REQUEST FOR COUNCIL ACTION

DATE ACTION REQUESTED: May 3, 2021				
Order __ No.	**Ordinance XX No. 2021-2877**	**Resolution __ No.**	**Motion __**	**Information ___**

SUBJECT: An Ordinance amending the Newberg Comprehensive Plan, X. 2018 Wastewater Master Plan incorporating the Addendum Riverfront Master Plan 2021 into the Newberg Comprehensive Plan	**Staff: Doug Rux, Director; Brett Musick, Emily Flock, Peter Olsen** **Department: Community Development** **File Number: CPTA20-0004**
Business Session	**Order on Agenda: Public Hearing**

HEARING TYPE: ☒ **LEGISLATIVE** ☐ **QUASI-JUDICIAL** ☐ **ADMINISTRATIVE**
☐ **NOT APPLICABLE**

RECOMMENDATION:

Adopt Ordinance No. 2021-2877.

EXECUTIVE SUMMARY:

A. SUMMARY: The proposed amendment does the following:

Incorporates the Addendum Riverfront Master Plan 2021 into the 2018 Wastewater Master Plan.

Changes to the 2018 Wastewater Master Plan occur at:

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Appendix F – Hess Creek Phase 1, Hess Creek Phase 2, Springbrook Road, Pinehurst Court, Maintenance Yard Improvements, Lift Station Improvements (short-term), I/I Projects Downtown, Fifth Street
Appendix K

B. BACKGROUND:

The Newberg City Council accepted the 2019 Riverfront Master Plan on September 16, 2019 by Resolution No. 2019-3596. The Riverfront Master Plan identified various wastewater improvements necessary to support the overall vision of the Riverfront area and the development/redevelopment opportunities.

Keller Associates are the consultants who worked with city staff on preparing the 2021 Riverfront Addendum.

The Newberg City Council initiated the Comprehensive Plan Text Amendment on July 6, 2020 by adoption of Resolution No. 2020-3686 (Attachment 1).

Oregon Administrative Rule (OAR) Chapter 660, Division 11 (660-011-0000) includes language in the Purpose Statement that a city or county must develop and adopt a public facility plan for areas within an Urban Growth Boundary. It further indicates that a plan is to assure that urban development is guided and supported by types and levels of urban facilities and services appropriate for the needs. OAR 660-011-0005 has a definition of Public Facilities Plan that includes sanitary sewer and its associated subsets of Treatment facilities system and Primary collection system. This proposal is to incorporate the 2018 Wastewater Master Plan - Addendum Riverfront Master Plan 2021 into the Newberg Comprehensive Plan to meet Oregon Statewide planning requirements.

The original 2018 Wastewater Master Plan was prepared under a 20 year horizon to 2037 and is updated approximately every 10 years. The Addendum Riverfront Master Plan 2021 is within the same 20 year horizon.

Oregon Revised Statutes and Oregon Administrative Rules govern the preparation of and amendments to wastewater master plans. Specifically Oregon Statewide Planning Goal 11 Public Facilities and Services, ORS 197.712(2)(e), Oregon Administrative Rules Chapter 660 Division 11 Public Facilities Planning are the applicable Statute, goals and rules.

For wastewater master plans the following are applicable provisions to be included:

OAR 660-011-0005(7) "Public Facility Systems"

(b) Sanitary sewer:

(A) Treatment facilities system;

(B) Primary collection system.

The 2018 Wastewater Master Plan is broken into the following sections:

1. Executive Summary
2. Project Planning
3. Collection System Existing Facilities
4. Collection System Hydraulic Evaluation
5. Collection System Improvement Alternatives
6. Recommended Collection System Improvements
7. Infiltration and Inflow
8. Recommended Infiltration and Inflow (I/I) Improvements
9. Wastewater Treatment Plant Existing Conditions
10. Wastewater Treatment Plant Improvement Alternatives
11. Recommended Wastewater Treatment Plant Improvements
12. Capital Improvement Plan
13. System Development Charges
14. Appendices

C. PROCESS: A comprehensive plan text amendment is a Type IV application and follows the procedures in Newberg Development Code 15.100.060. The Planning Commission will hold a legislative hearing on the application. The Commission will make a recommendation to the Newberg City Council. Following the Planning Commission's recommendation, the Newberg City Council will hold a legislative hearing to consider the matter. Important dates related to this application are as follows:

1.	6/7/20:	The Newberg City Council adopted Resolution 2020-3686 initiating the Comprehensive Plan Amendment.
2.	12/2/20, 1/7/ & 212/25/21:	The Ad Hoc Stormwater, Wastewater and Water Citizens Advisory Committee met three times.
3.	3/24/21:	Planning staff placed notice on Newberg's website, and posted

notice in four public buildings. The Newberg Graphic published notice of the hearing.

4. 4/5/21: The City Council held a work session on the 2018 Wastewater Master Plan – Addendum Riverfront Master Plan 2021.

5. 4/8/21: The Planning Commission held a public hearing, took public testimony, and deliberated on the proposal.

6. 5/3/21: After proper notice, the City Council held a legislative hearing to consider the item.

D. PUBLIC COMMENTS: As of the writing of this report, the city has received no written comments on the application. If the city receives written comments by the comment deadline, Planning staff will forward them to the City Council.

E. STAFF/AGENCY COMMENTS: As of the writing of this report, the City has received the following comments on the proposal.
TVF&R – Reviewed, no conflict
Ziply – Reviewed, no conflict

F. DISCUSSION:

Executive Summary

Refining the recommended Riverfront area infrastructure was the initial goal for this Wastewater Master Plan Technical Update, the City also identified other wastewater system analyses and recommended improvements since 2018 which are included in this update.

The 2021 Technical Update of the City of Newberg's (City's) 2018 Wastewater Master Plan (WWMP) focused on three key areas:

1. Riverfront - update the 2018 WMP analysis and capital improvement program (CIP) to include the Riverfront Master Plan (RMP) area.

2. Update to alternatives for S River Street and E Eleventh Street.

3. Update alternatives for the Springbrook Area

4. No changes to System Development Charges (SDCs) are proposed at this time. City Council discussion on SDCs and the urban renewal plan and report will be completed before addressing any potential changes to SDCs.

For the full text of the Comprehensive Plan amendment, see Exhibit "A" to the Ordinance.

G. AD HOC STORMWATER, WASTEWATER AND WATER WASTEWATER CITIZENS ADVISORY COMMITTEE

The Wastewater Master Plan Citizens Advisory Committee recommended on February 25, 2021 by a vote of 5 to 1that the City Council adopt the 2018 Wastewater Master Plan – Addendum Riverfront Master Plan 2021 utilizing the Technical Memorandum prepared by Keller Associates as an appendix to the 2018 Wastewater Master Plan.

H. PLANNING COMMISSION RECOMMENDATION

The Newberg Planning Commission held a public hearing on April 8, 2021, heard public testimony, and approved Resolution No. 2021-366 (Attachment 2) recommending that City Council incorporate the 2018 Wastewater Master Plan – Addendum Riverfront Master Plan 2021 into the Newberg Comprehensive Plan.

FISCAL IMPACT:

The funding for the 2018 Wastewater Master Plan - Addendum Riverfront Master Plan 2021 comes out of Fund 04: Proprietary Capital Projects – Wastewater, 04-5150-706408 in the amount of $79,980.00.

Addition of the Riverfront Master Plan Area wastewater projects increases the Wastewater Master Plan Project list up to $51,855,000. This is an increase of $3,530,000 or 7%. The Riverfront Master Plan wastewater projects are being evaluated for possible funding, in whole or in part, as part of the Urban Renewal Plan & Report development process.

STRATEGIC ASSESSMENT:
2020 Council Goals:
1. Change operational culture to one focused on Customer Service and act to Resolve Ongoing Legal Disputes

Not applicable.

2. Further develop an operational culture that adopts and cherishes Diversity, Equity, and Inclusion as core values.

The Wastewater Master Plan – Addendum Riverfront Master Plan 2021 supports a wastewater system in the Riverfront area that is accessible to all residents within the Riverfront area and the community.

3. Promote development of housing affordability such as houselessness, transitional housing, workforce housing.

The Wastewater Master Plan – Addendum Riverfront Master Plan 2021 supports the existing and additional land designated for housing to address housing affordability opportunities consistent with the goal.

4. Create and support an Urban Renewal Plan and Authority

The Wastewater Master Plan – Addendum Riverfront Master Plan 2021 assists in supporting development of an urban renewal plan by establishing appropriate wastewater improvements that will feed into the proposed project list being evaluated for the urban renewal program.

5. Collaborate with local partners and with entities like ICLEI in the development of a Sustainability program.

Not applicable.

Attachments:
1. City Council Resolution No. 2020-3686 Initiating the Comprehensive Plan Text Amendment
2. Planning Commission Resolution No. 2021-366

ORDINANCE NO. 2021-2877

AN ORDINANCE AMENDING THE NEWBERG COMPREHENSIVE PLAN, X. 2018 WASTEWATER MASTER PLAN INCORPORATING THE ADDENDUM RIVERFRONT MASTER PLAN 2021 INTO THE NEWBERG COMPREHENSIVE PLAN

RECITALS:

1. The City of Newberg last updated its Wastewater Master Plan in 2018.

2. The Newberg City Council adopted Resolution 2020-3686 on July 6, 2020, which initiated amendments to the Newberg Comprehensive Plan – Wastewater Master Plan.

3. The 2018 Wastewater Master Plan – Addendum Riverfront Master Plan 2021 was prepared in accordance with Oregon Statewide Planning Goal 11 - Public Facilities and Services, ORS 197.712(2)(e), and Oregon Administrative Rules Chapter 660 Division 11 Public Facilities Planning.

4. Oregon Administrative Rules Chapter 660 Division 11 Public Facilities Planning requires that a Wastewater Master Plan be a part of a Comprehensive Plan.

5. The 2018 Wastewater Master Plan – Addendum Riverfront Master Plan 2021 Ad Hoc Citizens Advisory Committee met three times during the plan development providing feedback to the consultant and city staff.

6. After proper notice, the Newberg Planning Commission opened the hearing on April 8, 2021, considered public testimony and deliberated. They found that the proposed amendment was in the best interests of the City.

7. The Newberg Planning Commission adopted Resolution No. 2021-366 recommending the City Council incorporate the 2018 Wastewater Master Plan – Addendum Riverfront Master Plan 2021 into the Newberg Comprehensive Plan.

8. After proper notice, the Newberg City Council opened the hearing on May 3, 2021, considered public testimony and deliberated. They found that the proposed amendments were in the best interests of the City.

THE CITY OF NEWBERG ORDAINS AS FOLLOWS:

1. The 2018 Wastewater Master Plan – Addendum Riverfront Master Plan 2021 is adopted as shown in Exhibit "A".

2. The Newberg Comprehensive Plan is amended as shown in Exhibit "C".

3. Adoption is based upon the findings in Exhibit "B".

4. Exhibits "A", "B", and "C" are hereby adopted and by this reference incorporated.

- **EFFECTIVE DATE** of this ordinance is 30 days after the adoption date, which is: June 2, 2021.

ADOPTED by the City Council of the City of Newberg, Oregon, this 3rd day of May, 2021, by the following votes: **AYE:** **NAY:** **ABSENT:** **ABSTAIN:**

____
Sue Ryan, City Recorder

ATTEST by the Mayor this 6th day of May, 2021.

____
Rick Rogers, Mayor

List of Exhibits:

Exhibit "A": 2018 Wastewater Master Plan – Addendum Riverfront Master Plan 2021
Exhibit "B": Findings including Attachment 1 Newberg Urban Area Growth Management Agreement 1979 (as amended) and Attachment 2 Five Year Multi-Funded & Wastewater Capital Improvement Plan
Exhibit "C": Comprehensive Plan Text Amendment

Exhibit "A" to Ordinance No. 2021-2877 – File CPTA20-0004

EXHIBIT "A"
Ordinance No. 2021-2877

City of Newberg

Wastewater Master Plan

May 2018

Adopted July 2, 2018
City Ordinance: 2018-2831

KELLER ASSOCIATES

Technical Update May 2021
Addendum - Riverfront Master Plan (Appendix K)

ORDINANCE NO. 2018-2831

AN ORDINANCE INCORPORATING THE 2018 WASTEWATER MASTER PLAN INTO THE NEWBERG COMPREHENSIVE PLAN AND AMENDING SECTION L. PUBLIC FACILITIES AND SERVICES OF THE COMPREHENSIVE PLAN

RECITALS:

1. The City of Newberg last updated its Wastewater Master Plan in 2007, Wastewater Treatment Plant Facilities Plan in 2007 and then in 2009 based on Oregon Department of Environmental Quality comments on the 2007 Wastewater Treatment Plant Facilities Plan.

2. The City of Newberg Engineering Services Department in FY 2016-2017 and 2017-2018 prepared an update to the 2007 Wastewater Master Plan.

3. The Newberg City Council adopted Resolution 2018-3434 on February 5, 2018, which initiated amendments to the Newberg Comprehensive Amendment.

4. The 2018 Wastewater Master Plan was prepared in accordance with Oregon Statewide Planning Goal 11 - Public Facilities and Services, ORS 197.712(2)(e), and Oregon Administrative Rules Chapter 660 Division 11 Public Facilities Planning.

5. Oregon Administrative Rules Chapter 660 Division 11 Public Facilities Planning requires that a Wastewater Master Plan be a part of a Comprehensive Plan.

6. The Wastewater Master Plan Ad Hoc Citizens Advisory Committee met four times during the plan development providing feedback to the consultant and city staff.

7. The Newberg Planning Commission adopted Resolution No. 2018-339 recommending the City Council incorporate the 2018 Wastewater Master Plan into the Comprehensive Plan and amend section L. Public Facilities and Services of the Comprehensive Plan.

8. After proper notice, the Newberg City Council opened the hearing on June 18, 2018, considered public testimony and deliberated. They continued the second reading of the proposed ordinance to July 2, 2018.

9. City Council held the second reading on the proposed ordinance on July 2, 2018 and they found that the proposed amendment was in the best interests of the City.

THE CITY OF NEWBERG RESOLVES AS FOLLOWS:

1. The 2018 Wastewater Master Plan is adopted as shown in Exhibit "A".

2. The Newberg Comprehensive Plan is amended as shown in Exhibit "C".

3. Adoption is based upon the findings in Exhibit "B".

4. Exhibits "A", "B" and "C" are hereby adopted and by this reference incorporated.

➢ **EFFECTIVE DATE** of this ordinance is 30 days after the adoption date, which is: August 1, 2018.

ADOPTED by the City Council of the City of Newberg, Oregon, this 2nd day of July, 2018 by the following votes: **AYE: 6 NAY: 1 ABSENT: 0 ABSTAIN: 0**

Sue Ryan, City Recorder

ATTEST by the Mayor this 5th day of July, 2018.

Bob Andrews, Mayor

List of Exhibits:

Exhibit "A": 2018 Wastewater Master Plan
Exhibit "B": Findings including Attachment 1 Newberg Urban Area Growth Management Agreement 1979 (as amended) and Attachment 2 Five Year Wastewater Capital Improvement Plan
Exhibit "C": Comprehensive Plan Changes

May 2018

City of Newberg, Oregon

Wastewater Master Plan

KELLER ASSOCIATES

Keller Associates
707 13th St. SE. Suite 280
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216115/b/S17-003

REGISTERED PROFESSIONAL ENGINEER
5/23/18
83510PE
OREGON
NOV. 10, 2009
PETER OLSEN
EXPIRES: 12/31/18

Signed by:
Peter Olsen, P.E.
Project Manager

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Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

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Tables, Charts and Figures

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Acronyms, Abbreviations, and Selected Definitions

AA	average annual
AACE	Association for the Advancement of Cost Engineering
AAD	average annual daily
AADF	average annual daily flow
AC	acres
AC	asbestos cement
ADW	average dry weather
ADWF	average dry weather flow
alt	alternative
ave	average
AWW	average wet weather
AWWF	average wet weather flow
BMP	Biosolids Management Plan
BOD	biochemical oxygen demand
C	Celsius
$CaCO_3$	calcium carbonate
CCTV	closed circuit television
$cBOD_5$	Carbonaceous 5-day biochemical oxygen demand
CCB	Chlorine Contact Basins
CDB	Clarifier Distribution Box
CIP	Capital Improvement Plan
CIPP	cured-in-place-pipe
CFR	Code of Federal Regulations
cf/cft	cubic feet
CMOM	Capacity Management, Operation and Maintenance
COD	chemical oxygen demand
C/O	cleanout
CR	condition rating
CSI	Construction Specifications Institute
CWA	Clean Water Act
DEQ	Oregon Department of Environmental Quality
DO	dissolved oxygen
DS	downstream
dt/d	dry tons per day
DWF	dry weather flow
ea	each
EDU	equivalent dwelling unit
e.g.	exempli gratia (for example)
ENR-CCI	Engineering News Record – Construction Cost Index
EPA	Environmental Protection Agency
etc.	et cetera (and others)
ETL	excess thermal load
FOG	fats, oil, and grease
fps	feet per second
ft	feet (or) foot

FTE	Full Time Equivalent
GAS	granular activated sludge
GFU	George Fox University
GIS	geographic information system
gpcd	gallons per capita per day
gpd	gallons per day
gph	gallons per hour
gpm	gallons per minute
HLR	hydraulic loading rate
HP/hp	horsepower
Hr/s	hour/s
HRT	hydraulic retention time
HVAC	heating, ventilation, and air conditioning
HWY	highway
Hz	hertz
i.e.	id est (that is)
I/I	inflow and infiltration
ID	identification
in	inch
IMD	Internal Management Directive
IPS	influent pump station
KW	kilowatt
lb	pound
lb/d	pounds per day
LF	linear foot
LS	lump sum
LxWxH	length x width x height
MBBR	moving bed biofilm reactor
MCC	motor control center
MG	million gallons
MGD	million gallons per day
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MH	manhole
min	minutes
mL	milliliter
MLSS	mixed liquor suspended solids
mm	millimeter
MMDW	maximum monthly average dry-weather
MMDWF	maximum monthly average dry-weather flow
MMWW	maximum monthly average wet-weather
MMWWF	maximum monthly average wet-weather flows
mo	month
mpn	most probable number
N/A	not applicable
NASSCO	National Association of Sewer Service Companies
NC	no change
NH_4	ammonium
NH_4-N	ammonium as nitrogen
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resource Conservation Service
NTU	Nephelometric turbidity units

OAR	Oregon Administrative Rules
OD	oxidation ditch
O&M	operation and maintenance
O_2/scfm	Oxygen per standard cubic feet per minute
OP	Orthophosphate
OUL	original useful life
PACP	pipeline assessment certification program
PDA	peak daily average
PDAF	peak daily average flow
PIF	peak instantaneous flow
ph	phase
pH	Hydrogen ion concentration (measure of the acidity or basicity)
PLC	programmable logic controller
POC	pollutants of concern
PO_4-P	Phosphorus as Phosphate
ppcd	pounds per capita per day
PSU	Portland State University
PVC	polyvinyl chloride plastic
PWk	peak week
PWkF	peak week flow
RAS	return the activated sludge
RCP	reinforced concrete pipe
RDII	rainfall-derived infiltration and inflow
RDS	raw, de-gritted sewage
RPA	reasonable potential analysis
RPM	revolutions per minute
RV	recreational vehicle
SBR	sequence batch reactor
SCADA	supervisory control and data acquisition
scfm	standard cubic foot per minute
sBOD	soluble biochemical oxygen demand
SCL	secondary clarifier
sCOD	soluble chemical oxygen demand
SDC	system development charge
SE	secondary effluent
SLR	solids loading rate
SRT	sludge retention time
SST	Sludge Storage Tanks
SWD	side water depth
TDH	total dynamic head
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TP	Total Phosphorus
TRC	technical review committee
TS	total solids
TSS	total suspended solids
UGB	urban growth boundary
URA	urban redevelopment area
US	United States
US	upstream
V	volts
VFD	variable frequency drive
VSS	volatile suspended solids

WAS	waste activated sludge
WQBELs	water quality based effluent limits
WWF	Wet Weather Flow
WWMM	wet weather maximum month
WWTP	wastewater treatment plant
yr	year
ZID	Zone of Immediate Dilution

1. EXECUTIVE SUMMARY

In 2016, the City of Newberg, Oregon, contracted with Keller Associates, Inc. (Keller) to complete a wastewater facility planning study for the City's sanitary sewer collection system and wastewater treatment plant (WWTP). The study area consists of all areas within the City of Newberg Urban Growth Boundary (UGB). This section summarizes the major findings of the facilities plan, including brief discussions of alternatives considered and final recommendations.

1.1 PLANNING CRITERIA

City-defined goals and objectives, engineering best practices, and regulatory requirements form the basis for planning and design. For the Newberg Wastewater Treatment Plant (WWTP) facilities, applicable regulatory requirements include the National Pollutant Discharge Elimination System (NPDES) permit, Total Maximum Daily Loads (TMDLs), State Water Quality Standards, Recycled Water (Reuse) Regulations, and Land Use and Comprehensive Plan Requirements. The planning criteria for the collection system are set by the City using engineering best practices.

1.2 DESIGN CONDITIONS

1.2.1 Study Area and Land Use

The study area, consisting of the urban growth boundary (UGB), is shown in Figure 1-1 on the following page. The study area slopes generally to the south toward the WWTP and eventually to the Willamette River. Figures 2-4 in Appendix A present the mapped floodplains, soils, and wetlands. The wastewater system currently serves only areas within the UGB. Further expansion of the UGB was not considered in this report. It is recommended that future development and capital improvements within the UGB provide adequate conveyance for the full build-out of the upstream sewer basins within the UGB.

1.2.2 Demographics

The City's population has been increasing at a steady rate over the past few decades. Historic populations were obtained from the U.S. Census and Yamhill County in cooperation with Portland State University (PSU). PSU analyzes historic trends and anticipates growth patterns to develop growth rates for 5-year increments. The most current population estimate provided by PSU was 23,480 in 2017. These growth rates provide a population projection for 2037 of 33,811. These growth rates were reviewed and approved by the technical advisory committee for this planning study. Additional details about growth calculations can be found in Section 2.2. The overall estimated population growth rate from 2017 to 2037 is approximately 1.8% annually.

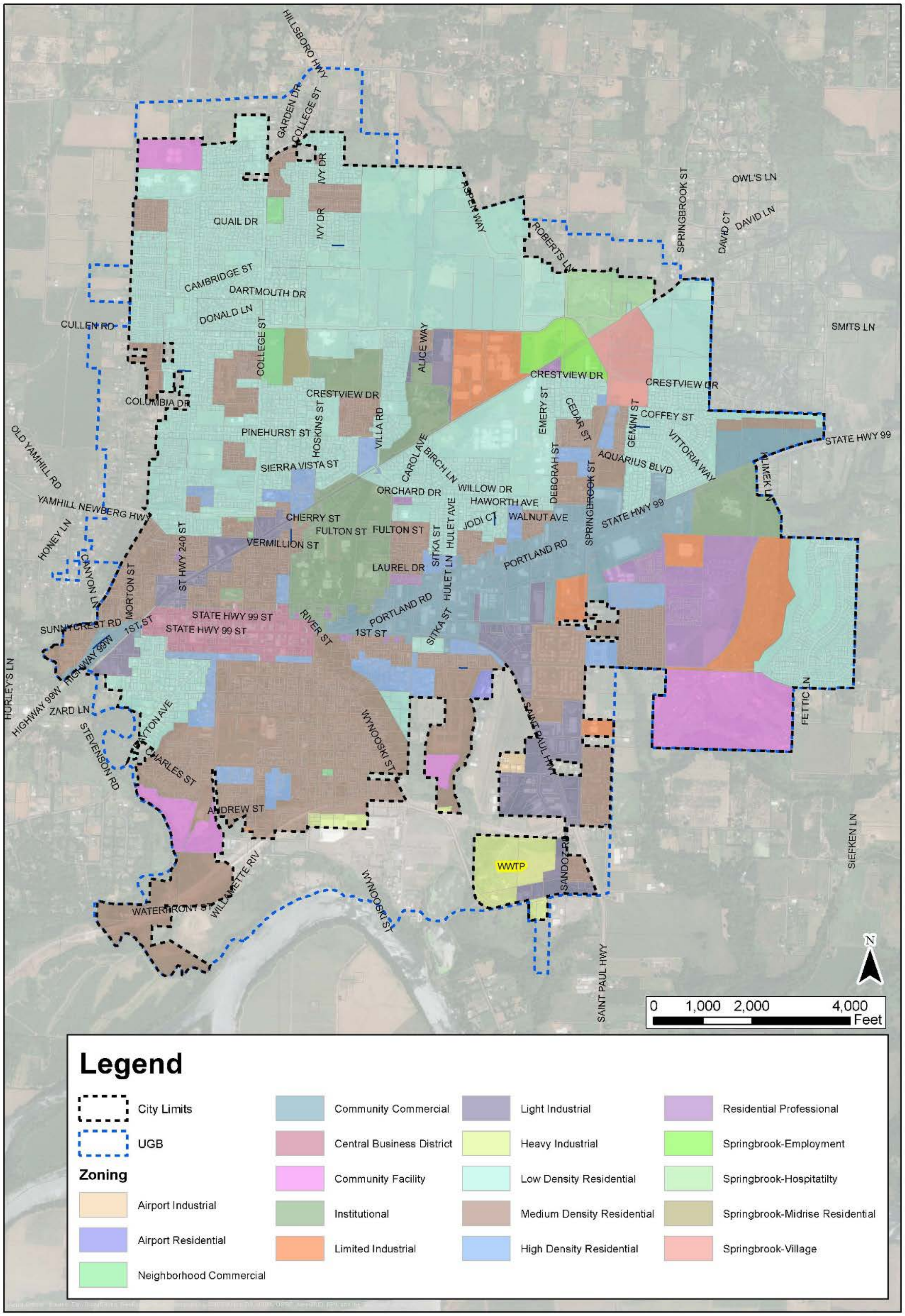


Figure 1-1: Study area and land use including UGB areas

1.2.3 Wastewater flows

Historical wastewater flows were evaluated to develop design flows and provide flow projections for the planning period. Observed flows for each year from 2012–2015 were developed for comparison with projected flows and are summarized in Table 1-1 below.

Table 1-1: Observed Historical Flows

	Historical Flows (MGD)				Design Flow (MGD)
Year	2012	2013	2014	2015	2015
Population	22,300	22,580	22,765	22,900	22,900
ADWF	2.25	2.51	2.19	2.14	**2.27**
$MMDWF_{10}$	2.96	3.63	2.93	2.30	**4.48**
AADF	3.78	2.69	3.27	3.54	**3.32**
AWWF	5.33	2.88	4.36	4.96	**4.38**
$MMWWF_5$	7.26	3.63	6.68	9.66	**9.66**
PWkF	10.8	6.02	8.73	14.5	**10.0**
$PDAF_5$	17.6	9.5	13.6	21.0	**21.5**
PIF_5	22.9	12.4	17.6	27.3	**28.0**
Total Rainfall (in/yr)	47	25	39	40	-

To project the design flows derived from the analysis, a projected flow per capita (reported in gallons per capita per day, gpcd) was developed. Projected design flows (MGD) are based on 2015 design flows with the addition of the product of projected unit flows (gpcd) and projected population increase (Table 1-2). Actual future flows will depend on a number of variables and could potentially be decreased through aggressive I/I reduction efforts.

Table 1-2: Projected Design Flows

	Design Flow (MGD)	Design Unit Flow (gpcd)	Projected Unit Flow (gpcd)[2]	Projected Design Flow (MGD)				
Year	2015	2015	-	2017	2022	2027	2032	2037
Population	22,900	22,900	-	23,480	25,797	28,343	31,139	33,811
ADWF	**2.27**	99	99	2.33	2.56	2.81	3.09	3.35
$MMDWF_{10}$	**4.48**	196	196	4.60	5.05	5.55	6.09	6.62
AADF	**3.32**	145	145	3.40	3.74	4.11	4.51	4.90
AWWF	**4.38**	191	191	4.49	4.94	5.42	5.96	6.47
$MMWWF_5$	**9.66**	422	250	9.81	10.4	11.0	11.7	12.4
PWkF	**10.0**	438	275	10.2	10.8	11.5	12.3	13.0
$PDAF_5$	**21.5**	941	325	21.7	22.5	23.3	24.2	25.1
PIF_5[1]	**28.0**	1,223	425	28.2	29.2	30.3	31.5	32.6

[1]The DEQ method produces a design flow of 67.1 MGD. PIF5 flow was adjusted based on continuous flow data from peak days between 2012 and 2015.
[2]Projected unit flow scaled down to reflect reduced I/I in future developments.

1.3 COLLECTION SYSTEM EVALUATION

The wastewater collection system consists of approximately 80 miles of gravity sewer mains, 3 miles of force main, and eight lift stations.

1.3.1 Lift Station Evaluation

There are eight lift stations and approximately 3 miles of force main operated and maintained by the City in its wastewater collection system (Figure 7 in Appendix A). Lift stations are generally named by their locations in the city: Andrew, Charles, Chehalem, Creekside, Dayton, Fernwood, Highway 240, and Sheridan. An onsite facility evaluation was completed in January 2017 with City operations personnel to review conditions of the lift station facilities, current maintenance activities, and operational problems encountered by City staff.

All stations are equipped with submersible pumps except Dayton, which uses self-priming, centrifugal pumps; however, the City is currently planning to upgrade the Dayton Lift Station with a submersible pump system. Table 3-2 contains summary information for the eight lift stations. Appendix C includes available data such as pump curves, data sheets, and other data resources.

This evaluation presents general observations and recommendations, along with specific recommendations for individual lift station sites. General recommendations are provided as a guideline to allow the City to maintain the lift stations for the 20-year planning period. Functionality, Inventory and any items of concern observed during the onsite evaluation are noted in Section 3.2.

Overall the Andrew, Charles, Chehalem, Creekside (although not lined), Fernwood, and Sheridan lift stations are in good condition. The Hwy 240 Lift Station is in need of preventative repairs and maintenance and the Dayton Lift Station has multiple notable deficiencies that are sited in the report.

1.3.2 Pipeline Condition and Capacity Evaluation

Except for the summary of the upper Hess Creek trunk line investigation, the inspection reports, pipeline rehabilitation, and spot repair recommendations for the collection system gravity mains are all summarized in Section 7.

The Upper Hess Creek trunk line investigation evaluated an exposed sewer pipe in Hess Creek (Section 3). The exposed pipe was first documented on August 8th, 2017 by City maintenance department and Keller Associates staff. Overall, the monitoring and testing indicates that the exposed pipe is not an excessive source of I/I to the Hess Creek trunk line. It is recommended that the pipe be monitored, but no immediate rehabilitation or replacement is required.

I/I is a concern in the Newberg collection system. In 2015, the City completed a Sanitary Sewer Infiltration and Inflow Study that assessed I/I. The study included a pump run time analysis, extensive flow monitoring, CCTV inspections, night-time flow monitoring, and smoke testing to generate a prioritized list of the top 25 I/I reduction projects in the study area, as well as a list of cross connections found while smoke testing, and spot repair needs identified through CCTV inspections (collectively, approximately 125,000 linear feet of pipeline has been inspected and incorporated in this master plan analysis).

Furthermore, continuous flow monitoring was completed for five weeks during January-March 2017 to better characterize the nature and distribution of I/I in the system. The City has a program to remove I/I where it is cost-effective. I/I investigation and characterization are included in the scope of this plan. Data collected for this project will be integrated with the results of the 2015 I/I Study; the prioritized lists will be revised accordingly (Appendix G).

Throughout the inspections, the most common operations and maintenance (O&M) defects found were roots, intruding taps, infiltration, and dirt or gravel in the pipe and laterals. The most frequent structural defects were cracks, fractures, and holes or breaks. There are 76 pipes that have at least one grade 5 defect, and an additional 68 pipes that have at least one grade 4 defect. These pipelines have partially collapsed/failed segments or segments that are near collapse/failure. All grade 5 defects should be repaired in the immediate future.

The first course of action that can reduce I/I in a system is to repair defects in the collection system. After completing replacement or rehabilitation of pipes in the priority CIP areas or on the spot repairs list, it is recommended that the City re-inspect the pipes using CCTV. One common mistake in I/I projects is that it is assumed the new or rehabilitated pipe completely fixes the inflow or infiltration problem. Additionally, continuous flow monitoring should continue to take place in the system. It is also recommended that the City establish a routine cleaning schedule for cleaning of the collection system. Routine cleaning of the pipes can remove debris buildup, which can cause unnecessary pressure/strain on the pipes and remove root intrusion. A more detailed description of operation and maintenance recommendations including staffing recommendations can be referenced in Section 6 of this report.

See Note 1

1.3.3 Collection System Improvement Alternatives

For each set of alternatives, there is also an unstated option to do nothing and make no changes. This option perpetuates existing deficiencies and increases the risk of surcharging, overflows, environmental damages, DEQ violations, and subsequent fines.

Dayton Lift Station

There are two alternatives to address the Dayton Lift Station deficiencies; rehabilitation of the station, and replacement of the station. Rehabilitation will not address the long-term needs of the station. Therefore, short-term improvements should be implemented

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1 while planning to replace the lift station. The lift station is already designed and bid out for construction.

Hess Creek Trunk Line and Villa Road

The trunk line in Hess Creek is limited in capacity and also presents numerous maintenance problems and costs. The exposed portion of the Hess Creek trunk line upstream of the Villa Road railroad crossing is not affected by any of the alternatives. Four alternatives have been explored to rehabilitate and/or replace sections of the Hess Creek trunk line (See Figure 16, Appendix A).

- **A. Parallel Gravity main, Hess Creek Line Upsizing and Rehabilitation:** Construct a larger parallel gravity main to the East and reconnect with the existing line. Upsize the portions of the existing line to reduce I/I. Improve access to the existing trunk line for inspection and maintenance.
- **B. New Lift Station, Local Grinder Pumps, Parallel Gravity Main, and Partial Abandonment of Hess Creek Line:** Build a lift station near the intersection of Villa Road, the railroad, and Hess Creek. Local grinder pumps would be installed to reach the gravity pipelines to the east and west of the canyon to primarily service the George Fox University campus. Construct a larger parallel gravity main to the East and reconnect with the existing line. Abandon-in-place approximately 8,500 linear feet of the Hess Creek trunk line.
- **C. New Lift Station, Parallel Gravity Main, and Partial Abandonment of Hess Creek Line:** Build a lift station north of where the Hess Creek trunk line crosses Portland Road. Construct a much larger parallel gravity main to the East and reconnect with the existing line. Abandon-in-place approximately 5,000 linear feet of the Hess Creek line south of the new lift station.
- **D. Replace the Hess Creek Line:** Upsize and replace the existing Hess Creek Line and fully line the sections that aren't replaced to decrease I/I.

Springbrook Road

Two alternatives were researched for this section of the conveyance system (See Figure 17, Appendix A): The existing trunk line could be upsized. Alternatively, a parallel gravity main could installed to help with the flows from the lift stations. The parallel line could also be used as an overflow to divert from either the lift station or other sections of the trunk line. With either alternative, certain sections of the line will need to be upsized.

South River Street

Deficiencies along the South River Street trunk line cause capacity issues upstream, therefore, upsizing stretches of existing pipe would alleviate capacity issues (See Figure 18, Appendix A). Additional flow monitoring and data collection could be beneficial to further characterize flow throughout the South River trunk line.

HWY 240 Lift Station

The hydraulic model indicates that the existing HWY 240 Lift Station is undersized for existing and future peak flows. The pumps at the lift station should be upsized to handle

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1 peak flows at buildout. Once the HWY 240 pumps have been upsized, the HWY 240 diversion structure should be adjusted to prevent flow going to the Dayton Lift Station. However, prior to upsizing HWY 240, South River Street improvements must be completed to prevent greater impacts to surcharging and overflows in the South River Street area.

Lift station trunk line consolidation/displacement were focuses of the alternatives evaluation. The alternatives did not present feasible opportunities to consolidate trunk lines. There are a variety of alternatives to displace and consolidate lift stations in conjunction with future infrastructure growth (See Figure 19, Appendix A).

1.3.4 Recommended Collection System Improvements

Lift Stations

Recommendations and tables are detailed in Section 6 of this report. In summary:

Priority 1 lift station improvements address existing deficiencies and have a total estimated cost of $1,429,000. Most of this estimate is for replacement of the Dayton Avenue Lift Station.

Long-term Priority 2 improvements assume that Andrew, Charles, Chehalem, and Creekside lift stations are displaced with other CIP projects. Fernwood, HWY 240 and Sheridan lift stations need video monitoring installed. HWY 240 will need to have upsized pumps. Sheridan will need several upgrades to improve flow.

Two new lift stations to service future development are recommended: one of them being a new lift station for the Hess Creek trunk line to address existing and future deficiencies. The second would be located North of the Fernwood Lift Station. A regional lift station is recommended to serve future development northeast of the intersection of Portland Road and Vittoria Way. Any pre-design for lift station abandonments should include a return on investment analysis.

Pipelines

The recommended alternative for Hess Creek trunk line and Villa Road is Alternative C - New Lift Station, Parallel Gravity Main, and Partial Abandonment of Hess Creek Line. This alternative can be completed as one project or could be divided into three phases.

The recommended alternative for Springbrook Road is adding a parallel gravity line. The improvements include upsizing a portion of the existing Springbrook line north of Fernwood Road.

It is recommended that the line on Pinehurst Court be disconnected from the North Main Street trunk line, re-graded to the west, and extended south to connect to the existing line on Creekside Court.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

Recommended improvements on South River Street include upsizing the existing trunk line. Part of preliminary design of the recommended improvements should include additional flow monitoring and data collection to further characterize flow throughout the South River trunk line basin, as well as evaluating other potential alignments to target replacement of pipe that is in the worst condition.

Improvements on North Main Street and Wynooski Street include resolving two segments of pipeline that were found to have inverse slopes during survey work for the master plan. It should be determined if the downstream pipeline should be replaced to match the upstream pipe size.

Future infrastructure along Chehalem Drive will be necessary to service developments predicted through buildout. It is recommended the gravity pipelines discharge to the HWY 240 wet well. In addition to serving future development, this infrastructure could allow for the displacement of Chehalem and Creekside Lift Stations.

Furthermore, the City will continue to budget $450,000-$600,000 annually for I/I related improvements. This work will continue to be directed by the I/I based priority improvements highlighted in Section 8 and any future supplemental I/I evaluations.

Future infrastructure in the Riverfront area will be necessary to service developments predicted in the next 20 years. This would include: a regional lift station, force main, and gravity mains. In addition to serving future development, this infrastructure could allow for the displacement of Andrew and Charles Lift Stations.

Facilities

The City completed a master plan on expanding and upgrading the City maintenance yard facilities. The recommended improvements project includes major site work, a new fleet building, and new administration building. This project is being funded over multiple years and through multiple sources as it is relevant to several City divisions.

Operations and Maintenance

Maintenance Division objectives – clean and inspect one-fifth of the gravity main system every year and handle repairs/issue work orders within one month.

Operations Division objectives – maintenance work on the lift stations needs to be completed within one month of submitting a work order. The division could consider shifting priorities of staff, so that at least one mechanic is responsible for prioritizing lift station O&M and ensuring maintenance is completed in a timely matter.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

1.3.5 Infiltration & Inflow

I/I is a concern in the Newberg collection system. The rapid response between precipitation events and increased flows suggests that a significant component of peak flow is from storm water inflow. The sustained increase in flow over several days following a large storm event suggests that groundwater is also infiltrating into the City's wastewater collection system.

Recent sanitary sewer infiltration and inflow studies which included a pump run time analysis, extensive flow monitoring, CCTV inspections, night-time flow monitoring, and smoke testing to generate a prioritized list of the top 25 I/I reduction projects in the study area, as well as a list of cross connections found while smoke testing, and spot repair needs identified through CCTV inspections have confirmed the excessive I/I.

Pump run time analysis was completed at each of the eight City-owned lift stations (Andrew, Charles, Chehalem, Creekside, Dayton, Fernwood, Highway 240, and Sheridan). They were visited to complete pump flow tests and facilities evaluations. When daily run times are compared with rainfall events, a close correlation between high rainfall months and monthly increase in run times is evident. This correlation indicates that I/I is the likely cause of increase in flow. Continuous flow monitoring was completed for five weeks during January-March 2017 to better characterize the nature and distribution of I/I in the system.

Cleaning and CCTV inspection of approximately 125,000 linear feet of City pipelines has been incorporated in this master plan analysis (See Figures 20-24, Appendix A). Pipelines were selected based on pipe age, material, size, results from pump run tests and flow monitoring, and recommendations from the City. The National Association of Sewer Service Companies' (NASSCO) pipeline assessment certification program (PACP) was used again to record defects and grade pipe condition during CCTV inspections as a method of standardization.

Smoke testing was completed on approximately 17.5 miles of pipe. Smoke introduced into the sanitary system should only be released from nearby manholes, cleanout pick holes, and building plumbing vents; smoke emitted anywhere else indicates a potential source of I/I (See Figures 25-26, Appendix A).

Throughout the inspections, the most common operations and maintenance (O&M) defects found were roots, intruding taps, infiltration, and dirt or gravel in the pipe and laterals. The most frequent structural defects were cracks, fractures, and holes or breaks.

The results were used from CCTV inspections, smoke testing, pipe age/material, and flow monitoring data to develop a preliminary prioritization of improvements. The first step (base) in the prioritization process is the CCTV inspection results Pipeline segments were then given a 1-10 score using breaks in score distribution and review of inspections near scoring thresholds. The second step in the prioritization process was to consider the pipeline age/materials. The third step in prioritizing improvements was to consider where sources of I/I were observed. Consequence of failure was incorporated into the prioritization process by using multiplying factors.

The first course of action that can reduce I/I in a system is to repair defects in the collection system. During storm events or day-to-day activities, water can infiltrate into pipes through defects such as breaks, cracks, holes, or other structural defects. If many defects are discovered in a single pipe, replacement or rehabilitation of the full pipe should be considered. Additionally, elements such as cleanouts, swales, house drains, and catch basins may be directly connected to the collection system. At the end of the day, the City needs to identify and repair I/I where feasible and practical.

It is recommended that the City establish a routine cleaning schedule for cleaning of the collection system. After completing replacement or rehabilitation of pipes in the priority CIP areas or on the spot repairs list, it is recommended that the City re-inspect the pipes using CCTV. Additionally, continuous flow monitoring should continue to take place in the system and in the influent of the wastewater treatment facility.

1.3.6 Recommended Infiltration & Inflow Improvements

It is recommended the City continue improvements on the system, broken into three categories: prioritized improvements for pipelines, spot repair/cross connection fixes and development of an ongoing I/I reduction plan. Identifying, monitoring and eliminating I/I is an ongoing and dynamic process.

Prioritized Improvements are detailed in Section 8 (See Figures 27, Appendix A). In Table 8-1 each of the top 70 deficient pipe segments were considered by score and grouped by location to create logical rehabilitation projects for the City. It should be noted that the City currently has a budget for rehabilitation/replacement of pipes in Priority 1 and 2 for next fiscal year.

Some pipelines may be in relatively good condition but have one or two locations where there are severe defects. Rather than replace the entire pipeline reach, localized spot repairs may be more appropriate for these locations. A priority list for spot repairs was compiled into Table 8-2.

It is also recommended the City continue to identify and monitor sources of I/I system-wide. Part of this ongoing process is continuous inspection, improvement, and progress tracking. It is recommended the City plan out routine CCTV inspections. The City should try to inspect 85,000 linear feet of pipe every year to complete the entire system on a 5-year rotation.

It is also recommended the City continues using the PACP format for future video inspections. The PACP format provides the City an industry standard, objective analysis and allows the condition of the same pipe to be compared over time. This could be helpful in tracking the deterioration of pipes, completing preventative maintenance activities, and identifying and correcting problems before a pipe fails.

1.4 EFFLUENT DISPOSAL

1.4.1 Effluent Disposal Options

Plant effluent performance was compared to the permit limits to demonstrate the historically compliant operation. Hypochlorite is injected as secondary effluent flows to the Chlorine Contact Basins (CCB). The serpentine flow in the CCB provides the disinfection contact time. Reclaimed Water and Reuse Water pumps draw from the effluent channel for non-potable plant water and reuse treatment, respectively. If required, disinfected effluent is dechlorinated with sodium bisulfite.

After disinfection, the effluent travels by gravity approximately 3,000-ft to discharge to the Willamette River. The outfall is a single port diffuser in the Willamette River at river mile 49.7. During the summer months, reuse water is sent to the neighboring Chehalem Glenn Golf Course for irrigation. This reduces discharge flow and effluent excess thermal load (ETL) to the Willamette River. The golf course is the sole purchaser of the reuse water.

1.4.2 Effluent Disposal Recommendation

The Water Master Plan (Murray, Smith & Associates 2017) discussed additional details of the non-potable water plan for the City and also potential future expansion, if demand requires.

1.5 WASTEWATER TREATMENT

1.5.1 Existing Facilities

The City of Newberg (City) owns and operates the Newberg Wastewater Treatment Plant (WWTP) located at 2301 Wynooski Street. The WWTP is an oxidation-ditch type, activated sludge plant. It consists of raw influent pumping; Headworks facility with influent flow measurement, screening, and grit removal; activated sludge oxidation ditches; equalization basin; secondary clarifiers; hypochlorite disinfection; dechlorination, membrane reuse; effluent outfall; sludge storage; solids dewatering; and Class A biosolids composting. There is also a septage receiving station that accepts various loads from septage trucks as well as residential RV owners.

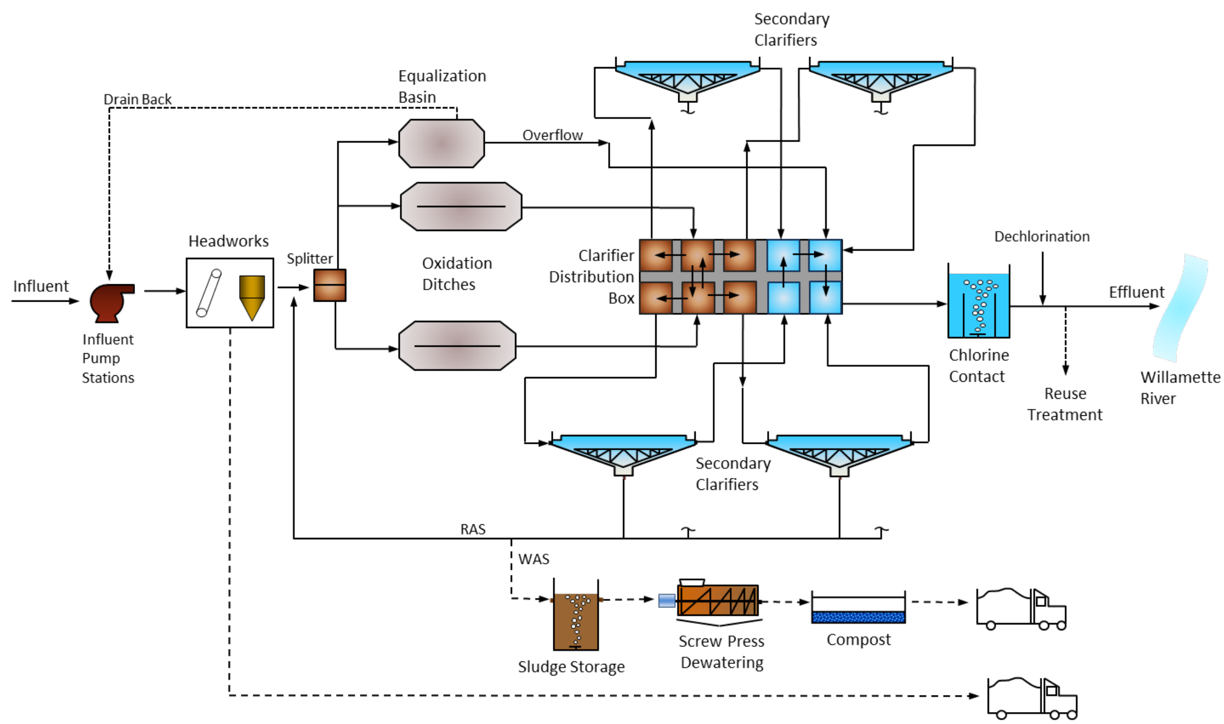


Figure 1-2: Process Flow Schematic

Influent pumping is located at the end of Hess Creek trunk line, approximately 500-ft west of the main campus. In 2015 a new IPS expansion wet well (referred to as New IPS) was constructed adjacent to the existing wet well (referred to as Existing IPS) to meet future projected influent flows. A new Headworks was built in 2015 to handle future peak flows. The Headworks handles preliminary treatment processes, including screening and grit removal. Secondary treatment system consists of two oxidation ditches and four secondary clarifiers. A new onsite sodium hypochlorite generation system was installed in 2017. Hypochlorite is injected at the CDB as secondary effluent flows to the Chlorine Contact Basins (CCB). After disinfection, the bulk of effluent is discharged to the Willamette River.

The solids are pumped from the Sludge Storage Tanks (SST) to the Solids Building where polymer is injected and mixed to promote solids flocculation prior to mechanical dewatering. Dewatered sludge is mixed with dried sawdust and recycled compost and enters one of two compost reactor vessels to produce Class A biosolids. The finished product is sold in bulk at the plant as Newgrow Compost.

Deficiencies of the existing wastewater treatment include (see Appendix H for individual inspection reports):

- The effluent piping from the CDB to the CCBs limits the capacity of the Secondary Clarifiers.
- The final segment of the outfall is a 24-inch diameter pipe prior to discharge into the Willamette River. At flows high flow times this results in significant headloss

and high pressures in the pipe. Notably, in the past the entire lid of the upstream manhole has been dislodged from the manhole due to the hydraulic condition.

- The Oxidation Ditch 1 & 2 gearbox seals are leaking, and the motors are off balance.
- Clarifier Distribution box has an isolation gate segment that is not functioning.
- Secondary clarifier 1, 2 & 4 have gearboxes that are leaking, or in need of mechanical investigation for sounds and improper function. Secondary Clarifiers 1-3 have corrosion that was also found on the conduits, fittings and fasteners of the electrical systems.
- Operations building has evidence of roof leakage and gutter system is in disrepair.
- Electrical building downspouts are less than functional and are allowing erosion of the surrounding areas.
- Secondary Building Common Facilities have severe corrosion on the downspouts and gutters. Building also has aged roof.
- Solids Building Common Facilities has roof leaks into the maintenance shop. And floor coating in dewatering area is chipped and degraded in many areas.
- RAS/WAS Pump Station has grease buildup in the flow meters – meters appear to be past their original useful life. WAS pump appears to have an alignment issue. RAS pump inlet is causing suction loss.
- Reclaim water pump is leaking and erratic. Reclaimed strainer not working resulting in bypass left continuously open.
- Biomedia filter material on the Odor Control System is in poor condition. The water pressure regulator is also broken, and the piping insulation is torn, worn or non-existent.
- Reuse system membrane has leaks at the couplings and wear where the supports are lacking.
- Sludge storage tanks have a heavy buildup of sludge/moss above the water level.
- Compost buildings show evidence of widespread roof leakage, including above the control room. There is also and electrical panel that has an enclosure not suitable for the environment and possess electric shock danger. The walls on both sides of the loadout tunnel are cracked and leaking. Furthermore, one of the VFD's has a failing operator interface.

1.5.2 Wastewater Composition

A wastewater influent characterization was developed using fractions typical to municipal wastewater with known rain inflow and infiltration (I&I). The I&I provides shorter collection system retention time and aerobic conditions which reduce the influent soluble BOD and COD fractions to the treatment plant. The influent wastewater composition is relatively dilute because of the I&I.

1.5.3 Treatment Alternatives

Secondary Clarifiers: The 2037 design maximum month wet weather flow (MMWWF) design of 12.4-mgd exceeds the existing liquid process capacity of the secondary clarifiers of 9.1-mgd. This capacity limitation is based on a secondary clarifiers hydraulic loading rated f 1,200-gpd/sf, per common industry standards. Re-rating the secondary clarifiers to a peak hydraulic loading rate of 1,300-gpd/sf is very feasible and would increase the current process capacity to 9.9-mgd.

Oxidation Ditches: A third 2.0-MG oxidation ditch would increase the total basin volume by 50 percent. The new oxidation ditch would be constructed with vertical walls, a 20-ft side water depth (SWD) and be equipped with fine bubble diffusers and horizontal acting propeller mixers to allow air on/off or low dissolved oxygen (DO) operation for future denitrification, if required.

Parallel Secondary Treatment Plant: Adding one new oxidation ditch, two new secondary clarifiers, and a RAS/WAS pump station; effectively creating a parallel secondary treatment plant that operates independently from the existing plant. The biggest advantage of this Alternative is that it leaves the existing plant unmodified, aside from the SE connection to the CCB. This simplifies construction sequencing and adds flexibility as to where the new oxidation ditch and clarifiers would be located on the site.

Batch Reactors: Sequencing batch reactors (SBR) combine activated sludge and clarification into a single structure. A SBR would operate in parallel and independent from the existing oxidation ditches.

Moving Bed Biofilm Reactor: The moving bed biofilm reactor (MBBR) is a biofilm process that relies on suspended carrier media. Screens are employed to retain the media in the process basins. Unlike conventional activated sludge there is no suspended biomass and no return biomass. The main advantage of the MBBR is the small footprint when compared to the other alternatives and lower capital cost.

Table 1-3: Alternatives Cost Summary

Parameter	Alt. 1B Oxidation Ditch ($Million)	Alt. 2 SBR ($Million)	Alt. 3B MBBR ($Million)
Fine Screening Upgrade	0	0	0.95
Reactor Process	6.59	15.29	5.97
Blower Building	2.21	2.21	2.21
Clarifier and RAS Pump Station	7.99	0	0
Equalization Basin Rehab	0	0	0.49
Total	**16.79**	**17.50**	**9.62**

1.5.4 Treatment Alternatives Ranking

In addition to the capital cost, additional factors are used to determine the most overall favorable alternative. Additional factors include constructability, phasing, operation and maintenance (O&M) effort, process familiarity with plant staff, and ease of operation. Table 1-4 lists the general definition and ranking of each alternative in a number of parameters. Each factor is ranked on a scale of 0 to 5, with 5 being the most favorable and 0 the least favorable. The highest total ranking value identifies the most favorable alternative based on the listed parameters. At this time, each parameter is weighted equally. The results favor the Alternative 1B oxidation ditch expansion. Additionally, if the improvements are phased, it would also be initially the lowest cost alternative.

Table 1-4: Alternatives Ranking

Parameter	Description	Alt. 1B Oxidation Ditch	Alt. 2 SBR	Alt. 3B MBBR
Capital Cost	Relative cost comparison that takes into account order of magnitude capital expenses	3	2	5
Constructability	Complexity related to physical improvements and ability to maintain plant operations during construction	1	5	3
Phasing Opportunity	Can be phased to provide incremental levels of treatment based on need and from a cash flow perspective	4	0	3
O&M	Relative cost comparison that takes into account operational expenses; including labor, power, and chemical costs.	3	2	1
Staff Process Familiarity	Use of current or new/advanced specific treatment approach	5	3	1
Ease of Operation	Relates to the amount of long-term operational complexity and attention the process requires. Allows systems to be offline for maintenance.	5	3	3
	Total	**21**	**15**	**16**

Note: Parameters ranked on a scale of 0 to 5, with 5 being the most favorable and 0 the least. The highest total value is most favorable.

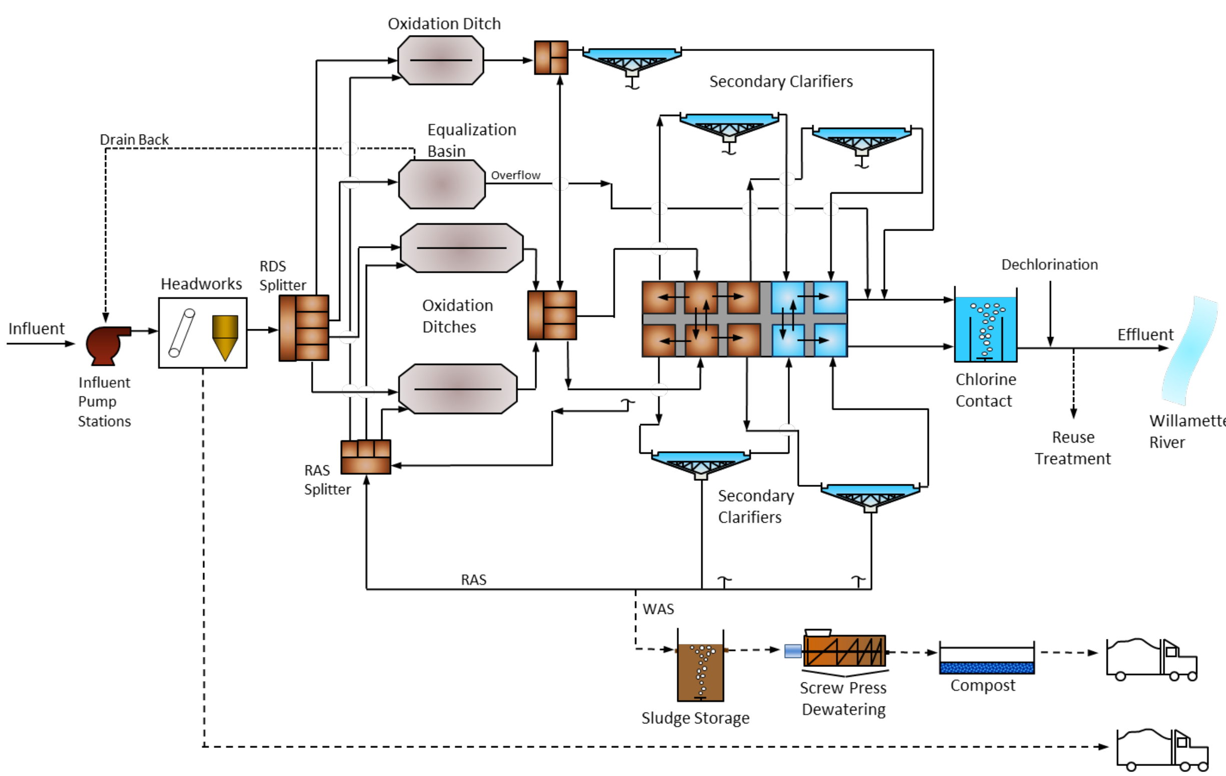
1.5.5 Recommended Treatment Improvements

Recommended projects are phased based on conditions of the existing facilities, capacity, and redundancy needs. The phasing of project improvements provides a roadmap for updating and expanding the existing WWTP for current and future conditions. This plan outlines a number of projects required for the 2037 planning horizon. A summary of the projects and their prioritization is listed in Table 1-5. Table 1-6 presents the proposed Newberg WWTP Process Schematic.

Table 1-5: Recommended WWTP Projects

ID#	Item	Primary Purpose
Priority 1 Improvements		
Wastewater Treatment Plant		
T1.a	Oxidation Ditch Rotor Replacement	Condition
T1.b	Sawdust Bays	Capacity
T1.c	Operations Remodel Project	Condition
T1.d	Oxidation Ditch 1 Rehabiltation	Capacity/Condition
T1.e	Roofing Replacement at the WWTP	Condition
T1.f	WWTP Hydraulic Improvements	Capacity
T1.g	Secondary Clarifier Rerating Study	Capacity
Priority 2 Improvements		
Wastewater Treatment Plant		
T2.a	Oxidation Ditch Expansion	Capacity/Redundancy
T2.b	Chlorine Contact Expansion	Capacity
T2.c	PLC Control System Replacement Evalution	Condition
Priority 3 Improvements		
Wastewater Treatment Plant		
T3.a	Secondary Clarifier 5	Capacity
T3.b	Equalization Basin Rehabilitation	Capacity/Condition

Figure 1-3: Proposed Newberg WWTP Process Schematic



See Note 1

1.6 CAPITAL IMPROVEMENT PLAN

1.6.1 Summary of Costs

Capital costs developed for the WWTP improvements are Class 5 estimates as defined by the Association for the Advancement of Cost Engineering (AACE). The costs of electrical, instrumentation and control, general site work, and installation are estimated as percentages of the base construction subtotal per unit process improvement. Actual construction costs may differ from the estimates presented, depending on specific design requirements and the economic climate at the time a project is bid. As a result, the final project costs will vary from the estimated presented in this document. The total estimated probable project costs include contractor markup and profit and contingences. Priorities are set for today and will be re-evaluated when there is a need for re-assessment. The CIP is based on modeling data that was available during the completion of this master plan. When projects are carried forward, the model, data, assumptions, etc., should be re-evaluated to make any necessary adjustments to the basis of the project.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

Table 1-6: Summary of Costs (20-Year CIP)

ID#	Item	Primary Purpose	Total Estimated Cost (2018)	SDC Growth Apportionment %	SDC Growth Apportionment Cost	City's Estimated Portion
Priority 1 Improvements						
Wastewater Collection System						
C1.a	Hess Creek Phase 1 - CIPP	Capacity	$ 1,000,000	2%	$ 20,000	$ 980,000
C1.b	Hess Creek Phase 2 - Parallel Gravity Line	Capacity	$ 6,649,000	2%	$ 131,000	$ 6,518,000
C1.c	Springbrook Road	Capacity	$ 3,812,000	20%	$ 751,000	$ 3,061,000
C1.d	Pinehurst Court	Capacity	$ 258,000	0%	$ -	$ 258,000
C1.e	Maintenance Yard Improvements	Capacity/Condition	$ 737,500	20%	$ 148,000	$ 589,500
C1.f	Lift Station Improvements (short term)	Condition	$ 1,429,000	1%	$ 14,000	$ 1,415,000
C1.g	I/I Projects	Capacity/Condition	$ 2,700,000	50%	$ 1,350,000	$ 1,350,000
C1.h	5th Street	Capacity/Condition	$ 350,000	16%	$ 55,000	$ 295,000
	Wastewater Collection System Priority 1 Total		$ 16,935,500		$ 2,469,000	$ 14,466,500
Wastewater Treatment Plant						
T1.a	Oxidation Ditch Rotor Replacement	Condition	$ 595,000	0%	$ -	$ 595,000
T1.b	Sawdust Bays	Capacity	$ 350,000	0%	$ -	$ 350,000
T1.c	Operations Remodel Project	Condition	$ 300,000	0%	$ -	$ 300,000
T1.d	Oxidation Ditch 1 Rehabiltation	Capacity/Condition	$ 700,000	11%	$ 78,000	$ 622,000
T1.e	Roofing Replacement at the WWTP	Condition	$ 220,000	0%	$ -	$ 220,000
T1.f	WWTP Hydraulic Improvements	Capacity	$ 480,000	14%	$ 69,000	$ 411,000
T1.g	Secondary Clarifier Rerating Study	Capacity	$ 60,000	22%	$ 14,000	$ 46,000
	Wastewater Treatment Plant Priority 1 Total		$ 2,705,000		$ 161,000	$ 2,544,000
	Total Priority 1 Improvements		**$ 19,640,500**		**$ 2,630,000**	**$ 17,010,500**
Priority 2 Improvements						
Wastewater Collection System						
C2.a	Hess Creek Phase 3 - Lift Station	Capacity	$ 2,121,000	2%	$ 42,000	$ 2,079,000
C2.b	River Street	Capacity	$ 2,764,000	12%	$ 341,000	$ 2,423,000
C2.c	HWY 240 Lift Station Upsize	Capacity	$ 454,000	19%	$ 87,000	$ 367,000
C2.d	Main and Wynooski Streets	Capacity	$ 328,000	1%	$ 4,000	$ 324,000
C2.e	Lift Station Improvements (long-term)	Condition	$ 375,000	11%	$ 41,000	$ 334,000
C2.f	I/I Projects	Capacity/Condition	$ 3,150,000	50%	$ 1,575,000	$ 1,575,000
C2.g	Wastewater Master Plan	Planning	$ 300,000	100%	$ 300,000	$ -
	Wastewater Collection System Priority 2 Total		$ 9,492,000		$ 2,390,000	$ 7,102,000
Wastewater Treatment Plant						
T2.a	Oxidation Ditch Expansion	Capacity/Redundancy	$ 11,841,000	22%	$ 2,617,000	$ 9,224,000
T2.b	Chlorine Contact Expansion	Capacity	$ 2,938,000	14%	$ 415,000	$ 2,523,000
T2.c	PLC Control System Replacement Evalution	Condition	$ 40,000	0%	$ -	$ 40,000
	Wastewater Treatment Plant Priority 2 Total		$ 14,819,000		$ 3,032,000	$ 11,787,000
	Total Priority 2 Improvements		**$ 24,311,000**		**$ 5,422,000**	**$ 18,889,000**
Priority 3 Improvements						
Wastewater Collection System						
C3.a	Chehalem Drive Phase 1 - 20-year Infrastructure	Future Development	$ 1,619,000	93%	$ 1,506,000	$ 113,000
C3.b	Riverfront Infrastructure	Future Development	$ 2,411,000	91%	$ 2,202,000	$ 209,000
C3.c	Providence Infrastructure	Future Development	$ 1,527,000	100%	$ 1,527,000	$ -
C3.d	Chehalem Drive Phase 2 - Buildout Infrastructure	Future Development	$ 888,000	0%	$ -	$ 888,000
C3.e	I/I Projects	Capacity/Condition	$ 3,150,000	50%	$ 1,575,000	$ 1,575,000
	Wastewater Collection System Priority 3 Total		$ 9,595,000		$ 6,810,000	$ 2,785,000
Wastewater Collection System						
T3.a	Secondary Clarifier 5	Capacity	$ 7,500,000	22%	$ 1,658,000	$ 5,842,000
T3.b	Equalization Basin Rehabilitation	Capacity/Condition	$ 980,000	0%	$ -	$ 980,000
	Wastewater Treatment Plant Priority 3 Total		$ 8,480,000		$ 1,658,000	$ 6,822,000
	Total Priority 3 Improvements		**$ 18,075,000**		**$ 8,468,000**	**$ 9,607,000**
Priority 4 Improvements						
Wastewater Collection System						
C4.a	Chehalem and Creekside LS Displacement/Future Trunkline	LS Consolidation	$ 3,492,000	25%	$ 889,000	$ 2,603,000
C4.b	Charles and Andrew LS Displacement	LS Consolidation	$ 1,322,000	0%	$ -	$ 1,322,000
	Total Priority 4 Improvements		**$ 4,814,000**		**$ 889,000**	**$ 3,925,000**
	TOTAL WASTEWATER IMPROVEMENTS COSTS (rounded)		**$ 66,840,500**		**$ 17,409,000**	**$ 49,431,500**

* All costs in 2018 Dollars. Costs include contingency (30%), engineering and construction management services (CMS; 25%), and legal, administrative, and permitting services as applicable.

The cost estimate herein is concept level information only based on our perception of current conditions at the project location and its accuracy is subject to significant variation depending upon project definition and other factors. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. This cost opinion is in 2018 dollars and does not include escalation to time of actual construction. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

1.7 SYSTEM DEVELOPMENT CHARGES

1.7.1 Summary of System Development Charges

The purpose of the System Development Charges (SDCs) is to bring equity between existing customers and new customers connecting to the City's wastewater system. The SDCs were updated as part of this planning effort. See Section 13 for a summary and Appendix J for the full report.

The City's current wastewater SDC is based on the number of fixture units. The City has a current SDC of $6,066 for the first 18 fixture units. The SDC has not been reviewed since 2007, but has been updated a number of times using industry excepted cost indices, like Engineering New Record Construction Cost Index (ENR-CCI) and Consumed Price Index Urban (CPIU). The updated analysis resulted in a proposed fee of $5,704 for the first 18 fixture units. The lower calculated fee is primarily a result of a reduced capital plan in this planning period.

Table 1-7: Existing and Maximum Allowable Wastewater SDCs

Customer Class	Existing SDC Fee	Reimbursement SDC	Improvement SDC	Total SDC or Maximum Allowable
For the first 18 fixture units	$6,066	$1,131	$4,573	$5,704
Per each fixture unit over 18	$338			$317
Efficiency Dwelling Unit (EDU)	$338			$317

The SDC as calculated in the study is lower than the existing SDC. The 2007 SDC study included $37 million in capital projects through 2040, which included SDC eligible extension and upgrade collection projects, which are no longer included in the current Master Plan. The amounts shown in Table 1-7 have been rounded for ease of administration.

1.7.2 SDC Recommendations

The following is a list of recommendations based on the review and analysis of the City's wastewater system, capital plans from the Draft Master Plan, and financing approach for the development of the SDCs:

- The City should adopt the wastewater SDCs for new connections to these respective systems which are no greater than the net allowable system development charges as set forth in this report.
- The adopted SDCs should continue to be updated annually by a local construction cost index such as the ENR-CCI for no more than five years before a complete update of the charge is again undertaken. This industry practice can keep the charge relatively current with construction pricing practices.
- The City should update the actual calculations for the SDCs at such time when a new capital improvement plan, public facilities plan, comprehensive system plan, or a comparable plan is approved or updated by the City.

2. PROJECT PLANNING

2.1 LOCATION

The study area consists of all areas within the City of Newberg Urban Growth Boundary (UGB). Figure 1 in Appendix A shows the land use and existing sanitary system facilities. The study area slopes generally to the south toward the WWTP and eventually the Willamette River. Figures 2-4 in Appendix A present the mapped floodplains, soils, and wetlands.

2.2 POPULATION TRENDS

The official population projections for the City of Newberg reflect the collaborative efforts of Yamhill County and Portland State University (PSU). These agencies published a document in June 2017 establishing the official coordinated population projection rates for all the cities in Yamhill County. The document is titled "Coordinated Population Forecast for Yamhill County, its Urban Growth Boundaries (UGB), and Areas Outside UGBs 2017-2067", and also includes a summary of historical populations from the U.S. Census.

The historical populations presented in the referenced document are shown in Table 2-1. Each year, PSU establishes a preliminary population estimate in November that is sent to state and local jurisdictions and community partners. This is followed in December by a certified population estimate December. 2017 was the most recent year established as a preliminary estimate at the time of these projections, and was used as the base starting point for population projections (Table 2-1). These projections were calculated using growth rates presented in the referenced document. Growth rates are not anticipated to be consistent for the entire planning period, and decrease at the end of the planning period. The overall estimated population growth from 2017 to 2037 (from 23,480 to 33,811) reflects an annual average growth rate of 1.8%.

Table 2-1: Population History and Projections

Year	Population	Source
1960	4,204	U.S. Census, Population Research Center: Portland State University
1970	6,507	U.S. Census, Population Research Center: Portland State University
1980	10,394	U.S. Census, Population Research Center: Portland State University
1990	13,086	U.S. Census, Population Research Center: Portland State University
2000	18,064	U.S. Census, Population Research Center: Portland State University
2010	22,110	U.S. Census, Population Research Center: Portland State University
2015	22,900	PSU Certified Population
2016	23,465	PSU Certified Population
2017	23,480	PSU Preliminary Population (Nov. 2017)
2022	25,797	Projected Using Coordinated Growth Rate of 1.9%
2027	28,343	Projected Using Coordinated Growth Rate of 1.9%
2032	31,139	Projected Using Coordinated Growth Rate of 1.9%
2037	33,811	Projected Using Coordinated Growth Rate of 1.3%

2.3 FLOWS

Historical wastewater flows were evaluated to develop design flows, and provide flow projections for the planning period. This section summarizes the results of the analysis. The methods recommended by the Oregon Department of Environmental Quality (DEQ) in "Guidelines for Making Wet-Weather and Peak Flow Projections for Sewage Treatment in Western Oregon" were used for estimating design flows in the City's system. A few of the values developed from DEQ methods were adjusted based on observed flow events at the wastewater treatment plant (WWTP). These adjustments are described in the appropriate sections below.

Average Annual Daily Flow (AADF)

The average annual daily flow (AADF) is the average daily flow for the entire year. An AADF was calculated for each year of data. Years with a complete data set (2012–2015) were averaged to obtain the design AADF.

Average Dry-Weather Flow (ADWF)

The average dry-weather flow (ADWF) is the average daily flow for the period of May–October. An ADWF was calculated for each year of data. Years with a complete data set (2012–2015) were averaged to obtain the design ADWF.

Average Wet-Weather Flow (AWWF)

The average wet-weather flow (AWWF) was calculated as the average daily flow for the periods encompassing January–April and November–December for each year of data. Four years' worth of data (2012–2015) was averaged to obtain the AWWF.

Maximum Monthly Dry-Weather Flow ($MMDWF_{10}$)

The maximum monthly dry-weather flow ($MMDWF_{10}$) represents the month with the highest flow during the summer months. DEQ's method for calculating $MMDWF_{10}$ is graphing the January–May monthly average flows for the most recent year against total precipitation for each month. A trend line is fitted to the data, which the $MMDWF_{10}$ is read from at a precipitation equal to the May 90% precipitation exceedance value (4.24 inches for Newberg) obtained from the National Oceanic and Atmospheric Administration's Summary of Monthly Normals from 1981 to 2010. Since DEQ states that May is typically the maximum monthly flow for the dry-weather period (May–October), selecting the May 90% precipitation exceedance most likely corresponds to the maximum monthly flow during the dry-weather period for a 10-year event.

Data from 2012–2016 was used according to DEQ guidance to produce Chart 2-1. The data point from May 2013 was excluded as an outlier since it does not follow the trend recognized by the rest of the data. Table 2-2 summarizes the data points illustrated in the chart.

Maximum Monthly Wet-Weather Flow ($MMWWF_5$)

The maximum monthly wet-weather flow ($MMWWF_5$) represents the highest monthly average during the winter period of high groundwater. DEQ's method for calculating

$MMWWF_5$ is developing a graph of January–May average daily flows vs. monthly precipitation, then reading $MMWWF_5$ from the trend line at a precipitation equal to the January 80% precipitation exceedance value (9.17 inches for Newberg), also obtained from the National Oceanic and Atmospheric Administration's Summary of Monthly Normals. Since DEQ states that January is typically the maximum monthly flow for wet-weather, selecting the January 80% precipitation exceedance most likely corresponds to the maximum monthly flow during the wet-weather period for a 5-year event. This result is illustrated in Chart 2-1 and broken down in Table 2-2.

Chart 2-1: Monthly Average Flow vs Rainfall ($MMDWF_{10}$ and $MMWWF_5$)

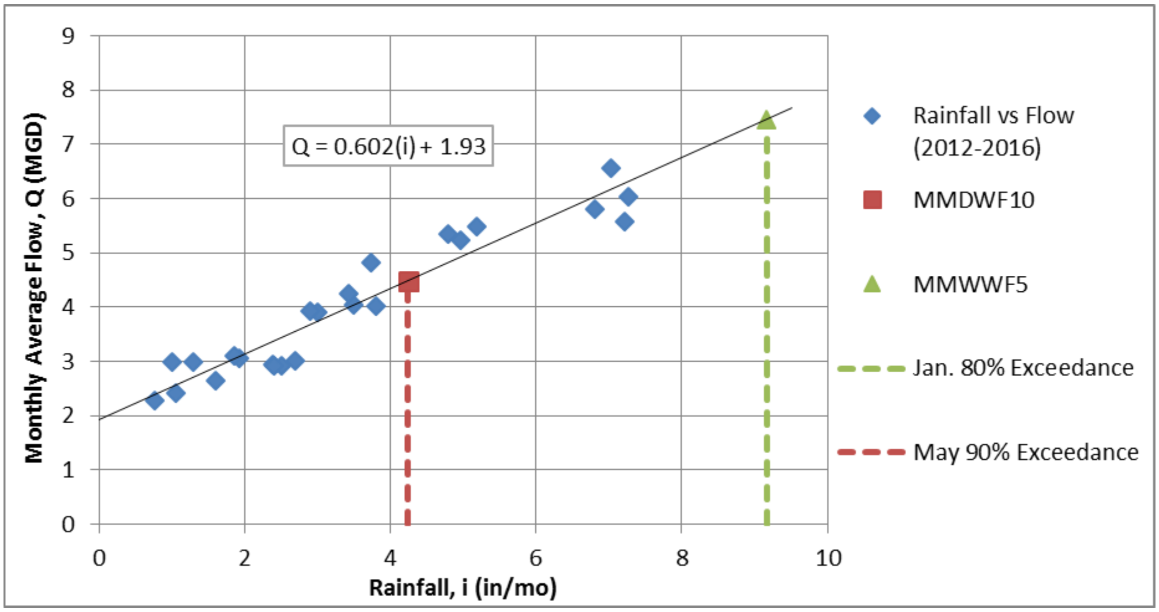


Table 2-2: Monthly Average Flow vs Rainfall ($MMDWF_{10}$ and $MMWWF_5$)

Month	Monthly Average Flow (MGD)					Rainfall (in/mo)				
	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
January	5.59	2.99	2.93	3.92	6.55	7.21	1.01	2.50	2.90	7.03
February	4.05	3.00	5.23	5.35	4.83	3.50	1.29	4.97	4.80	3.73
March	6.04	3.05	5.81	4.03	5.48	7.27	1.92	6.80	3.80	5.18
April	4.25	3.11	3.90	2.93	3.00	3.42	1.85	3.00	2.40	2.69
May[1]	2.95	3.47	2.65	2.27	2.41	2.39	6.47	1.60	0.76	1.06
$MMDWF_{10}$	4.48					4.24				
$MMWWF_5$	7.45					9.17				

[1]May 2013 data point excluded as an outlier.

To check the DEQ $MMWWF_5$ produced from the previously mentioned analysis, a rolling 30-day average was taken over the available flow data (July 2011–September 2016). This produced an observed maximum monthly average flow of 9.66 MGD that occurred during December 2–31, 2015. This observed maximum monthly average flow was used instead of that produced by the DEQ method, as it represents actual data for the City of Newberg.

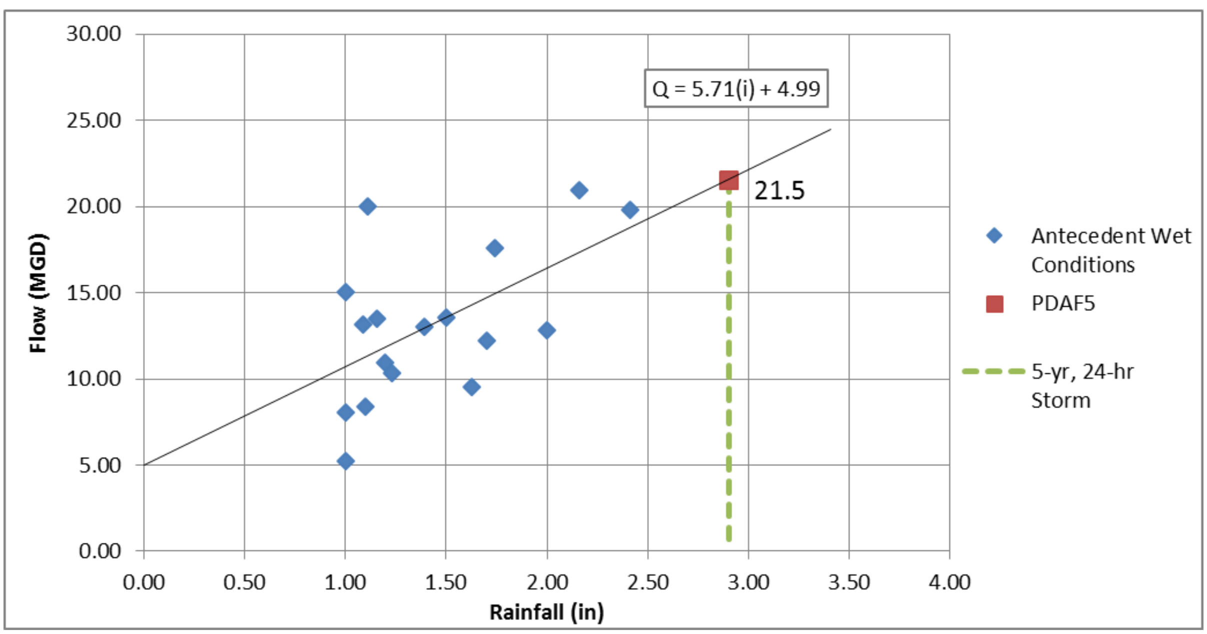
Peak Week Flow (PWkF)

A 7-day average flow was calculated for every day using the 7 previous days of data (rolling average). Peak week flow (PWkF) was then calculated as the maximum of all weekly (7-day) rolling averages in a given year (the maximum week was selected as the PWkF for each year from 2012-2015).

Peak Daily Average Flow ($PDAF_5$)

As outlined by DEQ, the peak daily average flow ($PDAF_5$) corresponds to the 5-year storm event, and is calculated as the flow resulting from a 5-year storm event during a period of likely high groundwater (January–April). DEQ's method for determining $PDAF_5$ is plotting daily plant flow against daily precipitation for large storm events over several years, using data only for wet-weather seasons when groundwater is high. A trend line is fitted to the data, which the $PDAF_5$ is then read from at the 5-year, 24-hour storm event (2.9 inches per the NOAA isopluvial maps for Oregon). For the purpose of this analysis, a large storm event is considered more than 1-inch in 24-hours. Antecedent conditions were evaluated on a case-by-case basis, and were considered wet if any day in the preceding three had a storm event of 0.5-inches or larger. Data points were also added or excluded based on cumulative rainfall for 30 days prior to the storm event. The cutoff for 30-day cumulative rainfall (for purposes of this analysis) is 5.5-inches. Some data points that did not fit general trends were investigated using either larger or smaller cumulative rainfall windows. Chart 2-2 below shows the results of the analysis.

Chart 2-2: Flow vs Rainfall ($PDAF_5$)



In analyzing the data, peak flows for a storm event were found to occur most frequently on the same day the precipitation reading was recorded. Therefore, rainfall for a specific day was associated with flow for the day of storm occurrence. The $PDAF_5$ produced from the previous analysis was compared with the top five flow events for 2012–2015 (see

Table 2-3 below). The DEQ method was used as the design value since it estimates a higher $PDAF_5$ than the top five flow events and was felt to be representative of the higher 5-year design rainfall event.

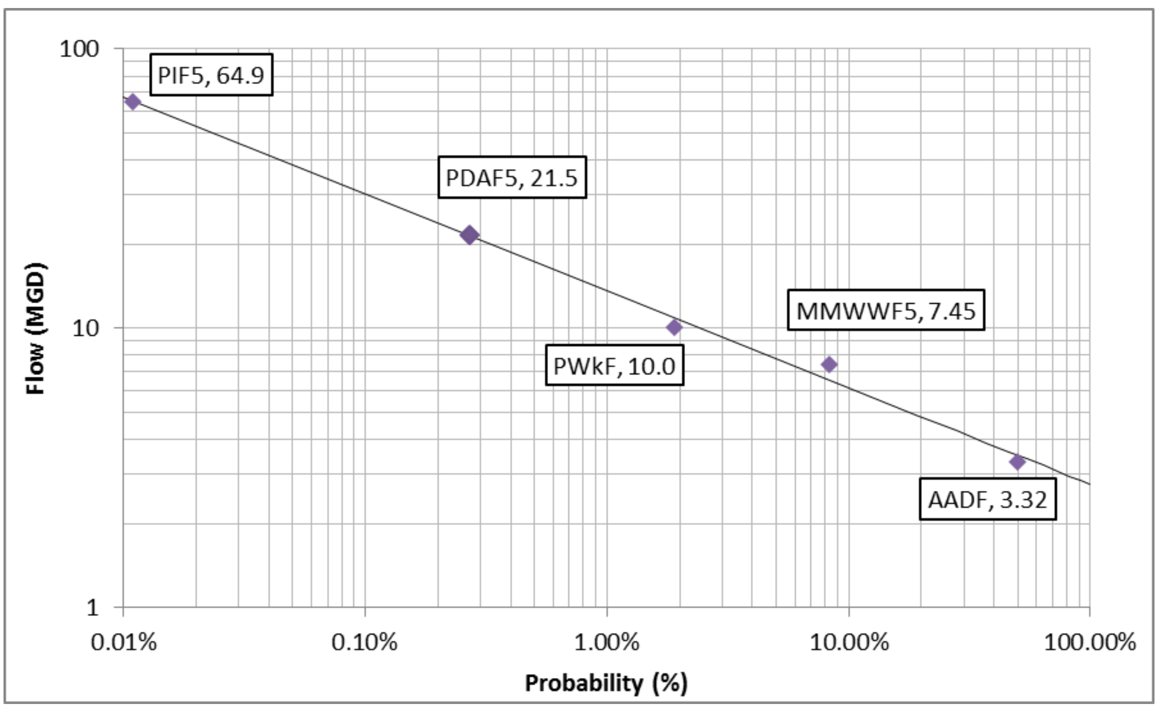
Table 2-3: Top Five Flow Events

Date	Flow (MGD)	Rain (in/day)
December 7, 2015	20.96	2.16
December 8, 2015	19.98	1.11
December 17, 2015	19.81	2.41
January 19, 2012	17.61	1.74
December 9, 2015	15.65	0.50

Peak Instantaneous Flow (PIF_5)

The peak instantaneous flow (PIF_5) represents the peak instantaneous flow (or peak hourly flow) associated with the $PDAF_5$. In the absence of hourly flow data, DEQ recommends obtaining the PIF_5 by extrapolation from their own chart titled Graph #3. $PDAF_5$, $MMWWF_5$, PWkF, and AADF are graphed (on specific log-probability scale) versus their probability of occurrence (Chart 2-3). A best-fit line between these known points is drawn. The PIF_5 is located where that best-fit line crosses the 0.011% probability.

Chart 2-3: DEQ Graph #3



The City has SCADA records, which provide continuous flow data that can be compared against the PIF_5 produced by the DEQ method. The DEQ PIF_5 represents a peaking factor of approximately 3, with respect to a $PDAF_5$ of 22.1 MGD (which is very large even for peak flows so heavily influenced by I/I). When groundwater is very high after a large storm event, the effect of I/I is more or less constant, which dampens the peaking that occurs. A peaking factor of approximately 1.3 was observed in the City's SCADA data for previous peak events (see Appendix B) and was used to estimate a more realistic PIF_5 of 28.7 MGD.

Infiltration and Inflow (I/I)

I/I is an issue in the collection system and results in high peak flows experienced at the WWTP during wet weather. The City has been working to characterize and evaluate I/I throughout the system. I/I work completed previously and for this master plan is discussed in Section 7. The City's ongoing efforts to reduce I/I in its system will affect flows at the treatment plant.

Observed Historical Flows and Projected Design Flows

Observed flows for each year from 2012–2015 were developed for comparison with projected flows, and are summarized in Table 2-4 below. Observed historical flows were derived as described in the preceding paragraphs, with the exception of $PDAF_5$ and PIF_5. The $PDAF_5$ for historical flows is the observed maximum from the corresponding year; the peaking factor of 1.3 was used to convert $PDAF_5$ to PIF_5.

Table 2-4: Observed Historical Flows

	Historical Flows (MGD)				Design Flow (MGD)
Year	2012	2013	2014	2015	2015
Population	22,300	22,580	22,765	22,900	22,900
ADWF	2.25	2.51	2.19	2.14	**2.27**
$MMDWF_{10}$	2.96	3.63	2.93	2.30	**4.48**
AADF	3.78	2.69	3.27	3.54	**3.32**
AWWF	5.33	2.88	4.36	4.96	**4.38**
$MMWWF_5$	7.26	3.63	6.68	9.66	**9.66**
PWkF	10.8	6.02	8.73	14.5	**10.0**
$PDAF_5$	17.6	9.5	13.6	21.0	**21.5**
PIF_5	22.9	12.4	17.6	27.3	**28.0**
Total Rainfall (in/yr)	47	25	39	40	-

To project the design flows derived from the analysis described in preceding paragraphs, a projected flow per capita (reported in gallons per capita per day, gpcd) was developed. This projected per capita flow is the same as the design unit flow for ADWF, $MMDWF_{10}$, AADF, and AWWF, but was scaled down for $MMWWF_5$, PWkF, $PDAF_5$, and PIF_5. Projected design flows (MGD) are based on 2015 design flows with the addition of the product of projected unit flows (gpcd) and projected population increase. This method recognizes the existing effects of I/I on flow, but projects a reduced I/I influence on wet-weather flows in future, more watertight, developments that employ better construction methods and materials. Projected design flows are summarized in Table 2-5 below. Actual future flows will depend on a number of factors, and could potentially be decreased through aggressive I/I reduction efforts. For this reason, it is recommended that flows be periodically reviewed and future capital projects be phased where practical.

Table 2-5: Projected Design Flows

	Design Flow (MGD)	Design Unit Flow (gpcd)	Projected Unit Flow (gpcd)[2]	Projected Design Flow (MGD)				
Year	2015	2015	-	2017	2022	2027	2032	2037
Population	22,900	22,900	-	23,480	25,797	28,343	31,139	33,811
ADWF	**2.27**	99	99	2.33	2.56	2.81	3.09	3.35
$MMDWF_{10}$	**4.48**	196	196	4.60	5.05	5.55	6.09	6.62
AADF	**3.32**	145	145	3.40	3.74	4.11	4.51	4.90
AWWF	**4.38**	191	191	4.49	4.94	5.42	5.96	6.47
$MMWWF_5$	**9.66**	422	250	9.81	10.4	11.0	11.7	12.4
PWkF	**10.0**	438	275	10.2	10.8	11.5	12.3	13.0
$PDAF_5$	**21.5**	941	325	21.7	22.5	23.3	24.2	25.1
PIF_5[1]	**28.0**	1,223	425	28.2	29.2	30.3	31.5	32.6

[1]The DEQ method produces a design flow of 67.1 MGD. PIF5 flow was adjusted based on continuous flow data from peak days between 2012 and 2015.

[2]Projected unit flow scaled down to reflect reduced I/I in future developments.

The City Planning Division, in line with the City Comprehensive Plan, outlined land use densities for current and projected growth, and infill areas where projected growth could occur. A summary of the densities provided by the City and utilized in this study for developing future flows from growth areas is provided in Table 2-6 below.

Table 2-6: Land Use Density Assumptions (Comprehensive Plan)

Zoning	Dwelling Units per Acre	Average Lot Size (sqft)	Average Lot Size (ac)
R-1	4.4	9,900	0.227
R-2	9.0	4,840	0.111
R-3, R-4	16.5	2,640	0.061
M-1, M-2, M-3	N/A	N/A	N/A
C-1, C-2, C-3	N/A	N/A	N/A
I	Institutional (Providence, GFU, etc.)	N/A	N/A

2.4 LOADINGS

The wastewater influent loading analysis follows the same methodology used for the flows. The historic wastewater loads are used to develop design loads and provide load projections for the planning period. This section summarizes the results of the carbonaceous 5-day biochemical oxygen demand ($cBOD_5$), total suspended solids (TSS), and ammonium as nitrogen (NH_4-N) load analysis. The following definitions summarize the terminology of the loading conditions:

Average Annual Daily (AAD)

The average annual (AA) is the average daily load for the entire year. An AA was calculated for each year of data. The years with a complete data set (2012-2015) were averaged to obtain the design AAD.

Average Dry-Weather (ADW)

The average dry-weather (ADW) is the average daily load for the period of May through October. An ADW was calculated for each year of data. The years with a complete data set (2012-2015) were averaged to obtain the design ADW.

Average Wet-Weather (AWW)

The average wet-weather (AWW) was calculated as the average daily load for the period encompassing January to April, and November to December for each year of data. Four years' worth of data (2012-2015) was averaged to obtain the AWW.

Max Month Dry-Weather (MMDW)

The max month dry-weather (MMDW) is the 91.7 percent probability (11/12) of occurrence in the daily influent wastewater for the period of May through October. An MMDW was calculated for each year of data. The years with a complete data set (2012-2015) were used to obtain the design MMDW.

Max Month Wet-Weather (MMWW)

The max month wet-weather (MMWW) is the 91.7 percent probability (11/12) of occurrence in the daily influent wastewater for the period January to April and November to December for each year of data. The years with a complete data set (2012-2015) were used to obtain the design MMWW.

Peak Week (PWk)

The peak week (PWk) is the 98.1 percent probability (51/52) of occurrence in the daily influent wastewater for the entire year. A PWk was calculated for each year of data. The years with a complete data set (2012-2015) were used to obtain the design PWk.

Peak Daily Average (PDA)

The peak daily average (PDA) is the 99.7 percent probability (364/365) of occurrence in the daily influent wastewater for the entire year. A PDA was calculated for each year of data. The years with a complete data set (2012-2015) were used to obtain the design PDA.

2.4.1 Observed Historic and Projected Design cBOD and TSS Loadings

Observed $cBOD_5$, TSS, and NH_4 loadings for the individual years from 2012 to 2015 were developed for development of projected loadings, and are summarized in Table 2-7, Table 2-8, and Table 2-9, respectively.

Table 2-7: Observed Historic $cBOD_5$ Loading

	Historic $cBOD_5$ Loading (lb/d)				
Year	2012	2013	2014	2015	2012-2015
Population	22,300	22,580	22,765	22,900	-
ADW	3,191	2,785	2,914	3,215	3,022
MMDW	3,984	3,374	4,516	4,188	3,979
AAD	3,155	2,998	2,881	3,174	3,051
AWW	3,116	3,189	6,247	3,137	3,079
MMWW	3,997	4,328	10,993	5,210	4,321
PWk	6,011	5,256	4,864	6,261	6,129
PDA	7,090	7,030	6,103	7,670	7,714

Table 2-8: Observed Historic TSS Loading

	Historic TSS Loading (lb/d)				
Year	2012	2013	2014	2015	2012-2015
Population	22,300	22,580	22,765	22,900	-
ADW	4,813	5,000	5,291	6,266	5,310
MMDW	6,872	6,955	7,600	8,521	7,862
AAD	5,081	4,882	5,776	6,549	5,545
AWW	5,376	4,759	6,247	6,820	5,784
MMWW	8,994	6,980	10,993	11,037	9,469
PWk	12,481	10,692	16,736	15,312	13,643
PDA	16,150	16,535	22,250	19,961	20,506

Table 2-9: Observed Historic NH_4-N Loading

	Historic NH_4-N Loading (lb/d)				
Year	2012	2013	2014	2015	2012-2015
Population	22,300	22,580	22,765	22,900	-
ADW	357	350	334	387	365
MMDW	394	396	390	486	440
AAD	352	364	291	348	340
AWW	346	381	265	310	317
MMWW	430	458	369	453	446
PWk	487	495	449	594	511
PDA	495	497	454	606	602

The analysis of the historical influent loadings of the full time period of 2012 through 2015 was used as the design loading for $cBOD_{5.}$ TSS, and NH_4-N. Unit loadings in pound per capita per day (ppcd) were calculated for each year of data analyzed. Projected unit loadings are the average of the individual 2012 to 2015 unit loads. Industrial loadings are expected to grow at the rate as domestic loads resulting in no changes to ratio of domestic to industrial loadings. The projected design loads in pounds per day (lb/d) are the sum of the design load and the product of projected unit load (ppcd) and projected population. Projected design $cBOD_5$, TSS, and NH_4-N loads are summarized in Table 2-10, Table 2-11, and Table 2-12, respectively.

Table 2-10: Projected Design $cBOD_5$ Load

	Design Load (lb/d)	Existing Unit Load (ppcd)	Projected Unit Load (ppcd)	Projected Design $cBOD_5$ Load (lb/d)				
Year	2012-2015	2015	-	2017	2022	2027	2032	2037
Population	-	22,900	-	23,480	25,797	28,343	31,139	33,811
ADW	3,022	0.14	0.13	3,150	3,450	3,800	4,200	4,550
MMDW	3,979	0.18	0.18	4,200	4,600	5,050	5,550	6,000
AAD	3,051	0.14	0.13	3,200	3,500	3,850	4,200	4,600
AWW	3,079	0.14	0.17	4,100	4,500	4,950	5,400	5,900
MMWW	4,321	0.23	0.27	6,350	7,000	7,700	8,450	9,150
PWk	6,129	0.27	0.25	5,850	6,400	7,050	7,750	8,400
PDA	7,714	0.33	0.31	7,250	7,950	8,750	9,600	10,450

Table 2-11: Projected Design TSS Load

	Design Load (lb/d)	Existing Unit Load (ppcd)	Projected Unit Load (ppcd)	Projected Design TSS Load (lb/d)				
Year	2012-2015	2015	-	2017	2022	2027	2032	2037
Population	-	22,900	-	23,480	25,797	28,343	31,139	33,811
ADW	5,310	0.27	0.24	5,550	6,100	6,700	7,350	8,000
MMDW	7,862	0.37	0.33	7,800	8,550	9,400	10,300	11,200
AAD	5,545	0.29	0.25	5,800	6,350	7,000	7,700	8,350
AWW	5,784	0.30	0.26	6,050	6,650	7,300	8,000	8,700
MMWW	9,469	0.48	0.42	9,850	10,850	11,900	13,100	14,200
PWk	13,643	0.67	0.61	14,350	15,750	17,300	19,000	20,600
PDA	20,506	0.87	0.83	19,450	21,350	23,450	25,750	27,950

Table 2-12: Projected Design NH_4-N Load

	Design Load (lb/d)	Existing Unit Load (ppcd)	Projected Unit Load (ppcd)	Projected Design NH_4-N Load (lb/d)				
Year	2012-2015	2015	-	2017	2022	2027	2032	2037
Population	-	22,900	-	23,480	25,797	28,343	31,139	33,811
ADW	365	0.017	0.016	380	410	450	500	540
MMDW	440	0.021	0.018	440	480	530	580	630
AAD	340	0.015	0.015	360	390	430	470	510
AWW	317	0.014	0.014	340	380	410	450	490
MMWW	446	0.020	0.019	450	490	540	590	640
PWk	511	0.026	0.022	530	580	640	700	760
PDA	602	0.026	0.023	540	590	650	710	770

2.5 PLANNING CRITERIA

See Note 1

2.5.1 Collection System

The City's conveyance system will be sized for the projected buildout peak instantaneous flow rates associated with the 5-year, 24-hour storm event. Based on the Comprehensive Plan updated in September 2015, buildout for the UGB and URA are projected to occur at approximately the same time as the planning period for this master plan. Where appropriate, new lines will be sized one nominal pipe size larger than what is needed for areas that may not be at buildout by the end of the planning period. Additionally, it should be noted that efforts to reduce I/I in the collection system could further extend the service population. When sizing gravity collection systems, pipelines are generally sized to carry peak design flows with 85% of the full capacity, and sewage lift stations are designed to handle these flows with the largest pump out of service (defined as firm capacity). These are consistent with industry design standards.

The evaluations performed as part of this master plan are used to develop and prioritize recommended improvements to address deficiencies in the collection system. These improvements are organized into the Capital Improvement Plan (CIP) and included in the System Development Charge (SDC) evaluation. For this model evaluation, pipe surcharging is allowed. A deficiency and potential overflow site is identified when the maximum hydraulic grade line for the peak instantaneous buildout flow (5-yr, 24-hr event) rises to within 2 feet of the manhole rim elevation (or ground elevation for elevated manholes). When the flow rises above the top of pipe in pipelines, the risk of overflows, backing up into homes, and exfiltration (escape of raw wastewater into the groundwater) increases. This deficiency evaluation threshold was discussed in workshops with City staff and determined to be appropriate for short-term peak flow conditions and to protect against overflows. Similar deficiency identification thresholds are used by other communities of relative size to Newberg in the region. It should be noted that this deficiency identification threshold is not a design standard and the CIP pipeline projects are all sized to conform to design standards, not the deficiency identification threshold.

2.5.2 Wastewater Treatment Plant

The future WWTP influent flows and loading were developed using the 2012 to 2015 historical data and population forecasts described above. A summary of the design conditions for the 20-year planning period is listed in Table 2-13.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table 2-13: WWTP Design Flow and Loadings for 2037

	WWTP Design Flows and Loadings			
Year	2037			
Population	33,811			
	Flow (MGD)	$cBOD_5$ (lb/d)	TSS (lb/d)	NH_4-N (lb/d)
ADW	3.4	4,550	8,000	540
MMDW	6.6	6,000	11,200	630
AAD	4.9	4,600	8,350	510
AWW	6.5	5,900	8,700	490
MMWW	12.4	9,150	14,200	640
PWk	13.0	8,400	20,600	760
PDA	25.1	10,450	27,950	770

2.6 REGULATORY REQUIREMENTS

Regulatory requirements, existing constraints, and water quality impacts directly affect the basis of design for new improvements. These issues are discussed below.

2.6.1 Collection System

Lift Station Design Regulatory Requirements

Lift stations are generally used to lift wastewater from a lower elevation, conveying it to a higher location where it is then discharged. Lift stations must meet requirements of DEQ. Typical guidelines governing lift station design include:

- Redundant Pumping Capacity – DEQ design criteria requires that the lift station firm capacity must be capable of conveying the larger of the 10-year dry-weather and 5-year wet-weather event. For Newberg, this means that the lift stations must be capable of pumping the 5-year, 24-hour storm peak instantaneous flow with the largest pump out of service.

- Hydrogen Sulfide Control – Hydrogen sulfide can be corrosive (especially to concrete materials) and often leads to odor problems. Where septic conditions are believed to occur, provisions for addressing hydrogen sulfide should be in place.

- Alarms – The alarm system should include high level, overflow, power, and pump fail conditions. DEQ design criteria require that an alarm condition results when all pumps are called on (loss of redundancy alarm) to keep up with inflow into the lift station. This is an indicator that the lift station firm capacity is exceeded.

- Standby Power – Since extended power outages may lead to wastewater backing up into homes and sanitary sewer overflows, provisions for standby power are required for every lift station. Mobile generators or portable trash pumps may be acceptable for lift stations, depending on the risk of overflow, available storage in the wet well and pipelines, alarms, and response time.

- DEQ has established a set of design guidelines for gravity collection systems and lift stations. These include design guidelines for wet well volumes, overflows, maximum force main velocities, and location/elevation relative to mapped floodplains, among others. Please refer to the following reference document for more details: http://www.oregon.gov/deq/Regulations/Pages/OARDiv052.aspx.

Pipeline Regulatory Rules (CMOM Rules)

CMOM refers to Capacity Management, Operation, and Maintenance of the entire wastewater conveyance system.

The vast majority of all sanitary sewer overflows originate from three sources in the collection system: 1) I/I; 2) roots; and 3) fats, oil, and grease (FOG). I/I problems are best addressed through a program of regular flow monitoring, TV monitoring, and pipeline rehabilitation and replacement. Blockages from roots or FOG are also addressed via a routine cleaning and monitoring program. A FOG control program may also involve public education and City regulations (e.g., requirements for installation and regular maintenance of grease interceptors). All new facilities believed to contribute FOGs should be equipped with grease interceptors.

All sanitary sewer overflows are prohibited by the Environmental Protection Agency (EPA), which oversees the DEQ. The Oregon sanitary sewer overflow rules include both wet-weather and dry-weather design criteria. DEQ has indicated that they have enforcement discretion, and that fines will not occur for overflow resulting from storm events that exceed the DEQ design criteria (i.e., greater than a winter 5-year storm event or a summer 10-year storm event).

In December 2009, DEQ developed a Sanitary Sewer Overflow Enforcement Internal Management Directive that provides guidance for preventing, reporting, and responding to sanitary sewer overflows. This document was later updated in November 2010. Municipalities are encouraged to adopt programs that reduce the likelihood of overflow events. Reporting requirements include notice within 24 hours and written reports within 5 days. The City can expect the next discharge permit to also include requirements for an Emergency Notification and Response Plan. This plan will replace the existing Contingency Plan for the Prevention and Handling of Sewer Spills and Unplanned Discharges. Appendix D of the directive outlines six elements to be included in the plans, which are summarized below.

1. Ensure the permittee is aware of such events.
2. Ensure appropriate personnel are notified and immediately dispatched for investigation and response.
3. Ensure the public, health agencies, and other affected public entities are immediately notified.

4. Ensure appropriate personnel are aware of and follow the plan, and are also appropriately trained.
5. Provide emergency operations.
6. Ensure DEQ is informed of the public notification steps taken.

Excessive Infiltration and Inflow

EPA defines excessive I/I as the quantity that can be economically eliminated from a sewer system by rehabilitation. Some guidelines for determining excessive I/I were developed in 1985 by EPA based on a survey of 270 standard metropolitan statistical area cities (EPA Infiltration/Inflow Analysis and Project Certification, 1985). Non-excessive numeric criteria for infiltration was defined as average daily dry-weather flows that are below 120 gpcd. Similarly, a guideline of 275 gpcd average wet-weather flow was established as an indicator below which is considered non-excessive storm water inflow.

Pipeline Surcharging

Pipeline surcharging occurs as flows exceed the capacity of a full pipe, causing wastewater to back up into manholes and services. Surcharging of gravity pipelines is generally discouraged because of: 1) the increased potential for backing up into residents' homes; 2) the increased potential of exfiltration; and 3) health risks associated with sanitary sewer overflows.

Illicit Cross Connections

Any illicit cross connections from the City's storm water system should be removed.

2.6.2 Wastewater Treatment Plant

The City of Newberg WWTP currently operates under the 2004 National Pollutant Discharge Elimination System (NPDES) permit with 2008 modification, which expired May 31, 2009 (Permit Number 100988). The permit was administratively extended until the new permit is issued. Oregon Department of Environmental Quality (DEQ) is the regulatory agency charged with the administration of the NPDES permit program established under the Clean Water Act (CWA). A copy of the permit and modification is included in Appendix B. The City's new permit is pending renewal and is scheduled to be released in 2018.

Current NPDES Permit Discharge Requirements

Effluent water quality requirements for the WWTP treated effluent outfall 001 per Schedule A of the current NPDES permit are listed in this section. The NPDES permit allows discharge of treated, disinfected, and dechlorinated effluent to the Willamette River at River Mile 49.7.

Table 2-14: Current Dry-Weather Requirements

Parameter	May 1 to October 31				
	Avg. Concentration (mg/L)		Monthly Avg.[2] (lb/d)	Weekly Avg.[2] (lb/d)	Daily Max.[2] (lb/d)
	Monthly	Weekly			
$cBOD_5$[1]	10 mg/L	15 mg/L	330	500	660
TSS	10 mg/L	15 mg/L	330	500	660

[1]cBOD5 concentration limits are considered equivalent to the minimum design criteria BOD5 specified in OAR 340-041.

[2]Summer mass load limits based upon average dry-weather design flow of 4.0 MGD. Winter mass load limits based upon avg. wet-weather design flow of 6.5 MGD. The daily mass load limit is suspended on any day in which the daily flow to the treatment facility exceeds 8 MGD (twice the design avg. dry-weather flow).

Table 2-15: Current Wet-Weather Requirements

Parameter	November 1 to April 30				
	Avg. Concentration (mg/L)		Monthly Avg.[2] (lb/d)	Weekly Avg.[2] (lb/d)	Daily Max.[2] (lb/d)
	Monthly	Weekly			
$cBOD_5$[1]	25 mg/L	40 mg/L	1,400	2,000	2,700
TSS	30 mg/L	45 mg/L	1,600	2,400	3,200

[1]cBOD5 concentration limits are considered equivalent to the minimum design criteria BOD5 specified in OAR 340-041.

[2]Summer mass load limits based upon average dry-weather design flow of 4.0 MGD. Winter mass load limits based upon avg. wet-weather design flow of 6.5 MGD. The daily mass load limit is suspended on any day in which the daily flow to the treatment facility exceeds 8 MGD (twice the design avg. dry-weather flow).

Table 2-16: Current Year-Round Requirements

Other Parameters (year-round)	Limitations
E. coli Bacteria	Shall not exceed 126 organisms per 100mL monthly geometric mean. No single sample shall exceed 406 organisms per 100mL.[1]
pH	Shall be within the range of 6.0 to 9.0
cBOD5 and TSS Removal Efficiency	Shall not be less than 85% monthly average for cBOD5 and 85% monthly for TSS.
Total Residual Chlorine	Shall not exceed a monthly average concentration of 0.02 mg/L and a daily maximum concentration of 0.05 mg/L.[2]
Excess Thermal Load (ETL)	Limits are calculated based on the ETL Limit Options A, B, or C below.[3]

[1]If a single sample exceeds 406 organisms per 100mL, then five consecutive re-samples may be taken at four-hour intervals beginning within 28 hours after the original sample was taken. If the log mean of the five re-samples is less than or equal to 126 organisms per 100mL, a violation shall not be triggered.

[2]When the total residual chlorine limitation is lower than 0.10 mg/L, the Department will use 0.10 mg/L as the compliance evaluation level (i.e. daily maximum concentrations below 0.10 mg/L will be considered in compliance with the limitation).

[3]See Permit Modification in Appendix B for ETL Limit Options.

Discharge requirements for the recycled wastewater outfall 101 were added in the 2008 NPDES permit modification. This outfall corresponds to the City's reuse water system that is used to irrigate a nearby golf course. The requirements include:

- No discharge to state waters is permitted. All recycled water shall be distributed for an approved use in accordance with OAR 340-055-0012 (1) and (2).
- Prior to land application of the recycled water, it shall receive Class A treatment as defined in OAR 340-055 to:
    - Prior to disinfection, turbidity must not exceed an average of 3 nephelometric turbidity units (NTU) within a 24-hour period, 5 NTU more than five percent of the time within a 24-hour period and 10 NTU at any time.
    - After disinfection, Total Coliform must not exceed a median of 2.2 organisms per 100mL based on results of the last seven days that analyses have been completed, and 23 total coliform organisms per 100mL in any single sample.
- All use of recycled water shall conform to the Recycled Water Use Plan approved by the Department. Upon approval of the Recycled Water Use Plan, the Plan shall become enforceable through this permit modification.

Seven emergency overflow points are also identified in the permit. The use of these lift stations as overflows is restricted to storm events as allowed under OAR 340-041-0009 (6) and (7) and instances of upset as defined in the General Conditions.

Biosolids

Both federal and state regulations apply to land application of biosolids from wastewater treatment plants. Title 40 of the Code of Federal Regulations, Part 503 (40 CFR §503) discusses standards for the use and disposal of biosolids. Oregon regulations include OAR 340-50. The state biosolids regulations were most recently revised in July 1995. They reference many of the federal technical biosolids regulations (40 CFR §503), including limits on trace pollutants and pathogens. Under state regulations the City must keep a Biosolids Management Plan (BMP). The City revised the BMP in 2015 to reflect the changes to the solids dewatering equipment.

Under normal circumstances, the City treats all solids removed in the wastewater treatment process by composting, and all compost produced meets requirements for Class A biosolids designation. As such, the compost has no restrictions on its use. The compost produced is sold or given away in bulk at the WWTP. All off-site transportation is done by the purchasers.

Mixing Zone

The current permit provides for a mixing zone that consists of the portion of Willamette River contained within a band extending out 75 ft from the west bank of the river and extending from a point 15 ft upstream of the outfall to a point 150 ft downstream of the outfall. The Zone of Immediate Dilution (ZID) is defined as the portion of the allowable mixing zone located within 15 ft of the point of discharge. The most recent mixing zone study was conducted in May 2010 by MixZon Inc.

Emerging and Future Water Quality Regulations

In the 20-year planning period water quality regulations are expected to become more stringent. While the timing of regulation changes is mostly unclear at this time, it is practical to review and anticipate changes to the extent possible. This section discusses some of the potential parameters that may be regulated over the planning period. It is anticipated that DEQ will issue the new NPDES permit within the next two years.

<u>Copper</u>

In January 2017, EPA approved the DEQ revised criteria for copper. The revised freshwater criteria is based on the EPA's 2007 recommendations to use the Biotic Ligand Model to derive site-specific criteria based on the water chemistry of the site, which affects the bioavailability and toxicity of copper to aquatic life. Table 30 Aquatic Life Water Quality for Toxic Pollutants has been amended to include the new requirements.

In late 2016, the City of Newberg volunteered to start monitoring effluent copper in anticipation of the requirement in the upcoming permit renewal. Recent monitoring results do not raise any concerns with meeting the revised copper criteria.

<u>Ammonia Rule</u>

In August 2015, EPA approved revisions to Oregon's ammonia water quality standards for the protection of aquatic life. This standard identifies that mussels and snails are the most sensitive species. DEQ did not adopt criteria for ammonia based on the absence of snails/mussels, but current information indicates that they are (or historically were) present through most of Oregon. DEQ did not preclude the development of site-specific criteria.

Currently, ammonia discharge is not regulated at the WWTP, although monitoring is required per Schedule B. The WWTP, however, does fully nitrify throughout the year. An updated reasonable potential analysis (RPA) in accordance with the DEQ Reasonable Potential Analysis for Toxic Pollutants – Internal Management Directive (IMD) is recommended using the newly adopted ammonia criteria. The updated ammonia criteria are multi variant and with sensitivity to both temperature and pH of the effluent stream and the receiving water body.

<u>Blending</u>

The Bypass Regulation pursuant to the CWA is stated in EPA's NPDES regulation Section 40 CFR 122.41(m). In summary, the Bypass Regulation and current NPDES permit defines a "bypass" as the intentional diversion of waste streams from a portion of a treatment facility. The regulation also states that a bypass that occurs for the essential maintenance to assure efficient operation of a treatment facility and that does not exceed effluent limitations is permitted. Bypass is prohibited unless it is unavoidable to prevent loss of life, personal injury, or severe property damage and there are no feasible alternatives to the bypass. The current NPDES permit also requires the reporting of any bypass under Schedule B. Requirements for expansion of the secondary treatment process to treat projected peak flows should be provided within the planning horizon.

Temperature

The Willamette River is also designated as a migration corridor for salmon and steelhead. Under OAR 340-041-0028, an applicable numeric temperature criterion of 20 °C may not be exceeded during the entire year.

Excess Thermal Load (ETL) limits were added to the NPDES permit in the 2008 modification in response to the DEQ temperature total maximum daily load (TMDL) initially approved by EPA in September 2006. However, in 2013 a federal ruling disapproved DEQ's temperature standard, in validating the "natural conditions criterion". While it is unclear how the rulemaking will be addressed, the numeric temperature criterion still applies. A near term discharge temperature limit is not expected. However, it is reasonable to expect that a limit could be added within the 20-year planning period. Increasing effluent reuse and thermal load credits are the best options to mitigate concerns for the City.

Nutrients

Nitrogen and phosphorus are the typical concerns for nutrient impaired receiving water bodies. The Middle Willamette Sub-basin, where the WWTP outfall is located, is not expected to be water quality limited for nutrients. While nutrient removal will probably not be required in the short-term, it is recommended that the approach be consider in the 20-year planning period in case nitrogen and/or phosphorus limits are imposed. The EPA is currently reviewing the need for nutrient removal requirements from WWTPs to protect the nation’s waters. This is generally the first step in establishing standards for criteria in the future. Should the EPA promulgate nutrient removal requirements, DEQ would allow Oregon treatment facilities time to comply by incorporating compliance schedules into the next permit renewal following promulgation.

Effluent Reuse

An alternative to direct river discharge of treated effluent is using effluent reuse for beneficial purposes. The WWTP currently uses reclaimed water (disinfection secondary effluent) within the property of the plant fence line to offset potable water use in process and maintenance of the facility. In 2008, a tertiary membrane system was added to provide Class A recycle water for irrigation at a local golf course. Approximately 0.5 MGD of recycle water is used at the golf course between the months of May and October. The standards for effluent reuse in Oregon are established under OAR 340-055. The membrane system currently has room for expansion. Planning considerations may include increasing the recycle water production to offset discharge to the Willamette River, if required.

<u>Oregon Human Health Water Quality Criteria</u>
On October 17, 2011, EPA approved revisions to Oregon's water quality standards designed to reduce or prevent toxic pollutants. EPA's approval makes the revised state standards, including new NPDES permitting implementation policies, effective for state and federal CWA programs. DEQ developed several IMDs to address additional details regarding the implementation of several proposed rule components.

Discharges must be evaluated for toxic pollutants of concern (POCs) that might cause an exceedance of the water quality standard in the receiving water body. The current water quality criteria for aquatic toxicity are listed in OAR 340-41 pollutant Tables 20, 33A and 33B, and for human health water quality criteria in OAR 340-41 pollutant Table 40. The IMD is used to identify POCs, conduct the RPA, and calculate water quality based effluent limits (WQBELs). The current RPA for Toxic Pollutants, Revision 3.1, which includes the Intake Credit Rule, was updated in February 2012. DEQ consolidated the RPA steps and calculations into a series of spreadsheets (RPA Workbook). When conducting the RPA, the permit writer uses these spreadsheets to determine the discharger's monitoring requirements, identify POCs, calculate reasonable potential, and, if necessary, develop effluent limits.

Reliability and Redundancy

The EPA Technical Bulletin EPA-430-99-74-001: *Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability* (1973) requires new or expanding wastewater treatment plants that discharge to a receiving stream to meet minimum standards for mechanical, electrical, and component reliability. Redundancy and reliability refer to the level of protection required for the environment and receiving stream. The standards are divided into three, increasingly stringent, classes of reliability:

- Reliability Class I: Works that discharge, or potential discharge, (1) is into public water supply, shellfish, or primary contact recreation waters, or (2) as a result of its volume and/or character, could permanently or unacceptably damage or affect the receiving waters or public health if normal operations were interrupted.
    - Example: discharging near drinking water intakes or into shellfish waters.
- Reliability Class II: Works that discharge, or potential discharge, as a result of its volume and/or character, would not permanently or unacceptably damage or affect the receiving waters or public health during periods of short-term operations interruptions, but could be damaging if continued interruption of normal operations were to occur (on the order of several days).
    - Example: discharging into recreational waters
- Reliability Class III: Works not otherwise classified as Class I or Class II.

Per the 2007 Facilities Plan Update (Brown & Caldwell), the Newberg WWTP is currently operated under a Class II requirement, however DEQ has indicated that all WWTP within the Willamette Valley are Class I facilities. Class I and Class II requirements are outlined in Table 2-17. In addition to these standards, unit operations must be designed to pass the peak hydraulic flow with one unit out of service. Also, mechanical components in the facility must be designed to enable repair or replacement without violating the effluent limitations or causing control diversion.

Table 2-17: EPA Requirements for Reliability

<table>
<tr><th>Component</th><th>Reliability Class I</th><th>Reliability Class II</th></tr>
<tr><td>Raw sewage pumps, lift stations</td><td colspan="2">Peak flow with largest unit out of service. Peak flow is defined as the maximum wastewater flow expected during the design period.</td></tr>
<tr><td>Mechanical bar screens</td><td colspan="2">One backup with either manual or mechanical cleaning shall be provided. Facilities with only two screens shall have at least one manually cleaned bar screen.</td></tr>
<tr><td>Grit removal</td><td colspan="2">Minimum two units.</td></tr>
<tr><td>Primary sedimentation</td><td colspan="2">50% of design flow capacity with the largest unit out of service. Design flow is defined as the flow used as the design basis of the component.</td></tr>
<tr><td>Activate sludge process</td><td colspan="2">A minimum of two equal volume basins shall be provided. No backup basin required.</td></tr>
<tr><td>Aeration blowers</td><td colspan="2">Supply the design air capacity with the largest unit out of service shall be provided. A minimum of two units.</td></tr>
<tr><td>Air diffusers</td><td colspan="2">With the largest section of diffusers isolated or out of service, oxygen transfer capacity shall not be measurably impaired.</td></tr>
<tr><td>Secondary sedimentation</td><td>The units shall be sufficient in number and size so that, with the largest unit out of service, the remaining units have capacity for at least 75% of the design flow.</td><td>The units shall be sufficient in number and size so that, with the largest unit out of service, the remaining units have capacity for at least 50% of the design flow.</td></tr>
<tr><td>Filters/advanced treatment</td><td>The units shall be sufficient in number and size so that, with the largest unit out of service, the remaining units have capacity for at least 75% of the design flow.</td><td>No backup required.</td></tr>
<tr><td>Disinfection basins</td><td colspan="2">50% of design flow capacity with the largest unit out of service. Design flow is defined as the flow used as the design basis of the component.</td></tr>
<tr><td>Effluent pumps</td><td colspan="2">Peak flow with largest unit out of service. Peak flow is defined as the maximum wastewater flow expected during the design period.</td></tr>
<tr><td rowspan="2">Electrical power</td><td colspan="2">Provisions of two separate and independent sources of electrical power, either from two separate utility substations or from a single substation and a works-based generator shall be provided. Designated backup source shall have sufficient capacity to operate all vital components, critical lighting, and ventilation during peak flow conditions.</td></tr>
<tr><td>The provision of backup power capacity for secondary treatment, final clarification, and advanced treatment is required. The provision of capacity for degritting and sludge handling and treatment is optional.</td><td>The provision of backup power capacity for secondary treatment, final clarification, and advanced treatment is optional. The provision of capacity for degritting and sludge handling and treatment is not required.</td></tr>
<tr><td>Sludge holding tanks</td><td colspan="2">The volume of the holding tank shall be based on the expected time necessary to perform maintenance and repair of the component in question.</td></tr>
<tr><td>Anaerobic digestion</td><td colspan="2">At least two digestion tanks shall be provided. Backup sludge mixing equipment shall be provided or the system shall be flexible enough such that with one piece of equipment out of service, total mixing capacity is not lost. Backup equipment may be</td></tr>
<tr><td>Aerobic digestion</td><td colspan="2">A backup basin is not required. At least two blowers or mechanical aerators shall be provided. Isolation of largest section of diffusers without measurably impairing oxygen transfer is allowed.</td></tr>
<tr><td>Sludge pumping</td><td colspan="2">Pumps sized to pump peak sludge quantity with one pump out of service. Backup pump may be uninstalled.</td></tr>
</table>

Source: EPA Technical Bulletin EPA-430-99-74-001: Design Criteria for Mechanical, Electric, and Fluids system and Components Reliability (1973)

Regulatory Summary

Based on the discussion above, Table 2-18 provides a summary of the assumed WWTP treatment requirements for the WWTP planning period.

Table 2-18: Assumed Treatment Requirements for Planning Period

Parameters	Current Discharge Requirements	Short-Term	2037 Planning Period
Effluent Requirements			
Dry-Weather (May 1-October 31)			
$cBOD_5$, monthly/weekly averages (mg/L)	10/15	10/15	10/15
TSS, monthly/weekly averages (mg/L)	10/15	10/15	10/15
Temperature	NA	NA	TBD[1]
Wet-Weather (November 1 to April 30)			
$cBOD_5$, monthly/weekly averages (mg/L)	25/40	25/40	25/40
TSS, monthly/weekly averages (mg/L)	30/45	30/45	30/45
Year-Round Requirements			
E. Coli Bacteria	126/100 mL	126/100 mL	126/100 mL
pH	6.0 to 9.0	6.0 to 9.0	6.0 to 9.0
cBOD5 and TSS Removal Efficiency	85% Removal	85% Removal	85% Removal
Total Residual Chlorine, monthly/weekly averages (mg/L)	0.02/0.05	0.02/0.05	0.02/0.05
Copper (mg/L)	NA	NA[2]	NA[2]
Ammonia (mg/L)	NA	NA[2]	NA[2]
Total Nitrogen (mg/L)	NA	NA	10.0
Total Phosphorus (mg/L)	NA	NA	1.0
Toxics (mg/L)	NA	NA[2]	NA[2]
Other Requirements			
Biosolids Regulatory Parameters	Class A	Class A	Class A
Recycled Water Regulatory Parameters	Class A	Class A	Class A
Facility Reliability and Redundancy Classification	Class II	Class I	Class I

[1]Pending revised DEQ rulemaking.

