FLOW PROJECTIONS

3.1 INTRODUCTION

This chapter reviews the existing collection system wastewater flows, summarizes the flow monitoring program performed by the City of Grants Pass (City) during the 2011/2012 wet weather season, and presents the projected wastewater flows for future conditions within the study area. The planning years for this evaluation include the existing year (2012), the short-term planning year (2025), and the long-term planning year (2035).

3.2 SEWER COLLECTION SYSTEM FLOWS

Wastewater consists of dry weather flow (DWF) and wet weather flow (WWF). Dry weather flow is representative of routine discharges into the collection system from customers as well as groundwater infiltration into pipes and manholes. Wet weather flow, that is flow during or immediately after a storm, is higher than dry weather flows due to direct inflow into the system and increased groundwater infiltration. Figure 3.1 illustrates the different flow components discussed in the following sections.

3.2.1 Dry Weather Flow

3.2.1.1 Dry Weather Flow (DWF) Components

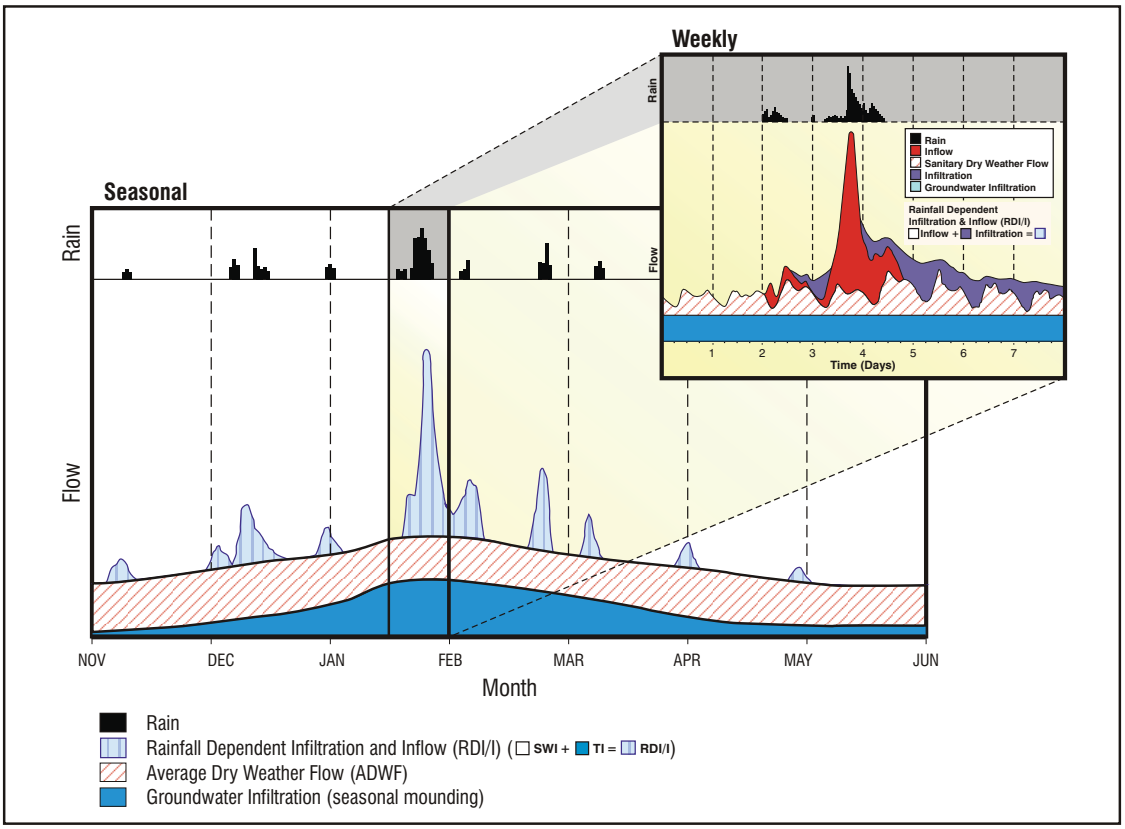
There are two primary components of DWF:

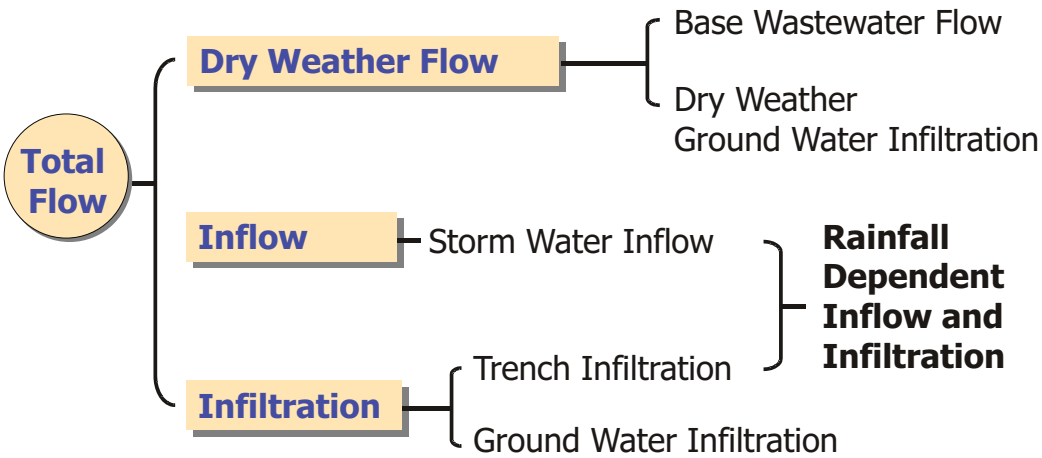
3.2.1.1.1 *Base Wastewater Flow (BWF)*

The BWF is the flow generated by routine water usage of the City's residential, commercial, and industrial customers. The flow has a diurnal pattern that varies with land use categories. Typically, a residential diurnal pattern has two peaks with the more pronounced peak following the wake-up hours of the day, and a less pronounced peak occurring in the evening. Commercial and industrial patterns, though they vary depending on the type of use, typically have more consistent higher flow patterns during business hours, and lower flows at night. Furthermore, the diurnal flow pattern experienced during a weekend may vary from the diurnal flow experienced during a weekday.

3.2.1.1.2 *Dry Weather Groundwater Infiltration (GWI)*

Dry weather GWI will enter the sewer system when the relative depth of the groundwater table is higher than the depth of the pipeline and when the susceptibility of the sanitary sewer pipe allows infiltration through defects such as cracks, misaligned joints, and broken pipelines. Dry weather GWI (or base infiltration) cannot easily be separated from BWF by flow measurement techniques. Therefore, dry weather GWI is typically grouped with BWF.





Note: This figure is not based on flow data specific to the City or this Master Plan

TYPICAL WASTEWATER FLOW COMPONENTS

FIGURE 3.1

CITY OF GRANTS PASS
WASTEWATER COLLECTION SYSTEM MASTER PLAN

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3.2.1.2 Average Dry Weather Flow

Average Dry Weather Flow (ADWF) is the average flow that occurs on a daily basis during the dry weather season, and is usually estimated from a 5-year average of dry weather flows. Based on 5-year historic average flows to the WRP, the ADWF for the City is approximately 5.2 million gallons per day (mgd). The ADWF serves as the baseline flow in the hydraulic model. The ADWFs are applied to a diurnal (24-hour) pattern, and cumulatively make up the flows experienced at the WRP. The diurnal patterns utilized for the City's collection system basins are provided in Appendix E.

Usually, the dry weather flow that is derived from the data collected over the flow monitoring period is similar to or slightly greater than the ADWF, partially because the flow monitoring data is collected during the rainy season when flows are enhanced by I/I. For the City's flow monitoring program conducted between October 2011 and February 2012, the dry weather flow was calculated to be 4.3 mgd. While the hydraulic model was calibrated to 4.3 mgd and to the flow monitoring data, the flow coefficients (discussed in Section 3.4.2) were created so that an ADWF of 5.2 mgd was represented in the model for the capacity analysis.

3.2.2 Wet Weather Flow

Wet Weather Flow (WWF) includes two components:

3.2.2.1.1 *Inflow and Infiltration (I/I)*

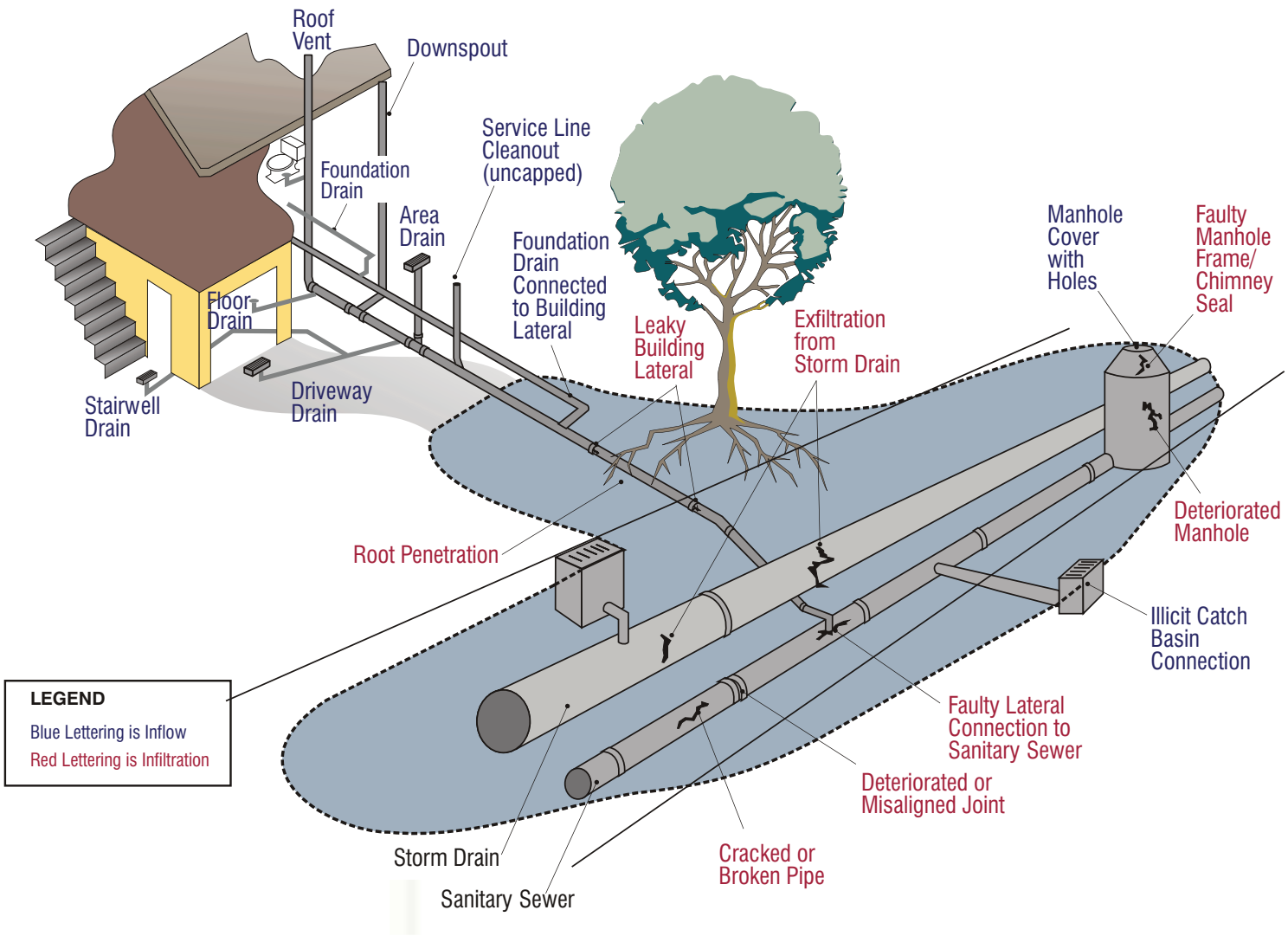
The stormwater inflow and infiltration response in the sewer system to rainfall is seen immediately (inflow) or within hours after the storm (infiltration).

