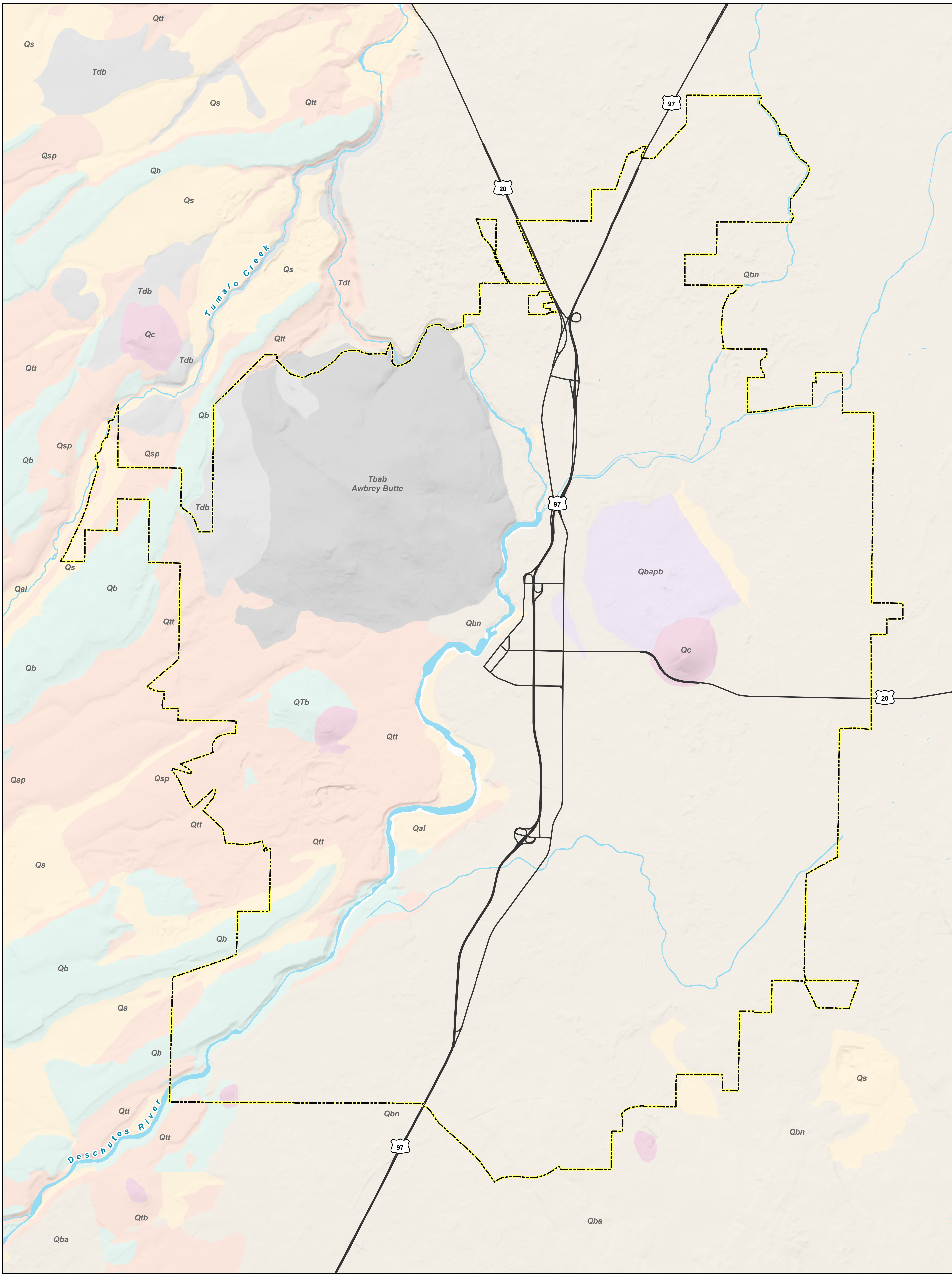
City of Bend Drainage Areas

Stormwater Infiltration Evaluation Update

GSI Water Solutions, Inc.

Date: September 1, 2020
Data Sources: DOGAMI, OGIC, USGS, ESRI

Document Path: Y:\0237_City_Bend\Source_Figures\018_Bend_Infiltration\Drainage_Report_Update\Figure1-1_Drainage Areas.mxd



LEGEND

Unconsolidated Sediments

- Quaternary Unconsolidated Deposits (Includes Qal, Qe, and Qs of Sherrod and others, 2004)

Miocene to Pleistocene Volcanic and Pyroclastic Rocks

- Newberry Basalt (Qbn)
- Tuff/Pumice (Includes Qsp, Qtt, Qds, and Tdt of Sherrod and others, 2004. Tumalo Tuff is stipled.)
- Basaltic Andesite of Pilot Butte (Qbapb)
- Cinder Cone Deposits (Qc)
- Quaternary Basalt and Andesite (Includes Qb and Qba of Sherrod and others, 2004)
- Basalt of Awbrey Butte (Tbab)

Miocene to Pleistocene Deschutes Formation

- Basalt (Tdt)

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

FIGURE 1-2

Surficial Geology in the City of Bend

Stormwater Infiltration Evaluation Update

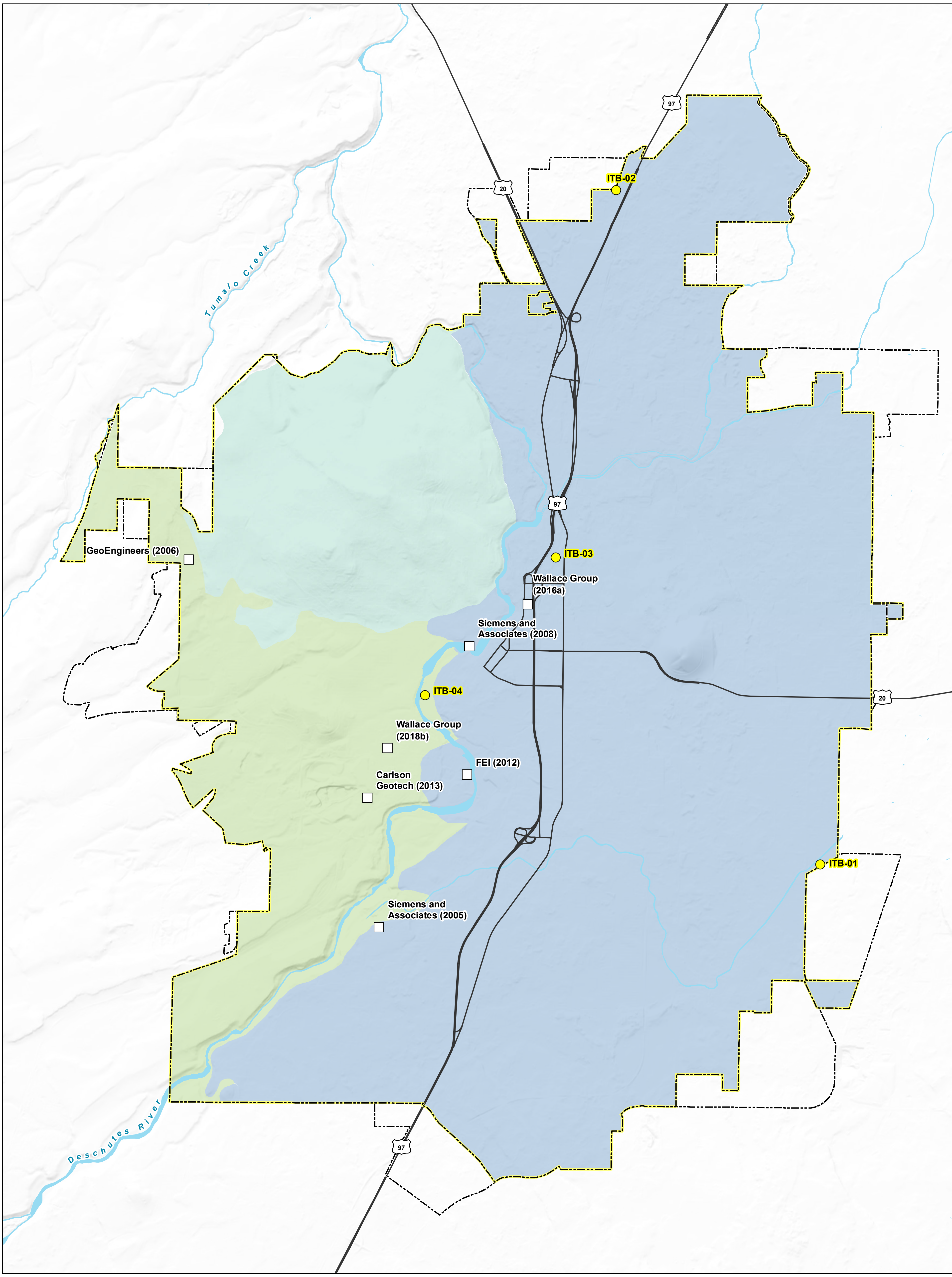
N

0 2,000 4,000 6,000
Feet

GSI Water Solutions, Inc.

Date: October 27, 2020
Data Sources: DOGAMI, OGIC, USGS, ESRI

Document Path: Y:\0237_City_Bend\Source_Figures\018_Bend_Infiltration\Drainage_Report_Update\Figure1-2_Area_Overview.mxd



LEGEND

- 2020 Geotechnical Boring
- Infiltration Test Location

Drainage Areas

- Drainage Area A
- Drainage Area B
- Drainage Area C

All Other Features

- City Boundary
- Urban Growth Boundary
- Major Road
- Watercourse
- Waterbody

FIGURE 2-1

Data Sources Used to Update Drainage Area Characteristics

Stormwater Infiltration Evaluation Update

NOTE

BGS: Below Ground Surface

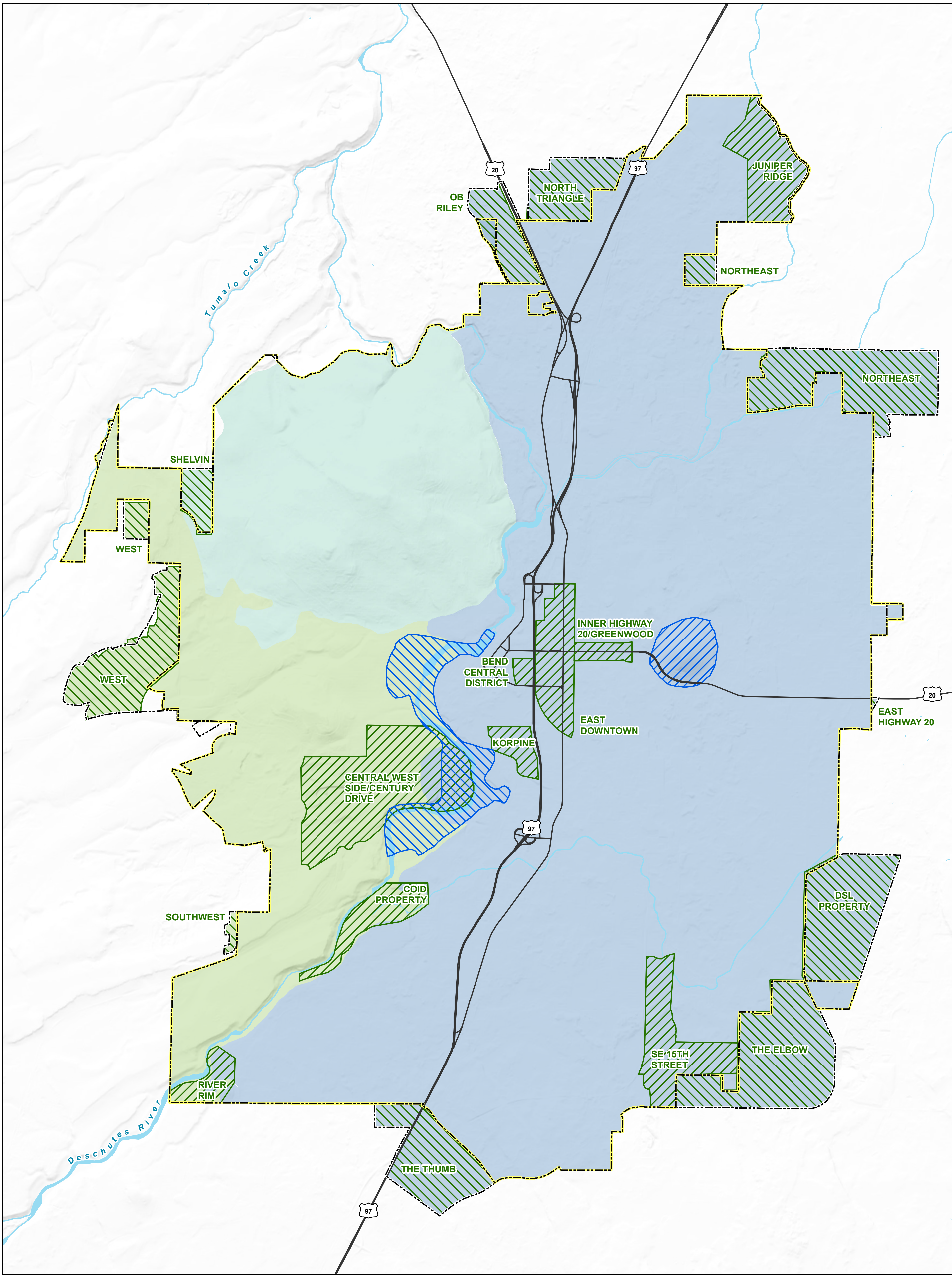
Date: October 27, 2020
Data Sources: DOGAMI, OGIC, USGS, ESRI

N

0 2,000 4,000 6,000
Feet

GSI Water Solutions, Inc.

Document Path: Y:\0237_City_Bend\Source_Figures\018_Bend_Infiltration\Drainage_Report_Update\Figure2-1_DataSources.mxd



LEGEND

- Alluvium of the Deschutes River
- Basalt of Pilot Butte
- Opportunity Area
- Expansion Area

Drainage Areas

- Drainage Area A
- Drainage Area B
- Drainage Area C

All Other Features

- City Boundary
- Urban Growth Boundary
- Major Road
- Watercourse
- Waterbody

Date: August 31, 2020
Data Sources: DOGAMI, OGIC, USGS, ESRI

N

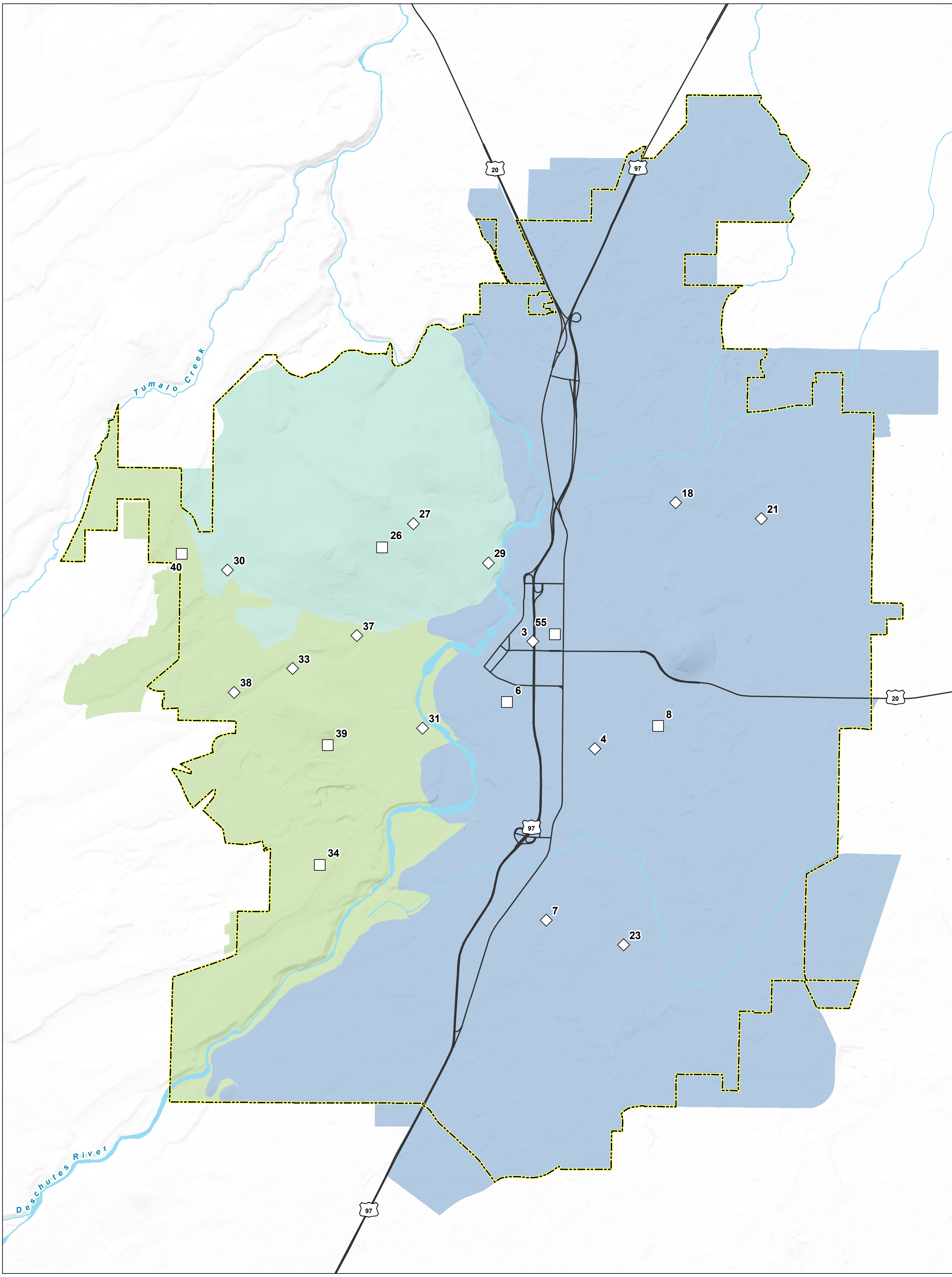
0 2,000 4,000 6,000
Feet

FIGURE 2-2

Updated Drainage Area Map

Stormwater Infiltration Evaluation Update

Document Path: Y:\0237_City_Bend\Source_Figures\018_Bend_Infiltration\Drainage_Report_Update\Figure2-2_.mxd



LEGEND

Infiltration Test Locations

- UICs Recommended for Testing Drywell
- UICs Recommended for Testing Drill Hole

Drainage Areas

- Drainage Area A
- Drainage Area B
- Drainage Area C

N

0 2,000 4,000 6,000 Feet

GSI Water Solutions, Inc.

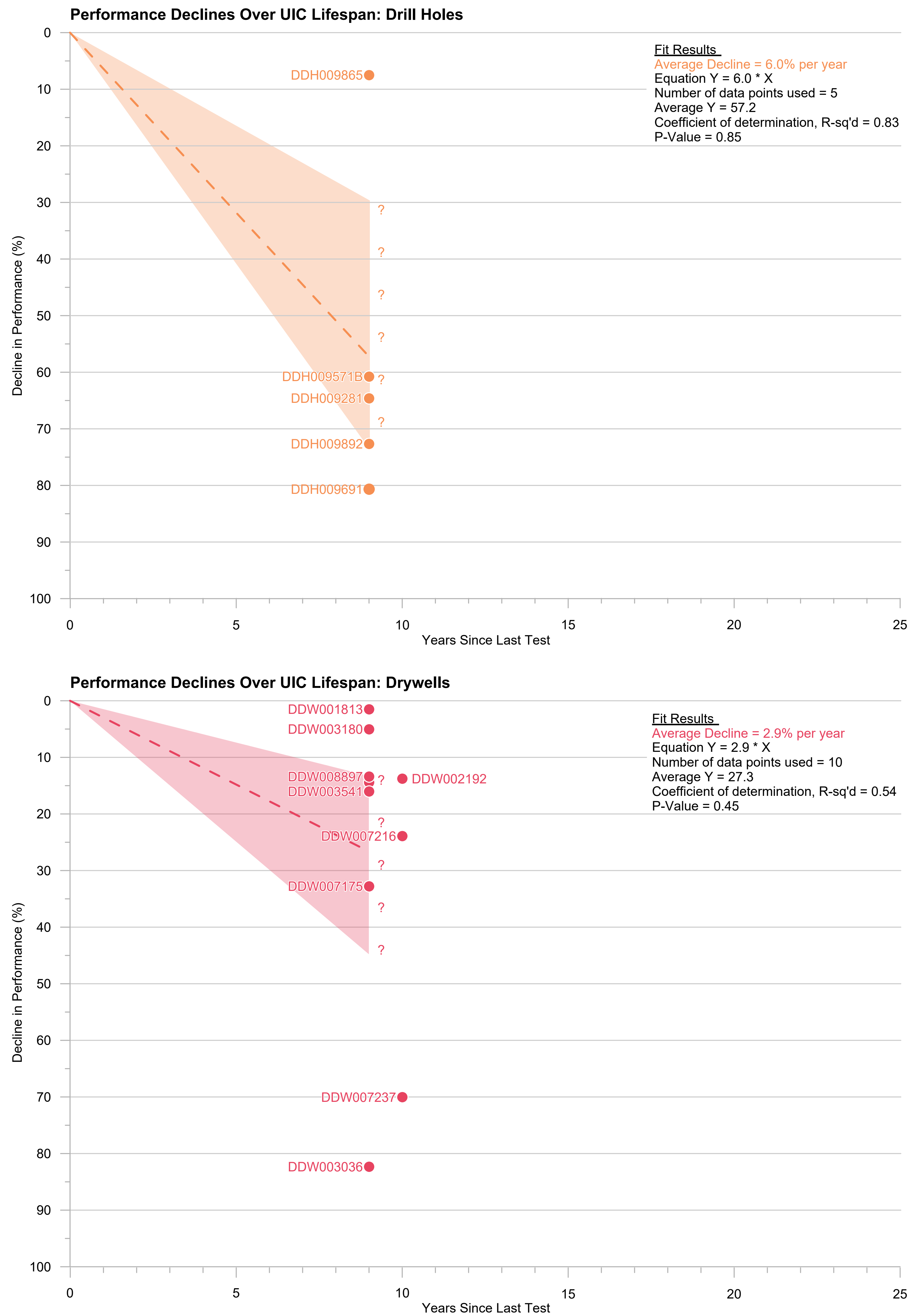
Date: October 27, 2020
Data Sources: DOGAMI, OGIC, USGS, ESRI

FIGURE 3-1

UICs Selected for 2020 Testing

Stormwater Infiltration Evaluation Update

Document Path: Y:\0237_City_Bend\Source_Figures\018_Bend_Infiltration\Drainage_Report_Update\Figure3-1_UICs_Selected_2020_Testing.mxd



LEGEND

- Drill Holes
- Drywells
- Linear Regression of Data
- 95% Confidence Interval for the Mean
- ? Trends of Performance Declines Beyond the Extent of the Current Dataset Is Unknown

FIGURE 3-2

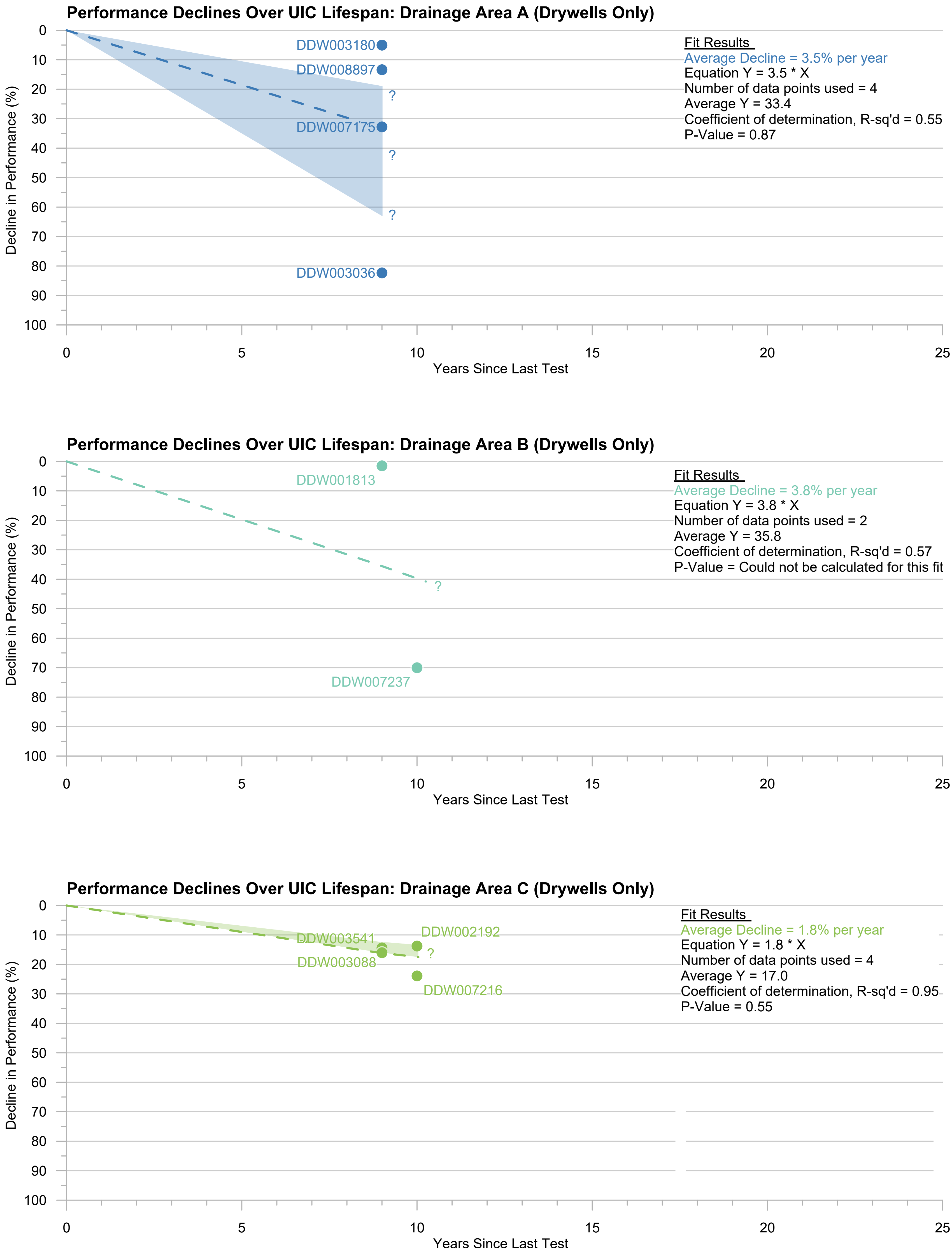
Performance Declines Over Time for Drywells and Drill Holes

Stormwater Infiltration Evaluation Update

NOTES

- Decline in UIC performance calculated using Falling Head infiltration testing data
- UICs that exhibited an increase in performance are not presented
- The calculated confidence intervals are estimates that the population mean for a given x value will fall within the confidence interval; the confidence interval does not mean that for any given UIC, there is a 95% probability that the performance of the UIC will fall within the confidence interval.
- The P-Value indicates the relative significance of the confidence interval's fit; commonly, a P-Value less than 0.05 indicates non-random (significant) results.

GSI Water Solutions, Inc.



LEGEND

- Drainage Area A
- Drainage Area B
- Drainage Area C
- Linear Regression of Data
- 95% Confidence Interval for the Mean
- ? Trends of Performance Declines Beyond the Extent of the Current Dataset Is Unknown

NOTES

- Decline in UIC performance calculated using Falling Head infiltration testing data
- UICs that exhibited an increase in performance are not presented
- Drill Hole data excluded from analysis in an attempt to limit/reduce the influence of UIC types
- The calculated confidence intervals are estimates that the population mean for a given x value will fall within the confidence interval; the confidence interval does not mean that for any given UIC, there is a 95% probability that the performance of the UIC will fall within the confidence interval.
- The P-Value indicates the relative significance of the confidence interval's fit; commonly, a P-Value less than 0.05 indicates non-random (significant) results.

FIGURE 3-3

Performance Declines Over Time for Drywells by Drainage Area

Stormwater Infiltration Evaluation Update

GSI Water Solutions, Inc.

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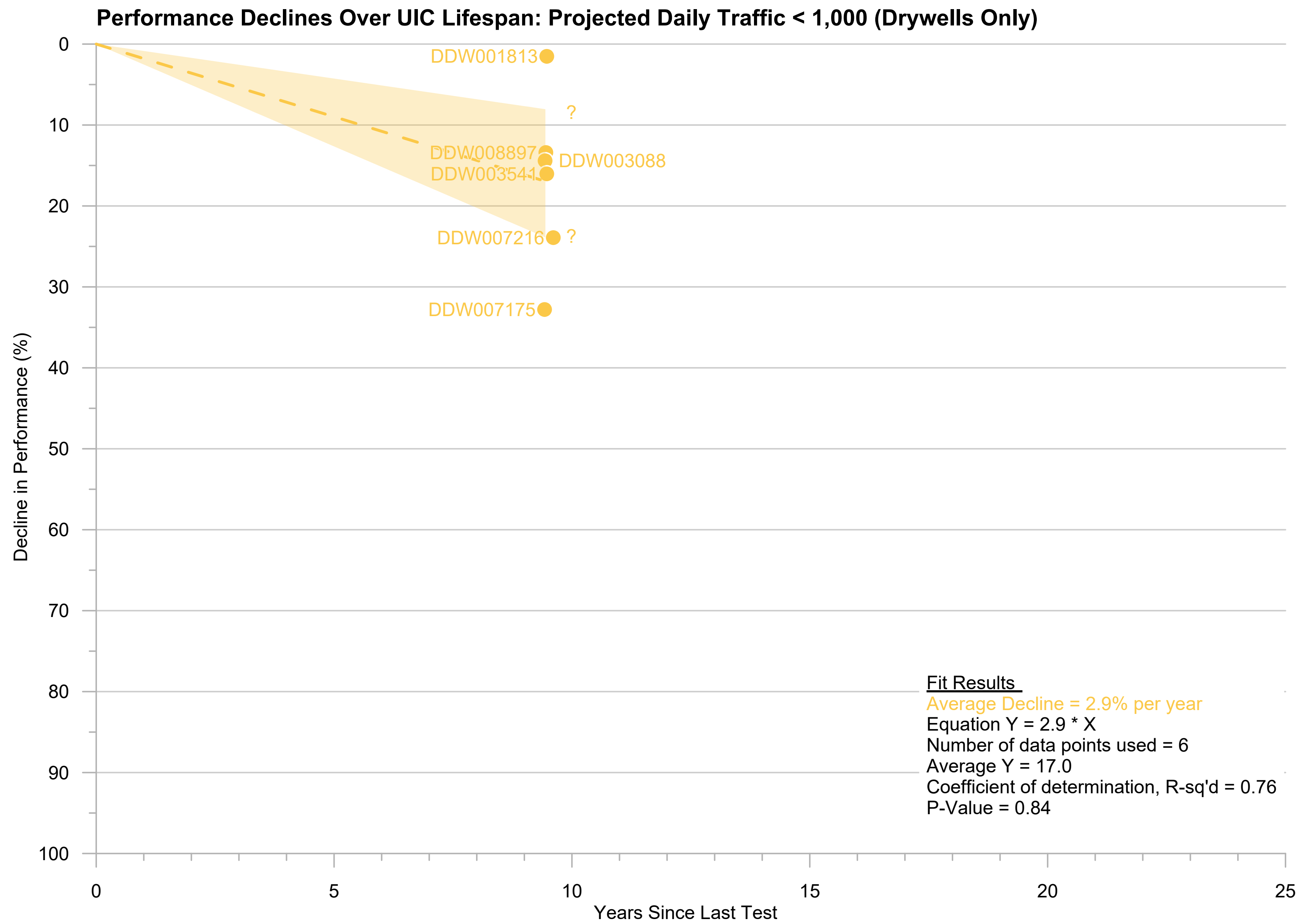
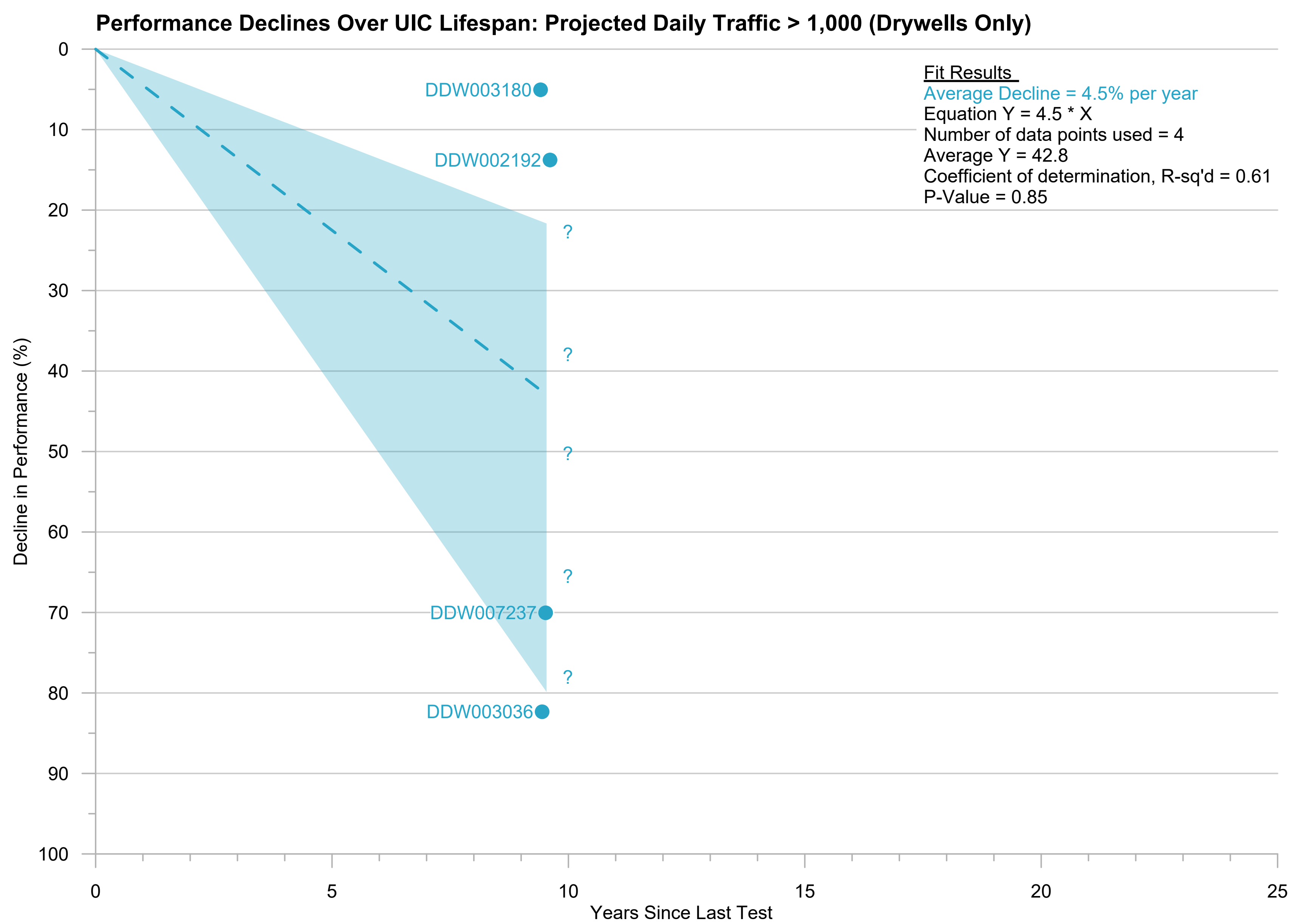




LEGEND

- Drill Holes
- Drywells
- Linear Regression of Data
- 95% Confidence Interval for the Mean
- ? Trends of Performance Declines Beyond the Extent of the Current Dataset Is Unknown

FIGURE 3-4

Performance Declines Over Time for Drywells by Traffic Category

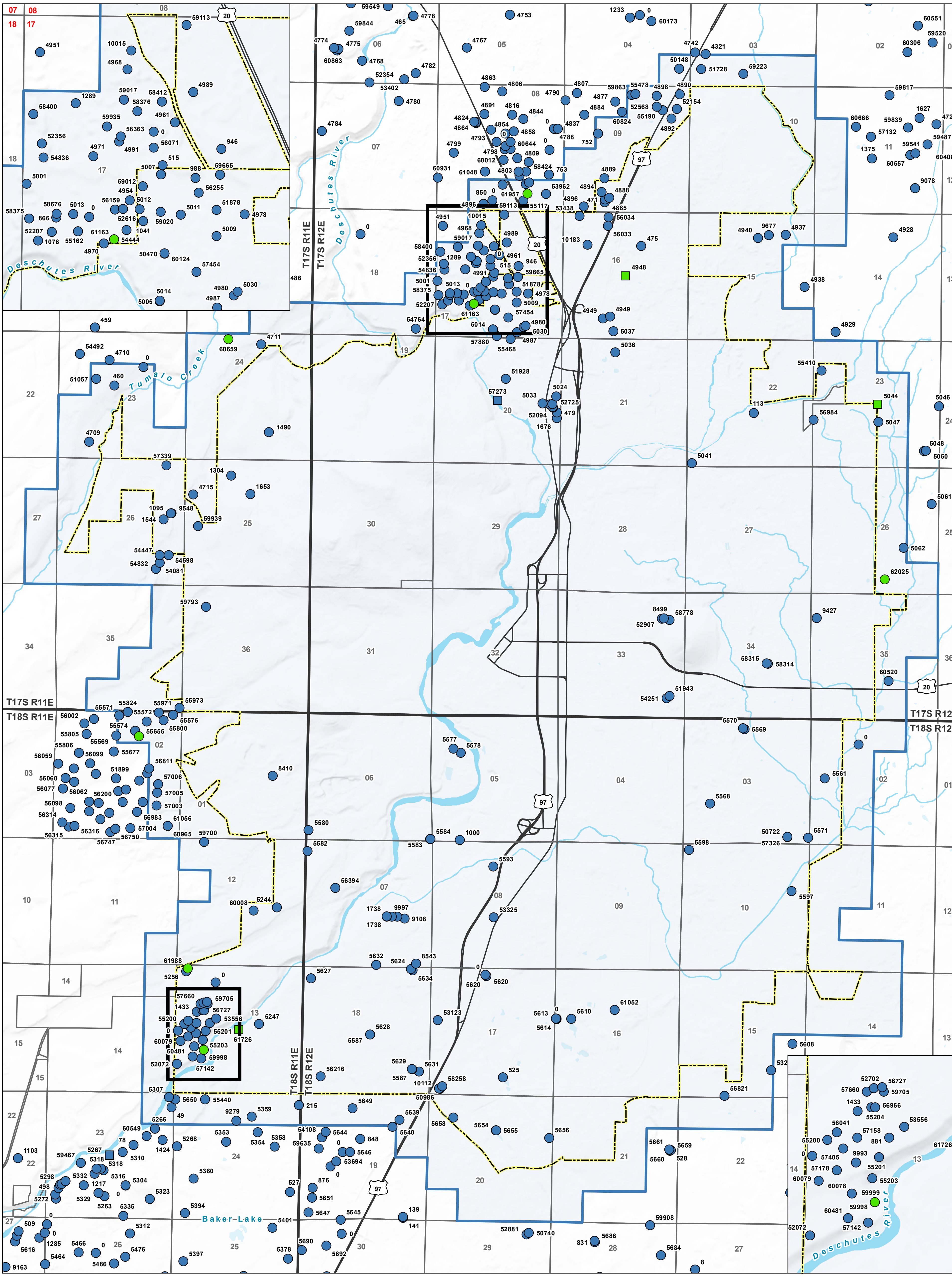
Stormwater Infiltration Evaluation Update

NOTES

- Decline in UIC performance calculated using Falling Head infiltration testing data
- UICs that exhibited an increase in performance are not presented
- The calculated confidence intervals are estimates that the population mean for a given x value will fall within the confidence interval; the confidence interval does not mean that for any given UIC, there is a 95% probability that the performance of the UIC will fall within the confidence interval.
- The P-Value indicates the relative significance of the confidence interval's fit; commonly, a P-Value less than 0.05 indicates non-random (significant) results.

