West Basin Facility Plan Project 7054

PART 3 - TECHNICAL MEMORANDUM 5

Conveyance – Existing System Capacity Analysis

FINAL / October 2025

Jacobs

Produced by: carollo

Clean Water Services

Clean Water Services

West Basin Facility Plan Project 7054

PART 3 - TECHNICAL MEMORANDUM 5

Conveyance – Existing System Capacity Analysis

FINAL / October 2025

This document is released for the purpose of information exchange review and planning only under the authority of Shad Roundy (Jacobs Engineering, Inc.), Oregon 81510PE, Expiration: 12/31/2026.

Jacobs Engineering, Inc is primary author for work presented in this technical memorandum.

Contents

Appendices

List of Figures

List of Tables

Abbreviations

cfs	Cubic feet per second
d/D	Depth to Diameter Ratio
fps	Feet per second
gpcd	Gallons per capita day
gpnad	Gallons per Net Acre per Day
MG	Million gallons
mg/L	Milligrams per liter
mgd	Million gallons per day
PS	Pump Station
psi	Pounds per square inch
R&R	Repair and Replacement Program
RDI/I	Rainfall Derived Infiltration and Inflow
SCADA	Supervisory Control and Data Acquisition
TM	Technical Memorandum
WRRF	Wastewater Resource Recovery Facility

CONVEYANCE – EXISTING SYSTEM CAPACITY ANALYSIS

5.1 Objective

This technical memorandum (TM) summarizes the existing sanitary conveyance system deficiencies and impact of rainfall derived infiltration and inflow (RDI/I) in the Clean Water Services (District's) West Basin.

The objectives of this TM include:

- Present an overview of system capacity deficiencies.
- Document existing RDI/I rates by subbasin.

5.2 Summary

Existing and future flow projections were completed as presented in *PART 3 - TM 3, Conveyance - Flow Development*, and the sanitary conveyance system was modeled to define existing and future system deficiencies based on hydraulic design criteria and the design storms presented in *PART 3 – TM2, Conveyance - Basis of Planning*. Additionally, existing RDI/I rates were summarized by subbasin throughout the sanitary conveyance system.

PART 3 – TM 6, Conveyance Infiltration and Inflow Cost Effectiveness Analysis will present analysis to define targets for RDI/I reduction in the system and provide details on the District's RDI/I Abatement Program.

5.3 References

This TM references the following:

- PART 2 - TM2 – Study Area Characteristics
- PART 3 – TM 2 – Conveyance Basis of Planning (Design Criteria, Design Storm, and Climate Impacts)
- PART 3 - TM 3 – Conveyance Flow Development
- PART 3 – TM 6 – Conveyance Infiltration and Inflow Cost Effectiveness Analysis
- PART 3 – TM 7 – Conveyance Improvement Alternatives Analysis
- PART 3 – TM 8 – Conveyance Capital Improvement Implementation Plan

5.4 Background

5.4.1 System Deficiency and Improvement Criteria

The District's criteria for establishing sanitary conveyance system capacity deficiencies are discussed in detail in *Part 3, TM2 – Conveyance Basis of Planning*. For sanitary sewer pipelines, the criteria focus on allowable surcharging above the pipe crown during a wet weather design storm event. For pump stations, the criteria focus on pumping peak wet weather flows with the largest pump out of service (firm capacity).

Maximum velocity and minimum scouring velocity for gravity pipelines are considered secondary criteria and are indicative of undersized or oversized piping, respectively.

The capacity deficiency criteria for this plan assume a high risk to property and health when the surcharged pipeline hydraulic gradeline (HGL) is within 3 feet of the ground surface and a moderate risk when the surcharged HGL is within 10 feet of the ground surface during the 5-year design storm.

Oregon Department of Environmental Quality (DEQ) guidelines (*Oregon Administrative Rule 340-041-0009*) indicate that sanitary sewer overflows are prohibited except during a winter storm event exceeding the one in five-year frequency and a summer storm event exceeding the one in ten-year frequency.

As described in *Part 3, TM 2, Conveyance Basis of Planning*, the District developed a 5-year design storm specifically for each treatment and collection basin (Rock Creek, Hillsboro, and Forest Grove) within the West Basin. Additionally, climate intensified storms were developed to test the sensitivity of the system to potential changes in storm frequency and depth. And peak intensity within the next 50 years.

5.4.2 Rainfall Derived Infiltration and Inflow

RDI/I is defined as stormwater that enters the sanitary conveyance system during or immediately following a rain event. Stormwater inflow reaches the sanitary conveyance system by direct connections, such as roof downspouts connected to sanitary sewers, yard and area drains, holes in manhole covers, cross-connections with storm drains or catch basins, and pipeline defects. Rainfall-derived infiltration includes stormwater that enters defective pipes, pipe joints, and manhole walls after percolating through the soil. RDI/I in sewer systems can cause many problems that ultimately result in increased costs. Problems include the following:

- Increased operational and capital costs in the sanitary conveyance system and at treatment plants.
- Reduced sewer conveyance and treatment capacity leading to increased potential for sanitary sewer overflows, flooding, and pollution.
- Reduced sewer conveyance and treatment capacity restricting future development.
- Soil flows into sewers causing structural damage and associated operational problems.
- Lowering groundwater levels lead to detrimental effects on local water resources.

RDI/I is represented as peak wet weather flow per developed acre (or net acre). Net acres are typically 65 to 75-percent of gross acres representing parcels served by the sewer system. RDI/I rates are characterized as follows:

- 50,000 gallons per net acre per day (gpnad) or greater- Excessively high RDI/I with extreme impacts on system capacity and high likelihood of sanitary sewer overflows.
- 25,000 to 50,000 gpnad – High RDI/I with possible impacts on system capacity and potential cause of sanitary sewer overflows.
- 15,000 to 25,000 gpnad – Medium-high RDI/I with possible impacts on system capacity and potential cause of sanitary sewer overflows.
- 10,000 to 15,000 gpnad – Medium RDI/I with possible impacts on system capacity and potential cause of sanitary sewer overflows.
- 5,000 to 10,000 gpnad – Medium-low RDI/I with possible impacts on system capacity.

- 2,500 to 5,000 gpnad – Low RDI/I consistent with allowance for new development and slow system degradation with time.

5.4.3 Capacity Improvement Responsibility

System improvements responsibilities including funding and implementation are based on intergovernmental agreements between the District and the partner cities. The funding and implementation responsibilities are summarized in this TM and applied to improvement projects in Part 3, TM 08, Conveyance Implementation Plan.

5.4.3.1 Funding Source Categories

Improvement projects to eliminate system capacity deficiencies are characterized by funding sources from intergovernmental agreements as described in Table 5.1 and below.

Table 5.1 Gravity System Capacity Improvement Funding Responsibilities

Project Category (Jurisdiction)	Size, Gravity Mainlines and Trunks	Funding Responsibility
New Gravity Pipe (Banks, Beaverton, Cornelius, Hillsboro, Gaston, and North Plains)	<= 12-inch	Partner City
	>12-inch	District/Partner City cost share based on proportional capacity[2]
New Gravity Pipe (Forest Grove)	< 24-inch	Partner City
	>=24-inch	District/Partner City cost share based on proportional capacity[2]
New Gravity Pipe (Unincorporated Washington County)	all pipe diameters	District
Gravity Pipe Replacement/Upsize[1] (Banks, Beaverton, Cornelius, Hillsboro, Gaston, and North Plains)	<=12-inch to <=12-inch	Partner City
	<12-inch to >12-inch	District/Partner City cost share based on proportional capacity[2]
	>=12-inch to >12-inch	District
Gravity Pipe Replacement/Upsize[1] (Forest Grove)	< 24-inch to <24-inch	Partner City
	<24-inch to >=24-inch	District/Partner City cost share based on proportional capacity[2]
	>=24-inch	District
Gravity Pipe Replacement/Upsize[1] (Unincorporated Washington County)	all pipe diameters	District

[1] Replacement/upsize responsibility also includes structural and operations & maintenance repairs to existing mainlines and trunks at designated existing pipeline sizes.

[2] Proportional capacity includes cross-sectional area of replacement or new sewer compared to a 12-inch diameter sewer for Banks, Beaverton, Cornelius, Hillsboro, Gaston, and North Plains, and a 24-inch diameter sewer for Forest Grove.

The District also funds all non-private pump stations, and all non-private force mains within the city jurisdictions and unincorporated Washington County.

5.4.3.2 Responsibility for Project Implementation

Improvement projects to eliminate system capacity deficiencies are characterized by implementation responsibility from intergovernmental agreements as follows:

- Projects implemented by the District include existing and new gravity pipelines 24-inches in diameter and larger within city jurisdictions, all non-private pump stations, and all non-private force mains.
- Projects implemented by cities include existing and new gravity pipelines smaller than 24-inches in diameter. For unincorporated areas, the District also implements projects smaller than 24-inches in diameter.
- Projects with shared District and city implementation include existing pipelines with a range of sizing above and below the 24-inch diameter threshold.
- Developers may implement new gravity mainline and trunk sewer projects when negotiated with the District and/or the applicable partner city.

5.4.3.3 Programmatic Implementation

In addition to capacity-related improvements, the District engages in an RDI/I Abatement Program and a Repair and Replacement Program (R&R). These programs are mentioned in this TM and documented with additional detail in TM 6 – Conveyance Infiltration and Inflow Cost Effectiveness Analysis, TM 7 – Conveyance Improvement Alternatives Analysis, and TM 8 – Conveyance Capital Improvement Implementation Plan.

- An RDI/I Abatement or Rehabilitation Program is a common method to reduce capital expenditures when compared to conveyance and treatment expansion depending on the extent of RDI/I influence. Rates of RDI/I reduction through rehabilitation are highly variable and cost recovery for successful programs typically occur over many years. The most effective programs eliminate RDI/I contributions from a combination of main lines, lateral connections, and private laterals.

  The District currently has an RDI/I Abatement Program with partner cities and in unincorporated Washington County which includes:

  - District sponsored flow monitoring of high RDI/I areas.
  - Contribution of 50-percent of the cost of RDI/I reduction projects that include rehabilitation or replacement of mainlines and laterals within city jurisdictions.
  - Contribution of 100-percent of the cost of RDI/I reduction projects in unincorporated Washington County.
  - A requirement that the rehabilitation work extend to full repair or replacement of sewer laterals including the portion of the lateral on private property.
  - Application for grant funding from the State of Oregon (on a case-by-case basis).
- The District and the cities also have individual R&R Programs to extend the useful life of the sanitary conveyance system by repairing or replacing aging infrastructure. These programs are implemented based on the implementation agreement in Section 5.4.3. The R&R Programs proactively rehabilitate sewers prior to failure and consider structural and maintenance defects. There can be some overlap between the RDI/I Abatement Program and an R&R Program, as structural failures in a pipeline can

contribute to higher RDI/I rates. Additionally, the District proactively evaluates condition of pump station infrastructure to ensure system operational reliability and replacement of mechanical, electrical, controls, and structural assets within standards for remaining useful life.

5.5 System Wet Weather Capacity and Rainfall Derived Infiltration and Inflow Characterization

5.5.1 Existing Wet Weather Flow Impacts (2025)

Existing (2025) deficiencies by HGL code and subbasin RDI/I rates (per net acre) are presented in Figure 5.1 based on the West Basin design storms. Major system deficiencies are described below. Pump station peak hour influent flows compared to firm capacity are presented in Table 5.2 for 2025.

5.5.1.1 Existing (2025) System Wet Weather Capacity

Trunk sewers, tributary trunks, and pump stations that experience capacity limitations based on existing (2025) wet weather flow (WWF) conditions include:

Rock Creek Basin

- *Lower Rock Creek Trunk*: From manhole 6918 (adjacent to Rock Creek at the Dawson Trunk confluence) to the Rock Creek Wastewater Resource Recovery Facility (WRRF). The trunk is approximately 9,700 feet (72 to 84-inches) and up to 25 feet deep including significant surcharge capacity. Under 2025 system peak flows, the trunk is surcharged with greater than 10 feet of freeboard from the rim elevation. Surcharging causes backwater into the upstream Beaverton Creek Trunk which is deficient.
- *Beaverton Creek Trunk (Beaverton Trunk)*:
  - *Reach 1*: From manhole 10545 (near confluence of Beaverton Creek and Rock Creek, south of E Main St and west of SE 69th Ave) to manhole 6918 (near intersection of Patterson St at the confluence with the Dawson Trunk). This is the lower section of the trunk (72-inch, 4,700 feet) with depths up to 25 feet and significant surcharge capacity. Under 2025 system peak flows, the trunk is surcharged within 10 feet of the rim elevation.
  - *Reach 2*: From manhole 10553 (near SW 205th Ave and Beaverton Creek) to manhole 10545 (south of E Main St and east of NE Century Blvd). This is the middle-lower section of the trunk (66-inch, 7,200 feet) with depths up to 20 feet. Under 2025 system peak flow, the trunk is surcharged within 10 feet of the rim.
  - *Reach 3*. From manhole 6968 (west of SW Honeywood Dr adjacent to Beaverton Creek) to manhole 10553 (near 205th Ave adjacent to Beaverton Creek). This is the middle-upper section of the trunk (60-inch, 5,800 feet) with depths up to 25 feet. Under 2025 system peak flow, the trunk is surcharged within 10 feet of the rim typically, and within 3 feet of the rim for the shallow sections of the trunk sewer.
  - *Reach 4*. From manhole 55670 (near intersection of 170th Ave and Johnson St) to manhole 6968 (near intersection of Longacre St and Alderwood Dr. This is the upper section of the trunk (48 to 54-inches, 9,300 feet) with depths typically below 15 feet. Under 2025 system peak flow, the trunk is surcharged within 3 feet of the rim typically (limited capacity and backwater) with risk of overflows or pressure conditions for sealed manhole lids for shallow sections of the trunk.

- *Beaverton Creek Tributary*: From manhole 54855 (at intersection of SW 170th Ave an SW Blanton St) to manhole 55687 (at the confluence with the Beaverton Creek Trunk). The tributary is approximately 3,500 feet (10 to 15-inches) and impacted by backwater from the Beaverton Creek Trunk. Under 2025 system peak flow, the trunk is surcharged within 3 feet of the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The pipeline segments are partially located in the City of Beaverton and partially within unincorporated Washington County.
- *Johnson Creek Trunk and Tributaries*: From manhole 52313 (near intersection of SW 170th Ave and SW Rigert Rd) to manhole 55698 (near intersection of Tualatin Valley Hwy and 153rd Dr). The trunk and tributaries are approximately 16,500 feet (10 to 30-inches) and impacted by backwater from the Beaverton Creek Trunk. Under 2025 system peak flow, the trunk and tributaries are surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The pipeline segments are partially located in the City of Beaverton and partially within unincorporated Washington County.
- *Erickson Creek Trunk and Tributaries*: From manhole 20551 (near intersection of SW Wilson Ave and SW 27th St); also from manhole 87958 (SW Cypress Ln); deficient sections downstream to manhole 12463 (south of SW Millikan Way and east of SW 144th Ave, near Willow Park). The trunk and tributaries are approximately 8,300 feet (12 to 24-inches) and impacted by backwater from the Beaverton Creek Trunk. Under 2025 system peak flow, the trunk and tributaries are surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The pipeline segments are located in the City of Beaverton. The City is currently working on RDI/I rehabilitation in some of the deficient segments of the Erickson Creek Trunk and Tributaries.
- *Cedar Mill Tributary*: From manhole 1824 (near intersection of Huntington Ave and Lanewood St) to manhole 11640 (near intersection of Foothill Dr and Dellwood Ave). The tributary to the Cedar Mill Trunk is approximately 1,700 feet (10-inches). Under 2025 system peak flow, the tributary is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The pipeline segments are within the City of Beaverton.
- *Willow Creek Trunk and Tributaries*: From manhole 13441 (west of NW Bauer Woods Rd near Willow Creek) to manhole 2230 (near NW Bronson Rd); also from manhole 14955 (NW 138th Pl) to manhole 14952 (west of NW 141st Pl); also manhole 23961 (west of SW Alderwood Dr near Willow Creek) to manhole 6968 at confluence with the Beaverton Creek Trunk. The trunk and tributaries are approximately 10,700 feet (12 to 36-inches). The lower segments at the confluence with the Beaverton Creek Trunk are impacted by backwater. Under 2025 system peak flow, the upper tributaries are surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The trunk segments are surcharged within 10 feet of the rim elevation. The pipeline segments are partially located in the City of Beaverton and partially within unincorporated Washington County. Most of the deficient segments are within unincorporated Washington County.
- *Rock Creek Upper Tributaries* (adjacent to Bethany): From manhole 25173 (backlots and trail near NW Spartan Way) to manhole 5240 (backlots and trail near NW Kahneeta Dr). The upper tributaries are approximately 2,800 feet (12-inches) and discharge to the trunk at 24-inches. The lower segments at the confluence with the Beaverton Creek Trunk are impacted by backwater. Under 2025 system peak flow, the upper tributary is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids with some downstream tributary segments experiencing surcharge

from backwater within 10 feet of the rim elevation. The pipeline segments are in unincorporated Washington County.

- *Bronson Creek Trunk*: From manhole 55719 (on NW Laidlaw Rd east of NW 130th Ave) to manhole 6876 (near intersection of SW 205th Ave and NW Anzalone Dr). The trunk is approximately 18,300 feet (12 to 27-inch). The lower segments at the confluence with the Beaverton Creek Trunk are impacted by backwater with surcharge within 10 feet of the rim. The middle to upper segments are capacity deficient and impacted by backwater to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The pipeline segments are partially located in the City of Beaverton; however, most of the deficient segments are within unincorporated Washington County.
- *Minter Bridge Trunk and Tributaries*: From manhole 70320 (near intersection of Margaret Ln and Jean Ct, immediately downstream of Fir Grove PS) to manhole 12312 (south of SE River Rd, near Rock Creek WRRF). The trunk and tributaries are approximately 4,000 feet (8-inch to 18-inch). The trunk segments are surcharged within 10 feet of the rim elevation. The pipeline segments are located in the City of Hillsboro.
- *Turner Creek Trunk*:
  - *Reach 1*: From manhole 12318 (near intersection of Ripplewood Ave and Rosespring Dr) to manhole 12314 upstream of the confluence with the Lower Rock Creek Trunk; also overflow piping between manholes 9851 and 9866 (next to creek and Valley Memorial Park Cemetery). This is the lower section of the trunk (24 to 30-inch, 4,600 feet). Under 2025 system peak flows, the lower portion of the reach is surcharged within 10 feet of the rim elevation, and the upper portion of the reach is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The pipeline segments are located in the City of Hillsboro.
  - *Reach 2*: From manhole 12424 (near intersection of Main St and 18th Ave) to manhole 12318 (adjacent to intersection of Ripplewood Ave and Rosespring Dr, with Turner Creek Preserve area). This is the middle section of the trunk (18 to 24-inch, 6,600 feet). Under 2025 system peak flows, the reach is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The pipeline segments are located in the City of Hillsboro.
  - *Reach 3*. From manhole 20275 (near intersection of NE Delsey Rd and NE Grant St) to manhole 12424 (near intersection of E Main St east of NE 18th Ave). This is the upper section of the trunk (10 to 18-inch, 1,000 feet). Under 2025 system peak flows, the reach is surcharged to the rim elevation, partially due to backwater from Reach 2, with risk of overflows or pressure conditions for sealed manhole lids. The pipeline segments are located in the City of Hillsboro.
- *Turner Creek Tributaries*: From manhole 20161 (near intersection of SE Bentley St and SE 37th Ave) to manhole 20164 (SE 36th Ave); multiple additional locations. The tributaries (8 to 15-inch, 2000 feet+) are surcharged within 10 feet of the rim elevation, partially due to backwater from the Turner Creek Trunk. The pipeline segments are located in the City of Hillsboro.
- *Aloha (3) Pump Station*: The Aloha Pump Station currently experiences high inflow from the adjacent creek and upstream RDI/I. Influent flow is estimated at 16 million gallons per day (mgd). Actual influent flows due to creek influence may be higher. The theoretical firm capacity for this station is 19 mgd, but firm capacity performance based on field drawdown testing is closer to 15 mgd.
- *Aloha Trunk & Tributaries*: From manhole 8749 (near intersection of 179th Ave and Sumac Ln) to manhole 8631 & manhole 25668 to manhole 836010 (along Butternut Creek to near intersection of 198th Ave and Butternut St). The tributary (8-inch, 1,300 feet) is surcharged to the rim elevation,

partially due to backwater from the trunk, with risk of overflows or pressure conditions for sealed manhole lids. The trunk (24-inch, 3,400 feet) is surcharged within 10 feet of the rim elevation and for shallow segments is surcharged within 3 feet of the rim elevation. The Aloha Subbasin is located in unincorporated Washington County.