3.2.2.1.2 *Groundwater Infiltration (GWI)*

GWI is not specific to a single rainfall event, but rather to the effects on the sewer system over the entire wet weather season. The depth of the groundwater table rising above the pipe invert elevation causes GWI. Sewer pipes within close proximity to a body of water can be greatly influenced by groundwater effects.

3.2.2.2 Inflow and Infiltration

Infiltration is stormwater that enters the sewer system by percolating through the soil and then through defects in pipelines, manholes, and joints. Inflow is stormwater that enters the sewer system via a direct connection to the system, such as roof drain and downspout connections, leaky manhole covers, and illegal storm drain connections. Some of the most common sources of I/I are shown in Figure 3.2. The adverse effects of I/I entering the sewer system is that it increases both the flow volume and peak flows such that the sewer system is operating at or above its capacity, as illustrated in Figure 3.3. If too much I/I enters the sewer system, sanitary sewer overflows (SSOs) could occur. For Grants Pass, the flow monitoring results indicate that the City collection system does have considerable I/I in certain parts of the system. The extent of the City I/I is described in Section 3.3.



SOURCES OF INFLOW AND INFILTRATION

FIGURE 3.2

CITY OF GRANTS PASS
WASTEWATER COLLECTION SYSTEM MASTER PLAN

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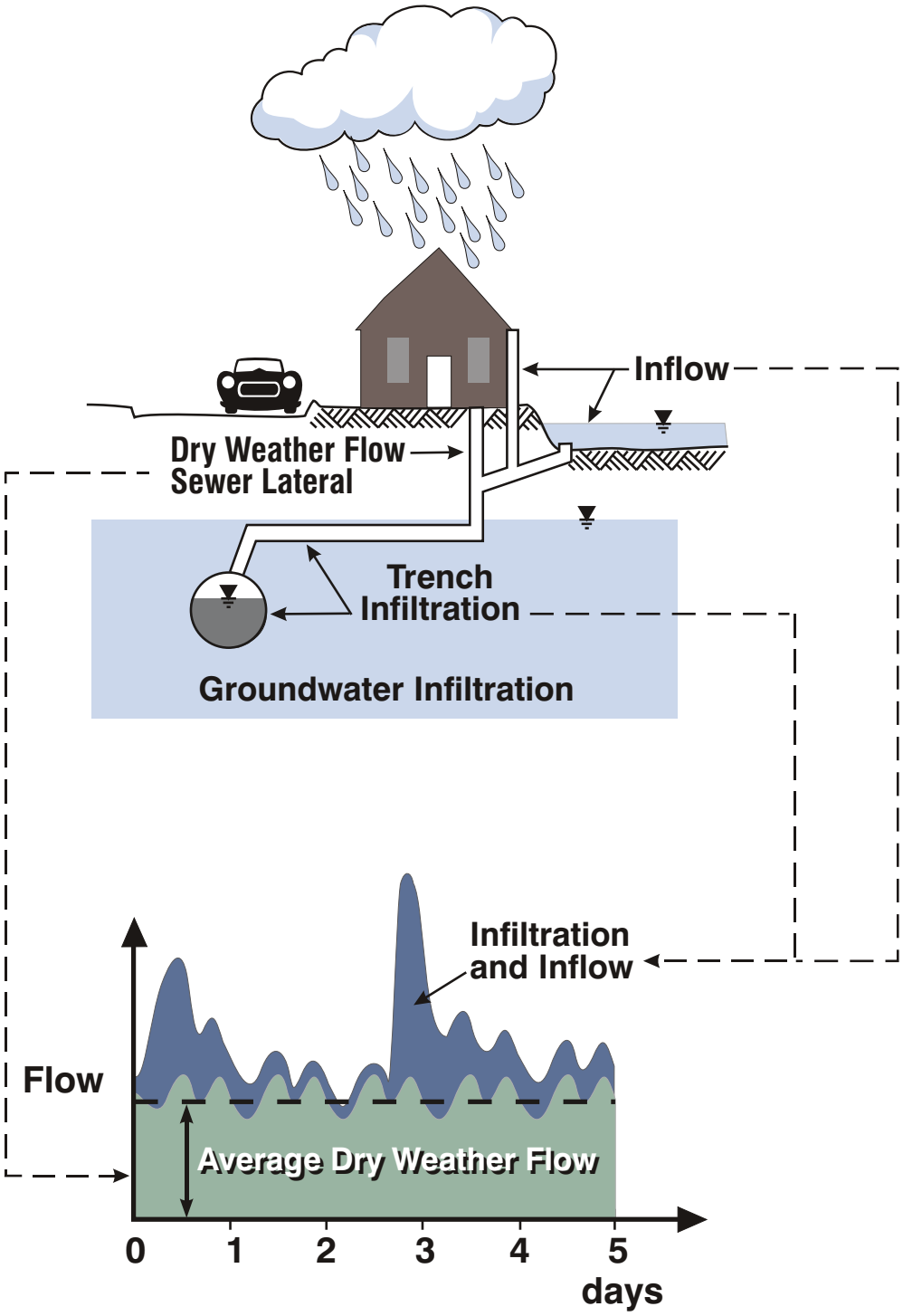


TYPICAL EFFECTS OF INFLOW AND INFILTRATION

FIGURE 3.3

CITY OF GRANTS PASS
WASTEWATER COLLECTION SYSTEM MASTER PLAN

I/I is modeled through the development of Rainfall Derived Inflow and Infiltration (RDII) Unit Hydrographs for the collection system. Typically, multiple RDII hydrographs are developed for a collection system to describe the I/I occurring at different locations throughout the system. This procedure provides a method for the hydraulic model to simulate the varying I/I that occurs based on the intensity and duration of storm events and the location within the collection system. RDII hydrographs are further discussed in Appendix E.

3.2.2.3 Groundwater Infiltration

Ground water infiltration, one of the components of I/I, is associated with extraneous water entering the sewer system through defects in pipes and manholes. GWI is related to the condition of the sewer pipes, manholes, and groundwater levels. GWI may occur throughout the year, although rates are typically higher in the late winter and early spring.

3.2.3 Peak Wet Weather Flow (Design Flow)

Peak Wet Weather Flow (PWWF) is the highest observed hourly flow that occurs following the design storm event, and is typically used for designing sewers and pump stations (therefore referred to as the “design flow”). PWWF occurs because wet weather I/I causes flows in the collection system to increase. While there is a peak flow associated with each storm event, in this study the PWWF represents the peak flow resulting from a design storm even, such as a 5-year, 24-hour design storm. PWWFs are modeled by simulating a storm event in the hydraulic model, after RDII unit hydrographs have been assigned to the collection system. The combination of the ADWFs and the I/I occurring from the storm event results in increased wet weather flows; during the design storm, these wet weather flows constitute the PWWF for the system.

3.3 FLOW MONITORING PROGRAM SUMMARY

Temporary flow monitoring was conducted to assist in the development of design flow criteria, and to correlate actual sewer system flows to the hydraulic model predicted flows. Flow monitoring data are used to calibrate the wastewater collection system hydraulic model for dry weather and wet weather flow.

Temporary flow monitoring was performed by the City during the 2011/2012 wet weather season. These flow monitoring programs, which began in October 2011 and continued through the beginning of February 2012, were used as part of this study to characterize both dry weather and wet weather flows in the City service area.

Carollo Engineers contracted with V&A Consulting Engineers (V&A) to conduct a temporary flow monitoring program at 10 monitoring sites within the City collection system. The meter sites were selected to best model the sewer areas and multiple sub-areas within the City’s collection system.

In addition to monitoring data from the 10 V&A flow meters, flow data was also available for the WRP for a portion of the flow monitoring period. Therefore, measured data from 11 total sites was available for use with model calibration. The V&A flow monitoring and inflow/infiltration report for the 11 sites where measured data was available is included in Appendix E. Flow monitoring data is further discussed in Appendix E where recorded dry weather flow, rainfall events and associated wet weather flows are detailed along with an I/I analysis study to determine the monitored basins with the highest contributing I/I. Flow monitor basins R42, I5, and H5 were shown experiencing the most significant I/I response, as shown on Figure 6 in Appendix E.

3.4 COLLECTION SYSTEM FLOW PROJECTIONS

This section summarizes the existing flows measured during the Flow Monitoring Program and presents the calculation of the design flows used to model the existing and future collection system.

3.4.1 Historic WRP Flows

In addition to flow monitoring data, historical influent data at the Water Reclamation Plant (WRP) were reviewed and presented in TM No. 3 - Water Restoration Plant Facility Plan, Influent Flows and Loads (Carollo, March 2013). The average monthly dry weather flow ranges from 4.94 mgd in 2008 to 5.32 mgd in 2010 with a 5-year average of 5.16 mgd. For this plan, the existing average dry weather flow equals to 5.21 mgd.