[2]No requirement anticipated unless changes in mixing zone dilution or regulatory requirements.

3. COLLECTION SYSTEM EXISTING FACILITIES

This section contains a description and evaluation of the existing wastewater collection system – including lift stations and pipelines – for the City of Newberg.

3.1 SYSTEM DESCRIPTION

The wastewater collection system consists of approximately 80 miles of gravity sewer mains, 3 miles of force main, and eight lift stations. The pipelines range from 4 to 42 inches in diameter. The gravity mains are summarized by diameter and material in Table 3-1. Figure 5 (Appendix A) illustrates the pipe diameters and Figure 6 illustrates the pipe material in the City's collection system. There are over 1,600 manholes in the City's collection system. Lift station locations and their basins are shown in Figure 7.

Table 3-1: Pipe Type and Size Summary

Pipe Diameter (in)	Pipe Material Lengths (ft)						Total by Diameter (ft)	% of Total
	Concrete[1]	PVC	Cast Iron	Ductile Iron	Clay	Unknown		
4"	1,165	1,156	84		2,442	580	*5,430*	*1.3%*
6"	10,840	10,319		522	20,306	1,832	*43,820*	*10.3%*
8"	112,181	116,616		2,679	30,158	1,890	*263,520*	*62.1%*
10"	4,582	10,406			4,150	11	*19,150*	*4.5%*
12"	20,042	8,104	520		4,016	423	*33,110*	*7.8%*
15"	21,930	3,434			351		*25,720*	*6.1%*
18"	2,627	5,259		180	591	330	*8,990*	*2.1%*
21"		9,903				243	*10,150*	*2.4%*
24"	597	3,848					*4,450*	*1.0%*
27"		904					*900*	*0.2%*
30"	5,118						*5,120*	*1.2%*
36"	2,340	1,346					*3,690*	*0.9%*
42"	177						*180*	*0.0%*
Total by Material (ft)	*181,600*	*171,300*	*600*	*3,380*	*62,010*	*5,310*	*424,230*	*100%*
% of Total	*42.8%*	*40.4%*	*0.1%*	*0.8%*	*14.6%*	*1.3%*	*80.3*	*MILES*

[1]Includes concrete, AC, RCP, and transite pipe materials.

3.2 CONDITION OF EXISTING FACILITIES

3.2.1 Lift Stations and Force Mains

There are eight lift stations and approximately 3 miles of force main operated and maintained by the City in its wastewater collection system (Figure 7 in Appendix A). Lift stations are generally named by their locations in the city: Andrew, Charles, Chehalem, Creekside, Dayton, Fernwood, Highway 240, and Sheridan.

An onsite facility evaluation was completed in January 2017 with City operations personnel to review conditions of the lift station facilities, current maintenance activities, and operational problems encountered by City staff. Pump drawdown tests were conducted with help from maintenance personnel to observe the wet well's condition and check the pumps' operation.

All stations are equipped with submersible pumps except Dayton, which uses self-priming, centrifugal pumps; however, the City is currently planning to upgrade the Dayton Lift Station with a submersible pump system. A number of the pumps have variable frequency drives (VFD) but are programmed to operate as soft starts. Each lift station alternates pumps between lead/lag (duplex systems) or lead/lag/standby (triplex systems) for equal runtime between pumps. Level control is through either Flygt Multitrode (older system) or Flygt MultiSmart (newer system) pump controllers. Multitrode systems use a conductive-rod-type level sensor to control the pump on and off sequences; MultiSmart systems use submersible transducer level sensors. Float switches are used for high-level alarms. The floats are a redundant system to the main level control and provide a reliable system for the high-level alarm. Table 3-2 contains summary information for the eight lift stations. Appendix C includes available data such as pump curves, data sheets, and other data resources.

Table 3-2: Lift Station Inventory

	Andrew	Charles	Chehalem	Creekside	Dayton	Fernwood	Highway 240	Sheridan
LIFT STATION								
Type	Wet-well, submersible, duplex pump system	Wet-well, submersible, duplex pump system	Wet-well, submersible, duplex pump system	Wet-well, submersible, duplex pump system	Wet-well, self-priming, centrifugal, duplex pump system	Wet-well, submersible, triplex pump system	Wet-well, submersible, triplex pump system	Wet-well, submersible, duplex pump system
Pump Type	Submersible, VFD (set for soft start), non-clog centrifugal (Flygt CP3127.090 MT)	Submersible, VFD (set for soft start), non-clog centrifugal (Flygt CP3127.090 MT)	Submersible, soft start, non-clog centrifugal (Flygt NP3171.090 HT)	Submersible, VFD (set for soft start), non-clog, centrifugal (Flygt CP3085.182 MT)	Vertical, soft start, self-priming centrifugal (Gorman-Rupp T10A-B)	Submersible, VFD (set for soft start), non-clog centrifugal (Flygt CP3170.090 HT)	Submersible, VFD (set for soft start), non-clog centrifugal (ABS XFP 150J-CH2)	Submersible, VFD (set for soft start), non-clog centrifugal (Flygt CP3102.090 MT)
Capacity[1] (gpm)	Each pump: 155 gpm @ approx. 43 ft. TDH	Each pump: 150 gpm @ approx. 43 ft. TDH	Each pump: 630 gpm @ approx. 112 ft. TDH	Each pump: 153 gpm @ approx. 30 ft. TDH	Each pump: 2,100 gpm @ approx. 90 ft. TDH (with 15 ft. suction lift)	Each pump: 900 gpm @ approx. 70 ft. TDH	Each pump: 1010 gpm @ approx. 60 ft. TDH	Each pump: 115 gpm @ approx. 40 ft. TDH
Pump (each)	7.5 hp @ 1,200 rpm (460V, 60 Hz, 3 ph)	7.5 hp @ 1,150 rpm (230V, 60 Hz, 1 ph)	30 hp @ 1,760 rpm (460V, 60 Hz, 3 ph)	3 hp @ 1,710 rpm (460V, 60 Hz, 3 ph)	75 hp @ 1,315 rpm (460V, 60 Hz, 3 ph)	30 hp @ 1,750 rpm (460V, 60 Hz, 3 ph)	25 hp @ 1,185 rpm (460V, 60 Hz, 3 ph)	5 hp @ 1,715 rpm (230V, 60 Hz, 3 ph)
Level Control Type	Conductive level probe (6-in increments)	Conductive level probe (6-in increments)	Pressure transducer and conductive probe	Conductive level probe (6-in increments)	Ultrasonic	Pressure transducer	Pressure transducer	Conductive level probe (6-in increments)
Overflow Point	Overflow discharge pipe	Inlet MH	Overflow discharge pipe	Overflow vault at pump station	MH south of pump station	MH at pump station	Diversion structure in collection system	MH just north of pump station
Overflow Discharge	To creek south of pump station	To storm drain in road	To creek south of pump station	To creek west of pump station	To creek south of pump station	To swale east of pump station	To Dayton pump station	To creek west of pump station
Auxiliary Power Type	Permanent natural gas generator	Permanent diesel generator	Permanent diesel generator	Portable generator	Permanent natural gas generator	Permanent diesel generator	Permanent natural gas generator	Portable generator
Location	At pump station	At pump station	At pump station	At WWTP	At pump station	At pump station	At pump station	At WWTP
Output (kW)	35	25	100	40	150	250	60	25
Fuel Tank Capacity (gal)	N/A	126	173	50	N/A	170	N/A	50
Transfer Switch	Automatic	Automatic	Automatic	Manual	Automatic	Automatic	Automatic	Manual
Alarm Telemetry Type	Radio, operator call-out	Radio, operator call-out	Radio, operator call-out	Radio, operator call-out	Radio, operator call-out	Radio, operator call-out	Radio, operator call-out	Radio, operator call-out
Originally Constructed	2000	2000	2004	1998	1993	2001	2010	2001
Year Upgraded	N/A	2010	2010	2008	2010	2010	N/A	N/A
Wet Well Diameter (ft)	6	5	8	5	12	12	12	6
Wet Well Net Storage (gal)	1,000	1,100	4,500	1,200	5,300	12,900	14,100	920
FORCE MAIN								
Length, Type	Approx. 900 ft. of 4-inch C-900	Approx. 990 ft. of 4-inch C-900	Approx. 3,120 ft. of 6-inch C-900	Approx. 525 ft. of 4-inch C-900	Approx. 4,000 ft. of 12-inch C-900 and DI	Approx. 3,200 ft. of 12-inch C-900	Approx. 2,775 ft. of 10-inch C-900	Approx. 500 ft. of two parallel 4-inch C-900
Profile, Continuously Ascending (Yes/No)	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Discharge Location	MH at S. College and E. 9th Street	MH at S. Blaine and E. 9th Street	MH at N. College Street and E. Henry Road	MH at N. Main Street and Creekside Lane	MH at S. River and E. 9th Street	MH at S. Springbrook and E. Fernwood Road	MH at E. Illinois and Deskins Street	MH at W. Sheridan and N. Morton Street
Combination Air Release/Vaccuum Valves	None	None	None	None	Yes	None	None	None

[1]Capacity as reported in record drawings and O&M Manuals

This evaluation presents general observations and recommendations, along with specific recommendations for individual lift station sites. General observations and some recommendations are presented first for the lift station sites, wet wells, buildings, electrical systems, instrumentation, telemetry, drawdown tests, housekeeping, maintenance, safety equipment, emergency generators, and security. General recommendations are provided as a guideline to allow the City to maintain the lift stations for the 20-year planning period. Any items of concern observed during the onsite evaluation are also noted. Lift station specific observations and recommendations follow.

A. General Observations

Sites

The lift station sites are easily accessible from roads and streets throughout the city. Sites have multiple access routes, allowing more reliable access to the lift station sites in an emergency situation. Most sites have limited operation space around their facilities and are fenced. Charles, Creekside, and Sheridan do not have fences around their facilities.

Wet Wells

Most of the wet wells are lined with a protective coating; this prevents deterioration of the concrete, and reduces the buildup of grease and debris, in the wet well.

Buildings

Half of the lift stations have buildings. Chehalem, Fernwood, and Highway 240 are masonry construction using concrete masonry or brick; Dayton is a metal building. The masonry buildings have a long service life – with at least twenty years of service still remaining – and require very little maintenance (other than routine cleaning). Dayton's metal building will require repairs and maintenance in the near future; these are addressed in the site-specific recommendations.

Roofs are the main source of building maintenance over time. Chehalem and Fernwood both have asphalt shingles and will likely require repair or replacement over the next 10 to 15 years. None of the buildings have windows, so future window maintenance or replacement is not required. The doors are steel, and most are painted. The hardware is generally in good condition, although the paint is deteriorating. Most deterioration at this time is oxidation of the exterior, exposed paint. This type of condition is normal for doors in these kinds of applications. The doors will be usable for many years, but some maintenance will be required.

Electrical Systems

Electrical systems at all lift stations are in good to fair condition. Electrical equipment becomes obsolete in time due to changes in technology. Parts and service for outdated equipment become more difficult to obtain in time, requiring replacement with new equipment. Most of the electrical equipment at the lift stations will become obsolete and require replacement within twenty years. The equipment can be replaced when this occurs; there is no urgency at this time.

Instrumentation

Instrumentation consists of pressure gauges, pressure transducers for analog transmission of pressures, conductive level sensors for digital transmission of incremental levels in the wet well, float switches, and one magnetic flow meter. The magnetic flow meter is located at the Highway 240 Lift Station. Level control, alarms, and flow are typically the only instruments lift stations require. Monitoring flow at lift stations is recommended for maintenance and operational benefits. A record of flow from a lift station can provide information on pump, sewer, and inflow conditions; unauthorized inflow; and future planning for expansion or replacement.

Telemetry

All sites have radio-based telemetry systems with communication to a central location. If a site cannot establish a direct link with the WWTP, it can relay data to the WWTP through the Highway 240 site or the reservoirs. The telemetry systems are currently functioning adequately and use SCADA Pack brick programmable logic controller (PLC) systems. The PLC is a self-contained controller with input and output terminals. Brick-type PLCs work well for lift stations since the system is simple, reliable, and compact. Lift stations generally do not require the complex PLC systems found in modular rack-mounted PLC systems. The stations are programmed with a variety of call-out alarms, which trigger a notification at the WWTP and a call to the on-call operator phone. Each of the lift stations have the following call-out alarms:

- High level
- Power out
- Generator on
- Station running on emergency power
- Individual pump faults
- Pump start differential
- VFD failure (for those stations with VFDs)
- Communication failure
- Standby generator trouble
- Telesafe status
- Telesafe board high temp
- Telesafe battery
- No pumps in auto

It is recommended that a call-out alarm be added that notifies operators if all of the pump in a lift station turn on (an indication of no redundancy). In addition to these alarms, the stations are all equipped with backup high and low floats. The floats are not connected to the SCADA, but will turn the pumps on (high) or off (low) if the water level reaches the floats. It is recommended that the floats be connected to the SCADA to send out unique alarms for the high/low water levels.

Drawdown Tests

During the site visit, drawdown pump tests were completed to review wet well conditions and determine approximate pump flow rates. Each pump and pumping combination were tested at all lift stations. Dayton and Fernwood have depth readouts on their PLCs that were used to record depth over time. The Highway 240 Lift Station has a flow meter on its discharge pipe, allowing for measured flow rates to be recorded over time. Andrew, Charles, Chehalem (pressure transducer was not operational at time of tests), Creekside, and Sheridan do not have continuous depth measurement readouts; for these lift stations, depth to the water surface was measured manually during testing. Estimates for average pump flow rates were calculated using the pump test data. These estimated flow rates, along with the rated pump capacities, are shown in Table 3-3. For the majority of the lift stations, the calculated flow rate was relatively close to the reported pump capacity. Dayton has had historical problems with pump capacity and overflows, which are discussed in more detail in the Dayton Lift Station section. Fernwood field test results are lower than expected.

Table 3-3: Measured Pump Flow Rates

	Avg Field Test Flow Rate (gpm)	Reported Pump Capacity (gpm)
Andrew	140	155
Charles	150	150
Chehalem	660	630
Creekside	190	153
Dayton[1]	1,300	2,100
Fernwood	670	900
2 Pumps	1,210	-
Highway 240	910	1,010
2 Pumps	1,230	-
Sheridan	180	115

[1]As reported by RH2, April 2016 (Appendix C)

Housekeeping/Maintenance

Interiors of the lift station buildings are being kept in very good condition. Floors and walls are clean, painted, and maintained. The wash-down hose (which should be stored off of the ground) was found on the floor at a few of lift stations. The source of wash-down water is a hose bib on the lift station side of a backflow preventer fed by a water source. Backflow preventers should be installed at least 12-inches aboveground to facilitate proper operation, maintenance, and inspection. The backflow preventer is located in an insulated fiberglass cover. Some covers have electric heaters – while others have heat tape – to prevent freezing at the backflow preventer. Heat tape is not typically used for permanent installation. It is recommended the heat tape be replaced with a more permanent, outdoor, strip-type heater for freeze protection of the wash-down assemblies. A number of pad locks at various sites were difficult to open during the field evaluation. Operators often use a chemical for corrosion control and freeze protection, but it does not appear to be working. Padlock maintenance should be improved to facilitate ease of operation.

The wet well interiors were clean, with only small amounts of floating debris and FOG buildup. Chehalem, Fernwood, and Highway 240 have built-in FOG wash-down sprayers in the wet well that automatically turn on with the pumps. Operators perform drawdowns and FOG wash-downs at the lift station wet wells monthly, which they have indicated is sufficient to prevent any larger backups or problems in the collection system from FOG. Other major monthly maintenance activities include pump checks, high-level alarm checks, cabinet heater tests, observation of vandalism or other problems, and generator checks when applicable (see Appendix C for a complete checklist). Dayton is a self-priming pump configuration with a slab over most of its wet well to support the pumps and piping. This slab causes cleaning and other maintenance to be more difficult. While the wet well was not completely observed due to the configuration, it likely has more accumulations than the open wet wells at sites with submersible pump setups.

Safety Equipment

All wet wells and most of the valve vaults have fall protection installed under the solid covers. The fall protection consists of a steel grating on hinges that covers the opening to prevent falling into the wet well or valve vault. The grates can be hinged up should access to the well or vault be required. There are fire extinguishers at the four lift station buildings, but not at the other four sites. There are no first aid cabinets nor emergency eye-wash stations installed, although operators carry first aid kits in their vehicles. Onsite wash-down water and hoses could be used if an operator were to be exposed to contaminated material at one of the lift stations. It is recommended that operators carry fire extinguishers in their vehicles for those stations that do not have one onsite.

Emergency Generators and Backup Power

All permanent generators are located outside in weatherproof enclosures. Charles, Chehalem, and Fernwood have emergency diesel generators; these run on diesel fuel stored in an above-ground tank at each generator. The fuel tanks are located under the generator frame skid (referred to as a sub-base fuel tank with a double wall containment) and fuel is pumped directly from the tank. Andrew, Dayton, and Highway 240 lift stations have natural-gas generators. Gas is fed to the generator though a gas meter. A service provider is utilized by the City to maintain the generators, which includes engine servicing and battery maintenance. The generators are exercised weekly for a short period of time.

Enclosures are generally not sound-insulated, except for the Fernwood Lift Station, which is equipped with a sound-insulated enclosure with air scoops. Dayton has minimal sound insulation. The engines have exhaust silencers, mounted in the enclosure with horizontal exhaust-flow, along with an upward outlet elbow and automatic weighted rain cap. The engines are only used during periodic exercises, so the silencer does not have an opportunity to dry out. This is likely causing interior corrosion to the exhaust silencer. Some exterior corrosion of the exhaust system was observed.

No backup power or emergency generators exist at Creekside and Sheridan, although these sites have a connection for a portable generator via a large flexible cord. These connections should be installed 34-inches aboveground for ease of operation. There is a portable, 40 kW diesel generator kept at the WWTP.

Security

Most of the sites are fenced and all have outdoor lighting. All lack security provisions. The electrical panels and access floor doors are locked, while the serving manholes are unlocked. No intrusion alarm system nor video equipment were observed at the sites. Use of video security provides a deterrent to vandalism, improved public safety, and a higher level of confidence in the reliability of the system.

HVAC

The sites with buildings have ventilation fans and louvers for ventilation and air cooling. The buildings also have inside electric unit heaters.

Cross Connection Control

Cross connections occur when the lift station discharge or wet well is accidently allowed to be connected to a potential source of potable water. The main locations of cross connection potential at the lift stations are wash-down hoses and air release valve discharges. The lift station buildings have wash-down hoses that have the potential for causing a cross connection through a flooded floor.

The other potential for cross connection is storm water surcharging of lift station sewer overflow systems that then flows into wet wells. The profiles of overflows connected to the storm system were not evaluated as part of this master plan. The City should consider installing a flap gate or some type of backflow control on sewer overflows at lift stations to prevent this potential cross connection.

A. Andrew Lift Station

Andrew Lift Station is located at 620 Andrew Street, with access to the site from Andrew Street. The lift station was installed in 2000, and no major upgrades have been performed since installation. The site is completely surrounded by chain-link fence with barbed-wire top strands. The electrical enclosure has a Yagi antenna for its SCADA system, as well as a low-mounted outdoor light nearby.

Andrew Lift Station

The lift station facility has a duplex submersible pump system installed in a circular wet well. One of the pumps in the wet well has a mixing valve that discharges part of its flow through a fitting to mix the wet well and help prevent settling of solids. The City has found these mixing valves to be inefficient, as they do not significantly improve lift station cleaning. The site does not have a building; electrical equipment is mounted outside in weatherproof enclosures. Wash-down water for the wet well is supplied by a backflow preventer connected to the water supply. The level in the wet well is monitored with a conductive level sensor and a high-level float backup system. A Flygt Multitrode duplex pump controller is used for pump operation. The pumps are constant-speed, mounted on steel pipe rails in the wet well to allow removal of the pumps without entering the wet well.

The valve vault is well-drained with no standing water. The floor drain of the valve vault is connected to the wet well. It appears the vault experienced some flooding on its floor previously; although it does not appear the water level was deeper than an inch. There is no flow meter or pressure gauge at the site. A natural gas generator with an automatic transfer switch is mounted on the back of the main electrical enclosure.

The Andrew Lift Station services approximately 55 lots, and discharges through a 4-inch force main leading to the gravity main a few blocks away at E. 9th and S. College Street. The velocity in the force main is approximately 4.0 fps. Each pump has a capacity of 155 gpm, with approximately 43 feet of total dynamic head (TDH). Typically, each pump runs about 65 minutes per day. There have been no known issues with the lift station overflowing, or with both pumps running continually for an extended period of time. In the 7-year pump runtime history analyzed, the maximum runtime was a total of 9.6 hours in a day at the lift station. If an overflow were to occur, there is a v-notch overflow weir in the wet well that directs flow to a creek approximately 90 feet to the south.

Overall, this lift station is in good condition. The wet well, pump rails, wet well safety grating, and wet well piping are in good condition. The wet well is coated to prevent concrete deterioration. The buildup of FOG on wet well walls and piping is minimal. Flange bolts in the wet well are corroding. Some flange and valve bolts in the valve vault are corroding; there is also some corrosion at the sharp edges where the coating application is thinnest. The electrical enclosure is in good condition. The enclosure for the generator is corroding in several locations, including the exhaust system.

B. Charles Lift Station

The Charles Lift Station was installed in 2000 at 922 Charles Street. The lift station is located on an elevated concrete slab in a very tight space between two residential houses and uses a shared driveway with one of the houses. The driveway has removable steel bollards between it and the lift station. Operators often experience difficulty getting crane trucks onto the lift station site because of the narrow driveway and tree in the median. The site is unfenced. Fencing should be installed to protect the public and prevent security problems; however, it doesn't appear adding a fence is practical due to the limited space available. There is a low-mounted outdoor light at the site.

Charles Lift Station

The lift station facility has a duplex submersible pump system in a wet well, with the valve vault attached directly to the wet well wall. One pump is equipped with a mixing valve similar to the Andrew Lift Station. The City has found that these are inefficient and unnecessary at the lift stations. Electrical equipment is mounted outside in weatherproof enclosures. Wash-down water for the wet well is supplied by a backflow preventer connected to the water supply. The level in the wet well is monitored with a conductive level sensor and a high-level float backup system. A Flygt Multitrode duplex pump controller is used for pump operation. Each pump runs with inverters to control its speed, while protecting it from feedback from the controls. Pumps are mounted on steel pipe rails in the wet well to allow their removal without entering the wet well. Piping in the wet well is in good condition.

The valve vault is well-drained with no standing water. The vault has a valve and connection provisions for flushing the force main downstream of the lift station or connecting temporary bypass pumping. There is no flow meter or pressure gauge at the site. A diesel onsite generator is installed on a base-mounted fuel tank. The generator is on a separate slab from the main lift station slab.

The lift station services approximately 45 homes, and discharges through a 4-inch force main leading to the gravity main a few blocks away at E. 9th and S. Blaine Street. The velocity in the force main is approximately 3.8 fps. Each pump has a capacity of 150 gpm, with approximately 43 feet of TDH. Typically, each pump runs about 65 minutes per day. There have been no known issues with the lift station overflowing, or with both pumps running continually for an extended period of time. In the 4-year pump runtime history analyzed, the maximum runtime was a total of 17.4 hours in a day at the lift station. Considering the typical peaking factors, this may be coming close to the capacity of the lift station during peak hour events and will be evaluated further as a part of the collection system hydraulic evaluation (see Section 4 of this master plan). If an overflow were to occur, the flow would back up into the inlet manhole. There is an overflow at the top of the inlet manhole that flows to the local storm drain on Charles Street, which then drains to a creek approximately 200 feet south of the lift station.

Overall, the Charles Lift Station is in good condition. The wet well, pump rails, wet well safety grating, wet well piping, and inlet manhole are in good condition. The wet well and inlet manhole have coatings to prevent concrete deterioration. The manhole cover is cast iron without any coating and is corroding. Corrosion of cast iron items that are exposed is common. The manhole cover is not locked. Some floating debris is in the wet well, but very little grease buildup existed at the time of the site visit. Minor corrosion of the piping system in the valve vault is occurring. The electrical enclosure is in good condition.

C. Chehalem Lift Station

Chehalem Lift Station is located at 2900 NE Chehalem Drive and was installed in 2004. The site has a small building, wet well, and generator. The site is fenced with access to the site through a gate. Electrical equipment is located inside the building. The exterior of the building contains the electric meter and enclosure for the meter transformers. The site is covered with a concrete slab, including the entrance access. The wet well cover is raised above the surrounding concrete with a double access floor door. There are two floor door covers; the one close to the building is the valve vault, and the second is the wet well. Flow into the lift station is from Chehalem Drive into the wet well. The discharge is out the opposite side into the valve vault. Both wet well and valve vault have steel safety grates over their openings when the covers are open. The disconnect switches for the wet well pumps are located next to the wet well in a weatherproof enclosure. Wash-down water for the wet well is supplied by a backflow preventer connected to the water supply. The water supply backflow preventer is located in an insulated housing with an electric heater in the enclosure. The onsite storm drain is piped directly into the wet well.

The level in the wet well is monitored with a transducer level sensor, a backup conductive level sensor, and a high-level float backup system. At the time of the site evaluation, the transducer level sensor was not operating. A new transducer had been ordered but not yet arrived. A Flygt MultiSmart duplex pump controller is used to control the pump operation. The pumps run through starters in the motor control center. Pumps are mounted on steel pipe rails in the wet well to allow for their

Chehalem Lift Station

removal without entering the wet well. The interior of the wet well and piping is lined with protective coating.

The lift station services approximately 290 lots, and discharges through a 6-inch force main leading to the gravity main at E. Henry Road and S. College Street. The velocity in the force main is approximately 4.0 fps. Each pump has a capacity of 630 gpm, with approximately 112 feet of TDH. Typically, each pump runs about 40 minutes per day. There have been no known issues with the lift station overflowing, or with both pumps running continually for an extended period of time. In the 7-year pump runtime history analyzed, the maximum runtime was a total of 6.8 hours in a day at the lift station. If an overflow were to occur, there is a v-notch overflow weir in the wet well that directs flow to a swale directly to the west.

Overall, the Chehalem Lift Station is in good condition. The protective lining in the wet well is in fair condition. There are some areas where the coating is cracking and separating from the substrate; this allows corrosive materials to seep under the coating, corrode the underlying material, damage the bond between the coating and the substrate, and cause the defect area to grow larger. This is primarily occurring around the piping near the wall penetration, which could be due to the small amount of movement that happens at the penetration. Cured coatings are generally rigid and are damaged by movement. The wet well had a small amount of FOG accumulation at the time of the site visit, even though it has a built-in FOG wash that automatically turns on with the pumps. Wash-down water breaks up the FOG and allows it to be pumped out, but it can solidify again in the force main or downstream gravity piping.

The valve vault is in good condition with very little rusting of pipe, fittings, and valves. The wet well has a floor drain in the bottom flowing to the wet well. There is no flow meter installed in the discharge pipe. There are pressure gauges on the discharge pipes, although they were shut off at the time of the site visit (operators did not know the reason for this).

The generator is in good condition, although the maintenance records were not present in the generator enclosure. It is good practice to retain generator records at the facility to ensure accessibility for maintenance personnel.

D. Creekside Lift Station

Creekside Lift Station is located at 1379 Creekside Court between two residential houses and was installed in 1998. There have been no major upgrades to this lift station, though the impellors on the pumps were replaced with N-impellors in 2010. This site has neither a building nor a generator and is unfenced. Electrical equipment is located in weatherproof enclosures. The site, including the entrance access, is covered with a concrete slab. The wet well cover is raised above the surrounding concrete with a double access floor door. There is one low-mounted area light. The SCADA omni antenna is mounted on the electrical enclosure.

Check and isolation valves for the pumps are located aboveground in an insulated enclosure. The valve enclosure also has an old air release valve that has been capped. There is no flow meter or pressure gauge installed in the discharge pipe. Wash-down water for the wet well is supplied by a backflow preventer connected to the water supply and located a few inches off the ground in an insulated housing with a piece of heat tape in the enclosure to prevent freezing.

Creekside Lift Station

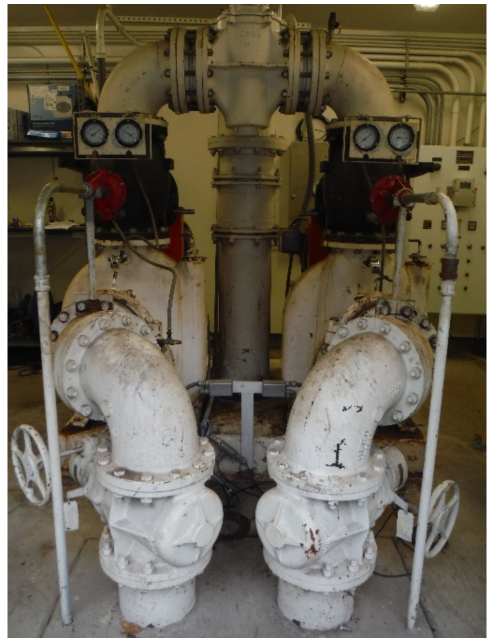
The level in the wet well is monitored with a conductive level sensor and a high-level float backup system. A Flygt Multitrode duplex pump controller is used for pump operation. Each pump runs with inverters to control its speed, while protecting it from feedback from the controls. Pumps are mounted on steel pipe rails in the wet well to allow for their removal without entering the wet well. One of the pumps in the wet well has a mixing valve, which the City has found to be inefficient and unnecessary in the lift stations. The electrical panel still has a motor starter for an air compressor, which the site had at one time, but has since been removed.

The Creekside Lift Station services approximately 60 homes, discharging through a 4-inch force main leading to the gravity main a few blocks away at N. Main Street and Creekside Lane. The velocity in the force main is approximately 3.9 fps. Each pump has a capacity of 153 gpm with approximately 30 feet of TDH and typically runs about one hour per day. There have been no known issues with the lift station overflowing, or with both pumps running continually for an extended period of time. In the 7-year pump runtime history analyzed, the maximum runtime was a total of 9.6 hours in a day at the lift station. If an overflow were to occur, there is a v-notch overflow weir in the wet well that directs flow to a box nearby, and then to a creek approximately 90 feet to the south.

The lift station has provisions for a portable generator for emergency operation. The portable generator is suitable; however, it is recommended that an onsite generator be permanently connected, which would provide better reliability than a portable generator. Many issues can arise during an emergency that would prevent use of a portable generator; blocked access, washed-out or damaged roads, generator failure, and greater need for the portable unit elsewhere are possibilities to consider.

Although not lined, the interior of the wet well is in good condition. The uncoated piping is corroding at the fittings. Coating piping after a station has already been in service is not recommended, as it is a major project that does not provide benefits in comparison to the work involved. The wet well had no FOG buildup.

E. Dayton Lift Station



Dayton Lift Station

Dayton Lift Station was installed in 1993 and is located at 830 Dayton Avenue. This lift station is an old, self-priming pump configuration and is planned for replacement in the near future. It currently has a building over a wet well, with the piping and pumps in the building. The building, which is metal with a coiling door for access to the pumps and piping, houses the electrical equipment. The suction pipes for the pumps pass through the floor and into the wet well. Near the building is a natural gas standby generator, which was replaced in 2010; the PLC was upgraded from Multitrode to MultiSmart at this same time. The site is fenced with access through a gate. A second gate leads to the access road along the force main alignment.

The level in the wet well is monitored with an ultrasonic level sensor and a high-level float backup system. A Flygt MultiSmart duplex pump controller is used for pump operation. There are pressure gauges on the discharge pipes.

The Dayton Lift Station services approximately 430 lots, discharging through a 12-inch force main leading to the gravity main at E. 9th and S. River Street. The velocity in the force main is approximately 3.7 fps. There are two air relief valves and one cleanout along the force main. Each pump has a reported capacity of 2,100 gpm (however, pump tests indicate that actual capacity may be much lower) and provides 15-feet of suction lift. Typically, each pump runs about 170 minutes per day. In the 7-year pump runtime history analyzed, the maximum runtime was a total of 22.6 hours in a day at the lift station. There have been issues with the lift station overflowing and both pumps running continually for an extended period of time. When an overflow occurs, it flows from the wet well into an overflow pipe, then proceeds into the creek to the south.

A Dayton Avenue Lift Station Rehabilitation Alternatives Letter Report was completed in April 2016 by RH2 Engineering, Inc. (Appendix C) to evaluate the current condition and performance of the lift station. The findings are summarized here. Historically, the lift station has experienced problems with pumping capacity and overflows. The station originally had a pumping capacity of 2,100 gpm, but City operators have reported observed pumping rates as low as 1,300 gpm. The Highway 240 Lift Station was constructed in 2009 to transfer up to 600 gpm from the Dayton Lift Station basin to the Wynooski sewer basin. This has reduced the frequency of overflows at Dayton, but the lift station continues to have performance and reliability issues. Deficiencies identified during the evaluation are summarized below (see Table 2 in RH2 report, Appendix C, for more details).

Deficiencies

- Inability to isolate pumps and perform maintenance on the station.
- Lack of bypass pumping system.
- Inaccurate level sensor readings.
- Regular "brownouts" causing programming, control issues, and overflows.
- Loss of prime on pumps.
- Reduced pumping capacity.
- Small wet well storage volume.

F. Fernwood Lift Station

Fernwood Lift Station is located at 4651 Fernwood Road and was installed in 2001. The fenced site has a small brick building, wet well, and generator. Electrical equipment is located inside the building, which also contains old equipment that is no longer used. An electric meter and enclosure for the meter transformers is located on the building's exterior. The site, including the entrance access, is covered with a concrete slab. The wet well cover is raised above the surrounding concrete with a triple access floor door. The wet well has steel safety grating over the opening when its access doors are open. The valve vault has two access doors but no steel safety grating.

The lift station was built as a duplex system with necessary space, piping, electrical, and other provisions to expand to a triplex system. The third pump was installed in 2010, and the valving was adjusted to utilize the larger force main that had been installed in 2001 with the station. The smaller force main was 6-inch, the larger is 12-inch. The level in the wet well is monitored with transducer level sensor and a high-level float backup system. A Flygt MultiSmart pump controller is used for pump operation. Pumps are mounted on steel pipe rails in the wet well to allow for their removal without entering the wet well. The interior of the wet well and piping is lined with protective coating.

Fernwood Lift Station

The Fernwood Lift Station services approximately 670 homes, discharging through a 12-inch force main leading to the gravity main at E. Fernwood and S. Springbrook Road. The velocity in the force main is approximately 2.6 fps with one pump operating and 3.4 fps with two pumps. The lift station should be adjusted to operate all three pumps together at least once a day to produce scour velocities (>3.5 fps) in the force main. There is a pressure gauge on the force main discharge pipe. Each pump has a reported capacity of 900 gpm, with approximately 70 feet of TDH.

Typically, each pump runs about 260 minutes per day. There have been no known issues with the lift station overflowing, or with multiple pumps running continually for an extended period of time. In the 7-year pump runtime history analyzed, the maximum runtime was a total of 12.3 hours in a day for the lift station. If an overflow were to occur, it would flow from the wet well into an overflow pipe, then into the creek northeast of the lift station. City staff have observed surcharging at the force main discharge manhole. The flow from the lift station may be contributing to surcharging and backups in the Springbrook line.

The wash-down water for the wet well is supplied by a backflow preventer connected to the water supply. The water supply backflow preventer is located in an insulated housing with an electric heater in the enclosure.

Overall, the Fernwood Lift Station is in good condition, though the field-tested pump capacity is lower than expected from the provided pump curves.

The wet well is in fair condition. There was some floating FOG accumulation in the wet well at the time of the site visit, but there was very little FOG buildup on the piping and wet well. The piping is uncoated and has surface rust (it does not appear to be severe or deep into the pipes). The wet well has an influent sewer discharge in the center of the three-pump installation. This configuration causes frequent plugging of the center pump by sucking up debris. The problem can be corrected by redirecting the influent sewage flow, or by installing a grinder on the influent. Normally, the best approach is to redirect the flow away from the pump suction.

The valve vault is in good condition with very little rusting of pipe, fittings, and valves. The wet well has a floor drain trench in the bottom for draining water entering from above. This station has a spare force main connection. Currently, only the larger force main is being used. The valves and adapters have their original finish with very little corrosion. The pipe is uncoated and is in good condition. There is and pressure gauge, but not a flow meter, installed in the discharge pipe.

The building is brick and in good condition. The steel painted doors are oxidized, which deteriorates the paint. The shingle roof is in fair condition, with very little shingle deterioration showing at this time. A weatherproof enclosure near the wet well houses the pump disconnects and the connection points for the submersible pumps. The enclosure is mounted very close to the wet well; there are no hazardous seal-offs visible at the enclosure. The generator and weather enclosure are both in good condition.

G. Highway 240 Lift Station

Highway 240 Lift Station

Highway 240 Lift Station is located at 319 W. Illinois Street and was installed in 2009. The lift station was intended to remove up to 600 gpm from the Dayton Lift Station basin to help alleviate overflow problems at Dayton (Master Plan Update, 2007). The fenced site has a small masonry building with prefinished metal trim. A valve vault, wet well, and generator are also located at the site. Electrical equipment is located inside the building, while an electric meter and enclosure for the meter transformers are on the building's exterior. Connection points for the pumps are located in an enclosure on the side of the building. The building has a Yagi antenna for the SCADA system. The site, including the entrance access, is covered with a concrete slab. The wet well cover is raised above the surrounding concrete with a triple access floor door. The wet well has steel safety grating over the opening when its access doors are open. The valve vault has two access doors, but no steel safety grating. The site has a flow meter in a single access door vault, which also does not have steel safety grating. The flow meter transmitter is located inside the building. There is a force main valve vault with double access doors, but not steel safety grating. The water supply has a backflow preventer inside the building with a surge tank installed.

The station is a triplex system. The level in the wet well is monitored with a transducer level sensor and a high-level float backup system. A Flygt MultiSmart pump controller is used for pump operation. Pumps are mounted on steel pipe rails in the wet well to allow for their removal without entering the wet well. The interior of the wet well is lined with protective coating, and piping is corrosion-resistant metal.

The Highway 240 Lift Station services approximately 950 homes, and discharges through a 10-inch force main leading to the gravity main at E. Illinois and Deskins Street. The velocity in the force main is approximately 3.7 fps. The force main has valved stub-outs for future, parallel force main to accommodate future growth. Each pump has a capacity of 1010 gpm, with approximately 60 feet of TDH. Typically, each pump runs about 300 minutes per day. There have been no known issues with the lift station overflowing, or with both pumps running continually for an extended period of time. In the 7-year pump runtime history analyzed, the maximum runtime was a total of 17.8 hours in a day at the lift station. There is a diversion structure with an overflow weir in the collection system at Highway 240 and N. Morton Street, preventing an overflow from occurring at the lift station. The overflow weir directs flow through the gravity main system to the Dayton Lift Station.

The wet well is in good condition. It had some floating FOG accumulation at the time of the site visit, but there was very little FOG buildup on the piping and wet well. The piping is uncoated but has very little corrosion, as it is made of corrosion-resistant metal. The pump removal rails are beginning to develop corrosion, which will cause difficulty in removing the pumps if it advances to a more severe condition.

The building is masonry and is in good condition. Its painted steel doors are oxidized, which deteriorates the paint; the doors should be repainted before the deterioration starts to damage the substrate. The generator and weather enclosure are in good condition.

The valve vault is in good condition with very little rusting of pipe, fittings, and valves. The piping and valves are coated with a protective coating. Safety grating should be added to both the valve and flow meter vaults. Covers on both vaults are heavy wheel load type, with deep structural members under them. This added depth of cover makes safety grates more difficult to install and less effective. In some cases, the heavy wheel load doors can be replaced with standard doors to make installation easier. When this is done, some type of protection is added to prevent vehicles from driving on top of the access doors.

The influent sewer discharges behind the three-pump system in the wet well. This configuration causes frequent plugging of the outer pump by sucking up debris; this can be corrected by redirecting the influent sewage flow, or by installing a grinder on the influent. Typically, the best approach is to redirect the flow away from the pump suction.

H. Sheridan Lift Station

Sheridan Lift Station

Sheridan Lift Station was installed in 2001 and is located at 610 W. Sheridan Street, with access to the site directly off Sheridan Street. The wet well is located near the street and has steel bollards to protect vehicles from running into the wet well top. The drainage water from the site slab and street flows to a drain trench near the street. The valve vault is located near the wet well. Flow into the wet well goes through a manhole, with multiple inflows combining before they flow to the wet well. The electrical enclosure is a weatherproof steel enclosure and has an antenna for the SCADA system. The site is unfenced and does not have a generator. The electrical enclosure has a connection point for a portable generator.

The lift station facility has a duplex submersible pump system installed in a circular wet well. One of the pumps has a mixing valve. The site does not have a building; the electrical equipment is mounted outside in weatherproof enclosures. The wet well has steel safety grating, and its interior has a protective coating. The level in the wet well is monitored with a conductive level sensor and a high-level float backup system. A Flygt Multitrode duplex pump controller is used for pump operation. The pumps are constant speed, mounted on steel pipe rails in the wet well to allow for their removal without entering the wet well.

The valve vault is well-drained with no standing water. The station has piping that allows two parallel, 4-inch force mains to be connected. Valve and tap provisions for flushing the force main and connecting temporary bypass pumping is included in the valve vault. The valve vault has steel safety grating. There is no flow meter at the site. The site has wash-down water hydrant. The water supply backflow preventer is mounted a few inches aboveground in an insulated housing with a piece of heat tape in the enclosure to prevent freezing.

The Sheridan Lift Station services approximately 15 homes, discharging through two parallel, 4-inch force mains leading to the gravity main a few blocks away at W. Sheridan and N. Morton Street. The velocity in the combined force main is approximately 2.3 fps. The lift station should be adjusted to operate both pumps together at least once a day to produce scour velocities (>3.5 fps) in the force main. Each pump has a capacity of 115 gpm, with approximately 40 feet of TDH. Typically, each pump runs about 15-20 minutes per day. There have been no known issues with the lift station overflowing, or with both pumps running continually for an extended period of time. In the 7-year pump runtime history analyzed, the maximum runtime was a total of 2.2 hours in a day at the lift station. If an overflow were to occur, the flow would back up into the inlet manhole. There is an overflow pipe at the top of the inlet manhole that flows to a creek west of the lift station, and eventually into the Chehalem Creek.

Overall, the Sheridan Lift Station is in good condition. The wet well, pump rails, wet well safety grating, and wet well piping are in good condition. The wet well coating prevents concrete deterioration. Some FOG accumulation was observed, but the buildup of FOG on wet well walls and piping was minimal. Some corrosion of hardware for the pump removal rail system is occurring, although at this time it is not severe. The valves and piping in the valve vault have a protective coating and are also in good condition. The electrical enclosure is in good condition. A portable heater is being used to heat the enclosure and prevent condensation. The heater should be replaced with an in-panel-type strip heater of the proper size.

3.4.2 Gravity Mains

Apart from the following summary of the upper Hess Creek trunk line investigation, please refer to Section 7 for gravity mains. The inspection reports, pipeline rehabilitation, and spot repair recommendations for the collection system gravity mains are all summarized in Section 7.

Upper Hess Creek Trunk line

There is a sanitary sewer pipe exposed in Hess Creek near Hess Creek Court. The facility ID is wwgm1046. GIS data states the pipe is a 12-inch, concrete pipe, installed in 1973, and is approximately 265 feet from MH to MH. The exposed pipe was first documented on August 8th, 2017 by City maintenance department and Keller Associates staff as they walked the Hess Creek trunk line alignment to determine where the best possible access points for smoke testing would be. See photo of the exposed pipe. During smoke testing the week of August 21st, the smoker was placed on the upstream MH. No smoke was visible from the exposed pipe.

Exposed Hess Creek Pipeline

Night-time monitoring was performed from 1 – 5 am on the morning of September 6th. The manhole downstream (DS) of the exposed section is H105004. The manhole upstream (US) of the exposed pipe is H105005. Within the measurement tolerances of night-time monitoring, the approximate depth and velocity of flow was approximately equal in the US and DS manhole's. There was not significantly more I/I flowing through the DS manhole compared to the US manhole. There is some build-up of solids in MH H105005 (US of the exposed pipe).

Overall, the monitoring and testing indicates that the exposed pipe is not an excessive source of I/I to the Hess Creek trunk line. It is recommended that the pipe be monitored, but no immediate rehabilitation or replacement is required.

3.3 COLLECTION SYSTEM OPERATION & MAINTENANCE SUMMARY

See Section 6.3 for Operation and Maintenance Summary and Recommendations

4. COLLECTION SYSTEM HYDRAULIC EVALUATION

4.1 COLLECTION SYSTEM COMPUTER MODEL

This section summarizes the wastewater collection system model development process and existing collection system analysis. It outlines the model construction and model calibration process, and also documents existing deficiencies. Improvements to address these deficiencies are presented in Section 6.

4.1.1 Model Construction

InfoSWMM Suite 14.5, Update #9 was selected as the modeling software for this project. InfoSWMM is a fully dynamic model which operates in conjunction with Esri ArcGIS and allows for evaluation of complex hydraulic flow patterns. The previous master plan collection system model was also completed in InfoSWMM (Brown & Caldwell, 2007).

The City GIS department maintains the Newberg GIS database. Pipe diameter and invert elevation data for the model were populated from this database. As part of model construction, 25 spot elevation locations were surveyed across the City, along trunk lines, to verify GIS database elevations. The surveyed elevation spot checks did not align with GIS database or previous model elevations. There was no apparent pattern to the discrepancies. The City elected to have all trunk line manholes surveyed to assure consistent elevation and invert data moving forward with model construction. Over 350 manhole rim and invert elevations were surveyed and entered into the City GIS database for use in model construction. In places where survey data was unable to be collected, record drawings were consulted.

Trunk lines with diameters of 10-inches and larger were modeled. Smaller pipe segments that connect trunk lines were also modeled regardless of diameter. Figure 8 in Appendix A shows the modeled lines in the system. After all manholes and pipes were created, and data populated in the model, several queries were conducted to reveal anomalies in the data. These included reverse slope pipes, unusual changes in pipe size, and uncommon configurations in the pipe network. The survey team did additional investigation where invert data indicated inverse slopes in the system. Anomalies were discussed with City personnel and appropriate changes were made to the model.

All eight lift stations (Andrews, Charles, Chehalem, Creekside, Dayton, Fernwood, HWY 240, and Sheridan) are included in the model. The lift station wet well dimensions and operational set points were taken from the operations and maintenance (O&M) manuals and verified with the system operators. Average pump capacities were verified by field tests and O&M manual pump curves were used to characterize the lift station pumps. All lift stations were modeled with their firm capacities (capacity with largest pump offline).

It is important to note that one of the basic assumptions of the hydraulic model is that all of the lines are free from physical obstructions such as roots and accumulated debris. Such maintenance issues, which certainly exist, must be discovered and addressed through consistent maintenance efforts. The modeled capacities discussed in this chapter represent the capacity assuming the sewer lines are in good working order.

4.1.2 Model Calibration

Model loads refer to the wastewater flows that enter the sewer collection system. These loads are comprised of wastewater collected from individual services (base flows), plus groundwater infiltration and storm water inflows (I/I). As part of this study, flow monitoring was completed during the wet weather period from January to February 2017. Flow monitoring data was collected at various manholes throughout the system to help calibrate the model. Eleven monitoring sites were selected, dividing the system into basins. Flow monitoring was also completed in 2014 for the 2015 Newberg Sanitary Sewer I&I Study. Three locations were consistent between the 2014 and 2017 flow monitoring periods. These locations were used as comparison points between the two sets of flow monitoring data. Three additional locations from the 2014 data were used to complete calibration of the 2017 model. Figure 9 (Appendix A) shows all flow monitoring locations and basins used for model calibration. The basins were used to characterize flows throughout the system. The collected data was analyzed along with continuous precipitation data to establish typical 24-hour patterns, average flows at each site, and gauge rainfall influence in the system. Both dry weather and wet weather periods were used for loading and calibration efforts. Loads for the model were developed and calibrated in several stages as described below.

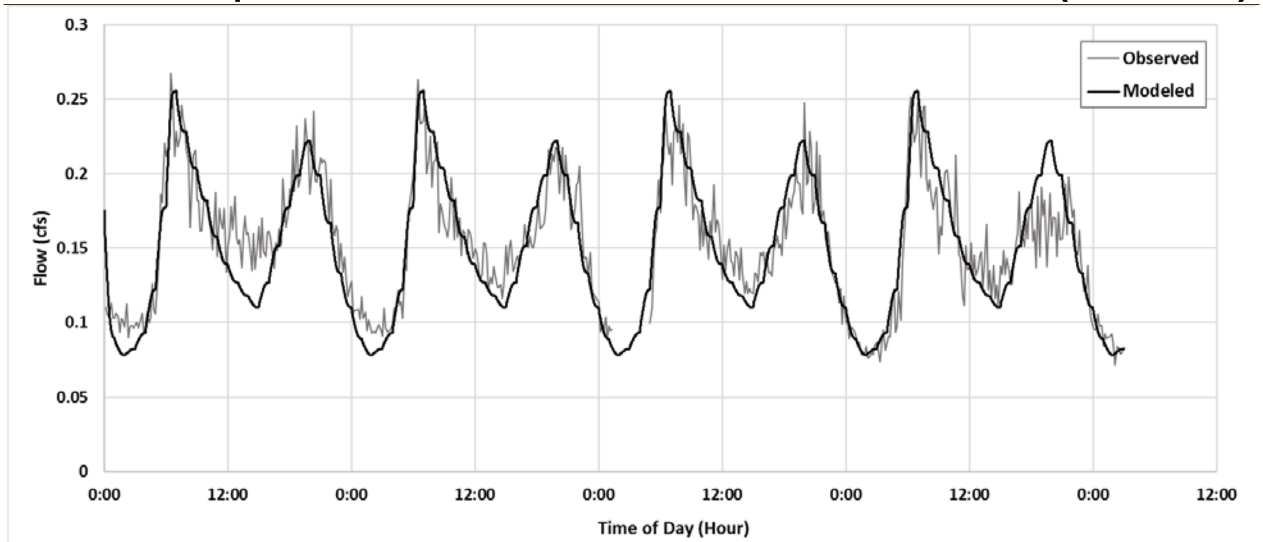
Dry Weather Flow (DWF) Calibration

As a starting point, base flows were estimated using winter potable water consumption data. January 2017 water meter readings provided by the City were used as average winter usage. Winter month average was used because it is most likely to exclude additional types of use, such as irrigation, that would not return to the sewer collection system. Individual water meter records for customers in Newberg were linked to the sewer model using GIS to provide a highly accurate distribution of potable water demands. Dry weather wastewater flows were assumed to be 95% of winter potable water demands. An average dry weather flow was assigned to each modeled manhole based on the consumption data.

A period of four dry days (none or trace amounts of rainfall) was analyzed from the flow monitoring data to select a typical day for each site, which was utilized to develop a diurnal flow pattern for the basin. This dry period was preceded by four days of none or trace amounts of rainfall. These typical patterns were assigned to all dry weather flows within the basin corresponding to the monitoring site.

The model was calibrated at the flow monitoring locations within the collection system and total modeled influent flow at the Wastewater Treatment Plant (WWTP) was compared to the targeted design average daily flow. Furthermore, WWTP inflow data, downstream of the influent lift station, was available for calibration comparison. Appendix D contains a summary of the data and analysis used for modeling purposes. An example of DWF calibration results are shown below in Chart 4-1.

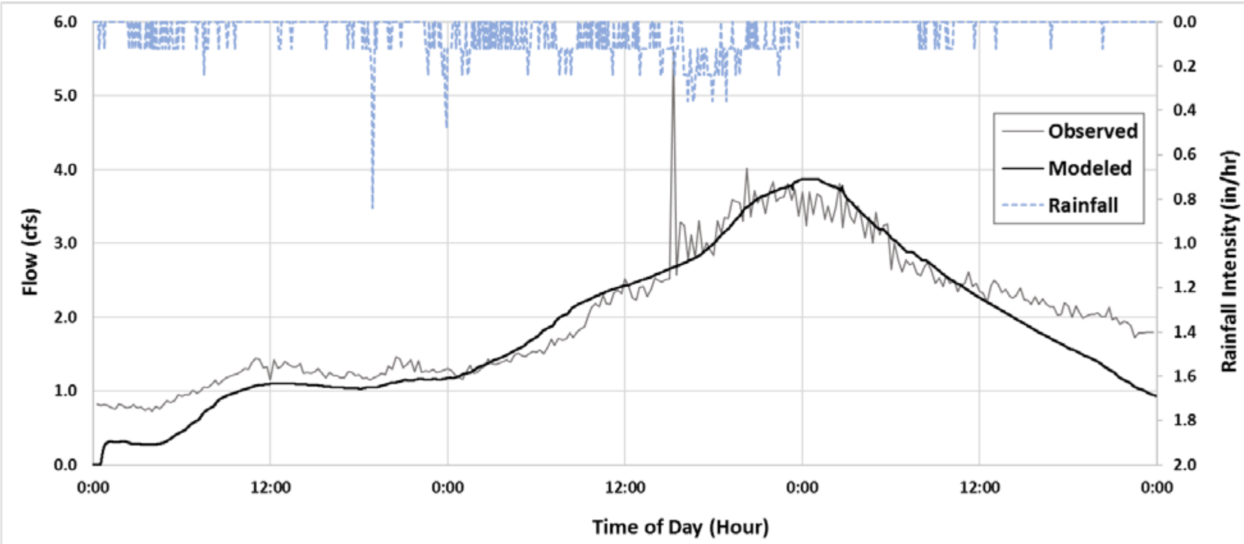
Chart 4-1: Sample DWF Calibration Site 16 – Modeled vs. Observed Flows (WWGM1810)



Wet Weather Flow (WWF) Calibration

The RTK method was used for rainfall-derived infiltration and inflow (RDII) prediction. Rainfall data for a 72-hour period with the highest cumulative (3.34 in) and highest intensity (0.84 in/hr) rainfall during the period of flow monitoring was utilized to calibrate wet weather flows. The storm event rainfall was entered into InfoSWMM. RTK parameters were then adjusted to calibrate the model with flow monitoring data. Again, total modeled influent flows at the WWTP were compared to the targeted design average daily flow and influent flow data in addition to calibrating the model at various locations within the collection system and at the WWTP influent lift station. Example calibration is shown in Chart 4-2.

Chart 4-2: Sample WWF Calibration Site 12 – Modeled vs. Observed Flows (WWGM1794)



Design Storm

The design storm for model evaluation was the 5-year, 24-hour storm event. A standard 24-hour NRCS rainfall distribution for a Type 1A storm was used. The rainfall for the 5-year, 24-hour storm event from NOAA isopluvial maps is 2.9 inches. This was used as the multiplier for the Type 1A storm hyetograph. The existing system, calibrated model was run with the design storm event. The modeled peak instantaneous and peak average day flows at the WWTP were compared to the design PIF_5 and $PDAF_5$ (Table 2-5). The peak flows matched the design values; therefore, no further calibration was completed on the model.

4.1.3 Existing Capacity Limitation

The calibrated model was used to determine the effects of a 5-year, 24-hour design storm event on the existing system. Figure 10 in Appendix A illustrates the potential overflow sites and surcharge threshold locations identified by the model analysis during the existing system peak flow scenario. The City defines surcharging as flow within two feet of the manhole rim elevation. The red nodes indicate potential flooding locations in the existing system. The main potential overflow areas are along Hess Creek, Villa Road, and Springbrook Road. Overflows have been observed by the City on Hess Creek, Villa Road, and Springbrook Road. Although present in the model, overflows at some of the other locations have not been observed by City staff, potentially due to the extra storage available in lateral lines which were not modeled or simply because overflows have not been noticed nor reported to City staff. Surcharging has been noted by City staff at a number of the model indicated locations and it is recommended that continued monitoring and investigations, especially during high flow events, to determine the actual extents of any flooding that may occur.

Those manholes that experience surcharging represent risk for backing up services or potential overflows. The majority of the manhole locations indicated by the model to be surcharging are located in the vicinity of potential overflow sites as well as South River Street, South Blaine Street, and South Howard Street. The manholes surcharging on South Blaine and Howard Streets are indicative of low capacity sections along South River Street. There are some, more isolated surcharging manholes indicated on North Main Street and Wynooski Road.

HWY 240 Lift Station

The model indicates minimal flow goes over the HWY 240 diversion structure towards Dayton Lift Station during peak flows. The peak flow entering the wet well for the HWY 240 lift station during the design storm event was approximately 1,600 gpm. The reported capacity of each HWY 240 pump is 1010 gpm. The field-tested capacity of two pumps is 1,230 gpm and three pumps is 1,410 gpm. The firm capacity of HWY 240 Lift Station's triplex system is lower than the existing peak inflow. In the existing system analysis, this does not cause any overflows or surcharging, but the wet well level increases above the lag pump start depth because the pump capacities are lower than the peak inflow to the station. In addition, some flow goes through the HWY 240 diversion. The total approximate flow for the HWY 240 basin which includes the flow diverted to the Dayton basin is 1,700 gpm.

4.1.4 Critical Slope Areas

The Ten States Recommended Standards for Wastewater Facilities (Great Lakes – Upper Mississippi River Board, 2014 edition) lists recommended minimum slopes for sanitary sewer gravity mains (Table 4-1). These slopes are based on average velocities, when flowing full, of 2.0 feet per second. These are used as general good practice when designing sewer gravity mains.

Table 4-1: Ten States Standards[A] Recommended Minimum Slopes

Nominal Sewer Size (in)	Min Slope (ft/100 ft)
8	0.400
10	0.280
12	0.220
15	0.150
18	0.120
21	0.100
24	0.080
27	0.067
30	0.058
36	0.046
42	0.037

[A]Recommended Standards for Wastewater Facilities (Great Lakes – Upper Mississippi River Board, 2014 edition).

Modeled gravity main slopes were compared with these recommended minimum slopes. The mains that are less than their recommended minimum slope are shown in Figure 11 (Appendix A). Pipes with inverse slopes are highlight in this figure as well. Low or inverse slopes can cause capacity issues and require higher than normal O&M. These mains should be monitored for capacity, odor, and solids buildup problems. All pipes in the collection system should be on a regular maintenance schedule. Pipes with low slopes may need to be cleaned more frequently to prevent solids buildup and flow disruption.

See Note 1

4.2 FUTURE COLLECTION SYSTEM PERFORMANCE

This section summarizes future flow projections and the model evaluation of future system expansion, and documents anticipated future deficiencies. Alternative improvements to address these deficiencies are presented in Section 5.

4.2.1 Future Flow Projections & Model Scenarios

Future loads were distributed based on PSU population projections (Section 2) and City projected future residential, commercial, and industrial growth. Flows per capita for projected population growth were assumed to be similar to existing flows per capita. Residential flows were projected using future growth area, average lot size, population density, and ADWF per capita attributed with residential contributions. Commercial, industrial, and institutional flows were projected using future growth areas indicated by City planning staff and typical flow per acre values (Metcalf and Eddie, 3rd Edition). Projected flows per zoning designation for the 20-year planning period are presented in Table 4-2. Projected flows per zoning designation for buildout are presented in Table 4-3.

Table 4-2: 20-Year Projected Flows by Zoning

Zoning	Average Lot Size[A] (ac)	Pop. Density[A, B] (people/ac)	Flow[C] (gpad)	Future Growth Area[A] (ac)	Flow[D] (gpd)
R-1	0.227	12	880	388	334,500
R-2	0.111	24	1,801	99	213,800
R-3, R-4	0.061	44	3,301	37	131,700
M-1, M-2, M-3	N/A	N/A	1,250	109	135,700
C-1, C-2, C-3	N/A	N/A	1,250	61	76,700
I	N/A	N/A	2,000	56	113,000
Infill	N/A	N/A	N/A	N/A	40,100
			Totals:	**751**	**1,046,000**

[A]Allocates 25% of area for roads and other public dedication, except on industrial and commercial zones, where 20% is allocated.
[B]Assume 2.69 people/dwelling unit (2010 US Census).
[C]Residential flows based on design ADWF per capita value of 99 gpcd (Table 2-5) then reduced by 25% accounting for removal of the industrial, commercial and institutional flows that contribute to the derivation of the 99 gpcd value. Industrial, commercial, and institutional flows based on typical flow per acre values (Metcalf and Eddie, 3rd Edition).
[D]Utilizes average annual dry-weather flows.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table 4-3: Buildout Projected Flows by Zoning

Zoning	Average Lot Size^A (ac)	Pop. Density$^{A, B}$ (people/ac)	Flow^C (gpad)	Future Growth Area^A (ac)	Flow^D (gpd)
R-1	0.227	12	880	159	139,800
R-2	0.111	24	1,801	37	66,800
I	N/A	N/A	1,000	16	16,500
			Totals:	**212**	**224,000**

^{A}Allocates 25% of area for roads and other public dedication, except on industrial and commercial zones, where 20% is allocated.
^{B}Assume 2.69 people/dwelling unit (2010 US Census).
^{C}Residential flows based on design ADWF per capita value of 99 gpcd (Table 2-5) then reduced by 25% accounting for removal of the industrial, commercial and institutional flows that contribute to the derivation of the 99 gpcd value. Industrial, commercial, and institutional flows based on typical flow per acre values (Metcalf and Eddie, 3rd Edition).
^{D}Utilizes average annual dry-weather flows.

See Note 1

The City provided projected growth areas as shown in Figure 12 in Appendix A. Flow associated with each growth area identified in Figure 12 was added to the closest modeled manhole to allocate future flows. Where applicable, future infrastructure, trunk lines and lift stations, were added to the model for future system evaluation. The Buildable Lands Study that is in process now, should also be taken into account for the design of any future improvements or new infrastructure. The future model was run to analyze the effects of future growth on the system for the 20-year planning horizon and buildout conditions. Trunk line basins, including how the future growth areas were assigned to each trunk line for the purposes of modeling in this master plan can be referenced in Figure 13 in Appendix A.

4.2.2 20-Year Capacity Limitations

Two lift stations with approximately 2,400 linear feet of force main and approximately 8,300 linear feet of gravity main were added to the model as future infrastructure to support growth indicated by the City in the next 20-years (Figure 12). The model was run to evaluate the effects of a 2037 peak day flow event on the existing system and this future infrastructure. Figure 14 in Appendix A illustrates the potential overflow sites and surcharge threshold locations identified by the 20-year model analysis. Overall, the problem areas identified in the 20-year evaluation are similar to the areas identified in the existing system analysis; Hess Creek, Villa Road, and Springbrook Road. The model indicates the volume of overflows and duration of overflows or surcharging increases in these areas compared to the existing scenario. A handful of manholes in these areas that were not concerns or did not exceed the surcharge threshold in the existing system evaluation, exceed the surcharge threshold or overflow in the 20-year evaluation.

South River Street, East 8th Street, and at the HWY 240 lift station are the three main areas in the 20-year model that increase from surcharging to overflows or present new problems in comparison to the existing evaluation. The number of

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

manholes indicating potential overflows and surcharging in the South River Street area increases significantly. Similar to the existing evaluation, the HWY 240 lift station cannot keep up with increased inflows. This scenario shows the wet well level causes surcharging in the upstream line and manhole. Higher flows pass through the HWY 240 diversion structure. The approximate peak flow for the HWY 240 basin which includes the flow diverted to the Dayton basin is 2,200 gpm.

See Note 1

4.2.3 Buildout Capacity Limitations

Approximately 2,000 linear feet of gravity main was added to the model for buildout infrastructure. The model was run to analyze the effects of a peak day flow event on the system at buildout conditions. Figure 15 in Appendix A illustrates the potential overflow sites and surcharge threshold exceedance locations identified by the buildout model analysis. The problem areas in the buildout scenario are very similar to those from the 2037 scenario; Hess Creek, Villa Road, Springbrook Road, South River Street, North Main Street, and HWY 240 Lift Station. The issues are similar to the 2037 findings with increased volume of overflows and duration of overflows and increased surcharging levels.

Similar to the other two evaluations, the HWY 240 lift station cannot keep up with increased inflows. This scenario shows the wet well level causes overflows at the upstream manhole and higher flows through the diversion structure, which causes a surcharge threshold exceedance issue in the trunk line flowing to the Dayton Lift Station. The approximate peak flow for the HWY 240 basin which includes the flow diverted to the Dayton basin is 2,700 gpm.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

5. COLLECTION SYSTEM IMPROVEMENT ALTERNATIVES

This section will present alternatives for the collection system to address the deficiencies presented in Sections 3 and 4.

5.1 LIFT STATION EXISTING CONDITION IMPROVEMENT ALTERNATIVES

Lift station existing conditions were summarized in Section 3. The deficiencies highlighted in Section 3, require minor improvements to resolve aside from Dayton Avenue Lift Station, discussed below. No alternatives were evaluated for the minor improvements. Lift station displacement is discussed in Section 5.2.3 in conjunction with pipeline improvements. Recommended short- and long-term lift station condition improvements are summarized in Section 6.

5.1.1 Dayton Lift Station

The RH2 report evaluated two alternatives to address the Dayton Lift Station deficiencies; rehabilitation of the station, and replacement of the station. The report finds that rehabilitation will not address the long-term needs of the station. Therefore, the recommendation is to implement a number of short-term improvements and then eventually replace the lift station. A Lift Station Replacement Conceptual Site Plan is attached to the RH2 report (Appendix C). The short-term improvements recommended in the RH2 report are listed below in order of need/urgency (see full report for additional details).

- Provide a means of bypass pumping.
- Remove and replace existing 3-way plug valve with new full-port 3-way valve.
- Verify and adjust level sensor calibration, programming, and signal scaling.
- Install temporary data logging power meter to monitor power quality and usage.
- Service and repair other valves within the lift station, including suction side check valves, air release valves, and discharge side check valve for Pump 2.
- Perform pigging and CCTV inspection of force main.

The Dayton Lift Station replacement project is under contract and the pre-construction meeting was held in January 2018. The City is currently working through the design phase.

5.2 CONVEYANCE IMPROVEMENT ALTERNATIVES

Summarized below are the system alternatives for the collection system to address the deficiencies presented in Section 4. Deficiencies identified in Section 4 that do not have multiple, feasible alternatives for improvements are addressed in Section 6. Alternatives are organized by location. All existing system deficiencies increase in the 20-year and buildout scenarios. Therefore, alternatives alleviate overflows and surcharging (water level within 2.0 feet of manhole rim elevation) through buildout conditions. Pipelines are sized to be one nominal size larger than hydraulically required in the model as directed by the City and standard

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

industry practice. As a general policy, all pipelines that are replaced in the alternative, at a minimum, match the upstream pipeline size. This is considered an industry good practice. Some specific cases are noted where existing downstream pipeline is smaller in size than the improvements recommended in the alternative. Advantages and disadvantages of alternatives, including capital cost and O&M considerations, are also discussed below. Detailed cost estimates of costs summarized in this section are presented in Appendix E.

For each set of alternatives, there is also an unstated option to do nothing and make no changes. This option perpetuates existing deficiencies and increases the risk of surcharging, overflows, environmental damages, DEQ violations, and subsequent fines.

5.2.1 Hess Creek Trunk Line and Villa Road

City staff have observed evidence of overflows along the Hess Creek trunk line and on Villa Road. The trunk line in Hess Creek is limited in capacity and also presents numerous maintenance problems and costs. Maintenance access varies along the pipeline from completely inaccessible along the lower and upper portions to fairly good in the vicinity of George Fox University. Figure 16 (Appendix A) illustrates the four alternatives summarized below that have been explored to rehabilitate and/or replace sections of the Hess Creek trunk line. Alternatives to address the deficiencies for the Villa Road pipeline are also included in the combined alternatives described below.

It should be noted that the alternatives evaluation in the hydraulic model assumes as much flow as possible from the future Springbrook development is directed to the Springbrook Road and North College Street trunk lines. The existing Springbrook Master Plan (June 2008) indicates most of flow will be directed to the Hess Creek trunk line. This flow is recommended to be re-directed to the Springbrook Road and North College Street trunk lines. In addition, supplementary flow monitoring is recommended as a part of preliminary design of any one alternative to further characterize the flow and I/I influence on the Hess Creek trunk line.

The exposed portion of the Hess Creek trunk line upstream of the Villa Road railroad crossing is not affected by any of the alternatives. The City has already investigated and stabilized the pipeline with wooden braces. The pipeline should be inspected regularly to monitor exposure of the pipeline in the creek and I/I in the line.

A) Parallel Gravity Main, Hess Creek Line Upsizing and Rehabilitation

Construct a 21- to 24-inch parallel gravity main to the east of the Hess Creek Canyon, from East Sherman Street and Villa Road to south of Corinne Drive where the line would reconnect with the existing Hess Creek line. The parallel line would collect all connections on the east side of the creek ravine, including the 8-inch diameter section of existing pipeline in Sherman Road that is the root cause for the overflows on the Villa Road pipeline.

Additionally; 1,900 linear feet of pipeline on Villa Road and Haworth Avenue need to be upsized to 12-inch diameter pipeline. Approximately 2,400 feet of existing pipeline would need to be re-graded to connect with the new alignment of the parallel gravity main.

The existing Hess Creek line would still need sections of upsizing and complete lining of the remaining sections to help reduce I/I influence on the line. Approximately 700 linear feet of the most southern section of the existing Hess Creek trunk line needs to be upsized from 15-inch to 36-inch diameter; 2,800 linear feet of the southern portion of the existing line needs to be upsized from 15- and 18-inch to 24-inch diameter; and an additional 800 feet further upstream needs to be upsized from 12-inch to 18-inch diameter. The remainder of the existing Hess Creek trunk line; approximately 8,400 feet; should be fully lined to decrease I/I influence as much as possible and extend the useful life of the pipeline. Cured-in-place pipe (CIPP) lining is assumed for the alternatives analysis. Other technologies could be used to line the pipeline and should be evaluated during pre-design.

Access to the Hess Creek trunk line for inspection and maintenance must be improved under this alternative. The lower three segments of Hess Creek trunk line are the most difficult to access. Replacement of these segments will require improvements to access and should be targeted to provide a maintenance access road sufficient to allow access with the City's TV truck. The other segments of the Hess Creek trunk line that make up the 4,300 linear feet recommended for replacement are also recommended to be improved to provide a maintenance access road.

B) New Lift Station, Local Grinder Pumps, Parallel Gravity Main, and Partial Abandonment of Hess Creek Line

For this alternative, a lift station would be built near the intersection of Villa Road, the railroad, and Hess Creek. The lift station would discharge to the manhole at Villa Road and Haworth Avenue, connecting to the same parallel gravity line presented in Alternative A. Connections to the existing Hess Creek trunk line south of Villa Road that are not re-directed to the parallel line on Villa Road, would need local grinder pumps to reach the gravity pipelines to the east and west of the canyon. Primarily, facilities along the George Fox University campus would be serviced with local grinder pumps. Based on the City's GIS data, there would be roughly 6-8 local grinder pumps required. This alternative would abandon-in-place approximately 8,500 linear feet of the Hess Creek trunk line south of the new lift station. A 700-foot section of the existing Hess Creek line, downstream of where the new gravity main would connect, would need to be upsized from 15-inch to 36-inch diameter. The existing Hess Creek line upstream would be lined to decrease I/I influence and extend the useful life of the pipeline.

Although this alternative abandons the largest portion of the Hess Creek trunk line, the cost and O&M of 6-8 local sump pumps makes this alternative impractical. For this reason, the alternative was not included in cost comparisons with the other Hess Creek alternatives.

C) New Lift Station, Parallel Gravity Main, and Partial Abandonment of Hess Creek Line

For this alternative, a lift station would be built north of where the Hess Creek trunk line crosses Portland Road. The exact location and connection point would be determined during preliminary design based on the feasibility of redirecting existing lines coming from East Hancock Street and Carlton Way. The lift station force main would discharge to a parallel gravity line with the same alignment as presented in Alternative A, at the south side of Portland Road near Church Street, or utilize the existing gravity line in Sherman Road to discharge at Sherman Road and Villa Road. The parallel gravity main would be a 24- and 27-inch line, larger than that proposed in Alternative A due to the lift station flow. The parallel line would collect all connections on the east side of the creek ravine, including the 8-inch diameter section of existing pipeline in Sherman Road that is the root cause for the overflows on the Villa Road pipeline. Additionally; 1,900 linear feet of pipeline on Villa Road and Haworth Avenue need to be upsized to 12-inch diameter pipeline. Approximately 2,400 feet of existing pipeline would need to be re-graded to connect with the new alignment of the parallel gravity main. This alternative does not require as many local grinder pumps as Alternative B. There may be one location near Wynooski Road and north of East 11th Street that requires a local grinder pump. This can be verified in preliminary design. This alternative would abandon-in-place approximately 5,000 linear feet of the Hess Creek line south of the new lift station.

A 700-foot section of existing Hess Creek trunk line, south of where the new parallel gravity line connects, would need to be upsized from a 15-inch to 36-inch diameter pipeline. An additional 800 feet further upstream of the proposed lift station, needs to be upsized from 12-inch to 18-inch diameter. The existing Hess Creek pipeline upstream of the new lift station; approximately 7,500 linear feet; would be lined to decrease I/I influence and extend the useful life of the pipeline.

D) Replacement of Hess Creek Line

For this alternative, the existing Hess Creek trunk line would be upsized and replaced to alleviate capacity deficiencies, minimize I/I influence, and extend useful life. Approximately 6,800 linear feet of existing pipeline with diameters ranging from 10- to 18-inch diameter; would be upsized to diameters ranging from 15- to 36-inch diameter. The remainder of the existing Hess Creek trunk line; approximately 6,000 feet; should be fully lined to decrease I/I influence as much as possible and extend the useful life of the pipeline. Similar to Alternative A, major improvements to trunk line access are recommended with this alternative. The current status of limited to no access to the trunk line increases risk and liability for the City due to potential overflows and pipeline stability.

This alternative would also include replacing the approximately 2,900 linear feet of 8- and 10-inch diameter pipelines along Villa Road and East Sherman Street that cause overflows. The upsized pipe would need to be 12-inch diameter pipeline. The improvements along Villa Road and East Sherman Street would result in smaller diameter pipeline required downstream along Hess Creek. There are four 8-inch diameter segments (approximately 800 feet) downstream of the improvements that increase in slope, preventing them from limiting capacity. The City can choose to replace and upsize the downstream portion of this Villa Road trunk line during preliminary design.

E) Lifecycle Cost and Alternatives Discussion

The annual O&M of a lift station is higher than that of gravity pipeline, so a 20-year life-cycle cost comparison was performed on Alternatives A, C, and D to evaluate the cost of each alternative (Table 5-1). The Hess Creek trunk line presents an ongoing O&M challenge for the Maintenance Division. The trunk line runs through private properties, there are limited points of access and they are insufficient for maintenance equipment, and the trunk line is below the ground water table for much of the winter. Details of the O&M cost estimates for each alternative can be found in Appendix E. The annual O&M cost is converted to a 20-year total using a net present value approach with a rate of 1.2%.

The three capital costs presented in Table 5-1, take into consideration constructability constraints of the trunk line in the Hess Creek Canyon, permitting and mitigation efforts, and ongoing access for maintenance activities. A local pipeline contractor provided input on the cost implications of working in the difficult construction environment of a creek canyon. The permitting, wetland mitigation, and restoration efforts required for improvements or repairs performed on the trunk line, increase the cost and level of effort for all projects related to the Hess Creek trunk line. Detailed cost estimates for each alternative can be found in Appendix E.

Alternative C has the lowest 20-year lifecycle cost, despite its higher annual O&M. Out of the three feasible alternatives, Alternative C eliminates the largest amount of pipeline in the Hess Creek canyon.

Table 5-1: Hess Creek 20-Year Lifecycle Costs

	Item	Annual Cost
Alternative A		
	Cleaning & CCTV Inspection (15,900 LF)	$ 6,400
	Pipeline Maintenance and Repairs (15,900 LF)	$ 1,700
	Access Road Maintenance	$ 5,000
	Annual O&M (rounded)	*$ 13,100*
	20-Year O&M (rounded)	$ 232,000
	Capital Cost	$ 12,354,000
	20-Year Lifecycle Cost (rounded)	**$ 12,586,000**
Alternative C		
	Lift Station O&M (power, worker O&M, equipment costs)	$ 32,000
	Cleaning & CCTV Inspection (11,100 LF)	$ 3,400
	Pipeline Maintenance and Repairs (11,100 LF)	$ 1,200
	Annual O&M (rounded)	*$ 36,600*
	20-Year O&M (rounded)	$ 648,000
	Capital Cost	$ 10,001,000
	20-Year Lifecycle Cost (rounded)	**$ 10,649,000**
Alternative D		
	Cleaning & CCTV Inspection (5,500 LF)	$ 2,500
	Pipeline Maintenance and Repairs (5,500 LF)	$ 600
	Access Road Maintenance	$ 5,000
	Annual O&M (rounded)	*$ 8,100*
	20-Year O&M (rounded)	$ 144,000
	Capital Cost	$ 12,223,000
	20-Year Lifecycle Cost (rounded)	**$ 12,367,000**

See Note 1

5.2.2 Springbrook Road

Figure 17 (Appendix A) presents the alternatives to resolve overflow and surcharging issues along South Springbrook Road. With all of the alternatives, it should be noted that that future flows allocated to the Springbrook trunkline for modeling purposes for this master plan, have the potential to be diverted to either the Hess Creek trunkline basin or the Providence trunkline. However, any flows diverted to the Providence trunkline will require pumping through the Fernwood lift station as opposed to gravity flow all the way down to the treatment plant headworks.

A) Replacement of Springbrook Road Line

For Alternative A, the existing gravity trunk line could be upsized from 15-inch to 24-inch diameter pipeline from Fernwood Road to south of the Sportsman Airpark (airport) right before it drops into Hess Creek Canyon (approximately 6,500 linear feet). In addition; roughly 2,100 linear feet upstream of Fernwood Road will need to be upsized from 15-inch to 21-inch diameter pipeline.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

B) Parallel Gravity Main

Another alternative to address the Springbook trunk line deficiencies includes a 21-inch diameter, parallel gravity main that would run west on East 2nd Street to HWY 219, then turn south and route through the Sportsman Airpark property and reconnect to the existing trunk line south of the airport before it drops into the creek bottom. This parallel line can be designed to receive all flows from either the Fernwood Lift Station force main or from the South Springbrook trunk line. These connections can be designed with overflow capabilities to transfer flow from one trunk line to the other if needed. Otherwise, a flow split downstream of the existing manhole in Fernwood and Springbrook can be utilized to send most of the flow down the new airport trunk line. This alternative also includes approximately 2,100 linear feet upstream of Fernwood Road that needs to be upsized from 15-inch to 21-inch diameter.

C) Alternatives Discussion

Estimated costs for the Springbrook Road Alternatives are summarized in Table 5-2. Detailed cost estimates for each alternative can be found in Appendix E.

Table 5-2: Springbrook Road Alternatives Estimated Costs

Alternative	Item	Unit	Unit Price	Quantity	Cost
A	Upsize existing pipeline				$ 3,176,000
	Mobilization	%	5	-	$ 158,800
				Subtotal (rounded)	$ 3,335,000
	Contingency	%	30	-	$ 1,000,500
				Subtotal (rounded)	$ 4,336,000
	Engineering and CMS	%	25	-	$ 1,084,000
				Project Total Cost (rounded):	**$5,420,000**
B	Parallel gravity main				$ 1,282,500
	Upsize existing pipeline				$ 915,000
				Subtotal (rounded)	$ 2,198,000
	Mobilization	%	5	-	$ 109,900
				Subtotal (rounded)	$ 2,308,000
	Contingency	%	30	-	$ 692,400
				Subtotal (rounded)	$ 3,001,000
	Engineering (25%) and Soft Costs				$ 810,250
				Project Total Cost (rounded):	**$3,812,000**

For both alternatives, they include continued use of two, 15-inch diameter segments (approximately 200 feet) downstream of the improvements. These segments increase in slope, preventing them from being capacity limiting. The City can choose to replace and upsize the downstream portion of this trunk line during preliminary design to prevent downstream pipeline from being smaller than the upstream pipeline. The average useful life of a pipeline is roughly 50-75 years; longer than the projected growth of this study.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

While the current Buildable Lands Study is not completed, once the final study is available, it is advisable to review growth beyond this study's buildout conditions and consider the impacts to the Springbrook Road gravity main.

Springbrook Road was recently improved and resurfaced as part of the Newberg-Dundee by-pass project. Alternative B reduces the impact improvements have on the newly resurfaced road. The majority of the parallel line would route through the airport and not require asphalt surface repair, further reducing the cost. On the other hand, the parallel line nearly doubles the linear feet of pipeline to clean, inspect, and maintain.

5.2.3 Lift Station and Trunk Line Consolidation/Displacement

Lift station and trunk line consolidation/displacement were focuses of the alternatives evaluation. The alternatives did not present feasible opportunities to consolidate trunk lines. There are a variety of alternatives to displace and consolidate lift stations in conjunction with infrastructure for future growth. These are summarized below.

Chehalem and Creekside Lift Stations (Figure 18)
Future growth areas to the west will connect to new infrastructure along NE Chehalem Drive. There is an opportunity here to redirect Chehalem and Creekside Lift Station flows west to this new line and south to HWY 240 Lift Station. The alignment of the new gravity main was estimated using elevation contours and tax lot lines as guidelines. The pipeline's vertical alignment is maintained at less than 20 feet deep for cost and O&M considerations. The proposed alignment from Chehalem Lift Station travels west for elevation considerations, before turning south toward Northeast Cullen Road. The alignment jogs a couple of times east and south. The alignment travels east to Chehalem Drive roughly west of Creekside Lift Station. The line turns south on Chehalem Drive to HWY 240 (Illinois Road), and follows the highway, crossing the creek on the highway bridge, and discharges into the HWY 240 Lift Station. Creekside Lift Station has a proposed alignment that crosses the creek west of the lift station and then turns south close to the creek to accommodate invert elevations lower than Creekside Lift Station, while being within 20 feet of ground elevation. The Creekside gravity line connects to the Chehalem line on HWY 240. This alignment would be refined as part of preliminary design. Both Chehalem and Creekside Lift Station could be displaced with this option.

Riverfront, Charles, and Andrew Lift Stations (Figure 18)
Future growth on the south waterfront will require a lift station (Riverfront Lift Station) to connect with the gravity main on East 12th and South Meridian Streets. The Charles and Andrew Lift Stations could gravity to this new lift station. This option reduces flow along East 9th Street and displaces two lift stations. The Riverfront Lift Station would not be necessary until the south waterfront develops. It is anticipated this will occur in the next 20 years. Depending on the timing, this

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

could coincide with the end of useful life of the Charles and Andrew Lift Stations. Instead of continuing to rehabilitate or improve these two lift stations, the Riverfront Lift Station could be developed and receive flows by gravity from the Charles and Andrew Lift Station basins. The alignments of these gravity mains consider elevation contours, tax lots lines, main line depths, and stream corridors. The proposed, general alignment takes the existing inlet invert from both lift stations and runs southwest/southeast respectively to meet at the railroad tracks, east of the Newberg Skate Park. Here the lines join and follow the railroad tracks before cutting south. The alignment jogs a bit to reach the proposed wet well to avoid low elevation/stream corridors as much as possible. This alignment would be refined as part of preliminary design.

HWY 240 Lift Station

HWY 240 Lift Station could be eliminated, and all flows could travel south to the Dayton Lift Station. However, the HWY 240 Lift Station was built to alleviate capacity issues at the Dayton Lift Station. Currently, the Dayton Lift Station is in design phase for replacement (see RH2 Report for more details, Appendix C). Displacing the HWY240 Lift Station would require the Dayton Lift Station to handle larger peak flows and require trunk line improvements between the HWY 240 and the Dayton Lift Stations. The City does not want to eliminate HWY 240 Lift Station and direct flow through Dayton Lift Station. Displacement of HWY 240 Lift Station was not investigated further.

See Note 1

6. RECOMMENDED COLLECTION SYSTEM IMPROVEMENTS

This section consists of the recommended plan to address the wastewater collection system deficiencies. The recommended projects presented here have been incorporated into the City Capital Improvement Plan (CIP) in Section 12.

6.1 RECOMMENDED LIFT STATION IMPROVEMENTS

Recommended lift station condition improvements summarized in Section 6.1, account for recommended lift station displacements discussed in Section 6.2. Lift stations that are recommended to be displaced, do not have long-term condition improvements associated with them. Costs presented in the following tables are planning level estimates and are in 2018 dollars. Actual costs may vary and should be refined further in the pre-design process. Engineering costs assume that multiple lift station projects will be grouped together for project administration efficiencies.

6.1.1 Priority 1 – Address Existing Deficiencies

Priority 1 lift station improvements address existing, short-term condition deficiencies that should be addressed in the next six years. Improvement costs are summarized by lift station in Table 6-1. Cost estimate details can be found in Appendix E. The majority of this estimate is for replacement of Dayton Lift Station. The City provided the latest construction cost estimate for this lift station which is included in Table 6-1. There are no recommended short-term improvements for the Andrew Lift Station.

Table 6-1: Lift Station Recommended Short-Term Improvements

Site	Recommended Improvements Cost
Charles Lift Station	$ 3,300
Chehalem Lift Station	$ 800
Creekside Lift Station	$ 15,000
Fernwood Lift Station	$ 14,300
HWY 240 Lift Station	$ 11,400
Sheridan Lift Station	$ 14,100
Lift Station Improvements Subtotal	*$ 59,000*
Contingency (30%)	*$ 17,700*
Engineering (20%)	*$ 15,400*
Administration (2%)	*$ 1,600*
Dayton Lift Station[1]	$ 1,335,000
Total Improvements Cost (rounded)	***$ 1,429,000***

[1]Dayton LS replacement cost provided by the City as most recent construction cost; includes mob, engineering, and admin.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

6.1.2 Priority 2 – Address Future Deficiencies

The following table summarizes recommended, long-term Priority 2 improvements by lift station (Table 6-2). These recommended improvements assume that Andrew, Charles, Chehalem, and Creekside lift stations are displaced through other CIP projects (discussed below) and therefore no long-term improvements are necessary. The Dayton Lift Station is recommended to be replaced in Priority 1, so it is assumed that the new lift station will not need long-term improvements. Cost estimate details can be found in Appendix E.

Table 6-2: Lift Station Recommended Long-Term Improvements

Site	Recommended Improvements Cost	
Fernwood Lift Station	$	66,600
HWY 240 Lift Station	$	43,000
Sheridan Lift Station	$	126,600
Lift Station Improvements Subtotal	*$*	*236,200*
Contingency (30%)	*$*	*70,900*
Engineering (20%)	*$*	*61,500*
Administration (2%)	*$*	*6,200*
Total Improvements Cost (rounded)	***$***	***375,000***

6.1.3 Future Infrastructure and Lift Station Displacement

Two new lift stations to service future development are recommended within the planning period. They are discussed in conjunction with future pipelines below in Section 6.2.3. Recommended lift station displacement options are also discussed in Section 6.2.3.

6.2 RECOMMENDED PIPELINE IMPROVEMENTS

This section summarizes the recommended pipeline improvements to address deficiencies from Section 4, including recommended alternatives from Section 5. Detailed cost estimates for all recommended improvements can be found in Appendix E.

6.2.1 Priority 1 – Address Existing Deficiencies

Priority 1 addresses short-term, existing capacity deficiencies highlighted in Section 4. The recommended alternatives from Section 5 are summarized and expanded upon below. Individual project sheets for Priority 1 projects, including location maps, are included in Appendix F.

Hess Creek Trunk Line and Villa Road

The recommended alternative for the Hess Creek trunk line and Villa Road is Alternative C – New Lift Station, Parallel Gravity Main, and Partial Abandonment of Hess Creek Line (Figure 15). This alternative will alleviate some of the operations and maintenance

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

(O&M) challenges with the Hess Creek trunk line by utilizing a new lift station near Portland Road to move flow to a proposed parallel line on Church Street, 3rd Street, and Corinne Drive; and abandon the trunk line in the southern portion of Hess Creek.

This alternative can be completed as one project but is recommended to be divided into three phases. Phase 1 includes CIPP of the upper portion of Hess Creek trunk line followed by flow monitoring of the basin to evaluate flows for pre-design of the lift station and parallel line. There are two segments of pipeline in the upper portion that should not be lined as they will be upsized in Phase 2. Phase 2 includes design and construction of the parallel line, as well as improvements to two sections of the existing Hess Creek trunk line that are undersized for existing flows. The final phase is design and construction of the lift station and force main, and connection to the parallel gravity line. Phase 1 and 2 are included in Priority 1 improvements. Phase 3 is included as a Priority 2 improvement. Phase 1 and 2 will provide I/I reduction and re-direct flow from the east side of the canyon away from the Hess Creek trunk line down the parallel line. A summary of the estimated costs of Phase 1 and 2 is presented in Table 6-3.

Table 6-3: Hess Creek Recommended Improvements – Phase 1 & 2 Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
Phase 1					
	CIPP, 8-18-inch[1]	LF	$ 98	7,500	$ 731,250
	Flow monitoring	LS	$ 20,000	1	$ 20,000
				Subtotal (rounded)	$ 752,000
	Mobilization	%	5	-	$ 37,600
				Subtotal (rounded)	$ 790,000
	Contingency	%	10	-	$ 79,000
				Subtotal (rounded)	$ 869,000
	Engineering and CMS	%	15	-	$ 130,350
				Phase 1 Cost (rounded):	**$1,000,000**
Phase 2					
	Parallel gravity main				$ 2,757,000
	Upsize existing pipeline				$ 1,118,750
				Subtotal (rounded)	$ 3,876,000
	Mobilization	%	5	-	$ 193,800
				Subtotal (rounded)	$ 4,070,000
	Contingency	%	30	-	$ 1,221,000
				Subtotal (rounded)	$ 5,291,000
	Engineering (25%) and Soft Costs				$ 1,357,750
				Phase 2 Cost (rounded):	**$6,649,000**

[1]CIPP costs increased by 30% for accessibility constraints in the Hess Creek Canyon.

Springbrook Road

The recommended alternative for Springbrook Road is Alternative B – Parallel Gravity Line (Figure 16). The improvements include upsizing a portion of the existing Springbrook line north of Fernwood Road. A new parallel gravity line will be added west

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

on 2nd St from the Fernwood Road intersection. The line will be bored under Hwy 219 and then run through Sportsman Airpark. The City planning department is in discussion with Airpark for other projects and the City thinks it is probable that the Airpark would be willing to negotiate an easement for the gravity sewer. During preliminary design it should be determined if the downstream pipeline should be replaced to match the upstream pipeline size. Refer to Table 5-2 for estimated costs.

While the current Buildable Lands Study is not completed, once the final study is available, it is advisable to review growth beyond this study's buildout conditions and consider the impacts to the Springbrook Road gravity main.

Pinehurst Court

Pinehurst Court in the HWY 240 basin has overflow concerns due to road elevations and the North Main Street trunk line invert elevation. It is recommended that the line on Pinehurst Court be disconnected from the North Main Street trunk line, re-graded to the west, and extended south to connect to the existing line on Creekside Court (Figure 18). Preliminary design should confirm Creekside Lift Station has capacity to handle Pinehurst Court flows. Pinehurst flows should also be considered when evaluating Creekside Lift Station displacement (see Section 6.2.3 for more discussion). Estimated costs are summarized in Table 6-4.

Table 6-4: Pinehurst Court Recommended Improvements Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
	Disconnect and re-direct to Creekside LS				$148,000
	Mobilization	%	5	-	$ 7,400
				Subtotal (rounded)	$156,000
	Contingency	%	30	-	$ 46,800
				Subtotal (rounded)	$203,000
	Engineering (25%) and Soft Costs				$ 54,400
				Project Total Cost (rounded):	**$258,000**

Additional Improvement Projects

The City completed a master plan on expanding and upgrading the City maintenance yard facilities. The recommended improvements project includes remodel of the building (completed in 2016/2017), major site work, a new fleet building, and new administration building. This project is being funded over multiple years and through multiple sources as it is relevant to several City divisions. The cost reflected in the CIP (Section 12) was provided by the City as the portion of the project costs to be allocated from the sewer funds.

The City is allocating $450,000-$600,000 annually for I/I specific projects. These projects will be directed by the I/I based priority improvements highlighted in Section 8 and coordination with other utility projects. This work is considered part of the annual replacement budget work for pipelines and manholes (see Section 12 for additional

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

discussion). The City has also budgeted $350,000 for sewer replacement on East 5th Street for the next fiscal year, in coordination with roadway improvements.

6.2.2 Priority 2 – Address Future Deficiencies

Hess Creek Trunk Line and Villa Road

As mentioned previously, Phase 3 of the Hess Creek and Villa Road Improvements – New Lift Station – is included in the Priority 2 projects. The cost estimate for Phase 3 is summarized in Table 6-5.

Table 6-5: Hess Creek Recommended Improvements – Phase 3 Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
Phase 3					
	Lift Station				$1,124,000
	Mobilization	%	5	-	$ 56,200
				Subtotal (rounded)	$1,181,000
	Contingency	%	30	-	$ 354,300
				Subtotal (rounded)	$1,536,000
	Engineering (25%) and Soft Costs				$ 585,000
				Phase 3 Cost (rounded):	**$2,121,000**

South River Street

Capacity deficiencies along the South River Street trunk line cause capacity issues upstream along South Blaine, Howard, and Chehalem Streets; and East 6th and 9th Streets. To alleviate these capacity issues, approximately 1,900 linear feet would be upsized from 21-inch to 30-inch diameter along South River Street between East 4th and 9th Streets. In addition, approximately 3,200 linear feet of 36-inch diameter pipeline would replace existing 30-inch diameter pipeline along South River Street south of East 9th Street, and along East 11th Street and Wynooski Street. (Figure 18). This new 36-inch diameter pipeline on East 11th Street and Wynooski Street would result in smaller diameter downstream pipelines. There are three 30-inch diameter segments (approximately 800 feet total) and one 24-inch diameter segment (approximately 300 feet) downstream of the improvements. The 24-inch diameter segment has a significantly higher slope than the other segments, which prevents it from being capacity limiting. During preliminary design it should be determined if the downstream pipeline should be replaced to match the upstream pipeline size. The cost estimate for these improvements is summarized in Table 6-6.

City staff are aware there is at least one connection between the South River Street trunk line and the South Chehalem Street pipeline (former trunk line) at East 6th Street. It is known that there are likely additional connections between the South River Street trunk line and the South Chehalem Street pipeline. The model has been calibrated with observed flow monitoring data and closely matches flow, depth, and velocity data upstream at Vermillion Street. Additional flow monitoring (number of locations focused in this area) and data collection could be beneficial to further characterize flow

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

throughout the South River trunk line. This is recommended as part of the preliminary design of any improvements related to the South River Street trunk line. Other parallel lines should also be investigated during preliminary design as a potential alignment as these other parallel lines may be in worse condition to replace and upsize.

Table 6-6: South River Street Recommended Improvements Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
	Upsize existing pipeline				$1,607,000
	Mobilization	%	5	-	$ 80,350
				Subtotal (rounded)	$1,688,000
	Contingency	%	30	-	$ 506,400
				Subtotal (rounded)	$2,195,000
	Engineering (25%) and Soft Costs				$ 568,750
				Project Total Cost (rounded):	**$2,764,000**

HWY 240 Lift Station

HWY 240 Lift Station will need upsized pumps as part of Priority 2. Prior to reaching the firm capacity at HWY 240, the pumps at the lift station should be upsized to handle peak flows at buildout (approximately 3,000 gpm at buildout with lift station displacement, recommended below). It is recommended the lift station controls/telemetry be adjusted now to add an alarm to alert operations staff when all pumps running. This information will indicate if flows at HWY 240 are beyond the firm capacity of the lift station. The cost estimate is summarized in Table 6-7.

It should be noted that prior to upsizing HWY 240, South River Street improvements must be completed to prevent additional surcharging and overflows in the area. When the HWY 240 pumps are upsized, the HWY 240 diversion structure should be adjusted to prevent flow going to the Dayton Lift Station, eliminating surcharging and overflows in the downstream pipeline or at the Dayton Lift Station. Operations at HWY 240 Lift station should be adjusted when the pumps are upsized to utilize both 10-inch force mains to maintain velocities of 7 feet per second or lower.

Table 6-7: HWY 240 Lift Station Recommended Improvements Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
	Upsize pumps	EA	$100,000	3	$ 300,000
	Mobilization	%	5	-	$ 15,000
				Subtotal (rounded)	$ 315,000
	Contingency	%	25	-	$ 78,750
				Subtotal (rounded)	$ 394,000
	Engineering and CMS	%	15	-	$ 59,100
				Project Total Cost (rounded):	**$ 454,000**

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

Main and Wynooski Streets Pipeline Improvements

North Main Street exceeds the surcharge threshold in future scenarios along Clifford Court. There is a single 12-inch diameter pipeline segment just upstream of the HWY 240 diversion structure. It is recommended this pipeline be upsized to be a 15-inch diameter to match the upstream pipeline and alleviate surcharging on North Main Street (Figure 19). While replacing this segment, it should be regraded with the segment upstream (WWGM1566) to resolve an inverse slope highlighted by survey data collected for model development. In addition, there is another pipeline segment upstream (WWGM1568) that has an inverse slope based on survey data and should be regraded to correct the slope.

It is recommended the pipeline segment on Wynooski Street north of East 11th Street be upsized from 10-inch to 15-inch diameter pipeline to alleviate surcharging along Wynooski Street (Figure 19). There is a short segment of 10-inch diameter pipeline downstream of this segment that has a steep slope that prevents it from causing capacity deficiencies. During preliminary design it can be determine if this segment should be replaced to match the upstream pipeline size. Cost estimates for both North Main Street and Wynooski Street Improvements are summarized in Table 6-8.

Table 6-8: Main and Wynooski Streets Improvements Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
North Main Street Improvements					
	Upsize/replace existing pipeline				$112,500
	Mobilization	%	5	-	$ 5,700
	Subtotal (rounded)				$119,000
	Contingency	%	30	-	$ 35,700
	Subtotal (rounded)				$155,000
	Engineering and CMS	%	25	-	$ 38,800
	Project Total Cost (rounded):				**$194,000**
Wynooski Street Improvements					
	Upsize existing pipeline				$ 78,000
	Mobilization	%	5	-	$ 3,900
	Subtotal (rounded)				$ 82,000
	Contingency	%	30	-	$ 24,600
	Subtotal (rounded)				$107,000
	Engineering and CMS	%	25	-	$ 26,800
	Project Total Cost (rounded):				**$134,000**

Additional Improvement Projects

The City will continue to budget $450,000-$600,000 annually for I/I related improvements. This work will continue to be directed by the I/I based priority improvements highlighted in Section 8 and any additional I/I evaluations completed. Continued coordination with other utility projects could provide cost savings for the City. This work is considered part of the annual replacement budget work for pipelines and manholes. Further discussion of annual replacement budgets is included in Section 12.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

In addition, within Priority 2 a master plan update is recommended to re-evaluate the existing system and system needs as growth occurs. This will assist the City in directing their funds to the highest priority improvement projects to continue delivering wastewater services to the City.

6.2.3 Future Infrastructure and Lift Stations

There are three areas where future infrastructure is recommended to service future growth. In two of these areas, lift station displacement options are recommended in conjunction with the addition of future infrastructure. These projects are summarized below. During any subsequent phases of any lift station abandonments, a return on investment analysis should be completed.

Providence LS Future Infrastructure

North of the Fernwood Lift Station, a regional lift station is recommended to serve future development northeast of the intersection of Portland Road and Vittoria Way. The approximate location of this future lift station can be located on Figure 15 (Buildout System Overflows and Surcharge Threshold Exceedance Locations) or Figure 28 (CIP Summary). The approximate location of the lift station was determined considering future development and elevation contours. The new force main will discharge into the existing line on Providence Drive. During pre-design, exact location and size should consider any Buildable Lands Study and future developments. The pre-design phase should also determine how much of the contributing basin area can flow be gravity into the existing line on Providence Drive versus requiring pumping with the new pump station. Where possible, gravity versus pumping is desired. The future infrastructure estimated costs are summarized in Table 6-9.

Table 6-9: Providence LS Future Infrastructure Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
	New pipeline				$ 436,700
	Lift Station				$ 428,000
	Subtotal (rounded)				$ 865,000
	Mobilization	%	5	-	$ 43,250
	Subtotal (rounded)				$ 909,000
	Contingency	%	30	-	$ 272,700
	Subtotal (rounded)				$ 1,182,000
	Engineering (25%) and Soft Costs				$ 344,300
	Project Total Cost (rounded):				**$ 1,527,000**

Chehalem Drive Future Infrastructure and Lift Station Displacement

Future infrastructure along Chehalem Drive will be necessary to service developments predicted through buildout. It is recommended the gravity pipelines discharge at the HWY 240 wet well. There is an existing stub out for an inlet from the west that can be utilized to connect the future pipeline. Near-future infrastructure, for growth within the next 20 years, includes a pipeline from approximately East Mountainview Drive, south on

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

Chehalem Drive to Hwy 240 (Illinois Road) and east to the lift station. This infrastructure cost estimate is in Table 6-10 as Phase 1. See lift station displacement considerations below that impact the vertical alignment of this pipeline. Additional infrastructure for buildout development includes pipeline extensions to the north and south of the Phase 1 pipeline along Chehalem Drive. These improvements are summarized as Phase 2 in Table 6-10.

In addition to serving future development, this infrastructure could allow for the displacement of Chehalem and Creekside Lift Stations. Additional gravity pipelines with approximate alignments shown in Figure 19 could transport Chehalem and Creekside Lift Station flows to the HWY 240 Lift Station. This infrastructure is recommended to decrease the capital cost and O&M required to continue operation of the two lift stations. The vertical alignment of Phase 1 improvements would need to be lower in general to facilitate the displacement of Chehalem and Creekside Lift Stations. Phase 3 in Table 6-10 summarizes the cost estimate for these changes.

Table 6-10: Chehalem Drive Future Infrastructure and Lift Station Displacement Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
Phase 1 (20-year)					
	New pipeline				$ 948,000
	Mobilization	%	5	-	$ 47,400
				Subtotal (rounded)	$ 996,000
	Contingency	%	30	-	$ 298,800
				Subtotal (rounded)	$ 1,295,000
	Engineering and CMS	%	25	-	$ 323,750
				Phase 1 Cost (rounded):	**$ 1,619,000**
Phase 2 (buildout)					
	New pipeline				$ 520,000
	Mobilization	%	5	-	$ 26,000
				Subtotal (rounded)	$ 546,000
	Contingency	%	30	-	$ 163,800
				Subtotal (rounded)	$ 710,000
	Engineering and CMS	%	25	-	$ 177,500
				Phase 2 Cost (rounded):	**$ 888,000**
Phase 3 (Chehalem and Creekside LS displacement)					
	New pipeline				$ 1,922,000
	Lift station demolition/removal				$ 30,000
				Subtotal (rounded)	$ 1,952,000
	Mobilization	%	5	-	$ 97,600
				Subtotal (rounded)	$ 2,050,000
	Contingency	%	30	-	$ 615,000
				Subtotal (rounded)	$ 2,665,000
	Engineering (25%) and Soft Costs				$ 826,450
				Phase 3 Cost (rounded):	**$ 3,492,000**

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

Riverfront Future Infrastructure and Lift Station Displacement

Future infrastructure in the Riverfront area will be necessary to service developments predicted in the next 20 years. Approximate regional lift station, force main, and gravity main locations are shown in Figure 19. See lift station displacement considerations below that impact the vertical alignment of the lift station. The force main discharge near East 12th Street will require upsize of the downstream pipeline. Cost estimates for the recommended infrastructure and improvements are in summarized as Phase 1 in Table 6-11.

In addition to serving future development, this infrastructure could allow for the displacement of Andrew and Charles Lift Stations. Additional gravity pipelines with approximate alignments shown in Figure 19 could transport Andrew and Charles Lift Station flows to the new, regional Riverfront Lift Station. This infrastructure is recommended to decrease the capital cost and O&M required to continue operation of the two existing lift stations. The vertical alignment of Phase 1 improvements should consider the displacement of Andrew and Charles Lift Stations during design phase. The estimated cost of displacement and new gravity pipelines for Andrew and Charles Lift Stations is summarized in Phase 2 in Table 6-11.

Table 6-11: Riverfront Future Infrastructure and Lift Station Displacement Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
Phase 1 (20-year)					
	New pipeline				$ 927,500
	Lift Station				$ 474,500
	Subtotal (rounded)				$ 1,402,000
	Mobilization	%	5	-	$ 70,100
	Subtotal (rounded)				$ 1,473,000
	Contingency	%	30	-	$ 441,900
	Subtotal (rounded)				$ 1,915,000
	Engineering (25%) and Soft Costs				$ 495,850
	Phase 1 Cost (rounded):				**$ 2,411,000**
Phase 2 (Charles and Andrew LS displacement)					
	New pipeline				$ 631,000
	Lift station demolition/removal				$ 20,000
	Subtotal (rounded)				$ 651,000
	Mobilization	%	5	-	$ 32,550
	Subtotal (rounded)				$ 684,000
	Contingency	%	30	-	$ 205,200
	Subtotal (rounded)				$ 890,000
	Engineering (25%) and Soft Costs				$ 431,600
	Phase 2 Cost (rounded):				**$ 1,322,000**

6.3 OPERATION AND MAINTENANCE RECOMMENDATIONS

The City Maintenance Division is responsible for most of the operation and maintenance (O&M) of the collection system. The O&M of the eight lift stations is handled by the Operations Division,

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

discussed below. The largest collection system task for the Maintenance Division staff, is routine cleaning and video inspection of the approximately 80 miles of gravity sewers in the system. The division aims to clean and inspect the entire collection system every 5 years. With the approximately 80 miles of gravity mains, this equates to cleaning and inspecting approximately 85,000 linear feet of pipeline each year. The division owns and operates a vactor truck for cleaning and a TV truck for CCTV inspection.

When defects are found during CCTV inspection, staff enter them into Cartegraph, an operations management system, to produce work orders. The staff perform spot repairs and general maintenance of the lines (i.e. root and clog removal). Lateral replacement, cured-in-place pipe (CIPP) lining, full line replacement, and manhole lining are contracted out to third parties. With these activities, the Maintenance Division provides oversight and completes paperwork for the projects.

Spot repairs require approximately 0.2 full-time employee (FTE) to complete. The Maintenance Division uses approximately 0.15 FTE to address general maintenance (i.e. root removal, plugged line maintenance, etc.). Lateral replacement is associated with point-of-sale of houses and provides inconsistent workload for the Maintenance Division. In general, the division estimates they spend less than 1% of their FTE for lateral replacement, overseeing the program and completing paperwork. The oversight and paperwork for cured-in-place pipe (CIPP), full-line replacement, and manhole lining accounts for approximately 2% of the Maintenance Division FTE. Maintenance staff reports that work orders for collection system repairs are taken care of within one month of submitting work orders, if not sooner.

The Maintenance Division has one FTE for a conveyance specialist, who coordinates and runs the fats, oils, and grease (FOG) program as well as continuous flow monitoring for the system. These are important programs for maintaining a clean and operational collection system. The flow monitoring is critical for I/I investigation and capacity related data collection.

Overall, the Maintenance Division objectives – clean and inspect one fifth of the gravity main system every year and handle repairs/issue work orders within one month – align with industry standards. The Maintenance Division reports being able to meet these objectives with the current staffing levels. At the present time, there is no need to adjust the staffing of the Maintenance Division for O&M of the collection system. As the system grows, assets are added, and regulations change; staffing requirements should be periodically re-evaluated.

The Operations Division is responsible for the operation and maintenance of the WWTP and the lift stations. Almost all work and inspections on lift stations require two people for safety requirements, typically a mechanic and an operator. The staff currently performs monthly O&M inspections on each lift station, which includes washing down the wet well, testing the pumps and all alarm systems, exercising the generator, checking the HMI readouts, and recording pump runtime data if necessary. Monthly inspections take approximately eight hours for two people (0.1 FTE). If a critical issue is encountered during inspections, the staff handle the work immediately. If issues or problems are found during inspections that do not need immediate attention, a work order is submitted, and additional time is spent another day to remedy the problem.

The main issue the Operations staff handles for the lift stations is clogged pumps. HWY 240 Lift Station currently has a clogged pump approximately once a week. Clogged pumps typically require 1-3 hours of work by two people. On average, operations staff estimates 0.13 FTE is spent to service clogged pumps. Other miscellaneous problems the staff encounters include controller and instrumentation issues. These issues are inconsistent and variable; they could require one hour of work or a full day. Typically, the Operations Division staff keep up with monthly inspections, clogged pumps, and essential issues.

Non-essential maintenance, such as pump performance repairs, are often difficult for staff to dedicate time to resolve. The availability of staff is highly dependent on the process units at the WWTP. Repairs and maintenance at the WWTP are balanced and prioritized with any lift station work. This arrangement means that sometimes non-essential maintenance at the lift stations can go months before being addressed.

It is recommended that identified maintenance work on the lift stations be completed within one month of submitting a work order. The division could consider shifting priorities of staff, so that at least one mechanic is responsible for prioritizing lift station O&M and ensuring maintenance is completed in a timely matter. Given the low, unpredictable occurrences of this maintenance, the division could also look to contract out more extensive maintenance work to ensure its completion within a month's time.

7. INFILTRATION AND INFLOW (I/I)

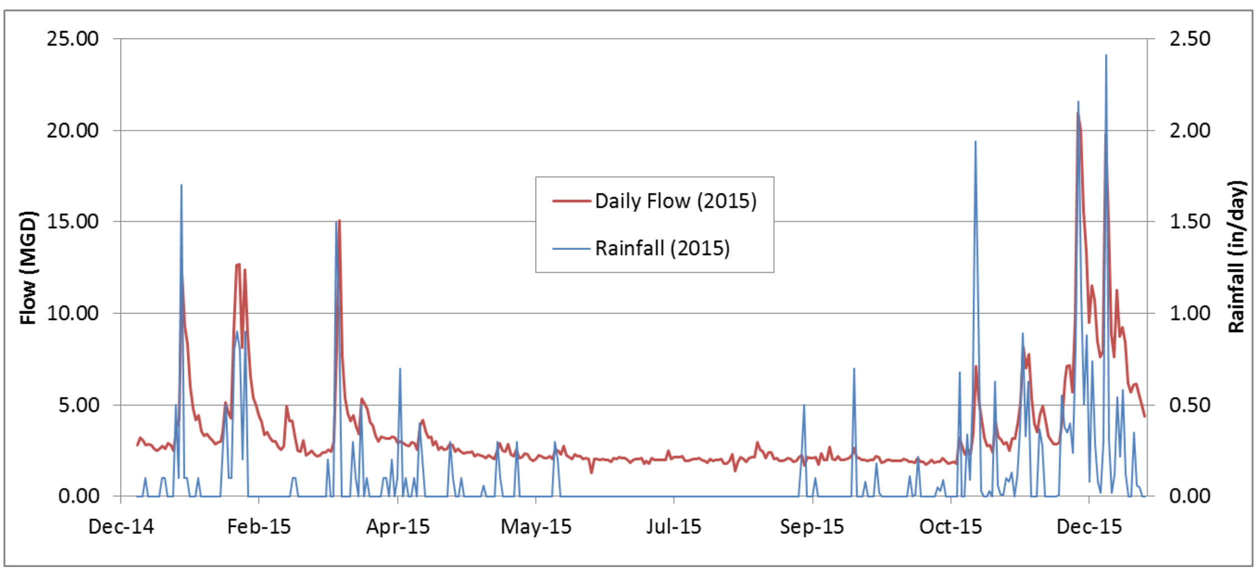
This section summarizes past and current City efforts to evaluate and reduce infiltration and inflow (I/I) from the collection system. The data collection and analysis completed as part of the master plan was completed in stages to prioritize efforts and identify areas with high I/I, ultimately identifying priority rehabilitation projects.

7.1 BACKGROUND

I/I is a concern in the Newberg collection system. In 2015, the City completed a Sanitary Sewer Infiltration and Inflow Study that assessed I/I primarily in the Dayton and Wynooski basins, which have large quantities of clay pipe. The study included a pump run time analysis, extensive flow monitoring, CCTV inspections, night-time flow monitoring, and smoke testing to generate a prioritized list of the top 25 I/I reduction projects in the study area, as well as a list of cross connections found while smoke testing, and spot repair needs identified through CCTV inspections.

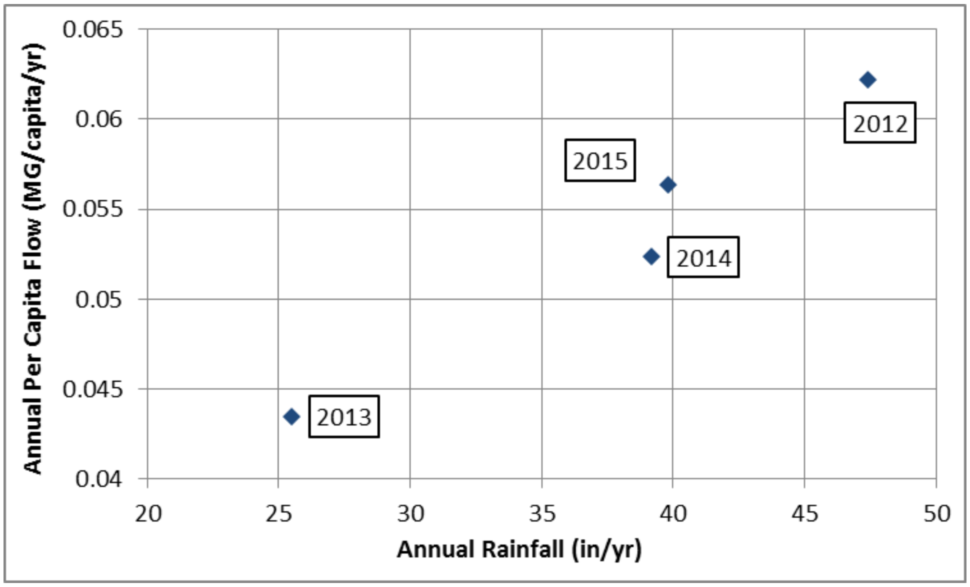
Visual evidence of I/I influence in the system can be seen in Chart 7-1, which shows the 2015 daily flows and precipitation recordings at the treatment plant site. The rapid response between precipitation events and increased flows suggests that a significant component of peak flow is from storm water inflow. The sustained increase in flow over several days following a large storm event suggests that groundwater is also infiltrating into the City's wastewater collection system. Flows for 2015 are representative of previous years.

Chart 7-1: 2015 Daily Flow and Precipitation



Evidence of I/I influence can also be seen by comparing annual rainfall against annual per capita flow. Chart 7-2 below shows a positive linear relationship between rainfall and normalized flow over the range of rainfall observed for 2012–2015.

Chart 7-2: Annual Rainfall vs. Per Capita Flow



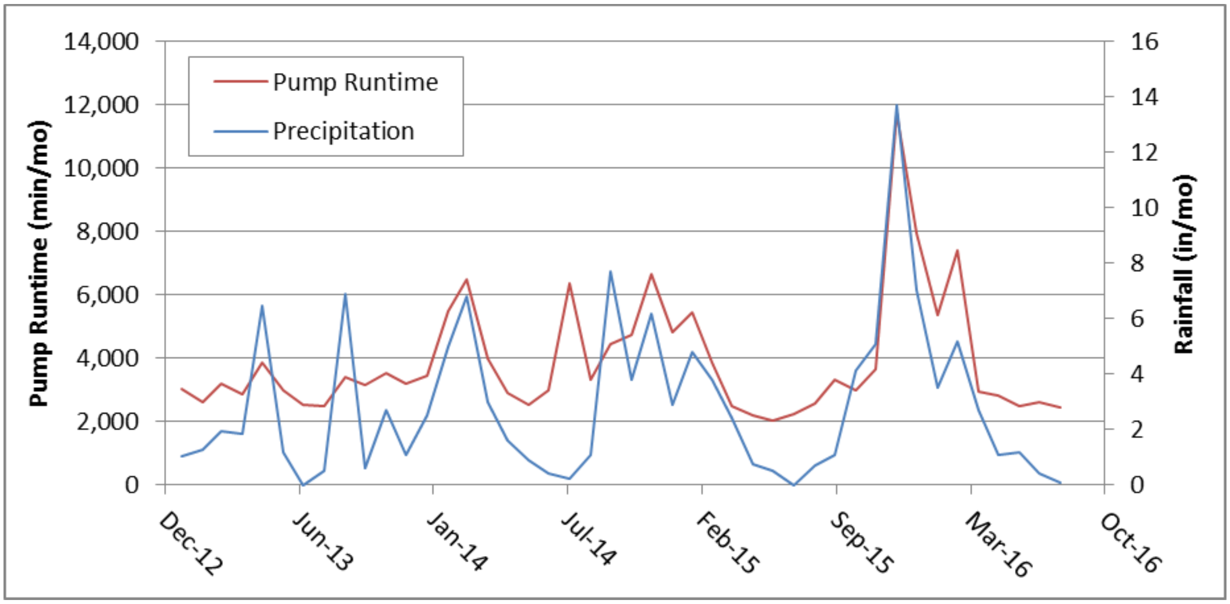
The City has a program to remove I/I where it is cost-effective. I/I investigation and characterization are included in the scope of this master plan. Data collected for this project will be integrated with the results of the 2015 I/I Study; the prioritized lists will be revised accordingly. The following sections detail the I/I efforts completed for this master planning effort.

7.2 PUMP RUN TIME ANALYSIS

Each of the eight City-owned lift stations (Andrew, Charles, Chehalem, Creekside, Dayton, Fernwood, Highway 240, and Sheridan) were visited to complete pump flow tests and facilities evaluations. City staff provided lift station history and anecdotal performance records. The lift stations and their service areas are shown in Figure 7 (Appendix A).

The daily run times for all eight public lift stations were analyzed. Chart 7-3 shows the results for the Andrew Lift Station (see Appendix G for all lift station run time graphs). When daily run times are compared with rainfall events, a close correlation between high rainfall months and monthly increase in run times is evident. This correlation indicates that I/I is the likely cause of increase in flow.

Chart 7-3: Andrew Lift Station Runtimes & Precipitation vs. Time



In order to compare high daily run times caused by I/I against average daily flows, several peaking factors were calculated. Peaking factors compare wet and dry weather flows. A higher peaking factor indicates more I/I in the lift station service area. The results of these analyses for January 2012–October 2016 are summarized in Table 7-1. The peaking factors are color scaled from red (highest I/I ratio) to green (lowest I/I ratio). Of the eight lift stations, Dayton had the highest peaking factors, which suggests the highest ratio of I/I to average flow in its service area.

Table 7-1: Lift Station Peaking Factors

Peaking Factors by Lift Station	Andrew	Charles	Chehalem	Creekside	Dayton	Sheridan	Fernwood	HWY 240
Summer Peak Factor summer peak day/summer avg day	2.1	1.9	1.7	1.8	2.1	3.1	1.5	1.9
Winter Peak Factor winter peak day/winter avg day	2.0	3.1	1.4	1.6	3.0	2.5	1.4	1.5
Peak Day Factor annual peak day/annual avg day	4.5	7.8	2.5	3.0	8.5	5.5	2.3	3.4
Peak Month Factor annual peak month/annual avg month	1.9	2.2	1.4	1.7	2.5	1.8	1.3	1.7
Winter-Summer Avg Factor winter avg day/summer avg day	1.9	2.8	1.3	1.7	3.6	1.7	1.3	2.3
Winter-Summer Peak Factor winter peak day/summer avg day	5.8	13.4	2.6	3.6	16.6	6.3	2.5	5.1
Totals	**18.3**	**31.2**	**11.0**	**13.3**	**36.2**	**20.9**	**10.4**	**16.1**

*Red is the highest factor in each category; green is the lowest.

The highest daily pump run time at the Dayton Lift Station was 8.5 times the average daily pump run time for 2012–2016. The Charles Lift Station was a close second for I/I based on run time peaking factors, followed by Sheridan. Dayton occasionally overflows to Chehalem Creek; thus, the area upstream of Dayton Lift Station should be a priority for repairing I/I problems. The City is currently in the process of improving Dayton due to capacity and condition issues.

The relative magnitude of peak I/I flows upstream of each lift station were compared for the years 2009 to 2016 (Table 7-2). Values were calculated by subtracting the average summer day run time for a given year from the peak day run time, and multiplying that by the average flow rate for the lift station. Rated pump capacities were used, where field test pump flow rates were close to the rated capacity. Field test capacities were used if the data indicated lower pump performance than the rated capacity (see Section 3.1 for pump performance discussion). From Table 7-2, it is evident that the area upstream of the Dayton Lift Station has the greatest volume of I/I. It was noted by City staff that I/I flows through the Fernwood and Highway 240 lift stations have increased in the last few years, which is affirmed by data in Table 7-2.

Table 7-2: Peak I/I Flow

I/I Flow (MGD)	Andrew	Charles	Chehalem	Creekside	Dayton	Sheridan	Fernwood	Hwy 240
2009	0.07	0.11	0.10	0.06	3.2	0.02	0.13	N/A
2010	0.06	0.09	0.17	0.05	1.8	0.01	0.12	0.35
2011	0.05	0.11	0.48	0.05	1.0	0.02	0.21	0.35
2012	0.06	0.09	0.25	0.07	1.3	0.01	0.16	0.37
2013	0.04	0.06	0.06	0.01	0.48	0.00	0.16	0.50
2014	0.07	0.14	0.08	0.01	1.0	0.01	0.18	0.70
2015	0.12	0.25	0.13	0.02	1.8	0.01	0.44	1.03
2016	0.08	0.13	0.13	0.01	0.9	0.01	0.54	1.04
Average	0.07	0.12	0.18	0.04	1.5	0.01	0.24	0.62

*Red indicates higher peak I/I flow in each category; green indicates lower I/I flows.

As a result of this analysis, subsequent phases of monitoring (e.g., flow monitoring, CCTV, and smoke testing) were focused in the service area upstream of the Dayton, Fernwood, and Highway 240 lift stations – which includes the Sheridan Lift Station service area. It is recommended that pump run time data be reviewed every couple of years to establish trends and prioritize rehabilitation efforts. It is also suggested the City install permanent flow meters and pressure gauges at all lift stations to better track I/I and pump performance. These instruments should be connected to the SCADA system to allow for continuous monitoring, recording, and trending.

7.3 FLOW MONITORING

Continuous flow monitoring was completed for five weeks during January-March 2017 to better characterize the nature and distribution of I/I in the system. Eleven flow monitors were placed throughout the system (See Figure 9 (Appendix A) based on staff recommendations, the pump run time analysis, previous I/I study data collected, and land use considerations. Eight flow monitors from Keller and three City-owned flow monitors were used to collect level, velocity, and flow data at 10- to 15-minute intervals. Rainfall data was collected at the WWTP weather station in 5-minute intervals.

Chart 7-4 illustrates the flow and precipitation data for Basins 2, 3, 16, and 17. Site 16 flow is significantly lower than flow at the other sites and thus appears to be near zero on the chart because of the axis scale. The pattern of flow in Basin 16 shows similar responses to rainfall as the other three basins. Appendix G shows flow and precipitation data over time for all of the flow monitoring sites. Flow monitoring basins 2, 12, 13, 14, 16, and 17 are sub-basins of another basin, as indicated by Chart 7-5.