- *Cross Creek Pump Station*: The Cross Creek Pump Station currently experiences high upstream RDI/I. Influent flow is estimated at 1.8 to 1.9 mgd with a firm capacity of 1.4 mgd.
- *Cross Creek Tributary*: From manhole 22776 (near intersection of Applegate Dr and 205th Ter) to manhole 55971 (near intersection of Vinwood Ter and Skiver St). The tributary sewer (8 to 12-inch, 3,850 feet) is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The Cross Creek Subbasin is located in unincorporated Washington County.
- *Butternut Pump Station*: The Butternut Pump Station (downstream from the Cross Creek Pump Station) is deficient based on potential impacts from excess flows from Cross Creek. Influent flow is estimated at 2.3 mgd with a firm capacity of 2.0 mgd (if the Cross Creek Station flow is not limited by existing firm capacity).
- *Butternut Tributary*: From manhole 77594 (intersection of SW 209th Ave and SE Buttnernut Creek Pkwy) to 834456 (near intersection of SE 78th Ave and SE Butternut Creek Pkwy). The tributary trunk (8 to 15-inch, 2,300 feet) is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The 8-inch segments located intermittently between 15-inch segments should be field-verified. The pipelines are located in the City of Hillsboro.

Hillsboro Basin

- *Lower Hillsboro Trunk*: From manhole 12290 (near Tualatin Valley Hwy and Dairy Creek) to the Hillsboro WRRF Influent Pump Station (near S 1st Ave). The trunk (36-inch, 7,700 feet) is surcharged within 10 feet of the rim elevation and for shallow segments is surcharged within 3 feet of the rim elevation. Surcharging in the Lower Hillsboro Trunk causes the system to backup into the upstream Council Creek Trunk and McKay Creek Trunk. Although these upstream trunk sewers have adequate capacity based on pipe sizes, the backwater from the Lower Hillsboro Trunk causes a risk of overflows and limits capacity for future growth. The trunk sewer is located partially in the City of Hillsboro and partially in the Jackson Bottom Wetlands (owned by the District).
- *McKay Creek Tributary*: From manhole 20253 (near intersection of 15th Ave and Thomas St) to manhole 20303 (near intersection of NE Jackson School Rd and NE Baldwin Dr); also, manhole 68440 (backlot of NE Birchaire Ln) and manhole 12252 (NE Jackson School Rd and NE Arlington Rd). The tributary sewer (8 to 10-inch, 5,500 feet) is surcharged to the rim elevation. Surcharging is partially due to high RDI/I and limiting local capacity and partially due to backwater from the Lower Hillsboro Trunk and McKay Creek Trunk. The pipelines are located in the City of Hillsboro.
- *Banks Pump Station*: The Banks Pump Station influent flow is estimated at 1.6 mgd with a firm capacity of 1.0 mgd. The pump station is located in the City of Banks.
- *West Forest Grove Trunk*: From manhole 20370 (near Gales Creek Rd) to manhole 13204 (near intersection of Main St and Bonnie Ln). The trunk (12 to 18-inch, 10,000 feet) is surcharged within 10 feet of the rim elevation. The pipelines are located in the City of Forest Grove.

Forest Grove Basin

- *Cornelius Tributaries*: From manhole 19376 (N 14th Ave immediately north of Tualatin Valley Hwy) to manhole 802962 (S Dogwood St and S 12th Ave). The tributary sewer (8 to 10-inch, 1,900 feet) is surcharged within 10 feet of the rim elevation. The pipelines are located in the City of Cornelius and survey information was provided by the City to confirm pipeline slopes.

  Note: Projects in the City of Cornelius, from manhole 20034 (near intersection of S 20th Ave and Ginger St) to manhole 838434 (on S Kodiak Cir west of S 12th Ave) were completed in 2019 and 2020 and have recently been updated in the District model (2025) to reflect improved capacity (12-inch improved to 20 to 21-inch, 3,400 feet). These recently improved pipeline segments have adequate capacity for existing and future flows.

- *Forest Grove Tributaries and Trunks*:
  - *South Forest Grove*: From manhole 25137 (near intersection of 12th Ave. and Elm St.) to manhole 18903 (near intersection of 12th Ave. and Hawthorne St); also from manhole 20387 (near intersection of 18th Ave. and Juniper St) to manhole 17602 (near intersection of 13th Pl and Kingwood St). The tributary sewers (8-inch, 1,000 feet) and trunk sewer (18-inch, 1,700 feet) are surcharged within 10 feet of the rim elevation and influenced by high RDI/I.
  - *Southwest Forest Grove:* From manhole 19120 (near intersection of A St. and 18th Ave.) to manhole 22091 (near intersection of 19th Ave. and Birch St).; also from manhole 20409 (near intersection of 21st Ave. and Douglas St) to manhole 20391 (near intersection of 19th Ave. and Hawthorne St); also from manhole 20395 (near intersection of 18th Ave. and Filbert St.) to manhole 20387 (near intersection of 18th Ave. and Juniper St.); also from manhole 20444 (near intersection of Pacific Ave. and Laurel St.) to manhole 12717 (near intersection of 18th Ave. and Maple St). The tributary sewers (8 to 10-inch, 2,200 feet) and trunk sewer (15 to 18-inch, 1,800 feet) are surcharged within 10 feet of the rim elevation and influenced by high RDI/I.

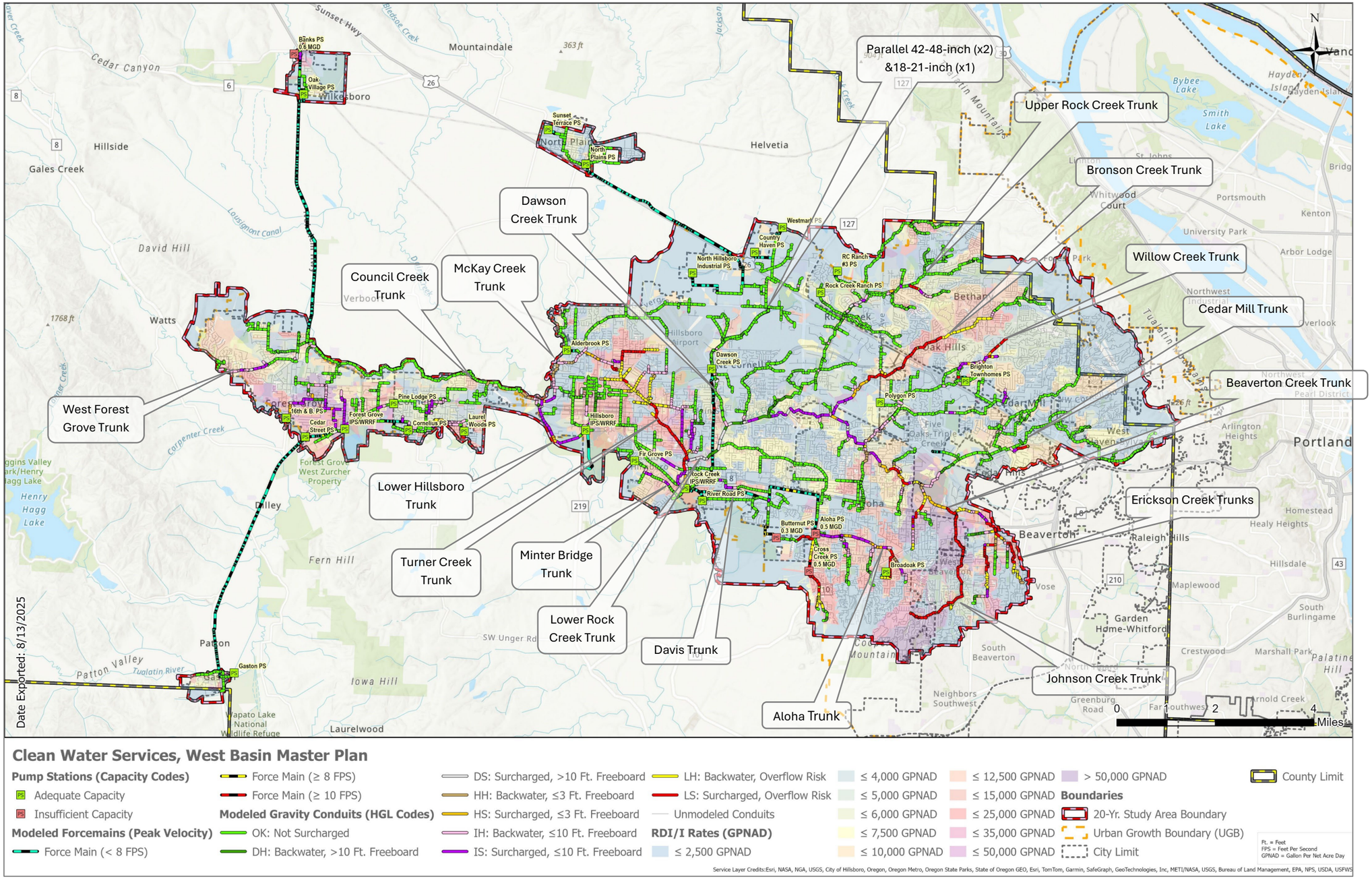


Figure 5.1 West Basin, 2025 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates); Trunk Name Reference.

Table 5.2 West Basin Pump Station Firm Capacity vs Influent Peak Hour Flow & Excess Firm Capacity (2025)

Pump Station	Basin	Firm Capacity (mgd)	2020 Peak Flow (mgd)	2025 Estimated Peak Flow (mgd)	Excess Firm Capacity (+) or Deficient Firm Capacity (-) (mgd)
16th & B. PS	Forest Grove	0.45	0.17	0.18	0.27
Cedar Street PS	Forest Grove	0.20	0.13	0.13	0.07
Cornelius PS	Forest Grove	8.40	4.14	4.36	4.04
Gaston PS	Forest Grove	0.85	0.78	0.79	0.06
Laurel Woods PS	Forest Grove	1.04	0.15	0.31	0.73
Pine Lodge PS	Forest Grove	0.43	0.33	0.34	0.09
Aloha PS[1]	Rock Creek	15.00	15.34	15.46	-0.46
Brighton Townhomes PS	Rock Creek	0.28	0.17	0.18	0.10
Broadoak PS	Rock Creek	0.14	0.07	0.07	0.07
Butternut PS	Rock Creek	2.00	2.13	2.31	-0.31
Country Haven PS	Rock Creek	0.20	0.003	0.07	0.13
Cross Creek PS	Rock Creek	1.40	1.83	1.88	-0.48
Dawson Creek PS	Rock Creek	18.00	9.13	11.94	6.06
Fir Grove PS	Rock Creek	0.74	0.70	0.72	0.02
North Hillsboro Industrial PS	Rock Creek	1.50	0.10	0.44	1.06
North Plains PS	Rock Creek	4.00	1.61	1.73	2.27
Polygon PS	Rock Creek	0.29	0.14	0.14	0.15
Rock Creek Ranch PS	Rock Creek	0.94	0.62	0.64	0.30
RC Ranch #3 PS	Rock Creek	0.24	0.10	0.10	0.14
River Road PS	Rock Creek	5.90	4.80	5.30	0.60
Sunset Terrace PS	Rock Creek	0.21	0.04	0.04	0.17
Westmark PS	Rock Creek	0.51	0.01	0.05	0.46
Alderbrook PS	Hillsboro	0.84	0.30	0.32	0.52
Banks PS	Hillsboro	1.00	1.52	1.59	-0.59
Oak Village PS	Hillsboro	1.40	0.59	0.59	0.81

[1]Aloha Pump Station has a manufacturer capacity of 19 mgd, but field drawdown testing indicates that the pump station is underperforming with a firm capacity of 15 mgd.

PS = pump station, mgd = million gallons per day, peak hour flow

5.5.1.2 System Attenuation and Relief

The trunk system in the Rock Creek Basin experiences significant attenuation particularly through the Beaverton Creek Trunk and the Lower Rock Creek Trunk. This means that when the system is surcharged significantly, the peak flow is delayed from the upstream tributary trunks and sewers to the downstream

trunk and treatment system. Additionally, upstream sanitary sewer overflow risk can be relieved from the downstream system. An example of the peak flow differential in the upstream Beaverton Creek Trunk is presented in Figure 5.2 illustrating peak flow without attenuation, peak flow with attenuation (significant surcharge storage), and peak flow if the manhole lids were not bolted down and flows were allowed to escape the system.

When the conveyance system is improved, some attenuation is removed from the system eliminating upstream deficiencies but potentially increasing downstream deficiencies for unimproved segments of pipe. When interpreting system deficiency mapping (see Figure 5.1), with existing infrastructure sizing, the greatest amount of attenuation is shown (greater impact upstream from stored peaks, lesser impact downstream). The manhole lids are also assumed to be bolted down to eliminate system relief.

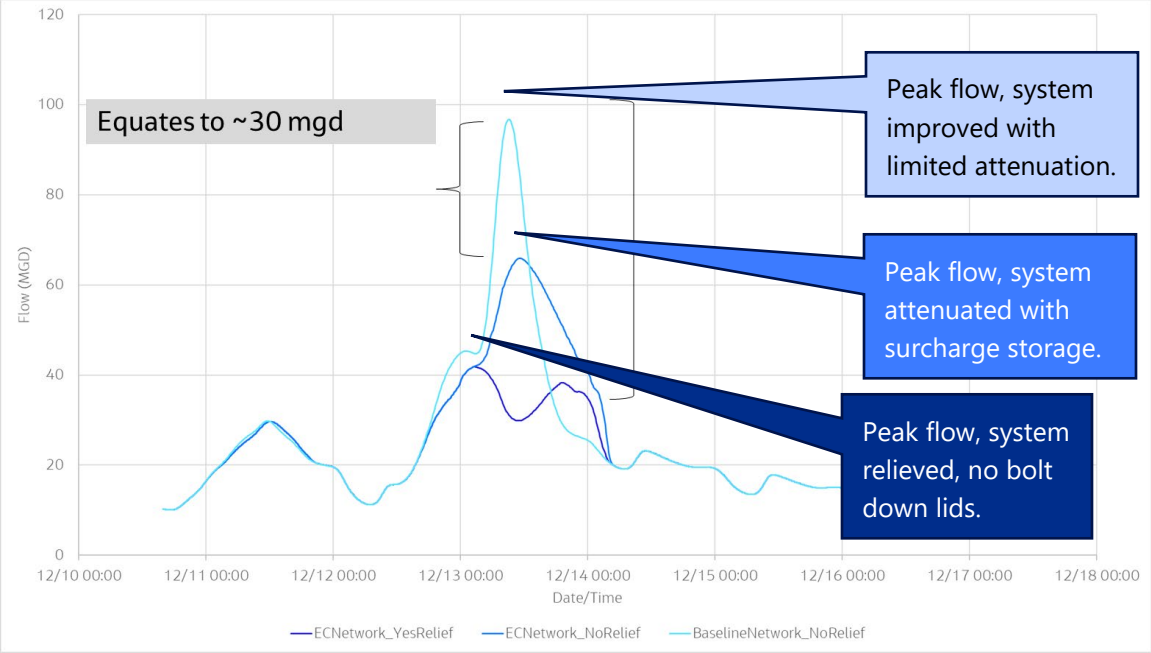


Figure 5.2 Peak Flow Example for the Beaverton Creek Trunk (without attenuation, with attenuation, with overflow relief, top to bottom)

5.5.1.3 Existing (2025) RDI/I Characterization

RDI/I characterization for the existing system with 2025 peak flows from the West Basin design storms include the following:

Rock Creek Basin

- Extremely high RDI/I (50,000 gpnad and greater) impacts the Erickson Creek Trunk and Tributaries, Johnson Creek Trunk and Tributaries, downstream Beaverton Creek Trunk and downstream Lower Rock Creek Trunk. Extremely high RDI/I areas are located within the City of Beaverton and unincorporated Washington County.
- High RDI/I (25,000 to 50,000 gpnad) impacts the Aloha Trunk and Tributaries, Aloha Pump Station, Cross Creek Tributary, Cross Creek Pump Station, Bronson Creek Trunk, and Turner Creek Trunk and

Tributaries. High RDI/I areas are located in the City of Hillsboro and unincorporated Washington County.

- Medium-High RDI/I (15,000 to 25,000 gpnad) impacts the Cedar Mill Tributary, Upper Rock Creek Tributary, and Minter Bridge Trunk and Tributaries. Medium-high RDI/I areas are located in the City of Beaverton, City of Hillsboro, and unincorporated Washington County.
- The remainder of the Rock Creek Basin is characterized by medium-low RDI/I (5,000 to 10,000 gpnad) and low RDI/I (2,500 to 5,000 gpnad). Developing industrial areas of north Hillsboro and developing residential/commercial areas of south Hillsboro are characterized with low RDI/I. The City of North Plains also experiences low RDI/I.

Hillsboro Basin

- Extremely high RDI/I (50,000 gpnad and greater) impacts the service area adjacent to the Banks Pump Station in the City of Banks.
- Most other piping in the City of Banks has been rehabilitated resulting in low RDI/I.
- High RDI/I (25,000 to 50,000 gpnad) impacts the Lower Hillsboro Trunk, and McKay Creek Trunk and Tributary within the City of Hillsboro.
- The City of Hillsboro has completed multiple phases of RDI/I abatement projects in their downtown system over the past decade. In the downtown area, RDI/I has been reduced from extremely high to high/moderate-high and alleviated overflow concerns in the local downtown sewers.
- Medium-high RDI/I (15,000 to 25,000 gpnad) impacts the West Forest Grove Trunk in the City of Forest Grove.
- The remainder of the Hillsboro Basin is characterized by medium-low RDI/I (5,000 to 10,000 gpnad) and low RDI/I (2,500 to 5,000 gpnad).

Forest Grove Basin

- Extremely high RDI/I (50,000 gpnad and greater) and high RDI/I (25,000 gpnad to 50,000 gpnad) impact the south and southwest Forest Grove Tributaries and the Forest Grove WRRF.
- The District has been working with the City of Forest Grove on three phases of RDI/I abatement and infrastructure rehabilitation in the downtown area. The success of the abatement projects is being evaluated over the next several winter seasons.
- High RDI/I (25,000 gpnad to 50,000 gpnad) impacts the City of Cornelius trunk system upstream of the Cornelius Pump Station and should be monitored. The remainder of the City of Cornelius is characterized by medium-low RDI/I (5,000 to 10,000 gpnad) and low RDI/I (2,500 to 5,000 gpnad).
- Most piping in the City of Gaston has been rehabilitated resulting in medium-low RDI/I.

5.5.2 Future (2045, 2075) Wet Weather Flow Impacts

Future deficiencies by HGL code are presented in Figure 5.3 and Figure 5.4 for the 2045 (20-year planning horizon) and 2075 (buildout planning horizon) for the West Basin design storms and applied to existing infrastructure capacity limitations. Additional system deficiencies (beyond impacts by 2025) are described below. Pump station peak hour influent flows compared to firm capacity for future conditions are presented in Tables 5.3 and 5.4 for future conditions.

Additional information is available in Appendix 5A which includes the following:

- Deficiency mapping for 5-year increments [2025 (repeat), 2030, 2035, 2040, 2045 (repeat) 2050, 2055, 2060 2065, 2070, 2075(repeat)]. 2025, 2045, and 2075 are also provided in the main body of this TM and repeated in the appendix.
- Deficiency mapping for climate intensified storm events (50-year impacts) for the 2075 buildout condition with increased precipitation depth/frequency and depth/frequency/intensity.
- A GIS dataset for more detailed review of system deficiency mapping and associated attributes during existing and future conditions.
- A spreadsheet hydraulic profile tool which can be used to show existing and future system deficiencies of the major interceptors, trunks, and all modeled pipelines during the West Basin design storms. An example profile is provided in the appendix for the Beaverton Creek and Lower Rock Creek Trunks.

The future deficiency maps present existing RDI/I rates. Future development RDI/I rates for the capacity assessment were capped at 2,500 gpnad and existing RDI/I rates lower than 4,000 gpnad were degraded to 4,000 gpnad. The RDI/I is heavily weighted to existing conditions for areas of high RDI/I and deficiencies are driven by a combination of future growth and existing RDI/I wet weather response. Future development includes both infill development and projected urban growth expansion areas (Urban Reserves) as identified in *Part 2, TM 2, Study Area Characteristics*.