3.4.2 Wastewater Flow Coefficients

In order to develop wastewater flow projections and allocate future flows to the collection system, relationships between land use and wastewater generation were developed. These relationships, called wastewater flow factors are established based on the average wastewater flow generated for each existing land use type. The land use flow factors were established to project the estimated ADWF through build out of the City's wastewater collection system and project future flows within the study area boundary.

Average wastewater flow coefficients are rates, usually expressed in gallons per day per acre (gpda), applied to either gross or net acres for calculating average day flow generated from a particular land use. A flow coefficient was developed for each of the urban and rural land use classifications discussed previously. The flow coefficient provides a means to transform a land use category from acreage into wastewater flow. The resulting flow is then input into the appropriate sewer area in the sewer system model. Wastewater flow coefficients for residential areas can range between 1,000 to 4,000 gpda, and commercial and industrial areas might range from 500 to 2,500 gpda, with typical values averaging approximately 1,000 gpda. Land uses designated as open space and agriculture is assumed to generate negligible amounts of sewage flow, and as a result have a flow coefficient of zero.

The coefficients are developed using the following procedure:

- Average flows for each flow metering tributary area were derived from the flow-monitoring data (described in the Model Development and Calibration TM).
- Using GIS, the acres for each land use type contained in each flow-monitoring tributary area were calculated.
- Preliminary coefficients for each land use type were assumed based on typical values, which can be estimated from the approximate number of dwelling units per acre, the assumed per capita wastewater generation rates, and/or the typical number of people per dwelling unit for each land use type.
- The coefficients for each flow metering tributary area were adjusted up or down (balanced) within a reasonable amount (based on engineering judgment) until the calculated average flows from each tributary match what was measured during the flow monitoring period. If the flow coefficients produced average flows that were significantly different from the field measured flows, further investigation was conducted to verify that the tributary basins were delineated correctly and if the collection system configuration was correct.
- Once the coefficients for the 14 flow meter tributary areas were balanced, the weighted average of the coefficients for each land use type was calculated based on the acreage contribution from each metering tributary area.
- The flow coefficients were then adjusted to balance the calculated flows for the overall developed sewer service area, where flow-monitoring data was available. Since flow data for the WRP was available, the weighted average flow coefficients were adjusted to dry weather flow calculated for the flow monitoring period.
- The WRP dry weather flow was compared to the historical 5-year ADWF, and the coefficients were adjusted up to meet the ADWF of 5.20 mgd.

For example, for Flow Meter D60, the average day flow during the flow-monitoring period was approximately 0.611 mgd. The tributary service area upstream of this flow monitor is developed with buildings falling into a variety of zoning categories, including business park, commercial, industrial, and low-, medium-, and high-density residential. The preliminary flow coefficients were multiplied by the acreages for each land use designation and adjusted until the flows equaled 0.611 mgd. This process was repeated for each flow meter, and weighted flow coefficients were calculated for each land use category.

Table 3.1 presents the weighted wastewater flow coefficients and land use areas that represent the City's existing ADWF. The land use coefficients predict the ADWF to the WRP to be 5.21 MGD, a 0.1 percent different from the historical 5-year ADWF of 5.20 MGD. As with most cities, residential land use makes up the majority of developed land and wastewater flow. For Grants Pass, residential customers make up approximately 81 percent of the current flow.

Table 3.1 Flow Coefficients Development Summary
Wastewater Collection System Master Plan
City of Grants Pass

Zoning Category		Existing Service Area	Flow Coefficients	Flow Balance for Existing Service Area	
		Sewered Area (acre)	Adjusted ADWF Coefficient[1] (gpad)	Overall Wastewater Generation[2] (gpd)	Percent of Total Flow (%)
Urban Area					
BP	Business Park	147.7	1020	150,588	2.9%
CBD	Central Business District	24.2	1140	27,570	0.5%
GC	General Commercial	661.8	1050	694,922	13.3%
I	Industrial	83.7	1080	90,384	1.7%
IP	Industrial Park	18.8	1080	20,331	0.4%
NC	Neighborhood Commercial	4.1	1050	4,335	0.1%
OS	Open Space	0	0	0	0%
R-1-10	Residential - Low Density	223.2	690	156,026	3.0%
R-1-12	Residential - Low Density	363.4	960	348,816	6.7%
R-1-6	Residential - Moderate Density	366.9	1380	506,383	9.7%
R-1-8	Residential - Low Density	1,293.2	960	1,241,314	23.8%
R-2	Residential - Moderate Density	574.1	1380	792,169	15.2%
R-3	Residential - High Density	557.5	1620	903,119	17.3%
R-4	Residential - High-Rise Density	87.1	1800	156,854	3.0%
RI	Rural Industrial	0	1080	0	0%
RTC-1	Riverfront Tourist Commercial	5.0	960	4,823	0.1%
RTC-2	Riverfront Tourist Commercial	10.4	960	9,989	0.2%
RTC-3	Riverfront Tourist Commercial	0	960	0	0%
	Subtotal	**4,421.1**		**5,107,622**	**98.1%**
Rural Area					
GC	General Commercial	0	1050	0	0%
R-1-12	Residential - Low Density	0	960	0	0%
R-1-8	Residential - Low Density	0	960	0	0%
RC	Rural Commercial	0	1050	0	0%
RR1	Rural Residential 1 Acre	352.8	240	84,689	1.6%
RR2.5	Rural Residential 2.5 Acre	4.4	210	931	0.02%
RR5	Rural Residential 5 Acre	78.7	180	14,127	0.3%
WR	Woodlot Resource	0	0	0	0%
	Subtotal	**435.9**		**99,746**	**1.9%**
--	Streets, Canals, etc.	0.0	0	0	0%
	Grand Total	**4,857.0**		**5,207,368**	**100%**
	Total Predicted Flow[3]			**5.21 MGD**	
	5-Year Average Dry Weather Flow[4]			**5.20 MGD**	
	Percent Difference			**0.1%**	

Notes:
(1) Flow coefficients were generated by determining the coefficients that would result in the predicted flows equaling the measured flows over the course of the flow monitoring period. Basin-specific flow coefficients were developed, and an overall weighted average coefficient for each land use category was developed. Then, the coefficients are adjusted up to meet the WRP's historical annual ADWF of 5.2 mgd. The DWF to the WRP during the monitoring period was less than the ADWF (4.3 mgd compared to 5.2 mgd, respectively), so the flow coefficients were increased to represent the historical ADWF.
(2) Overall wastewater generation is the adjusted average coefficient multiplied by the existing sewered acreage. This value serves as a flow balance against the ADWF.
(3) Total predicted flow is calculated by multiplying the adjusted flow coefficient for each land use category by the existing sewered service area for that category. This step serves as a check that the ADWF is being correctly represented.
(4) Total ADWF represents the historical 5-year annual average dry weather flow, based on historical flow data from the WRP.

As presented in Chapter 2, future land use designations are different from the existing designations. The City provided a relationship between existing and future designations. Table 3.2 summarizes this relationship and details flow factors that will be used in the future flow projections.

Table 3.2 Existing Zoning and Future Land Use Correlation
Wastewater Collection System Master Plan
City of Grants Pass

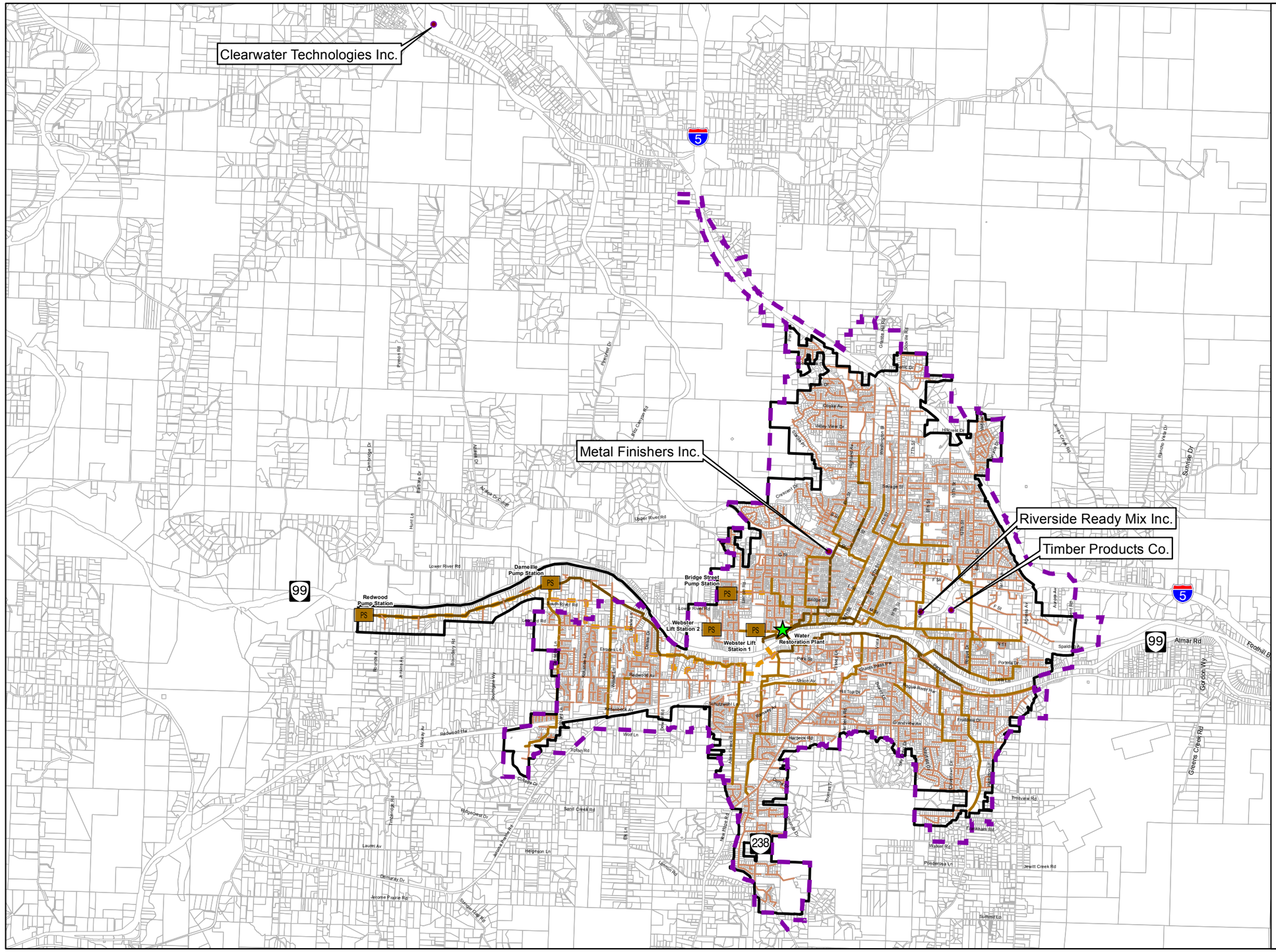
Comprehensive Plan Land Use	Existing Zoning Designation
LR	R-1-12/R-1-10/R-1-8
MR	R-1-6/R-2
HR	R-3/R-3-2
HRR	R-4/R-4-2/R-5
NC	NC
CBD	CBD
RTC	RTC-1/RTC-2/RTC-3
GC	GC
COMM	COMM
BP	BP
IP	IP
I	I/RI
EMP	I/IP/BP

3.4.3 Industrial Customers

The City's four industrial dischargers within the study area are:

- Riverside Ready Mix, located 531 SE Mill Street.
- Metal Finishers, located 817 SW Foundry Street.
- Timber Products, located 1090 SE "M" Street.
- Clearwater Technology located 111 Haines Ln (Outside Study Area, trucked to the WRP Plant).