GSI Water Solutions, Inc.

Y:\0237_City_Bend\Source_Figures\018_Bend_Infiltration



LEGEND

Well Log Search Boundary (2011)

Water Well, Located Using

Coordinates, OWRD

Section

Previously Located

New or Previously Unlocated

All Other Features

City Boundary

Major Road

Watercourse

Waterbody

FIGURE 4-1

Water Well Location Map

Stormwater Infiltration Evaluation Update

N

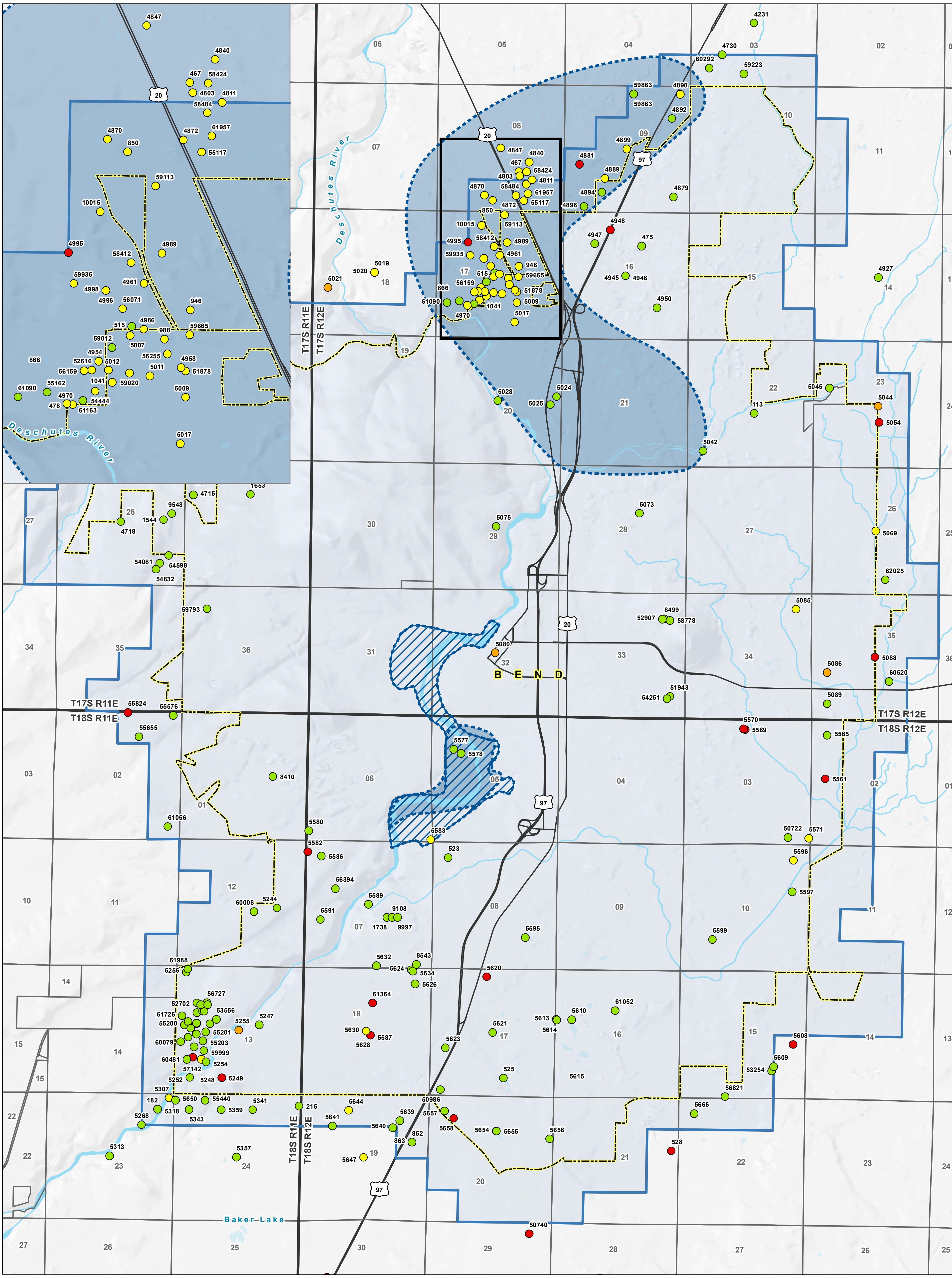
0 2,000 4,000 6,000

Feet

GSI Water Solutions, Inc.

Date: October 27, 2020
Data Sources: OWRD, OGIC, USGS, ESRI

Document Path: Y:\0237_City_Bend\Source_Figures\018_Bend_Infiltration\Drainage_Report_Update\Figure4-1_Water_Well_Inventory.mxd, abarry



LEGEND

- Potential Area with Perched Water
- Potential Area with Perched Water, Update
- Well Log Search Boundary

Water Wells with Static Water Levels within 225 feet of Ground Surface

- 0 - 30 feet SWL
- 30 - 100 feet SWL
- 100 - 225 feet SWL
- >225 feet SWL

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

Date: October 9, 2020
Data Sources: OWRD, OGIC, USGS, ESRI

N

0 2,000 4,000 6,000
Feet

GSI Water Solutions, Inc.

FIGURE 4-2

Potential Areas of Perched Groundwater

Stormwater Infiltration Evaluation Update

City of Bend

Appendix A. Compilation of Geotechnical Information and Well Logs for Updating the GeoEngineers (2007) Drainage Area Report

October 2020

Prepared by:
GSI Water Solutions, Inc.
55 SW Yamhill St., Suite 300, Portland, OR, 97204

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Contents

Tables

1. Background

Based on a review of geotechnical reports and U.S. Geological Survey studies, GeoEngineers (2007) divided the City of Bend (City) into four Drainage Areas that share common stormwater infiltration characteristics. The Drainage Areas correspond with geologic units shown in Figure 1-2 of the report to which this appendix is attached, and are summarized in the following bullets:

- **Drainage Area 1**, located east of the Deschutes River and underlain by the Pleistocene- and Holocene-age Newberry Basalt (Qbn),
- **Drainage Area 2**, located in the northwest portion of the City and underlain by older basalt of the Awbrey Butte Shield Volcano (Tbab),
- **Drainage Area 3**, is a small area that corresponds with basaltic and andesitic cinder cones (QTp), and
- **Drainage Area 4**, located in the southwest portion of the City and underlain by tuffaceous sedimentary rocks.

Table A-1 provides a summary of the estimated hydraulic conductivities and exfiltration rates developed for the Drainage Areas from GeoEngineers (2007). The hydraulic conductivities were estimated from typical values for the predominant rock types within each Drainage Area using values from Freeze and Cherry (1979).

Table A-1. Hydraulic Conductivity and Exfiltration Rate Estimates from GeoEngineers (2007), City of Bend Drainage Areas.

Drainage Area		Hydraulic Conductivity	Drywell Exfiltration Rate [1]	Drill Hole Exfiltration Rate
GeoEngineers (2007)	Bend SWMP (2014)	(in/hr)	(ft^3/s)	(ft^3/s)
1	A	3.5	0.1	0.01
2	B	1.4	0.04	0.004
3	A	7.1	0.2	0.02
4	C	0.14	0.004	0.0004

Notes

(1) Assumes a standard double-depth drywell with an active barrel section of 10 feet

(2) Assumes a 100 feet deep, six-inch diameter drill hole

in/hr = inches per hour

ft^3/s = cubic feet per second

SWMP = Stormwater Master Plan

The City's 2014 Stormwater Master Plan (SWMP), which was developed to guide stormwater management activities in the City, made slight modifications to the GeoEngineers (2007) drainage areas. Specifically, the SWMP combined Drainage Area 1 and Drainage Area 3 into a single area ("Drainage Area A"), renamed Drainage Area 2 as "Drainage Area B," and renamed Drainage Area 4 as "Drainage Area C." The Drainage Areas in the SWMP are shown in Figure 1-1 of the report to which this appendix is attached. The SWMP made the following characterizations about infiltration in each area[1]:

[1] See Table 9.2 and discussion on Pages 10-3 and 10-4 of URS (2014)

- **Drainage Area A** is characterized by well-draining soils where drywells are generally acceptable.
- **Drainage Area B** is characterized by steep slopes and soils that are not well-draining where drywells have limited suitability,
- **Drainage Area C**, is characterized by areas with poorly-draining soils where drywells have limited suitability. Drill holes may be suitable (if the drill hole can bypass the low permeability tuff layer).

2. Compilation of Infiltration Test Data from Geotechnical Reports and Summer 2020 Infiltration Testing

This section provides a compilation of infiltration test data from geotechnical reports that the City provided to GSI Water Solutions, Inc. (GSI) (Section 2.1) and infiltration testing conducted by the Wallace Group during the summer of 2020 (Section 2.2).

2.1 Infiltration Test Data from Geotechnical Reports

This section documents the methods (Section 2.1.1) and results (Section 2.1.2) that GSI used to compile and evaluate infiltration test data from geotechnical reports.

2.1.1 Methods

The City provided GSI with 48 geotechnical investigation reports for proposed development projects in the City. The geotechnical investigations were dated between 2006 and 2019, and were conducted to support public works projects (e.g., pedestrian bridges, stormwater improvement projects, fire stations, schools, etc.) as well as residential, mixed use, and commercial developments.

Twelve (12) of the 48 geotechnical reports contained infiltration test data from newly-dug test pits or borings[2], and reported an infiltration rate or hydraulic conductivity for the project site. Note that hydraulic conductivity and infiltration rate are both indicators of soil permeability, but that they are not equivalent. Infiltration rate is the rate that water moves through soil for a given test setup (i.e., the type of infiltration device that was used and the head conditions during the test); hydraulic conductivity is the rate that water moves through soil *per unit area per unit hydraulic gradient*. In other words, infiltration rate reflects and test-specific conditions, and hydraulic conductivity is an intrinsic property of the soil.

The following sections discuss the methods that GSI used to compile infiltration rates (Section 2.1.1.1) and calculate hydraulic conductivity (Section 2.1.1.2).

2.1.1.1 Methods Used to Compile Infiltration Rates

GSI determined the location of each test in the 12 geotechnical reports based on property address and/or maps included in the reports. A total of 38 infiltration tests were documented in the reports. A geologic unit was assigned to each test location based on geologic mapping from Sherrod et al., (2004), and a drainage area was assigned to each test location based on the drainage areas in GeoEngineers (2007) and the City's 2014 SWMP (URS, 2014).

[2] Three reports contained infiltration test data from existing drywells. These reports were not included in the update of the GeoEngineers (2007) drainage area report because the measured infiltration rates were likely affected by drywell ageing.

2.1.1.2 Methods Used to Calculate Hydraulic Conductivity

If hydraulic conductivity was not provided in a geotechnical report, we used Darcy's Law to approximate hydraulic conductivity from the infiltration test data (e.g., Fetter, 1994):

$$Q = KA\nabla h \tag{A.1}$$

Where:

K is hydraulic conductivity in feet per second,

Q is the volumetric flow rate in cubic feet per second,

A is the area in square feet, and

∇h is the hydraulic gradient in feet per foot.

For a constant head test, Equation (A.1) can be re-arranged to calculate hydraulic conductivity as follows:

$$K = \frac{Q/A}{\left(\frac{h_2 - h_1}{x_2 - x_1}\right)} \tag{A.2}$$

Where:

K is hydraulic conductivity in feet per second,

Q is the constant inflow rate during the constant head test in cubic feet per second,

A is the area of the test pit bottom and sidewalls in square feet,

h_2 is the water depth (head) in the test pit during the constant head test in feet,

h_1 is the head at some point beneath the test pit (assumed to be zero), and

$x_2 - x_1$ is the distance required for the head to become zero.

In order to approximate hydraulic conductivity using Equation (A.2), the geotechnical report must have documented the volume of water infiltrated, the dimensions of the test pit or boring, and the head (water depth) in the test pit or boring. In Equation (A.2), we assumed that the value of $x_2 - x_1$ is 2.0 feet, to align the equation with assumptions in the Central Oregon Stormwater Manual Test Pit Method 4C. Eleven (11) values of hydraulic conductivity were either documented in the reports, or could be calculated by Equation (A.2) based on data provided in the reports.

2.1.2 Results

The locations of infiltration tests are summarized in Table A-2. Note that the infiltration rates in Table A-2 are unfactored.

Table A-2. Unfactored Infiltration Rates and Hydraulic Conductivities from Geotechnical Reports.

Report	Test ID	Lithology of Tested Interval	Drainage Area	Unfactored Infiltration Rate (in/hr)	Hydraulic Conductivity (in/hr)
GeoEngineers (2006)	B-5	Tuff	4 (C)	6	--
	B-13	Tuff		4.8	--
Siemens & Associates (2008)	B-2	Fill	1 (A)	--	3.1
	B-3	Fill		--	147.5 [1]
	B-4	Fill		--	103 [1]
Wallace Group (2011)	B-02	Fill	4 (C)	1.0	--
Wallace Group (2014)	TP-12	--	1 (A)	2.6	--
	TP-15	--		2.0	--
FEI Testing & Inspection (2015)	Location 1	--	4 (C)	5	3.3
	Location 2			0	8.4
Carlson Geotech (2016)	IT-1	--	1 (A)	13	--
	IT-2	--		60	--
Hart Crowser (2018a)	HC-14-1	Tuff	4 (C)	2	--
	HC-14-2	Tuff		6	--
	HC-14-3	Tuff		9	--
	HC-14-5	Weathered Tuff		7	--
	HC-14-8	Weathered Tuff		7	--
	HC-14-9	Weathered Tuff		4	--
	HC-14-11	Tuff		7	--
	HC-14-12	Tuff		<1	--
	HC-14-13	Tuff		6	--
	HC-14-14(9.5')	Tuff		2	--
	HC-14-14(14.5')	Weathered Tuff		4	--
	HC-14-15(6.8')	--		0	--
	HC-14-15(8.5')	Tuff		2	--
Hart Crowser (2018b)	HC-G-2INF	Fill	4 (C)	8	--
	HC-G-3INF	Tuff		5	--
Carlson Geotech (2018a)	IT-1	--	4 (C)	1	--
Carlson Geotech (2018b)	IT-1	--	1 (A)	1	--
	IT-2	--		1	--
Carlson Geotech (2018c)	IT-1	--	1 (A)	4.5	--
	IT-2	--		3	--
Carlson Geotech (2019)	IT-1	N. Bas. & Overlying Alluvium	1 (A)	1.0	1.4
	IT-2	N. Bas. & Overlying Alluvium		1.0	0.9
	IT-3	N. Bas. & Overlying Alluvium		1.0	1.3
	IT-4	N. Bas. & Overlying Alluvium		3.5	1.3
	IT-5	N. Bas. & Overlying Alluvium		2.5	2.2
	IT-6	N. Bas. & Overlying Alluvium		3.0	1.1

Notes

(1) Value is the average of a falling head test and a constant head test

-- = Not provided in the report or could not be calculated

2.2 Summer 2020 Infiltration Testing

This section documents the methods (Section 2.2.1) and results (Section 2.2.2) of the drilling and infiltration testing conducted during Summer of 2020 by the Wallace Group.

2.2.1 Methods

Detailed documentation of the drilling and infiltration testing methods is provided in the Wallace Group's July 31, 2020, technical memorandum (Appendix B). Each borehole was advanced to 20 feet below ground surface (bgs), so the borehole tests would represent soil characteristics over the depth interval of a typical drywell installation, and soils were logged in general accordance with the Unified Soil Classification System (USCS). After reaching total depth, the Wallace Group conducted an infiltration test in general accordance with the Central Oregon Stormwater Manual (COSM) Method C. Infiltration testing involved introducing potable water into the 3.75 inch (0.3215 feet) diameter borehole at a constant rate for at least one hour to maintain a constant water column height, and then stopping the water and flow and measuring the fall of the water level. Wallace Group staff directly measured infiltration rates during the falling-head portion of the testing. GSI calculated a hydraulic conductivity based on data collected during the constant head portion of the tests according to the following formula (USDI, 1993)[3]:

$$K = \frac{720(Q)\left[ln\left(\frac{h}{r} + \sqrt{\left(\frac{h}{r}\right)^2 + 1}\right) - 1\right]}{2\pi h^2} \tag{A.3}$$

Where:

K is hydraulic conductivity in inches per hour,

Q is the constant inflow rate during the constant head test in cubic feet per minute,

r is the radius of the borehole in feet, and

h is the height of the water column in feet.

The value of 720 in Equation (A.3) is a factor that converts feet per minute to inches per hour.

2.2.2 Results

The locations of borings advanced during summer 2020 by the Wallace Group are shown in Figure 2-1 of the report to which this appendix is attached. The calculations of hydraulic conductivity according to Equation (A.3) are provided in Table A-3, and a summary of the infiltration rates measured by Wallace Group and the hydraulic conductivities calculated by GSI are provided in Table A-4.

[3] We are using the equation for "Condition I" because the sum of the height of the water column in the borehole and the depth to groundwater at the borehole is greater than three times the height of the water column in the borehole during the test (see pg. 90 of USDI [1993]).

Table A-3. Hydraulic Conductivity Calculations from Borings Advanced During Summer 2020.

Borehole	Discharge Rate (ft^3/min)	Water Column Height (feet)	Boring Radius (feet)	Hydraulic Conductivity (in/hr)
ITB-01	3.26	5.4	0.156	41.5
ITB-02	9.16	0.5	0.156	> 3,693
ITB-03	3.89	10.2	0.156	16.6
ITB-04	0.03	10.0	0.156	0.15

Notes

ft^3/min = cubic feet per minute

in/hr = inches per hour

Table A-4. Unfactored Infiltration Rates and Hydraulic Conductivities from Borings Advanced During Summer 2020.

Borehole	Lithology of Tested Interval	Drainage Area	Unfactored Infiltration Rate (in/hr)	Hydraulic Conductivity (in/hr)
ITB-01	Newberry Basalt	1 (A)	40.2	41.5
ITB-02	Newberry Basalt	1 (A)	>6	> 3,693
ITB-03	Newberry Basalt	1 (A)	151.2	16.6
ITB-04	Deschutes River Alluvium	4 (C)	2.4	0.15

Notes

in/hr = inches per hour

3. Infiltration Test Data Summary and Exfiltration Rates in Drainage Areas

GSI estimated exfiltration rates for hypothetical drywells and drillholes within each Drainage Area. The methods that GSI used to estimate exfiltration rates are provided in Section 3.1, and GSI's summary of exfiltration rate estimates are provided in Section 3.2.

3.1 Methods

Exfiltration rates are estimated based on hydraulic conductivity. In Drainage Area A, GSI estimated the exfiltration rate using the hydraulic conductivity values from the geotechnical reports and summer 2020 infiltration tests in Table A-2 and Table A-3, respectively. In Drainage Area B and Drainage Area C, GSI estimated exfiltration rates using hydraulic conductivities that are typical values for the rock types within each drainage area from Freeze and Cherry (1979), which were also used by GeoEngineers (2007). In

Drainage Area B, the typical values from Freeze and Cherry (1979) were used because no new hydraulic conductivity values were available from the geotechnical reports. In Drainage Area C, the typical values from Freeze and Cherry (1979) were used because the lithology measured by the hydraulic conductivity values was not reported in geotechnical reports (causing uncertainty as to whether the hydraulic conductivity is representative of the dominant tuff lithology), or because the test was conducted in Deschutes River Alluvium (i.e., ITB-04, which is not the dominant lithology in Drainage Area C).

GSI estimated exfiltration from a hypothetical drywell using an equation from Appendix I of the Spokane County Public Works Guidelines for Stormwater Management (1998):

$$Q = \frac{K}{\left(\frac{1}{2\pi h}\right)\left(ln\left[\frac{h}{r} + \sqrt{\left(\frac{h}{r}\right)^2 + 1}\right] - \frac{\sqrt{\left(\frac{h}{r}\right)^2 + 1}}{\frac{h}{r}} + \frac{1}{\frac{h}{r}}\right)} \quad \text{(A.4)}$$

Where:

Q is the exfiltration rate from a drywell in cubic feet per second,

K is hydraulic conductivity in feet per second,

h is the side depth of the drywell in feet (10 feet for a standard Type B drywell), and

r is the effective radius in feet (9.5 feet for a standard Type B drywell).

Equation (A.4) was also used by GeoEngineers (2007) to estimate exfiltration rates from drywells, using the same values for *h* and *r*.

GSI estimated exfiltration from a hypothetical drill hole using an equation from Lambe and Whitman (1969):

$$Q = 2.75(K)(D)(h) \quad \text{(A.5)}$$

Where:

Q is exfiltration rate in cubic feet per second,

K is hydraulic conductivity in feet per second,

D is diameter in feet (assumed to be 6-inches),

h is head in the drill hole in feet (assumed to be 100 feet).

Equation (A.5) was also used by GeoEngineers (2007) to estimate exfiltration rates from drill holes, using the same values for *D* and *h*.

3.2 Results

Table A-5 summarizes the hydraulic conductivities in each drainage area that were used to estimate exfiltration rate. The hydraulic conductivity in Drainage Area A includes values measured by Wallace Group

(2020) in fresh rock of the Newberry Basalt[4] and values measured by Carlson Geotech (2019) in the sands and silts overlying the Newberry Basalt[5]. The values from Siemens and Associates (2008) were not used to estimate exfiltration rate in Drainage Area A because the report measured the hydraulic conductivity of fill material at the site, which is not related to the hydraulic properties of the Qbn.

Table A-5. Hydraulic Conductivities in City of Bend Drainage Areas.

Drainage Area	Number of Tests	Minimum Hydraulic Conductivity (in/hr)	Median Hydraulic Conductivity (in/hr)	Average Hydraulic Conductivity (in/hr)	Maximum Hydraulic Conductivity (in/hr)	Typical Hydraulic Conductivity (in/hr)
A	9	0.90	1.4	418	3,693	6.2 [1]
B	0	--	--	--	--	1.4 [2]
C	0	--	--	--	--	0.14 [2]

Notes

(1) Geometric mean of the 9 hydraulic conductivity values, as summarized in Table A-2 and Table A-3 and described in the text.

(2) See Table 2 of GeoEngineers (2007). Typical for the rock type in the drainage area, based on values in Freeze and Cherry (1979).

in/hr = inches per hour

Table A-6 summarizes GSI's estimate of the exfiltration rates at hypothetical drywells and drill holes in each Drainage Area.

Table A-6. Estimated Drywell and Drill Hole Exfiltration Rates in City of Bend Drainage Areas.

Drainage Area	Hydraulic Conductivity (in/hr)	Drywell Exfiltration Rate (ft^3/s)	Drill Hole Exfiltration Rate (ft^3/s)
A	6.2 [1]	0.18	0.020
B	1.4 [2]	0.04	0.004
C	0.14 [2]	0.004	0.0004

Notes

(1) Geometric mean of the 9 hydraulic conductivity values, as summarized in Table A-2 and Table A-3 and described in the text.

(2) See Table 2 of GeoEngineers (2007). Typical for the rock type in the drainage area, based on values in Freeze and Cherry (1979).

in/hr = inches per hour

ft^3/s = cubic feet per second

[4] Borings ITB-01, ITB-02, and ITB-03 in Table A-3

[5] Test pits IT-1 through IT-6 in Table A-2

4. Evaluation of Tuff Depths in Southwest Bend (Drainage Area C)

Tuff is a volcanic ash that is common in the shallow subsurface soils of southwest Bend, and that is characterized by very low potential for infiltration. GeoEngineers (2007) developed a summary table showing the occurrence of tuff in the subsurface based on geotechnical reports and water wells. GSI updated the GeoEngineers (2007) summary table based on the geotechnical reports provided by the City (dated 2006 to 2019), and driller logs of water wells downloaded from the Oregon Water Resources Department (OWRD). The updated compilation of tuff depths is organized by township, range, and section, and is provided in Table A-7. Because the nature and extent of tuff is highly complex, the information in Table A-7 is intended as a planning tool that should be further evaluated with borings at the proposed infiltration site.

5. References

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Table A-7: Tuff Depths from Well Logs and Geotechnical Reports Within Drainage Area C

WELL ID			LOCATION INFORMATION [1]											CONSTRUCTION INFORMATION						
Well Log / Borehole ID	OWRD Well/Borehole or Geotech Report	Well Name / Geotech Project Name*	T	T Char	R	R Char	S	Q 160	Q 40	Tax Lot ID	Street of Well / Borehole	Longitude	Latitude	Drilled Depth (feet)	Completed Depth (feet)	Depth to First Water (feet bgs)	Post Static Water Level (feet bgs)	Tuff Top (feet bgs)	Tuff Bottom (feet bgs)	Tuff Notes
DESC1304	OWRD WW		17	S	11	E	25			171125A000117		44.07860815	121.3560535	716	720	561	457.5	28	65	Pumice and fractured basalt interbeds
DESC1653	OWRD WW	Copperstone Well	17	S	11	E	25					44.07777778	121.3519444	700	700	528	510			
DESC4713	OWRD WW		17	S	11	E	25					44.07305556	121.36	358	350	324	310	32	73	Pumice and fractured basalt interbeds
DESC4715	OWRD WW		17	S	11	E	25					44.0763761	121.36206	572	570	475	445	0	70	Pumice
B-1	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											25	30.4	Bottom Tuff Not Encountered
B-2	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											10	30.5	Bottom Tuff Not Encountered
B-3	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											8	41.5	Bottom Tuff Not Encountered
B-4	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											0	0	No Tuff Encountered
B-5	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											20	30.8	Bottom Tuff Not Encountered
B-6	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											25	30.3	Bottom Tuff Not Encountered
B-7	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											30	35.3	Bottom Tuff Not Encountered
B-8	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											26	30.3	Bottom Tuff Not Encountered
B-9	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											25	31.3	Bottom Tuff Not Encountered
B-10	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											13	25.3	Bottom Tuff Not Encountered
B-11	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											7.5	27	Bottom Tuff Not Encountered
B-12	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											13	40.3	Bottom Tuff Not Encountered
B-13	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											20	30.3	Bottom Tuff Not Encountered
B-14	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											33	35.8	Bottom Tuff Not Encountered
B-15	GR	Shevlin Meadows Subdivision*	17	S	11	E	25											0	0	No Tuff Encountered
Drill Hole	GR	Bordeaux and Skyline*	17	S	11	E	25											18	85	
DESC1544	OWRD WW		17	S	11	E	26				62628 MCCLAIN DR	44.073517	121.366759	478	478	460	368	50	120	Pumice
DESC4716	OWRD WW		17	S	11	E	26				62628 MCCLAIN DR			475	475	401	401			
DESC4718	OWRD WW		17	S	11	E	26							386	386	360	360			
DESC9548	OWRD WW		17	S	11	E	26					44.074192	121.365494	415	415	356	356	64	118	Pumice and pink tuff
DESC54081	OWRD WW		17	S	11	E	26				SHEVLIN PARK RD	44.06853	121.3673	395	395	328	301	8	42	Pumice
DESC54447	OWRD WW		17	S	11	E	26				SHEVLIN PARK RD	44.0939	121.3673	440	440	339	326	3	55	Pumice
DESC54598	OWRD WW		17	S	11	E	26				SHERLIN PARK RD	44.06942	121.3659	480	480	323	305	9	39	Pumice
DESC54832	OWRD WW		17	S	11	E	26				SHEVLIN PARK RD	44.06783	121.3679	435	435	359	343	3	124	Pumice and sandstone interbeds
DESC51145	OWRD WW		17	S	11	E	35				SKYLINER RD			504	503	448	340	25	90	Pumice
DESC59793	OWRD WW		17	S	11	E	36	NW	NW	300	MT WASHINGTO DRIVE AND LEMHU PASS RIVE BEND, OR	44.06333333	121.3597222	475	475	395	306	0	175	Pumice and fractured basalt interbeds
DESC57575-57586	OWRD BH		17	S	11	E	36	SE	SW					25-35						
DESC57854	OWRD BH		17	S	11	E	36	NW	NE					60						
DESC57855	OWRD BH		17	S	11	E	36	NW	NE					55				50	55	
DESC57856	OWRD BH		17	S	11	E	36	NW	NE					45				40	45	
DESC57857	OWRD BH		17	S	11	E	36	NW	NE					45				45	45	
DESC57858	OWRD BH		17	S	11	E	36	NW	NE					45				45	45	
DESC57859	OWRD BH		17	S	11	E	36	NW	NE					45				45	45	
DESC57860	OWRD BH		17	S	11	E	36	NW	NE					25				25	25	
DESC57861	OWRD BH		17	S	11	E	36	NW	NE					25				25	25	
DESC57862	OWRD BH		17	S	11	E	36	NW	NE					35				25	35	
DESC57863	OWRD BH		17	S	11	E	36	NW	NE					35				25	35	
DESC5075	OWRD WW		17	S	12	E	29				RT 3, BOX 295			635	635	0	615			
DESC5080	OWRD WW		17	S	12	E	32				RT 1, BOX 354			60	60		32	37	42	Pumice and gravels
DESC51899	OWRD WW		18	S	11	E	2			171135D000100	PHASE II BROKEN TOP DEVELOPMENT, BEND			507	507	308	301	18	29	Pumice
DESC55572	OWRD WW		18	S	11	E	2				NON ASSIGNED LOT #3	44.04611111	121.37388888	470	470	440	380	0	102	Pumice and sandstone interbeds
DESC55574	OWRD WW		18	S	11	E	2				NON ASSIGNED LOT #8	44.04499999	121.37583333	512	512	492	390	0	21	Pumice and gravels
DESC55576	OWRD WW		18	S	11	E	2				NON ASSIGNED LOT #1 GUARD SHACK WELL	44.05112	121.3649	470	470	430	328	23	70	Pumice
DESC55655	OWRD WW		18	S	11	E	2	NE	NW	1000	19065 MACALPINE LP	44.048629	121.370323	496	496	370	370	16	40	Pumice
DESC55800	OWRD WW		18	S	11	E	2				NON ASSIGNED LOT 4	44.05083333	121.365	452	452	415	344	0	82	Pumice and fractured basalt interbeds
DESC55971	OWRD WW		18	S	11	E	2				NON ASSIGNED LOT #2	44.05138	-121.3672	430	430	392	359	30	62	Pumice
DESC55973	OWRD WW		18	S	11	E	2				NON ASSIGNED LOT #1 RESIDENCE	44.05194	-121.3639	430	430	400	358	2	54	Ash
DESC56811	OWRD WW		18	S	11	E	2			171135D000100	NON ASSIGNED LOT #42	44.04499999	121.36749999	430	430	370	349	9	68	Pumice and sandstone interbeds
DESC57003	OWRD WW		18	S	11	E	2			171135D000100	NON ASSIGNED LOT #51 MACALPINE LOOP BEND	44.04083333	121.36611111	405	405	365	340	30	65	Pumice and sandstone interbeds
DESC57005	OWRD WW		18	S	11	E	2			171135D000100	NON ASSIGNED LOT #52 MACALPINE LOOP	44.04222222	121.36638888	410	410	385	310	12	90	Pumice and clay interbeds
DESC57006	OWRD WW		18	S	11	E	2			171135D000100	NON ASSIGNED LOT #53 MACALPINE LOOP BEND	44.04333333	121.36611111	410	410	390	310	0	105	Pumice and sands
DESC61056	OWRD WW		18	S	11	E	2	SE	SE	1900	SKYLINE RANCH RD AND CARTWRIGHT TRACT W	44.038389	121.365611	603	603	390	362	16	120	Pumice and sands
DESC215	OWRD WW		18	S	11	E	12				19588 BUCK CANYON	44.006567	121.344293	406	406		367	26	67	Pumice and fractured basalt interbeds
DESC5244	OWRD WW		18	S	11	E	12				19489 KEMPLE	44.02921	121.3481	396	395		367			
DESC8410	OWRD WW		18	S	11	E	12					44.044258	121.348996	530	530	360	330	12	85	Pumice and fractured basalt interbeds
DESC51900	OWRD WW		18	S	11	E	12			10	BROKEN TOP DEVELOPMENT PHASE II, BEND			542	522	266	301	6	25	Ash and fractured basalt interbeds
DESC60008	OWRD WW		18	S	11	E	12	SE	NW	800	19467 CARTMILL DR BEND OR	44.028768	121.351744	476	476	395	385			
DESC52702	OWRD BH		18	S	11	E	13	SW	SW					450						
DESC53556	OWRD BH		18	S	11	E	13	SE	NW					460						
DESC55200	OWRD BH		18	S	11	E	13	SW	NW					512						
DESC55201	OWRD BH		18	S	11	E	13	SW	NW					512						
DESC55203	OWRD BH		18	S	11	E	13	SE	NW					372						
DESC55204	OWRD BH		18	S	11	E	13	SE	NE					465						
DESC56041	OWRD BH		18	S	11	E	13	SW	NW					492						
DESC56727	OWRD BH		18	S	11	E	13	SE	NW					475						
DESC56966	OWRD BH		18	S	11	E	13	SW	NW					490						

Table A-7: Tuff Depths from Well Logs and Geotechnical Reports Within Drainage Area C