5.5.2.1 Future (2045, 2075) System Wet Weather Capacity Characterization

The future system capacity characterization is described below for 2045, 2075, and 2075 with climate intensification for peak wet weather flows.

Rock Creek Basin Existing System Deficiencies with Increased Impact from Future Flows

- *Lower Rock Creek Trunk*: By 2045 and 2075 (with and without climate intensification), the trunk is surcharged with greater than 10 feet of freeboard from the rim elevation. Surcharging causes significant backwater into the upstream Beaverton Creek Trunk. With upstream improvements to the Beaverton Creek Trunk, the Lower Rock Creek Trunk will experience additional peak flow impacts (attenuation removal) causing potential overflows by 2050.
- *Beaverton Creek Trunk (Beaverton Trunk)*:
  - *Reach 1*: By 2045, the lower section of the trunk is typically surcharged within 10 feet of the rim elevation, and the shallowest segments are surcharged within 3 feet of the rim elevation, increasing potential for overflows. By 2075 (with and without climate intensification), significant segments are surcharged within 3 feet of the rim elevation generating additional backwater into the upstream reaches of the Beaverton Creek Trunk system.
  - Reach 2: By 2045, the middle-lower section of the trunk is typically surcharged within 10 feet of the rim elevation, and the shallowest segments are surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. Surcharging and associated backwater have a significant impact on the upstream system capacity. By 2075 (with and without climate intensification, most of the reach is surcharged to the rim elevation and pressurized with risk of overflows.
  - *Reach 3*. By 2045, the middle-upper section of the trunk is typically surcharged within 3 feet of the rim elevation, and the shallowest segments are surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. Surcharging has a significant impact on

the upstream system capacity. By 2075 (with and without climate intensification, most of the reach is surcharged to the rim elevation with severe risk of overflows.

  - *Reach 4*. By 2045, the upper section of the trunk is typically surcharged within 3 feet of the rim elevation, and the shallowest segments are surcharged to the rim with risk of overflows or pressure conditions for sealed manhole lids. Surcharging has a significant impact on the upstream system capacity in the Johnson Creek Trunk and Tributaries, Erickson Creek Trunk and Tributaries, and Beaverton Creek Tributary. By 2075 (with and without climate intensification, most of the reach is surcharged to the rim elevation with severe risk of overflows.

- *Beaverton Creek Tributary*: By 2045 and 2075 (with and without climate intensification), the tributary trunk is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The tributary trunk is impacted by backwater from the Beaverton Creek Trunk.
- *Johnson Creek Trunk and Tributaries*: By 2045 and 2075 (with and without climate intensification) the tributary trunk is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The tributary trunk is impacted by backwater from the Beaverton Creek Trunk.
- *Erickson Creek Trunk and Tributaries*: By 2045 and 2075 (with and without climate intensification) the tributary trunk is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The tributary trunk is impacted by backwater from the Beaverton Creek Trunk.
- *Cedar Mill Tributary*: By 2045, the tributary is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids similar to 2025 conditions. By 2075, a significant length of the trunk and additional tributaries are surcharged within 10 feet of the rim. With climate intensification the shallow sections of the trunk are surcharged within 3 feet of the rim elevation, and the tributaries are surcharged to the rim elevation with risk of overflows. The trunk is impacted by backwater from the Beaverton Creek Trunk.
- *Willow Creek Trunk and Tributaries*: By 2045, the upper tributaries are surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The upper trunk is surcharged within 10 feet of the rim. The lower trunk is surcharged within 10 feet of the rim elevation. By 2075 (with and without climate intensification) the trunk and tributaries are surcharged to the rim elevation with risk of overflows. The trunk system is impacted by backwater from the Beaverton Creek Trunk.
- *Rock Creek Upper Tributaries* (adjacent to Bethany): By 2045, the upper tributary is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids with some downstream tributary segments experiencing surcharge from backwater within 10 feet of the rim elevation similar to 2025 conditions. By 2075, the lower trunk experiences backwater from the Beaverton Creek Trunk resulting in surcharge within 10 feet of the rim elevation. With climate intensification, there is a greater backwater impact resulting in surcharging within 3 feet of the rim. Additional tributary segments are also under capacity with surcharge within 10 feet of the rim elevation with climate intensification.
- *Bronson Creek Trunk*: By 2045 and 2075 (with and without climate intensification) the trunk is extensively surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. The trunk is also impacted by backwater from the Beaverton Creek Trunk.
- *Minter Bridge Trunk and Tributaries*: By 2045, the trunk segments are surcharged within 10 feet of the rim elevation similar to 2025 conditions. By 2075, some segments of the trunk are surcharge to the

rim elevation with risk of overflows or pressure conditions for sealed manhole lids. With climate intensification, additional segments are at risk of overflow.

- *Turner Creek Trunk*: By 2045 and 2075 (with and without climate intensification) all reaches of the trunk are extensively surcharged to the rim elevation with risk of overflows and significant pressure conditions for sealed manhole lids.
- *Turner Creek Tributaries*: By 2045 and 2075 (with and without climate intensification), many of the tributaries are surcharged to the rim elevation with risk of overflows largely due to backwater from the Turner Creek Trunk.
- *Aloha (3) Pump Station*: By 2045, the Aloha Pump Station is 1 mgd deficient and by 2075 the pump station is 2 mgd deficient. Climate intensification generates up to a 4 mgd deficiency if the upstream trunk and tributary sewers can convey higher RDI/I.
- *Aloha Trunk & Tributaries*: By 2045, trunk is surcharged to within 3 feet or the rim elevation and the upper tributaries are surcharged to the rim elevation with risk of overflows or pressure conditions for sealed lids. By 2075 (with and without climate intensification), the trunk and tributaries are significantly surcharged to the rim elevation with risk of overflows.
- *Cross Creek Pump Station*: By 2045, the Cross Creek Pump Station is 0.8 mgd deficient and by 2075 (with and without climate intensification) the pump station is 3 mgd deficient. The deficiency is generated in part by high RDI/I and in part by impacts of growth in North Cooper Mountain. If North Cooper Mountain is served through alternate routes, the Cross Creek Pump Station deficiencies will be consistent with 2025 peak flow conditions.
- *Cross Creek Tributary*: By 2045 and 2075 (with and without climate intensification), The tributary sewer is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids.
- *Butternut Pump Station*: By 2045, the Butternut Pump Station is 0.7 mgd deficient and by 2075 (with and without climate intensification) the pump station is 3 mgd deficient. The deficiency is identified with Cross Creek Pump Station discharging into the Butternut Tributary sewer.
- *Butternut Tributary*: By 2045 and 2075 (with and without climate intensification), The tributary sewer is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids.

Rock Creek Basin Additional System Deficiencies due to Future Flows

- *Jacobson/Helvetia, Bendemeer Trunk*: From manhole 75054 (near intersection of Westmark Dr and Croeni Ave) to manhole 63607 (near intersection of Century Blvd and Five Oaks Dr); also, Country Haven Pump Station discharge to manhole 13786. By 2045, the trunks (12 to 18-inch, 4,600 feet) are surcharged within 10 feet of the rim elevation. By 2075 (with and without climate intensification), the trunks are surcharged to the rim elevation with risk of overflows. The capacity deficiency is due to industrial growth in the trunk service area.
- *Country Haven Pump Station (future Jacobson Pump Station and Force Main)*: The Country Haven Pump Station has 0.2 mgd firm capacity and is deficient by 0.2 mgd by 2045, 2.3 mgd by 2075, and up to 2.8 mgd with climate intensification. The District is planning to replace the pump station with a higher capacity pump station and new force main (Jacobson Pump Station) to support service area growth. The new pump station will also allow the District to decommission the West Mark Pump Station. Deficiencies do not reflect the additional flow from the West Mark Pump Station.

- *North Industrial Pump Station, Force Main, Gravity:* The North Industrial Pump Station has a firm capacity of 1.5 mgd. The District intends to expand the capacity of the station and build a second force main to support industrial growth. The pump station is deficient by 1.7 mgd by 2045 and 2075 (with and without climate intensification); however, this number could increase or decrease depending on the type of industrial development. The downstream trunk, from manhole 827851 (NE Starr Blvd south of NE Huffman St) to manhole 26519 (east of NE Huffman St and NE 59th Ave, 24-inch, 6200 feet) is surcharged within 10 feet of the rim elevation by 2045 and to the rim elevation by 2075 (with and without climate intensification). The existing 10-inch force main discharges to the trunk sewer. Future plans for the pump station expansion include a second force main that will bypass critical sections of the downstream trunk eliminating the surcharging deficiencies.
- *Dawson Creek Pump Station:* The Dawson Creek Pump Station has a firm capacity of 18 mgd and is deficient by 14 mgd by 2045, 20 mgd by 2075, and 24 mgd with climate intensification. The deficiency will be partially resolved by planned expansion of the pump station to 27.5 mgd firm capacity. The remaining flow deficiency will be diverted to the Dawson Creek Trunk.
- *Dawson Creek Trunk:* From manhole 6895 (near intersection of NE Brookwood Pkwy and NE Veterans Dr) to manhole 6916 (at confluence with Beaverton Trunk and Lower Rock Creek Trunk at Rock Creek). The trunk sewer (24 to 27-inch, 6,200 feet) is surcharged within 10 feet of the rim elevation by 2045 and 2075 (with and without climate intensification). The deficiencies will increase (surcharge to rim elevation with risk of overflow) with additional flow diverted to the Dawson Creek Trunk from the Dawson Creek Pump Station Diversion.
- *Parallel 42 to 48-inch (x2) + 18 to 20-inch (x1):* From manholes 26512, 26525, and 72369 (near NE Evergreen Pkwy and immediately north of N Support Rd) to the Dawson Pump Station Diversion (south of NE Cornell Road near NE Brookwood Pkwy). The trunks include three pipelines (~10,000 feet each). By 2045, the trunks are surcharged to within the rim elevations in the upstream segments and within 10 feet of rim elevations in the downstream segments. The surcharging in the trunks is caused by backwater due to limiting capacity in the downstream Dawson Creek Pump Station and Dawson Creek Trunk. These deficiencies will be resolved with improvements to downstream capacity. In 2075 (with and without climate intensification), the length of sewer impacted by surcharging to the rim elevation increases prior to downstream improvements.
- *North Plains Pump Station:* The North Plains Pump Station has a 4 mgd firm capacity and is deficient by 0.4 mgd by 2045, 1.3 mgd by 2075, and 2 mgd with climate intensification. The District will study the North Plains service area in more detail if new areas come into the City's UGB.

<u>Hillsboro Basin Existing System Deficiencies with Increased Impact from Future Flows</u>

- *Lower Hillsboro Trunk*: By 2045, the trunk is surcharged within 3 feet of the rim elevation and for shallow segments is surcharged to the rim elevation. By 2075 (with and without climate intensification), the trunk is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids. Surcharging in the Lower Hillsboro Trunk causes the system to back up substantially into the upstream Council Creek Trunk and McKay Creek Trunk also generating risk of overflows.
- *McKay Creek Tributary* By 2045 and 2075 (with and without climate intensification), the tributary sewer is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids.

- *Banks Pump Station*: By 2045, the Banks Pump Station is 0.7 mgd deficient and by 2075 (with and without climate intensification) the pump station is greater than 3.5 mgd deficient. The deficiency assumes growth areas within the City may be routed to the pump station.
- *West Forest Grove Trunk*: By 2045, the upper trunk is surcharged to the rim elevation with risk of overflows or pressure conditions for sealed manhole lids and the lower trunk is surcharged within 10 feet of the rim elevation. By 2075 (with and without climate intensification), a more significant length of the trunk (upper and lower) is surcharged to the rim elevation.

Hillsboro Basin Additional System Deficiencies due to Future Flows

- *Oak Village Pump Station*: The Oak Village Pump Station has a firm capacity of 1.4 mgd and is deficient by up to 0.2 mgd by 2075 (with and without climate impacts). The District is reconfiguring the pump station service upstream to better serve growth and utilize available capacity in the near-term.
- *McKay Creek Trunk*: From manhole 12242 (near NW Glencoe Rd and Ne Harewood St) to manhole 12290 (near Dairy Creek at the confluence of the Lower Hillsboro Trunk and south of SW Tualatin Hwy). The trunk (30-inch, 9,500 feet) is impacted by backwater from the Lower Hillsboro Trunk with surcharging/backwater to the rim elevation by 2045 and 2075 (with and without climate intensification) causing risk of overflows.
- *Council Creek Trunk*: From manhole 13199 (near Sunset Dr and Hwy 47) to manhole 12290 (near Dairy Creek at the confluence of the Lower Hillsboro Trunk and south of SW Tualatin Hwy). The trunk (42 to 48-inch, 32,000 feet) is impacted by backwater from the Lower Hillsboro Trunk with surcharging/backwater to the rim elevation by 2045 and 2075 (with and without climate intensification) causing risk of overflows.

Forest Grove Basin Existing System Deficiencies with Increased Impact from Future Flows

- *Cornelius Tributaries*: By 2045 and 2075 (with and without climate intensification), the tributaries are surcharged within 10 feet of the rim elevation similar to 2025 conditions.
- *Forest Grove Tributaries and Trunks*: By 2045 and 2075 (with and without climate intensification), the tributaries and trunks are surcharged within 10 feet of the rim elevation similar to 2025 conditions.

Forest Grove Basin Additional System Deficiencies due to Future Flows

- *Gaston Pump Station*: The Gaston Pump Station has a 0.85 mgd firm capacity and is deficient by 0.1 mgd by 2045 and 0.2 mgd by 2075 (with and without climate intensification)

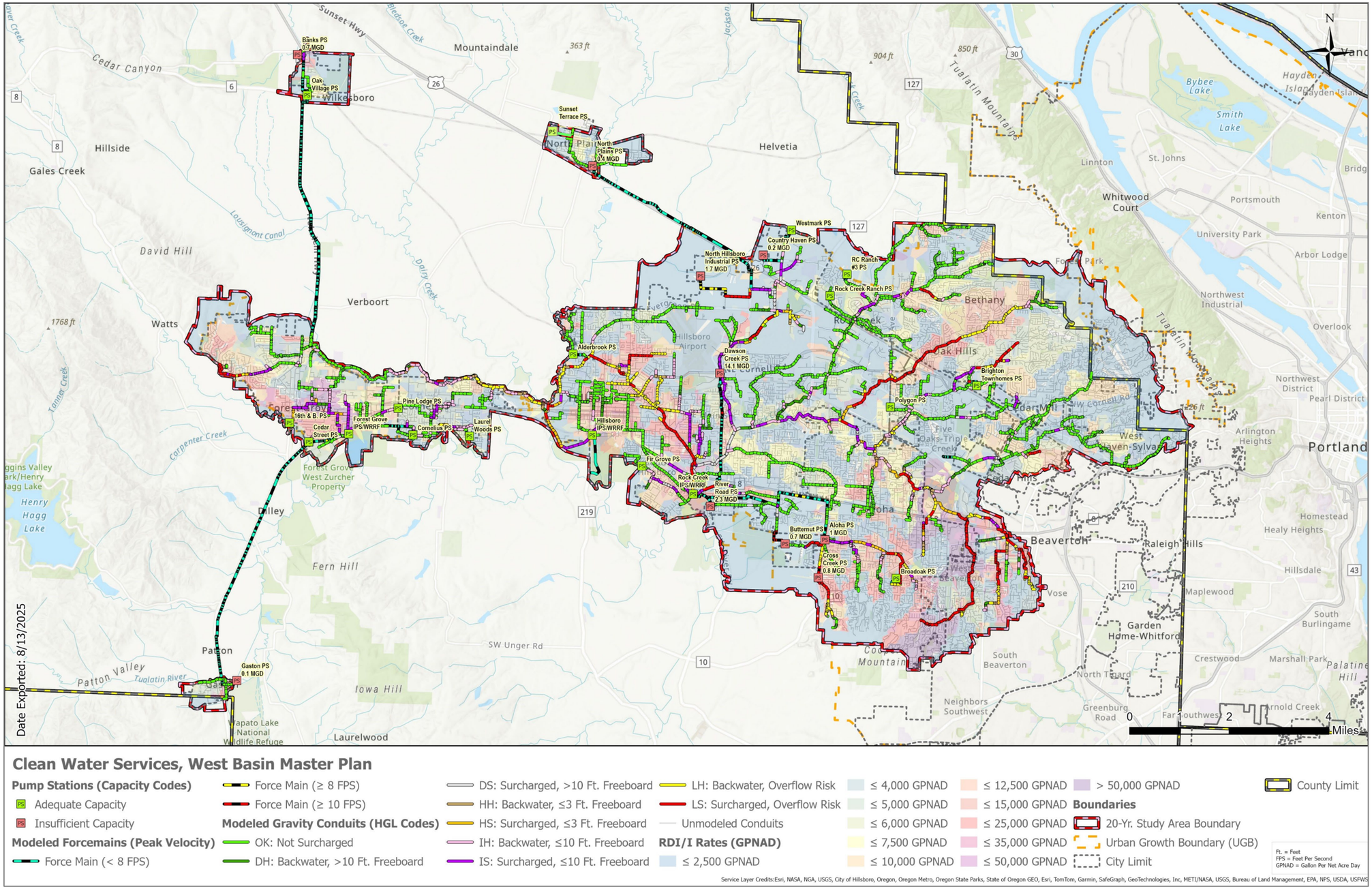


Figure 5.3 West Basin, 2045 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)

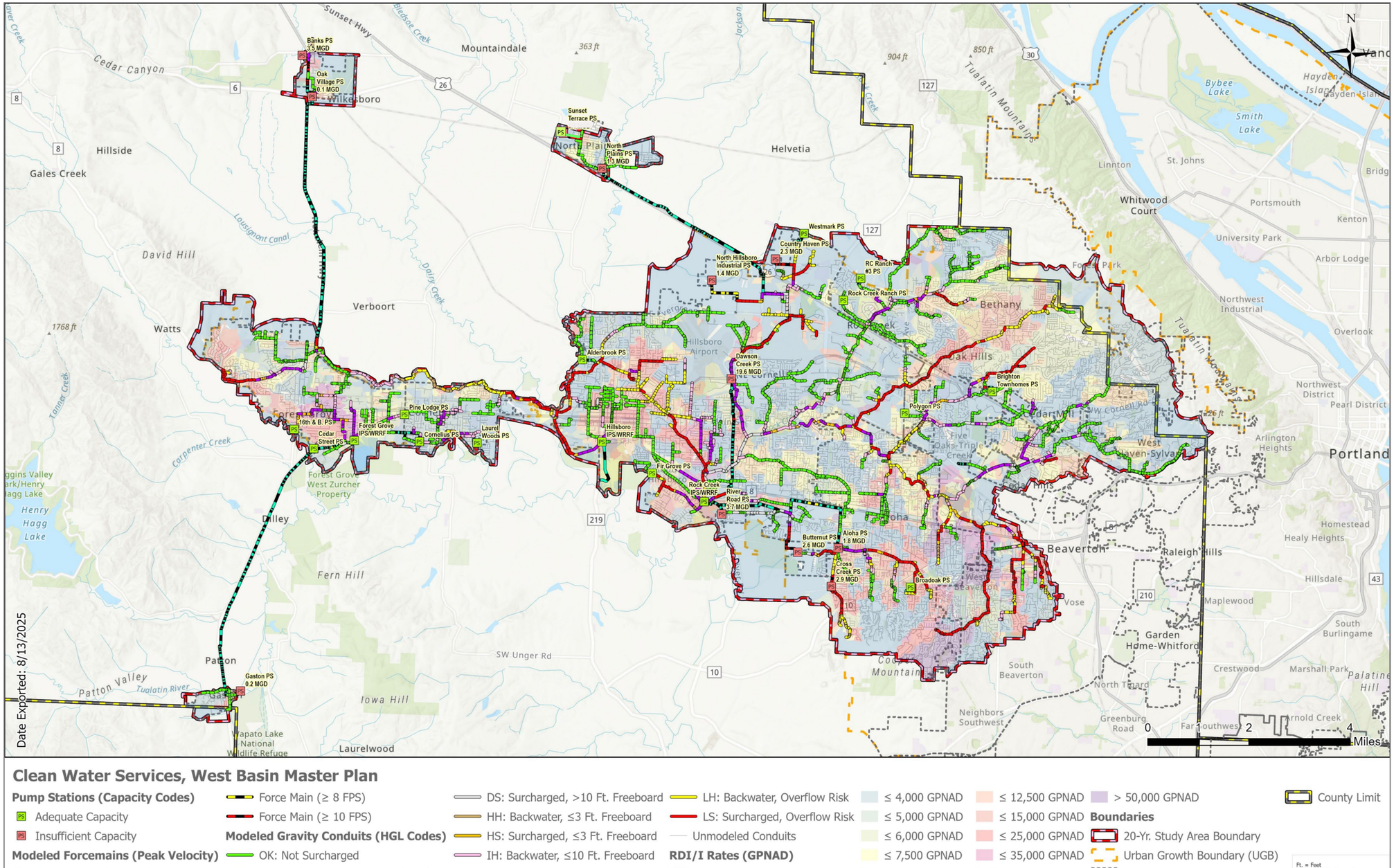


Figure 5.4 West Basin, 2075 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)