The location of these customers is illustrated in Figure 3.4. Four years' worth of data was summarized for each of the City's industrial dischargers. Figure 3.5 presents the historic total flows and projected flows. The City does not plan on adding additional industrial customers to the study area.



Legend

- Industrial Discharger
- WRP
- Lift/Pump Station

Pipelines

- 8" and Smaller
- 10" - 16"
- 18" and Larger
- Force Mains
- Existing Sewer Service Area
- UGB
- Tax Lots

N

0 4,000 8,000 Feet

Figure 3.4
Industrial Dischargers Locations
Wastewater Collection System
Master Plan
City of Grants Pass

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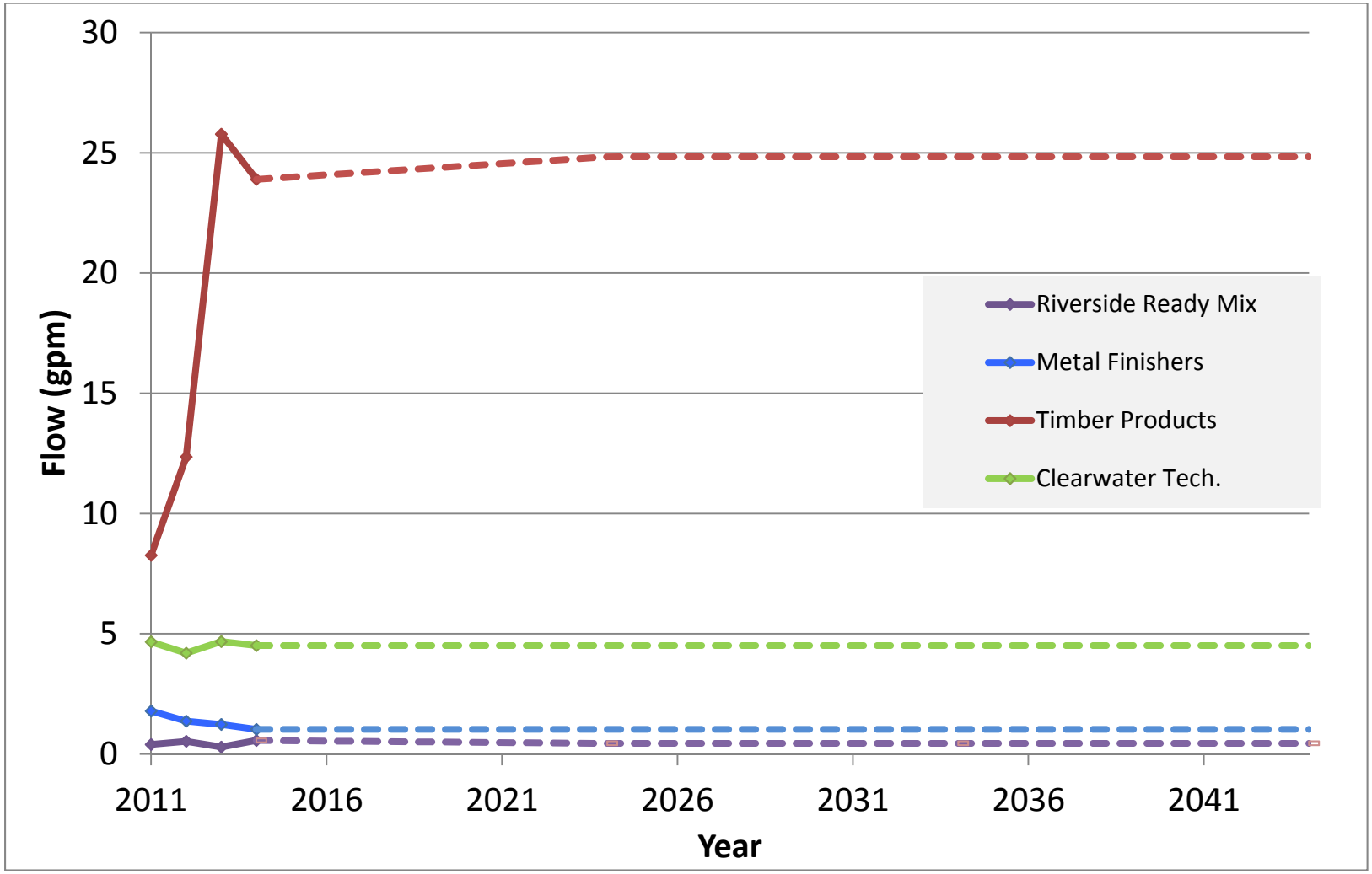

HISTORIC AND PROJECTED INDUSTRIAL DISCHARGERS FLOWS

FIGURE 3.5

CITY OF GRANTS PASS
WASTEWATER COLLECTION SYSTEM MASTER PLAN

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3.4.4 Future Customer Connection Assumptions

Some areas in the City's study area are currently undeveloped but not connected to the collection system. As these areas develop, the City will need to expand its existing collection system to serve these new customers.

Figure 3.6 shows the assumptions on where these areas are planned to be connected. Infrastructure recommendations to serve the future undeveloped area are developed as part of Chapter 5 - Collection System Analysis.

3.4.5 Wastewater Basins

To identify capacity requirements for specific facilities throughout the system, flows were developed for each wastewater basins. These wastewater basins are based on the understanding of the system. The City's collection system consists of 23 wastewater basins, as shown in Figure 3.7.

Future wastewater basins were named with a double letter based on which basin they are designated to flow. For instance, future basin FF flows to existing basin F.

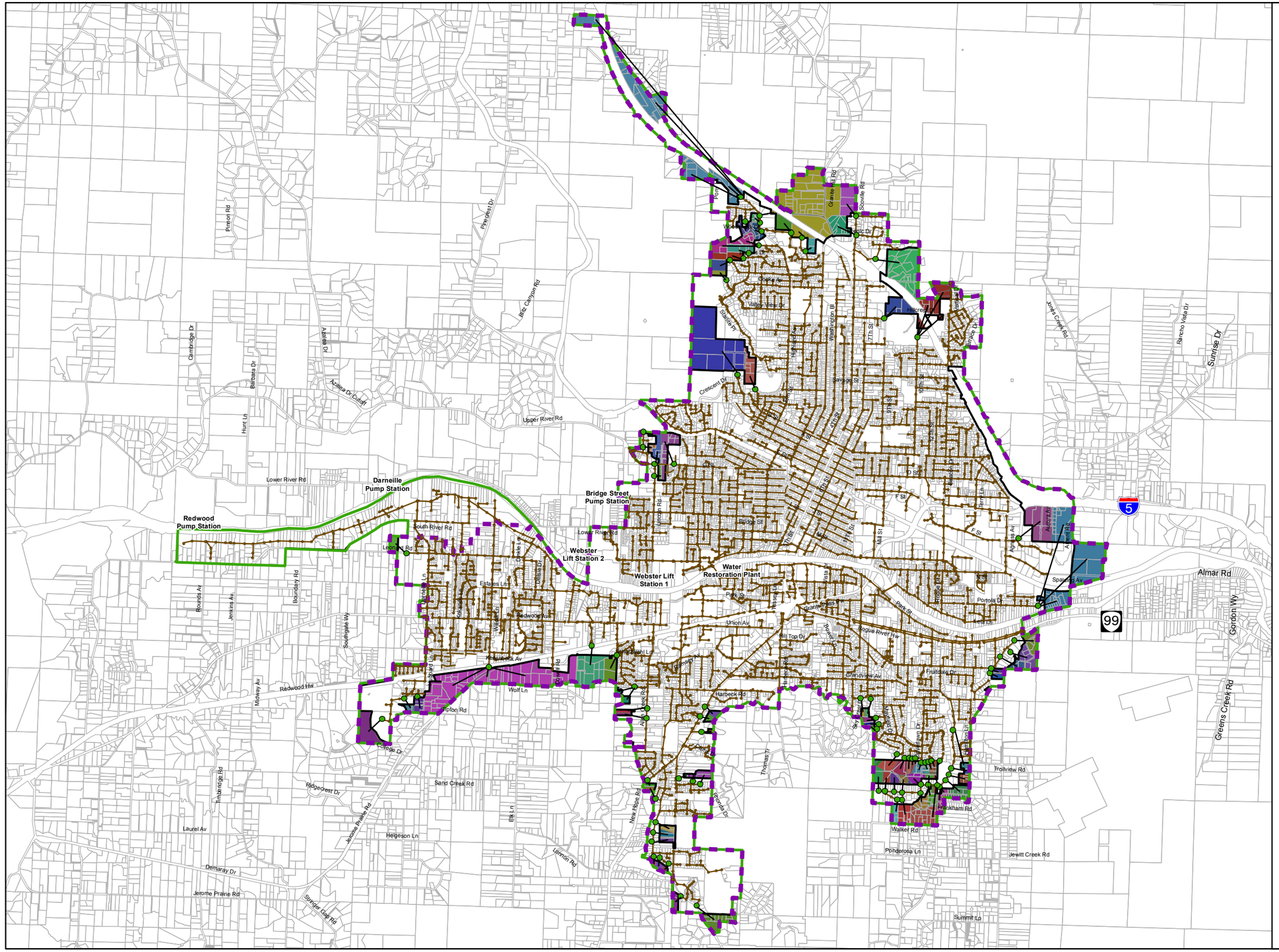
3.4.6 Existing and Projected Average Dry Weather Flow

Developing an accurate estimate of the future quantity of wastewater generated at build out of the collection system is an important step in maintaining and sizing sewer system facilities, for both existing conditions and future scenarios.