Chart 7-4: Flow Monitoring Basins with Sub-basins

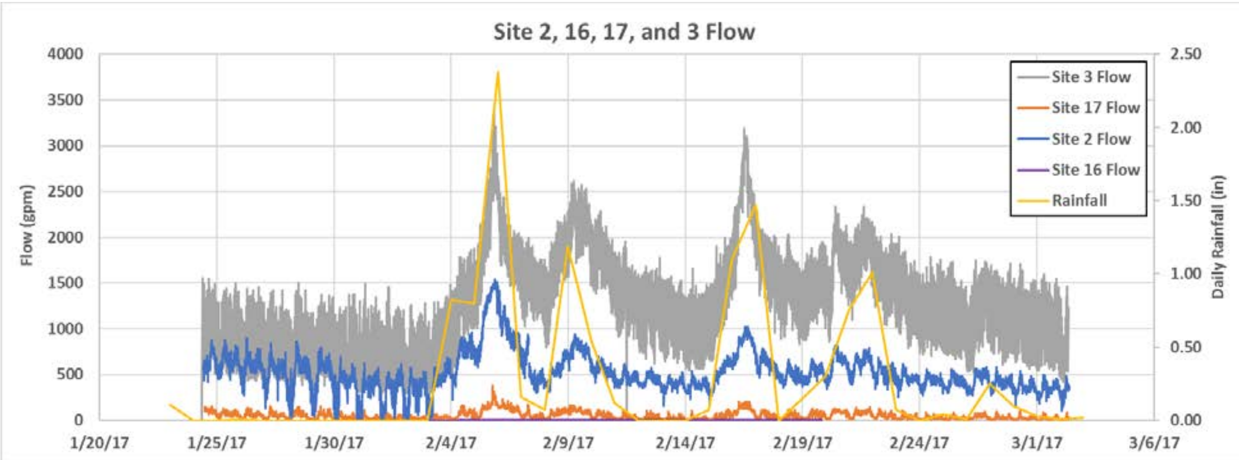
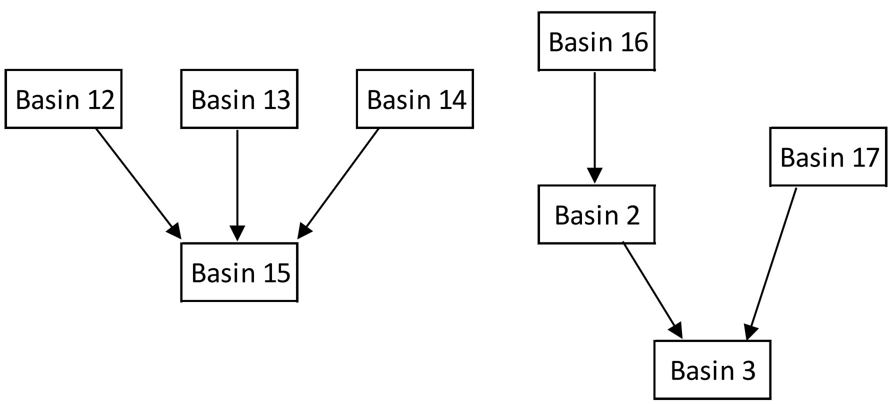


Chart 7-5: Flow Monitoring Basins with Sub-basins



7.4 CCTV CLEANING AND INSPECTION

As a part of the 2015 I/I Study, cleaning and video inspection of City pipelines was completed in 2014. Pipelines were selected based on pipe age, material, size, results from pump run tests and flow monitoring, and recommendations from the City. City staff and Pacific Int-R-Tek performed closed-circuit television (CCTV) inspections on approximately 80,000 linear feet of pipelines in the Dayton and Wynooski Basins.

It was suggested that an additional 70,000 linear feet of pipeline (approximately) be cleaned and inspected, which included pipes in the Hess Creek and Springbrook basins. As a part of data collection for this master plan City staff inspected approximately 55,000 linear feet of additional pipeline. Areas inspected in 2014 and 2017 are shown in Figure 20 (Appendix A). Collectively, approximately 125,000 linear feet of pipeline has been inspected and incorporated in this master plan analysis.

The National Association of Sewer Service Companies' (NASSCO) pipeline assessment certification program (PACP) was used again to record defects and grade pipe condition during CCTV inspections. This is the same program used in the 2015 I/I Study, and creates comparable baseline for the pipelines studied and allows for the tracking of pipe condition over time. The program operates by creating specific codes for the various defects found in pipelines. In theory, if multiple operators were to inspect the same pipeline they would generate "identical" PACP reports. While this may not be exactly true, it is a method of standardization of CCTV inspections. PACP defects are separated into two categories: structural and O&M. The types of defects for each category are listed in Table 7-3.

Table 7-3: PACP Structural and O&M Defects

Structural	O&M
Cracks	Settled deposits
Fractures	Root intrusion
Break in pipe/Holes	Defective taps/laterals
Collapse	Infiltration
Deformation	Sags
Defective joint	Obstacles/Obstructions
Surface Damage/Corrosion	Vermin
	Angled alignments

Operators record and code observations and defects during the CCTV inspection. From this coding, the PACP software assigns a grade of 1 to 5 to each defect, with 1 being a minor defect and 5 being most significant defect. Table 7-4 indicates the general assignment of condition grades from NASSCO.

Table 7-4: General Assignment of Pipe Condition Grades

Grade 5	Collapsed or collapse imminent
Grade 4	Collapse likely in foreseeable future
Grade 3	Collapse unlikely in near future
Grade 2	Minimal collapse risk
Grade 1	Acceptable structural condition

After grading all the defects, the software generates a PACP report, which has three different types of ratings: pipe rating, quick rating, and rating index. The pipe rating is the sum of the number of each grade of defect multiplied by the defect grade. For example, a pipe with four grade 5 defects would have a rating of 20. The quick rating is a four-digit number that indicates the highest grade defect (first digit) and the number of its occurrences (second digit), the second highest grade defect (third digit), and the number of its occurrences (fourth digit). For example, a pipe with two grade 5 defects, no grade 4 defects, one grade 3 defect, and any number of grade 2 and 1 defects would have a quick rating of 5231. If there are more than nine of a defect grade then a letter code is used to the number of defects as follows: A – 10 to 14, B – 15 to 19, C – 20 to 24, etc.

The rating index is an average severity of defects along the pipe. The rating index is calculated by the pipe rating divided by the total number of defects. Each of the three ratings are separated into structural, O&M, and overall ratings, resulting in a total of nine (9) ratings per inspection. The structural ratings are calculated using only the structural defects listed in Table 7-3, and the O&M ratings are calculated using only the O&M defects listed in Table 7-3. The overall rating is the sum of the structural and O&M ratings. Examples of the PACP report format and ratings can be reference in Appendix G. City staff have individual records of each of the PACP reports which are not included in the Appendix of this master plan.

Some inspections were abandoned because a defect (such as a root ball or protruding tap) made it impossible for the camera to continue. Reverse inspections were performed for some abandoned inspections, but not all. Reverse inspections were noted in the data, and PACP scores and the two inspections were combined.

Throughout the inspections, the most common operations and maintenance (O&M) defects found were roots, intruding taps, infiltration, and dirt or gravel in the pipe and laterals. The most frequent structural defects were cracks, fractures, and holes or breaks.

Figure 21 (Appendix A) shows the highest grade defect along a pipe length. There are 76 pipes that have at least one grade 5 defect, and an additional 68 pipes that have at least one grade 4 defect. These pipelines have partially collapsed/failed segments or segments that are near collapse/failure. In the 2015 study, the majority of the grade 5 defects were structural, consisting of holes or breaks in the pipe. However, the majority of the grade 5 and 4 defects discovered during the 2017 inspections were O&M defects: inflow runners and gushers, and root intrusions. Some of these are located within pipeline segments where full length rehabilitation or replacement is recommended. A localized spot repair may be appropriate for other grade 5 defects. All grade 5 defects should be repaired in the immediate future.

It is recommended the City continues using the PACP format for future video inspections. The PACP format provides the City an industry standard, objective analysis and allows the condition of the same pipe to be compared over time. This could be helpful in tracking the deterioration of pipes, completing preventative maintenance activities, and identifying and correcting problems before a pipe fails.

7.5 PRIORITIZATION

In the 2015 I/I Study, The results were used from CCTV inspections, smoke testing, pipe age/material, and flow monitoring data to develop a preliminary prioritization of improvements. The consequence of failure was also considered in prioritizing needed improvements. This study follows the same prioritization methodology. This section summarizes the prioritization process.

The first step (base) in the prioritization process is the CCTV inspection results. After reviewing the overall PACP ratings for the pipelines inspected in Newberg's system in 2014, we found that many of the overall ratings were skewed for operation and maintenance items that could be managed by the City (e.g. removal of gravel in pipeline). Therefore, in developing the initial prioritization schedule, the PACP structural ratings were weighted more heavily than the O&M

ratings. An adjusted overall PACP rating for each pipe segment was calculated by giving the structural rating 75% of the weight and operational rating a 25% weight. This rating was then normalized by dividing the total PACP rating by the pipeline length. Pipeline segments were then given a 1-10 score using breaks in score distribution and review of inspections near scoring thresholds. Figure 22 (Appendix A) illustrates this step.

The second step in the prioritization process was to consider the pipeline age/materials. Thus, a 90 year-old pipeline with similar deficiencies to a pipeline that is 30 years old gets a higher priority for replacement. Most pipelines of a given material were installed in the same time period. For example, nearly all of the clay pipes in the City were installed in the 1920s. Age and material were incorporated into the pipe condition score as additional points added to the PACP score. Table 7-5 shows the points added to a pipeline's score based on material data.

Table 7-5: Material / Age Adjustments

Material	Adjustment
Clay	+2
Concrete	+1
Transite	+0.5

The third step in prioritizing improvements was to consider where sources of I/I were observed. In the 2015 study, night time flow monitoring occurred, and the observed flowrate resulted in a score adjustment increase in pipes. Table 7-6 shows the points added to a pipeline's score based on night-time flow data in gallons per minute (gpm).

Table 7-6: Night-time Monitoring Flow Adjustments

Night-time Flow (gpm)	Adjustment
Flow > 25	+3
25 > Flow > 10	+1
10 > Flow > 5	+0.5

Pipelines surveyed in 2017 did not have additional data collected with respect to night-time flow observations. It was decided to not include the night-time observation in the scope of work. To account for the discrepancy between the two studies, several sensitivity checks were completed. For example, the highest night-time flow adjustment of 3 was given to all of the 2017 study pipelines and compared. In a similar, but opposite check, night-time flow adjustments were removed as a factor in the 2015 study pipelines and compared.

The condition score of a pipe was the sum of the PACP score and the two score adjustments. The range for this score is 0 to 15 (10 for PACP, 2 for material/age, 3 for night-time flow). The highest score a pipeline in the study received was 13. Figure 23 (Appendix A) shows the condition score of pipe segments. After completion of the comparison checks, it was determined that night-time flow observations had minimal- to no-impact on the condition scores of the pipe segments that had the largest existing condition scores. While the pipes surveyed in 2015 still make up the majority of the large condition scores, this is to be expected, as many of the pipes surveyed in 2015 were the older and more deteriorated pipes located in the Dayton and Wynooski Basins.

The risk of failure to the City is a function of both the likelihood of failure (pipeline condition) and the consequence of failure. For example, a pipeline failure that services a small residential cul-de-sac will have a much smaller impact than a larger interceptor that services a business district or school/hospital. Consequence of failure was incorporated into the prioritization process by using multiplying factors. Table 7-7 shows the parameters and factors applied for consequence of failure. If one of the parameters fit a pipeline segment, that pipeline segment's condition score was multiplied by the corresponding factor. If a pipeline fit multiple parameters, it was multiplied by each factor. For example, an 18-inch interceptor pipeline that runs through the commercial zone would have its condition score multiplied by 1.2 and then by 1.1 to calculate its final I/I impact score. The I/I impact score -- the condition score multiplied by all applicable consequence factors -- was used to develop the preliminary pipeline rehabilitation/replacement prioritization schedule for the pipe segments in the study area. Figure 24 (Appendix A) illustrates I/I impact scores for the analyzed portion of Newberg's system.

Table 7-7: Consequence of Failure Factors

Parameter	Factor
If commercial zone	x 1.1
If next to school or creek	x 1.1
If interceptor ≥18"	x 1.2
If interceptor ≥12"	x 1.1

It is believed that a CCTV inspection is a critical component in making a final pipeline condition assessment for recommending pipeline rehabilitation/replacement near to the time the work will be completed. Because of this, the pipeline prioritization process for rehabilitation/replacement projects is weighted heavily towards those sections that were within the scope and budget of the master plan for CCTV inspection. Pipelines that were outside of the CCTV inspection scope of the master plan appear as low priority due to the prioritization process.

7.6 SMOKE TESTING

Based on available pump run and flow analysis, pipe age and material, previous experience from the 2015 I/I Study, and input from City staff, areas of the system were prioritized for smoke testing. Figure 25 in Appendix A shows the areas included in smoke testing for the 2015 I/I Study and prioritized areas for smoke testing for this master plan. The length of pipe smoke tested for the 2015 I/I Study totaled 110,000 linear feet. For this master plan, we prioritized 98,800 linear feet for smoke testing and completed nearly all of that linear footage as shown in Figure 26 in Appendix A. Due to the results of the pump run analysis, priority area 3 (Fernwood) was included in the targeted smoke testing areas. Priority areas 1 and 2 were targeted to investigate the Hess Creek trunk line. Priority 4 was targeted as a residential area. Priority 5 was targeted as a commercial/industrial area.

There was less overlap for the smoke testing pipelines and CCTV inspection pipelines when compared with the 2015 I/I Study. This is due to the complexities of the process of cleaning and CCTV inspections and input/direction from City staff. Smoke testing can be completed on pipelines with manholes that are hard to access. City staff cleared away access paths to many manholes for the Hess Creek trunk line that are not accessible to a TV truck, but can be accessed by a smaller all-terrain vehicle carrying the smoke testing equipment.

The City of Newberg notified all property owners within the smoke testing area one week in advance of testing. They were notified with door hangers, and testing information was posted on the City website. Emergency services and dispatch were notified one week prior to and again each day with updates as to the daily location of smoke testing.

Keller Associates provided the smoke testing equipment, which consisted of two Hurco Power Smokers, LiquiSmoke, and road signs. The smoker introduces smoke in the sanitary sewer system through the top of a manhole. The two smoker assemblies were run at the same time, approximately two manholes apart. Smoke introduced into the sanitary system should only be released from nearby manholes, cleanout pick holes, and building plumbing vents; smoke emitted anywhere else indicates a potential source of I/I.

Throughout the 17.5 miles of pipe smoke tested, 32 total problem locations were noted (see Figure 26 in Appendix A). There were no illegal vents, 2 cross-connections, 14 cleanouts, 4 laterals, 1 indoor/plumbing, 8 manholes and 3 other problems notesd during smoke testing. These sites and concerns are summarized in Table 7-8 below. Photos and field notes of each problem are also presented in Appendix G. The main problems found, reason for concern, and recommended actions are listed below:

- Broken or open cleanouts (C/O)
  - Can collect localized storm water, especially if located near a low point
  - Notify property owner and seal C/O
- Leaking laterals
  - Allow high infiltration into the sewer system
  - Notify property owner and repair lateral (Note: the City's lateral replacement program is discussed later in this study)
- Cross-connections
  - Consist of direct connections to the sewer system that should be connected to the storm water system instead, such as roof drains and storm water catch basins
  - For cross-connections on private property, notify property owner and have cross-connection removed
  - For cross-connections on City property, investigate to confirm cross-connection, remove cross-connection

Additional observations from smoke testing:

- Several leaking/broken laterals may be highlighting damages that occurred by third party utilities during their installation (i.e. Picture ID 4 and 22).

Table 7-8: Record of Smoke Testing Problem Locations

Picture ID	Date	MH Tested	Address	Defect Type	Recommended Action	Photo
1	8/23/2017	H95020	2200 Thorne St	lateral; C/O	contact property owner; cap C/O	Y
2	8/23/2017	H95020	2219 Thorne St	lateral	contact property owner	Y
3	8/23/2017	H95020	2210 Thorne St	C/O	cap C/O	Y
4	8/23/2017	H95020	2220 Thorne St	C/O and phone pedestal	cap C/O; investigate phone pedestal	Y
5	8/23/2017	H105005	MH H105004	MH	rehabilitate MH	Y
6	8/23/2017	H104008	MH H114005	MH	rehabilitate MH	Y
7	8/23/2017	H114003	wwgm0167 (between MH H114140 and G114002)	no smoke	investigate line	N
8	8/23/2017	G123073	Hoover Park	C/O	cap C/O	N
9	8/23/2017	G123073	MH G123072	MH	rehabilitate MH	N
10	8/23/2017	H131082	MH H131082	MH	rehabilitate MH	N
11	8/24/2017	H95023	2340 Thorne St	indoor plumbing	follow-up with owner	Y
12	8/24/2017	H95012	unmarked MH (east of MH H95012)	MH	seal rim; replace lid	Y
13	8/24/2017	G105046	1104 S Pennington Dr	C/O	cap C/O	Y
14	8/24/2017	G105046	1000B Pennington Ct	C/O	cap C/O	Y
15	8/24/2017	G105046	1011A Pennington Ct	C/O	cap C/O	Y
16	8/24/2017	G105046	1021A Pennington Ct	C/O	cap C/O	Y
17	8/24/2017	G105046	Intersection of S Pennington Dr and Hoskins St	catch basin	verify cross connection	Y
18	8/24/2017	G105046	1020 Sierra Vista Dr	irrigation control box	contact property owner	Y
19	8/24/2017	K110003	534 The Greens Ave	lateral	contact property owner	Y
20	8/24/2017	K120022	5270 Wedgewood Lp	area drain	verify cross connection	Y
21	8/28/2017	G99058	2215 Prospect Dr	C/O	cap C/O	Y
22	8/28/2017	G108006	504 Mission Dr	lateral	contact property owner	N
23	9/12/2017	J120032	3891 Oak Meadows Lp	MH	investigate source; rehabilitate MH	Y
24	9/12/2017	I123067	216 Acorn St	C/O	cap C/O	Y
25	9/12/2017	I113155	North of MH I113155 (new MH)	MH	rehabilitate MH	Y
26	9/12/2017	K120054	148 Argyle Ct	C/O	cap C/O	Y
27	9/12/2017	K120054	136 The Greens Ave	C/O	cap C/O	Y
28	9/14/2017	K120042	5217 Fairway St	C/O	cap C/O	Y
29	9/14/2017	I113050	700 Deborah Rd	C/O	cap C/O	Y
30	9/14/2017	H123040	MH H123039	MH	seal rim	Y
31	9/12/2017	I113155	3411 Hayes St building 7	C/O	cap C/O	Y

Estimations of the cost and associated benefits of removing cross-connections identified by smoke testing are addressed in the Potential I/I Reductions in Section 7.7. Recommended actions to reduce I/I from defects identified through smoke testing are discussed in Section 8.

7.7 POTENTIAL I/I REDUCTIONS

The first course of action that can reduce I/I in a system is to repair defects in the collection system. During storm events or day-to-day activities, water can infiltrate into pipes through defects such as breaks, cracks, holes, or other structural defects. If many defects are discovered in a single pipe, replacement or rehabilitation of the full pipe should be considered.

Options for full pipe repair include open trench repair/replacement or trenchless rehabilitation. Both options should be considered for their ease of use and overall cost to the City, explained in Section 7.8 of this report. If the overall pipe is in good condition, but contains single or a small number of defects, then a spot repair may be more appropriate.

Additionally, elements such as cleanouts, swales, house drains, and catch basins may be directly connected to the collection system. In the 2015 study, additional actions to reduce I/I were considered and analyzed. Smoke testing was completed for the I/I Study as well as this master plan, and analysis of cross-connections, swales, and catch basins was completed.

During smoke testing, sources of storm water inflow were identified, and the storm water runoff methodology referred to as the rational method was used to determine inflow. Table 8-3 lists these cross connections, their estimated inflow, and estimated cost per gpm to eliminate the cross-connections.

The only two cross-connections identified during the 2017 investigation was four catch basins at an intersection and another location with an area drain. In the 2015 Study there were a number of driveway and roof drains that were identified. The driveway, area, and roof drains are the most cost-effective to repair. Owners whose roof drains were found to be connected to the sewer system during the 2015 Study should have been notified and required to disconnect them from the sewer system, rerouting them to the yard or street or reconnecting them to the storm system per Newberg Municipal Code 13.10.080 Subsection D. There should be minimal cost to the City to have property owners disconnect their roof drains from the sewer.

The City should disconnect the catch basins and the area drain connected to the sewer system. These connections should be verified by the City with tracer dye tests and video inspections. Improvement costs for each of these repairs have been estimated in Table 8-3 in Section 8. The total cost to the City to complete all of these improvements is estimated to be only $25,000 and should result in a reduced peak storm water inflow over 1,000 gpm. The benefit of removing these sources of storm water inflow is primarily capacity-related. Reduced flows result in lower risk of sanitary sewer overflows and have the potential to offset or delay capital expansion projects for the collection and treatment systems that are triggered by hydraulic capacity.

For the 2015 I/I Study, the cost of conveying and treating wastewater was evaluated. The data available covered 2012 through 2014 for the wastewater fund, including the budgeted line items and the actual costs incurred. The total expenditures including debt service ranged from $4.1 million up to $5.6 million. The wastewater expenses can be separated into two categories: fixed and variable. The fixed costs are those that remain the same whether I/I is removed (i.e. most equipment, personnel, etc.). Variable costs are those that can be reduced if I/I were reduced (i.e. chemicals to treat, electrical bills, equipment repair, supplies, etc.).

Line items for the Operations (WWTP) and the WW Collection were reviewed to determine those that include a variable component. The percentage of the line item attributable to variable flows was estimated, and all variable costs were summed up and then divided by an approximated average daily flow to arrive at a cost per gpm due to variable costs. On average, it costs approximately $102 for every gpm of the average annual flow. The City can evaluate for varying payback periods, but if using 10 years, a repair cost should be less than $1,020 per gpm to be justified. If a longer payback period is used, a higher repair cost can be justified.

This is a planning level evaluation of the cost to convey and treat inflow and infiltration. If the City desires, a much more detailed evaluation can be performed to break out the variable costs more accurately. At the end of the day, the City needs to identify and repair I/I where feasible and practical. The cost to convey and treat should only be used to limit the amount of money spent on I/I reduction if the system had very limited amounts of I/I. Please note, due to the potential offset to treatment plant or other capital improvements if I/I flows are reduced, the evaluation summarized above does not account for savings. These savings have the potential to be much larger than pipeline and lateral rehabilitation costs.

7.8 REPLACEMENT / REHABILITATION COST ESTIMATES

Planning level costs were developed for replacement projects based on the length of pipe. The budget estimate of $220 per linear foot assumes open trench installation, 8-inch to 12-inch pipeline replacement as well as lateral replacement (within the right-of-way), installation of cleanouts at the property line, and manhole replacements. The cost also includes a 20% contingency and a 15% cost for engineering and construction management services.

If open trenching proves to be too disruptive in certain areas, there are alternative trenchless rehabilitation techniques. Two of the more common techniques are pipe bursting and use of cured-in-place-pipe (CIPP). Pipe bursting is often used if a pipe needs to be upsized by one nominal size (e.g. 10-inch in diameter to 12-inch in diameter). CIPP involves the use of a textile liner tube and liquid resin, which cures in place, and is more common when the pipe does not need upsizing. None of the recommended rehabilitation projects overlap with pipes identified in the WWMP as recommended for upsizing within the buildout planning period. Depending on the application, the City could realize a potential project saving of 20-40+% by using trenchless technologies instead of open trench replacement.

Trenchless technologies may be ideal for areas with high traffic because there is no trenching and the process can often be done in one night. However, trenchless technologies may not be recommended where there are many laterals that need to be replaced, pipeline sags, or other large defects that require spot repairs. For CIPP projects, roots and intruding taps must be removed before using CIPP. Spot repairs can also be done using CIPP. As part of the project pre-design, the City should perform further CCTV inspection to gather the most current information and evaluate each project and defects present to decide the most appropriate rehabilitation technique. For example, while trenchless rehabilitation may be cheaper than replacement, it is not possible to CIPP a collapsed pipe.

Additional pipes have yet to be inspected with CCTV and may be contributing large amounts of I/I to the system. It is recommended the City CCTV all collection system piping. If this work were contracted out to a third-party contractor, the City should expect an approximate cost of $1.90-2.00 per linear foot of pipe to clean and CCTV, not including fees for mobilization, unusual work, standby, and traffic control.

7.9 RECOMMENDED OPERATIONAL AND ADMINISTRATIVE PRACTICES

After completing replacement or rehabilitation of pipes in the priority CIP areas or on the spot repairs list, it is recommended that the City re-inspect the pipes using CCTV. One common mistake in I/I projects is that it is assumed the new or rehabilitated pipe completely fixes the inflow or infiltration problem, and then efforts are focused elsewhere. However, it is not uncommon to see new inflow problems into the pipe arise at a different portion of the pipe after one problem is addressed, especially in cases of spot repairs or where the pipe is below the groundwater table. Often, water that was leaking into the pipe through one defect will migrate to other defects and continue infiltrating. Continued CCTV monitoring after project completion shall ensure that the project was done correctly, so that efforts can be appropriately directed towards other defects in the system.

Additionally, continuous flow monitoring should continue to take place in the system and in the influent of the wastewater treatment facility. As peaking factors are a primary indicator of I/I, it is important to collect data and track flow. Comparing flow in the collection system during drier periods to wetter periods will provide a peaking factor. One indication of a successful I/I program is a continuous decrease of the peaking factor as more defects are corrected. Through continuous monitoring and data collection, the City should be able to determine the effectiveness of its I/I program in the coming years.

It is recommended that the City establish a routine cleaning schedule for cleaning of the collection system. Routine cleaning of the pipes can remove debris buildup, which can cause unnecessary pressure/strain on the pipes and remove root intrusion. While root intrusion is an issue that should be addressed, routine cleaning can break off root intrusion, meaning that the root itself will not grow and expand the already existing defect in the pipe, potentially saving the cost of replacement or rehabilitation in the future. A more detailed description of operation and maintenance recommendations including staffing recommendations can be referenced in Section 6 of this report.

Finally, it is highly recommended that the City continues open interaction and involvement with its constituency about the nature of the project and the work being completed. Public forums, town halls, flyers, and bulletins are potential methods to disseminate information and receive feedback from the public. Especially in the cases of pipeline work on busy streets or commercial areas, prior notice should be given informing residents of the disturbance, including approximate timeline of the repairs.

8. RECOMMENDED INFILTRATION AND INFLOW (I/I) IMPROVEMENTS

8.1 RECOMMENDED IMPROVEMENTS

Tracking and identifying sources of I/I was completed through pump run time tests, continuous flow monitoring, video inspections, smoke testing, and night-time monitoring. The top priorities for rehabilitation/replacement/spot repair, and cross-connections identified during smoke testing, are likely large contributors to the I/I in the system. It is recommended the City continue improvements on the system, broken into three categories: prioritized improvements for pipelines, spot repair/cross connection fixes and development of an ongoing I/I reduction plan. It is recommended that rehabilitation and replacement improvements on the prioritized projects continue with the modifications to the priorities as presented in this section of the master plan. The spot repairs/cross connections should be a higher priority to be addressed in the near term. The ongoing I/I reduction plan should be continued to further prevent I/I in the wastewater collection system. It should be noted that City staff have recently been working on I/I rehabilitation projects in the Springbrook Trunk Line basin, in lieu of other areas highlighted in the downtown area, due reported overflow conditions.

The recommended improvements were compared to recent rehabilitation/replacement projects (within the last four years) provided by the City and compared with other recommended improvements in this Master Plan which address capacity deficiencies. Projects that had been replaced or rehabilitated recently were not included in these I/I recommendations. None of the capital improvement projects listed in Section 6 of this master plan include pipes recommended for replacement in this section. Progress was made with the inspection efforts for this master plan, however, much of the Hess Creek, Wynooski, and Dayton Trunk Lines were still not CCTV inspected during this master plan as directed by City staff. It is recommended that all trunk lines be video inspected and the results compared with recommendations in this section and Section 6 of this master plan to re-evaluate project priorities for these pipelines.

8.1.1 Prioritized Improvements for Pipelines

Using the methodology described in Section 7, the top 70 pipe segments from both the 2015 and 2017 inspections were considered by score and grouped by location to create logical rehabilitation projects for the City. The pipe segments are listed and numbered by project in Table 8-1 below. Figure 27 (Appendix A) shows the location of each project. Noted on Figure 27, Priority Project 1 was completed by the City in 2016 and Priority Project 2 is scheduled for the 2018/2019 fiscal year. Priority Projects 13 and 21 overlap with Capital Improvement Plan (CIP) Project C1.b (Section 12) and should be resolved when the CIP project is completed. The available data was reviewed for each of the priority projects to create a project sheet, which highlights the defects found for the pipes, makes some suggestions for rehabilitation techniques (if applicable), and gives a conceptual level opinion of probable costs (Appendix F).

During the most recent round of inspections, some pipes did not receive a full-length inspection. These inspections are considered “abandoned,” and should be cleaned and re-inspected by the City to ensure that there are no defects along the remainder of the pipe length.

Table 8-1: Project Prioritization for Pipe Segments

Project Priority	Pipe Segment	Material	Diameter (in)	Risk Score	Total Length (ft)	CIP Year
1	wwgm1360	CLAY	8	13.2	1129	1
	wwgm0428	CLAY	8	11		
	wwgm1361	CLAY	8	10		
	wwgm1359	CLAY	8	6.6		
2	wwgm1318	CLAY	12	12.1	2299	1
	wwgm1323	CONC	15	10.45		
	wwgm1322	CLAY	8	10		
	wwgm1304	CLAY	12	9.9		
	wwgm1755	CLAY	12	8.8		
	wwgm1753	CLAY	12	8.8		
	wwgm1306	CLAY	12	8.8		
	wwmG136064	MH	n/a	n/a		
	wwgm1744	CLAY	8	8		
3	wwgm1368	CLAY	12	12.1	1025	2
	wwgm1369	CLAY	12	8.8		
	wwgm1309	CLAY	12	6.6		
4	wwgm0270	CLAY	6	13.2	1087	2
	wwgm1787	CLAY	8	9.9		
	wwgm0271	CLAY	6	4.4		
5	wwgm1604	CLAY	12	13.2	643	3
	wwgm1607	CLAY	12	12.1		
	wwgm1373	CLAY	12	9.9		
6	wwgm2080	PVC	12	--	1148	3
	wwgm1299	CLAY	6	12.5		
	wwgm1300	CLAY	6	7.5		
7	wwgm0217	CLAY	6	13	948	4
	wwgm1623	CLAY	6	12		
	wwgm0199	CLAY	6	11		
	wwgm1624	CLAY	6	6.5		
	wwgm1625	CLAY	6	2		
8	wwgm1758	CLAY	8	11	1266	4
	wwgm1365	CLAY	8	11		
	wwgm1757	CLAY	8	8		
	wwgm1302	CLAY	8	7		
	wwgm1958	CLAY	8	6.6		
	wwgm1364	CLAY	8	5.5		
9	wwgm0105	CLAY	6	11	484	4
	wwgm1980	CLAY	8	10		
	wwgm1777	CLAY	8	2		
10	wwgm1784	CLAY	8	10.5	995	5
	wwgm1900	CLAY	6	9		
	wwgm0100	CLAY	6	6		
	wwgm0348	CLAY	8	3		
11	wwgm1584	CLAY	8	10	762	5
	wwgm1594	CLAY	10	8		
	wwgm1585	CLAY	8	7		
	wwgm1586	CLAY	8	2		
12	wwgm0367	CONC	12	10.8	673	6
	wwgm0264	CLAY	8	6		
	wwgm0247	CONC	8	4.5		
13	wwgm0433	CLAY	6	10	189	6
14	wwgm1305	CLAY	8	9	921	6
	wwgm1370	CLAY	8	8.8		
	wwgm1883	CLAY	6	3		
	wwgm1993	CLAY	8	2		
15	wwgm0176	CLAY	6	9.9	682	7
	wwgm0174	CLAY	8	6		

Table 8-1 (Continued): Project Prioritization for Pipe Segments

16	wwgm1765	CLAY	8	9	533	7
17	wwgm1680	CLAY	8	9	360	7
18	wwgm1310	CLAY	8	8	1151	7
	wwgm1750	CLAY	6	7		
	wwgm1357	CLAY	8	7		
19	wwgm1271	CLAY	6	8	1166	8
	wwgm1253	CONC	15	7.15		
	wwgm1402	CLAY	10	6.05		
20	wwgm1630	CLAY	8	8	851	8
	wwgm1629	CLAY	8	8		
21	wwgm0332	CLAY	6	8	944	8
	wwgm2136	CONC	12	7.7		
	wwgm0259	CLAY	6	6		
22	wwgm0429	CLAY	8	7.5	711	8
	wwgm1362	CLAY	8	4.95		
23	wwgm1613	CLAY	10	6.6	643	9
24	wwgm1775	CLAY	8	6.6	963	9
	wwgm1601	CLAY	8	6.6		
	wwgm1598	CLAY	8	6.5		
25	wwgm1351	CLAY	8	6	1549	9
	wwgm1343	CLAY	8	6		
	wwgm1354	CLAY	8	5		
26	wwgm1428	CLAY	8	5	822	9
	wwgm1424	CLAY	8	5		
	wwgm1423	TRAN	8	3		

Using the project sheets in Appendix F, it is recommended that the City take immediate action to remedy the priority pipe segments in Table 8-1. Additionally, the City can use this document as a resource to identify future pipe rehabilitation projects and can be used as a reference when making future infrastructure improvements to save money. For example, if a roadway containing a defective pipe segment is being improved or replaced, combining the two efforts into one project will save the City time and money. It should be noted that the City currently has a budget for rehabilitation/replacement of pipes in Priority 1 and 2 for next fiscal year. This master plan update of the I/I priority list does not require a change in Priority 1 and 2 from the 2015 I/I study.

8.1.2 Spot Repairs / Cross Connections

Some pipelines may be in relatively good condition but have one or two locations where there are severe defects. Rather than replace the entire pipeline reach, localized spot repairs may be more appropriate for these locations. For this analysis, any pipeline with a PACP grade 4 or 5 defect that was not included in the top priority pipeline rehabilitation/replacement projects is included in the spot repair priority list in Table 8-2 below.

Table 8-2: Spot Repair List

Highest Defect	Pipe Segment	Material	Diameter (in)
class 5 structural	wwgm1649	Concrete	12
class 5 structural	wwgm1581	Clay	6
class 5 structural	wwgm1561	Clay	6
class 5 structural	wwgm1352	Concrete	15
class 5 structural	wwgm0659	Transite	8
class 5 O&M	wwgm1898	Clay	8
class 5 O&M	wwgm1836	Clay	8
class 5 O&M	wwgm1759	Clay	8
class 5 O&M	wwgm1739	Concrete	15
class 5 O&M	wwgm1709	Concrete	15
class 5 O&M	wwgm1695	Concrete	8
class 5 O&M	wwgm1693	Concrete	8
class 5 O&M	wwgm1692	Concrete	8
class 5 O&M	wwgm1485	Concrete	8
class 5 O&M	wwgm1484	Concrete	8
class 5 O&M	wwgm1453	PVC	8
class 5 O&M	wwgm1412	PVC	8
class 5 O&M	wwgm1411	Concrete	15
class 5 O&M	wwgm1379	Concrete	15
class 5 O&M	wwgm1132	PVC	18
class 5 O&M	wwgm1118	Concrete	8
class 5 O&M	wwgm1113	PVC	12
class 5 O&M	wwgm1079	Concrete	8
class 5 O&M	wwgm1078	Concrete	8
class 5 O&M	wwgm1074	Concrete	8
class 5 O&M	wwgm1073	Concrete	8
class 5 O&M	wwgm1050	Concrete	6
class 5 O&M	wwgm1035	PVC	10
class 5 O&M	wwgm1034	PVC	8
class 5 O&M	wwgm0971	Concrete	8
class 5 O&M	wwgm0970	Concrete	8
class 5 O&M	wwgm0749	Concrete	8
class 5 O&M	wwgm0620	Concrete	8
class 5 O&M	wwgm0617	PVC	12
class 4 structural	wwgm2134	Clay	8
class 4 structural	wwgm1628	Clay	8
class 4 structural	wwgm1626	Clay	8
class 4 O&M	wwgm2079	PVC	12
class 4 O&M	wwgm1956	Clay	8
class 4 O&M	wwgm1845	Concrete	8
class 4 O&M	wwgm1778	Unknown	8
class 4 O&M	wwgm1681	Clay	8
class 4 O&M	wwgm1631	Clay	8
class 4 O&M	wwgm1582	Clay	8

Table 8-2 (Continued): Spot Repair List

Highest Defect	Pipe Segment	Material	Diameter (in)
class 4 O&M	wwgm1516	Concrete	8
class 4 O&M	wwgm1514	Concrete	8
class 4 O&M	wwgm1510	Concrete	8
class 4 O&M	wwgm1507	Concrete	8
class 4 O&M	wwgm1505	Concrete	8
class 4 O&M	wwgm1497	Concrete	8
class 4 O&M	wwgm1488	Concrete	8
class 4 O&M	wwgm1483	Concrete	8
class 4 O&M	wwgm1482	PVC	8
class 4 O&M	wwgm1443	PVC	8
class 4 O&M	wwgm1425	Clay	8
class 4 O&M	wwgm1419	Concrete	15
class 4 O&M	wwgm1380	Concrete	15
class 4 O&M	wwgm1372	Clay	10
class 4 O&M	wwgm1332	Concrete	15
class 4 O&M	wwgm1331	Concrete	15
class 4 O&M	wwgm1295	PVC	8
class 4 O&M	wwgm1263	PVC	8
class 4 O&M	wwgm1257	Concrete	12
class 4 O&M	wwgm1194	PVC	12
class 4 O&M	wwgm1076	PVC	18
class 4 O&M	wwgm1055	Concrete	12
class 4 O&M	wwgm1054	Concrete	12
class 4 O&M	wwgm1049	Concrete	8
class 4 O&M	wwgm1036	PVC	8
class 4 O&M	wwgm1031	PVC	8
class 4 O&M	wwgm0964	PVC	8
class 4 O&M	wwgm0933	PVC	8
class 4 O&M	wwgm0792	PVC	8
class 4 O&M	wwgm0781	PVC	8
class 4 O&M	wwgm0766	PVC	8
class 4 O&M	wwgm0747	Concrete	8
class 4 O&M	wwgm0738	Concrete	8
class 4 O&M	wwgm0704	Transite	8
class 4 O&M	wwgm0662	Transite	8
class 4 O&M	wwgm0518	PVC	8
class 4 O&M	wwgm0512	PVC	8
class 4 O&M	wwgm0509	PVC	8

Recommended actions to reduce I/I from defects identified through smoke testing are found below in Table 8-3. Estimates of the cost and associated benefits of removing cross-connections identified by smoke testing are addressed in this table and discussed in more detail in Potential I/I Reductions, Section 7.7.

Table 8-3: Estimated Inflows and Improvement Costs for Cross-Connections

Picture ID	Address	Inflow Source	Area of Inflow, A (ac)	Runoff Co-efficient, C	Rainfall Intensity, i (in/hr)	Inflow, Q (cfs)	Inflow, Q (gpm)	Estimated Improvement City Cost	Cost per GPM
17	Intersection of S Pennington Dr and Hoskins St	catch basin (4x)	3.95	0.59	1.85	4.33	1943	$24,465	$13
20	5270 Wedgewood Lp	lawn (rolling)	0.02	0.75	1.85	0.03	15	$500	$33
						Totals:	**2000**	**$25,000**	**$13**

8.1.3 Ongoing I/I Reduction Plan

It is recommended that the City continue to identify and monitor sources of I/I system-wide. This I/I study did not investigate the entire sanitary sewer system in the City of Newberg. This study, however, did incorporate piping from all four basins. It re-confirmed the previous master plan and I/I study findings that the Dayton and Wynooski Basins are the worst contributors of I/I in the system. The rest of the sewer system, should be investigated for sources of I/I on a continual basis. Tables 8-1 through 8-3 should be considered dynamic tables and thus should be updated periodically to reflect new information found in ongoing I/I investigations.

Part of this ongoing process is continuous inspection, improvement, and progress tracking. It is recommended the City plan out routine CCTV inspections. The City should try to inspect 85,000 linear feet of pipe every year in order to complete the entire system on a 5-year rotation. This will allow the City to maintain updated records on defects in their collection system. Using the same methodologies established from these two studies, pipes should have their risk scores continuously updated after inspections, and Table 8-1 should dynamically change to reflect updates in the system and prioritize new pipes as defective ones are rehabilitated, replaced, or repaired. Additionally, the remaining pipes in the system which have not been inspected should be targeted for CCTV inspection by the City.

It is estimated, based on 80 miles of pipeline and a 100-year life cycle, that the City should be replacing 4,220 linear feet of pipeline a year. With an approximate $180 per linear foot (approximate based on mix of open trench, pipe bursting, and CIPP rehab/replacement), this means that the City should budget approximately $800,000 per year just for pipeline replacement. This budget number was considered in grouping projects and estimating how many years it would take to complete the rehabilitation or replacement of the pipelines.

Continued monitoring in areas that have been studied and where improvements are made is important for tracking I/I in the system and for estimating the effect rehabilitation/replacement efforts have on I/I. This information can help identify effective methods of reducing or eliminating I/I in areas of the system. The monitoring will also help to track I/I over time and allow the City to identify areas where I/I is getting worse. Investigations and improvement work can be focused on those areas to reduce system I/I. Identifying, monitoring and eliminating I/I is an ongoing and dynamic process. It is recommended the City continue rehabilitation/replacement efforts and continue to monitor and track I/I throughout the sanitary sewer system.

9. WASTEWATER TREATMENT PLANT EXISTING FACILITIES

The City of Newberg (City) owns and operates the Newberg Wastewater Treatment Plant (WWTP) located at 2301 Wynooski Road, as shown in Figure 9-1. The WWTP is an oxidation-ditch type, activated sludge plant with Class A biosolids composting. The last comprehensive study of the plant was the 2007 Facilities Plan Update (Brown and Caldwell, Revised October 2007). This chapter provides an overview of the existing treatment plant including process description, plant capacity analysis, and facilities condition assessment.

Figure 9-1: Location Map

The City currently provides wastewater treatment services to its residents, commercial establishments, institutional customers, and a number of industries. Since its initial construction, many improvements have been made to the Newberg WWTP in order to handle changing average and peak flow events. The following timeline illustrates the key improvements made to the WWTP.

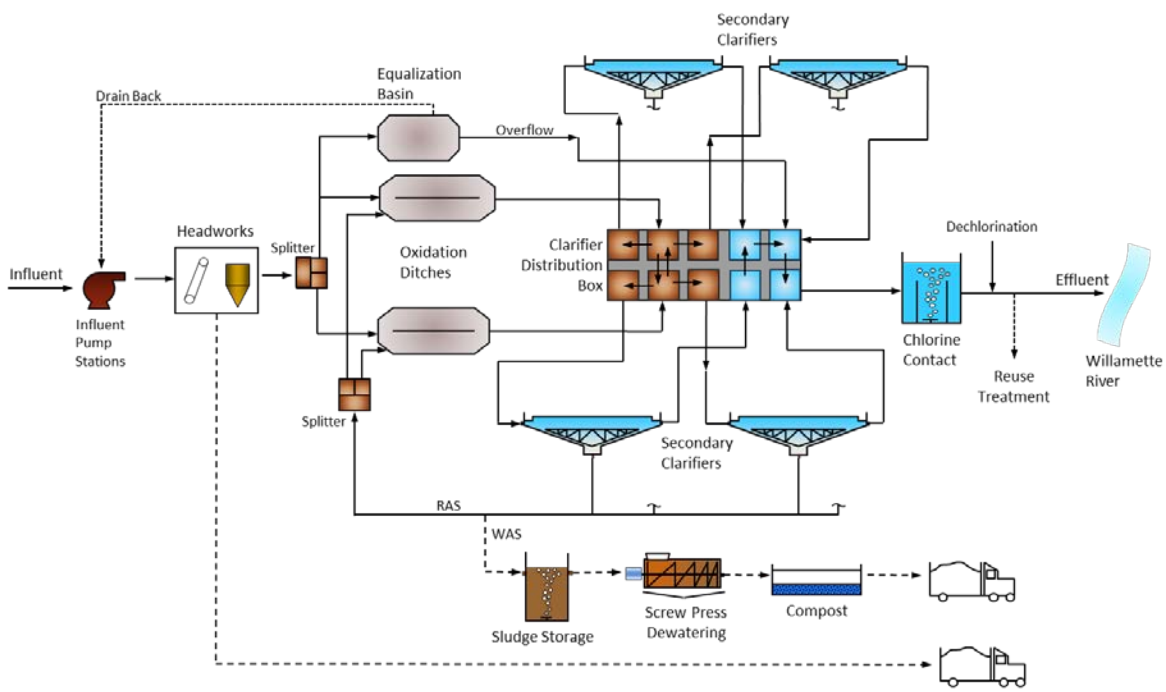
- 1987: Initial plant construction.
- 1997: Instrumentation and control improvements were made throughout the plant.
- 2004: Original Headworks was upgraded with two perforated plate mechanical screens, screening compactors, and a redundant grit classifier. Compost curing bays and blower building were also constructed.
- 2008: Reuse membrane system was added. The main switchgear and standby generator were also replaced.

- 2009: Sawdust drying system was added to improve composting operations and capacity.
- 2012: Rotor gear boxes were replaced at the Oxidation Ditches.
- 2013: A fourth Secondary Clarifier and fifth RAS pump were added. Motor and drive assemblies replaced in the three existing Secondary Clarifiers.
- 2015: A new influent pump station (IPS) expansion wet well was added to increase influent pumping capacity. A new Headworks facility was constructed to replace the existing facility. Solids dewatering improvements included new sludge feed pumps and two new screw presses installed in place of one of the existing belt filter press. A Septage Receiving Facility was also added.
- 2017: Upgrades to the disinfection system included a new hypochlorite generation system in the Secondary Building and removal of the chlorine gas system from the Chlorination Building.

9.1 SYSTEM DESCRIPTION

The Newberg WWTP consists of raw influent pumping; Headworks facility with influent flow measurement, screening, and grit removal; activated sludge oxidation ditches; equalization basin; secondary clarifiers; hypochlorite disinfection; dechlorination; membrane reuse; effluent outfall; sludge storage; solids dewatering; and biosolids composting. A simplified schematic of the treatment process is provided in Figure 9-2. Class A reuse water is sold to the Chehalem Glenn Golf Course for irrigation and Class A composted biosolids are sold to the community. The plant also accepts septage from local septic pumpers and RVs on a daily basis. For NPDES permit compliance, composite influent samples are taken at the Headworks facility downstream of screening, and effluent sampling is downstream of dechlorination.

Figure 9-2: Process Flow Schematic



Many modifications have been made to the facility since 1987, as listed in the above timeline. The following describes each treatment process, provides an equipment summary, and highlights changes made to the WWTP since the 2007 Facilities Plan Update.

9.1.1 Influent Pumping

Influent pumping is located at the end of Hess Creek trunk line, approximately 500-ft west of the main campus. In 2015 a new influent pump station (IPS) expansion wet well (referred to as New IPS) was constructed adjacent to the existing wet well (referred to as Existing IPS) to meet future projected influent flows. The New IPS wet well houses two submersible pumps and was designed with provisions for a third pump. During normal flow events, influent is directed only to the Existing IPS. The New IPS is used when the influent flow exceeds the capacity of the Existing IPS or at least once a month to exercise the pumps. The New IPS has a single 30-inch diameter force main and the Existing IPS as two 20-inch diameter force mains, all discharge to the Headworks facility. A summary of the IPS pumps is listed in Table 9-1.

Table 9-1: Influent Pumping Details

Process or Design Parameter	Unit	Value
Total Influent Pumping Firm Capacity	mgd	38.7
Existing IPS		
Pump type		non-clog submersible
Number of pumps		4 (2 small, 2 large)
Capacity small pumps 1 &2 (each)	mgd	4.8 at 95.5 ft static head
Motor, drive small pumps 1 &2 (each)	HP	120, VFD
Capacity large pump 3	mgd	11 at 95.5 ft static head
Motor, drive large pump 3	HP	248, VFD
Capacity large pump 4	mgd	10.6 at 95.5 ft static head
Motor, drive large pump 4	HP	280, VFD
New IPS		
Pump type		non-clog submersible
Number of pumps		2 + space for 1 future
Capacity (each)	mgd	9.25 at 102 ft TDH
Motor (each), drive	HP	215, VFD

9.1.2 Headworks

A new Headworks was built in 2015 to handle future peak flows. It replaced the old Headworks facility, which was decommissioned and demolished. The Headworks handles preliminary treatment processes, including screening and grit removal. Perforated plate mechanical screens and corresponding screenings washer/compactors from the previous Headworks were refurbished and relocated to the new Headworks. A third manual bar screen was also included. The facility has two Eutek HeadCell® free vortex/stacked tray grit removal systems with corresponding grit classifier/dewatering units. Summary information on the Headworks facility is listed in Table 9-2.

Table 9-2: Headworks Details

Process or Design Parameter	Unit	Value
Influent Screens		
Number of units		2
Type		perforated plate
Capacity (each)	mgd	23
Screen opening size	mm	10
Screenings Washing and Dewatering		
Number of units		2
Type		washer/compactor
Grit Removal System		
Number of units		2
Type (each)		6 stacked trays
Diameter	feet	12
Peak hydraulic capacity (each)	mgd	23
Grit Pumps		
Number of units		2
Pump type		recessed impeller
Capacity (each)	gpm	300 at 27 ft, TDH
Motor (each)	HP	10
Grit Washing		
Number of units		2
Type		classification/washing
Capacity (each)	gpm	300
Wet Well Drain Pumps		
Number of units		2
Pump type		non-clog submersible
Capacity (each)	gpm	340 at 34 ft, TDH
Motor, drive (each)	HP	5, constant speed

9.1.3 Secondary Treatment

Secondary treatment system consists of two oxidation ditches and four secondary clarifiers. Flow from the Headworks is split at the Raw, Degritted, Sewage (RDS) Distribution Box to the two oxidation ditches. The oxidation ditches provide biological secondary treatment. Air is provided by surface rotor aerators. Mixed liquor from each oxidation ditch flows to the Clarifier Distribution Box (CDB) to split to each secondary clarifier. The process also includes an equalization basin that is used only in extreme peak flow events. The RDS Distribution Box has an overflow weir to the equalization basin. The basin includes jet aerators for mixing to keep solids suspended and air to keep the contents from going septic. The equalized flow can either be drained to the IPS or sent to the clarified-water section of the CDB. A summary of the oxidation ditches and the equalization basin equipment is listed in Table 9-3.

Table 9-3: Oxidation Ditch and Equalization Basin Details

Process or Design Parameter	Unit	Value
Oxidation Ditches		
Total volume (each)	MG cft	2 267,000
Hydraulic retention time (HRT)	hours	15 hrs at 6.5 mgd
Solids retention time (SRT)	days	20 days (summer), 25 days (winter)
Design MLSS	mg/L	2,000
Aeration equipment		
Surface aerators, each basin		4
Type		rotating brush
Capacity	lbs oxygen/HP/hour	2
Total connected hp per basin		200 (two-speed)
Motor (each)	HP	50
Equalization Basin		
Total volume	mgd	1.3
Maximum return rate	mgd	2
Aeration and mixing pumps		
Number of units		2
Pump type		jet aeration
Motor (each)	HP	7.5

There are four circular secondary clarifiers. The fourth secondary clarifier was added in 2013 to increase clarification capacity during the winter flows. Secondary effluent from each clarifier is combined in the clarified-water section of the CDB prior to disinfection. Settled sludge in the secondary clarifiers is either recycled as return activated sludge (RAS) to the oxidation ditches or wasted as waste activated sludge (WAS) to solids handling treatment. RAS and WAS pumps are located in the basement of the Secondary Building. A summary of the secondary clarifier and RAS and WAS pumping equipment is provided in Table 9-4.

Table 9-4: Secondary Clarifier and RAS/WAS Pumping Details

Process or Design Parameter	Unit	Value
Number of units		4
Size	diameter, feet	80
Sidewater depth	feet	15
Surface area (each)	square feet	5,027
Capacity at Surface Overflow Rates		
400 gpd/sq ft	mgd	8
800 gpd/sq ft	mgd	16
1,200 gpd/sq ft	mgd	24.1
Return Activated Sludge (RAS) Pumps		
Number of units		5 (4 large, 1 small)
Pump type		centrifugal
Capacity large pumps 1, 2, 4, & 5	gpm	2,800 at 36ft, TDH
Motor, drive large pumps 1, 2, 4, & 5	HP	40, VFD
Capacity small pump 3	gpm	850 at 20ft, TDH
Motor, drive small pump 3	HP	40, VFD
Maximum RAS rate	mgd	13
Waste Activated Sludge (WAS) Pumps		
Number of units		3
Pump type		centrifugal
Capacity (each)	gpm	300
Motor, drive	HP	5, VFD

9.1.4 Disinfection

A new onsite sodium hypochlorite generation system was installed in 2017. The new system was added to the main floor of the Secondary Building. It replaced the old chlorine gas system. Hypochlorite is injected at the CDB as secondary effluent flows to the Chlorine Contact Basins (CCB). The serpentine flow in the CCB provides the disinfection contact time. Reclaimed Water and Reuse Water pumps draw from the effluent channel for non-potable plant water and reuse treatment, respectively. If required, disinfected effluent is dechlorinated with sodium bisulfite. A summary of the disinfection and reclaimed and reuse equipment is provided in Table 9-5 and Table 9-6, respectively.

Table 9-5: Disinfection Details

Process or Design Parameter	Unit	Value
Sodium Hypochlorite Generation		
Capacity	lb free available Cl/day	450 to 500
Concentration generated	%	12.5
Number of pumps		1
Metering pump capacity	gph	180
Number of storage tanks		1
Tank volume (each)	gallons	2,500
Concentration diluted	%	0.8
Number of pumps		2
Metering pump capacity (each)	gph	660
Number of storage tanks		2
Tank volume (each)	gallons	2,500
Brine tank (dry salt storage)		
Tank volume	cf	1,400
Chlorine Contact		
Number of basins		2
Basin volume (total)	gallons	303,000
SE Pipe (CDB to CCB) volume (total)	gallons	17,000
Total chlorine contact volume	gallons	320,000
Detention time at 3.4 mgd (2017 AADF)	minutes	136
Detention time at 10.2 mgd (2017 PWkF)	minutes	45
Sodium Bisulfite Dechlorination		
Tank volume	gallons	1,550
Number of pumps		2
Metering pump capacity (each)	gph	0.58

Table 9-6: Reclaimed and Reuse Water Details

Process or Design Parameter	Unit	Value
Reclaimed Water Pumps		
Number of units		2
Pump type		vertical turbine
Capacity (each)	gpm	350 at 180 ft TDH
Motor (each), drive	HP	25, constant
Reuse Water Pumps		
Number of units		2
Pump type		vertical turbine
Capacity (each)	gpm	800 at 60 ft TDH
Motor (each), drive	HP	20, constant

9.1.5 Outfall

After disinfection, the effluent travels by gravity approximately 3,000-ft to discharge to the Willamette River. The outfall is a single port diffuser in the Willamette River at river mile 49.7. Summary of details of the outfall are provided in Table 9-7.

Table 9-7: Outfall Details

Process or Design Parameter	Unit	Value
Outfall		
Length (total)	ft	2,986
Diameter	inch	36 & 24
Discharge Location		Willamette River

9.1.6 Reuse Water

Up to 1.0 mgd of Class A reuse water is produced from the tertiary membrane system. Chlorinated secondary effluent is pumped from the CCBs to the Membrane Building for treatment. The Pall pressurized membrane system contains thousands of hollow tube membranes that pull flow from outside to the inside of the membrane. This effectively filters the water to Class A standards. During the summer months, reuse water is sent to the neighboring Chehalem Glenn Golf Course for irrigation. The golf course is the sole purchaser of the reuse water. The Water Master Plan (Murray, Smith & Associates 2017) discussed additional details of the non-potable water plan for the City and also potential future expansion, if demand requires. A summary of the membrane system is listed in Table 9-8.

Table 9-8: Membrane Reuse Details

Process or Design Parameter	Unit	Value
Type of membranes		Pressurized
Number of membrane trains		2
Number of membrane modules per train		26
Maximum Influent Capacity (total)	gpm	800
Effluent Pumps		
Number of pumps		2
Pump type		centrifugal
Capacity (each)	gpm	700 at 105 ft TDH
Motor (each), drive	HP	30, VFD

9.1.7 Solids Treatment

WAS is wasted from the secondary clarifiers and is stored in one of the two aerated Sludge Storage Tanks (SSTs). The solids are pumped from the SSTs to the Solids Building where polymer is injected and mixed to promote solids flocculation prior to mechanical dewatering. Dewatered sludge is mixed with dried sawdust and recycled compost and enters one of two compost reactor vessels to produce Class A biosolids. The finished product is sold in bulk at the plant as Newgrow Compost.

The plant has operated the Class A compost facility since the initial construction. While other biosolids stabilization processes have been investigated, the change to an anaerobic digestion or thermal drying process has been cost prohibitive. The composting process at the plant is unique. It is an in-vessel tunnel reactor. The biosolids are mixed with sawdust and recycled compost, and the mixture is heated and pushed through the reactors with a hydraulic ram. The compost is then stored in aerated piles with the storage bays.

Since the last facilities plan update two major improvements to increase the capacity of the compost process were completed: adding a sawdust drier and new sludge dewatering equipment. In 2009, a commercial sawdust drying system was added to decrease the water content of the sawdust, which is mixed with the dewatered sludge for composting. Two Huber screw presses were installed in 2015, replacing the existing belt filter presses, in order to increase capacity and efficiency of the dewatering process. This dewatering update also included two new polymer makeup systems. Summary details on the solids treatment system is listed in Table 9-9.

Table 9-9: Solids Treatment Details

Process or Design Parameter	Unit	Value
Sludge Storage Tanks		
Number of units		2
Side water depth	feet	12
Capacity (each)	gallons	80,000
Aeration system		
Type		coarse bubble
Number of blowers		3 (2 large, 1 small)
Blower type		rotary lobe
Capacity large blowers (each)	scfm	375
Motor , drive large blowers (each)	HP	20, constant
Capacity small blower	scfm	154
Motor , drive small blower	HP	10, constant
Screw Press Feed Pumps		
Number of units		2
Pump type		rotary lobe
Capacity (each)	gpm	90 at 115 ft TDH
Motor (each), drive	HP	7.5, VFD
Screw Press Dewatering		
Number of units		2
Capacity (each)	gpm	90
Motor (each), drive	HP	5, VFD
Feed solids concentration	%	1.5
Polymer System		
Number of units		2
Type		liquid activation
Pump type		progressive cavity
Capacity (each)	gph	5
Motor (each), drive	HP	0.5, VFD
Compost Facility		
Number of reactor tunnels		2
Reactor dimensions (each)	LxWxH ft	66 x 18 x 12
Number of curing bays		5

9.1.8 Odor Control System

The odor control system provides treatment to foul air from the Headworks, compost reactor tunnels, and the compost curing bays. The system includes a packed tower ammonia scrubber and size modular biofilters. The system was installed in 2002 as a component of the compost system improvements. The biofilter media requires replacement based on age and condition. A summary of the odor control system is listed in Table 9-10.

Table 9-10: Odor Control Details

Process or Design Parameter	Unit	Value
Scrubber		
Number of units		1
Capacity	scfm	14,000
Biofilter		
Number of units		6
Unit dimensions (each)	LxWxH ft	40 x 7 x 6
Media per unit	cft	1,300
Media type		Bioteg bpc 5-/100 (shredded pine roots)

9.1.9 Septage Receiving Facility

The septage receiving station accepts various loads from septage trucks that are permitted to offload at the plant as well as residential RV owners. The septage receiving station provides a disposal location for local haulers and provides revenue to the City. There are two delivery points: 1) Septage Receiving Station for large truck haulers and 2) RV Delivery Station. While there are risks associated with accepting septage, (such as possible treatment process upsets and additional maintenance), the new septage receiving station helps to mitigate these concerns.

The Septage Receiving Station allows automated access to approved haulers. The haulers connect to the system via a camlock hose fitting. The automated access and billing system will prompt the user to enter information and then a control valve opens to enable septage to flow into the station. The system also collects and stores a sample of the septage. The influent control valve will automatically close if the pH of the flow is outside of an acceptable range. The flow exits the enclosed station and enters a screening vault to remove large solids, including rags, rocks, and trash prior to entering the collection system manhole. The RV Delivery Station is provided for RV owners to empty their vehicles. A coin operated system allows access to the discharge manhole. The manhole is connected to the collection system that is conveyed to the IPS.

9.1.10 Plant Power

In 2008 the plant electrical power distribution system was upgraded with a new plant switchgear and standby generator. The switchgear is 480Y/277V (3-phase, 4-wire) and is constructed with a main-tie-main bus configuration. Bus “A” is fed from a 2,000-kVA PGE utility transformer, and Bus “B” is fed with a 2000-KW diesel, standby generator. The standby generator has the capacity to provide backup power for the entire plant. Power is distributed from the plant switchgear to MCCs that are distributed throughout the plant. Concrete encased duct banks are used to route the electrical power feeder cables throughout the facility.

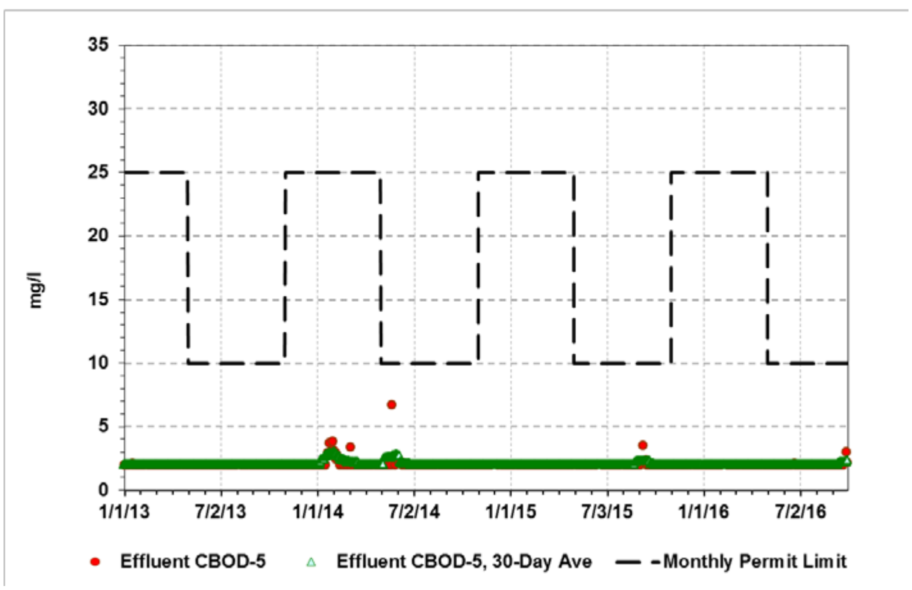
9.2 CONDITION OF EXISTING FACILITIES

This section provides a review of the existing plant conditions. Plant effluent performance was compared to the permit limits to demonstrate the historically compliant operation. Biosolids compost compliance with EPA regulations is also discussed. The physical and operational condition of the existing plant was reviewed to identify hydraulic and process capacities within the plant. A condition assessment was also used to predict the remaining lifespan of existing equipment. This analysis is used to inform and develop the list of plant improvements.

9.2.1 Effluent Performance

Historical trends of effluent cBOD and TSS concentrations are shown in Figure 9-3 and Figure 9-4, respectively. The figures show daily average and moving 30-day average concentrations for the past three years in relation to the current monthly average effluent permit requirements. The National Pollution Discharge Elimination System (NPDES) permit limits include average monthly and weekly concentrations, average monthly and weekly mass loadings, and a daily maximum mass loading. However, the daily mass loading is suspended when the daily influent flow exceeds 8-mgd. More details on the NPDES permit limits are discussed in Section 2. The plant has historically operated consistently with little risk of exceeding permit limits.

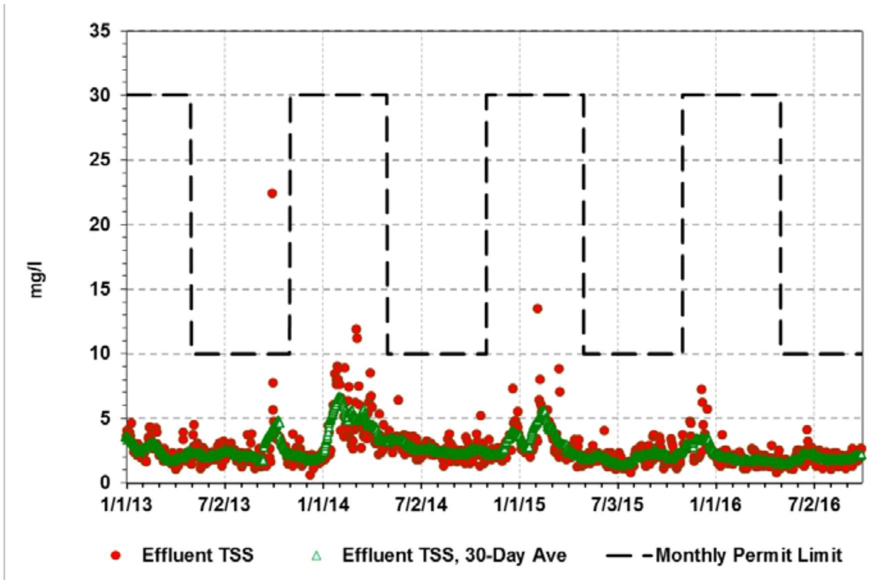
Figure 9-3: Historical Effluent cBOD



Note: Laboratory detection limit is 2.0 mg/L cBOD.

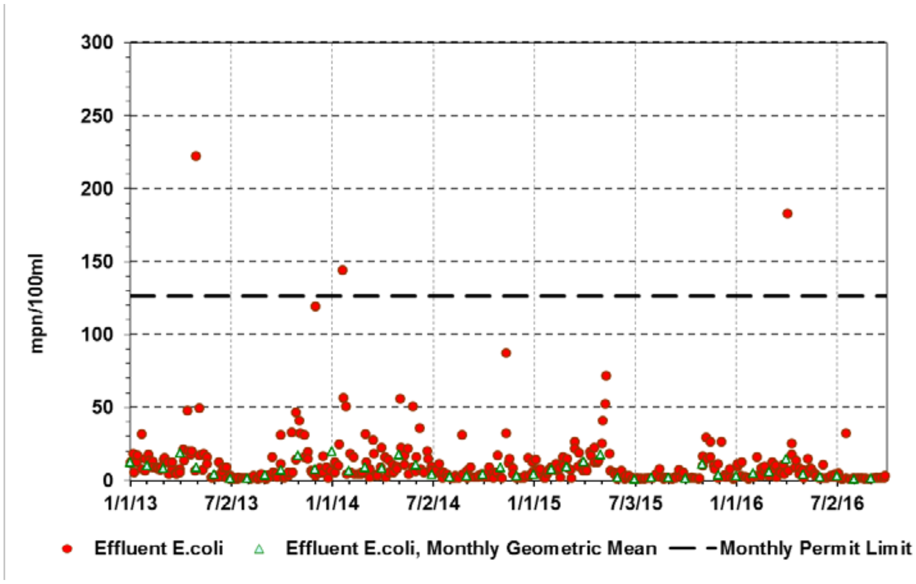
In general, the effluent TSS trend line (Figure 9-4) matches the shape of the influent flow. During peak flow events the hydraulic loading rate of the secondary clarifiers increases, effectively reducing settling time and TSS removal. This can lead to spikes in the effluent TSS. The daily effluent TSS result shown in Figure 9-4 in excess of the monthly permit limit occurred when the daily influent flow exceeded 8-mgd, suspending the daily maximum mass loading requirement. There is little concern of exceeding the permit limit given the short duration of the events and their occurrence during the winter, rainy season, as discussed above.

Figure 9-4: Historical Effluent TSS



Additional year-round permit requirements include effluent E. coli bacteria (Figure 9-5), pH (Figure 9-6), cBOD and TSS removal efficiency (Figure 9-7), and total residual chlorine (Figure 9-8). The figures show historical compliance with the year-round limitations.

Figure 9-5: Historical Effluent E. coli



Note: No single sample shall exceed 406 organisms per 100-mL.
mpn = most probable number

Figure 9-6: Historical Effluent pH

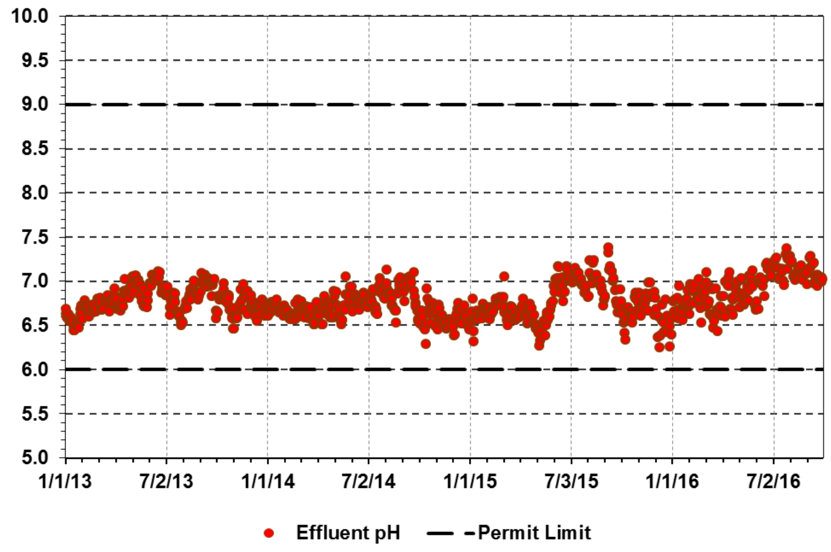


Figure 9-7: Historical Monthly Average cBOD and TSS Removal Efficiency

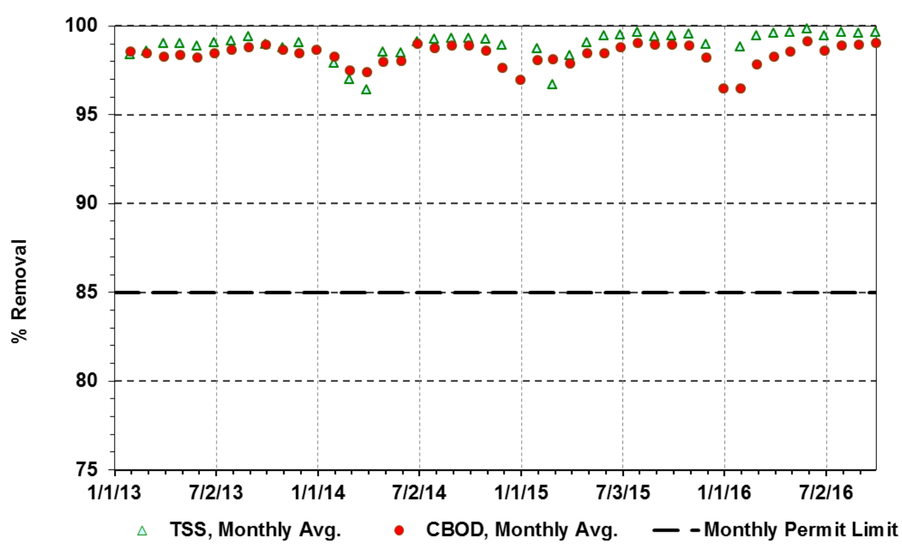
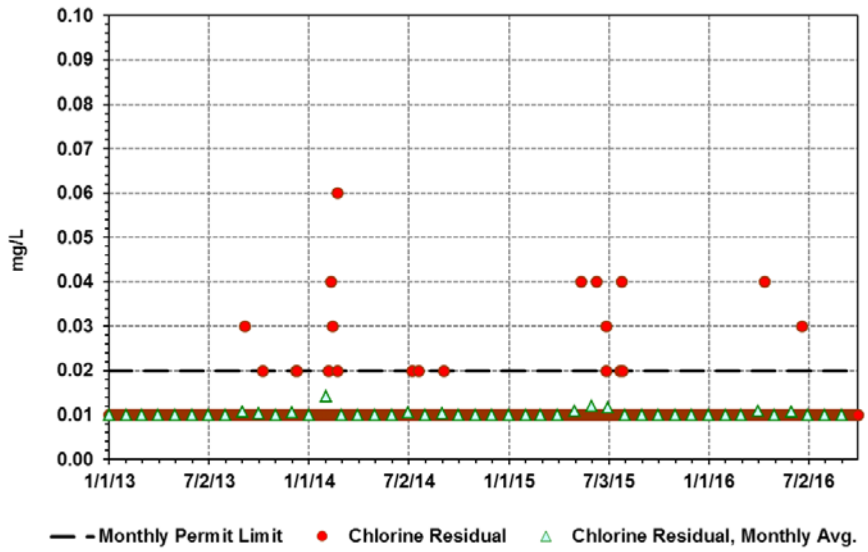


Figure 9-8: Historical Effluent Total Residual Chlorine

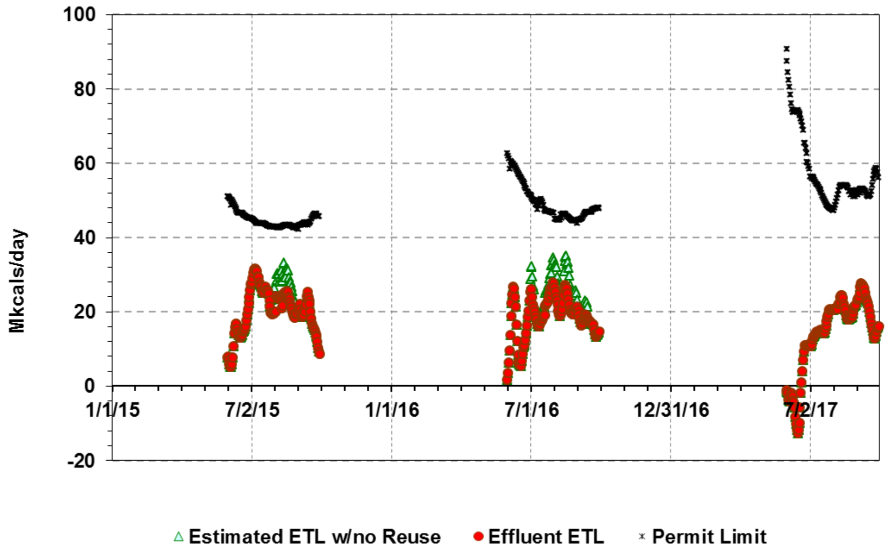


Note: Per the NPDES permit, daily maximum concentrations below 0.10-mg/L are considered in compliance with the limitation.

Figure 9-9 presents the excess thermal load (ETL) conditions. The 2009 NPDES permit modification added seasonal ETL limitations, June 1 through September 30, to protect the salmon and steelhead migration corridor in the Willamette River. Equations listed in the permit modification are used to determine the daily ETL limit, based on ambient river temperature, and the discharged effluent ETL, based on effluent flow and temperature. The plant has been in compliance since the addition of the ETL requirement.

The impact of the reuse system on ETL was also reviewed. During summer months the plant produces reuse water that is sold to the nearby golf course. This reduces discharge flow and effluent ETL to the Willamette River. Figure 9-9 includes a theoretical effluent ETL assuming no reuse water was produced and all effluent was discharged to the Willamette River. The result does show an increase in discharge ETL; however the impact does not trigger concern for compliance. In the future if ETL limits become more stringent the reuse system could be used to mitigate compliance concerns.

Figure 9-9: Historical Effluent ETL



9.2.2 Compost Performance

The composting process is used for biosolids stabilization. The Class A biosolids meet EPA's 40 CFR 503.13 requirements for pollutant concentrations, pathogens, and vector attraction reduction. Reject material that has not met pathogen reduction requirements recycles back through the tunnel reactors for additional treatment or is treated in a stock pile compost manner until it meets EPA requirements. All compost sold as Newgrow meets EPA requirements for Class A biosolids. Table 9-11 lists the Newgrow average metals data from 2016 compared to EPA's 40 CFR 504.13 metals requirements.

Table 9-11: Newgrow Compost 2016 Average Metals Data

Parameter	Units	2016 Average	EPA Maximum Allowable
Arsenic	mg/kg	4.31	41
Cadmium	mg/kg	0.42	39
Chromium	mg/kg	15.8	1,200
Copper	mg/kg	140	1,500
Lead	mg/kg	8	300
Mercury	mg/kg	0.275	17
Molybdenum	mg/kg	1.88	75
Nickel	mg/kg	13.73	420
Selenium	mg/kg	1.71	36
Zinc	mg/kg	334	2,800

Note: Average of all laboratory tests in 2016. Results per City's website: http://www.newbergoregon.gov/operations/page/compost-metals-and-content

9.2.3 Hydraulic Analysis

A hydraulic model of the plant was developed using Visual Hydraulics © Version 4.2 to determine the hydraulic capacity and identify any limiting structures at the existing plant. The model was developed by working backwards from the effluent discharge point in the Willamette River through each hydraulic control and/or treatment process. Operating conditions for these simulations are as follows:

- River level: Ordinary High Water Level is 86.38-ft
- Two (2) screens in service
- Two (2) grit removal basins in service
- Two (2) oxidation ditches in service
- Equalization Basin not in service
- Four (4) secondary clarifiers in service
- Two (2) chlorine contact basins in service

Each treatment process through the plant is comprised of hydraulic elements, or control structures. Examples of hydraulic elements include weirs, channel bends, etc. that cause energy loss and reduce the energy grade line. Elevations of hydraulic elements were taken from existing construction and record drawings of the plant. Drawings dated prior to 2007 require elevation adjustment of adding 3.382-ft to reflect the NAVD-88 datum. Table 9-12 summarizes the flow elements used for the development of the hydraulic analysis of the existing treatment plant. The hydraulic profile of the existing plant is Sheet G-01 in Appendix F.

Table 9-12: Process Hydraulic Elements

Process	Hydraulic Control Elevations (NAV '88)	Assumptions
Screens	Screen channel invert: 178.25	Screens in service: 2 Headloss through Screen: 1.0 ft
Grit Removal	Effluent weir elevation: 177.08	Basins in service: 2 Headloss through Grit Removal: 1.0 ft
RDS Distribution Box	Weir elevation: 172.45	Flow split evenly between 2 Oxidation Ditches
Equalization Basin Overflow	Weir elevation: 173.70	
Oxidation Ditches	Adjustable effluent weir elevation: 170.38	Oxidation Ditches in service: 2
Clarifier Distribution Box Chambers 1-6	Weir elevation: 167.21 Box invert elevation: 157.38	Secondary Clarifiers in service: 4 Flow split evenly between Clarifiers
Secondary Clarifiers 1 & 2	Effluent weir elevation: 166.88 Launder invert elevation: 165.13	
Secondary Clarifiers 3 & 4	Effluent weir elevation: 164.88 Launder invert elevation: 163.13	
Clarifier Distribution Box Chambers 7-10	Box invert elevation: 157.38	Chambers connected to combine Clarifier effluent prior to Disinfection
Chlorine Contact Basin	Influent gate invert elevation: 155.0 Influent gate dimensions: 3' x 4' Effluent weir elevation: 161.71	Basins in service: 2
Reclaim and Reuse Pump Channel/Final Weir	Weir elevation: 159.63	Worst case assumes no Reclaim or Reuse pumps in service
Willamette River	Ordinary low water elevation: 55.38 Ordinary high water elevation: 86.38	High water elevation

Hydraulic Capacity

The model was used to develop a hydraulic grade line through the plant and identify limiting flow elements. To assess the maximum flow capacity of the plant, two criteria were used:

- Impaired Flow Control or Process Operation – This hydraulic criterion is reached when the water exceeds an intended water control elevation for effective process operation. Examples include submergence of splitter box control weirs and submergence of clarifier effluent weirs.
- Overflowing Condition – This hydraulic criterion is reached when the water surface elevation is greater than the top of the walls of the basin, structure, or channel.

The maximum process and overflowing flows for each hydraulic element are listed in Table 9-13.

Table 9-13: Results of Existing Plant Hydraulic Analysis

Flow Element	Maximum Process Condition	Maximum Process Flow, MGD	Overflowing Condition, MGD
Screens	Process design capacity	46.0	40.5
Grit Removal	Effluent weir submerged Process design capacity	34.5 46.0	40.5
RDS Distribution Box	Split weir submerged Overflow to Equalization	21.0 27.0	36.0
Oxidation Ditches	Effluent weir submerged	31.0 + 15.5 RAS	40.5 +20.0 RAS
Clarifier Distribution Box Chambers 1-6	Weir submerged	27.0 + 13.5 RAS	40.5 +20.0 RAS
Secondary Clarifier 1&2	Weir submerged	30.0	41.0 +20.25 RAS
Secondary Clarifier 3&4	Weir submerged	27.5	40.5 +20.0 RAS
Chlorine Contact Basin	Effluent weir submerged	29.0	41.25
Reclaim and Reuse Pump Channel	Final weir submerged	39.5	41.25
Outfall	24" pipe section velocity above 10 ft/s	20.5	N/A

Hydraulic Summary

The hydraulic analysis suggests that the current plant process configuration can pass up to 21.0-mgd without hydraulically compromising a process or flow control structure. The plant can hydraulically pass the projected 2037 Peak Instantaneous Flow of 34.5-mgd (determined in Section 2) without overflowing any structures. Elements identified to have hydraulic limitations include:

- The RDS Distribution Box weir split to the Oxidation Ditches is submerged at flows above 21.0-mgd. The water surface elevation in the box will overflow to the Equalization Basin at 27.0-mgd.
- At peak flow conditions, the CDB is hydraulically limited by the elevation of Secondary Clarifiers 1 and 2 effluent weirs and the mixed liquor split. Adjusting the elevation of the weirs or increasing the weir length may add capacity to the process.
- The effluent piping from the CDB to the CCBs limits the capacity of the Secondary Clarifiers. Increasing the size of the pipe or adding an additional pipe would reduce friction losses at high flows.
- The final effluent weir located at the Reclaim and Reuse pump channel is a critical hydraulic control at the plant. Modifications to this weir elevation or length could increase the hydraulic capacity of the CCBs. Review of water elevation requirements for the vertical turbine pumps should be conducted prior to any modifications.
- The final segment of the outfall is a 24-inch diameter pipe prior to discharge into the Willamette River. At flows above 20.5-mgd the velocity in the pipe is greater than 10-fps. This results in significant headloss and high pressures in the pipe. Notably, in the past the entire lid of the upstream manhole has been dislodged from the manhole due to the hydraulic condition.

9.2.4 Process Analysis

Conventional oxidation ditches are operated with sludge ages, or solids retention time (SRT), between 20 and 40 days and a hydraulic retention time (HRT) between 24 and 28 hours. The Newberg oxidation ditches are operated like a conventional activated sludge system, with both lower SRT and HRT when compared to conventional oxidation ditches. This operation provides nitrifying conditions, oxidizing influent ammonia to nitrate and nitrite. The current NPDES permit requires only BOD and TSS removal but the City traditionally runs the plant to fully nitrify by controlling the operation of the rotor aerators.

Liquid Process Capacity

The process capacity analysis includes analyzing both the current nitrification mode and BOD removal only mode. The secondary clarifier analysis used industry standard loading rates and the chlorine contact basin must meet the minimum contact time requirements. The contact time requirements used are per the 10 State Standards (Recommended Standards for Wastewater Facilities 2014; although these standards are well-known throughout the country, it should be noted that Oregon has not formally adopted them) and the Washington Criteria for Sewage Works peak day flow (also not formally adopted by Oregon). Key design parameters that form the basis of the capacity evaluation are listed in Table 9-14. The process capacity evaluation is based on all units in service.

Table 9-14: Liquid Process Design Parameters

Parameter	Units	Nitrification Mode	BOD Removal Only Mode
Oxidation Ditches			
Total Volume	MG	4	4
Temperature	deg C	12	12
SRT	days	10	3
MLSS, maximum	mg/L	3,500	1,500
SVI, maximum (assumed)	mL/g	200	300
Aerator Power	hp	400	400
Secondary Clarifiers			
Total Clarifier Surface Area	sf	20,100	20,100
Hydraulic Loading Rate, maximum	gpd/sf	1,200	1,200
Solids Loading Rate, maximum	lb/d/sf	25	15
Chlorine Contact			
Volume	gal	320,000	320,000
HRT at Peak Instantous Flow	min	15	15
HRT at Peak Daily Flow	min	20	20

The oxidation ditch capacity was evaluated using BioWin 5.2 wastewater modeling software. Figure 9-10 shows the BioWin model schematic of the plant secondary treatment process. A wastewater influent characterization was developed using fractions typical to municipal wastewater with known rain inflow and infiltration (I&I). The I&I provides shorter collection system retention time and aerobic conditions which reduce the influent soluble BOD and COD fractions to the treatment plant. The influent characterization fractions are provided in Table 9-15 and the resulting influent wastewater composition for the Maximum Month Wet Weather (MMWW) flow condition is shown in Table 9-16. The influent wastewater composition is relatively dilute as a result of the I&I. This influent condition can create a concern for the NPDES permit requirement of 85 percent removal of BOD and TSS, specifically in BOD removal only mode. That is due to the shorter SRT which can limit floc formation and result in higher effluent TSS.

Figure 9-10: BioWin Model Schematic

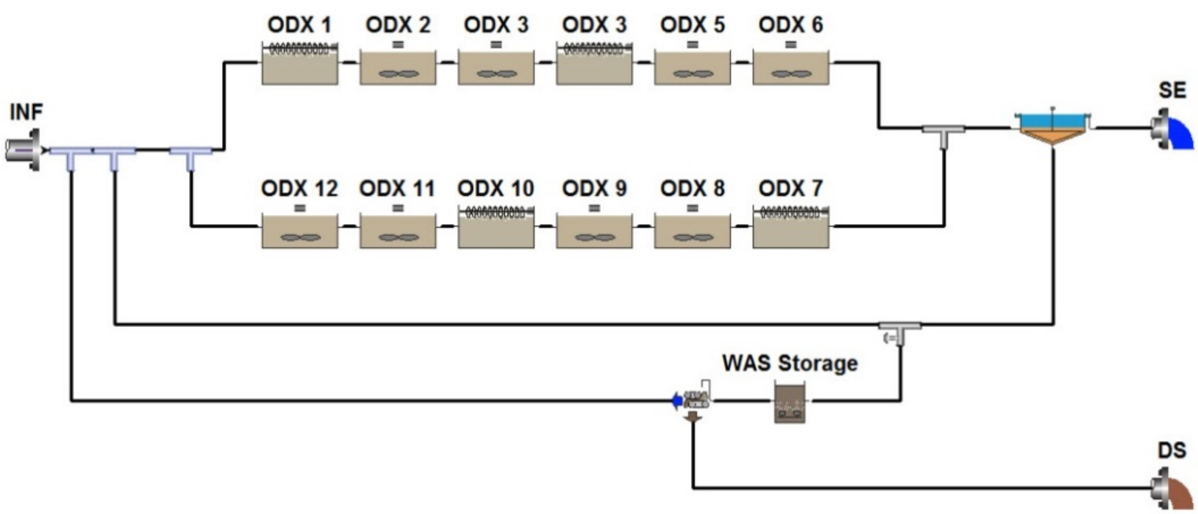


Table 9-15: Influent Characterization Fractions

Fraction	Value
COD/BOD	2.30
VSS/TSS	0.70
NH_4-N/TKN	0.67
PO_4-P/TP	0.50
TP/BOD	0.025
sCOD/COD	0.30
sBOD/BOD	0.20
TKN/BOD	0.17

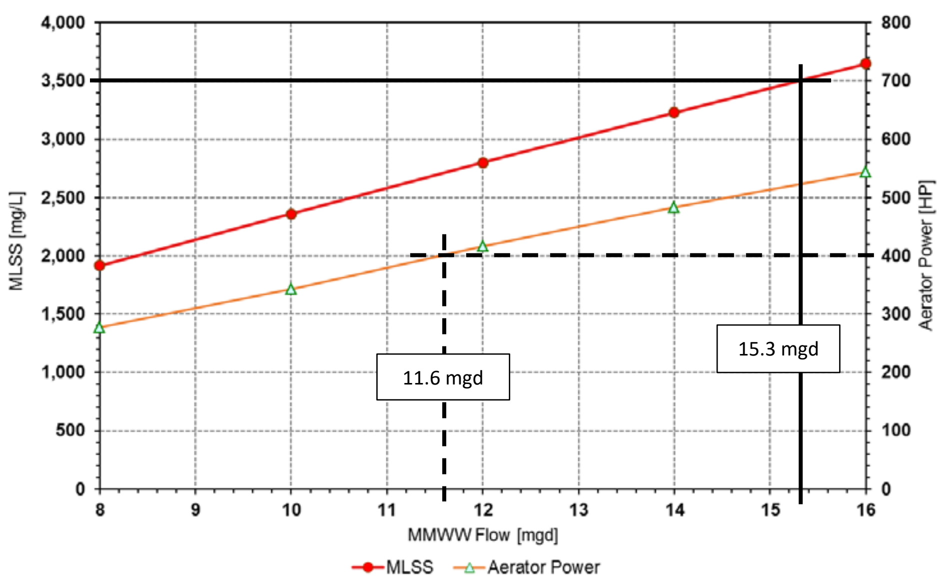
Table 9-16: Model Input Influent Composition

Parameter	Units	Value
TSS	**mg/L**	**141**
VSS	mg/L	98.7
COD	mg/L	209.3
sCOD	mg/L	63
BOD	**mg/L**	**91**
sBOD	mg/L	18.2
TKN	**mg/L**	**9**
NH_4-N	mg/L	6
TP	mg/L	2.3
OP	mg/L	1.1
Alkalinity	mg/L as $CaCO_2$	100

Note: Values calculated from influent characterization fractions in Table 9-15

The design influent composition was used in model simulations over a range of flows. Two capacity charts were generated for the two oxidation ditch operational modes, nitrification and BOD removal only, to show (1) the relationship between flow and MLSS, and flow and peak aerator power (Figure 9-11 and Figure 9-13, respectively) and (2) the relationship between flow and clarifier hydraulic and solids loading rates (Figure 9-12 and Figure 9-14, respectively). Figure 9-15 shows the relationship between peak capacity and chlorine contact hydraulic retention time. Process design parameters from Table 9-14 were added to the figures to determine a capacity for the corresponding parameter. A summary of the process capacity analysis is listed in Table 9-17.

Figure 9-11: Nitrification Capacity vs. MLSS and Peak Aerator Power



Note: The black solid and dashed lines represent the design parameter per Table 9-14 (horizontal) and the resulting MMWW flow capacity (vertical).

Figure 9-12: Nitrification Capacity vs. Clarifier Hydrualic and Solids Loading Rates

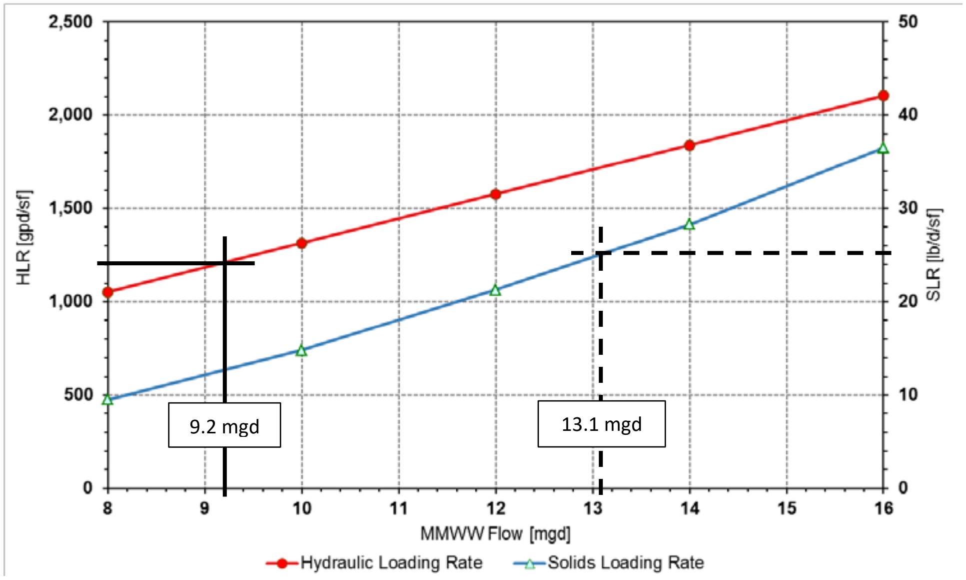
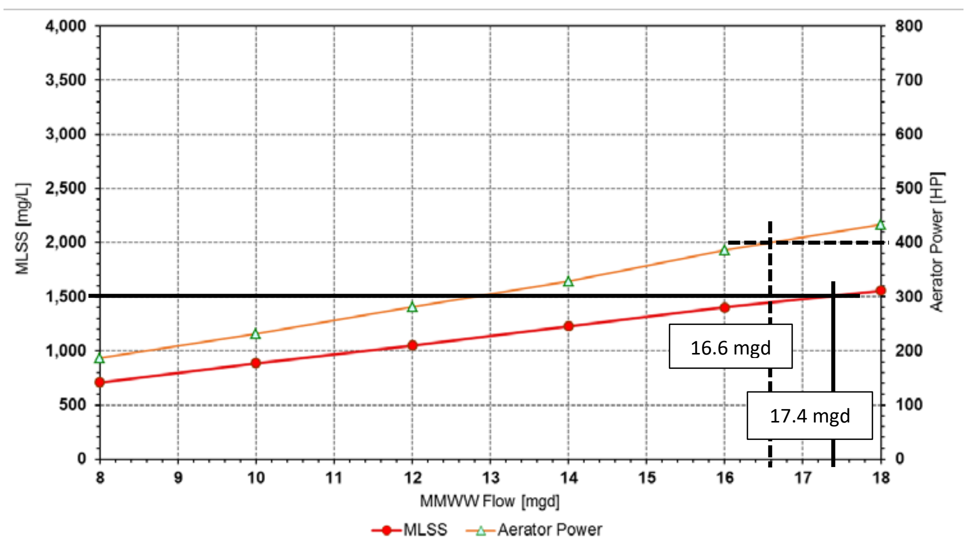


Figure 9-13: BOD Removal Only Capacity vs. MLSS and Peak Aerator Power



Note: The black solid and dashed lines represent the design parameter per Table 9-14 (horizontal) and the resulting MMWW flow capacity (vertical).

Figure 9-14: BOD Removal Only Capacity vs. Clarifier Hydrualic and Solids Loading Rates

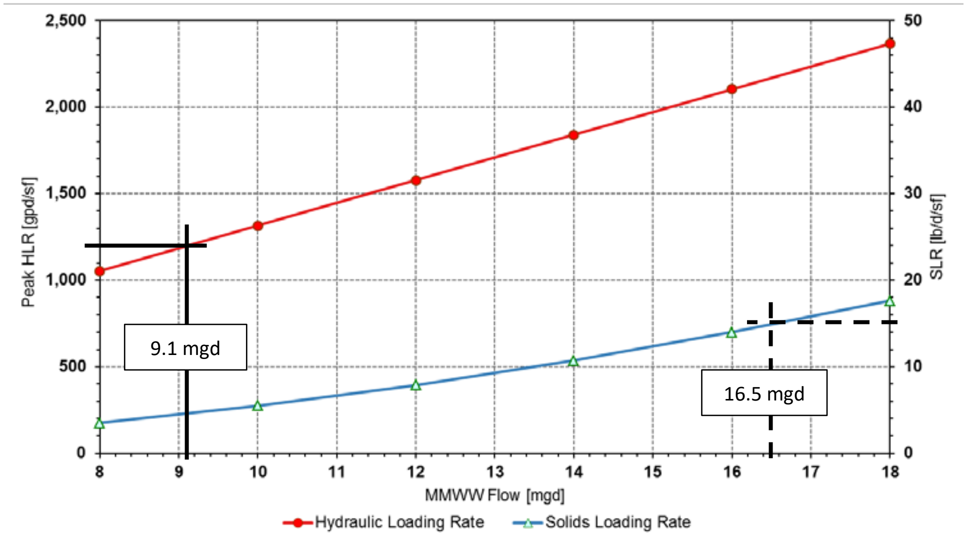
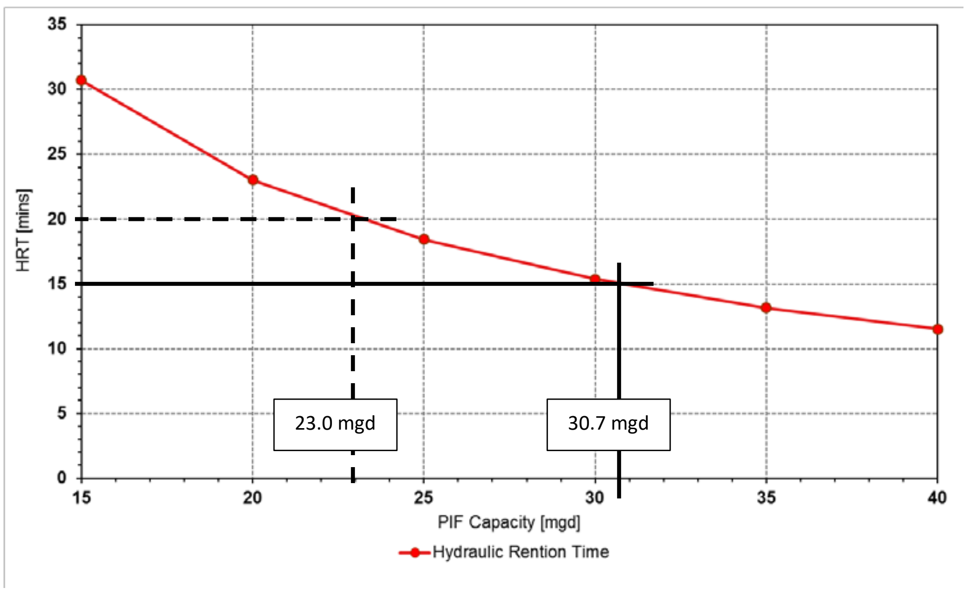


Figure 9-15: Capacity vs. Chlorine Contact Hydraulic Rention Time



Note: The black solid lines represent the design parameter per Table 9-14 (horizontal) and the resulting PIF flow capacity (vertical).

Table 9-17: Liquid Process Capacity Summary

Parameter	Capacity Condition	Nitrification		BOD Removal Only		Comments
		Capacity	Estimated Year Met[1]	Capacity	Estimated Year Met[1]	
Oxidation Ditch MLSS	MMWWF	15.3 mgd	2059	17.4 mgd	2075	
Oxidation Ditch Peak Aerator Power	MMWWF	11.6 mgd	2031	16.6 mgd	2069	Assumes efficiency of 75% and a 20% increase of MMWW loading
Secondary Clarifier Hydraulic Loading	MMWWF	9.2 mgd	-	9.1 mgd	-	Condition already met
Secondary Clarifier Solids Loading	MMWWF	13.1 mgd	2042	16.5 mgd	2069	Assumes 50% RAS
Chlorine Contact Hydraulic Retention	PIF	30.7 mgd	2028	30.7 mgd	2028	
	PDAF	23.0 mgd	2024	23.0 mgd	2024	

Note: [1] 'Estimated Year Met' was determined based on the linear regression of the capacity condition flow projection in Section 2 (2017 to 2037).

Liquid Process Summary

For BOD removal only operational mode, the capacity governing parameter for the secondary clarifiers is the peak hydraulic loading of 1,200-gpd/ft^2 based on industry standards. Using a ratio between peak and MMWW flow, the maximum design capacity based on MMWW flow is 9.1-mgd (Figure 9-12 and Figure 9-14). While the hydraulic analysis shows that the clarifiers can pass more flow, in order to show higher operational flows an increase in the peak hydraulic loading rate would need to be verified. This can be done through clarifier capacity re-rating and approval from DEQ. The historical flow data suggest that peak events which would exceed the current peak hydraulic loading are infrequent (less than three times per year) and of short duration (less than 24-hours per event).

For nitrification mode, peak aerator power demand is the first capacity limitation other than the secondary clarifier hydraulic loading. The two oxidation ditches can handle up to 11.6-mgd with all four rotor aerators in service per ditch. Aeration capacity could be increased by adding coarse bubble diffusers that do not require installation on the floor of the ditches.

The secondary clarifier solids loading rate is limiting at flows above 13.1-mgd and 16.5-mgd for nitrification and BOD removal only modes, respectively. It is anticipated that the maximum solids loading rates may be increased through the same approach of hydraulic testing and rerating of the clarifiers. In addition, process modifications or operation strategy changes may be employed to reduce the solids loading during peak flows (i.e. establishing RAS storage).

In BOD removal only mode, the primary limitation is the secondary clarifier peak hydraulic loading rate. All other parameters are not likely to limit capacity in the short term. However, a switch to BOD removal only would have impacts downstream of the oxidization ditches. The WAS yield could increase up to 50 percent resulting in additional solids to be composted. The shorter SRT can also limit floc formation and result in higher effluent TSS.

Solids Process Capacity

The solids capacity analysis includes review of the sludge dewatering and composting processes. Key design parameters that form the basis of the capacity evaluation for the two processes are listed in Table 9-18. WAS loading projections, listed in Table 9-19, were estimated based on the influent cBOD projections listed in Section 2 and a 1.2 yield ratio. The capacity evaluation is based on all units in service.

Table 9-18: Solids Process Design Parameters

Parameter	Units	Value
WAS Loading		
Yield Ratio based on Influent cBOD Projections	-	1.2
Screw Press Dewatering		
Influent Capacity at 90%	gpm	162
Influent Sludge Concentration	% TS	1.5
Compost Reactor Tunnel		
Tunnel Reactor Volume	cy	1050
Target Influent Mixture Concentration	% TS	43
Minimum Volumetric Retention Time	days	16
Typical Tunnel Reactor Temperature Range	deg C	50 to 70

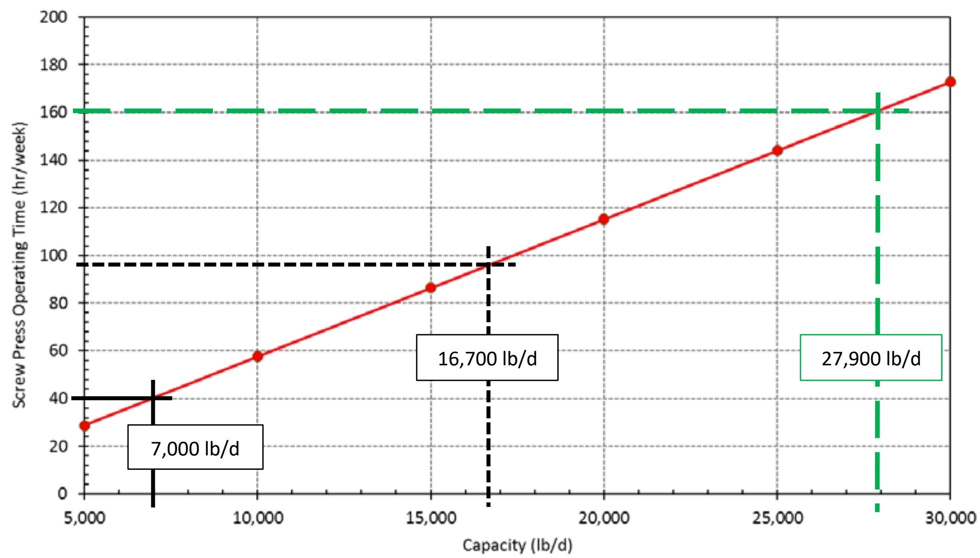
Table 9-19: WAS Loading Projections

	Projected Design WAS Load (lb/d)				
Year	2017	2022	2027	2032	2037
ADW	3,840	4,200	4,620	5,040	5,520
MMWW	7,620	8,400	9,240	10,140	10,980
PDA	8,700	9,540	10,500	11,520	12,540

Note: WAS load based on 1.2 yield ratio on the influent cBOD projections in Section 2.

Figure 9-16 shows the relationship between the sludge dewatering solids loading capacity and the screw press operating time. The capacity was reviewed under three different operating scenarios. The more screw press operating hours per week, the more solids dewatered.

Figure 9-16: Capacity vs. Screw Press Dewatering Operating Time



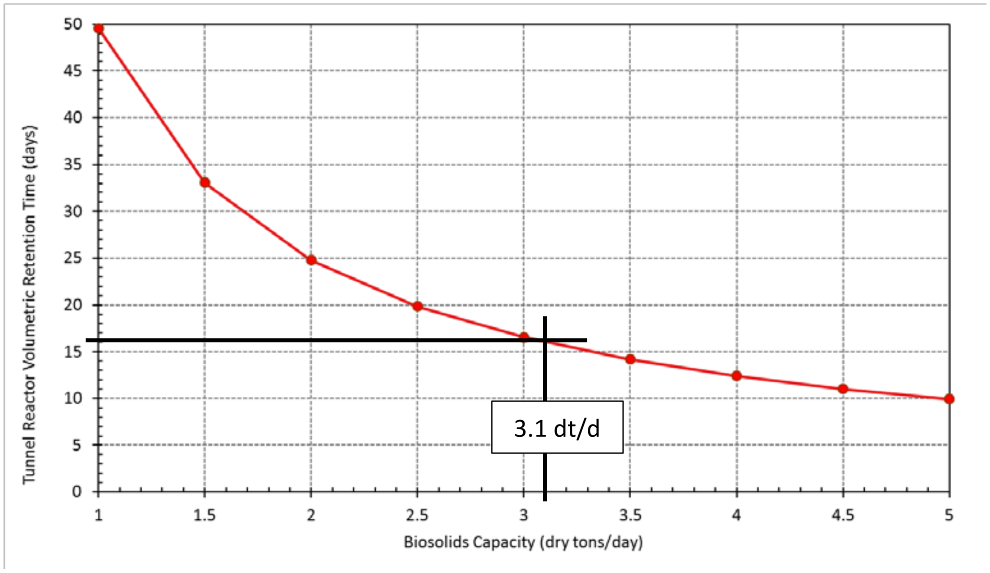
Note: Assumes 1.5% TS sludge feed and two screw presses operating at 90% capacity. The horizontal lines represent the weekly operating durations, solid black line: 40-hrs (8-hrs/day with a 5-day week), dashed black line: 96-hrs (24-hrs/day with a 4-day week), and dashed green line: 161-hrs (23-hrs/day with a 7-day week). The vertical lines are the resulting capacity.

The capacity of the compost system is analyzed based on the volumetric retention time within the tunnel reactors. To meet EPA's 40 CFR 503 rules for Class A biosolids the biosolids must meet Process to Further Reduce Pathogen (PFRP) and Vector Attraction Reduction (VAR) stabilization requirements. PFRP requires biosolids be a minimum temperature of 55°C for 3 consecutive days and for VAR a minimum of 40°C for 14 consecutive days. For capacity analysis, a retention time of 16 days is used to assure compliance with all EPA's 40 CFR 503 requirements. Additional assumptions for the compost analysis are listed in Table 9-20. The relationship between solids loading capacity and the tunnel reactor volumetric retention time is in Figure 9-17.

Table 9-20: Compost Analysis Assumptions

Parameter	Units	Sludge	Sawdust	Compost Recycle
Solids Concentration	% TS	17	90	40
Density	lb/cf	62	15	34
Sludge Volume Ratio	sludge:(sawdust or compost recycle)	1	1.3	1.3

Figure 9-17: Capacity vs. Compost Reactor Tunnel Volumetric Retention Time



Note: The black lines represent the design parameter (horizontal) and the resulting capacity (vertical).

Solids Process Summary

Solids dewatering capacity was evaluated based on screw press operating time per week. Currently the screw presses are both operated approximately 40-hours per week, 8-hours per 5-day week. Increasing the screw press operating time to 96-hours per week (4-days of 24-hour operation) more than doubles the current solids throughput capacity.

The solids concentration and the volume ratio of the three components (sludge, sawdust, and compost recycle) that make up the compost are important to the compost tunnel reactor capacity. Recent improvements to the process, including the sawdust drier and the sludge dewatering equipment improvements, have increased the capacity of the compost reactors. The calculated capacity of 3.1-dry ton solids per day equates to approximately 1,130-dry ton solids per year. A summary of the solids capacity analysis is listed in Table 9-21.

Table 9-21: Solids Process Capacity Summary

Parameter	Capacity Condition	Capacity	Estimated Year Met[1]	Comments
Screw Press Dewatering	cBOD ADW	7,000 lb/d	2055	operting time: 40 hrs per week
	cBOD MMWW	16,700 lb/d	2070	operting time: 96 hrs per week
Compost Reactor Tunnels	cBOD ADW	3.1 dt/d	2045	assumes 16 day VRT and Table 20 conditions

Note: [1] 'Estimated Year Met' was determined based on the linear regression of the capacity condition load projection in Section 2 (2017 to 2037).

9.2.5 Condition Assessment

This section presents the results of the planning level condition assessment of the mechanical, electrical, and structural facilities associated with the plant. The intent was to provide an assessment of the condition of each process area by conducting field inspections, receiving input from City staff, and producing an estimate of remaining life. The condition assessment took into consideration the age, observed physical condition, and information from the City staff on performance and reliability of each component to inform recommendation of future improvements.

Assessment Approach

The project approach included interviews with the plant staff and physical inspection of the facilities to assess the condition and remaining life of the system assets through the following tasks.

Task 1 – Meet with City Staff

On February 14, 2017, HDR met with City staff to discuss details of the assessment process and provide a foundation for the City's objectives for this assessment. Topics included:

- Specific documented or undocumented operations and/or maintenance issues
- Discuss current planning for equipment replacement or improvements

Task 2 – Assessment of Facilities

The purpose of this task was to conduct field inspections of the designated process facilities and rate the condition of various assets. The asset inspections were conducted on February 14, 2017 and February 15, 2017. The inspection excluded the recent improvement projects (influent pump stations, Headworks, dewatering equipment, and septage receiving station) as it is assumed these assets are in new condition. Also excluded were the processes that are not in use (equalization basin and DAFT). The process facilities inspected were as follows:

- RDS Distribution Box
- Oxidation Ditches (excluding structural given current rehabilitation project)
- Clarifier Distribution Box
- Secondary Clarifiers
- Chlorine Contact Basin
- Chlorination Building
- Outfall
- Reuse Membrane System and Building
- RAS/WAS Pump Station
- RAS Distribution Box
- Sludge Storage Tanks and Building
- Solids Building Common Facilities
- Sawdust Drying System
- Compost Building and Reactors
- Compost Curing Bays and Blower Room

- Odor Control System
- PLC Control System
- Plant Power Supply, Distribution, and Generator
- Electrical Building
- Operations Building

Inspection Forms

Inspection form templates were developed for the assessments. The inspection form templates include each asset type pertinent to the facility, a condition rating score, notes and photos. Inspection forms for each facility are provided in Appendix F. Each facility was evaluated on the following system assets:

- Civil and Site – roads, drainage, exterior lighting, landscaping, and fencing
- Architectural – roofs, doors, window, floors, paint system, and finishes
- Structural – building structures, process structures, concrete condition, structural steel condition, supports, and miscellaneous metals
- Power Distribution – main feed, transformers, switchgear, and transfer switches
- Electrical – MCCs, VFDs, major motors, conduit, wiring, and disconnects
- Instrumentation/Analyzers – field devices, control panels, level of instrumentation, primary elements, SCADA systems, and network communications.
- Process or Mechanical Equipment – air compressors, rotors, gear box, and blower
- Pumping Systems – pumps, motors, tanks, and associated valves
- Piping Valves – above ground not supplied as part of pumping systems
- HVAC – air handling equipment, make-up air units, heating equipment, ductwork, controls, and support equipment
- Odor Control – need and/or condition

Estimated Original Useful Life and Remaining Useful Life

The original useful life of equipment varies from utility to utility and is dependent on several factors such as environment, hours of operation, material, installation, maintenance frequency, and many others. The evaluation used recognized industry useful life estimate sources that are listed in Appendix F.

Based on the original useful life, the remaining life can be estimated. For example; if a pump was installed in 2000 and is estimated to provide service for 20 years then by default replacement should be planned for 2020 at 0 years remaining useful life. However, if upon a condition assessment, the pump is still providing service and is in good condition, then the replacement can be delayed.

Condition Rating

A condition rating is a subjective measure of the state of deterioration given to each utility. A basic rating was established based on “Best Professional Judgment,” which includes a number of factors including remaining percent of original life, overall description and condition, and the level of maintenance effort necessary to return the asset type to good working order. Performance and reliability is based on staff interviews. Review of operating logs and operating data is considered when available. A summary of the condition rating methodology is shown in Table 9-22 and outlined below.

Table 9-22: Condition Rating Methodology

Condition Rating	Description	Percent of Original Useful Life (OUL)	Maintenance Effort
0	Unknown		
1	New or Excellent Condition	100% OUL	Normal Preventive Maintenance
2	Minor Defects Only	75% OUL	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50% OUL	Normal Preventive Maintenance, Major Corrective Maintenance
4	Significant Deterioration	25% OUL	Rehabilitation, if possible
5	Virtually Unserviceable	<5% OUL	Replace

Condition Rating Methodology

- If equipment has surpassed its estimated original useful life (refer to Useful Life Table in Appendix F) then consider its condition.
- If the age of the asset exceeds its useful life, then follow this logic:
  - By default, it is rated a Condition Rating (CR) 4 (Poor)
  - If it shows severe deterioration, then maintain the CR4 (Poor)
  - Consider upgrading to a CR3 (Fair) if it appears to be in good condition, performs its function, and does not have an immediate need to repair or replace to meet industry standards.
  - Consider upgrading to a CR2 (Good) only if we have a report or an assessment that the asset is performing well and repair or replacement may be delayed beyond the 10 year horizon.
- If the age of the asset is within its original useful life, then follow this logic:
  - If equipment is a recent installation or has 90% or more estimated remaining useful life, then by default it is a CR1 (New)
  - If equipment has 50% or more remaining useful life and there is no indications of frequent repairs or physical deterioration, the rating should be a CR2 (Good)
  - If equipment has less than 50% remaining useful life and there are reports of frequent repairs or physical deterioration, then rating should be CR3 (Fair)
  - If equipment has less than 50% remaining useful life, findings of significant deterioration and reports indicating a need for rehabilitation, then the rating should be CR4 (Poor)
- Assign a condition rating in the column labeled CR for the lowest rated asset in Asset Type grouping.

Condition Assessment Summary

The assets and facilities included in this condition assessment were grouped together to ease the evaluation of the system. The results of the assessment are summarized in

Table 9-23. These results will be used in the alternatives analysis and recommendations for capital improvements.

During the interviews with the plant staff and in reviewing the draft Fiscal Years 2017-2022 Capital Improvement Program (dated March 6, 2017), previously identified plant improvements projects were discussed. These deficiencies are listed below:

- Oxidation Ditch Rotor Replacement – The existing brush aerators have been in operation since the plant start up in 1987. The plan is to replace one rotor per year for the next seven years. Rotor #8 was replaced in 2017.
- Oxidation Ditch 1 Rehabilitation – Inspection of the oxidation ditches identified the need to improve the structural integrity of the basins. This improvement will extend the useful life of the basins. Oxidation Ditch 2 repairs were constructed in the summer of 2017. Oxidation Ditch 1 is still in need of the structural rehabilitation.
- Sawdust Bays – As part of the biosolids compost process, sawdust is dried and mixed with the solids and recycled compost. The sawdust is stored in the curing bays for cover from rain. The sawdust should stay under cover in inclement weather otherwise it will become too wet and unusable. Additional storage bays are needed to provide covered storage of sawdust and adequate area for compost curing.
- Operations Building Remodel – The existing administration/operations building has underutilized space. A remodel of unused or unfinished areas will allow for City staff work stations and a staff meeting room.
- Roofing Replacement – The maintenance of roofs on the existing buildings has been deferred over the years. Many of the buildings require new gutters and soffits to collect and control water from the roofs. The roofs of the chlorination and compost buildings were replaced in 2017. The remaining roof improvements include the administration building and secondary building.

Table 9-23: Condition Rating and Estimated Remaing Life Summary

Facility/Process Name	In Service Date	Rehab Date	Items Replaced/Installed	Expected Original Useful Life, Years	Current Overall Condition Rating[1]	Percent of Original Useful Life	Estimated Remaining Life, Years	Comments
RDS Distribution Box	1986	N/A	N/A	60	2.3	67%	40.0	
Oxidation Ditch 1								
Structure	1986	N/A		35	4.4	14%	5.0	Condition based on Ox. Ditch Rehab project. Structural improvements planned for 2019/20.
Equipment	1986	2012	Rotor gear boxes replaced	25	2.3	67%	16.7	Rotor seals need replacement
Oxidation Ditch 2								
Structure	1986	2017	Structural improvements and re-surface	35	2.7	57%	20.0	Condition based on Ox. Ditch Rehab project
Equipment	1986	2012, 2017	Rotor gear boxes replaced, Rotor 8 replaced	25	2.3	67%	16.7	Rotor seals need replacement
Clarifier Distribution Box	1986	N/A	N/A	60	2.0	75%	45.0	
Secondary Clarifier 1								
Structure	1986	N/A	N/A	60	2.6	60%	36.0	
Equipment	1986	2013	Motor/drive assembly replaced	25		60%	15.0	
Secondary Clarifier 2								
Structure	1986	N/A	N/A	60	2.7	58%	34.5	
Equipment	1986	2013	Motor/drive assembly replaced	25		58%	14.4	
Secondary Clarifier 3								
Structure	1986	N/A	N/A	60	2.5	63%	37.5	
Equipment	1986	2013	Motor/drive assembly replaced	25		63%	15.6	
Secondary Clarifier 4								
Structure	2013	N/A	N/A	60	1.0	100%	60.0	
Equipment	2013	N/A	N/A	25		100%	25.0	Recommend flushing of upper gear box
Secondary Building Common Facilities	1986	2017	Hypochlorite generation system added	50	2.5	63%	31.3	Roof and gutter improvements scheduled for 2020/21
RAS/WAS Pump Station	1986	2015, 2016	RAS Pump 5 added, RAS Pump 3 replaced, WAS Pump 3 replaced	25	2.3	69%	17.2	Recommend upgrades to instruments, pipe supports, and pump inlet alignments
RAS Distribution Box	1986	N/A	N/A	60	2.3	67%	40.0	
Chlorine Contact Basin	1986	2015	New catwalk	60	2.0	75%	45.0	
Chlorination Building Common Facilities	1986	2017	Removal of chlorine gas system, Roof replaced	50	2.0	75%	37.5	
Sodium Bisulfite Dechlorination System	1986	2017	Dechlorination system replaced	15	1.2	95%	14.3	
Reclaimed and Reuse Water Pumps	1986	2008	Reuse pumps added	25	2.7	57%	14.3	
Outfall	1986	N/A	N/A	50	2.3	67%	33.3	
Odor Control System	2004	2017	Water piping improvements	12	2.8	54%	6.5	Biofilter media replacement scheduled for 2018/19
Reuse Membrane System and Building	2008	N/A	N/A	20	1.5	88%	17.5	Recommend pipe support improvements
Sludge Storage Tanks and Building	1986	N/A	N/A	50	2.5	63%	31.3	
Solids Building Common Facilities	1986	N/A	N/A	50	2.3	68%	33.8	Recommend repair of roof slab cracks
Sawdust Drying System	2009	2017	Air locks replaced	25	1.6	86%	21.5	
Compost Building and Reactors	1986	2017	Roof replaced	50	2.5	64%	31.8	Structural improvements recommended
Compost Curing Bays and Blower Room	2004	N/A	N/A	50	2.0	75%	37.5	
Plant Power Supply, Distribution, and Generator	1986	2008	Plant switchgear and standby generator replaced	30	1.3	94%	28.1	
Operations Building	1986	N/A	N/A	50	2.5	63%	31.3	Partial remodel scheduled for 2019/20. Roof and gutter improvements required.
PLC Control System	1986	N/A	N/A	15	3.0	50%	7.5	Recommend evaluation for replacement
Electrcial Building	2008	N/A	N/A	30	1.7	83%	25.0	

Note:[1] See appendix for facility/process inspection forms.

10. WASTEWATER TREATMENT PLANT IMPROVEMENT ALTERNATIVES

This section is the alternatives analysis of the wastewater plant improvements to meet the planning period conditions. The main concerns at the plant during the planning period involve secondary treatment (secondary clarifiers and oxidation ditches).

10.1 SECONDARY TREATMENT

The 2037 design maximum month wet weather flow (MMWWF) of 12.4-mgd exceeds the existing secondary clarifiers liquid process rated capacity of 9.1-mgd. This capacity limitation is based on a secondary clarifier hydraulic loading rating of 1,200-gpd/sf, per common industry standards. The capacity analysis is discussed in Section 9. Higher loading rates are likely possible, and are not unprecedented, but require stress testing and Oregon Department of Environmental Quality (DEQ) approved re-rating.

Peak instantaneous flows (PIF) to the plant typically occur only a few times per year, and are not sustained for more than a day. The secondary clarifiers are working well and have no history of failure or significant decline in effluent quality during peak flow events. Therefore, testing and re-rating the clarifiers for higher peak flows is appropriate. Table 10-1 compares the clarifier capacity at different hydraulic loading rates and the corresponding number of clarifiers required to meet the peak design flow. Note that this analysis only considers hydraulic loading rate; the solids loading rate requires separate considerations. Solids flux is used to describe the area required for solids settling. A preliminary solids flux analysis on the existing secondary clarifiers estimates a maximum mixed liquor suspended solids (MLSS) concentration of 2,700-mg/L at 32.6-mgd, the projected 2037 PIF.

Re-rating the secondary clarifiers to a peak hydraulic loading rate of 1,300-gpd/sf is very feasible and would increase the current process capacity to 9.9-mgd (MMWWF). Hydraulic loading rates as high as 1,650-gpd/sf are rare, but not unheard of in the industry. The higher loading rate should be explored given the limited PIF annual occurrences.

Table 10-1: Secondary Clarifier Capacity Based on Hydraulic Loading Rates

Loading Rate (gpd/sf)	Current Capacity MM / PIF (mgd)	Flow to Each Clarifier at PIF (mgd)	Number of Clarifiers Required for 2037 PIF 32.6 mgd
1,200	9.1 / 24	6.0	6
1,300	9.9 / 26	6.5	5
1,650	12.6 / 33	8.2	4

The oxidation ditches are currently undergoing structural rehabilitation to extend the useful life of the structures. Per the process capacity analysis, the oxidation ditches are limited by the oxygen delivery capability of the surface aerators at a MMWWF of 11.6-mgd. While the oxygen supply limitation could be overcome a number of ways, additional volume capacity is desired by the City to add redundancy and increase overall resiliency of the secondary process. To provide symmetry and basin redundancy, the secondary treatment expansion could be designed such that the new train has the same capacity as half of the existing secondary treatment system (4.6-mgd MMWWF). The capacity is control by the secondary clarifier hydraulic capacity at 9.1-mgd.