Table 5.3 West Basin Pump Station Firm Capacity vs Influent Peak Hour Flow (Future Flow Conditions)

Pump Station	Basin	Firm Capacity (mgd)	2025 Estimated Peak Flow (mgd)	2030 Estimated Peak Flow (mgd)	2035 Estimated Peak Flow (mgd)	2040 Estimated Peak Flow (mgd)	2045 Estimated Peak Flow (mgd)	2050 Estimated Peak Flow (mgd)	2055 Estimated Peak Flow (mgd)	2060 Estimated Peak Flow (mgd)	2065 Estimated Peak Flow (mgd)	2070 Estimated Peak Flow (mgd)	2075 Estimated Peak Flow (mgd)	2075 (Design Storm + frequency/ depth) Estimated Peak Flow (mgd)	2075 (Design Storm + frequency/ depth/intensity) Estimated Peak Flow (mgd)
16th & B. PS	Forest Grove	0.45	0.18	0.20	0.21	0.23	0.25	0.26	0.27	0.29	0.31	0.32	0.34	0.35	0.40
Cedar Street PS	Forest Grove	0.20	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16
Cornelius PS	Forest Grove	8.40	4.36	4.47	4.50	4.53	4.56	5.78	6.03	6.27	6.50	6.74	6.97	7.04	7.32
Gaston PS	Forest Grove	0.85	0.79	0.81	0.83	0.90	0.98	0.99	1.00	1.02	1.03	1.04	1.06	1.08	1.08
Laurel Woods PS	Forest Grove	1.04	0.31	0.33	0.35	0.37	0.39	0.40	0.42	0.44	0.46	0.48	0.50	0.51	0.56
Pine Lodge PS	Forest Grove	0.43	0.34	0.34	0.35	0.35	0.36	0.36	0.36	0.37	0.37	0.38	0.39	0.40	0.41
Aloha PS[1]	Rock Creek	15.00	15.46	15.58	15.73	15.87	15.99	16.11	16.22	16.34	16.47	16.60	16.75	17.07	19.18
Brighton Townhomes PS	Rock Creek	0.28	0.18	0.18	0.18	0.18	0.18	0.18	0.19	0.19	0.19	0.19	0.19	0.19	0.20
Broadoak PS	Rock Creek	0.14	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08
Butternut PS[2]	Rock Creek	2.00	2.31	2.41	2.60	2.75	2.75	3.73	3.90	4.07	4.24	4.41	4.58	4.64	4.95
Country Haven PS[3]	Rock Creek	0.20	0.07	0.19	0.31	0.37	0.39	1.53	1.73	1.93	2.13	2.32	2.53	2.58	3.02
Cross Creek PS[2]	Rock Creek	1.40	1.88	1.94	2.09	2.22	2.22	3.32	3.52	3.72	3.93	4.13	4.35	4.41	4.78
Dawson Creek PS[4]	Rock Creek	18.00	11.94	19.81	26.76	30.18	32.10	34.60	35.33	35.82	36.32	36.94	37.63	38.00	42.10
Fir Grove PS	Rock Creek	0.74	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
North Hillsboro Industrial PS	Rock Creek	1.50	0.44	1.68	2.54	2.88	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21
North Plains PS	Rock Creek	4.00	1.73	2.53	3.77	4.35	4.43	4.73	4.84	4.96	5.07	5.19	5.33	5.39	5.99
Polygon PS	Rock Creek	0.29	0.14	0.14	0.15	0.15	0.16	0.16	0.17	0.18	0.18	0.19	0.20	0.20	0.22
Rock Creek Ranch PS	Rock Creek	0.94	0.64	0.66	0.68	0.70	0.72	0.74	0.76	0.78	0.81	0.83	0.87	0.88	1.03
RC Ranch #3 PS	Rock Creek	0.24	0.10	0.10	0.14	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.20
River Road PS[5]	Rock Creek	5.90	5.30	5.45	6.44	7.35	7.35	8.14	8.24	8.36	8.47	8.56	8.70	8.82	9.63
Sunset Terrace PS[6]	Rock Creek	0.21	0.04	0.53	1.46	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90
Westmark PS	Rock Creek	0.51	0.05	0.13	0.18	0.18	0.19	0.19	0.20	0.21	0.21	0.22	0.23	0.23	0.24
Alderbrook PS	Hillsboro	0.84	0.32	0.35	0.37	0.39	0.41	0.50	0.54	0.58	0.61	0.65	0.69	0.70	0.71
Oak Village PS	Hillsboro	1.00	1.59	1.59	1.59	1.65	1.71	3.08	3.35	3.63	3.90	4.18	4.46	4.53	4.85
Banks PS	Hillsboro	1.40	0.59	0.59	0.60	0.73	0.87	1.18	1.24	1.30	1.36	1.42	1.48	1.51	1.55

[1]Aloha Pump Station has a manufacturer's capacity of 19 mgd, but field drawdown testing indicates that the pump station is underperforming with a firm capacity of 15 mgd.

[2]Butternut Pump Station flows prior to any flow diversion from decommissioning Cross Creek Pump Station.

[3]Country Have Pump Station to be replaced by Jacobson Pump Station.

[4]Dawson Creek Pump Station deficiency reflects combination of deficiency in the Dawson Creek Pump Station and Dawson Creek Trunk.

[5]River Road Pump Station firm capacity prior to installation of additional pump in open pump slot.

[6]Sunset Terrace Pump Station capacity deficiency based on early analysis of UGB Expansion in the City of North Plains. UGB Expansion adoption is currently being re-evaluated and could result in no capacity deficiency for the Sunset Terrace PS (August 2025).

PS = Pump Station, mgd = million gallons per day, peak hour flow

Table 5.4 West Basin Pump Station Excess Available Firm Capacity [Future Flow Conditions, Excess Firm Capacity (+), Deficient Firm Capacity (-)]

Pump Station	Basin	Firm Capacity (mgd)	2025 Excess/ Deficient Capacity (mgd)	2030 Excess/ Deficient Capacity (mgd)	2035 Excess/ Deficient Capacity (mgd)	2040 Excess/ Deficient Capacity (mgd)	2045 Excess/ Deficient Capacity (mgd)	2050 Excess/ Deficient Capacity (mgd)	2055 Excess/ Deficient Capacity (mgd)	2060 Excess/ Deficient Capacity (mgd)	2065 Excess/ Deficient Capacity (mgd)	2070 Excess/ Deficient Capacity (mgd)	2075 Excess/ Deficient Capacity (mgd)	2075 (Design Storm + frequency/ depth) Excess/ Deficient Capacity (mgd)	2075 (Design Storm + frequency/ depth/ intensity) Excess/ Deficient Capacity (mgd)
16th & B. PS	Forest Grove	0.45	0.27	0.25	0.24	0.22	0.20	0.19	0.18	0.16	0.14	0.13	0.11	0.11	0.05
Cedar Street PS	Forest Grove	0.20	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.04	0.04
Cornelius PS	Forest Grove	8.40	4.04	3.93	3.90	3.87	3.84	2.62	2.37	2.13	1.90	1.66	1.43	1.36	1.08
Gaston PS	Forest Grove	0.85	0.06	0.04	0.02	-0.05	-0.13	-0.14	-0.15	-0.17	-0.18	-0.19	-0.21	-0.23	-0.23
Laurel Woods PS	Forest Grove	1.04	0.73	0.71	0.69	0.67	0.65	0.64	0.62	0.60	0.58	0.56	0.54	0.53	0.48
Pine Lodge PS	Forest Grove	0.43	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.05	0.04	0.04	0.02
Aloha PS[1]	Rock Creek	15.00	-0.46	-0.58	-0.73	-0.87	-0.99	-1.11	-1.22	-1.34	-1.47	-1.60	-1.75	-2.07	-4.18
Brighton Townhomes PS	Rock Creek	0.28	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.08
Broadoak PS	Rock Creek	0.14	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06
Butternut PS[2]	Rock Creek	2.00	-0.31	-0.41	-0.60	-0.75	-0.75	-1.73	-1.90	-2.07	-2.24	-2.41	-2.58	-2.64	-2.95
Country Haven PS[3]	Rock Creek	0.20	0.13	0.01	-0.11	-0.17	-0.19	-1.33	-1.53	-1.73	-1.93	-2.12	-2.33	-2.38	-2.82
Cross Creek PS[2]	Rock Creek	1.40	-0.48	-0.54	-0.69	-0.82	-0.82	-1.92	-2.12	-2.32	-2.53	-2.73	-2.95	-3.01	-3.38
Dawson Creek PS[4]	Rock Creek	18.00	6.06	-1.81	-8.76	-12.18	-14.10	-16.60	-17.33	-17.82	-18.32	-18.94	-19.63	-20.00	-24.10
Fir Grove PS	Rock Creek	0.74	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
North Hillsboro Industrial PS	Rock Creek	1.50	1.06	-0.18	-1.04	-1.38	-1.71	-1.71	-1.71	-1.71	-1.71	-1.71	-1.71	-1.71	-1.71
North Plains PS	Rock Creek	4.00	2.27	1.47	0.23	-0.35	-0.43	-0.73	-0.84	-0.96	-1.07	-1.19	-1.33	-1.39	-1.99
Polygon PS	Rock Creek	0.29	0.15	0.15	0.14	0.14	0.13	0.13	0.12	0.11	0.11	0.10	0.09	0.09	0.07
Rock Creek Ranch PS	Rock Creek	0.94	0.30	0.28	0.26	0.24	0.22	0.20	0.18	0.16	0.13	0.11	0.07	0.06	-0.09
RC Ranch #3 PS	Rock Creek	0.24	0.14	0.14	0.10	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.04
River Road PS[5]	Rock Creek	5.90	0.60	0.45	-0.54	-1.45	-1.45	-2.24	-2.34	-2.46	-2.57	-2.66	-2.80	-2.92	-3.73
Sunset Terrace PS[6]	Rock Creek	0.21	0.17	-0.32	-1.25	-1.69	-1.69	-1.69	-1.69	-1.69	-1.69	-1.69	-1.69	-1.69	-1.69
Westmark PS	Rock Creek	0.51	0.46	0.38	0.33	0.33	0.32	0.32	0.31	0.30	0.30	0.29	0.28	0.28	0.27
Alderbrook PS	Hillsboro	0.84	0.52	0.49	0.47	0.45	0.43	0.34	0.30	0.26	0.23	0.19	0.15	0.14	0.13
Oak Village PS	Hillsboro	1.00	-0.59	-0.59	-0.59	-0.65	-0.71	-2.08	-2.35	-2.63	-2.90	-3.18	-3.46	-3.53	-3.85
Banks PS	Hillsboro	1.40	0.81	0.81	0.80	0.67	0.53	0.22	0.16	0.10	0.04	-0.02	-0.08	-0.11	-0.15

[1]Aloha Pump Station has a manufacturer's capacity of 19 mgd, but field drawdown testing indicates that the pump station is underperforming with a firm capacity of 15 mgd.

[2]Butternut Pump Station flows prior to any flow diversion from decommissioning Cross Creek Pump Station.

[3]Country Have Pump Station to be replaced by Jacobson Pump Station.

[4]Dawson Creek Pump Station deficiency reflects combination of deficiency in the Dawson Creek Pump Station and Dawson Creek Trunk.

[5]River Road Pump Station firm capacity prior to installation of additional pump in open pump slot.

[6]Sunset Terrace Pump Station capacity deficiency based on early analysis of UGB Expansion in the City of North Plains. UGB Expansion adoption is currently being re-evaluated and could result in no capacity deficiency for the Sunset Terrace PS (August 2025).

PS = Pump Station, mgd = million gallons per day, peak hour flow

5.6 System Dry Weather Capacity Characterization

Dry weather flow (DWF) conditions do not typically cause sanitary sewer overflows; however, pipelines should operate without surcharge during low rainfall conditions and non-rainfall conditions to allow odors to move downstream to pump stations and treatment facilities where odor control infrastructure is available. Additionally, 20 percent of the pipeline depth is typically reserved for higher rainfall periods for mainlines and tributaries. Often, larger trunk lines are sized to allow up to 50 percent of the pipeline depth for higher rainfall periods from the collective upstream service area. Depth to diameter (d/D) ratio is the typical metric used to understand limiting dry weather flow capacity with a value exceeding 0.8 d/D (less than 20 percent reserve capacity) as the metric to define a dry weather flow deficiency.

5.6.1 Depth to Diameter Ratio, Dry Weather Capacity

System capacity (d/D during wintertime dry weather conditions representing some influence from groundwater infiltration are presented in Figures 5.5, 5.6, and 5.7 for 2025, 2045, and 2075 respectively. Dry weather capacity for the system is characterized as follows:

- *2025 Dry weather capacity*: During 2025 dry weather flow conditions, the system typically operates at 60-percent full or less (d/D =< 0.6) including the Beaverton Creek Trunk and the Turner Creek Trunk. There are a few exceptions as described below.
  - Dawson Creek Trunk: The Dawson Creek Pump Station Diversion Structure splits flow between the pump station and the Dawson Creek Trunk. The orifice gate to the Dawson Creek Trunk is set to allow continuous flows at approximately 70 to 80-percent flow depth (d/D = 0.7-0.8) with excess flow diverted to the pump station. This operation intentionally isolates larger industrial flows to the gravity system vs the pump station.
  - *Lower Rock Creek Trunk*: The Rock Creek WRRF Influent Pump Station is set during dry weather conditions to an energy efficiency mode, where wastewater can back up into the Lower Rock Creek Trunk and fill the pipe to full (d/D = 1). This mode also allows for equalization storage in the conveyance system to generate more uniform flow and load conditions to the treatment facility. The District is monitoring impact of storing wastewater in the concrete trunk sewer for potential corrosion, hydrogen sulfide gases, and infrastructure degradation.
  - *Lower Hillsboro Trunk*: The trunk sewer operates at 60 to70-percent flow depth (d/D = 0.6-0.7). This is an indication that the trunk sewer has limited capacity for future growth.
  - *Miscellaneous Areas*: There are some localized segments where pipes have flat slopes generating flow depth greater the 60-percent (d/D > 0.6).
- *2045 Dry weather capacity:* During 2045 dry weather flow conditions, the system typically operates at 60-percent full or less (d/D =< 0.6) including the Beaverton Creek Trunk and the Turner Creek Trunk. The exceptions listed for 2025 still apply and typically with greater impact. For example, the Lower Hillsboro Trunk operates at 70 to 80-percent flow depth (d/D = 0.7-0.8) causing additional backwater to the Council Creek Trunk and the McKay Creek Trunk during dry weather conditions. The Dawson Creek Trunk and Dawson Pump Station are under capacity due to future industrial dry weather flows and prior to any improvements the system backs up into the parallel 48-inch (x2) and 21-inch (x1) trunk sewers upstream of the Dawson Pump Station Diversion.

- *2075 Dry weather capacity:* During 2075 dry weather flow conditions, the system typically operates at 60-percent full or less (d/D =< 0.6); however, the Beaverton Creek Trunk operates at 70 to 80-percent flow depth (d/D = 0.7-0.8) due to growth in the Rock Creek Basin. The exceptions listed for 2025 and 2045 still apply and typically with greater impact. For example, the Lower Hillsboro Trunk operates at 80 to 90-percent flow depth (d/D = 0.8-0.9) causing more severe backwater to the Council Creek Trunk and the McKay Creek Trunk during dry weather conditions. The Dawson Creek Trunk and Dawson Pump Station are more severely under capacity due to building out future industrial dry weather flows and the system continues to back up into the parallel 48-inch (x2) and 21-inch (x1) trunk sewers upstream of the Dawson Pump Station Diversion. Gravity sewers in North Hillsboro are also operating full (d/D = 1) due to industrial area growth.

5.6.1 Solids Dry Weather Scouring Characterization

To achieve solids scouring in gravity sewers, industry standards recommend an average dry weather flow velocity of 2 feet per second (fps) to maintain solids in suspension or a peak dry weather flow velocity of 3 to 3.5 fps to resuspend solids once settled. Maintaining solids in suspension or flushing out solids daily is a recommended practice (*Recommended Standards for Wastewater Facilities, "10 State Standards*," 2014 Edition, Published by Health Research Ince, Health Education Services Division, http://www.healthresearch.org/store/ten-state-standards). This practice minimizes loss of capacity in sewers from solids cementation, reduces risk of blockages, and improves odor control strategies.

The near-term flows (2025) provide the worst-case condition for limiting scouring velocities as shown in Figure 5.8. The lower tributaries and trunk sewers typically operate at 2 fps dry weather flow velocity or greater. Many of the upper tributary and mainlines operate at less than 2 fps and may be subject to solids deposition risks requiring more frequent maintenance and flushing for longer periods without storm events. These pipelines typically experience increased velocities above 3.5 fps, which flush out solids during spring, fall, and wintertime storm events.