Base flow can be estimated for a wastewater system by comparing dry weather flow and wet weather flow at the various flow monitoring locations. To estimate ADWF for more specific areas, such as individual wastewater basins, dry weather flows are typically estimated based on the area contributing to flows and flow coefficients developed for each land use type. This method is developed based on the assumption that areas with similar land uses, such as low density residential parcels, produce equivalent quantities of wastewater flow. System-wide flows can be compared to known flows at flow monitors, or at the treatment plant to verify accuracy. This method of estimating base flows is an industry standard for planning and provides sufficiently accurate data for planning purposes.

3.4.6.1 <u>Existing Average Dry Weather Flows</u>

The City’s current base flows were derived by calculating the areas of land currently contributing flow to the wastewater collection system. The total acreage only accounts for the developed properties that are currently connected to the collection system. As presented in Section 3.3, the existing dry weather flow for the entire collection system is estimated at 5.21 mgd.



Legend

- Contributing Manholes
- Other Manholes
- Flow Contributing Manhole
- Other Pipelines
- Future Growth Areas
- Study Area Boundary
- Existing Sewer Service Area
- UGB

N

0 5,000 10,000 Feet

Figure 3.6
Future Customer Connection Assumptions
Collection System Master Plan Update
City of Grants Pass

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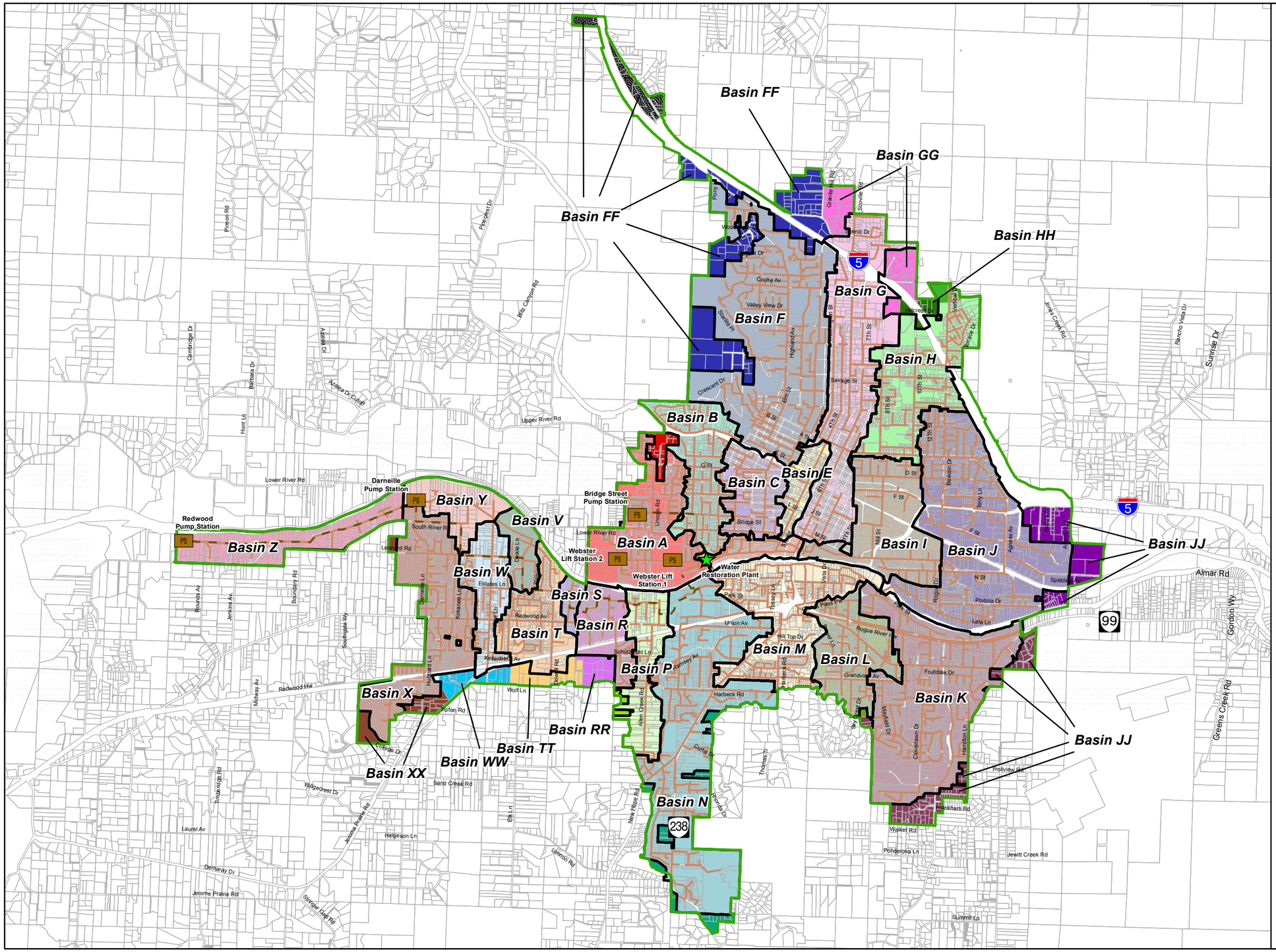

Legend

- WRP
- Lift/Pump Station
- Tax Lots
- Study Area
- Collection System Sewer Basins

Existing Wastewater Basins

- Basin A
- Basin B
- Basin C
- Basin D
- Basin E
- Basin F
- Basin G
- Basin H
- Basin I
- Basin J
- Basin K
- Basin L
- Basin M
- Basin N
- Basin P
- Basin R
- Basin S
- Basin T
- Basin V
- Basin W
- Basin X
- Basin Y
- Basin Z

Future Wastewater Basins

- AA
- FF
- GG
- HH
- JJ
- KK
- LL
- NN
- PP
- RR
- TT
- WW
- XX

N

0 5,000 10,000 Feet

Figure 3.7
Wastewater Basins
Collection System Master Plan Update
City of Grants Pass

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3.4.6.2 Projected Average Dry Weather Flows

The projected dry weather flows were developed based on the future land-use map presented in Chapter 2. Historical and projected flows are shown in Figure 3.8. Future average base flows for the study area are anticipated to increase to 7.01 mgd by the year 2025, and 9.07 mgd by the year 2035.

Projected flows were generated in a similar manner as the existing ADWF. The flow coefficients developed for the existing land use categories were applied to the future build-out land use (acres) to project the wastewater flow generated from infill and new development. The resulting flows represent the projected inflow in the hydraulic model.

3.4.6.2.1 *Short-Term Projections (2025)*

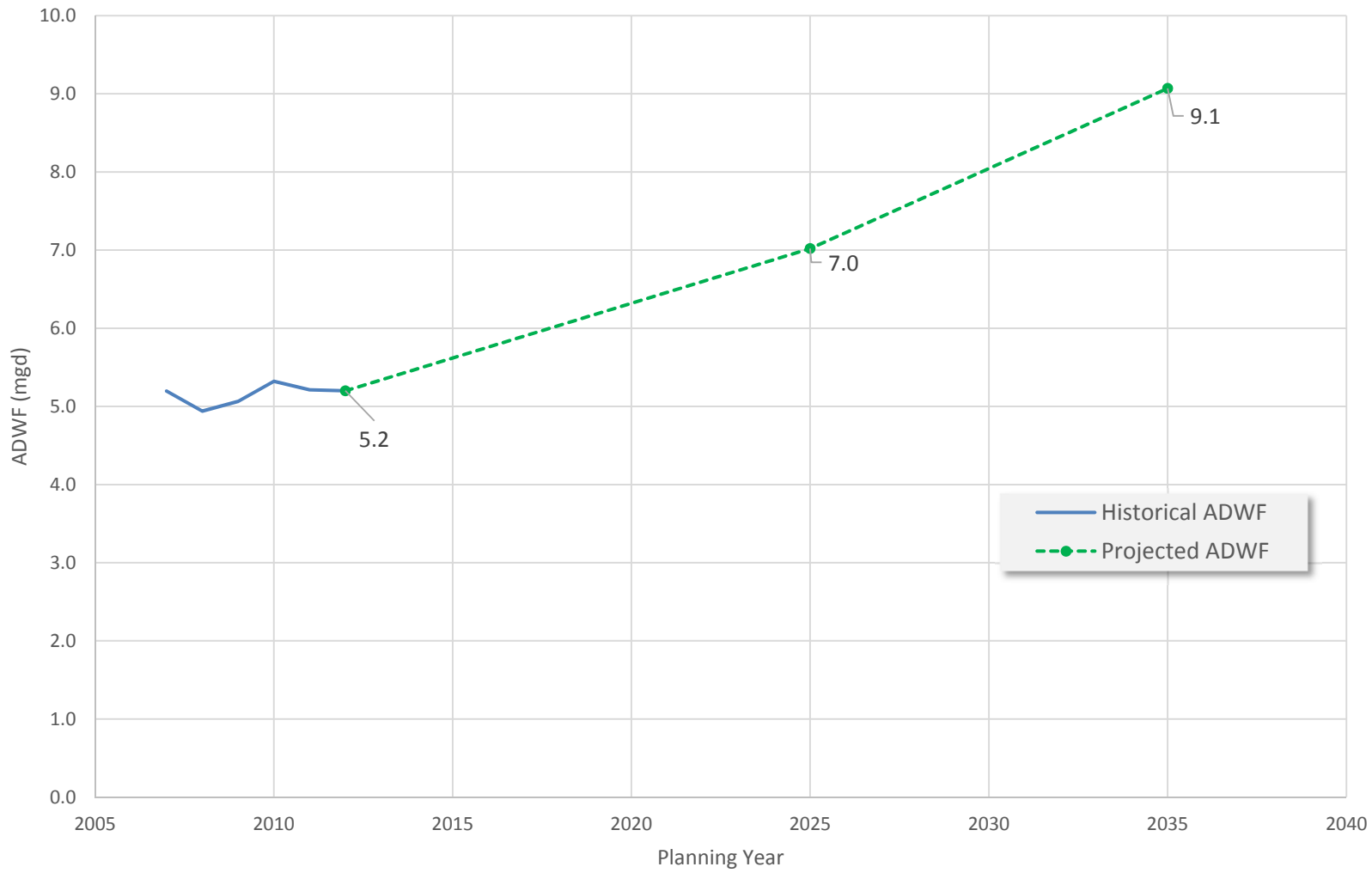
The total average dry weather for the City's collection system is based on the rates of growth used in the WRP Facility Plan (Carollo, March 2013). The WRP Facility Plan plans a rate of growth of 2.1 percent per year between existing conditions and year 2025. The existing dry weather flow of 5.21 mgd is therefore raised by 27 percent to a total of 7.01 mgd in 2025. The next step in short-term flow projections is to spatially allocate the additional 1.78 mgd of dry weather flow into the collection system.