A secondary treatment technology screening workshop was held on April 24, 2017. At the meeting, a number of technologies were discussed as options for expansion. Slides and notes from the meeting are included in Appendix I. The following secondary expansion options were shortlisted for this alternatives evaluation:

- A third oxidation ditch
- A Sequencing Batch Reactor (SBR) in parallel to the existing plant
- A Moving Bed Biofilm Reactor (MBBR) in parallel to the existing plant

10.2 ALTERNATIVES

The 2037 influent design flows and loadings from Section 2 were converted to the influent characterization in Table 10-2. Industry standard wastewater fractions (see Section 9) were used to establish any missing parameters needed for inputs to the secondary treatment analysis model. The values in Table 10-2 are specific to the expansion train only, and are applied to all alternatives as equal to the capacity of one of existing oxidation ditches.

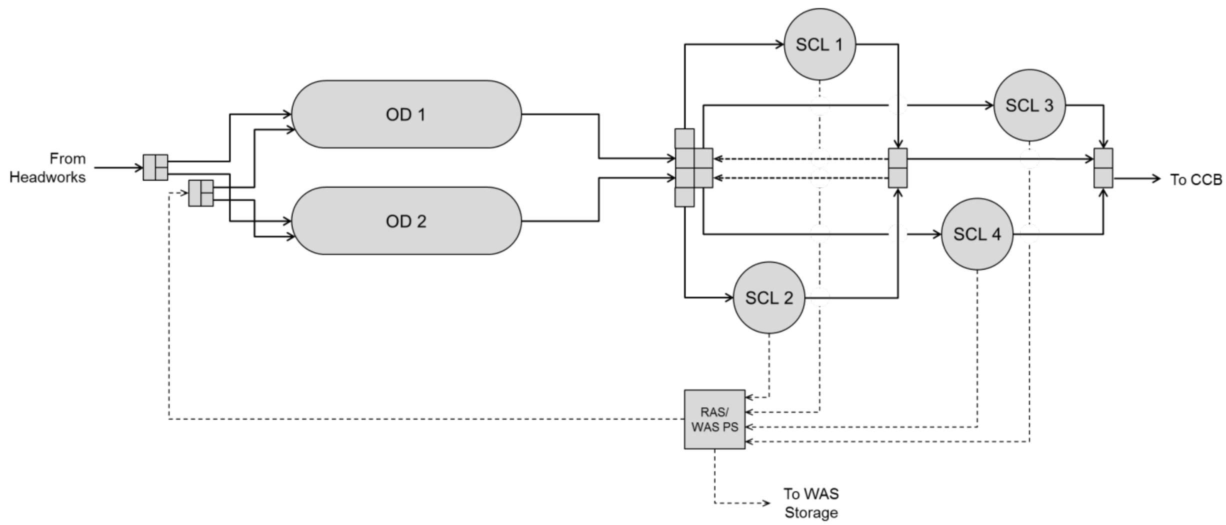
Table 10-2: Design Flows and Loading for Secondary Expansion

Parameter	Units	Average	Max. Month	Max. Day	Peak Instantaneous Flow
Flow	mgd	1.9	4.6	9.6	12.5
TSS	lb/d	3,199	5,440	10,707	-
BOD	lb/d	1,762	3,505	4,003	-
NH_4-N	lb/d	195	245	295	-
TSS	mg/L	204	137	134	-
VSS	mg/L	123	96	55	-
COD	mg/L	293	204	200	-
sCOD	mg/L	102	61	50	-
BOD	mg/L	113	89	50	-
sBOD	mg/L	34	18	10	-
TKN	mg/L	19	9.2	6.1	-
NH_4-N	mg/L	13	6.2	3.7	-
TP	mg/L	2.8	2.2	1.2	-
OP	mg/L	1.4	1.1	0.6	-

Note: NH_4-N = ammonium, VSS = volatile suspended solids, COD = chemical oxygen demand, sCOD = soluble COD, sBOD = soluble BOD, TKN = total Kjeldahl nitrogen, TP = total phosphorus, OP = othrophosphate

Figure 10-1 shows a schematic layout of the existing secondary treatment process for reference. All alternatives are designed for full nitrification and are assumed to have the same oxygen demand and air demand.

Figure 10-1: Schematic of Existing Secondary Treatment



Note: OD = oxidation ditch, SCL = secondary clarifier, CCB = chlorine contact basin, PS = pump station

10.2.1 Alternative 1: Oxidation Ditch

A third 2.0-MG oxidation ditch would increase the total basin volume by 50 percent. In this alternative the new oxidation ditch would be constructed with vertical walls, a 20-ft side water depth (SWD), and equipped with fine bubble diffusers and horizontal acting propeller mixers to allow air on/off or low dissolved oxygen (DO) operation. This would enable future denitrification, if required.

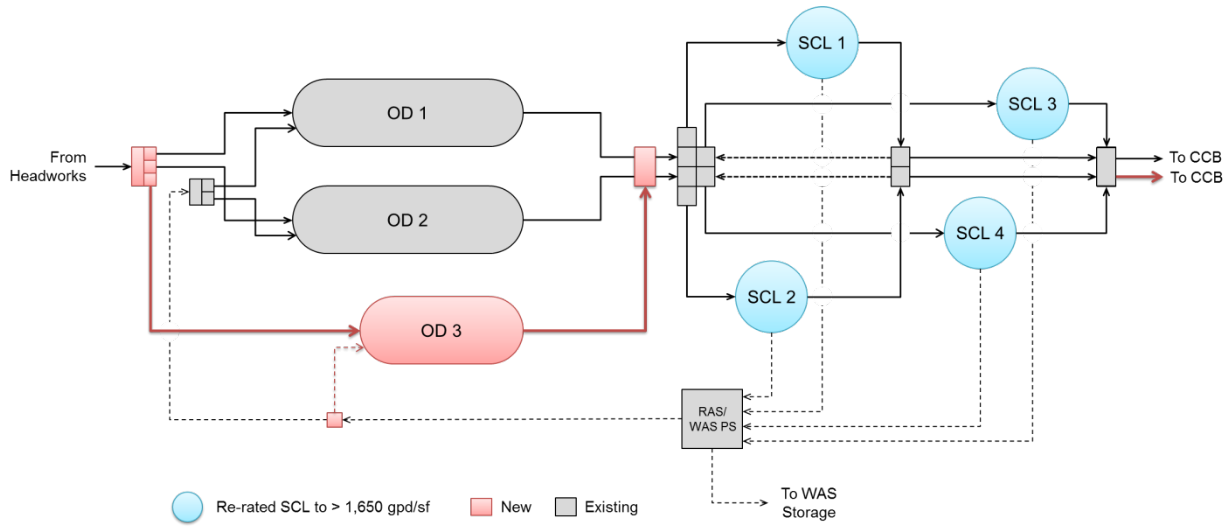
Three options were considered to increase the secondary clarifier capacity:

- 1A - Re-rate the existing secondary clarifiers to 1,650-gpd/sf (Figure 10-2)
- 1B - Re-rate the existing secondary clarifiers to 1,300-gpd/sf and add one secondary clarifier (Figure 10-3)
- 1C - Add two secondary clarifiers (Figure 10-4)

Alternative 1A

Alternative 1A, re-rating the secondary clarifiers to 1,650-gpd/sf, would be the lowest cost option since no additional secondary clarifiers are required. However, this alternative would require extensive testing. Modifications to flow distribution are required to integrate a third oxidation ditch. This includes a new three-way Raw, Degritted Sewage (RDS) split box and an oxidation ditch effluent mixed liquor (ML) junction box. To add hydraulic capacity, a parallel secondary effluent (SE) pipe between the Clarifier Distribution Box (CDB) and the Chlorine Contact Basins (CCB) will be required. The RAS distribution to the new oxidation ditch may be achieved through valve flow control or by expanding the RAS distribution box. The control valve option would be easier to implement and is proposed for this alternative.

Figure 10-2: Schematic of Oxidation Ditch Alternative 1A



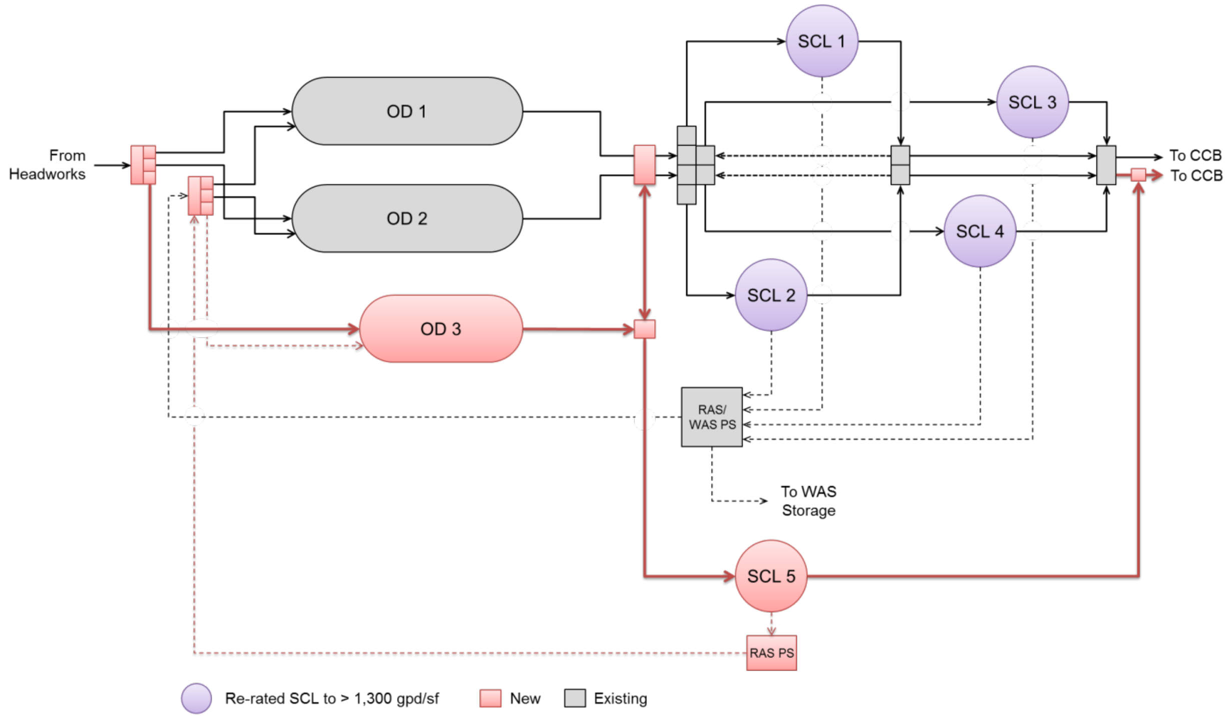
Note: OD = oxidation ditch, SCL = secondary clarifier, CCB = chlorine contact basin, PS = pump station

Alternative 1B

Alternative 1B requires the secondary clarifiers to be re-rated for 1,300-gpd/sf, which is perhaps more likely than Alternative 1A. The oxidation ditch integration requires the same modifications as in Alternative 1A, and also includes an additional junction box that directs ML from the new oxidation ditch to a new secondary clarifier. This new secondary clarifier may be dedicated to the new oxidation ditch, simplifying flow control, but would limit redundancy and operational flexibility. Alternatively, the flow distribution between the oxidation ditches and the new secondary clarifier can be designed such that ML flow from Oxidation Ditches 1 and 2 could also be sent to the new secondary clarifier.

The new secondary clarifier will also require a new RAS pump station. Since the new clarifier may receive an uneven amount of ML, the RAS from both the new and existing RAS pump stations will need to be combined in a new junction box before it can be split evenly between the three oxidation ditches (Figure 10-3). Since the process operates a single sludge system, the new pump station does not need to include additional WAS pumps. All WAS can be wasted from the existing RAS/WAS pump station located in the Secondary Building. Secondary effluent from the new secondary clarifier would connect to a new parallel SE pipe between the CDB and CCB.

Figure 10-3: Schematic of Oxidation Ditch Alternative 1B

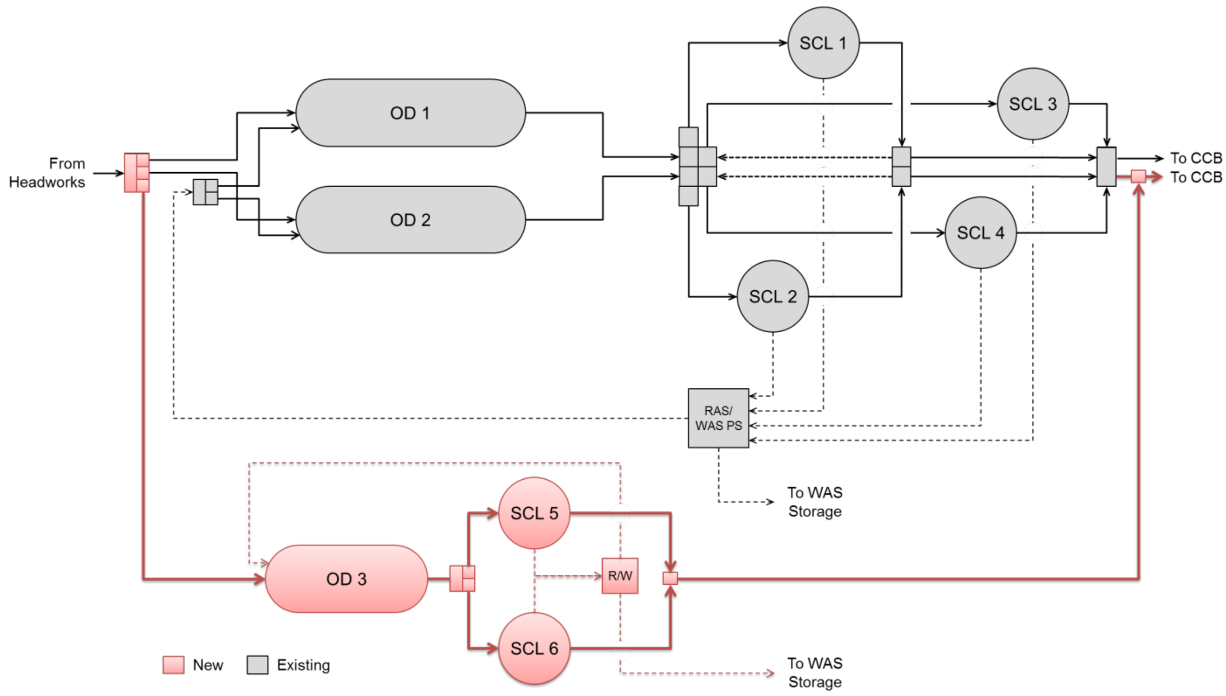


Note: OD = oxidation ditch, SCL = secondary clarifier, CCB = chlorine contact basin, PS = pump station

Alternative 1C

Alternative 1C adds one new oxidation ditch, two new secondary clarifiers, and a RAS/WAS pump station; effectively creating a parallel secondary treatment plant that operates independently from the existing (Figure 10-4). The biggest advantage of this alternative is that it leaves most of the existing secondary treatment process unmodified. RDS split box modification and CDB hydraulic improvements are required. This simplifies construction sequencing and adds flexibility as to the location of the new oxidation ditch and secondary clarifiers on the plant site.

Figure 10-4: Schematic of Oxidation Ditch Alternative 1C



Note: OD = oxidation ditch, SCL = secondary clarifier, CCB = chlorine contact basin, PS = pump station, R/W = RAS/WAS PS

Alternative 1 Summary

Alternative 1B adds a new oxidation ditch and a new secondary clarifier integrated into the existing plant. This alternative provides the best balance between additional secondary treatment capacity and operational flexibility. Re-rating the existing secondary clarifiers to a peak hydraulic load of 1,300-gpd/sf is very achievable given the historic performance. Alternative 1B will be carried forward for further analysis. The cost estimate will assume that the new oxidation ditch, clarifier, RAS pump station, and necessary yard piping and flow distribution modifications will be constructed at the same time. In practice, the additional oxidation ditch may be constructed first while deferring the new secondary clarifier to a future time based on effluent performance and need.

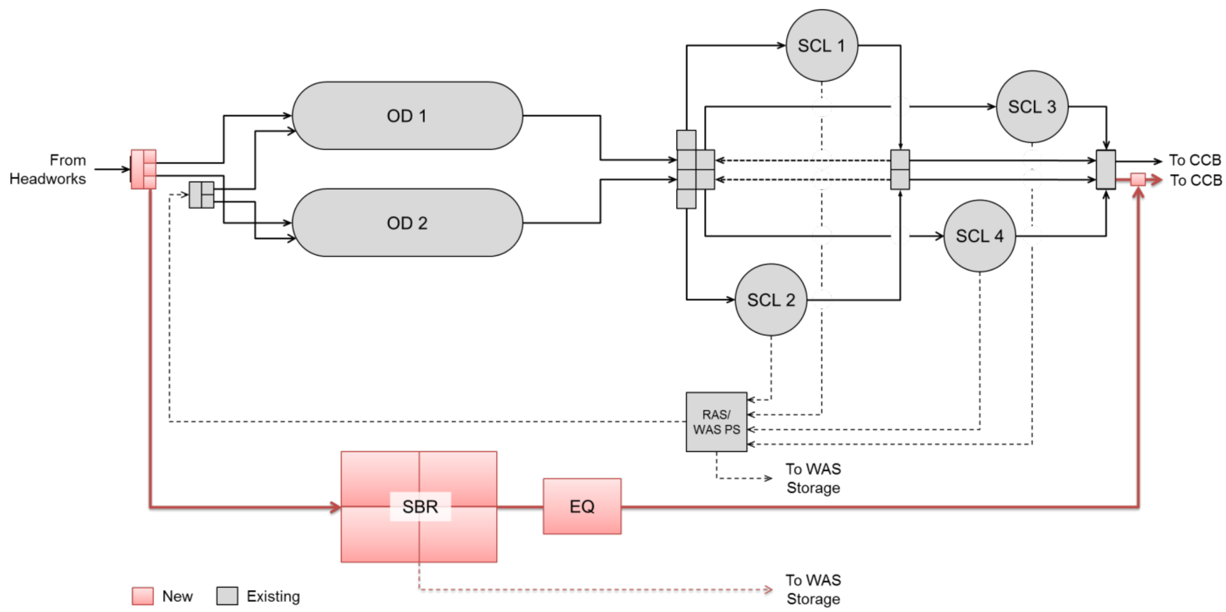
In summary, Alternative 1B has the following advantages and disadvantages:

- Advantages
  - Maintains one treatment technology and a single biological process system
  - Expansion can be phased
  - Future control/management of peak flows may eliminate need for the new secondary clarifier and associated RAS pump station
- Disadvantages
  - The addition of a fifth secondary clarifier is needed to meet 2037 design flow at 1,300-gpd/sf hydraulic loading rate
  - Challenging construction and construction sequencing for yard piping and new or modified flow distribution boxes

10.2.2 Alterative 2 – Sequencing Batch Reactor

Sequencing batch reactors (SBR) combine activated sludge and clarification into a single structure. In this alternative a SBR would operate in parallel and independent from the existing oxidation ditches. Modifications to the RDS flow split are required for adding the new treatment train. A flow control valve from the Headwork could also be used to regulate flow to the SBR. For comparison of alternatives, expansion of the RDS box will be used. The equalized SBR effluent would combine with the secondary clarifier effluent in or upstream of the CCBs. A schematic of the SBR alternative is in Figure 10-5.

Figure 10-5: Schematic of SBR Alternative 2



Note: OD = oxidation ditch, SCL = secondary clarifier, CCB = chlorine contact basin, PS = pump station, EQ = effluent equalization

There are many different ways the operational cycle can be controlled to provide aerobic, anoxic, and anaerobic conditions during the fill and reaction. There is always settling and decanting sequences. Most SBRs lower the water surface during the decant phase, but some are designed at a constant or near constant water surface level. Figure 10-6 shows a typical SBR cycle and Figure 10-7 is a photo of an SBR installation.

Figure 10-6: Illustration of Typical SBR Cycle

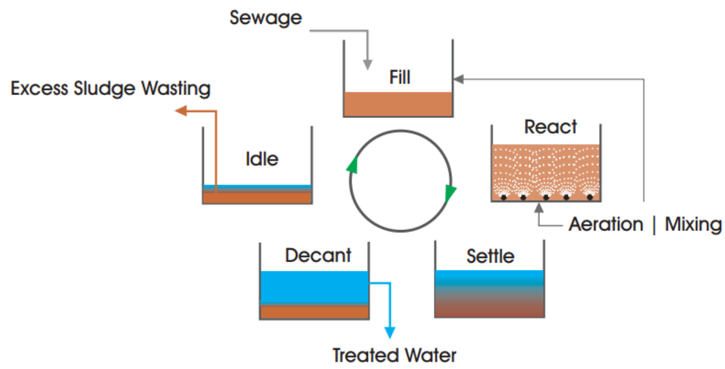


Figure 10-7: Example of SBR Installation

One other advantage the SBR offers is that it could be converted to granular activated sludge (GAS) at a later point to increase capacity and further improve effluent water quality. GAS is an emerging technology that is based on SBR technology.

This alternative requires a total tank volume of 4.0-MG. The tank volume is typically divided into individual cells for continuous operation. The number of individual cells would be subject to the final design and selected vendor. Depending on the decant water surface elevation, the SBR effluent may need to be pumped. If pumping is required, then the existing flow equalization basin can be used for SBR effluent (decant) equalization.

Alternative 2 Summary

The SBR alternative has the following advantages and disadvantages:

- Advantages:
  - Treatment and solids removal take place in the same tank (no need for additional secondary clarifiers and RAS/WAS pump station)
  - Construction can occur without impacts to existing plant operations
  - Separate biological system can be used for cross seeding
  - Fully automated system
- Disadvantages:
  - Parallel, independent treatment process requiring additional training
  - SBR decant requires equalization and may need to be pumped
  - No opportunity for phasing construction cost

10.2.3 Alternative 3 – Moving Bed Biofilm Reactor

The moving bed biofilm reactor (MBBR) is a biofilm process that relies on suspended carrier media like the example shown in Figure 10-8. Screens are employed to retain the media in the process basins (Figure 10-9). Different vendors offer different media products that vary in shape, specific area, and buoyancy. Unlike conventional activated sludge there is no suspended biomass and no return biomass. Therefore, the sole purpose solids retention step is to reduce the concentration of particulates in the effluent (typically from 100 – 200-mg/L to 5 – 20-mg/L TSS) depending on effluent requirements and influent composition. For MBBRs particulate capture can be achieved by conventional secondary clarifiers (minus the RAS) or commonly via dissolved air flotation, and also filtration. Alternatively, when lower retention rates are required, simple plate settlers or settling lagoons may be sufficient.

Integrated Fixed Film Activated Sludge, or IFAS, is the combination of attached growth biofilm and a typical suspended biomass. The IFAS process operates similarly to conventional activated sludge with secondary clarification and RAS and WAS streams. While this process would work for the City, it would also require additional secondary clarifiers and a new RAS pump station. As discussed above, the MBBR process adds little solids loading to the secondary clarifiers and is a lower capital cost than IFAS.

Figure 10-8: MBBR Media Photos

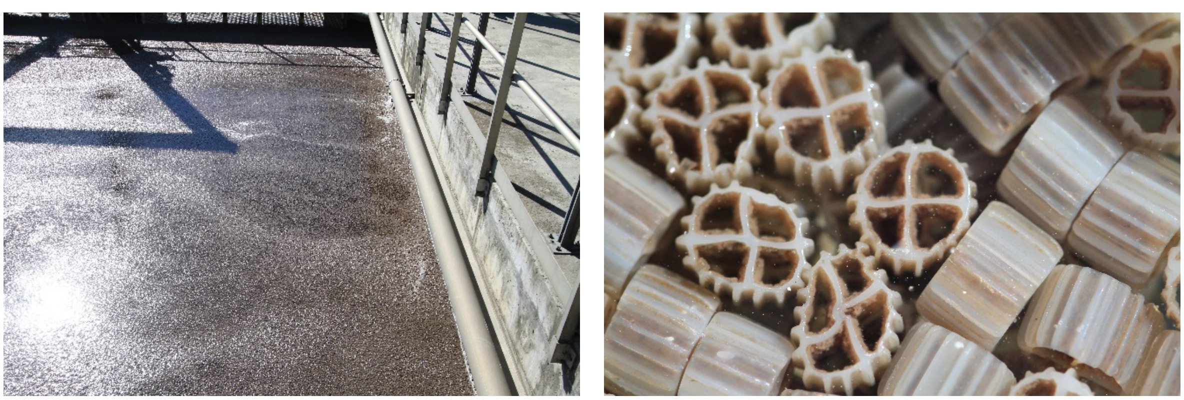


Figure 10-9: MBBR Screen Photos

The main advantage of the MBBR is the small footprint when compared to the other alternatives. Another advantage is overall lower capital cost. The process can also be expanded incrementally by increasing the media fill rate over time. This corresponds to the amount of media that occupies basin volume when the water is drained.

MBBR operation is simplified by the fact that it does not require maintaining a solids retention time (SRT). Also, because it utilizes medium coarse bubble aeration, diffuser maintenance as required for fine bubble diffusers is not needed. One disadvantage of the coarse bubble aeration is lower oxygen transfer efficiency and without primary clarification upstream, fine screening is required. The MBBR alternative will assume the existing Headworks 10-mm perforated plates would be replaced with smaller, 3-mm opening plates and a third mechanical screen would be added in place of the bypass bar screen to compensate for any lost hydraulic capacity due to the smaller openings.

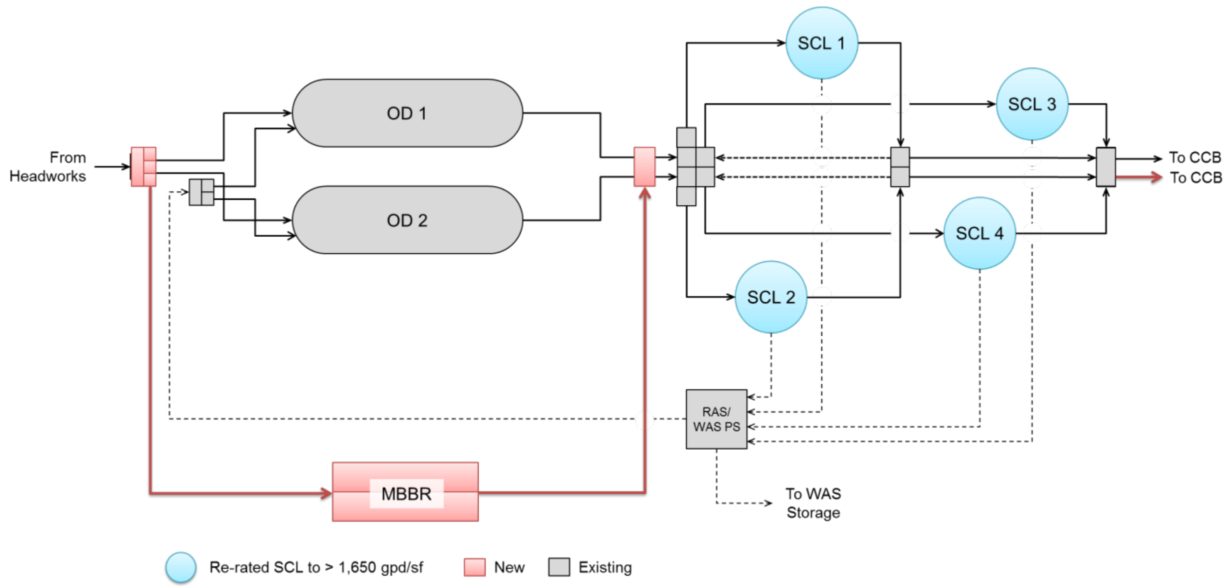
Two options were considered for the MBBR alternative:

- 3A - Re-rating the existing secondary clarifiers to 1,650-gpd/sf
- 3B - Re-rating the existing secondary clarifiers to 1,300-gpd/sf and diverting MBBR effluent in excess of this capacity to another solids retention unit process

Alternatives 3A and 3B

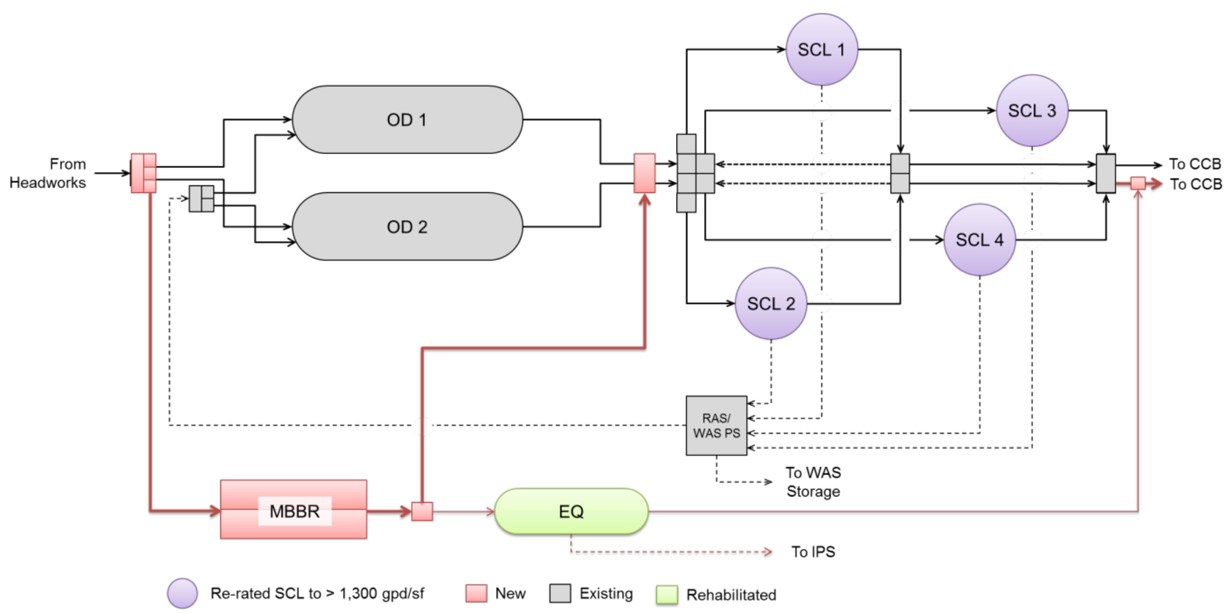
Alternative 3A (Figure 10-10) relies on re-rating the existing secondary clarifiers to a maximum hydraulic loading rate of 1,650-gpd/sf (similar to Alternative 1A). Alternative 3B (Figure 10-11) considers diverting MBBR effluent in excess of the re-rated 1,300-gpd/sf existing secondary clarifiers capacity to another solids retention unit process. Options for another solids retention process include a disc of cloth filter, plate settler, or the rehabilitating the existing equalization basin as a settling basin.

Figure 10-10: Schematic of MBBR Alternative 3A



Note: OD = oxidation ditch, SCL = secondary clarifier, CCB = chlorine contact basin, PS = pump station, R/W = RAS/WAS PS

Figure 10-11: Schematic of MBBR Alternative 3B



Note: OD = oxidation ditch, SCL = secondary clarifier, CCB = chlorine contact basin, PS = pump station, R/W = RAS/WAS PS, EQ = equalization basin

The required reactor volume of the MBBR is 0.5-MG. Alternative 3B is selected for further comparison with the use of existing equalization basin for storage or settling at peak flows. The equalization basin requires structural rehabilitation in order to be used as part of the treatment process. It has a volume of 1.0-MG; thus, cumulative peak flows of less than 1.0-MG could be drained back to the influent pump station. Alternatively, if solids concentration is acceptable, this flow could be directed by gravity to the CCBs.

Alternative 3B Summary

The MBBR Alternative 3B has the following advantages and disadvantages:

- Advantages:
  - Reduction of the secondary clarifier solids loading rate (higher hydraulic capacity possible)
  - Biomass that cannot wash out
  - No SRT and no diffuser maintenance
  - Simple to operate
  - Smallest footprint
  - Phasing opportunities (media fill, equalization basin rehabilitation)
- Disadvantages:
  - Parallel, independent treatment process requiring additional training
  - Different technology (new to plant staff)
  - Requires fine screening

10.3 ALTERNATIVE COMPARISON

In this section the three alternatives for secondary treatment expansion are compared. Table 10-3 lists the unit process requirements and major components for each alternative. All three alternatives have the approximately the same oxygen demand for the biological process. The airflow capacity is higher for the MBBR process given the need for media mixing and screen sparge/cleaning air. As mentioned above, each alternative includes specific new components (e.g., basins, equipment) and modifications (flow splitting, piping and structure tie-ins).

Table 10-3: Unit Process Requirements by Alternative

Parameter	Unit	Alt. 1B Oxidation Ditch	Alt. 2 SBR	Alt. 3B MBBR	Comment
Fine Screening Upgrade					
Type	-	NC	NC	Perforated Plate Upgrade	Replace bypass bar screen with fine screen
Opening	mm	NC	NC	3	Replace existing screen plates with finer opening
Peak Hydraulic Capacity	mgd	NC	NC	NC	Headworks to pass design PIF of 46 mgd
Secondary Reactor Tanks					
Type	-	Oxidation Ditch	SBR	MBBR	
Total Volume	MG	2.0	4.0	0.5	
Side Water Depth	ft	20	21	20	
Blower Building					
Building Foot Print	sf	250	250	250	
Number of Blowers	-	3	3	3	
Type	-	fine bubble	fine bubble	medium bubble	
Design Flow Rate	scfm	1,500	1,500	2,500	3.0 lb O_2/scfm
Peak Flow Rate	scfm	3,000	3,000	5,000	3.0 lb O_2/scfm
Total Firm HP	HP	200	200	200	18 scfm/HP
Average HP	HP	75	75	75	
Secondary Clarifier Expansion					
Number of Clarifiers	-	1	0	0	Match existing design features
Diameter	ft	80	-	-	
Side Water Depth	ft	16	-	-	
RAS Pump Station					
Building Foot Print	sf	600	-	-	
Number of RAS Pumps	-	2	-	-	
Design RAS Rate	%	50	-	-	
Firm Capacity	mgd	4.8	-	-	
Equalization Basin Rehab					
Structural Improvements	-	NC	NC	1	Use as settling basin at peak flows
Other					
RDS Split Box Expansion	-	1	1	1	Expand to 3-way split
RAS Split Box Expansion	-	1	-	-	Expand to 3-way split
ML/MBBR Eff. Control Box	-	1	-	1	Flow control box
ML/MBBR Eff. Junction Box	-	1	-	1	Flow junction box prior to secondary clarifiers
Effluent Equalization	-	-	1	-	
SE Junction Box	-	1	1	1	Effluent control and/or integration box
Parallel SE Pipe from CDB to CCB	-	1	1	1	

Note: NC = no change to existing parameter

10.3.1 Alternatives Constructability Comparison

The alternatives differ significantly with regard to constructability. Alternative 2 SBR could be constructed with minimal impact on the existing plant operation as it functions as a fully independent parallel train. The required interconnections are limited to flow split downstream of the Headworks and a SE connection into the CCBs.

Alternative 1B oxidation ditch requires multiple ties-in to the existing process: RDS distribution, RAS, ML and SE piping. This will require multiple process/system shutdown and complex yard piping. If constructed in a single phase, the impact on operations would be significant. There are however opportunities to construct in phases. The fifth secondary clarifier for instance is not needed at the same time as the new oxidation ditch.

Alterative 3B would also function as an independent parallel process and the interconnections are limited to RDS connection and a new pipe from the equalization basin to the CCB. Under normal operation, the MBBR effluent flow could utilize an existing connection to the CDB for split to the existing secondary clarifiers.

10.3.2 Alternatives Cost Comparison

Capital costs developed for the alternative analysis are Class 5 estimates as defined by the Association for the Advancement of Cost Engineering (AACE). Actual construction costs may differ from the estimates presented, depending on specific design requirements and the economic climate at the time a project is bid. An AACE Class 5 estimate is normally expected to be within -50 and +100 percent of the actual construction cost. As a result, the final project costs will vary from the estimated presented in this document. The range of accuracy for a Class 5 cost estimate is broad, but these are typical levels of accuracy for planning work and they apply to all alternatives so that the relative estimated costs of the alternatives are comparable and can be used for decision-making. It is important to communicate this level of accuracy to policy- and decision-makers.

Capital costs for each component of an alternative were developed as separate probable cost opinions. The components were added in combinations to create the three complete cost alternatives. Capital costs are outlined by division using Construction Specifications Institute (CSI) organization. Line item estimates (e.g., quantity and unit costs) are prepared for key cost items such as concrete, earthwork, structures, process piping, and equipment as detailed in each cost estimate worksheet included in Appendix I. The total estimated probable project capital costs are summarized in Table 10-4.

Table 10-4: Alternatives Cost Summary

Parameter	Alt. 1B Oxidation Ditch ($Million)	Alt. 2 SBR ($Million)	Alt. 3B MBBR ($Million)
Secondary Clarifier Rerating	0.06	0	0.06
Fine Screening Upgrade	0	0	0.96
Reactor Process	8.89	19.27	7.91
Blower Building	2.95	2.95	2.95
Clarifier and RAS Pump Station	7.79	0	0
Equalization Basin Rehab	0	0	0.98
Total	**19.69**	**22.22**	**12.86**

Note: Costs include markups of 5% mobilization, bonds, and insurance; 15% contractor's overhead and profile; 25% miscellaneous items and contingencies, 10% design engineering, 8% engineering services during construction, 5% construction management and inspection, and 5% other indirect costs.

The oxidation ditch and MBBR alternatives all identified sub-options linked to the existing secondary clarifier capacity. The sub-option selected for further analysis assumed the existing secondary clarifiers can effectively be re-rated to a hydraulic loading rate of 1,300-gpd/sf. If the re-rating determines that the existing clarifier capacity can be increased to 1,650-gpd/sf, then Alternative 1B and Alternative 3B cost estimates should be modified.

As mentioned in Section 10.2.1, the secondary clarifier and RAS Pump Station are needed by 2037 for Alternative 1B at a hydraulic loading rate of 1,300-gpd/sf. If the improvements are phased, the upfront project cost for the Alternative 1B improvements would be approximately $11.8M making it the lowest cost of the three alternatives.

MBBR Additional Considerations

Given that Alternative 3B MBBR is the lowest cost option, additional considerations were taken to fully evaluate the operations and maintenance associated with the technology. The City plant staff visited two MBBR/IFAS facilities: Williams Monaco Wastewater Treatment Plant (WWTP) in South Adams County, CO and Crow Creek WWTP in Cheyenne, WY. The City toured the plants and spoke with operators from these facilities to get first-hand information on how the system operates, process controls, and typical maintenance items/concerns. Overall, the City staff found the site visits very informative and it gave them a better understanding of the technology. The consensus was that the MBBR system was more difficult to operate than the IFAS process, and that both WWTP exhibited poor settling effluent solids. Both plants discussed converting the MBBR to IFAS process; which as discussed above in Section 10.2.3, IFAS is not cost advantageous for the City. The biggest concern for the City is the uncertainty of the impact of the MBBR solids on the City's current compost process. The site visit experience was used to inform the MBBR ranking selection below.

10.3.3 Alternatives Ranking

In addition to the capital cost, additional factors are used to determine the most overall favorable alternative. Additional factors include constructability, phasing, operation and maintenance (O&M) effort, process familiarity with plant staff, and ease of operation. Table 10-5 lists the general definition and ranking of each alternative in a number of parameters. Each factor is ranked on a scale of 0 to 5, with 5 being the most favorable and 0 the least favorable. The highest total ranking value identifies the most favorable alternative based on the listed parameters. At this time, each parameter is weighted equally. The results favor the Alternative 1B oxidation ditch expansion. Additionally, if the improvements are phased, it would also be initially the lowest cost alternative.

Table 10-5: Alternatives Ranking

Parameter	Description	Alt. 1B Oxidation Ditch	Alt. 2 SBR	Alt. 3B MBBR
Capital Cost	Relative cost comparison that takes into account order of magnitude capital expenses	3	2	5
Constructability	Complexity related to physical improvements and ability to maintain plant operations during construction	1	5	3
Phasing Opportunity	Can be phased to provide incremental levels of treatment based on need and from a cash flow perspective	4	0	3
O&M	Relative cost comparison that takes into account operational expenses; including labor, power, and chemical costs.	3	2	1
Staff Process Familiarity	Use of current or new/advanced specific treatment approach	5	3	1
Ease of Operation	Relates to the amount of long-term operational complexity and attention the process requires. Allows systems to be offline for maintenance.	5	3	3
	Total	**21**	**15**	**16**

Note: Parameters ranked on a scale of 0 to 5, with 5 being the most favorable and 0 the least. The highest total value is most favorable.

11. RECOMMENDED WASTEWATER TREATMENT PLANT IMPROVEMENTS

This section provides details and phasing information on the recommended wastewater treatment plant (WWTP) improvements. Projects identified in Section 9 and Section 10 are phased based on conditions of the existing facilities, capacity, and redundancy needs. The projects are discussed below in order of highest priority to lowest priority.

11.1 PRIORITY 1 IMPROVEMENTS

Priority 1 improvements are comprised of existing deficiencies that are critical needs, as well as those that were previously identified by City staff in the draft Fiscal Years 2017-2022 Capital Improvement Program. These projects include replacement of old equipment, rehabilitation of existing structures, and process improvements. Hydraulic improvements and the Secondary Clarifier re-rating study were identified as requirements for treating peak flows. It is anticipated that these projects would be implemented within next six years.

11.1.1 Oxidation Ditch Rotor Replacement

Each oxidation ditch has four rotor aerators that provide oxygen for the biological treatment in the oxidation ditches. The existing rotors have been in operation since the WWTP start-up in 1987. Given the age and condition of the equipment, it is recommended that each rotor be replaced in order of greatest need. The rotors are inspected annually to monitoring condition and conduct routine maintenance. The plan is to replace one rotor per year for the next seven years. Rotor #8 was replaced in 2017.

11.1.2 Oxidation Ditch 1 Rehabilitation

Inspection of the oxidation ditches identified the need to improve the structural integrity of the basins. Subgrade infill and shotcrete additions are needed to address cracking and further deterioration of the structure. This improvement project extends the useful life of the basins. Oxidation Ditch 2 repairs were completed in the summer of 2017. Oxidation Ditch 1 is still in need of structural rehabilitation.

11.1.3 Sawdust Bays

As part of the biosolids compost process, sawdust is dried and mixed with the biosolids and recycled compost prior to the reactors. The sawdust needs to be stored undercover for protection from weather elements, otherwise it can become too wet and unusable. The sawdust is currently stored in the compost curing bays, limiting the availability of these bays to provide capacity for the compost process. Additional storage bays are needed to provide covered storage of sawdust and adequate area for compost curing.

11.1.4 Operations Building Remodel

The existing administration/operations building has underutilized space. A remodel of unused and unfinished areas will allow for City staff work stations and a staff meeting room.

11.1.5 Roofing Replacement

The maintenance of roofs on the existing buildings has been deferred over the years. Many of the buildings require new gutters and soffits to collect and control water from the roofs. The roofs of the chlorination and compost buildings were replaced in 2017. The remaining roof improvements include the administration building and secondary building.

11.1.6 WWTP Hydraulic Improvements

The hydraulic analysis in Section 9 identified process elements that contribute to hydraulic limitations within the WWTP. This project would address a number of hydraulic restrictions at peak conditions. The following hydraulic improvements were identified as Priority 1 items:

- At peak flow conditions, the Clarifier Distribution Box (CDB) has hydraulic limitations. The restrictions are due to the elevation of the weirs in Secondary Clarifiers 1 and 2 and small size of the mixed liquor flow split weirs. Modifications to the CDB are required in order to treat more flow through the process.
- The final effluent weir located at the Reclaim and Reuse pump channel and the Chlorine Contact Basins (CCBs) effluent weirs provide significant headloss at high flows due to the weir length. Modifications to the weir elevation, length or used of an adjustable weir would decrease the headloss of the disinfection process. Review of water elevation requirements for the vertical turbine pumps and the volume required for chlorine contact should be conducted prior to any modifications.
- The effluent piping from the CDB to the CCBs can limit the capacity of Secondary Clarifiers 3 and 4 at high flows. Increasing the size of the pipe or adding an additional pipe would reduce friction losses at high flows. The additional pipe should also be designed to accept flow from future expansion of the secondary treatment process. An additional chlorine injection location will be required to ensure proper dosing to both secondary effluent pipes.

11.1.7 Secondary Clarifier Re-rating

The capacity of the secondary clarifiers is currently confined by common industry standards to a hydraulic loading rate of 1,200-gpd/sf. Higher loading rates are likely possible, and are not unprecedented, but require stress testing and Oregon Department of Environmental Quality (DEQ) approved re-rating.

Peak instantaneous flows (PIF) to the plant typically occur only a few times per year, and are not sustained for more than a day. The secondary clarifiers are working well and have no history of failure or significant decline in effluent quality during peak flow events. Therefore, testing and re-rating the clarifiers for higher peak flows is appropriate. The results of the study should be used to determine the capacity of the secondary clarifiers, understand future expansion timing, as well as identify potential improvements to the current system. The timing of Secondary Clarifier 5 is currently based on the likelihood that a higher loading rate will be accepted as sufficient treatment for infrequent peak flows.

11.2 PRIORITY 2 IMPROVEMENTS

The oxidation ditch and chlorine contact expansion projects are identified as Priority 2 improvements to be implemented following Priority 1 projects. Addressing the hydraulic limitations downstream of the oxidation ditches is important to providing capacity to the secondary process.

11.2.1 Oxidation Ditch Expansion

The existing oxidation ditches have sufficient capacity to treat the projected flows and loadings for the next twelve years. However, even with structural improvements, the lack of redundancy in the process qualifies this project as a greater need for the WWTP than just for capacity requirements. The oxidation ditch expansion project includes a new Raw, Degritted, Sewage (RDS) split box, a reactor basin, a blower building, new return activated sludge (RAS) split box, and associated piping. The oxidation ditch expansion will also impact the solids loading on the clarifiers and should be reviewed during the design of the oxidation ditch.

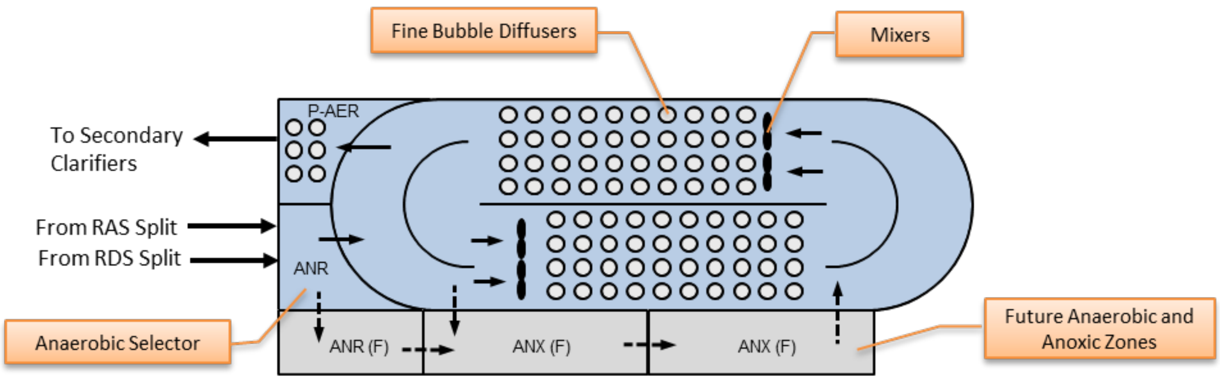
Oxidation Ditch

The intent is that the new and old oxidation ditches will be operated with a single biology. That is, the mixed liquor suspended solids (MLSS) from all three ditches will be collected at a single point (new RAS distribution box) and redistributed back to all ditches. This means that the design parameters for solids retention time (SRT) and MLSS are the same for the new and existing oxidation ditches.

It is assumed that the new oxidation ditch will have a total volume of 2.0 MG with a side water depth of 20 ft, width of 60 ft and length of 235 ft. The new oxidation ditch will have a racetrack layout with straight vertical wall construction. RDS flow to the oxidation ditches will be controlled at the new influent split box to equally split the flow between the three treatment trains. RDS and RAS will initially pass through an anaerobic zone before entering the oxidation ditch racetrack. Upon exiting the racetrack, the mixed liquor is aerated in the post aeration zone to oxidize residual ammonia and raise the dissolved oxygen (DO) during air off cycles. The anaerobic and post-aerobic zones are optional, however for this evaluation it is assumed they will be included as it provides flexibility for operating in simultaneous nitrification and denitrification (SNDN). A schematic layout of the proposed oxidation ditch expansion is provided in Figure 11-1.

Oxygen supply will be provided through low pressure air and fine bubble diffusion using membrane diffusers. The aeration system control will be designed to operate in air on/off mode when conditions permit, to maximize nitrogen removal. This minimizes energy demand by oxygen recovery and also minimizes alkalinity consumption. Oxygen reduction potential (ORP) probes will be used to monitor the air on/off cycles and DO probes will be used to control the air supply.

Figure 11-1: Proposed Oxidation Ditch Expansion Layout



Note: Figure not to scale. ANR = anaerobic zone, (F) = future, ANX = anoxic zone, P-AER = post-aeration zone.

If phosphorus and nitrogen removal is required in the future, additional anaerobic and anoxic zones may be added along the outside of the new oxidation ditch. The existing oxidation ditches would require additional modifications to allow phosphorus removal. Alternatively, chemical phosphorus removal could be used for permit compliance. Biological phosphorus removal may provide additional value by increasing the bio-available phosphorus in the compost.

To monitor process performance, effluent quality, and control aeration, the new oxidation ditch will be equipped with online analytical instrumentation for DO, ORP, pH, ammonia (NH_4-N), nitrite (NO_2-N), and total suspended solids (TSS). Phosphate (PO_4-P) and nitrate (NO_3-N) analyzer while useful are not required in the absence of nutrient limits. Conduit space for power supply and signal wires should be provided to allow easy installation of such instrumentation in the future.

Blower Building

The blower building will house the low pressure air (LPA) blowers that supply air to the new oxidation ditch. The new blower building will be located at the front end of the new oxidation ditch. This minimizes LPA pipe length and allows for a symmetrical layout of the air piping. Blower number and type should be developed during the detailed design.

11.2.2 Chlorine Contact Expansion

The existing CCBs are limited at peak day and peak instantaneous flows by the reduction in hydraulic retention time. Since Oregon has not adopted its own rules, the 10 State Standards and the Washington Criteria for Sewage Works (Orange Book) are used in Section 9 to evaluate the process capacity. Following these guidelines, additional CCB volume is required within the next six to ten years. Short-term, high-rate disinfection could be used to postpone the expansion, if the sodium hypochlorite system can accommodate the additional demand.

It is assumed the new CCB will be located to the southeast of the existing basins and sized to match the volume of the existing basins. The existing basins are approximately 134,500 gallons each. A flow split structure would be required to provide split to the additional basin.

11.2.3 PLC Control System Replacement Evaluation

The plant is controlled by a single Siemens Simatic 505 Programmable Logic Control (PLC) and uses Wonderware InTouch as the operator interface. The current PLC and human-machine interface (HMI) system at the WWTP was installed in 1998. The Simatic 505 is a "mature" product line and it is likely that replacement parts will become increasingly more difficult to obtain from the manufacturer. The condition assessment review recommended a study be conducted to provide a thorough review and evaluate if the system should be replaced.

11.3 PRIORITY 3 IMPROVEMENTS

Priority 3 projects are identified as future improvements to address the least urgent needs within the planning horizon. The Secondary Clarifier 5 expansion is currently in this category; however, the results of the secondary clarifier re-rating study should be used to update the implementation planning of this improvement.

11.3.1 Secondary Clarifier 5

The results of the secondary clarifier re-rating evaluation will provide direction on the timing required for the additional clarifier. The current phasing assumes that the re-rating will allow a higher peak hydraulic loading rate and postpone the expansion. As mentioned above, the oxidation ditch expansion will impact the solids loading on the clarifiers and should be reviewed during the design of the oxidation ditches.

Adding a secondary clarifier proposes a few complexities in integrating with the existing four clarifiers. It is anticipated that the hydraulic improvements between the CDB and CCB will include the installation of an additional pipe between the two structures. The new secondary effluent pipe will serve as a location to combine flows upstream of the CCB. Modifications to the oxidation ditch mixed liquor flow control and split are required to allow flow from both the new and old oxidation ditches to feed the new secondary clarifier. For cost estimating, it is assumed that the additional secondary clarifier would be sized similarly to the existing clarifiers to provide symmetry, however the details of the clarifier should be reviewed during the detailed design.

11.3.2 Equalization Basin Rehabilitation

It has been well documented in previous reports and condition assessments that the equalization basin is in poor condition. With known leaks and other structural issues, the basin is only used to manage extreme peak flow events. Even while in poor condition, the basin provides flexibility and security during the winter season. The hydraulic improvements and the oxidation ditch expansion should alleviate concerns during peak flows. However, it is recommended that the equalization basin be rehabilitated to continue to serve as an asset for flexibility to WWTP staff.

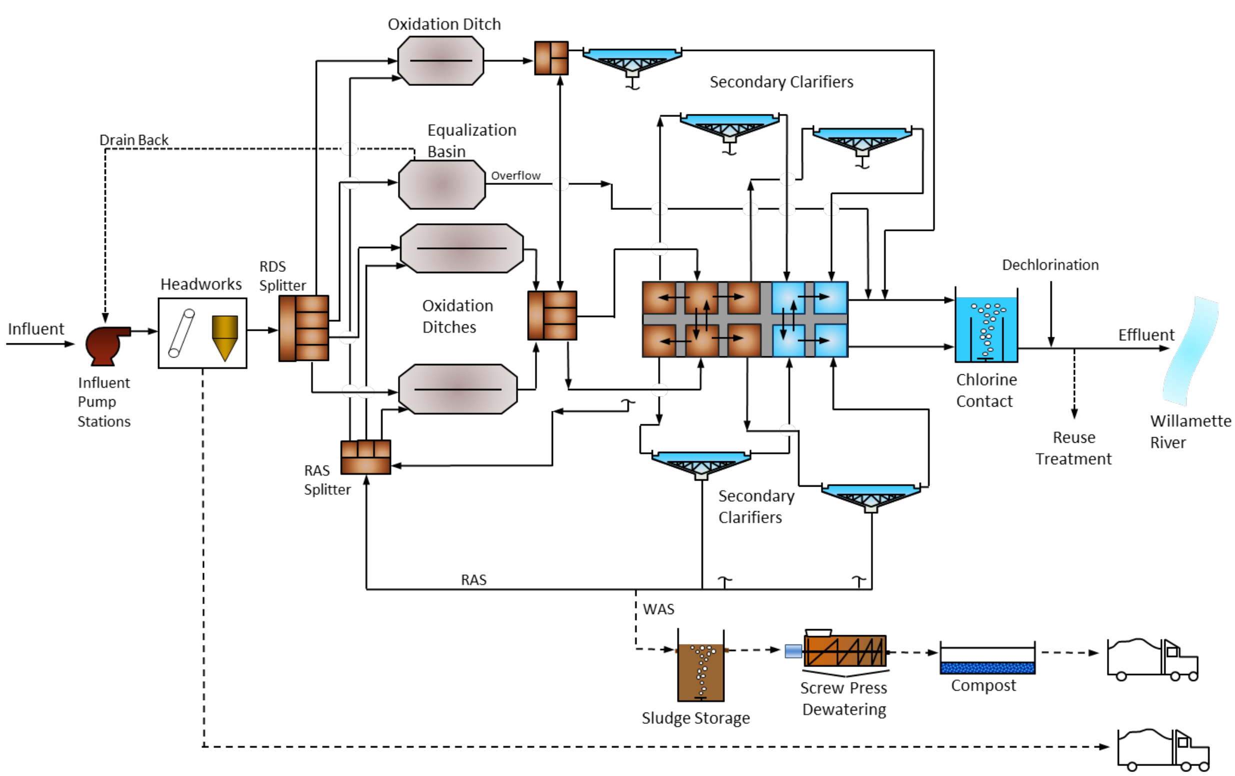
11.4 SUMMARY

The phasing of project improvements provides a roadmap for updating and expanding the existing WWTP for current and future conditions. This plan outlines a number of projects required for the 2037 planning horizon. A summary of the project prioritization is listed in Table 11-1. This outline will be expanded with preliminary costs to develop the Capital Improvements Plan (CIP) in Section 12. The future proposed process flow schematic is presented in Figure 11-2. A preliminary site layout of all the improvements is provided in Drawing C-01 included in Appendix I.

Table 11-1: Project Prioritization

ID#	Item	Primary Purpose
Priority 1 Improvements		
Wastewater Treatment Plant		
T1.a	Oxidation Ditch Rotor Replacement	Condition
T1.b	Sawdust Bays	Capacity
T1.c	Operations Remodel Project	Condition
T1.d	Oxidation Ditch 1 Rehabiltation	Capacity/Condition
T1.e	Roofing Replacement at the WWTP	Condition
T1.f	WWTP Hydraulic Improvements	Capacity
T1.g	Secondary Clarifier Rerating Study	Capacity
Priority 2 Improvements		
Wastewater Treatment Plant		
T2.a	Oxidation Ditch Expansion	Capacity/Redundancy
T2.b	Chlorine Contact Expansion	Capacity
T2.c	PLC Control System Replacement Evalution	Condition
Priority 3 Improvements		
Wastewater Treatment Plant		
T3.a	Secondary Clarifier 5	Capacity
T3.b	Equalization Basin Rehabilitation	Capacity/Condition

Figure 11-2: Proposed Newberg WWTP Process Schematic



See Note 1

12. CAPITAL IMPROVEMENT PLAN

12.1 BASIS FOR ESTIMATE OF PROBABLE COST

Capital costs developed for the recommended improvements are Class 5 estimates as defined by the Association for the Advancement of Cost Engineering (AACE). Actual construction costs may differ from the estimates presented, depending on specific design requirements and the economic climate at the time a project is bid. An AACE Class 5 estimate is normally expected to be within -50 and +100 percent of the actual construction cost. As a result, the final project costs will vary from the estimated presented in this document. The range of accuracy for a Class 5 cost estimate is broad, but these are typical levels of accuracy for planning work and they apply to all alternatives so that the relative estimated costs of the alternatives are comparable and can be used for decision-making. It is important to communicate this level of accuracy to policy- and decision-makers.

The costs of electrical, instrumentation and control, general site work, and installation are estimated as percentages of the base construction subtotal per unit process improvement. The percentages differ per the extent of the improvements based on experience and knowledge of the costs of these items on recent similar WWTP upgrade and expansion projects. Equipment pricing from manufactures of the large equipment items are also used to develop the estimates.

Some of the costs of the Priority 1 improvements were taken from the Draft Fiscal Years 2017-2022 CIP dated March 6, 2017. The costs of these projects were not updated as part of this effort.

The total estimated probable project costs include contractor markup and profit and contingences. Overall project costs include total construction costs, but also an additional markup for costs of engineering design, engineering during construction, construction management and inspection, and other indirect costs as presented in Table 12-1. For the collection system projects, contractor's overhead and profit are worked into the base construction cost and the other indirect costs are identified and included, where required, as a specific line item.

Table 12-1: Illustration of Cost Estimating Procedure

Parameter	Example
Base Construction Cost (A)	$1,000
Mobilization, Bonds, and Insurance (5% of A)	$50
Contractor's Overhead and Profit (15% of A)	$150
Subtotal (B)	**$1,200**
Contingency (25% of B)	$300
Construction Subtotal (C)	**$1,500**
Engineering & CMS (23% of C)	$345
Other Indirect Costs (5% of C)	$75
Total Estimated Probable Project Cost	***$1,920***

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

12.2 SUMMARY OF COSTS (20-YEAR CIP)

The cost summary of the projects as prioritized in Sections 6, 8, and 11 are listed in Table 12-2 (Capital Improvement Plan) on the following page. The percent SDC eligibility factored in the existing peak flow, projected 2037 peak flow, and projected buildout peak flow. The amount of capacity that can be utilized for future connections up to the projected 20-year planning period is used as the percentage for SDC eligibility. Priority 1 projects are the short-term projects to be completed in the next 5 years. Costs shown are planning-level estimates and can vary depending on market conditions; they shall be updated as the project is further refined in the pre-design and design phases. Individual project sheets for Priority 1 projects; including project description, location map, and cost estimate; are included in Appendix F. Priorities are set for today and will be re-evaluated when there is a need for re-assessment. The CIP is based on modeling data that was available during the completion of this master plan. When projects are carried forward, the model, data, assumptions, etc., should be re-evaluated to make any necessary adjustments to the basis of the project.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

See Note 1

Table 12-2: Summary of Costs (20-Year CIP)

ID#	Item	Primary Purpose	Total Estimated Cost (2018)	SDC Growth Apportionment %	SDC Growth Apportionment Cost	City's Estimated Portion
Priority 1 Improvements						
Wastewater Collection System						
C1.a	Hess Creek Phase 1 - CIPP	Capacity	$ 1,000,000	2%	$ 20,000	$ 980,000
C1.b	Hess Creek Phase 2 - Parallel Gravity Line	Capacity	$ 6,649,000	2%	$ 131,000	$ 6,518,000
C1.c	Springbrook Road	Capacity	$ 3,812,000	20%	$ 751,000	$ 3,061,000
C1.d	Pinehurst Court	Capacity	$ 258,000	0%	$ -	$ 258,000
C1.e	Maintenance Yard Improvements	Capacity/Condition	$ 737,500	20%	$ 148,000	$ 589,500
C1.f	Lift Station Improvements (short term)	Condition	$ 1,429,000	1%	$ 14,000	$ 1,415,000
C1.g	I/I Projects	Capacity/Condition	$ 2,700,000	50%	$ 1,350,000	$ 1,350,000
C1.h	5th Street	Capacity/Condition	$ 350,000	16%	$ 55,000	$ 295,000
		Wastewater Collection System Priority 1 Total	$ 16,935,500		$ 2,469,000	$ 14,466,500
Wastewater Treatment Plant						
T1.a	Oxidation Ditch Rotor Replacement	Condition	$ 595,000	0%	$ -	$ 595,000
T1.b	Sawdust Bays	Capacity	$ 350,000	0%	$ -	$ 350,000
T1.c	Operations Remodel Project	Condition	$ 300,000	0%	$ -	$ 300,000
T1.d	Oxidation Ditch 1 Rehabiltation	Capacity/Condition	$ 700,000	11%	$ 78,000	$ 622,000
T1.e	Roofing Replacement at the WWTP	Condition	$ 220,000	0%	$ -	$ 220,000
T1.f	WWTP Hydraulic Improvements	Capacity	$ 480,000	14%	$ 69,000	$ 411,000
T1.g	Secondary Clarifier Rerating Study	Capacity	$ 60,000	22%	$ 14,000	$ 46,000
		Wastewater Treatment Plant Priority 1 Total	$ 2,705,000		$ 161,000	$ 2,544,000
		Total Priority 1 Improvements	**$ 19,640,500**		**$ 2,630,000**	**$ 17,010,500**
Priority 2 Improvements						
Wastewater Collection System						
C2.a	Hess Creek Phase 3 - Lift Station	Capacity	$ 2,121,000	2%	$ 42,000	$ 2,079,000
C2.b	River Street	Capacity	$ 2,764,000	12%	$ 341,000	$ 2,423,000
C2.c	HWY 240 Lift Station Upsize	Capacity	$ 454,000	19%	$ 87,000	$ 367,000
C2.d	Main and Wynooski Streets	Capacity	$ 328,000	1%	$ 4,000	$ 324,000
C2.e	Lift Station Improvements (long-term)	Condition	$ 375,000	11%	$ 41,000	$ 334,000
C2.f	I/I Projects	Capacity/Condition	$ 3,150,000	50%	$ 1,575,000	$ 1,575,000
C2.g	Wastewater Master Plan	Planning	$ 300,000	100%	$ 300,000	$ -
		Wastewater Collection System Priority 2 Total	$ 9,492,000		$ 2,390,000	$ 7,102,000
Wastewater Treatment Plant						
T2.a	Oxidation Ditch Expansion	Capacity/Redundancy	$ 11,841,000	22%	$ 2,617,000	$ 9,224,000
T2.b	Chlorine Contact Expansion	Capacity	$ 2,938,000	14%	$ 415,000	$ 2,523,000
T2.c	PLC Control System Replacement Evalution	Condition	$ 40,000	0%	$ -	$ 40,000
		Wastewater Treatment Plant Priority 2 Total	$ 14,819,000		$ 3,032,000	$ 11,787,000
		Total Priority 2 Improvements	**$ 24,311,000**		**$ 5,422,000**	**$ 18,889,000**
Priority 3 Improvements						
Wastewater Collection System						
C3.a	Chehalem Drive Phase 1 - 20-year Infrastructure	Future Development	$ 1,619,000	93%	$ 1,506,000	$ 113,000
C3.b	Riverfront Infrastructure	Future Development	$ 2,411,000	91%	$ 2,202,000	$ 209,000
C3.c	Providence Infrastructure	Future Development	$ 1,527,000	100%	$ 1,527,000	$ -
C3.d	Chehalem Drive Phase 2 - Buildout Infrastructure	Future Development	$ 888,000	0%	$ -	$ 888,000
C3.e	I/I Projects	Capacity/Condition	$ 3,150,000	50%	$ 1,575,000	$ 1,575,000
		Wastewater Collection System Priority 3 Total	$ 9,595,000		$ 6,810,000	$ 2,785,000
Wastewater Collection System						
T3.a	Secondary Clarifier 5	Capacity	$ 7,500,000	22%	$ 1,658,000	$ 5,842,000
T3.b	Equalization Basin Rehabilitation	Capacity/Condition	$ 980,000	0%	$ -	$ 980,000
		Wastewater Treatment Plant Priority 3 Total	$ 8,480,000		$ 1,658,000	$ 6,822,000
		Total Priority 3 Improvements	**$ 18,075,000**		**$ 8,468,000**	**$ 9,607,000**
Priority 4 Improvements						
Wastewater Collection System						
C4.a	Chehalem and Creekside LS Displacement/Future Trunkline	LS Consolidation	$ 3,492,000	25%	$ 889,000	$ 2,603,000
C4.b	Charles and Andrew LS Displacement	LS Consolidation	$ 1,322,000	0%	$ -	$ 1,322,000
		Total Priority 4 Improvements	**$ 4,814,000**		**$ 889,000**	**$ 3,925,000**
		TOTAL WASTEWATER IMPROVEMENTS COSTS (rounded)	**$ 66,840,500**		**$ 17,409,000**	**$ 49,431,500**

* All costs in 2018 Dollars. Costs include contingency (30%), engineering and construction management services (CMS; 25%), and legal, administrative, and permitting services as applicable.

The cost estimate herein is concept level information only based on our perception of current conditions at the project location and its accuracy is subject to significant variation depending upon project definition and other factors. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. This cost opinion is in 2018 dollars and does not include escalation to time of actual construction. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

12.3 OTHER ANNUAL COSTS

In addition to the capital improvement costs presented in Table 12-2, the following expected annual operating costs are recommended for consideration in setting annual budgets for the collection system:

- Additional collection system replacement/rehabilitation needs: Based on linear feet of pipeline, and number of manholes and cleanouts, the City should budget a total of $1,285,000/year for pipeline replacement/rehabilitation (to be either contracted out or completed using City crews). The City already budgets $450,000 for I/I related pipeline replacement/rehabilitation projects. This amount, combined with the other priority capital improvement projects, the City will be targeting enough manholes, pipelines, etc to cover the recommended average annual amount.
- Pump station annual costs will go down as the City prepares to abandon four small pump stations and build one large and one medium pump station.
- Collection system cleaning and CCTV needs: City maintenance staff currently follow a five-year timeline to clean and CCTV inspect the entire system as summarized in Section 6.3. No change is recommended to the current practice of cleaning and CCTV inspection.
- Annual O&M costs for the collection system may increase due to the increase in linear feet of pipeline. But lowering the need to enter into the Hess creek area to service the Hess creek trunk line may amount to a net zero impact to O&M costs due to Priority 1 improvements.

Priority 1 improvements at the treatment plant provide benefit to the time and effort spent on operations and maintenance (O&M) items associated with these projects. Many of the projects were identified based on condition and needs associated with O&M. The following provides a brief description of the impacts of each Priority 1 project on O&M:

- Oxidation Ditch Rotor Replacement – The oxidation ditch rotors are in need of replacement primarily based on the age and condition of the equipment. It is anticipated the replacement of an old rotor will reduce the O&M on that equipment. Currently, most of the rotor gear box seals leak and accumulate sludge in the area of the gear box. This requires weekly draining/cleaning. Seals will be replaced at the time of the corresponding rotor replacement.
- Sawdust Bays – The addition of two sawdust bays will provide the City with additional covered storage for compost curing process while keeping the sawdust dry. This increase in capacity will provide additional flexibility in the composting process.
- Operations Remodel Project – Remodeling existing unused space in the administration/operations building will provide a more comfortable area for staff to work and meet. These added assets will have little effect on O&M requirements.
- Oxidation Ditch 1 Rehabilitation – Structural rehabilitation will have little impact on O&M. Repair to any cracks within the structures that leak, will reduce any recycle to the Influent Pump Station (IPS) that may be occurring.
- Roofing Replacement at the WWTP – Leaky roofs and corroded gutters have required added maintenance for staff. Replacement of the roofs, gutters, and soffits will remove these troublesome concerns.

- WWTP Hydraulic Improvements – Hydraulic improvement to the WWTP will help reduce operational concerns during peak flow events. The improvements are likely to be changes to passive flow split structures and additional pipes to reduce headloss. These added assets will have little effect on O&M.
- Secondary Clarifier Re-rating Study – This study should include stress testing event which will require plant staff effort to conduct the analysis. This effort is anticipated to be of short duration, less than one week. The result of the study could have a future impact on O&M, if additional secondary clarifiers are required sooner than anticipated.

No additional process equipment is anticipated as part of Priority 1. This results in no increase in connected power usage or associated O&M labor. Overall, the projected increase in influent flows and loadings will increase the total labor, power, and chemical usage of the plant. Routine O&M will be required to keep existing equipment in good working condition, and as existing equipment ages it will likely require additional resources to maintain and operate.

13. SYSTEM DEVELOPMENT CHARGES

The System Development Charges (SDCs) was updated as part of this planning effort. The full SDC analysis, HDR City of Newberg Wastewater System Development Charge Study dated May 2018, is provided in Appendix J. This section provides an overview of the update to the SDC.

13.1 INTRODUCTION

The purpose of the SDCs is to bring equity between existing customers and new customers connecting to the City's wastewater system. The objective of the study was to update the cost-based charges for new customers connecting to, or requesting additional capacity to, the City's wastewater system. By establishing cost-based SDCs, the City attempts to have "growth pay for growth" and existing utility customers will, for the most part, be sheltered from the financial impacts of growth.

The City has a current SDC of $6,533 for the first 18 fixture units. The SDC has not been reviewed since 2007. However, the SDC has been updated a number of times using industry excepted cost indices, like Engineering New Record Construction Cost Index (ENR-CCI) and Consumed Price Index Urban (CPIU), since 2007.

General industry recommendations are to adjust these charges annually for changes in construction costs and to update the charges every three to five years, or whenever comprehensive planning documents for the systems have been updated. Given the time since the last update and the availability of the Master Plan for the wastewater utility, it is timely to update the charges for the wastewater utility at this time. The City has undertaken this study to determine parity between existing and new utility customers.

13.2 SDC ANALYSIS AND RESULTS

The SDCs have been calculated in a manner which conforms to generally accepted rate making practices and are based on the City's wastewater system planning and design criteria. The calculations also take into account the financing mechanisms of capital improvements. Based on the sum of the component costs, the "net allowable" SDC is determined. "Net" refers to the "gross" SDC, net of any credits for future debt service principal to be paid within a customer's rates. "Allowable" refers to the concept that the calculated SDC is the City's cost-based (i.e., maximum) charge. The City, as a matter of policy, may charge any amount up to the cost-based SDC, but not over that amount. Charging an amount greater than the allowable SDC would not meet the "nexus" test of charging cost-based SDCs which are proportionally related to the benefit derived by the customer.

SDCs must be implemented according to the capacity requirement or impact each new development has on the utility system. This way, the SDC is related to the impact the customer places on the system, and to the benefit they derive from the service provided.

The City's current wastewater SDC is based on the number of fixture units. The updated analysis resulted in a proposed fee of $5,704 for the first 18 fixture units. Details of the development of the wastewater SDC are discussed in greater detail in the full report (Appendix J). Table 13-1 lists the existing and maximum wastewater system development charge.

Table 13-1: Existing and Maximum Allowable Wastewater SDCs

Customer Class	Existing SDC Fee	Reimbursement SDC	Improvement SDC	Total SDC or Maximum Allowable
For the first 18 fixture units	$6,533	$1,131	$4,573	$5,704
Per each fixture unit over 18	$364			$317
Efficiency Dwelling Unit (EDU)	$364			$317

The SDC as calculated in the study is lower than the existing SDC. The lower calculated fee is primarily a result of a reduced capital plan in this planning period. The 2007 SDC study included $37 million in capital projects through 2040, which included SDC eligible extension and upgrade collection projects, which are no longer included in the current Master Plan. The amounts shown in Table 13-1 have been rounded for ease of administration. Table 13-1 shows the wastewater SDC for the first 18 fixture units is $5,704.

13.3 RECOMMENDATIONS

The following is a list of recommendations based on the review and analysis of the City's wastewater system, capital plans from the Master Plan, and financing approach for the development of the SDCs:

- The City should adopt the wastewater SDCs for new connections to these respective systems which are no greater than the net allowable system development charges as set forth in this report.
- The adopted SDCs should be updated annually by using industry accepted indices such as the local construction cost index from the ENR-CCI for no more than five years before a complete update of the charge is again undertaken. This industry practice can keep the charge relatively current with construction pricing practices.
- The City should update the actual calculations for the SDCs at such time when a new capital improvement plan, public facilities plan, comprehensive system plan, or a comparable plan is approved or updated by the City.

APPENDICES

APPENDIX A: FIGURES

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

APPENDIX B: PLANNING CRITERIA

APPENDIX C: PUMP STATION INFORMATION

APPENDIX D: HYDRAULIC EVALUATION INFORMATION

APPENDIX E: COST ESTIMATE DETAILS *See Note 1*

APPENDIX F: PRIORITY 1 PROJECT SHEETS *See Note 1*

APPENDIX G: I & I

APPENDIX H: WWTP EXISTING DEFICIENCIES

APPENDIX I: WWTP IMPROVEMENTS

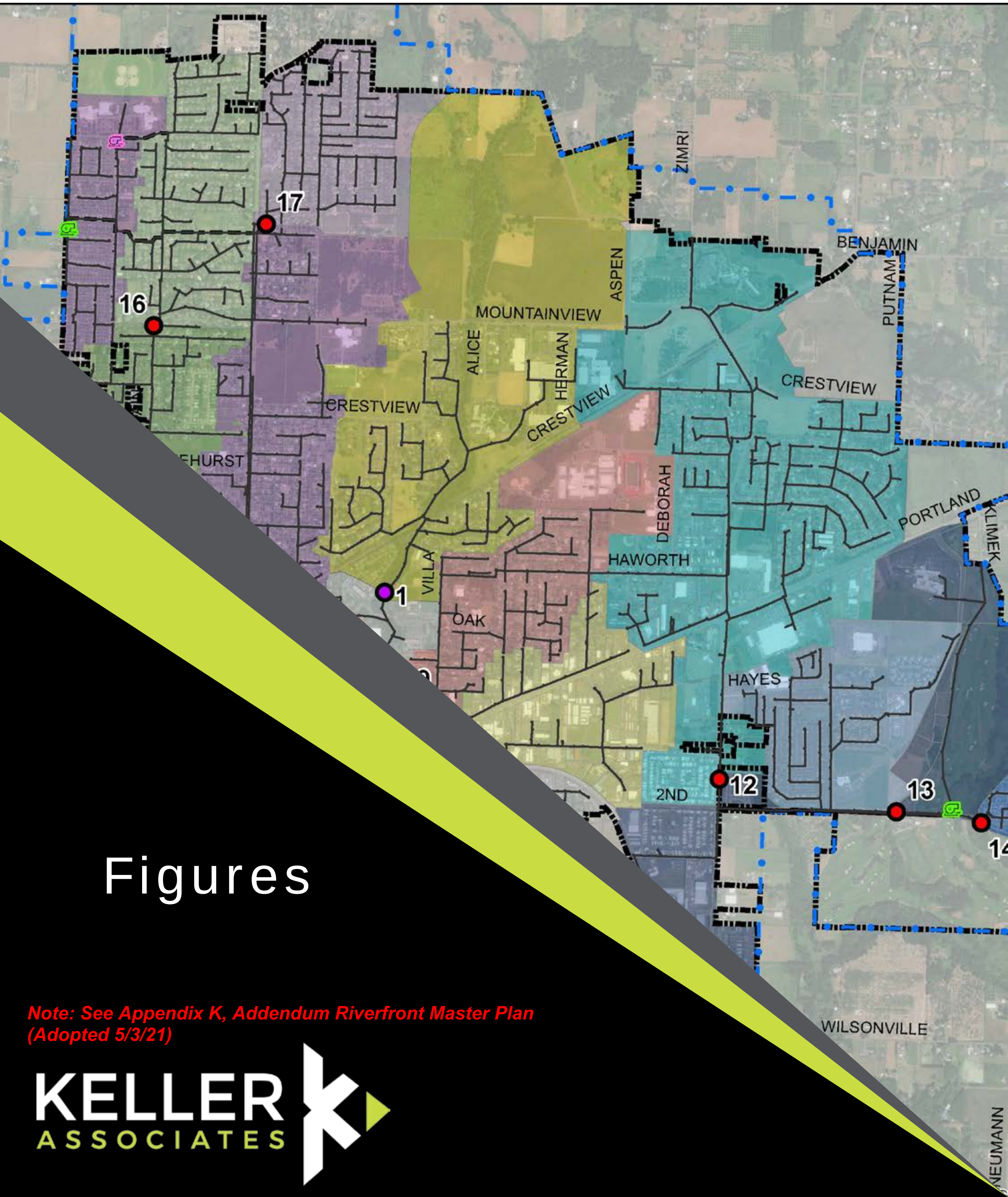
APPENDIX J: SDC REPORT

APPENDIX K: 2021 Technical Update, Addendum Riverfront Master Plan

Note 1: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

City of Newberg OREGON

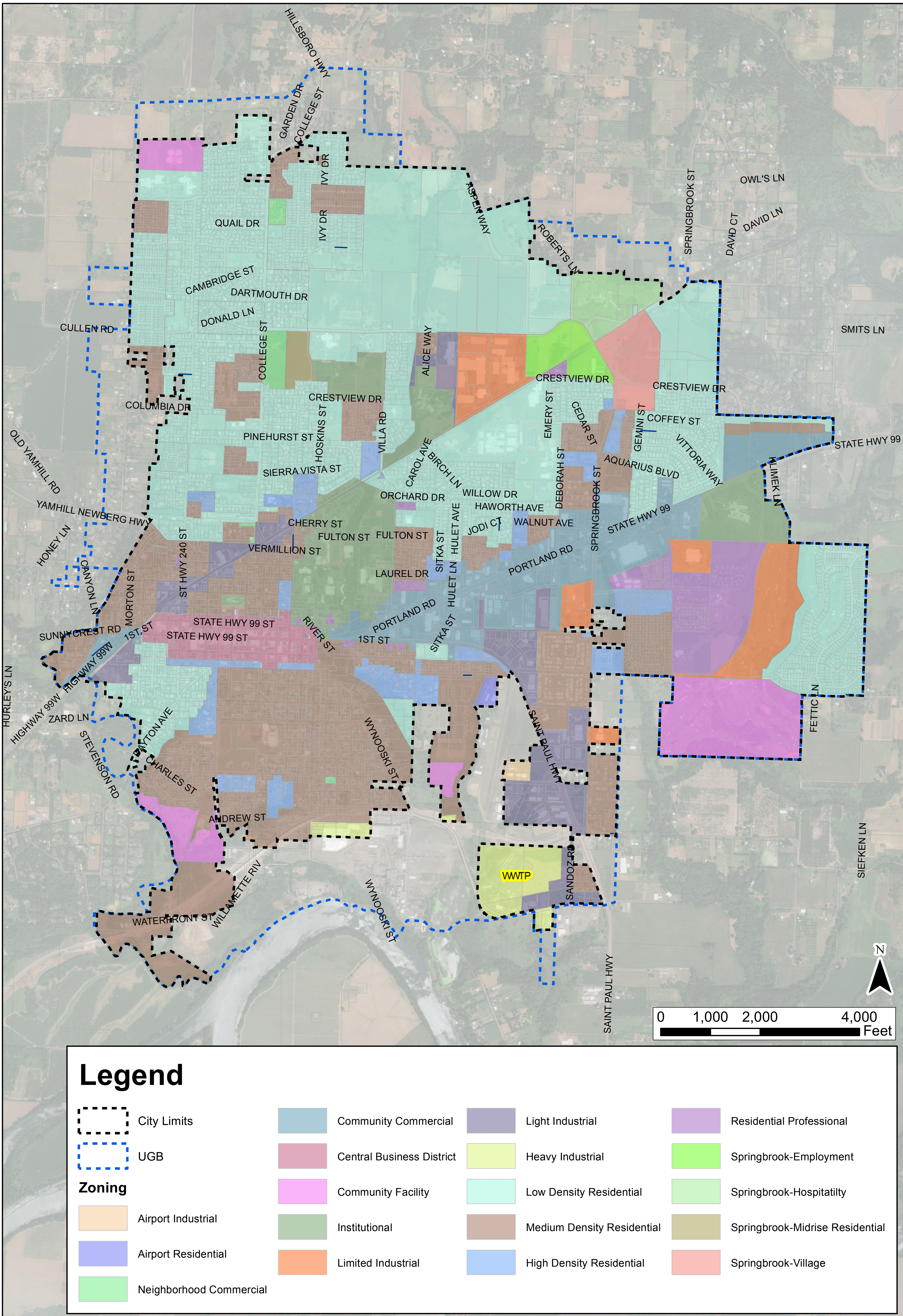
Appendix A



Figures

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

KELLER ASSOCIATES



KELLER ASSOCIATES

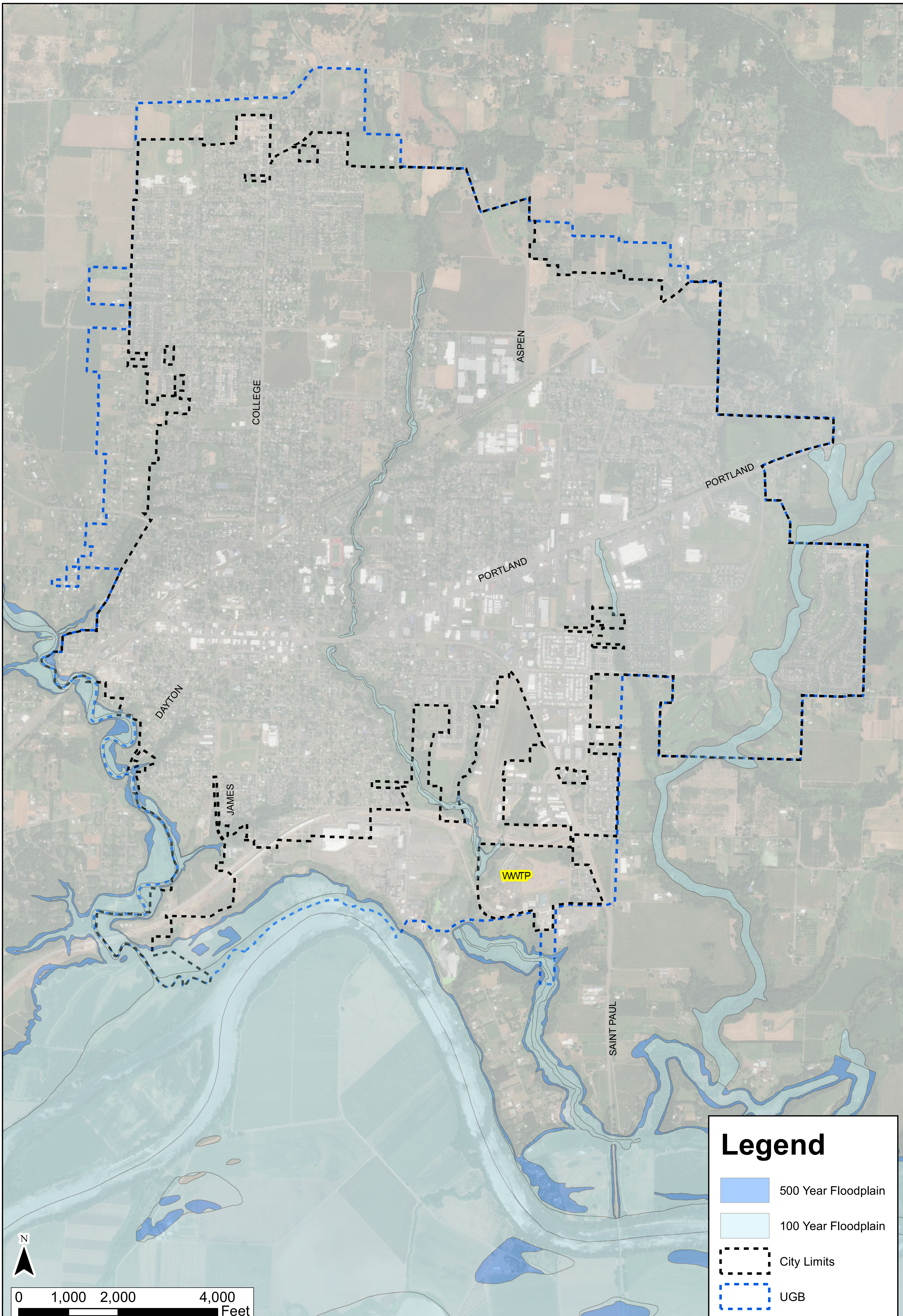
City Zoning

Wastewater Master Plan

City of Newberg OREGON

Figure 1

City of Newberg, OR
March 2018



KELLER ASSOCIATES

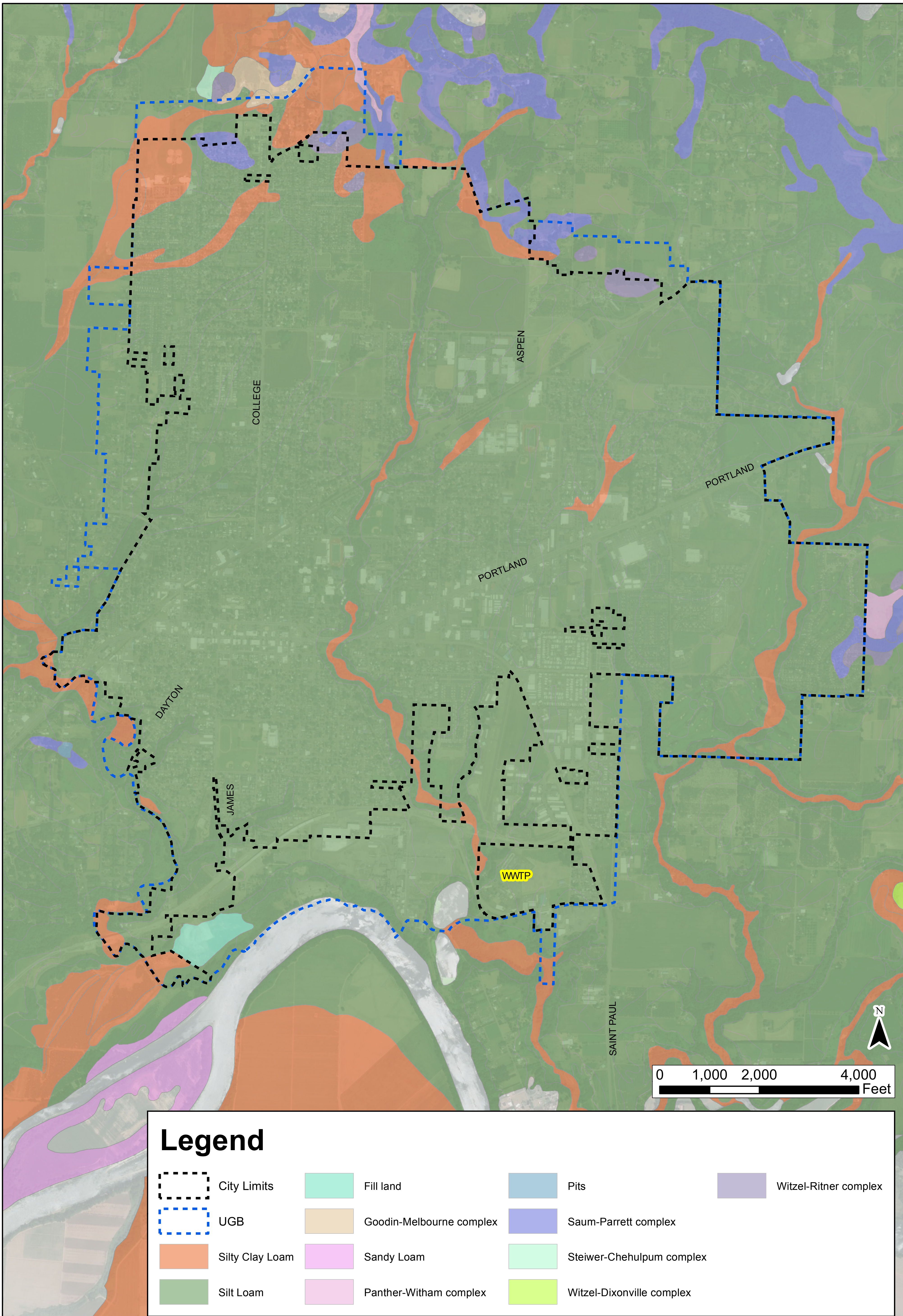
Floodplains

Wastewater Master Plan

City of Newberg OREGON

Figure 2

City of Newberg, OR
March 2018



KELLER ASSOCIATES

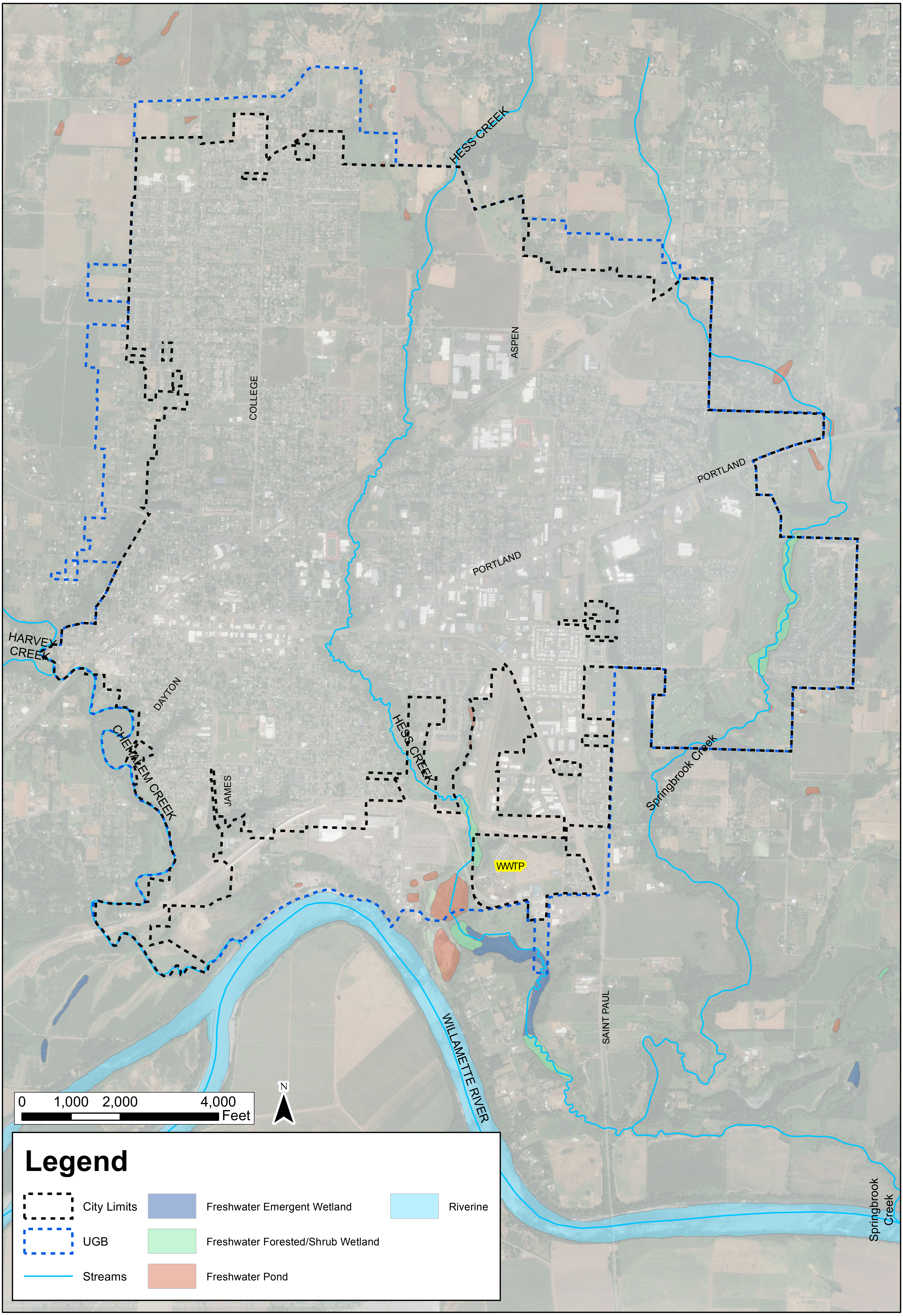
Soils

Wastewater Master Plan

City of Newberg OREGON

Figure 3

City of Newberg, OR
March 2018



KELLER ASSOCIATES

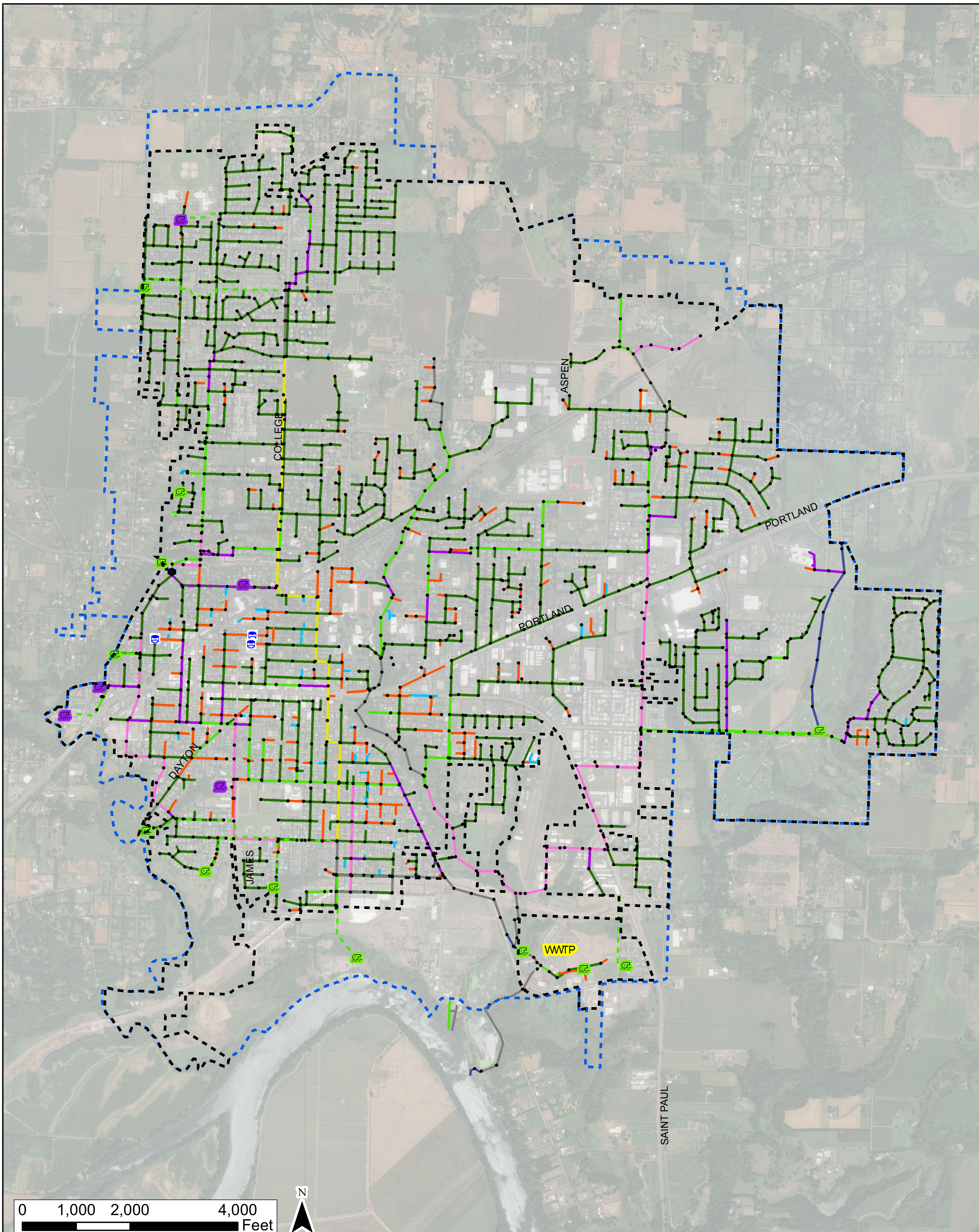
Wetlands

Wastewater Master Plan

City of Newberg OREGON

Figure 4

City of Newberg, OR
March 2018



Legend

City Limits	FlushTank	Manhole
UGB	Pump Station	
DiversionChamber	Private Pumpstation	

Force Main

- 2
- 4
- 10
- 12

Gravity Main

- Unknown
- 4
- 6
- 8
- 10
- 12
- 15
- 21
- 24
- 42

KELLER ASSOCIATES

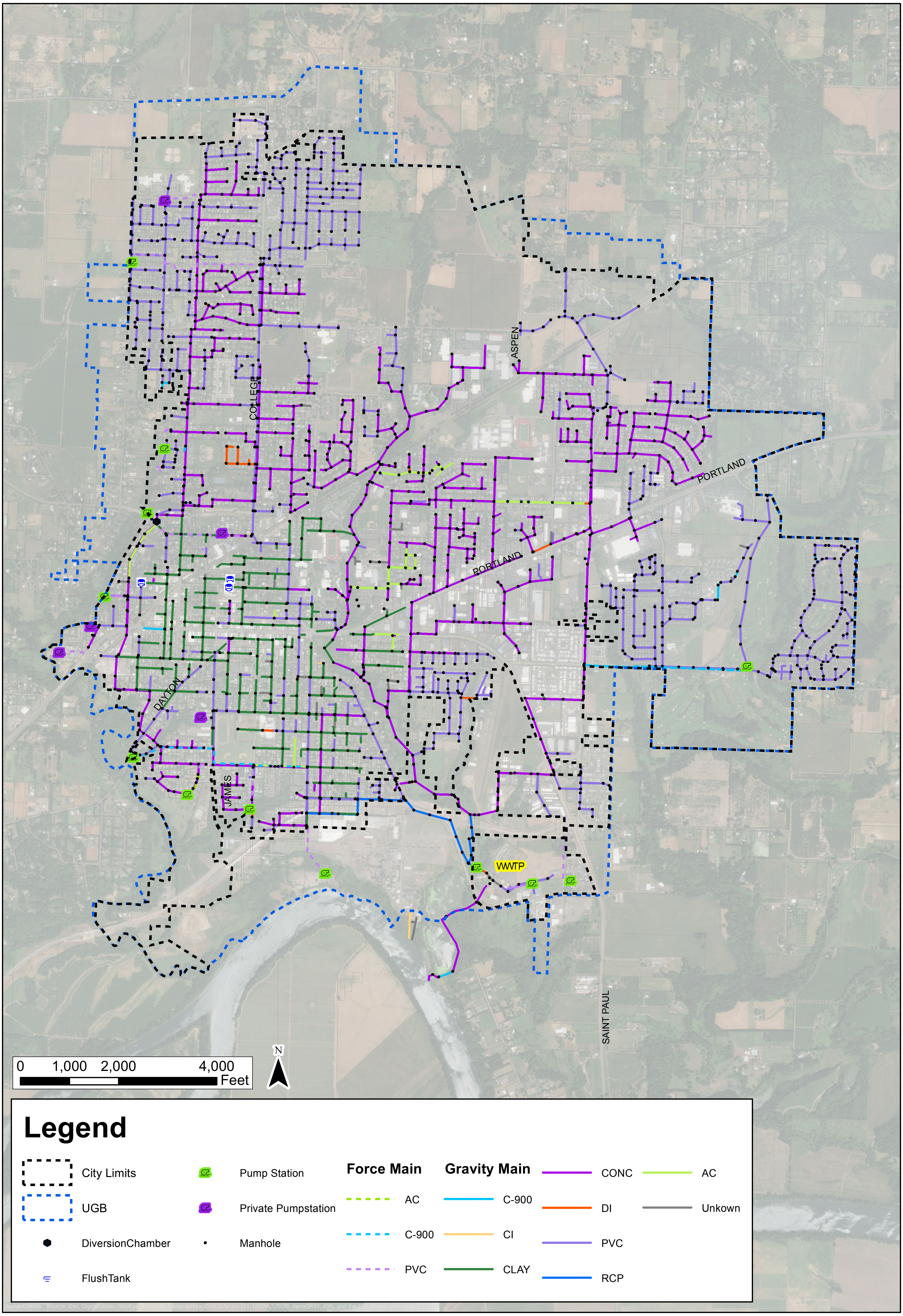
Existing System - Pipe Diameter

Wastewater Master Plan

City of Newberg OREGON

Figure 5

City of Newberg, OR
March 2018



KELLER ASSOCIATES

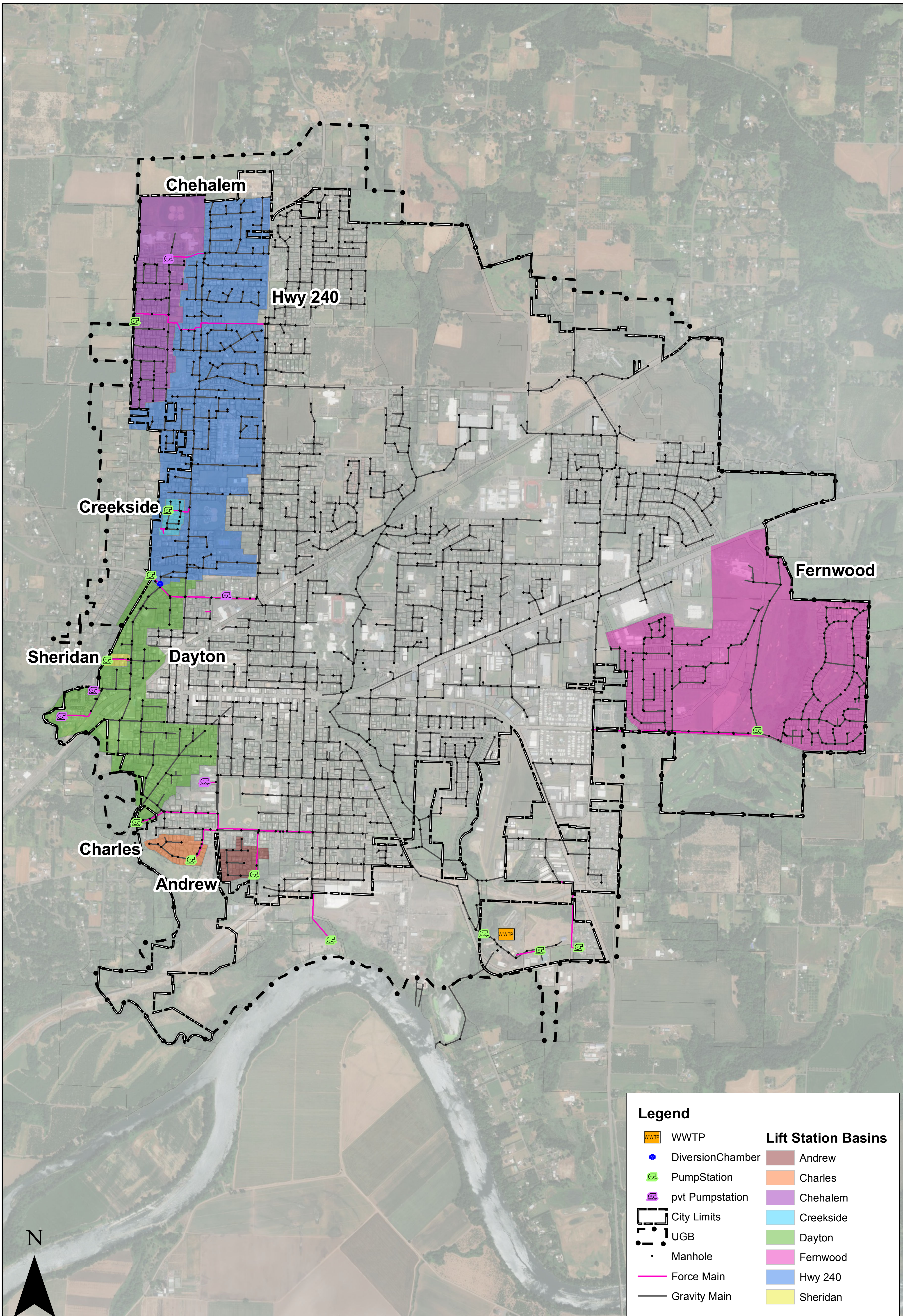
Existing System - Pipe Material

Wastewater Master Plan

City of Newberg OREGON

Figure 6

City of Newberg, OR
March 2018



KELLER ASSOCIATES

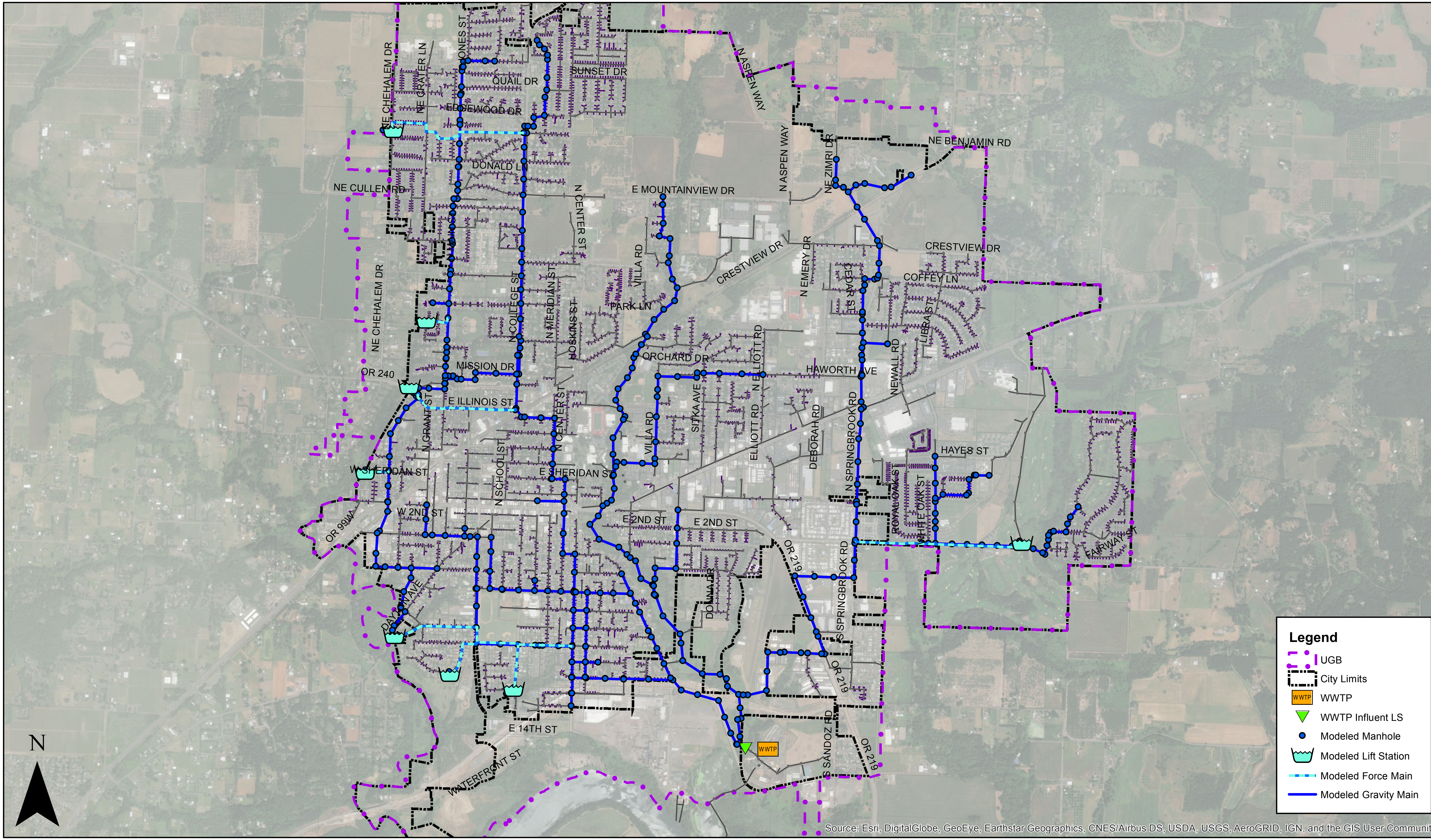
Lift Station Basins

Wastewater Master Plan

City of Newberg OREGON

Figure 7

City of Newberg, OR
March 2018



KELLER ASSOCIATES

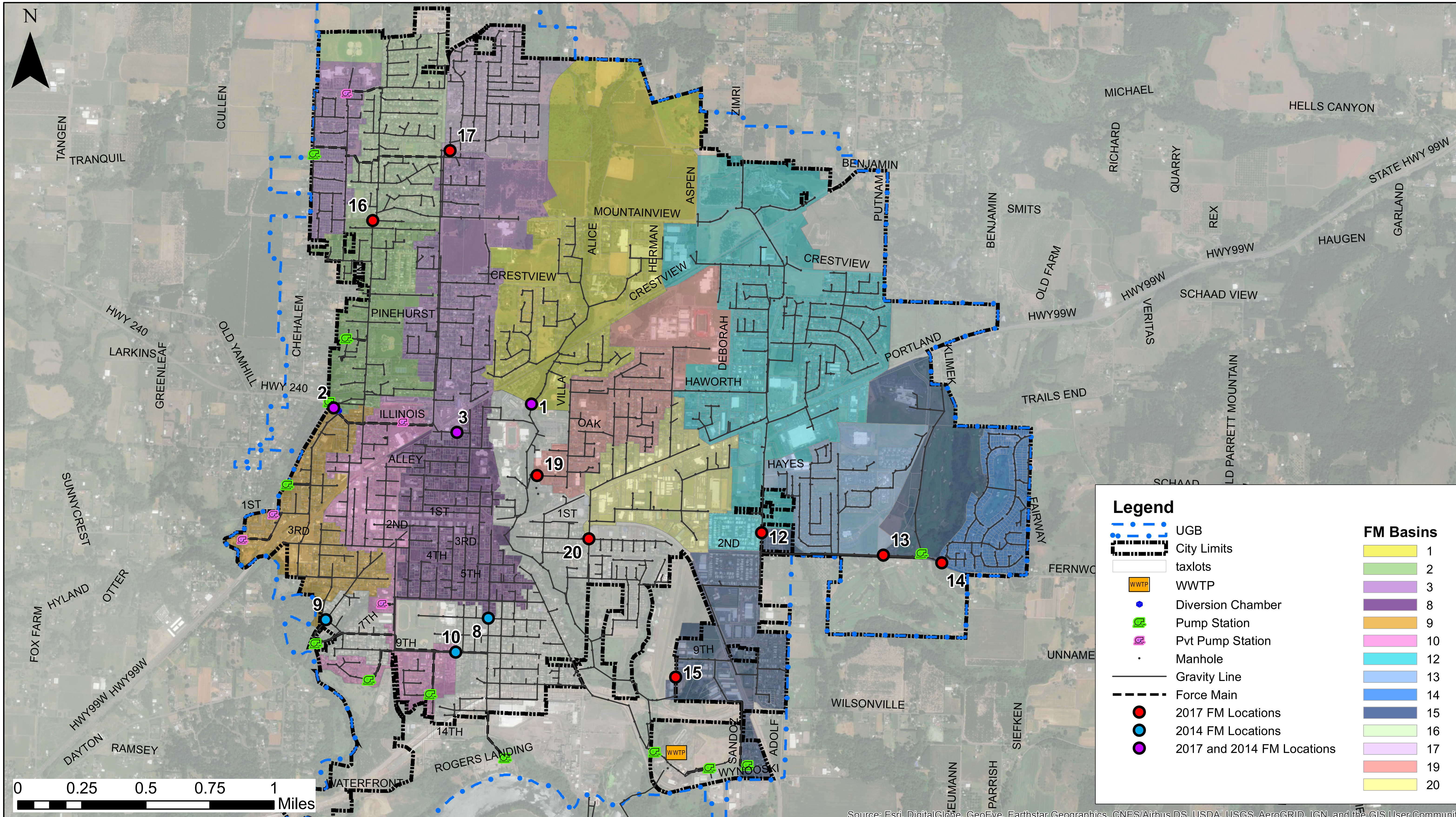
Existing System Modeled Facilities

Wastewater Master Plan

City of Newberg OREGON

Figure 8

City of Newberg, OR
March 2018



KELLER ASSOCIATES

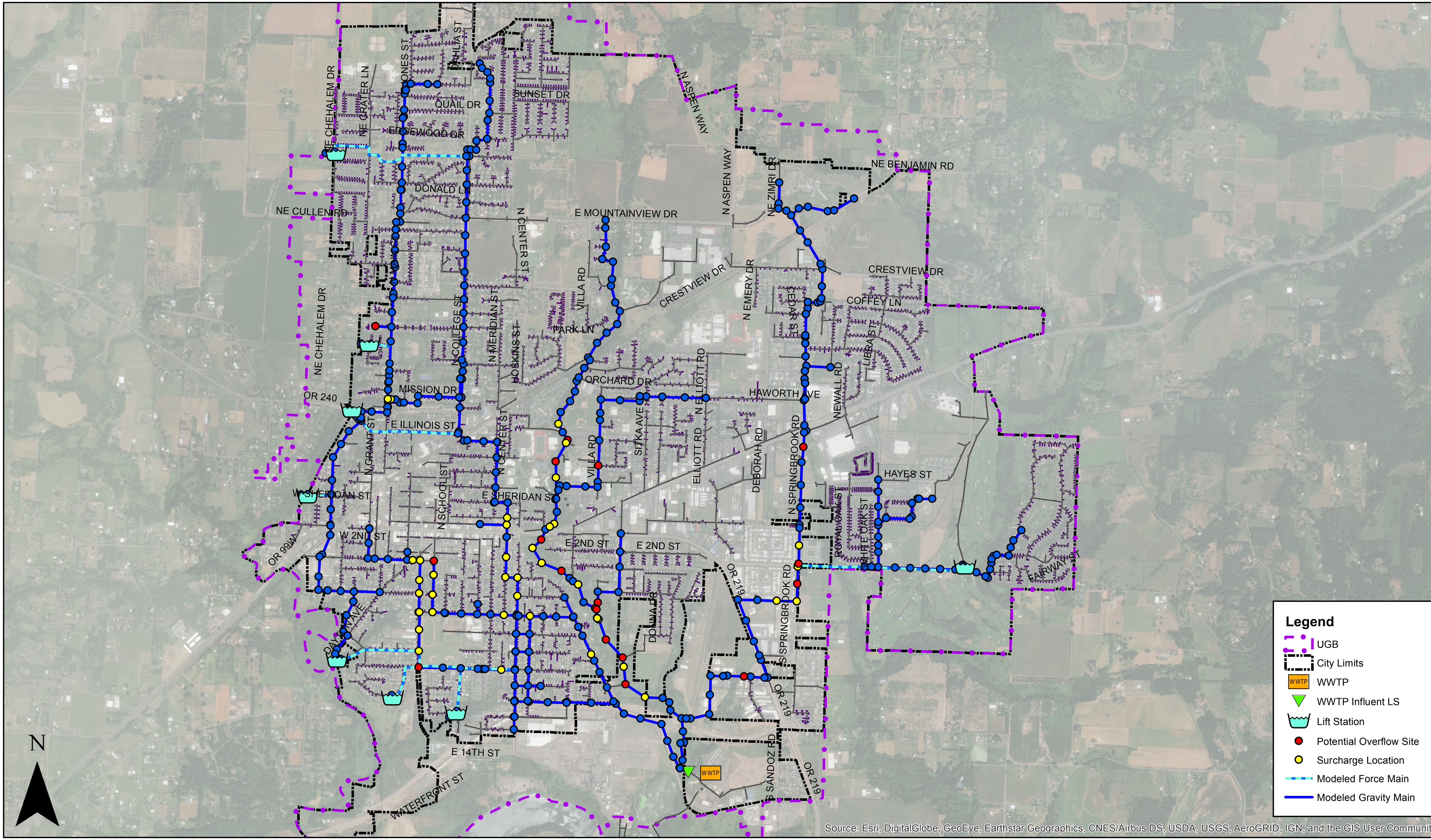
Flow Monitoring Locations

Wastewater Master Plan

City of Newberg OREGON

Figure 9

City of Newberg, OR
March 2018



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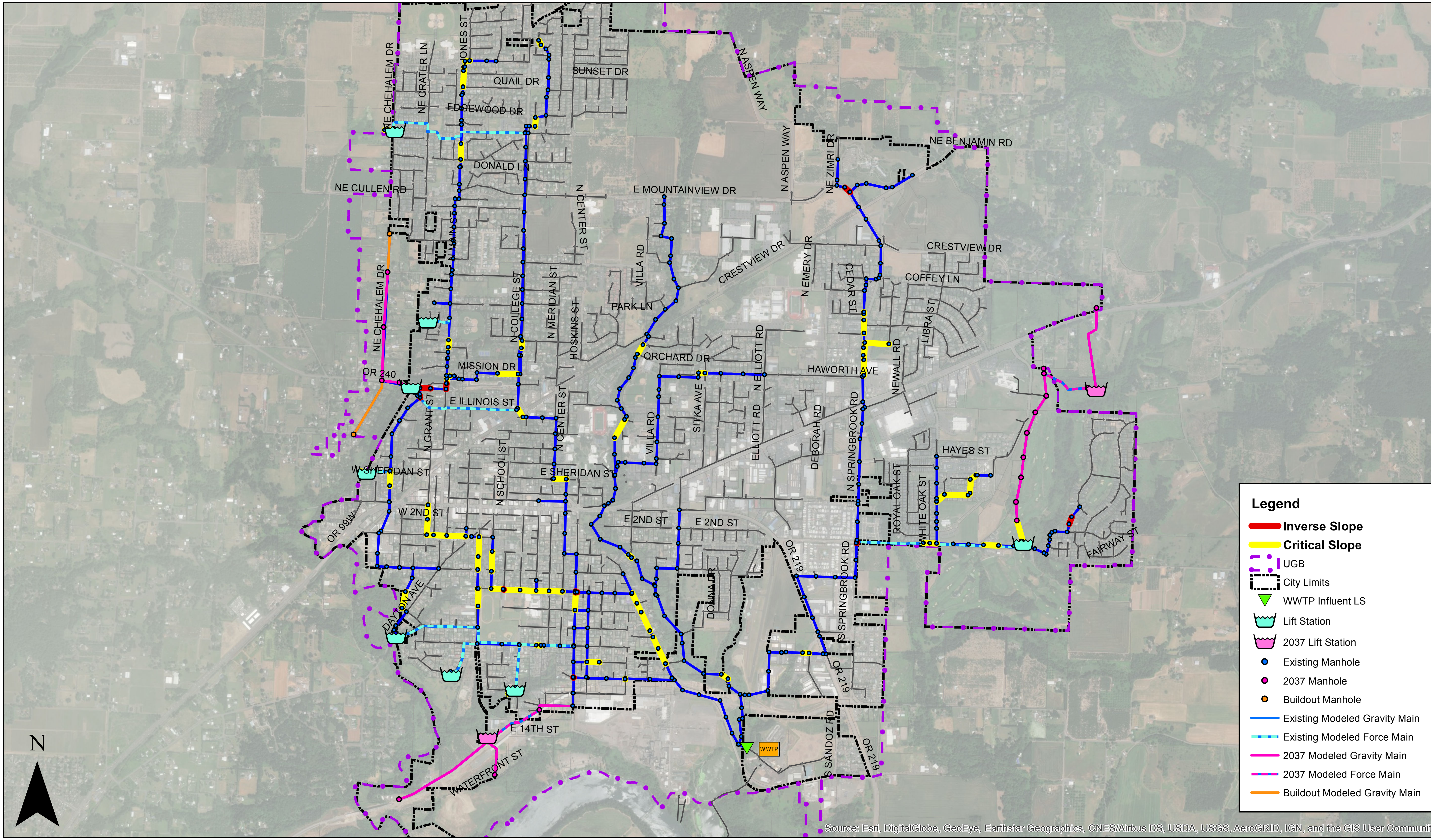
Existing System Evaluation - Peak Flows (PIF5)