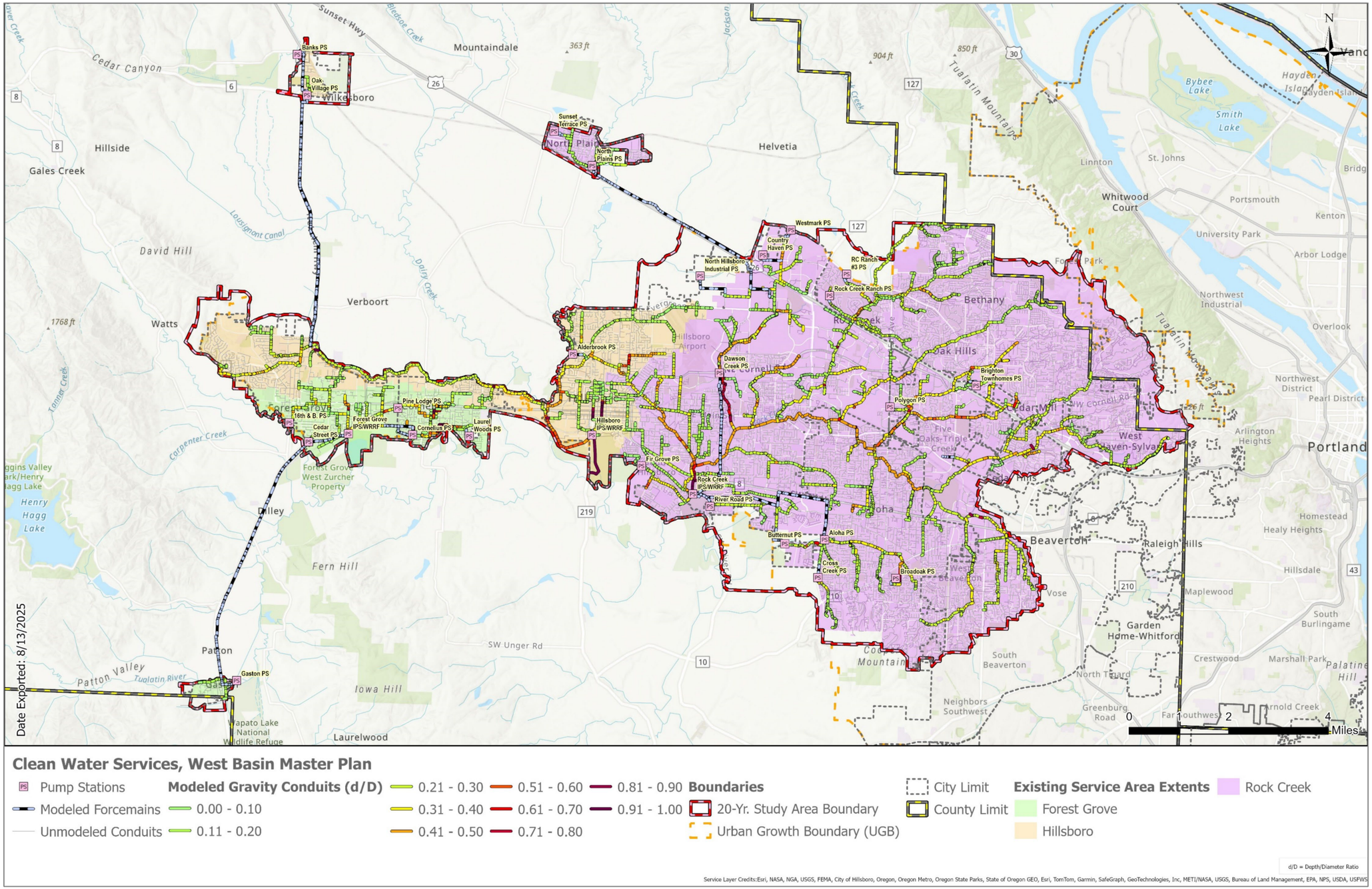


Figure 5.5 West Basin, 2025 Sanitary Conveyance System Deficiencies, Winter-time Dry Weather Flow (maximum flow depth to diameter ratios, d/D) d/D = depth to diameter ratio

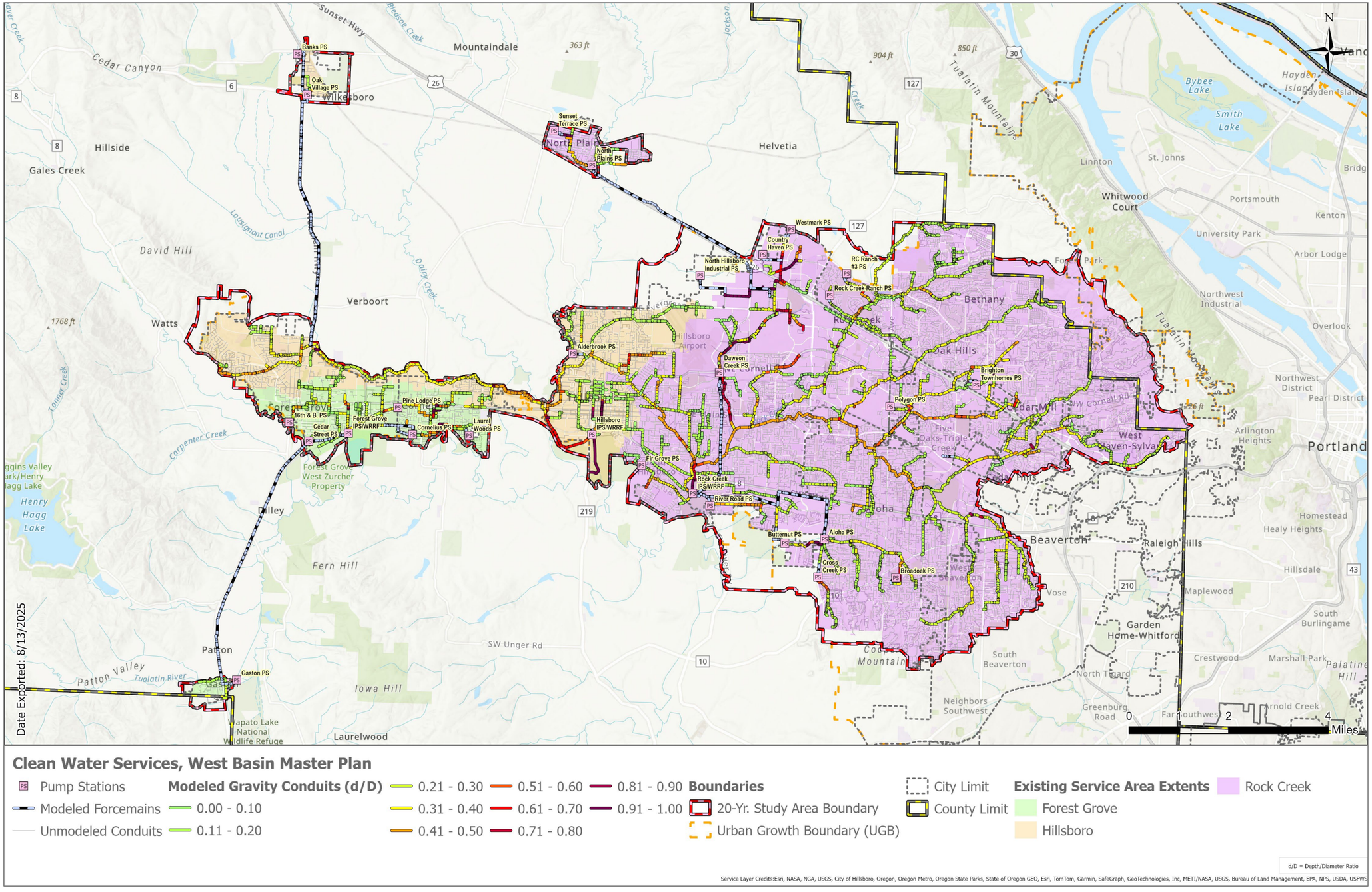


Figure 5.6 West Basin, 2045 Sanitary Conveyance System Deficiencies, Winter-time Dry Weather Flow (maximum flow depth to diameter ratios, d/D) d/D = depth to diameter ratio

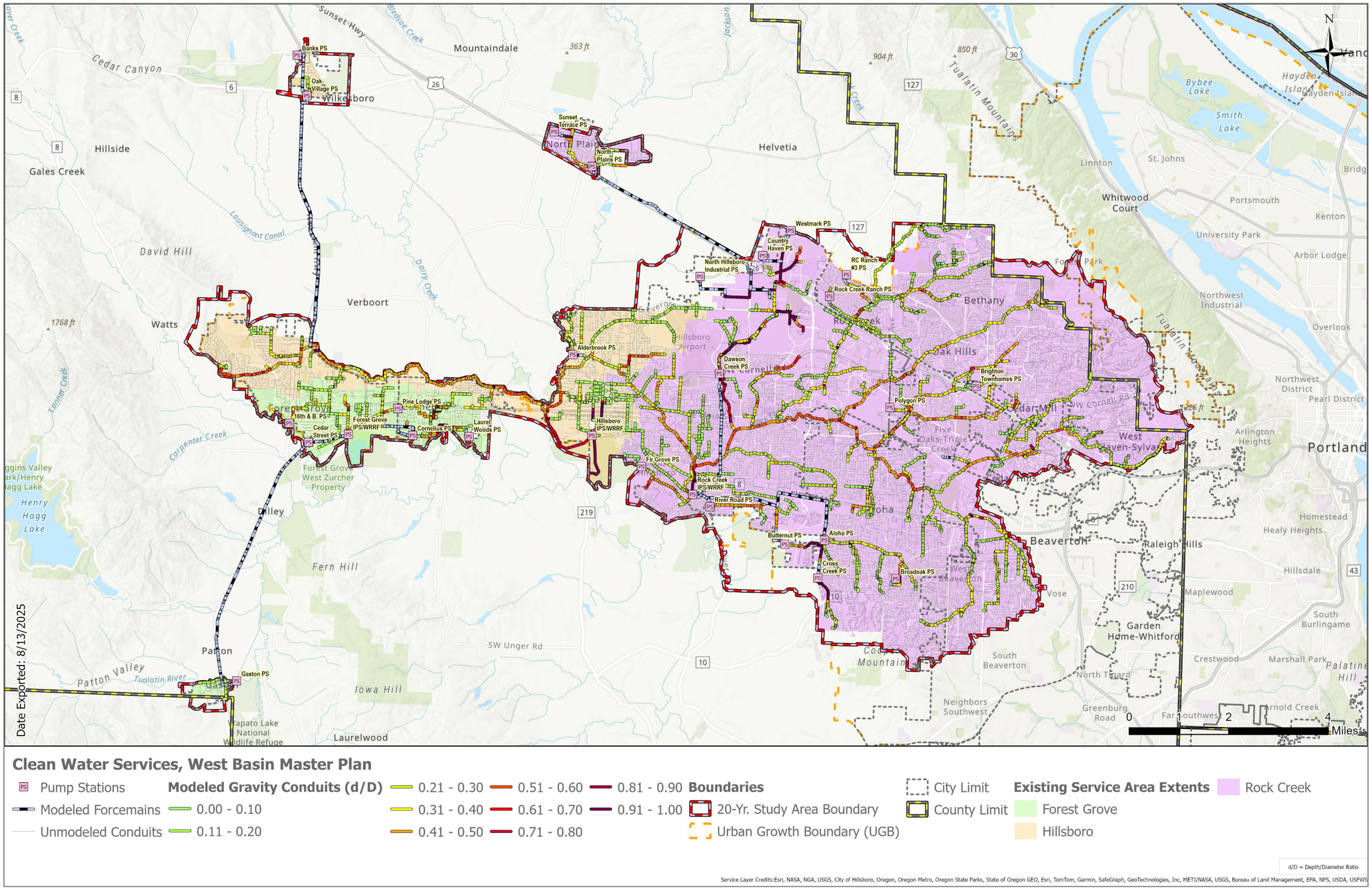


Figure 5.7 West Basin, 2075 Sanitary Conveyance System Deficiencies, Winter-time Dry Weather Flow (maximum flow depth to diameter ratios, d/D) d/D = depth to diameter ratio

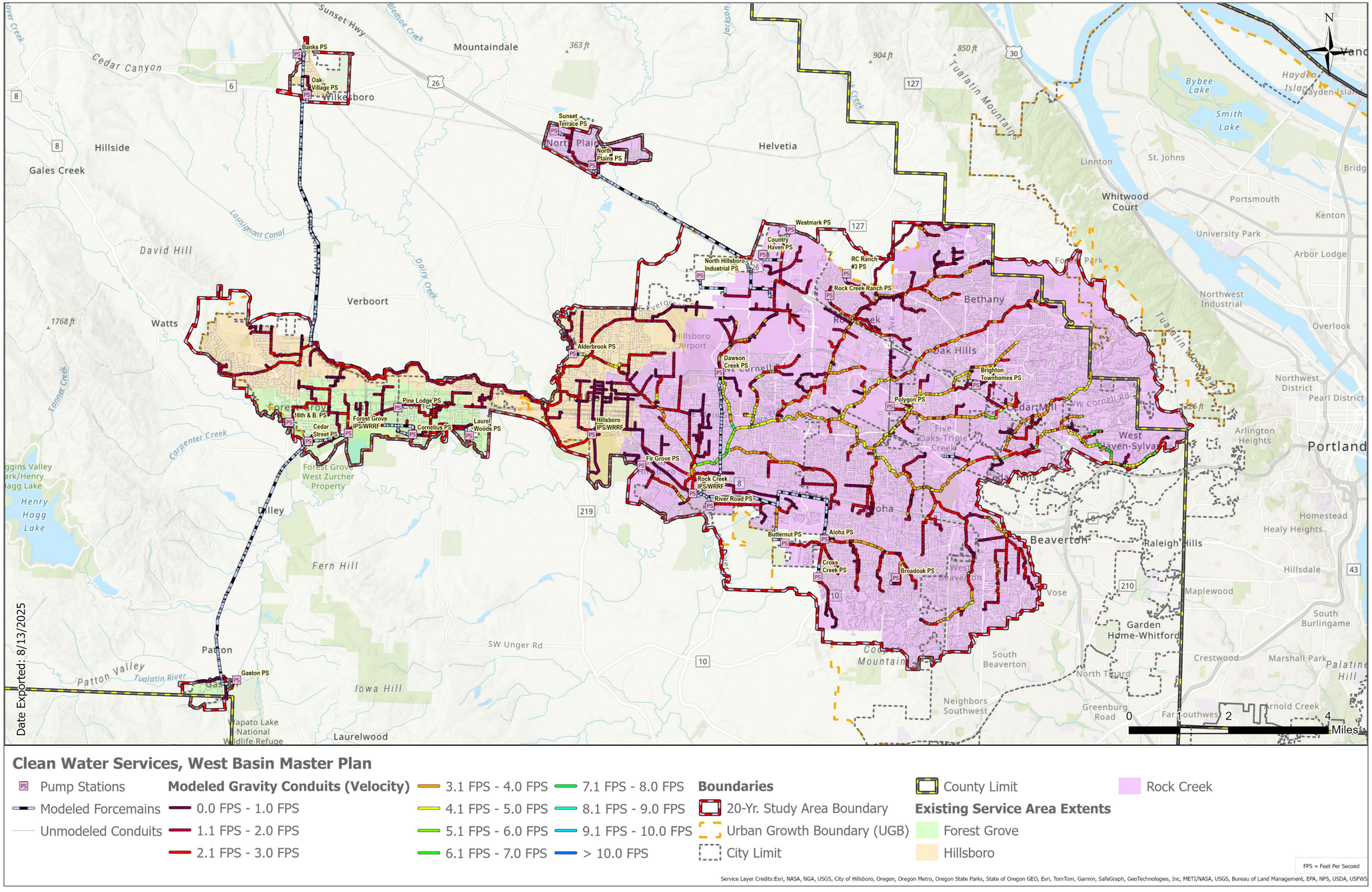


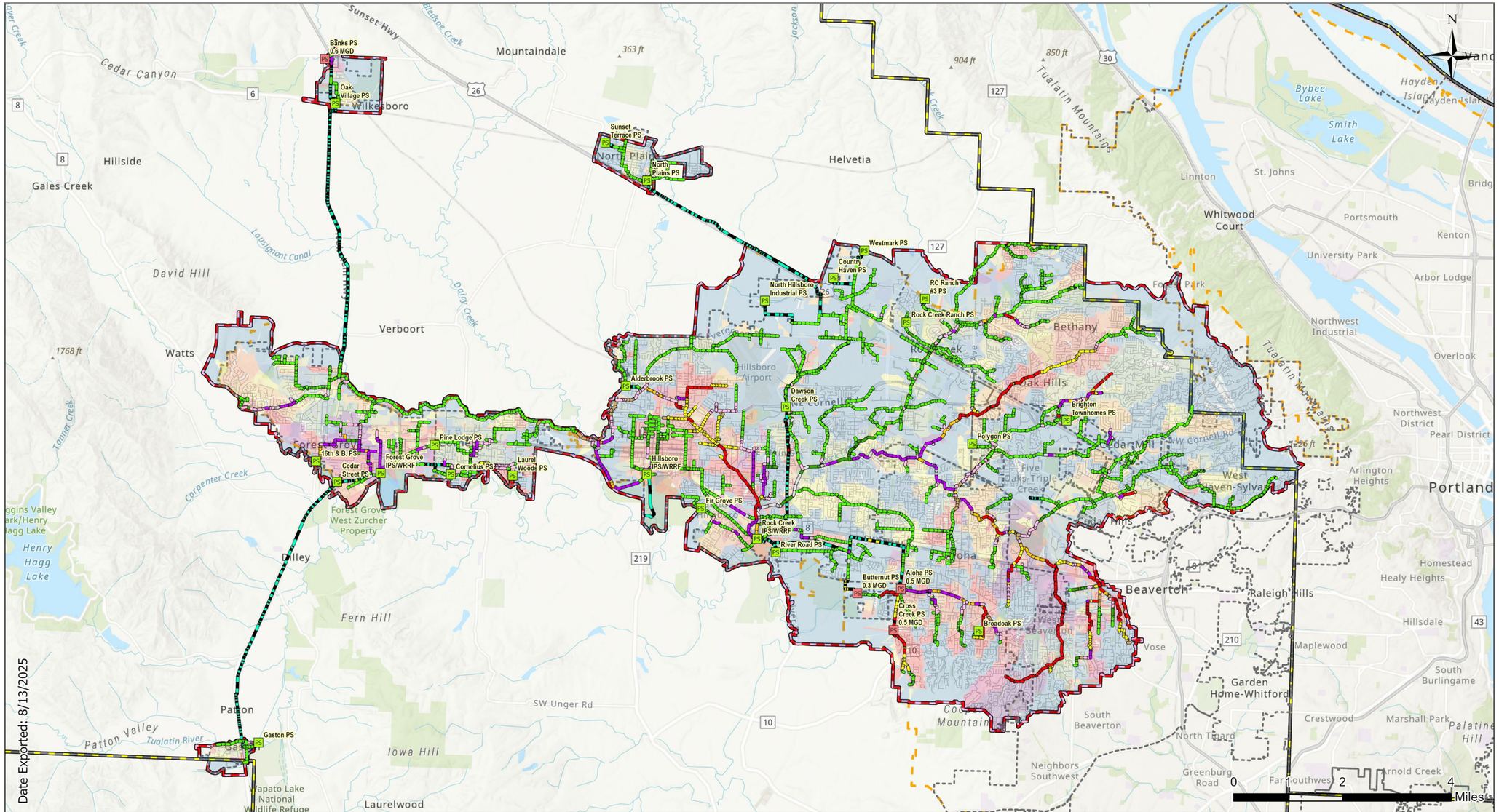
Figure 5.8 West Basin, 2025 Sanitary Conveyance System Deficiencies, Dry Weather Flow, Near-term Solids Scouring Velocities, FPS = feet per second

APPENDIX 5A

5-YEAR INCREMENT DEFICIENCY MAPPING, EXAMPLE HYDRAULIC PROFILE

Electronic Items Provided:

- GIS database for deficiency mapping in 5-year increments for dry and wet weather flow conditions
- Hydraulic Profile Spreadsheet Tool for all modeled pipelines (demonstrates system capacity in 5-year increments)
- InfoWorks ICM Hydraulic Models



Clean Water Services, West Basin Master Plan

Pump Stations (Capacity Codes)
- Adequate Capacity
- Insufficient Capacity

Modeled Forcemains (Peak Velocity)
- Force Main (< 8 FPS)
- Force Main (≥ 8 FPS)
- Force Main (≥ 10 FPS)

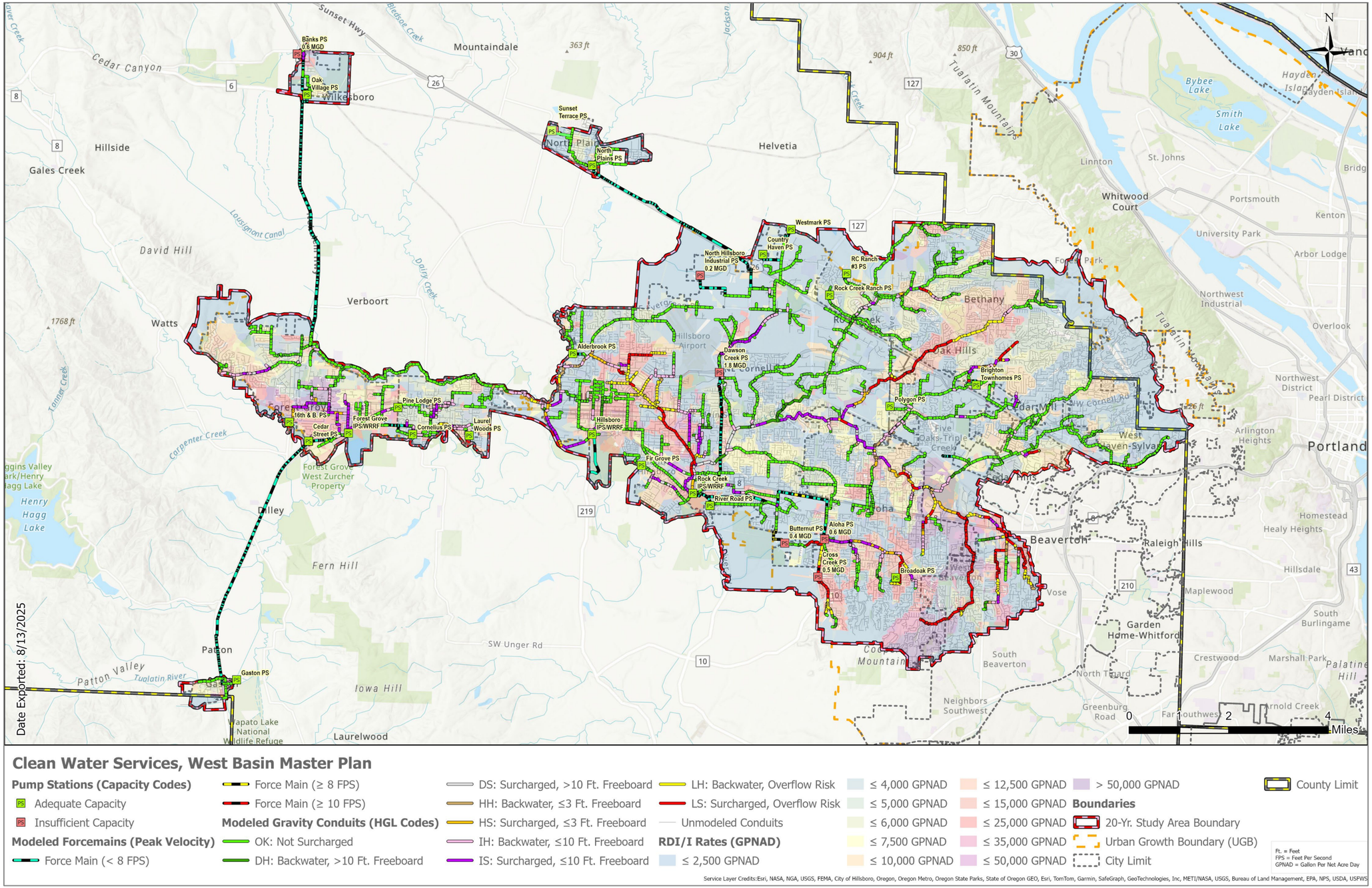
Modeled Gravity Conduits (HGL Codes)
- OK: Not Surcharged
- DH: Backwater, >10 Ft. Freeboard
- DS: Surcharged, >10 Ft. Freeboard
- HH: Backwater, ≤3 Ft. Freeboard
- HS: Surcharged, ≤3 Ft. Freeboard
- IH: Backwater, ≤10 Ft. Freeboard
- IS: Surcharged, ≤10 Ft. Freeboard
- LH: Backwater, Overflow Risk
- LS: Surcharged, Overflow Risk
- Unmodeled Conduits