The City provided assumptions on where to allocated short-term dry weather flows. All vacant parcels within the existing service area are assumed to be build-out by 2025 at the exception of three areas:

- Along the frontage on Highland/Vine.
- The industrial area on Foothill.
- The easterly portion of the Spalding area.

3.4.6.2.2 *Long-Term Projections (2035)*

The City plans on its Study area to be build-out by planning year 2033, therefore, the long-term projected flows assume 100 percent development and occupancy of all land areas within the study area. Using the flow coefficients presented in Section 3.4.2 and the City's GIS future land use data presented in Chapter 2, build-out flows are developed for the collection system. Build-out dry weather flows when the study area is considered build-out is estimated at 9.07 mgd.



HISTORICAL AND PROJECTED ADWF TREND

FIGURE 3.8

CITY OF GRANTS PASS
WASTEWATER COLLECTION SYSTEM MASTER PLAN

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3.4.6.3 Average Dry Weather Flow Projection Summary

All of the various flow coefficients summarized in this chapter helped to ultimately develop short-term and long-term sanitary dry weather flows. Table 3.3 presents the existing and projected trend of dry weather flows within the City's study area and Figure 3.8 graphically illustrates the flow projection results.

Table 3.3 ADWF Projections Summary by Sewer Basin
Wastewater Collection System Master Plan
City of Grants Pass

Sewer Basin ID	Existing ADWF (mgd)	2025 ADWF (mgd)	2035 ADWF (mgd)
Basins A/AA	0.15	0.37	0.45
Basin B	0.22	0.26	0.27
Basin C	0.18	0.19	0.20
Basin D	0.06	0.08	0.08
Basin E	0.05	0.07	0.08
Basins F/FF	0.59	0.75	1.24
Basins G/GG	0.40	0.52	0.69
Basins H/HH	0.28	0.43	0.49
Basin I	0.27	0.35	0.37
Basins J/JJ	0.52	0.73	0.90
Basins K/KK	0.38	0.54	0.81
Basins L/LL	0.22	0.26	0.26
Basin M	0.32	0.42	0.44
Basins N/NN	0.53	0.77	0.82
Basins P/PP	0.10	0.11	0.24
Basins R/RR	0.11	0.14	0.20
Basin S	0.03	0.03	0.04
Basins T/TT	0.22	0.25	0.32
Basin V	0.05	0.05	0.08
Basins W/WW	0.16	0.19	0.31
Basins X/XX	0.33	0.43	0.60
Basin Y	0.03	0.03	0.06
Basin Z	0.03	0.03	0.05
Total (mgd)	**5.21**	**7.01**	**9.07**

3.4.7 Peak Wet Weather Flow Development

Peak wet weather flows in a wastewater collection system are caused by rainfall dependent I/I. Peak hour flows can result in flows more than ten times the base flow, causing utilities to construct high-capacity infrastructure to convey and treat these extraneous flows. This section describes the methodology used for developing existing and future peak hour flows within the City's sewer system, which was subsequently used for performing the capacity analysis as described in Chapter 5.

3.4.7.1 Design Storm

Design storms are rainfall events used to analyze the performance of a collection system under peak flows and volumes, and have specific recurrence interval and rainfall duration. Developing a design storm can be accomplished in different ways. If historic data is not available, a synthetic design storm can be developed. For locations in Oregon, the National Oceanic and Atmospheric Administration (NOAA) publishes isopluvial (rainfall contour) maps that can be used to approximate the total rainfall depth for a range of design storms. For the City, the 5-year, 24-hour design storm was chosen to represent the design flows. The 5-year, 24-hour design storm event for the area surrounding Grants Pass is 3.5 inches. In Oregon, the 5-year, 24-hour design storm is typical for use with modeling wet weather flows in collection systems. Essentially, this design storm has a five percent chance (1/20) that 3.5 inches of rain will fall in any 24-hour period in a given year.

For the distribution of the design storm, it is possible to utilize a synthetic distribution or to establish a custom distribution based on historical data. The Natural Resources Conservation Service (NRCS), formally known as the Soil Conservation Service (SCS), method is typically used to distribute the rainfall volume and establish a peak intensity over a given storm duration. The NRCS method includes the use of developed normalized rainfall hyetograph distribution curves based on the storm's geographical location. However, during the planning of this capacity analysis, it was determined that utilizing a synthetic distribution for the design storm would result in peak flows that do not represent the intensity of storms that are typical for Grants Pass. The NRCS distributions would result in a storm intensity that is relatively high for the area, and would result in over-conservative design recommendations due to these inflated peak flows.

The alternative was to develop a custom design storm based on historical storm events that have occurred in Grants Pass, and to utilize a distribution that resulted in lower intensities but equivalent volumes to the design storm. Over the flow monitoring period, the highest volume storm that occurred was between January 18 and January 20, 2012. During this storm, the 24-hour period with the highest rain resulted in a total rainfall of approximately 1.95 inches, with the whole 46.5-hour storm event dropping approximately 2.95 inches of

rain.[1] The January 18-20 storm event distribution was used as the basis for the City's custom design storm. The 3.5-inch NOAA 5-year, 24-hour design magnitude was applied to the City's custom design distribution to produce the custom design storm.

Figure 3.9 shows the custom design storm used for the capacity analysis. The custom storm resulted in a peak rainfall intensity of 0.34 inches, compared to the NRCS peak intensity of 0.55 inches. As shown, antecedent rain was included before the 3.5-inch, 24-hour storm. This antecedent rain is actual rain data measured during the flow monitoring period from the rain gauge Grant10, which measured the highest amount of rain out of the five gauges monitored during the January 18-20 storm event. The purpose of including the antecedent rain was to mimic typical rainfall patterns in the region and to ensure that the peak flows through the system were appropriately conservative for planning. By using the custom distribution, excessive peak intensities were avoided. However, to ensure that the custom distribution provided conservative enough estimates of peak flows for planning, the antecedent rainfall was included prior to the design storm event.

3.4.7.2 I/I Development Methodology

Assumptions are made to estimate I/I in the sewer collection system are described in the sections below:

- Assumptions for existing customers;
- Assumptions for new customers.

All assumptions below are included in the results presented in section 3.4.7.3.

3.4.7.2.1 *I/I Assumptions for Existing Condition*

The I/I resulting from the design storm is simulated using the RDII unit hydrographs developed for the existing service area and each flow meter basin. The unit hydrographs are developed as a part of the wet weather calibration process of the hydraulic model, and are described in further detail in Appendix E. To simulate I/I, the calibrated RDII unit hydrographs were applied to each sewer basin during the design storm. The I/I that occurs during the design storm is representative of the I/I coming from the existing infrastructure.

3.4.7.2.2 *I/I Degradation Assumption*

The City wishes to account for degradation of their existing system in the future scenarios. Degradation is the slow decline in condition of the sewer collection system that allows an increase in I/I in the system. For the purpose of this study, it is assumed that degradation is 6 percent per decade. New sewer collection system should degrade less than old systems, therefore, degradation is a percentage of the existing I/I.

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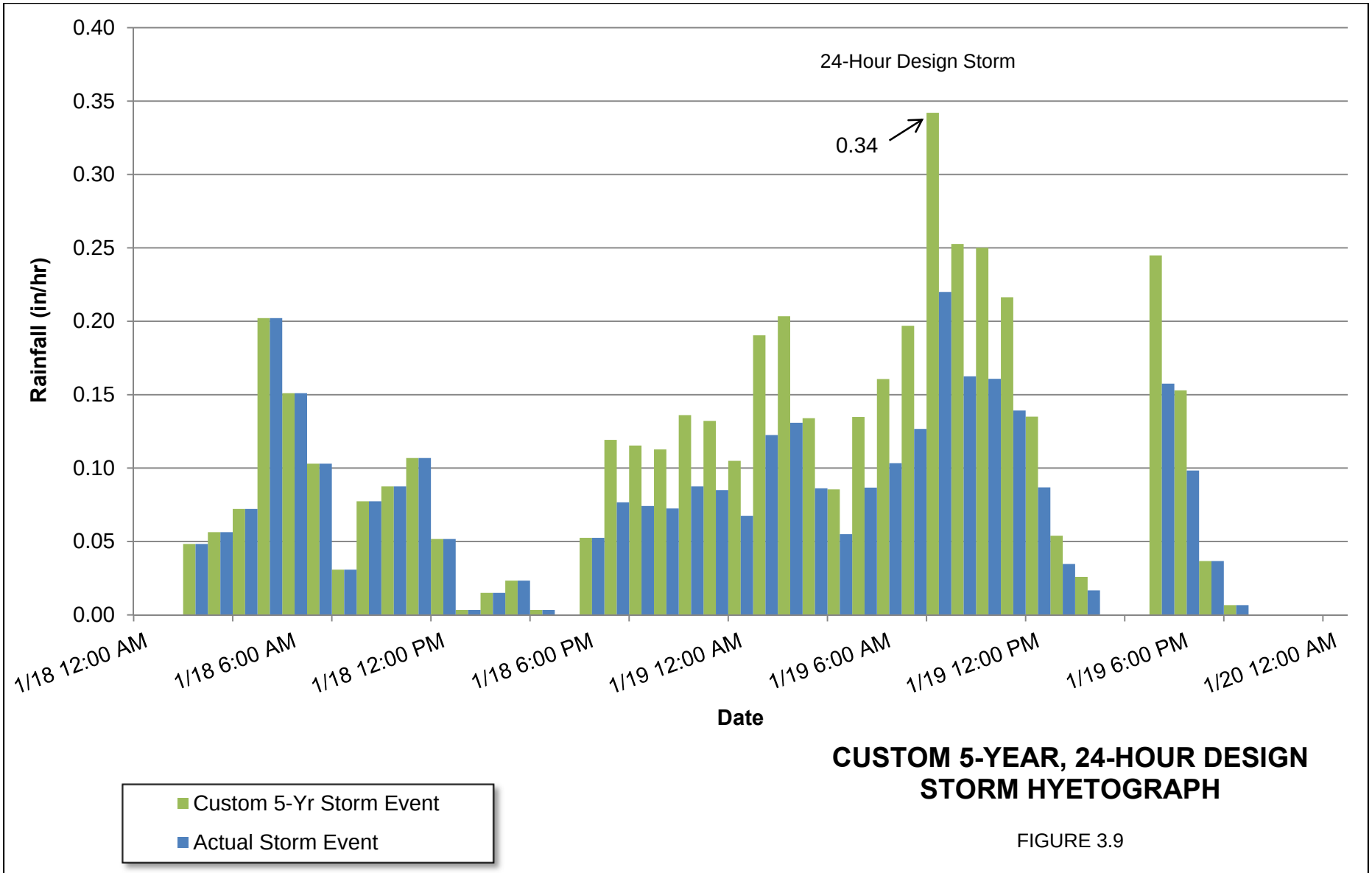
[1] Source: V&A Flow Monitoring Data, average rainfall for the January 18-20, 2012 storm from rain gauges VA Gauge, Grant4, and Grant10. These three rain gauges were the most representative gauges based on proximity to the City and influence on the collection system.