Wastewater Master Plan

City of Newberg OREGON

Figure 10

City of Newberg, OR
March 2018



Existing Inverse and Critical Slopes

Wastewater Master Plan

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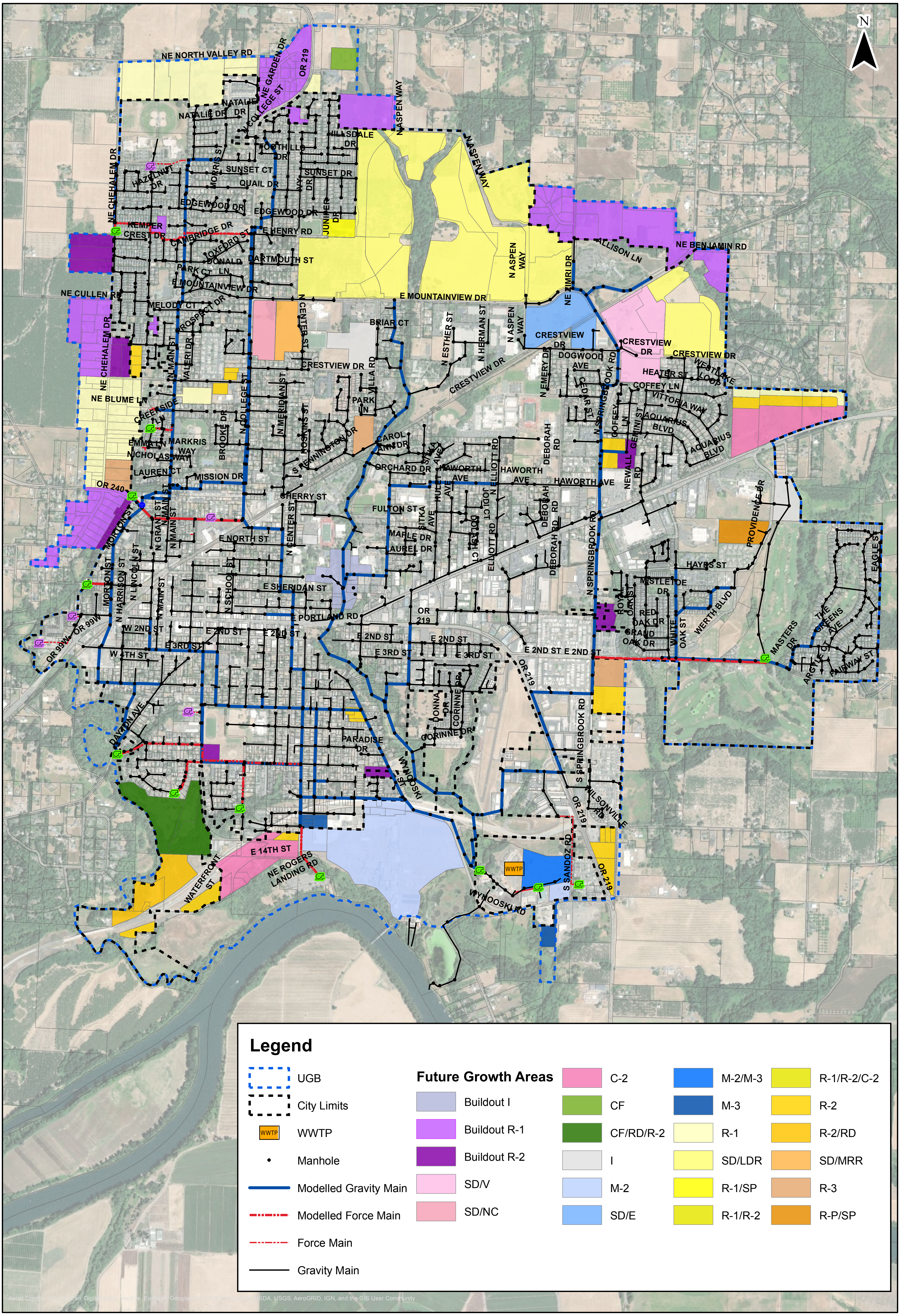
City of Newberg OREGON

Figure 11

City of Newberg, OR
March 2018



Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

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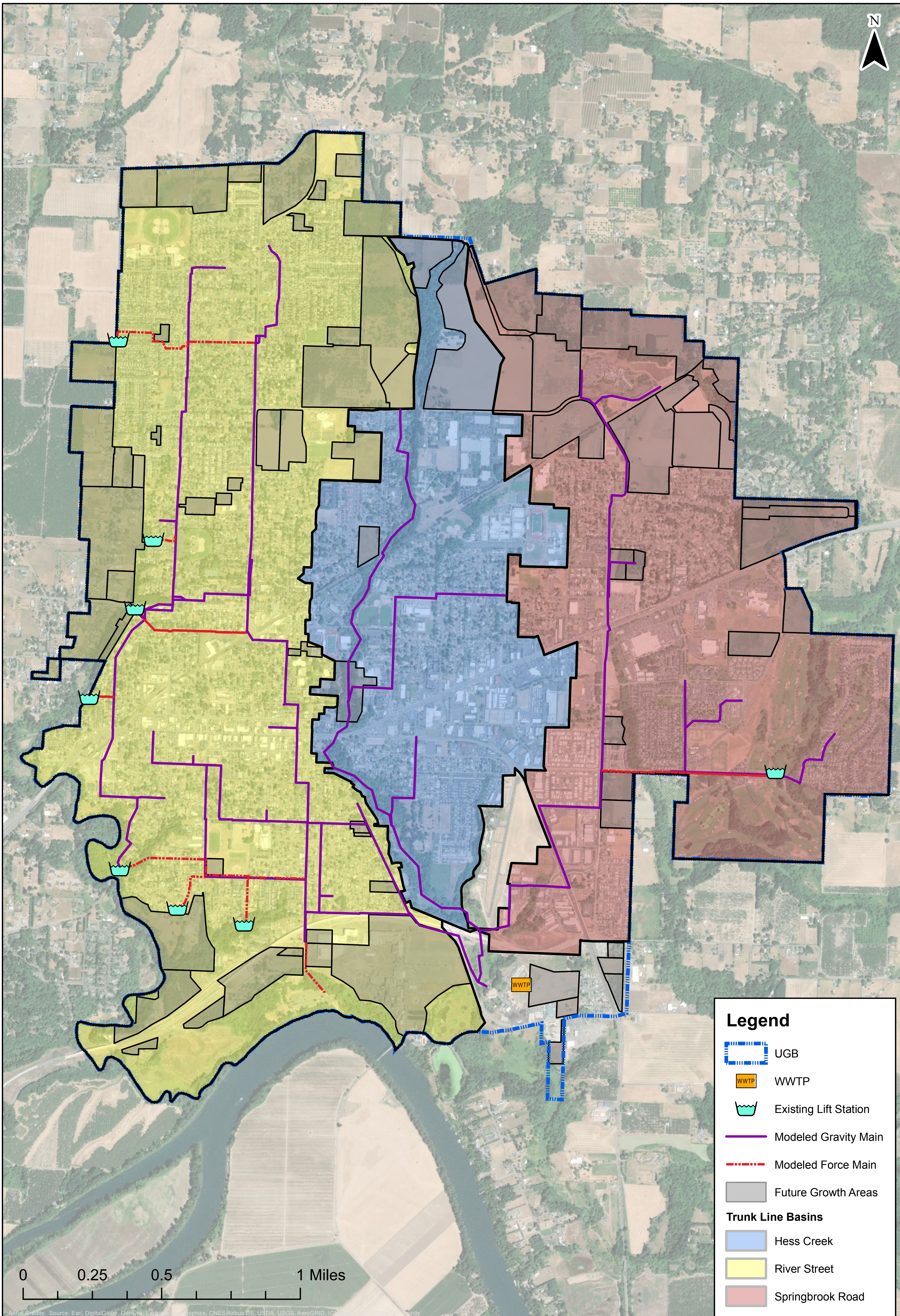
Future Growth Areas 20-Year and Buildout

Wastewater Master Plan

City of Newberg OREGON

Figure 12

City of Newberg, OR
May 2018



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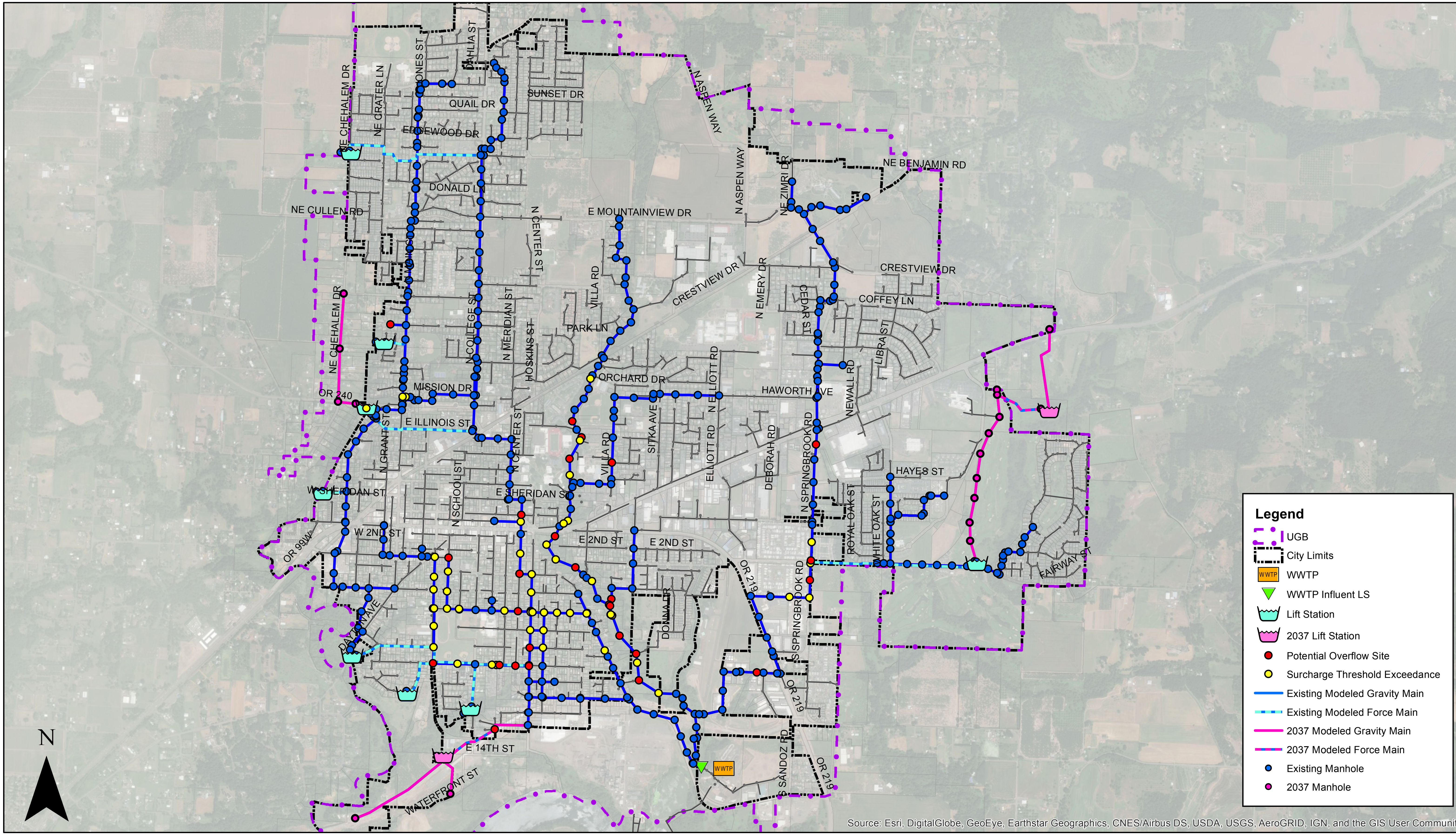
Trunk Line Basins

Wastewater Master Plan

City of Newberg OREGON

Figure 13

City of Newberg, OR
May 2018



KELLER ASSOCIATES

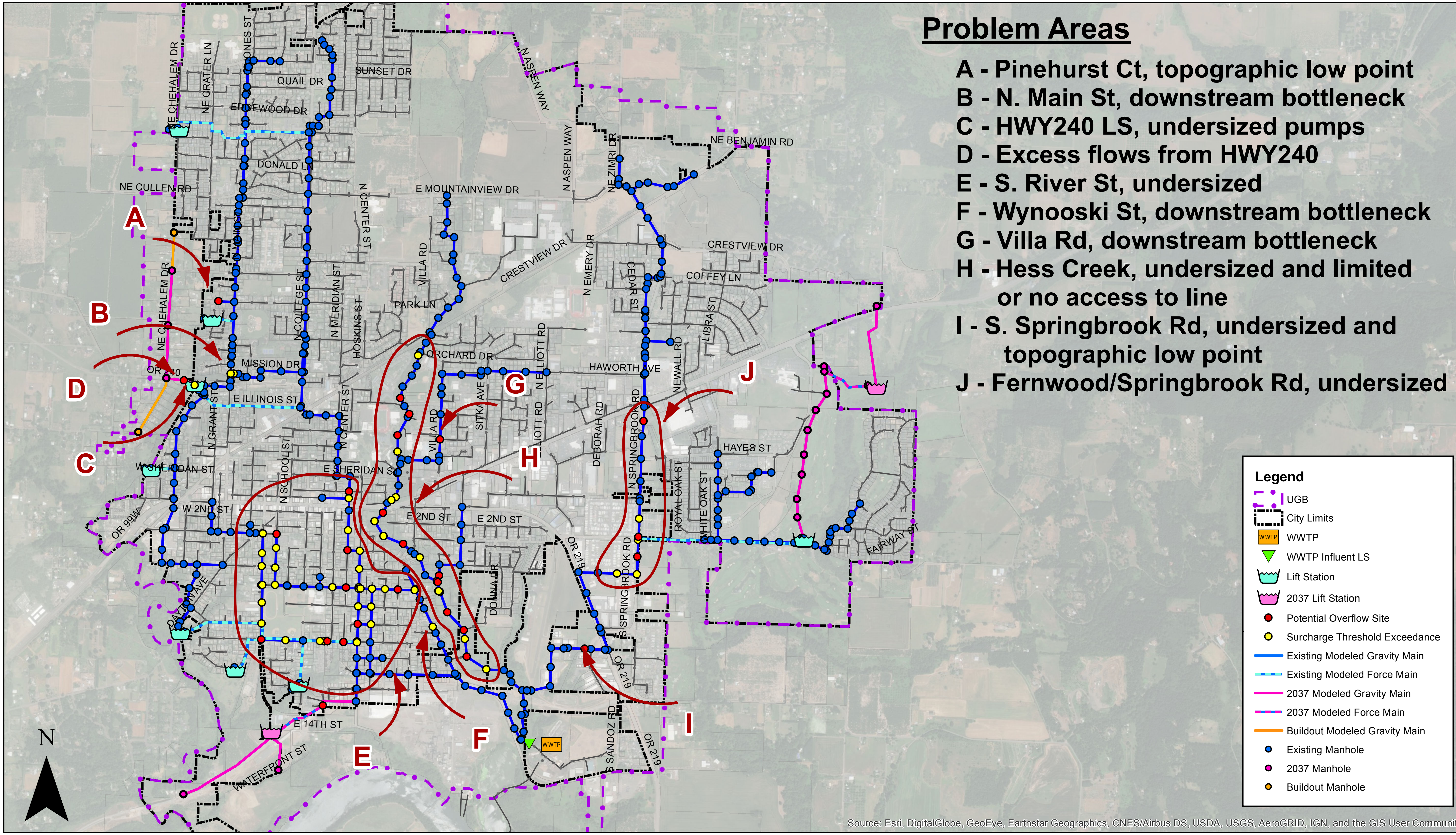
20-Year System Evaluation - Peak Flows (PIF5)

Wastewater Master Plan

City of Newberg OREGON

Figure 14

City of Newberg, OR
May 2018



Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

KELLER ASSOCIATES

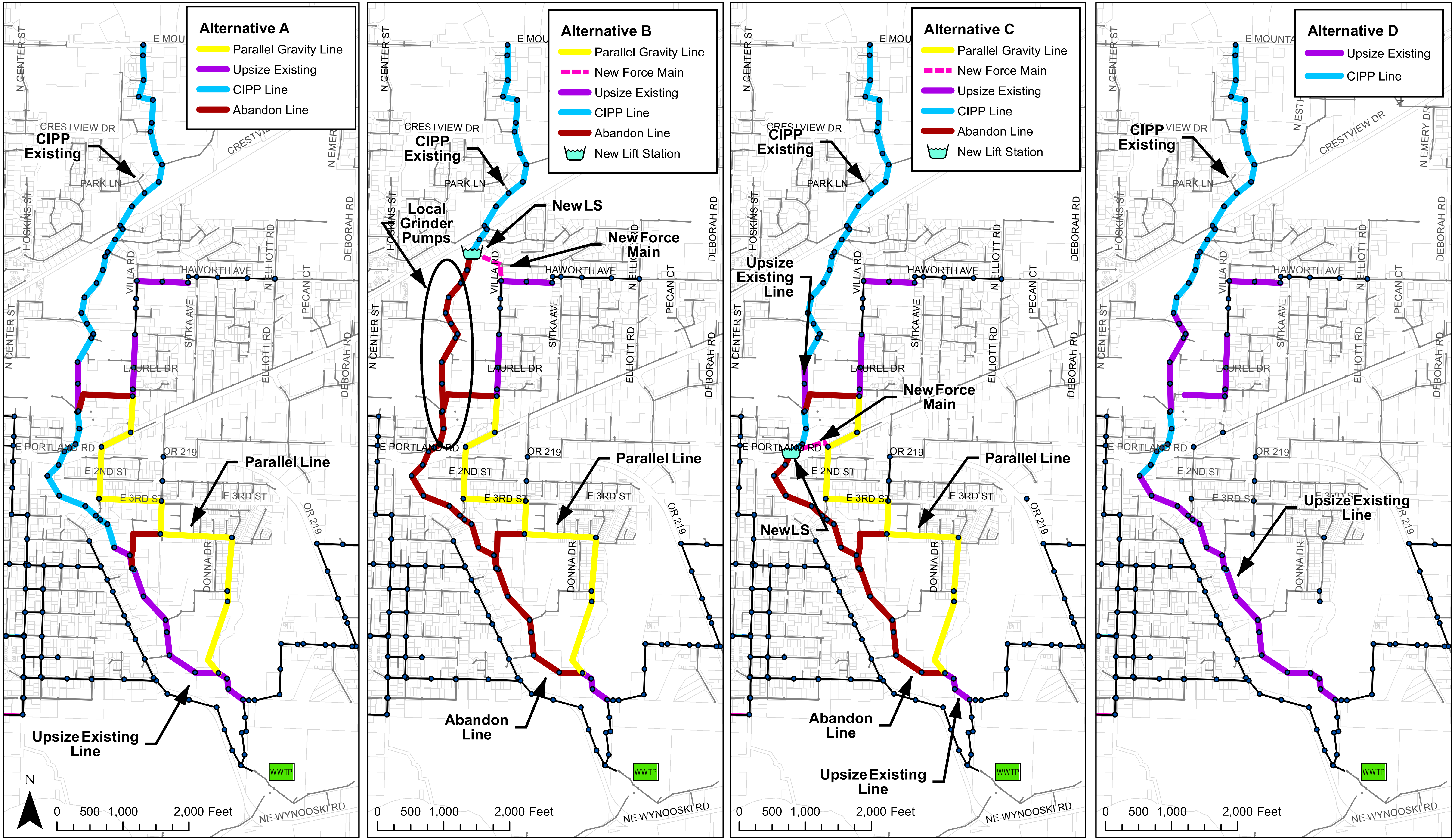
Buildout System Evaluation - Peak Flows (PIF5)

Wastewater Master Plan

City of Newberg OREGON

Figure 15

City of Newberg, OR
May 2018



Hess Creek Alternatives

Wastewater Master Plan

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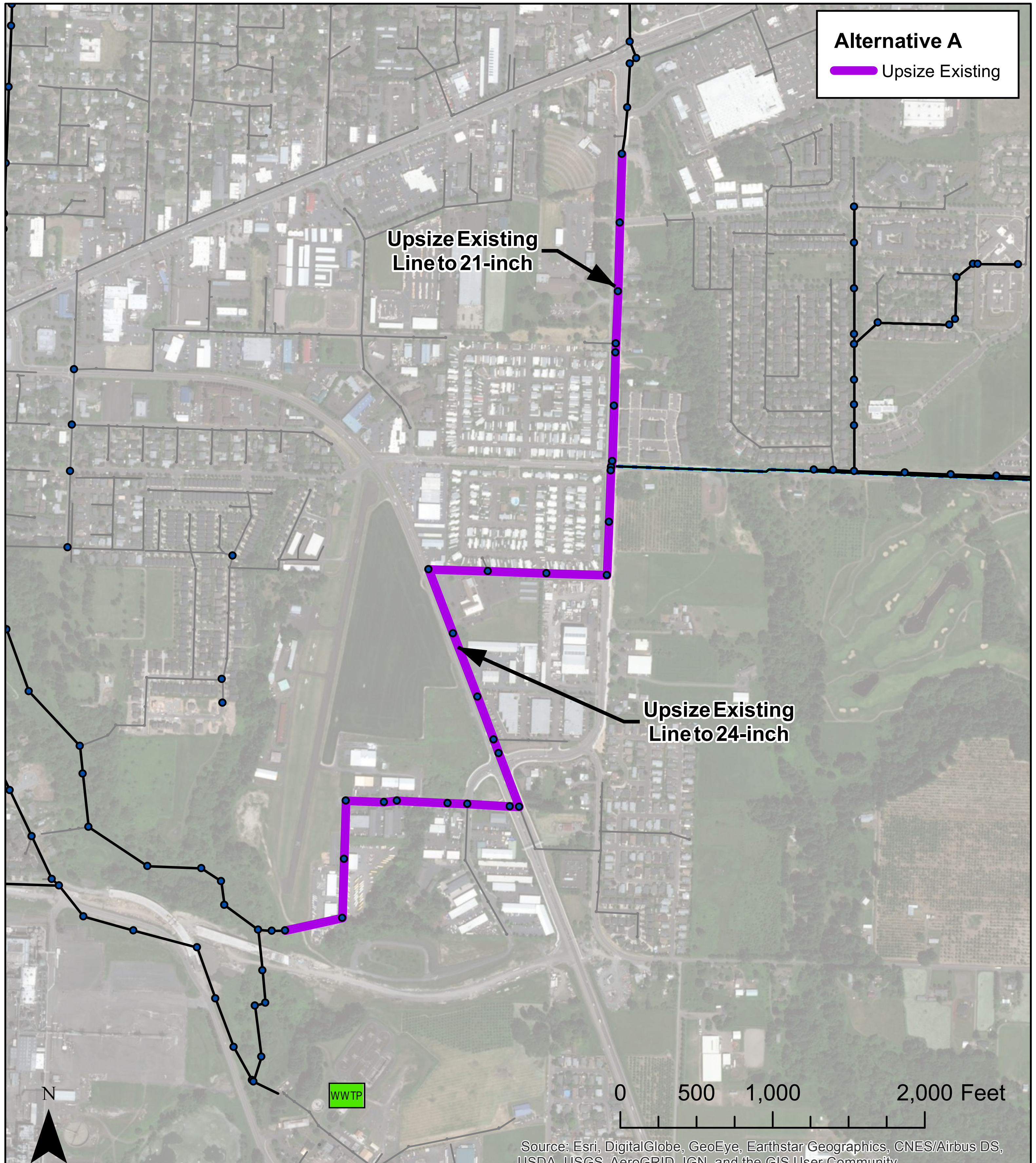
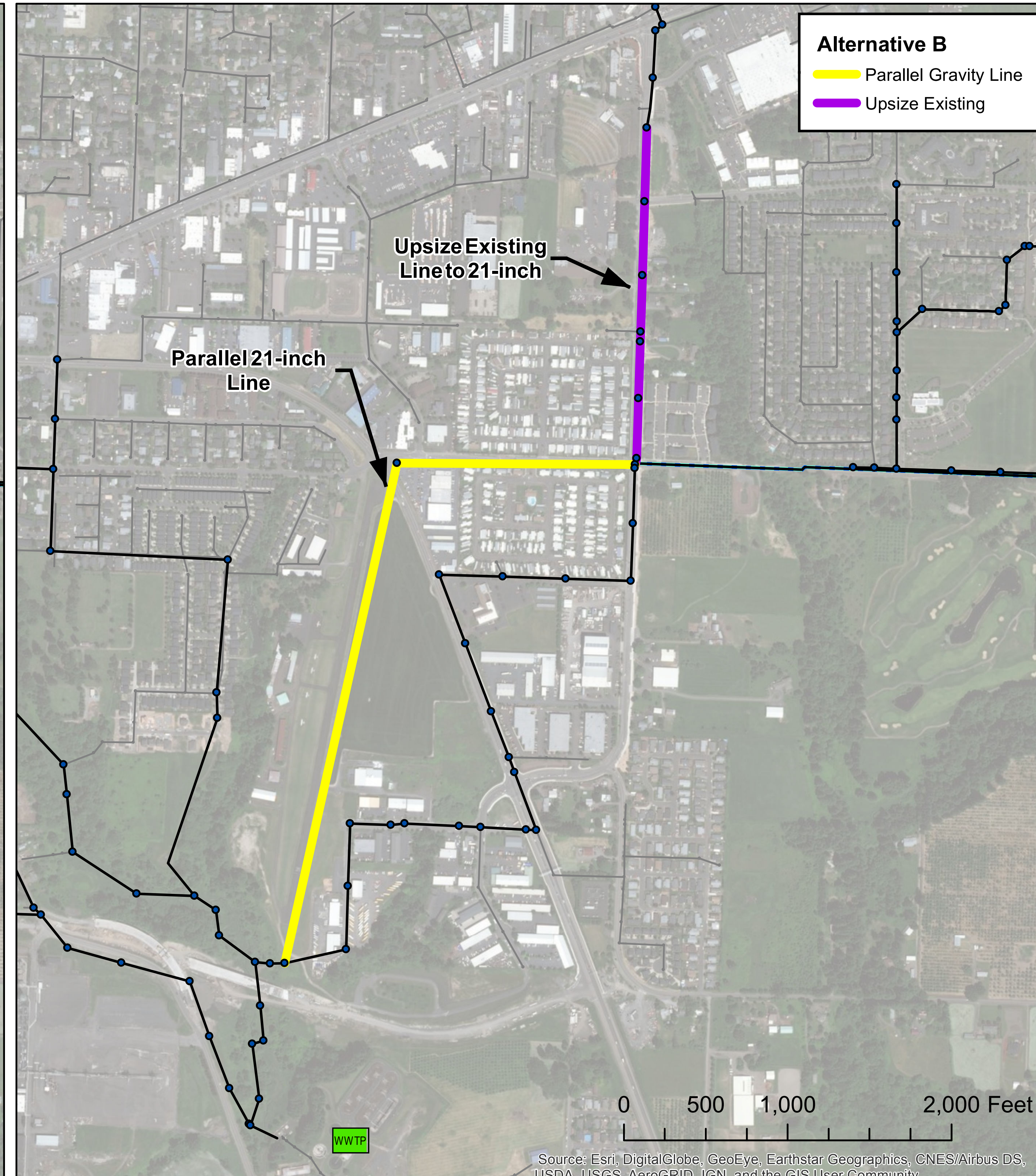
City of Newberg OREGON

Figure 16

City of Newberg, OR
May 2018





Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

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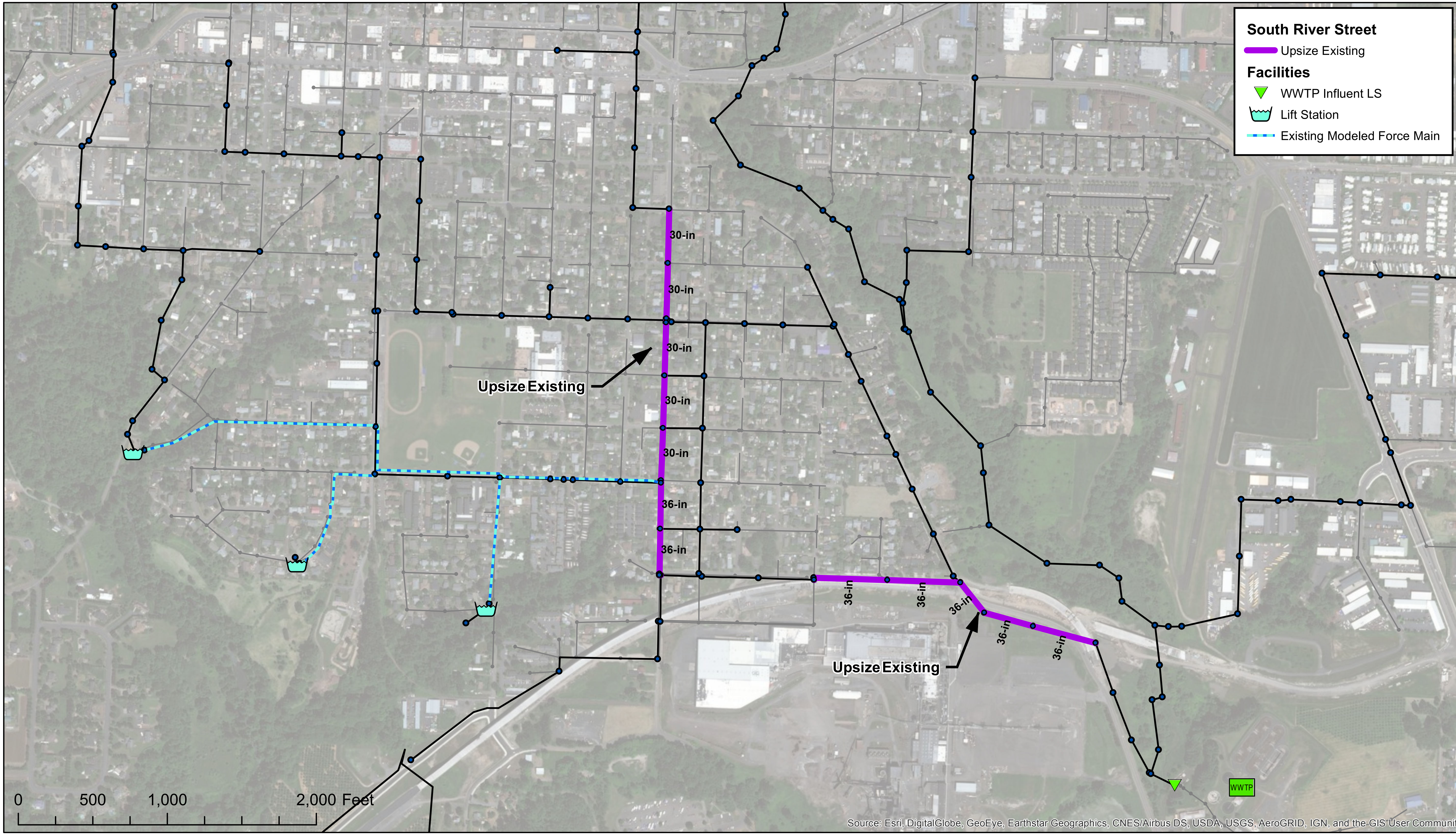
Springbrook Road Alternatives

Wastewater Master Plan

City of Newberg OREGON

Figure 17

City of Newberg, OR
May 2018



Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

KELLER ASSOCIATES

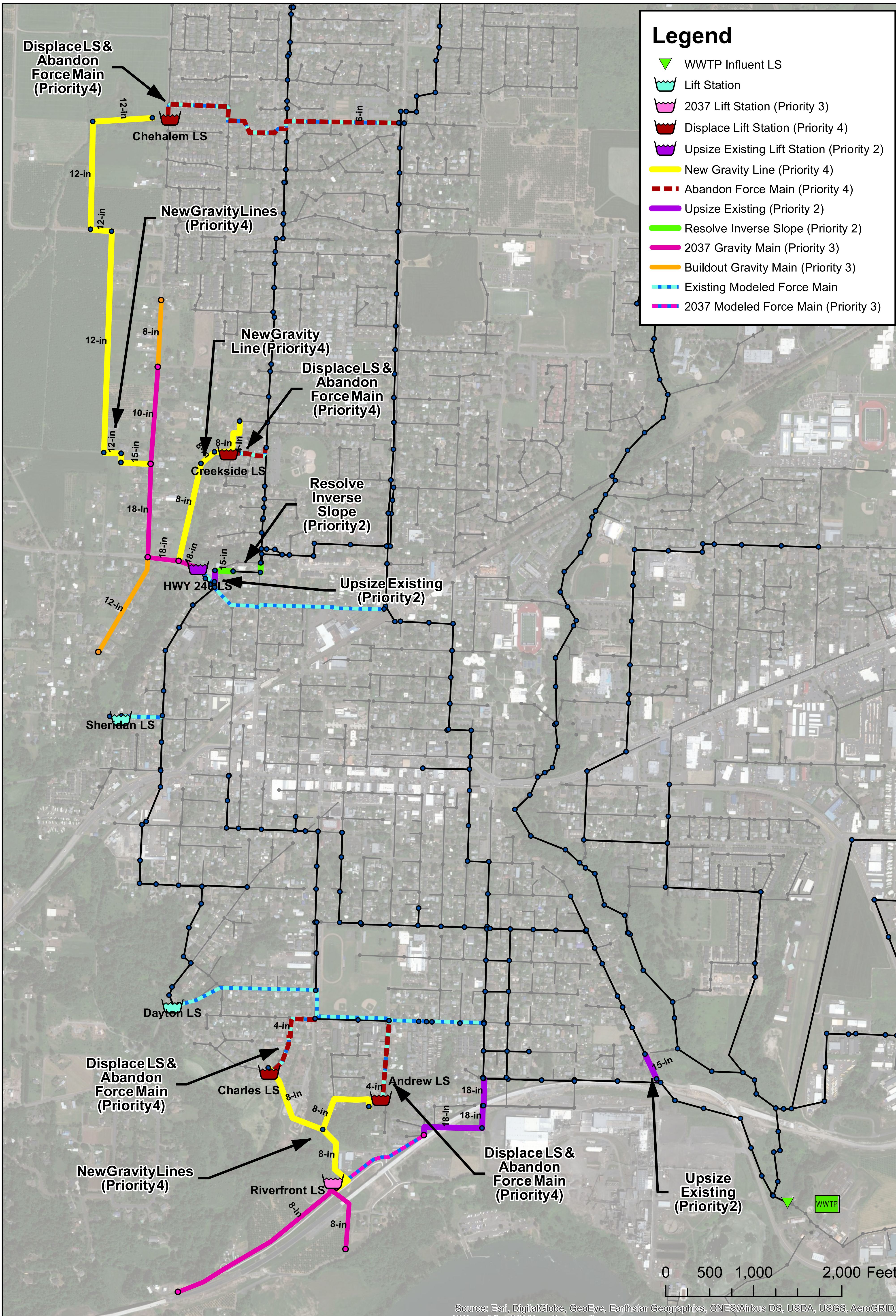
South River Street Improvements

Wastewater Master Plan

City of Newberg OREGON

Figure 18

City of Newberg, OR
May 2018



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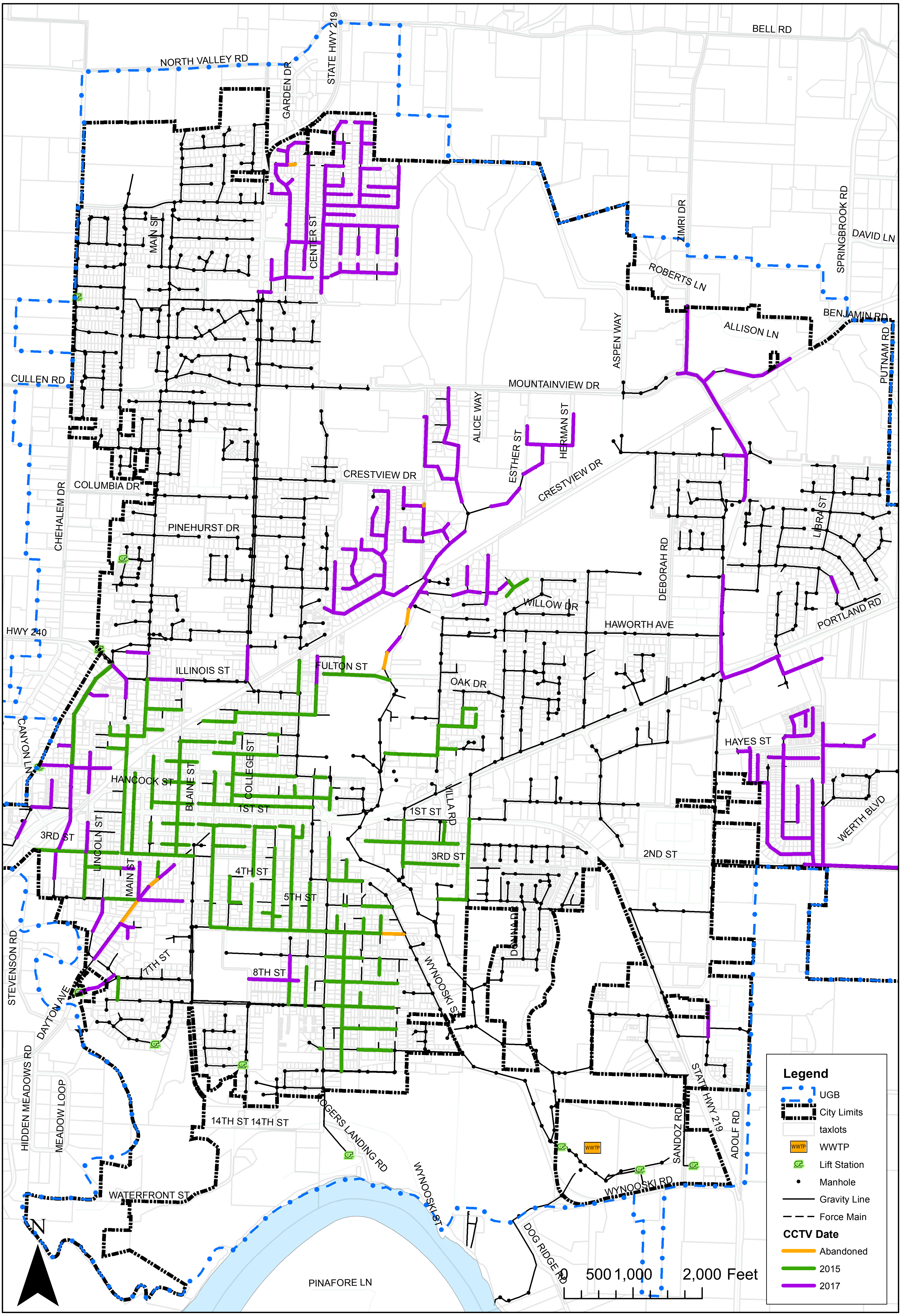
Additional Improvements & Lift Station Consolidation

Wastewater Master Plan

City of Newberg OREGON

Figure 19

City of Newberg, OR
May 2018



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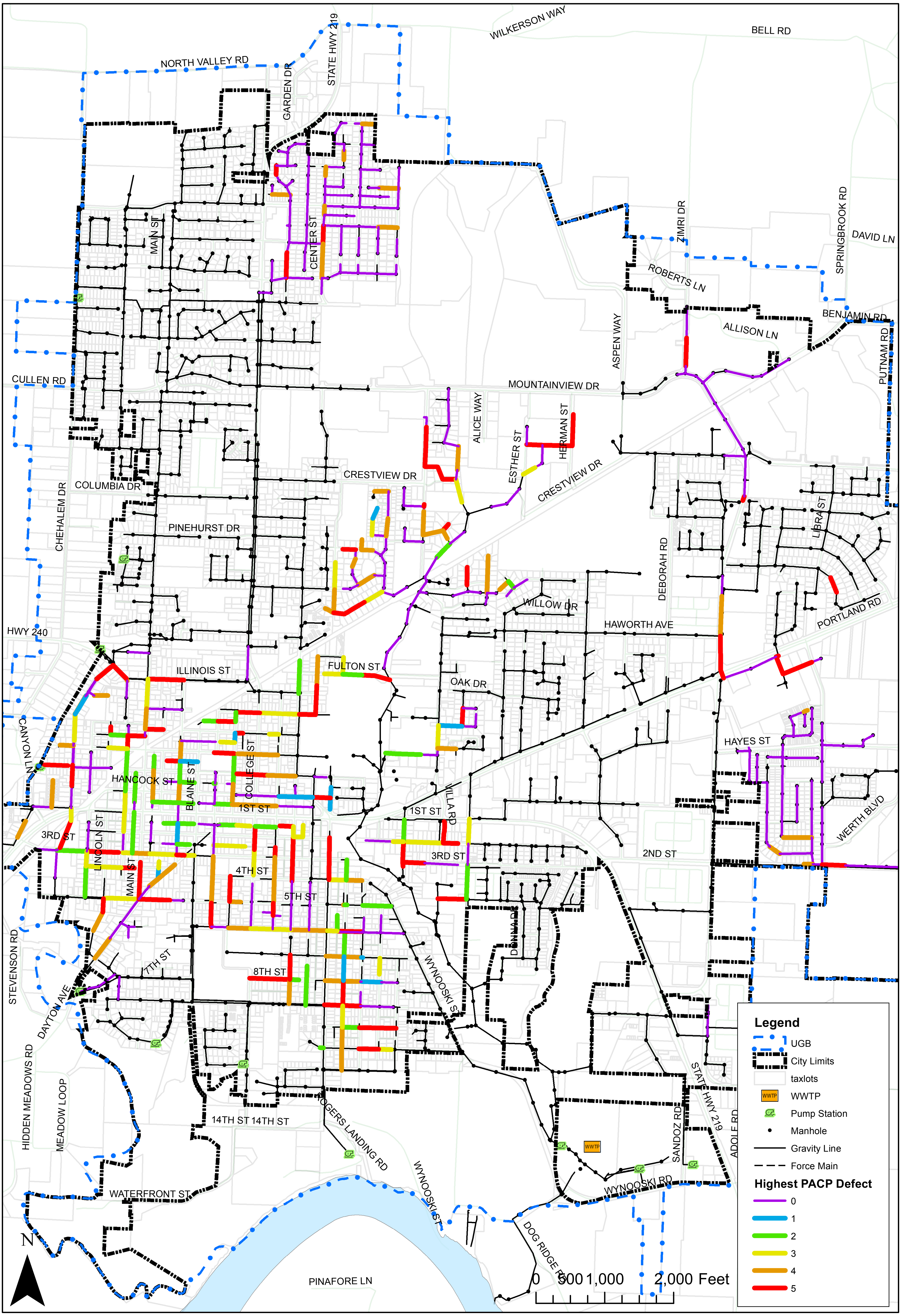
CCTV Inspections Completed

Wastewater Master Plan

City of Newberg OREGON

Figure 20

City of Newberg, OR
May 2018



Highest PACP Grade Defect Found in Pipe

Wastewater Master Plan

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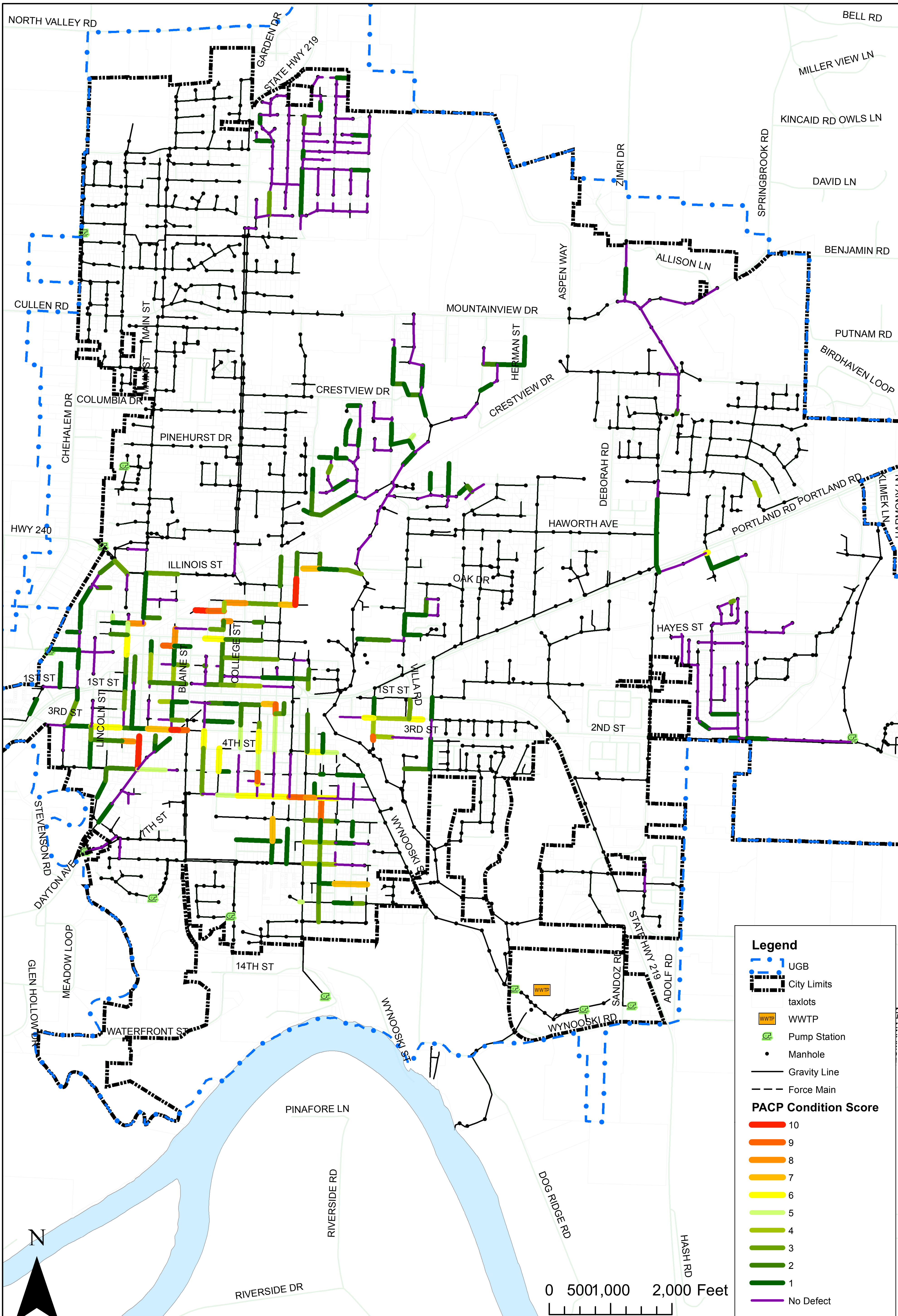
City of Newberg OREGON

Figure 21

City of Newberg, OR
May 2018



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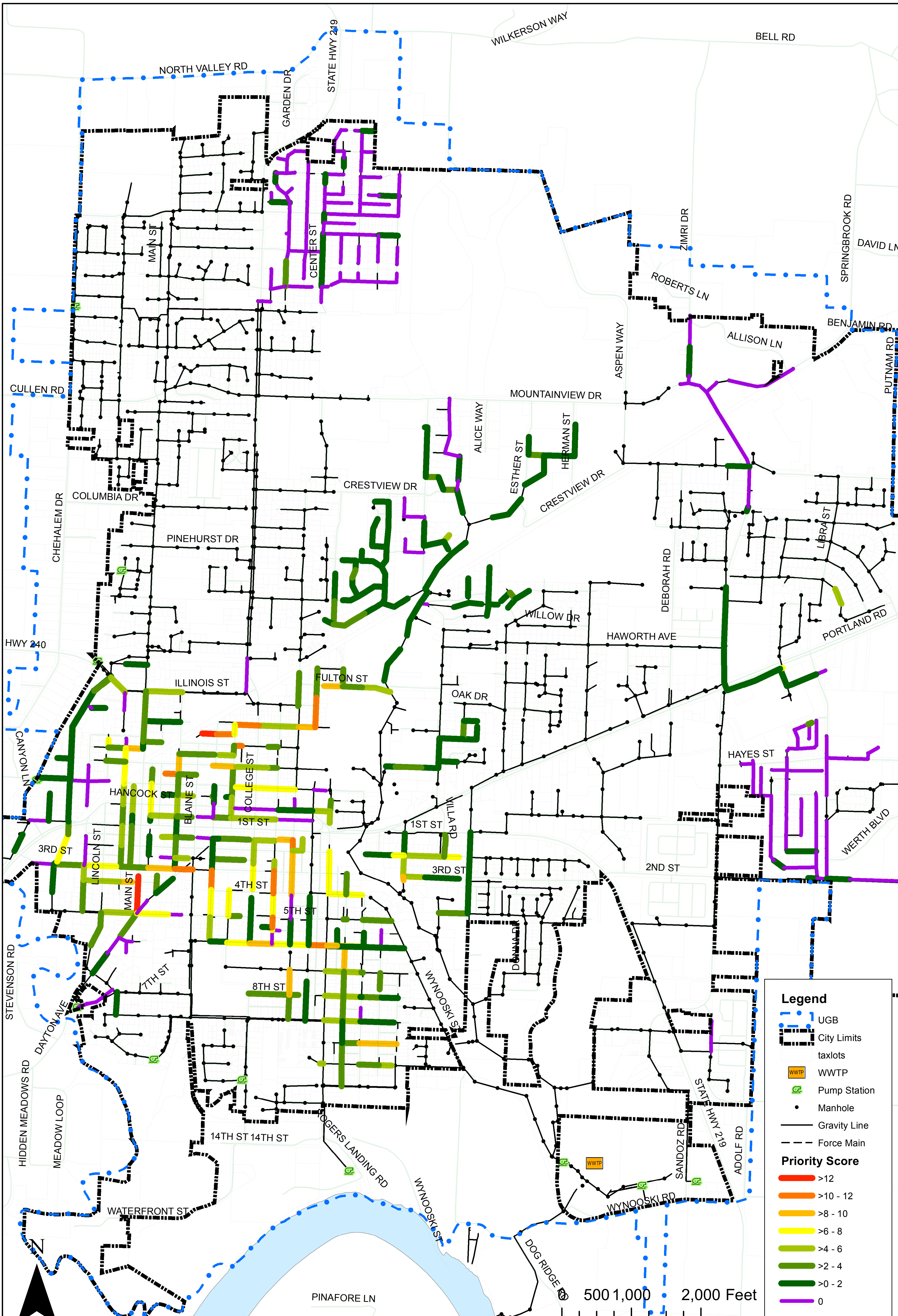
Pipe Condition 1-10 PACP Score

Wastewater Master Plan

City of Newberg OREGON

Figure 22

City of Newberg, OR
May 2018



Pipe Condition, PACP, Material, and Night-time Flow

Wastewater Master Plan

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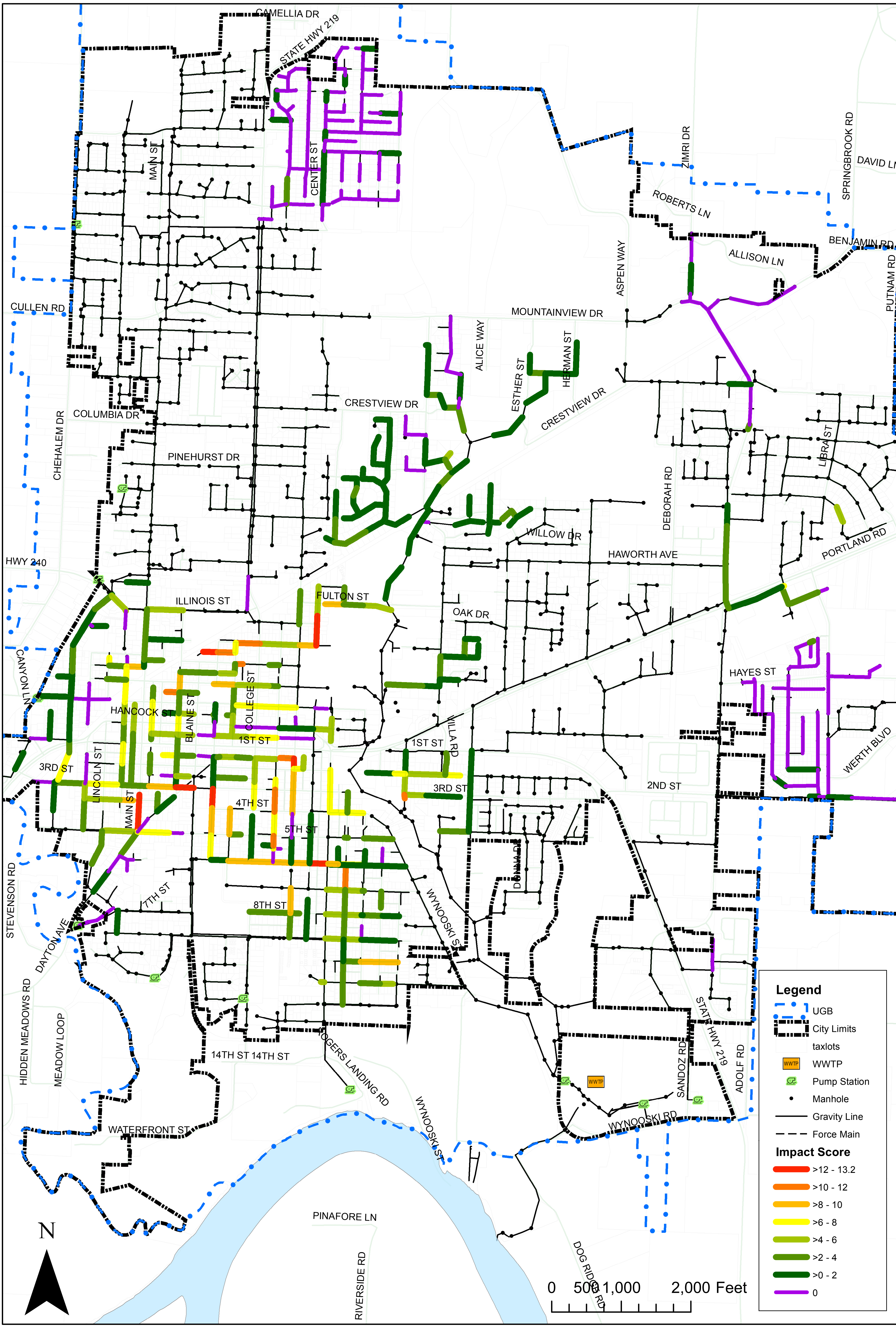
City of Newberg OREGON

Figure 23

City of Newberg, OR
May 2018



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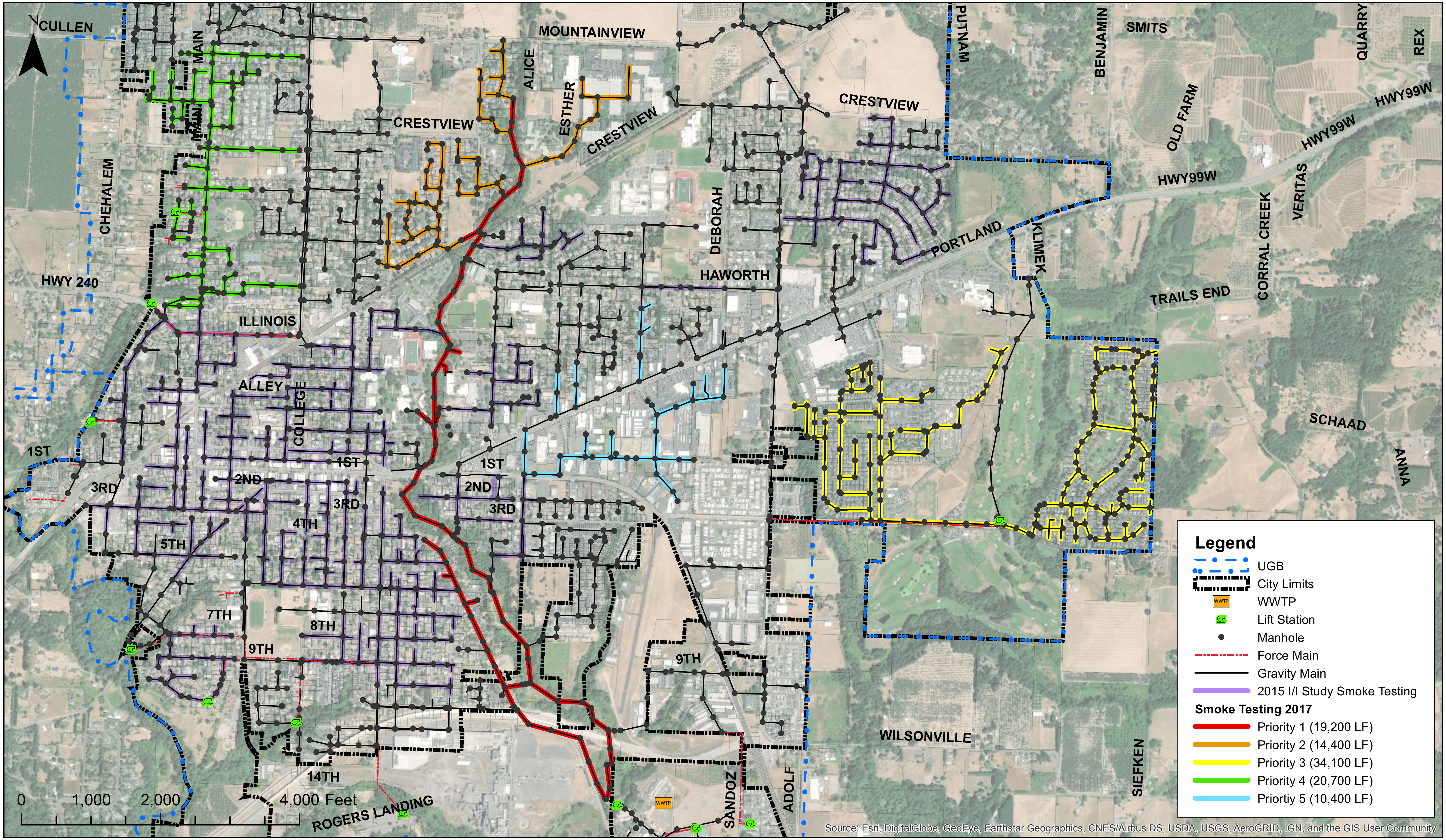
I/I Impact Scores

Wastewater Master Plan

City of Newberg OREGON

Figure 24

City of Newberg, OR
May 2018



2017 Smoke Testing Priorities

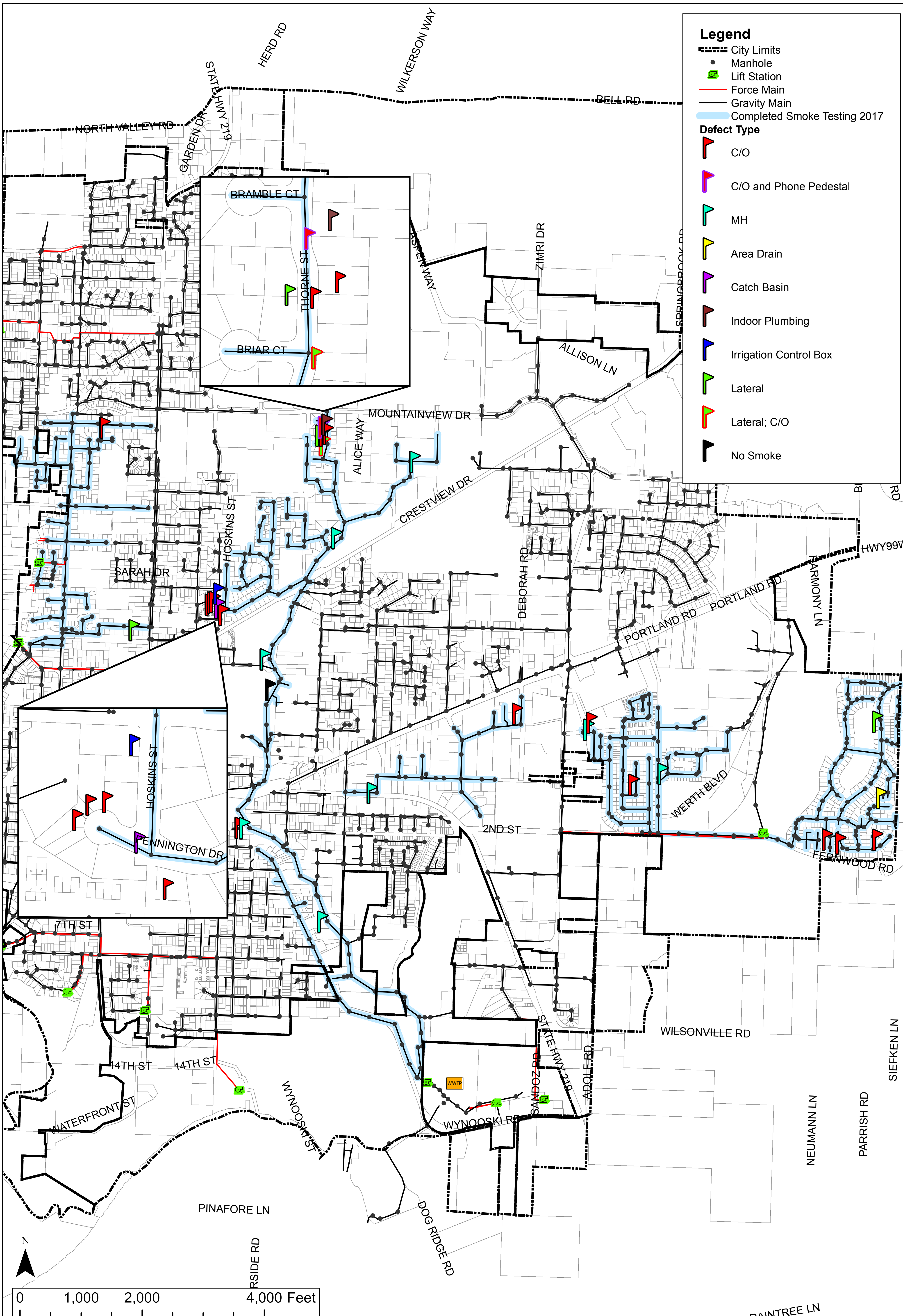
Wastewater Master Plan

KELLER ASSOCIATES

City of Newberg OREGON

Figure 25

City of Newberg, OR
May 2018

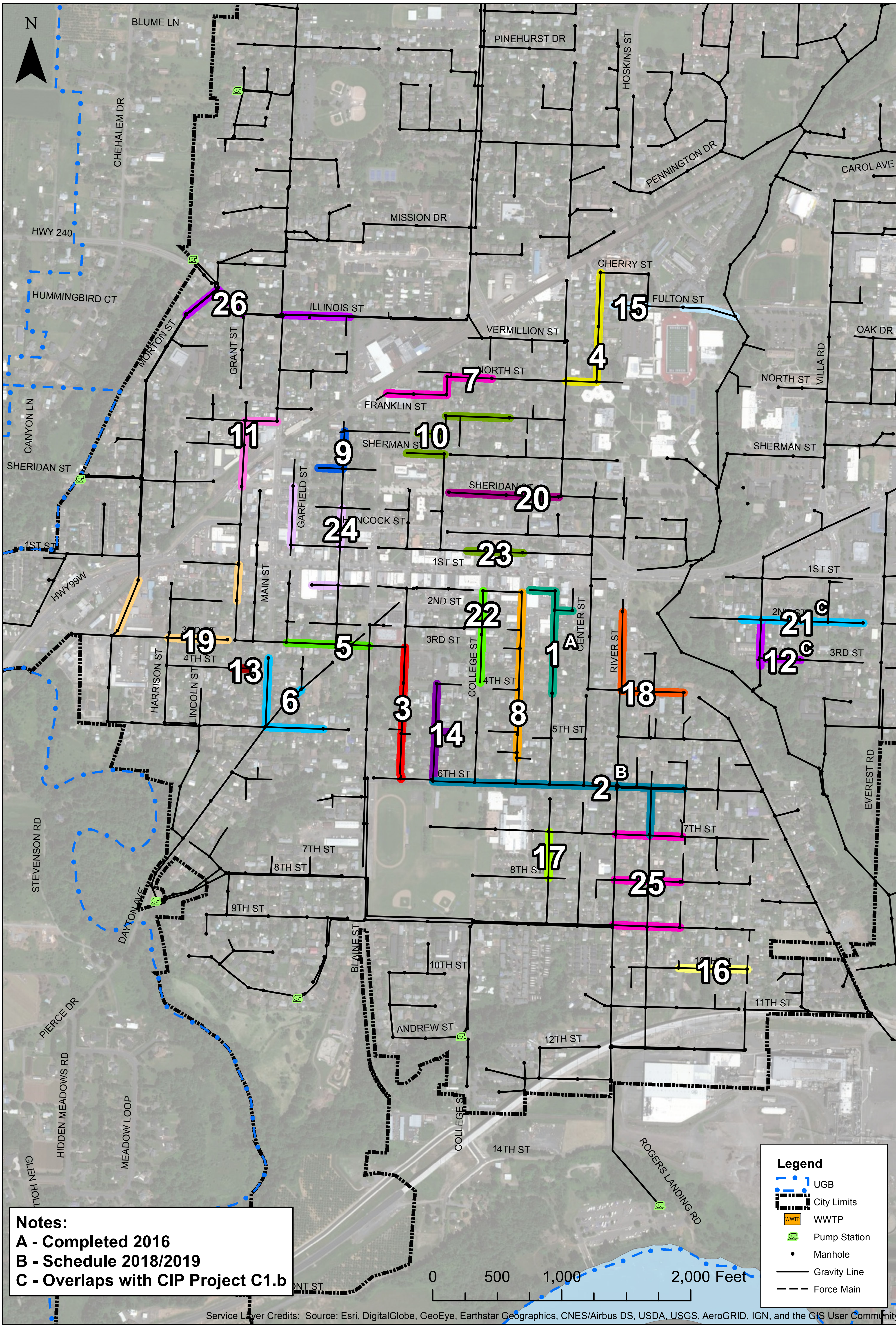


Smoke Testing Results

Wastewater Master Plan

Figure 26

City of Newberg, OR
May 2018



Notes:
A - Completed 2016
B - Schedule 2018/2019
C - Overlaps with CIP Project C1.b

Legend
- UGB
- City Limits
- WWTP
- Pump Station
- Manhole
- Gravity Line
- Force Main

KELLER ASSOCIATES

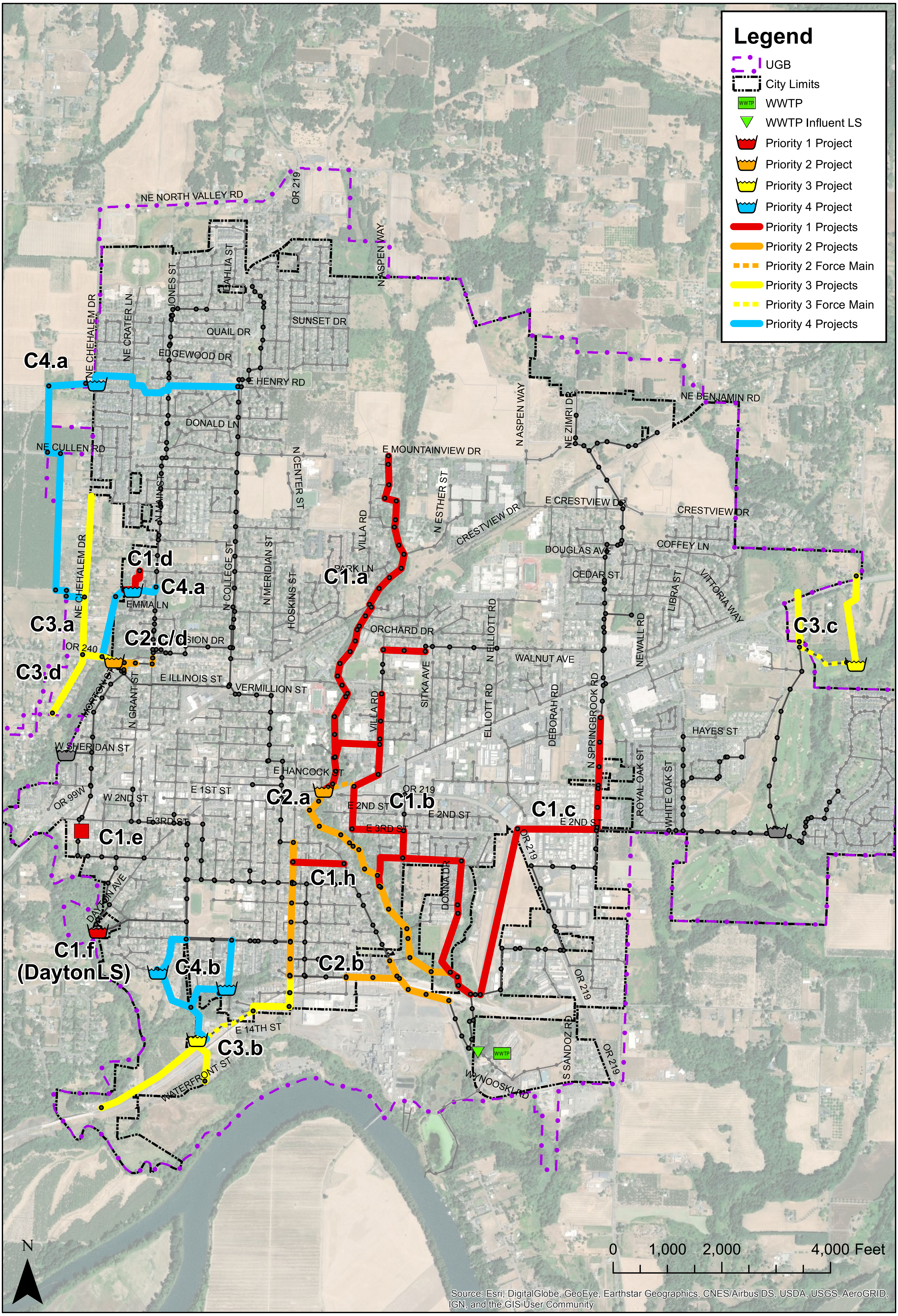
I/I Priority CIP Projects

Wastewater Master Plan

City of Newberg OREGON

Figure 27

City of Newberg, OR
May 2018



Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

KELLER ASSOCIATES

Collection System CIP

Wastewater Master Plan

City of Newberg OREGON

Figure 28

City of Newberg, OR
May 2018

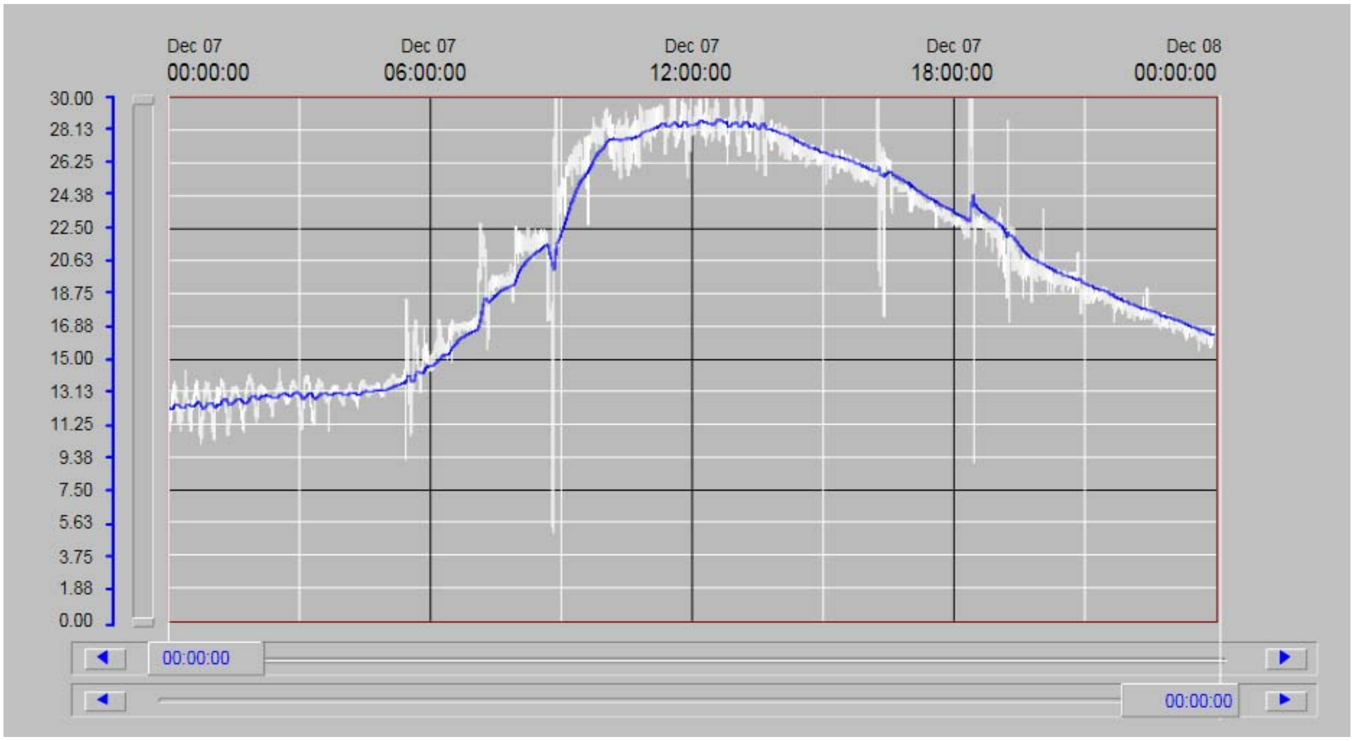
City of Newberg OREGON

Appendix B

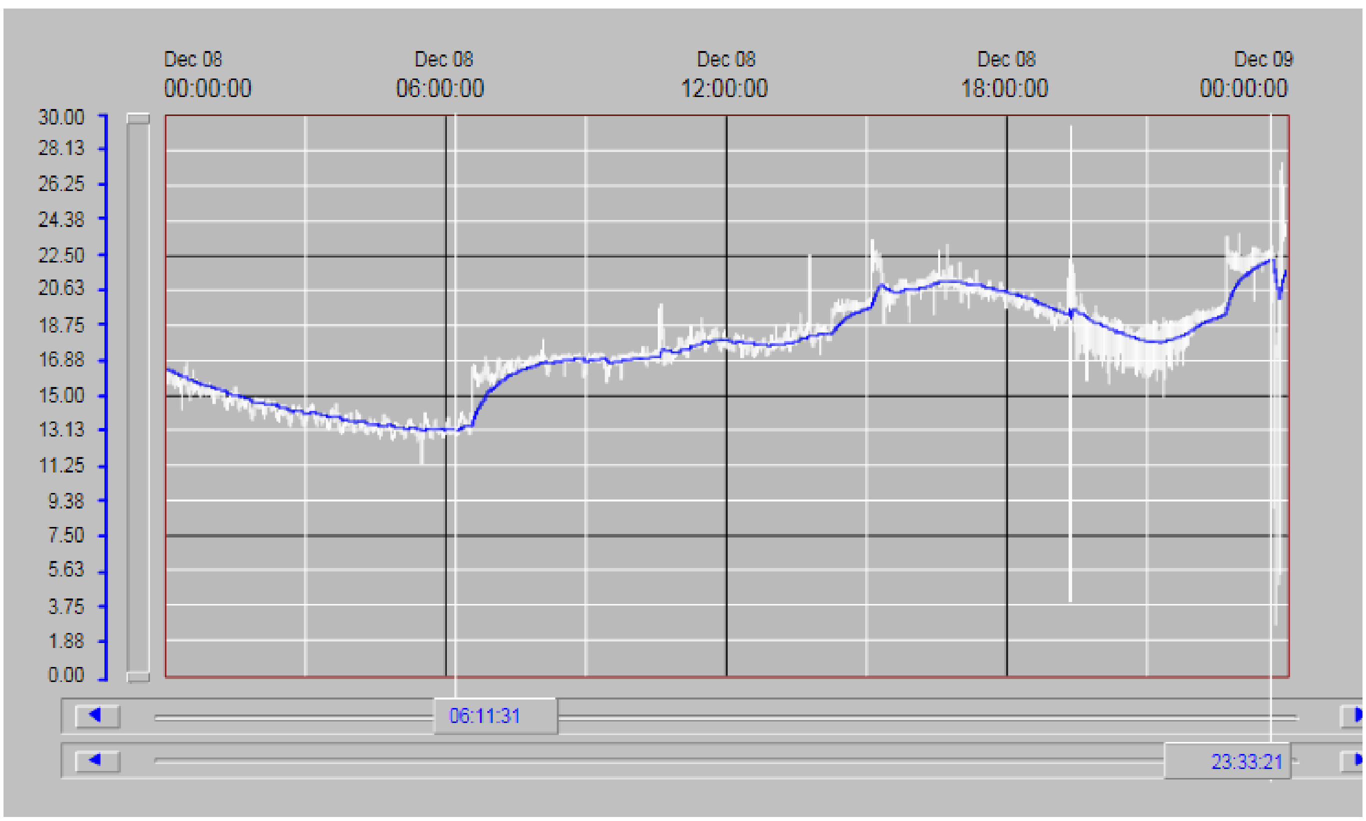
Planning Criteria

KELLER ASSOCIATES

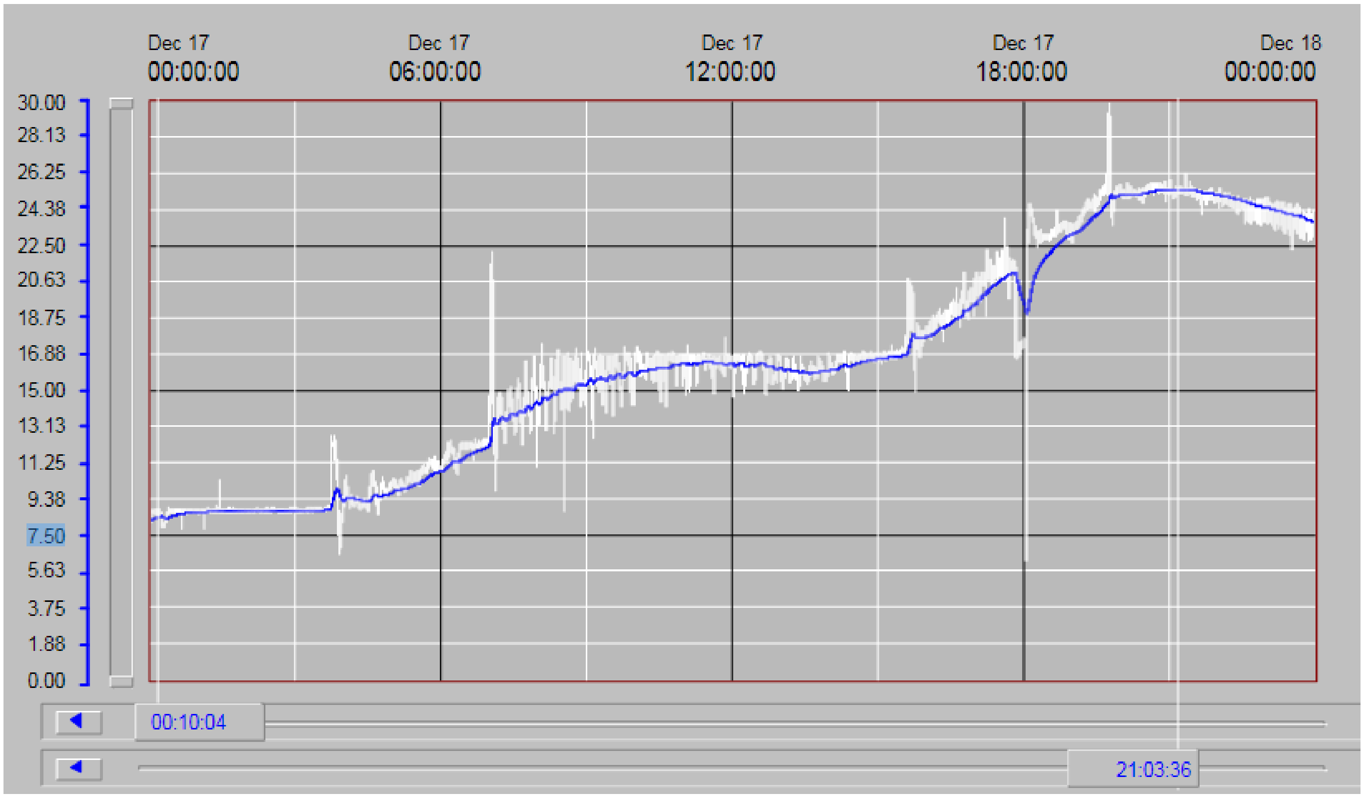
Date:	7-Dec-15			
Flow (MGD):	20.96	PF:	1.34542	
Rainfall (in):	2.16	60 day rainfall:		13.97 in



Date:	8-Dec-15			
Flow (MGD):	19.98	PF:	1.126126	
Rainfall (in):	1.11	60 day rainfall:		15.08 in



Date:	17-Dec-15		
Flow (MGD):	19.81	PF:	1.287229
Rainfall (in):	2.41	60 day rainfall:	20.10 in



ISSUED

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
WASTE DISCHARGE PERMIT

Department of Environmental Quality
Western Region – Salem Office
750 Front Street NE, Suite 120, Salem, OR 97301-1039
Telephone: (503) 378-8240

Issued pursuant to ORS 468B.050 and The Federal Clean Water Act

ISSUED TO:

Newberg, City of
P.O. Box 970
Newberg, OR 97132

SOURCES COVERED BY THIS PERMIT:

Type of Waste	Outfall Number	Outfall Location
Treated Wastewater	001	R.M. 49.7
Emergency Overflows:		
Dayton Avenue PS	002	Chehalem Creek
Andrew Street PS	004	Chehalem Creek
Charles Street PS	005	Chehalem Creek
Chehalem Street PS	006	Chehalem Creek
Creekside Lane PS	007	Chehalem Creek
Sheridan Street PS	008	Chehalem Creek
Fernwood Road PS	009	Sprinbrook Creek

FACILITY TYPE AND LOCATION:

Activated Sludge
Newberg - Wynooski Street STP
2301 Wynooski Street
Newberg, Oregon
Treatment System Class: Level IV
Collection System Class: Level III

RECEIVING STREAM INFORMATION:

Basin: Willamette
Sub-Basin: Middle Willamette
Receiving Stream: Willamette River
LLID: 1227618456580 - 49.7 - D
County: Yamhill

EPA REFERENCE NO: OR003235-2

Issued in response to Application No. 992393 received April 3, 1997.

This permit is issued based on the land use findings in the permit record.

Mark E Hamlin
for Michael H. Kortenhof, Western Region Water Quality Manager

June 22, 2004
Date

PERMITTED ACTIVITIES

Until this permit expires or is modified or revoked, the permittee is authorized to construct, install, modify, or operate a wastewater collection, treatment, control and disposal system and discharge to public waters adequately treated wastewaters only from the authorized discharge point or points established in Schedule A and only in conformance with all the requirements, limitations, and conditions set forth in the attached schedules as follows:

Page

Unless specifically authorized by this permit, by another NPDES or WPCF permit, or by Oregon Administrative Rule, any other direct or indirect discharge to waters of the state is prohibited, including discharge to an underground injection control system.

SCHEDULE A

1. Waste Discharge Limitations not to be exceeded after permit issuance.

a. Treated Effluent Outfall 001

(1) May 1 - October 31:

Parameter	Average Effluent Concentrations		Monthly* Average lb/day	Weekly* Average lb/day	Daily* Maximum lbs
	Monthly	Weekly			
$CBOD_5$ (See Note 1)	10 mg/L	15 mg/L	330	500	660
TSS	10 mg/L	15 mg/L	330	500	660

(2) November 1 - April 30:

Parameter	Average Effluent Concentrations		Monthly* Average lb/day	Weekly* Average lb/day	Daily* Maximum lbs
	Monthly	Weekly			
$CBOD_5$ (See Note 1)	25 mg/L	40 mg/L	1400	2000	2700
TSS	30 mg/L	45 mg/L	1600	2400	3200

* Average dry weather design flow to the facility equals 4.0 MGD. Summer mass load limits based upon average dry weather design flow to the facility. Winter mass load limits based upon average wet weather design flow to the facility equaling 6.5 MGD. The daily mass load limit is suspended on any day in which the daily flow to the treatment facility exceeds 8 MGD (twice the design average dry weather flow).

(3)

Other parameters (year-round)	Limitations
E. coli Bacteria	Shall not exceed 126 organisms per 100 mL monthly geometric mean. No single sample shall exceed 406 organisms per 100 mL. (See Note 3)
pH	Shall be within the range of 6.0 - 9.0
$CBOD_5$ and TSS Removal Efficiency	Shall not be less than 85% monthly average for $CBOD_5$ and 85% monthly for TSS.
Total Residual Chlorine	Shall not exceed a monthly average concentration of 0.02 mg/L and a daily maximum concentration of 0.05 mg/L. (See Note 4)

(4) Except as provided for in OAR 340-045-0080, no wastes shall be discharged and no activities shall be conducted which violate Water Quality Standards as adopted in OAR 340-041 except in the following defined mixing zone:

The allowable mixing zone is that portion of the Willamette River contained within a band extending out seventy five (75) feet from the west bank of the river and extending from a point fifteen (15) feet upstream of the outfall to a point one hundred fifty (150) feet downstream from the outfall. The Zone of Immediate Dilution (ZID) shall be defined as that portion of the allowable mixing zone that is within fifteen (15) feet of the point of discharge.

b. Emergency Overflow Outfalls 002 and 004 through 009

(1) No wastes shall be discharged from these outfalls, unless the cause of the discharge is due to storm events as allowed under OAR 340-041-0120 (13) or (14) as follows:

(2) Raw sewage discharges are prohibited to waters of the State from November 1 through May 21, except during a storm event greater than the one-in-five-year, 24-hour duration storm, and from May 22 through October 31, except during a storm event greater than the one-in-ten-year, 24-hour duration storm. If an overflow occurs between May 22 and June 1, and if the permittee demonstrates to the Department's satisfaction that no increase in risk to beneficial uses occurred because of the overflow, no violation shall be triggered if the storm associated with the overflow was greater than the one-in-five-year, 24-hour duration storm.

c. No activities shall be conducted that could cause an adverse impact on existing or potential beneficial uses of groundwater. All wastewater and process related residuals shall be managed and disposed in a manner that will prevent a violation of the Groundwater Quality Protection Rules (OAR 340-040).

NOTES:

1. The $CBOD_5$ concentration limits are considered equivalent to the minimum design criteria for BOD_5 specified in Oregon Administrative Rules (OAR) 340-041. These limits and $CBOD_5$ mass limits may be adjusted (up or down) by permit action if more accurate information regarding $CBOD_5/BOD_5$ becomes available.

2. At the point of discharge, the Willamette River is water quality limited for temperature (summer), fecal coliform (fall, winter and spring), several toxic parameters (PCB, aldrin, dieldrin, DDT, DDE, iron and mercury) year around and biological criteria (due to skeletal deformities in juvenile squawfish). A Total Maximum Daily Load (TMDL) has not been issued for any of these parameters at the time of permit issuance. Upon EPA approval of a TMDL addressing any of these pollutants, this permit may be reopened to include any Waste Load Allocation (WLA), best management practice or any other condition required by the TMDL.

3. If a single sample exceeds 406 organisms per 100 mL, then five consecutive re-samples may be taken at four-hour intervals beginning within 28 hours after the original sample was taken. If the log mean of the five re-samples is less than or equal to 126 organisms per 100 mL, a violation shall not be triggered.

4. When the total residual chlorine limitation is lower than 0.10 mg/L, the Department will use 0.10 mg/L as the compliance evaluation level (i.e. daily maximum concentrations below 0.10 mg/L will be considered in compliance with the limitation).

SCHEDULE B

1. **Minimum Monitoring and Reporting Requirements** (unless otherwise approved in writing by the Department).

The permittee shall monitor the parameters as specified below at the locations indicated. The laboratory used by the permittee to analyze samples shall have a quality assurance/quality control (QA/QC) program to verify the accuracy of sample analysis. If QA/QC requirements are not met for any analysis, the results shall be included in the report, but not used in calculations required by this permit. When possible, the permittee shall re-sample in a timely manner for parameters failing the QA/QC requirements, analyze the samples, and report the results.

a. Influent

The facility influent cyanide and grab samples and all measurements are taken at the entrance to grit chamber. Composite and metals samples are taken just after the grit chamber. The composite sampler is located in the grit pump room.

Item or Parameter	Minimum Frequency	Type of Sample
Total Flow (MGD)	Daily	Measurement
Flow Meter Calibration	Semi-Annual	Verification
$CBOD_5$	2/Week	Composite
TSS	2/Week	Composite
pH	3/Week	Grab
Toxics:		
Metals (Ag, As, Cd, Cr, Cu, Hg, Mo, Ni, Pb, Se, Zn) & Cyanide, measured as total is mg/L (See Note 1)	Semi-annually using 3 consecutive days between Monday and Friday, inclusive	24-hour daily composite (See Note 2)

b. Treated Effluent Outfall 001

The facility effluent cyanide, bacteria, pH and chlorine residual grab samples and all measurements are taken from the Cipolletti weir discharge. Composite and metals samples are taken just prior to the Cipolletti weir. The composite sampler is located in reclaimed water pump room.

Item or Parameter	Minimum Frequency	Type of Sample
Total Flow (MGD)	Daily	Calculation (see Note 3)
Flow Meter Calibration (see Note 3)	Semi-Annual	Verification
$CBOD_5$	2/Week	Composite
Ammonia (NH3-N)	2/Week	Composite
TSS	2/Week (see Note 4)	Composite
Hardness (mg/L $CaCO_3$)	See Note 4	Grab
pH	3/Week	Grab
Effluent Temperature, Daily Max (See Note 5)	Daily	Continuous
E. coli	2/Week	Grab (See Note 6)
Quantity Chlorine Used	Daily	Measurement
Total Chlorine Residual	Daily	Grab
Pounds Discharged ($CBOD_5$ and TSS)	2/Week	Calculation

b. *Treated Effluent Outfall 001 (continued)*

Item or Parameter	Minimum Frequency	Type of Sample
Average Percent Removed ($CBOD_5$ and TSS)	Monthly	Calculation
Nutrients		
TKN, NO2+NO3-N, Total Phosphorus	1/Week (May-Oct)	24-hour Composite
Toxics:		
Metals (Ag, As, Cd, Cr, Cu, Hg, Mo, Ni, Pb, Se, Zn) & Cyanide, measured as total is mg/L (See Notes 1 and 4)	Semi-annually using 3 consecutive days between Monday and Friday, inclusive	24-hour daily composite (See Note 2)
Iron	Monthly (see Note 7)	24-hour daily composite
Priority Pollutants (see Note 8)	(see Note 8)	24-hour daily composite
Whole Effluent Toxicity (See Note 9)	Annually	Acute & chronic

c. Biosolids Management (see Note 10)

Item or Parameter	Minimum Frequency	Type of Sample
Sludge analysis including: Total Solids (% dry wt.) Volatile solids (% dry wt.) Biosolids nitrogen for: NH_3-N; NO_3-N; & TKN (% dry wt.) Phosphorus (% dry wt.) Potassium (% dry wt.) pH (standard units)	Quarterly	Composite sample to be representative of the product prior to being sold or given away (See Note 11)
Sludge metals content for: Ag, As, Cd, Cr, Cu, Hg, Mo, Ni, Pb, Se & Zn, measured as total in mg/kg	Quarterly	Composite sample to be representative of the product prior to being sold or given away (See Note 11)
Record of amount of Class A biosolids derived material sold or given away.	Each Occurrence	Record of date and volume of compost sold or given away.
Record of locations where Class B biosolids are applied on each DEQ approved site. (Site location maps to be maintained at treatment facility for review upon request by DEQ)	Each Occurrence	Record of date, volume & locations where biosolids were applied recorded on site location map.
Class A PFRP maintain 55C or higher for 3 days or longer.	Daily	Record of temperatures at 55°C or higher
Class B PSRP maintain 40C or higher for 5 days, during which 4 hours must exceed 55C.	Daily	Record of temperatures at 40°C or higher and at 55°C or higher
Vector Attraction Reduction Option #5 at least 14 days at over 40C (104F) with the average temperature of over 45C.	Daily	Record of temperatures at 45°C or higher and at 40°C or higher
Record of compost process time	Quarterly	Record of compost process time by tracking a marker or other known method

c. Biosolids Management (continued)

Item or Parameter	Minimum Frequency	Type of Sample
Fecal coliform bacteria per gram total solids (dry weight basis) or Salmonella sp. bacteria per four grams total solids (dry weight basis)	Quarterly	At least seven (7) individual samples representative of the product to be beneficially used (See Note 11)

d. Emergency Overflow Outfalls 002 and 004 through 009

Item or Parameter	Minimum Frequency	Type of Sample
Flow	Daily (during each occurrence)	Estimate duration and volume

e. Willamette River

Item or Parameter	Minimum Frequency	Type of Sample
Metals (Ag, Cd, Cu, Pb) measured as total in mg/L	Semi-annually during one of the 3 consecutive days of effluent monitoring (See Note 12)	Grab
TSS	See Note 12	Grab
Hardness (mg/L $CaCO_3$)	See Note 12	Grab

2. **Reporting Procedures**

a. Monitoring results shall be reported on approved forms. The reporting period is the calendar month. Reports must be submitted to the appropriate Department office by the 15th day of the following month.

b. State monitoring reports shall identify the name, certificate classification and grade level of each principal operator designated by the permittee as responsible for supervising the wastewater collection and treatment systems during the reporting period. Monitoring reports shall also identify each system classification as found on page one of this permit.

c. Monitoring reports shall also include a record of the quantity and method of use of all sludge removed from the treatment facility and a record of all applicable equipment breakdowns and bypassing.

3. **Report Submittals**

a. The permittee shall have in place a program to identify and reduce inflow and infiltration into the sewage collection system. An annual report shall be submitted to the Department by February 15 each year, which details sewer collection maintenance activities that reduce inflow and infiltration. The report shall state those activities that have been done in the previous year and those activities planned for the following year.

b. For any year in which biosolids are land applied, a report shall be submitted to the Department by February 19 of the following year that describes solids handling activities for the previous year and includes, but is not limited to, the required information outlined in OAR 340-050-0035(6)(a)-(e).

c. An annual report covering temperature monitoring done in the calendar year is due by February 15th of the following year. The report shall include results of any temperature monitoring conducted on the influent, sidestreams or the Willamette River. The report shall include calculations of the weekly averages of the daily maximum temperatures of the effluent.

NOTES:

1. For influent and effluent cyanide samples, at least six (6) discrete grab samples shall be collected over the operating day. Each aliquot shall not be less than 100 mL and shall be collected and composited into a larger container, which has been preserved with sodium hydroxide for cyanide samples to insure sample integrity.

2. Daily 24-hour composite samples shall be analyzed and reported separately. Toxic monitoring results and toxics removal efficiency calculations shall be tabulated and submitted with the Pretreatment Program Annual Report as required in Schedule E. Submittal of toxic monitoring results with the monthly Discharge Monitoring Report is not required.

3. The effluent flow is to be calculated based on the influent flow and adjusted by measure and/or estimated side stream flows. Where possible, calibration of side stream flow meters shall be performed at the frequency specified.

4. During the first two years after permit issuance, special monitoring for cadmium, copper, lead, mercury and silver shall be conducted on the effluent during at least one of the three consecutive days of monitoring. TSS and hardness shall be monitored simultaneously. The special monitoring for cadmium, copper, lead and silver shall be conducted using a "clean" sampling method, an "ultra-clean" sampling method, EPA method 1669 or any other test method approved by the Department. The special monitoring for mercury shall be conducted in accordance with EPA Method 1631. At the permittee's option, the results of the special monitoring may be used for one or more of the three consecutive days monitoring that is required on a semi-annual basis. After the first two years, special monitoring of the effluent for cadmium, copper, lead, mercury and silver may be eliminated unless otherwise notified in writing by the Department. For all tests, the method detection limit *shall be reported along with the sample result.*

5. When continuous monitors are used, record the time between temperature readings, and results are to be tabulated and submitted in an annual report. Continuous temperature monitors must be audited in June and December, following procedures described in DEQ Procedural Guidance for Water Temperature Monitoring. Continuous temperature monitors are to be checked visually monthly to insure that the devices are still in place and submerged.

6. *E. coli* monitoring must be conducted according to any of the following test procedures as specified in **Standard Methods for the Examination of Water and Wastewater, 19th Edition**, or according to any test procedure that has been authorized and approved in writing by the Director or an authorized representative:

Method	Reference	Page	Method Number
mTEC agar, MF	Standard Methods, 18th Edition	9-29	9213 D
NA-MUG, MF	Standard Methods, 19th Edition	9-63	9222 G
Chromogenic Substrate, MPN	Standard Methods, 19th Edition	9-65	9223 B
Colilert QT	Idexx Laboratories, Inc.		

7. During the first year after permit issuance, monitoring for iron shall be conducted on the effluent at the frequency specified. The method detection limit must be lower than 0.3 mg/L. After the first year, iron monitoring of the effluent may be eliminated unless otherwise notified in writing by the Department. For all tests, the method detection limit shall be reported along with the sample result.

8. The permittee shall perform all testing required in Part D of EPA Form 2A. The testing includes all metals (total recoverable), cyanide, phenols, hardness and the 85 pollutants included under volatile organic, acid extractable and base-neutral compounds. In addition, the permittee shall monitor for the pesticide pollutants listed in Table II of Appendix D of 40 CFR Part 122. Three scans are required during the 4 ½ years after

permit issuance. Two of the three scans must be performed no fewer than 4 months and no more than 8 months apart. The effluent samples shall be 24-hour daily composites, except where sampling volatile compounds. In this case, six (6) discrete samples (not less than 100 mL) collected over the operating day are acceptable. The permittee shall take special precautions in compositing the individual grab samples for the volatile organics to insure sample integrity (i.e. no exposure to the outside air). Alternately, the discrete samples collected for volatiles may be analyzed separately and averaged.

9. Beginning no later than calendar year 2004, the permittee shall conduct Whole Effluent Toxicity testing for a period of four (4) years in accordance with the frequency specified above. If the Whole Effluent Toxicity tests show that the effluent samples are not toxic at the dilutions determined to occur at the Zone of Immediate Dilution and the Mixing Zone, no further Whole Effluent Toxicity testing will be required during this permit cycle. Note that four Whole Effluent Toxicity test results will be required along with the next NPDES permit renewal application.

10. If alternative methods of demonstrating compliance with federal pathogen reduction and/or vector attraction reduction requirements are used, the monitoring and sampling frequency shall be based on 40 CFR Part 503 and shall conform to the approved Biosolids Management Plan.

11. Composite samples from the Compost pile shall be taken from reference areas in the Compost pile pursuant to Test Methods for Evaluating Solid Waste, Volume 2; Field Manual, Physical/Chemical Methods, November 1986, Third Edition, Chapter 9.

    Inorganic pollutant monitoring must be conducted according to Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Second Edition (1982) with Updates I and II and third Edition (1986) with Revision I.

12. During the first two years after permit issuance, the Willamette River shall be monitored for cadmium, copper, lead, silver, TSS and hardness when special monitoring of the effluent is conducted (see Note 5). The Willamette River monitoring for cadmium, copper, lead and silver shall be conducted using a "clean" sampling method, an "ultra-clean" sampling method, EPA method 1669 or any other test method approved by the Department. After the first two years, Willamette River monitoring for cadmium, copper, lead and silver may be eliminated. For all tests, the method detection limit shall be reported along with the sample result. The Willamette River shall be sampled for hardness at the same time the river is sampled for metals.

SCHEDULE C

Compliance Schedules and Conditions

1. Within 180 days of permit issuance, the permittee shall submit to the Department for review and approval a proposed program and time schedule for identifying and reducing inflow. Within 60 days of receiving written Department comments, the permittee shall submit a final approvable program and time schedule. The program shall consist of the following:

   a. Identification of all overflow points and verification that sewer system overflows are not occurring up to a 24-hour, 5-year storm event or equivalent;

   b. Monitoring of all pump station overflow points;

   c. A program for identifying and removing all inflow sources into the permittee's sewer system over which the permittee has legal control; and

   d. If the permittee does not have the necessary legal authority for all portions of the sewer system or treatment facility, a program and schedule for gaining legal authority to require inflow reduction and a program and schedule for removing inflow sources.

2. By no later than ninety (90) days after permit issuance, the permittee shall submit to the Department a report which either identifies known sewage overflow locations and a plan for estimating the frequency, duration and quantity of sewage overflowing, or confirms that there are no overflow points. The report shall also provide a schedule to eliminate the overflow(s), if any.

3. By no later than June 30, 2005, the permittee shall submit to the Department for approval Sewer Use Ordinance revisions. The permittee shall conduct a comprehensive review of the City's sewer use ordinance to ensure consistency with 40 CFR § 403 pretreatment regulations and USEPA Region 10 Model Sewer Use Ordinance and revise as necessary to provide the legal authorities to fully implement the federal industrial pretreatment program. (See Note 1)

4. By no later than June 30, 2006, the permittee shall submit to DEQ for approval local limits developed with an emphasis on maximum allowable headworks loading (MAHL) and in accordance with 40 CFR § 403.5(c)(1). (See Note 1)

5. By no later than June 30, 2006, the permittee shall submit to the Department for approval pretreatment program implementation procedures. The procedures must include but not be limited to, industrial user survey, permit application procedure, permit process, IU notification procedures, self monitoring report, inspection procedures, sampling requirements, investigations, budget requirements, data base management, sewer use charges and enforcement response plan. (See Note 1)

6. The permittee is expected to meet the compliance dates, which have been established in this schedule. Either prior to or no later than 14 days following any lapsed compliance date, the permittee shall submit to the Department a notice of compliance or noncompliance with the established schedule. The Director may revise a schedule of compliance if he/she determines good and valid cause resulting from events over which the permittee has little or no control.

NOTE:

1. In the event the City of Newberg or the Department determine the City has acquired a categorical or significant industrial user as defined in 40 CFR § 403.3, the City must submit a revised schedule of

compliance to condense the time allowed to develop a fully functional pretreatment program. The amount of time will be dependent on the circumstances at the time including the City's progress toward developing the pretreatment program and timing of the industry connecting to the sewer but in no case shall exceed one hundred eighty (180) days. Any revised time schedule must be approved by the Department.

SCHEDULE D

Special Conditions

1. All biosolids shall be managed in accordance with the current, DEQ approved biosolids management plan. Any changes in solids management activities that significantly differ from operations specified under the approved plan require the prior written approval of the DEQ. Land application of Class B biosolids is allowed only after site authorization approval is issued by the Department in accordance with the biosolids management plan.

2. This permit may be modified to incorporate any applicable standard for biosolids use or disposal promulgated under section 405(d) of the Clean Water Act, if the standard for biosolids use or disposal is more stringent than any requirements for biosolids use or disposal in the permit, or controls a pollutant or practice not limited in this permit.

   Biosolids that do not meet Class A pathogen and vector attraction reduction requirements of 40 CFR Part 503 or that contain metal concentrations greater than the concentration specified in 40 CRF 503.13 Table 3 shall not be sold or given away.

3. **Whole Effluent Toxicity Testing**

   a. The permittee shall conduct whole effluent toxicity tests as specified in Schedule B of this permit.

   b. Bioassay tests may be dual end-point tests, only for the fish tests, in which both acute and chronic end-points can be determined from the results of a single chronic test (the acute end-point shall be based upon a 48-hour time period).

   c. Acute Toxicity Testing - Organisms and Protocols

      (1) The permittee shall conduct 48-hour static renewal tests with the *Ceriodaphnia dubia* (water flea) and the *Pimephales promelas* (fathead minnow).

      (2) The presence of acute toxicity will be determined as specified in **Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms**, Fourth Edition, EPA/600/4-90/027F, August 1993.

      (3) An acute bioassay test shall be considered to show toxicity if there is a statistically significant difference in survival between the control and 100 percent effluent, unless the permit specifically provides for a Zone of Immediate Dilution (ZID) for toxicity. If the permit specifies such a ZID, acute toxicity shall be indicated when a statistically significant difference in survival occurs at dilutions greater than that which is found to occur at the edge of the ZID.

   d. Chronic Toxicity Testing - Organisms and Protocols

      (1) The permittee shall conduct tests with: *Ceriodaphnia dubia* (water flea) for reproduction and survival test endpoint, *Pimephales promelas* (fathead minnow) for growth and survival test endpoint, and *Raphidocelis subcapitata* (green alga formerly known as *Selanastrum capricornutum*) for growth test endpoint.

      (2) The presence of chronic toxicity shall be estimated as specified in **Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms**, Third Edition, EPA/600/4-91/002, July 1994.

(3) A chronic bioassay test shall be considered to show toxicity if a statistically significant difference in survival, growth, or reproduction occurs at dilutions greater than that which is known to occur at the edge of the mixing zone. If there is no dilution data for the edge of the mixing zone, any chronic bioassay test that shows a statistically significant effect in 100 percent effluent as compared to the control shall be considered to show toxicity.

e. Quality Assurance

(1) Quality assurance criteria, statistical analyses and data reporting for the bioassays shall be in accordance with the EPA documents stated in this condition and the Department's **Whole Effluent Toxicity Testing Guidance Document**, January 1993.

f. Evaluation of Causes and Exceedances

(1) If toxicity is shown, as defined in sections c.(3) or d.(3) of this permit condition, another toxicity test using the same species and Department approved methodology shall be conducted within two weeks, unless otherwise approved by the Department. If the second test also indicates toxicity, the permittee shall follow the procedure described in section f.(2) of this permit condition.

(2) If two consecutive bioassay test results indicate acute and/or chronic toxicity, as defined in sections c.(3) or d.(3) of this permit condition, the permittee shall evaluate the source of the toxicity and submit a plan and time schedule for demonstrating compliance with water quality standards. Upon approval by the Department, the permittee shall implement the plan until compliance has been achieved. Evaluations shall be completed and plans submitted to the Department within 6 months unless otherwise approved in writing by the Department.

g. Reporting

(1) Along with the test results, the permittee shall include: 1. the dates of sample collection and initiation of each toxicity test; 2. the type of production; and 3. the flow rate at the time of sample collection. Effluent at the time of sampling for bioassay testing should include samples of required parameters stated under Schedule B, condition 1. of this permit.

(2) The permittee shall make available to the Department, on request, the written standard operating procedures they, or the laboratory performing the bioassays, are using for all toxicity tests required by the Department.

h. Reopener

(1) If bioassay testing indicates acute and/or chronic toxicity, the Department may reopen and modify this permit to include new limitations and/or conditions as determined by the Department to be appropriate, and in accordance with procedures outlined in Oregon Administrative Rules, Chapter 340, Division 45.

4. The permittee shall comply with Oregon Administrative Rules (OAR), Chapter 340, Division 49, "Regulations Pertaining To Certification of Wastewater System Operator Personnel" and accordingly:

a. The permittee shall have its wastewater system supervised by one or more operators who are certified in a classification <u>and</u> grade level (equal to or greater) that corresponds with the classification (collection and/or treatment) of the system to be supervised as specified on page one of this permit.

Note: **A "supervisor" is defined as the person exercising authority for establishing and executing the specific practice and procedures of operating the system in accordance with the policies of the permittee and requirements of the waste discharge permit. "Supervise" means responsible for the technical operation of a system, which may affect its performance or the quality of the effluent produced. Supervisors are not required to be on-site at all times.**

b. The permittee's wastewater system may not be without supervision (as required by Special Condition 4.a. above) for more than thirty (30) days. During this period, and at any time that the supervisor is not available to respond on-site (i.e. vacation, sick leave or off-call), the permittee must make available another person who is certified at no less than one grade lower then the system classification.

c. If the wastewater system has more than one daily shift, the permittee shall have the shift supervisor, if any, certified at no less than one grade lower than the system classification.

d. The permittee is responsible for ensuring the wastewater system has a properly certified supervisor available at all times to respond on-site at the request of the permittee and to any other operator.

e. The permittee shall notify the Department of Environmental Quality in writing within thirty (30) days of replacement or redesignation of certified operators responsible for supervising wastewater system operation. The notice shall be filed with the Water Quality Division, Operator Certification Program, 811 SW 6th Ave, Portland, OR 97204. This requirement is in addition to the reporting requirements contained under Schedule B of this permit.

f. Upon written request, the Department may grant the permittee reasonable time, not to exceed 120 days, to obtain the services of a qualified person to supervise the wastewater system. The written request must include justification for the time needed, a schedule for recruiting and hiring, the date the system supervisor availability ceased and the name of the alternate system supervisor(s) as required by 4.b. above.

5. The permittee shall notify the appropriate DEQ Office in accordance with the response times noted in the General Conditions of this permit, of any malfunction that could result in a permit violation or endanger public health or the environment so that corrective action can be coordinated between the permittee and the Department.

6. Unless otherwise approved in writing by the Department, all inflow sources are to be permanently disconnected from the sanitary sewer system in accordance with the approved inflow removal plan required by Schedule C, Condition 1.

7. The permittee shall not be required to perform a hydrogeologic characterization or groundwater monitoring during the term of this permit provided:

a. The facilities are operated in accordance with the permit conditions, and;

b. There are no adverse groundwater quality impacts (complaints or other indirect evidence) resulting from the facility's operation.

If warranted, at permit renewal the Department may evaluate the need for a full assessment of the facilities impact on groundwater quality.

SCHEDULE E

Pretreatment Activities

Upon Permit issuance, the permittee shall implement the following pretreatment activities:

1. The permittee shall update its inventory of industrial users at a frequency and diligence adequate to ensure proper identification of industrial users subject to pretreatment standards, but no less than once per year. The permittee shall notify these industrial users of applicable pretreatment standards in accordance with 40 CFR § 403.8(f)(2)(iii).

2. The permittee must develop and maintain a data management system designed to track the status of the industrial user inventory, discharge characteristics, and compliance. In accordance with 40 CFR § 403.12(o), the permittee shall retain all records relating to pretreatment program activities for a minimum of three years, and shall make such records available to the Department and USEPA upon request. The permittee shall also provide public access to information considered effluent data under 40 CFR Part 2.

3. The permittee shall submit by March 1 of each year, a report that describes the permittee's pretreatment program during the previous calendar year. The content and format of this report shall be as established by the Department.

4. The permittee shall submit in writing to the Department a statement of the basis for any proposed modification of its approved program and a description of the proposed modification in accordance with 40 CFR § 403.18. No substantial program modifications may be implemented by the permittee prior to receiving written authorization from the Department.

Upon Department approval of the revised pretreatment program procedures (required by Schedule C, Conditions 3, 4 and 5), the permittee shall implement the following pretreatment activities:

5. The permittee shall conduct and enforce its Pretreatment Program, as approved by the Department, and comply with the General Pretreatment Regulations (40 CFR Part 403). The permittee shall secure and maintain sufficient resources and qualified personnel to carry out the program implementation procedures described in this permit.

6. The permittee shall adopt all legal authority necessary to fully implement its approved pretreatment program and to comply with all applicable State and Federal pretreatment regulations. The permittee must also establish, where necessary, contracts or agreements with contributing jurisdictions to ensure compliance with pretreatment requirements by industrial users within these jurisdictions. These contracts or agreements shall identify the agency responsible for all implementation and enforcement activities to be performed in the contributing jurisdictions. Regardless of jurisdictional situation, the permittee is responsible for ensuring that all aspects of the pretreatment program are fully implemented and enforced.

7. The permittee shall enforce categorical pretreatment standards promulgated pursuant to Section 307(b) and (c) of the Act, prohibited discharge standards as set forth in 40 CFR § 403.5(a) and (b), or local limitations developed by the permittee in accordance with 40 CFR § 403.5(c), whichever are more stringent, or are applicable to nondomestic users discharging wastewater to the collection system. Locally derived discharge limitations shall be defined as pretreatment standards under Section 307(d) of the Act.

   A technical evaluation of the need to revise local limits shall be performed at least once during the term of this permit and must be submitted to the Department as part of the permittee's NPDES permit application, unless the Department requires in writing that it be submitted sooner. Limits development will be in accordance with the procedures established by the Department.

8. The permittee shall issue individual discharge permits to all Significant Industrial Users in a timely manner. The permittee shall also reissue and/or modify permits, where necessary, in a timely manner. Discharge permits must contain, at a minimum, the conditions identified in 40 CFR § 403.8(f)(1)(iii). Unless a more stringent definition has been adopted by the permittee, the definition of Significant Industrial User shall be as stated in 40 CFR § 403.3(t).

9. The permittee shall randomly sample and analyze industrial user effluents at a frequency commensurate with the character, consistency, and volume of the discharge. At a minimum, the permittee shall sample all Significant Industrial Users for all regulated pollutants twice per year. Alternatively, at a minimum, the permittee shall sample all Significant Industrial Users for all regulated pollutants once per year, if the permittee has pretreatment program criteria in its approved procedures for determining appropriate sampling levels for industrial users, and provided the sampling criteria indicate once per year sampling is adequate. At a minimum, the permittee shall conduct a complete facility inspection once per year. Additionally, at least once every two years the permittee shall evaluate the need for each Significant Industrial User to develop a slug control plan. Where a plan is deemed necessary, it shall conform to the requirements of 40 CFR § 403.8(f)(2)(v).

   Where the permittee elects to conduct all industrial user monitoring in lieu of requiring self-monitoring by the user, the permittee shall gather all information which would otherwise have been submitted by the user. The permittee shall also perform the sampling and analyses in accordance with the protocols established for the user.

   Sample collection and analysis, and the gathering of other compliance data, shall be performed with sufficient care to produce evidence admissible in enforcement proceedings or in judicial actions. Unless specified otherwise by the Director in writing, all sampling and analyses shall be performed in accordance with 40 CFR Part 136.

10. The permittee shall review reports submitted by industrial users and identify all violations of the user's permit or the permittee's local ordinance.

11. The permittee shall investigate all instances of industrial user noncompliance and shall take all necessary steps to return users to compliance. The permittee's enforcement actions shall track its approved Enforcement Response Plan, developed in accordance with 40 CFR § 403.8(f)(5). If the permittee has not developed an approved Enforcement Response Plan, it shall develop and submit a draft to the Department for review within 90 days of the issuance of this permit.

12. The permittee shall publish, at least annually in the largest daily newspaper published in the permittee's service area, a list of all industrial users which, at any time in the previous 12 months, were in Significant Noncompliance with applicable pretreatment requirements. For the purposes of this requirement, an industrial user is in Significant Noncompliance if it meets one or more of the criteria listed in 40 CFR 403.8(f)(2)(vii).

NPDES GENERAL CONDITIONS
(SCHEDULE F)

SECTION A. STANDARD CONDITIONS

1. Duty to Comply

The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of Oregon Revised Statutes (ORS) 468B.025 and is grounds for enforcement action; for permit termination, suspension, or modification; or for denial of a permit renewal application.

2. Penalties for Water Pollution and Permit Condition Violations

Oregon Law (ORS 468.140) allows the Director to impose civil penalties up to $10,000 per day for violation of a term, condition, or requirement of a permit.

In addition, a person who unlawfully pollutes water as specified in ORS 468.943 or ORS 468.946 is subject to criminal prosecution.

3. Duty to Mitigate

The permittee shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment. In addition, upon request of the Department, the permittee shall correct any adverse impact on the environment or human health resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

4. Duty to Reapply

If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and have the permit renewed. The application shall be submitted at least 180 days before the expiration date of this permit.

The Director may grant permission to submit an application less than 180 days in advance but no later than the permit expiration date.

5. Permit Actions

This permit may be modified, suspended, revoked and reissued, or terminated for cause including, but not limited to, the following:

a. Violation of any term, condition, or requirement of this permit, a rule, or a statute;

b. Obtaining this permit by misrepresentation or failure to disclose fully all material facts; or

c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

The filing of a request by the permittee for a permit modification or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

6. Toxic Pollutants

The permittee shall comply with any applicable effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

7. Property Rights

The issuance of this permit does not convey any property rights of any sort, or any exclusive privilege.

8. Permit References

Except for effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants and standards for sewage sludge use or disposal established under Section 405(d) of the Clean Water Act, all rules and statutes referred to in this permit are those in effect on the date this permit is issued.

SECTION B. OPERATION AND MAINTENANCE OF POLLUTION CONTROLS

1. Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls, and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems that are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit.

2. Duty to Halt or Reduce Activity

For industrial or commercial facilities, upon reduction, loss, or failure of the treatment facility, the permittee shall, to the extent necessary to maintain compliance with its permit, control production or all discharges or both until the facility is restored or an alternative method of treatment is provided. This requirement applies, for example, when the primary source of power of the treatment facility fails or is reduced or lost. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

3. Bypass of Treatment Facilities

a. Definitions

(1) "Bypass" means intentional diversion of waste streams from any portion of the treatment facility. The term "bypass" does not include nonuse of singular or multiple units or processes of a treatment works when the nonuse is insignificant to the quality and/or quantity of the effluent produced by the treatment works. The term "bypass" does not apply if the diversion does not cause effluent limitations to be exceeded, provided the diversion is to allow essential maintenance to assure efficient operation.

(2) "Severe property damage" means substantial physical damage to property, damage to the treatment facilities or treatment processes which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

b. Prohibition of bypass.

(1) Bypass is prohibited unless:

(a) Bypass was necessary to prevent loss of life, personal injury, or severe property damage;

(b) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgement to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance; and

(c) The permittee submitted notices and requests as required under General Condition B.3.c.

(2) The Director may approve an anticipated bypass, after considering its adverse effects and any alternatives to bypassing, when the Director determines that it will meet the three conditions listed above in General Condition B.3.b.(1).

c. Notice and request for bypass.

(1) Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior written notice, if possible at least ten days before the date of the bypass.

(2) Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required in General Condition D.5.

4. <u>Upset</u>

a. Definition. "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operation error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation.

b. Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of General Condition B.4.c are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

c. Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

(1) An upset occurred and that the permittee can identify the causes(s) of the upset;

(2) The permitted facility was at the time being properly operated;

(3) The permittee submitted notice of the upset as required in General Condition D.5, hereof (24-hour notice); and

(4) The permittee complied with any remedial measures required under General Condition A.3 hereof.

d. Burden of proof. *In any enforcement proceeding the permittee seeking to establish the occurrence of* an upset has the burden of proof.

5. Treatment of Single Operational Event

For purposes of this permit, A Single Operational Event which leads to simultaneous violations of more than one pollutant parameter shall be treated as a single violation. A single operational event is an exceptional incident which causes simultaneous, unintentional, unknowing (not the result of a knowing act or omission), temporary noncompliance with more than one Clean Water Act effluent discharge pollutant parameter. A single operational event does not include Clean Water Act violations involving discharge without a NPDES permit or noncompliance to the extent caused by improperly designed or inadequate treatment facilities. Each day of a single operational event is a violation.

6. Overflows from Wastewater Conveyance Systems and Associated Pump Stations

a. Definitions

(1) "Overflow" means the diversion and discharge of waste streams from any portion of the wastewater conveyance system including pump stations, through a designed overflow device or structure, other than discharges to the wastewater treatment facility.

(2) "Severe property damage" means substantial physical damage to property, damage to the conveyance system or pump station which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of an overflow.

(3) "Uncontrolled overflow" means the diversion of waste streams other than through a designed overflow device or structure, for example to overflowing manholes or overflowing into residences, commercial establishments, or industries that may be connected to a conveyance system.

b. Prohibition of overflows. Overflows are prohibited unless:

(1) Overflows were unavoidable to prevent an uncontrolled overflow, loss of life, personal injury, or severe property damage;

(2) There were no feasible alternatives to the overflows, such as the use of auxiliary pumping or conveyance systems, or maximization of conveyance system storage; and

(3) The overflows are the result of an upset as defined in General Condition B.4. and meeting all requirements of this condition.

c. Uncontrolled overflows are prohibited where wastewater is likely to escape or be carried into the waters of the State by any means.

d. Reporting required. Unless otherwise specified in writing by the Department, all overflows and uncontrolled overflows must be reported orally to the Department within 24 hours from the time the permittee becomes aware of the overflow. Reporting procedures are described in more detail in General Condition D.5.

7. Public Notification of Effluent Violation or Overflow

If effluent limitations specified in this permit are exceeded or an overflow occurs, upon request by the Department, the permittee shall take such steps as are necessary to alert the public about the extent and nature of the discharge. Such steps may include, but are not limited to, posting of the river at access points and other places, news releases, and paid announcements on radio and television.

8. Removed Substances

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in such a manner as to prevent any pollutant from such materials from entering public waters, causing nuisance conditions, or creating a public health hazard.

SECTION C. MONITORING AND RECORDS

1. Representative Sampling

Sampling and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring points specified in this permit and shall be taken, unless otherwise specified, before the effluent joins or is diluted by any other waste stream, body of water, or substance. Monitoring points shall not be changed without notification to and the approval of the Director.

2. Flow Measurements

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to ensure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to insure that the accuracy of the measurements is consistent with the accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than ± 10 percent from true discharge rates throughout the range of expected discharge volumes.

3. Monitoring Procedures

Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.

4. Penalties of Tampering

The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate, any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than two years, or by both. If a conviction of a person is for a violation committed after a first conviction of such person, punishment is a fine not more than $20,000 per day of violation, or by imprisonment of not more than four years or both.

5. Reporting of Monitoring Results

Monitoring results shall be summarized each month on a Discharge Monitoring Report form approved by the Department. The reports shall be submitted monthly and are to be mailed, delivered or otherwise transmitted by the 15th day of the following month unless specifically approved otherwise in Schedule B of this permit.

6. Additional Monitoring by the Permittee

If the permittee monitors any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR 136 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the Discharge Monitoring Report. Such increased frequency shall also be indicated. For a pollutant parameter that may be sampled more than once per day (e.g., Total Chlorine Residual), only the average daily value shall be recorded unless otherwise specified in this permit.

7. Averaging of Measurements

Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean, except for bacteria which shall be averaged as specified in this permit.

8. Retention of Records

Except for records of monitoring information required by this permit related to the permittee's sewage sludge use and disposal activities, which shall be retained for a period of at least five years (or longer as required by 40 CFR part 503), the permittee shall retain records of all monitoring information, including all calibration and maintenance records of all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time.

9. Records Contents

Records of monitoring information shall include:

a. The date, exact place, time and methods of sampling or measurements;

b. The individual(s) who performed the sampling or measurements;

c. The date(s) analyses were performed;

d. The individual(s) who performed the analyses;

e. The analytical techniques or methods used; and

f. The results of such analyses.

10. Inspection and Entry

The permittee shall allow the Director, or an authorized representative upon the presentation of credentials to:

a. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit, and

d. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by state law, any substances or parameters at any location.

SECTION D. REPORTING REQUIREMENTS

1. Planned Changes

The permittee shall comply with Oregon Administrative Rules (OAR) 340, Division 52, "Review of Plans and Specifications". Except where exempted under OAR 340-52, no construction, installation, or modification involving disposal systems, treatment works, sewerage systems, or common sewers shall be commenced until the plans and specifications are submitted to and approved by the Department. The permittee shall give notice to the Department as soon as possible of any planned physical alternations or additions to the permitted facility.

2. Anticipated Noncompliance

The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity that may result in noncompliance with permit requirements.

3. Transfers

This permit may be transferred to a new permittee provided the transferee acquires a property interest in the permitted activity and agrees in writing to fully comply with all the terms and conditions of the permit and the rules of the Commission. No permit shall be transferred to a third party without prior written approval from the Director. The permittee shall notify the Department when a transfer of property interest takes place.

4. Compliance Schedule

Reports of compliance or noncompliance with, or any progress reports on interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date. Any reports of noncompliance shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirements.

5. Twenty-Four Hour Reporting

The permittee shall report any noncompliance that may endanger health or the environment. Any information shall be provided orally (by telephone) within 24 hours, unless otherwise specified in this permit, from the time the permittee becomes aware of the circumstances. During normal business hours, the Department's Regional office shall be called. Outside of normal business hours, the Department shall be contacted at 1-800-452-0311 (Oregon Emergency Response System).