RDI/I Rates (GPNAD)
- ≤ 2,500 GPNAD
- ≤ 4,000 GPNAD
- ≤ 5,000 GPNAD
- ≤ 6,000 GPNAD
- ≤ 7,500 GPNAD
- ≤ 10,000 GPNAD
- ≤ 12,500 GPNAD
- ≤ 15,000 GPNAD
- ≤ 25,000 GPNAD
- ≤ 35,000 GPNAD
- ≤ 50,000 GPNAD
- > 50,000 GPNAD

Boundaries
- County Limit
- 20-Yr. Study Area Boundary
- Urban Growth Boundary (UGB)
- City Limit

Ft. = Feet
FPS = Feet Per Second
GPNAD = Gallon Per Net Acre Day

Figure 5A.1 West Basin, 2025 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)



Clean Water Services, West Basin Master Plan

Pump Stations (Capacity Codes)
- Adequate Capacity
- Insufficient Capacity

Modeled Forcemains (Peak Velocity)
- Force Main (< 8 FPS)
- Force Main (≥ 8 FPS)
- Force Main (≥ 10 FPS)

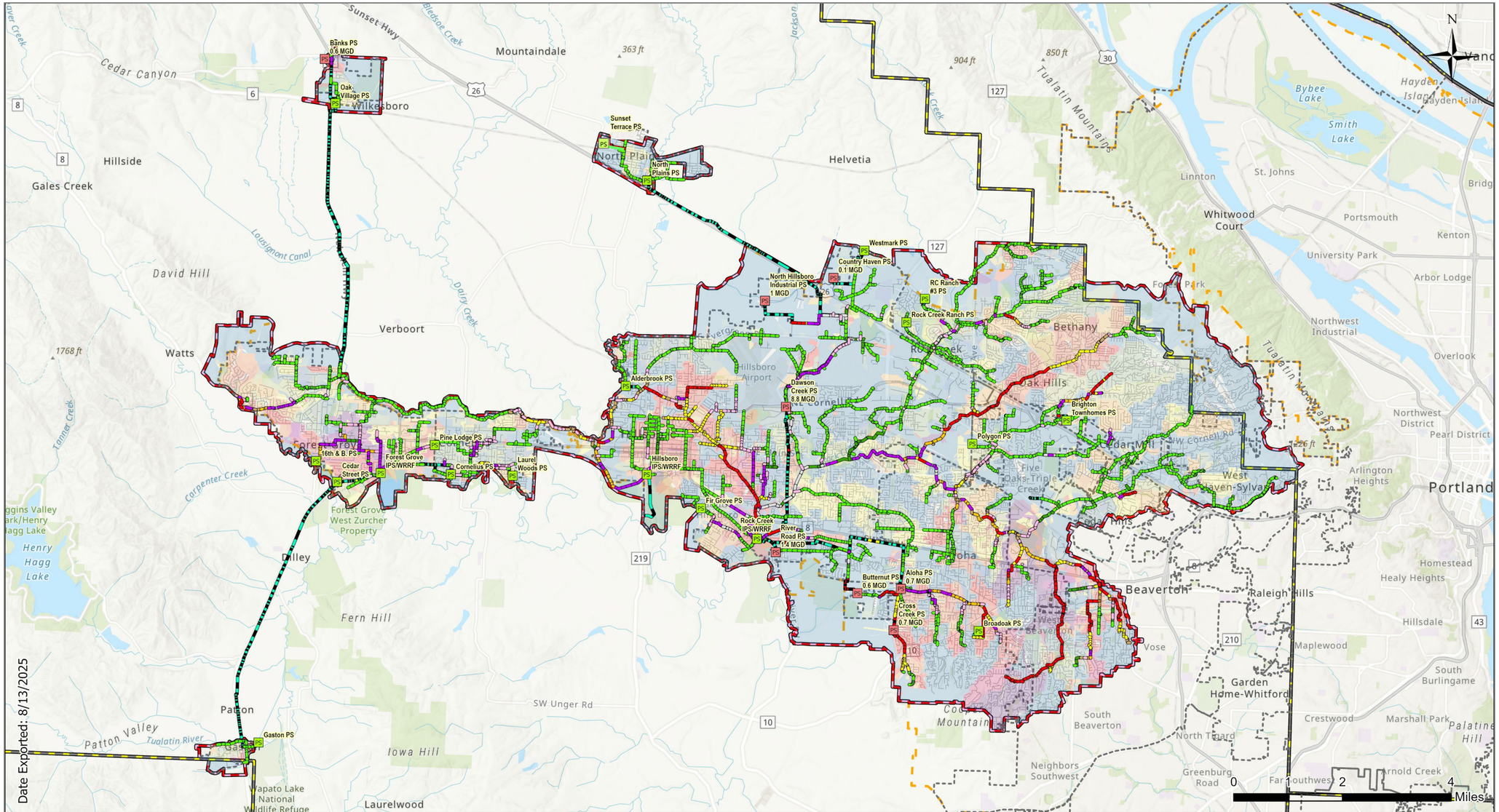
Modeled Gravity Conduits (HGL Codes)
- OK: Not Surcharged
- DH: Backwater, >10 Ft. Freeboard
- DS: Surcharged, >10 Ft. Freeboard
- HH: Backwater, ≤3 Ft. Freeboard
- HS: Surcharged, ≤3 Ft. Freeboard
- IH: Backwater, ≤10 Ft. Freeboard
- IS: Surcharged, ≤10 Ft. Freeboard
- LH: Backwater, Overflow Risk
- LS: Surcharged, Overflow Risk
- Unmodeled Conduits

RDI/I Rates (GPNAD)
- ≤ 2,500 GPNAD
- ≤ 4,000 GPNAD
- ≤ 5,000 GPNAD
- ≤ 6,000 GPNAD
- ≤ 7,500 GPNAD
- ≤ 10,000 GPNAD
- ≤ 12,500 GPNAD
- ≤ 15,000 GPNAD
- ≤ 25,000 GPNAD
- ≤ 35,000 GPNAD
- ≤ 50,000 GPNAD
- > 50,000 GPNAD

Boundaries
- County Limit
- 20-Yr. Study Area Boundary
- Urban Growth Boundary (UGB)
- City Limit

Ft. = Feet
FPS = Feet Per Second
GPNAD = Gallon Per Net Acre Day

Figure 5A.2 West Basin, 2030 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)



Clean Water Services, West Basin Master Plan

Pump Stations (Capacity Codes)
- Adequate Capacity
- Insufficient Capacity

Modeled Forcemains (Peak Velocity)
- Force Main (< 8 FPS)
- Force Main (≥ 8 FPS)
- Force Main (≥ 10 FPS)

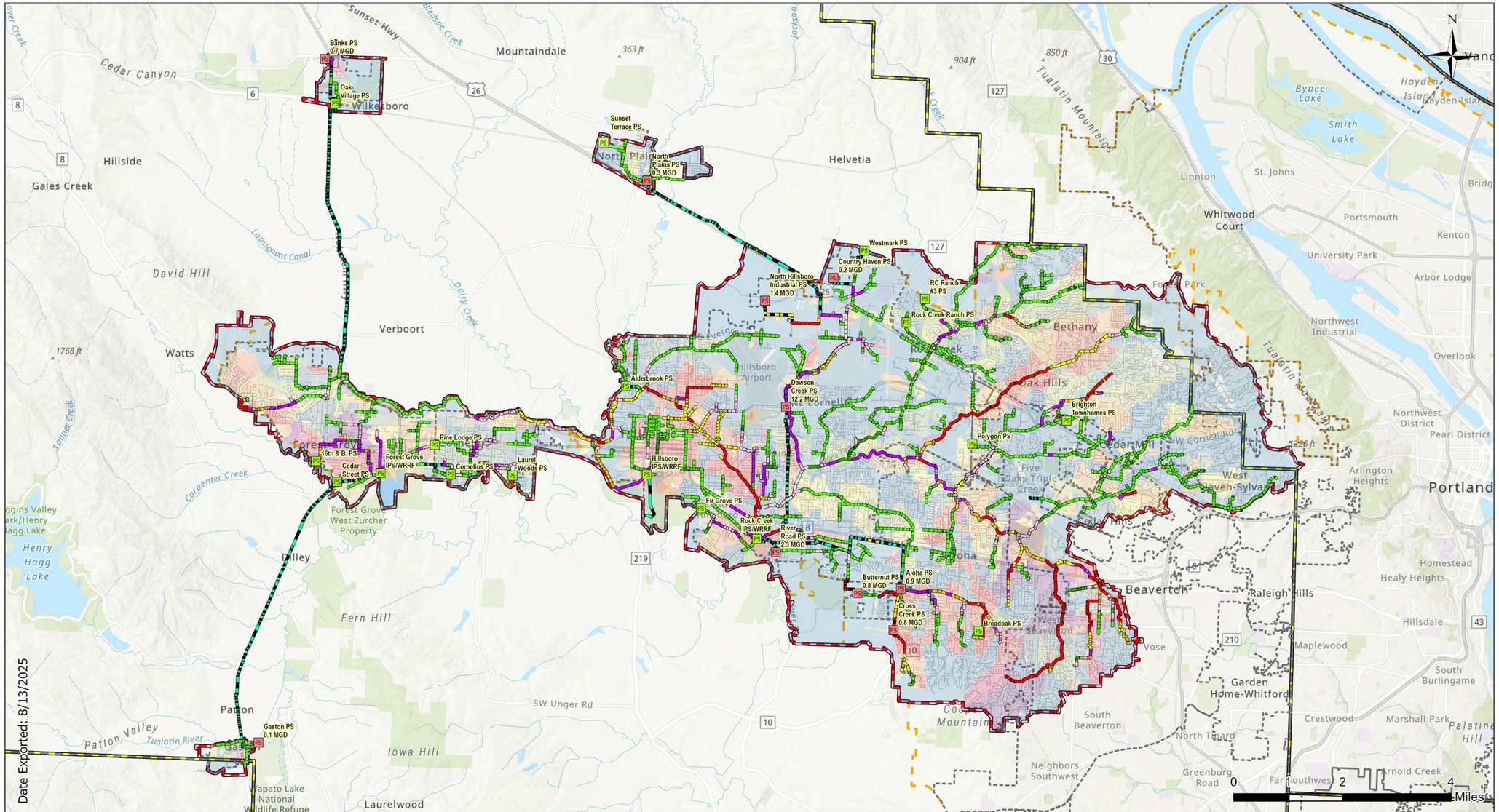
Modeled Gravity Conduits (HGL Codes)
- OK: Not Surcharged
- DH: Backwater, >10 Ft. Freeboard
- DS: Surcharged, >10 Ft. Freeboard
- HH: Backwater, ≤3 Ft. Freeboard
- HS: Surcharged, ≤3 Ft. Freeboard
- IH: Backwater, ≤10 Ft. Freeboard
- IS: Surcharged, ≤10 Ft. Freeboard
- LH: Backwater, Overflow Risk
- LS: Surcharged, Overflow Risk
- Unmodeled Conduits

RDI/I Rates (GPNAD)
- ≤ 2,500 GPNAD
- ≤ 4,000 GPNAD
- ≤ 5,000 GPNAD
- ≤ 6,000 GPNAD
- ≤ 7,500 GPNAD
- ≤ 10,000 GPNAD
- ≤ 12,500 GPNAD
- ≤ 15,000 GPNAD
- ≤ 25,000 GPNAD
- ≤ 35,000 GPNAD
- ≤ 50,000 GPNAD
- > 50,000 GPNAD

Boundaries
- County Limit
- 20-Yr. Study Area Boundary
- Urban Growth Boundary (UGB)
- City Limit

Ft. = Feet
FPS = Feet Per Second
GPNAD = Gallon Per Net Acre Day

Figure 5A.3 West Basin, 2035 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)



Clean Water Services, West Basin Master Plan

Pump Stations (Capacity Codes)
- Adequate Capacity
- Insufficient Capacity

Modeled Forcemains (Peak Velocity)
- Force Main (< 8 FPS)
- Force Main (≥ 8 FPS)
- Force Main (≥ 10 FPS)

Modeled Gravity Conduits (HGL Codes)
- OK: Not Surcharged
- DH: Backwater, >10 Ft. Freeboard
- DS: Surcharged, >10 Ft. Freeboard
- HH: Backwater, ≤3 Ft. Freeboard
- HS: Surcharged, ≤3 Ft. Freeboard
- IH: Backwater, ≤10 Ft. Freeboard
- IS: Surcharged, ≤10 Ft. Freeboard
- LH: Backwater, Overflow Risk
- LS: Surcharged, Overflow Risk
- Unmodeled Conduits

RDI/I Rates (GPNAD)
- ≤ 2,500 GPNAD
- ≤ 4,000 GPNAD
- ≤ 5,000 GPNAD
- ≤ 6,000 GPNAD
- ≤ 7,500 GPNAD
- ≤ 10,000 GPNAD
- ≤ 12,500 GPNAD
- ≤ 15,000 GPNAD
- ≤ 25,000 GPNAD
- ≤ 35,000 GPNAD
- ≤ 50,000 GPNAD
- > 50,000 GPNAD

Boundaries
- County Limit
- 20-Yr. Study Area Boundary
- Urban Growth Boundary (UGB)
- City Limit

Ft. = Feet
FPS = Feet Per Second
GPNAD = Gallon Per Net Acre Day

Figure 5A.4 West Basin, 2040 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)

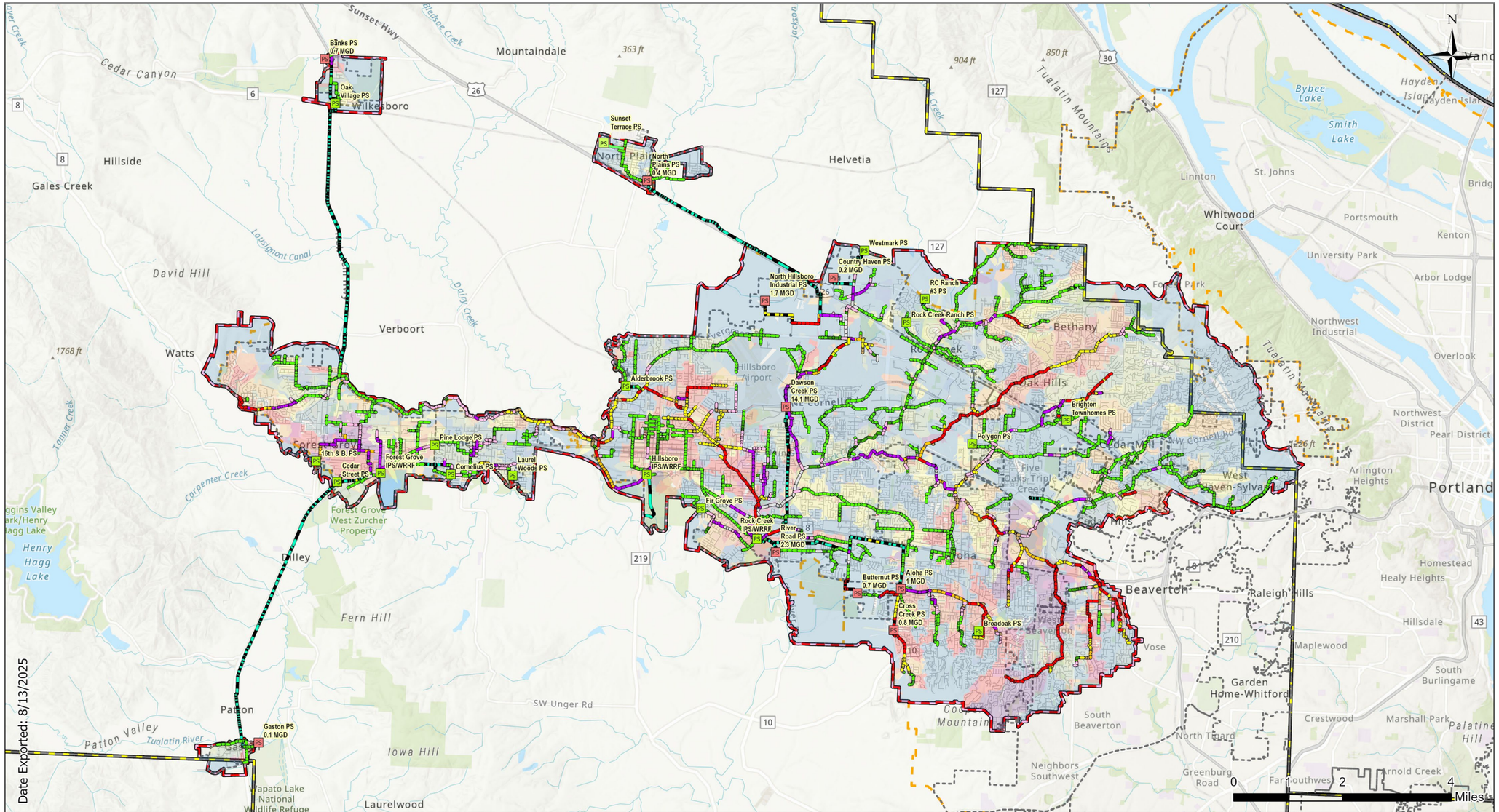


Figure 5A.5 West Basin, 2045 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)