WELL ID			LOCATION INFORMATION [1]											CONSTRUCTION INFORMATION						
Well Log / Borehole ID	OWRD Well/Borehole or Geotech Report	Well Name / Geotech Project Name*	T	T Char	R	R Char	S	Q 160	Q 40	Tax Lot ID	Street of Well / Borehole	Longitude	Latitude	Drilled Depth (feet)	Completed Depth (feet)	Depth to First Water (feet bgs)	Post Static Water Level (feet bgs)	Tuff Top (feet bgs)	Tuff Bottom (feet bgs)	Tuff Notes
DESC57142	OWRD BH		18	S	11	E	13	NW	SW					210						
DESC57158	OWRD BH		18	S	11	E	13	NW	SW					430						
DESC57178	OWRD BH		18	S	11	E	13	NW	SW					500						
DESC57660	OWRD BH		18	S	11	E	13	SW	NW					510						
DESC5577	OWRD WW	River Well #1	18	S	12	E	5					44.04694444	121.3177778	900	900	119	564	9	44	Ash and fractured basalt interbeds
DESC5578	OWRD WW	River Well #2	18	S	12	E	5					44.047095	121.319176	800	800		242			
DESC5579	OWRD WW		18	S	12	E	5							700	700	360	360	21	36	Pumice and fractured basalt interbeds
DESC50900	OWRD BH		18	S	12	E	5	SW	NW					40				0	40	
DESC50901	OWRD BH		18	S	12	E	5	SW	NW					40				0	40	
DESC50902	OWRD BH		18	S	12	E	5	SW	NW					40				0	40	
DESC50903	OWRD BH		18	S	12	E	5	SW	NW					40				0	40	
DESC5580	OWRD WW		18	S	12	E	6					44.03809	121.3432	367	367	328	314	1	42	Pumice and fractured basalt interbeds
DESC5582	OWRD WW		18	S	12	E	6					44.035688	121.343333	160	160			5	96	Pumice
DESC5583	OWRD WW		18	S	12	E	6					44.03777778	121.3222222	257	257	195	191			
DESC5584	OWRD WW		18	S	12	E	6					44.03777778	121.3222222	258	258	195	191	15	45	Pumice
KB-1	GR	Westside Village Marketplace*	18	S	12	E	6											11	51	Pumice and fractured basalt interbeds
KB-2	GR	Westside Village Marketplace*	18	S	12	E	6											3.5	64	Pumice and fractured basalt interbeds
WB-1	GR	Westside Village Marketplace*	18	S	12	E	6											3	62	Bend Pumice present beneath Tuff
WB-2	GR	Westside Village Marketplace*	18	S	12	E	6											2	57	Bend Pumice present beneath Tuff
WB-3	GR	Westside Village Marketplace*	18	S	12	E	6											3	55	Bend Pumice present beneath Tuff
WB-4	GR	Westside Village Marketplace*	18	S	12	E	6											3	39.5	Bottom Tuff Not Encountered
WB-5	GR	Westside Village Marketplace*	18	S	12	E	6											3	56	Bend Pumice present beneath Tuff
WB-6	GR	Westside Village Marketplace*	18	S	12	E	6											7	59	Bend Pumice present beneath Tuff
WB-7	GR	Westside Village Marketplace*	18	S	12	E	6											5	54	Bend Pumice present beneath Tuff
WB-8	GR	Westside Village Marketplace*	18	S	12	E	6											3	16	Bottom Tuff Not Encountered
WB-9	GR	Westside Village Marketplace*	18	S	12	E	6											2	57	Bend Pumice present beneath Tuff
WB-10	GR	Westside Village Marketplace*	18	S	12	E	6											2.5	55	Bend Pumice present beneath Tuff
B-1	GR	OSU Campus*	18	S	12	E	6											4.5	31.5	Bottom Tuff Not Encountered
B-2	GR	OSU Campus*	18	S	12	E	6											6	21.5	Bottom Tuff Not Encountered
B-4	GR	OSU Campus*	18	S	12	E	6											6	14	Bottom Tuff Not Encoutnered
DESC5581	OWRD BH		18	S	12	E	6	SW	SW					40				15	40	Black claystone
DESC51804	OWRD BH		18	S	12	E	6	SW	NW					45				15	45	Red fractured tufstone (brown tufstone above)
DESC51805	OWRD BH		18	S	12	E	6	SW	NW					58				48	58	Red tufstone (brown tufstone above)
DESC51806	OWRD BH		18	S	12	E	6	SW	NW					39				28	39	Fractured red tufstone (brown turfstone above)
DESC51807	OWRD BH		18	S	12	E	6	SW	NW					80				32	80	Fractured red tufstone (brown turfstone above)
DESC51808	OWRD BH		18	S	12	E	6	SW	NW					48				28	48	Fractured red tufstone (brown turfstone above)
DESC51809	OWRD BH		18	S	12	E	6	SW	NW					80				37	80	Fractured red tufstone (brown turfstone above)
DESC51810	OWRD BH		18	S	12	E	6	SW	NW					55				53	55	Fractured red tufstone (brown turfstone above)
DESC51811	OWRD BH		18	S	12	E	6	SW	NW					50				25	50	Fractured red tufstone (brown turfstone above)
DESC51812	OWRD BH		18	S	12	E	6	SW	NW					50				25	50	Fractured red tufstone (brown turfstone above)
DESC53855	OWRD BH		18	S	12	E	6	NW	SE					25						
DESC53856	OWRD BH		18	S	12	E	6	NW	SE					25						
DESC53857	OWRD BH		18	S	12	E	6	NW	SE					29				0	19	
DESC57655	OWRD BH		18	S	12	E	6	NE	NE									10	27	Pumice between tuft layers
DESC57655	OWRD BH		18	S	12	E	6	NE	NE					67				47	55	
DESC57656	OWRD BH		18	S	12	E	6	NE	NE									5	40	Pumice between tuft layers
DESC57656	OWRD BH		18	S	12	E	6	NE	NE					95				95	>95	
DESC57782	OWRD BH		18	S	12	E	6	NE	NE					20						
DESC57783	OWRD BH		18	S	12	E	6	NE	NE					20						
DESC57784	OWRD BH		18	S	12	E	6	NE	NE					20						
DESC57785	OWRD BH		18	S	12	E	6	NE	NE					20						
DESC57815	OWRD BH		18	S	12	E	6	SW	SE					20						
DESC57816	OWRD BH		18	S	12	E	6	SW	SE					20						
DESC57817	OWRD BH		18	S	12	E	6	SW	SE					20						
DESC57818	OWRD BH		18	S	12	E	6	SW	SE					20						
DESC57819	OWRD BH		18	S	12	E	6	SW	SE					20						
DESC57820	OWRD BH		18	S	12	E	6	SW	SE					20						
DESC57821	OWRD BH		18	S	12	E	6	SW	SE					50				50	>50	
DESC57822	OWRD BH		18	S	12	E	6	SW	SE					40				40	>40	
DESC57823	OWRD BH		18	S	12	E	6	SW	SE					35				35	>35	
DESC1738	OWRD WW	Rock Bluff #2	18	S	12	E	7				61473 BLAKELY RD	44.02777778	121.3288889	800	800	404	402.5	24	86	Pumice and fractured basalt interbeds
DESC5585	OWRD WW	Westwood Well	18	S	12	E	7					44.03555556	121.3419444	331	310		277	10	48	Pumice
DESC5586	OWRD WW		18	S	12	E	7							311	311	306	254			
DESC5587	OWRD WW		18	S	12	E	7					44.01444444	121.3325	388	385	367	349			
DESC5589	OWRD WW		18	S	12	E	7							378	378		360			
DESC5591	OWRD WW		18	S	12	E	7							408	408		378	225	277	Pumice
DESC8543	OWRD WW	Roats - Well # 9	18	S	12	E	7				CORNER BROOKSWOOD BLVD AND PINE BROOK	44.02333333	121.3244444	500	500	382	386	10	21	Gray vesicular basalt and broken rock
DESC9108	OWRD WW	Rock Bluff # 1	18	S	12	E	7					44.02805556	121.3277778	812	812	389	376	50	81	Pumice and gravels
DESC9997	OWRD WW	Rock Bluff # 3	18	S	12	E	7				POWERS RD	44.028269	121.32897	850	850	395	395	50	79	Pumice and fractured basalt interbeds
DESC56394	OWRD WW		18	S	12	E	7			181207CB01700	19717 MOUNT BACHELOR VILLAGE DR	44.03151	121.338875	465	465	327	302	4	56	Pumice

Table A-7: Tuff Depths from Well Logs and Geotechnical Reports Within Drainage Area C

WELL ID			LOCATION INFORMATION [1]											CONSTRUCTION INFORMATION						
Well Log / Borehole ID	OWRD Well/Borehole or Geotech Report	Well Name / Geotech Project Name*	T	T Char	R	R Char	S	Q 160	Q 40	Tax Lot ID	Street of Well / Borehole	Longitude	Latitude	Drilled Depth (feet)	Completed Depth (feet)	Depth to First Water (feet bgs)	Post Static Water Level (feet bgs)	Tuff Top (feet bgs)	Tuff Bottom (feet bgs)	Tuff Notes
B-1	GR	Rock Bluff Reservoir*	18	S	12	E	7											25	36	Bottom Tuff Not Encountered
B-2	GR	Rock Bluff Reservoir*	18	S	12	E	7											0	0	No Tuff Encountered
B-3	GR	Rock Bluff Reservoir*	18	S	12	E	7											21	36	Bottom Tuff Not Encountered
B-4	GR	Rock Bluff Reservoir*	18	S	12	E	7											20	36	Bottom Tuff Not Encountered
B-5	GR	Rock Bluff Reservoir*	18	S	12	E	7											27	36	Bottom Tuff Not Encountered
B-6	GR	Rock Bluff Reservoir*	18	S	12	E	7											25	65	Bottom Tuff Not Encountered
B-7	GR	Rock Bluff Reservoir*	18	S	12	E	7											19	55	Bottom Tuff Not Encountered
B-8	GR	Rock Bluff Reservoir*	18	S	12	E	7											21	66	Bottom Tuff Not Encountered
B-9	GR	Rock Bluff Reservoir*	18	S	12	E	7											24	28	Bottom Tuff Not Encountered
B-10	GR	Rock Bluff Reservoir*	18	S	12	E	7											31	36	Bottom Tuff Not Encountered
B-11	GR	Rock Bluff Reservoir*	18	S	12	E	7											24	36	Bottom Tuff Not Encountered
B-12	GR	Rock Bluff Reservoir*	18	S	12	E	7											18	28	Bottom Tuff Not Encountered
DESC523	OWRD WW		18	S	12	E	8							484	484	470	461	58	80	Pumice
DESC5593	OWRD WW		18	S	12	E	8				20184 REED LANE			465	465	449	433	19	55	Gray fractured rock
DESC5595	OWRD WW		18	S	12	E	8							570	570		530	7	49	Soft gray lava and cinders

Notes:

* Water Well Location Database updated through July 11, 2020. See below for geotech project report references:

OSU Campus = Carlson Geotech, 2015c

Rock Bluff Reservoir = Siemens and Associates, 2005

Sheldon Meadows Subdivision = GeoEgnineers, 2006)

Westside Village Marketplace = Kleinfelder, 2006; Wallace Group, 2018b

[1] Wells were located based on the best available location information, which includes the following subsets of location data (listed in decreasing location accuracy): latitudes and longitudes; City tax lot numbers; street addresses; ¼-¼ section; ¼-section; or section. The location data presented on this table represents the most up-to-date location information, based on the City's field reconnaissance program and/or other location methods (e.g., historica

Acronyms:

bgs = below ground surface
BH = Borehole
Char = Township/Range Character
gpm = gallons per minute
GR = Geotechnical Report
OWRD = Oregon Water Resources Department
Q = Quarter
R = Range
S = Section
T = Township
WW = Water Well

City of Bend

Appendix B. Wallace Group Report: City of Bend Stormwater Infiltration Evaluation.

October 2020

Prepared by:
GSI Water Solutions, Inc.
55 SW Yamhill St., Suite 300, Portland, OR, 97204

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geosystem experts

October 26, 2020

Mr. Matt Kohlbecker
Groundwater Solutions, Inc (dba GSI Water Solutions)
55 SW Yamhill St.
Portland, Oregon 97204

Subject: City of Bend Stormwater Infiltration Evaluation
Various City of Bend Selected Locations
Bend, Oregon 97701
Project No. 11325 (3)

Dear Mr. Kohlbecker:

This letter summarizes the results of a stormwater infiltration study, conducted at four City of Bend selected boring locations in Bend, Oregon (**Figure 1**). The borings were conducted to assist the City of Bend in developing improved soil mapping tools for its future Stormwater Master Plan update. These locations were selected due to proposed future development in the area, known existing issues, or providing information for future upgrades of existing facilities.

GEOLOGIC SETTING

Bend is located at the western margin of the High Lava Plains Physiographic Province of Central Oregon. This region is characterized by semi-arid high desert vegetation along the eastern foothills of the High Cascade Mountain Range. Annual precipitation in the Bend area is approximately ten inches, most of which falls in the form of snow during the winter months. The geology of the eastern and central portions of Bend is largely comprised of relatively thin volcanic soils overlying basalt flows (Sherrod et al., 2004). The geology of west Bend, geologically divided by the Deschutes River, is comprised of relatively thin volcanic soils overlying Pleistocene age welded tuff (pyroclastic-flow and fallout deposits), pumice (fallout deposits), and basalt flows. Areas within the floodplain of the Deschutes River are composed of thin volcanic soils overlying Holocene and Pleistocene alluvium. The geology of east Bend is composed of relatively thin volcanic soils overlying Pleistocene age Newberry basalt flows (Sherrod et al., 2004).

Groundwater within the study area is hosted in volcanic flows, pyroclastic deposits, and interbedded sedimentary units under unconfined or semi-confined water table conditions.

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Local groundwater is generally more than 100 feet below ground surface (bgs), except in localized areas adjacent to the Deschutes River which have a shallow perched aquifer.

METHODS

Infiltration testing, for the purposes of this study, was conducted in general accordance with COSM Method 4C, Test Pit Method. Water was supplied from either an adjacent fire hydrant (test locations ITB-02 and ITB-03) or from two 500-gallon-gravity-fed-water tank supplied by Haztech Drilling (test locations ITB-01 and ITB-04). The water-flow rate was monitored using an inline-flow meter and one-inch PVC hose which introduced water directly into the bottom of the boring to limit turbulence and provide more accurate data. In each boring, the drill casing used to advance the hole was pulled up to expose and isolate the zone of interest for each infiltration test.

FINDINGS

On July 7, 2020, Haz-Tech Drilling began drilling at the four selected locations with Wallace Group oversight. Drilling was concluded on July 9, 2020. The borings were drilled using a truck mounted CME 75 drill rig. Continuous-rock-core sampling was conducted via HQ-core method (2.5-inch inside diameter and 3.75-inch outside diameter). Depths, encountered lithologies, and relevant characteristics of the encountered rock and soil are listed below and on the boring logs included in **Appendix A.** A summary of the tested intervals, infiltration rates, wetted area of each boring, depth, and saturated drawdown rates is provided in **Table 1**.

ITB-01: Stevens Road

On July 7, 2020, ITB-01 was tested from 10.0 feet to 19.5 feet bgs. Soil was encountered from 0.0 feet to 1.0 feet bgs with basalt bedrock from 1.0 feet to 19.5 feet bgs. An area of heavily fractured and weathered rock was observed from 12 feet to 13 feet bgs and this was inferred to be the primary infiltration zone in this boring. No groundwater was encountered.

The water tank used for this infiltration test was operated at a maximum-discharge rate for the test duration (approximately 24.4 gallons per minute [gpm]) with a total of 1,500 gallons introduced into the boring during the test. The maximum water level observed in the boring during the test was 5.4 feet (14.1 feet bgs), with an observed drawdown rate of 40.2 inches per hour.

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ITB-02: Loco Road and Clausen Road

On July 8, 2020, ITB-02 was tested from 10.0 feet to 20.0 feet bgs with basalt bedrock from 1.0 feet to 20.0 feet bgs. The basalt-rock-core sample observed from 18 feet to 20 feet bgs was broken and weathered. This was interpreted as an interflow between two basalt units which typically have high infiltration rates. No groundwater was encountered.

The fire hydrant was operated at a maximum-discharge rate, approximately 68.5 gpm (limited by the one-inch PVC hose), for the test duration, with a total of 8,225 gallons introduced into the boring during the test. The maximum-water level observed in the boring during the test was 0.5 feet (19.5 feet bgs). The boring drained in less than five seconds upon test completion.

ITB-03: NE Underwood Avenue and NE 3rd Street

On July 8, 2020, ITB-03 was tested from 10.0 feet to 20.0 feet bgs. Soil was encountered from 0.0 feet to 6.5 feet bgs with basalt bedrock from 6.5 feet to 20.0 feet bgs. The basalt-rock-core sample observed from 12 feet to 17 feet bgs was broken and weathered. This was inferred to be the primary infiltration zone in this boring. No groundwater was encountered.

The fire hydrant used for this test was operated at approximately 29.1 gpm for the duration of the test to maintain a steady-state head during the testing interval with a total of 4,610 gallons introduced into the boring during the test. The maximum water level observed in the boring during the test was 10.2 feet (9.8 feet bgs), with a drawdown rate of 151.2 inches per hour.

ITB-04: Unnamed alley adjacent to NW Riverfront Street

On July 9, 2020, ITB-04 was tested from 4.0 feet to 14.0 feet bgs. Soil observed from 0.0 to 4.0 feet bgs was disturbed fill. The soil from 4 feet to 12.5 feet bgs was native alluvial deposits composed of sand, gravel, and cobbles. While static groundwater was not encountered in this layer, the soil was saturated. Below 12.5 feet bgs, saprolitic-weathered-in-place tuff was encountered. Tuff and tuff-derived soils are generally impermeable or have low infiltration rates in Bend, therefore, 4 feet to 14 feet bgs was isolated for the purpose of the infiltration test.

Water from the water tank was discharged at approximately 0.25 gpm for the test duration with a total of 58 gallons introduced into the boring upon test completion. The maximum water level observed in the boring during the test was 10.0 feet (4.0 feet bgs), with a drawdown rate of 2.4 inches per hour.

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LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of our profession practicing in the same locality, under similar conditions and at the date the services were provided. Our findings, conclusions, and recommendations are based on an isolated field locations and related data. It is possible that conditions could vary between or beyond the points explored or data evaluated. Wallace Group makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion or instrument of service provided.

This report may be used only by Groundwater Solutions, Inc (dba GSI Water Solutions), the City of Bend, their representatives, and only for the purposes stated for this specific engagement within a reasonable time from its issuance but in no event later than three (3) years from the date of the report.

We trust this letter will meet your requirements at this time. If you have questions, or we can be of further service, please do not hesitate to contact our Bend office at 541.382.4707

REFERENCES

Central Oregon Intergovernmental Council, Updated August 2010, *Central Oregon Stormwater Manual (COSM)*.

Sherrod, David R., Taylor, Edward M., Ferns, Mark L., Scott, William E., Conrey, Richard M., and Smith, Gary A., 2004, *Geologic Map of the Bend 30- x 60-Minute Quadrangle, Central Oregon. United States Geological Survey*.

Enclosed:

Figure 1 Infiltration Testing Location Map
Table 1 Summary of Infiltration Testing Results
Appendix A Well Logs and Legend

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PROFESSIONAL AUTHENTICITY

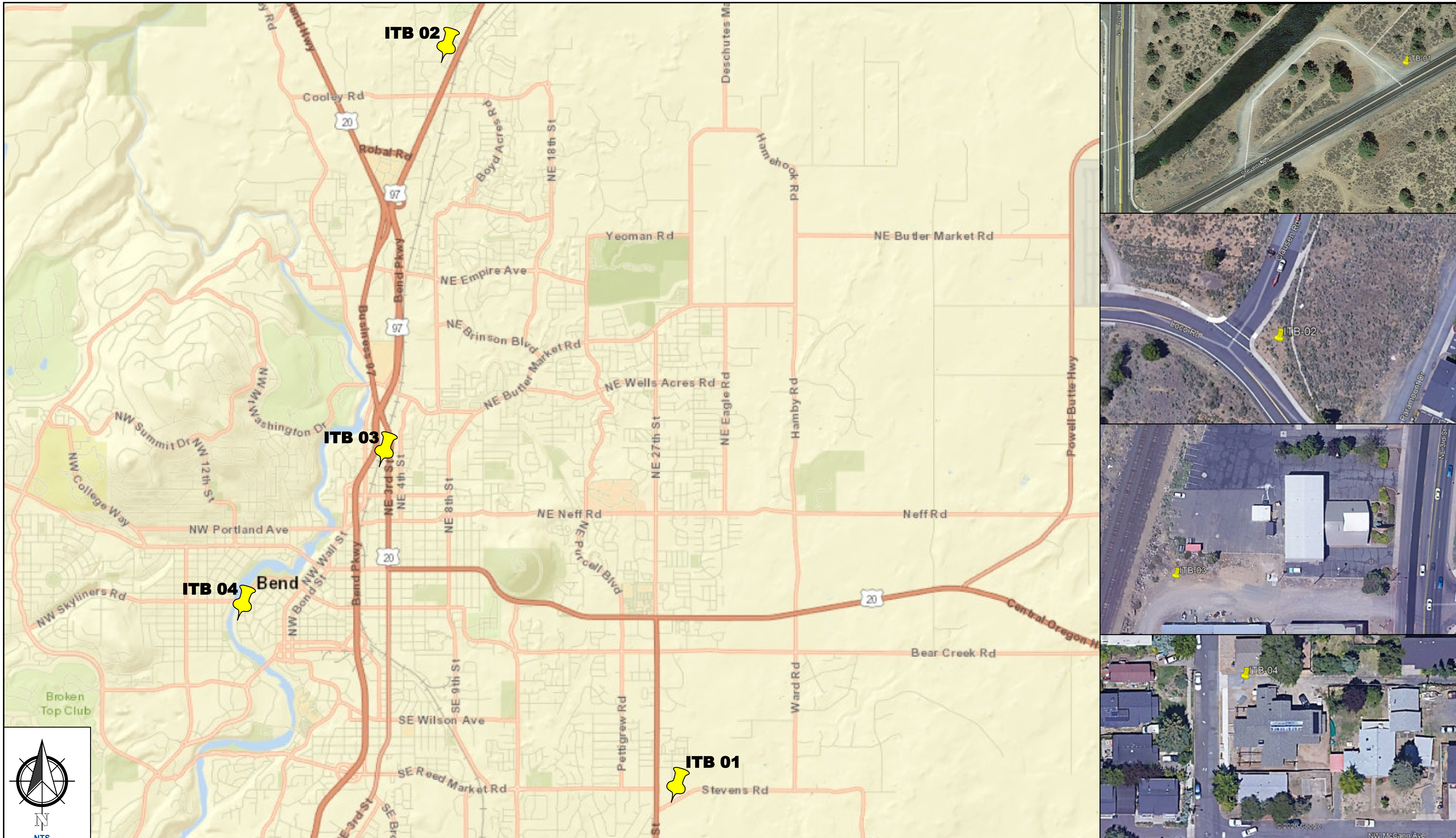
This report has been authored and reviewed by the undersigned, respectively. This report is void if the original seal(s) and signature(s) are not included.

Stephen M. Woodward, R.G.
Staff Geologist

Shane M. Cochran, R.G.
Project Geologist

62915 NE 18th Street, Suite 1, Bend, OR 97701 **p |** 541.382.4707 **f |** 541.383.8118 wallacegroup-inc.com

FIGURES



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CITY OF BEND STORMWATER INFILTRATION EVALUATION
INFILTRATION TESTING LOCATION MAP
BEND, OREGON

PROJECT No.:	11325 (3)
DRAWN:	July 30, 2020
DRAWN BY:	DTJ
CHECKED BY:	SMC
FILE NAME:	11325 (3)_FIGURE_1.DWG

FIGURE
1

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TABLES

TABLE 1: SUMMARY OF INFILTRATION TEST RESULTS City of Bend Stormwater Infiltration Evaluation Various City of Bend Selected Locations Bend, Oregon							
Boring #	**Boring Depth (feet)**	**Tested Interval (feet bgs)**	**Head of Water During Test (feet)**	**Wetted Area (ft^2)**	**Tested Infiltration Rate (gpm)**	**GPM/ft^2**	**Drawdown Rate (inches/hour)**
ITB-01	19.5	10.0 - 19.5	5.40	5.30	24.40	4.60	40.2
ITB-02	20.0	10.0 - 20.0	0.50	0.49	68.50	139.80	N/A, unable to fill
ITB-03	20.0	10.0 - 20.0	10.20	10.10	29.10	2.88	151.2
ITB-04	20.0	4.0 - 14.0	10.00	9.89	0.25	0.03	2.4

Notes:
bgs - below ground surface
gpm - gallons per minute
ft - feet
N/A - not applicable

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APPENDIX A

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Bend, OR 97701
(541) 382-4707

KEY TO SYMBOLS

CLIENT Groundwater Soultions Inc
PROJECT NAME City of Bend Infiltration Study
PROJECT NUMBER 11325-3
PROJECT LOCATION Bend, Oregon

LITHOLOGIC SYMBOLS (Unified Soil Classification System)

- ASPHALT: Asphalt
- BASALT: Basalt
- FILL: Fill (artificial fill)
- ML: USCS Silt
- SM: USCS Silty Sand
- TOPSOIL: Topsoil

SAMPLER SYMBOLS

- No Recovery (NR)
- Rock Core (RC)
- Split Spoon (SS)

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
MC - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
FINES - PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)
OC - ORGANIC CONTENT (%)
TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UCCS- UNCONFINED COMPRESSION
ppm - PARTS PER MILLION

Water Level at Time of Drilling, or as Shown
Water Level at End of Drilling, or as Shown
Water Level After 24 Hours, or as Shown

BORING NUMBER ITB-01

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Bend, OR 97701
(541) 382-4707

CLIENT Groundwater Soultions Inc
PROJECT NAME City of Bend Infiltration Study
PROJECT NUMBER 11325-3
PROJECT LOCATION Bend, Oregon
DATE STARTED 7/7/20 **COMPLETED** 7/7/20
GROUND ELEVATION
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger & HQ-Wireline Coring
AT TIME OF DRILLING ---
LOGGED BY SMW **CHECKED BY** SC
24HRS AFTER DRILLING ---
NOTES Stevens Rd

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0				SM	1.0	SILTY SAND, moist, brown, overburden
1.0–19.5					19.5	BASALT, unweathered to moderately weathered, gray with red interbeds, vesicular to massive, R4
5	RC C-1	100 (100)				
10	RC C-2	100 (53)	12-13' bgs broken red interflow loss of water			
15	RC C-3	100 (87)				

Bottom of borehole at 19.5 feet.

The Wallace Group
62915 NE 18th Street, Suite 1
Bend, OR 97701
(541) 382-4707

BORING NUMBER ITB-02

CLIENT	Groundwater Soultions Inc	PROJECT NAME	City of Bend Infiltration Study
PROJECT NUMBER	11325-3	PROJECT LOCATION	Bend, Oregon
DATE STARTED	7/8/20 COMPLETED 7/8/20	GROUND ELEVATION	
DRILLING CONTRACTOR	Haz-Tech Drilling, Inc.	GROUND WATER LEVELS:	
DRILLING METHOD	Hollow Stem Auger & HQ-Wireline Coring	AT TIME OF DRILLING	---
LOGGED BY	SMW CHECKED BY SC	24HRS AFTER DRILLING	---
NOTES	Lobo/Clausen		

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0				SM	1.0	SILTY SAND, moist, brown, overburden
	RC C-1	57 (27)				BASALT, slightly weathered to unweathered, gray, R3 to R4, fractured with tan weathering
5	RC C-2	100 (57)				
10	RC C-3	100 (100)				
15	RC C-4	88 (60)	18' bgs very broken red interflow loss of water at 18' bgs			
20					20.0	Bottom of borehole at 20.0 feet.

BORING NUMBER ITB-03

The Wallace Group
62915 NE 18th Street, Suite 1
Bend, OR 97701
(541) 382-4707

CLIENT Groundwater Soultions Inc
PROJECT NAME City of Bend Infiltration Study
PROJECT NUMBER 11325-3
PROJECT LOCATION Bend, Oregon
DATE STARTED 7/8/20 **COMPLETED** 7/8/20
GROUND ELEVATION
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger & HQ-Wireline Coring
AT TIME OF DRILLING ---
LOGGED BY SMW **CHECKED BY** SC
24HRS AFTER DRILLING ---
NOTES Underwood/3rd

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0				SM		SILTY SAND, moist, brown, overburden
	NR C-1	0 (0)				
5						
6.5						BASALT, slightly weathered to moderately weathered, gray, R3
	RC C-2	85 (60)				
10						
	RC C-3	100 (13)				
15						
	RC C-4	100 (62)	weathered and broken 12-17' bgs lost circulation			
20						20.0

Bottom of borehole at 20.0 feet.

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62915 NE 18th Street, Suite 1
Bend, OR 97701
(541) 382-4707

BORING NUMBER ITB-04

CLIENT Groundwater Soultions Inc
PROJECT NAME City of Bend Infiltration Study
PROJECT NUMBER 11325-3
PROJECT LOCATION Bend, Oregon
DATE STARTED 7/9/20 **COMPLETED** 7/9/20
GROUND ELEVATION
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger & HQ-Wireline Coring
AT TIME OF DRILLING ---
LOGGED BY SMW **CHECKED BY** SC
24HRS AFTER DRILLING ---
NOTES Alley at Riverfront

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS	Corrected N-Value	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0 – 0.2						Asphalt
0.2 – 4.0				SM		Fill, gravel, cobbles, steel pipe
4.0 – 12.5				SM		Moist, brown, sand, gravel, cobbles, rounded alluvial deposits, native
12.5 – 20.0	SS S-1 (15)	1 3 3		ML		Wet, weathered tuff, saprolite, ML with sand and clay, MH (elastic silt) once disturbed

Bottom of borehole at 20.0 feet.

City of Bend

Appendix C. UIC Testing Methods and Data Analysis to Evaluate UIC Ageing

October 2020

Prepared by:
GSI Water Solutions, Inc.
55 SW Yamhill St., Suite 300, Portland, OR, 97204

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Contents

1. Introduction

This appendix was prepared by GSI Water Solutions, Inc. (GSI) to document an evaluation of the rate of performance declines over the lifespan of Underground Injection Control (UIC) facilities owned by the City of Bend (City). The work activities described in this appendix were completed for the City as part of the City's 2020 Stormwater Infiltration Evaluation Update. The objective of this appendix is to help inform future decision making related to stormwater management, including the most suitable UIC facility type (e.g., drywells or drill holes) and prioritization of UIC maintenance activities.

1.1 Summary of Findings

Since 2010, the City has conducted infiltration tests at about 150 City-owned UICs in accordance with the full-scale drywell/drill hole test method in Appendix 4B of the Central Oregon Stormwater Manual (COSM). GSI developed a framework to select 20 previously-tested UICs that are representative of the different UIC types, drainage areas, soil classes, zoning types, and traffic levels in the City.

In June of 2020, infiltration testing was completed at the 20 selected UICs shown in Figure C-1. GSI compared the infiltration rates from the June 2020 testing to historical infiltration rates to evaluate the change in performance over time. Changes in performance over the lifespan of a UIC were evaluated using linear regression trends and confidence intervals. While statistical parameters (i.e., coefficients of determination, p-values) indicate that more data should be collected to improve the confidence in estimates of performance decline trends, including their relative statistical significance, the following preliminary trends/observations are summarized for the following categories of UICs:

- **By UIC Type:** The data and trends suggest that the performance of a drill hole will decline about twice as fast as that of a drywell (within 10 years, drill hole performance can be expected to decline about 6.0% per year and drywell performance can be expected to decline about 2.9% per year, see Figure C-2).
- **Drywells By City Drainage Area:** The data and trends available at the time of this report suggest that the performance of drywells in Drainage Area A and Drainage Area B will decline at approximately equivalent rates (Drainage Area A ~3.5%/year; Drainage Area B ~3.8%/year, see Figure C-3). The average annual performance declines of drywells in Drainage Area C, however, are approximately half that of Drainage Areas A and B (Drainage Area C ~1.8%/year).
- **Drywells By Projected Daily Traffic Counts**: The data and trends suggest that the performance of drywells in higher traffic areas (≥1,000 trips/day) will decline slightly faster than drywells in lower traffic areas (<1,000 trips/day) (higher traffic ~4.5%/year; lower traffic ~2.9%/year, see Figure C-4).

GSI recommends that the City continue to collect updated infiltration testing data about every five years to refine the understanding of performance decline trends, including their relative statistical significance. The tested UICs should include some of the 20 UICs that were tested in June 2020, as well as other previously-tested UICs that are chosen so that the City can develop multiple data points along the "Years Since Last Test" axis in Figure C-2 through Figure C-4.

1.2 Appendix Organization

This appendix is organized in the following structure, which also represents the general approach and sequence of activities for this evaluation:

- **Section 2: Selection of UICs for Retesting.** This section presents a review of historical infiltration tests conducted by the City, and presents the framework that GSI and the City used to select UICs to be retested.
- **Section 3: 2020 UIC Testing.** This section documents the methods and results of infiltration testing for UICs that were re-tested in June 2020.
- **Section 4: Evaluation of UIC Performance Declines.** This section compares the June 2020 infiltration testing data to historical data and evaluates the rate and of performance declines over the lifespan of City-owned UICs.

2. Selection of UICs for Retesting

This section reviews historical infiltration testing data of the City's UICs, and also presents the framework that GSI and the City used to select UICs for retesting.

2.1 Methods for Selecting UICs to Retest

GSI reviewed historical infiltration testing data for 149 City-owned UICs. The 149 UICs consist of both drill holes and drywells, and are located in various drainage areas, soil classes, and zoning types throughout the City. Table C-1, which is attached to the end of this appendix, presents construction information, historical infiltration testing data, and estimated baseline performance parameters (i.e., infiltration rates) for the 149 City-owned UICs. The infiltration rates were calculated from both the constant head and falling head portions of the City's UIC Infiltration Testing Forms in accordance with the methods outlined in Appendix 4B of the COSM (COIC, 2010).

Per GSI's March 10, 2020, proposal and scope of work, 20 UICs were to be retested in 2020 to evaluate the rate of performance declines of UICs. The selection of UICs for retesting proceeded according to the following methodology:

1. UICs with incomplete datasets (i.e., could not compute an infiltration rate) were removed from further consideration (101 of the 149 UICs were retained).
2. UICs with a calculated saturated hydraulic conductivity less than or equal to zero[1] were removed from further consideration because saturated hydraulic conductivity was initially a parameter under consideration for evaluating performance declines (87 of the 149 UICs were retained).
3. UICs that have been reconditioned but are missing post-reconditioning testing data were removed from further consideration (83 of the 149 UICs were retained).
4. UICs with recent (2017-Present) testing data were removed from further consideration because insufficient time may have passed for measurable UIC ageing to occur (41 of the 149 UICs were retained).
5. Twenty of the remaining 41 UICs were selected for testing in an attempt to provide a representative sample of each of the remaining City drainage areas, Natural Resources Conservation Service (NRCS) soil classes, traffic categories, zoning types, and facility types (i.e., drywells and drill holes). Consideration was also given to accessibility (i.e., to avoid the need for traffic control during testing) and proximity to a City of Bend fire hydrant (i.e., to avoid using hydrants from other jurisdictions to supply water for the testing).

[1] UICs with saturated hydraulic conductivities less than or equal to zero are likely the result of measurement inaccuracies/errors more commonly associated with the constant head portion of infiltration tests, or from conditions during the test not meeting the assumptions of the equation for calculating a saturated hydraulic conductivity. Saturated hydraulic conductivities were calculated using Equation (A.3) in Appendix A.

2.2 Results

The 20 UICs selected for retesting are listed on Table C-2 and shown on Figure C-1. A summary of the number of drainage areas, UIC types, soil classes, zoning types, and traffic categories represented by the selected UICs is presented on Table C-3. In general, the UICs selected for retesting are representative of the different facility types (i.e., drywells or drill holes), traffic categories, and drainage areas in the City. The selected UICs were not representative of soil type or zoning types because of the large number of soil and zoning types in the City; more than 20 UICs would need to be tested to produce a representative sample of UIC performance in these categories.

3. 2020 UIC Testing

This section documents the procedures and results of infiltration testing at UICs selected for retesting.

3.1 Methods

Infiltration testing was completed for the 20 selected UICs by GSI between June 15th and June 30th, 2020. The June 2020 retesting was designed to replicate conditions (i.e., flow rates and head buildup in the UIC) that occurred during the previous test to facilitate a direct comparison of infiltration rates.

A summary of the sequence and procedures for infiltration testing is provided below, which are based on the methods described in Appendix 4B of the Central Oregon Stormwater Manual (COIC, 2010):

1. Document pre-test information on the field form for the UIC being tested:
   - Record the date, UIC ID or number, location, and weather conditions.
   - Measure the total depth of the UIC using the depth sounder, note depth on the form.
   - Note the pre-test flow totalizer reading.
2. Conduct the infiltration test:
   - Introduce water into the UIC for about 30 minutes, raising the water level up to the "Target Depth to Water." Record water depth and flow totalizer reading approximately every five minutes.
   - Maintain a constant water level in the UIC for approximately 60 minutes (water level should be the "Target Depth to Water"). Record the water depth and flow totalizer reading every five minutes.
   - Shut off the water. Record the water depth every five minutes for 30 minutes.

3.2 Results

Three of the 20 UICs originally selected for testing (DDH009555[2], DDH009009[3] and DDH009365[4]) could not be tested due to access issues or evidence indicating that the UIC had been recently reconditioned. Replacement test locations were selected for these UICs in consultation with the City (see footnotes for details). Field forms documenting the results of the infiltration testing for all 20 UICs are provided in Attachment C-1.

[2] The test at drill hole DDH009555 was aborted because drywell efficiency had significantly increased since the original test, suggesting that the drill hole had been reconditioned. Replaced with drill hole DDH009662.
[3] The test at drill hole DDH009009 was aborted because a neighbor indicated that the drill hole was recently reconditioned, and drywell efficiency had significantly increased since the original test. Replaced with drill hole DDH009878.
[4] The test at drill hole DDH009365 could not be performed because it was inaccessible (contractors performing pavement work). Replaced with drill hole DDH009896.

4. Evaluation of UIC Performance Declines

This section compares the June 2020 infiltration testing data to historical data and evaluates the rate of performance declines over time at City-owned UICs.

4.1 Methods

To evaluate the rate and nature of performance declines of the 20 UICs that were retested, updated infiltration rates were calculated for both the constant head and falling head portions of the infiltration tests in accordance with the methods outlined in Appendix 4B of the Central Oregon Stormwater Manual (COIC, 2010). The infiltration rates measured in June 2020 were compared to historical infiltration rates to evaluate the change in performance at each UIC since the last round of testing was completed.

Conceptually, the performance of a UIC should decrease over time as the UIC becomes clogged from solids in stormwater. Therefore, calculated infiltration rates [5] that exhibited an increase in performance were excluded from GSI's evaluation. The observed increases in performance may be the result of the inability to replicate previous test locations, particularly during the constant head portion of the testing, which has more variables that must be accounted for and managed (i.e. maintaining a constant flow rate and head). Other possible explanations for increases in UIC performance could be unreported reconditioning that occurred between the original test and the June 2020 test, or measurement inaccuracies. Due to the greater number of measurement inaccuracies/errors associated with the constant head portion of infiltration testing, only results from the falling head portion of the infiltration tests was used in evaluating changes in performance over time.

Changes in performance over the lifespan of a UIC were evaluated within the following categories:

- By UIC type (drill hole vs. drywell)
- By City drainage area
- By Daily Traffic Category (≥1,000 trips/day vs. <1,000 trips per day)

To compare the relative rate of performance declines over the lifespan of a UIC within each of the above categories, a linear regression and 95% confidence interval on the mean was calculated for each category. Based on the linear regression for each category, an average annual performance decline was estimated and statistical parameters (i.e., coefficient of determination, p-value) were calculated to evaluate the relative statistical significance of the results.

Performance decline is strongly affected by facility type (drill holes or drywells). Therefore, to remove the influence of facility type, our evaluation of performance declines by the drainage area and traffic count categories was performed only on drywells, for the following reasons:

- Drywells and drill holes are not evenly distributed among drainage areas and traffic categories (see Table 3-1 of the report to which this appendix is attached) which could potentially bias the results of the analysis, and
- The drywell dataset was larger and, therefore, more statistically robust.

4.2 Results

The total and annual change in performance (i.e., infiltration rate) for each of 20 retested UICs is presented on Table C-4. An evaluation of annual change in performance within each of the groups/categories of

[5] 20 UICs x 2 infiltration tests (constant head and falling head portions) = 40 calculated infiltration rates possible

interest is presented on Tables C-5 through C-7 and Figures C-2 through C-4, which are attached to the end of this appendix. A summary of the results for each group/category is provided below:

4.2.1 By UIC Type

The coefficients of determination[6] and p-values[7] for both drill holes and drywells (Figure C-2) indicate that more data should be collected to improve confidence in performance decline trends, including their relative statistical significance. However, the data and trends available at the time of this report suggest that the performance of a drill hole will decline about twice as fast as that of a drywell (drill hole ~6.0%/year; drywell ~3.0%/year, see regression equations in Figure C-2). A statistical summary of the performance declines over time for drywells and drill holes is presented in Table C-8 below. The influence of other variables (e.g., drainage areas, traffic levels, soil classes, etc.) likely affects the performance decline estimates for each facility type, though these influences are not well understood based on the number of data points available at the time of this report.

Table C-8. Performance Declines[1] Over Time for Drywells and Drill Holes.