A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. If the permittee is establishing an affirmative defense of upset or bypass to any offense under ORS 468.922 to 468.946, and in which case if the original reporting notice was oral, delivered written notice must be made to the Department or other agency with regulatory jurisdiction within 4 (four) calendar days. The written submission shall contain:

a. A description of the noncompliance and its cause;

b. The period of noncompliance, including exact dates and times;

c. The estimated time noncompliance is expected to continue if it has not been corrected;

d. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance; and

e. Public notification steps taken, pursuant to General Condition B.7.

The following shall be included as information that must be reported within 24 hours under this paragraph:

a. Any unanticipated bypass which exceeds any effluent limitation in this permit.

b. Any upset which exceeds any effluent limitation in this permit.

c. Violation of maximum daily discharge limitation for any of the pollutants listed by the Director in this permit.

The Department may waive the written report on a case-by-case basis if the oral report has been received within 24 hours.

6. Other Noncompliance

The permittee shall report all instances of noncompliance not reported under General Condition D.4 or D.5, at the time monitoring reports are submitted. The reports shall contain:

a. A description of the noncompliance and its cause;

b. The period of noncompliance, including exact dates and times;

c. The estimated time noncompliance is expected to continue if it has not been corrected; and

d. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

7. Duty to Provide Information

The permittee shall furnish to the Department, within a reasonable time, any information that the Department may request to determine compliance with this permit. The permittee shall also furnish to the Department, upon request, copies of records required to be kept by this permit.

Other Information: When the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or any report to the Department, it shall *promptly submit such facts or information.*

8. Signatory Requirements

All applications, reports or information submitted to the Department shall be signed and certified in accordance with 40 CFR 122.22.

9. Falsification of Information

A person who supplies the Department with false information, or omits material or required information, as specified in ORS 468.953 is subject to criminal prosecution.

10. Changes to Indirect Dischargers - **[Applicable to Publicly Owned Treatment Works (POTW) only]**

The permittee must provide adequate notice to the Department of the following:

a. Any new introduction of pollutants into the POTW from an indirect discharger which would be subject to section 301 or 306 of the Clean Water Act if it were directly discharging those pollutants and;

b. Any substantial change in the volume or character of pollutants being introduced into the POTW by a source introducing pollutants into the POTW at the time of issuance of the permit.

c. For the purposes of this paragraph, adequate notice shall include information on (i) the quality and quantity of effluent introduced into the POTW, and (ii) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

11. Changes to Discharges of Toxic Pollutant - **[Applicable to existing manufacturing, commercial, mining, and silvicultural dischargers only]**

The permittee must notify the Department as soon as they know or have reason to believe of the following:

a. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels:

   (1) One hundred micrograms per liter (100 μg/L);

   (2) Two hundred micrograms per liter (200 μg/L) for acrolein and acrylonitrile; five hundred micrograms per liter (500 μg/L) for 2,4-dinitrophenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter (1 mg/L) for antimony;

   (3) Five (5) times the maximum concentration value reported for that pollutant in the permit application in accordance with 40 CFR 122.21(g)(7); or

   (4) The level established by the Department in accordance with 40 CFR 122.44(f).

b. That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

   (1) Five hundred micrograms per liter (500 μg/L);

   (2) One milligram per liter (1 mg/L) for antimony;

   (3) Ten (10) times the maximum concentration value reported for that pollutant in the permit application in accordance with 40 CFR 122.21(g)(7); or

   (4) The level established by the Department in accordance with 40 CFR 122.44(f).

SECTION E. DEFINITIONS

1. BOD means five-day biochemical oxygen demand.
2. TSS means total suspended solids.
3. mg/L means milligrams per liter.
4. kg means kilograms.
5. m^3/d means cubic meters per day.
6. MGD means million gallons per day.
7. Composite sample means a sample formed by collecting and mixing discrete samples taken periodically and based on time or flow.
8. FC means fecal coliform bacteria.
9. Technology based permit effluent limitations means technology-based treatment requirements as defined in 40 CFR 125.3, and concentration and mass load effluent limitations that are based on minimum design criteria specified in OAR 340-41.
10. CBOD means five day carbonaceous biochemical oxygen demand.
11. Grab sample means an individual discrete sample collected over a period of time not to exceed 15 minutes.
12. Quarter means January through March, April through June, July through September, or October through December.
13. Month means calendar month.
14. Week means a calendar week of Sunday through Saturday.
15. Total residual chlorine means combined chlorine forms plus free residual chlorine.
16. The term "bacteria" includes but is not limited to fecal coliform bacteria, total coliform bacteria, and E. coli bacteria.
17. POTW means a publicly owned treatment works.

MODIFICATION

This Modification Shall be Attached to and Made a Part of Permit #100988

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
WASTE DISCHARGE PERMIT

Department of Environmental Quality
Western Region – Salem Office
750 Front Street NE, Suite 120, Salem, OR 97301-1039
Telephone: (503) 378-8240

Issued pursuant to ORS 468B.050 and The Federal Clean Water Act

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ISSUED TO:

Newberg, City of
P.O. Box 970
Newberg, OR 97132

SOURCES COVERED BY THIS PERMIT:

Type of Waste	Outfall Number	Outfall Location
Treated Wastewater	001	R.M. 49.7
Recycled Water Reuse	101	Class A Reuse
Emergency Overflows:		
Dayton Avenue PS	002	Chehalem Creek
Andrew Street PS	004	Chehalem Creek
Charles Street PS	005	Chehalem Creek
Chehalem Drive PS	006	Chehalem Creek
Creekside Lane PS	007	Chehalem Creek
Sheridan Street PS	008	Chehalem Creek
Fernwood Road PS	009	Springbrook Creek

FACILITY TYPE AND LOCATION:

Activated Sludge
Newberg - Wynooski Road STP
2301 Wynooski Road
Newberg, Oregon
Treatment System Class: Level IV
Collection System Class: Level III

RECEIVING STREAM INFORMATION:

Basin: Willamette
Sub-Basin: Middle Willamette
Receiving Stream: Willamette River
LLID: 1227618456580 - 49.7 - D
County: Yamhill

EPA REFERENCE NO: OR003235-2

This permit was originally issued on June 22, 2004 in response to Application No. 992393 received April 3, 1997. This modification is in accordance with OAR 340-045-0055. This permit is issued based on the land use findings in the permit record.

Mark E Hamlin
for John J. Ruscigno, Water Quality Manager
Western Region North

July 31, 2008
Date

ADDENDUM NO. 1

Modification #1: Permit No. 100988, Schedule A, Condition 1.a.(3) is modified to add the following effluent limits:

(3) Other parameters

Year-round (except as noted)	Limitations
Excess Thermal Load (ETL)	Limits are calculated based on the ETL Limit Options A, B or C below (see Note 5)

(A) ETL Limits June 1 through September 30: (when no river information is reported)

Must not exceed a rolling seven-day average of 40 million Kcals/day

(B) ETL Limits June 1 through September 30: (when river flows are reported)

Salmon & Steelhead Migration Corridor
The ETL Limit may be calculated on a daily basis when river flows are reported. The ETL may be calculated as follows:

$ETL = (((0.00006878 \times Q_R) + 0.8745) - 0.1) \times 2.94 \times 2.447 \times (24.9-20)$

Where: Q_R = the rolling seven-day average ambient river flow (cfs) recorded at USGS Gauge 14197900 (Willamette River at Newberg)

(C) ETL Limits June 1 through September 30: (when river flows and temperatures are reported)

Salmon & Steelhead Migration Corridor
The ETL Limit may be calculated on a daily basis when both river flows and temperatures are reported. The ETL may be calculated as follows:

$ETL = (((0.00006878 \times Q_R) + 0.8745) - a) \times 2.94 \times 2.447 \times (24.9-20)$

Where: Q_R = the rolling seven-day average ambient river flow (cfs) recorded at USGS Gauge 14197900 (Willamette River at Newberg)

The value for a in the above equations is determined based on the relationship between the rolling seven-day average maximum natural thermal potential river temperature in °C (T_{RM_N}), the rolling seven-day average natural thermal potential river temperature in °C (T_{RA_N}) and the applicable criteria in °C as follows:

T_{RM_N} = (0.9982 x the daily maximum ambient river temperature in °C) – 0.53
T_{RA_N} = (0.9402 x the daily average ambient river temperature in °C) + 0.21

If T_{RM_N} is less than or equal to 20 °C, then $a = 0$
If T_{RM_N} is greater than 20 °C and T_{RA_N} is greater than or equal to 20 °C, then $a = 0$
If T_{RM_N} is greater than 20 °C and T_{RA_N} is less than 20 °C, then $a = 1 - (T_{RA\_N} \div 20\ °C)$

Modification #2: Permit No. 100988, Schedule A, Condition 1.d. is added to read as follows:

d. Recycled Wastewater Outfall 101

(1) No discharge to state waters is permitted. All recycled water shall be distributed for an approved use in accordance with OAR 340-055-0012 (1) and (2) (2) Prior to land *application of the recycled water, it shall* receive Class A treatment as defined in OAR 340-055 to:

(a) Prior to disinfection, turbidity must not exceed an average of 2 nephelometric turbidity units (NTUs) within a 24-hour period, 5 NTUs more than five percent of the time within a 24-hour period and 10 NTUs at any time.

(b) After disinfection, Total Coliform must not exceed a median of 2.2 organisms per 100 mL based on results of the last seven days that analyses have been completed, and 23 total coliform organisms per 100mL in any single sample.

(3) All use of recycled water shall conform to the Recycled Water Use Plan approved by the Department. Upon approval of the Recycled Water Use Plan, the Plan shall become enforceable through this permit modification.

Modification #3: Permit No. 100988, Schedule A, Note 5 is added to read as follows:

5. If any ETL Option other than Option A is used, the Discharge Monitoring Report must state which option was used during that month and include all data necessary to calculate the ETL limit. Limits are to be calculated and compliance will be evaluated starting on the seventh day of the TMDL period (June 7th).

Modification #4: Permit No. 100988, Schedule B, Condition 1.b. is modified to add the following effluent monitoring requirements:

Item or Parameter	Minimum Frequency	Type of Sample
Temperature:		
Effluent Temperature, Average of Daily Maximums (June 1 through September 30)	Daily (as a rolling seven-day average starting June 7)	Calculation
Excess Thermal Load or ETL (June 1 through September 30)	Daily (as a rolling seven-day average starting June 7)	Calculation (See Note 13)

Modification #5: Permit No. 100988, Schedule B, Condition 1.e. is modified to add the following Willamette River monitoring requirements:

Item or Parameter	Minimum Frequency	Type of Sample
Flow, daily average	Daily when using ETL Limit Option B or C	Continuous (see Note 14)
Flow, average of daily averages	Daily when using ETL Limit Option B or C (as a rolling seven-day average)	Calculation
Temperature	Daily when using ETL Limit Option C	Continuous (see Note 5)
Temperature, daily average	Daily when using ETL Limit Option C	Calculation
Temperature, daily maximum	Daily when using ETL Limit Option C	Continuous (see Note 5)
ETL limit	Daily when using ETL Limit Option B or C	Calculation (see Schedule A, Condition 1.a.(3))

Modification #6: Permit No. 100988, Schedule B, Condition 1.f. is added to read as follows:

f. Recycled Wastewater Outfall 101 (when discharging recycled water)

Item or Parameter	Minimum Frequency	Type of Sample
Total Recycled Flow Discharged (MGD)	Daily	Measurement
Flow Meter Calibration	Annually	Verification
Chlorine Residual	Daily	Grab
pH	2/Week	Grab
Nutrients (TKN, NO_2+NO_3-N, NH_3, Total Phosphorus)	Once during the first quarter of discharge of recycled water	Grab

	(See Note 16)	
Total Coliform	Daily	Grab
Turbidity	Hourly (See Note 17)	Measurement

Modification #7: Permit No. 100988, Schedule B, Condition 3.c. is modified to read as follows:

c. Data from temperature monitoring required by Schedule B, Condition 1.b. shall be submitted on the Permittee's monthly discharge monitoring report.

Modification #8: Permit No. 100988, Schedule B, Condition 3.d. is added to read as follows:

d. By no later than February 15 of each year that recycled water is generated and used, the permittee shall submit to the Department an annual report describing the effectiveness of the recycled water system to comply with approved recycled water use plan, the rules of Division 55, and the limitations and conditions of this permit applicable to reuse of recycled water.

Modification #9: Permit No. 100988, Schedule B, Notes 13, 14, 15, 16, and 17 are added to read as follows:

13. Calculated as follows:
(Rolling seven-day average of daily maximum effluent temperatures in °C - applicable stream temperature standard, 20°C) x (Rolling seven-day average of daily flow in MGD) x 3.785 = Excess Thermal Load, in Million Kcals/day.

14. Receiving stream flow rate may be derived from the USGS gauging station Number 14197900 (Willamette River at Newberg). In the event that this data is temporarily unavailable, the Permittee may use the daily stream flow rate from the nearest USGS gauging station adjusted by the average ratio between the flow rates at the two stations for the seven-day period prior to the loss of data from the Newberg station. If data is not available from either station, the Permittee may use the historical average flow rate for the Newberg station for that date. In the event the gauging station data becomes permanently unavailable, the Permittee must obtain Department approval for an alternative flow determination strategy.

15. In the event that temperature data for the Willamette River is temporarily unavailable from the USGS station at Newberg, the Permittee may use the historical average temperature data from the Newberg station for that date.

16. Upon Department issuance of this permit modification, monitoring for nutrients will only be required once during the initial first quarter of distributing recycled water. After the first quarter, monitoring of the recycled water for nutrients may be eliminated unless otherwise notified in writing by the Department. Monitoring results shall be reported on approved forms and submitted by no later than the 15th day of the month following the month in which the sampling event occurred.

17. Monitoring data for turbidity will be collected continuously using an on-line turbidimeter. Hourly turbidity data may be extracted and reported on approved forms from the continuously recorded data. Should the on-line turbidimeter become inoperable, then the hourly turbidity data may be collected manually on an hourly frequency during the interim period.

Modification #10: Permit No. 100988, Schedule D, Conditions 8, 9 and 10 are added to read as follows:

8. The permittee shall meet the requirements for use of recycled water under Division 55, including the following:

   a. No recycled water shall be released by the permittee until a Recycled Water Use Plan is approved by the Department.

   b. All recycled water shall be managed in accordance with the approved Recycled Water Use Plan. No substantial changes shall be made in the approved plan without written approval of the Department.

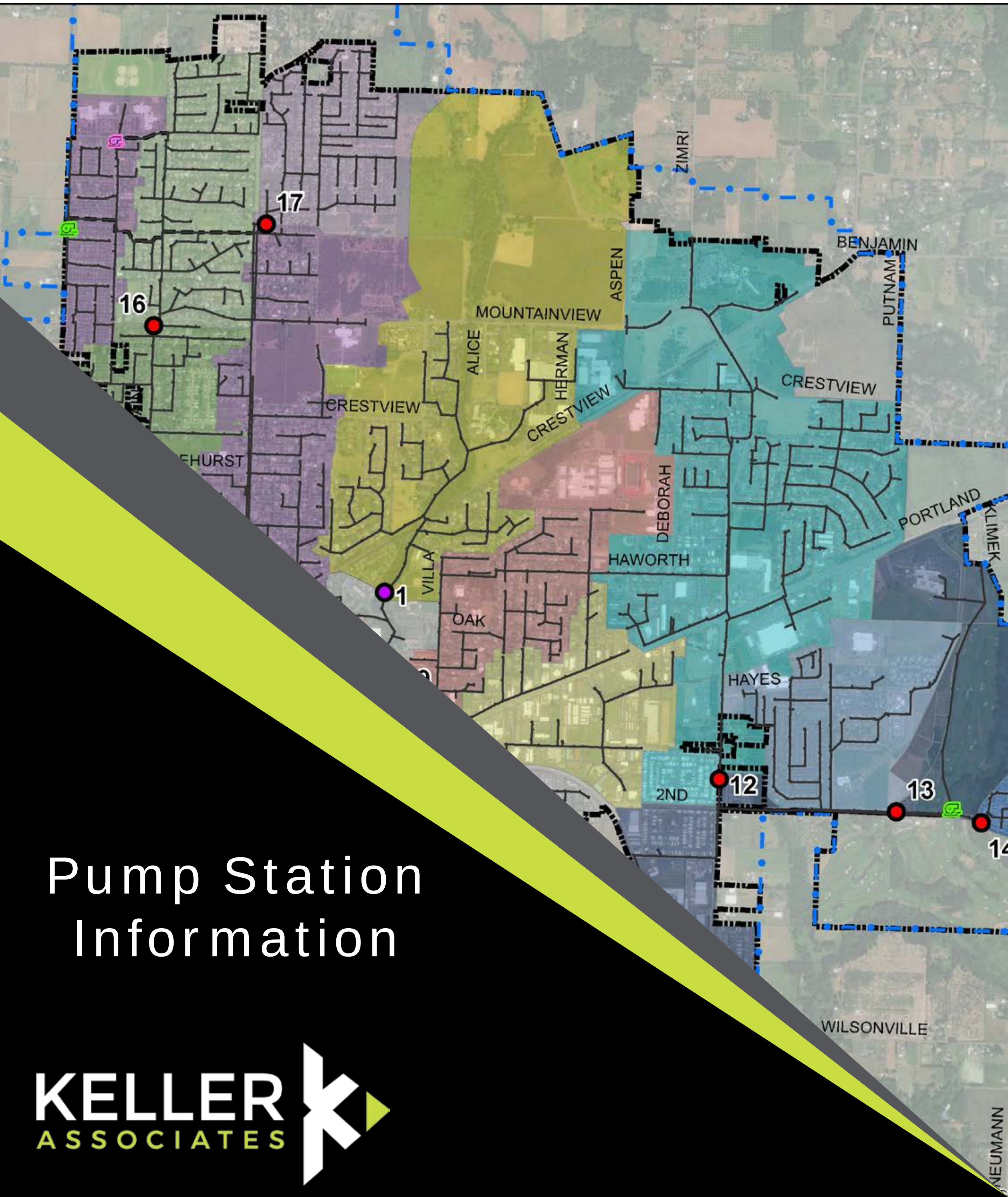
   c. The permittee shall notify the Department within 24 hours if it is determined that the treated effluent is being used in a manner not in compliance with OAR 340-055. When the Department offices are not open, the permittee shall report the incident of noncompliance to the Oregon Emergency Response System (Telephone Number 1-800-452-0311).

   d. No recycled water shall be made available to a person proposing to recycle unless that person certifies in writing that they have read and understand the provisions in these rules. This written certification shall be kept on file by the sewage treatment system owner and be made available to the Department for inspection.

9. All recycled water used at the treatment plant site for landscape irrigation shall be exempt from OAR 340-055 provided the recycled water receives secondary treatment and disinfection. All landscape irrigation shall be confined to the treatment plant site. No spray or drift shall be allowed off the treatment plant site. Landscape irrigation shall be conducted following sound irrigation practices.

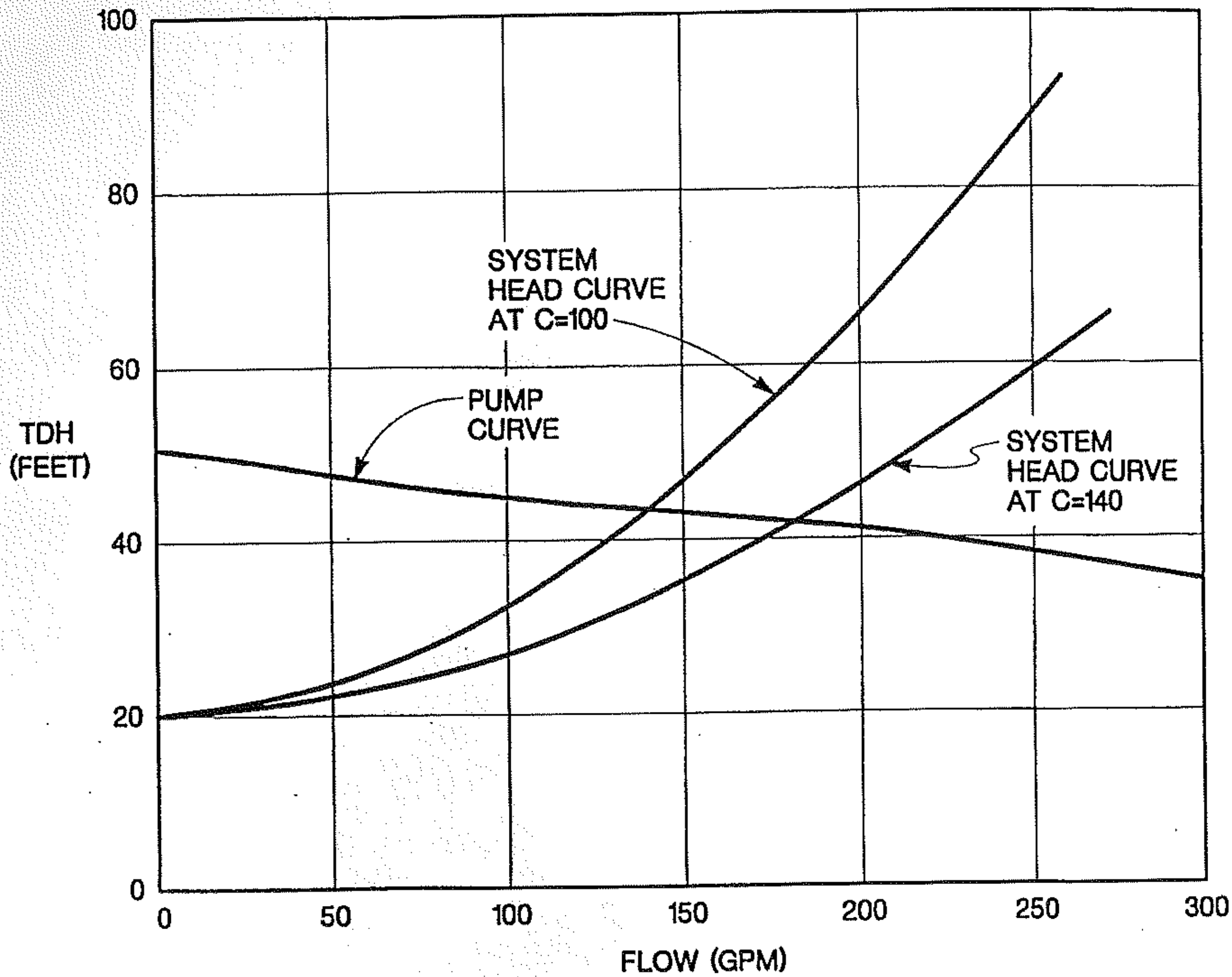
City of Newberg OREGON

Appendix C



Pump Station Information

KELLER ASSOCIATES



CITY OF NEWBERG

ANDREW STREET PUMP STATION SYSTEM CURVES

PERFORMANCE CURVE

FLYGT	PERFORMANCE CURVE	PRODUCT: CP3127.090	TYPE: MT
DATE: 2000-05-19	PROJECT: Charles & Andrew Street Pump Sta	CURVE NO: 63-434-00-2240	ISSUE: 3

	1/1-LOAD	3/4-LOAD	1/2-LOAD
POWER FACTOR	0.88	0.85	0.77
EFFICIENCY	83.5 %	84.5 %	83.5 %
MOTOR DATA	—	—	—

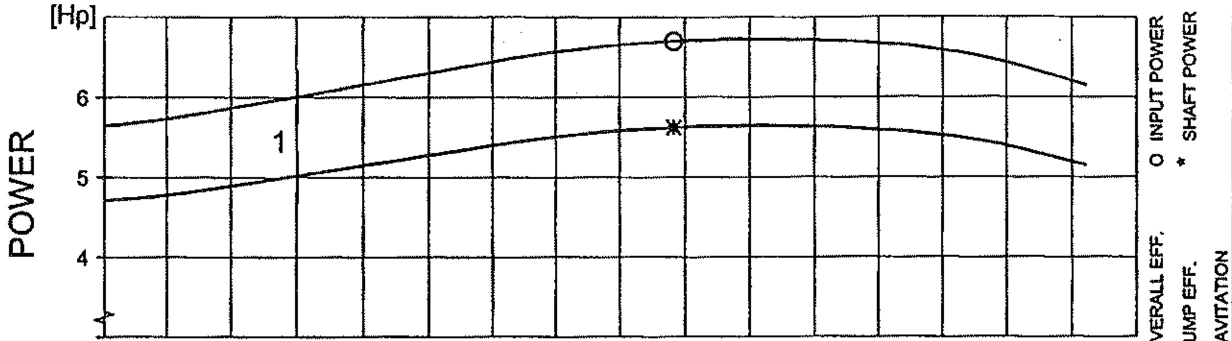
RATED POWER	7.5	Hp
STARTING CURRENT ...	52	A
RATED CURRENT ...	9.6	A
RATED SPEED	1740	rpm
TOT.MOM.OF INERTIA ...	0.082	kgm2
NO. OF BLADES	1	

COMMENTS

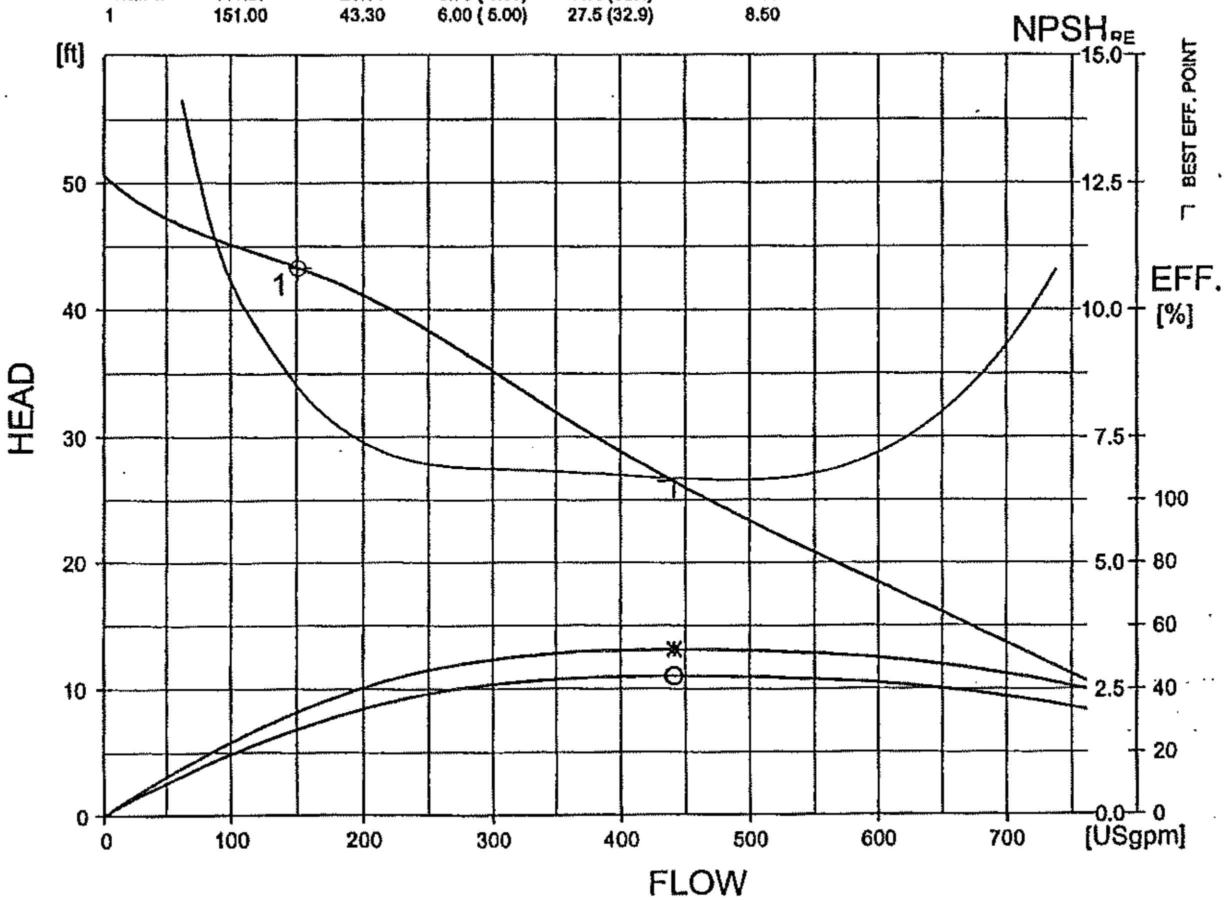
INLET/OUTLET: - /100 mm

IMP. THROUGHLET: 80 mm

MOTOR #: 21-10-4AL		STATOR: 12YSER	REV: 10
FREQ.: 60 Hz	PHASES: 3	VOLTAGE: 230 V	POLES: 4
GEARTYPE: ---		RATIO: ---	



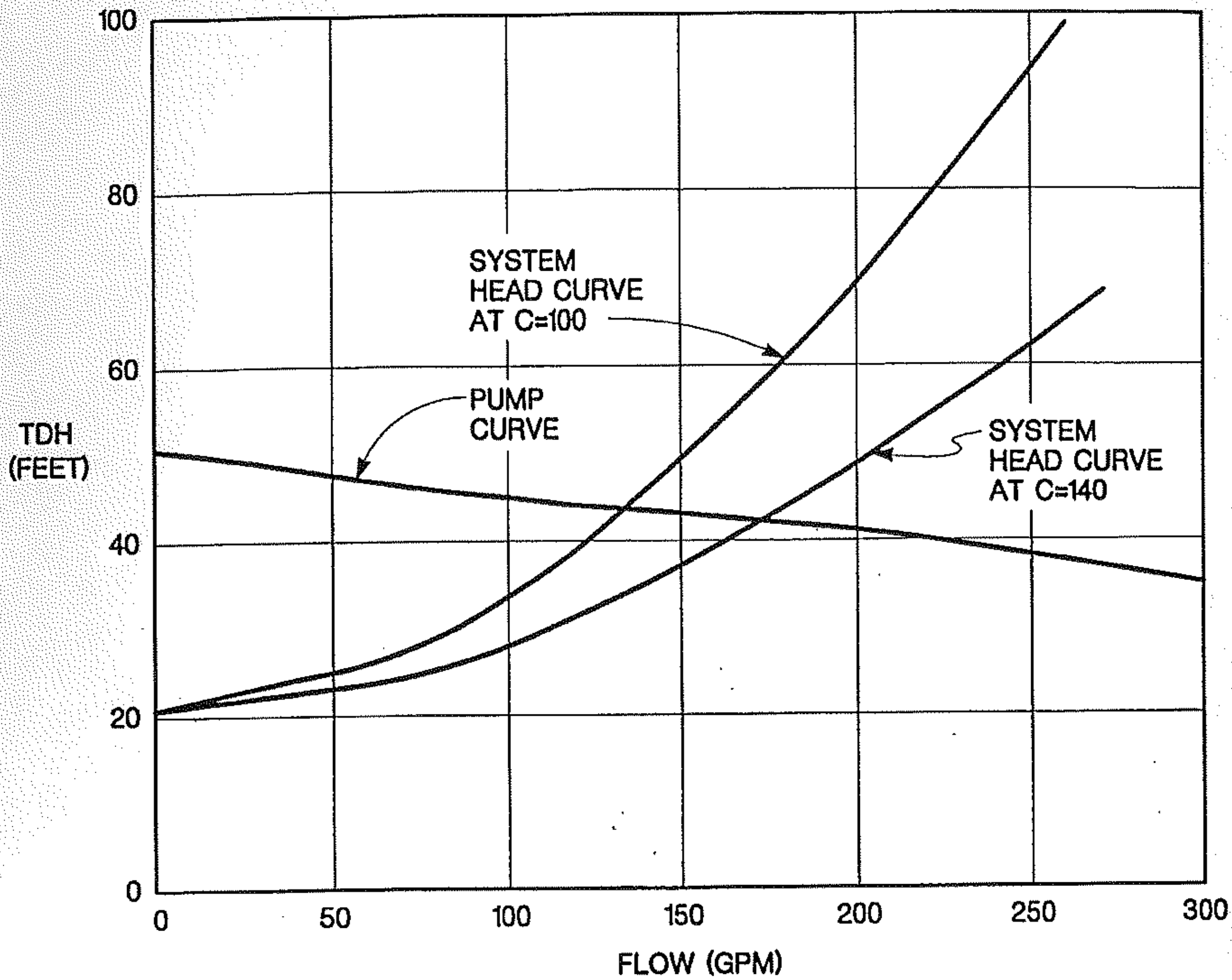
DUTY-POINT:	FLOW[USgpm]	HEAD[ft]	POWER[Hp]	EFF.[%]	NPSH[ft]	GUARANTEE
B.E.P.:	441.37	26.51	6.70 (5.63)	44.2 (52.6)	6.69	
1	151.00	43.30	6.00 (5.00)	27.5 (32.9)	8.50	



FLYPS 2.0 (1118)

Performance with clear water and ambient temp 40 °C

FLYGT CURVE



CITY OF NEWBERG

CHARLES STREET PUMP STATION SYSTEM CURVES

FLYGT	PERFORMANCE CURVE	PRODUCT CP3127.090	TYPE MT
DATE 2000-05-19	PROJECT Charles & Andrew Street Pump Sta	CURVE NO 63-434-00-2240	ISSUE 3

	1/1-LOAD	3/4-LOAD	1/2-LOAD
POWER FACTOR	0.88	0.85	0.77
EFFICIENCY	83.5 %	84.5 %	83.5 %
MOTOR DATA	—	—	—

RATED POWER	7.5	Hp
STARTING CURRENT ...	52	A
RATED CURRENT ...	9.6	A
RATED SPEED	1740	rpm
TOT.MOM.OF INERTIA ...	0.082	kgm2
NO. OF BLADES	1	

MOTOR #	STATOR	REV
21-10-4AL	12YSER	10

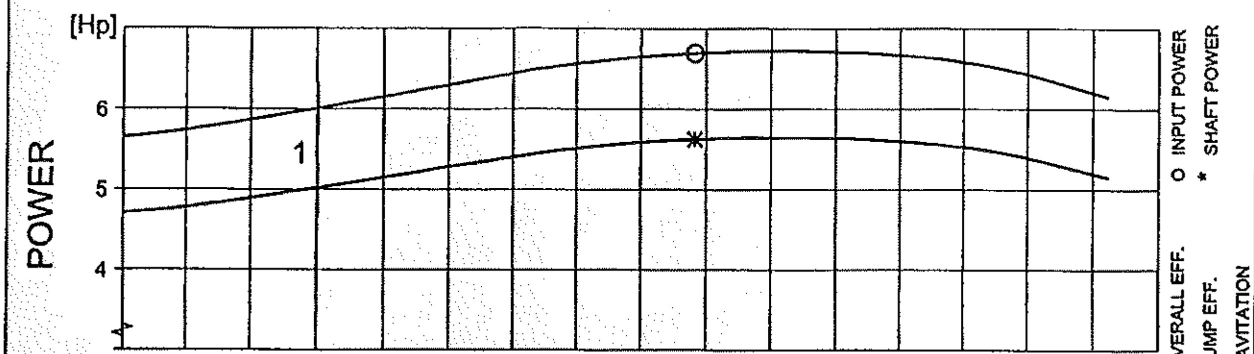
FREQ.	PHASES	VOLTAGE	POLES
60 Hz	3	230 V	4

GEARTYPE	RATIO
---	---

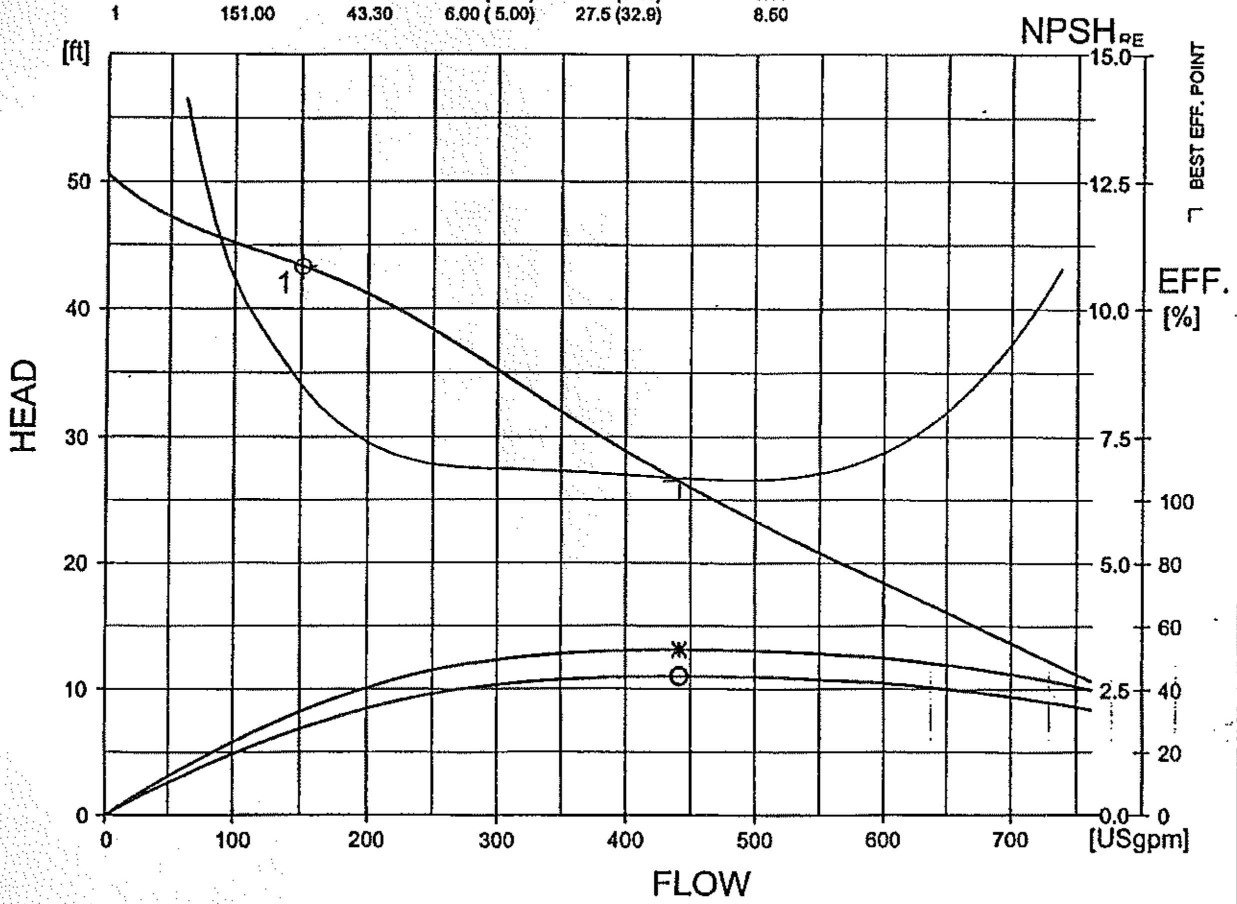
COMMENTS

INLET/OUTLET: - /100 mm

IMP. THROUGHLET: 80 mm



DUTY-POINT:	FLOW[USgpm]	HEAD[ft]	POWER[Hp]	EFF.[%]	NPSH[ft]	GUARANTEE
B.E.P.:	441.37	26.51	6.70 (5.63)	44.2 (52.6)	6.69	
1	151.00	43.30	6.00 (5.00)	27.5 (32.9)	8.50	

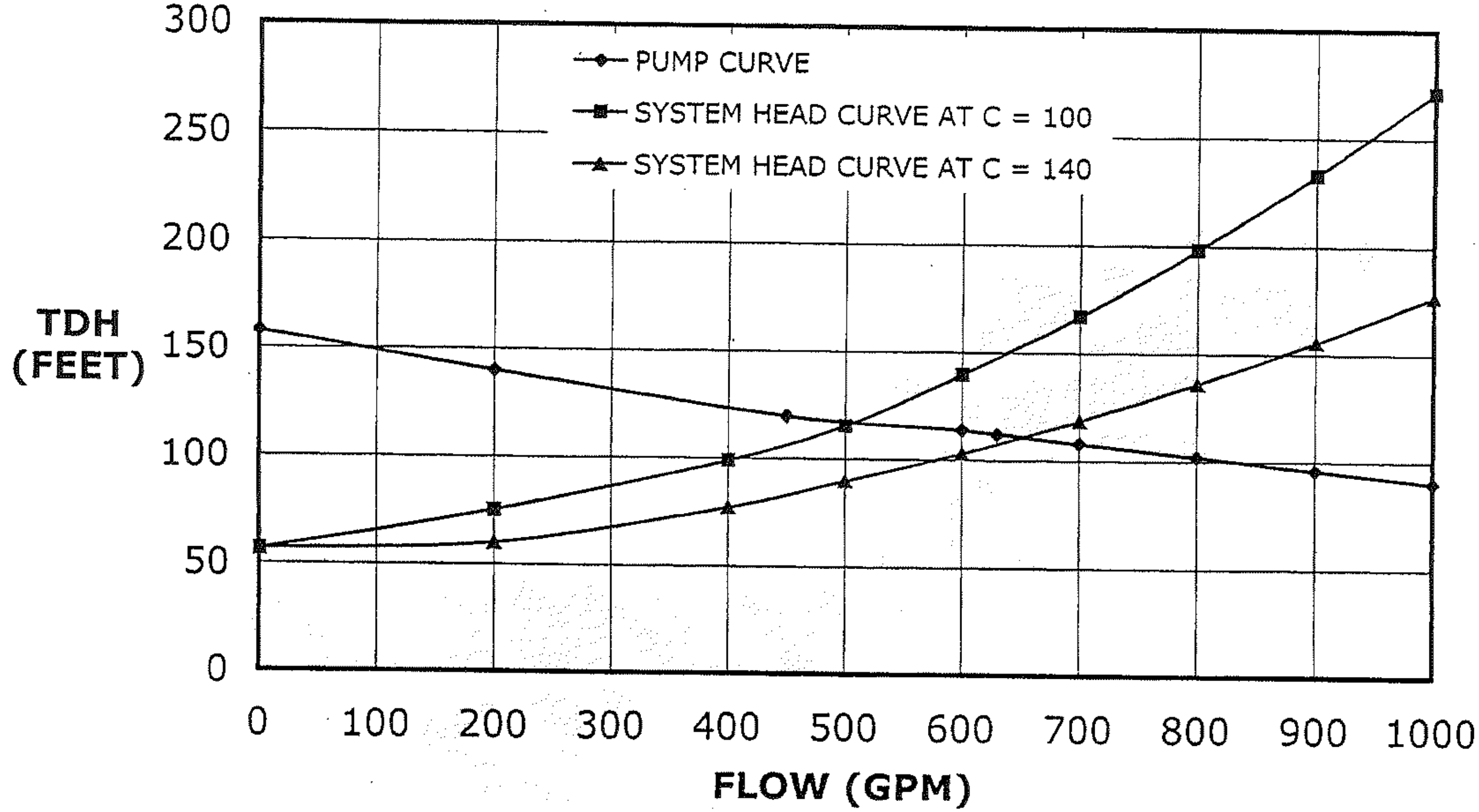


FLYPS 2.0 (1118)

Performance with clear water and ambient temp 40 °C

FLYGT CURVE

CITY OF NEWBERG
CHEHALEM DRIVE PUMP STATION
SYSTEM CURVES



FLYGT

PERFORMANCE CURVE

PRODUCT	TYPE
NP3171.090	HT

DATE	PROJECT	CURVE NO	ISSUE
2003-09-03	Newberg, Chehalem Dr. SPS	63-453-00-6050	2

	1/1-LOAD	3/4-LOAD	1/2-LOAD
POWER FACTOR	0.83	0.77	0.66
EFFICIENCY	89.5 %	90.5 %	90.0 %
MOTOR DATA	---	---	---

RATED POWER	30	hp
STARTING CURRENT ...	257	A
RATED CURRENT ...	38	A
RATED SPEED	1760	rpm
TOT.MOM.OF INERTIA ...	0.16	kgm2
NO. OF BLADES	2	

IMPELLER DIAMETER: 286 mm

MOTOR #	STATOR	REV
25-17-4AA	07YSER	10

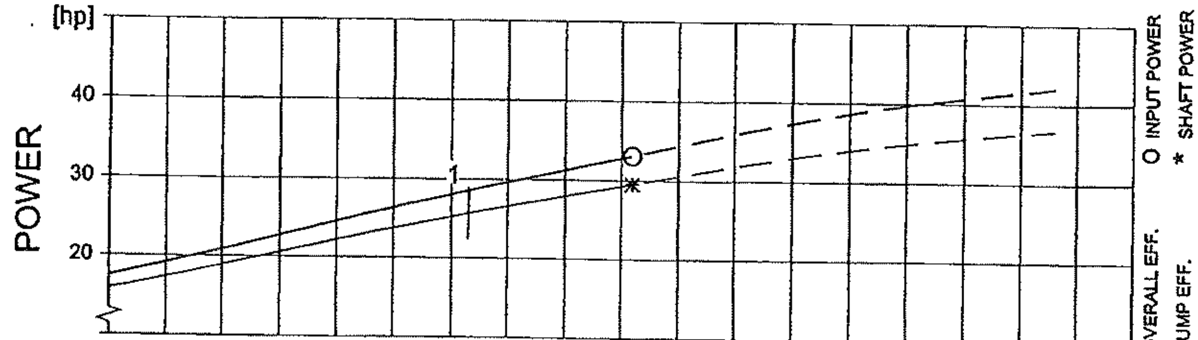
FREQ.	PHASES	VOLTAGE	POLES
60 Hz	3	460 V	4

GEARTYPE	RATIO
---	---

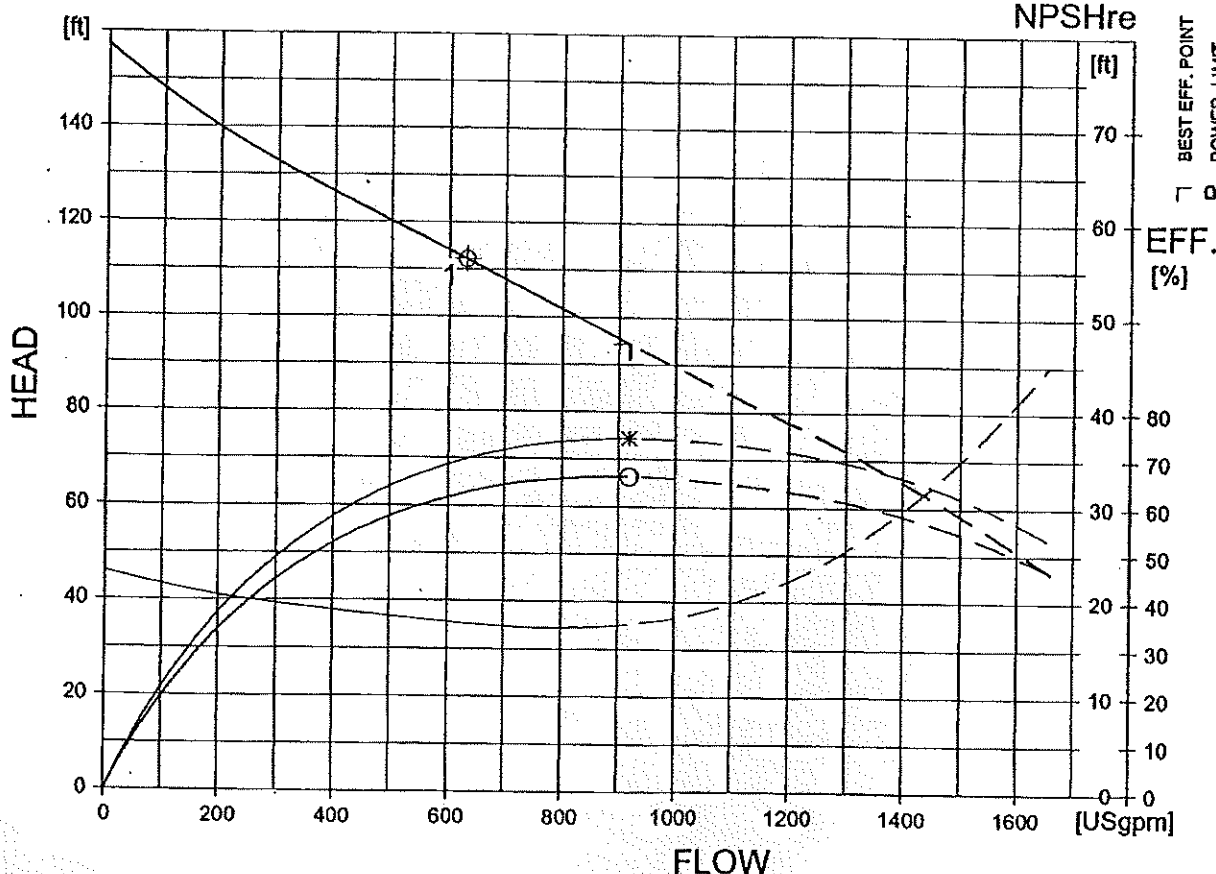
COMMENTS

INLET/OUTLET: - /100 mm

IMP. THROUGHLET: ---



DUTY-POINT	FLOW[USgpm]	HEAD[ft]	POWER [hp]	EFF. [%]	NPSHre[ft]
1	631	112	28.6 (25.7)	62.7 (69.8)	17.7
B.E.P.	920	94.3	33.2 (29.6)	66.3 (74.3)	17.7



FLYPS2.17 (20021016)

NPSHre = NPSH3% + min. operational margin

Performance with clear water and ambient temp 40 °C

FLYGT CURVE

PERFORMANCE CURVE

FLYGT

PRODUCT	TYPE
CP3085.182	MT

DATE	PROJECT	CURVE NO	ISSUE
98-02-02	Creekside Lift Station	63-434-00-5330	2

	1/1-LOAD	3/4-LOAD	1/2-LOAD
MOTOR COS FI	0.80	0.73	0.61
MOTOR EFFICIENCY	77.6 %	77.8 %	74.8 %
GEAR EFFICIENCY	---	---	---

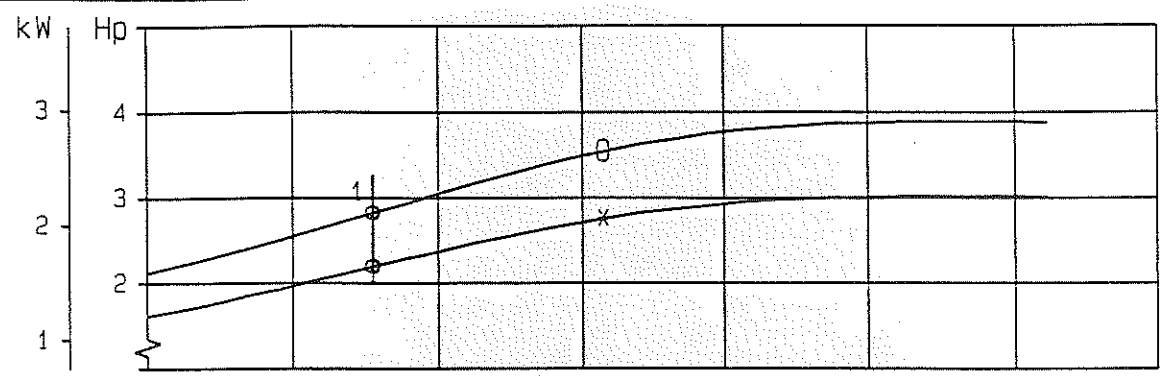
MOTOR SHAFT POWER	3.0 HP
STARTING CURRENT	24.0 A
RATED CURRENT	4.50 A
RATED SPEED	1710 RPM
TOT.MOM.OF INERTIA	0.807 LBF*FT
NO. OF BLADES	1

IMPELLER DIAMETER	--- MM
MOTORTYPE	15-10-4AL
STATOR	38D
REV	10
FREQ	60 HZ
PHASES	3
VOLTAGE	460 V
POLES	4
GEARTYPE	---
RATIO	---

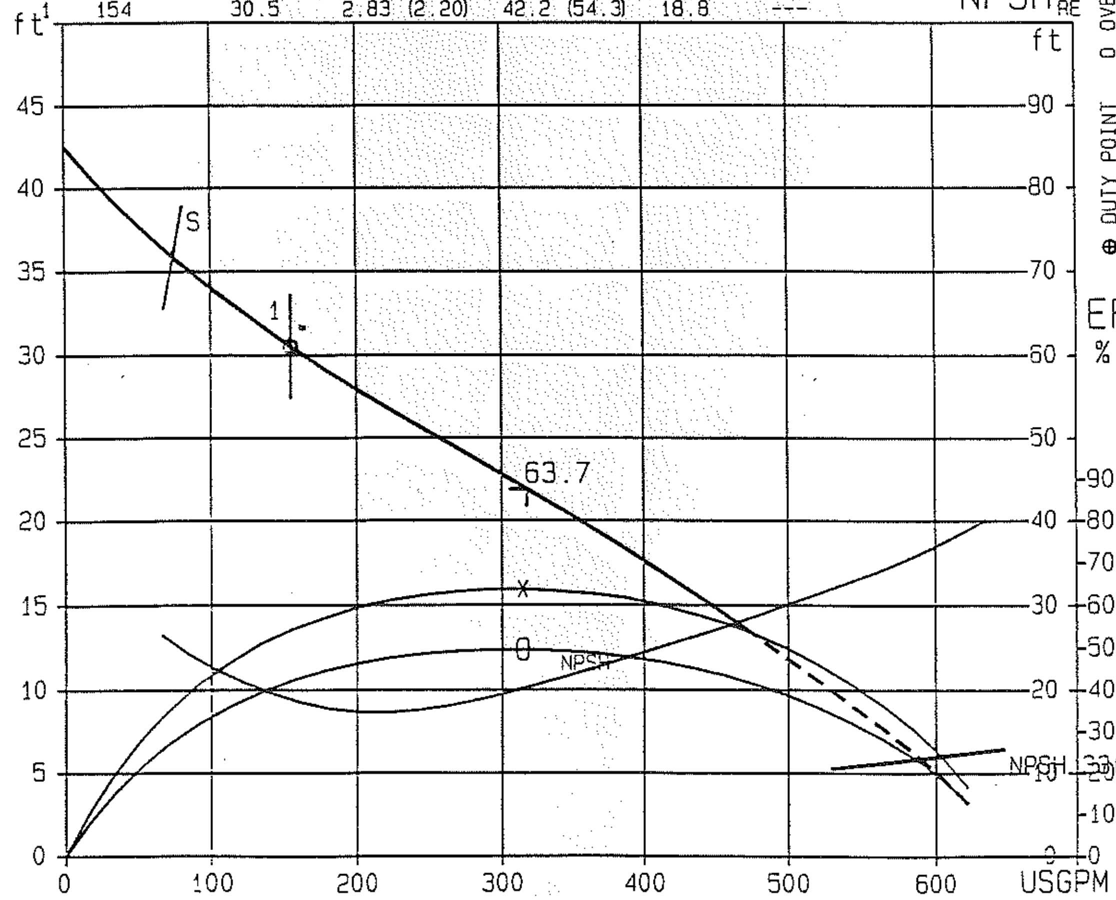
COMMENTS
NEVA-CLOG

OUTLET
4 INCH

IMP. THROUGHLET
3 INCH



DUTY-POINTS:	FLOW (USGPM)	HEAD (ft)	POWER (Hp)	EFF (%)	NPSH (ft)	GUARANTY
BEP:	318	21.9	3.55 (2.76)	49.5 (63.7)	20.5	---
1	154	30.5	2.83 (2.20)	42.2 (54.3)	18.8	---



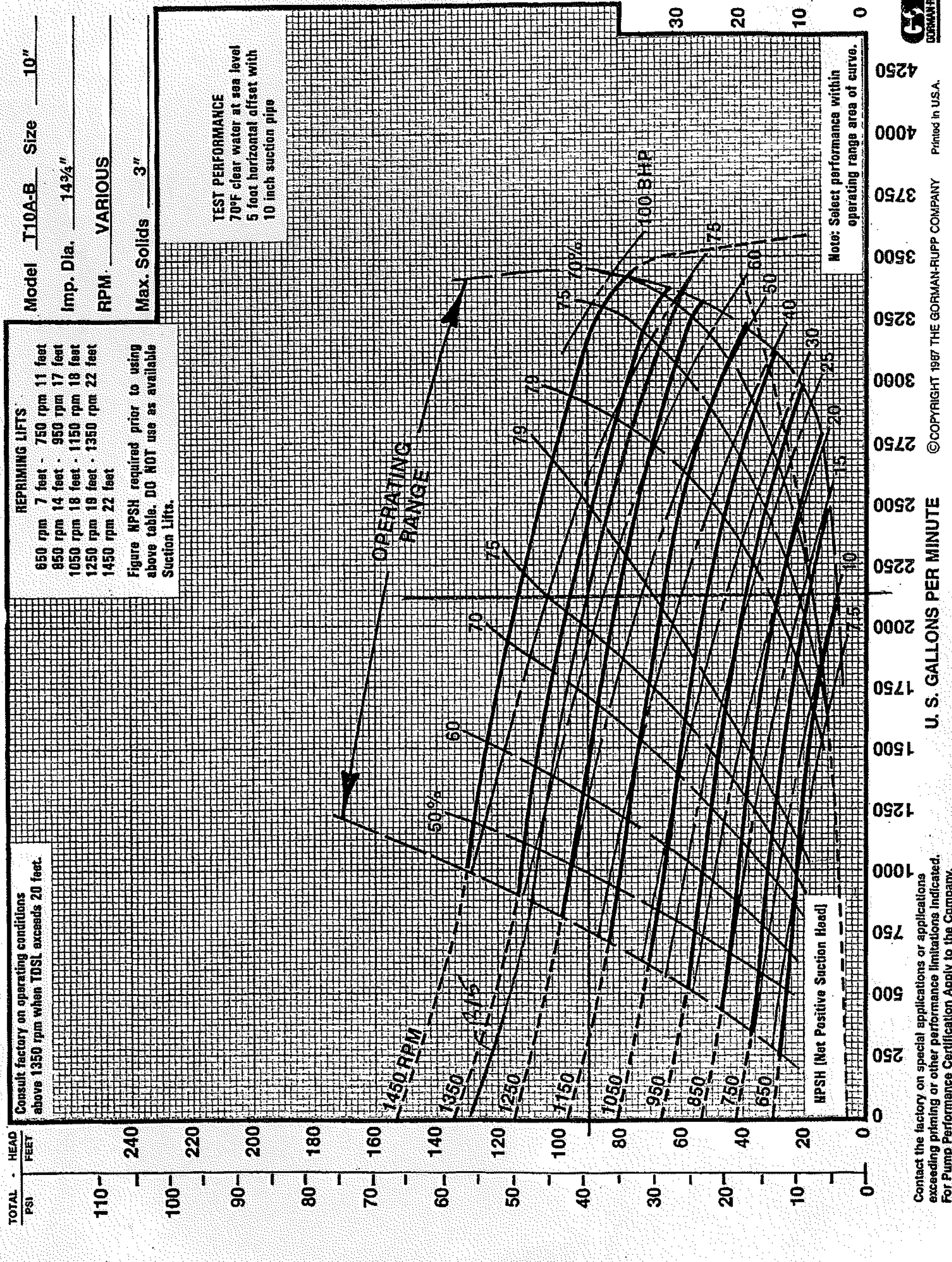
S: RISK FOR SEDIMENTATION AT VELOCITY BELOW 0.6 M/S
(STANDARD DIAM. 4 INCH)

CURVES SHOW PERFORMANCE WITH CLEAR WATER

FLYGT

Roy Voskuil Queen Pump Company

FLYPS 1.2



Contact the factory on special applications or applications exceeding priming or other performance limitations indicated. For Pump Performance Certification Apply to the Company.

Fernwood

FLYGT	PERFORMANCE CURVE	PRODUCT CP3170.090	TYPE HT
DATE 2000-08-10	PROJECT	CURVE NO 63-464-00-2350	ISSUE 2

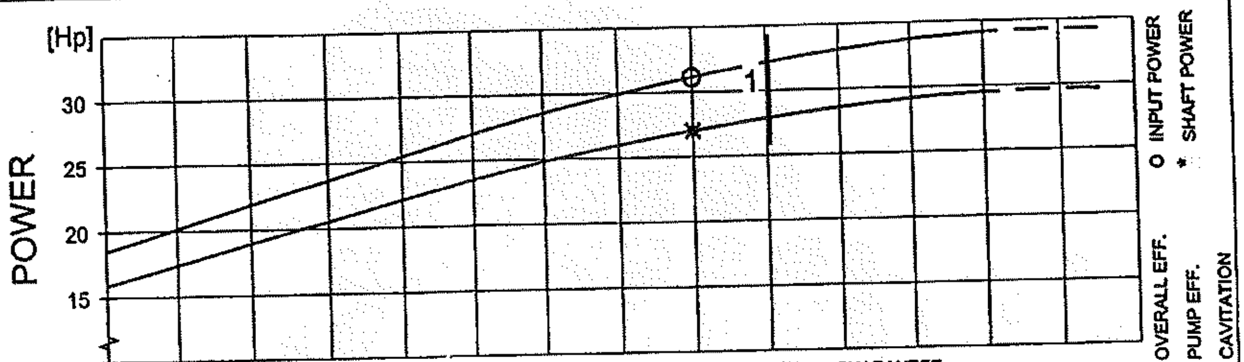
	1/1-LOAD	3/4-LOAD	1/2-LOAD
POWER FACTOR	0.90	0.88	0.83
EFFICIENCY	86.0 %	86.5 %	85.5 %
MOTOR DATA	—	—	—

COMMENTS

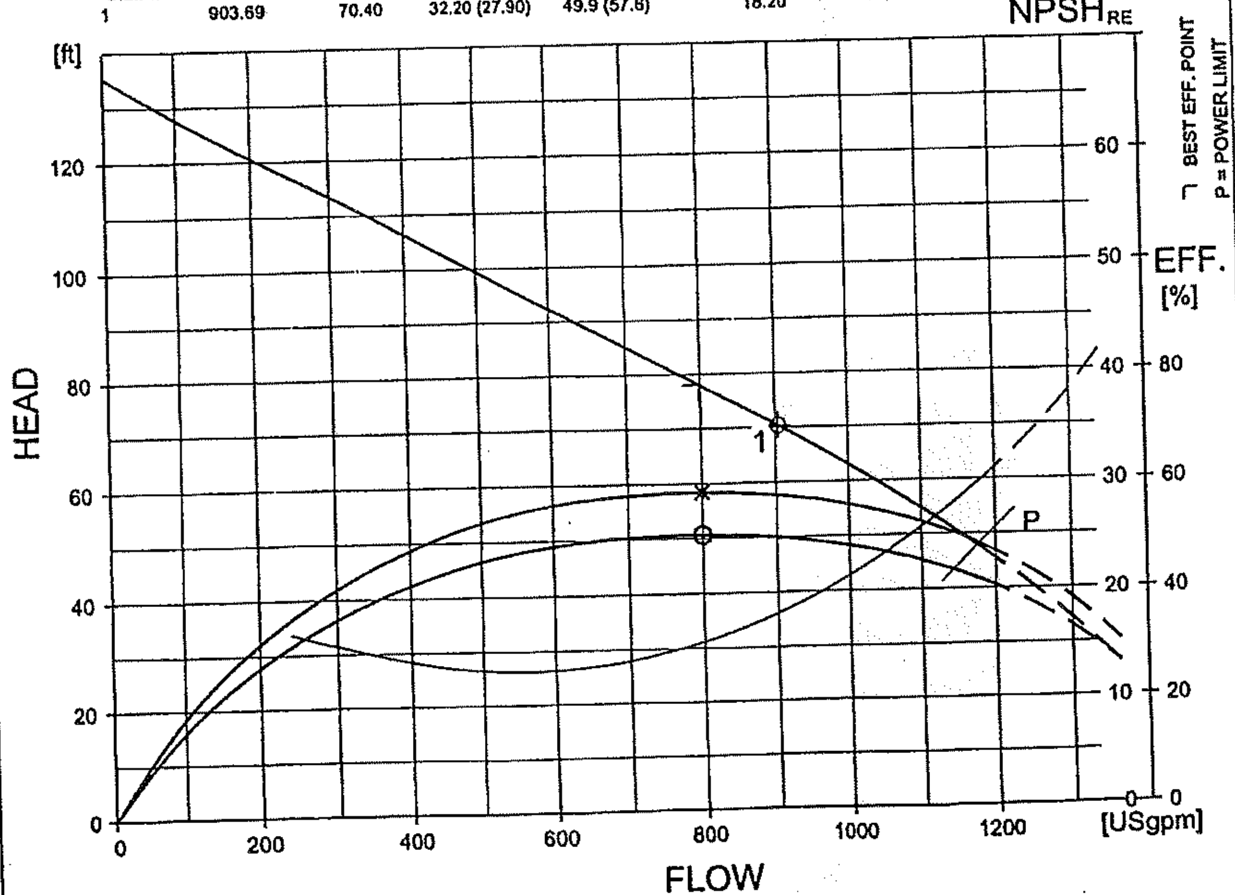
INLET/OUTLET	- /100 mm
IMP. THROUGHLET	76 mm

RATED POWER	30	Hp
STARTING CURRENT ...	221	A
RATED CURRENT ...	36	A
RATED SPEED	1750	rpm
TOT.MOM.OF INERTIA ...	0.29	kgm2
NO. OF BLADES	1	

IMPELLER DIAMETER	281 mm	
MOTOR # 27-20-4AA	STATOR 37YSER	REV 10
FREQ. 60 Hz	PHASES 3	VOLTAGE 460 V
POLES 4		
GEARTYPE —	RATIO —	



DUTY-POINT:	FLOW[USgpm]	HEAD[ft]	POWER[Hp]	EFF.[%]	NPSH[ft]	GUARANTEE
S.E.P.:	799.57	78.02	31.15 (27.02)	50.7 (58.4)	15.61	
1	903.69	70.40	32.20 (27.90)	49.9 (57.6)	18.20	



FLYPS 2.0 (1118)

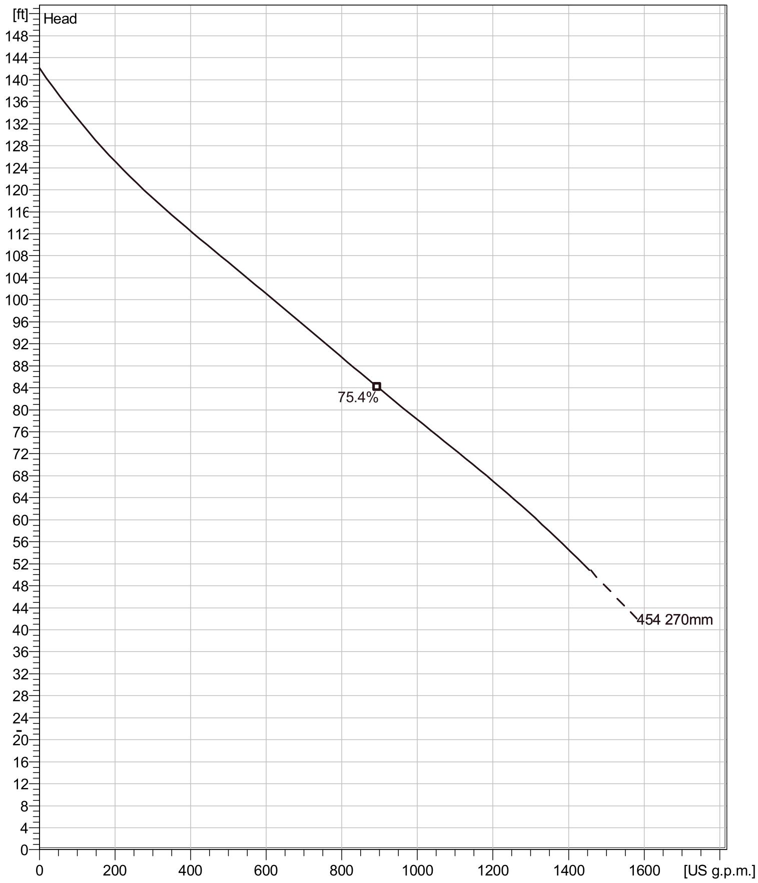
Performance with clear water and ambient temp 40 °C

FLYGT CURVE

Fernwood

NP 3171 HT 3~ 454

Technical specification



Water, pure *Curve ISO*

Note: Picture might not correspond to the current configuration.

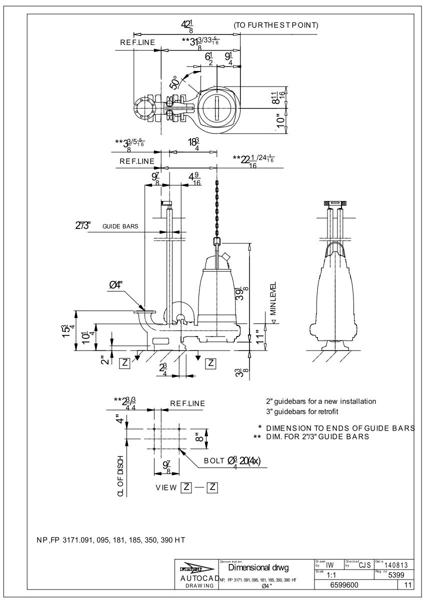
General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron ™
Discharge Flange Diameter	3 15/16 inch
Inlet diameter	3 15/16 inch
Impeller diameter	270 mm
Number of blades	2

Installation: P - Semi permanent, Wet



Motor

Motor #	N3171.095 25-17-4AA-W 30hp
Approval	FM
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	30 hp
Rated current	36 A
Starting current	230 A
Rated speed	1755 rpm
Power factor	
1/1 Load	0.87
3/4 Load	0.83
1/2 Load	0.73
Motor efficiency	
1/1 Load	89.0 %
3/4 Load	90.0 %
1/2 Load	90.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			2017-02-27	

xylem

NP 3171 HT 3~ 454

Performance curve

FLYGT

Pump

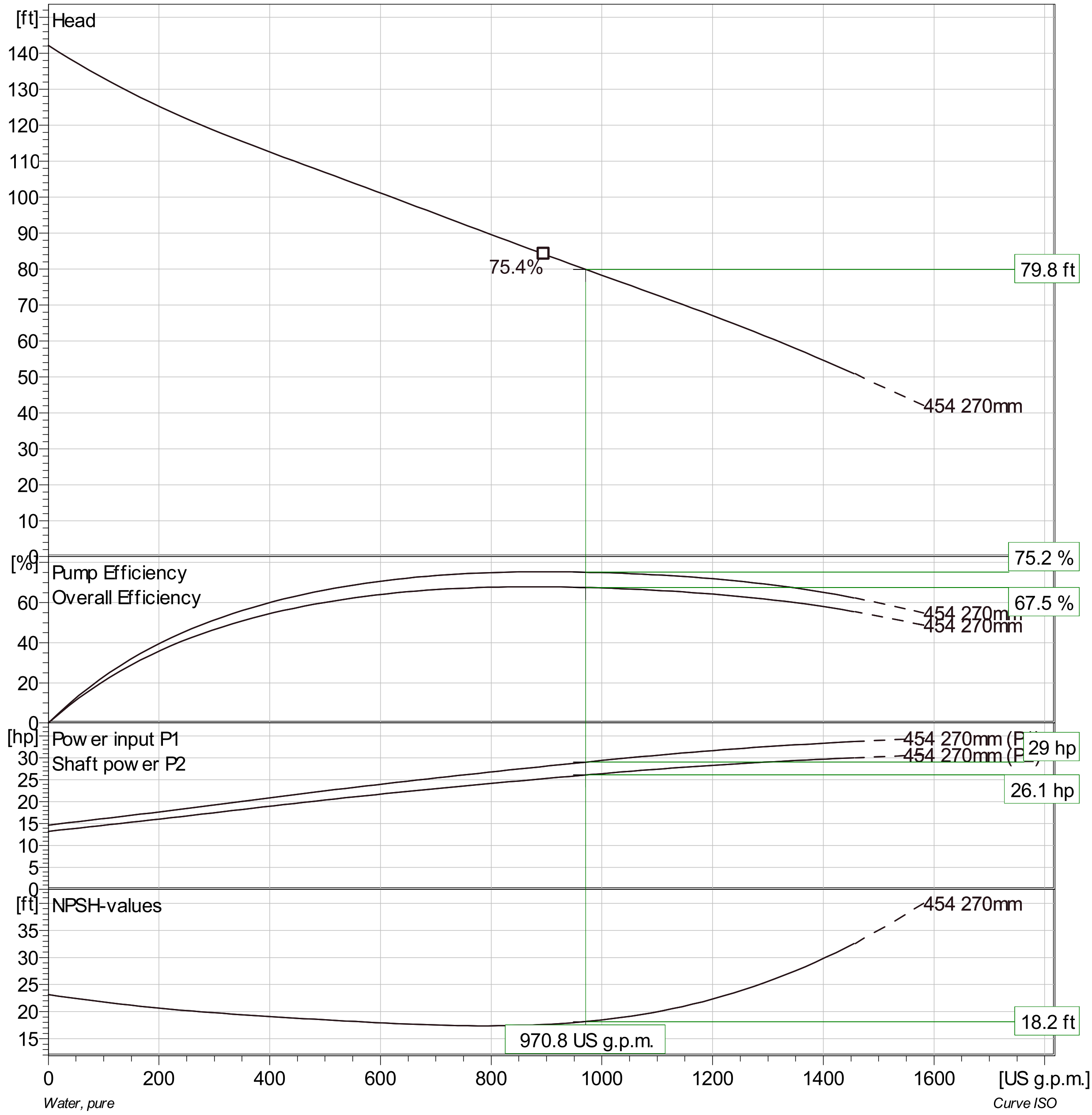
Discharge Flange Diameter	3 15/16 inch
Inlet diameter	100 mm
Impeller diameter	10 5/8"
Number of blades	2

Motor

Motor #	N3171.095 25-17-4AA-W 30hp
Approval	FM
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	30 hp
Rated current	36 A
Starting current	230 A
Rated speed	1755 rpm

Power factor	
1/1 Load	0.87
3/4 Load	0.83
1/2 Load	0.73

Motor efficiency	
1/1 Load	89.0 %
3/4 Load	90.0 %
1/2 Load	90.5 %



Duty point

Flow	Head
909 US g.p.m.	70 ft

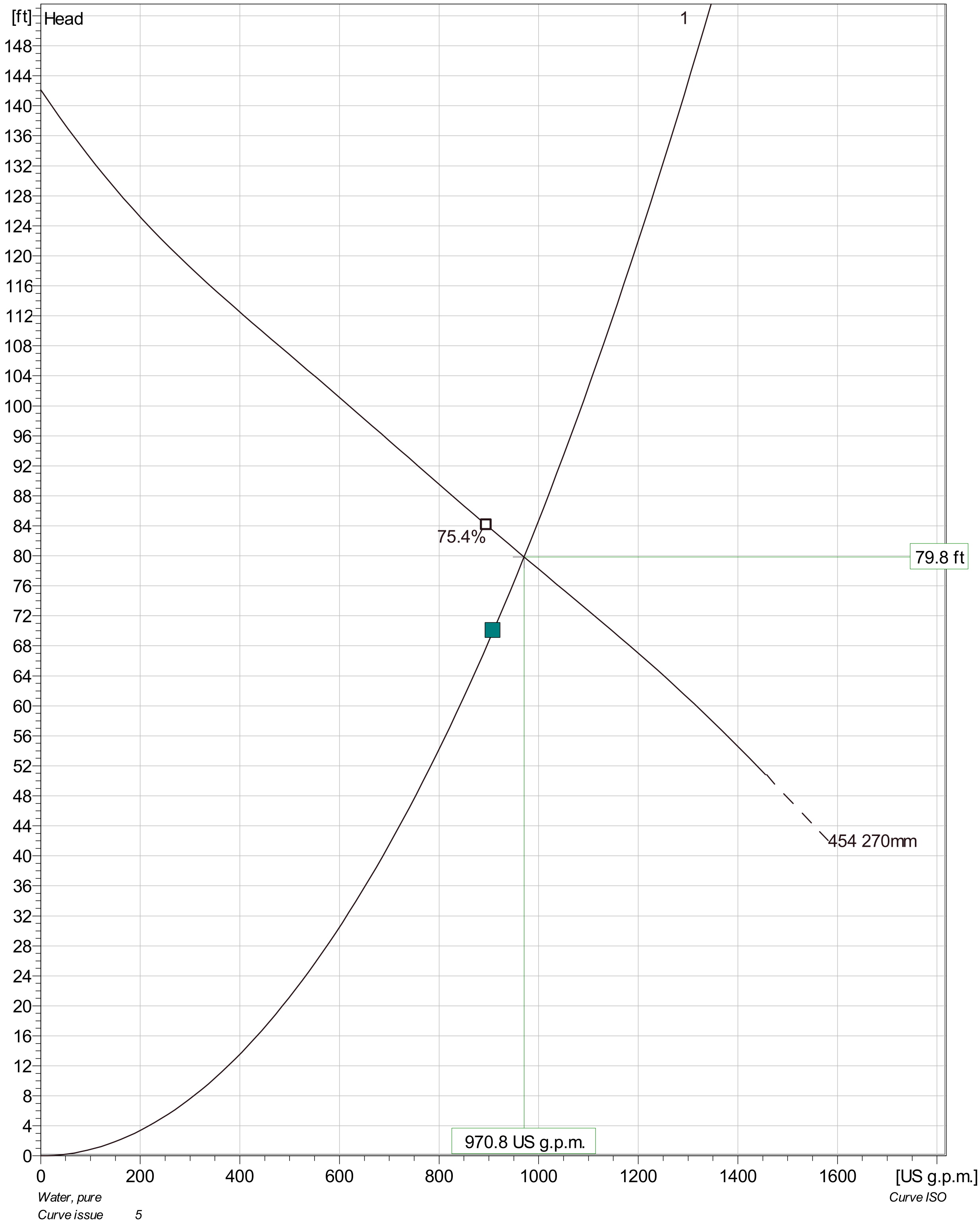
Guarantee

ISO_9906_Grade Grade 1
No

Project	Project ID	Created by	Created on	Last update
			2017-02-27	

NP 3171 HT 3~ 454

Duty Analysis

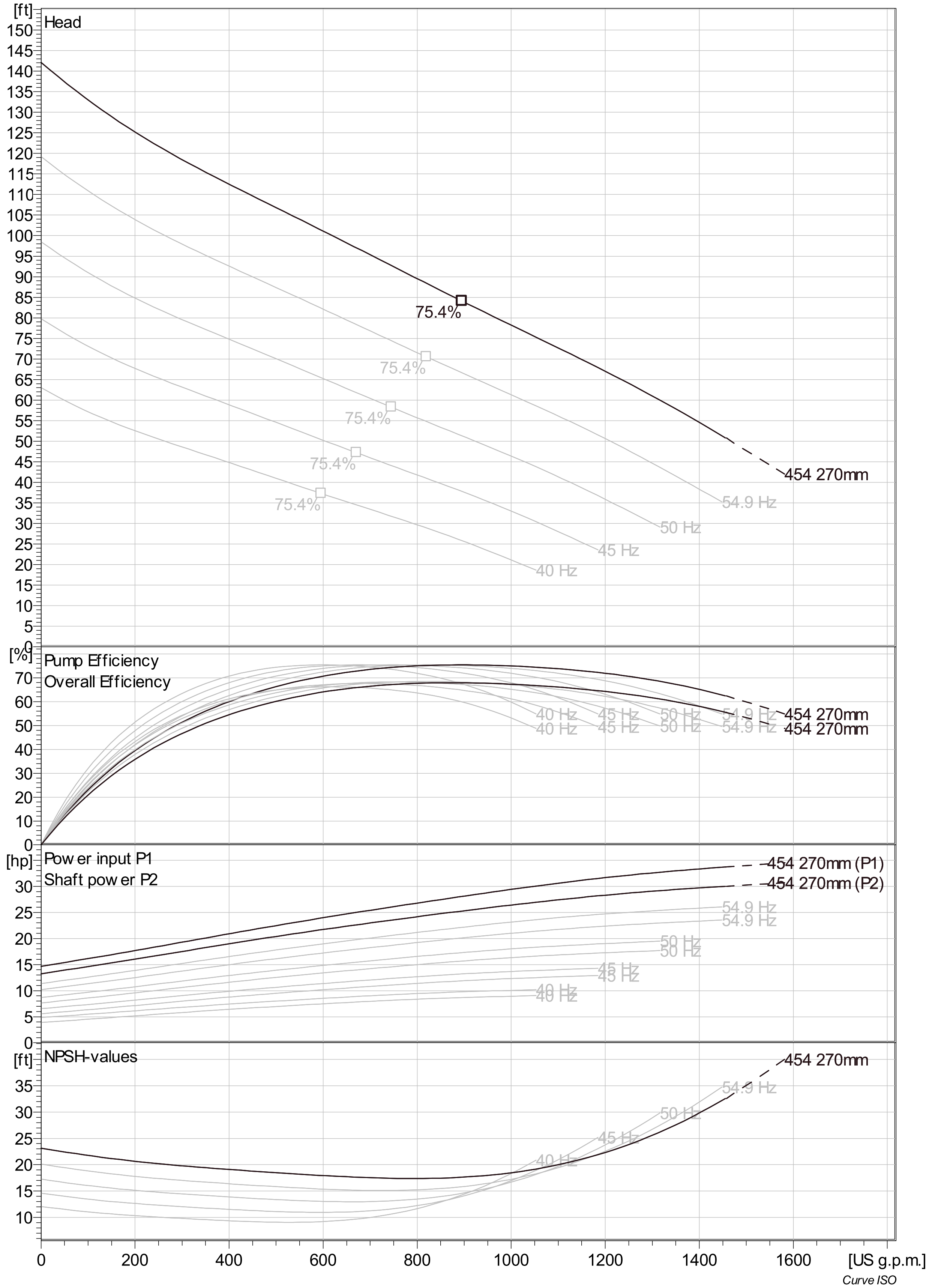


Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	971 US g.p.m.	79.8 ft	26.1 hp	971 US g.p.m.	79.8 ft	26.1 hp	75.2 %	372 kWh/US MG	18.2 ft

Project	Project ID	Created by	Created on	Last update
			2017-02-27	

NP 3171 HT 3~ 454

VFD Curve



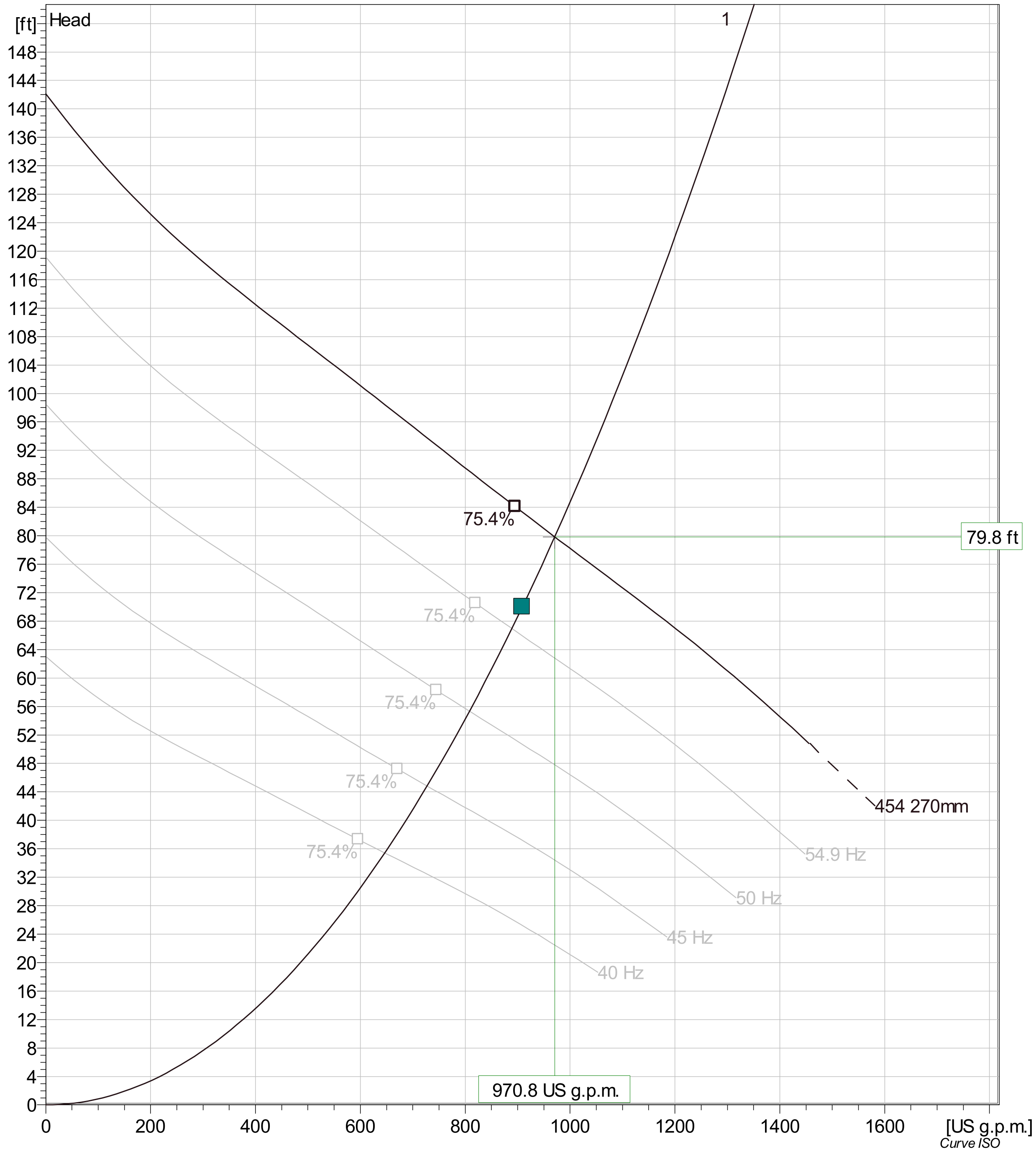
Project	Project ID	Created by	Created on	Last update
			2017-02-27	

xylem

NP 3171 HT 3~ 454

VFD Analysis

FLYGT

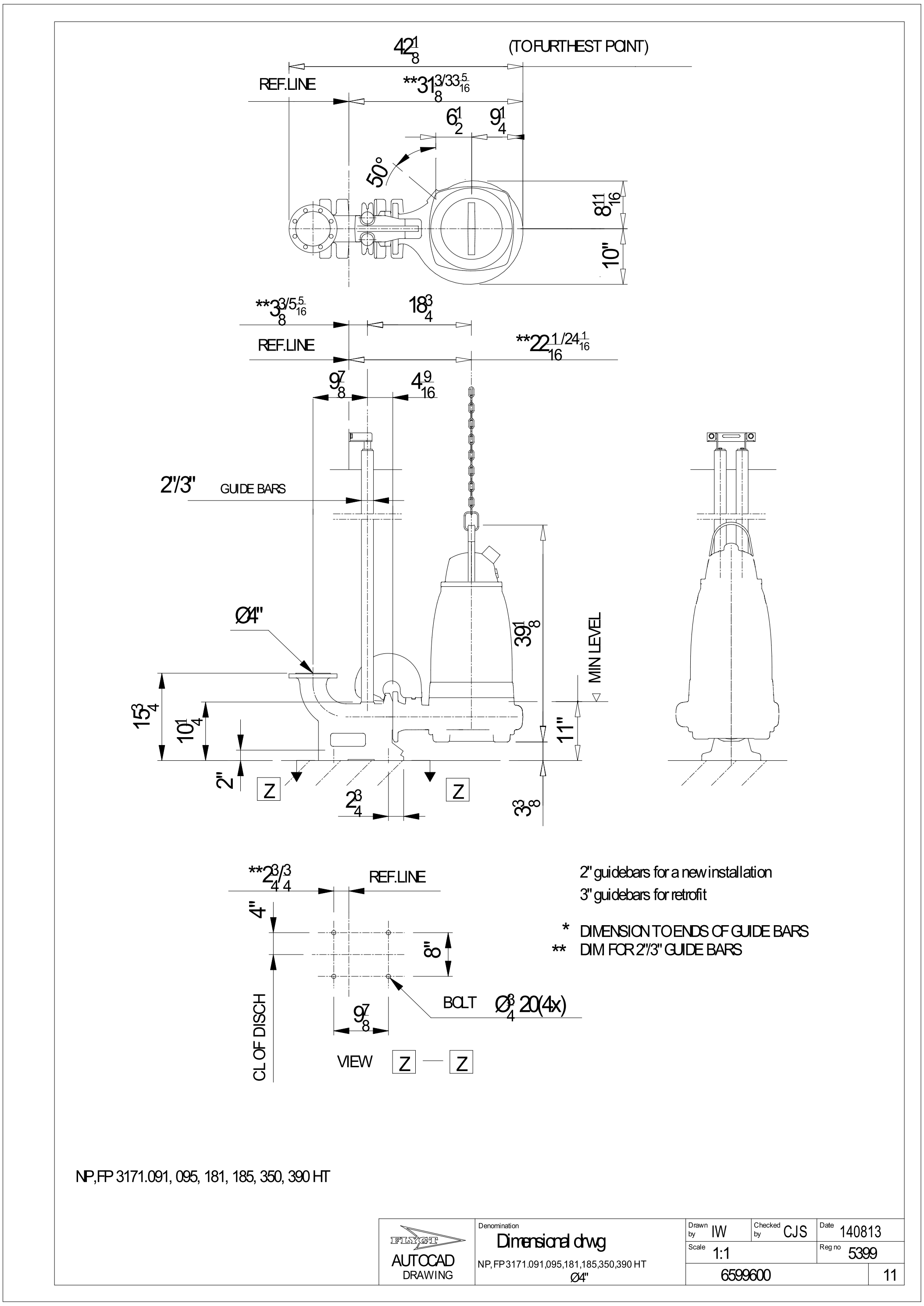


Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	971 US g.p.m.	79.8 ft	26.1 hp	971 US g.p.m.	79.8 ft	26.1 hp	75.2 %	372 kWh/US MG	18.2 ft
1	54.9 Hz	889 US g.p.m.	67 ft	20 hp	889 US g.p.m.	67 ft	20 hp	75.2 %	309 kWh/US MG	15.8 ft
1	50 Hz	808 US g.p.m.	55.3 ft	15.1 hp	808 US g.p.m.	55.3 ft	15.1 hp	75.2 %	256 kWh/US MG	13.5 ft
1	45 Hz	727 US g.p.m.	44.8 ft	11 hp	727 US g.p.m.	44.8 ft	11 hp	75.2 %	209 kWh/US MG	11.4 ft
1	40 Hz	647 US g.p.m.	35.4 ft	7.71 hp	647 US g.p.m.	35.4 ft	7.71 hp	75.2 %	168 kWh/US MG	9.48 ft

Project	Project ID	Created by	Created on	Last update
			2017-02-27	

NP 3171 HT 3~ 454

Dimensional drawing

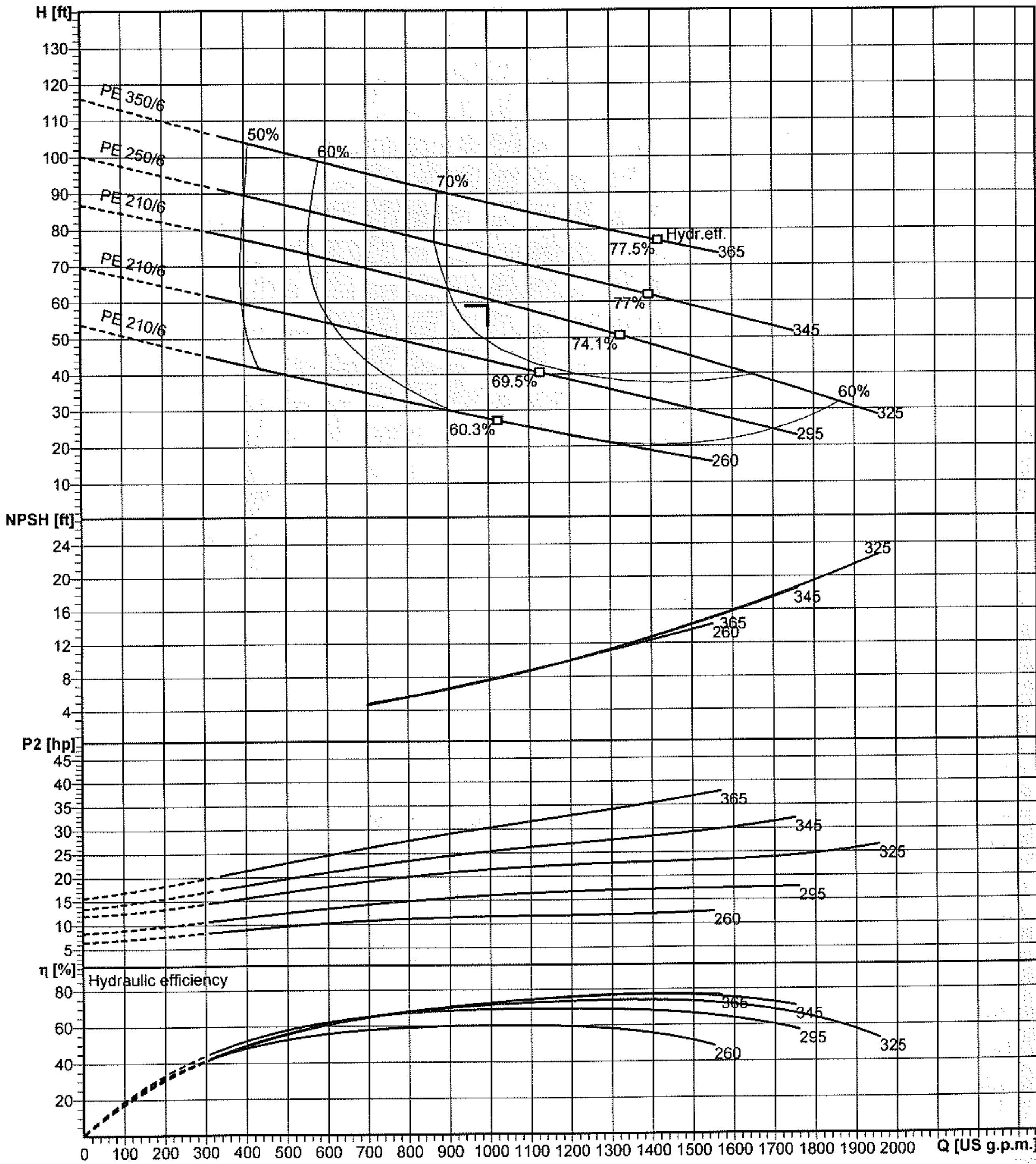


Project	Project ID	Created by	Created on	Last update
			2017-02-27	

240

Pump performance curves
XFP 150J-CH2 60 HZ

Curve number				
Reference curve XFP 150J-CH2				
			Discharge	Frequency 60 Hz
Density 62.43 lb/ft³	Viscosity 0.0000169 ft²/s	Testnorm Hydraulic Institute	Rated speed 1185 rpm	Date 2010-04-13
Flow 1012 US g.p.m.	Head 60.5 ft	Rated power 21.6 hp	Hydraulic efficiency 71.8 %	NPSH 7.7 ft



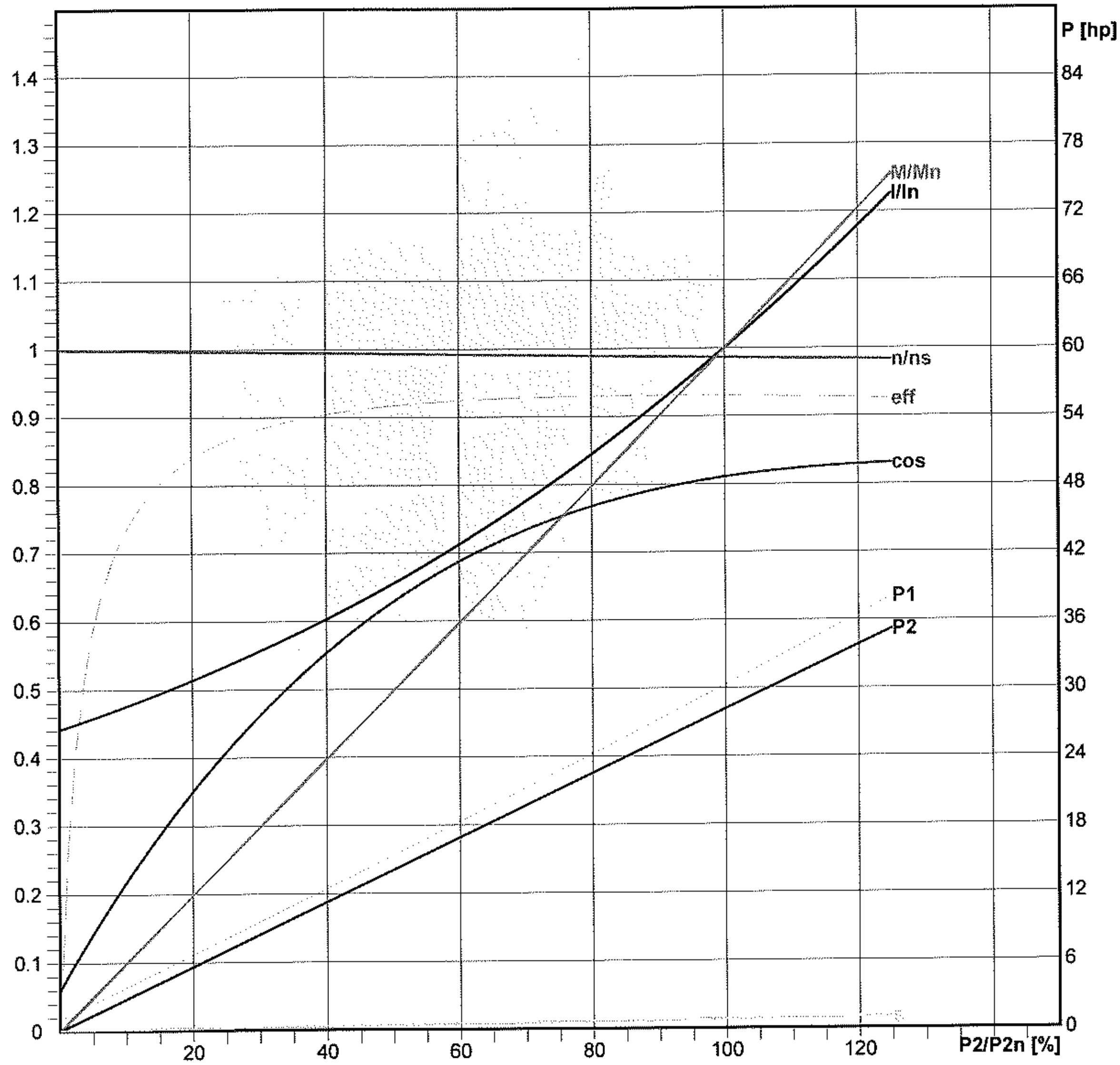
Impeller size	N° of vanes	Impeller	Solid size	Revision 2010-03-08
14.4..10.2 inch	2	2-vane channel impeller	3 1/8 x 3 7/8"	

ABSEL PRO 1.7.2 / 2007-02-07

Motor performance curve
PE 210/6

Frequency
60 Hz

Rated power	Service factor	Nominal speed	Number of poles	Rated voltage	Date
28.2 hp		1185 rpm	6	460 V	2010-04-13



Loading	No load	25 %	50 %	75 %	100 %	125 %
P1 [hp]	0.9888	8.141	15.36	22.73	30.28	38.06
P2 [hp]	0	7.04	14.08	21.12	28.16	35.2
I [A]	15.43	18.67	22.89	28.29	34.96	42.87
eff [%]	0	86.48	91.69	92.91	93	92.48
cos	0.05999	0.4081	0.6279	0.7521	0.8107	0.831
n [rpm]	1199	1196	1192	1188	1184	1179
M [lbf ft]	0	30.92	62.04	93.38	124.9	156.8
s [%]	0.08333	0.3333	0.6667	1	1.333	1.75

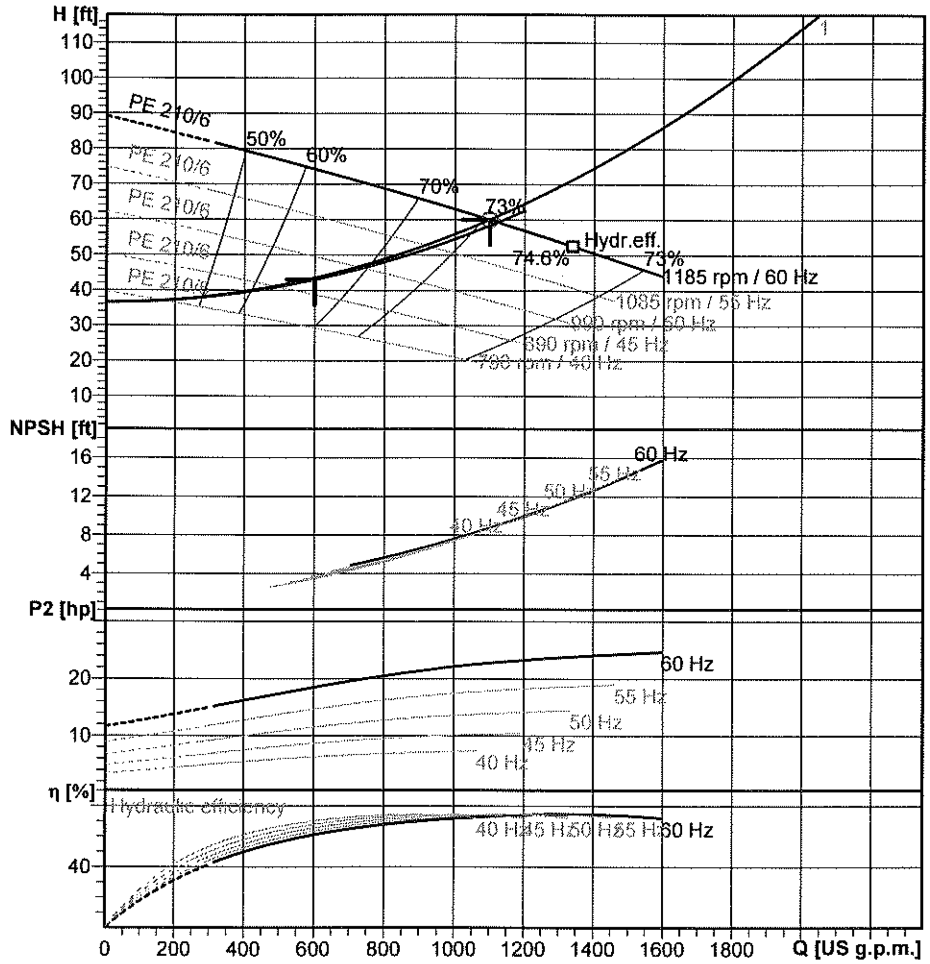
Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia		
231 A	300 lbf ft	8.94 lb ft²		

ABSEL PRO 1.7.2 / 2007-02-07

240

XFP 150J-CH2 60 HZ



Testnorm
Hydraulic Institute

2009-11-10

Operating data specification

Flow	1099 US g.p.m.	Head	60 ft
Static head	36.5 ft	Efficiency	73.2 %
Shaft power	22.7 hp	NPSH	8.7 ft
Fluid	Water	Temperature	39 °F
Nature of system	Single head pump	No. of pumps	1

Pump data

Type	XFP 150J-CH2 60 HZ	Make	ABS
Series	XFP PE4-PE6	Impeller	2-vane channel impeller
N° of vanes	2	Impeller size	14.4..10.2 inch
Free passage	3 1/8 x 3 7/8"	Suction port	

Motor data

Rated voltage	460 V	Frequency	60 Hz
Rated power P2	28.2 hp	Nominal speed	1185 rpm
Number of poles	6	Efficiency	93 %
Power factor	0.811	Rated current	35 A
Starting current	231 A	Rated torque	125 lbf ft
Starting torque	300 lbf ft	Degree of protection	IP68
Insulation class	F		

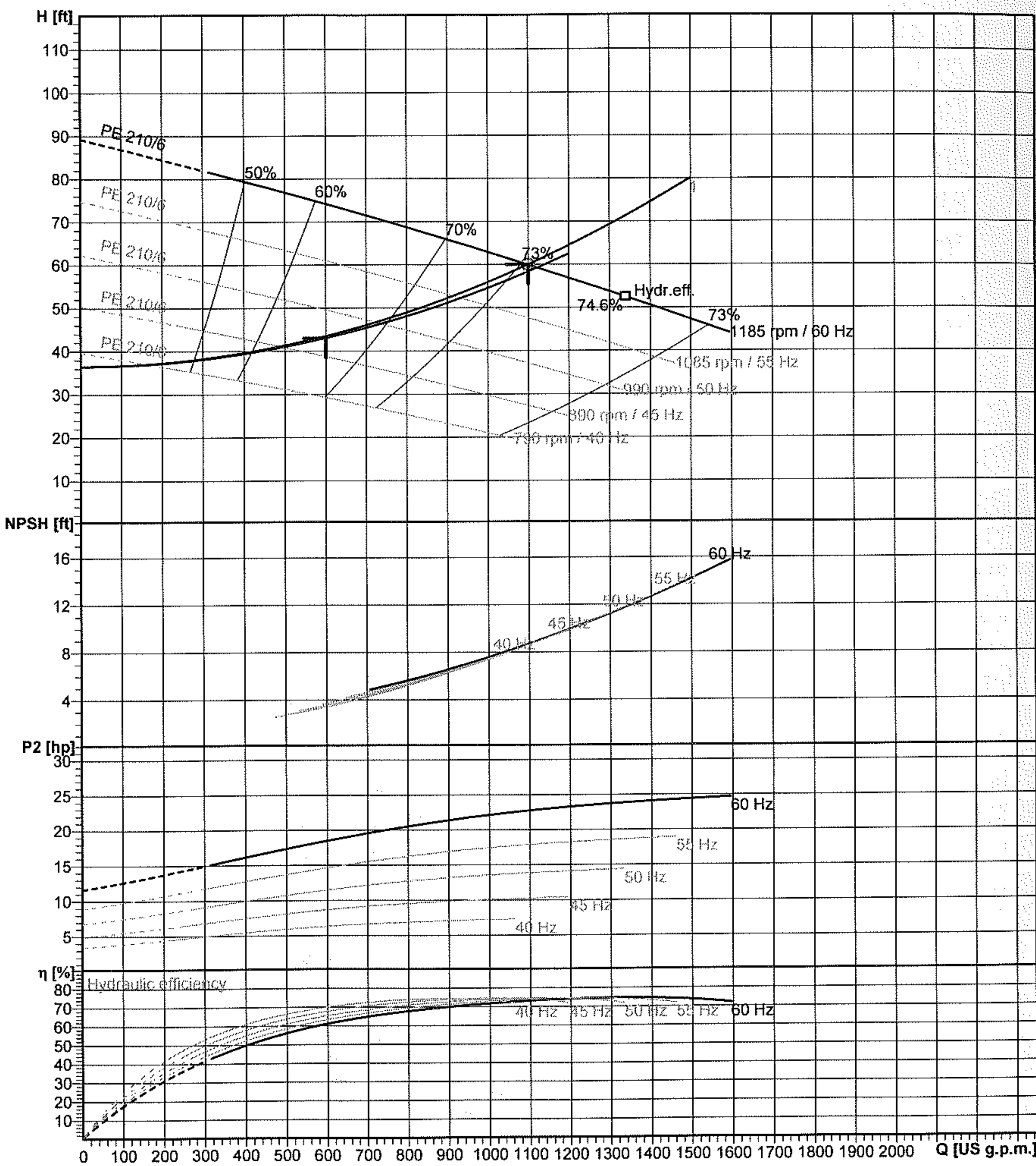
abs

We know how water works

INITIAL

Pump performance curves
XFP 150J-CH2 60 HZ

			Discharge	Curve number
				Reference curve XFP 150J-CH2
				Frequency 60 Hz
Density 62.43 lb/ft³	Viscosity 0.0000169 ft²/s	Testnorm Hydraulic Institute	Rated speed 1185 rpm	Date 2010-02-05
Flow 1099 US g.p.m.	Head 60 ft	Rated power 22.7 hp	Hydraulic efficiency 73.2 %	NPSH 8.7 ft



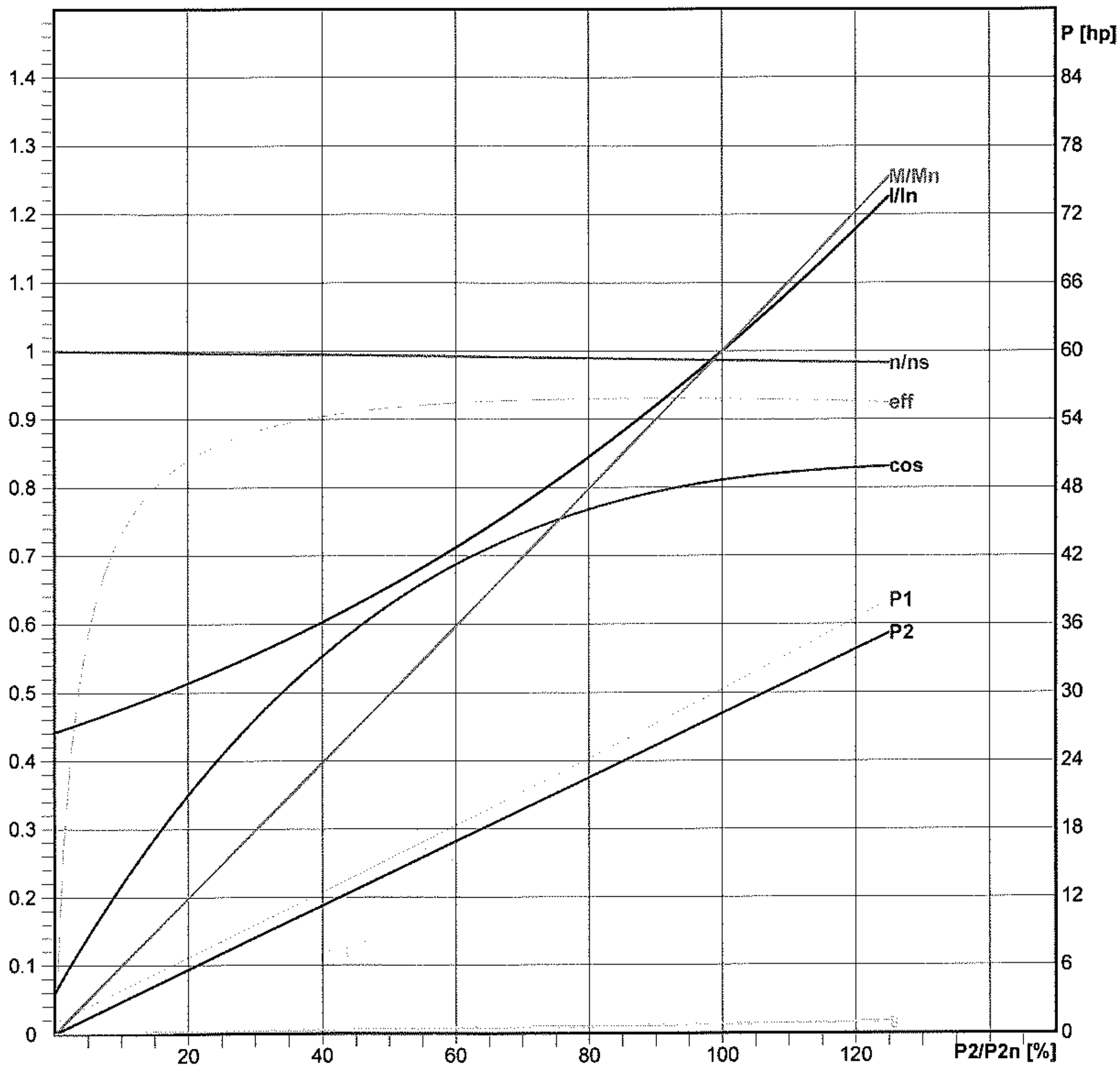
Impeller size	N° of vanes	Impeller	Solid size	Revision 2009-11-10
14.4..10.2 inch	2	2-vane channel impeller	3 1/8 x 3 7/8"	

ABSEL PRO 1.7.2 / 2007-02-07

Motor performance curve
PE 210/6

Frequency
60 Hz

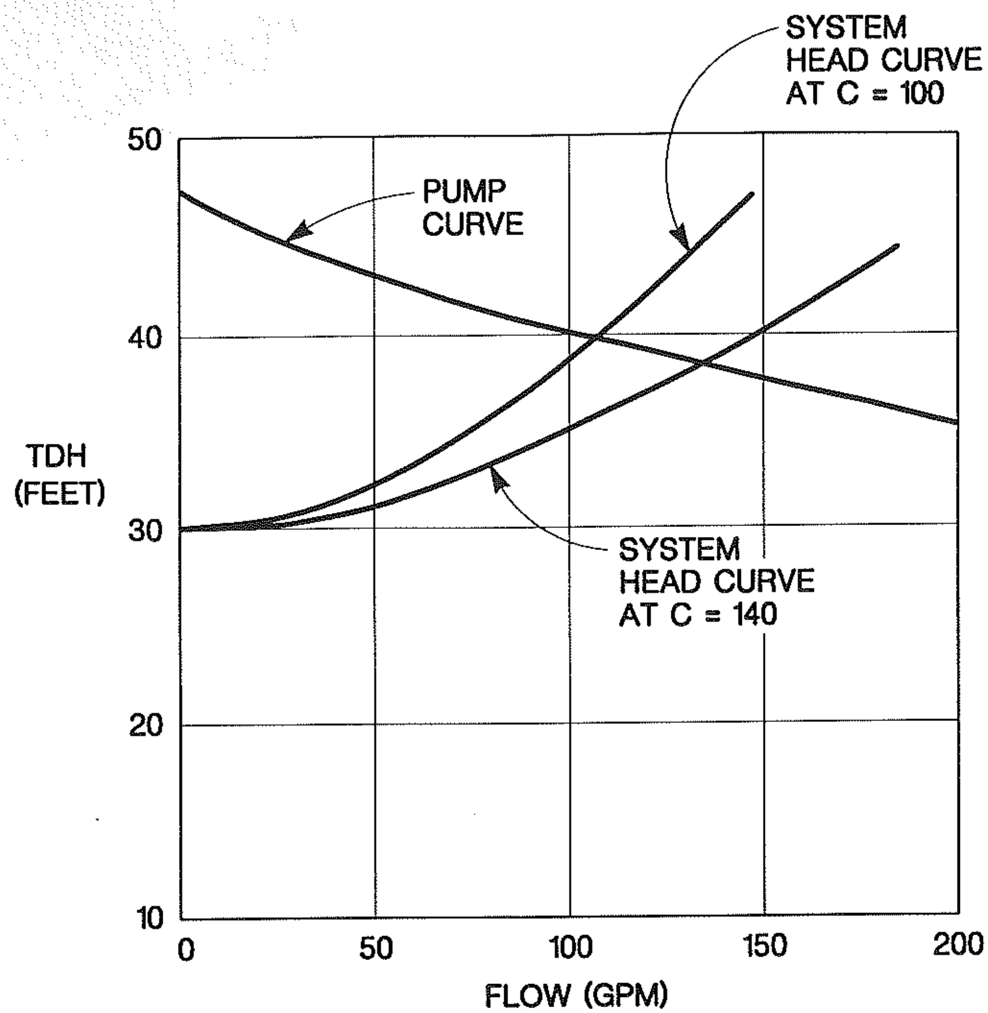
Rated power	Service factor	Nominal speed	Number of poles	Rated voltage	Date
28.2 hp		1185 rpm	6	460 V	2010-02-05



Loading	No load	25 %	50 %	75 %	100 %	125 %
P1 [hp]	0.9888	8.141	15.36	22.73	30.28	38.06
P2 [hp]	0	7.04	14.08	21.12	28.16	35.2
I [A]	15.43	18.67	22.89	28.29	34.96	42.87
eff [%]	0	86.48	91.69	92.91	93	92.48
cos	0.05999	0.4081	0.6279	0.7521	0.8107	0.831
n [rpm]	1199	1196	1192	1188	1184	1179
M [lbf ft]	0	30.92	62.04	93.38	124.9	156.8
s [%]	0.08333	0.3333	0.6667	1	1.333	1.75

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia
231 A	300 lbf ft	8.94 lb ft²



CITY OF NEWBERG

SHERIDAN STREET PUMP STATION SYSTEM CURVES

FLYGT	PERFORMANCE CURVE	PRODUCT: CP3102.090	TYPE: MT
DATE: 2000-05-22	PROJECT: Sheridan Street Pump Station	CURVE NO: 63-434-00-3730	ISSUE: 1

	1/1-LOAD	3/4-LOAD	1/2-LOAD
POWER FACTOR	0.88	0.86	0.79
EFFICIENCY	81.0 %	82.5 %	81.5 %
MOTOR DATA	---	---	---

RATED POWER	5.0	Hp
STARTING CURRENT ...	31	A
RATED CURRENT ...	6.5	A
RATED SPEED	1715	rpm
TOT.MOM.OF INERTIA ...	0.36	kgm2
NO. OF BLADES	1	

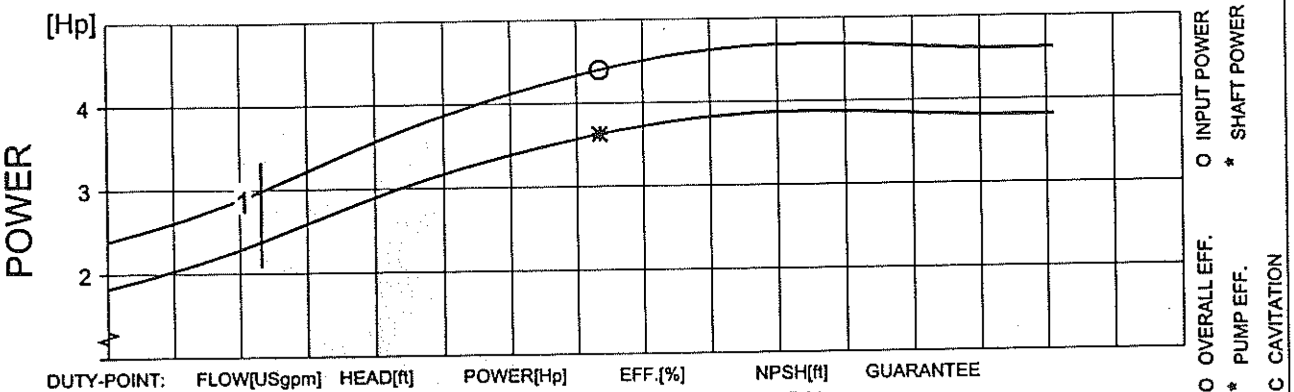
IMPELLER DIAMETER: 173 mm

MOTOR #		STATOR	REV
18-11-4AL		12YSER	10
FREQ.	PHASES	VOLTAGE	POLES
60 Hz	3	230 V	4
GEARTYPE		RATIO	
---		---	

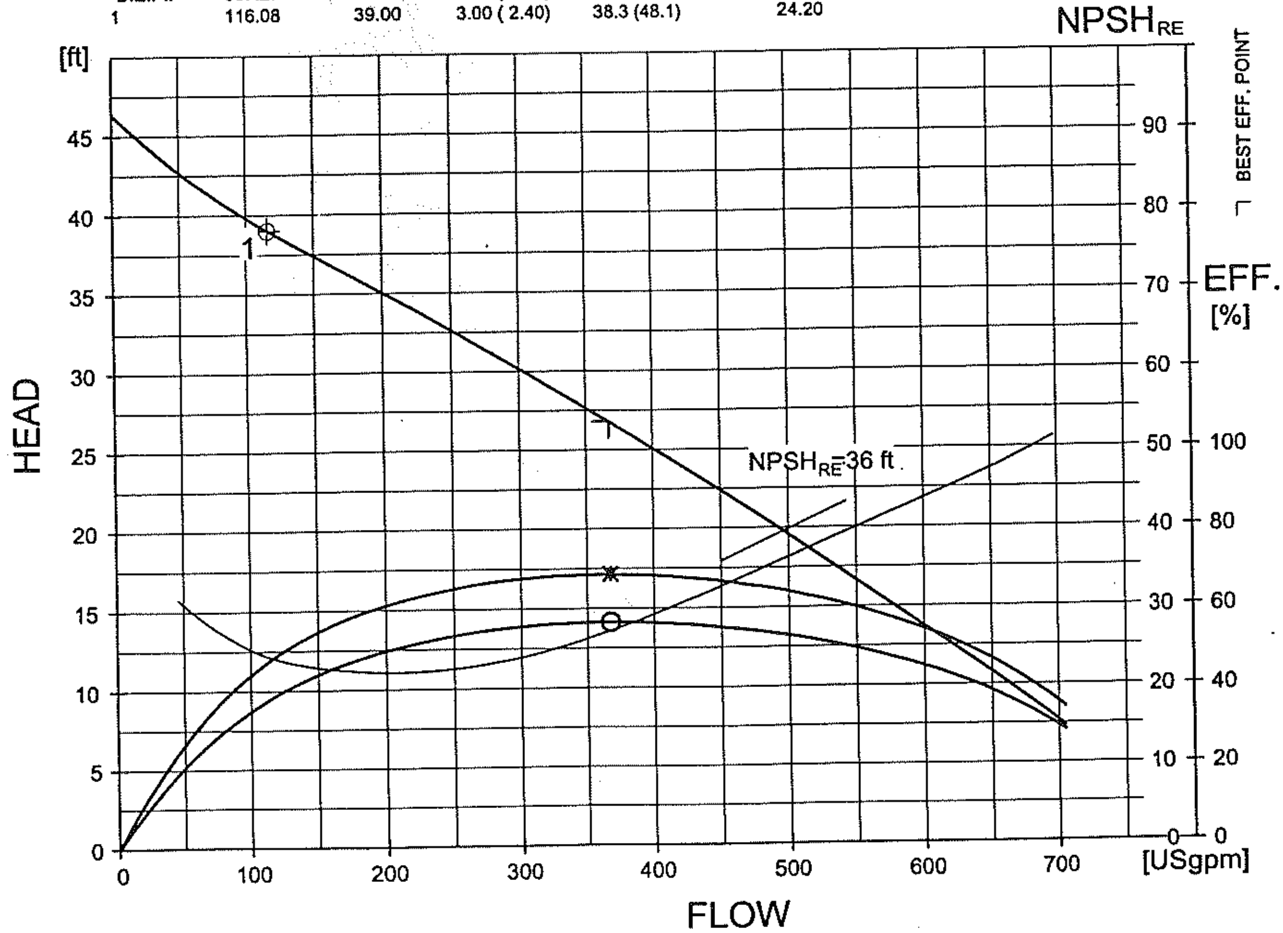
COMMENTS

INLET/OUTLET: - /100 mm

IMP. THROUGHLET: 76 mm



DUTY-POINT:	FLOW[USgpm]	HEAD[ft]	POWER[Hp]	EFF.[%]	NPSH[ft]	GUARANTEE
B.E.P.:	367.27	26.79	4.40 (3.63)	56.6 (68.6)	27.24	
1	116.08	39.00	3.00 (2.40)	38.3 (48.1)	24.20	



FLYPS 2.0 (1118)

Performance with clear water and ambient temp 40 °C

FLYGT CURVE

Pump Station Check List Monthly

Month: Jan

Note all discrepancies or needs and write work requests	614 Andrew st.	922 Charles St.	1345 Creekside Ln.	618 Sheridan St.	830 Dayton Ave.	4501 E Fernwood RD.	2500 NE. Chehalem	HWY 240 319 W Illinois St.
Date	1/10/17	1/10/17	1/10/17	1/10/17	1/10/17	1/10/17	1/10/17	1/10/17
Operator Initials	ET/BS	ET/BS	ET/BS	BS/ET	BS/ET	BS/ET	BS/ET	ET/BS
Fire Extinguisher's	N/A	N/A	N/A	N/A	X	X	X	X
Check for no alarms, "Available" lights are lit	X	X	X	X	X	X	X	X
Check pump #1 operation	X	X	X	X	X	X	X	X
Pump #1 Hours	8069.3	7894	2576.7	911	27208	10024.3	3156.5	4871.3
Check pump #2 operation	X	X	X	X	X	X		X
Pump #2 Hours	7777.9	7368	2161.2	764.2	26290.1	9560.5	3064.9	4944.8
Check pump #3 operation	N/A	N/A	N/A	N/A	N/A	X	N/A	X
Pump #3 Hours	N/A	N/A	N/A	N/A	N/A	3565.7	N/A	4904.4
Check high level alarm operation	X	X	X	X	X	X	X	X
Check that flush valve operates correctly	X	X	X	X	N/A	X	X	N/A
Wetwell								X
Washdown wetwell piping and pump rails	X	X	X	X	N/A	X	X	X
Wash down level probe and float	X	X	X	X	Grease Air Relief Valves	X	X	X
Check for debris or heavy grease	X	X	X	X	X	X	X	X
Valve Vault and BFPD Box								
Clean vault and grating and fill "P" trap	X	X	N/A	X	N/A	X	X	X
Ensure no standing water or debris in vault	X	X	N/A	X	N/A	X	X	X
Check for leaking plumbing	X	X	X	X	N/A	X	X	X
Check heat tape on RP device in winter	X	X	N/A	X	N/A	X	X	X

	Andrews	Charles	Creekside	Sheridan	Dayton Ave.	Fernwood	Chehalem	HWY 240
Control Cabinet								
Cabinet heater working (ambient below 50F) Cabinet fan working (ambient above 80F)	X	X	X	X	X	X	X	X
Check for moisture in cabinet	X	X	X	X	X	X	X	X
Secure Area Before Leaving								
Trash picked up? Area clean?	X	X	X	X	X	X	X	X
Any vandalism or problems noted	X	X	X	X	X	X	X	X
Water shut off to BFP Device	X	X	N/A	X	N/A	N/A	X	X
Float and Multitrode probe in place	X	X	X	X	X	X	X	X
Pumps are in Auto? Breakers shut?	X	X	X	X	X	X	X	X
Everything is Locked	X	X	X	X	X	X	X	X
Generators								
Hour Reading	303.1	111.3	Check UPS Operation	Check UPS Operation	344.1	367.4	276.8	109.3
Fuel Level	N/A	*Full*			N/A	Full	Full	N/A
Oil Level	Ok	Ok			Ok	Good	Good	Good
Test Operation	X	X			**X**	X	X	X

Comments: generator is not working at this time waiting for pasts from onan

DAYTON AVENUE LIFT STATION REHABILITATION ALTERNATIVES LETTER REPORT

Prepared by RH2 Engineering, Inc.