CUSTOM 5-YEAR, 24-HOUR DESIGN STORM HYETOGRAPH

FIGURE 3.9

CITY OF GRANTS PASS
WASTEWATER COLLECTION SYSTEM MASTER PLAN

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3.4.7.2.3 *Direct Inflow for Future Service Area Assumption*

To model I/I from infill and new development in the future service area, a direct inflow technique is used. Instead of simulating I/I using an RDII unit hydrograph, I/I is simulated by assuming a constant I/I flow factor per acre of new development. I/I flow factors can range from 1,000 to over 10,000 gpd/acre in the northwest. As detailed in Section 3.4.7.4 below, existing I/I flow factors for the City range from 1,231 gpd/acre to 9,320 gpd/acre.

An I/I Flow Factor of 1,000 gpd/acre is a reasonable assumption for estimating I/I in areas of new development to reflect improved construction methods and integrity of new materials. Therefore, the generation constant used for new development areas was 1,000 gpd/acre.

3.4.7.2.4 *Capacity Bottleneck Assumption*

The peak flows (existing and future) for the wastewater basins presented in Table 3.4 include improvements to correct capacity deficiencies presented in Chapter 5 - System Analysis. The improvement projects alleviate capacity bottlenecks upstream in each basin, which allows higher peak flows to be conveyed through the system. All values below represent the flows to the WRP if the capacity bottlenecks are resolved. This ensures that the PWWF truly represents the peak hour flow, without dampening due to upstream capacity deficiencies. Peak flows without improvements would be underestimates of actual peak system inflow.

3.4.7.3 Existing and Projected Peak Wet Weather Flows

The PWWF represents the maximum hourly flow rate under the selected design storm presented in Section 3.4.7.1 and growth conditions. Components of the design flow include the ADWF predicted for the scenario and the peak I/I rate predicted by the model using the assumptions described above. To develop the design flows in the hydraulic model, the design storm is routed through the model and the resulting I/I from existing and future development creates the design flow. Table 3.4 provides the peak hour design flow under both existing and future scenarios for each wastewater basin.

As shown in Table 3.4, projected growth increases the PWWFs predicted by the hydraulic model throughout the collection system. For the 5-year, 24-hour design storm, PWWFs up to 27.2 mgd are predicted for the existing condition. PWWFs up to 32.9 mgd and 37.6 mgd are predicted for the short-term and long-term conditions, respectively.

Table 3.4 Design Flows by Wastewater Basin(1) Wastewater Collection System Master Plan City of Grants Pass			
Wastewater Basin	**Existing Peak Flow (mgd)**	**2025 Peak Flow (mgd)**	**2035 Peak Flow (mgd)**
Basins A/AA	1.71	3.45	4.07
Basin B	1.70	2.24	2.56
Basin C	3.58	4.32	5.26
Basin D	7.68	9.73	11.24
Basin E	0.75	0.86	0.97
Basins F/FF	2.73	3.40	4.28
Basins G/GG	4.89	5.93	6.58
Basins H/HH	1.92	2.45	2.66
Basin I	1.54	2.30	2.34
Basins J/JJ	2.80	3.42	3.74
Basins K/KK	1.06	1.47	2.16
Basins L/LL	1.18	1.30	1.42
Basin M	6.27	7.67	8.86
Basins N/NN	1.43	2.07	2.42
Basins P/PP	1.56	1.68	1.78
Basins R/RR	2.14	2.35	2.60
Basin S	2.27	2.49	2.72
Basins T/TT	3.23	3.56	4.02
Basin V	3.60	3.95	4.44
Basins W/WW	0.44	0.52	0.70
Basins X/XX	1.10	1.37	1.64
Basin Y	5.91	6.32	7.29
Basin Z	0.47	0.53	0.54
Total (mgd)	**27.2**	**32.9**	**37.6**

Notes:
(1) These conditions represent the flows to the WRP if the capacity bottlenecks are resolved. This ensures that the PWWF truly represents the peak hour flow, without dampening due to upstream capacity deficiencies.

3.4.7.4 Peaking Factors and Peak I/I Rates

There are several metrics used to quantify the severity of the system's I/I. For this analysis, two metrics were used: Instantaneous Peaking factor and Peak I/I Rate. Table 3.5 presents

the calculated peak I/I rates and instantaneous peaking factors for each wastewater basin for current and future conditions under the 5-year, 24-hour design storm. It should be noted that these values are directly related to the volume and intensity of the design storm. A smaller rainfall event would produce lower values.

3.4.7.4.1 *Instantaneous Peaking Factor*

The instantaneous peaking factor was estimated by dividing the peak flow by the base flow. The PWWF:ADWF peaking factors reflect the nature of the projected I/I response with new development; as new development is added to the service area, the ratio decreases because the predicted I/I for new areas is less than that for existing development. However, in some cases, the ratio might increase as the City also plans for I/I degradation for existing customers.

The City's overall peaking factor under existing conditions is 5.2. In general, a system with a peaking factor value of more than 5 is usually considered to be experiencing significant I/I. Under future scenarios, the peaking factor decreases down to 4.1 due to the addition of new development to the collection system.

3.4.7.4.2 *Peak I/I Rate (gpad)*

The peak I/I rate is calculated by subtracting the base flow from the peak flow at the time the peak flow occurred. The base flow corresponds to the dry weather flow at the time the peak flow occurs. The base flow is therefore different from the ADWF. The base flow occurring at the time of the peak was determined using the diurnal curves for each basin. In general, a peak I/I per acre value greater than 3,500 gpad represents a high response of a collection system, while a peak I/I per acre value greater than 6,000 or 7,000 gpad is considered significantly high.

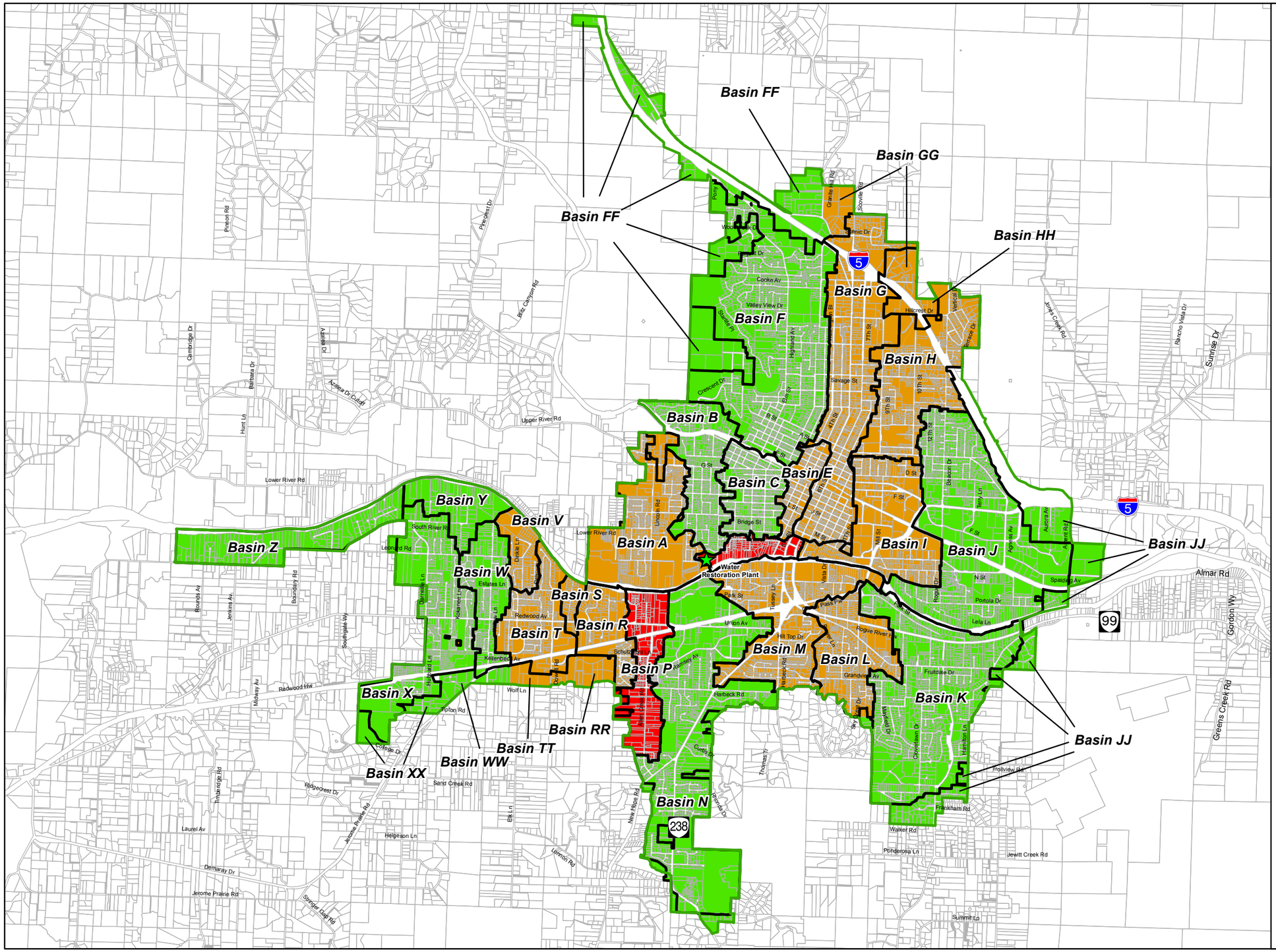
The highest peak I/I per acre rate under existing conditions is approximately 9,320 gpad in Basin D, which is considered significantly high. The City's overall existing peak I/I rate value is approximately 3,390 gpad. Out of the City's 23 wastewater basins, 11 basins have a peak I/I rate higher than 3,500 gpad with 2 basins with values above the 6,000 gpad threshold. Figure 3.10 classifies the wastewater basins based on their existing peak I/I rate value. This map ranks the basins from lowest value in green (<3,500 gpad) to highest value in red (> 6,000 gpad). Wastewater basins with significant I/I include basin D and basin P. This is consistent with the findings from the I/I analysis performed as part of the flow monitoring program.