Facility Type	Number of Tests	Minimum Performance Decline (% / gpm per year)	Median Performance Decline (% / gpm per year)	Average Performance Decline (% / gpm per year)	Maximum Performance Decline (% / gpm per year)
Drywell	10	0.2% / 0.2 gpm	1.6% / 1.2 gpm	2.9% / 2.0 gpm	8.7% / 8.9 gpm
Drill Hole	5	0.8% / 0.7 gpm	7.3% / 7.0 gpm	6.0% / 6.8 gpm	8.5% / 13.2 gpm

Notes
(1) Reported performance declines are based on the falling head tests reported in Table C-5
gpm = gallons per minute

4.2.2 Drywells, By City Drainage Area

The coefficients of determination and p-values for all three City drainage areas (Figure C-3) indicate that more data should be collected to improve confidence in performance decline trends, including their relative statistical significance. However, the data and trends available at the time of this report suggest that the performance of UICs in Drainage Area A and Drainage Area B will decline at approximately equivalent rates (Drainage Area A ~3.5%/year; Drainage Area B ~3.8%/year, see Figure C-3 and Table C-6). The average annual performance declines of UICs in Drainage Area C, however, are approximately half that of Drainage Areas A and B (Drainage Area C ~1.8%/year). A statistical summary of the performance declines over time for UICs in the different drainage areas is presented in Table C-9 below. The influence of other variables (e.g., categories, soil classes, etc.) likely affects the performance decline estimates for each drainage area, though these influences are not well understood based on the number of data points available at the time of this report.

[6] The coefficient of determination (also known as r-squared value) is the proportion of the variance in the dependent variable that is predictable from the independent variable. Coefficients of determination normally range from 0 to 1, with values closer to 1 indicating a better goodness of fit. The coefficient of determination does not indicate whether the independent variable is caused by changes to the dependent variable.
[7] The p-value is the probability is the probability of obtaining test results at least as extreme as the results actually observed, under the assumption that the null hypothesis is correct. Commonly, for a p-value less than 0.05, the null hypothesis is rejected and the results are considered statistically significant.

Table C-9. Performance Declines[1] Over Time for Drywells By Drainage Area.

Drainage Area	Number of Tests	Minimum Performance Decline (% / gpm per year)	Median Performance Decline (% / gpm per year)	Average Performance Decline (% / gpm per year)	Maximum Performance Decline (% / gpm per year)
Drainage Area A	4	0.5% / 0.9 gpm	2.4% / 1.7 gpm	3.5% / 3.3 gpm	8.7% / 8.9 gpm
Drainage Area B	2	0.2% / 0.2 gpm	3.8% / 0.2 gpm	3.8% / 0.2 gpm	7.4% / 0.2 gpm
Drainage Area C	4	1.4% / 0.4 gpm	1.6% / 1.4 gpm	1.8% / 1.5 gpm	2.5% / 3.0 gpm

Notes
(1) Reported performance declines are based on the falling head tests reported in Table C-6
gpm = gallons per minute

4.2.3 By Projected Daily Traffic Counts

The coefficients of determination and p-values for both traffic categories (more or less than 1,000 trips/day) (Figure C-4) indicate that more data should be collected to improve our confidence in performance decline trends, including their relative statistical significance. However, the data and trends available at the time of this report suggest that the performance of UICs in higher traffic areas (≥1,000 trips/day) will decline approximately 65% faster than lower traffic areas (<1,000 trips/day) (higher traffic ~4.5%/year; lower traffic ~2.9%/year, see Figure C-4 and Table C-7). A statistical summary of the performance declines over time for drywells and drill holes is presented in Table C-10 below. The influence of other variables (e.g., drainage areas, soil classes, etc.) likely affects the performance decline estimates for the different traffic categories, though these influences are not well understood based on the number of data points available at the time of this report.

Table C-10. Performance Declines[1] Over Time for Drywells in Streets With <1,000 TPD and ≥1,000 TPD.

Drainage Area	Number of Tests	Minimum Performance Decline (% / gpm per year)	Median Performance Decline (% / gpm per year)	Average Performance Decline (% / gpm per year)	Maximum Performance Decline (% / gpm per year)
<1,000 TPD	6	0.2% / 0.2 gpm	1.7% / 0.9 gpm	2.9% / 1.5 gpm	7.7% / 3.0 gpm
≥1,000 TPD	4	0.5% / 0.2 gpm	4.4% / 0.7 gpm	4.5% / 2.6 gpm	8.7% / 8.9 gpm

Notes
(1) Reported performance declines are based on the falling head tests reported in Table C-7
gpm = gallons per minute
TPD = trips per day

5. Recommendations

GSI recommends that the City continue to collect updated infiltration testing data about every five years to refine the understanding of performance decline trends, including their relative statistical significance. The tested UICs should include some of the 20 UICs that were tested in June 2020, as well as other previously-tested UICs that are chosen so that the City can develop multiple data points along the "Years Since Last Test" axis in Figure C-2 through Figure C-4. Future infiltration testing should be designed to replicate conditions (i.e., flow rates and head buildup in the UIC) that occurred during previous testing to facilitate a direct comparison of infiltration rates.

6. References

COIC, 2010. *Central Oregon Stormwater Manual*. Central Oregon Intergovernmental Council. Updated August 2010.

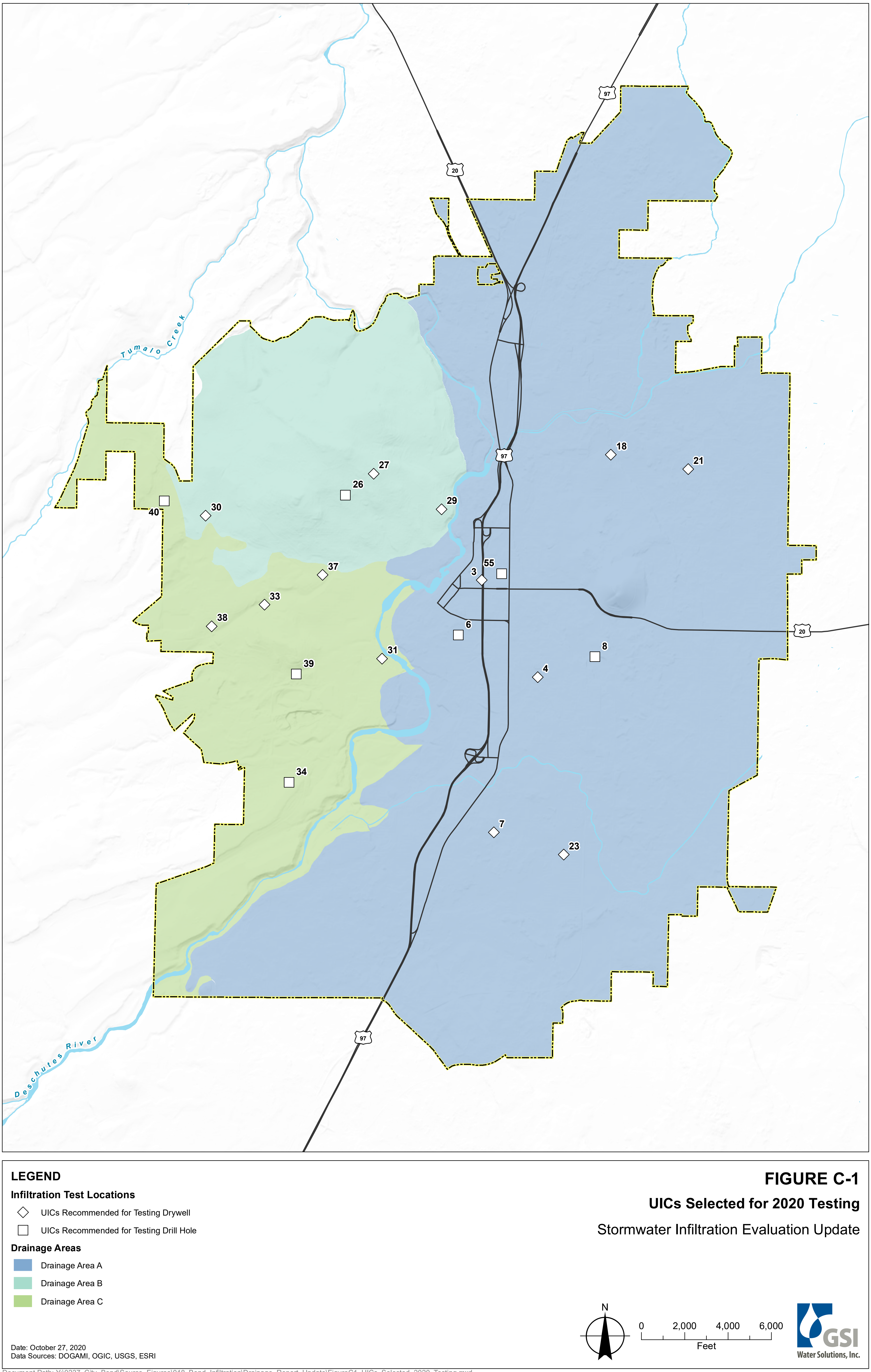


FIGURE C-1

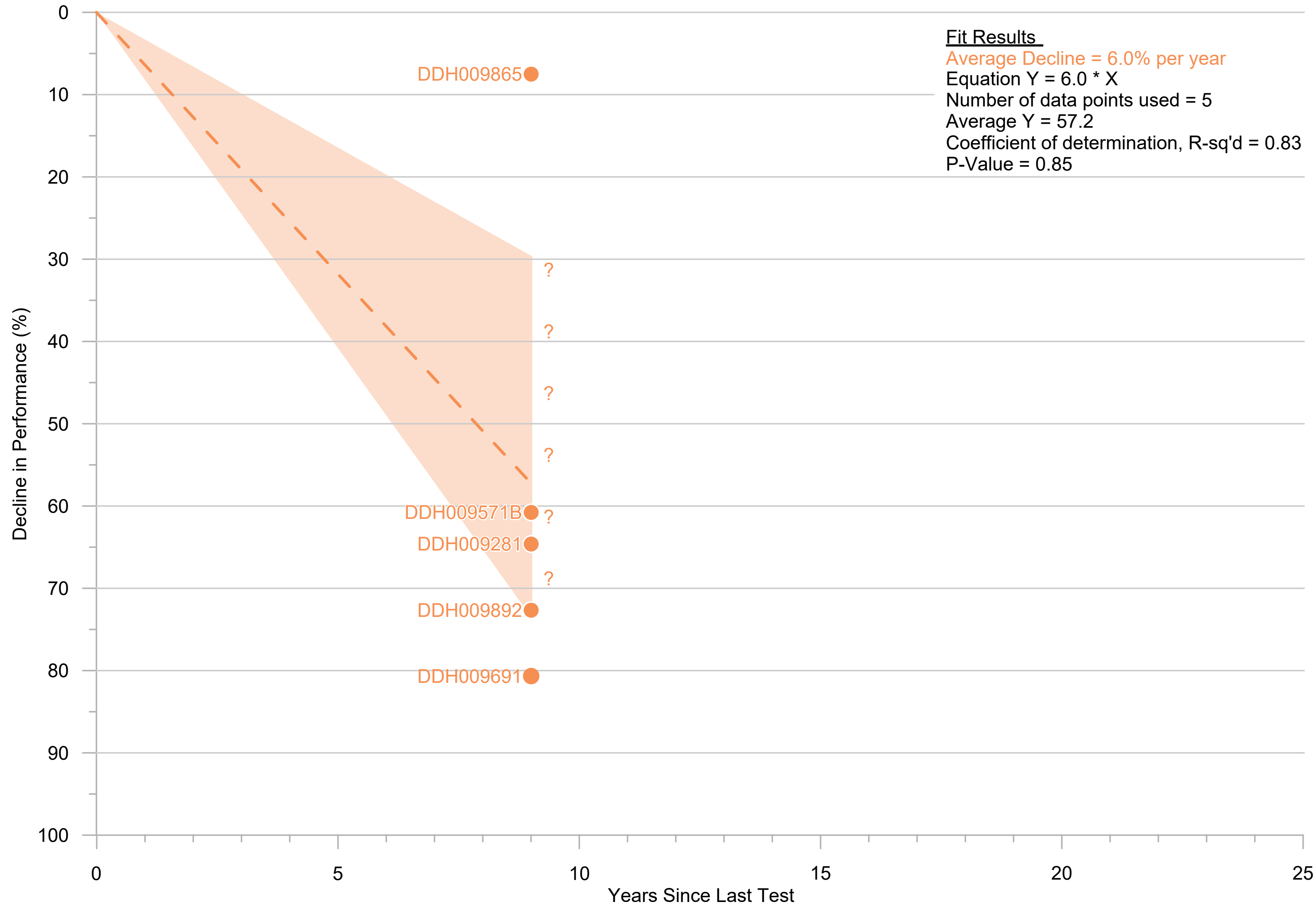
UICs Selected for 2020 Testing

Stormwater Infiltration Evaluation Update

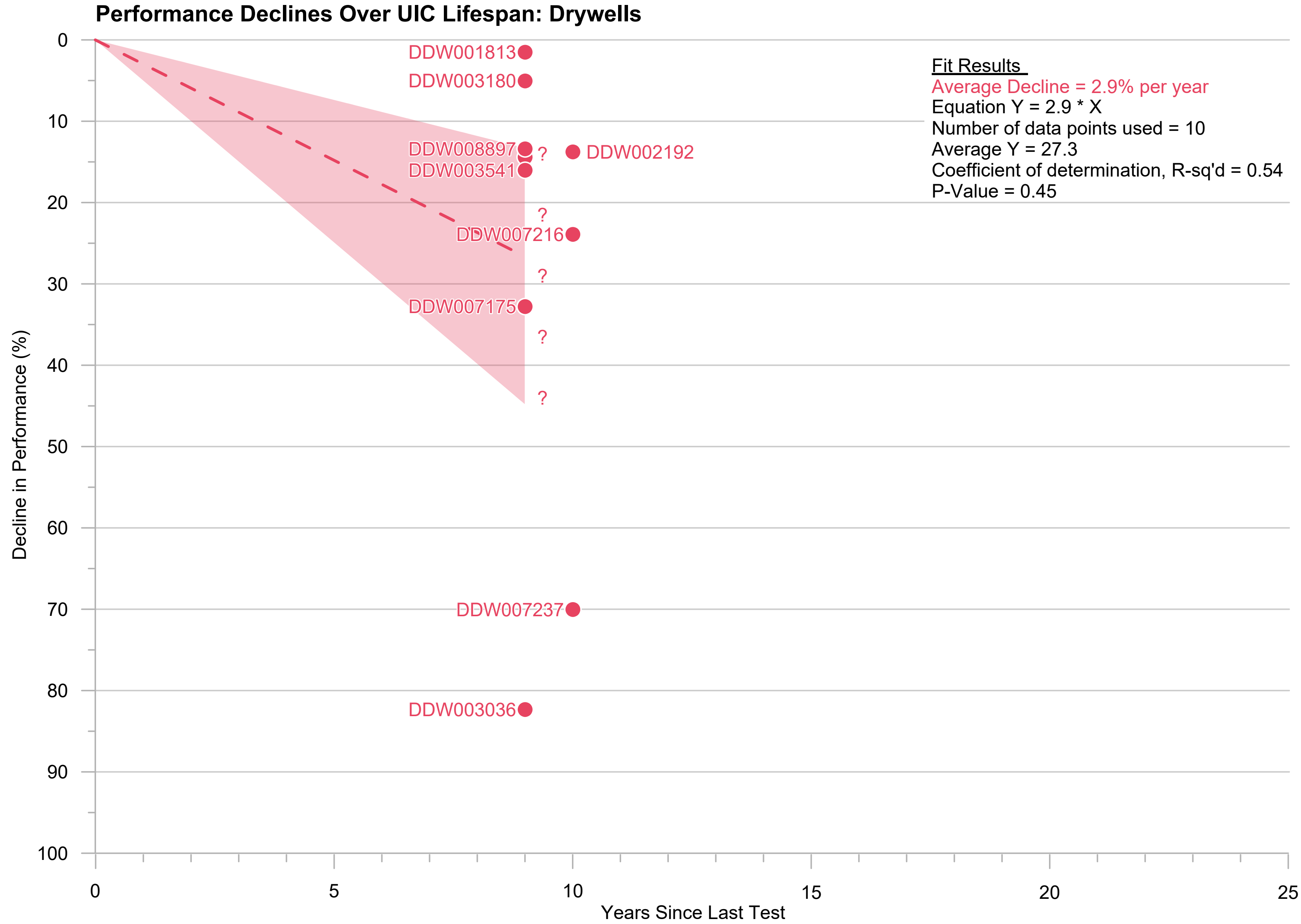
Date: October 27, 2020
Data Sources: DOGAMI, OGIC, USGS, ESRI

Document Path: Y:\0237_City_Bend\Source_Figures\018_Bend_Infiltration\Drainage_Report_Update\FigureC1_UICs_Selected_2020_Testing.mxd

Performance Declines Over UIC Lifespan: Drill Holes



Performance Declines Over UIC Lifespan: Drywells



LEGEND

- Drill Holes
- Drywells
- Linear Regression of Data
- 95% Confidence Interval for the Mean
- ? Trends of Performance Declines Beyond the Extent of the Current Dataset Is Unknown

NOTES

- Decline in UIC performance calculated using Falling Head infiltration testing data
- UICs that exhibited an increase in performance are not presented
- The calculated confidence intervals are estimates that the population mean for a given x value will fall within the confidence interval; the confidence interval does not mean that for any given UIC, there is a 95% probability that the performance of the UIC will fall within the confidence interval.
- The P-Value indicates the relative significance of the confidence interval's fit; commonly, a P-Value less than 0.05 indicates non-random (significant) results.

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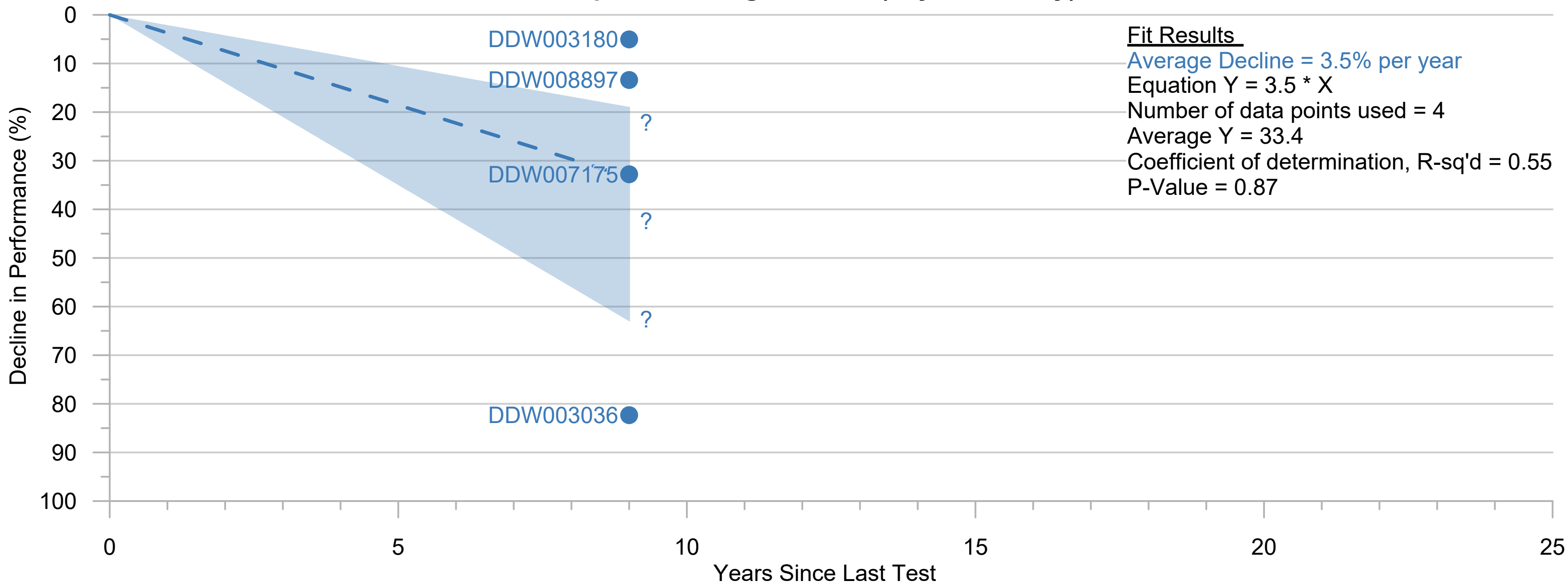
FIGURE C-2

Performance Declines Over Time for Drywells and Drill Holes

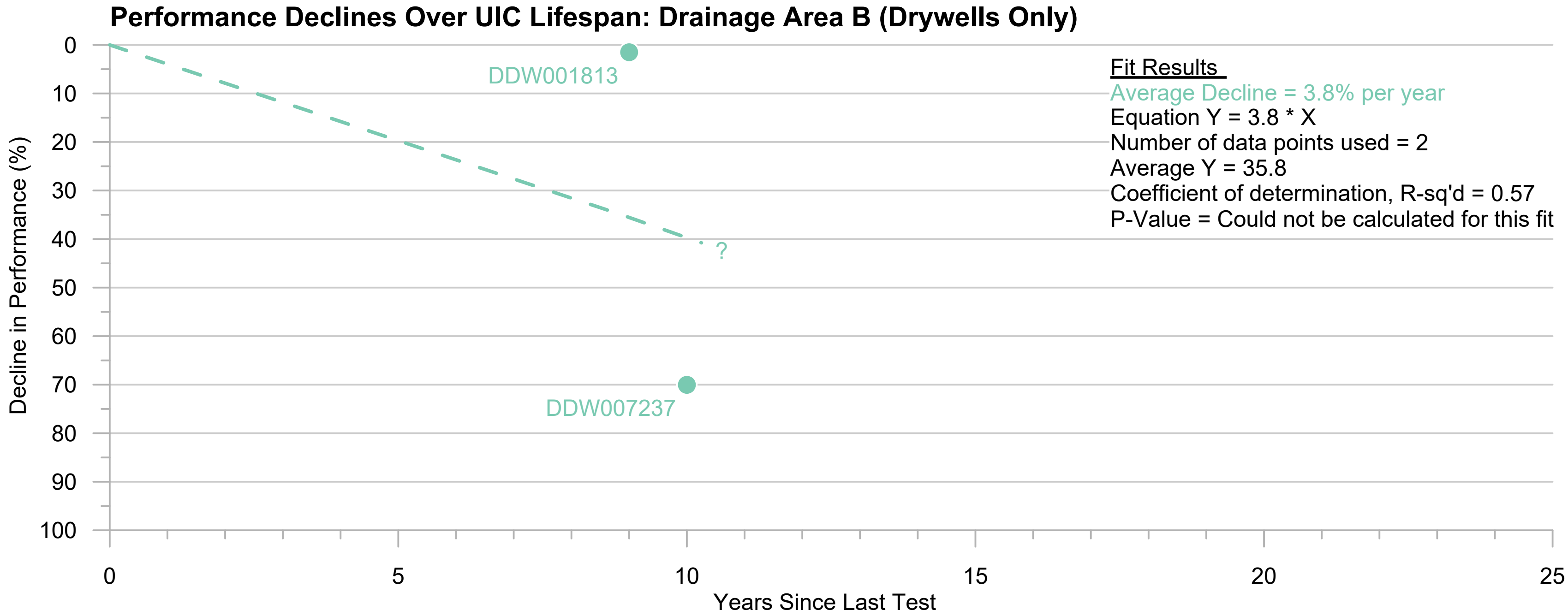
Stormwater Infiltration Evaluation Update

GSI Water Solutions, Inc.

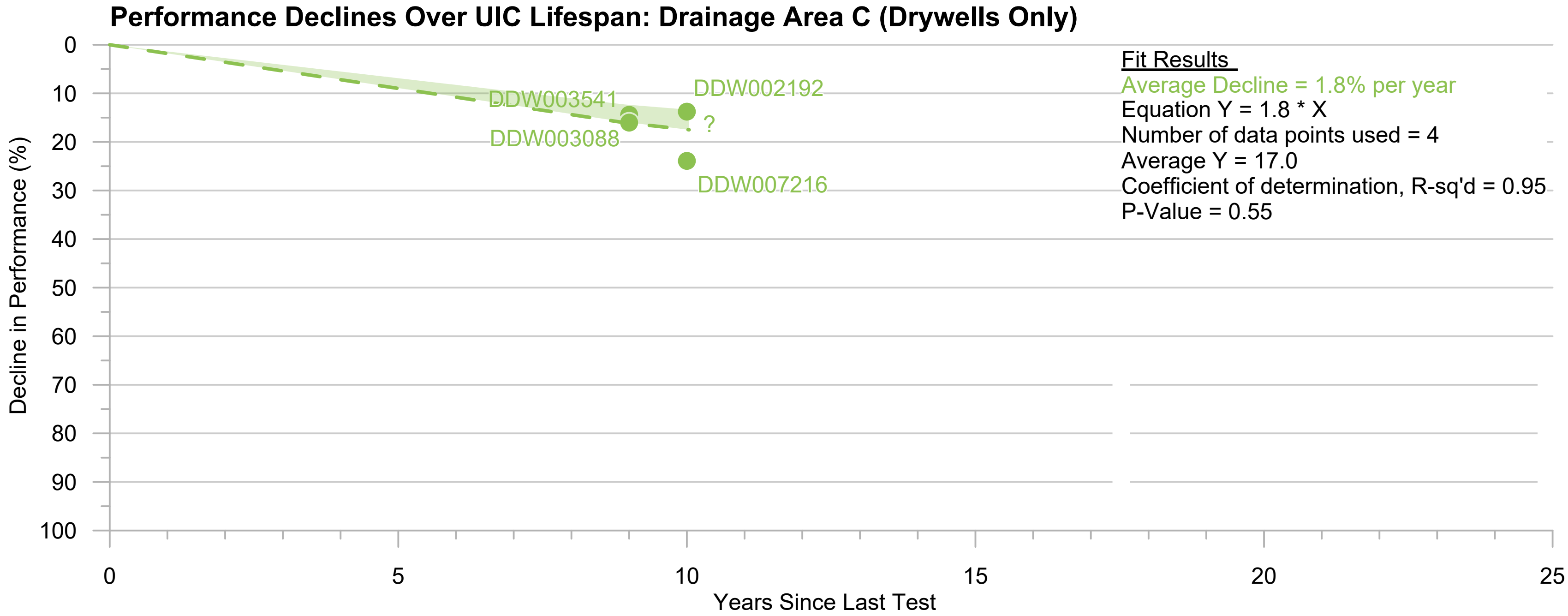
Performance Declines Over UIC Lifespan: Drainage Area A (Drywells Only)



Performance Declines Over UIC Lifespan: Drainage Area B (Drywells Only)



Performance Declines Over UIC Lifespan: Drainage Area C (Drywells Only)



LEGEND

- Drainage Area A
- Drainage Area B
- Drainage Area C
- Linear Regression of Data
- 95% Confidence Interval for the Mean

NOTES

- Decline in UIC performance calculated using Falling Head infiltration testing data
- UICs that exhibited an increase in performance are not presented
- Drill Hole data excluded from analysis in an attempt to limit/reduce the influence of UIC types
- The calculated confidence intervals are estimates that the population mean for a given x value will fall within the confidence interval; the confidence interval does not mean that for any given UIC, there is a 95% probability that the performance of the UIC will fall within the confidence interval.
- The P-Value indicates the relative significance of the confidence interval's fit; commonly, a P-Value less than 0.05 indicates non-random (significant) results.

FIGURE C-3

Performance Declines Over Time for Drywells by Drainage Area

Stormwater Infiltration Evaluation Update

GSI Water Solutions, Inc.

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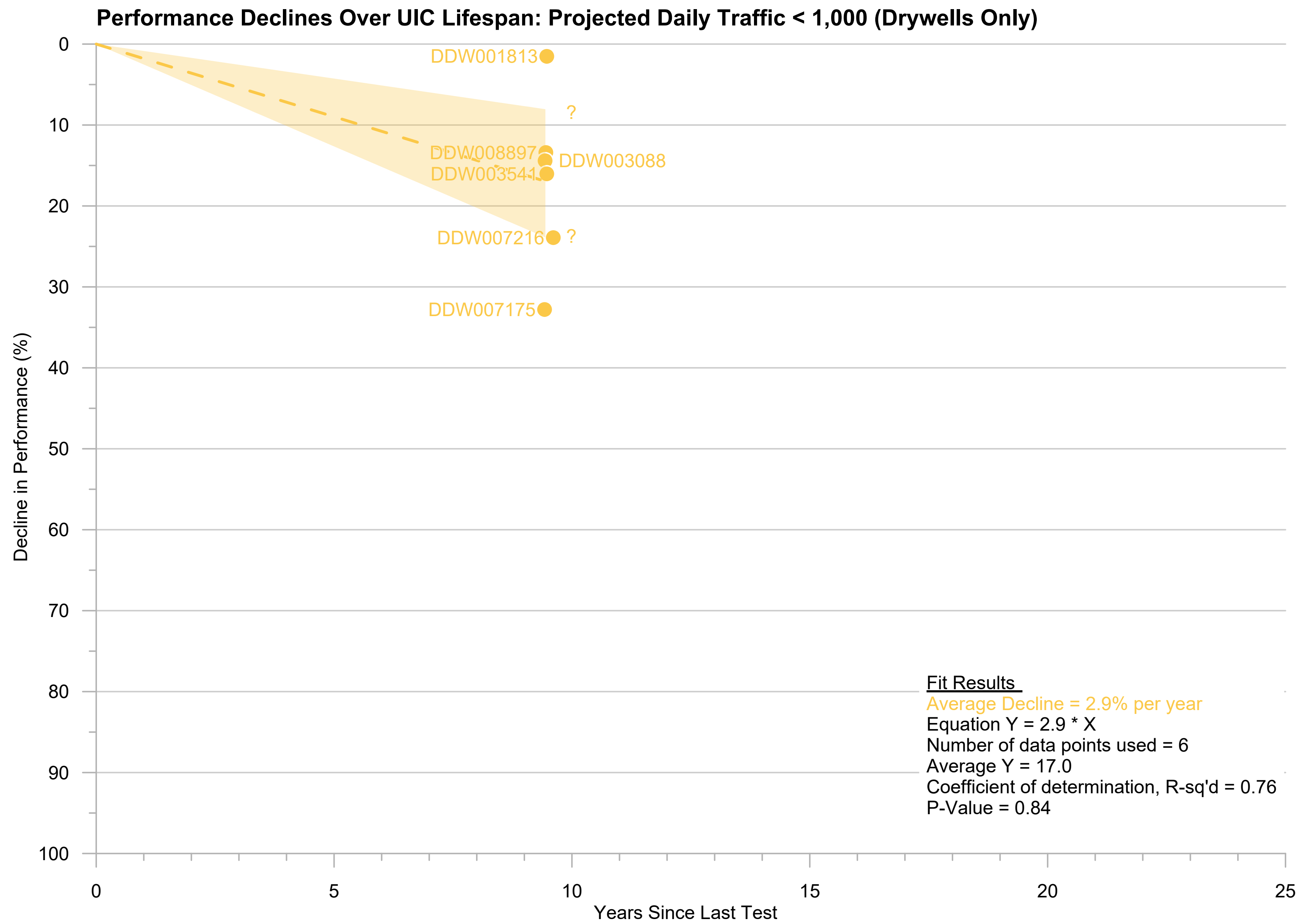

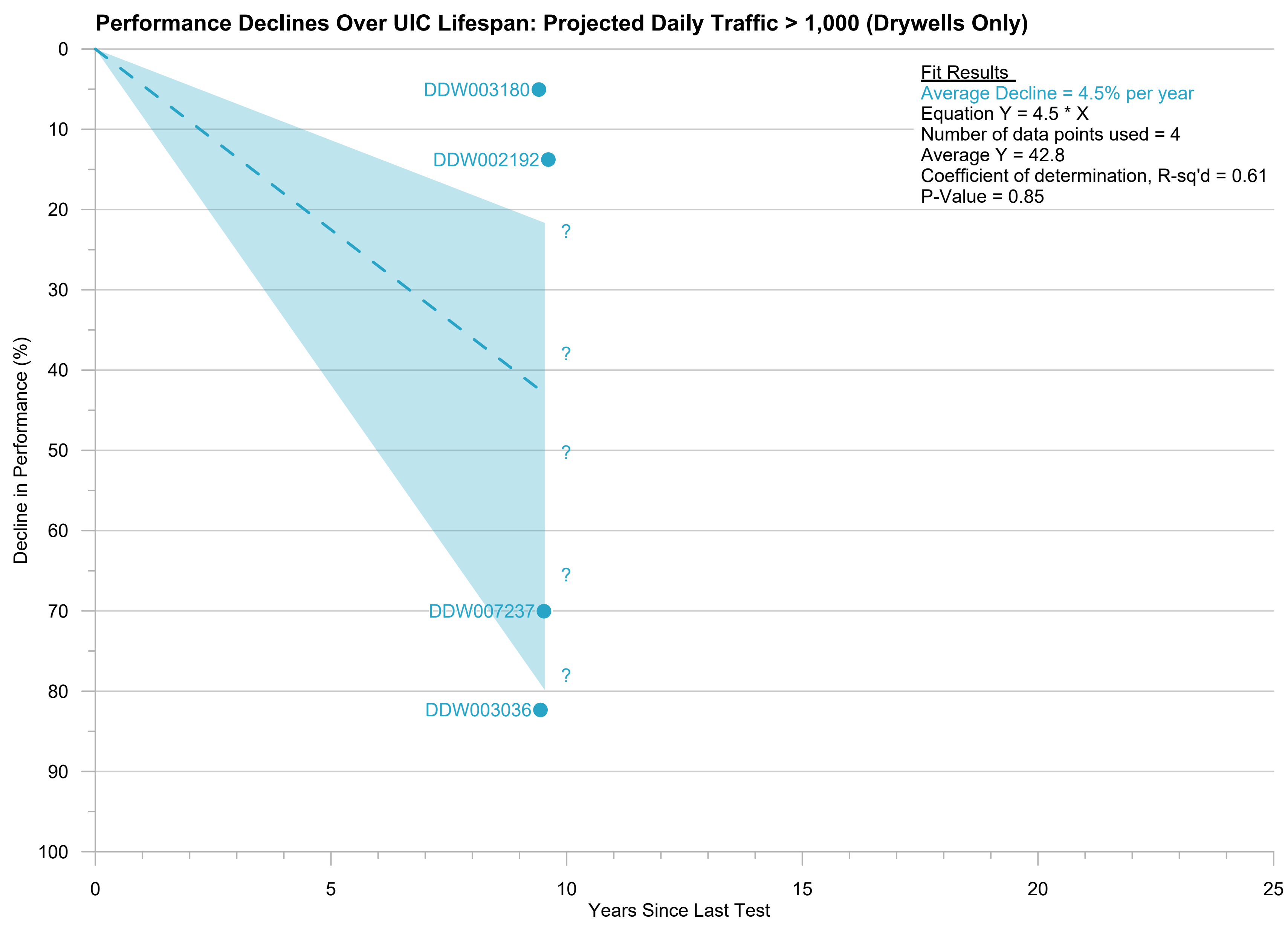

LEGEND

- Drill Holes
- Drywells
- Linear Regression of Data
- 95% Confidence Interval for the Mean
- ? Trends of Performance Declines Beyond the Extent of the Current Dataset Is Unknown

FIGURE C-4

Performance Declines Over Time for Drywells by Traffic Category

Stormwater Infiltration Evaluation Update

NOTES

- Decline in UIC performance calculated using Falling Head infiltration testing data
- UICs that exhibited an increase in performance are not presented
- The calculated confidence intervals are estimates that the population mean for a given x value will fall within the confidence interval; the confidence interval does not mean that for any given UIC, there is a 95% probability that the performance of the UIC will fall within the confidence interval.
- The P-Value indicates the relative significance of the confidence interval's fit; commonly, a P-Value less than 0.05 indicates non-random (significant) results.

GSI Water Solutions, Inc.