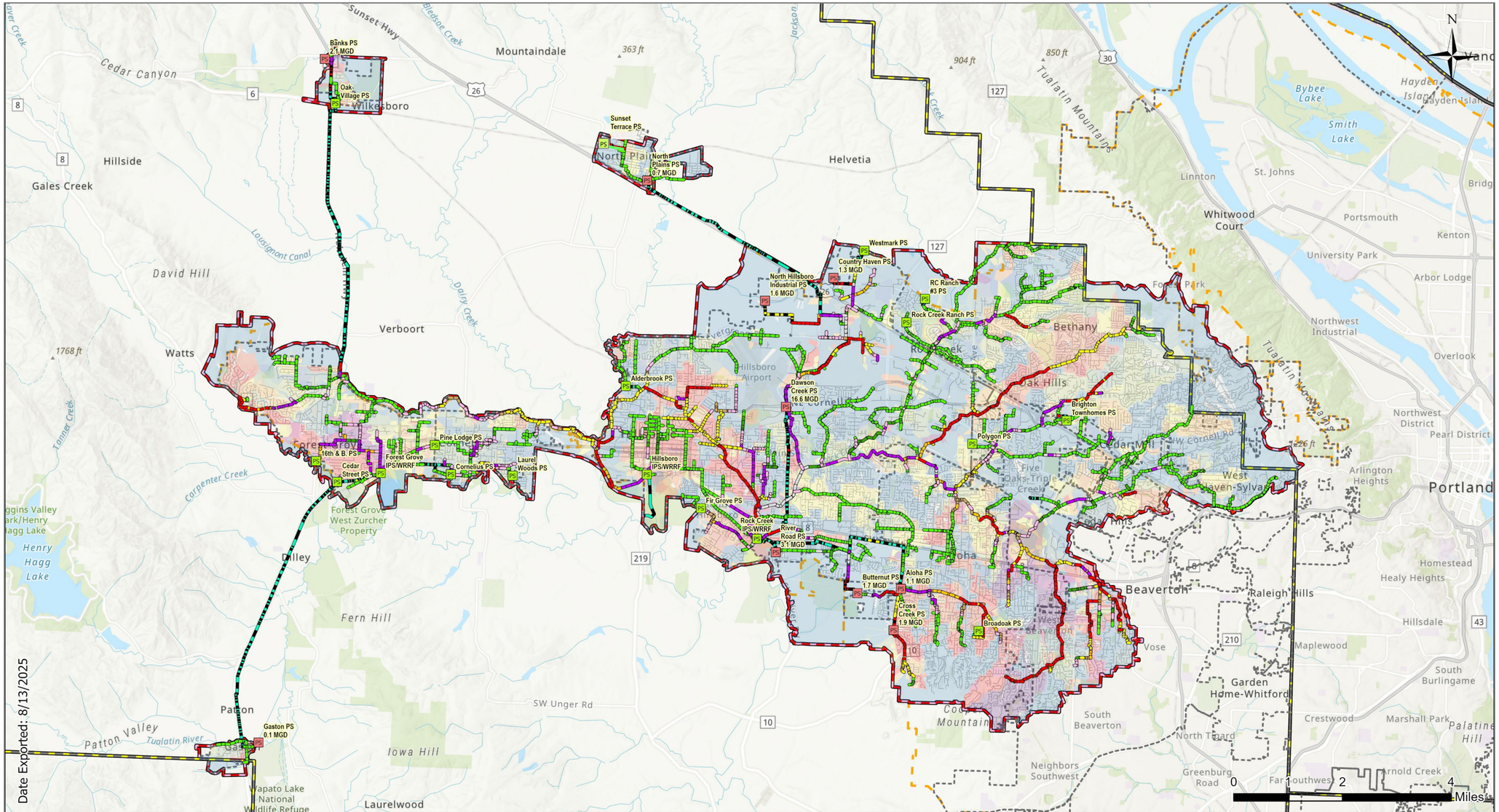
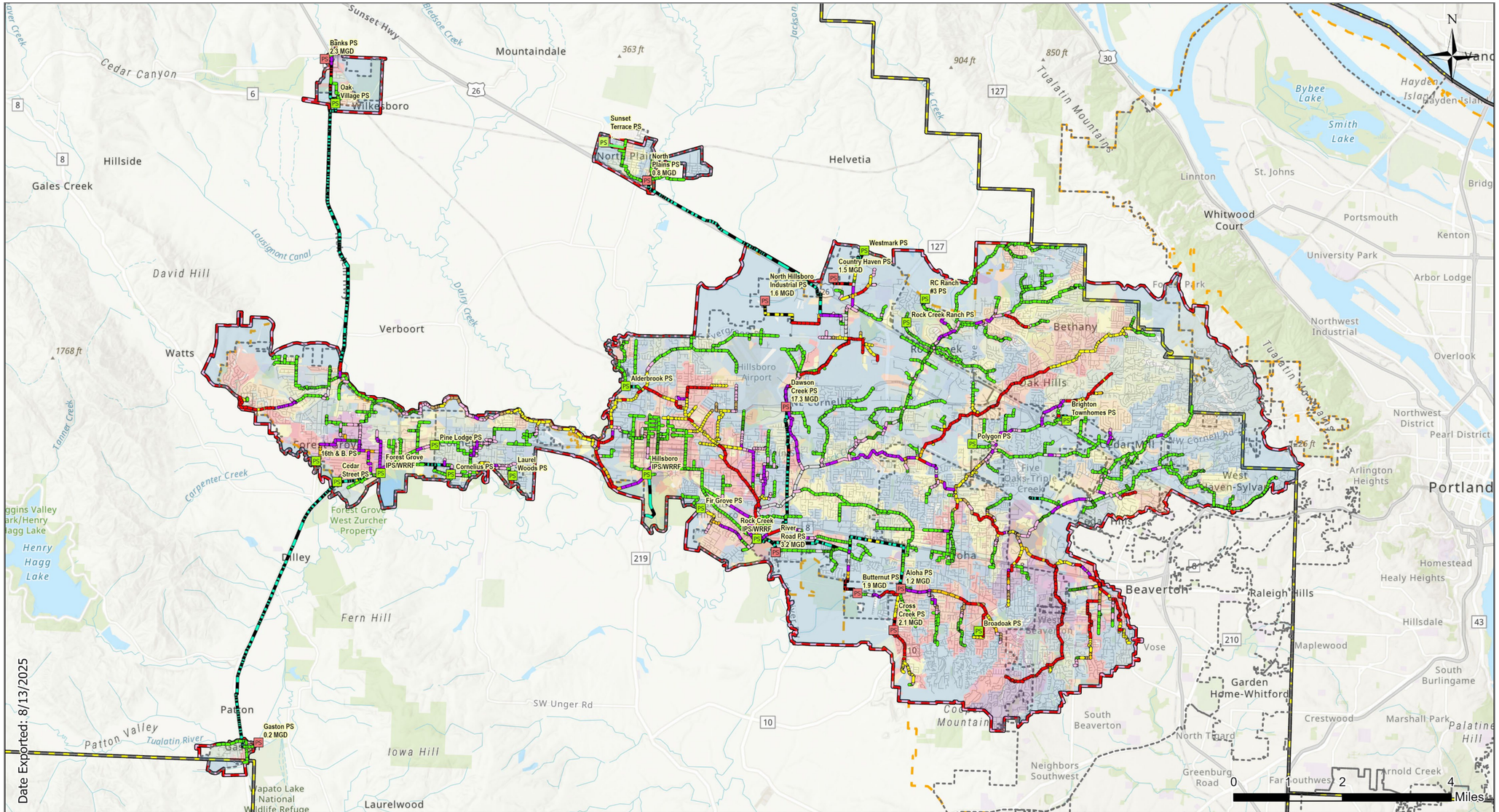


Figure 5A.6 West Basin, 2050 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)



Clean Water Services, West Basin Master Plan

Pump Stations (Capacity Codes)
- Adequate Capacity
- Insufficient Capacity

Modeled Forcemains (Peak Velocity)
- Force Main (< 8 FPS)
- Force Main (≥ 8 FPS)
- Force Main (≥ 10 FPS)

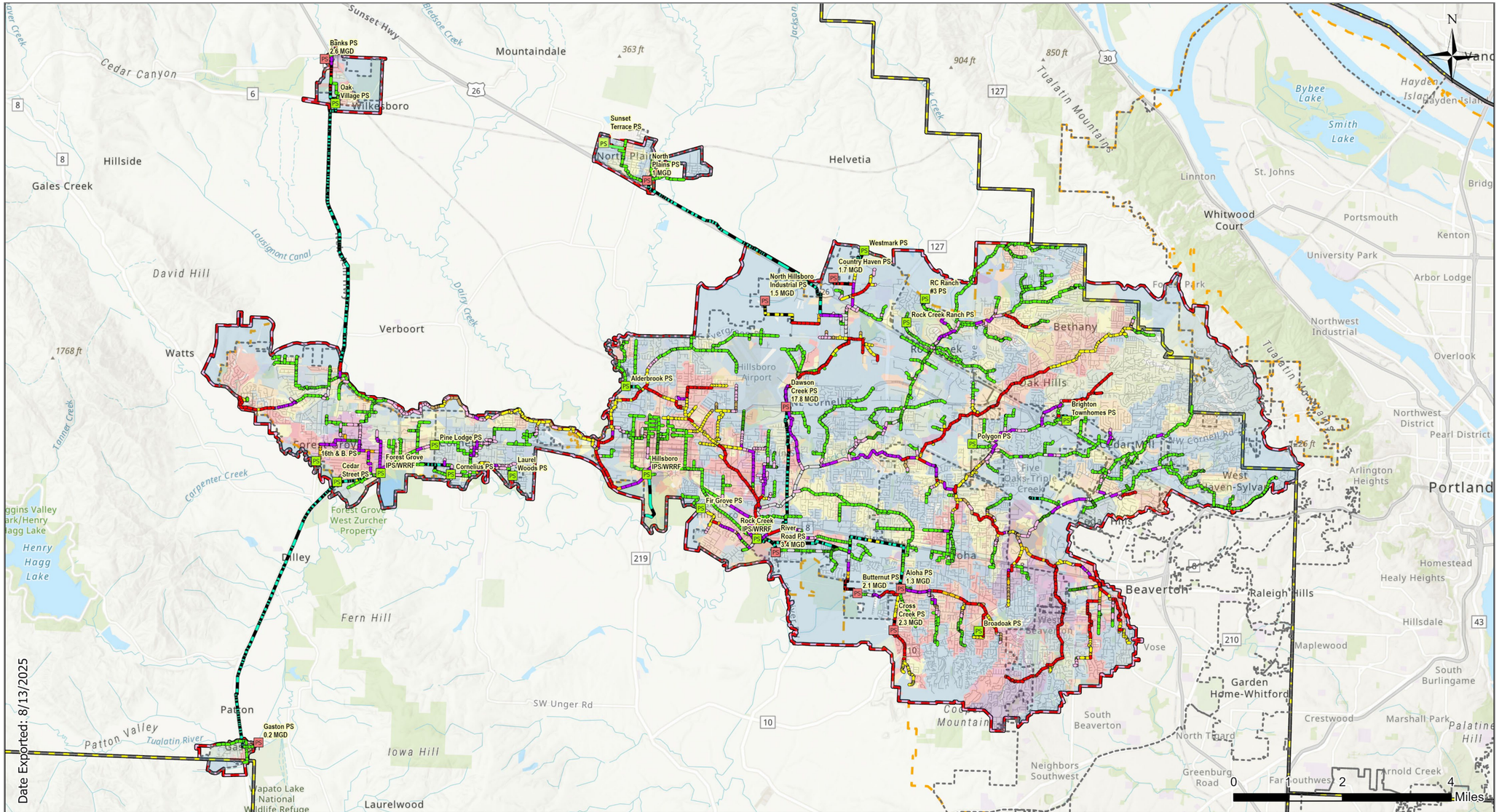
Modeled Gravity Conduits (HGL Codes)
- OK: Not Surcharged
- DH: Backwater, >10 Ft. Freeboard
- DS: Surcharged, >10 Ft. Freeboard
- HH: Backwater, ≤3 Ft. Freeboard
- HS: Surcharged, ≤3 Ft. Freeboard
- IH: Backwater, ≤10 Ft. Freeboard
- IS: Surcharged, ≤10 Ft. Freeboard
- LH: Backwater, Overflow Risk
- LS: Surcharged, Overflow Risk
- Unmodeled Conduits

RDI/I Rates (GPNAD)
- ≤ 2,500 GPNAD
- ≤ 4,000 GPNAD
- ≤ 5,000 GPNAD
- ≤ 6,000 GPNAD
- ≤ 7,500 GPNAD
- ≤ 10,000 GPNAD
- ≤ 12,500 GPNAD
- ≤ 15,000 GPNAD
- ≤ 25,000 GPNAD
- ≤ 35,000 GPNAD
- ≤ 50,000 GPNAD
- > 50,000 GPNAD

Boundaries
- County Limit
- 20-Yr. Study Area Boundary
- Urban Growth Boundary (UGB)
- City Limit

Ft. = Feet
FPS = Feet Per Second
GPNAD = Gallon Per Net Acre Day

Figure 5A.7 West Basin, 2055 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)



Clean Water Services, West Basin Master Plan

Pump Stations (Capacity Codes)
- Adequate Capacity
- Insufficient Capacity

Modeled Forcemains (Peak Velocity)
- Force Main (< 8 FPS)
- Force Main (≥ 8 FPS)
- Force Main (≥ 10 FPS)

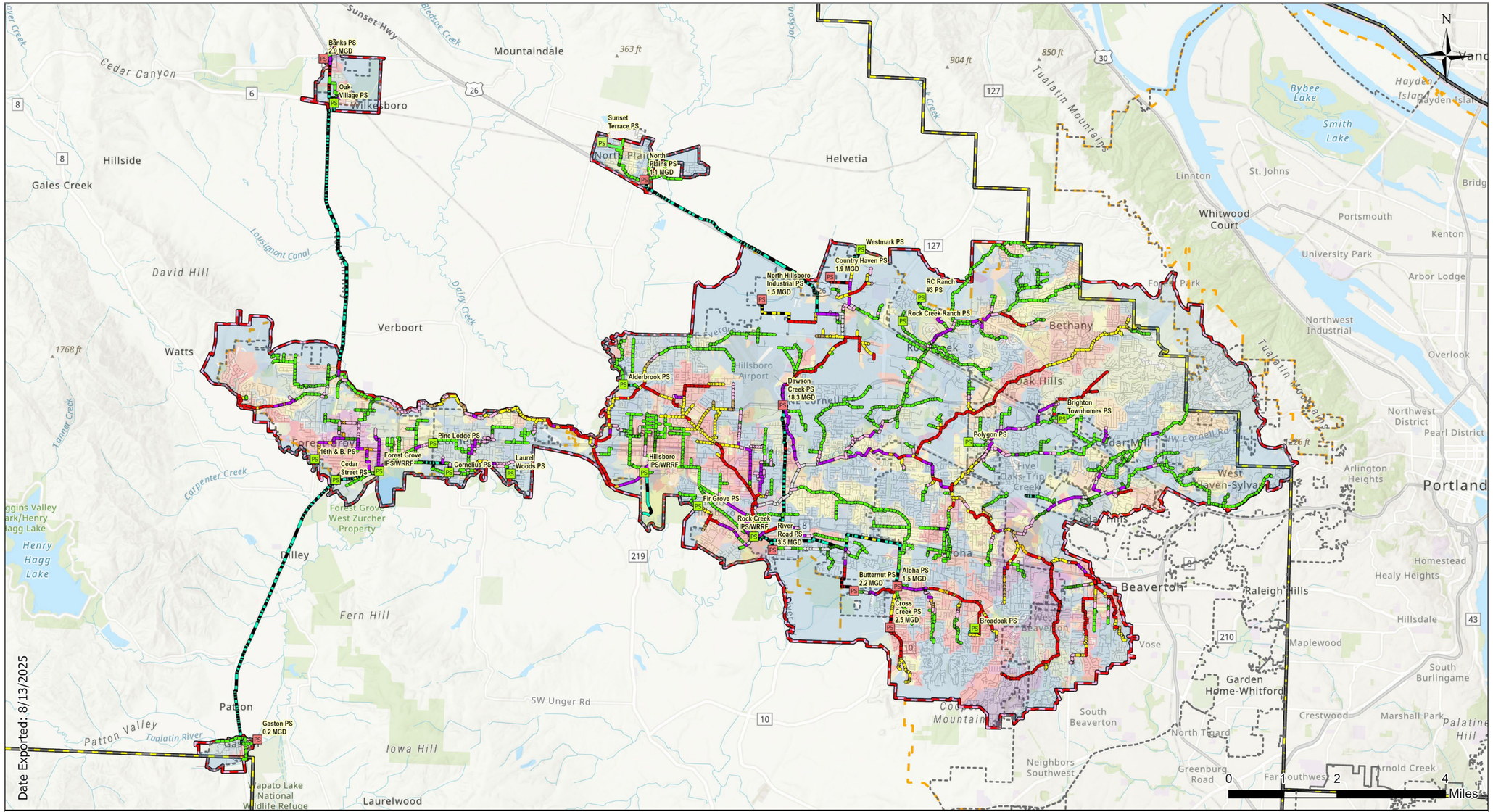
Modeled Gravity Conduits (HGL Codes)
- OK: Not Surcharged
- DH: Backwater, >10 Ft. Freeboard
- DS: Surcharged, >10 Ft. Freeboard
- HH: Backwater, ≤3 Ft. Freeboard
- HS: Surcharged, ≤3 Ft. Freeboard
- IH: Backwater, ≤10 Ft. Freeboard
- IS: Surcharged, ≤10 Ft. Freeboard
- LH: Backwater, Overflow Risk
- LS: Surcharged, Overflow Risk
- Unmodeled Conduits

RDI/I Rates (GPNAD)
- ≤ 2,500 GPNAD
- ≤ 4,000 GPNAD
- ≤ 5,000 GPNAD
- ≤ 6,000 GPNAD
- ≤ 7,500 GPNAD
- ≤ 10,000 GPNAD
- ≤ 12,500 GPNAD
- ≤ 15,000 GPNAD
- ≤ 25,000 GPNAD
- ≤ 35,000 GPNAD
- ≤ 50,000 GPNAD
- > 50,000 GPNAD

Boundaries
- County Limit
- 20-Yr. Study Area Boundary
- Urban Growth Boundary (UGB)
- City Limit

Ft. = Feet
FPS = Feet Per Second
GPNAD = Gallon Per Net Acre Day

Figure 5A.8 West Basin, 2060 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)



Clean Water Services, West Basin Master Plan

Pump Stations (Capacity Codes)
- Adequate Capacity
- Insufficient Capacity

Modeled Forcemains (Peak Velocity)
- Force Main (< 8 FPS)
- Force Main (≥ 8 FPS)
- Force Main (≥ 10 FPS)

Modeled Gravity Conduits (HGL Codes)
- OK: Not Surcharged
- DH: Backwater, >10 Ft. Freeboard
- DS: Surcharged, >10 Ft. Freeboard
- HH: Backwater, ≤3 Ft. Freeboard
- HS: Surcharged, ≤3 Ft. Freeboard
- IH: Backwater, ≤10 Ft. Freeboard
- IS: Surcharged, ≤10 Ft. Freeboard
- LH: Backwater, Overflow Risk
- LS: Surcharged, Overflow Risk
- Unmodeled Conduits

RDI/I Rates (GPNAD)
- ≤ 2,500 GPNAD
- ≤ 4,000 GPNAD
- ≤ 5,000 GPNAD
- ≤ 6,000 GPNAD
- ≤ 7,500 GPNAD
- ≤ 10,000 GPNAD
- ≤ 12,500 GPNAD
- ≤ 15,000 GPNAD
- ≤ 25,000 GPNAD
- ≤ 35,000 GPNAD
- ≤ 50,000 GPNAD
- > 50,000 GPNAD

Boundaries
- County Limit
- 20-Yr. Study Area Boundary
- Urban Growth Boundary (UGB)
- City Limit

Ft. = Feet
FPS = Feet Per Second
GPNAD = Gallon Per Net Acre Day

Figure 5A.9 West Basin, 2065 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)

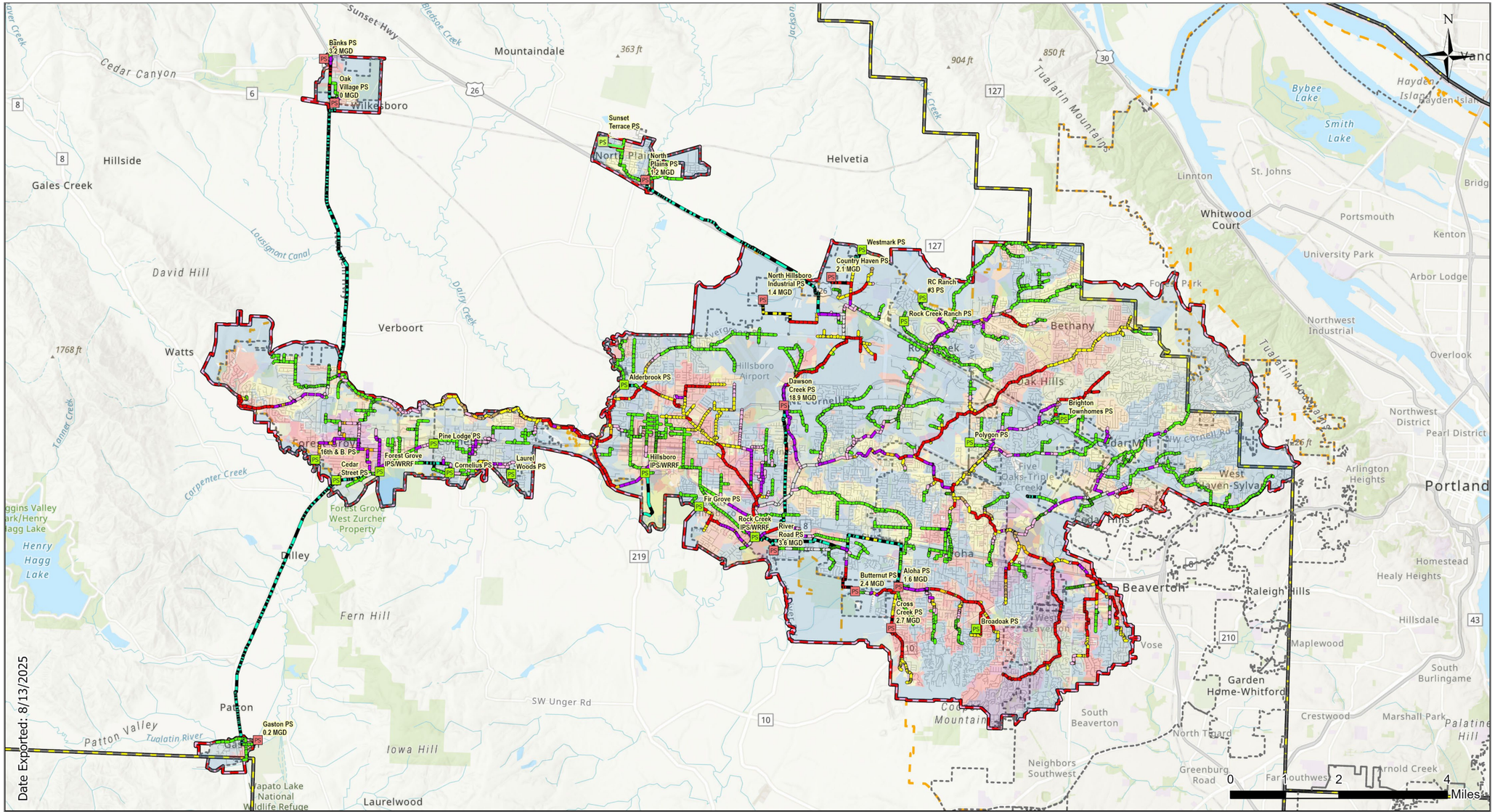


Figure 5A.10 West Basin, 2070 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)