Date: April 7, 2016

RH2 ENGINEERING, INC.
www.rh2.com
mailbox@rh2.com
1.800.720.8052

WASHINGTON LOCATIONS

BOTHELL
MAIN OFFICE
22722 29th Drive SE, Suite 210
Bothell, WA 98021

BELLINGHAM

EAST WENATCHEE

ISSAQUAH

RICHLAND

TACOMA

OREGON LOCATIONS

NORTHERN OREGON
MAIN OFFICE
6500 SW Macadam Ave. Suite 125
Portland, OR 97239

SOUTHERN OREGON
Medford

April 7, 2016

Mr. Jason Wuertz, P.E.
Project Manager
City of Newberg
Public Works Department
414 East First Street
Newberg, OR 97132

Sent via: *US Mail and E-Mail*

Subject: Dayton Avenue Lift Station Rehabilitation Alternatives Letter Report

Dear Mr. Wuertz:

As requested by the City of Newberg (City), RH2 Engineering Inc., (RH2) has completed its evaluation of the Dayton Avenue Lift Station's (Station) condition and hydraulic performance. This letter is intended to present the findings of this evaluation and to provide recommendations for remedial actions, including alternatives for both rehabilitating and replacing the Station.

Background

The City constructed the Dayton Avenue Lift Station in 1993 as a replacement for the 8th Street Lift Station. Designed as an above-grade, self-priming sewer pump station, the Station is equipped with two (2) 75-horsepower (hp) 10-inch Model T10A-B Gorman-Rupp self-priming centrifugal pumps. These pumps are located within a 320 square foot pump and electrical building located on top of a 12-foot-diameter, 10-foot deep wetwell. Operation of the Station is controlled with a Multitrode MultiSmart Pump Station Manager that is configured to operate based on the wetwell level as reported by an ultrasonic level sensor. The Station flow rate is calculated based on the pump run time, and change in wetwell level between pump start and stop. The wetwell is equipped with floats for pump on/off control and high level alarm. The Station is connected to the City's master supervisory control and data acquisition (SCADA) system which provides monitoring of station flows and alarm conditions. The Station is also equipped with a 125 kilowatt (kW), natural gas fueled, back-up generator that is located outdoors and adjacent to the building.

Sewage discharge from the Station is pumped into an approximately 4,000-foot-long, 12-inch-diameter force main that discharges into a receiving manhole, located near the intersection of East 9th Street and South River Street. The force main rises from an elevation of approximately 105 feet at the Station, to approximately 162 feet at the receiving manhole, and is equipped with two sewage air relief valves and one cleanout along the alignment. The force main pipe materials consists of both ductile iron and SDR 26 polyvinyl chloride (PVC). The majority of the force main, which originally served the 8th Street Lift Station, was upgraded in 1985. Approximately 650 feet of ductile iron force main was constructed as part of the Station upgrade in 1993.

According to Dayton Avenue Lift Station as-constructed record drawings, the design criteria listed indicates that each pump in the Station was originally intended to have a pumping capacity of 2,100 gallons per minute (gpm) at 90 feet total dynamic head (TDH). However, City operators have reported numerous instances where the actual pumping capacity has been greatly reduced, with observed pumping rates as low as 1,300 gpm. As a result of the reduced and/or erratic pumping capacity, as well as other factors, the Station has historically been prone to sewage overflows. In an effort to reduce loading on the Station, the City constructed the Highway 240 Lift Station in 2009 to transfer up to 600 gpm from the Station's basin to the neighboring basin (*City of Newberg Sewerage Master Plan Update 2007*, prepared by Brown and Caldwell, and revised in 2009). While this has helped to reduce the frequency of sewage overflows, the Station continues to have problems with poor performance and low reliability.

The City hired RH2 to evaluate the current condition and performance of the Station, and to recommend alternatives for rehabilitation and/or replacement of the Station to address these ongoing issues. This report summarizes these findings and recommendations.

Historical Station Flows and Overflows

According to City-provided overflow records, 15 overflow events occurred between 2005 and 2009, with 9 of these events occurring within 2006. Almost all overflow events during this period were attributed to high rain storm events, during which flows at the Newberg Wastewater Treatment Plant peaked between 13.0 and 20.5 million gallons per day (MGD). Between 2009 and 2012, the number of overflow events decreased to only four events, of which three events were attributed to a power or sensor failure, and only one event attributed to a high rainfall event. In 2015, overflow events occurred on December 7th and 17th, both of which are attributed to high rainfall events.

To evaluate the effect that either an increase/decrease in precipitation, and/or the construction of the Highway 240 Lift Station may have had on reducing the frequency of the overflow events at the Station, RH2 analyzed the precipitation data over this time period. As shown in **Table 1**, six of the seven rainfall-related overflow events occurred prior to the construction of the Highway 240 Lift Station. During this time, the average annual rainfall was generally less than the annual rainfall that has occurred since the Highway 240 Lift Station was constructed. In addition, seven of the top ten precipitation events have occurred since the Highway 240 Lift Station was constructed, only one of which resulted in an overflow event at the Dayton Avenue Lift Station.

Table 1
Historical Precipitation (Years 2005 through 2013)

Average Daily Precipitation (Inches)										
Month	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Average**
1	0.06	**0.37**	0.12	0.24	0.19	0.22	0.15	**0.26**	0.07	0.19
2	0.02	0.08	0.18	0.08	0.08	0.13	0.16	0.11	0.06	0.10
3	0.14	0.12	0.10	0.15	0.13	0.18	**0.25**	**0.29**	0.08	0.16
4	0.10	0.08	0.07	0.10	0.08	0.13	0.18	0.13	0.07	0.10
5	0.13	0.09	0.03	0.05	0.12	0.15	0.15	0.12	0.14	0.11
6	0.07	0.03	0.03	0.04	0.02	0.11	0.04	0.10	0.04	0.05
7	0.02	0.00	0.02	0.00	0.01	0.01	0.04	0.03	0.00	0.01
8	0.01	0.00	0.02	0.05	0.01	0.00	0.00	0.00	0.02	0.01
9	0.08	0.03	0.08	0.01	0.06	0.07	0.04	0.00	**0.25**	0.07
10	0.11	0.04	0.17	0.05	0.12	0.19	0.08	0.22	0.03	0.11
11	0.18	**0.40**	0.16	0.17	0.24	0.20	0.21	**0.27**	0.11	0.21
12	**0.29**	0.20	0.24	0.14	0.18	**0.31**	0.12	**0.30**	0.07	0.20
Average	0.10	0.12	0.10	0.09	0.10	0.14	0.12	0.15	0.08	0.11

Data Source: Weather Underground (www.wunderground.com)

#.##	Average daily precipitation exceeds monthly average between 2005 and 2013.
#.##	Average daily rainfall within top 10-percent of all precipitation events between 2005 and 2013.
#.##	Reported overflow event related to rainfall event.

This analysis would suggest that the following statements are true:

1. The Highway 240 Lift Station has been effective at reducing flows to the Dayton Avenue Lift Station.
2. The current pumping capacity at the Dayton Avenue Lift Station appears to be sufficient to handle basin inflows.
3. The cause(s) of the overflows may be related to factors unrelated to the pumping capacity of the Station.

A further analysis of the lift station performance and pumping capacity is provided later in this report.

Condition Assessment

On July 23, 2015, RH2 conducted a condition assessment and performance testing of the Station and force main. The condition assessment included visual inspection of Station components and interviews with City operations staff regarding maintenance and operation of the Station. This assessment identified a number of deficiencies, which are summarized in **Table 2**, with a more detailed discussion of the condition of Station components to follow. The noted Station deficiencies provided in **Table 2** are assigned a priority ranking, ranging from 1 to 5, with 1 having the highest priority and 5 the lowest. **Table 2** also provides recommended remedial actions for the listed station deficiencies, which are separated into short-term and long-term improvements. Short-term improvements would address immediate needs to improve operation and reliability of the Station, while long-term improvements address long-term needs, including the recommended replacement of the Station. A more detailed discussion of the recommended remedial actions is provided in the last section of this report.

Table 2
Summary of Deficiencies and Recommended Actions

Summary of Deficiencies and Recommended Actions			
Lift Station Deficiencies	Priority Level	Recommended Action	
		Short-term Improvements	Long-term Improvements
The 3-way plug valve located at the pump discharge is broken. This results in the inability to isolate the pump station from the force main for routine maintenance and repairs.	1	Remove and replace existing 3-way plug valve with new full-port 3-way valve. Cut sheets for a replacement valve are included in the Attachments.	N/A
The Station has no means of isolation or bypass pumping for use in an emergency or during rehabilitation.	1	Provide bypass pumping port and isolation valve. See Preliminary Design Bypass Pumping Alternatives plan in the Attachments for details.	N/A
The Check Valves at Pump No. 1 and No. 2 are showing signs of leakage at the hinge pin.	1	Repair/replace check valve packing at the hinge pin.	N/A
The availability of spare parts for the pumps is limited.	2	N/A	Recommend eventual replacement of pumps with submersibles. See Conceptual Site Plan in the Attachments for details.
The ultrasonic level sensor readings do not appear to accurately represent values measured during drawdown testing.	2	Verify and adjust ultrasonic level sensor calibration, programming, and signal scaling.	Perform regular inspection and calibration of level sensing equipment.
Lift station experiences regular "brownouts" that have caused station programming and control problems.	2	Install temporary data logging power meter to monitor power quality and usage to better pinpoint source and cause of power sag.	Based on monitoring results, evaluate and install voltage sag protector or uninterruptible power supply (UPS) unit.
It appears that pump discharge flow is being recirculated back to the wetwell through the pump air release valve when the pump is operating at full capacity. The air release valve should close once the pumps have reached a fully primed condition.	4	Contact pump manufacturer and service/adjust air release valves so that valves close under fully primed conditions.	N/A
Pressure gauge installed along force main at Cleanout Man Hole is installed with a 0 to 60 psi range that exceeds the anticipated operating pressure at this point.	5	Recommend replacing gauge with 0 to 10 psi gauge to improve accuracy of gauge readings.	N/A
Suction side check valve and air valves have been know to stick open, resulting in loss of prime and reduced capacity.	3	Perform regular maintenance on suction side check valves and air release valves per manufacturer recommendation.	Recommend eventual replacement of pumps with submersibles. See Conceptual Site Plan in the Attachments for details.
The wetwell has limited capacity and only provides 0.12 hour average time to overflow (per original design). Size does not provide adequate response time should pump failure or loss of prime occur.	2	N/A	Recommend eventual replacement of pumps with submersibles. See Conceptual Site Plan in the Attachments for details.
According to as-built records, it appears that the last 1,350 lineal feet of force main is installed with a sag in the main with only a minor elevation difference between the upstream and downstream high points on either side of the sag. In RH2's experience, this type of condition often results in unstable hydraulic condition due to a siphoning effect that can occur under certain flow conditions. These conditions can affect pump performance. While it does not appear that this condition affected the pump performance during recent testing, it may help explain the anecdotal reports from operators of reduced and/or fluctuating pumping rates.	5	N/A	N/A
It appears that the system may be experiencing a minor increase in headloss (approximately 2 to 3 psi over new conditions). This increase may be due to pump wear, minor blockage, or corrosion within the force main.	4	N/A	Recommend installing pigging station and performing closed-circuit television (CCTV) investigation and pigging of the force main.

Pumps

The Station is equipped with two (2) 75-hp 10-inch Model T10A-B Gorman-Rupp self-priming centrifugal pumps with 14 ¾-inch impellers. The pumps are intended to operate at 2,100 gpm, with one running and one redundant during normal flows, alternating between pump cycles. During high flow periods, the two pumps are intended to operate in parallel at a combined capacity of 2,500 gpm. While originally designed to operate at a capacity of 2,100 gpm at 90 feet of TDH, the pumps have been observed to be operating at a significantly lower capacity, with pumping rates as low as approximately 1,300 gpm. This observation was confirmed during drawdown testing performed by RH2, results of which are presented in the **Capacity Assessment** section of this report. Further, City operators have reported that the pumps routinely lose prime and have experienced frequent clogging issues, which have resulted in the pumps overheating and Station overflows.

The pumps are installed with pressure gauge assemblies, containing both suction and discharge pressure gauges for each pump. Both gauge assemblies are original and of questionable condition. New 0 to 60 pounds per square inch (psi) discharge pressure gauges have been installed near the original gauge tap location and appear to be in good working condition. The suction side pressure gauges appear operational, but have not been confirmed to provide accurate readings.

Maintenance of the pumps is made difficult by the inability of the pumps to be isolated due to a broken 3-way plug valve at the pump discharge header. As a result, operators must rely on the discharge side check valves to hold back the contents of the force main to perform maintenance on the pumps. Due to safety concerns caused by the inability to isolate the pumps, routine maintenance and inspection of the condition of internal components, such as impellers, casing, wear plates, and clearances, have been deferred, possibly causing inefficient and unreliable pump performance. These issues, coupled with limited availability of spare parts for the pumps, have further increased the difficulty of properly maintaining the pumps.

Wetwell

The Station has a 12-foot-diameter, 10-foot-deep wetwell with approximately 6,500 gallons of storage capacity. According to the design criteria shown in the as-constructed records for the Station, the wetwell was intended to provide approximately 7 minutes of storage prior to overflow should pump failure occur. According to the pump manufacturer, under normal operating conditions the pumps are capable of self-priming in approximately 5 minutes. While this length of time may be adequate under normal operating conditions, it may be inadequate during higher than typical flows. In this instance, the limited wetwell capacity has been insufficient in providing adequate time to respond to and correct issues caused by poor pump operation, resulting in sewage overflows.

Aside from the limited capacity, the wetwell appears to be in good condition. Accumulation of fat, oils, and grease (FOG) does not appear to be a significant issue, and the City performs annual cleaning of the wetwell to remove grease and grit. Also, soluble sulfides and odor do not appear to be a significant problem in the wetwell. There is minor deterioration of the cement on the wetwell interior wall, but the wetwell remains in sound structural condition.

In 2008, the City retrofitted the wetwell and installed a "V" shaped plate at the influent pipe to break up the influent flow and minimize air entrainment in the wetwell. Prior to installation of the diverter plate, the Station had been experiencing significant problems with pump cavitation due to the influent drop into the wetwell, leading to air entrainment at the pump suction. Since installation of this diverter plate, it appears the problem with cavitation has been resolved.

Valves and Piping

The Station piping consists of 10-inch ductile iron suction, and 10- and 12-inch ductile iron discharge piping. There is a 10-inch plug valve and a flap check valve on the suction side of each pump. The flap check valves serve to keep the suction piping full and maintain pump prime. A 10-inch spring check valve is located on the discharge side of each pump. Air release valves are also located on the discharge side of the pumps, which are tapped into the upstream side of the swing check valve. The air release valves act to evacuate air and facilitate self-priming of the pumps. A 10-inch, 3-way plug valve is located where the pump discharges meet at a common header and serves as the Stations only means of isolation from the force main.

In general, the piping appears to be in satisfactory condition given the age of the Station, and RH2 observed no signs of significant corrosion. That said, several problems associated with valves at the Station were observed that require remedial action. The most urgent issue associated with the Station is the inability to isolate the Station from the force main for routine maintenance or repairs due to the broken 3-way plug valve at the pump discharge. Further, the Station does not have a bypass piping system that would allow for replacement of this valve or other Station rehabilitative measures. The installation of a bypass pumping system and replacement of this valve should be a top priority.

City operators note that on occasion, the suction side check valves will not seat properly, resulting in loss of prime. Additionally, the pump discharge air release valves have been known to not close properly once the pump has reached a fully primed condition, resulting in minor reductions in pumping capacity. RH2 observed signs of minor leakage at the hinge pin of the check valve on the discharge side of Pump No. 2. Repair of these valves should be addressed in future lift station maintenance.

Force Main

The Station discharge is pumped through an approximately 4,000-foot-long, 12-inch-diameter force main that discharges into a receiving manhole, located near the intersection of East 9th Street and South River Street. The force main rises from an elevation of approximately 105 feet at the Station, to approximately 162 feet at the receiving manhole, and is equipped with two sewage air relief valves and one cleanout along the alignment, as shown in **Figure 1**. Pressure gauges are also installed along the force main at the air relief valve and cleanout locations. The force main materials consist of both ductile iron and SDR 26 PVC pipe. The majority of the force main, which originally served the 8th Street Lift Station, was upgraded in 1985. Approximately 650 feet of ductile iron force main was constructed as part of the Station upgrade in 1993.

Figure 1
Force Main Alignment and Pressure Gauge Locations

According to City records, it appears that the air relief valves were last serviced or replaced in March, 2012. During the condition assessment and performance testing performed on July 23, 2015, City staff observed a minor amount of air and wastewater purging from the second air relief valve along the force main, suggesting it is operating as intended. No such observation was made at the first air relief valve and its condition is unclear.

The pressure gauges installed at the air relief valves, both with a 0 to 30 psi range, appear to be in good condition. The pressure gauge located at the cleanout manhole appears significantly older and is installed with a 0 to 60 psi range. In general, it is recommended that pressure gauges be installed so that the normal operating pressure falls within 25 to 75 percent of the gauge range. Since normal operating pressure at this location is around 4 psi, the installed gauge greatly exceeds this standard recommendation and compromises the accuracy of pressure readings taken at this point. It is recommended that this gauge be replaced with a 0 to 10 or 0 to 15 psi range gauge.

Finally, City staff have reported that, at times, the receiving manhole has been observed in a flooded condition when both pumps are operating in parallel. This would suggest that the receiving gravity sewer line may be undersized to convey higher pumped flows. RH2 did not observe this during the performance testing, and it is unclear if this is a normal or infrequent event. It is recommended that further evaluation and modeling of the downstream system be considered as part of any future design related to the Station or force main.

A more detailed discussion of the condition of the force main is provided in the **Hydraulic Analysis** section of this report.

Controls and Telemetry

Operation of the Station is controlled with a Multitrode MultiSmart Pump Station Manager that is configured to operate based on the wetwell level as reported by an ultrasonic level sensor. The Station flow rate is calculated based on the pump run time and the corresponding change in wetwell level between pump start and stop times. The wetwell is equipped with floats for pump on/off control and high level alarm. The Station is connected to the City's master SCADA system, which provides monitoring of station flows and alarm conditions.

In general, the control and telemetry equipment appear to be in good condition, with the exception of the ultrasonic level sensing equipment that did not accurately represent level measurements taken in the field during drawdown testing. Any inaccuracy in level measurement will result in inaccurate flow rate data calculated by the Multitrode MultiSmart Pump Station Manager and collected by the SCADA system. The effect of this inaccuracy in the analysis of Station operation and pumping is discussed in further detail in the **Capacity Assessment** section of this report. Although it is not clear as to what is causing the inaccuracy in the readings, possible causes can include sensor orientation, calibration, programming, and/or signal scaling. It is recommended that the sensor be serviced by a technician to verify proper calibration, installation, and integration with the control system.

Electrical

The Station has a 480-volt, 3-phase, 300-amp electrical service, as well as a 125 kW natural gas powered back-up generator. Although the Station electrical components and emergency back-up generator appear to be in good working order, the station does experience regular "brownouts," which have caused programming and control issues as well as sewage overflows. The source of these brownouts is not clearly understood at this time and a more detailed investigation may be warranted. It is recommended that a data logging power meter be temporarily installed to monitor power quality and usage to better pinpoint the source of these "brownouts." Based on the evaluation of the monitoring results, it may be appropriate to install either a voltage sag protection or an uninterruptible power supply (UPS) unit to help protect against intermittent drops in power supply. Alternatively, the collected data may be of use in working with Portland General Electric to identify potential power distribution issues that could be corrected.

Capacity Assessment

Pump Performance Testing

On July 23, 2015, RH2 and City staff performed drawdown testing to evaluate the current pumping capacity of the Station. The drawdown testing procedure involved field measurements of the "Pump On" and "Pump Off" levels, and recording the wetwell fill and drawdown time between pump cycles. Repeated tests were conducted for each pump to confirm results. Based on the as-constructed wetwell geometry and recorded field measurements, the discharge capacity for each pump was calculated, and is summarized in **Table 3**. Results from the drawdown test, including field measurements and calculations, are attached to this report.

Table 3
Pump Capacity Based on Drawdown Testing

Pump	Capacity (gpm)
No. 1	1,344
No. 2	1,347

As shown in **Table 3**, drawdown testing shows the current operating capacity of the station as approximately 1,350 gpm. This is consistent with flow rates observed and noted by City staff in the past, although higher flow rates have also been observed, as discussed in the **Pump Run Time/Cycle Analysis** section of this report.

Pump Run Time/Cycle Analysis

The City-provided SCADA data included the cycles per day for each pump, run time per day for each pump, and total daily flow for the Station. This data covered the 2012, 2013, and 2014 calendar years. RH2 analyzed the data provided to calculate the approximate instantaneous pump flow rates for each day as shown in **Figure 2**. The design and tested flow rate of 2,100 gpm and 1,350 gpm, respectively, are also shown for reference.

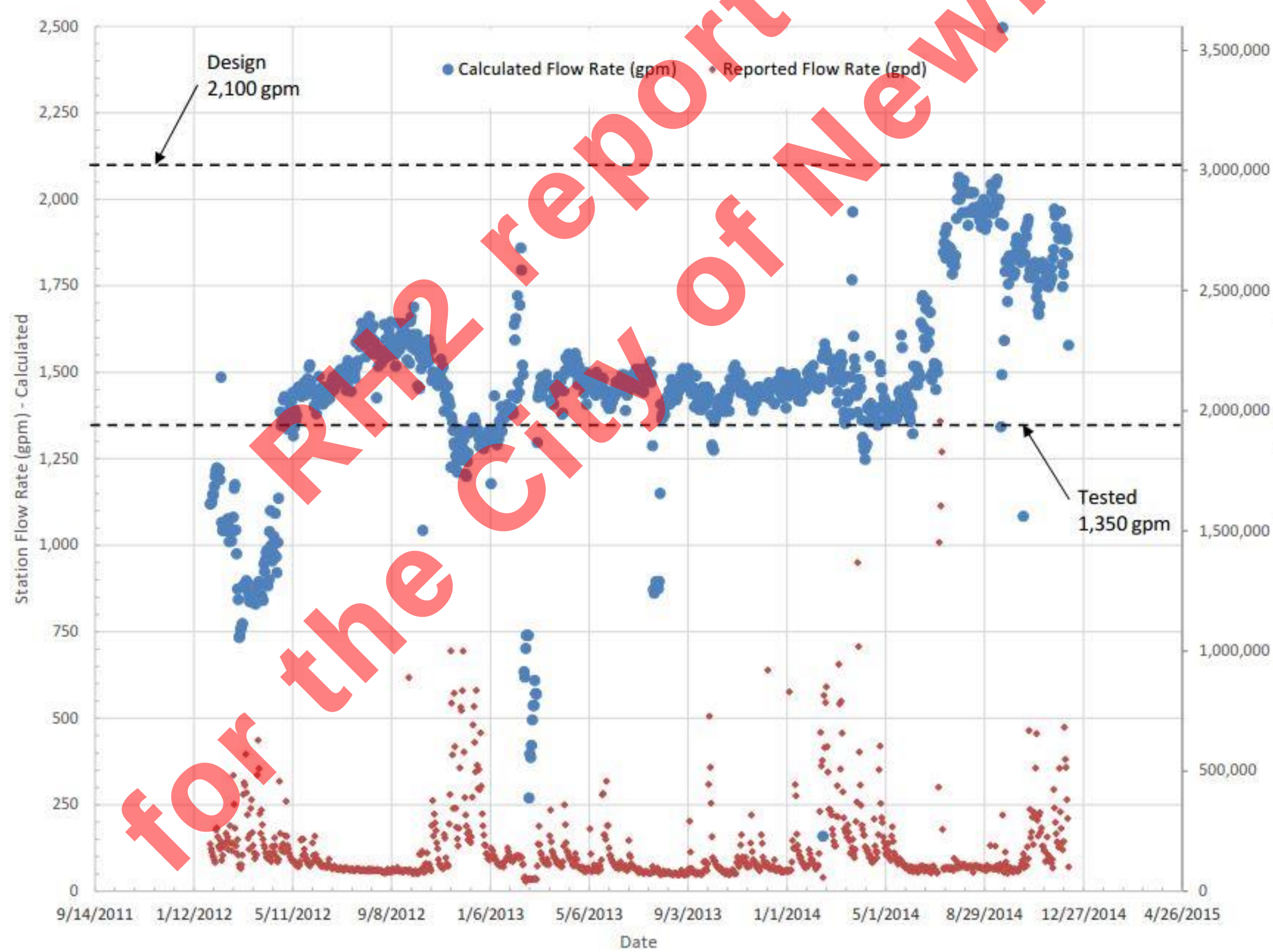


Figure 2
Historical Flow Rate (2012 to 2014)

As can be seen in **Figure 2**, the calculated flow rates vary considerably throughout the 3-year period encompassed by the data. This high variability in flow rates is likely do to inaccurate daily flow volumes provided by the SCADA data rather than actual variability of the pumps themselves. As the Station does not have a flow meter, daily flow volumes are calculated based on rates of change of level in the wetwell, pump run times, and pump starts as previously discussed. Since pump run times and pump starts are reliable, it is likely that the high variability seen in **Figure 2** is due to inaccurate level readings. As noted in the **Condition Assessment** section, it was observed that the level readings and pump flow rates displayed on the controller were not corresponding to levels measured in the field and tested flow rates, which tends to support this assessment.

Further, an analysis of the SCADA data was performed to determine the performance and operation of the individual pumps over the 3-year period, which is presented in **Table 4**. As shown in **Table 4**, it appears that Pump No. 1 and Pump No. 2 have historically been operating very similarly to each other. Particularly telling is the similarity in the average run time per cycle for each pump. This suggests that both pumps have operated at very similar rates over this period, which is consistent with drawdown testing results showing both pumps operating at about 1,350 gpm. This analysis indicates that the Station performance issues are likely not tied to a particular pump. Rather, it suggests that either the pumps are equally affected by other factors within the system, or that the pumps may be installed with a different belt configuration and operating at a lower speed.

Table 4
Individual Pump Run Time/Cycle Analysis

Item	Pump No. 1	Pump No. 2
Average Cycles/Day	33.1	33.1
Minimum Cycles/Day	13.0	13.0
Maximum Cycles/Day	122.0	122.0
Average Run Time/Day (min)	63.9	61.9
Minimum Run Time/Day (min)	21.0	18.0
Maximum Run Time/Day (min)	572.0	531.0
Average Run Time/Cycle (min)	1.8	1.7
Minimum Run Time/Cycle (min)	0.8	0.7
Maximum Run Time/Cycle (min)	8.3	7.6

Table 5 shows overall Station operation for the three-year period, as well as the performance for each individual year. An analysis of the operation over this period shows that the Station has operated fairly consistently. As shown in **Table 5**, the average run time per cycle has remained steady, suggesting that the Station capacity has also remained steady. The average starts per hour values show that the Station loading has remained fairly steady as well, with the exception of 2013, which had a drier than typical wet weather season.

Table 5
Analysis of Historical Station Operation

Item	Minimum	Maximum	Average
3 yr Historical Starts per Hour	0.5	5.1	1.4
2012 Starts per Hour	0.6	4.4	1.4
2013 Starts per Hour	0.6	3.9	1.1
2014 Starts per Hour	0.5	5.1	1.4
3 yr Historical Run Time/Cycle (min)	0.7	7.9	1.7
2012 Run Time/Cycle	1.4	7.9	1.7
2013 Run Time/Cycle	1.4	2.7	1.7
2014 Run Time/Cycle	0.7	5.0	1.7

Further, review of the three-year historical flow data shows that the Station received an average daily flow of about 0.17 MGD and peak day flow of about 1.5 MFD. The peak day flow of 1.5 MGD occurred on January 19, 2012, which also corresponds to the day of the maximum run time per day for each pump in **Table 4**. On this day, the pumps were operating a total of approximately 18.4 hours and could not keep up with the incoming flow, resulting in a sewage overflow. This was the only overflow event that occurred during the period encompassed by the SCADA data. While the Station was adequately handling average flows and most wet weather flows during this period, it was inadequate in handling this peak flow event.

<u>*Hydraulic Analysis*</u>

A system head curve for the Station was developed based on as-constructed records, assumed pipeline conditions, and the current operating capacity determined from drawdown testing. During the pump drawdown testing, pressure measurements were recorded at existing gauge locations along the force main alignment and at the pump discharge.

The measured pressure values were then compared to calculated pressure values based on the system head curve for new pipe conditions. The system head curve was then revised and validated to account for age and condition of the pipe by adjusting the roughness coefficient to match calculated pressures in the force main to measured field conditions. The calculated pressures differ from measured values by approximately 2 to 3 psi. This indicates that the system is experiencing a minor increase in headloss over original (new) conditions. The calculations for the system head curve are attached to this report. The system head curve, based on performance testing, was overlaid on the pump curve provided by the manufacturer, which can be seen in **Figure 3**.

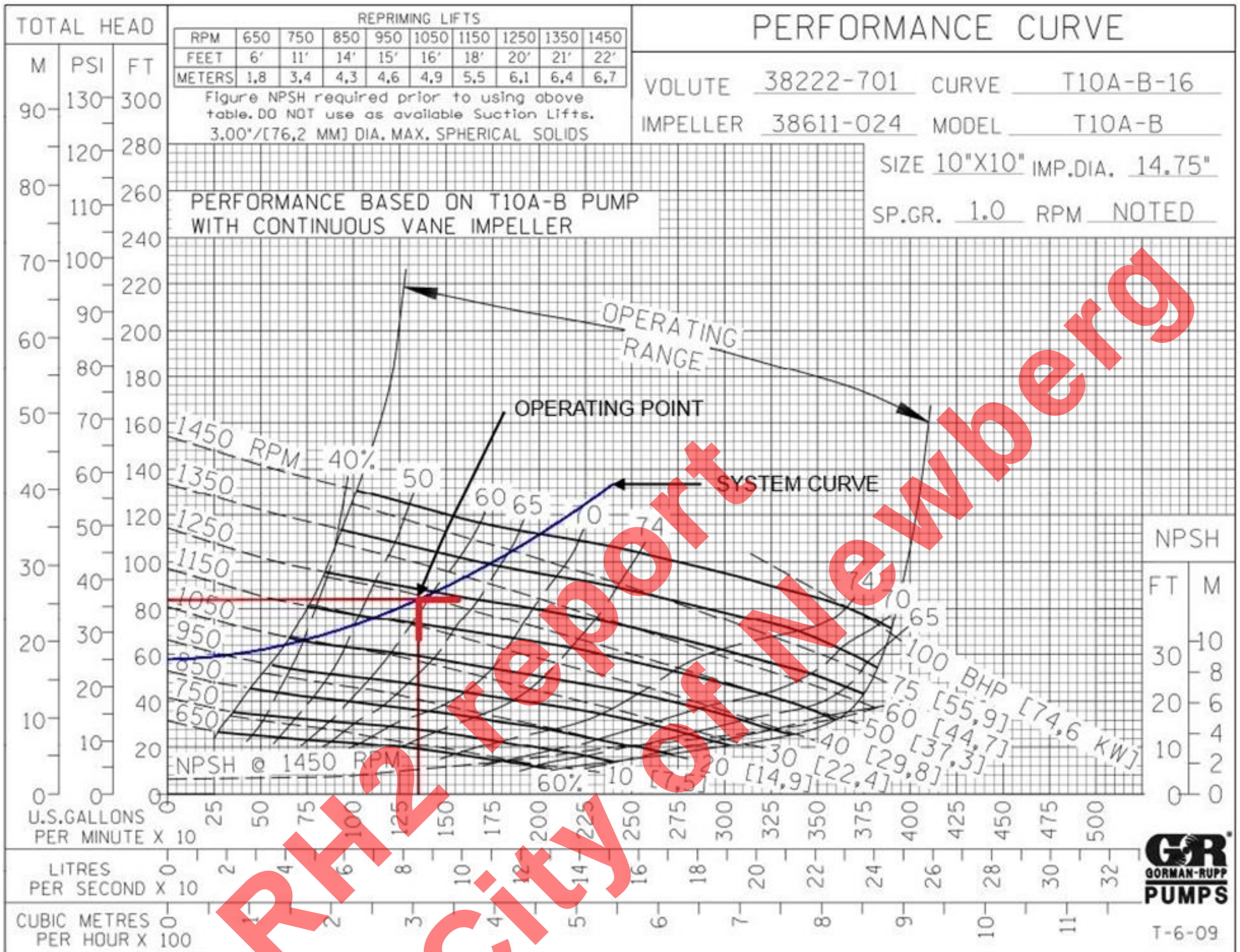


Figure 3
System and Pump Curves

The operating point of 1,350 gpm at a TDH of 84 feet obtained from the performance testing is also indicated in **Figure 3**. According to as-constructed records, the pumps are expected to be operating at a speed of 1,315 rotations per minute (rpm). However as shown in **Figure 3**, the system curve and performance testing data would suggest that the pumps are operating on the curve for a speed of approximately 1,250 rpm. A decrease in pumping capacity would typically indicate that the pumps are experiencing an increase in head in the system. However, this does not appear to be the case here as the pumps are operating at a lower head and lower capacity than originally designed. Although this may suggest that the pumps are operating at a lower speed than originally designed, the operating speeds of the pumps were field verified using a tachometer by City staff.

As previously discussed, the hydraulic analysis also shows that there is a minor increase in headloss over new conditions. This minor increase in headloss in the system could indicate a minor blockage or corrosion in the force main, although the TDH of the system is still less than that of the original design.

One possible cause of decreased capacity could be wear or damage to the impeller or casing due to the Station's history of problems with cavitation. According to email correspondence with the City and the pump supplier, the station was experiencing significant problems with cavitation due to the influent drop into the wetwell leading to air entrainment at the pump suction. To resolve this problem, the City installed a "V" shaped plate at the influent pipe to break up the influent flow and minimize air entrainment in the wetwell. Since installation of this diverter plate, it appears the problem with cavitation has been resolved, yet the pumps continue to perform poorly.

Also, according to as-constructed records, it appears that the last 1,350 lineal feet of force main is installed with a sag in the main, with only minor elevational differences between the upstream and downstream high points on either side of the sag. In RH2's experience, this type of condition often results in unstable hydraulic condition due to a siphoning effect that can occur under certain flow conditions. These conditions can affect pump performance. While it does not appear that this condition affected the pump performance during recent testing, it may help explain anecdotal reports from operators of reduced and/or fluctuating pumping rates; however, the siphoning effect would not be significant enough to account for the dramatic difference between the current operating capacity and the original design capacity.

Recommendations

Due to the configuration of the existing Station, it has been prone to a series of ongoing issues that affect the Station's maintainability, reliability, and performance. The following section presents two alternatives to address these issues: rehabilitation of the Station and replacement of the Station. The rehabilitative alternative includes short-term measures that could be implemented now to improve maintainability and operational reliability of the Station, yet this rehabilitative alternative does not address the long-term needs of the Station for several reasons. First, the use of above-grade self-priming pumps, coupled with the limited capacity of the wetwell, make the Station more prone to sewage overflows. Second, the availability of spare parts for the installed pumps is limited, making continued maintenance of the pumps increasingly difficult. Finally, due to the existing layout of the Station, retrofitting the Station in place with submersibles is not feasible. For these reasons, RH2 recommends the following short-term improvements be implemented with the intention of ultimately replacing the Station.

Station Rehabilitation Alternative

As previously discussed, the most urgent remedial action is to provide a means of bypass pumping to be able to take the Station offline for further maintenance and rehabilitative actions. The Bypass Pumping Alternatives Plan is attached to this report. The first alternative involves the installation of an Inserta-Valve and a tapping sleeve with the valve just downstream of where the future lift station connection would be. Once installed, the tapping tee and valve would serve as a connection point for bypass piping, as well as a pigging station, and the Inserta-Valve would serve as a means of isolating the Station from the force main. The second alternative would connect bypass piping to the upstream side of the existing butterfly valve at the abandoned 8th Street Lift Station site. Both alternatives would utilize a temporary, diesel-driven bypass pump drawing wastewater from the existing wetwell through the access opening.

Once bypass pumping is in place and the Station is isolated from the force main, further rehabilitative actions can be performed. These rehabilitative actions were previously summarized in **Table 2** and are presented below in order of need/urgency. These actions include:

- Removing and replacing the broken 3-way plug valve with a new full-port 3-way valve;
- Verifying and adjusting the ultrasonic level sensor orientation, calibration, programming, and signal scaling;
- Installing a temporary data logging power meter to monitor power quality and usage to better pinpoint the source and cause of the reoccurring "brownouts" at the Station;
- Servicing and repairing the other valves within the Station, including the suction side check valves, the air release valves, and the discharge side check valve for Pump No. 2; and
- Performing closed-circuit television inspection and pigging of the force main.

Station Replacement Alternative

As the Station rehabilitation alternative does not meet the long-term needs of the Station, the replacement of the Station is the preferred alternative. The existing configuration of the Station is not appropriate for the application, and RH2 recommends replacing the Station with a submersible configuration with a higher capacity wetwell.

The Dayton Avenue Lift Station Replacement Conceptual Site Plan is attached to this report, and shows a conceptual plan for replacing the Station with a new station on the existing property. The new lift station would be comprised of a new 12-foot-diameter, 20-foot-deep wetwell with triplex submersible pumps and a new valve/meter vault. The existing building and emergency generator would remain in place. The overflow of the new wetwell would be configured to utilize the existing Station for overflow storage and pumping. Due to the existing site layout and topography, the work would involve site regrading and retaining walls. Also, the influent 18-inch and 8-inch gravity sewers would be intercepted at new manholes and rerouted to the new wetwell.

As previously discussed and based on the information available, it appears that issues at the Station are more likely attributed to pump selection and Station reliability than a lack of pumping capacity. Even when operating at a lower capacity than intended in the original design, the Station has had only three overflow events due to wet weather in the last 3 years. Further, the City has taken steps to divert flows within the basin and has begun a multi-year infiltration and inflow reduction program that is anticipated to further stabilize Station inflows. Based on the information available at this time, RH2 expects that the future Station capacity would be in the range of 1,500 to 1,900 gpm. Due to the concern regarding the accuracy of the Station flow records, it may be beneficial to consider installing flow monitoring in the upstream manhole to obtain a better understanding of Station inflows for future pump selection. This should be done as part of the preliminary design of the Station replacement.

Table 6 provides an engineer's planning-level estimate for the replacement of the Dayton Avenue Lift Station.

Table 6
Engineer's Planning-level Estimate for Station Replacement Alternative

	Construct New Lift Station with Three Submersible Pumps	Matl Units	Total Cost
Construction			
1	Mobilization/Demo/Site Prep/Cleanup/Demobilization (7% of Construction Cost)	LS	$59,500
2	Temporary Erosion and Sedimentation Control	LS	$1,900
3	Site Work and Utilities	LS	$66,600
4	Structural	LS	$296,200
5	Mechanical	LS	$70,200
6	Pumps and Motors	LS	$132,000
7	Electrical and Automatic Control	LS	$282,100
	Subtotal		$908,500
	Contingency	25%	$227,200
	Construction Cost Subtotal		$1,136,000
Design & Permitting			
1	Engineering Design, Survey, & Permitting (15% of Construction Cost)		$170,400
2	Permitting Fees (5% of Construction Cost)		$56,800
3	Construction Administration (10% of Construction Cost)		$113,600
	Engineering & Permitting Subtotal		$341,000
	Total Project Cost		$1,477,000

This concludes RH2's evaluation of this facility and this letter report. If you have any questions or require additional information, please contact me by phone at (503) 246-0881 ext. 5360 or email at kpettibone@rh2.com.

Sincerely,

RH2 ENGINEERING, INC.

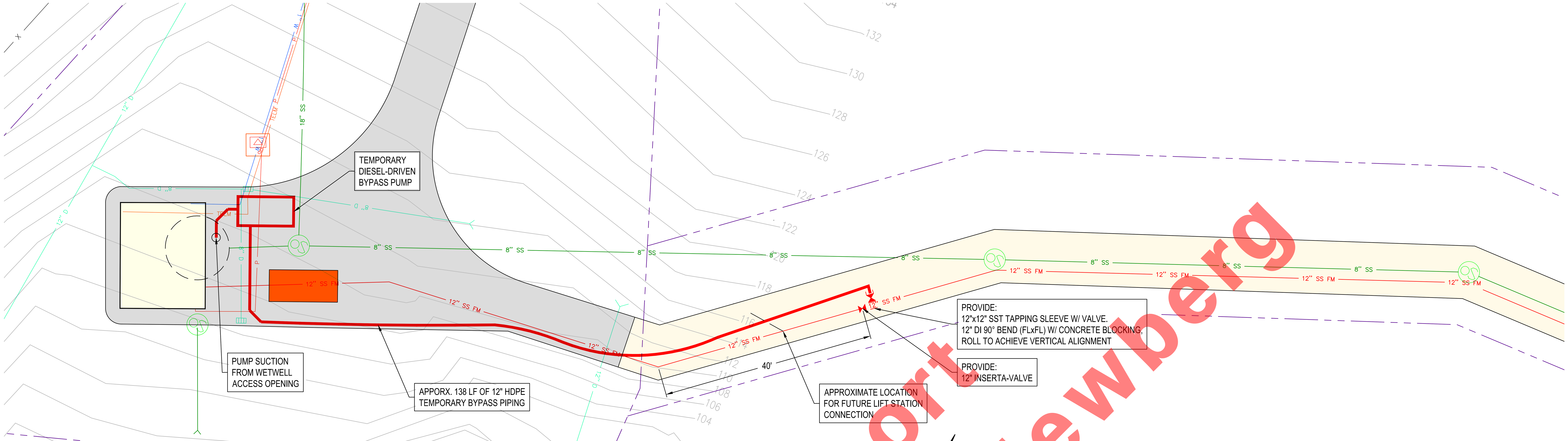
Kyle M. Pettibone, P.E.
Project Manager

REGISTERED PROFESSIONAL ENGINEER
88113
OREGON
SEPT. 10, 2013
KYLE PETTIBONE
EXPIRES 12/31/2016

RLB/KMP/JB/sp/djc

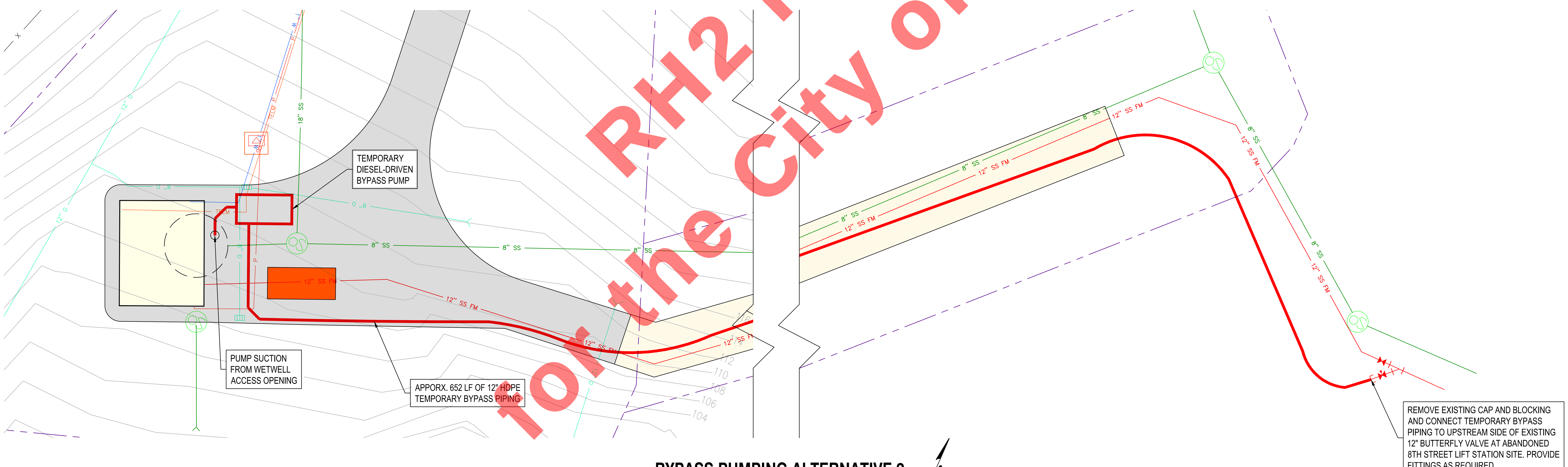
Attachments:

- Preliminary Design Bypass Pumping Alternatives Plan
- Dayton Avenue Lift Station Replacement Conceptual Site Plan
- Drawdown Testing Results
- Hydraulic Calculations
- 3-way Plug Valve Cut Sheets



BYPASS PUMPING ALTERNATIVE 1

1" = 10'



BYPASS PUMPING ALTERNATIVE 2

1" = 10'

REGISTERED PROFESSIONAL ENGINEER 88113 OREGON SEPT. 10, 2013 KYLE PETTIBONE
EXPIRES: 12/31/2016

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PORTLAND, OR
6500 SW Macadam Ave, Suite 125

CITY OF NEWBERG

DAYTON AVENUE LIFT STATION

PRELIMINARY DESIGN

BYPASS PUMPING ALTERNATIVES

PRELIMINARY

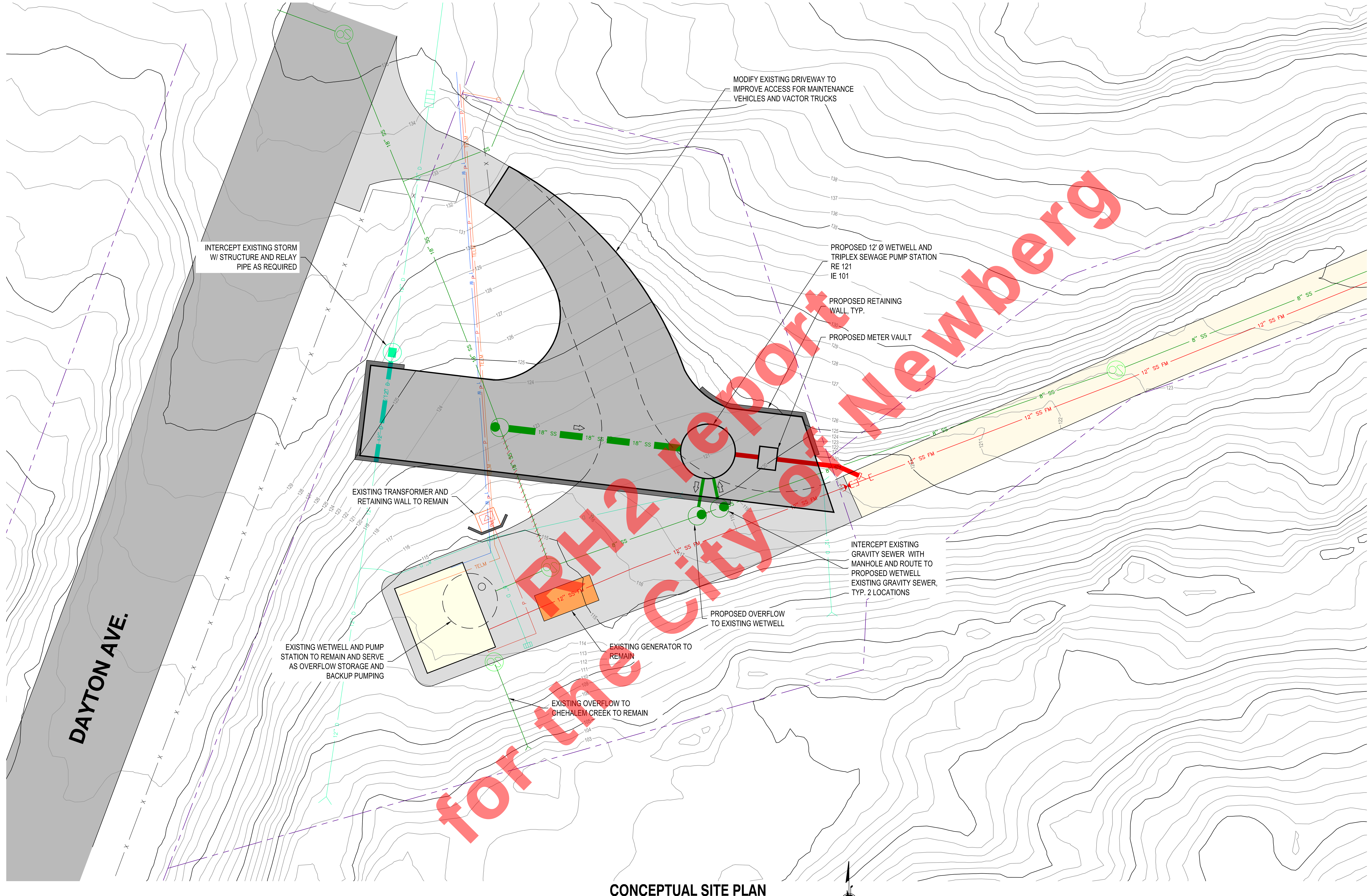
ENGINEER: JRB
REVIEWED: KMP
SAVE DATE: Aug 12, 2015
PLOT DATE: Aug 12, 2015
CLIENT: NEW
FILENAME: DAYTON-D-BYPASS PUMPING.DWG
JOB NO.: 814-136

REVISIONS

NO.	DATE	DESCRIPTION	BY	REVIEW

SCALE: SHOWN
0" 1" 2"
DRAWING IS FULL SCALE WHEN BAR MEASURES 2"

DWG NO.: C01
SHEET NO.: 1 / 3



CONCEPTUAL SITE PLAN

1" = 10'

REGISTERED PROFESSIONAL ENGINEER 88113
OREGON SEPT. 10, 2013 KYLE PETTIBONE
EXPIRES: 12/31/2016

RH2 ENGINEERS SCIENTISTS
RH2 ENGINEERING, INC.
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PORTLAND, OR
6500 SW Macadam Ave, Suite 125

CITY OF NEWBERG
DAYTON AVENUE LIFT STATION

City of Newberg

PRELIMINARY DESIGN
CONCEPTUAL SITE PLAN

PRELIMINARY

ENGINEER: JRB | SAVE DATE: Oct 6, 2015 | CLIENT: NEW | JOB NO.: 814-136
REVIEWED: KMP | PLOT DATE: Oct 8, 2015 | FILENAME: DAYTON-D-PROPOSED SITE.DWG

REVISIONS

NO.	DATE	DESCRIPTION	BY	REVIEW

SCALE: SHOWN
0" 1" 2"
DRAWING IS FULL SCALE WHEN BAR MEASURES 2"

DWG NO.: C02
SHEET NO.: 2 / 3

City of Newberg
Dayton Lift Station

Drawdown Testing

Drawdown Test Field Measurements (Pump 1)												
Pump 1	Wetwell Level @ T=Initial (ft)	T=Initial (min)	Wetwell Level @ T=Pump ON (ft)	T=Pump On (min)	Wetwell Level @ T=Pump Off (ft)	T=Pump Off (min)	Wetwell Level @ T=Final (ft)	T=Final (mm:ss)	Dynamic Pressure at pumps (psi)	Dynamic Pressure at 8th and Blaine (psi)	Dynamic Pressure at 9th and School (psi)	Dynamic Pressure at 9th and Meridian (psi)
Run No. 1	1.50	0	3.75	6.95	1.50	8.68	3.9	15.38	32	6.8	3.5	6
Run No. 2	1.5	0	3.75	6.70	1.50	8.49	3.9	15.43	32	6.8	3.5	6
Run No. 3	1.5	0	3.75	6.50	1.50	8.38	3.9	14.57	32	6.8	3.5	6
Notes:												

CALCULATIONS									
Pump 1	Initial Inflow Rate (gpm)	Final Inflow Rate (gpm)	Average Inflow Rate (gpm)	Inflow Volume (gal)	Δ Wetwell Volume (gal)	Pumped Volume (gal)	Pump Run Time (min)	Pump Capacity (gpm)	**Average Pump Capacity (gpm)**
Run No. 1	274	303	289	501	1904	2404	1.74	1386	**1354.01**
Run No. 2	284	293	288	516	1904	2420	1.79	1351	
Run No. 3	293	328	310	582	1904	2486	1.88	1325	

Drawdown Test Field Measurements (Pump 2)												
Pump 2	Wetwell Level @ T=Initial (ft)	T=Initial (mm:ss)	Wetwell Level @ T=Pump ON (ft)	T=Pump On (mm:ss)	Wetwell Level @ T=Pump Off (ft)	T=Pump Off (mm:ss)	Wetwell Level @ T=Final (ft)	T=Final (mm:ss)	Dynamic Pressure at pumps (psi)	Dynamic Pressure at 8th and Blaine (psi)	Dynamic Pressure at 9th and School (psi)	Dynamic Pressure at 9th and Meridian (psi)
Run No. 1	1.50	0	3.75	6.85	1.50	8.62	3.9	15.57	32	6.8	3.5	6
Run No. 2	1.5	0	3.75	6.70	1.50	8.51	3.9	15.37	32	6.8	3.5	6
Run No. 3	1.5	0	3.75	6.86	1.50	8.62	3.9	15.33	32	6.8	3.5	6
Notes:												

CALCULATIONS									
Pump 2	Initial Inflow Rate (gpm)	Final Inflow Rate (gpm)	Average Inflow Rate (gpm)	Inflow Volume (gal)	Δ Wetwell Volume (gal)	Pumped Volume (gal)	Pump Run Time (min)	Pump Capacity (gpm)	**Average Pump Capacity (gpm)**
Run No. 1	278	292	285	506	1904	2410	1.77	1358	**1356.21**
Run No. 2	284	296	290	526	1904	2430	1.81	1340	
Run No. 3	277	303	290	511	1904	2414	1.76	1371	

City of Newberg
Dayton Lift Station

Hydraulic Calculations
Summary of Minor Losses in Pump Station

Fitting Type	K- value	10" Suction # of Fittings	10" Suction Total K	12" Discharge # of Fittings	12" Discharge Total K
90° Bend	0.6	1	0.6	5	3
45° Bend	0.45	1	0.45		0
22.5° Bend	0.2		0		0
11.25° Bend	0.1		0		0
Wye/Tee - Thru Flo	0.26		0		0
Check Valve	1.3		0	1	1.3
3-Way Plug - Branch Flow	1.26		0	1	1.26
Plug Valve - Thru Flow	0.25	1	0.25		0
Pipe Entrance	0.04	1	0.04		0
Pipe Exit	1		0		0
Loss per 10ft of 10"/12" Pipe	0.05	12		18	
		Total K	1.34	Total K	5.56
		Minor Loss	0.63 ft	Minor Loss	1.27 ft

Summary of Elevations

Elev. at Pump Suction	113.25
Elev. at Pumped Water Lvl	103.9
Elev. at High Pt	162.0
Elev. at Forcemain Start	104.5

Summary of Total Dynamic Head (Calculated)

Static Head	Hs	58.1	
Dynamic Head	Hf	25.7	
TDH Required (Calc)		84 ft	@ 1350 gpm
		117 ft	@ 2100 gpm
Calculated PSIg @ Pump	32 psi	74 ft	See Note 1
Reported PSIg @ Pump	32 psi	74 ft	See Note 2
Reported PSIg @ Pump	52 psi	120 ft	See Note 3

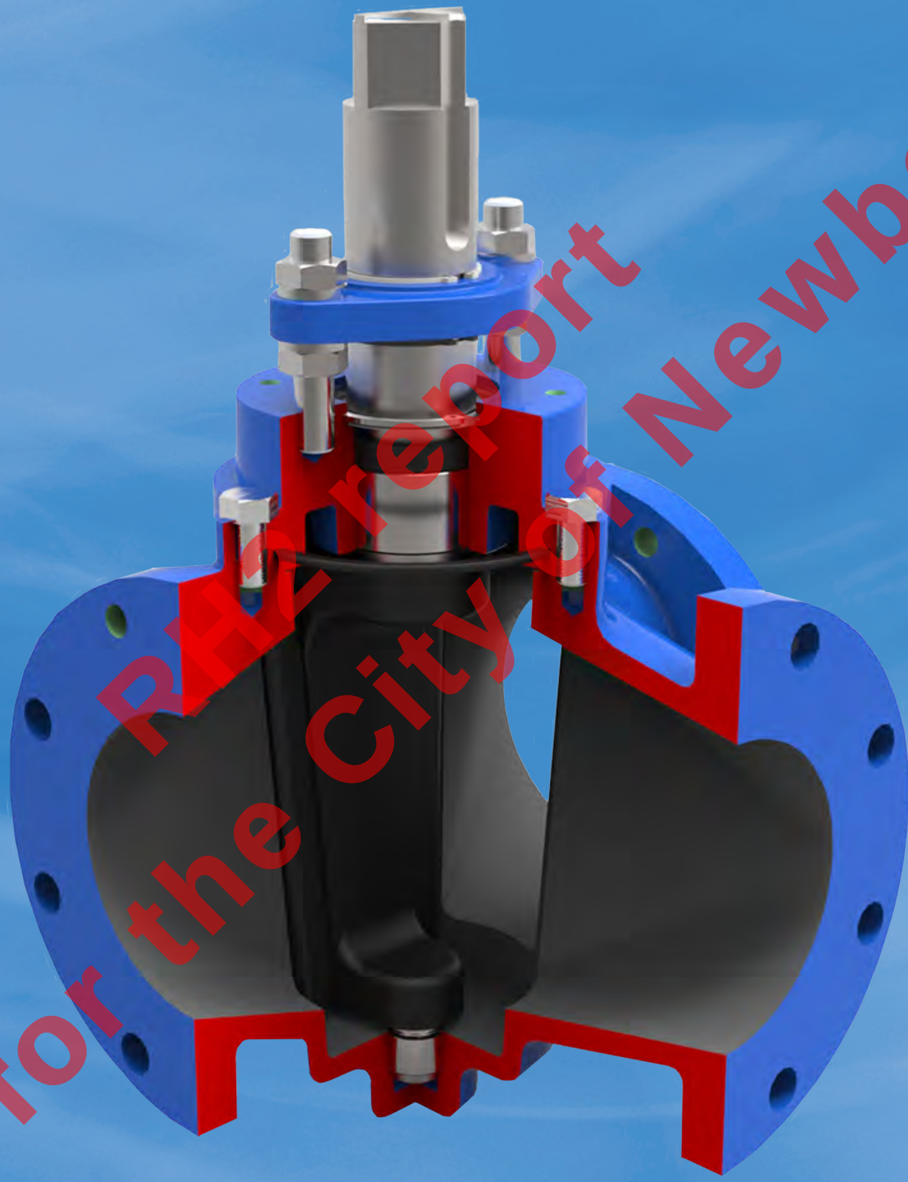
1) Pipeline roughness coeff adjusted to match calc and reported PSIg
2) 0/60 gauge tapped in pump casing.
3) 0/60 gauge at Pump 2 discharge. Gauge at Pump 1 broken.

	Station Location			Minor Losses			Pipeline Losses			Forcemain Hydraulic Profile				
	CWE Station	KCM Station	Overall	Fitting/Component Description	Centerline Elevation (ft)	Minor Losses (ft)	Segment Pipe Length (ft)	Pipe Material	Pipe Losses (ft)	Elevation Gain (ft)	Cumulative Losses in Forcemain (ft)	Calculated Pressure in Forcemain (ft)	Calculated Pressure in Forcemain (psi)	Measured Gauge Pressure (psi)
Dayton Ave LS Forcemain	0+0		0+0	Start Forcemain	104.5		0	DI	0.00	0.00	0.00	81.92	35.52	
	0+35		0+35	22.5° Bend	105	0.05	35	DI	0.21	0.50	0.25	81.17	35.19	
	0+88		0+88	22.5° Bend	106	0.05	53	DI	0.31	1.50	0.61	79.82	34.60	
	1+56		1+56	22.5° Bend	112	0.05	68	DI	0.40	7.50	1.05	73.37	31.81	
	2+46		2+46	22.5° Bend	114	0.05	90	DI	0.53	9.50	1.62	70.80	30.69	
	2+93		2+93	22.5° Bend	114.5	0.05	47	DI	0.28	10.00	1.95	69.98	30.34	
	3+94		3+94	22.5° Bend	115	0.05	101	DI	0.59	10.50	2.58	68.84	29.84	
	5+84		5+84	45° Bend	115	0.10	190	DI	1.11	10.50	3.80	67.63	29.32	
	5+97		5+97	45° Bend	121	0.10	13	DI	0.08	16.50	3.98	61.45	26.64	
	6+42		6+42	22.5° Bend	123	0.05	45	DI	0.26	18.50	4.29	59.14	25.64	
	6+47		6+47	45° Bend	124	0.10	5	DI	0.03	19.50	4.42	58.01	25.15	
	6+57	0+37	6+57	Wye Connection	125.5	0.06	10	DI	0.06	21.00	4.54	56.39	24.45	
8th Street LS Forcemain		1+68	7+88	Transition to PVC	151		131	PVC SDR 26	0.77	46.50	5.30	30.12	13.06	
		11+17	17+37	90° Bend	161	0.15	949	PVC SDR 26	5.34	56.50	10.80	14.62	6.34	
		11+25	17+45	Air Relief Valve	161.25		8	PVC SDR 26	0.05	56.75	10.85	14.33	6.21	6.8
		14+10	20+30	90° Bend	161	0.15	285	PVC SDR 26	1.61	56.50	12.60	12.82	5.56	
		19+84	26+04	Air Relief Valve	161.5		574	PVC SDR 26	3.23	57.00	15.84	9.09	3.94	
		22+19	28+39	22.5° Bend	160.5	0.05	235	PVC SDR 26	1.32	56.00	17.21	8.71	3.78	3.5
		22+73	28+93	22.5° Bend	160.5	0.05	54	PVC SDR 26	0.30	56.00	17.57	8.36	3.62	
		29+70	35+90	Cleanout MH	156		697	PVC SDR 26	3.93	51.50	21.49	8.93	3.87	6.0
		32+67	38+87	11.25° Bend	161.5	0.03	297	PVC SDR 26	1.67	57.00	23.19	1.73	0.75	
		33+35	39+55	Pipe Exit	162	0.25	68	PVC SDR 26	0.38	57.50	23.82	0.60	0.26	
						Check:	3955	HL in pipe only	22.28					

Asbuilts show localized low point with only minor elevation gain between U/S and D/S high point.. Pipeline may be operating under siphon conditions during certain flow conditions that could cause unstable hydraulic conditions. This may explain anecdotal reports of reduced pumping flows by City operators. Gauge installed at Cleanout MH rated for 0/60 psi range may be affecting accuracy of measured reading.

ISO 9001 Certified

MILLIKEN
VALVE



MILLCENTRIC®
100% Port 3-WAY PLUG VALVE

MILLIKEN VALVE

Milliken Valve offers the following for your water and wastewater needs:

- Eccentric Plug Valves
  - Series 601/600 Flanged & MJ
  - Series 601S Stainless Steel
  - Series 601RL Rubber Lined
  - Series 602 High Pressure
  - Series 613 Threaded End
  - Series 604 Three Way
  - Series 606 Grooved End
  - Series 611/610 Flanged & MJ
  - Series 625 UL/CGA Listed
- AWWA Swing Check Valves
- Wafer Check Valves
- Flex Check Valves
- Spring Loaded Check Valves
- AWWA Butterfly Valves
- General Service Butterfly Valves

Milliken Valve designs, develops, manufactures and markets plug valves and check valves which are available with various accessories, controls and actuators. These valves are used primarily in the water, wastewater and industrial markets.

Milliken Valve was founded over 25 years ago and manufactures the eccentric plug valve for water, wastewater and industrial applications. Milliken has grown consistently until it is now a leading manufacturer of high quality plug valves.

Milliken has a quality management system independently certified to ISO 9001.

A market leading, wide selection of plug valves is available for most water, wastewater and industrial applications:

Multiport 100% Port 3-Way Plug Valve

- 3-Way Valve 3" – 16", suitable for flow diversion and isolation.

Eccentric Plug Valve

- Size range ½" - 72"
- Pressure rating up to Class 250
- Rubber lined 3" and larger
- Glass lined 3" and larger
- Stainless steel ½" - 48"

Flex Check Valve

The eccentric plug valve is perfectly complemented by a soft-seated flexible-disc check valve in sizes 2" to 24" and is available with manual back-flushing device, position indicator and limit switch.

Swing Check Valve

Milliken Valve also has a wide selection of high quality metal or soft seated swing check valves in sizes 2" to 72" with accessories available for spring or weight assisted closing and air cushion or oil decelerator anti-slam devices under the respected CCNE brand.

MILLCENTRIC® 100% Port 3-way Plug Valve

Quality, reliability, safety and value are the Milliken criteria embodied in the Millcentric 100% Port 3-Way plug valve.

High quality manufacturing processes from advanced CAD engineering to CNC machining ensure reliable operation with high flow capability.

The Milliken 100% Port 3-Way plug valve is designed for regulation, diversion and isolation of water (clean or dirty) and sludge and slurries. The single tapered plug design can be arranged to provide a wide selection of flow configurations.

High flow and large solids passage are key features of the Milliken 100% Port 3-Way valve; a 3" round solid can pass through a 4" valve without compression.

Although the regular usage of a Milliken 3-Way valve is for flow diversion applications, the valve can provide tight shut-off, which is factory set when requested at order placement. (Not available with double-style plug or on 14" and 16" valves).

Body & Seat

The 3-Way valve body is a high integrity casting in cast iron ASTM A126 Class B. The precision machined, internal tapered surface of the body is the valve seat which is provided with a corrosion and erosion resistant epoxy coating. Other materials are available.

End Connections

The 3-flanges are to ASME/ANSI B16.1 Class 125 flat faced.

Certain sizes of valve require some tapped bolt holes because of limited access for nuts behind the flange, details are shown on page 5.

Plug

The ductile iron plug is totally encapsulated (3" thru 12") with a molded and vulcanized elastomer providing sealing and tight shut-off. For tight shut-off applications, it is advisable that the flow is against the rear of the plug. Tight shut-off not available with double-style plug or on 14" and 16" valves.

A large-diameter stem and upper and lower trunnion are integral with the plug casting. The upper end of the stem has a 2" square drive for wrench operation and also 2 keyways for maximum versatility when mounting gear operators. A cast marking on the end of the shaft indicates the plug face orientation.

The single style plug is standard in the Milliken 3-Way valve to provide straight-through and 90° flow paths. A double-style plug is optionally available upon request (not tight shut-off).

Bearings

The plug rotates in permanently lubricated, corrosion resistant stainless steel bearings in the body and bonnet.

Bonnet Seal

The bolted bonnet is assembled in a precision location in the body and uses superior 'O'-Ring sealing, with metal to metal contact, providing lower stress compared to traditional gaskets.

Stem Seal

Multiple self-adjusting U-cup seals provide positive stem sealing with trouble-free service.

Operation

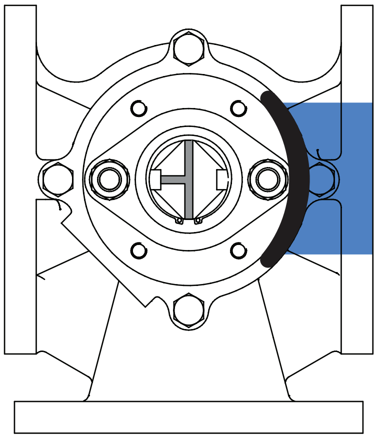
Manual operation by lever or gear available on all sizes. Chainwheel operation is also available.

Electric or pneumatic actuation is available on request.

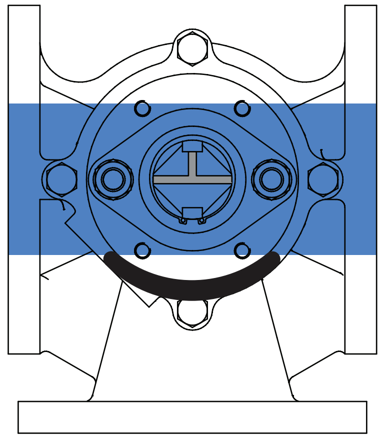
Coating

The valve interior and exterior surfaces are coated with 10-12 mils of 2-Part epoxy.

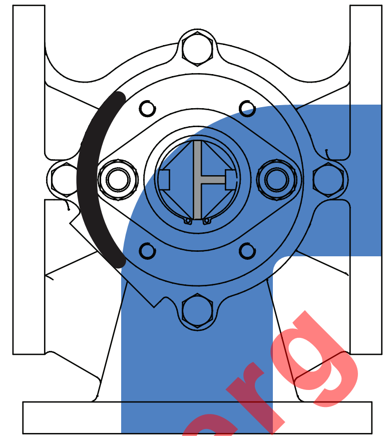
Available Flow Paths



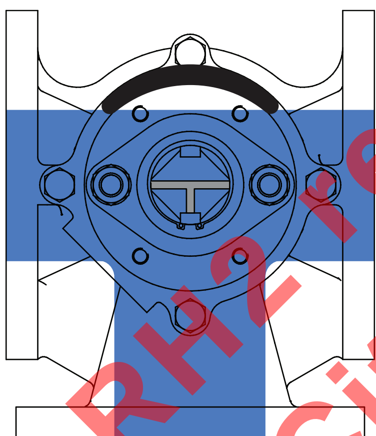
Valve in closed position*



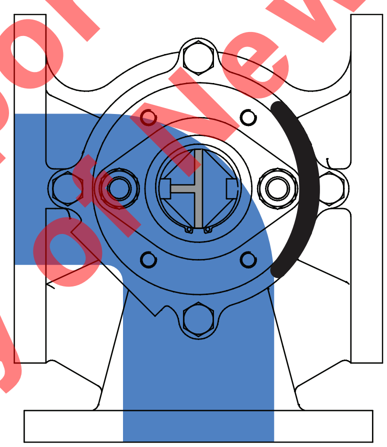
Flow straight through valve



Flow through 90˚ to side port



All 3 ports connected and open



Flow through 90˚ to side port

*It is advisable that the flow is against the rear side of the plug for tight shut-off applications. Not available with double-style plug.

Pressure/Temperature ratings

Flange rating to ASME/ANSI B16.1 Class 125, the maximum cold working pressure for all sizes is 175psi.

The operating temperature of the valve may depend on the elastomer used for the plug and seals. Refer to the elastomer selection guide on page 4.

Installation

The 3-Way valve can be installed in any orientation although it is advisable to have the valve stem vertical for ease of access.

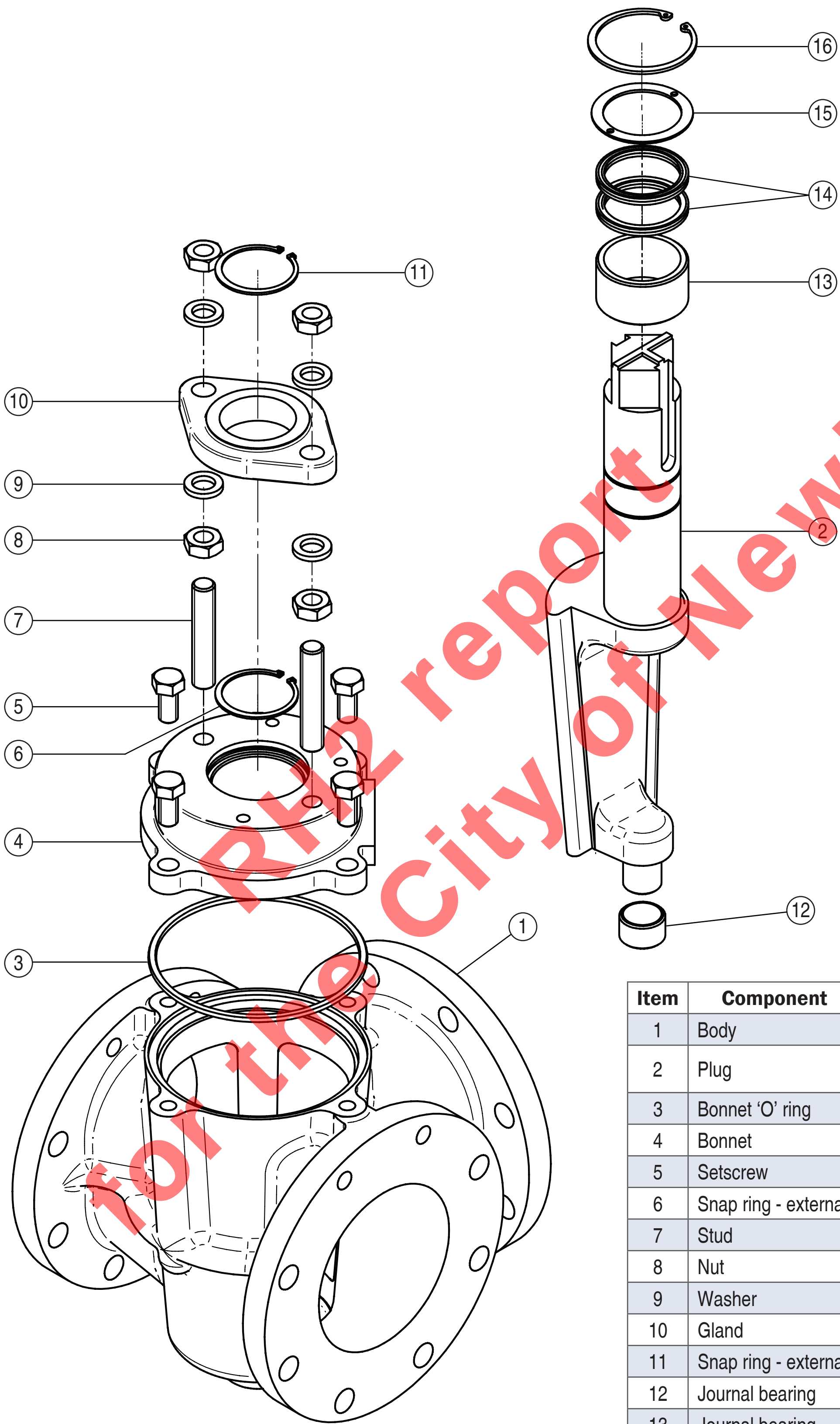
If the valve has been supplied for tight shut-off, the flow path and therefore the upstream pressure should be against the rear side of the plug.

In-Line Maintenance

In the unlikely event of gland leakage, the stem seals can be replaced without removing the bonnet. Access to the inside of the body for inspection or cleaning does not require removal of the valve from the line.

If wear should occur between the plug face and the seat, the plug can be adjusted externally.

Standard Materials of Construction - 3” to 16”



Item	Component	Material
1	Body	Cast iron A126 Class B
2	Plug	Ductile iron ASTM A536 Rubber coated
3	Bonnet ‘O’ ring	Elastomer as specified
4	Bonnet	Cast iron A126 Class B
5	Setscrew	Steel - zinc plated
6	Snap ring - external	Steel
7	Stud	Steel - zinc plated
8	Nut	Steel - zinc plated
9	Washer	Steel - zinc plated
10	Gland	Ductile iron ASTM A536
11	Snap ring - external	Steel
12	Journal bearing	Stainless Steel
13	Journal bearing	Stainless Steel
14	‘U’ cup seal	Elastomer as specified
15	Seal retaining ring	Brass
16	Snap ring - internal	Steel

Elastomers Available for MILLCENTRIC® 100% Port 3-Way Valves

■ NBR - Nitrile

A general purpose material sometimes referred to as BUNA N with a temperature range -20°F to 212°F. Used on sewage, water, air, hydrocarbon and mineral oils.

■ EPDM

An excellent polymer for use on chilled water through to LP steam applications, having a temperature range of -35°F to 250°F. Resistance to many acids, alkalies, detergents, phosphate esters, alcohols and glycols is an added benefit. Use on hydrocarbons <u>must</u> be avoided.

■ CR - Neoprene

This versatile material shows outstanding resistance to abrasion and ozone. Chemical resistance to a wide range of petroleum based products and dilute acids and alkalies. Temperature range -20°F to 225°F.

■ FKM - Viton®

Retention of mechanical properties at high temperature is an important feature of this elastomer: temperature range is -10°F to 300°F. It also has excellent resistance to oils, fuels, lubricants and most mineral acids and aromatic hydrocarbons. NOT suitable for water or steam applications.

Pressure Rating

Size	Drilling	Pressure
3" to 16"	Class 125	175 psig

Body (Shell) Hydrotest = 1.5 x rated pressure

Seat hydrotest = 1.0 x rated pressure (for tight shut-off applications only)

Ordering Information

Valve Types	Designation
Class 125 Flanged Cast Iron	604
Class 125 Flanged Ductile Iron	614
Class 125 Flanged 316 Stainless Steel	604S

Seat

Epoxy (604/614)	E
Stainless Steel (604S)	S

Elastomer Trim

EPDM	0
Nitrile (Buna)	1
Viton	2
Neoprene	3

Gear Operators

Gearbox complete with handwheel AGHW

Available in 90˚, 180˚, 270˚ and 360˚ configurations.

Style

Available port positions as shown on page 8.

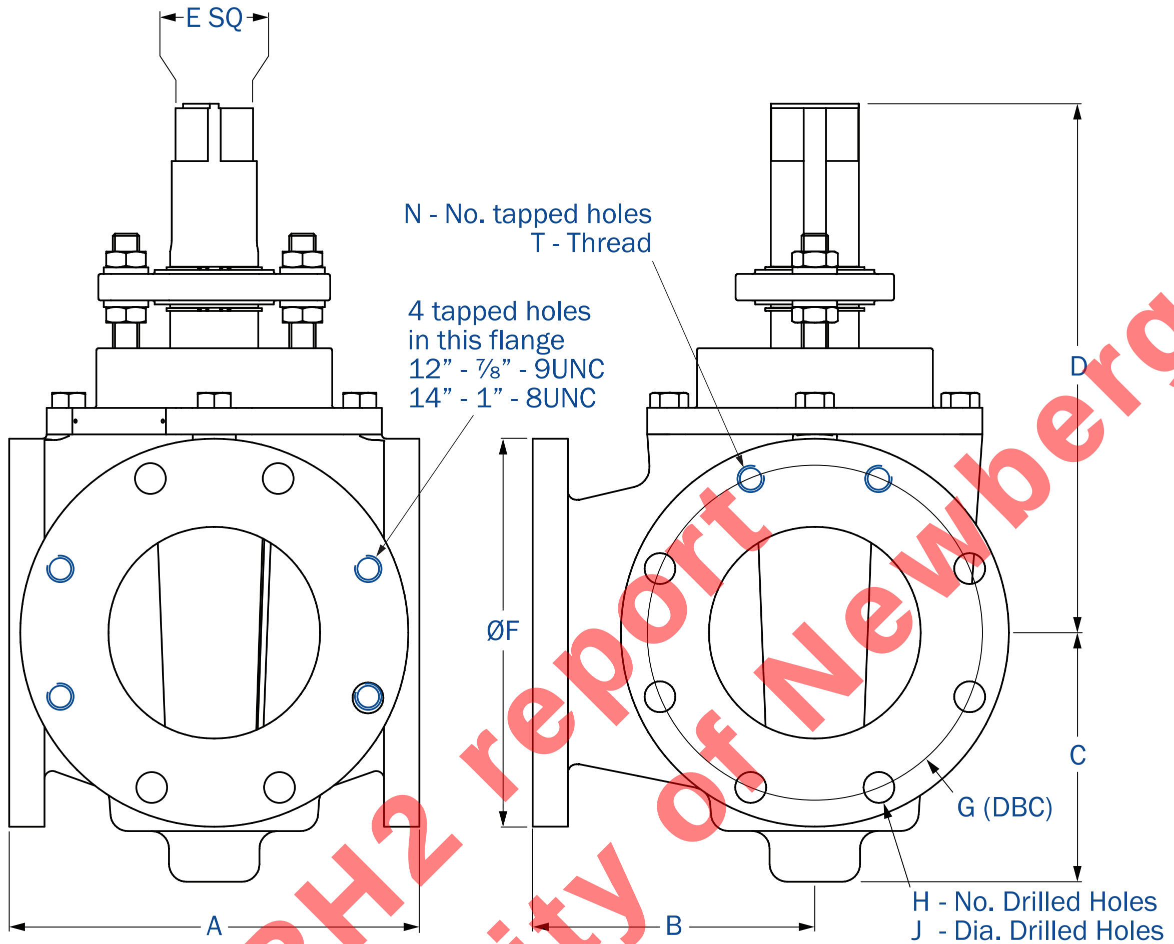
The style can be factory set and should be requested at time of order.

■ Elastomer Selection Chart

Service	Elastomer	Average Useful Temperature Range	Service	Elastomer	Average Useful Temperature Range	Service	Elastomer	Average Useful Temperature Range
Acetone	EPDM	-35˚F to 250˚F	Caustic Soda	EPDM	-35˚F to 250˚F	Oil Animal	Nitrile	-20˚F to 212˚F
Air	EPDM	-35˚F to 250˚F	Cement Slurry	EPDM	-35˚F to 250˚F	Oil Mobil Therm Light	Viton	10˚F to 250˚F
Air w/Oil	Nitrile	0˚F to 212˚F	Copper Sulphate	EPDM	-35˚F to 250˚F	Oil Mobil Therm 600	Viton	10˚F to 250˚F
Alcohol, Amyl	EPDM	0˚F to 212˚F	Creosote (Coal)	Nitrile	-20˚F to 212˚F	Oil Mobil Therm 603	Nitrile	-20˚F to 212˚F
Alcohol, Aromatic	Viton	10˚F to 250˚F	Coal Slurry	Nitrile	-20˚F to 212˚F	Oil Lubricating	Nitrile	-20˚F to 212˚F
Alcohol, Butyl	Neoprene	-20˚F to 225˚F	Diesel Fuel No. 3	Nitrile	-20˚F to 212˚F	Oil Vegetable	Nitrile	-20˚F to 212˚F
Alcohol, Denatured	Nitrile	-20˚F to 212˚F	Diethylene Glycol	EPDM	-35˚F to 250˚F	Paint Latex	Nitrile	-20˚F to 212˚F
Alcohol, Ethyl	EPDM	-35˚F to 250˚F	Ethylene Glycol	EPDM	-35˚F to 250˚F	Phosphate Ester	EPDM	-35˚F to 250˚F
Alcohol, Grain	Nitrile	-20˚F to 212˚F	Fatty Acid	Nitrile	-20˚F to 212˚F	Propane	Nitrile	-20˚F to 212˚F
Alcohol, Isospropyl	Neoprene	-20˚F to 225˚F	Fuel Oil No. 2	Nitrile	-20˚F to 212˚F	Rape Seed Oil	EPDM	-35˚F to 250˚F
Alcohol, Methyl	EPDM	-35˚F to 250˚F	Fertilizer Liquid ($H_4N_2O_2$)	EPDM	-35˚F to 250˚F	Sewage with Oil	Nitrile	-20˚F to 212˚F
Ammonia, Anhydrous	Neoprene	-20˚F to 225˚F	Gasoline Keg	Nitrile	-20˚F to 212˚F	Sodium Hydroxide 20%	EPDM	-35˚F to 250˚F
Ammonia, Nitrate	EPDM	-35˚F to 250˚F	Gas Natural	Nitrile	-20˚F to 212˚F	Starch	EPDM	-35˚F to 250˚F
Ammonia, Water	EPDM	-35˚F to 250˚F	Glue Animal	Nitrile	-20˚F to 212˚F	Steam 250˚F	EPDM	-35˚F to 250˚F
Animal Fats	Nitrile	-20˚F to 212˚F	Green Liquor	EPDM	-35˚F to 250˚F	Stoddard Solvent	Nitrile	-20˚F to 80˚F
Black Liquor	EPDM	-35˚F to 250˚F	Hydraulic oil	Nitrile	-20˚F to 212˚F	Sulphuric Acid 10% 50%	Neoprene	-20˚F to 158˚F
Blast Furnace Gas	Neoprene	-20˚F to 225˚F	Hydrogen	Nitrile	-20˚F to 212˚F	Sulphuric Acid 100%	Viton	10˚F to 300˚F
Butane	Nitrile	-20˚F to 212˚F	JP4 JP5	Viton	0˚F to 300˚F	Trichlorethylene Dry	Viton	10˚F to 300˚F
Bunker Oil "C"	Nitrile	-20˚F to 212˚F	Kerosene	Nitrile	-20˚F to 212˚F	Triethanol Amine	EPDM	-35˚F to 250˚F
Calcium Chloride	EPDM	-35˚F to 250˚F	Ketone	EPDM	-35˚F to 250˚F	Varnish	Viton	10˚F to 300˚F
Carbon Dioxide	EPDM	-35˚F to 250˚F	Lime Slurry	EPDM	-35˚F to 250˚F	Water, Fresh	EPDM	-35˚F to 250˚F
Carbon Monoxide (Cold)	Neoprene	-20˚F to 150˚F	Methane	Nitrile	-20˚F to 212˚F	Water, Salt	EPDM	-35˚F to 250˚F
Carbon Monoxide (Hot)	Viton	10˚F to 300˚F	Methyl Ethyl Ketone	EPDM	-35˚F to 250˚F	Xylene	Viton	10˚F to 300˚F
Carbon Tetrachloride	Viton	10˚F to 300˚F	Naptha (Berzin)	Nitrile	-20˚F to 212˚F			

NOTE: Above elastomer/temperature chart are guidelines only. See Milliken Compatibility Chart for specific applications.

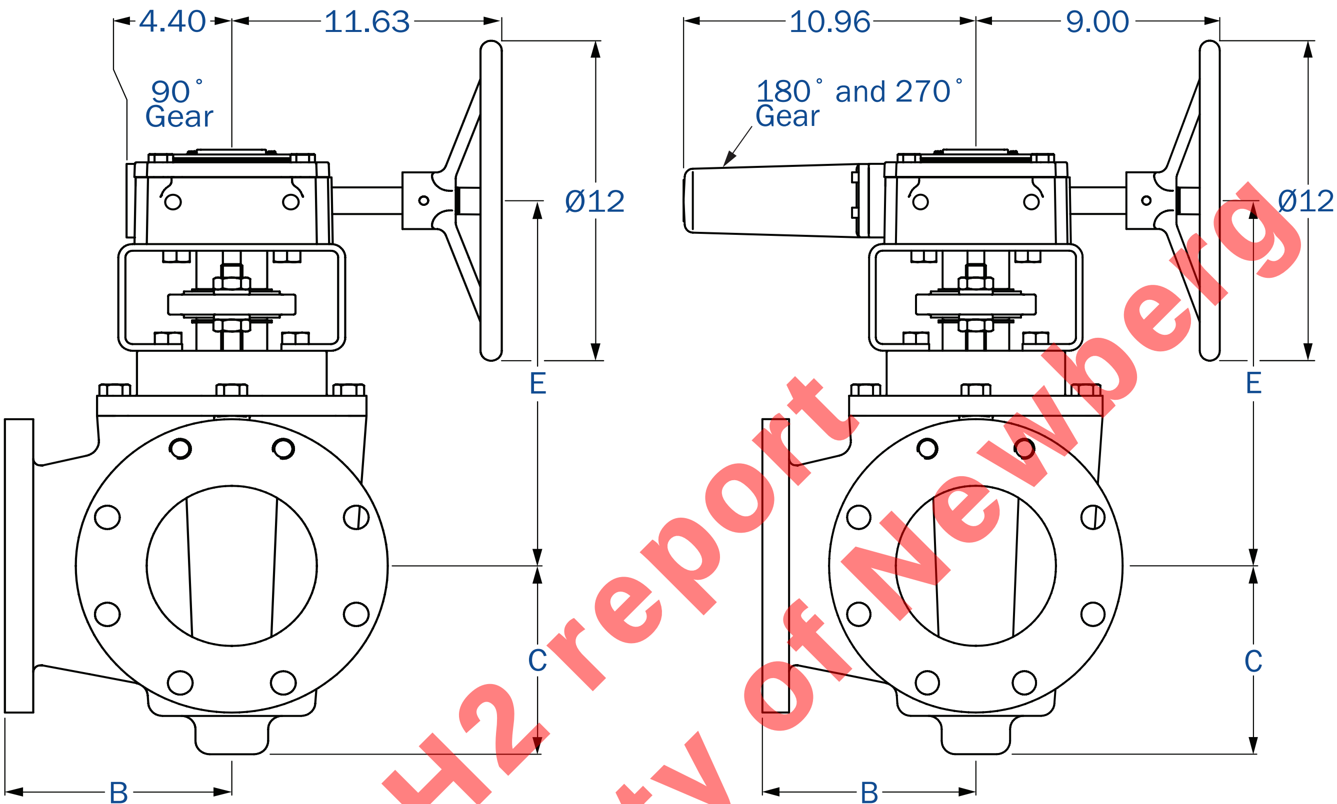
Series 604 MILLCENTRIC® 100% Port 3-Way Plug Valve



Flanged End - Fig. 604 - Class 125								
Dimensions in	Nominal Valve Size							
	3”	4”	6”	8”	10”	12”	14”	16”
A	8	9.88	11.63	13.88	16.75	19	21	23.75
B	5.5	6.5	8	9	11	11.56	12.5	15.13
C	4.81	5.94	7.06	10.94	10.94	12.88	14.19	14.75
D	9.04	13.36	15.04	18.69	18.69	21.20	21.10	22.00
E	1*	2	2	2	2	2	2	2
F	7.50	9.00	11.00	13.50	16.00	19.00	21.00	23.50
G	6.00	7.50	9.50	11.75	14.25	17.00	18.75	21.25
H	4	6	6	4	12	12	10	16
J	0.75	0.75	0.88	0.88	1	1	1.13	1.13
N	-	2	2	4	-	-	2	-
T	-	⅝” - 11 UNC	¾” - 10 UNC	¾” - 10 UNC	-	-	1” - 8 UNC	-
Weight - lb	65	120	170	325	380	475	850	970

Note: Drawings are for information purposes only; please request certified drawings before preparing piping drawings.
* Adaptor available to convert to 2” Nut.

Series 604AGHW MILLCENTRIC® 100% Port 3-Way Plug Valve



Flanged End - Fig. 604AGHW - Class 125							
Dimensions in	Nominal Valve Size						
	4"	6"	8"	10"	12"	14"	16"
A*	9.88	11.63	13.88	16.75	19	21	23.75
B	6.50	8	9	11	11.56	12.50	15.13
C	5.94	7.06	10.94	10.94	12.88	14.19	14.75
E	12.94	14.06	17.75	17.75	19.50	20.38	21.06
Weight - lb	200	250	405	460	555	937	1053

Note: 3" gear operated valve details upon request.
Drawings are for information purposes only; please request certified drawings before preparing piping drawings.
* Face to face dimension and flange drilling see page 5.

Accessories

Wrench

Wrench operators are available for all sizes (for tight shut-off, we recommend the use of a gear operator).

Power operation

Pneumatic, electric and hydraulic operation is available, complete with limit switches and solenoid valves when required.

Styling Ring (for wrench operated valves)

The valve may be ordered with the plug positions pre-set at the factory to suit the port flow requirements. This is achieved by fitting a styling ring to the valve stem.

Gear operators

Gear operators are available for all sizes.

They can be provided with 90°, 180° or 270° travel and are fitted with travel stops. 360° travel is also available.

Locking device

Factory fitted locking devices are available for wrench operated and gear operated valves.

Double-style plug

To provide 90º flow paths only, a double-style plug is available which operates through 90º travel and isolates either straight-through port (Style A90 only).

Styling Ring

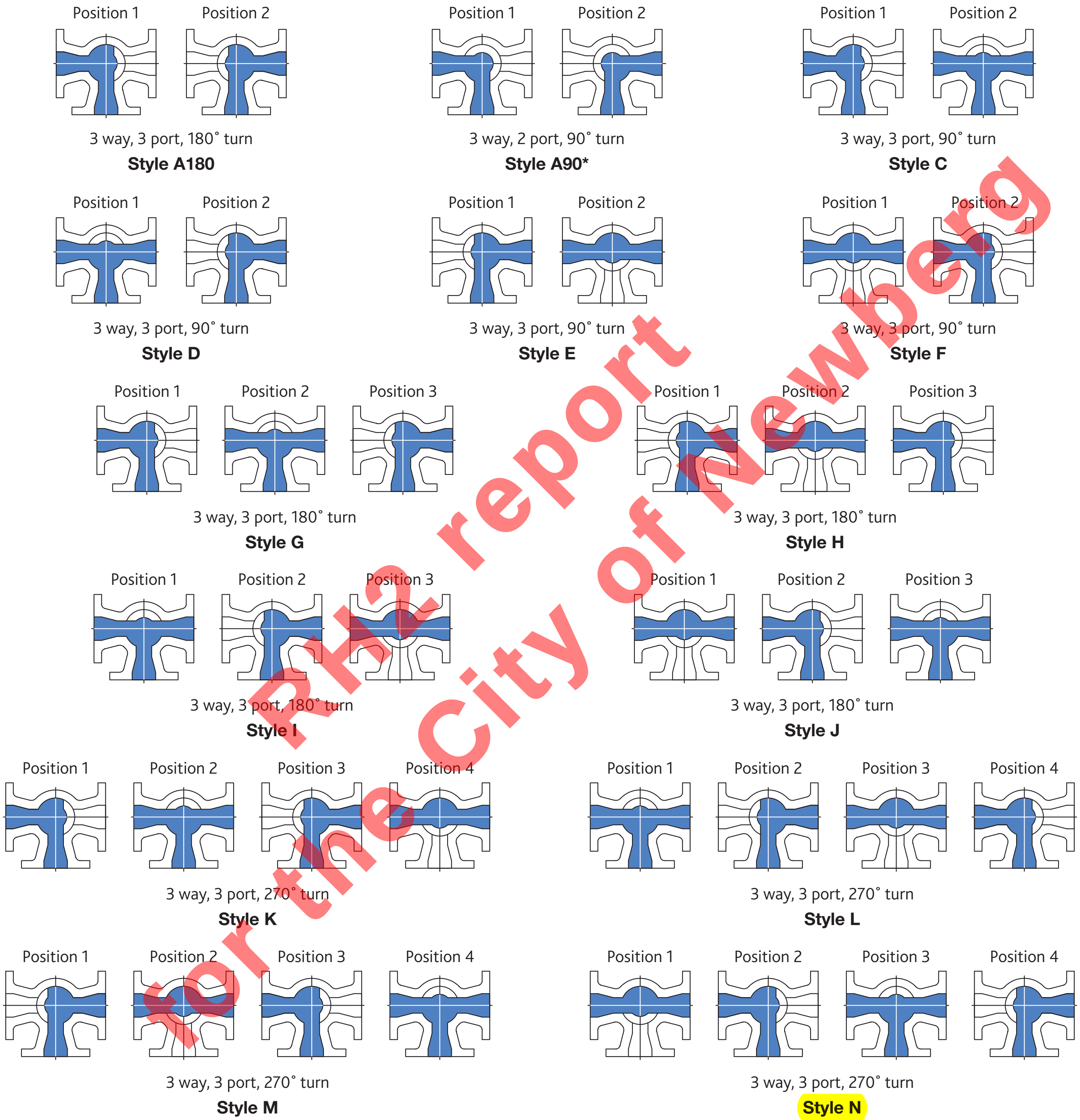
Gear Operator

Shown with 180°/270° Gear

3-Way Valve Port Positions

Three-Way Valve Port Positions

Viewed from above



* Requires Double-Style Plug. Not tight shut-off. Consult Milliken for special pricing and availability.

HOW TO ORDER

When ordering 3-Way Valves, specify style letter of the port position required.

Technical Specification

MILLCENTRIC® 100% Port 3-Way Plug Valves

Valves shall be of the 100% Port 3-Way non-lubricated concentric type with a totally encapsulated plug. The elastomer shall be suitable for the service intended.

Valve flanges shall comply with ASME/ANSI B16.1 Class 125, including facing, drilling and thickness. Valves shall be designed for a maximum working pressure of 175 CWP.

The valve body and bonnet shall be in cast iron to ASTM A126 Class B and the plug shall be ductile iron to ASTM A536 Grade 65-45-12. The axial position of the plug shall be held by the adjustable gland, and the valve shall operate without the need to lift the plug prior to turning.

Replaceable sleeve-type bearings, manufactured in oil-impregnated stainless steel shall be fitted in the body and bonnet. Stem seals shall be self-adjusting U-cup type and be replaceable without removing the bonnet from the valve.

The valve stem shall be provided with a 2" square nut for use with removable levers or extended T-handles. Wrench operated valves shall be capable of being converted to gear or automated operation without removing the bonnet from the valve.

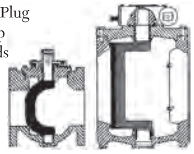
Where required, gear operators shall be of heavy duty construction with a ductile iron quadrant supported by upper and lower oil-impregnated bronze bearings. The worm gear and shaft shall be manufactured in hardened steel and run in high efficiency roller bearings. Gear operators shall require single handwheel operation only.

100% Port 3-Way plug valves shall be Millcentric Series 604 as manufactured by Milliken Valve - Bethlehem, Pennsylvania.

Series 600/601
Eccentric Plug Valve

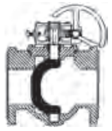
Flanged and MJ

Welded Nickel Seat
Stainless Steel Bearings
ANSI-B16.1 Flanges
Solid Ductile Iron Plug
Low Pressure Drop
Flanged & MJ Ends
Sizes 2"-72" FL
Sizes 3"-48" MJ



Series 601S
Eccentric Plug Valve

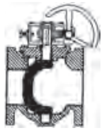
All Stainless Steel Construction
ANSI B16.5 Class 150 Flanges
Low Pressure Drop
Size: 1/2"-24"



Series 601RL
Eccentric Plug Valve

Rubber Lined

Soft Rubber Lining
Stainless Steel Bearings
ANSI B16.1 Flanges
Solid Ductile Iron Plug
Low Pressure Drop
Sizes 3"-54"



Series 602
Eccentric Plug Valve

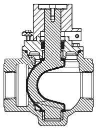
High Pressure

Welded Nickel Seat
Stainless Steel Bearings
ANSI B16.1 Class 250 Flanges
Solid Ductile Iron Plug
Low Pressure Drop
Sizes 2½"-54"

Series 613A
Eccentric Plug Valve

Threaded End

Ductile Iron Construction
Round Port
Stainless Steel Bearings
Low Pressure Drop
Memory Stop
NPT End Connections
Sizes ½"-2"



Series 604
100% Port 3 Way Plug Valve

Three Way Valve

Solid Ductile Iron Plug
Stainless Steel Bearings
Low Pressure Drop
Lift & Turn NOT Required
High Solids & Flow Capacity
Sizes 3"-16"

Series 606
Eccentric Plug Valve

Grooved End

Welded Nickel Seat
Stainless Steel Bearings
AWWA C-606 Grooved
Solid Ductile Iron Plug
Low Pressure Drop
Ductile or Steel Pipe
Sizes 3"-24"

Series 611/610
Eccentric Plug Valve

Flanged and MJ

Ductile Iron Body
ANSI B16.1 Flanges
MJ AWWA C111
Welded Nickel Seat
Solid Ductile Iron Plug
Low Pressure Drop
Sizes 2"-72" FL
Sizes 3"-48" MJ

Model 625
Eccentric Plug Valve

Available in Threaded
and Flanged Ends
Rated for 175 psi
Sizes ½"-4"
UL/CGA Listed

Series 600FP/601FP
Eccentric Plug Valve

Full/100% Port
Welded Nickel Seat
Stainless Steel Bearings
ANSI-B16.1 Flanges
Solid Ductile Iron Plug
Low Pressure Drop
Flanged & MJ Ends
Sizes 2"-48" FL
Sizes 3"-48" MJ

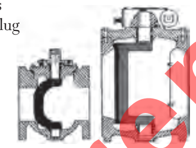


Figure 396/397
General Service
Butterfly Valve

Complies with MSS SP 67
Ductile Iron Body
DI-NP Disc
Other Materials Upon Request
Wrench or Gear
Operated Available
2"-48" Size Range

Figure 510A/511A
AWWA Butterfly Valve

Complies with AWWA C-504
Class 150B Flanged or MJ
Cast iron body and disc
Seat in body
Flow through disc on
24" and larger
Epoxy Paint on all sizes
standard 3" -72"

Series 8500
AWWA Swing Check

Full waterway
Ductile Iron Construction
Weight or Spring
Air Cushion
SS body seat ring
Buna disc insert
Sizes 3"-24"

Series 8000
AWWA Swing Check

Full waterway
Weight or Spring
Bronze/SS Body Seat Ring
Bronze/Buna/EPDM disc insert
Sizes 2"-36"

Series 9000
AWWA Swing Check

Clear waterway
Weight or Spring
Air or Oil Cushion
Bronze/SS Body seat ring
Bronze/Buna/EPDM disc insert
Sizes 3"-72"

Model 720A
Wafer Check Valve

Center Guided
Check Valve
Rated for 250 psi
SS Disc/EPDM Seat
Sizes 2"-12"

Series 700
Wafer Check Valve

Wafer Check Valve

ANSI Class 125/150
High Flow Capacity
Narrow Face-to-Face
Sizes 3"-12"
316 SS Internals
Disc Position Indicator

Figure 851
Flex Check

Million Cycle Certification
Complete Ductile Iron Construction
250 psi Pressure Rating
Fully Epoxy Lined Interior
No Internal Shafts, Bearings or Bushings
No External Levers, Weights or Springs
Mechanical Indicator (3"-16")
2"-24" Size Range
Backflush Devices
Proximity Switches

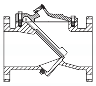
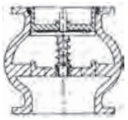


Figure 740A
Double Disc Check Valve

Wafer pattern
check valve
rated for 250 psi.
Available in sizes
2"-48" with a
SS Disc/EPDM Seat

Figure 821A
Globe Style Check Valve

Center guided
check valve.
SS Disc/EPDM Seat
and is available
in sizes 2"-36".