Table C-1: Historical Infiltration Testing Data and Baseline Performance Parameters

GENERAL INFORMATION							HISTORICAL INFILTRATION TESTING DATA [2]										CALCULATED PERFORMANCE PARAMETERS [3]			LOCATION DATA	
									Constant Head Test		Falling Head Test						Constant Head Test (COSM Method)		Falling Head Test		
GSI Map ID	FacilityID[1]	Facility Type	Install Year	UIC Depth (feet bgs)	UIC Radius (feet)	Reconditioned (Y/N)	Test Date	Field Sheet	Sustained Flow Rate (cfm)	Sustained DTW (feet bgs)	Initial DTW (feet bgs)	5 Minute DTW (feet bgs)	5 Minute DTW Time (minutes)	Final DTW (feet bgs)	Final Time (minutes)	Head in UIC - Constant Head Test (feet)	Potential Max Infiltration Rate - COSM Const Head (cfm per foot of head)	Infiltration Rate - Falling Head @ 5 min (inches/minute)	Lattitude	Longitude
1	Brosterhouse/Murphy	Drywell		17.8	4.0		10/11/2019	Yes	3.6	12.3	12.3	12.7	5.0	13.3	25.0	5.5	0.7	0.9		
2	DDH001010	Drill Hole	Jan-84	31.2	0.5		1/10/2012	Yes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.02163	-121.30334
3	DDH001021 (A)	Drill Hole	Jan-03	175.0	0.3		1/21/2015	Yes	19.2	154.2	154.2	159.6	5.0	160.8	10.0	20.8	0.9	13.0	44.07063	-121.36323
4	DDH001918	Drill Hole		25.2	0.3		1/5/2011	No	4.0	0.1	0.1	4.5	0.5	8.4	1.5	25.1	0.2	105.6		
5	DDH002017	Drill Hole	Aug-07	33.0	0.5		4/17/2018	Yes	4.8	NA	3.2	18.1	5.0	24.8	20.0	NA	NA	35.8	44.01087	-121.33481
6	DDH009009	Drill Hole	Jan-84	62.0	0.3		2/3/2011	No	12.0	0.6	0.6	41.0	1.0	49.2	5.0	61.4	0.2	484.8	44.08122	-121.33946
7	DDH009017 (A)	Drill Hole	Jun-80	78.1	0.5	N	8/22/2016	Yes	8.4	2.2	18.2	18.6	5.0	18.6	5.0	75.9	0.1	1.0	44.09147	-121.30617
	DDH009017 (B)	Drill Hole	Jun-80	78.1	0.5	Y	6/19/2017	Yes	12.6	1.6	1.6	55.8	5.0	58.6	30.0	76.5	0.2	130.1	44.09147	-121.30617
8	DDH009050	Drill Hole	Jan-80	19.0	0.3		1/6/2011	No	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.0866	-121.26247
9	DDH009057	Drill Hole	Jan-84	24.2	0.3		1/31/2011	No	2.0	1.6	1.6	3.4	5	17.7	25	22.6	0.1	4.3	44.08055	-121.27807
12	DDH009118 (A)	Drill Hole	Aug-04	144.0	0.5	N	9/23/2015	Yes	28.2	0.0	17.8	NA	NA	NA	NA	144.0	0.2	NA	44.06877	-121.3559
	DDH009118 (B)	Drill Hole	Aug-04	144.0	0.5	Y	2/18/2016	Yes	37.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.06877	-121.3559
13	DDH009122	Drill Hole	Aug-05	70.3	0.5		5/26/2017	Yes	5.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.0711	-121.35797
14	DDH009124	Drill Hole	Aug-05	96.8	0.5	Y	6/6/2017	Yes	14.4	2.8	2.8	76.2	5.0	94.2	30.0	94.0	0.2	176.2	44.07177	-121.35596
15	DDH009128	Drill Hole	Aug-04	Full	0.5		4/17/2018	Yes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.06979	-121.35507
16	DDH009129	Drill Hole	Aug-04	50.5	0.5		8/3/2016	Yes	18.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.06963	-121.35849
17	DDH009130	Drill Hole	Aug-04	52.7	0.5		8/3/2016	Yes	40.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.06994	-121.35908
18	DDH009165	Drill Hole	Aug-05	41.6	0.5	Y	6/19/2017	Yes	39.6	24.1	NA	NA	NA	NA	NA	17.5	2.3	NA	44.07821	-121.28566
19	DDH009180	Drill Hole	Jan-96	7.7	0.3		2/2/2011	No	2.0	0.1	0.1	3.3	5	7.1	15	7.6	0.3	7.7	44.06757	-121.27669
20	DDH009220	Drill Hole	Jan-82	Full	0.5		4/17/2018	Yes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.06659	-121.30086
21	DDH009227	Drill Hole	Aug-06	33.9	0.5		4/18/2018	Yes	16.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.0679	-121.30066
22	DDH009241	Drill Hole	Jan-80	11.6	0.3		1/6/2011	No	48.0	0.1	0.1	11.6	0.3	11.6	0.3	11.5	4.2	460.0	44.07205	-121.29106
23	DDH009249	Drill Hole	Jan-82	82.8	0.5		2/18/2015	Yes	12.0	82.8	0.0	0.1	25.0	18.0	35.0	0.0	NA	0.0	44.06955	-121.30354
24	DDH009273	Drill Hole	Jan-00	111.7	0.5	Y	5/17/2017	Yes	6.0	3.3	3.3	53.3	5.0	78.2	40.0	108.4	0.1	120.0	44.06689	-121.3263
25	DDH009273	Drill Hole	Jan-00	111.7	0.5	N	5/17/2017	Yes	79.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.06689	-121.3263
26	DDH009281	Drill Hole	Aug-07	70.4	0.3		1/11/2011	No	3.0	0.4	0.4	2.2	2.0	20.2	17.0	70.0	0.0	10.8	44.0716	-121.33142
27	DDH009292	Drill Hole	Aug-07	83.3	0.5		7/5/2016	Yes	7.2	1.9	1.9	2.0	5.0	2.0	5.0	81.4	0.1	0.2	44.06998	-121.33418
28	DDH009295	Drill Hole	Aug-06	90.2	0.5	Y	6/19/2017	Yes	40.2	50.0	NA	NA	NA	NA	NA	40.2	1.0	NA	44.06986	-121.33689
29	DDH009297	Drill Hole	Aug-06	102.0	0.5		7/11/2016	Yes	36.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.072	-121.33742
30	DDH009312	Drill Hole	Jan-97	82.5	0.5		7/5/2016	Yes	6.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.0752	-121.33365
31	DDH009333 (A)	Drill Hole	Jan-98	72.2	0.5	N	6/4/2015	Yes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.06756	-121.30457
	DDH009333 (B)	Drill Hole	Jan-98	72.2	0.5	Y	2/23/2016	Yes	42.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.06756	-121.30457
32	DDH009334 (A)	Drill Hole	Jul-95	88.0	0.5	N	6/4/2015	Yes	19.8	0.0	0.0	8.7	30.0	8.7	30.0	88.0	0.2	3.5	44.06758	-121.30486
	DDH009334 (B)	Drill Hole	Jul-95	88.0	0.5	Y	2/22/2016	Yes	4.2	NA	0.0	25.0	5.0	33.0	15.0	NA	NA	60.0	44.06758	-121.30486
33	DDH009340	Drill Hole	Aug-07	63.3	0.5		8/3/2016	Yes	31.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.06599	-121.32157
34	DDH009365	Drill Hole	Jan-80	21.0	0.3		1/7/2011	No	66.0	0.1	0.1	12.0	0.2	21.0	2.0	20.9	3.2	952.0	44.07458	-121.30575
37	DDH009381	Drill Hole	Aug-07	27.7	0.5		4/17/2018	Yes	1.8	NA	1.3	4.5	5.0	9.2	15.0	NA	NA	7.7	44.01083	-121.34206
38	DDH009382	Drill Hole	Aug-07	11.1	0.5		4/17/2018	Yes	1.2	NA	2.5	4.5	5.0	9.7	30.0	NA	NA	4.8	44.01096	-121.33477
41	DDH009403 (A)	Drill Hole	Jul-00	95.0	0.5	N	9/25/2015	Yes	2.0	0.0	NA	NA	NA	NA	NA	95.0	0.0	NA	44.01631	-121.33885
	DDH009403 (B)	Drill Hole	Jul-00	95.0	0.5	Y	3/1/2016	Yes	16.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.01631	-121.33885
42	DDH009462 (A)	Drill Hole	Jul-96	97.0	0.5	N	6/8/2015	Yes	NA	NA	14.6	20.0	1.0	21.3	10.0	NA	NA	64.8	44.01269	-121.32563
	DDH009462 (B)	Drill Hole	Jul-96	97.0	0.5	Y	6/8/2015	Yes	7.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.01269	-121.32563
43	DDH009488	Drill Hole	Jun-97	24.0	0.5		4/17/2018	Yes	18.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.05586	-121.30412
44	DDH009489	Drill Hole	Jan-94	11.6	0.5		4/17/2018	Yes	4.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.05586	-121.30402
45	DDH009532	Drill Hole	Jan-78	18.4	0.5	Y	8/22/2016	Yes	3.6	1.8	16.4	17.2	5.0	18.0	10.0	16.6	0.2	1.9	44.06515	-121.30564
46	DDH009546	Drywell	Aug-07	89.4	0.5	Y	5/17/2017	Yes	40.2	NA	72.0	Dry?	NA	Dry?	NA	NA	NA	NA	44.06537	-121.32186
47	DDH009555	Drill Hole	Jan-86	15.5	0.3		2/3/2011	No	24.0	1.7	1.7	2.3	1	15.5	3	13.8	1.7	7.2	44.06269	-121.26982
48	DDH009571	Drill Hole	Jan-80	37.6	0.3		1/7/2011	No	8.0	0.1	0.1	17.0	0.5	37.6	2.0	37.5	0.2	450.7	44.05144	-121.28735
49	DDH009594	Drill Hole	Jan-70	32.7	0.3		2/1/2011	No	14.0	0.1	0.1	10	1	32.7	3	32.6	0.4	118.8	44.05202	-121.29889
53	DDH009657	Drill Hole	Jun-00	11.2	0.5		4/18/2018	Yes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.04637	-121.28386
54	DDH009658	Drill Hole	Jun-00	Full	0.5		4/18/2018	Yes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.04582	-121.28387
55	DDH009662 (A)	Drill Hole	Jan-88	17.5	0.5		8/23/2016	Yes	6.0	2.3	16.2	17.5	3.0	17.5	3.0	15.2	0.4	5.2	44.06184	-121.30386
	DDH009662 (B)	Drill Hole	Jan-88	16.9	0.5		6/25/2016	Yes	3.5	1.2	1.2	3.6	4.0			15.8	0.2	7.4	44.06184	-121.30386
56	DDH009691	Drill Hole	Aug-04	15.0	0.3		1/6/2011	No	20.9	0.1	0.1	15.0	1.0	15.0	1.0	14.9	1.4	178.8	44.05402	-121.31136
57	DDH009741	Drill Hole	Jan-82	15.8	0.3		2/3/2011	No	1.0	0.1	0.1	0.3	10	1.1	30	15.7	0.1	0.2	44.04608	-121.29683
58	DDH009818	Drill Hole	Jan-84	18.9	0.3		1/7/2011	No	28.0	0.1	0.1	13.0	0.2	14.0	1.0	18.8	1.5	1032.0	44.04899	-121.27974
59	DDH009829	Drill Hole	Sep-06	95.0	0.5	Y	6/6/2017	Yes	12.0	2.3	2.3	42.0	5.0	57.9	30.0	92.7	0.1	95.3	44.05198	-121.28326
60	DDH009865 (A)	Drill Hole	Aug-04	53.2	0.3		1/14/2011	No	6.0	8.0	8.0	42.4	5.0	42.4	5.0	45.2	0.1	82.6	44.03518	-121.34082
61	DDH009878	Drill Hole	Jan-83	35.0	0.3		1/12/2011	No	96.0	2.5	2.5	16	1	35	2	32.5	3.0	162.0	44.04496	-121.32599
62	DDH009892 (A)	Drill Hole	Jan-96	21.6	0.3		1/12/2011	No	56.0	0.1	2.5	21.6	1.0	21.6	3.0	21.5	2.6	229.2	44.04889	-121.33977
63	DDH009896	Drill Hole	Jan-99	33.4	2.0		1/10/2011	No	2.0	0.1	0.1	5	5	26	22	33.3	0.1	11.8	44.03772	-121.30577
64	DDH009913		Sep-06	68.5			1/20/2015	Yes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.03931	-121.31452
65	DDH009914	Drill Hole	Jul-06	82.4	0.5	Y	6/16/2017	Yes	45.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.03999	-121.32007
66	DDH009927	Drill Hole	Jan-94	61.6	0.5		2/1/2016	Yes	136.2	NA	58.0	58.7	5.0	59.5	10.0	NA	NA	1.6	44.04153	-121.31216
67	DDH009956 (A)	Drill Hole	Jan-88	97.3	0.5	N	6/4/2015	Yes	10.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.04147	-121.29394
	DDH009956 (B)	Drill Hole	Jan-88	97.3	0.5	Y	2/25/2016	Yes	36.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.04147	-121.29394
68	DDH009993 (A)	Drill Hole	Aug-04	88.0	0.5	N	9/24/2015	Yes	10.2	NA	3.6	4.2	5.0	5.1	25.0	NA	NA	1.4	44.01789	-121.31031
	DDH009993 (B)	Drill Hole	Aug-04	88.0	0.5	Y	2/22/2016	Yes	1.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.01789	-121.31031
69	DDH009994 (A)	Drill Hole	Aug-04	94.0	0.5	N	9/24/2015	Yes	1.8	NA	7.9	13.2	5.0	18.9	20.0	NA	NA	12.7	44.018	-121.30837
	DDH009994 (B)	Drill Hole	Aug-04	94.0	0.5	Y	2/29/2016	Yes	4.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.018	-121.30837
70	DDH010006	Drill Hole	Jan-00	97.8	0.5		2/18/2015	Yes	1.8	97.8	97.8	NA	NA	67.3	30.0	NA	NA	NA	44.069587	-121.303655

Table C-1: Historical Infiltration Testing Data and Baseline Performance Parameters

GENERAL INFORMATION							HISTORICAL INFILTRATION TESTING DATA [2]									CALCULATED PERFORMANCE PARAMETERS [3]			LOCATION DATA	
									Constant Head Test		Falling Head Test					Constant Head Test (COSM Method)		Falling Head Test		
GSI Map ID	FacilityID[1]	Facility Type	Install Year	UIC Depth (feet bgs)	UIC Radius (feet)	Reconditioned (Y/N)	Test Date	Field Sheet	Sustained Flow Rate (cfm)	Sustained DTW (feet bgs)	Initial DTW (feet bgs)	5 Minute DTW (feet bgs)	5 Minute DTW Time (minutes)	Final DTW (feet bgs)	Final Time (minutes)	Head in UIC - Constant Head Test (feet)	Potential Max Infiltration Rate - COSM Const Head (cfm per foot of head)	Infiltration Rate - Falling Head @ 5 min (inches/minute)	Lattitude	Longitude
72	DDH010013 (A)	Drill Hole	Jan-00	94.5	0.5	N	6/8/2015	Yes	4.8	NA	3.0	4.5	2.0	9.7	25.0	NA	NA	9.0	44.013869	-121.334006
	DDH010013 (B)	Drill Hole	Jan-00	94.5	0.5	Y	3/2/2016	Yes	7.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.013869	-121.334006
73	DDW001009	Drywell	Jul-06	12.2	2.0		2/2/2011	No	22.0	5.5	5.5	6.9	5	9.9	25	6.7	3.3	3.4	44.09125	-121.29668
74	DDW001239	Drywell	Jul-95	13.5	4.0		6/7/2017	Yes	6.6	2.9	2.9	5.1	5.0	7.7	30.0	10.6	0.6	5.3	44.05029	-121.33195
75	DDW001299 (A)	Drywell	Jan-06	13.0	2.0		1/4/2011	No	36.5	5	5	8	5	10.9	15	8.0	4.6	7.2	44.07528	-121.27129
76	DDW001375	Drywell	Jun-75	13.0	2.0		1/2/2011	No	52.0	10.3	10.3	11.1	2.0	13.0	5.0	2.7	19.3	4.8	44.03053	-121.29137
77	DDW001548	Drywell	Jan-06	13.3	4.0		7/7/2016	Yes	12.0	2.6	2.6	3.0	5.0	4.2	30.0	10.7	1.1	1.0	44.06258	-121.33188
78	DDW001763	Drywell	Jun-00	11.2	4.0		8/16/2016	Yes	18.0	3.2	6.4	7.6	5.0	9.2	25.0	8.0	2.3	2.9	44.0571	-121.31605
79	DDW001813	Drywell	Jan-94	10.0	2.0		1/5/2011	No	48.0	4.8	4.8	6.6	2	9.1	10	5.2	9.2	10.8	44.06993	-121.31452
80	DDW002192	Drywell	Jul-70	13.0	2.0		11/14/2010	No	56.0	3.2	3.2	4.4	5.0	6.4	25.0	9.8	5.7	2.9	44.05762	-121.34547
81	DDW003024	Drywell	Jan-96	10.5	4.0		7/8/2016	Yes	8.4	2.6	2.6	3.8	5.0	4.9	30.0	7.9	1.1	2.9	44.06321	-121.32896
82	DDW003036	Drywell	Jan-82	12.0	0.3		1/10/2011	No	40.0	10.3	10.3	12.0	1.0	12.0	1.0	1.7	23.5	20.4	44.06101	-121.30735
83	DDW003046	Drywell	Jun-56	14.3	2.0		1/10/2011	No	12.0	3.6	3.6	5.5	2	8.3	12	10.7	1.1	11.4	44.05179	-121.31637
84	DDW003088	Drywell	Jan-99	10.2	2.0		1/18/2011	No	44.0	5.6	5.6	7.9	1.0	9.9	5.0	4.6	9.6	27.6	44.05095	-121.32469
85	DDW003155	Drywell	Jul-95	10.6	4.0		4/4/2017	Yes	4.8	3.3	3.3	3.5	5.0	4.1	25.0	7.3	0.7	0.4	44.04801	-121.33186
86	DDW003180	Drywell	Jun-78	13.6	2.0		1/20/2011	No	48.0	9.6	9.6	12.9	5.0	12.9	5.0	4.0	12.0	7.9	44.02909	-121.30477
87	DDW003228	Drywell	Jul-95	14.0	4.0		4/4/2017	Yes	6.6	4.0	4.1	4.2	5.0	4.3	15.0	10.0	0.7	0.2	44.04727	-121.3317
88	DDW003247	Drywell	Jul-95	12.8	4.0		6/8/2017	Yes	2.4	3.4	3.4	3.5	5.0	4.0	30.0	9.4	0.3	0.2	44.04652	-121.3316
89	DDW003256	Drywell	Jun-99	11.0	4.0		4/4/2017	Yes	4.2	3.8	3.8	3.9	5.0	4.0	25.0	7.2	0.6	0.2	44.04776	-121.33197
90	DDW003411	Drywell	Jul-86	12.3	4.0		7/5/2016	Yes	NA	3.0	3.0	3.1	5.0	4.0	30.0	9.3	NA	0.2	44.07372	-121.32895
91	DDW003451	Drywell	Jan-92	10.5	4.0		4/11/2016	Yes	24.0	NA	4.0	5.0	5.0	8.8	30.0	NA	NA	2.4	44.04211	-121.29024
92	DDW003490	Drywell	Jan-84	11.4	4.0		10/15/2018	Yes	19.8	4.0	4.0	4.5	5.0	6.1	40.0	7.4	2.7	1.2	44.01884	-121.29883
93	DDW003541	Drywell	Jan-00	13.0	2.0		1/6/2011	No	14.0	10	10	10.7	1	13	7	3.0	4.7	8.4	44.05483	-121.35467
94	DDW007091	Drywell	Jan-94	11.3	2.0		1/5/2011	No	46.0	9.1	9.1	10.7	1.0	10.7	1.0	2.2	20.9	19.2	44.08264	-121.2705
95	DDW007155	Drywell	Aug-04	11.0	4.0		9/23/2015	Yes	1.8	2.7	2.8	2.9	5.0	3.3	25.0	8.3	0.22	0.24	44.0688	-121.35593
96	DDW007156	Drywell	Aug-04	10.2	4.0		8/3/2016	Yes	19.8	3.7	6.5	7.6	5.0	9.8	25.0	6.5	3.0	2.6	44.0696	-121.35853
97	DDW007157	Drywell	Aug-04	10.0	4.0		8/4/2016	Yes	1.8	3.5	6.5	7.6	5.0	9.8	25.0	6.5	0.3	2.6	44.06997	-121.35905
98	DDW007175	Drywell	Jan-90	9.6	2.0		1/14/2011	No	16.0	5.9	5.9	7.7	5.0	7.7	5.0	3.7	4.3	4.3	44.07702	-121.28487
99	DDW007216	Drywell	Jan-89	11.0	2.0		11/12/2010	No	4.0	2	2.1	2.75	5	4.01	25	9.0	0.4	1.6	44.06147	-121.3353
100	DDW007226	Drywell	Jan-88	10.8	4.0		7/6/2016	Yes	25.2	3.6	3.6	6.1	5.0	9.2	30.0	7.2	3.5	6.0	44.06977	-121.3297
101	DDW007229	Drywell	Jan-94	11.0	4.0		7/6/2016	Yes	37.8	4.4	4.4	7.7	5.0	9.7	30.0	6.6	5.7	7.9	44.07014	-121.34263
102	DDW007237	Drywell	Jul-86	11.0	2.0		12/13/2010	No	1.0	3.3	3.3	3.4	5	3.6	25	7.7	0.13	0.2	44.07434	-121.32652
103	DDW007241	Drywell	Jan-97	10.8	4.0		7/5/2016	Yes	4.8	1.6	1.6	3.8	5.0	5.5	30.0	9.2	0.5	5.2	44.07491	-121.32814
104	DDW007485	Drywell	Jan-00	13.4	2.0		1/24/2011	No	66.0	11.3	11.3	12.6	1	13.2	5	2.1	31.4	15.6	44.05425	-121.33842
105	DDW007527	Drywell	Jan-94	9.8	2.0		1/19/2011	No	6.0	3.5	3.6	4.2	5.0	6.6	25.0	6.3	1.0	1.4	44.05154	-121.33506
106	DDW007553	Drywell	Aug-07	11.4	4.0		1/4/2018	Yes	30.0	9.3	9.3	10.8	5.0	11.3	10.0	2.2	14.0	3.7	44.05871	-121.31567
107	DDW007554	Drywell	Aug-07	11.3	4.0		1/4/2018	Yes	14.4	8.4	8.4	10.1	5.0	10.4	10.0	2.9	5.0	4.1	44.05884	-121.31586
108	DDW007555	Drywell	Aug-07	11.6	4.0		1/4/2018	Yes	24.0	3.7	3.7	6.4	5.0	10.8	20.0	7.9	3.0	6.5	44.05917	-121.31548
109	DDW007556	Drywell	May-05	11.8	4.0		1/5/2018	Yes	19.2	3.7	3.7	5.8	5.0	9.5	30.0	8.1	2.4	5.0	44.05916	-121.31511
110	DDW007557	Drywell	Jan-97	9.0	2.0		10/8/2010	No	15.0	3	3	4	5	4.58	10	6.0	2.5	2.4	44.05881	-121.31422
111	DDW007602	Drywell	Jan-97	?	2.0		10/13/2010	No	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.05275	-121.3345
112	DDW007613	Drywell	Jan-90	11.0	2.0		1/3/2011	No	48.0	6.5	6.5	9.2	1	11	4	4.5	10.7	32.4	44.0395	-121.27878
113	DDW007771	Drywell	Jan-82	10.0	0.0		1/21/2011	No	16.0	4.1	4.1	5.6	5.0	9.6	20.0	5.9	2.7	3.6	44.0746	-121.27982
114	DDW007772	Drywell	Jan-82	0.0	2.0		?	No	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.07476	-121.27982
115	DDW008009	Drywell	Jan-96	12.0	2.0		1/13/2011	No	18.0	5.6	5.6	7.0	2.0	9.5	8.0	6.4	2.8	8.4	44.10434	-121.28579
116	DDW008036	Drywell	Jan-84	11.2	4.0		10/9/2018	Yes	40.8	4.5	4.5	7.3	5.0	11.2	30.0	6.7	6.1	6.8	44.019	-121.29488
117	DDW008038	Drywell	Jan-84	10.4	4.0		10/9/2018	Yes	34.2	4.4	4.4	8.0	5.0	10.4	20.0	6.0	5.7	8.6	44.01899	-121.29554
118	DDW008043	Drywell	Jan-84	10.6	4.0		10/15/2018	Yes	36.6	4.2	4.2	6.3	5.0	9.8	30.0	6.4	5.7	4.9	44.01899	-121.29803
119	DDW008044	Drywell	Jan-84	10.7	4.0		10/11/2018	Yes	31.8	2.3	2.3	4.9	5.0	8.9	30.0	8.3	3.8	6.2	44.01891	-121.30002
120	DDW008045	Drywell	Jan-84	11.5	4.0		10/11/2018	Yes	45.6	3.3	3.3	6.9	5.0	10.4	30.0	8.2	5.6	8.6	44.01886	-121.3012
121	DDW008138	Drywell	Jan-67	12.0	2.0		11/11/2010	No	4.0	2.0	2.0	3.6	5.0	4.9	20.0	10.0	0.4	3.8	44.04973	-121.34212
122	DDW008451	Drywell	Jun-00	9.6	4.0		7/20/2016	Yes	29.4	3.4	4.3	5.4	5.0	7.9	25.0	6.2	4.7	2.6	44.06935	-121.3595
123	DDW008452	Drywell	Jun-00	9.5	4.0		1/21/2016	Yes	10.2	3.5	4.3	5.4	5.0	7.9	25.0	6.0	1.7	2.6	44.06993	-121.36027
124	DDW008479	Drywell	Jan-01	16.0	2.0		12/13/2010	No	14.0	6.8	6.8	7.4	5	9.7	25	9.2	1.5	1.4	44.06837	-121.36111
125	DDW008496	Drywell	Jan-98	11.0	2.0		?	No	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.06556	-121.34488
126	DDW008513	Drywell	Jan-94	11.7	4.0		7/7/2016	Yes	52.8	7.0	7.0	10.0	5.0	11.1	25.0	4.7	11.2	7.2	44.06308	-121.33838
127	DDW008608	Drywell	Jan-99	11.0	2.0		?	No	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.04182	-121.33626
128	DDW008672	Drywell	Jan-01	10.7	2.0		1/21/2011	No	40.0	4.5	4.5	6	5	8.5	25	6.2	6.5	3.6	44.02636	-121.29249
129	DDW008778	Drywell	Jan-99	11.5	2.0		2/2/2011	No	24.0	5.2	5.2	5.7	5.0	7.5	25.0	6.3	3.8	1.2	44.04333	-121.3086
130	DDW008779	Drywell	Jan-02	11.0	4.0		1/27/2016	Yes	70.2	5.3	5.3	9.3	5.0	11.0	10.0	5.8	12.2	9.6	44.04275	-121.31061
131	DDW008780	Drywell	Jan-02	11.0	4.0		2/1/2016	Yes	61.8	7.5	7.5	9.7	5.0	11.0	15.0	3.5	17.7	5.2	44.04225	-121.31094
132	DDW008787	Drywell	Jun-98	12.0	4.0		2/1/2016	Yes	52.2	7.5	7.5	11.2	5.0	12.0	10.0	4.5	11.6	8.8	44.04158	-121.31486
133	DDW008897	Drywell	Jan-98	11.7	2.0		1/4/2011	No	62.0	6.4	6.4	10.0	6.0	10.0	6.0	5.3	11.7	7.2	44.04879	-121.29736
134	DDW008920	Drywell	Jul-95	10.9	4.0		6/7/2017	Yes	6.6	8.2	8.2	9.5	5.0	10.1	15.0	2.7	2.4	3.1	44.04875	-121.33169
135	DDW008924	Drywell	Jul-95	11.9	4.0		6/9/2017	Yes	1.8	4.3	4.3	4.8	5.0	5.4	25.0	7.6	0.2	1.2	44.0467	-121.33127
136	DDW008928	Drywell	Jul-95	11.1	4.0		6/9/2017	Yes	3.6	2.7	2.7	4.5	5.0	5.1	15.0	8.4	0.4	4.3	44.04532	-121.33135
137	DDW008951	Drywell	Jan-02	11.7	0.0		2/1/2011	No	80.0	9.3	9.3	10.7	1.0	11.7	3.0	2.4	33.3	16.8	44.07651	-121.26093
138	DDW009526	Drywell	Jul-05	15.2	4.0		10/10/2018	Yes	37.8	12.6	12.6	14.2	5.0	14.8	20.0	2.6	14.7	3.8	44.01933	-121.3038
139	DDW009527	Drywell	Jul-05	14.3	4.0		10/10/2018	Yes	37.8	12.1	12.1	13.9	5.0	14.3	10.0	2.2	17.6	4.3	44.01922	-121.30379
140	DDW009528	Drywell	Jul-05	14.2	4.0		10/10/2018	Yes	40.2	10.1	10.1	12.4	5.0	14.2	15.0	4.1	9.9	5.5	44.01912	-121.3038
141	DDW009529	Drywell	Jul-05	13.9	4.0		10/10/2018	Yes	45.0	4.9	4.9	8.9	5.0	13.9	25.0	9.0	5.0	9.6	44.01905	-121.30365

Table C-1: Historical Infiltration Testing Data and Baseline Performance Parameters

GENERAL INFORMATION							HISTORICAL INFILTRATION TESTING DATA [2]										CALCULATED PERFORMANCE PARAMETERS [3]			LOCATION DATA	
									Constant Head Test		Falling Head Test						Constant Head Test (COSM Method)		Falling Head Test		
GSI Map ID	FacilityID[1]	Facility Type	Install Year	UIC Depth (feet bgs)	UIC Radius (feet)	Reconditioned (Y/N)	Test Date	Field Sheet	Sustained Flow Rate (cfm)	Sustained DTW (feet bgs)	Initial DTW (feet bgs)	5 Minute DTW (feet bgs)	5 Minute DTW Time (minutes)	Final DTW (feet bgs)	Final Time (minutes)	Head in UIC - Constant Head Test (feet)	Potential Max Infiltration Rate - COSM Const Head (cfm per foot of head)	Infiltration Rate - Falling Head @ 5 min (inches/minute)	Lattitude	Longitude
142	DDW009600	Drywell	Jan-80	12.0	4.0		1/27/2016	Yes	46.2	7.7	7.7	10.0	5.0	12.0	15.0	4.3	10.7	5.6	44.04165	-121.31363
143	DDW010099	Drywell	Jan-00	14.7	4.0		10/9/2018	Yes	40.2	13.7	13.7	14.3	5.0	14.6	25.0	1.0	40.2	1.4	44.018867	-121.293504
144	DDW010129	Drywell	Aug-08	13.0	4.0		7/6/2016	Yes	39.6	3.5	3.5	5.9	5.0	8.0	15.0	9.5	4.2	5.8	44.06574407	-121.3416454
145	DDW010130	Drywell	Aug-08	11.3	4.0		7/6/2016	Yes	46.2	6.0	6.0	6.4	5.0	8.2	30.0	5.3	8.7	1.0	44.06566543	-121.3415208
146	DDW010152	Drywell	Jul-13	13.3	4.0		8/5/2016	Yes	3.0	3.7	4.1	4.6	5.0	5.2	25.0	9.6	0.3	1.2	44.07305218	-121.3612805
147	DDW010153	Drywell	Jul-13	13.9	4.0		8/4/2016	Yes	49.2	6.9	8.2	9.2	5.0	12.0	25.0	7.0	7.0	2.4	44.07287355	-121.3608314
148	DDW010154	Drywell	Jul-13	13.5	4.0		8/4/2016	Yes	39.0	12.5	12.5	13.5	5.0	NA	NA	1.0	39.0	2.4	44.07270567	-121.3602661
149	DDW010559	Drywell	Sep-17	14.3	4.0		9/25/2017	Yes	36.0	5.7	5.7	8.3	5.0	12.1	30.0	8.6	4.2	6.1	44.05513608	-121.3074568

<u>Notes:</u>

1 Facility IDs were provided by the City of Bend, and were modified as descibed below for facilities with multiple rounds of infiltration testing data:
 (A) First round of infiltration testing data (pre-reconditioning)
 (B) Second round of infiltration testing data (post-reconditioning)

2 Infiltration testing data was provided by the City of Bend and processed by GSI in accordance with the following procedure:
 - The 'Sustained Flow Rate' and 'Depth to Water' Constant Head Test values in the table above were sourced from the 'UIC Static Water Depth (1 HR)' field of the City of Bend's UIC Infiltration Testing Form. If no values were recorded in this field, the values were sourced from the 'UIC Filling (30 Min.)' field of the City's form if the depth to water measurements were relatively stable.
 - The 'Initial DTW', 'Fastest DTW', 'Fastest Time', 'Final DTW', and 'Final Time' values in the table above were sourced from the 'Falling Head Test (30 Min)' field of the City of Bend's UIC Infiltration Testing Form.

3 Parameters were calculated according to the methods outlined in the Central Oregon Stormwater Manual (COIC, 2010)

<u>Acronyms:</u>
bgs = below ground surface
cfm = cubic feet per minute
DEQ = Department of Environmental Quality
NA = No data available

Table C-2: UIC Selection Methodology - Detailed Results

GENERAL INFORMATION							UIC SELECTION CRITERIA							
GSI Map ID	FacilityID[1]	Facility Type	Install Year	UIC Depth (feet bgs)	UIC Radius (feet)	Reconditioned (Y/N)	Saturated Hydraulic Conductivity - USDI (inches/minute)	Test Date	Distance to Nearest City Hydrant (feet)	City Drainage Area	NRCS Soil Class	Zoning	Projected Daily Traffic Counts	SELECTED UIC[1]
3	DDW003036	Drywell	Jan-82	12.0	0.3		42.70	1/10/2011	55	1	155C	CL	>1,000	YES
55	DDH009662	Drill Hole	Jan-88	17.5	0.5		0.15	8/23/2016	14	1	155C	CL	<1,000	YES
4	DDW008897	Drywell	Jan-98	11.7	2.0		2.96	1/4/2011	85	1	155C	IG	<1,000	YES
6	DDH009691	Drill Hole	Aug-04	15.0	0.3		0.59	1/6/2011	14	1	155C	RM	<1,000	YES
7	DDW003180	Drywell	Jun-78	13.6	2.0		2.54	1/20/2011	75	1	155C	RS	>1,000	YES
8	DDH009571	Drill Hole	Jan-80	37.6	0.3		0.05	1/7/2011	25	1	155C	RS	<1,000	YES
18	DDW007175	Drywell	Jan-90	9.6	2.0		0.84	1/14/2011	47	1	38B	RS	<1,000	YES
21	DDW001299	Drywell	Jan-06	13.0	2.0		0.91	1/4/2011	142	1	58C	RS	<1,000	YES
23	DDW008672	Drywell	Jan-01	10.7	2.0		1.69	1/21/2011	92	1	72C	RS	<1,000	YES
26	DDH009281	Drill Hole	Aug-07	70.4	0.3		0.01	1/11/2011	36	2	157C	RS	<1,000	YES
27	DDW007237	Drywell	Jul-86	11.0	2.0		0.03	12/13/2010	81	2	61C	RS	>1,000	YES
29	DDW001813	Drywell	Jan-94	10.0	2.0		2.32	1/5/2011	68	2	62D	RS	<1,000	YES
30	DDW007155	Drywell	Aug-04	11.0	4.0		0.02	9/23/2015	39	2	72C	RS	<1,000	YES
31	DDW003088	Drywell	Jan-99	10.2	2.0		2.26	1/18/2011	85	4	157C	MR	<1,000	YES
33	DDW002192	Drywell	Jul-70	13.0	2.0		1.44	11/14/2010	74	4	157C	RS	>1,000	YES
34	DDH009865	Drill Hole	Aug-04	53.2	0.3		0.03	1/14/2011	84	4	157C	RS	<1,000	YES
37	DDW007216	Drywell	Jan-89	11.0	2.0		0.11	11/12/2010	71	4	72C	RM	<1,000	YES
38	DDW003541	Drywell	Jan-00	13.0	2.0		0.58	1/6/2011	131	4	72C	RS	<1,000	YES
40	DDH001021	Drill Hole	Jan-03	175.0	0.3		0.35	1/21/2015	111	4	72C	RS	>1,000	YES
39	DDH009892	Drill Hole	Jan-96	21.6	0.3		0.96	1/12/2011	21	4	72C	RS	<1,000	YES
25	DDH001918	Drill Hole	???	25.2	0.3		0.05	1/5/2011	-1	1	?	?	NA	NO
1	DDW003046	Drywell	Jun-56	14.3	2.0		0.28	1/10/2011	71	1	155C	CG	>1,000	NO
2	DDH009896	Drill Hole	Jan-99	33.4	2.0		0.01	1/10/2011	18	1	155C	CG	>1,000	NO
5	DDW001375	Drywell	Jun-75	13.0	2.0		1.48	1/2/2011	68	1	155C	IL	>1,000	NO
9	DDH009241	Drill Hole	Jan-80	11.6	0.3		2.44	1/6/2011	53	1	155C	RS	<1,000	NO
10	DDW007557	Drywell	Jan-97	9.0	2.0		0.65	10/8/2010	60	1	157C	CB	>1,000	NO
11	DDH009365	Drill Hole	Jan-80	21.0	0.3		1.19	1/7/2011	10	1	157C	CL	>1,000	NO
12	DDH009594	Drill Hole	Jan-70	32.7	0.3		0.11	2/1/2011	159	1	157C	RM	<1,000	NO
13	DDW008778	Drywell	Jan-99	11.5	2.0		1.00	2/2/2011	69	1	157C	RM	<1,000	NO
14	DDH009741	Drill Hole	Jan-82	15.8	0.3		0.03	2/3/2011	38	1	157C	RM	<1,000	NO
15	DDW007613	Drywell	Jan-90	11.0	2.0		2.49	1/3/2011	92	1	157C	RS	<1,000	NO
16	DDH009555	Drill Hole	Jan-86	15.5	0.3		0.89	2/3/2011	66	1	36A	RM	<1,000	NO
17	DDW001009	Drywell	Jul-06	12.2	2.0		0.86	2/2/2011	70	1	38B	RM	<1,000	NO
19	DDW008009	Drywell	Jan-96	12.0	2.0		0.74	1/13/2011	68	1	38B	RS	<1,000	NO
20	DDH009180	Drill Hole	Jan-96	7.7	0.3		0.21	2/2/2011	31	1	38B	RS	<1,000	NO
22	DDH009057	Drill Hole	Jan-84	24.2	0.3		0.03	1/31/2011	21	1	58C	RS	<1,000	NO
24	DDH009818	Drill Hole	Jan-84	18.9	0.3		0.61	1/7/2011	67	1	72C	RS	<1,000	NO
28	DDH009009	Drill Hole	Jan-84	62.0	0.3		0.03	2/3/2011	36	2	61C	RS	<1,000	NO
32	DDH009878	Drill Hole	Jan-83	35.0	0.3		0.79	1/12/2011	85	4	157C	MU	>1,000	NO
35	DDW007527	Drywell	Jan-94	9.8	2.0		0.25	1/19/2011	71	4	157C	RS	<1,000	NO
36	DDW008138	Drywell	Jan-67	12.0	2.0		0.10	11/11/2010	99	4	62D	RS	<1,000	NO
41	DDW008479	Drywell	Jan-01	16.0	2.0		0.39	12/13/2010	74	4	72C	RS	<1,000	NO
-	DDH009488	Drill Hole	Jun-97	24.0	0.5		NA	4/17/2018	107	1	155C	CL	>1,000	NO
-	DDH009489	Drill Hole	Jan-94	11.6	0.5		NA	4/17/2018	90	1	155C	CL	>1,000	NO
-	DDH009334 (A)	Drill Hole	Jul-95	88.0	0.5	N	0.02	6/4/2015	132	1	155C	ME	#N/A	NO
-	DDH010006	Drill Hole	Jan-00	97.8	0.5		NA	2/18/2015	267	1	155C	ME	<1,000	NO
-	DDH009249	Drill Hole	Jan-82	82.8	0.5		NA	2/18/2015	238	1	155C	ME	<1,000	NO
-	DDH009333 (A)	Drill Hole	Jan-98	72.2	0.5	N	NA	6/4/2015	56	1	155C	ME	#N/A	NO
-	DDH009334 (B)	Drill Hole	Jul-95	88.0	0.5	Y	NA	2/22/2016	132	1	155C	ME	#N/A	NO
-	DDH009333 (B)	Drill Hole	Jan-98	72.2	0.5	Y	NA	2/23/2016	56	1	155C	ME	#N/A	NO
-	DDH010007	Drill Hole	Jan-00	90.6	0.5	Y	NA	1/8/2020	287	1	155C	ME	<1,000	NO