In basins, where significant growth is planned, the peak I/I rate decreases because the predicted I/I for new areas is less than that for the existing development, however, in basins where little growth is expected, the peak I/I rate increases because of the I/I degradation of 6 percent per decade assumption. Some basins have a peak I/I rate value almost constant due to the average between degradation and new growth.

Table 3.5 Peaking Factors and Peak I/I Rates
Wastewater Collection System Master Plan
City of Grants Pass

Wastewater Basin	Existing Conditions		2025 Conditions		2035 Conditions	
	Peaking Factor	Peak I/I Rate (gpda)	Peaking Factor	Peak I/I Rate (gpda)	Peaking Factor	Peak I/I Rate (gpda)
Basins A/AA	5.6	5,597	4.1	3,322	3.9	3,071
Basin B	4.7	3,389	3.9	3,611	3.9	3,634
Basin C	4.7	3,294	4.4	3,657	3.7	3,637
Basin D	4.3	9,320	4.0	12,025	3.8	13,304
Basin E	3.3	4,412	3.2	4,286	3.6	4,910
Basins F/FF	5.2	3,337	4.8	4,053	3.6	2,314
Basins G/GG	4.2	4,310	3.9	5,177	3.8	3,664
Basins H/HH	6.2	5,336	5.0	4,852	4.8	4,465
Basin I	4.9	3,786	4.5	3,782	4.7	3,529
Basins J/JJ	5.3	3,483	4.5	3,522	4.1	2,872
Basins K/KK	3.2	1,231	2.9	1,505	2.8	1,579
Basins L/LL	8.1	4,115	6.9	4,300	7.3	4,267
Basin M	5.3	4,039	4.4	3,861	4.1	3,623
Basins N/NN	5.5	1,845	3.9	1,907	3.7	1,883
Basins P/PP	7.1	7,673	6.8	7,223	7.1	6,770
Basins R/RR	7.9	4,020	7.2	3,629	6.8	4,174
Basin S	8.3	3,583	7.5	3,864	7.0	3,004
Basins T/TT	7.8	4,041	7.0	4,305	6.3	4,645
Basin V	8.2	4,037	7.3	4,229	6.7	4,176
Basins W/WW	4.0	1,778	3.5	2,050	3.1	1,448
Basins X/XX	6.1	2,571	4.6	2,632	3.7	2,463
Basin Y	7.6	2,043	6.4	1,177	5.4	977
Basin Z	26.5	2,563	25.8	2,212	23.7	1,780
Total (mgd)	**5.2**	**3,391**	**4.7**	**3,513**	**4.1**	**2,969**

Notes:
(1) Peak I/I rate equals to the peak I/I divided by the total acreage contributing to I/I for each wastewater basin.
(2) When subtracting flows between basins, the accuracy in reported peak flows decreases. Most basins require subtraction of more than 2 flow streams from upstream basins. The "level of confidence" in peaking factor and Peak I/I rates for these basins is less than for basins located directly upstream.
(3) These conditions represent the flows to the WRP if the capacity bottlenecks are resolved. This ensures that the PWWF truly represents the peak hour flow, without dampening due to upstream capacity deficiencies.



Legend

- WRP
- Tax Lots
- Study Area
- Collection System Sewer Basins

Wastewater Basins Peak I/I gpad

- Peak I/I rate less than 3,500 gpad
- Peak I/I rate between 3,500 gpad and 6,000 gpad
- Peak I/I rate above 6,000 gpad

Figure 3.10
Peak I/I Rates Ranking for Existing Conditions
Collection System Master Plan Update
City of Grants Pass

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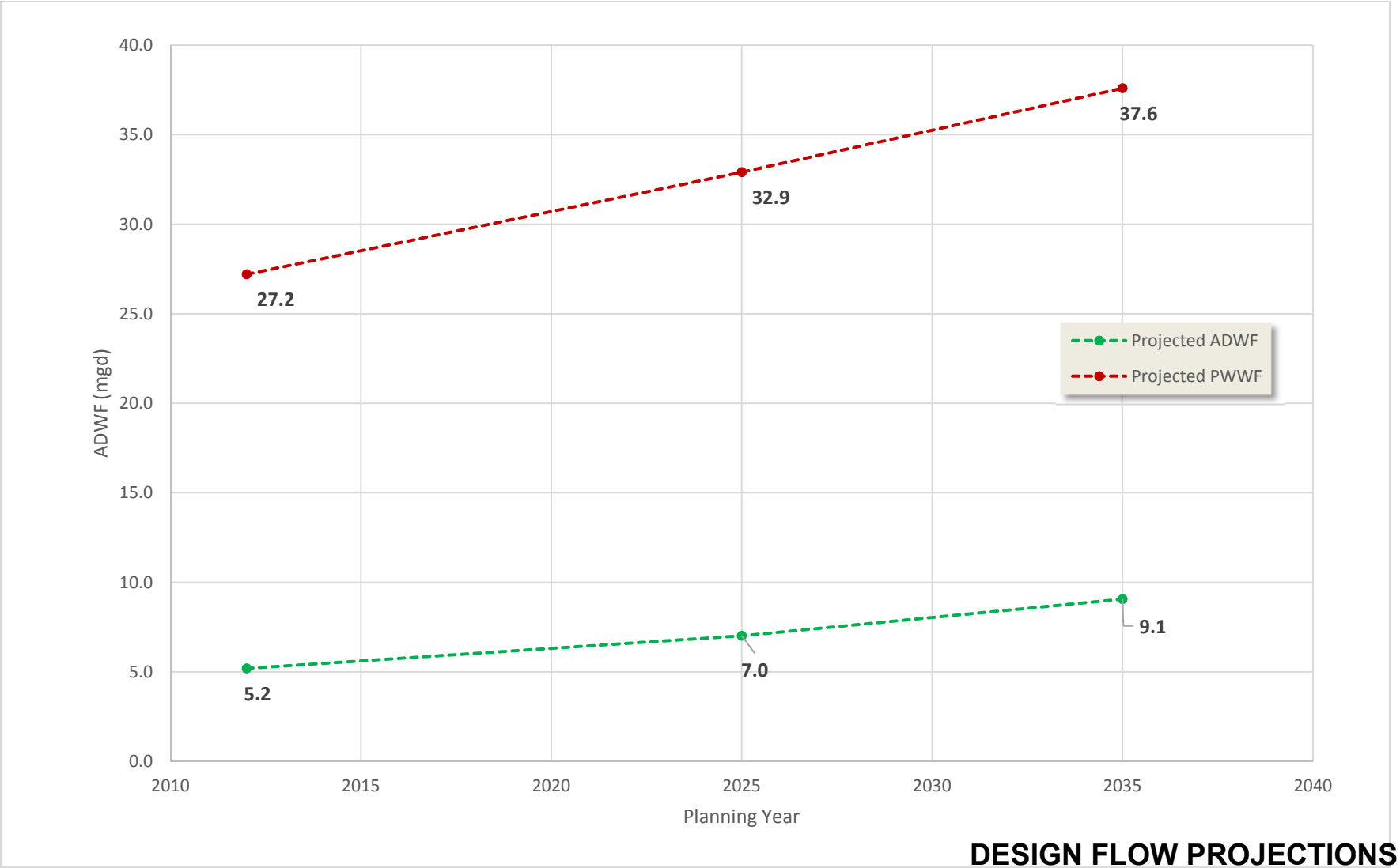
3.4.8 Flow Projection Summary

This section summarizes the flow projection results developed in the above sections. Figure 3.11 summarizes the flow projections. In the long-tern, the maximum peak wet weather flow is estimated at 37.6 mgd at the WRP, as shown in Table 3.6. All conditions reflect PWWF predictions for existing and future development conditions, but with capacity bottlenecking minimized throughout the system. PWWFs from these scenarios more closely represent the wastewater inflows to the system and the potential existing and future PWWFs to the WRP once necessary improvements are implemented.

Table 3.6 Existing and Projected Wastewater Flows to WRP
Wastewater Collection System Master Plan
City of Grants Pass

Condition[3]	Average Dry Weather Flow (ADWF) (mgd)	Peak Wet Weather Flow (PWWF)[1] (mgd)	Peaking Factor (PWWF:ADWF)[2]
Existing	5.2	27.2	5.2
Short-Term (2025)	7.0	32.9	4.7
Long-Term (2035)	9.1	37.6	4.1

Notes:
(1) The PWWF flow (design flow) is the peak hourly flow.
(2) Peaking factor is the Peak Wet Weather Flow divided by the Average Dry Weather Flow.
(3) These conditions represent the flows to the WRP if the capacity bottlenecks are resolved. This ensures that the PWWF truly represents the peak hour flow, without dampening due to upstream capacity deficiencies.



DESIGN FLOW PROJECTIONS

FIGURE 3.11

CITY OF GRANTS PASS
WASTEWATER COLLECTION SYSTEM MASTER PLAN

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