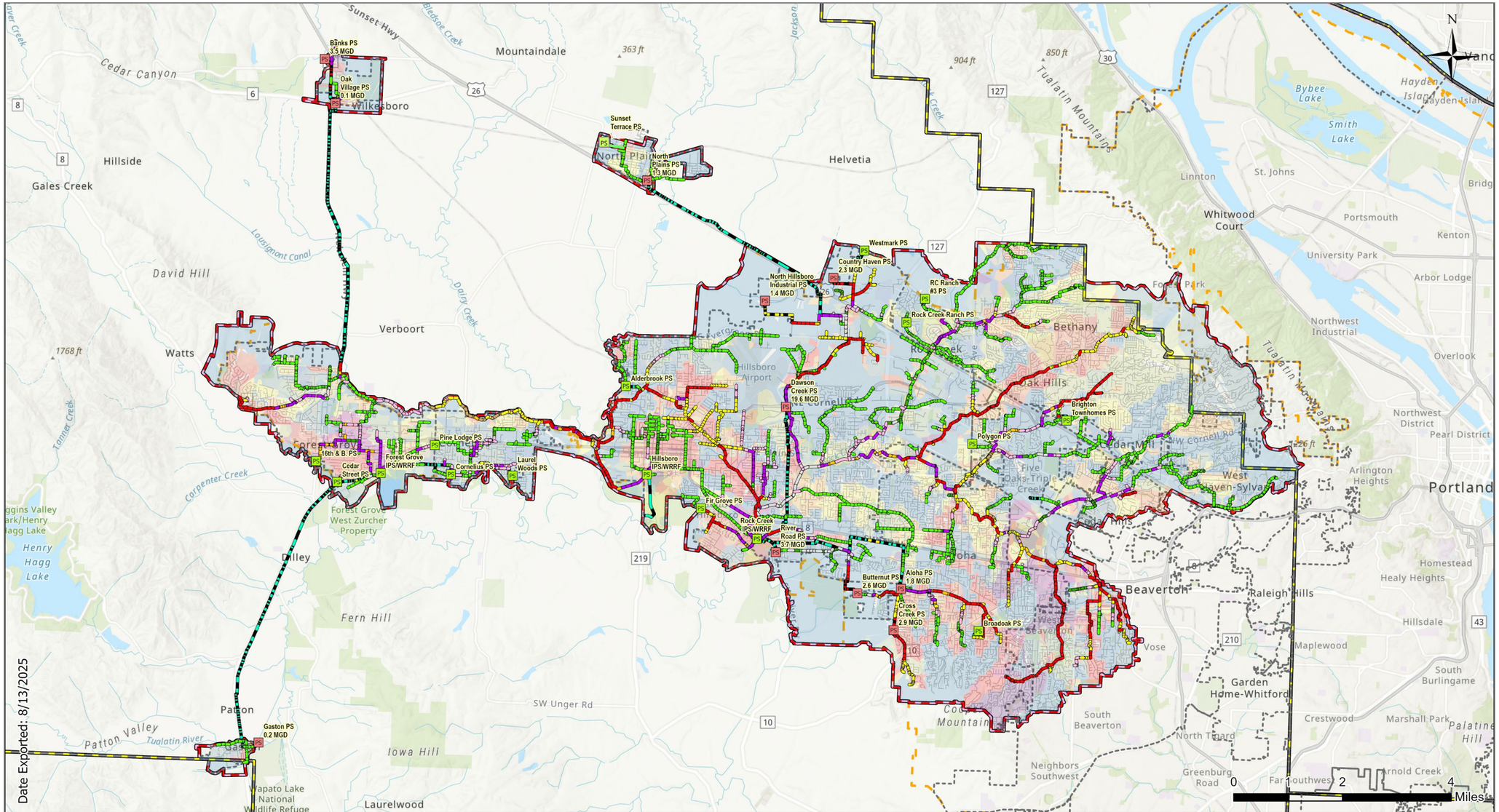
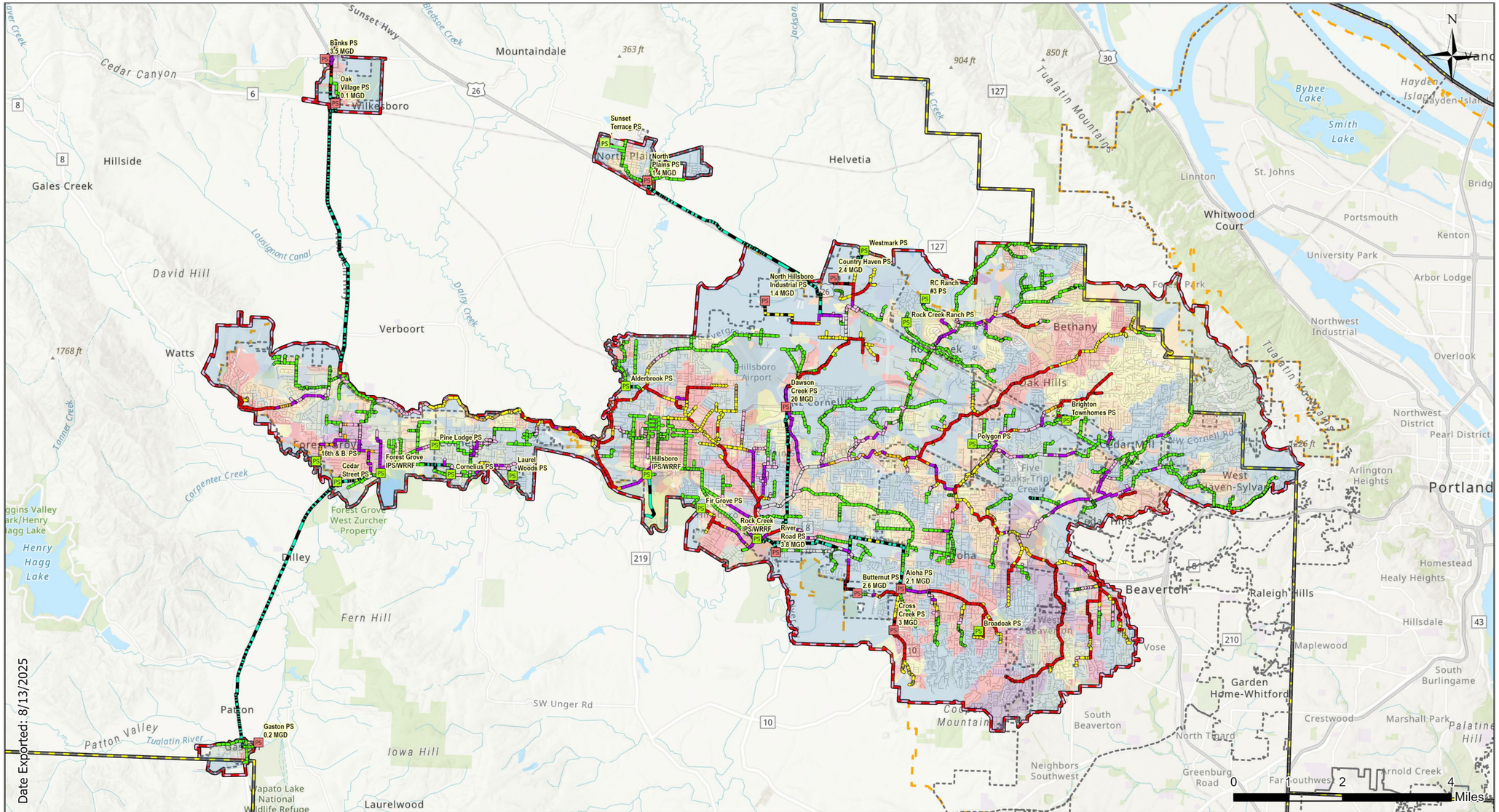


Figure 5A.11 West Basin, 2075 Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)



Clean Water Services, West Basin Master Plan

Pump Stations (Capacity Codes)
- Adequate Capacity
- Insufficient Capacity

Modeled Forcemains (Peak Velocity)
- Force Main (< 8 FPS)
- Force Main (≥ 8 FPS)
- Force Main (≥ 10 FPS)

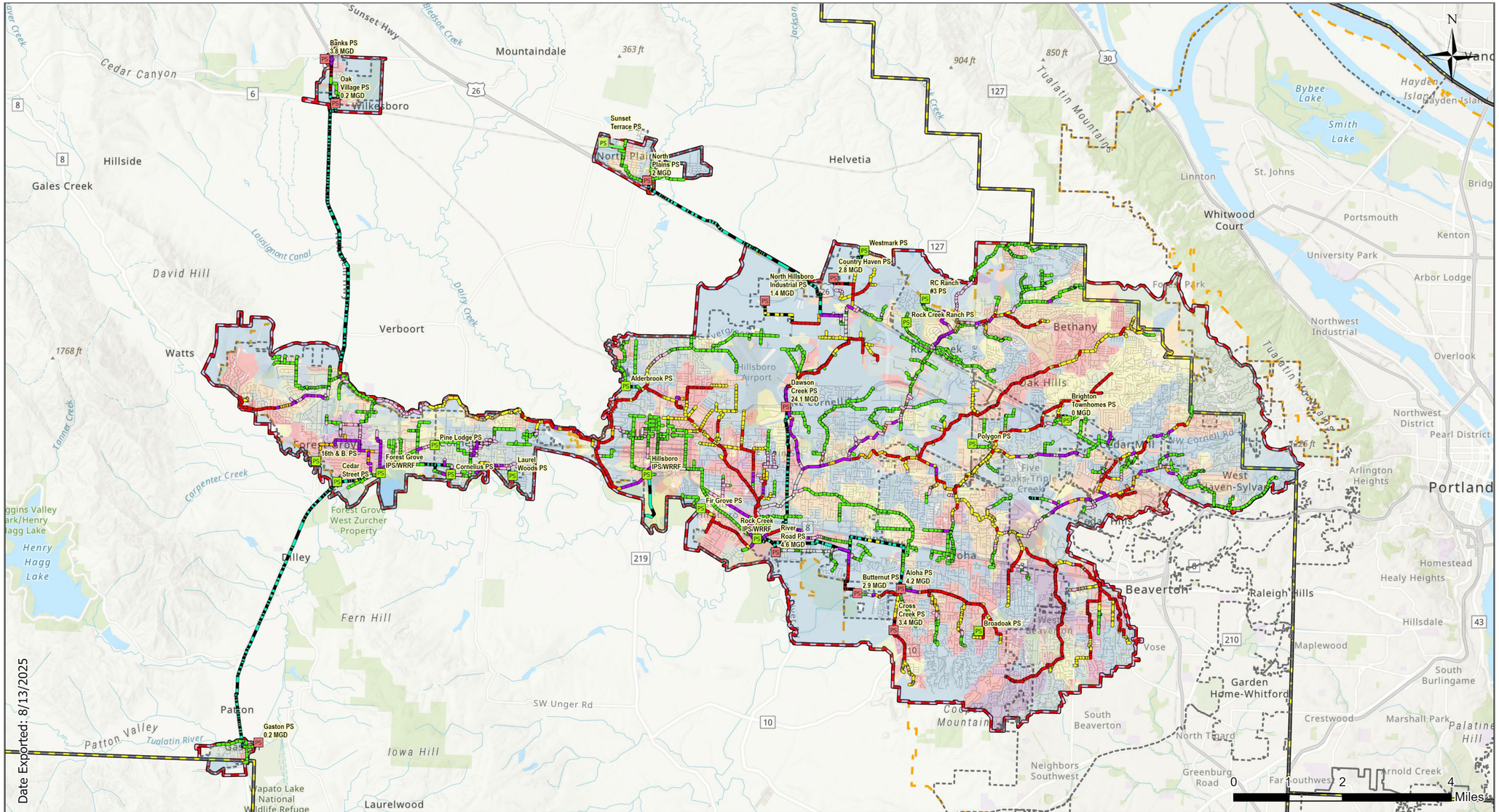
Modeled Gravity Conduits (HGL Codes)
- OK: Not Surcharged
- DH: Backwater, >10 Ft. Freeboard
- DS: Surcharged, >10 Ft. Freeboard
- HH: Backwater, ≤3 Ft. Freeboard
- HS: Surcharged, ≤3 Ft. Freeboard
- IH: Backwater, ≤10 Ft. Freeboard
- IS: Surcharged, ≤10 Ft. Freeboard
- LH: Backwater, Overflow Risk
- LS: Surcharged, Overflow Risk
- Unmodeled Conduits

RDI/I Rates (GPNAD)
- ≤ 2,500 GPNAD
- ≤ 4,000 GPNAD
- ≤ 5,000 GPNAD
- ≤ 6,000 GPNAD
- ≤ 7,500 GPNAD
- ≤ 10,000 GPNAD
- ≤ 12,500 GPNAD
- ≤ 15,000 GPNAD
- ≤ 25,000 GPNAD
- ≤ 35,000 GPNAD
- ≤ 50,000 GPNAD
- > 50,000 GPNAD

Boundaries
- County Limit
- 20-Yr. Study Area Boundary
- Urban Growth Boundary (UGB)
- City Limit

Ft. = Feet
FPS = Feet Per Second
GPNAD = Gallon Per Net Acre Day

Figure 5A.12 West Basin, 2075 (Design Storm + frequency/depth) Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)



Clean Water Services, West Basin Master Plan

Pump Stations (Capacity Codes)
- Adequate Capacity
- Insufficient Capacity

Modeled Forcemains (Peak Velocity)
- Force Main (< 8 FPS)
- Force Main (≥ 8 FPS)
- Force Main (≥ 10 FPS)

Modeled Gravity Conduits (HGL Codes)
- OK: Not Surcharged
- DH: Backwater, >10 Ft. Freeboard
- DS: Surcharged, >10 Ft. Freeboard
- HH: Backwater, ≤3 Ft. Freeboard
- HS: Surcharged, ≤3 Ft. Freeboard
- IH: Backwater, ≤10 Ft. Freeboard
- IS: Surcharged, ≤10 Ft. Freeboard
- LH: Backwater, Overflow Risk
- LS: Surcharged, Overflow Risk
- Unmodeled Conduits

RDI/I Rates (GPNAD)
- ≤ 2,500 GPNAD
- ≤ 4,000 GPNAD
- ≤ 5,000 GPNAD
- ≤ 6,000 GPNAD
- ≤ 7,500 GPNAD
- ≤ 10,000 GPNAD
- ≤ 12,500 GPNAD
- ≤ 15,000 GPNAD
- ≤ 25,000 GPNAD
- ≤ 35,000 GPNAD
- ≤ 50,000 GPNAD
- > 50,000 GPNAD

Boundaries
- County Limit
- 20-Yr. Study Area Boundary
- Urban Growth Boundary (UGB)
- City Limit

Ft. = Feet
FPS = Feet Per Second
GPNAD = Gallon Per Net Acre Day

Figure 5A.13 West Basin, 2075 (Design Storm + frequency/depth/intensity) Sanitary Conveyance System Deficiencies, West Basin Design Storms (HGL codes & Existing Peak RDI/I Rates)

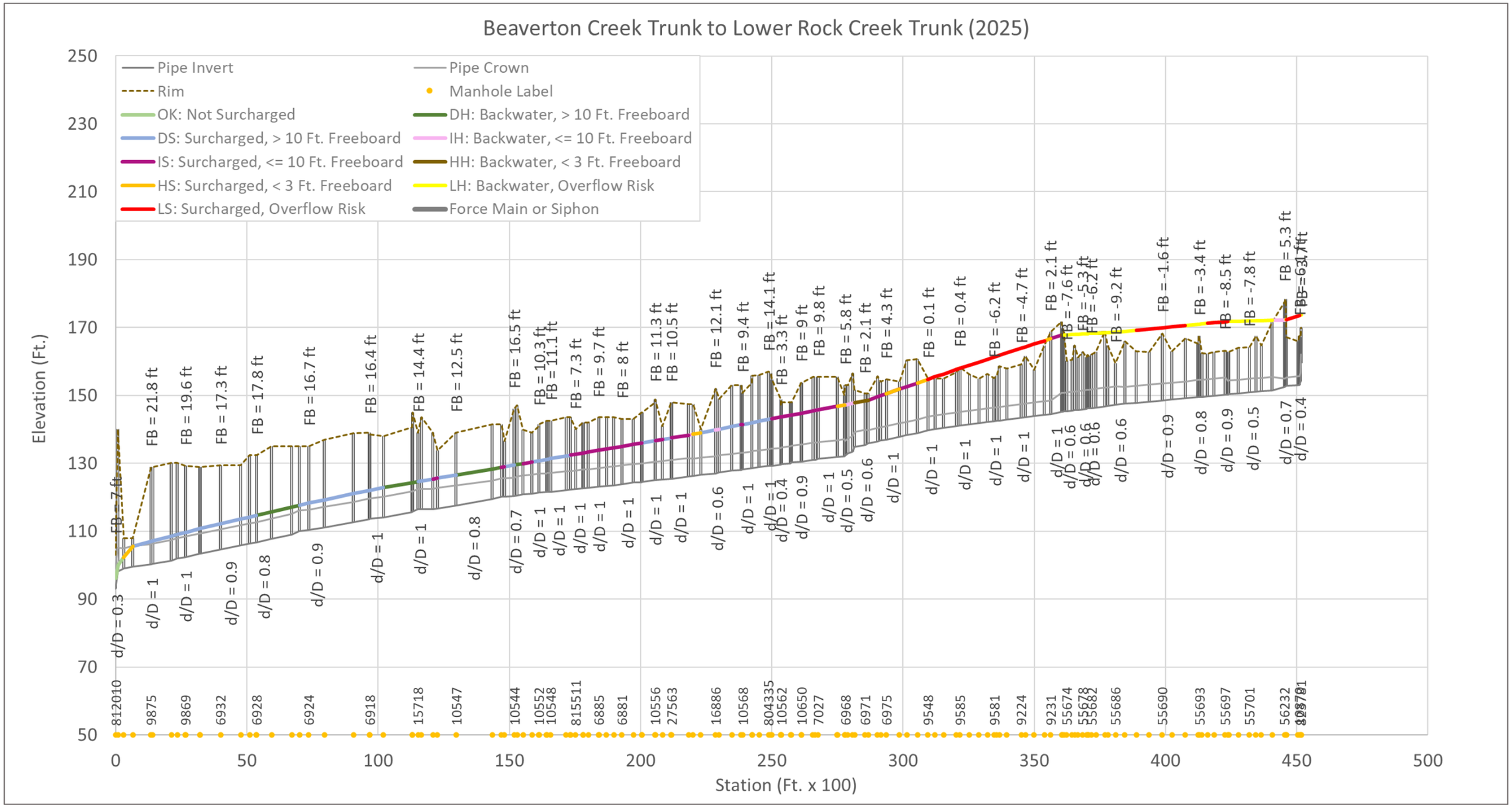


Figure 5A.14 Example Hydraulic Profile from Spreadsheet Hydraulic Profile Tool