Table C-2: UIC Selection Methodology - Detailed Results

GENERAL INFORMATION							UIC SELECTION CRITERIA							
GSI Map ID	FacilityID[1]	Facility Type	Install Year	UIC Depth (feet bgs)	UIC Radius (feet)	Reconditioned (Y/N)	Saturated Hydraulic Conductivity - USDI (inches/minute)	Test Date	Distance to Nearest City Hydrant (feet)	City Drainage Area	NRCS Soil Class	Zoning	Projected Daily Traffic Counts	SELECTED UIC[1]
-	DDW001763	Drywell	Jun-00	11.2	4.0		0.24	8/16/2016	66	1	155C	PF	>1,000	NO
-	DDH009220	Drill Hole	Jan-82	Full	0.5		NA	4/17/2018	67	1	155C	RH	>1,000	NO
-	DDH009227	Drill Hole	Aug-06	33.9	0.5		NA	4/18/2018	147	1	155C	RH	>1,000	NO
-	DDH009462 (A)	Drill Hole	Jul-96	97.0	0.5	N	NA	6/8/2015	5771	1	155C	RL	#N/A	NO
-	DDH009462 (B)	Drill Hole	Jul-96	97.0	0.5	Y	NA	6/8/2015	5771	1	155C	RL	#N/A	NO
-	DDW008038	Drywell	Jan-84	10.4	4.0		0.36	10/9/2018	116	1	155C	RS	>1,000	NO
-	DDW008036	Drywell	Jan-84	11.2	4.0		0.50	10/9/2018	70	1	155C	RS	>1,000	NO
-	DDW008044	Drywell	Jan-84	10.7	4.0		0.42	10/11/2018	54	1	155C	RS	>1,000	NO
-	DDW003490	Drywell	Jan-84	11.4	4.0		0.26	10/15/2018	118	1	155C	RS	>1,000	NO
-	DDW008043	Drywell	Jan-84	10.6	4.0		0.42	10/15/2018	55	1	155C	RS	>1,000	NO
-	DDW010099	Drywell	Jan-00	14.7	4.0		-57.78	10/9/2018	122	1	155C	RS	#N/A	NO
-	DDH009630	Drill Hole	Jan-94	39.7	0.5		NA	1/7/2020	352	1	155C	RS	<1,000	NO
-	DDH009631	Drill Hole	Jan-94	20.9	0.5		NA	1/7/2020	325	1	155C	RS	<1,000	NO
-	DDH009605	Drill Hole	Jun-97	64.0	0.5		NA	1/7/2020	64	1	155C	RS	<1,000	NO
-	DDH009381	Drill Hole	Aug-07	27.7	0.5		NA	4/17/2018	3893	1	156C	RL	<1,000	NO
-	DDH009380	Drill Hole	Jul-82	29.2	0.5		NA	1/7/2020	3680	1	156C	RL	<1,000	NO
-	DDH009384	Drill Hole	Jul-82	18.8	0.5		NA	1/7/2020	3670	1	156C	RL	<1,000	NO
-	DDH009385	Drill Hole	Jul-82	57.9	0.5		NA	1/7/2020	3642	1	156C	RL	<1,000	NO
-	DDW010559	Drywell	Sep-17	14.3	4.0		0.47	9/25/2017	90	1	157C	CG	#N/A	NO
-	DDW003451	Drywell	Jan-92	10.5	4.0		NA	4/11/2016	44	1	157C	IL	<1,000	NO
-	DDH009532	Drill Hole	Jan-78	18.4	0.5	Y	0.08	8/22/2016	174	1	157C	ME	<1,000	NO
-	DDW007555	Drywell	Aug-07	11.6	4.0		0.32	1/4/2018	63	1	157C	PF	<1,000	NO
-	DDW007556	Drywell	May-05	11.8	4.0		0.25	1/5/2018	63	1	157C	PF	<1,000	NO
-	DDW007553	Drywell	Aug-07	11.4	4.0		-6.02	1/4/2018	77	1	157C	PF	>1,000	NO
-	DDW007554	Drywell	Aug-07	11.3	4.0		-1.07	1/4/2018	130	1	157C	PF	>1,000	NO
-	DDH009657	Drill Hole	Jun-00	11.2	0.5		NA	4/18/2018	118	1	157C	PF	>1,000	NO
-	DDH009658	Drill Hole	Jun-00	Full	0.5		NA	4/18/2018	104	1	157C	PF	>1,000	NO
-	DDH009403 (A)	Drill Hole	Jul-00	95.0	0.5	N	0.00	9/25/2015	3276	1	157C	RL	#N/A	NO
-	DDH010013 (A)	Drill Hole	Jan-00	94.5	0.5	N	NA	6/8/2015	4611	1	157C	RL	#N/A	NO
-	DDH009993 (A)	Drill Hole	Aug-04	88.0	0.5	N	NA	9/24/2015	1730	1	157C	RL	#N/A	NO
-	DDH009994 (A)	Drill Hole	Aug-04	94.0	0.5	N	NA	9/24/2015	1221	1	157C	RL	#N/A	NO
-	DDH009993 (B)	Drill Hole	Aug-04	88.0	0.5	Y	NA	2/22/2016	1730	1	157C	RL	#N/A	NO
-	DDH009994 (B)	Drill Hole	Aug-04	94.0	0.5	Y	NA	2/29/2016	1221	1	157C	RL	#N/A	NO
-	DDH009403 (B)	Drill Hole	Jul-00	95.0	0.5	Y	NA	3/1/2016	3276	1	157C	RL	#N/A	NO
-	DDH010013 (B)	Drill Hole	Jan-00	94.5	0.5	Y	NA	3/2/2016	4611	1	157C	RL	#N/A	NO
-	DDH002017	Drill Hole	Aug-07	33.0	0.5		NA	4/17/2018	5295	1	157C	RL	<1,000	NO
-	DDH009382	Drill Hole	Aug-07	11.1	0.5		NA	4/17/2018	5283	1	157C	RL	<1,000	NO
-	DDH001010	Drill Hole	Jan-84	31.2	0.5		NA	1/10/2020	1061	1	157C	RL	<1,000	NO
-	DDH009956 (A)	Drill Hole	Jan-88	97.3	0.5	N	NA	6/4/2015	149	1	157C	RM	#N/A	NO
-	DDH009956 (B)	Drill Hole	Jan-88	97.3	0.5	Y	NA	2/25/2016	149	1	157C	RM	#N/A	NO
-	DDW008779	Drywell	Jan-02	11.0	4.0		0.65	1/27/2016	59	1	157C	RS	<1,000	NO
-	DDH009829	Drill Hole	Sep-06	95.0	0.5	Y	0.01	6/6/2017	220	1	157C	RS	<1,000	NO
-	DDH009165	Drill Hole	Aug-05	41.6	0.5	Y	0.80	6/19/2017	161	1	157C	RS	<1,000	NO
-	DDW009529	Drywell	Jul-05	13.9	4.0		0.58	10/10/2018	131	1	157C	RS	>1,000	NO
-	DDW009527	Drywell	Jul-05	14.3	4.0		-7.58	10/10/2018	203	1	157C	RS	<1,000	NO
-	DDW009526	Drywell	Jul-05	15.2	4.0		-4.32	10/10/2018	241	1	157C	RS	<1,000	NO
-	DDW008780	Drywell	Jan-02	11.0	4.0		-2.02	2/1/2016	85	1	157C	RS	<1,000	NO
-	DDW009528	Drywell	Jul-05	14.2	4.0		-0.49	10/10/2018	173	1	157C	RS	<1,000	NO
-	DDH009913		Sep-06	68.5			NA	1/20/2015	81	1	157C	RS	<1,000	NO
-	DDH009927	Drill Hole	Jan-94	61.6	0.5		NA	2/1/2016	38	1	157C	RS	<1,000	NO
-	DDH009017 (A)	Drill Hole	Jun-80	78.1	0.5	N	0.01	8/22/2016	46	1	34C	ME	#N/A	NO

Table C-2: UIC Selection Methodology - Detailed Results

GENERAL INFORMATION							UIC SELECTION CRITERIA							SELECTED UIC[1]
GSI Map ID	FacilityID[1]	Facility Type	Install Year	UIC Depth (feet bgs)	UIC Radius (feet)	Reconditioned (Y/N)	Saturated Hydraulic Conductivity - USDI (inches/minute)	Test Date	Distance to Nearest City Hydrant (feet)	City Drainage Area	NRCS Soil Class	Zoning	Projected Daily Traffic Counts	
-	DDH009017 (B)	Drill Hole	Jun-80	78.1	0.5	Y	0.02	6/19/2017	46	1	34C	ME	#N/A	NO
-	DDW007771	Drywell	Jan-82	10.0	0.0		NA	1/21/2011	57	1	36A	RS	<1,000	NO
-	DDW007772	Drywell	Jan-82	0.0	2.0		NA	?	73	1	36A	RS	<1,000	NO
-	DDW007091	Drywell	Jan-94	11.3	2.0		-0.90	1/5/2011	125	1	38B	RS	<1,000	NO
-	DDH009050	Drill Hole	Jan-80	19.0	0.3		NA	1/6/2011	38	1	58C	RS	<1,000	NO
-	DDW008951	Drywell	Jan-02	11.7	0.0		NA	2/1/2011	73	1	58C	RS	>1,000	NO
-	DDH009082	Drill Hole	Jan-86	20.6	0.5		NA	1/10/2020	83	1	58C	RS	<1,000	NO
-	DDH009081	Drill Hole	Jan-86	10.2	0.5		NA	1/10/2020	25	1	58C	RS	<1,000	NO
-	DDW008045	Drywell	Jan-84	11.5	4.0		0.60	10/11/2018	91	1	72C	RS	>1,000	NO
-	DDW007226	Drywell	Jan-88	10.8	4.0		0.33	7/6/2016	81	2	157C	RS	<1,000	NO
-	DDW007157	Drywell	Aug-04	10.0	4.0		0.02	8/4/2016	74	2	157C	RS	<1,000	NO
-	DDH009124	Drill Hole	Aug-05	96.8	0.5	Y	0.02	6/6/2017	47	2	157C	RS	<1,000	NO
-	DDW010154	Drywell	Jul-13	13.5	4.0		-56.05	8/4/2016	215	2	157C	RS	#N/A	NO
-	DDH009130	Drill Hole	Aug-04	52.7	0.5		NA	8/3/2016	79	2	157C	RS	<1,000	NO
-	DDH009122	Drill Hole	Aug-05	70.3	0.5		NA	5/26/2017	4	2	157C	RS	<1,000	NO
-	DDW007241	Drywell	Jan-97	10.8	4.0		0.06	7/5/2016	57	2	61C	RS	<1,000	NO
-	DDW003411	Drywell	Jul-86	12.3	4.0		NA	7/5/2016	50	2	61C	RS	>1,000	NO
-	DDH009312	Drill Hole	Jan-97	82.5	0.5		NA	7/5/2016	20	2	61C	RS	<1,000	NO
-	DDH009297	Drill Hole	Aug-06	102.0	0.5		NA	7/11/2016	117	2	61C	RS	<1,000	NO
-	DDH009340	Drill Hole	Aug-07	63.3	0.5		NA	8/3/2016	276	2	61C	RS	<1,000	NO
-	DDH009371	Drill Hole	Jan-90	146.5	0.5		NA	1/10/2020	294	2	61C	RS	<1,000	NO
-	DDH009273	Drill Hole	Jan-00	111.7	0.5	Y	0.00	5/17/2017	12	2	62D	PF	>1,000	NO
-	DDH009273	Drill Hole	Jan-00	111.7	0.5	N	NA	5/17/2017	12	2	62D	PF	>1,000	NO
-	DDH009292	Drill Hole	Aug-07	83.3	0.5		0.01	7/5/2016	34	2	62D	RS	<1,000	NO
-	DDW007229	Drywell	Jan-94	11.0	4.0		0.46	7/6/2016	160	2	62D	RS	<1,000	NO
-	DDW010130	Drywell	Aug-08	11.3	4.0		0.29	7/6/2016	122	2	62D	RS	#N/A	NO
-	DDW010129	Drywell	Aug-08	13.0	4.0		0.50	7/6/2016	110	2	62D	RS	#N/A	NO
-	DDH009295	Drill Hole	Aug-06	90.2	0.5	Y	0.19	6/19/2017	140	2	62D	RS	<1,000	NO
-	DDH009546	Drywell	Aug-07	89.4	0.5	Y	NA	5/17/2017	53	2	62D	RS	<1,000	NO
-	DDW008496	Drywell	Jan-98	11.0	2.0		NA	?	97	2	62D	RS	<1,000	NO
-	DDW008513	Drywell	Jan-94	11.7	4.0		0.00	7/7/2016	106	2	72C	RM	>1,000	NO
-	DDW008452	Drywell	Jun-00	9.5	4.0		0.11	1/21/2016	180	2	72C	RS	>1,000	NO
-	DDW001548	Drywell	Jan-06	13.3	4.0		0.14	7/7/2016	72	2	72C	RS	>1,000	NO
-	DDW008451	Drywell	Jun-00	9.6	4.0		0.32	7/20/2016	186	2	72C	RS	>1,000	NO
-	DDW007156	Drywell	Aug-04	10.2	4.0		0.23	8/3/2016	186	2	72C	RS	<1,000	NO
-	DDW010153	Drywell	Jul-13	13.9	4.0		0.62	8/4/2016	76	2	72C	RS	#N/A	NO
-	DDW010152	Drywell	Jul-13	13.3	4.0		0.04	8/5/2016	76	2	72C	RS	#N/A	NO
-	DDH009118 (A)	Drill Hole	Aug-04	144.0	0.5	N	0.01	9/23/2015	42	2	72C	RS	#N/A	NO
-	DDH009118 (B)	Drill Hole	Aug-04	144.0	0.5	Y	NA	2/18/2016	42	2	72C	RS	#N/A	NO
-	DDH009129	Drill Hole	Aug-04	50.5	0.5		NA	8/3/2016	176	2	72C	RS	<1,000	NO
-	DDH009128	Drill Hole	Aug-04	Full	0.5		NA	4/17/2018	79	2	72C	RS	<1,000	NO
-	DDW003024	Drywell	Jan-96	10.5	4.0		0.11	7/8/2016	185	2	85A	RM	<1,000	NO
-	DDW009600	Drywell	Jan-80	12.0	4.0		-0.29	1/27/2016	80	3	157C	RS	<1,000	NO
-	DDW008787	Drywell	Jun-98	12.0	4.0		-0.16	2/1/2016	99	3	85A	MR	>1,000	NO
-	DDW007485	Drywell	Jan-00	13.4	2.0		-2.39	1/24/2011	72	4	155D	RS	<1,000	NO
-	DDW003155	Drywell	Jul-95	10.6	4.0		0.06	4/4/2017	135	4	157C	MU	>1,000	NO
-	DDW003228	Drywell	Jul-95	14.0	4.0		0.08	4/4/2017	99	4	157C	MU	>1,000	NO
-	DDW003256	Drywell	Jun-99	11.0	4.0		0.05	4/4/2017	97	4	157C	MU	>1,000	NO
-	DDW001239	Drywell	Jul-95	13.5	4.0		0.08	6/7/2017	73	4	157C	MU	>1,000	NO
-	DDW003247	Drywell	Jul-95	12.8	4.0		0.03	6/8/2017	77	4	157C	MU	>1,000	NO
-	DDW008924	Drywell	Jul-95	11.9	4.0		0.02	6/9/2017	95	4	157C	MU	>1,000	NO

Table C-2: UIC Selection Methodology - Detailed Results

GENERAL INFORMATION							UIC SELECTION CRITERIA							SELECTED UIC[1]
GSI Map ID	FacilityID[1]	Facility Type	Install Year	UIC Depth (feet bgs)	UIC Radius (feet)	Reconditioned (Y/N)	Saturated Hydraulic Conductivity - USDI (inches/minute)	Test Date	Distance to Nearest City Hydrant (feet)	City Drainage Area	NRCS Soil Class	Zoning	Projected Daily Traffic Counts	
-	DDW008928	Drywell	Jul-95	11.1	4.0		0.05	6/9/2017	89	4	157C	MU	>1,000	NO
-	DDW008920	Drywell	Jul-95	10.9	4.0		-0.64	6/7/2017	146	4	157C	MU	>1,000	NO
-	DDW007602	Drywell	Jan-97	?	2.0		NA	10/13/2010	93	4	157C	RS	<1,000	NO
-	DDW008608	Drywell	Jan-99	11.0	2.0		NA	?	86	4	61C	MU	<1,000	NO
-	DDH009914	Drill Hole	Jul-06	82.4	0.5	Y	NA	6/16/2017	338	4	85A	RS	<1,000	NO
-	Brosterhouse/Murphy	Drywell		17.8	4.0		0.03	10/11/2019	-1					NO

Notes:

[1] Selection of UICs for retesting proceeded according to the following selection methodology:

1. UICs with incomplete datasets (i.e., could not compute a saturated hydraulic conductivity according to the methods outlined in the Central Oregon Stormwater Manual (COIC, 2010) were removed from further considration (101/149 UICs retained)
2. UICs with saturated hydraulic conductivies less than or equal to zero were removed from further consideration (85/149 UICs retained)
3. UICs that have been reconditioned but are missing post-reconditioning testing data were removed from further consideration (83/149 UICs retained)
4. UICs with recent (2016-Present) testing data were removed from further consideration (41/149 UICs retained)
5. UICs farther than 250 feet from a City-owned fire hydrant were removed from further consideration (41/149 UICs retained)
6. For the remaining 41 UICs, UICs were selected in an attempt to provide a representative sample of each of the remaining NRCS Soil Classes and Zoning Types for each City Drainage Area.
   For UICs with similar Soil Classes and Zoning Types within the same City Drainage Area, preferance was given to UICs with higher saturated hydraulic conductivities (20/149 UICs retained)

Shading / Font:

UIC removed from further consideration

General Acronyms:

bgs = below ground surface
cfm = cubic feet per minute
DEQ = Department of Environmental Quality
NA = No data available

NRCS Soil Class Legend:

155(	Wanoga sandy loam, 0 to 15 percent slopes
155[	Wanoga sandy loam, 15 to 30 percent slopes
156(	Wanoga-Fremkle-Henkle complex, 0 to 15 percent slopes
157(	Wanoga-Fremkle-Rock outcrop complex, 0 to 15 percent slopes
34C	Deschutes-Stukel complex, 0 to 15 percent slopes
36A	Deskamp loamy sand, 0 to 3 percent slopes
38B	Deskamp-Gosney complex, 0 to 8 percent slopes
58C	Gosney-Rock outcrop-Deskamp complex, 0 to 15 percent slopes
61C	Henkle-Fryrear-Lava flows complex, 0 to 15 percent slopes
62D	Henkle-Lava flows-Fryrear complex, 15 to 50 percent slopes
72C	Laidlaw sandy loam, 0 to 15 percent slopes
85A	Lundgren sandy loam, 0 to 3 percent slopes

Zoning Legend:

CB	CENTRAL BUSINESS DISTRICT
CG	COMMERCIAL GENERAL
CL	COMMERCIAL LIMITED
IG	INDUSTRIAL GENERAL
IL	INDUSTRIAL LIGHT
ME	MIXED EMPLOYMENT
MR	MIXED RIVERFRONT
MU	MIXED URBAN
PF	PUBLIC FACILITIES
RH	RESIDENTIAL URBAN HIGH DENSITY
RL	RESIDENTIAL URBAN LOW DENSITY
RM	RESIDENTIAL URBAN MEDIUM DENSITY
RS	RESIDENTIAL URBAN STANDARD DENSITY

Table C-3: UIC Selection Methodology - Summary of Group/Category Results

GROUP / CATEGORY						
City Drainage Area	Number of Selected UICs	Number of Drywells	Number of Drill Holes	Number of Unique NRCS Soil Classes	Number of Unique Zoning Types	Number of Projected Daily Traffic Count Categories
A	9 (out of 25 available)	6 (out of 13 available)	3 (out of 12 available)	4 (out of 6 available)	4 (out of 7 available)	2 (out of 2 available)
B	4 (out of 5 available)	3 (out of 3 available)	1 (out of 2 available)	4 (out of 4 available)	1 (out of 1 available)	2 (out of 2 available)
C	7 (out of 11 available)	4 (out of 7 available)	3 (out of 4 available)	2 (out of 3 available)	3 (out of 4 available)	2 (out of 2 available)

Notes:
"Available" means that the existing testing data meets GSI's criteria for being a candidate for testing.

Table C-4: Updated Infiltration Testing Data and Evaluation of Performance Declines - All UICs

GENERAL INFORMATION						INFILTRATION TESTING DATA [2]							CALCULATED PARAMETERS [3]								DATA FLAGS / COMMENTS [4]	
								Constant Head Test		Falling Head Test			Constant Head Test (COSM Method)				Falling Head Test					
GSI Map ID	FacilityID [1]	Facility Type	Install Year	UIC Depth (feet bgs)	UIC Radius (feet)	Test Date	Duration Between Tests (years)	Sustained Flow Rate (cfm)	Sustained DTW (feet bgs)	Initial DTW (feet bgs)	5 Minute DTW (feet bgs)	5 Minute DTW Time (minutes)	Head in UIC (feet)	Potential Max Infiltration Rate (cfm / ft of head)	Total Change in Performance (%)	Annual Change in Performance (% / year)	Potential Max Infiltration Rate (inches / minute)	Total Change in Performance (%)	Annual Change in Performance (gpm/year)	Annual Change in Performance (% / year)	Data Flags	Comments
40	DDH001021	Drill Hole	Jan-03	175.0	0.3	1/21/2015	-	17.2	154.2	154.2	159.6	5	20.8	0.8	-	-	0.62	-	-	-	Qvar>10%	
40	DDH001021	Drill Hole	Jan-03	173.5	0.3	6/30/2020	5.4	8.3	143.8	143.8	152.3	5	29.7	0.3	66.1%	12.1%	0.69	-10.1%	-1.6	-1.9%		
26	DDH009281	Drill Hole	Aug-07	70.4	0.3	1/11/2011	-	4.0	0.4	0.4	2.2	2	70.0	0.06	-	-	0.15	-	-	-	Qvar>10%	
26	DDH009281	Drill Hole	Aug-07	96.1	0.3	6/17/2020	9.4	7.9	0.25	0.25	2.43	5	95.9	0.08	-44.8%	-4.7%	0.05	64.6%	0.8	6.8%		
8	DDH009571	Drill Hole	Jan-80	37.6	0.3	1/7/2011	-	12.4	0.1	0.1	37.6	2	37.5	0.3	-	-	6.00	-	-	-	Qvar>10%	Measuring point questionable (catch basin vs borehole)
8	DDH009571	Drill Hole	Jan-80	38.3	0.3	6/22/2020	9.5	21.1	15.2	15.2	37.9	5	23.1	0.9	-176.0%	-18.6%	2.35	60.8%	14.4	6.4%	Qvar>10%	Measuring point questionable (catch basin vs borehole)
55	DDH009662	Drill Hole	Jan-88	17.5	0.5	8/23/2016	-	6.0	2.3	16.2	17.5	5	15.2	0.4	-	-	2.40	-	-	-		
55	DDH009662	Drill Hole	Jan-88	16.9	0.5	6/25/2020	3.8	3.5	1.2	1.2	3.6	4	15.8	0.2	44.5%	11.6%	0.47	80.6%	13.8	21.0%	Qvar>10%	
6	DDH009691	Drill Hole	Aug-04	15.0	0.3	1/6/2011	-	20.9	0.1	0.1	15.0	1	14.9	1.4	-	-	12.00	-	-	-	Qvar>10%	
6	DDH009691	Drill Hole	Aug-04	15.0	0.3	6/17/2020	9.5	10.4	0.3	0.3	14.5	5	14.7	0.7	49.5%	5.2%	2.32	80.7%	12.5	8.5%		
34	DDH009865	Drill Hole	Aug-04	53.2	0.3	1/14/2011	-	7.3	8	8	42.4	5	45.2	0.2	-	-	1.83	-	-	-	Qvar>10%	
34	DDH009865	Drill Hole	Aug-04	56.9	0.3	6/30/2020	9.5	10.2	0.3	0.3	40.14	5	56.6	0.2	-11.6%	-1.2%	1.69	7.5%	0.7	0.8%		
39	DDH009892	Drill Hole	Jan-96	21.6	0.3	1/12/2011	-	61.1	0.1	2.5	21.6	3	21.5	2.8	-	-	4.00	-	-	-	Qvar>10%	Measuring point questionable (catch basin vs borehole)
39	DDH009892	Drill Hole	Jan-96	52.7	0.3	6/23/2020	9.5	30.4	45.3	48.2	49.8	4	7.5	4.1	-43.6%	-4.6%	1.09	72.7%	13.2	7.7%		Depth of UIC substantially increased, has UIC been rehabbed/cleaned?
21	DDW001299	Drywell	Jan-06	13.0	2.0	1/4/2011	-	36.5	5	5	8	5	8.0	4.6	-	-	0.90	-	-	-	Qvar>10%	
21	DDW001299	Drywell	Jan-06	13.4	2.0	6/18/2020	9.5	30.8	9.47	9.47	11.14	5	3.9	7.8	-71.5%	-7.6%	1.02	-13.3%	-1.1	-1.4%		
29	DDW001813	Drywell	Jan-94	10.0	2.0	1/5/2011	-	53.6	4.8	4.8	7.3	4	5.2	10.3	-	-	1.44	-	-	-		
29	DDW001813	Drywell	Jan-94	10.0	2.0	6/23/2020	9.5	27.3	8.0	8.0	9.2	5	2.0	13.9	-35.3%	-3.7%	1.42	1.5%	0.2	0.2%		
33	DDW002192	Drywell	Jul-70	13.0	2.0	11/14/2010	-	65.2	3.2	3.2	4.4	5	9.8	6.7	-	-	0.29	-	-	-	Qvar>10%	DTW of 3.2 ft is above overflow piping (4.7 ft)
33	DDW002192	Drywell	Jul-70	15.2	2.0	6/22/2020	9.6	23.3	5.35	5.35	6.39	5	9.9	2.4	64.4%	6.7%	0.25	13.8%	0.4	1.4%	Qvar>10%	
3	DDW003036	Drywell	Jan-82	12.0	0.3	1/10/2011	-	38.7	10.3	10.3	12.0	1	1.7	22.8	-	-	12.00	-	-	-		
3	DDW003036	Drywell	Jan-82	10.5	0.3	6/18/2020	9.4	26.7	8.5	8.5	10.3	5	2.0	13.6	40.5%	4.3%	2.12	82.3%	8.9	8.7%	Qvar>10%	
31	DDW003088	Drywell	Jan-99	10.2	2.0	1/18/2011	-	50.9	5.6	5.6	9.9	5	4.6	11.1	-	-	2.24	-	-	-	Qvar>10%	
31	DDW003088	Drywell	Jan-99	10.4	2.0	6/23/2020	9.4	27.4	5	5	9.32	5	5.4	5.1	54.1%	5.7%	1.92	14.4%	2.3	1.5%		
7	DDW003180	Drywell	Jun-78	13.6	2.0	1/20/2011	-	54.0	9.6	9.6	12.9	5	4.0	13.5	-	-	1.98	-	-	-		
7	DDW003180	Drywell	Jun-78	13.7	2.0	6/16/2020	9.4	27.1	10.7	10.7	13.1	5	3.0	9.0	33.1%	3.5%	1.88	5.1%	0.9	0.5%		
38	DDW003541	Drywell	Jan-00	13.0	2.0	1/6/2011	-	57.8	10	10	12.6	5	3.0	19.3	-	-	2.08	-	-	-	Qvar>10%	
38	DDW003541	Drywell	Jan-00	13.0	2.0	6/24/2020	9.5	33.6	9.0	9.0	11.9	5	4.0	8.3	56.8%	6.0%	1.75	16.0%	3.0	1.7%	Qvar>10%	
30	DDW007155	Drywell	Aug-04	11.0	4.0	9/23/2015	-	2.7	2.7	2.7	2.8	5	8.3	0.3	-	-	0.03	-	-	-	Qvar>10%	
30	DDW007155	Drywell	Aug-04	11.3	4.0	6/24/2020	4.8	1.6	3.3	3.3	3.5	7	8.0	0.2	39.7%	8.4%	0.04	-48.0%	-0.4	-10.1%	Qvar>10%	
18	DDW007175	Drywell	Jan-90	9.6	2.0	1/14/2011	-	15.3	5.9	5.9	7.2	5	3.7	4.1	-	-	0.84	-	-	-		
18	DDW007175	Drywell	Jan-90	10.2	2.0	6/15/2020	9.4	18.4	5.72	5.72	6.77	5	4.4	4.1	0.2%	0.0%	0.57	32.8%	1.9	3.5%		
37	DDW007216	Drywell	Jan-89	11.0	2.0	11/12/2010	-	9.4	2.0	2.0	2.8	5	9.0	1.0	-	-	0.20	-	-	-	Qvar>10%	
37	DDW007216	Drywell	Jan-89	11.3	2.0	6/19/2020	9.6	5.7	2.1	2.1	2.8	6	9.2	0.6	40.9%	4.3%	0.15	23.9%	0.4	2.5%	Qvar>10%	
27	DDW007237	Drywell	Jul-86	11.0	2.0	12/13/2010	-	4.6	3.3	3.3	3.4	5	7.7	0.60	-	-	0.03	-	-	-	Qvar>10%	
27	DDW007237	Drywell	Jul-86	11.3	2.0	6/17/2020	9.5	0.2	3.59	3.59	3.62	5	7.7	0.03	95.8%	10.1%	0.01	70.0%	0.2	7.4%	Qvar>10%	
23	DDW008672	Drywell	Jan-01	10.7	2.0	1/21/2011	-	40.0	4.5	4.5	6.0	5	6.2	6.5	-	-	0.58	-	-	-		
23	DDW008672	Drywell	Jan-01	11.6	2.0	6/16/2020	9.4	29.3	9.4	9.4	10.8	5	2.3	13.0	-101.8%	-10.8%	1.50	-159.0%	-7.4	-16.9%		
4	DDW008897	Drywell	Jan-98	11.7	2.0	1/4/2011	-	64.2	6.4	6.4	9.8	5	5.3	12.1	-	-	1.54	-	-	-		
4	DDW008897	Drywell	Jan-98	10.8	2.0	6/15/2020	9.5	32.8	8.0	8.0	9.8	6	2.8	11.9	1.5%	0.2%	1.33	13.4%	1.5	1.4%		
SUMMARY STATISTICS [5]				MINIMUM			3.8												0.2	0.2%		
				MEDIAN			9.5												1.5	3.0%		
				AVERAGE			9.1												4.1	5.0%		
				MAXIMUM			9.6												14.4	21.0%		

Notes:

[1] Facility IDs were provided by the City of Bend, and were modified as descibed below for facilities with multiple rounds of infiltration testing data:
(A) First round of infiltration testing data (pre-reconditioning)
(B) Second round of infiltration testing data (post-reconditioning)

[2] Infiltration testing data was provided by the City of Bend and processed by GSI in accordance with the following procedure:
- The 'Sustained Flow Rate' and 'Depth to Water' Constant Head Test values in the table above were sourced from the 'UIC Static Water Depth (1 HR)' field of the City of Bend's UIC Infiltration Testing Form. If no values were recorded in this field, the values were sourced from the 'UIC Filling (30 Min.)' field of the City's form if the depth to water measurements were relatively stable.
- The 'Initial DTW', 'Fastest DTW', 'Fastest Time', 'Final DTW', and 'Final Time' values in the table above were sourced from the 'Falling Head Test (30 Min)' field of the City of Bend's UIC Infiltration Testing Form.

[3] Parameters were calculated according to the Central Oregon Stormwater Manual (2010)

[4] See the bullets below for explanations of data flags/notes:
- Qvar>10% indicates that the flowrate varied by more than ten percent during the constant head portion of testing, potentially impacting the validity/reliability of the calculated infiltration rate according to the COSM method.
- A substantial increase in the total depth of a UIC potentially indicates that the UIC was cleaned/rehabilitated since the first round of testing, potentially impacting the validity/reliability of the calculated infiltration rates.
- For some UICs, there is uncertainty associated with the measuring point used to collect water level measurements during the first round of testing (catch basin vs. drywell/borehole). Subsequently, the calcluated infiltration rates may be unreliable.

[5] Calculated summary statistics of change in performance do not include UICs that exhibited an increase in performance.

Text Color:
BLUE = Increase in infiltration rate since first round of infiltration testing
RED = Decline in infiltration rate since first round of infiltration testing

Acronyms:
bgs = below ground surface
cfm = cubic feet per minute
COSM = Central Oregon Stormwater Manual
DEQ = Department of Environmental Quality
DTW = Depth to water
NA = No data available
UIC = Underground Injection Control Facility

Table C-5: Updated Infiltration Testing Data and Evaluation of Performance Declines - By UIC Type

GENERAL INFORMATION						INFILTRATION TESTING DATA [2]							CALCULATED PARAMETERS [3]								DATA FLAGS / COMMENTS [4]	
								Constant Head Test		Falling Head Test			Constant Head Test (COSM Method)				Falling Head Test					
GSI Map ID	FacilityID [1]	Facility Type	Install Year	UIC Depth (feet bgs)	UIC Radius (feet)	Test Date	Duration Between Tests (years)	Sustained Flow Rate (cfm)	Sustained DTW (feet bgs)	Initial DTW (feet bgs)	5 Minute DTW (feet bgs)	5 Minute DTW Time (minutes)	Head in UIC (feet)	Potential Max Infiltration Rate (cfm / ft of head)	Total Change in Performance (%)	Annual Change in Performance (% / year)	Potential Max Infiltration Rate (inches / minute)	Total Change in Performance (%)	Annual Change in Performance (gpm / year)	Annual Change in Performance (% / year)	Data Flags	Comments
DRILL HOLES																						
40	DDH001021	Drill Hole	Jan-03	175.0	0.3	1/21/2015	-	17.2	154.2	154.2	159.6	5	20.8	0.8	-	-	0.62	-	-	-	Qvar>10%	
40	DDH001021	Drill Hole	Jan-03	173.5	0.3	6/30/2020	5.4	8.3	143.8	143.8	152.3	5	29.7	0.3	66.1%	12.1%	0.69	-10.1%	-1.6	-1.9%		
26	DDH009281	Drill Hole	Aug-07	70.4	0.3	1/11/2011	-	4.0	0.4	0.4	2.2	2	70.0	0.06	-	-	0.15	-	-	-	Qvar>10%	
26	DDH009281	Drill Hole	Aug-07	96.1	0.3	6/17/2020	9.4	7.9	0.25	0.25	2.43	5	95.9	0.08	-44.8%	-4.7%	0.05	64.6%	0.8	6.8%		
8	DDH009571	Drill Hole	Jan-80	37.6	0.3	1/7/2011	-	12.4	0.1	0.1	37.6	2	37.5	0.3	-	-	6.00	-	-	-	Qvar>10%	Measuring point questionable (catch basin vs borehole)
8	DDH009571	Drill Hole	Jan-80	38.3	0.3	6/22/2020	9.5	21.1	15.2	15.2	37.9	5	23.1	0.9	-176.0%	-18.6%	2.35	60.8%	14.4	6.4%	Qvar>10%	Measuring point questionable (catch basin vs borehole)
55	DDH009662	Drill Hole	Jan-88	17.5	0.5	8/23/2016	-	6.0	2.3	16.2	17.5	5	15.2	0.4	-	-	2.40	-	-	-		
55	DDH009662	Drill Hole	Jan-88	16.9	0.5	6/25/2020	3.8	3.5	1.2	1.2	3.6	4	15.8	0.2	44.5%	11.6%	0.47	80.6%	13.8	21.0%	Qvar>10%	
6	DDH009691	Drill Hole	Aug-04	15.0	0.3	1/6/2011	-	20.9	0.1	0.1	15.0	1	14.9	1.4	-	-	12.00	-	-	-	Qvar>10%	
6	DDH009691	Drill Hole	Aug-04	15.0	0.3	6/17/2020	9.5	10.4	0.3	0.3	14.5	5	14.7	0.7	49.5%	5.2%	2.32	80.7%	12.5	8.5%		
34	DDH009865	Drill Hole	Aug-04	53.2	0.3	1/14/2011	-	7.3	8	8	42.4	5	45.2	0.2	-	-	1.83	-	-	-	Qvar>10%	
34	DDH009865	Drill Hole	Aug-04	56.9	0.3	6/30/2020	9.5	10.2	0.3	0.3	40.14	5	56.6	0.2	-11.6%	-1.2%	1.69	7.5%	0.7	0.8%		
39	DDH009892	Drill Hole	Jan-96	21.6	0.3	1/12/2011	-	61.1	0.1	2.5	21.6	3	21.5	2.8	-	-	4.00	-	-	-	Qvar>10%	Measuring point questionable (catch basin vs borehole)
39	DDH009892	Drill Hole	Jan-96	52.7	0.3	6/23/2020	9.5	30.4	45.3	48.2	49.8	4	7.5	4.1	-43.6%	-4.6%	1.09	72.7%	13.2	7.7%		Depth of UIC substantially increased, has UIC been rehabbed/cleaned?
SUMMARY STATISTICS [5]				MINIMUM			9.4												0.7	0.8%		
				MEDIAN			9.5												7.0	7.3%		
				AVERAGE			9.5												6.8	6.0%		
				MAXIMUM			9.5												13.2	8.5%		
DRYWELLS																						
21	DDW001299	Drywell	Jan-06	13.0	2.0	1/4/2011	-	36.5	5	5	8	5	8.0	4.6	-	-	0.90	-	-	-	Qvar>10%	
21	DDW001299	Drywell	Jan-06	13.4	2.0	6/18/2020	9.5	30.8	9.47	9.47	11.14	5	3.9	7.8	-71.5%	-7.6%	1.02	-13.3%	-1.1	-1.4%		
29	DDW001813	Drywell	Jan-94	10.0	2.0	1/5/2011	-	53.6	4.8	4.8	7.3	4	5.2	10.3	-	-	1.44	-	-	-		
29	DDW001813	Drywell	Jan-94	10.0	2.0	6/23/2020	9.5	27.3	8.0	8.0	9.2	5	2.0	13.9	-35.3%	-3.7%	1.42	1.5%	0.2	0.2%		
33	DDW002192	Drywell	Jul-70	13.0	2.0	11/14/2010	-	65.2	3.2	3.2	4.4	5	9.8	6.7	-	-	0.29	-	-	-	Qvar>10%	DTW of 3.2 ft is above overflow piping (4.7 ft)
33	DDW002192	Drywell	Jul-70	15.2	2.0	6/22/2020	9.6	23.3	5.35	5.35	6.39	5	9.9	2.4	64.4%	6.7%	0.25	13.8%	0.4	1.4%	Qvar>10%	
3	DDW003036	Drywell	Jan-82	12.0	0.3	1/10/2011	-	38.7	10.3	10.3	12.0	1	1.7	22.8	-	-	12.00	-	-	-		
3	DDW003036	Drywell	Jan-82	10.5	0.3	6/18/2020	9.4	26.7	8.5	8.5	10.3	5	2.0	13.6	40.5%	4.3%	2.12	82.3%	8.9	8.7%	Qvar>10%	
31	DDW003088	Drywell	Jan-99	10.2	2.0	1/18/2011	-	50.9	5.6	5.6	9.9	5	4.6	11.1	-	-	2.24	-	-	-	Qvar>10%	
31	DDW003088	Drywell	Jan-99	10.4	2.0	6/23/2020	9.4	27.4	5	5	9.32	5	5.4	5.1	54.1%	5.7%	1.92	14.4%	2.3	1.5%		
7	DDW003180	Drywell	Jun-78	13.6	2.0	1/20/2011	-	54.0	9.6	9.6	12.9	5	4.0	13.5	-	-	1.98	-	-	-		
7	DDW003180	Drywell	Jun-78	13.7	2.0	6/16/2020	9.4	27.1	10.7	10.7	13.1	5	3.0	9.0	33.1%	3.5%	1.88	5.1%	0.9	0.5%		
38	DDW003541	Drywell	Jan-00	13.0	2.0	1/6/2011	-	57.8	10	10	12.6	5	3.0	19.3	-	-	2.08	-	-	-	Qvar>10%	
38	DDW003541	Drywell	Jan-00	13.0	2.0	6/24/2020	9.5	33.6	9.0	9.0	11.9	5	4.0	8.3	56.8%	6.0%	1.75	16.0%	3.0	1.7%	Qvar>10%	
30	DDW007155	Drywell	Aug-04	11.0	4.0	9/23/2015	-	2.7	2.7	2.7	2.8	5	8.3	0.3	-	-	0.03	-	-	-	Qvar>10%	
30	DDW007155	Drywell	Aug-04	11.3	4.0	6/24/2020	4.8	1.6	3.3	3.3	3.5	7	8.0	0.2	39.7%	8.4%	0.04	-48.0%	-0.4	-10.1%	Qvar>10%	
18	DDW007175	Drywell	Jan-90	9.6	2.0	1/14/2011	-	15.3	5.9	5.9	7.2	5	3.7	4.1	-	-	0.84	-	-	-		
18	DDW007175	Drywell	Jan-90	10.2	2.0	6/15/2020	9.4	18.4	5.72	5.72	6.77	5	4.4	4.1	0.2%	0.0%	0.57	32.8%	1.9	3.5%		
37	DDW007216	Drywell	Jan-89	11.0	2.0	11/12/2010	-	9.4	2.0	2.0	2.8	5	9.0	1.0	-	-	0.20	-	-	-	Qvar>10%	
37	DDW007216	Drywell	Jan-89	11.3	2.0	6/19/2020	9.6	5.7	2.1	2.1	2.8	6	9.2	0.6	40.9%	4.3%	0.15	23.9%	0.4	2.5%	Qvar>10%	
27	DDW007237	Drywell	Jul-86	11.0	2.0	12/13/2010	-	4.6	3.3	3.3	3.4	5	7.7	0.60	-	-	0.03	-	-	-	Qvar>10%	
27	DDW007237	Drywell	Jul-86	11.3	2.0	6/17/2020	9.5	0.2	3.59	3.59	3.62	5	7.7	0.03	95.8%	10.1%	0.01	70.0%	0.2	7.4%	Qvar>10%	
23	DDW008672	Drywell	Jan-01	10.7	2.0	1/21/2011	-	40.0	4.5	4.5	6.0	5	6.2	6.5	-	-	0.58	-	-	-		
23	DDW008672	Drywell	Jan-01	11.6	2.0	6/16/2020	9.4	29.3	9.4	9.4	10.8	5	2.3	13.0	-101.8%	-10.8%	1.50	-159.0%	-7.4	-16.9%		
4	DDW008897	Drywell	Jan-98	11.7	2.0	1/4/2011	-	64.2	6.4	6.4	9.8	5	5.3	12.1	-	-	1.54	-	-	-		
4	DDW008897	Drywell	Jan-98	10.8	2.0	6/15/2020	9.5	32.8	8.0	8.0	9.8	6	2.8	11.9	1.5%	0.2%	1.33	13.4%	1.5	1.4%		
SUMMARY STATISTICS [5]				MINIMUM			9.4												0.2	0.2%		
				MEDIAN			9.5												1.2	1.6%		
				AVERAGE			9.5												2.0	2.9%		
				MAXIMUM			9.6												8.9	8.7%		

Notes:

[1] Facility IDs were provided by the City of Bend, and were modified as descibed below for facilities with multiple rounds of infiltration testing data:
(A) First round of infiltration testing data (pre-reconditioning)
(B) Second round of infiltration testing data (post-reconditioning)

[2] Infiltration testing data was provided by the City of Bend and processed by GSI in accordance with the following procedure:
- The 'Sustained Flow Rate' and 'Depth to Water' Constant Head Test values in the table above were sourced from the 'UIC Static Water Depth (1 HR)' field of the City of Bend's UIC Infiltration Testing Form. If no values were recorded in this field, the values were sourced from the 'UIC Filling (30 Min.)' field of the City's form if the depth to water measurements were relatively stable.
- The 'Initial DTW', 'Fastest DTW', 'Fastest Time', 'Final DTW', and 'Final Time' values in the table above were sourced from the 'Falling Head Test (30 Min)' field of the City of Bend's UIC Infiltration Testing Form.

[3] Parameters were calculated according to the Central Oregon Stormwater Manual (2010)

[4] See the bullets below for explanations of data flags/notes:
- Qvar>10% indicates that the flowrate varied by more than ten percent during the constant head portion of testing, potentially impacting the validity/reliability of the calculated infiltration rate according to the COSM method.
- A substantial increase in the total depth of a UIC potentially indicates that the UIC was cleaned/rehabilitated since the first round of testing, potentially impacting the validity/reliability of the calculated infiltration rates.
- For some UICs, there is uncertainty associated with the measuring point used to collect water level measurements during the first round of testing (catch basin vs. drywell/borehole). Subsequently, the calcuated infiltration rates may be unreliable.

[5] Calculated summary statistics of change in performance do not include UICs that exhibited an increase in performance.

Text Color:
BLUE = Increase in infiltration rate since first round of infiltration testing
RED = Decline in infiltration rate since first round of infiltration testing

Acronyms:
bgs = below ground surface
cfm = cubic feet per minute
COSM = Central Oregon Stormwater Manual
DEQ = Department of Environmental Quality
DTW = Depth to water
NA = No data available
UIC = Underground Injection Control Facility

Table C-6: Updated Infiltration Testing Data and Evaluation of Performance Declines - By Drainage Area

GENERAL INFORMATION							INFILTRATION TESTING DATA[2]							CALCULATED PARAMETERS[3]								DATA FLAGS / COMMENTS[4]	
									Constant Head Test		Falling Head Test			Constant Head Test (COSM Method)				Falling Head Test					
GSI Map ID	FacilityID[1]	Drainage Area	Facility Type	Install Year	UIC Depth (feet bgs)	UIC Radius (feet)	Test Date	Duration Between Tests (years)	Sustained Flow Rate (cfm)	Sustained DTW (feet bgs)	Initial DTW (feet bgs)	5 Minute DTW (feet bgs)	5 Minute DTW Time (minutes)	Head in UIC (feet)	Potential Max Infiltration Rate (cfm / ft of head)	Total Change in Performance (%)	Annual Change in Performance (% / year)	Potential Max Infiltration Rate (inches / minute)	Total Change in Performance (%)	Annual Change in Performance (gpm / year)	Annual Change in Performance (% / year)	Data Flags	Comments
DRAINAGE AREA A																							
8	DDH009571	A	Drill Hole	Jan-80	37.6	0.3	1/7/2011	-	12.4	0.1	0.1	37.6	2	37.5	0.3	-	-	6.00	-	-	-	Qvar>10%	Measuring point questionable (catch basin vs borehole)
8	DDH009571	A	Drill Hole	Jan-80	38.3	0.3	6/22/2020	9.5	21.1	15.2	15.2	37.9	5	23.1	0.9	-176.0%	-18.6%	2.35	60.8%	14.4	6.4%	Qvar>10%	Measuring point questionable (catch basin vs borehole)
55	DDH009662	A	Drill Hole	Jan-88	17.5	0.5	8/23/2016	-	6.0	2.3	16.2	17.5	5	15.2	0.4	-	-	2.40	-	-	-		
55	DDH009662	A	Drill Hole	Jan-88	16.9	0.5	6/25/2020	3.8	3.5	1.2	1.2	3.6	4	15.8	0.2	44.5%	11.6%	0.47	80.6%	13.8	21.0%	Qvar>10%	
6	DDH009691	A	Drill Hole	Aug-04	15.0	0.3	1/6/2011	-	20.9	0.1	0.1	15.0	1	14.9	1.4	-	-	12.00	-	-	-	Qvar>10%	
6	DDH009691	A	Drill Hole	Aug-04	15.0	0.3	6/17/2020	9.5	10.4	0.3	0.3	14.5	5	14.7	0.7	49.5%	5.2%	2.32	80.7%	12.5	8.5%		
21	DDW001299	A	Drywell	Jan-06	13.0	2.0	1/4/2011	-	36.5	5	5	8	5	8.0	4.6	-	-	0.90	-	-	-	Qvar>10%	
21	DDW001299	A	Drywell	Jan-06	13.4	2.0	6/18/2020	9.5	30.8	9.47	9.47	11.14	5	3.9	7.8	-71.5%	-7.6%	1.02	-13.3%	-1.1	-1.4%		
3	DDW003036	A	Drywell	Jan-82	12.0	0.3	1/10/2011	-	38.7	10.3	10.3	12.0	1	1.7	22.8	-	-	12.00	-	-	-		
3	DDW003036	A	Drywell	Jan-82	10.5	0.3	6/18/2020	9.4	26.7	8.5	8.5	10.3	5	2.0	13.6	40.5%	4.3%	2.12	82.3%	8.9	8.7%	Qvar>10%	
7	DDW003180	A	Drywell	Jun-78	13.6	2.0	1/20/2011	-	54.0	9.6	9.6	12.9	5	4.0	13.5	-	-	1.98	-	-	-		
7	DDW003180	A	Drywell	Jun-78	13.7	2.0	6/16/2020	9.4	27.1	10.7	10.7	13.1	5	3.0	9.0	33.1%	3.5%	1.88	5.1%	0.9	0.5%		
18	DDW007175	A	Drywell	Jan-90	9.6	2.0	1/14/2011	-	15.3	5.9	5.9	7.2	5	3.7	4.1	-	-	0.84	-	-	-		
18	DDW007175	A	Drywell	Jan-90	10.2	2.0	6/15/2020	9.4	18.4	5.72	5.72	6.77	5	4.4	4.1	0.2%	0.0%	0.57	32.8%	1.9	3.5%		
23	DDW008672	A	Drywell	Jan-01	10.7	2.0	1/21/2011	-	40.0	4.5	4.5	6.0	5	6.2	6.5	-	-	0.58	-	-	-		
23	DDW008672	A	Drywell	Jan-01	11.6	2.0	6/16/2020	9.4	29.3	9.4	9.4	10.8	5	2.3	13.0	-101.8%	-10.8%	1.50	-159.0%	-7.4	-16.9%		
4	DDW008897	A	Drywell	Jan-98	11.7	2.0	1/4/2011	-	64.2	6.4	6.4	9.8	5	5.3	12.1	-	-	1.54	-	-	-		
4	DDW008897	A	Drywell	Jan-98	10.8	2.0	6/15/2020	9.5	32.8	8.0	8.0	9.8	6	2.8	11.9	1.5%	0.2%	1.33	13.4%	1.5	1.4%		
SUMMARY STATISTICS[5]					MINIMUM			9.4												0.9	0.5%		
					MEDIAN			9.4												1.7	2.4%		
					AVERAGE			9.4												3.3	3.5%		
					MAXIMUM			9.5												8.9	8.7%		
DRAINAGE AREA B																							
26	DDH009281	B	Drill Hole	Aug-07	70.4	0.3	1/11/2011	-	4.0	0.4	0.4	2.2	2	70.0	0.06	-	-	0.15	-	-	-	Qvar>10%	
26	DDH009281	B	Drill Hole	Aug-07	96.1	0.3	6/17/2020	9.4	7.9	0.25	0.25	2.43	5	95.9	0.08	-44.8%	-4.7%	0.05	64.6%	0.8	6.8%		
29	DDW001813	B	Drywell	Jan-94	10.0	2.0	1/5/2011	-	53.6	4.8	4.8	7.3	4	5.2	10.3	-	-	1.44	-	-	-		
29	DDW001813	B	Drywell	Jan-94	10.0	2.0	6/23/2020	9.5	27.3	8.0	8.0	9.2	5	2.0	13.9	-35.3%	-3.7%	1.42	1.5%	0.2	0.2%		
30	DDW007155	B	Drywell	Aug-04	11.0	4.0	9/23/2015	-	2.7	2.7	2.7	2.8	5	8.3	0.3	-	-	0.03	-	-	-	Qvar>10%	
30	DDW007155	B	Drywell	Aug-04	11.3	4.0	6/24/2020	4.8	1.6	3.3	3.3	3.5	7	8.0	0.2	39.7%	8.4%	0.04	-48.0%	-0.4	-10.1%	Qvar>10%	
27	DDW007237	B	Drywell	Jul-86	11.0	2.0	12/13/2010	-	4.6	3.3	3.3	3.4	5	7.7	0.60	-	-	0.03	-	-	-	Qvar>10%	
27	DDW007237	B	Drywell	Jul-86	11.3	2.0	6/17/2020	9.5	0.2	3.59	3.59	3.62	5	7.7	0.03	95.8%	10.1%	0.01	70.0%	0.2	7.4%	Qvar>10%	
SUMMARY STATISTICS[5]					MINIMUM			9.5												0.2	0.2%		
					MEDIAN			9.5												0.2	3.8%		
					AVERAGE			9.5												0.2	3.8%		
					MAXIMUM			9.5												0.2	7.4%		
DRAINAGE AREA C																							
40	DDH001021	C	Drill Hole	Jan-03	175.0	0.3	1/21/2015	-	17.2	154.2	154.2	159.6	5	20.8	0.8	-	-	0.62	-		-	Qvar>10%	
40	DDH001021	C	Drill Hole	Jan-03	173.5	0.3	6/30/2020	5.4	8.3	143.8	143.8	152.3	5	29.7	0.3	66.1%	12.1%	0.69	-10.1%	-1.6	-1.9%		
34	DDH009865	C	Drill Hole	Aug-04	53.2	0.3	1/14/2011	-	7.3	8	8	42.4	5	45.2	0.2	-	-	1.83	-		-	Qvar>10%	
34	DDH009865	C	Drill Hole	Aug-04	56.9	0.3	6/30/2020	9.5	10.2	0.3	0.3	40.14	5	56.6	0.2	-11.6%	-1.2%	1.69	7.5%	0.7	0.8%		
39	DDH009892	C	Drill Hole	Jan-96	21.6	0.3	1/12/2011	-	61.1	0.1	2.5	21.6	3	21.5	2.8	-	-	4.00	-		-	Qvar>10%	Measuring point questionable (catch basin vs borehole)
39	DDH009892	C	Drill Hole	Jan-96	52.7	0.3	6/23/2020	9.5	30.4	45.3	48.2	49.8	4	7.5	4.1	-43.6%	-4.6%	1.09	72.7%	13.2	7.7%		Depth of UIC substantially increased, has UIC been rehabbed/cleaned?
33	DDW002192	C	Drywell	Jul-70	13.0	2.0	11/14/2010	-	65.2	3.2	3.2	4.4	5	9.8	6.7	-	-	0.29	-		-	Qvar>10%	DTW of 3.2 ft is above overflow piping (4.7 ft)
33	DDW002192	C	Drywell	Jul-70	15.2	2.0	6/22/2020	9.6	23.3	5.35	5.35	6.39	5	9.9	2.4	64.4%	6.7%	0.25	13.8%	0.4	1.4%	Qvar>10%	
31	DDW003088	C	Drywell	Jan-99	10.2	2.0	1/18/2011	-	50.9	5.6	5.6	9.9	5	4.6	11.1	-	-	2.24	-		-	Qvar>10%	
31	DDW003088	C	Drywell	Jan-99	10.4	2.0	6/23/2020	9.4	27.4	5	5	9.32	5	5.4	5.1	54.1%	5.7%	1.92	14.4%	2.3	1.5%		
38	DDW003541	C	Drywell	Jan-00	13.0	2.0	1/6/2011	-	57.8	10	10	12.6	5	3.0	19.3	-	-	2.08	-		-	Qvar>10%	
38	DDW003541	C	Drywell	Jan-00	13.0	2.0	6/24/2020	9.5	33.6	9.0	9.0	11.9	5	4.0	8.3	56.8%	6.0%	1.75	16.0%	3.0	1.7%	Qvar>10%	
37	DDW007216	C	Drywell	Jan-89	11.0	2.0	11/12/2010	-	9.4	2.0	2.0	2.8	5	9.0	1.0	-	-	0.20	-		-	Qvar>10%	
37	DDW007216	C	Drywell	Jan-89	11.3	2.0	6/19/2020	9.6	5.7	2.1	2.1	2.8	6	9.2	0.6	40.9%	4.3%	0.15	23.9%	0.4	2.5%	Qvar>10%	
SUMMARY STATISTICS[5]					MINIMUM			9.4												0.4	1.4%		
					MEDIAN			9.5												1.4	1.6%		
					AVERAGE			9.5												1.5	1.8%		
					MAXIMUM			9.6												3.0	2.5%		

Notes:

[1] Facility IDs were provided by the City of Bend, and were modified as descibed below for facilities with multiple rounds of infiltration testing data:
(A) First round of infiltration testing data (pre-reconditioning)
(B) Second round of infiltration testing data (post-reconditioning)

[2] Infiltration testing data was provided by the City of Bend and processed by GSI in accordance with the following procedure:
- The 'Sustained Flow Rate' and 'Depth to Water' Constant Head Test values in the table above were sourced from the 'UIC Static Water Depth (1 HR)' field of the City of Bend's UIC Infiltration Testing Form. If no values were recorded in this field, the values were sourced from the 'UIC Filling (30 Min.)' field of the City's form if the depth to water measurements were relatively stable.
- The 'Initial DTW', 'Fastest DTW', 'Fastest Time', 'Final DTW', and 'Final Time' values in the table above were sourced from the 'Falling Head Test (30 Min)' field of the City of Bend's UIC Infiltration Testing Form.

[3] Parameters were calculated according to the Central Oregon Stormwater Manual (2010)

[4] See the bullets below for explanations of data flags/notes:
- Qvar>10% indicates that the flowrate varied by more than ten percent during the constant head portion of testing, potentially impacting the validity/reliability of the calculated infiltration rate according to the COSM method.
- A substantial increase in the total depth of a UIC potentially indicates that the UIC was cleaned/rehabilitated since the first round of testing, potentially impacting the validity/reliability of the calculated infiltration rates.
- For some UICs, there is uncertainty associated with the measuring point used to collect water level measurements during the first round of testing (catch basin vs. drywell/borehole). Subsequently, the calcluated infiltration rates may be unreliable.

[5] Calculated summary statistics of change in performance do not include drill holes, UICs that exhibited an increase in performance, or a duration between tests of less than five years.

Text Color:
BLUE = Increase in infiltration rate since first round of infiltration testing
RED = Decline in infiltration rate since first round of infiltration testing

Acronyms:
bgs = below ground surface
cfm = cubic feet per minute
COSM = Central Oregon Stormwater Manual
DEQ = Department of Environmental Quality
DTW = Depth to water
NA = No data available
UIC = Underground Injection Control Facility

Table C-7: Updated Infiltration Testing Data and Evaluation of Performance Declines - By Traffic

GENERAL INFORMATION							INFILTRATION TESTING DATA[2]							CALCULATED PARAMETERS[3]								DATA FLAGS / COMMENTS[4]	
									Constant Head Test		Falling Head Test			Constant Head Test (COSM Method)				Falling Head Test					
GSI Map ID	FacilityID[1]	Projected Daily Traffic Count	Facility Type	Install Year	UIC Depth (feet bgs)	UIC Radius (feet)	Test Date	Duration Between Tests (years)	Sustained Flow Rate (cfm)	Sustained DTW (feet bgs)	Initial DTW (feet bgs)	5 Minute DTW (feet bgs)	5 Minute DTW Time (minutes)	Head in UIC (feet)	Potential Max Infiltration Rate (cfm / ft of head)	Total Change in Performance (%)	Annual Change in Performance (% / year)	Potential Max Infiltration Rate (inches / minute)	Total Change in Performance (%)	Annual Change in Performance (gpm / year)	Annual Change in Performance (% / year)	Data Flags	Comments
PDT < 1,000																							
8	DDH009571	<1,000	Drill Hole	Jan-80	37.6	0.3	1/7/2011	-	12.4	0.1	0.1	37.6	2	37.5	0.3	-	-	6.00	-	-	-	Qvar>10%	Measuring point questionable (catch basin vs borehole)
8	DDH009571	<1,000	Drill Hole	Jan-80	38.3	0.3	6/22/2020	9.5	21.1	15.2	15.2	37.9	5	23.1	0.9	-176.0%	-18.6%	2.35	60.8%	14.4	6.4%	Qvar>10%	Measuring point questionable (catch basin vs borehole)
55	DDH009662	<1,000	Drill Hole	Jan-88	17.5	0.5	8/23/2016	-	6.0	2.3	16.2	17.5	5	15.2	0.4	-	-	2.40	-	-	-		
55	DDH009662	<1,000	Drill Hole	Jan-88	16.9	0.5	6/25/2020	3.8	3.5	1.2	1.2	3.6	4	15.8	0.2	44.5%	11.6%	0.47	80.6%	13.8	21.0%	Qvar>10%	
6	DDH009691	<1,000	Drill Hole	Aug-04	15.0	0.3	1/6/2011	-	20.9	0.1	0.1	15.0	1	14.9	1.4	-	-	12.00	-	-	-	Qvar>10%	
6	DDH009691	<1,000	Drill Hole	Aug-04	15.0	0.3	6/17/2020	9.5	10.4	0.3	0.3	14.5	5	14.7	0.7	49.5%	5.2%	2.32	80.7%	12.5	8.5%		
21	DDW001299	<1,000	Drywell	Jan-06	13.0	2.0	1/4/2011	-	36.5	5	5	8	5	8.0	4.6	-	-	0.90	-	-	-	Qvar>10%	
21	DDW001299	<1,000	Drywell	Jan-06	13.4	2.0	6/18/2020	9.5	30.8	9.47	9.47	11.14	5	3.9	7.8	-71.5%	-7.6%	1.02	-13.3%	-1.1	-1.4%		
18	DDW007175	<1,000	Drywell	Jan-90	9.6	2.0	1/14/2011	-	15.3	5.9	5.9	7.2	5	3.7	4.1	-	-	0.84	-	-	-		
18	DDW007175	<1,000	Drywell	Jan-90	10.2	2.0	6/15/2020	9.4	18.4	5.72	5.72	6.77	5	4.4	4.1	0.2%	0.0%	0.57	32.8%	1.9	3.5%		
23	DDW008672	<1,000	Drywell	Jan-01	10.7	2.0	1/21/2011	-	40.0	4.5	4.5	6.0	5	6.2	6.5	-	-	0.58	-	-	-		
23	DDW008672	<1,000	Drywell	Jan-01	11.6	2.0	6/16/2020	9.4	29.3	9.4	9.4	10.8	5	2.3	13.0	-101.8%	-10.8%	1.50	-159.0%	-7.4	-16.9%		
4	DDW008897	<1,000	Drywell	Jan-98	11.7	2.0	1/4/2011	-	64.2	6.4	6.4	9.8	5	5.3	12.1	-	-	1.54	-	-	-		
4	DDW008897	<1,000	Drywell	Jan-98	10.8	2.0	6/15/2020	9.5	32.8	8.0	8.0	9.8	6	2.8	11.9	1.5%	0.2%	1.33	13.4%	1.5	1.4%		
26	DDH009281	<1,000	Drill Hole	Aug-07	70.4	0.3	1/11/2011	-	4.0	0.4	0.4	2.2	2	70.0	0.06	-	-	0.15	-	-	-	Qvar>10%	
26	DDH009281	<1,000	Drill Hole	Aug-07	96.1	0.3	6/17/2020	9.4	7.9	0.25	0.25	2.43	5	95.9	0.08	-44.8%	-4.7%	0.05	64.6%	0.8	6.8%		
29	DDW001813	<1,000	Drywell	Jan-94	10.0	2.0	1/5/2011	-	53.6	4.8	4.8	7.3	4	5.2	10.3	-	-	1.44	-	-	-		
29	DDW001813	<1,000	Drywell	Jan-94	10.0	2.0	6/23/2020	9.5	27.3	8.0	8.0	9.2	5	2.0	13.9	-35.3%	-3.7%	1.42	1.5%	0.2	0.2%		
30	DDW007155	<1,000	Drywell	Aug-04	11.0	4.0	9/23/2015	-	2.7	2.7	2.7	2.8	5	8.3	0.3	-	-	0.03	-	-	-	Qvar>10%	
30	DDW007155	<1,000	Drywell	Aug-04	11.3	4.0	6/24/2020	4.8	1.6	3.3	3.3	3.5	7	8.0	0.2	39.7%	8.4%	0.04	-48.0%	-0.4	-10.1%	Qvar>10%	
34	DDH009865	<1,000	Drill Hole	Aug-04	53.2	0.3	1/14/2011	-	7.3	8	8	42.4	5	45.2	0.2	-	-	1.83	-	-	-	Qvar>10%	
34	DDH009865	<1,000	Drill Hole	Aug-04	56.9	0.3	6/30/2020	9.5	10.2	0.3	0.3	40.14	5	56.6	0.2	-11.6%	-1.2%	1.69	7.5%	0.7	0.8%		
39	DDH009892	<1,000	Drill Hole	Jan-96	21.6	0.3	1/12/2011	-	61.1	0.1	2.5	21.6	3	21.5	2.8	-	-	4.00	-	-	-	Qvar>10%	Measuring point questionable (catch basin vs borehole)
39	DDH009892	<1,000	Drill Hole	Jan-96	52.7	0.3	6/23/2020	9.5	30.4	45.3	48.2	49.8	4	7.5	4.1	-43.6%	-4.6%	1.09	72.7%	13.2	7.7%		Depth of UIC substantially increased, has UIC been rehabbed/cleaned?
31	DDW003088	<1,000	Drywell	Jan-99	10.2	2.0	1/18/2011	-	50.9	5.6	5.6	9.9	5	4.6	11.1	-	-	2.24	-	-	-	Qvar>10%	
31	DDW003088	<1,000	Drywell	Jan-99	10.4	2.0	6/23/2020	9.4	27.4	5	5	9.32	5	5.4	5.1	54.1%	5.7%	1.92	14.4%	2.3	1.5%		
38	DDW003541	<1,000	Drywell	Jan-00	13.0	2.0	1/6/2011	-	57.8	10	10	12.6	5	3.0	19.3	-	-	2.08	-	-	-	Qvar>10%	
38	DDW003541	<1,000	Drywell	Jan-00	13.0	2.0	6/24/2020	9.5	33.6	9.0	9.0	11.9	5	4.0	8.3	56.8%	6.0%	1.75	16.0%	3.0	1.7%	Qvar>10%	
37	DDW007216	<1,000	Drywell	Jan-89	11.0	2.0	11/12/2010	-	9.4	2.0	2.0	2.8	5	9.0	1.0	-	-	0.20	-	-	-	Qvar>10%	
37	DDW007216	<1,000	Drywell	Jan-89	11.3	2.0	6/19/2020	9.6	5.7	2.1	2.1	2.8	6	9.2	0.6	40.9%	4.3%	0.15	23.9%	0.4	2.5%	Qvar>10%	
SUMMARY STATISTICS[5]					MINIMUM			9.4												0.2	0.2%		
					MEDIAN			9.5												0.9	1.7%		
					AVERAGE			9.5												1.5	2.9%		
					MAXIMUM			9.6												3.0	7.7%		
PDT > 1,000																							
3	DDW003036	>1,000	Drywell	Jan-82	12.0	0.3	1/10/2011	-	38.7	10.3	10.3	12.0	1	1.7	22.8	-	-	12.00	-	-	-		
3	DDW003036	>1,000	Drywell	Jan-82	10.5	0.3	6/18/2020	9.4	26.7	8.5	8.5	10.3	5	2.0	13.6	40.5%	4.3%	2.12	82.3%	8.9	8.7%	Qvar>10%	
7	DDW003180	>1,000	Drywell	Jun-78	13.6	2.0	1/20/2011	-	54.0	9.6	9.6	12.9	5	4.0	13.5	-	-	1.98	-	-	-		
7	DDW003180	>1,000	Drywell	Jun-78	13.7	2.0	6/16/2020	9.4	27.1	10.7	10.7	13.1	5	3.0	9.0	33.1%	3.5%	1.88	5.1%	0.9	0.5%		
27	DDW007237	>1,000	Drywell	Jul-86	11.0	2.0	12/13/2010	-	4.6	3.3	3.3	3.4	5	7.7	0.60	-	-	0.03	-	-	-	Qvar>10%	
27	DDW007237	>1,000	Drywell	Jul-86	11.3	2.0	6/17/2020	9.5	0.2	3.59	3.59	3.62	5	7.7	0.03	95.8%	10.1%	0.01	70.0%	0.2	7.4%	Qvar>10%	
40	DDH001021	>1,000	Drill Hole	Jan-03	175.0	0.3	1/21/2015	-	17.2	154.2	154.2	159.6	5	20.8	0.8	-	-	0.62	-	-	-	Qvar>10%	
40	DDH001021	>1,000	Drill Hole	Jan-03	173.5	0.3	6/30/2020	5.4	8.3	143.8	143.8	152.3	5	29.7	0.3	66.1%	12.1%	0.69	-10.1%	-1.6	-1.9%		
33	DDW002192	>1,000	Drywell	Jul-70	13.0	2.0	11/14/2010	-	65.2	3.2	3.2	4.4	5	9.8	6.7	-	-	0.29	-	-	-	Qvar>10%	DTW of 3.2 ft is above overflow piping (4.7 ft)
33	DDW002192	>1,000	Drywell	Jul-70	15.2	2.0	6/22/2020	9.6	23.3	5.35	5.35	6.39	5	9.9	2.4	64.4%	6.7%	0.25	13.8%	0.4	1.4%	Qvar>10%	
SUMMARY STATISTICS[5]					MINIMUM			9.4												0.2	0.5%		
					MEDIAN			9.5												0.7	4.4%		
					AVERAGE			9.5												2.6	4.5%		
					MAXIMUM			9.6												8.9	8.7%		

Notes:

[1] Facility IDs were provided by the City of Bend, and were modified as descibed below for facilities with multiple rounds of infiltration testing data:
(A) First round of infiltration testing data (pre-reconditioning)
(B) Second round of infiltration testing data (post-reconditioning)

[2] Infiltration testing data was provided by the City of Bend and processed by GSI in accordance with the following procedure:
- The 'Sustained Flow Rate' and 'Depth to Water' Constant Head Test values in the table above were sourced from the 'UIC Static Water Depth (1 HR)' field of the City of Bend's UIC Infiltration Testing Form. If no values were recorded in this field, the values were sourced from the 'UIC Filling (30 Min.)' field of the City's form if the depth to water measurements were relatively stable.
- The 'Initial DTW', 'Fastest DTW', 'Fastest Time', 'Final DTW', and 'Final Time' values in the table above were sourced from the 'Falling Head Test (30 Min)' field of the City of Bend's UIC Infiltration Testing Form.

[3] Parameters were calculated according to the Central Oregon Stormwater Manual (2010)

[4] See the bullets below for explanations of data flags/notes:
- Qvar>10% indicates that the flowrate varied by more than ten percent during the constant head portion of testing, potentially impacting the validity/reliability of the calculated infiltration rate according to the COSM method.
- A substantial increase in the total depth of a UIC potentially indicates that the UIC was cleaned/rehabilitated since the first round of testing, potentially impacting the validity/reliability of the calculated infiltration rates.
- For some UICs, there is uncertainty associated with the measuring point used to collect water level measurements during the first round of testing (catch basin vs. drywell/borehole). Subsequently, the calcluated infiltration rates may be unreliable.

[5] Calculated summary statistics of change in performance do not include drill holes, UICs that exhibited an increase in performance, or a duration between tests of less than five years.

Text Color:
BLUE = Increase in infiltration rate since first round of infiltration testing
RED = Decline in infiltration rate since first round of infiltration testing

Acronyms:
bgs = below ground surface
cfm = cubic feet per minute
COSM = Central Oregon Stormwater Manual
DEQ = Department of Environmental Quality
DTW = Depth to water
NA = No data available
PDT = Projected Daily Traffic Count
UIC = Underground Injection Control Facility

City of Bend

Appendix D. Water Well Location Database.

October 2020

Prepared by:
GSI Water Solutions, Inc.
55 SW Yamhill St., Suite 300, Portland, OR, 97204

Table D-1: Water Well Location Database

OBJECTID *	SHAPE *	Well_ID	gw_well_tag_nbr	gw_site_id	gw_logid	gw_logid_2	gw_logid_3	gw_logid_4	gw_logid_5	Taxlot	Township	township_char	Range	range_char	Section_	Tax_lot_Num	qtr160	qtr40	qtr10	Latitude	Longitude	WELL_STATUS	BUFFTYPE	Site_Inspection_Performed	Field_Verified	Source	Combined_Notes	Site_Plan_URL	well_log_url	LastEditDate	LastEditor
584	Point	WELL00001	<Null>	<Null>	4211	58261?	<Null>	<Null>	<Null>	161136D001100	16	S	11	E	36	1100	SE	<Null>	<Null>	44.14008	-121.3472	Active	Well He	No	No	Site_Plan	Found	https://	http://apps.wr	43314.39375	DB
585	Point	WELL00002	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	161236D005800	16	S	12	E	36	1800	<Null>	<Null>	<Null>	44.1384	-121.226	Active	Well He	No	No	Hand_Sketch	Found	https://	<Null>	43334.57431	DB
586	Point	WELL00003	<Null>	<Null>	6479	<Null>	<Null>	<Null>	<Null>	1.711E+12	17	S	11	E	10	2712	<Null>	<Null>	<Null>	44.11051	-121.3872	Active	500 Fe	No	No	Site_Plan	Found	https://	http://apps.wr	43314.38333	DB
587	Point	WELL00004	<Null>	Apr-33	4709	<Null>	<Null>	<Null>	<Null>	1.711E+12	17	S	11	E	23	5900	SW	SW	<Null>	44.08229	-121.3787	Active U	500 Fe	No	No	Unknown	Could r	https://	http://apps.wr	43314.39306	DB
588	Point	WELL00005	<Null>	Mar-33	4661	<Null>	<Null>	<Null>	<Null>	1.71101E+12	17	S	11	E	1	408	NW	SW	<Null>	44.13129	-121.359	Active	500 Fe	No	No	Site_Plan	Found	https://	http://apps.wr	43314.39375	DB
589	Point	WELL00006	<Null>	Mar-33	4669	<Null>	<Null>	<Null>	<Null>	1.71102E+12	17	S	11	E	2	600	SW	NW	<Null>	44.13276	-121.3825	Active	500 Fe	No	No	Hand_Sketch	Found	https://	http://apps.wr	43314.39375	DB
590	Point	WELL00007	65100	Mar-33	4665	<Null>	<Null>	<Null>	<Null>	1.71102E+12	17	S	11	E	2	900	SW	NE	<Null>	44.12833	-121.3759	Active	500 Fe	No	No	Hand_Sketch	Found	https://	http://apps.wr	43314.39375	DB
591	Point	WELL00008	<Null>	Mar-33	4672	<Null>	<Null>	<Null>	<Null>	171103A000400	17	S	11	E	3	400	NE	NW	<Null>	44.13716	-121.3933	Active	500 Fe	No	No	Hand_Sketch	Found	https://	http://apps.wr	43314.39375	DB
592	Point	WELL00009	<Null>	Mar-33	4676	<Null>	<Null>	<Null>	<Null>	171103BB00300	17	S	11	E	3	300	NW	NW	<Null>	44.13655	-121.4044	Active	500 Fe	No	No	Hand_Sketch	Found	https://	http://apps.wr	43314.39306	DB
593	Point	WELL00010	<Null>	Mar-33	733	<Null>	<Null>	<Null>	<Null>	171104A000100	17	S	11	E	4	100	NE	NE	<Null>	44.13781	-121.404	Active	500 Fe	No	No	Hand_Sketch	Found	https://	http://apps.wr	43314.38333	DB
594	Point	WELL00011	<Null>	Apr-33	1444	<Null>	<Null>	<Null>	<Null>	171110A000100	17	S	11	E	10	100	NE	NE	<Null>	44.12328	-121.3876	Active	500 Fe	No	No	Hand_Sketch	Found	https://	http://apps.wr	43314.39375	DB
595	Point	WELL00012	<Null>	Apr-33	4680	<Null>	<Null>	<Null>	<Null>	171110A000200	17	S	11	E	10	200	NE	NE	<Null>	44.12109	-121.3852	Closure	Unknow	No	No	Unknown	Could r	https://	http://apps.wr	43314.39306	DB
596	Point	WELL00013	<Null>	Apr-33	4681	<Null>	<Null>	<Null>	<Null>	171110A000300	17	S	11	E	10	300	<Null>	<Null>	<Null>	44.11957	-121.3858	Active	500 Fe	No	No	Site_Plan	Found	https://	http://apps.wr	43314.39375	DB
597	Point	WELL00014	<Null>	Apr-33	9586	<Null>	<Null>	<Null>	<Null>	171110A000500	17	S	11	E	10	500	NE	SW	<Null>	44.1172	-121.3863	Closure	Unknow	No	No	Unknown	Could r	https://	http://apps.wr	43314.38264	DB
598	Point	WELL00015	75953	Apr-33	4688	<Null>	<Null>	<Null>	<Null>	1.71111E+12	17	S	11	E	11	200	NE	NW	<Null>	44.1219	-121.3719	Active	500 Fe	No	No	Site_Plan	Found	https://	http://apps.wr	43314.39306	DB
599	Point	WELL00016	<Null>		60881	<Null>	<Null>	<Null>	<Null>	1.71111E+12	17	S	11	E	11	600	NW	SE	<Null>	44.1177	-121.3744	Active	500 Fe	No	No	Hand_Sketch	Revise	https://	http://apps.wr	43314.38333	DB
600	Point	WELL00017	<Null>	Apr-33	4689	<Null>	<Null>	<Null>	<Null>	1.71111E+12	17	S	11	E	11	1800	SE	SE	<Null>	44.11278	-121.3655	Active	500 Fe	No	No	Site_Plan	Revise	https://	http://apps.wr	43314.39306	DB
601	Point	WELL00018	<Null>	Apr-33	1365	<Null>	<Null>	<Null>	<Null>	1.71112E+12	17	S	11	E	12	201	NW	NE	<Null>	44.1218	-121.3558	Active	500 Fe	No	No	Hand_Sketch	Found	https://	http://apps.wr	43314.39375	DB
602	Point	WELL00019	112224	Jun-55	59909	<Null>	<Null>	<Null>	<Null>	1.71113E+12	17	S	11	E	13	800	NW	SW	<Null>	44.09828	-121.3596	Active	Well He	No	No	Hand_Sketch	Revise	https://	http://apps.wr	43314.38403	DB
603	Point	WELL00020	<Null>		60709	<Null>	<Null>	<Null>	<Null>	1.71113E+12	17	S	11	E	13	809	SE	SW	<Null>	44.10909	-121.3598	Active	500 Fe	No	No	Hand_Sketch	Revise	https://	http://apps.wr	43314.38333	DB
604	Point	WELL00021	<Null>	Apr-33	4692	<Null>	<Null>	<Null>	<Null>	1.71113E+12	17	S	11	E	13	810	<Null>	<Null>	<Null>	44.10458	-121.3514	Active U	500 Fe	No	No	Unknown	Could r	https://	http://apps.wr	43314.39375	DB
605	Point	WELL00022	<Null>	Apr-33	4693	<Null>	<Null>	<Null>	<Null>	1.71113E+12	17	S	11	E	13	810	<Null>	<Null>	<Null>	44.1045	-121.3514	Active U	500 Fe	No	No	Unknown	Could r	https://	http://apps.wr	43314.41042	DB
606	Point	WELL00023	<Null>	Apr-33	4693	<Null>	<Null>	<Null>	<Null>	1.71113E+12	17	S	11	E	13	812	<Null>	<Null>	<Null>	44.10329	-121.3547	Active	500 Fe	No	No	Hand_Sketch	Revise	https://	http://apps.wr	43314.39375	DB
607	Point	WELL00024	<Null>		59701	<Null>	<Null>	<Null>	<Null>	1.71113E+12	17	S	11	E	13	1400	NW	NE	<Null>	44.10757	-121.3632	Active	500 Fe	No	No	Site_Plan	Revise	https://	http://apps.wr	43314.38403	DB
608	Point	WELL00025	<Null>	Apr-33	4701	<Null>	<Null>	<Null>	<Null>	1.71114E+12	17	S	11	E	14	99	<Null>	<Null>	<Null>	44.09958	-121.3636	Active	Well He	No	No	Aerial_Photo	Could r	https://	http://apps.wr	43314.41042	DB
609	Point	WELL00026	<Null>	Apr-33	4696	<Null>	<Null>	<Null>	<Null>	1.71114E+12	17	S	11	E	14	99	NE	SE	<Null>	44.09957	-121.3635	Active	Well He	No	No	Aerial_Photo	Could r	https://	http://apps.wr	43314.39306	DB
610	Point	WELL00027	<Null>	Apr-33	459	<Null>	<Null>	<Null>	<Null>	1.71114E+12	17	S	11	E	14	302	SW	SW	<Null>	44.09539	-121.378	Active	500 Fe	No	No	Site_Plan	Revise	https://	http://apps.wr	43314.39375	DB
611	Point	WELL00028	<Null>	Apr-33	4697	<Null>	<Null>	<Null>	<Null>	1.71114E+12	17	S	11	E	14	2200	SE	NE	<Null>	44.09996	-121.369	Active	500 Fe	No	No	Hand_Sketch	Found	https://	http://apps.wr	43314.39306	DB
612	Point	WELL00029	<Null>	Apr-33	4698	<Null>	<Null>	<Null>	<Null>	1.71114E+12	17	S	11	E	14	4601	NW	NW	<Null>	44.09991	-121.3752	Active	Well He	No	No	Aerial_Photo	Could r	https://	http://apps.wr	43314.39306	DB
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685	Point	WELL00102	<Null>	Nov-21	4824	<Null>	<Null>	<Null>	<Null>	171208B003200	17	S	12	E	8	3200	NW	NE	<Null>	44.11924	-121.3177	Active	500 Fe	No	No	Aerial_Photo	Update	https://	http://apps.wr	43314.39236	DB
686	Point	WELL00103	<Null>	Dec-21	4864	<Null>	<Null>	<Null>	<Null>	171208B003200	17	S	12	E	8	3200	NW	NE	<Null>	44.11937	-121.3177	Active	500 Fe	No	No	Aerial_Photo	Update	https://	http://apps.wr	43314.39236	DB
687	Point	WELL00104	<Null>	<Null>	61048	4866	<Null>	<Null>	<Null>	171208C000400	17	S	12	E	8	400	SW	NE	<Null>	44.11368968	-121.3161826	Active	500 Fe	No	No	Hand_Sketch	OWRD	https://	http://apps.wr	43528.73958	EM
688	Point	WELL00105	<Null>	May-33	850	4972?	<Null>	<Null>	<Null>	171208C000700	17	S	12	E	8	700	SW	SE	<Null>	44.110418	-121.314986	Active	500 Fe	Yes	Yes	Field_GPS	Well is	https://	http://apps.wr	43480.60486	EM
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690	Point	WELL00107	<Null>	May-33	4799	<Null>	<Null>	<Null>	<Null>	171208C001400	17	S	12	E	8	1400	<Null>	<Null>	<Null>	44.11582	-121.3212	Active	500 Fe	No	No	Address	Revise	https://	http://apps.wr	43314.39306	DB
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692	Point	WELL00109	<Null>	<Null>	753	59447	<Null>	<Null>	<Null>	171208D000202	17	S	12	E	8	202	SE	NE	<Null>	44.11343	-121.30605	Active	500 Fe	Yes	Yes	Field_GPS	Within s	https://	http://apps.wr	43433.38264	DB
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734	Point	WELL00151	<Null>	Jun-33	5111	<Null>	<Null>	<Null>	<Null>	1.71213E+12	17	S	12	E	13	700	<Null>	<Null>	<Null>	44.10049	-121.2238	Active U	500 Fe	No	No	Unknown	Could r	https://	http://apps.wr	43314.41042	DB
735	Point	WELL00152	<Null>	Feb-29	4928	<Null>	<Null>	<Null>	<Null>	171214AB00800	17	S	12	E	14	800	<Null>	<Null>	<Null>	44.10662	-121.2512	Active	500 Fe	No	No	Tax_Lot_Num.	Revise	https://	http://apps.wr	43314.41042	DB
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760	Point	WELL00177	<Null>	<Null>	58376	<Null>	<Null>	<Null>	<Null>	171217B001900	17	S	12	E	17	1900	NW	SE	<Null>	44.10466	-121.3163	Active	500 Fe	No	No	Hand_Sketch	Locatio	https://	http://apps.wr	43314.38403	DB

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763	Point	WELL00180	<Null>	<Null>	56071	4972	4997	<Null>	<Null>	171217B002200	17	S	12	E	17	2200	NW	SE	<Null>	44.10293	-121.3152	Active	500 Fe	No	No	Hand_Sketch	Locatio	https://	http://apps.wr	43528.60417	EM
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768	Point	WELL00185	<Null>	<Null>	4954	4952	<Null>	<Null>	<Null>	171217C000103	17	S	12	E	17	103	SW	NE	<Null>	44.100414	-121.316759	Active	500 Fe	Yes	Yes	Field_GPS	Well is	https://	http://apps.wr	43500.59861	EM
769	Point	WELL00186	<Null>	Jul-33	5001	<Null>	<Null>	<Null>	<Null>	171217C000400	17	S	12	E	17	400	SW	NW	<Null>	44.10115	-121.3236	Active	500 Fe	No	No	Hand_Sketch	Revise	https://	http://apps.wr	43314.39167	DB
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787	Point	WELL00204	<Null>	Jul-33	4970	<Null>	<Null>	<Null>	<Null>	171217CD02700	17	S	12	E	17	2700	SW	SE	<Null>	44.098332	-121.318441	Active U	500 Fe	Yes	Yes	Field_GPS	Well is	https://	http://apps.wr	43479.45208	EM
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795	Point	WELL00212	<Null>	Jul-33	51928	5022	<Null>	<Null>	<Null>	171220AC00300	17	S	12	E	20	300	NE	SW	<Null>	44.08997	-121.3126	Formal	Abando	Yes	No	Site_Plan	No evid	https://	http://apps.wr	43433.58333	EM
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798	Point	WELL00215	<Null>	Jul-33	55410	5045	<Null>	<Null>	<Null>	1.71223E+12	17	S	12	E	23	1800	NW	NW	<Null>	44.09126	-121.2624	Formal	Abando	Yes	No	Qtr_Qtr	Well wa	https://	http://apps.wr	1/15/2019 12:18:00 PM	EM
799	Point	WELL00216	<Null>	Jul-33	56984	5043	<Null>	<Null>	<Null>	171217DB01200	17	S	12	E	23	1200	SW	NW	<Null>	44.08565	-121.263589	Formal	Abando	Yes	Yes	Field_GPS	Well Vis	https://	http://apps.wr	43433.58333	EM
800	Point	WELL00217	<Null>	Jul-33	5046	<Null>	<Null>	<Null>	<Null>	171223DA00500	17	S	12	E	23	500	SW	NW	<Null>	44.087299	-121.243712	Active	500 Fe	Yes	Yes	Field_GPS	Well is	https://	http://apps.wr	43488.47639	EM
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804	Point	WELL00221	<Null>	Jul-33	5061	<Null>	<Null>	<Null>	<Null>	1.71226E+12	17	S	12	E	26	203	NE	NE	<Null>	44.07611	-121.2447	Closure	Unknow	No	No	Qtr_Qtr	Site pla	https://	http://apps.wr	43314.42292	DB
805	Point	WELL00222	<Null>	Aug-33	5062	<Null>	<Null>	<Null>	<Null>	171226D003300	17	S	12	E	26	3300	SE	NW	<Null>	44.07106	-121.2491	Active	500 Fe	No	No	Hand_Sketch	Revise	https://	http://apps.wr	43314.42361	DB
806	Point	WELL00223	39583	Dec-21	52907	<Null>	<Null>	<Null>	<Null>	171233A000101	17	S	12	E	33	101	NE	NE	<Null>	44.06268	-121.2874	Active	Well He	Yes	No	GPS_Coordinates	City of	https://	http://apps.wr	43798	EM
807	Point	WELL00224	<Null>	Dec-27	8499	<Null>	<Null>	<Null>	<Null>	171233A000102	17	S	12	E	33	102	NE	NE	<Null>	44.06272	-121.2871	Active	Well He	Yes	No	GPS_Coordinates	City of	https://	http://apps.wr	43452.38681	EM
808	Point	WELL00225	100376	Aug-46	58778	<Null>	<Null>	<Null>	<Null>	171233A000105	17	S	12	E	33	105	NE	NE	<Null>	44.06255	-121.2862	Active	Well He	Yes	No	GPS_Coordinates	City of	https://	http://apps.wr	43452.38681	EM
809	Point	WELL00226	22878	Dec-27	51943	<Null>	<Null>	<Null>	<Null>	171233DD00102	17	S	12	E	33	102	SE	SE	<Null>	44.053837	-121.286075	Active	Well He	Yes	No	GPS_Coordinates	City of	https://	http://apps.wr	43452.38681	EM
810	Point	WELL00227	52414	Dec-27	54251	<Null>	<Null>	<Null>	<Null>	171233DD00102	17	S	12	E	33	102	SE	SE	<Null>	44.053577	-121.286529	Active	Well He	Yes	No	GPS_Coordinates	City of	https://	http://apps.wr	43452.38681	EM
811	Point	WELL00228	<Null>	<Null>	60520	<Null>	<Null>	<Null>	<Null>	1.71235E+12	17	S	12	E	35	1205	SE	NW	<Null>	44.05580133	-121.2513189	Active	500 Fe	No	No	Hand_Sketch	Locatio	https://	http://apps.wr	43528.45833	EM
812	Point	WELL00229	<Null>	Aug-33	9427	5087	<Null>	<Null>	<Null>	171235BB01800	17	S	12	E	35	1800	NW	NW	<Null>	44.06292	-121.2628	Formal	Abando	Yes	No	Field_GPS	Found	https://	http://apps.wr	43452.52639	EM
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819	Point	WELL00236	<Null>	<Null>	56404	<Null>	<Null>	<Null>	<Null>	1.7132E+12	17	S	13	E	20	700	SW	NE	<Null>	44.08487	-121.1916	Active	500 Fe	No	No	Hand_Sketch	Revise	https://	http://apps.wr	43314.42708	DB
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895	Point	WELL00312	<Null>	<Null>	9993	<Null>	<Null>	<Null>	<Null>	181113C000400	18	S	11	E	13	400	SW	NW	<Null>	44.014679	-121.360738	Active	500 Fe	Yes	Yes	Field_GPS	Well is	https://	http://apps.wr	43437.625	EM
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975	Point	WELL00392	<Null>	Dec-33	514	<Null>	<Null>	<Null>	<Null>	181136DB02800	18	S	11	E	36	2800	NE	SW	<Null>	43.97102	-121.3533	Active	500 Fe	No	No	Site_Plan	Found	https://	http://apps.wr	43333.48333	DB
976	Point	WELL00393	<Null>	Dec-33	5419	<Null>	<Null>	<Null>	<Null>	181136DB02800	18	S	11	E	36	2800	SE	SW	<Null>	43.9716	-121.353	Closure	Unknow	No	No	Unknown	locatio	https://	http://apps.wr	43314.38681	DB
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978	Point	WELL00395	<Null>	Dec-33	5557	<Null>	<Null>	<Null>	<Null>	181201B002600	18	S	12	E	1	2600	NW	NE	<Null>	44.0486	-121.2351	Closure	Unknow	No	No	Unknown	Locatio	https://	http://apps.wr	43314.38611	DB
979	Point	WELL00396	<Null>	Dec-33	5559	<Null>	<Null>	<Null>	<Null>	181201D000700	18	S	12	E	1	700	SE	NW	<Null>	44.04058	-121.2301	Active	500 Fe	No	No	Hand_Sketch	Found	https://	http://apps.wr	43333.48403	DB
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981	Point	WELL00398	<Null>	Dec-33	5561	<Null>	<Null>	<Null>	<Null>	181202BC01000	18	S	12	E	2	1000	NW	SW	<Null>	44.04458	-121.261306	Active	500 Fe	Yes	Yes	Field_GPS	Well is l	https://	http://apps.wr	43438.42708	EM
982	Point	WELL00399	<Null>	Dec-21	5569	<Null>	<Null>	<Null>	<Null>	181203BA00321	18	S	12	E	3	321	NW	NE	<Null>	44.050134	-121.274138	Closure	500 Fe	Yes	No	Avion_Files	Locatio	https://	http://apps.wr	43439.42708	EM
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985	Point	WELL00402	<Null>	<Null>	5571	<Null>	<Null>	<Null>	<Null>	181203DD00600	18	S	12	E	3	600	SE	SE	<Null>	44.037763	-121.263848	Closure	500 Fe	Yes	Yes	Field_GPS	Only a f	https://	http://apps.wr	43480.675	EM
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992	Point	WELL00409	<Null>	Dec-33	5580	<Null>	<Null>	<Null>	<Null>	181206C002200	18	S	12	E	6	2200	SW	SW	<Null>	44.03809	-121.3432	Active	500 Fe	Yes	Yes	Field_GPS	Well is v	https://	http://apps.wr	43438.42708	EM
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996	Point	WELL00413	<Null>	Jun-00	1738	50445	<Null>	<Null>	<Null>	181207DB00100	18	S	12	E	7	100	SE	NW	<Null>	44.02829	-121.33065	Active	Well He	Yes	No	GPS_Coordinates	COB We	https://	http://apps.wr	43483.71528	EM
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1001	Point	WELL00418	<Null>	Dec-33	5597	<Null>	<Null>	<Null>	<Null>	1.8121E+12	18	S	12	E	10	401	NE	SE	<Null>	44.03164	-121.266411	Active	500 Fe	Yes	Yes	Field_GPS	Owners	https://	http://apps.wr	12/3/2018 10:28:00 AM	EM
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1006	Point	WELL00423	<Null>	<Null>	53254	<Null>	<Null>	<Null>	<Null>	1.81215E+12	18	S	12	E	15	1700	SE	SW	<Null>	44.011099	-121.269402	Active	500 Fe	Yes	Yes	Field_GPS	Well is i	https://	http://apps.wr	43446.51806	EM
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1014	Point	WELL00431	<Null>	Dec-33	525	<Null>	<Null>	<Null>	<Null>	1.81217E+12	18	S	12	E	17	2400	SE	SW	<Null>	44.009997	-121.311988	Active U	Well He	Yes	Yes	Field_GPS	Golf Co	https://	http://apps.wr	43425.49375	EM
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1018	Point	WELL00435	<Null>	Jan-22	5634	<Null>	<Null>	<Null>	<Null>	181218AA00100	18	S	12	E	18	100	NE	NE	<Null>	44.02214	-121.326488	Active	Well He	Yes	Yes	Field_GPS	Well is v	https://	http://apps.wr	43480.48819	EM
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1021	Point	WELL00438	<Null>	Dec-33	5629	5632	<Null>	<Null>	<Null>	181218DD05000	18	S	12	E	18	5000	SE	SE	<Null>	44.01084	-121.3264	Formal	Abando	Yes	No	Aerial_Photo	Well is c	https://	http://apps.wr	43481.56458	EM
1022	Point	WELL00439	<Null>	Dec-33	5649	<Null>	<Null>	<Null>	<Null>	181219B000100	18	S	12	E	19	100	<Null>	<Null>	<Null>	44.00628	-121.3358	Active	500 Fe	No	No	Hand_Sketch	Found	https://	http://apps.wr	43333.49722	DB
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1092	Point	WELL00509	<Null>	<Null>	5048	5049	<Null>	<Null>	<Null>	1.71223E+12	17	S	12	E	23	1700	SE	SE	<Null>	44.08218	-121.246	Formal	Abando	No	No	Address	Could N	https://	http://apps.wr	43332.57014	DB
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1115	Point	WELL00532	<Null>	<Null>	5303	<Null>	<Null>	<Null>	<Null>	<Null>	18	S	11	E	23	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Informa	https://	http://apps.wr	43494.38056	EM
1116	Point	WELL00533	<Null>	Oct-33	5304	<Null>	<Null>	<Null>	<Null>	<Null>	18	S	11	E	23	<Null>	<Null>	<Null>	<Null>	43.99719351	-121.3716955	Closure	Unknow	No	No	OWRD	OWRD i	https://	http://apps.wr	43437.45139	EM
1117	Point	WELL00534	<Null>	Oct-33	5307	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	NE	<Null>	<Null>	44.0073563	-121.3649301	Closure	500 Fe	Yes	No	OWRD	Not enc	https://	http://apps.wr	43437.45139	EM
1118	Point	WELL00535	<Null>	<Null>	5309	<Null>	<Null>	<Null>	<Null>	<Null>	18	S	11	E	23	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Informa	https://	http://apps.wr	43437.45139	EM
1119	Point	WELL00536	<Null>	<Null>	5310	<Null>	<Null>	<Null>	<Null>	181123AC01600	18	S	11	E	23	1600	<Null>	<Null>	<Null>	44.00099	-121.3722	Closure	Unknow	No	No	Tax_Lot_Num.	River B	https://	http://apps.wr	43333.55139	DB
1120	Point	WELL00537	<Null>	<Null>	5311	<Null>	<Null>	<Null>	<Null>	<Null>	18	S	11	E	23	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Site ma	https://	http://apps.wr	43437.45139	EM
1121	Point	WELL00538	<Null>	<Null>	5312	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	43.99167	-121.370892	Closure	Unknow	No	No	Unknown	Local re	https://	http://apps.wr	43333.55208	DB
1122	Point	WELL00539	<Null>	<Null>	53123	<Null>	<Null>	<Null>	<Null>	1.81217E+12	18	S	12	E	17	1700	SW	NW	<Null>	44.01648	-121.3224	Formal	Abando	Yes	No	Unknown	Large s	https://	http://apps.wr	43423.625	EM
1123	Point	WELL00540	<Null>	<Null>	5313	<Null>	<Null>	<Null>	<Null>	<Null>	18	S	11	E	23	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Well log	https://	http://apps.wr	43437.45139	EM
1124	Point	WELL00541	<Null>	<Null>	5316	<Null>	<Null>	<Null>	<Null>	181123CA01700	18	S	11	E	23	1700	NE	NE	<Null>	43.99889	-121.3752	Closure	Unknow	No	No	Unknown	Deschu	https://	http://apps.wr	43333.55208	DB

1125	Point	WELL00542	<Null>	Oct-33	5318	<Null>	<Null>	<Null>	<Null>	181123CA01600	18	S	11	E	23	1600	NE	NE	<Null>	43.99907	-121.3756	Closure	Unknow	No	No	Unknown	Deschu	https://	http://apps.wrd	43333.55208	DB
1126	Point	WELL00543	<Null>	<Null>	53402	<Null>	<Null>	<Null>	<Null>	1.71206E+12	17	S	12	E	6	11000	SW	SE	<Null>	44.12417	-121.3292	Formal	Abando	No	No	Address	Propert	https://	http://apps.wrd	43318.34306	DB
1127	Point	WELL00544	<Null>	<Null>	53438	<Null>	<Null>	<Null>	<Null>	171216B000301	17	S	12	E	16	300	NE	NW	<Null>	44.10872	-121.3011	Formal	Abando	Yes	No	Tax_Lot_Num.	Appears	https://	http://apps.wrd	43518.65278	EM
1128	Point	WELL00545	<Null>	<Null>	54764	<Null>	<Null>	<Null>	<Null>	171218D000200	17	S	12	E	18	200	SE	NE	<Null>	44.09564	-121.327	Closure	Unknow	Yes	No	Address	Visited t	https://	http://apps.wrd	43529.40625	EM
1129	Point	WELL00546	<Null>	<Null>	55468	5023	<Null>	<Null>	<Null>	171220AB00151	17	S	12	E	17	151	SW	SE	<Null>	44.0945705	-121.3118743	Formal	Abando	Yes	No	Address	OWRD i	https://	http://apps.wrd	11/ 12:39:00 PM	EM
1130	Point	WELL00547	<Null>	<Null>	1095	5579	<Null>	<Null>	<Null>	181205B000800	18	S	12	E	5	800	NE	SW	<Null>	44.074219	-121.36558	Formal	Abando	Yes	No	Tax_Lot_Num.	Closure	https://	http://apps.wrd	11/12/2018 11:57:00 AM	EM
1131	Point	WELL00548	<Null>	<Null>	5586	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	NW	NW	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38542	DB
1132	Point	WELL00549	<Null>	Dec-21	5589	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38611	DB
1133	Point	WELL00550	<Null>	<Null>	5591	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	SW	NW	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38542	DB
1134	Point	WELL00551	<Null>	<Null>	5595	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	SE	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38542	DB
1135	Point	WELL00552	<Null>	<Null>	5596	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	NE	NE	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38542	DB
1136	Point	WELL00553	<Null>	Dec-33	5658	5657	<Null>	<Null>	<Null>	181220BB09000	18	S	12	E	10	<Null>	NW	NW	Aug-24	44.00534128	-121.3197636	Closure	Well He	Yes	No	Avion_Files_and_OWRD	Avion o	https://	https://apps.w	43493.58542	EM
1137	Point	WELL00554	<Null>		5599	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	SW	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38542	DB
1138	Point	WELL00555	<Null>	Dec-33	5602	<Null>	<Null>	<Null>	<Null>	1.81213E+12	18	S	12	E	13	302	NW	NE	<Null>	44.01752	-121.2324	Closure	Unknow	No	No	Unknown	Could r	https://	http://apps.wrd	43314.38542	DB
1139	Point	WELL00556	<Null>		5609	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	SE	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43333.55208	DB
1140	Point	WELL00557	<Null>		5615	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	SW	SW	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38472	DB
1141	Point	WELL00558	<Null>		5621	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38542	DB
1142	Point	WELL00559	<Null>	<Null>	56216	56034	<Null>	<Null>	<Null>	<Null>	18	S	12	E	18	4900	SW	SW	<Null>	44.0099	-121.3409	Formal	Abando	Yes	No	Tax_Lot_Num.	Well ca	https://	http://apps.wrd	43515.46389	EM
1143	Point	WELL00560	<Null>		5623	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	SW	NW	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38472	DB
1144	Point	WELL00561	<Null>	Jan-22	5626	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	NE	NE	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38472	DB
1145	Point	WELL00562	<Null>	Dec-33	5627	<Null>	<Null>	<Null>	<Null>	181218BB06100	18	S	12	E	18	6100	NW	NW	<Null>	44.02113367	-121.3425834	Closure	Unknow	Yes	No	OWRD	Not end	https://	http://apps.wrd	43528.4375	EM
1146	Point	WELL00563	<Null>		5630	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not end	https://	http://apps.wrd	43314.38472	DB
1147	Point	WELL00564	<Null>	Dec-33	5631	<Null>	<Null>	<Null>	<Null>	181218DD05800	18	S	12	E	18	5800	SE	SE	<Null>	44.01055	-121.3253	Closure	Unknow	No	No	Unknown	No well	https://	http://apps.wrd	43314.38472	DB
1148	Point	WELL00565	<Null>		5641	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	NW	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	River B	https://	http://apps.wrd	43333.55208	DB
1149	Point	WELL00566	<Null>		5644	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	NW	NE	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38472	DB
1150	Point	WELL00567	<Null>	Jan-34	5656	<Null>	<Null>	<Null>	<Null>	181221BC03800	18	S	12	E	20	3800	NE	SE	<Null>	44.00311769	-121.3045505	Closure	500 Fe	Yes	No	OWD_and_Site_Plan	No evid	https://	http://apps.wrd	43495.30833	EM
1151	Point	WELL00568	<Null>		5657	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	NW	NW	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43314.38472	DB
1152	Point	WELL00569	<Null>		5666	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	NW	NW	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43333.55208	DB
1153	Point	WELL00570	<Null>	<Null>	57273	5029	<Null>	<Null>	<Null>	<Null>	17	S	12	E	20	<Null>	NW	NE	<Null>	<Null>	<Null>	Formal	Abando	No	No	Unknown	Not en	https://	http://apps.wrd	43315.45694	DB
1154	Point	WELL00571	<Null>	<Null>	57339	<Null>	<Null>	<Null>	<Null>	1.71126E+12	17	S	11	E	26	102	NE	NE	<Null>	44.0797	-121.3664	Formal	Abando	Yes	No	Address	Well wa	https://	http://apps.wrd	43494.32778	EM
1155	Point	WELL00572	<Null>	<Null>	57454	4962	57415	<Null>	<Null>	171217DC07900	17	S	12	E	17	7900	SW	SE	<Null>	44.09702	-121.3123	Formal	Abando	Yes	No	Unknown	Well wa	https://	http://apps.wrd	12/3/2018 9:10:00 AM	EM
1156	Point	WELL00573	<Null>	<Null>	57772	<Null>	<Null>	<Null>	<Null>	181125DB03700	18	S	11	E	25	3700	NE	SW	<Null>	43.98268	-121.3514	Formal	Abando	No	No	Address	No site	https://	http://apps.wrd	43315.45764	DB
1157	Point	WELL00574	<Null>	<Null>	58314	<Null>	<Null>	<Null>	<Null>	1.71234E+12	17	S	12	E	34	1200	SW	SE	<Null>	44.05763	-121.2705	Formal	Abando	Yes	No	Address	Taxlot a	https://	http://apps.wrd	43494.30278	EM
1158	Point	WELL00575	<Null>	<Null>	58315	9520	<Null>	<Null>	<Null>	1.71234E+12	17	S	12	E	34	1200	SW	SE	<Null>	44.05767	-121.2707	Formal	Abando	Yes	No	Address	Taxlot a	https://	http://apps.wrd	43494.30278	EM
1159	Point	WELL00576	<Null>	<Null>	5620	5619	5618	58682	<Null>	181217BA00902	18	S	12	E	17	902	NE	NW	<Null>	44.02157446	-121.3147615	Formal	Abando	Yes	No	Address	OWRD p	https://	http://apps.wrd	43494.30278	EM
1160	Point	WELL00577	<Null>	<Null>	58915	<Null>	<Null>	<Null>	<Null>	181125CA00400	18	S	11	E	25	400	SE	NW	<Null>	43.98579	-121.3567	Formal	Abando	No	No	Address	Well wa	https://	http://apps.wrd	43314.55972	DB
1161	Point	WELL00578	<Null>	<Null>	60238	<Null>	<Null>	<Null>	<Null>	181126CD01100	18	S	11	E	26	1100	SE	SW	<Null>	43.98136	-121.3765	Formal	Abando	No	No	Address	Addres	https://	http://apps.wrd	43314.54514	DB
1162	Point	WELL00579	<Null>	<Null>	60486	60485	<Null>	<Null>	<Null>	1.71113E+12	17	S	11	E	13	400	NE	SE	<Null>	44.1004	-121.349	Formal	Abando	No	No	Address	Could r	https://	http://apps.wrd	43314.53333	DB
1163	Point	WELL00580	<Null>	Jan-22	863	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	NE	SE	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	JL Wa	https://	http://apps.wrd	43314.38264	DB
1164	Point	WELL00581	<Null>	Jan-22	9108	<Null>	<Null>	<Null>	<Null>	181207DA03700	18	S	12	E	7	3700	SE	NE	<Null>	44.02805	-121.3278	Closure	Unknow	Yes	No	Unknown	Duplica	https://	http://apps.wrd	43488.775	EM
1165	Point	WELL00582	<Null>	<Null>	9288	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Closure	Unknow	No	No	Unknown	Not en	https://	http://apps.wrd	43333.55208	DB
1166	Point	WELL00583	<Null>	<Null>	9548	<Null>	<Null>	<Null>	<Null>	171126AD00100	17	S	11	E	3	100	NE	SE	<Null>	44.074192	-121.365494	Active U	500 Fe	Yes	Yes	Field_GPS	Well is	https://	http://apps.wrd	43515.44792	EM
1167	Point	WELL00584	<Null>	<Null>	5628	<Null>	<Null>	<Null>	<Null>	181218DB07500	18	S	12	E	18	7500	NW	SE	<Null>	44.014766	-121.333135	Closure	500 Fe	Yes	No	Avion_Files_and_OWRD	Well is	https://	https://apps.w	43490.44792	EM
1168	Point	WELL00585	<Null>	<Null>	5587	<Null>	<Null>	<Null>	<Null>	181218DB07500	18	S	12	E	18	7500	NW	SE	<Null>	44.014731	-121.333127	Closure	500 Fe	Yes	No	Avion_Files_and_OWRD	Well is	https://	https://apps.w	43490.44792	EM
1169	Point	WELL00586	<Null>	<Null>	5632	<Null>	<Null>	<Null>	<Null>	181218AB04403	18	S	12	E	7	4403	SW	SE	<Null>	44.022712	-121.332276	Closure	500 Fe	Yes	No	Avion_Files_and_OWRD	Well loc	https://	https://apps.w	43490.44792	EM
1170	Point	WELL00587	<Null>	Jul-14	5659	<Null>	<Null>	<Null>	<Null>	1.81221E+12	18	S	12	E	21	106	SE	NE	<Null>	44.00181599	-121.2853173	In Use	500 Fe	No	No	Avion_Files	Well is nearby 4 other well log entires. (			43493.48681	EM
1171	Point	WELL00588	<Null>	<Null>	5660	<Null>	<Null>	<Null>	<Null>	1.81221E+12	18	S	12	E	21	100	SE	NE	<Null>	44.00176023	-121.2853367	Not in U	Unknow	No	No	Avion_Files	Well is nearby 4 other well log entires. (			43493.51111	EM
1172	Point	WELL00589	<Null>	<Null>	5661	<Null>	<Null>	<Null>	<Null>	1.81221E+12	18	S	12	E	21	106	SE	NE	<Null>	44.0019095	-121.2854358	In Use	500 Fe	No	No	Avion_Files	Well is nearby 4 other well log entires. (			43493.51111	EM
1173	Point			4948	4948						17	S	12	E	16		NW	NE													GSI
1174	Point			5044	5044						17	S	12	E	23																GSI
1175	Point		57365	55655	55655					1000	18	S	11	E	2	1000	NE	NW		44.048629	121.370323										GSI
1176	Point			59999	59998															44.012791	121.35947										GSI
1177	Point		122608	60659	60659					100	17	S	11	E	24	100	NW	NE		44.094194	121.35675										GSI
1178	Point		129777	61163	61163					1001	17	S	12	E	17	1001	SW	NE		44.098538	121.317773										GSI
1179	Point		135207	61726	61726					1702	18	S	11	E	13	1702	NW	SW													GSI
1180	Point		136371	61957	61957					900	17	S	12	E	8	900	SE	SW		44.111208	121.309402										GSI
1181	Point		134621	61988	61988					300	18	S	11	E	13	300	NW	NW		44.022101	121.362143										GSI
1182	Point		137967	62025	62025					4600	17	S	12	E	26	4600	SE	SW		44.067417	121.252056										GSI

Notes:

* Water Well Location Database updated through July 11, 2020 and is based on the "All Wells" tabe of the databse provided by the City

[1] Wells were located based on the best available location information, which includes the following subsets of location data (listed in decreasing location accuracy): latitudes and longitudes; City tax lot numbers; street addresses; ¼-¼ section; ¼-section; or section. The location data presented on this table represents the most up-to-date location information, based on the City's field reconnaissance program and/or other location methods (e.g., historical maps, aerial imagery)

Shading:

New or previously unlocated water well

GSI Water Solutions, Inc.

Table D-2: Regional Water Table

BEND AREA WELLS							
No.	Well ID	Well Log ID	Ground Surface Elevation (feet)	Total Depth (feet bgs)	Drill Log Water Level Data		
					Date	SWL (feet bgs)	GW Elev (feet)
CITY OF BEND							
1	Outback Well #1	DESC 8509	3981.50	701	1993	482	3500
2	Outback Well #2	DESC 50953	3981.50	752	1997	482	3500
3	Outback Well #3	DESC 53735	3981.50	850	2001	477	3505
4	Outback Well #4	DESC 54252	3978.50	850	2001	478	3501
5	Outback Well #5	DESC 56371	3978.50	861	2004	486	3493
6	Outback Well #6	DESC 56449	3981.50	864	2004	480	3502
7	Outback Well #7	DESC 57760	3981.50	860.5	2006	470	3512
8	Bear Creek Well #1	DESC 51943	3657.00	970	1998	628	3029
9	Bear Creek Well #2	DESC 54251	3657.00	1100	2001	652	3005
10	Pilot Butte Well #1	DESC 8499	3754.00	1065	1993	731	3023
11	Pilot Butte Well #3	DESC 52907	3782.00	1140	2000	786	2996
12	Pilot Butte Well #4	DESC 58778	3712.20	1160	2009	702	3010
13	Rock Bluff Well #1	DESC 50976	3834.00	512	1997	378	3456
14	Rock Bluff Well #2	DESC 50445	3834.00	800	1996	402	3432
15	Rock Bluff Well #3	DESC 9997	3834.00	850	1995	395	3439
16	Shilo Well #3	DESC 5613	3765.76	410	1974	335	3431
17	River Well #1 (West)	DESC 5577	3606.00	900	1972	564	3042
18	River Well #2 (East)	DESC 5578	3606.00	800	1978	242	3364
19	Copperstone Well	DESC 1653	3782.00	700	1992	510	3272
20	Westwood Well	DESC 5585	3842.00	310	1977	277	3565
21	Airport Well East	DESC 52008	3432.80	928	1998	582	2851
22	Hole Ten N	DESC 5655	3871.40	488	1986	410	3461
23	Hole Ten S	DESC 5654	3871.40	502	1987	412	3459
24		DESC5580	3731.00	367	1979	314	3417
25		DESC5582	NA	160	dry well		
AVION WATER COMPANY							
1	China Hat 1	DESC 50740	3956.32	622	1997	499	3457
2	China Hat 2	DESC 52881	3957.79	624	2000	501	3457
3	Deschutes River Woods	DESC 55124	3934.87	520	2003	405	3530
4	Conestoga	DESC 5722	3668.35	840	1978	800	2868
5	Parrell Road	DESC 50986	3850.68	470	1995	387	3464
6	Riverbend #1	DESC 5640	3865.44	440	1980	388	3477
7	Tekampe A	DESC 5659	3804.15	430	1989	373	3431
8	Tekampe C	DESC 528	3804.30	435	1979	374	3430
9	Tekampe B	DESC 5660	3804.12	435	1987	375	3429
10	Sundance Well #2	DESC 5725	3890.91	925	1975	855	3036
11	Riverbend #2	DESC 4143	3865.91	447	1993	390	3476
12	Dyer Well	DESC 58007	3427.17	854	2007	694	2733
13	Tuscarora Well	DESC 5462	3944.42	275	1978	233	3711
14		DESC5054	3500.00	639	1974	587	2913
16		DESC56821	3700.00	700	2005	507	3193
17		DESC5587	3835.00	385	1976	349	3486
18		DESC5628	3835.00	376	1978	346	3489
ROATS WATER COMPANY							
1	ROATS 3	DESC 5634	3837.91	406	1974	403	3435
2	ROATS 4	DESC 5624	3836.32	384	1987	384	3452
4	ROATS 9	DESC 8543	3828.09	382	1993	386	3442
5	ROATS 10	DESC 57243	3934.72	173	2006	396	3539
OWRD State Observation Wells							
1		DESC 5524	3942	405	1968	168	3774

Notes:

Ground surface elevation data estimated from various sources including Google Earth

GSI Water Solutions, Inc.