MILLIKEN VALVE

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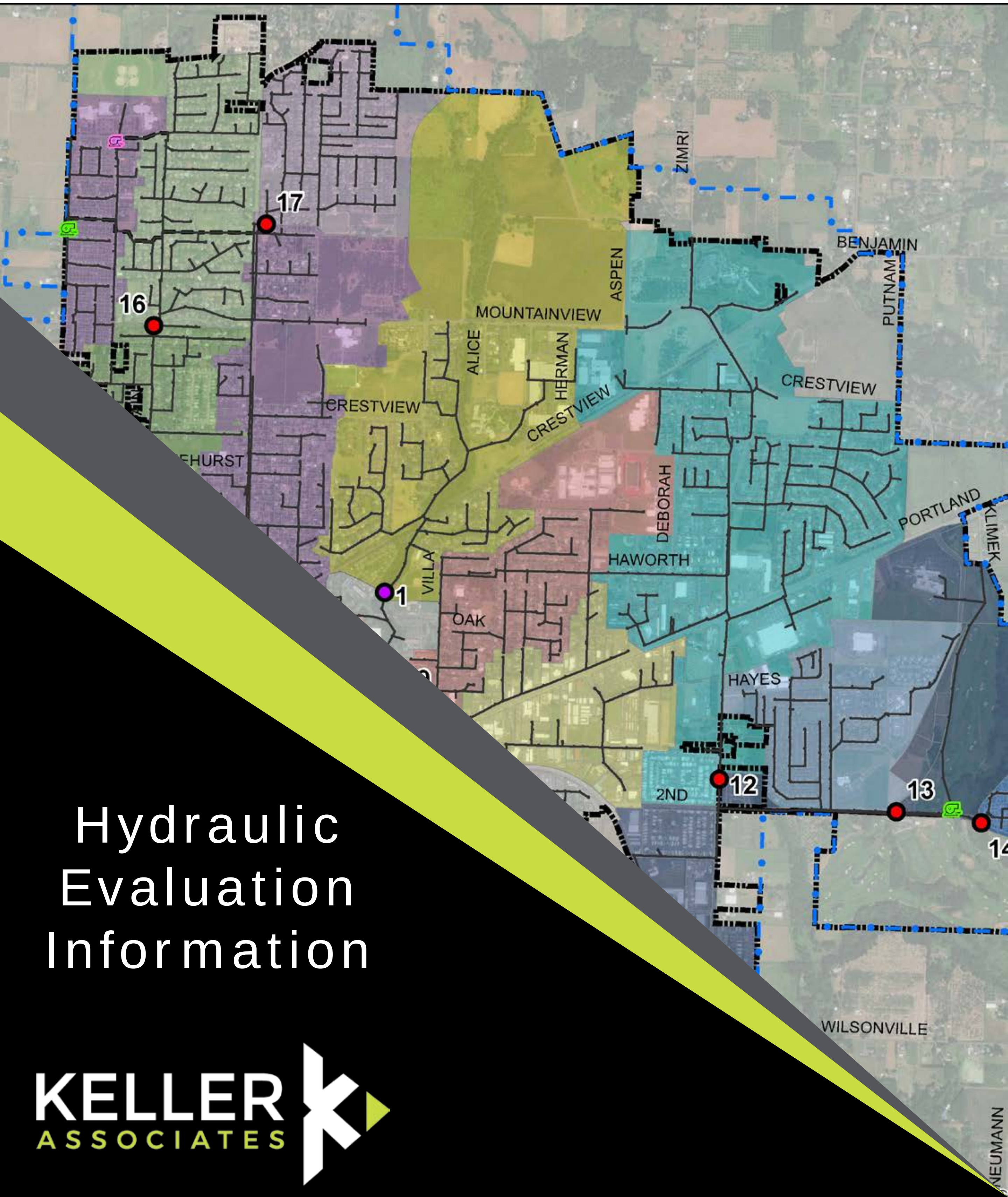
Appendix D



Hydraulic Evaluation Information

KELLER ASSOCIATES

Appendix D1:
Existing System
Model Data

Existing System Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
J-100	172.40	164.00	2017			0.3	164.3	8.1	0.2	0	0.00
J-110	170.05	158.70	2017			9.0	167.7	2.3	2.1	0	0.00
J-120_ANDR	150.60	148.40	2017			41.3	189.7	-39.1	0.4	0	0.00
J-130_CHAR	154.10	151.20	2017			82.9	234.1	-80.0	1.2	0	0.00
J-140_CHEHAL	196.10	177.10	2017			134.3	311.4	-115.3	1.5	0	0.00
J-150_CREEKSD	174.60	160.60	2017			20.0	180.6	-1.4	0.4	0	0.00
J-160_DAY	113.50	107.00	2017			440.9	547.9	-434.4	2.9	0	0.00
J-170_FERN1	140.60	137.60	2017			87.4	225.0	-84.4	2.7	0	0.00
J-190_HWY240_1	165.00	143.00	2017			80.8	223.8	-58.8	3.4	0	0.00
J-210_SHER1	156.60	132.60	2017			63.9	196.5	-39.9	0.5	0	0.00
J-230_CHEHAL_BASEFLOW	196.10	186.09	2017	0.083	FM3_DIURNAL	0.2	186.3	9.8	0.2	0	0.00
J-240_CREEK_BASEFLOW	174.60	165.97	2017	0.011	FM2_DIURNAL	0.1	166.0	8.6	0.0	0	0.00
J-250_SHER_BASEFLOW	156.60	138.76	2017	0.004	FM9_DIURNAL	0.1	138.8	17.8	0.0	0	0.00
J-260_CHAR_BASEFLOW	154.10	146.92	2017	0.025	FM10_DIURNAL	0.1	147.0	7.1	0.1	0	0.00
J-270_ANDR_BASEFLOW	150.60	143.66	2017	0.023	FM10_DIURNAL	0.1	143.8	6.8	0.1	0	0.00
J-280_HWY240_WEIR	172.40	163.80	2008			1.1	164.9	7.5	3.4	0	0.00
WWMF109000	175.61	167.20	1978	0	FM2_DIURNAL	2.2	169.4	6.2	4.1	0	0.00
WWMF109001	175.70	167.76	1978	0	FM2_DIURNAL	1.4	169.2	6.5	3.3	0	0.00
WWMF109002	175.26	168.39	1980	0.014	FM2_DIURNAL	2.7	171.1	4.2	3.3	0	0.00
WWMF109003	178.18	169.02	1978	0	FM2_DIURNAL	3.2	172.3	5.9	3.3	0	0.00
WWMF109004	183.87	171.53	1978	0.042	FM2_DIURNAL	4.4	175.9	7.9	3.3	0	0.00
WWMF109005	187.09	173.61	1978	0.032	FM2_DIURNAL	4.3	178.0	9.1	3.2	0	0.00
WWMF109006	188.45	175.99	1994	0.014	FM2_DIURNAL	4.2	180.2	8.3	3.1	0	0.00
WWMF109040	177.87	174.77	1980	0	FM2_DIURNAL	3.1	177.9	0.0	0.3	0.001755	1.28
WWMF109150	174.88	168.17	1995	0	FM2_DIURNAL	2.1	170.2	4.6	3.3	0	0.00
WWMF109153	172.73	166.55	2017	0.023	FM2_DIURNAL	2.2	168.8	4.0	3.3	0	0.00
WWMF117018	168.07	157.50	1976	0.001	FM9_DIURNAL	1.3	158.8	9.2	3.0	0	0.00
WWMF117019	170.98	158.59	1976	0.004	FM9_DIURNAL	0.8	159.4	11.6	2.5	0	0.00
WWMF117020	167.67	159.73	1976	0.016	FM9_DIURNAL	1.0	160.7	7.0	2.5	0	0.00
WWMF117021	166.65	160.66	1976	0.004	FM9_DIURNAL	0.8	161.5	5.2	2.5	0	0.00
WWMF117022	169.11	161.98	1976	0	FM9_DIURNAL	0.7	162.7	6.4	2.5	0	0.00
WWMF117023	173.64	163.58	1976	0	FM2_DIURNAL	0.7	164.3	9.4	2.5	0	0.00
WWMF117024	172.69	163.87	1976	0	FM2_DIURNAL	0.4	164.3	8.4	0.2	0	0.00
WWMF117025	170.57	164.41	1976	0	FM2_DIURNAL	1.8	166.2	4.4	3.4	0	0.00
WWMF117026	173.30	164.30	1976	0	FM2_DIURNAL	2.4	166.7	6.6	3.4	0	0.00
WWMF117027	176.97	165.11	1978	0.005	FM2_DIURNAL	2.5	167.6	9.4	3.4	0	0.00
WWMF117028	173.99	165.19	2017	0	FM2_DIURNAL	2.7	167.9	6.1	3.4	0	0.00
WWMF118001	173.89	165.39	2017	0	FM2_DIURNAL	2.5	167.9	6.0	0.1	0	0.00
WWMF118002	170.94	165.74	1978	0	FM2_DIURNAL	2.1	167.9	3.1	0.1	0	0.00
WWMF118003	182.24	170.44	1992	0.014	FM2_DIURNAL	0.1	170.5	11.7	0.1	0	0.00
WWMF118023	179.54	169.65	2003	0	FM2_DIURNAL	0.1	169.7	9.8	0.1	0	0.00
WWMF118024	174.53	167.53	2003	0	FM2_DIURNAL	0.7	168.3	6.3	0.1	0	0.00
WWMF118025	170.14	166.25	2017	0	FM2_DIURNAL	2.1	168.3	1.8	0.1	0	0.00
WWMF118026	169.96	165.75	2003	0.014	FM2_DIURNAL	2.5	168.3	1.7	3.4	0	0.00
WWMF118048	164.64	154.99	2010	0	FM2_DIURNAL	7.6	162.6	2.0	3.6	0	0.00
WWMF118049	172.54	162.17	2010	0.148	FM2_DIURNAL	1.7	163.9	8.6	3.6	0	0.00
WWMF118050	173.02	162.98	2017	0	FM2_DIURNAL	1.6	164.6	8.4	3.4	0	0.00

Existing System Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMF127007	162.68	148.57	1922	0.004	FM9_DIURNAL	0.9	149.5	13.2	2.8	0	0.00
WWMF127008	161.46	149.01	1962	0.001	FM9_DIURNAL	1.0	150.0	11.4	2.8	0	0.00
WWMF127009	155.12	149.42	1962	0.001	FM9_DIURNAL	1.1	150.5	4.6	2.8	0	0.00
WWMF127010	158.39	150.14	1962	0.001	FM9_DIURNAL	0.8	151.0	7.4	2.8	0	0.00
WWMF127011	160.70	150.90	1962	0	FM9_DIURNAL	0.8	151.7	9.0	2.8	0	0.00
WWMF127012	163.01	151.90	1962	0.017	FM9_DIURNAL	0.9	152.8	10.2	2.8	0	0.00
WWMF127013	163.38	152.22	1962	0	FM9_DIURNAL	0.7	152.9	10.4	2.7	0	0.00
WWMF127014	171.41	152.96	1962	0	FM9_DIURNAL	1.1	154.0	17.4	2.7	0	0.00
WWMF127015	171.72	153.38	1980	0.044	FM9_DIURNAL	1.0	154.4	17.3	2.8	0	0.00
WWMF127016	170.94	154.81	1980	0	FM9_DIURNAL	0.3	155.1	15.8	2.7	0	0.00
WWMF127017	166.06	156.17	2017	0.025	FM9_DIURNAL	0.8	157.0	9.1	2.7	0	0.00
WWMF127044	165.32	157.16	1922	0.013	FM9_DIURNAL	0.1	157.2	8.1	0.0	0	0.00
WWMF127115	172.54	167.50	1922	0.001	FM10_DIURNAL	2.6	170.1	2.4	2.3	0	0.00
WWMF127116	173.89	168.23	1922	0.001	FM10_DIURNAL	1.6	169.8	4.1	1.1	0	0.00
WWMF127117	174.12	168.63	1922	0.003	FM10_DIURNAL	1.8	170.4	3.7	1.1	0	0.00
WWMF127118	173.08	168.96	1922	0	FM10_DIURNAL	1.8	170.7	2.4	1.1	0	0.00
WWMF127119	176.51	170.40	1922	0.014	FM10_DIURNAL	1.7	172.1	4.4	1.0	0	0.00
WWMF127203	177.79	169.66	2017	0.001	FM10_DIURNAL	1.8	171.4	6.3	1.1	0	0.00
WWMF127220	176.26	170.34	2017	0	FM10_DIURNAL	1.8	172.1	4.2	1.1	0	0.00
WWMF137001	135.40	125.96	1996	0	FM9_DIURNAL	0.3	126.2	9.2	2.8	0	0.00
WWMF137002	140.83	132.89	1996	0.001	FM9_DIURNAL	0.3	133.2	7.6	2.8	0	0.00
WWMF137003	157.74	144.94	1962	0.005	FM9_DIURNAL	0.4	145.3	12.4	2.8	0	0.00
WWMF137004	158.00	147.00	1962	0	FM9_DIURNAL	0.7	147.7	10.3	2.8	0	0.00
WWMF137005	160.72	147.32	1962	0	FM9_DIURNAL	1.3	148.6	12.1	2.8	0	0.00
WWMF137006	162.06	148.06	1962	0	FM9_DIURNAL	1.0	149.1	13.0	2.8	0	0.00
WWMF137072	114.53	109.76	2017	0.019	FM9_DIURNAL	0.4	110.1	4.4	2.8	0	0.00
WWMF79028	227.32	216.32	1989	0.012	FM16_DIURNAL	1.3	217.6	9.7	0.8	0	0.00
WWMF79029	224.60	216.75	1979	0	FM16_DIURNAL	1.2	218.0	6.6	0.8	0	0.00
WWMF79030	224.89	217.37	1979	0	FM16_DIURNAL	0.7	218.1	6.8	0.8	0	0.00
WWMF79031	224.55	218.07	1979	0	FM16_DIURNAL	0.5	218.6	6.0	0.8	0	0.00
WWMF89019	213.10	199.16	1978	0	FM16_DIURNAL	0.9	200.1	13.0	0.9	0	0.00
WWMF89020	211.27	200.18	1978	0	FM16_DIURNAL	0.3	200.4	10.8	0.9	0	0.00
WWMF89021	211.58	201.22	1997	0.028	FM16_DIURNAL	0.6	201.8	9.8	0.9	0	0.00
WWMF89022	215.49	201.60	1978	0	FM16_DIURNAL	1.8	203.4	12.1	0.9	0	0.00
WWMF89023	214.29	205.30	1978	0.005	FM16_DIURNAL	0.6	205.9	8.4	0.9	0	0.00
WWMF89024	217.25	208.19	1995	0.028	FM16_DIURNAL	0.4	208.6	8.7	0.9	0	0.00
WWMF89025	222.97	212.45	1989	0	FM16_DIURNAL	0.4	212.8	10.2	0.9	0	0.00
WWMF89026	224.97	213.74	1989	0	FM16_DIURNAL	0.3	214.0	10.9	0.9	0	0.00
WWMF89027	226.06	215.21	1989	0.009	FM16_DIURNAL	0.4	215.6	10.4	0.9	0	0.00
WWMF89160	214.29	204.27	1978	0.003	FM16_DIURNAL	1.3	205.6	8.7	0.9	0	0.00
WWMF99007	190.72	177.87	1978	0.12	FM2_DIURNAL	4.5	182.4	8.3	3.1	0	0.00
WWMF99008	190.47	178.31	1978	0	FM2_DIURNAL	4.6	182.9	7.5	2.9	0	0.00
WWMF99009	190.76	179.26	1978	0.028	FM2_DIURNAL	5.2	184.5	6.3	2.9	0	0.00
WWMF99011	189.86	180.34	1978	0	FM2_DIURNAL	6.0	186.4	3.5	2.9	0	0.00
WWMF99012	189.63	180.58	1978	0.042	FM2_DIURNAL	6.2	186.8	2.9	2.9	0	0.00
WWMF99013	193.15	186.08	1978	0.032	FM2_DIURNAL	2.4	188.4	4.7	2.8	0	0.00
WWMF99014	196.47	188.32	1978	0	FM2_DIURNAL	4.4	192.7	3.8	2.7	0	0.00

Existing System Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMF99015	198.21	189.24	1978	0.023	FM2_DIURNAL	5.6	194.8	3.4	2.7	0	0.00
WWMF99016	201.32	190.51	1978	0.002	FM16_DIURNAL	4.6	195.1	6.2	1.0	0	0.00
WWMF99017	200.59	191.25	1978	0	FM16_DIURNAL	4.0	195.2	5.3	1.0	0	0.00
WWMF99018	203.24	192.94	1978	0.019	FM16_DIURNAL	2.6	195.5	7.7	1.0	0	0.00
WWMF99152	203.96	195.57	1997	0.003	FM16_DIURNAL	0.6	196.1	7.8	0.9	0	0.00
WWMG108005	183.37	177.08	1965	0	FM2_DIURNAL	0.1	177.1	6.2	0.0	0	0.00
WWMG108006	189.94	178.43	1965	0	FM2_DIURNAL	0.1	178.5	11.4	0.0	0	0.00
WWMG108007	192.96	178.60	1965	0.014	FM2_DIURNAL	0.2	178.8	14.2	0.0	0	0.00
WWMG108008	192.80	179.75	1965	0.003	FM3_DIURNAL	1.6	181.3	11.5	0.5	0	0.00
WWMG108009	191.30	180.80	1965	0	FM3_DIURNAL	0.5	181.3	10.0	0.5	0	0.00
WWMG108010	191.25	181.43	1965	0	FM3_DIURNAL	0.3	181.8	9.5	0.5	0	0.00
WWMG108011	191.59	181.53	1965	0.241	FM3_DIURNAL	0.5	182.0	9.6	0.5	0	0.00
WWMG108080	192.99	178.59	2000	0.003	FM3_DIURNAL	2.7	181.3	11.7	4.4	0	0.00
WWMG109046	191.61	179.31	2017	0	FM3_DIURNAL	2.1	181.4	10.2	4.0	0	0.00
WWMG109047	191.73	180.34	2017	0.031	FM3_DIURNAL	1.2	181.5	10.2	4.1	0	0.00
WWMG109048	192.23	181.12	2017	0.017	FM3_DIURNAL	1.0	182.1	10.1	4.1	0	0.00
WWMG109049	195.67	182.02	2017	0.003	FM3_DIURNAL	0.9	182.9	12.8	4.1	0	0.00
WWMG109050	202.56	186.00	2017	0.003	FM3_DIURNAL	0.6	186.6	16.0	4.1	0	0.00
WWMG109051	205.91	188.97	2017	0.003	FM3_DIURNAL	0.6	189.6	16.3	4.1	0	0.00
WWMG114000	141.22	135.51	1957	0.01	FM1_DIURNAL	3.1	138.6	2.6	5.6	0	0.00
WWMG114001	144.62	137.22	1960	0.002	FM1_DIURNAL	6.3	143.5	1.1	4.0	0	0.00
WWMG114002	144.74	138.28	1960	0.005	FM1_DIURNAL	6.5	144.7	0.0	4.2	0.32469	15.98
WWMG116235	186.74	172.55	2000	0.001	FM8_DIURNAL	5.2	177.8	9.0	8.3	0	0.00
WWMG116236	189.28	173.27	2000	0.003	FM8_DIURNAL	5.2	178.5	10.8	7.8	0	0.00
WWMG116237	190.20	173.99	2000	0.004	FM8_DIURNAL	5.1	179.1	11.1	7.4	0	0.00
WWMG116238	192.41	174.79	2000	0.001	FM8_DIURNAL	4.8	179.6	12.8	7.0	0	0.00
WWMG116239	192.87	175.11	2000	0.007	FM3_DIURNAL	4.8	179.9	13.0	7.0	0	0.00
WWMG116240	195.22	176.26	2000	0.003	FM3_DIURNAL	4.2	180.5	14.7	7.0	0	0.00
WWMG116241	194.63	176.56	2000	0.003	FM3_DIURNAL	4.1	180.6	14.0	7.0	0	0.00
WWMG117195	193.76	176.86	2000	0.003	FM3_DIURNAL	4.1	180.9	12.8	7.0	0	0.00
WWMG118004	184.85	174.35	1965	0	FM2_DIURNAL	0.1	174.4	10.4	0.0	0	0.00
WWMG118086	193.38	178.01	2017	0.014	FM3_DIURNAL	3.2	181.2	12.2	4.4	0	0.00
WWMG118104	194.06	184.64	2017	0	FM3_DIURNAL	0.8	185.4	8.6	3.4	0	0.00
WWMG123072	133.92	121.01	1956	0.002	FM1_DIURNAL	11.6	132.6	1.3	7.2	0	0.00
WWMG123073	133.66	122.28	1956	0.002	FM1_DIURNAL	11.3	133.6	0.1	6.0	0	0.00
WWMG123074	134.19	122.74	2017	0.002	FM1_DIURNAL	11.5	134.2	0.0	10.2	1.171054	17.45
WWMG123075	157.62	125.12	1957	0.002	FM1_DIURNAL	10.6	135.7	21.9	8.6	0	0.00
WWMG123076	136.92	125.36	2017	0.009	FM1_DIURNAL	11.0	136.4	0.6	8.6	0	0.00
WWMG123077	137.48	125.89	1957	0.002	FM1_DIURNAL	10.9	136.8	0.7	7.0	0	0.00
WWMG123078	140.22	132.71	1957	0.007	FM1_DIURNAL	5.2	137.9	2.3	7.0	0	0.00
WWMG123079	144.47	135.01	1957	0.002	FM1_DIURNAL	3.6	138.6	5.9	5.6	0	0.00
WWMG126098	172.90	163.54	1922	0.001	FM8_DIURNAL	7.7	171.2	1.7	0.5	0	0.00
WWMG126102	171.25	164.40	1922	0.003	FM8_DIURNAL	6.9	171.3	0.0	0.5	0.001508	1.34
WWMG126147	182.25	174.04	1922	0	FM8_DIURNAL	0.7	174.8	7.5	0.1	0	0.00
WWMG126164	183.79	180.00	1922	0.001	FM8_DIURNAL	0.0	180.0	3.8	0.0	0	0.00
WWMG126200	170.67	164.87	1922	0.001	FM10_DIURNAL	4.2	169.1	1.6	2.4	0	0.00
WWMG126236	171.33	158.58	2000	0.002	FM8_DIURNAL	10.8	169.4	2.0	11.1	0	0.00

Existing System Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMG126237	171.90	161.43	2000	0.002	FM8_DIURNAL	9.5	170.9	1.0	11.1	0	0.00
WWMG126238	172.23	162.28	2000	0.001	FM8_DIURNAL	9.7	172.0	0.3	11.1	0	0.00
WWMG126239	174.59	163.94	2000	0.001	FM8_DIURNAL	9.7	173.7	0.9	11.1	0	0.00
WWMG126240	177.02	165.66	2000	0	FM8_DIURNAL	8.6	174.2	2.8	11.1	0	0.00
WWMG126241	175.65	168.22	2000	0.002	FM8_DIURNAL	7.1	175.3	0.3	10.0	0	0.00
WWMG126242	184.33	171.64	2017	0	FM8_DIURNAL	4.6	176.3	8.1	9.6	0	0.00
WWMG126243	183.79	171.83	2000	0	FM8_DIURNAL	5.2	177.0	6.8	8.8	0	0.00
WWMG127109	169.81	163.83	1988	0.001	FM10_DIURNAL	5.0	168.9	1.0	2.4	0	0.00
WWMG127110	169.22	164.26	1988	0.001	FM10_DIURNAL	4.7	169.0	0.2	2.4	0	0.00
WWMG127114	171.40	165.69	1922	0.001	FM10_DIURNAL	3.8	169.5	1.9	2.4	0	0.00
WWMG127133	174.28	168.63	1922	0.01	FM10_DIURNAL	0.8	169.5	4.8	0.2	0	0.00
WWMG127188	172.56	163.75	2017	0.004	FM8_DIURNAL	7.5	171.3	1.3	0.5	0	0.00
WWMG127195	175.81	166.36	2017	0.003	FM8_DIURNAL	8.5	174.9	0.9	10.1	0	0.00
WWMG136015	168.77	153.68	1987	0.006	FM8_DIURNAL	8.4	162.1	6.7	19.2	0	0.00
WWMG136016	169.06	155.01	2017	0.003	FM8_DIURNAL	8.9	163.9	5.1	19.2	0	0.00
WWMG136017	168.95	155.82	1987	0.008	FM8_DIURNAL	9.5	165.3	3.6	11.9	0	0.00
WWMG136018	169.04	156.39	1987	0.006	FM8_DIURNAL	9.9	166.3	2.7	11.1	0	0.00
WWMG136019	170.03	156.83	1987	0	FM8_DIURNAL	11.0	167.8	2.2	11.1	0	0.00
WWMG136020	169.14	155.24	1987	0.011	FM8_DIURNAL	8.9	164.1	5.0	13.7	0	0.00
WWMG136021	170.05	158.68	1987	0.002	FM8_DIURNAL	9.1	167.8	2.3	2.1	0	0.00
WWMG136035	166.04	157.45	2017	0.005	FM10_DIURNAL	6.6	164.1	2.0	3.8	0	0.00
WWMG136036	167.71	158.46	1962	0	FM10_DIURNAL	6.5	165.0	2.7	3.6	0	0.00
WWMG136037	169.93	159.28	1962	0.003	FM10_DIURNAL	6.7	166.0	4.0	3.5	0	0.00
WWMG136038	168.40	160.06	1962	0.007	FM10_DIURNAL	6.1	166.1	2.3	2.6	0	0.00
WWMG136039	166.31	161.22	1962	0	FM10_DIURNAL	5.1	166.3	0.0	2.5	0.002214	0.51
WWMG136050	169.82	154.69	1948	0.005	FM8_DIURNAL	7.3	162.0	7.8	5.4	0	0.00
WWMG136051	168.57	155.25	1948	0.003	FM8_DIURNAL	8.1	163.4	5.2	4.6	0	0.00
WWMG136053	169.28	156.74	1948	0.003	FM8_DIURNAL	9.5	166.3	3.0	4.2	0	0.00
WWMG136054	169.10	157.95	1948	0.003	FM8_DIURNAL	9.3	167.2	1.9	3.5	0	0.00
WWMG136064	169.61	159.97	1922	0.001	FM8_DIURNAL	8.5	168.5	1.1	2.1	0	0.00
WWMG136065	172.07	160.39	1922	0.003	FM8_DIURNAL	8.8	169.2	2.8	2.0	0	0.00
WWMG136066	173.75	160.79	1922	0.004	FM8_DIURNAL	9.1	169.9	3.8	2.0	0	0.00
WWMG136067	174.96	161.45	1922	0.001	FM8_DIURNAL	9.3	170.8	4.2	2.0	0	0.00
WWMG136068	174.21	162.01	1922	0.001	FM8_DIURNAL	9.0	171.0	3.2	1.0	0	0.00
WWMG136069	174.23	162.03	1922	0	FM8_DIURNAL	9.0	171.1	3.2	1.0	0	0.00
WWMG136070	172.10	162.60	2017	0	FM8_DIURNAL	8.6	171.2	0.9	1.0	0	0.00
WWMG136074	169.20	164.31	1922	0.005	FM8_DIURNAL	0.1	164.4	4.8	0.0	0	0.00
WWMG136095	168.48	162.53	2017	0.004	FM10_DIURNAL	5.4	168.0	0.5	2.4	0	0.00
WWMG136097	169.32	160.50	2017	0.003	FM8_DIURNAL	6.8	167.3	2.0	0.6	0	0.00
WWMG136100	174.20	163.12	1922	0	FM8_DIURNAL	6.8	169.9	4.3	0.3	0	0.00
WWMG136254	170.01	159.70	2017	0.003	FM8_DIURNAL	7.6	167.3	2.8	0.6	0	0.00
WWMG136260	170.10	157.00	1987	0	FM8_DIURNAL	10.9	167.9	2.2	11.1	0	0.00
WWMG137106	168.49	161.89	1962	0	FM10_DIURNAL	5.1	167.0	1.5	2.5	0	0.00
WWMG137107	169.49	162.99	2017	0	FM10_DIURNAL	5.7	168.7	0.8	2.5	0	0.00
WWMG137183	169.27	163.12	2017	0.001	FM10_DIURNAL	5.6	168.7	0.6	2.4	0	0.00
WWMG137193	168.38	156.07	1948	0.004	FM8_DIURNAL	8.9	165.0	3.4	4.6	0	0.00
WWMG137194	166.98	158.03	2017	0.007	FM10_DIURNAL	6.8	164.8	2.2	3.7	0	0.00

Existing System Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMG137195	168.38	158.48	2017	0.009	FM10_DIURNAL	6.7	165.2	3.2	3.6	0	0.00
WWMG146012	169.80	152.08	2017	0.003	FM8_DIURNAL	8.9	161.0	8.8	2.2	0	0.00
WWMG146013	169.88	152.54	1987	0.002	FM8_DIURNAL	8.5	161.0	8.9	0.7	0	0.00
WWMG146014	168.98	152.58	1987	0.004	FM8_DIURNAL	8.4	161.0	8.0	19.2	0	0.00
WWMG146025	170.67	155.04	2017	0.011	FM8_DIURNAL	6.0	161.0	9.7	0.4	0	0.00
WWMG146075	168.83	151.83	2015	0.002	FM8_DIURNAL	9.1	160.9	7.9	19.2	0	0.00
WWMG146076	168.97	151.13	2017	0.002	FM8_DIURNAL	9.8	160.9	8.1	20.7	0	0.00
WWMG146077	169.92	150.36	2015	0.003	FM8_DIURNAL	10.3	160.7	9.3	24.9	0	0.00
WWMG146078	170.02	154.03	2015	0.003	FM8_DIURNAL	6.7	160.8	9.3	4.8	0	0.00
WWMG146079	171.02	149.70	2015	0.003	FM8_DIURNAL	10.4	160.1	10.9	26.6	0	0.00
WWMG79032	225.97	218.21	1979	0.023	FM16_DIURNAL	0.8	219.0	7.0	0.8	0	0.00
WWMG79033	231.39	222.83	1979	0.002	FM16_DIURNAL	0.4	223.2	8.2	0.8	0	0.00
WWMG79034	232.65	224.69	1979	0.019	FM16_DIURNAL	0.4	225.1	7.5	0.8	0	0.00
WWMG79195	246.66	240.18	1996	0	FM17_DIURNAL	0.3	240.5	6.2	0.8	0	0.00
WWMG79196	248.13	240.58	1996	0.002	FM17_DIURNAL	0.5	241.1	7.0	0.8	0	0.00
WWMG79244	249.95	241.37	1996	0.001	FM17_DIURNAL	0.5	241.9	8.1	0.8	0	0.00
WWMG79245	250.59	242.09	1996	0	FM17_DIURNAL	0.5	242.6	8.0	0.8	0	0.00
WWMG79246	251.11	242.45	1996	0.004	FM17_DIURNAL	0.6	243.0	8.1	0.8	0	0.00
WWMG89076	227.29	218.83	1978	0.014	FM3_DIURNAL	0.1	218.9	8.4	0.0	0	0.00
WWMG89185	227.99	220.04	1995	0	FM3_DIURNAL	1.0	221.1	6.9	3.3	0	0.00
WWMG89186	229.62	220.50	1995	0	FM17_DIURNAL	0.7	221.2	8.4	0.9	0	0.00
WWMG89187	230.23	221.07	1995	0.001	FM17_DIURNAL	0.7	221.8	8.5	0.9	0	0.00
WWMG89189	231.53	222.20	1995	0.002	FM17_DIURNAL	0.5	222.7	8.8	0.9	0	0.00
WWMG89192	235.58	226.02	1995	0	FM17_DIURNAL	0.4	226.5	9.1	0.9	0	0.00
WWMG89193	237.71	228.02	1996	0.035	FM17_DIURNAL	0.4	228.4	9.3	0.9	0	0.00
WWMG89194	242.49	234.52	1996	0.013	FM17_DIURNAL	0.4	234.9	7.6	0.8	0	0.00
WWMG89250	227.31	220.40	2017	0	FM3_DIURNAL	0.4	220.8	6.5	1.0	0	0.00
WWMG89258	227.59	214.58	2003	0.021	FM3_DIURNAL	0.8	215.4	12.2	4.3	0	0.00
WWMG89259	227.27	216.37	2017	0	FM3_DIURNAL	0.8	217.2	10.1	4.3	0	0.00
WWMG89260	226.99	217.01	2017	0	FM3_DIURNAL	1.1	218.1	8.9	4.3	0	0.00
WWMG89261	228.20	217.97	2017	0	FM3_DIURNAL	0.8	218.8	9.4	3.3	0	0.00
WWMG99099	207.14	191.77	2017	0.003	FM3_DIURNAL	0.6	192.4	14.7	4.1	0	0.00
WWMG99100	208.65	197.15	2003	0.024	FM3_DIURNAL	0.5	197.7	11.0	4.1	0	0.00
WWMG99101	213.19	204.69	2017	0	FM3_DIURNAL	0.5	205.2	8.0	4.1	0	0.00
WWMG99102	222.20	208.50	2017	0	FM3_DIURNAL	0.6	209.1	13.1	4.1	0	0.00
WWMG99104	223.52	210.39	2003	0	FM3_DIURNAL	0.7	211.1	12.4	4.2	0	0.00
WWMG99105	225.44	212.56	2017	0.01	FM3_DIURNAL	0.8	213.3	12.1	4.2	0	0.00
WWMH104008	161.15	146.86	1972	0.001	FM1_DIURNAL	7.2	154.0	7.1	1.3	0	0.00
WWMH104009	156.71	148.29	1972	0.001	FM1_DIURNAL	6.0	154.3	2.5	1.3	0	0.00
WWMH104010	159.65	150.28	2017	0.002	FM1_DIURNAL	4.1	154.3	5.3	1.3	0	0.00
WWMH104011	160.09	150.77	1972	0.017	FM1_DIURNAL	3.8	154.6	5.5	1.3	0	0.00
WWMH104012	161.27	151.90	1973	0.004	FM1_DIURNAL	2.9	154.8	6.5	1.3	0	0.00
WWMH104040	219.73	209.84	1960	0	FM19_DIURNAL	0.3	210.1	9.6	0.8	0	0.00
WWMH104041	218.44	210.12	1970	0.035	FM19_DIURNAL	0.6	210.7	7.7	0.8	0	0.00
WWMH104042	216.89	211.37	1970	0.006	FM19_DIURNAL	0.5	211.8	5.0	0.8	0	0.00
WWMH104043	222.04	213.21	1960	0.012	FM19_DIURNAL	0.5	213.7	8.4	0.8	0	0.00
WWMH104044	223.91	214.86	2017	0.055	FM19_DIURNAL	0.4	215.3	8.6	0.8	0	0.00

Existing System Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMH105001	166.19	152.88	1973	0.028	FM1_DIURNAL	2.0	154.9	11.3	1.3	0	0.00
WWMH105002	165.42	155.42	1973	0.001	FM1_DIURNAL	0.4	155.9	9.6	1.2	0	0.00
WWMH105003	166.74	157.69	2017	0.011	FM1_DIURNAL	0.4	158.1	8.6	1.2	0	0.00
WWMH105004	169.00	160.00	1973	0.001	FM1_DIURNAL	0.4	160.4	8.6	1.2	0	0.00
WWMH105005	170.73	162.03	1973	0.022	FM1_DIURNAL	0.4	162.5	8.3	1.2	0	0.00
WWMH105017	170.16	163.31	1973	0.001	FM1_DIURNAL	0.5	163.8	6.4	1.2	0	0.00
WWMH114003	147.33	140.08	1960	0.002	FM1_DIURNAL	7.3	147.3	0.0	4.4	0.249632	11.51
WWMH114004	155.60	140.80	2017	0.03	FM1_DIURNAL	9.5	150.3	5.3	2.8	0	0.00
WWMH114005	153.43	141.58	2017	0.002	FM1_DIURNAL	11.6	153.2	0.2	2.7	0	0.00
WWMH114006	156.67	143.28	1972	0.001	FM1_DIURNAL	10.2	153.5	3.2	1.3	0	0.00
WWMH114007	161.60	145.32	1972	0.001	FM1_DIURNAL	8.4	153.8	7.8	1.3	0	0.00
WWMH114026	152.90	145.81	1958	0.002	FM19_DIURNAL	0.4	146.2	6.7	1.8	0	0.00
WWMH114027	157.65	153.65	1958	0.009	FM19_DIURNAL	0.4	154.0	3.6	1.8	0	0.00
WWMH114028	184.27	174.85	1958	0	FM19_DIURNAL	0.4	175.2	9.0	1.8	0	0.00
WWMH114029	187.00	176.84	1958	0.003	FM19_DIURNAL	4.0	180.8	6.2	1.8	0	0.00
WWMH114030	188.24	177.83	1978	0.006	FM19_DIURNAL	5.2	183.0	5.2	1.8	0	0.00
WWMH114031	190.00	180.15	1958	0.528	FM19_DIURNAL	9.9	190.0	0.0	2.2	0.069591	11.54
WWMH114033	200.82	190.84	1960	0.003	FM19_DIURNAL	0.3	191.1	9.7	0.9	0	0.00
WWMH114035	201.55	192.53	1960	0	FM19_DIURNAL	0.5	193.0	8.6	0.9	0	0.00
WWMH114036	202.46	193.10	1960	0.017	FM19_DIURNAL	0.5	193.6	8.9	0.9	0	0.00
WWMH114037	202.53	194.33	2017	0.009	FM19_DIURNAL	0.5	194.9	7.7	0.8	0	0.00
WWMH114038	211.82	201.80	2017	0.003	FM19_DIURNAL	0.3	202.1	9.7	0.8	0	0.00
WWMH114039	218.44	208.10	1960	0	FM19_DIURNAL	0.3	208.4	10.0	0.8	0	0.00
WWMH114127	152.90	142.30	1958	0.002	FM19_DIURNAL	0.5	142.8	10.1	1.8	0	0.00
WWMH114140	149.02	139.21	2017	0.005	FM1_DIURNAL	7.8	147.0	2.0	2.6	0	0.00
WWMH123003	167.83	157.32	2017	0.011	FM20_DIURNAL	0.3	157.6	10.2	2.6	0	0.00
WWMH123004	169.80	160.05	2017	0.01	FM20_DIURNAL	0.8	160.9	8.9	2.6	0	0.00
WWMH123005	174.74	163.03	2017	0.003	FM20_DIURNAL	0.8	163.8	10.9	2.5	0	0.00
WWMH123006	177.34	164.58	2017	0.039	FM20_DIURNAL	1.1	165.7	11.7	2.5	0	0.00
WWMH123007	181.08	167.07	2017	0.177	FM20_DIURNAL	0.8	167.9	13.2	2.5	0	0.00
WWMH123068	129.07	118.12	1956	0.002	FM1_DIURNAL	10.8	128.9	0.2	8.2	0	0.00
WWMH123069	132.54	118.70	1956	0.002	FM1_DIURNAL	10.7	129.4	3.2	7.2	0	0.00
WWMH123070	132.82	119.14	2017	0.039	FM1_DIURNAL	10.6	129.7	3.1	7.2	0	0.00
WWMH123071	130.54	119.89	1956	0.002	FM1_DIURNAL	10.7	130.5	0.0	8.8	0.402643	17.59
WWMH126133	169.82	161.52	1996	0.004	FM8_DIURNAL	2.4	163.9	5.9	1.0	0	0.00
WWMH131073	110.05	102.95	1970	0.002	FM1_DIURNAL	5.0	107.9	2.1	6.5	0	0.00
WWMH131074	111.91	103.87	1970	0.002	FM1_DIURNAL	7.5	111.4	0.5	6.5	0	0.00
WWMH131075	113.89	106.08	1970	0.002	FM1_DIURNAL	7.8	113.9	0.0	6.1	0.203466	17.13
WWMH131080	118.92	107.40	1970	0.002	FM1_DIURNAL	9.7	117.1	1.9	6.1	0	0.00
WWMH131081	117.91	108.26	1970	0.036	FM1_DIURNAL	9.7	117.9	0.0	5.6	0.260906	19.30
WWMH131082	121.41	110.06	1970	0.002	FM1_DIURNAL	11.4	121.4	0.0	6.8	0.322627	19.60
WWMH131083	124.77	111.72	1994	0.002	FM1_DIURNAL	12.5	124.2	0.6	5.2	0	0.00
WWMH133000	126.34	115.16	1994	0.002	FM1_DIURNAL	9.2	124.3	2.0	6.4	0	0.00
WWMH133001	123.99	116.99	2017	0.002	FM20_DIURNAL	7.0	124.0	0.0	3.1	1.511477	20.09
WWMH133002	124.37	117.76	2017	0.002	FM20_DIURNAL	6.6	124.4	0.0	2.6	0.083548	7.37
WWMH133066	124.96	116.27	1956	0.002	FM1_DIURNAL	8.7	125.0	0.0	9.9	1.282381	19.31
WWMH133067	128.79	117.04	1956	0.002	FM1_DIURNAL	9.6	126.6	2.2	8.2	0	0.00

Existing System Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMH133096	125.99	114.54	1994	0.002	FM1_DIURNAL	9.7	124.3	1.7	6.5	0	0.00
WWMH136135	168.89	158.83	1996	0.002	FM8_DIURNAL	3.7	162.5	6.4	1.0	0	0.00
WWMH136204	169.50	159.79	1996	0.003	FM8_DIURNAL	3.6	163.4	6.1	1.0	0	0.00
WWMH136247	165.60	155.57	1996	0.002	FM8_DIURNAL	2.2	157.8	7.8	2.1	0	0.00
WWMH136248	168.62	156.42	1996	0.003	FM8_DIURNAL	4.3	160.7	7.9	2.1	0	0.00
WWMH136249	165.59	157.01	1998	0.007	FM8_DIURNAL	4.3	161.3	4.3	1.0	0	0.00
WWMH136250	163.00	157.81	1996	0.002	FM8_DIURNAL	3.8	161.6	1.4	1.0	0	0.00
WWMH136253	169.46	159.45	2001	0.004	FM8_DIURNAL	3.5	162.9	6.5	1.0	0	0.00
WWMH136262	169.50	161.48	2017	0.002	FM8_DIURNAL	5.9	167.3	2.2	0.5	0	0.00
WWMH141000	115.54	91.24	1986	0.002	FM8_DIURNAL	2.2	93.4	22.1	41.9	0	0.00
WWMH141001	112.20	95.40	1986	0.002	FM1_DIURNAL	0.8	96.2	16.0	13.4	0	0.00
WWMH141002	111.85	96.14	1986	0.002	FM1_DIURNAL	1.6	97.8	14.1	13.4	0	0.00
WWMH141003	111.74	96.53	1986	0.002	FM1_DIURNAL	1.4	98.0	13.8	13.3	0	0.00
WWMH141004	111.43	97.06	1986	0.002	FM1_DIURNAL	1.6	98.6	12.8	13.3	0	0.00
WWMH141005	111.43	97.72	1970	0.002	FM1_DIURNAL	1.5	99.2	12.2	13.3	0	0.00
WWMH141006	130.02	119.82	1970	0.002	FM15_DIURNAL	0.4	120.2	9.8	5.5	0	0.00
WWMH141007	154.01	149.19	1970	0.002	FM15_DIURNAL	0.3	149.5	4.5	5.5	0	0.00
WWMH141071	110.74	101.64	1970	0.002	FM1_DIURNAL	2.3	104.0	6.8	8.0	0	0.00
WWMH141072	109.94	102.73	1970	0.002	FM1_DIURNAL	3.6	106.4	3.6	8.0	0	0.00
WWMH146000	117.26	92.54	1986	0.002	FM8_DIURNAL	2.0	94.5	22.7	28.5	0	0.00
WWMH146001	154.12	142.01	1988	0.002	FM8_DIURNAL	0.7	142.8	11.4	28.5	0	0.00
WWMH146002	163.76	143.45	1988	0.002	FM8_DIURNAL	3.1	146.5	17.2	28.5	0	0.00
WWMH146003	163.72	144.27	1988	0.002	FM8_DIURNAL	4.0	148.3	15.4	28.5	0	0.00
WWMH146004	166.10	145.38	1988	0.002	FM8_DIURNAL	5.0	150.4	15.7	28.5	0	0.00
WWMH146005	169.64	145.89	1988	0.021	FM8_DIURNAL	6.1	152.0	17.6	28.5	0	0.00
WWMH146006	168.68	146.57	1988	0.003	FM8_DIURNAL	6.7	153.3	15.4	28.5	0	0.00
WWMH146007	172.13	147.71	1988	0.008	FM8_DIURNAL	7.7	155.4	16.8	26.7	0	0.00
WWMH146008	172.32	148.65	1988	0.003	FM8_DIURNAL	8.8	157.4	14.9	26.6	0	0.00
WWMH146246	168.90	153.93	1996	0.002	FM8_DIURNAL	0.3	154.3	14.6	2.1	0	0.00
WWMH146247	171.99	148.89	2015	0.002	FM8_DIURNAL	10.6	159.5	12.5	26.6	0	0.00
WWMH95018	173.00	165.10	1992	0.004	FM1_DIURNAL	0.5	165.6	7.4	1.2	0	0.00
WWMH95019	173.00	166.45	1991	0.001	FM1_DIURNAL	0.4	166.8	6.2	1.2	0	0.00
WWMH95020	176.67	169.94	1991	0.002	FM1_DIURNAL	0.3	170.3	6.4	1.2	0	0.00
WWMH95021	205.65	187.21	1991	0.004	FM1_DIURNAL	0.2	187.4	18.2	1.2	0	0.00
WWMH95022	204.76	190.07	1991	0.006	FM1_DIURNAL	0.3	190.4	14.4	1.2	0	0.00
WWMH95023	207.20	191.85	1991	0.004	FM1_DIURNAL	0.4	192.3	14.9	1.2	0	0.00
WWMH95024	210.40	192.85	1991	0.001	FM1_DIURNAL	0.4	193.2	17.2	1.2	0	0.00
WWMI102001	208.60	197.52	1976	0	FM12_DIURNAL	2.7	200.2	8.4	2.0	0	0.00
WWMI102002	218.13	198.62	1976	0	FM12_DIURNAL	4.7	203.3	14.9	2.0	0	0.00
WWMI102003	215.84	199.90	1976	0.142	FM12_DIURNAL	7.8	207.7	8.1	2.0	0	0.00
WWMI102066	210.77	203.23	1970	0.004	FM12_DIURNAL	0.4	203.6	7.2	1.4	0	0.00
WWMI102067	214.51	208.13	2017	0.005	FM12_DIURNAL	0.4	208.5	6.0	1.4	0	0.00
WWMI102068	219.20	212.88	2017	0.027	FM12_DIURNAL	0.4	213.3	5.9	1.4	0	0.00
WWMI102069	221.49	213.72	1970	0	FM12_DIURNAL	0.7	214.5	7.0	1.4	0	0.00
WWMI102070	219.80	214.21	1977	0.014	FM12_DIURNAL	0.6	214.8	5.0	1.4	0	0.00
WWMI102071	220.03	214.40	1977	0.002	FM12_DIURNAL	0.6	215.0	5.0	1.4	0	0.00
WWMI102072	223.35	216.64	1977	0.011	FM12_DIURNAL	0.5	217.2	6.2	1.4	0	0.00

Existing System Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMI102073	225.66	218.21	1977	0.011	FM12_DIURNAL	0.4	218.7	7.0	1.3	0	0.00
WWMI102131	225.87	219.28	1999	0	FM12_DIURNAL	0.6	219.9	6.0	1.3	0	0.00
WWMI102132	227.75	220.88	2017	0	FM12_DIURNAL	0.3	221.2	6.5	0.7	0	0.00
WWMI104050	232.35	222.32	2008	0.002	FM12_DIURNAL	0.4	222.7	9.6	0.7	0	0.00
WWMI104051	229.69	222.06	2017	0	FM12_DIURNAL	0.2	222.3	7.4	0.7	0	0.00
WWMI111032	193.30	179.27	1970	0	FM12_DIURNAL	6.2	185.5	7.8	4.0	0	0.00
WWMI111035	188.10	181.39	1970	0.005	FM12_DIURNAL	6.7	188.1	0.0	4.2	0.045479	9.54
WWMI111036	203.57	182.78	1970	0	FM12_DIURNAL	6.6	189.4	14.2	4.2	0	0.00
WWMI111037	205.03	189.43	2017	0.023	FM12_DIURNAL	0.4	189.8	15.2	4.2	0	0.00
WWMI111040	193.00	180.54	1970	0	FM12_DIURNAL	6.5	187.1	5.9	4.0	0	0.00
WWMI111053	203.84	193.35	2017	0.043	FM12_DIURNAL	0.5	193.9	9.9	4.2	0	0.00
WWMI111099	202.79	195.95	2017	0.076	FM12_DIURNAL	0.9	196.9	5.9	3.5	0	0.00
WWMI112000	207.16	196.52	2017	0	FM12_DIURNAL	0.6	197.2	10.0	2.0	0	0.00
WWMI121026	177.80	171.05	1970	0	FM15_DIURNAL	6.8	177.8	0.0	4.6	0.413423	13.60
WWMI121027	179.87	172.17	1970	0	FM15_DIURNAL	7.6	179.7	0.1	4.6	0	0.00
WWMI121028	179.60	172.66	1970	0.03	FM15_DIURNAL	6.9	179.6	0.0	4.1	0.293008	10.12
WWMI121029	182.20	174.79	1970	0	FM12_DIURNAL	6.3	181.1	1.1	4.0	0	0.00
WWMI121030	185.90	176.89	1970	0	FM12_DIURNAL	5.6	182.5	3.4	4.0	0	0.00
WWMI121031	190.60	178.01	1970	0.002	FM12_DIURNAL	5.9	183.9	6.7	4.0	0	0.00
WWMI121100	186.60	177.06	1996	0.002	FM12_DIURNAL	5.7	182.7	3.9	4.0	0	0.00
WWMI121103	179.74	172.35	2001	0	FM15_DIURNAL	7.4	179.7	0.0	4.7	0.000207	0.03
WWMI131009	165.55	152.25	1970	0.001	FM15_DIURNAL	3.7	155.9	9.6	5.5	0	0.00
WWMI131010	167.11	153.52	1970	0	FM15_DIURNAL	5.1	158.6	8.5	5.5	0	0.00
WWMI131011	165.59	154.68	1970	0	FM15_DIURNAL	5.8	160.4	5.2	5.5	0	0.00
WWMI131012	164.21	154.97	1970	0	FM15_DIURNAL	6.1	161.1	3.1	5.5	0	0.00
WWMI131013	163.40	156.32	1970	0	FM15_DIURNAL	7.1	163.4	0.0	5.6	0.006047	3.71
WWMI131014	167.17	156.45	1970	0.002	FM15_DIURNAL	8.0	164.4	2.7	5.6	0	0.00
WWMI131017	173.93	157.55	1970	0	FM15_DIURNAL	8.1	165.6	8.3	4.4	0	0.00
WWMI131018	174.47	158.73	1970	0.016	FM15_DIURNAL	7.2	165.9	8.5	4.4	0	0.00
WWMI131019	173.04	160.63	1970	0	FM15_DIURNAL	6.9	167.5	5.5	4.4	0	0.00
WWMI131020	171.74	161.93	1970	0	FM15_DIURNAL	7.3	169.2	2.5	4.4	0	0.00
WWMI131021	174.05	163.74	1970	0	FM15_DIURNAL	7.4	171.1	2.9	4.4	0	0.00
WWMI131022	176.99	165.43	1970	0	FM15_DIURNAL	7.6	173.0	3.9	4.4	0	0.00
WWMI131023	177.45	166.71	1970	0.01	FM15_DIURNAL	8.0	174.7	2.7	4.4	0	0.00
WWMI131024	178.04	168.13	1970	0	FM15_DIURNAL	8.2	176.4	1.7	4.4	0	0.00
WWMI131025	177.79	169.55	1970	0	FM15_DIURNAL	7.6	177.1	0.7	3.7	0	0.00
WWMI131111	172.52	160.90	2017	0	FM15_DIURNAL	7.0	167.9	4.6	4.4	0	0.00
WWMI141008	162.12	150.54	1970	0.002	FM15_DIURNAL	2.6	153.1	9.0	5.5	0	0.00
WWMI81	279.93	268.14	2009	0	FM12_DIURNAL	0.2	268.4	11.6	0.6	0	0.00
WWMI92143	265.85	257.49	2008	0	FM12_DIURNAL	0.3	257.8	8.1	0.6	0	0.00
WWMI92144	264.43	256.47	2008	0	FM12_DIURNAL	0.3	256.8	7.7	0.6	0	0.00
WWMI92146	263.91	254.54	2017	0	FM12_DIURNAL	1.4	255.9	8.0	0.6	0	0.00
WWMI92147	262.12	243.47	2017	0	FM12_DIURNAL	0.3	243.8	18.3	0.7	0	0.00
WWMI92148	251.71	241.52	2017	0	FM12_DIURNAL	0.2	241.8	10.0	0.7	0	0.00
WWMI92149	245.17	236.97	2017	0	FM12_DIURNAL	0.2	237.2	8.0	0.7	0	0.00
WWMI92150	241.50	229.75	2017	0	FM12_DIURNAL	0.2	229.9	11.6	0.7	0	0.00
WWMI92151	239.75	225.75	2017	0.02	FM12_DIURNAL	0.4	226.1	13.6	0.7	0	0.00

Existing System Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMI92152	234.71	223.96	2017	0	FM12_DIURNAL	0.3	224.3	10.4	0.7	0	0.00
WWMI92156	263.55	244.65	2017	0	FM12_DIURNAL	0.1	244.7	18.8	0.0	0	0.00
WWMI92157	260.95	245.57	2008	0	FM12_DIURNAL	0.1	245.7	15.3	0.0	0	0.00
WWMI92158	255.21	247.11	2017	0	FM12_DIURNAL	0.1	247.2	8.0	0.0	0	0.00
WWMI92159	253.49	248.10	2008	0	FM12_DIURNAL	0.1	248.2	5.3	0.0	0	0.00
WWMI92161	255.92	249.58	2017	0.038	FM12_DIURNAL	0.1	249.7	6.2	0.0	0	0.00
WWMJ111043	194.89	184.33	2001	0.001	FM13_DIURNAL	0.2	184.6	10.3	0.6	0	0.00
WWMJ111047	185.59	176.73	2004	0.003	FM13_DIURNAL	0.6	177.3	8.3	0.7	0	0.00
WWMJ111056	204.04	191.76	2005	0.006	FM13_DIURNAL	0.2	192.0	12.0	0.6	0	0.00
WWMJ111094	184.62	177.95	2008	0.009	FM13_DIURNAL	0.4	178.4	6.2	0.7	0	0.00
WWMJ111103	185.08	176.58	2017	0	FM13_DIURNAL	0.9	177.5	7.6	0.7	0	0.00
WWMJ120001	175.85	163.63	2003	0.05	FM13_DIURNAL	0.3	164.0	11.9	0.2	0	0.00
WWMJ120009	173.82	163.22	2001	0	FM13_DIURNAL	0.7	164.0	9.9	1.4	0	0.00
WWMJ120010	164.76	153.07	2001	0	FM15_DIURNAL	0.2	153.3	11.5	1.4	0	0.00
WWMJ120012	177.26	160.24	2001	0	FM13_DIURNAL	0.9	161.2	16.1	1.4	0	0.00
WWMJ120013	175.25	161.35	2001	0	FM13_DIURNAL	0.6	162.0	13.3	1.4	0	0.00
WWMJ120014	174.68	162.10	2001	0	FM13_DIURNAL	0.7	162.8	11.9	1.4	0	0.00
WWMJ120015	176.85	164.04	2001	0	FM13_DIURNAL	0.0	164.0	12.8	0.0	0	0.00
WWMJ120016	147.26	124.42	2001	0	FM15_DIURNAL	0.3	124.7	22.5	2.1	0	0.00
WWMJ120017	140.24	122.37	2001	0	FM15_DIURNAL	0.3	122.7	17.6	2.1	0	0.00
WWMJ120018	140.24	135.90	2001	0	FM15_DIURNAL	0.0	135.9	4.3	0.0	0	0.00
WWMJ120021	176.02	166.16	2001	0	FM13_DIURNAL	0.5	166.6	9.4	1.3	0	0.00
WWMJ120022	179.00	168.60	2001	0	FM13_DIURNAL	0.6	169.2	9.8	1.3	0	0.00
WWMJ120023	183.04	172.55	2001	0	FM13_DIURNAL	0.4	172.9	10.1	0.6	0	0.00
WWMJ120024	187.12	177.01	2001	0	FM13_DIURNAL	0.3	177.3	9.8	0.6	0	0.00
WWMJ120025	179.01	174.85	2004	0.001	FM13_DIURNAL	1.3	176.1	2.9	0.7	0	0.00
WWMJ120026	178.93	174.41	2004	0.001	FM13_DIURNAL	1.6	176.0	2.9	0.7	0	0.00
WWMJ120027	183.34	176.14	2004	0.001	FM13_DIURNAL	0.6	176.8	6.6	0.7	0	0.00
WWMJ120032	183.73	172.89	2004	0.002	FM13_DIURNAL	0.6	173.5	10.3	0.7	0	0.00
WWMJ120033	182.16	171.58	2004	0	FM13_DIURNAL	0.4	172.0	10.1	1.3	0	0.00
WWMJ120034	141.74	124.85	2005	0	FM15_DIURNAL	0.4	125.2	16.5	1.0	0	0.00
WWMJ120035	133.71	126.31	2017	0	FM15_DIURNAL	0.4	126.7	7.0	1.0	0	0.00
WWMJ120036	137.44	127.46	2005	0	FM14_DIURNAL	0.5	127.9	9.5	1.0	0	0.00
WWMJ120037	140.82	132.41	2005	0.002	FM14_DIURNAL	0.2	132.6	8.2	1.0	0	0.00
WWMJ120038	150.33	139.45	2017	0	FM14_DIURNAL	0.3	139.8	10.5	1.0	0	0.00
WWMJ120039	150.91	141.24	2005	0	FM14_DIURNAL	0.3	141.6	9.3	1.0	0	0.00
WWMJ120040	153.37	143.48	2005	0	FM14_DIURNAL	0.3	143.8	9.6	1.0	0	0.00
WWMJ120041	157.38	146.02	2005	0.004	FM14_DIURNAL	0.3	146.3	11.1	1.0	0	0.00
WWMJ120042	169.74	153.34	2005	0.094	FM14_DIURNAL	0.3	153.6	16.1	0.9	0	0.00
WWMJ120043	177.19	167.14	2017	0	FM13_DIURNAL	0.6	167.7	9.5	1.3	0	0.00
WWMJ120048	178.45	159.33	2017	0	FM15_DIURNAL	0.4	159.7	18.8	1.4	0	0.00
WWMJ120060	152.36	136.72	2017	0.008	FM14_DIURNAL	0.3	137.0	15.3	1.0	0	0.00
WWMK120007	170.09	154.55	2005	0.002	FM14_DIURNAL	0.4	154.9	15.2	0.6	0	0.00
WWMK120008	172.35	154.54	2005	0.002	FM14_DIURNAL	0.7	155.3	17.1	0.6	0	0.00
WWMK120009	171.58	156.94	2005	0.021	FM14_DIURNAL	0.4	157.3	14.3	0.6	0	0.00

Existing System Flows, 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
A1_100	WWMG136021	J-110	28.5	0.013	159.18	159.72	1.00	4.92	1.91	2.06	2.63	0.42	1.00
R1_100	WWMG136018	WWMG136053	265.4	0.013	156.39	157.74	1.25	4.61	0.51	1.40	1.23	0.30	1.00
R1_101	WWMG136017	WWMG137193	265.9	0.013	155.82	157.07	1.25	4.43	0.47	0.59	0.48	0.13	1.00
R1_102	WWMG136015	WWMG136050	265.7	0.013	153.68	155.69	1.25	5.62	0.76	2.39	2.50	0.43	1.00
WWFM0026	J-140_CHEHAL	WWMG89250	3120.0	0.013	188.80	221.61	0.50	0.84	1.05	1.00	5.15	1.19	0.97
WWFM0028	J-130_CHAR	WWMG136039	995.0	0.013	151.20	161.27	0.33	0.29	1.01	0.40	4.62	1.39	1.00
WWFM0038	J-120_ANDR	WWMG136037	920.0	0.013	148.40	159.28	0.33	0.31	1.18	0.42	5.25	1.32	1.00
WWFM0039	J-210_SHER1	WWMF117018	495.0	0.013	152.94	157.78	0.33	0.28	0.98	0.24	2.73	0.84	1.00
WWFM0040	J-210_SHER1	WWMF117018	495.0	0.013	152.94	157.78	0.33	0.28	0.98	0.24	2.73	0.84	1.00
WWFM0041	J-160_DAY	WWMG136016	4000.0	0.013	107.00	155.11	1.00	5.46	1.20	3.03	5.19	0.56	1.00
WWFM0042	J-170_FERN1	WWMI121103	3290.0	0.013	137.60	173.53	1.00	5.18	1.09	2.73	3.47	0.53	1.00
WWFM0045	J-150_CREEKSD	WWMF109004	523.0	0.013	178.85	171.53	0.33	0.34	1.40	0.34	3.90	0.98	1.00
WWFM0048	J-190_HWY240_1	WWMG118104	2336.2	0.013	159.33	185.21	0.83	3.25	1.11	3.41	6.32	1.05	0.97
WWGM0002	WWMF118023	WWMF118002	232.9	0.013	169.65	166.04	0.83	2.73	1.55	0.02	1.54	0.01	0.53
WWGM0015	WWMG146013	WWMG146012	11.4	0.013	152.54	152.27	1.50	16.19	2.38	0.68	1.81	0.04	1.00
WWGM0152	WWMG123075	WWMG123074	221.5	0.013	125.12	122.95	1.50	10.40	0.98	8.60	4.87	0.83	1.00
WWGM0153	WWMG123076	WWMG123075	96.9	0.013	125.36	125.12	1.50	5.23	0.25	8.61	4.87	1.65	1.00
WWGM0154	WWMG123077	WWMG123076	105.3	0.013	125.89	125.58	1.50	5.70	0.29	6.99	3.96	1.23	1.00
WWGM0155	WWMG123079	WWMG123078	254.3	0.013	135.01	132.85	1.50	9.68	0.85	5.62	5.10	0.58	1.00
WWGM0156	WWMG114000	WWMG123079	20.2	0.013	135.51	135.38	1.50	8.42	0.64	5.62	4.75	0.67	1.00
WWGM0161	WWMH114127	WWMG114000	176.5	0.013	142.30	136.13	0.67	2.26	3.50	1.79	6.38	0.79	0.84
WWGM0162	WWMH114027	WWMH114026	137.8	0.013	153.65	145.99	0.67	2.85	5.57	1.79	8.62	0.63	0.57
WWGM0163	WWMH114028	WWMH114027	372.4	0.013	174.85	153.65	0.67	2.89	5.70	1.78	8.63	0.62	0.57
WWGM0164	WWMH114029	WWMH114028	244.1	0.013	176.84	175.07	0.67	1.03	0.73	1.78	5.17	1.73	0.96
WWGM0165	WWMG114001	WWMG114000	415.0	0.013	137.22	136.13	1.00	1.83	0.26	3.95	5.04	2.17	1.00
WWGM0166	WWMG114002	WWMG114001	326.7	0.013	138.28	137.32	1.00	1.93	0.29	3.13	3.99	1.62	1.00
WWGM0167	WWMH114140	WWMG114002	421.1	0.013	139.21	138.58	1.00	1.38	0.15	2.60	3.31	1.89	1.00
WWGM0168	WWMH114004	WWMH114003	183.5	0.013	140.80	140.18	0.83	1.27	0.34	2.77	5.09	2.18	1.00
WWGM0169	WWMH114005	WWMH114004	186.8	0.013	141.58	140.90	0.83	1.32	0.36	2.73	5.01	2.07	1.00
WWGM0170	WWMH114006	WWMH114005	235.2	0.013	143.28	141.62	1.00	2.99	0.71	1.33	1.75	0.44	1.00
WWGM0171	WWMH114007	WWMH114006	287.4	0.013	145.32	143.41	1.00	2.90	0.66	1.33	2.63	0.46	1.00
WWGM0173	WWMH104008	WWMH114007	218.6	0.013	146.86	145.48	1.00	2.83	0.63	1.33	2.69	0.47	1.00
WWGM0177	WWMG117195	WWMG116241	203.1	0.013	176.86	176.72	1.75	4.16	0.07	6.99	3.78	1.68	1.00
WWGM0182	WWMG116240	WWMG116239	324.0	0.013	176.26	175.44	1.75	7.97	0.25	7.00	4.06	0.88	1.00
WWGM0184	WWMG116239	WWMG116238	175.0	0.013	175.11	174.82	1.75	6.45	0.17	6.98	3.51	1.08	1.00
WWGM0191	WWMG118086	WWMG117195	481.3	0.013	178.01	177.21	1.75	6.46	0.17	4.11	2.99	0.64	1.00
WWGM0198	WWMG116238	WWMG116237	308.0	0.013	174.79	174.06	1.75	7.71	0.24	6.93	3.35	0.90	1.00
WWGM0206	WWMH141005	WWMH141004	268.5	0.013	97.72	97.06	2.50	20.35	0.25	13.34	4.22	0.66	0.61
WWGM0207	WWMH141006	WWMH141005	91.1	0.013	119.82	98.68	1.25	31.55	23.86	5.49	15.68	0.17	0.35
WWGM0208	WWMH141007	WWMH141006	88.7	0.013	149.19	120.52	1.25	37.75	34.15	5.49	21.59	0.15	0.26
WWGM0209	WWMI141008	WWMH141007	383.1	0.013	150.54	149.32	1.25	3.65	0.32	5.49	4.80	1.51	0.88
WWGM0210	WWMI131009	WWMI141008	386.6	0.013	152.25	150.54	1.25	4.30	0.44	5.48	4.47	1.28	1.00
WWGM0211	WWMH141071	WWMH141005	274.1	0.013	101.64	98.68	1.25	6.71	1.08	8.03	6.69	1.20	0.95
WWGM0212	WWMH141072	WWMH141071	157.2	0.013	102.73	101.74	1.25	5.13	0.63	8.03	6.55	1.57	1.00
WWGM0213	WWMH131073	WWMH141072	156.2	0.013	102.95	102.76	1.25	2.25	0.12	6.54	5.33	2.91	1.00
WWGM0214	WWMH131074	WWMH131073	353.7	0.013	103.87	102.95	1.25	3.29	0.26	6.54	5.33	1.99	1.00
WWGM0215	WWMH131075	WWMH131074	466.2	0.013	106.08	104.30	1.25	3.99	0.38	5.97	4.86	1.50	1.00
WWGM0232	WWMG126164	WWMG126243	19.0	0.013	180.00	179.48	0.83	3.63	2.74	0.00	1.07	0.00	0.02
WWGM0235	WWMH131080	WWMH131075	352.5	0.013	107.40	106.16	1.25	3.83	0.35	6.11	4.97	1.59	1.00
WWGM0238	WWMH131081	WWMH131080	182.1	0.013	108.26	107.50	1.25	4.17	0.42	5.58	4.55	1.34	1.00
WWGM0251	WWMG123074	WWMG123073	237.0	0.013	122.74	122.41	1.50	3.92	0.14	6.03	3.41	1.54	1.00
WWGM0253	WWMG123073	WWMG123072	350.6	0.013	122.28	121.33	1.50	5.47	0.27	6.03	3.58	1.10	1.00
WWGM0273	WWMH123007	WWMH123006	362.7	0.013	167.07	165.11	1.00	2.62	0.54	2.48	3.96	0.95	0.75
WWGM0276	WWMG89261	WWMG89260	130.2	0.013	217.97	217.62	1.50	5.45	0.27	3.27	3.59	0.60	0.51
WWGM0317	WWMF127015	WWMF127014	174.7	0.013	153.38	153.05	1.25	2.81	0.19	2.75	2.64	0.98	0.79
WWGM0354	WWMG116241	WWMG116240	65.5	0.013	176.56	176.26	1.75	10.72	0.46	7.00	4.05	0.65	1.00

Existing System Flows, 5-year, 24-hour storm event

Input								Output						
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM0356	WWMG123072	WWMH123071	423.4	0.013	121.01	119.99	1.50	5.16	0.24	7.21	4.08	1.40	1.00
WWGM0357	WWMH123071	WWMH123070	218.3	0.013	119.89	119.30	1.50	5.46	0.27	7.19	4.07	1.32	1.00
WWGM0372	WWMH141000	OF-3	177.3	0.013	91.24	90.60	3.50	60.44	0.36	41.88	7.01	0.69	0.60
WWGM0373	WWMH146002	WWMH146001	341.1	0.013	143.45	142.81	2.50	17.77	0.19	28.55	6.33	1.61	0.86
WWGM0374	WWMH141001	WWMH141000	169.5	0.013	95.40	92.32	2.50	55.29	1.82	13.35	9.12	0.24	0.38
WWGM0375	WWMH146001	WWMH146000	248.6	0.013	142.01	96.56	2.00	97.55	18.59	28.55	26.82	0.29	0.37
WWGM0376	WWMH146000	WWMH141000	12.7	0.013	92.54	92.32	2.50	53.95	1.73	28.54	8.34	0.53	0.66
WWGM0377	WWMH141002	WWMH141001	338.4	0.013	96.14	95.50	2.50	17.84	0.19	13.35	4.62	0.75	0.57
WWGM0378	WWMH141003	WWMH141002	71.2	0.013	96.53	96.34	2.50	21.19	0.27	13.35	4.62	0.63	0.57
WWGM0379	WWMH141004	WWMH141003	214.7	0.013	97.06	96.68	2.50	17.23	0.18	13.34	4.58	0.77	0.57
WWGM0408	WWMG123078	WWMG123077	241.2	0.013	132.71	125.99	1.50	17.54	2.79	6.99	5.20	0.40	1.00
WWGM0409	WWMH114026	WWMH114127	91.2	0.013	145.81	142.30	0.67	2.37	3.85	1.79	7.31	0.75	0.67
WWGM0411	WWMJ120034	WWMJ120016	95.6	0.013	124.85	124.55	2.00	12.67	0.31	1.00	2.55	0.08	0.18
WWGM0416	WWMJ120010	WWMJ120016	150.3	0.013	153.07	125.35	1.00	15.43	18.77	1.40	12.16	0.09	0.20
WWGM0417	WWMG89185	WWMG89261	61.3	0.013	220.04	218.95	0.83	2.92	1.78	3.27	6.12	1.12	0.96
WWGM0467	WWMJ120039	WWMJ120038	83.6	0.013	141.24	139.90	0.83	2.77	1.60	0.96	4.62	0.35	0.41
WWGM0468	WWMI131019	WWMI131018	377.8	0.013	160.63	159.36	1.25	3.75	0.34	4.39	3.83	1.17	1.00
WWGM0478	WWMJ120033	WWMJ120022	233.1	0.013	171.58	168.94	0.83	2.33	1.13	1.30	4.39	0.56	0.53
WWGM0479	WWMI131017	WWMI131014	277.3	0.013	157.55	156.79	1.25	3.38	0.27	4.40	3.59	1.30	1.00
WWGM0481	WWMJ120043	WWMJ120021	136.8	0.013	167.14	166.38	0.83	1.63	0.56	1.30	3.46	0.80	0.65
WWGM0482	WWMI131012	WWMI131011	85.1	0.013	155.05	154.68	1.25	4.26	0.43	5.49	4.47	1.29	1.00
WWGM0487	WWMJ120012	WWMJ120048	300.7	0.013	160.24	159.95	1.00	1.11	0.10	1.40	2.32	1.26	0.72
WWGM0491	WWMH146004	WWMH146003	432.9	0.013	145.38	144.42	2.50	19.32	0.22	28.54	5.81	1.48	1.00
WWGM0492	WWMJ120016	WWMJ120017	72.7	0.013	124.42	122.53	2.00	36.48	2.60	2.06	6.27	0.06	0.16
WWGM0496	WWMJ120001	WWMJ120009	135.7	0.013	163.63	163.52	1.00	1.01	0.08	0.21	1.31	0.21	0.39
WWGM0506	WWMJ120038	WWMJ120060	126.8	0.013	139.45	137.33	0.83	2.83	1.67	0.96	4.70	0.34	0.40
WWGM0507	WWMI131014	WWMI131013	132.0	0.013	156.45	156.36	1.25	1.69	0.07	5.58	4.55	3.31	1.00
WWGM0510	WWMJ120032	WWMJ120033	210.9	0.013	172.89	172.22	0.67	0.68	0.32	0.66	2.46	0.97	0.72
WWGM0511	WWMJ120037	WWMJ120036	54.2	0.013	132.41	127.58	1.00	10.66	8.95	1.00	6.81	0.09	0.27
WWGM0514	WWMJ120021	WWMJ120009	298.0	0.013	166.16	163.57	0.83	2.04	0.87	1.30	3.97	0.64	0.58
WWGM0516	WWMJ120023	WWMJ120033	67.7	0.013	172.55	172.22	0.83	1.53	0.49	0.65	2.78	0.42	0.44
WWGM0519	WWMJ120036	WWMJ120035	200.7	0.013	127.46	126.51	1.00	2.45	0.47	1.00	3.04	0.41	0.44
WWGM0520	WWMI131022	WWMI131021	449.4	0.013	165.43	163.80	1.25	3.89	0.36	4.39	3.75	1.13	1.00
WWGM0526	WWMJ120022	WWMJ120043	163.3	0.013	168.60	167.62	0.83	1.70	0.60	1.30	3.53	0.77	0.64
WWGM0528	WWMJ120025	WWMJ120026	55.0	0.013	174.85	174.46	0.67	1.02	0.71	0.66	1.88	0.64	1.00
WWGM0530	WWMK120007	WWMJ120042	162.3	0.013	154.55	153.63	0.83	1.65	0.57	0.62	2.84	0.38	0.42
WWGM0531	WWMK120008	WWMK120007	150.4	0.013	154.54	154.67	0.83	0.64	0.09	0.61	1.63	0.95	0.65
WWGM0533	WWMI131024	WWMI131023	384.7	0.013	168.13	166.74	1.25	3.88	0.36	4.38	3.57	1.13	1.00
WWGM0536	WWMH146005	WWMH146004	339.5	0.013	145.89	145.46	2.50	14.60	0.13	28.54	5.81	1.96	1.00
WWGM0539	WWMJ120013	WWMJ120012	299.8	0.013	161.35	160.47	1.00	1.93	0.29	1.40	2.52	0.72	0.67
WWGM0540	WWMI131013	WWMI131012	332.9	0.013	156.32	154.97	1.25	4.11	0.41	5.48	4.47	1.33	1.00
WWGM0546	WWMJ120048	WWMJ120010	298.8	0.013	159.33	153.40	1.00	5.02	1.98	1.40	5.47	0.28	0.36
WWGM0555	WWMI131010	WWMI131009	382.6	0.013	153.52	152.35	1.25	3.57	0.31	5.48	4.47	1.54	1.00
WWGM0556	WWMJ120026	WWMJ120032	469.1	0.013	174.41	173.94	0.67	0.38	0.10	0.66	2.23	1.72	0.79
WWGM0558	WWMI131023	WWMI131022	389.7	0.013	166.71	166.12	1.25	2.51	0.15	4.39	3.89	1.75	1.00
WWGM0559	WWMI131021	WWMI131020	444.1	0.013	163.74	162.05	1.25	3.99	0.38	4.39	3.70	1.10	1.00
WWGM0565	WWMJ120042	WWMJ120041	243.6	0.013	153.34	146.17	0.83	3.76	2.94	0.95	5.74	0.25	0.34
WWGM0569	WWMK120009	WWMK120008	256.7	0.013	156.94	155.59	0.83	1.59	0.53	0.61	2.77	0.38	0.42
WWGM0580	WWMI131025	WWMI131024	397.1	0.013	169.55	168.16	1.25	3.82	0.35	3.65	3.37	0.96	1.00
WWGM0583	WWMI131020	WWMI131111	300.8	0.013	161.93	161.03	1.25	3.53	0.30	4.39	3.57	1.24	1.00
WWGM0584	WWMJ120035	WWMJ120034	182.1	0.013	126.31	125.09	1.00	2.92	0.67	1.00	3.36	0.34	0.40
WWGM0597	WWMJ120041	WWMJ120040	68.6	0.013	146.02	143.82	0.83	3.93	3.21	0.96	5.95	0.25	0.34
WWGM0598	WWMJ120024	WWMJ120023	299.3	0.013	177.01	172.94	0.83	2.56	1.36	0.65	3.91	0.25	0.34
WWGM0600	WWMJ120040	WWMJ120039	69.7	0.013	143.48	141.44	0.83	3.75	2.93	0.96	5.76	0.26	0.35
WWGM0601	WWMJ120014	WWMJ120013	300.3	0.013	162.10	161.35	1.00	1.78	0.25	1.40	2.56	0.79	0.66
WWGM0602	WWMJ120027	WWMJ120025	274.0	0.013	176.14	175.10	0.67	0.74	0.38	0.66	2.46	0.88	0.96

Existing System Flows, 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM0604	WWMI131011	WWMI131010	248.7	0.013	154.68	153.66	1.25	4.14	0.41	5.48	4.47	1.33	1.00
WWGM0608	WWMH146003	WWMH146002	355.4	0.013	144.27	143.74	2.50	15.84	0.15	28.54	5.81	1.80	1.00
WWGM0612	WWMJ120018	WWMJ120017	36.1	0.013	135.90	122.53	2.00	142.74	39.81	0.00	0.00	0.00	0.04
WWGM0617	WWMJ120009	WWMJ120014	334.7	0.013	163.22	162.43	1.00	1.73	0.24	1.40	2.73	0.81	0.62
WWGM0651	WWMH114036	WWMH114035	142.3	0.013	193.10	192.59	1.00	2.13	0.36	0.85	2.70	0.40	0.42
WWGM0652	WWMH114037	WWMH114036	269.2	0.013	194.33	193.69	1.00	1.74	0.24	0.84	2.41	0.48	0.45
WWGM0653	WWMH114035	WWMH114033	401.0	0.013	192.53	191.06	1.00	2.16	0.37	0.85	2.72	0.40	0.42
WWGM0654	WWMH114033	WWMH114031	501.1	0.013	190.84	180.52	0.83	3.14	2.06	0.86	3.32	0.27	0.68
WWGM0661	WWMH114031	WWMH114030	331.2	0.013	180.15	177.84	0.67	1.01	0.70	1.77	5.06	1.75	1.00
WWGM0682	WWMI102001	WWMI112000	311.0	0.013	197.52	196.80	0.83	1.05	0.23	2.05	4.01	1.94	0.88
WWGM0691	WWMH114039	WWMH114038	385.7	0.013	208.10	201.86	0.83	2.79	1.62	0.82	4.45	0.30	0.37
WWGM0696	WWMH104041	WWMH104040	127.4	0.013	210.12	209.95	1.00	1.30	0.13	0.82	2.24	0.63	0.47
WWGM0699	WWMI112000	WWMI111099	35.8	0.013	196.52	196.17	0.83	2.17	0.98	2.05	4.30	0.95	0.82
WWGM0700	WWMI102003	WWMI102002	479.9	0.013	199.90	198.72	0.83	1.09	0.25	2.05	3.76	1.89	1.00
WWGM0711	WWMH104042	WWMH104041	314.4	0.013	211.37	210.45	1.00	1.93	0.29	0.78	2.50	0.41	0.42
WWGM0716	WWMH114038	WWMH114037	386.6	0.013	201.80	194.53	0.83	3.00	1.88	0.83	4.45	0.27	0.37
WWGM0717	WWMI102002	WWMI102001	342.7	0.013	198.62	197.76	0.83	1.10	0.25	2.05	3.76	1.87	1.00
WWGM0723	WWMH104040	WWMH114039	92.9	0.013	209.84	208.22	1.00	4.71	1.74	0.82	4.50	0.17	0.28
WWGM0734	WWMH104044	WWMH104043	421.9	0.013	214.86	213.33	1.00	2.15	0.36	0.76	2.63	0.36	0.40
WWGM0756	WWMH104011	WWMH104010	218.1	0.013	150.77	150.31	1.00	1.64	0.21	1.33	2.57	0.81	1.00
WWGM0760	WWMH104009	WWMH104008	208.7	0.013	148.29	146.88	1.00	2.93	0.68	1.33	2.81	0.45	1.00
WWGM0761	WWMH104010	WWMH104009	80.7	0.013	150.28	148.29	1.00	5.59	2.47	1.33	3.52	0.24	1.00
WWGM0762	WWMH104012	WWMH104011	194.5	0.013	151.90	150.79	1.00	2.69	0.57	1.31	2.71	0.49	1.00
WWGM0763	WWMG89187	WWMG89186	177.2	0.013	221.07	220.81	0.83	0.84	0.15	0.87	2.29	1.04	0.66
WWGM0801	WWMF99008	WWMF99007	81.6	0.013	178.31	178.07	1.00	1.93	0.29	2.91	3.71	1.51	1.00
WWGM0802	WWMF99011	WWMF99009	299.7	0.013	180.34	179.40	1.00	2.00	0.31	2.86	3.64	1.43	1.00
WWGM0826	WWMF99014	WWMF99013	273.8	0.013	188.32	186.28	0.83	1.89	0.74	2.74	5.05	1.45	1.00
WWGM0846	WWMF89021	WWMF89020	143.4	0.013	201.22	200.31	0.67	0.96	0.63	0.94	3.29	0.98	0.77
WWGM0855	WWMF99015	WWMF99014	137.3	0.013	189.24	188.44	0.83	1.67	0.58	2.74	5.03	1.64	1.00
WWGM0863	WWMG99101	WWMG99100	364.6	0.013	204.69	197.49	1.75	22.27	1.97	4.09	7.05	0.18	0.29
WWGM0867	WWMG89258	WWMG99105	356.9	0.013	214.58	212.84	1.50	7.33	0.49	4.22	4.37	0.58	0.54
WWGM0870	WWMG89259	WWMG89258	281.6	0.013	216.37	214.94	1.50	7.49	0.51	4.24	4.42	0.57	0.53
WWGM0880	WWMF89019	WWMF99152	352.5	0.013	199.16	197.43	0.67	0.85	0.49	0.94	3.00	1.11	0.85
WWGM0882	WWMF99152	WWMF99018	123.2	0.013	195.57	194.64	0.67	1.05	0.75	0.96	3.49	0.91	0.91
WWGM0884	WWMF89160	WWMF89022	378.6	0.013	204.27	201.78	0.67	0.98	0.66	0.90	2.59	0.92	1.00
WWGM0896	WWMG99100	WWMG99099	270.4	0.013	197.15	192.18	1.75	21.48	1.84	4.11	6.89	0.19	0.30
WWGM0898	WWMF89020	WWMF89019	15.5	0.013	200.18	199.28	0.67	2.91	5.82	0.94	5.09	0.32	0.70
WWGM0917	WWMG99102	WWMG99101	363.5	0.013	208.50	204.83	1.75	15.92	1.01	4.11	5.55	0.26	0.35
WWGM0940	WWMF89025	WWMF89024	268.4	0.013	212.45	208.40	0.67	1.48	1.51	0.85	4.40	0.57	0.54
WWGM0953	WWMG89189	WWMG89187	214.5	0.013	222.20	221.48	0.83	1.27	0.34	0.87	2.71	0.69	0.57
WWGM0991	WWMF99012	WWMF99011	60.3	0.013	180.58	180.41	1.00	1.89	0.28	2.86	3.64	1.51	1.00
WWGM0992	WWMF99013	WWMF99012	275.8	0.013	186.08	180.65	1.00	5.00	1.97	2.79	4.18	0.56	1.00
WWGM0993	WWMF89023	WWMF89160	85.0	0.013	205.30	204.46	0.67	1.20	0.98	0.90	3.73	0.75	0.96
WWGM0996	WWMF89026	WWMF89025	34.1	0.013	213.74	212.80	0.67	2.01	2.76	0.85	5.52	0.42	0.46
WWGM0998	WWMF89024	WWMF89023	240.0	0.013	208.19	205.30	0.67	1.33	1.21	0.89	3.88	0.67	0.76
WWGM1005	WWMF99009	WWMF99008	233.4	0.013	179.26	178.50	1.00	2.03	0.33	2.90	3.70	1.43	1.00
WWGM1033	WWMG89193	WWMG89192	152.0	0.013	228.02	226.44	0.83	2.23	1.04	0.87	3.84	0.39	0.43
WWGM1035	WWMG89192	WWMG89189	364.7	0.013	226.02	224.07	0.83	1.60	0.53	0.87	3.08	0.54	0.51
WWGM1039	WWMG89186	WWMG89185	115.6	0.013	220.50	220.14	0.83	1.22	0.31	0.88	2.39	0.72	0.93
WWGM1045	WWMH105017	WWMH105005	193.4	0.013	163.31	162.19	1.00	2.71	0.58	1.21	3.37	0.45	0.47
WWGM1046	WWMH105005	WWMH105004	264.4	0.013	162.03	160.05	1.00	3.08	0.75	1.23	3.70	0.40	0.44
WWGM1047	WWMH105004	WWMH105003	275.1	0.013	160.00	157.72	1.00	3.24	0.83	1.23	3.85	0.38	0.43
WWGM1051	WWMH105003	WWMH105002	277.9	0.013	157.69	155.42	1.00	3.22	0.82	1.24	3.75	0.39	0.44
WWGM1052	WWMH105002	WWMH105001	341.6	0.013	155.42	152.93	1.00	3.04	0.73	1.24	3.68	0.41	0.72
WWGM1053	WWMH105001	WWMH104012	61.1	0.013	152.88	151.90	1.00	4.51	1.61	1.31	3.97	0.29	1.00
WWGM1054	WWMI102066	WWMI111099	425.2	0.013	203.23	196.17	1.00	4.59	1.66	1.40	3.46	0.31	0.55

Existing System Flows, 5-year, 24-hour storm event

		Input						Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1055	WWMI102067	WWMI102066	153.3	0.013	208.13	205.74	1.00	4.45	1.56	1.40	5.01	0.31	0.38
WWGM1056	WWMI102068	WWMI102067	295.6	0.013	212.88	208.27	1.00	4.45	1.56	1.39	5.01	0.31	0.38
WWGM1060	WWMI102069	WWMI102068	254.8	0.013	213.72	213.18	1.00	1.64	0.21	1.37	2.68	0.83	0.62
WWGM1061	WWMI102070	WWMI102069	123.0	0.013	214.21	213.73	1.00	2.23	0.39	1.37	2.53	0.61	0.65
WWGM1062	WWMI102071	WWMI102070	42.2	0.013	214.40	214.31	1.00	1.65	0.21	1.36	3.00	0.82	0.56
WWGM1069	WWMI102073	WWMI102072	115.9	0.013	218.21	216.84	0.83	2.38	1.18	1.34	4.50	0.56	0.54
WWGM1070	WWMI102131	WWMI102073	126.5	0.013	219.28	218.55	0.83	1.66	0.58	1.33	3.52	0.80	0.66
WWGM1071	WWMI102132	WWMI102131	195.8	0.013	220.88	219.42	0.83	1.89	0.75	0.69	2.78	0.37	0.47
WWGM1072	WWMI104051	WWMI102132	58.5	0.013	222.06	221.22	1.50	12.59	1.44	0.69	3.82	0.06	0.16
WWGM1075	WWMH95019	WWMH95018	134.7	0.013	166.45	165.40	1.50	9.29	0.78	1.20	3.62	0.13	0.24
WWGM1076	WWMH95020	WWMH95019	346.9	0.013	169.94	166.45	1.50	10.53	1.00	1.20	3.78	0.11	0.24
WWGM1077	WWMH95021	WWMH95020	218.5	0.013	187.21	170.61	1.50	29.00	7.62	1.20	8.08	0.04	0.14
WWGM1080	WWMH95022	WWMH95021	259.8	0.013	190.07	187.35	1.50	10.75	1.05	1.19	4.01	0.11	0.23
WWGM1081	WWMH95023	WWMH95022	376.0	0.013	191.85	190.15	1.50	7.06	0.45	1.19	3.01	0.17	0.28
WWGM1082	WWMH95024	WWMH95023	157.0	0.013	192.85	191.99	1.50	7.77	0.55	1.18	3.18	0.15	0.26
WWGM1090	WWMI92151	WWMI92152	344.6	0.013	225.75	224.65	1.50	5.94	0.32	0.69	2.37	0.12	0.22
WWGM1091	WWMI92150	WWMI92151	107.8	0.013	229.75	226.53	1.50	18.16	2.99	0.67	4.90	0.04	0.13
WWGM1104	WWMI92147	WWMI92148	349.7	0.013	243.47	242.07	1.50	6.65	0.40	0.67	2.49	0.10	0.21
WWGM1105	WWMI92148	WWMI92149	281.5	0.013	241.52	237.17	1.50	13.06	1.55	0.67	3.89	0.05	0.15
WWGM1106	WWMI92149	WWMI92150	500.5	0.013	236.97	229.90	1.50	12.49	1.41	0.67	3.77	0.05	0.16
WWGM1107	WWMI92161	WWMI92159	465.0	0.013	249.58	248.23	1.25	3.48	0.29	0.05	1.08	0.01	0.08
WWGM1108	WWMI92159	WWMI92158	128.4	0.013	248.10	247.76	1.25	3.32	0.26	0.05	1.06	0.01	0.08
WWGM1109	WWMI92158	WWMI92157	403.4	0.013	247.11	245.75	1.25	3.75	0.34	0.05	1.13	0.01	0.07
WWGM1110	WWMI92157	WWMI92156	182.5	0.013	245.57	245.13	1.25	3.17	0.24	0.05	1.02	0.01	0.08
WWGM1111	WWMI92156	WWMI92147	203.0	0.013	244.65	243.61	1.25	4.62	0.51	0.05	1.27	0.01	0.11
WWGM1113	WWMI81	WWMI92143	411.7	0.013	268.14	257.94	1.00	5.61	2.48	0.64	4.75	0.11	0.23
WWGM1114	WWMI92143	WWMI92144	108.8	0.013	257.49	256.50	1.00	3.40	0.91	0.64	3.32	0.19	0.29
WWGM1116	WWMI92144	WWMI92146	160.8	0.013	256.47	254.96	1.00	3.45	0.94	0.64	1.21	0.19	0.64
WWGM1117	WWMI92146	WWMI92147	136.7	0.013	254.54	255.51	1.00	3.00	0.71	0.64	1.17	0.21	0.66
WWGM1119	WWMH95018	WWMH105017	341.9	0.013	165.10	163.46	1.00	2.47	0.48	1.21	3.22	0.49	0.48
WWGM1129	WWMI102072	WWMI102071	423.4	0.013	216.64	214.42	1.00	2.58	0.52	1.35	2.99	0.52	0.56
WWGM1131	WWMI92152	WWMI104050	237.8	0.013	223.96	222.64	1.50	7.83	0.56	0.69	2.73	0.09	0.20
WWGM1132	WWMI104050	WWMI104051	65.3	0.013	222.32	222.24	1.50	3.68	0.12	0.69	2.08	0.19	0.24
WWGM1164	WWMJ111094	WWMJ111103	264.2	0.013	177.95	177.19	1.00	1.91	0.29	0.65	2.37	0.34	0.38
WWGM1165	WWMJ111047	WWMJ120027	138.4	0.013	176.73	176.33	0.67	0.65	0.29	0.66	2.45	1.01	0.74
WWGM1167	WWMJ111043	WWMJ120024	300.3	0.013	184.33	177.46	0.83	3.31	2.29	0.65	4.71	0.20	0.30
WWGM1168	WWMJ111056	WWMJ111043	236.2	0.013	191.76	184.80	0.83	3.76	2.95	0.65	5.16	0.17	0.28
WWGM1176	WWMJ120060	WWMJ120037	175.6	0.013	136.72	132.73	0.83	3.30	2.27	0.99	5.29	0.30	0.38
WWGM1194	WWMJ120015	WWMJ120001	129.3	0.013	164.04	163.96	1.00	0.89	0.06	0.00	0.00	0.00	0.01
WWGM1200	WWMH136249	WWMH136248	255.9	0.013	157.01	156.62	0.83	0.86	0.15	1.03	1.89	1.21	1.00
WWGM1201	WWMH136248	WWMH136247	334.1	0.013	156.42	155.89	0.83	0.87	0.16	2.05	3.76	2.35	1.00
WWGM1202	WWMH136247	WWMH146246	312.0	0.013	155.57	154.41	0.83	1.34	0.37	2.05	4.02	1.54	0.89
WWGM1204	WWMH146006	WWMH146005	259.1	0.013	146.57	146.06	2.50	18.20	0.20	28.52	5.81	1.57	1.00
WWGM1205	WWMH146246	WWMH146006	62.4	0.013	153.93	149.33	0.83	5.96	7.39	2.06	9.83	0.35	0.70
WWGM1206	WWMI131018	WWMI131017	61.3	0.013	158.73	158.05	1.25	6.80	1.11	4.40	5.65	0.65	1.00
WWGM1218	WWMH146007	WWMH146006	489.6	0.013	147.71	146.63	2.50	19.26	0.22	26.65	5.43	1.38	1.00
WWGM1234	WWMF109006	WWMF109005	292.6	0.013	175.99	173.63	1.00	3.20	0.81	3.13	4.46	0.98	1.00
WWGM1236	WWMF99007	WWMF109006	290.0	0.013	177.87	176.84	1.00	2.12	0.36	3.11	4.00	1.46	1.00
WWGM1242	WWMG108011	WWMG108010	145.8	0.013	181.53	181.43	1.00	0.93	0.07	0.51	2.27	0.55	0.42
WWGM1244	WWMG109046	WWMG108080	372.6	0.013	179.31	178.79	1.75	5.92	0.14	4.00	3.02	0.68	1.00
WWGM1245	WWMG108009	WWMG108008	368.6	0.013	180.80	179.80	1.00	1.86	0.27	0.51	2.17	0.28	0.75
WWGM1246	WWMG108010	WWMG108009	155.3	0.013	181.43	180.86	1.00	2.16	0.37	0.51	2.32	0.24	0.37
WWGM1247	WWMG108008	WWMG108080	32.5	0.013	179.75	179.04	1.00	5.27	2.18	0.83	4.27	0.16	1.00
WWGM1248	WWMG108080	WWMG118086	202.1	0.013	178.59	178.22	1.75	6.78	0.18	4.41	3.37	0.65	1.00
WWGM1249	WWMG108007	WWMG108006	411.5	0.013	178.60	178.44	1.00	0.70	0.04	0.03	0.48	0.04	0.12
WWGM1252	WWMF127016	WWMF127015	14.4	0.013	154.81	153.41	1.25	20.21	9.79	2.67	4.34	0.13	0.51

Existing System Flows, 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1253	WWMF127014	WWMF127013	423.4	0.013	152.96	152.22	1.25	2.70	0.17	2.74	2.91	1.01	0.72
WWGM1254	WWMF127013	WWMF127012	60.6	0.013	152.22	151.92	1.25	4.55	0.50	2.73	3.28	0.60	0.64
WWGM1255	WWMF127012	WWMF127011	403.9	0.013	151.90	150.91	1.25	3.20	0.25	2.77	3.01	0.86	0.70
WWGM1264	J-250_SHER_BASEFLOW	F118029	40.0	0.013	138.76	138.60	0.67	0.76	0.40	0.01	0.79	0.01	0.07
WWGM1266	WWMF127017	WWMF127016	310.0	0.013	156.17	155.05	1.25	3.88	0.36	2.67	3.62	0.69	0.58
WWGM1272	WWMF127044	WWMF127007	515.5	0.013	157.16	148.58	0.67	1.56	1.66	0.03	1.22	0.02	0.55
WWGM1273	J-260_CHAR_BASEFLOW	F137193	20.0	0.013	146.92	146.60	0.67	1.53	1.60	0.07	2.27	0.05	0.15
WWGM1289	WWMF137072	F137204	13.8	0.013	109.76	108.50	1.50	31.83	9.18	2.83	9.64	0.09	0.23
WWGM1290	WWMF137001	WWMF137072	126.8	0.013	125.96	110.35	1.50	36.99	12.40	2.79	12.30	0.08	0.19
WWGM1291	WWMF137002	WWMF137001	97.3	0.013	132.89	126.51	1.50	26.93	6.57	2.79	9.84	0.10	0.22
WWGM1292	WWMF137003	WWMF137002	348.1	0.013	144.94	133.22	1.50	19.28	3.37	2.79	7.76	0.14	0.26
WWGM1293	WWMF137004	WWMF137003	112.0	0.013	147.00	146.31	1.25	5.07	0.62	2.78	4.22	0.55	0.53
WWGM1294	WWMF137005	WWMF137004	334.5	0.013	147.32	147.10	1.25	1.66	0.07	2.78	2.75	1.68	0.77
WWGM1304	WWMG136067	WWMG136066	318.9	0.013	161.45	160.79	1.00	1.62	0.21	2.03	2.59	1.25	1.00
WWGM1306	WWMG136068	WWMG136067	324.9	0.013	162.01	161.46	1.00	1.47	0.17	1.06	1.44	0.72	1.00
WWGM1307	WWMG136069	WWMG136068	15.2	0.013	162.03	162.06	1.00	1.58	0.20	1.02	1.96	0.65	1.00
WWGM1308	WWMG136070	WWMG136069	238.7	0.013	162.60	162.23	1.00	1.40	0.15	1.01	2.17	0.72	1.00
WWGM1309	WWMG126098	WWMG136070	350.4	0.013	163.54	162.65	1.00	1.80	0.25	0.57	1.35	0.32	1.00
WWGM1313	WWMG126237	WWMG126236	363.7	0.013	161.43	160.29	1.75	8.87	0.31	11.09	4.61	1.25	1.00
WWGM1314	WWMG126238	WWMG126237	243.2	0.013	162.28	161.50	1.75	8.97	0.32	11.10	4.61	1.24	1.00
WWGM1316	WWMG126236	WWMG136260	371.1	0.013	158.58	157.50	1.75	8.55	0.29	11.10	4.62	1.30	1.00
WWGM1318	WWMG136064	WWMG136021	266.7	0.013	159.97	158.79	1.00	2.37	0.44	2.05	3.16	0.86	1.00
WWGM1319	WWMG136260	WWMG136019	27.7	0.013	157.00	157.13	1.75	10.86	0.47	11.11	4.62	1.02	1.00
WWGM1320	WWMG136019	WWMG136018	355.3	0.013	156.83	156.60	1.75	4.03	0.06	11.12	4.62	2.76	1.00
WWGM1321	WWMG136021	WWMG136019	18.6	0.013	158.68	157.07	1.50	30.99	8.70	1.78	1.99	0.06	1.00
WWGM1323	WWMG136054	WWMG136053	357.5	0.013	158.95	157.87	1.25	3.55	0.30	3.50	3.02	0.99	1.00
WWGM1324	WWMG136018	WWMG136017	353.6	0.013	156.39	155.92	1.75	5.78	0.13	10.43	4.34	1.81	1.00
WWGM1325	WWMG136016	WWMG136015	308.7	0.013	155.01	154.14	2.25	16.44	0.28	19.22	5.15	1.17	1.00
WWGM1326	WWMG136035	WWMG136016	273.2	0.013	157.45	156.86	1.25	3.00	0.22	3.83	3.31	1.28	1.00
WWGM1330	WWMG136015	WWMG146014	301.7	0.013	153.68	152.93	2.25	15.44	0.25	19.24	5.36	1.25	1.00
WWGM1331	WWMG136050	WWMG146078	299.1	0.013	155.69	155.03	1.25	3.03	0.22	4.79	3.91	1.58	1.00
WWGM1338	WWMH146247	WWMH146008	500.0	0.013	148.89	148.71	2.50	7.78	0.04	26.65	5.43	3.42	1.00
WWGM1339	WWMH146008	WWMH146007	492.1	0.013	148.65	147.73	2.50	17.73	0.19	26.65	5.43	1.50	1.00
WWGM1341	WWMG136020	WWMG136016	17.1	0.013	155.24	155.16	1.75	10.83	0.47	13.69	5.69	1.26	1.00
WWGM1342	WWMG136051	WWMG136050	311.8	0.013	156.25	155.69	1.25	2.74	0.18	4.61	3.76	1.68	1.00
WWGM1352	WWMG137193	WWMG136051	365.9	0.013	157.07	156.25	1.25	3.06	0.22	4.60	3.75	1.51	1.00
WWGM1353	WWMG136053	WWMG137193	351.0	0.013	157.74	157.09	1.25	2.78	0.19	4.18	3.41	1.50	1.00
WWGM1355	WWMG136017	WWMG136020	350.6	0.013	155.82	155.44	1.75	5.22	0.11	11.93	4.96	2.29	1.00
WWGM1356	WWMG126239	WWMG126238	402.9	0.013	163.94	162.54	1.75	9.34	0.35	11.09	4.73	1.19	1.00
WWGM1358	WWMG126240	WWMG126239	136.0	0.013	165.66	164.18	1.75	16.53	1.09	11.10	6.12	0.67	1.00
WWGM1368	WWMG126102	WWMG127188	280.1	0.013	164.40	163.76	1.00	1.70	0.23	0.51	1.21	0.30	1.00
WWGM1369	WWMG127188	WWMG126098	394.2	0.013	163.75	163.69	1.00	0.44	0.02	0.53	1.29	1.21	1.00
WWGM1371	WWMF127118	WWMF127117	137.1	0.013	168.96	168.71	0.83	0.94	0.18	1.09	2.00	1.17	1.00
WWGM1372	WWMF127117	WWMF127116	260.2	0.013	168.63	168.33	0.83	0.74	0.12	1.10	2.23	1.48	1.00
WWGM1373	WWMF127116	WWMF127115	383.8	0.013	168.23	167.52	1.00	1.53	0.18	1.26	2.26	0.82	1.00
WWGM1378	WWMF127008	WWMF127007	264.7	0.013	149.01	148.58	1.25	2.60	0.16	2.76	2.73	1.06	0.77
WWGM1379	WWMF127007	WWMF137006	197.4	0.013	148.57	148.06	1.25	3.28	0.26	2.79	2.89	0.85	0.76
WWGM1380	WWMF137006	WWMF137005	304.8	0.013	148.06	147.32	1.25	3.18	0.24	2.78	2.38	0.87	0.91
WWGM1381	WWMF127011	WWMF127010	262.6	0.013	150.90	150.14	1.25	3.48	0.29	2.76	3.17	0.80	0.67
WWGM1382	WWMF127010	WWMF127009	188.0	0.013	150.14	149.57	1.25	3.56	0.30	2.76	3.02	0.78	0.70
WWGM1383	WWMF127009	WWMF127008	256.2	0.013	149.42	149.01	1.25	2.58	0.16	2.76	2.49	1.07	0.85
WWGM1389	WWMG137106	WWMG136039	319.7	0.013	161.89	161.27	1.25	2.84	0.19	2.50	2.64	0.88	1.00
WWGM1390	WWMG136039	WWMG136038	487.1	0.013	161.22	160.06	1.25	3.15	0.24	2.55	2.77	0.81	1.00
WWGM1401	WWMF127203	WWMF127118	309.4	0.013	169.66	169.21	0.83	0.84	0.15	1.08	2.18	1.29	1.00
WWGM1402	WWMF127220	WWMF127203	279.8	0.013	170.34	169.81	0.83	0.95	0.19	1.07	2.09	1.12	1.00
WWGM1403	WWMF127119	WWMF127220	6.1	0.013	170.40	170.39	0.83	0.89	0.16	1.06	2.16	1.20	1.00

Existing System Flows, 5-year, 24-hour storm event

	Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1411	WWMF117018	WWMF127017	299.9	0.013	157.50	157.45	1.25	0.83	0.02	2.65	2.65	3.18	0.76
WWGM1419	WWMF117021	WWMF117020	303.3	0.013	160.66	159.88	1.25	3.28	0.26	2.50	2.95	0.76	0.66
WWGM1420	WWMF117022	WWMF117021	299.7	0.013	161.98	160.74	1.25	4.15	0.41	2.49	3.42	0.60	0.57
WWGM1422	WWMF117023	WWMF117022	323.4	0.013	163.58	162.10	1.25	4.37	0.46	2.49	3.79	0.57	0.53
WWGM1442	WWMG89194	WWMG89193	242.3	0.013	234.52	232.09	0.83	2.19	1.00	0.84	3.76	0.38	0.43
WWGM1447	WWMG79195	WWMG89194	361.0	0.013	240.18	234.89	1.00	4.31	1.47	0.83	4.24	0.19	0.30
WWGM1448	WWMG79196	WWMG79195	87.5	0.013	240.58	240.31	0.83	1.22	0.31	0.83	2.69	0.68	0.55
WWGM1449	WWMG79244	WWMG79196	136.6	0.013	241.37	240.83	0.83	1.38	0.40	0.83	2.82	0.60	0.53
WWGM1451	WWMG79245	WWMG79244	130.4	0.013	242.09	241.67	0.83	1.24	0.32	0.83	2.68	0.67	0.55
WWGM1452	WWMG79246	WWMG79245	103.7	0.013	242.45	242.24	0.83	0.99	0.20	0.83	2.48	0.84	0.59
WWGM1462	WWMF79030	WWMF79029	22.4	0.013	217.37	216.90	0.67	1.75	2.10	0.83	3.14	0.47	1.00
WWGM1463	WWMF79031	WWMF79030	108.5	0.013	218.07	217.49	0.67	0.88	0.53	0.82	3.05	0.93	0.81
WWGM1464	WWMG79032	WWMF79031	93.8	0.013	218.21	218.07	0.67	0.47	0.15	0.82	2.53	1.77	0.89
WWGM1465	WWMG79033	WWMG79032	338.1	0.013	222.83	218.65	0.67	1.34	1.24	0.79	4.00	0.59	0.55
WWGM1470	WWMF89022	WWMF89021	316.5	0.013	201.60	201.25	0.67	0.40	0.11	0.90	2.74	2.25	0.90
WWGM1476	WWMF79029	WWMF79028	79.0	0.013	216.75	216.67	0.67	0.38	0.10	0.83	2.38	2.16	1.00
WWGM1477	WWMF79028	WWMF89027	318.4	0.013	216.32	215.51	0.67	0.61	0.25	0.84	2.73	1.38	0.83
WWGM1480	WWMF89027	WWMF89026	129.8	0.013	215.21	213.96	0.67	1.19	0.96	0.85	3.70	0.72	0.63
WWGM1481	WWMG79034	WWMG79033	192.5	0.013	224.69	223.14	0.67	1.08	0.81	0.79	3.39	0.73	0.63
WWGM1529	WWMG99105	WWMG99104	313.1	0.013	212.56	210.77	1.50	7.94	0.57	4.19	4.55	0.53	0.52
WWGM1534	WWMG99104	WWMG99102	343.8	0.013	210.39	208.69	1.75	11.14	0.49	4.14	4.29	0.37	0.42
WWGM1539	J-240_CREEK_BASEFLOW	F109157	40.0	0.013	165.97	165.77	0.67	0.85	0.50	0.02	1.25	0.02	0.10
WWGM1547	WWMF109005	WWMF109004	286.3	0.013	173.61	171.64	1.00	2.96	0.69	3.15	4.01	1.07	1.00
WWGM1548	WWMF109040	WWMF109005	312.3	0.013	174.77	173.63	1.00	2.15	0.37	0.34	0.78	0.16	1.00
WWGM1551	WWMF109153	WWMF118026	185.5	0.013	166.55	166.13	1.25	3.07	0.23	3.34	3.30	1.09	1.00
WWGM1552	WWMF109000	WWMF109153	150.9	0.013	167.20	166.64	1.25	3.94	0.37	3.31	3.34	0.84	1.00
WWGM1553	WWMF109001	WWMF109000	19.1	0.013	167.76	167.35	1.25	9.47	2.15	4.08	5.45	0.43	1.00
WWGM1554	WWMF109150	WWMF109001	118.9	0.013	168.21	167.81	1.00	2.07	0.34	3.30	4.23	1.60	1.00
WWGM1555	WWMF109002	WWMF109150	98.1	0.013	168.39	168.17	1.00	1.69	0.22	3.30	4.20	1.96	1.00
WWGM1557	WWMF109003	WWMF109002	144.6	0.013	169.02	168.82	1.00	1.33	0.14	3.28	4.18	2.48	1.00
WWGM1560	WWMF109004	WWMF109003	439.3	0.013	171.53	170.03	1.00	2.08	0.34	3.28	4.18	1.58	1.00
WWGM1564	WWMF117024	WWMF117023	30.3	0.013	163.87	163.98	1.25	3.89	0.36	0.22	0.79	0.06	0.28
WWGM1565	WWMF117025	J-280_HWY240_WEIR	145.5	0.013	164.41	164.00	1.00	1.89	0.28	3.39	4.56	1.79	0.95
WWGM1566	WWMF117026	WWMF117025	205.2	0.013	164.30	164.49	1.25	1.97	0.09	3.39	2.76	1.72	1.00
WWGM1567	WWMF117027	WWMF117026	309.7	0.013	165.11	164.50	1.25	2.87	0.20	3.39	2.76	1.18	1.00
WWGM1568	WWMF117028	WWMF117027	109.5	0.013	165.19	165.27	1.25	1.75	0.07	3.38	2.75	1.94	1.00
WWGM1569	WWMF118001	WWMF117028	7.0	0.013	165.39	165.49	1.00	4.25	1.42	0.07	0.35	0.02	1.00
WWGM1570	WWMF118002	WWMF118001	97.7	0.013	165.74	165.59	1.00	1.40	0.15	0.07	0.60	0.05	1.00
WWGM1571	WWMF118026	WWMF117028	157.5	0.013	165.75	165.44	1.25	2.87	0.20	3.36	2.74	1.17	1.00
WWGM1572	WWMF118025	WWMF118026	63.1	0.013	166.25	166.13	0.83	0.96	0.19	0.11	0.72	0.11	1.00
WWGM1573	WWMF118024	WWMF118025	90.1	0.013	167.53	166.28	0.83	2.58	1.39	0.10	1.43	0.04	0.95
WWGM1574	WWMF118023	WWMF118024	104.3	0.013	169.65	167.58	0.83	3.09	1.98	0.03	1.75	0.01	0.45
WWGM1575	WWMF118003	WWMF118023	80.8	0.013	170.44	169.70	0.83	2.10	0.92	0.05	1.62	0.02	0.11
WWGM1590	WWMG137107	WWMG136095	352.4	0.013	162.99	162.63	1.25	2.06	0.10	2.43	2.24	1.18	1.00
WWGM1591	WWMG137183	WWMG137107	20.2	0.013	163.12	163.09	1.25	2.49	0.15	2.45	2.26	0.98	1.00
WWGM1592	WWMG127109	WWMG137183	378.9	0.013	163.83	163.22	1.25	2.59	0.16	2.43	2.42	0.94	1.00
WWGM1603	WWMG127133	WWMF127115	158.0	0.013	168.63	167.52	0.83	1.84	0.70	0.24	1.09	0.13	1.00
WWGM1604	WWMF127115	WWMG127114	114.6	0.013	167.50	165.93	1.00	4.17	1.37	2.37	5.27	0.57	1.00
WWGM1605	WWMG127110	WWMG127109	258.2	0.013	164.26	163.91	1.25	2.38	0.14	2.37	2.38	1.00	1.00
WWGM1606	WWMG126200	WWMG127110	395.2	0.013	164.87	164.33	1.25	2.39	0.14	2.36	2.27	0.99	1.00
WWGM1607	WWMG127114	WWMG126200	144.7	0.013	165.69	164.97	1.00	2.51	0.50	2.36	3.27	0.94	1.00
WWGM1614	WWMG126147	WWMG127195	520.6	0.013	174.04	167.46	0.83	2.46	1.26	0.26	0.65	0.11	0.95
WWGM1617	WWMG108006	WWMG108005	410.2	0.013	178.43	177.32	1.00	1.85	0.27	0.03	0.91	0.01	0.08
WWGM1618	WWMG108005	WWMG118004	141.8	0.013	177.08	174.65	0.83	2.87	1.71	0.03	1.63	0.01	0.07
WWGM1619	WWMG118004	WWMF118003	276.8	0.013	174.35	170.49	0.83	2.59	1.39	0.03	1.52	0.01	0.07
WWGM1639	WWMH131082	WWMH131081	491.9	0.013	110.06	108.31	1.25	3.85	0.36	5.53	4.50	1.43	1.00

Existing System Flows, 5-year, 24-hour storm event

Input								Output					
Pipe ID	**Upstream MH**	**Downstream MH**	**Length (ft)**	**Roughness**	**US Invert (ft)**	**DS Invert (ft)**	**Diameter (ft)**	**Full Flow (cfs)**	**Slope (%)**	**Max Flow (cfs)**	**Max Velocity (ft/s)**	**Max.Flow/Full Flow**	**Max.Depth/Full Depth**
WWGM1641	WWMH131083	WWMH131082	431.1	0.013	111.72	110.18	1.25	3.86	0.36	5.16	4.21	1.34	1.00
WWGM1642	WWMH133096	WWMH131083	28.8	0.013	114.54	113.17	1.50	22.92	4.76	5.16	9.77	0.23	1.00
WWGM1643	WWMH133000	WWMH133096	8.6	0.013	115.16	114.79	1.50	21.85	4.33	6.37	8.33	0.29	1.00
WWGM1644	WWMH133001	WWMH133096	178.1	0.013	116.99	114.79	1.00	3.96	1.24	1.23	3.31	0.31	1.00
WWGM1645	WWMH133002	WWMH133001	137.9	0.013	117.76	116.99	1.00	2.66	0.56	1.87	2.89	0.70	1.00
WWGM1646	WWMH133066	WWMH133000	199.1	0.013	116.27	115.71	1.50	5.57	0.28	6.36	3.89	1.14	1.00
WWGM1647	WWMH133067	WWMH133066	262.2	0.013	117.04	116.48	1.50	4.85	0.21	8.24	4.66	1.70	1.00
WWGM1648	WWMH123005	WWMH123004	499.4	0.013	163.03	160.10	1.00	2.73	0.59	2.54	3.97	0.93	0.76
WWGM1649	WWMH123004	WWMH123003	414.2	0.013	160.05	157.64	1.00	2.72	0.58	2.55	4.07	0.94	0.74
WWGM1650	WWMH123003	WWMH133002	218.2	0.013	157.32	118.02	1.00	15.25	18.31	2.57	9.11	0.17	0.64
WWGM1653	WWMH123068	WWMH133067	370.2	0.013	118.12	117.29	1.50	4.97	0.22	8.24	4.66	1.66	1.00
WWGM1654	WWMH123069	WWMH123068	123.6	0.013	118.70	118.42	1.50	5.00	0.23	7.23	4.09	1.45	1.00
WWGM1655	WWMH123070	WWMH123069	90.4	0.013	119.14	119.08	1.50	2.71	0.07	7.23	4.09	2.67	1.00
WWGM1660	J-270_ANDR_BASEFLOW	G146040	40.0	0.013	143.66	143.50	0.67	0.76	0.40	0.07	1.45	0.09	0.19
WWGM1669	WWMG136095	WWMG137106	424.2	0.013	162.53	161.89	1.25	2.51	0.15	2.50	2.34	1.00	1.00
WWGM1685	WWMH126133	WWMH136204	209.2	0.013	161.52	160.41	0.83	1.60	0.53	1.02	3.11	0.64	1.00
WWGM1689	WWMH104043	WWMH104042	449.2	0.013	213.21	211.83	1.00	1.97	0.31	0.78	2.52	0.39	0.42
WWGM1709	WWMI111099	WWMI111053	500.2	0.013	195.95	193.92	1.25	4.12	0.41	3.52	3.97	0.86	0.68
WWGM1710	WWMI111036	WWMI111035	289.1	0.013	182.78	181.39	1.25	4.48	0.48	4.22	3.44	0.94	1.00
WWGM1713	WWMH114030	WWMH114029	101.7	0.013	177.83	176.93	0.67	1.14	0.89	1.77	5.08	1.56	1.00
WWGM1718	WWMH123006	WWMH123005	305.9	0.013	164.58	163.32	1.00	2.29	0.41	2.53	3.59	1.11	0.84
WWGM1739	WWMI111053	WWMI111037	117.3	0.013	193.35	190.22	1.25	10.55	2.67	4.20	8.11	0.40	0.44
WWGM1740	WWMI111037	WWMI111036	53.8	0.013	189.43	183.25	1.25	21.96	11.56	4.22	12.17	0.19	0.65
WWGM1742	WWMG136254	WWMG136054	261.9	0.013	159.70	158.92	1.00	1.94	0.30	0.58	0.85	0.30	1.00
WWGM1743	WWMG136097	WWMG136254	257.5	0.013	160.50	159.70	1.00	1.99	0.31	0.58	0.76	0.29	1.00
WWGM1753	WWMG136065	WWMG136064	267.0	0.013	160.39	159.99	1.00	1.38	0.15	2.05	2.61	1.49	1.00
WWGM1755	WWMG136066	WWMG136065	260.3	0.013	160.79	160.39	1.00	1.40	0.15	2.04	2.60	1.46	1.00
WWGM1756	WWMG136100	WWMG136066	198.2	0.013	163.12	160.79	1.00	3.86	1.18	0.25	0.37	0.07	1.00
WWGM1760	WWMG136038	WWMG136037	352.2	0.013	160.06	159.28	1.25	3.04	0.22	2.56	2.12	0.84	1.00
WWGM1762	WWMG136037	WWMG137195	338.6	0.013	159.28	158.68	1.25	2.72	0.18	3.54	2.91	1.30	1.00
WWGM1763	WWMG137194	WWMG136035	319.2	0.013	158.03	157.53	1.25	2.56	0.16	3.81	3.11	1.49	1.00
WWGM1764	WWMG136074	WWMG136050	250.6	0.013	164.31	163.74	0.83	1.05	0.23	0.01	0.69	0.01	0.07
WWGM1766	WWMH136250	WWMH136249	137.8	0.013	157.81	157.38	0.83	1.22	0.31	1.03	2.44	0.84	1.00
WWGM1767	WWMH136135	WWMH136250	405.9	0.013	158.83	157.93	0.83	1.03	0.22	1.03	2.23	1.00	1.00
WWGM1768	WWMH136253	WWMH136135	199.3	0.013	159.45	159.02	0.83	1.02	0.22	1.03	2.41	1.01	1.00
WWGM1769	WWMH136204	WWMH136253	223.9	0.013	159.79	159.68	0.83	0.49	0.05	1.02	2.03	2.11	1.00
WWGM1770	WWMH136262	WWMG136097	336.6	0.013	161.48	160.50	1.00	1.92	0.29	0.48	0.71	0.25	1.00
WWGM1771	WWMF117019	WWMF117018	281.5	0.013	158.59	157.78	1.25	3.46	0.29	2.54	2.74	0.73	0.73
WWGM1773	WWMF117020	WWMF117019	458.0	0.013	159.73	158.77	1.25	2.96	0.21	2.53	3.03	0.86	0.64
WWGM1779	WWMG109049	WWMG109048	306.6	0.013	182.02	181.21	1.75	8.14	0.26	4.06	3.27	0.50	0.52
WWGM1780	WWMG109050	WWMG109049	279.0	0.013	186.00	182.32	1.75	18.20	1.32	4.09	6.09	0.22	0.32
WWGM1781	WWMG109051	WWMG109050	272.6	0.013	188.97	186.45	1.75	15.24	0.92	4.09	5.37	0.27	0.35
WWGM1782	WWMG99099	WWMG109051	272.6	0.013	191.77	189.26	1.75	15.20	0.92	4.10	5.37	0.27	0.35
WWGM1788	WWMG116237	WWMG116236	301.4	0.013	173.99	173.53	1.75	6.19	0.15	7.36	3.36	1.19	1.00
WWGM1790	WWMI121026	WWMI131025	351.3	0.013	171.05	170.10	1.25	3.36	0.27	3.75	3.54	1.12	1.00
WWGM1791	WWMI121027	WWMI121026	336.7	0.013	172.17	171.05	1.25	3.73	0.33	4.58	3.73	1.23	1.00
WWGM1792	WWMI121103	WWMI121027	23.1	0.013	172.36	172.37	1.25	1.65	0.06	4.61	3.85	2.80	1.00
WWGM1793	WWMI121028	WWMI121103	38.1	0.013	172.66	172.36	1.25	5.78	0.80	4.07	3.80	0.70	1.00
WWGM1794	WWMI121029	WWMI121028	365.6	0.013	174.79	172.66	1.25	4.93	0.58	4.02	3.98	0.81	1.00
WWGM1795	WWMI121030	WWMI121029	347.9	0.013	176.89	174.79	1.25	5.02	0.60	4.01	4.00	0.80	1.00
WWGM1796	WWMI121100	WWMI121030	59.7	0.013	177.06	176.89	1.25	3.41	0.28	4.03	3.52	1.18	1.00
WWGM1798	WWMI121031	WWMI121100	342.8	0.013	178.01	177.06	1.25	3.41	0.28	4.00	3.26	1.17	1.00
WWGM1799	WWMI111032	WWMI121031	450.4	0.013	179.27	178.01	1.25	3.42	0.28	4.00	3.26	1.17	1.00
WWGM1800	WWMI111040	WWMI111032	452.8	0.013	180.54	179.27	1.25	3.42	0.28	4.01	3.27	1.17	1.00
WWGM1802	WWMI111035	WWMI111040	306.3	0.013	181.39	180.54	1.25	3.40	0.28	4.01	3.27	1.18	1.00
WWGM1810	WWMF99016	WWMF99015	147.1	0.013	190.51	189.39	0.83	1.91	0.76	0.99	2.63	0.52	1.00

Existing System Flows, 5-year, 24-hour storm event

Input								Output						
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1811	WWMF99017	WWMF99016	75.7	0.013	191.25	190.62	0.83	2.00	0.83	0.99	3.49	0.49	1.00
WWGM1812	WWMF99018	WWMF99017	160.5	0.013	192.94	191.30	0.83	2.21	1.02	0.99	3.82	0.44	1.00
WWGM1828	WWMG146025	WWMG146013	253.0	0.013	155.04	152.57	1.50	10.38	0.98	0.43	1.27	0.04	1.00
WWGM1834	WWMG126242	WWMG126241	303.3	0.013	171.64	168.53	1.75	16.05	1.03	9.56	6.74	0.60	1.00
WWGM1835	WWMG126241	WWMG127195	139.7	0.013	168.22	167.46	1.75	11.69	0.54	10.04	5.41	0.86	1.00
WWGM1837	WWMG126243	WWMG126242	254.9	0.013	171.83	171.74	1.75	2.98	0.04	9.08	3.99	3.05	1.00
WWGM1839	WWMG116235	WWMG126243	292.4	0.013	172.55	172.04	1.75	6.62	0.17	8.34	3.47	1.26	1.00
WWGM1840	WWMG127195	WWMG126240	187.0	0.013	166.36	165.81	1.75	8.59	0.29	10.12	4.69	1.18	1.00
WWGM1842	WWMG116236	WWMG116235	299.3	0.013	173.27	172.84	1.75	6.01	0.14	7.85	3.39	1.31	1.00
WWGM1967	WWMJ120017	J120019	23.4	0.013	122.37	121.60	2.00	41.02	3.29	2.06	6.79	0.05	0.15
WWGM2024	J-230_CHEHAL_BASEFLOW	F89189	40.0	0.013	186.09	185.93	0.67	0.76	0.40	0.18	1.90	0.23	0.31
WWGM2026	WWMG89260	WWMG89259	285.5	0.013	217.01	216.37	1.50	4.97	0.22	4.29	3.68	0.86	0.64
WWGM2035	WWMG109047	WWMG109046	377.4	0.013	180.34	179.71	1.75	6.47	0.17	4.01	3.27	0.62	0.82
WWGM2037	WWMG109048	WWMG109047	349.8	0.013	181.12	180.53	1.75	6.51	0.17	4.05	3.14	0.62	0.54
WWGM2039	J-110	WWMG136054	228.4	0.013	159.72	158.95	1.00	2.07	0.34	2.06	2.62	0.99	1.00
WWGM2053	WWMG89250	WWMG89260	19.4	0.013	220.40	220.10	0.67	1.50	1.55	1.03	4.61	0.68	0.61
WWGM2054	WWMG89076	WWMG89260	43.7	0.013	218.83	218.00	0.67	1.66	1.90	0.03	1.83	0.02	0.13
WWGM2073	WWMG118104	WWMG117195	36.0	0.013	184.64	184.46	1.25	4.57	0.50	3.41	4.27	0.75	0.62
WWGM2074	J-100	WWMF117024	15.3	0.013	164.00	163.89	1.00	3.02	0.72	0.22	0.95	0.07	0.34
WWGM2075	J-280_HWY240_WEIR	WWMF118050	45.7	0.013	163.80	163.06	1.00	4.53	1.62	3.37	4.88	0.74	1.00
WWGM2076	WWMF118050	WWMF118049	85.0	0.013	162.98	162.58	1.00	2.44	0.47	3.37	4.53	1.38	1.00
WWGM2077	WWMF118049	WWMF118048	138.0	0.013	162.17	154.99	1.00	8.13	5.21	3.55	6.05	0.44	1.00
WWGM2078	WWMF118048	HWY240LS	20.0	0.013	154.99	155.00	1.00	0.80	0.05	3.56	4.60	4.46	1.00
WWGM2093	WWMG136036	WWMG137194	61.3	0.013	158.51	158.08	1.25	5.41	0.70	3.73	3.29	0.69	1.00
WWGM2094	WWMG137195	WWMG136036	88.7	0.013	158.48	158.46	1.25	0.97	0.02	3.62	3.19	3.73	1.00
WWGM2110	WWMH114003	WWMH114140	66.3	0.013	140.08	139.38	1.00	3.66	1.06	2.60	3.31	0.71	1.00
WWGM2119	WWMI131111	WWMI131019	95.9	0.013	160.90	160.63	1.25	3.43	0.28	4.39	3.58	1.28	1.00
WWGM2137	WWMJ111103	WWMJ111047	30.1	0.013	177.19	176.75	1.00	4.31	1.46	0.65	2.20	0.15	0.41
WWGM2146	WWMG146012	WWMG146076	311.7	0.013	152.08	151.46	1.50	4.69	0.20	2.20	1.33	0.47	1.00
WWGM2147	WWMG146075	WWMG146076	9.4	0.013	151.83	152.31	3.00	151.15	5.14	19.07	4.99	0.13	1.00
WWGM2148	WWMG146014	WWMG146075	9.1	0.013	152.58	152.68	2.25	32.47	1.10	19.17	6.06	0.59	1.00
WWGM2149	WWMG146076	WWMG146077	275.8	0.013	151.13	150.91	3.00	18.84	0.08	20.64	4.29	1.10	1.00
WWGM2150	WWMG146078	WWMG146077	26.9	0.013	154.74	152.10	1.25	20.27	9.85	4.79	7.72	0.24	1.00
WWGM2151	WWMG146077	WWMG146079	380.7	0.013	150.36	149.98	3.00	21.07	0.10	24.90	3.71	1.18	1.00
WWGM2152	WWMG146079	WWMH146247	372.3	0.013	149.70	149.05	3.00	27.87	0.17	26.65	3.77	0.96	1.00

Appendix D2:
20-Year System Model Data

20-Year Flows (2037), 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
J-100	172.40	164.00	2017			0.3	164.3	8.1	0.0	0	0.00
J-110	170.05	158.70	2017			10.1	168.8	1.3	2.2	0	0.00
J-120_ANDR	150.60	148.40	2017			42.1	190.5	-39.9	0.4	0	0.00
J-130_CHAR	154.10	151.20	2017			302.9	454.1	-300.0	1.2	0	0.00
J-140_CHEHAL	196.10	177.10	2017			158.2	335.3	-139.2	1.5	0	0.00
J-150_CREEKSD	174.60	160.60	2017			20.0	180.6	-1.5	0.4	0	0.00
J-160_DAY	113.50	107.00	2017			1021.2	1128.2	-1014.7	2.9	0	0.00
J-170_FERN1	140.60	137.60	2017			104.6	242.2	-101.6	2.7	0	0.00
J-190_HWY240_1	165.00	143.00	2017			73.1	216.1	-51.1	3.4	0	0.00
J-210_SHER1	156.60	132.60	2017			179.2	311.8	-155.2	0.5	0	0.00
J-230_CHEHAL_BASEFLOW	196.10	186.09	2017	0.135	FM3_DIURNAL	0.4	186.5	9.6	0.5	0	0.00
J-240_CREEK_BASEFLOW	174.60	165.97	2017	0.011	FM2_DIURNAL	0.1	166.0	8.6	0.0	0	0.00
J-250_SHER_BASEFLOW	156.60	138.76	2017	0.004	FM9_DIURNAL	0.1	138.8	17.8	0.0	0	0.00
J-260_CHAR_BASEFLOW	154.10	146.92	2017	0.025	FM10_DIURNAL	0.1	147.0	7.1	0.1	0	0.00
J-270_ANDR_BASEFLOW	150.60	143.66	2017	0.023	FM10_DIURNAL	0.1	143.8	6.8	0.1	0	0.00
J-280_HWY240_WEIR	172.40	163.80	2008			0.6	164.4	8.0	3.4	0	0.00
J-F102	177.00	168.63	2037	0.033	FM3_DIURNAL	0.2	168.8	8.2	0.9	0	0.00
J-F103	188.00	182.92	2037	0.059	FM3_DIURNAL	0.3	183.2	4.8	0.4	0	0.00
J-F106_RIVERFRONT	152.00	149.00	2037			328.8	477.8	-325.8	3.8	0	0.00
J-F107_PROVIDENCE	168.00	165.00	2037			232.8	397.8	-229.8	1.5	0	0.00
J-F108_PROV_BASEFLOW	182.00	167.08	2037	0.136	FM12_DIURNAL	0.4	167.5	14.5	0.5	0	0.00
J-F110	164.00	159.00	2037	0.053	FM10_DIURNAL	0.3	159.3	4.7	0.7	0	0.00
J-F111	167.00	162.00	2037	0.056	FM10_DIURNAL	0.4	162.4	4.6	0.5	0	0.00
J-F112	159.00	153.90	2037			5.1	159.0	0.0	1.0	0.11778	6.60
J-F115	185.00	170.13	2037			0.4	170.6	14.4	0.4	0	0.00
WWMF109000	175.61	167.20	1978	0.000	FM2_DIURNAL	2.0	169.2	6.4	3.7	0	0.00
WWMF109001	175.70	167.76	1978	0.000	FM2_DIURNAL	1.5	169.2	6.5	3.3	0	0.00
WWMF109002	175.26	168.39	1980	0.014	FM2_DIURNAL	2.7	171.1	4.2	3.3	0	0.00
WWMF109003	178.18	169.02	1978	0.000	FM2_DIURNAL	3.3	172.3	5.9	3.3	0	0.00
WWMF109004	183.87	171.53	1978	0.042	FM2_DIURNAL	4.4	176.0	7.9	3.3	0	0.00
WWMF109005	187.09	173.61	1978	0.032	FM2_DIURNAL	4.4	178.0	9.1	3.3	0	0.00
WWMF109006	188.45	175.99	1994	0.014	FM2_DIURNAL	4.3	180.3	8.1	3.2	0	0.00
WWMF109040	177.87	174.77	1980	0.000	FM2_DIURNAL	3.1	177.9	0.0	0.3	0.006523	2.85
WWMF109150	174.88	168.17	1995	0.000	FM2_DIURNAL	2.1	170.2	4.6	3.3	0	0.00
WWMF109153	172.73	166.55	2017	0.023	FM2_DIURNAL	2.2	168.8	3.9	3.4	0	0.00
WWMF117018	168.07	157.50	1976	0.001	FM9_DIURNAL	1.3	158.8	9.3	3.0	0	0.00
WWMF117019	170.98	158.59	1976	0.004	FM9_DIURNAL	0.8	159.4	11.6	2.5	0	0.00
WWMF117020	167.67	159.73	1976	0.016	FM9_DIURNAL	1.0	160.7	7.0	2.5	0	0.00
WWMF117021	166.65	160.66	1976	0.004	FM9_DIURNAL	0.8	161.5	5.2	2.5	0	0.00
WWMF117022	169.11	161.98	1976	0.000	FM9_DIURNAL	0.7	162.7	6.4	2.5	0	0.00
WWMF117023	173.64	163.58	1976	0.000	FM2_DIURNAL	0.7	164.3	9.4	2.5	0	0.00
WWMF117024	172.69	163.87	1976	0.000	FM2_DIURNAL	0.4	164.3	8.4	0.0	0	0.00
WWMF117025	170.57	164.41	1976	0.000	FM2_DIURNAL	1.8	166.2	4.4	3.4	0	0.00
WWMF117026	173.30	164.30	1976	0.000	FM2_DIURNAL	2.4	166.7	6.6	3.4	0	0.00
WWMF117027	176.97	165.11	1978	0.005	FM2_DIURNAL	2.5	167.6	9.4	3.4	0	0.00
WWMF117028	173.99	165.19	2017	0.000	FM2_DIURNAL	2.7	167.9	6.1	3.4	0	0.00
WWMF118001	173.89	165.39	2017	0.000	FM2_DIURNAL	2.5	167.9	6.0	0.1	0	0.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMF118002	170.94	165.74	1978	0.000	FM2_DIURNAL	2.1	167.9	3.1	0.1	0	0.00
WWMF118003	182.24	170.44	1992	0.014	FM2_DIURNAL	0.1	170.5	11.7	0.1	0	0.00
WWMF118023	179.54	169.65	2003	0.000	FM2_DIURNAL	0.1	169.7	9.8	0.1	0	0.00
WWMF118024	174.53	167.53	2003	0.000	FM2_DIURNAL	0.8	168.3	6.2	0.1	0	0.00
WWMF118025	170.14	166.25	2017	0.000	FM2_DIURNAL	2.1	168.3	1.8	0.1	0	0.00
WWMF118026	169.96	165.75	2003	0.014	FM2_DIURNAL	2.6	168.3	1.7	3.4	0	0.00
WWMF118048	164.64	154.99	2010	0.000	FM2_DIURNAL	4.3	159.2	5.4	3.6	0	0.00
WWMF118049	172.54	162.17	2010	0.148	FM2_DIURNAL	0.5	162.6	9.9	3.6	0	0.00
WWMF118050	173.02	162.98	2017	0.000	FM2_DIURNAL	1.2	164.2	8.8	3.4	0	0.00
WWMF127007	162.68	148.57	1922	0.004	FM9_DIURNAL	0.9	149.4	13.3	2.7	0	0.00
WWMF127008	161.46	149.01	1962	0.001	FM9_DIURNAL	1.0	150.0	11.4	2.7	0	0.00
WWMF127009	155.12	149.42	1962	0.001	FM9_DIURNAL	1.0	150.5	4.7	2.7	0	0.00
WWMF127010	158.39	150.14	1962	0.001	FM9_DIURNAL	0.8	150.9	7.4	2.7	0	0.00
WWMF127011	160.70	150.90	1962	0.000	FM9_DIURNAL	0.8	151.7	9.0	2.7	0	0.00
WWMF127012	163.01	151.90	1962	0.017	FM9_DIURNAL	0.9	152.8	10.2	2.7	0	0.00
WWMF127013	163.38	152.22	1962	0.000	FM9_DIURNAL	0.7	152.9	10.5	2.6	0	0.00
WWMF127014	171.41	152.96	1962	0.000	FM9_DIURNAL	1.1	154.0	17.4	2.7	0	0.00
WWMF127015	171.72	153.38	1980	0.044	FM9_DIURNAL	1.0	154.3	17.4	2.7	0	0.00
WWMF127016	170.94	154.81	1980	0.000	FM9_DIURNAL	0.3	155.1	15.8	2.6	0	0.00
WWMF127017	166.06	156.17	2017	0.025	FM9_DIURNAL	0.8	156.9	9.1	2.6	0	0.00
WWMF127044	165.32	157.16	1922	0.013	FM9_DIURNAL	0.1	157.2	8.1	0.0	0	0.00
WWMF127115	172.54	167.50	1922	0.001	FM10_DIURNAL	2.1	169.6	3.0	2.3	0	0.00
WWMF127116	173.89	168.23	1922	0.001	FM10_DIURNAL	1.7	169.9	4.0	1.1	0	0.00
WWMF127117	174.12	168.63	1922	0.003	FM10_DIURNAL	1.9	170.5	3.6	1.1	0	0.00
WWMF127118	173.08	168.96	1922	0.000	FM10_DIURNAL	1.9	170.8	2.3	1.1	0	0.00
WWMF127119	176.51	170.40	1922	0.014	FM10_DIURNAL	1.8	172.2	4.3	1.0	0	0.00
WWMF127203	177.79	169.66	2017	0.001	FM10_DIURNAL	1.9	171.5	6.3	1.1	0	0.00
WWMF127220	176.26	170.34	2017	0.000	FM10_DIURNAL	1.8	172.2	4.1	1.1	0	0.00
WWMF137001	135.40	125.96	1996	0.000	FM9_DIURNAL	0.3	126.2	9.2	2.7	0	0.00
WWMF137002	140.83	132.89	1996	0.001	FM9_DIURNAL	0.3	133.2	7.6	2.7	0	0.00
WWMF137003	157.74	144.94	1962	0.005	FM9_DIURNAL	0.4	145.3	12.4	2.7	0	0.00
WWMF137004	158.00	147.00	1962	0.000	FM9_DIURNAL	0.6	147.6	10.4	2.7	0	0.00
WWMF137005	160.72	147.32	1962	0.000	FM9_DIURNAL	1.2	148.6	12.2	2.7	0	0.00
WWMF137006	162.06	148.06	1962	0.000	FM9_DIURNAL	0.9	149.0	13.1	2.7	0	0.00
WWMF137072	114.53	109.76	2017	0.019	FM9_DIURNAL	0.4	110.1	4.4	2.7	0	0.00
WWMF79028	227.32	216.32	1989	0.012	FM16_DIURNAL	1.3	217.6	9.7	0.8	0	0.00
WWMF79029	224.60	216.75	1979	0.000	FM16_DIURNAL	1.2	218.0	6.6	0.8	0	0.00
WWMF79030	224.89	217.37	1979	0.000	FM16_DIURNAL	0.7	218.1	6.8	0.8	0	0.00
WWMF79031	224.55	218.07	1979	0.000	FM16_DIURNAL	0.5	218.6	6.0	0.8	0	0.00
WWMF89019	213.10	199.16	1978	0.000	FM16_DIURNAL	0.9	200.1	13.0	0.9	0	0.00
WWMF89020	211.27	200.18	1978	0.000	FM16_DIURNAL	0.3	200.4	10.8	0.9	0	0.00
WWMF89021	211.58	201.22	1997	0.028	FM16_DIURNAL	0.6	201.8	9.8	0.9	0	0.00
WWMF89022	215.49	201.60	1978	0.000	FM16_DIURNAL	1.8	203.4	12.1	0.9	0	0.00
WWMF89023	214.29	205.30	1978	0.005	FM16_DIURNAL	0.6	205.9	8.4	0.9	0	0.00
WWMF89024	217.25	208.19	1995	0.028	FM16_DIURNAL	0.4	208.6	8.7	0.9	0	0.00
WWMF89025	222.97	212.45	1989	0.000	FM16_DIURNAL	0.4	212.8	10.2	0.9	0	0.00
WWMF89026	224.97	213.74	1989	0.000	FM16_DIURNAL	0.3	214.0	10.9	0.9	0	0.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input						Output					
Manhole ID	**Rim Elev.**	**Invert Elev.**	**Install Year**	**Avg DWF (cfs)**	**DWF Pattern**	**Max Depth (ft)**	**Max HGL (ft)**	**Freeboard (ft)**	**Max Inflow (cfs)**	**Total Flood Vol. (MG)**	**Time Flooded (hrs)**
WWMF89027	226.06	215.21	1989	0.009	FM16_DIURNAL	0.4	215.6	10.4	0.9	0	0.00
WWMF89160	214.29	204.27	1978	0.003	FM16_DIURNAL	1.3	205.5	8.7	0.9	0	0.00
WWMF99007	190.72	177.87	1978	0.133	FM2_DIURNAL	4.7	182.6	8.1	3.2	0	0.00
WWMF99008	190.47	178.31	1978	0.000	FM2_DIURNAL	4.9	183.2	7.3	3.0	0	0.00
WWMF99009	190.76	179.26	1978	0.028	FM2_DIURNAL	5.5	184.8	6.0	3.0	0	0.00
WWMF99011	189.86	180.34	1978	0.000	FM2_DIURNAL	6.4	186.8	3.1	2.9	0	0.00
WWMF99012	189.63	180.58	1978	0.050	FM2_DIURNAL	6.6	187.2	2.5	2.9	0	0.00
WWMF99013	193.15	186.08	1978	0.032	FM2_DIURNAL	2.8	188.8	4.3	2.8	0	0.00
WWMF99014	196.47	188.32	1978	0.000	FM2_DIURNAL	4.8	193.1	3.4	2.7	0	0.00
WWMF99015	198.21	189.24	1978	0.023	FM2_DIURNAL	5.9	195.2	3.0	2.7	0	0.00
WWMF99016	201.32	190.51	1978	0.002	FM16_DIURNAL	5.0	195.5	5.8	1.0	0	0.00
WWMF99017	200.59	191.25	1978	0.000	FM16_DIURNAL	4.4	195.6	5.0	1.0	0	0.00
WWMF99018	203.24	192.94	1978	0.019	FM16_DIURNAL	3.0	195.9	7.3	1.0	0	0.00
WWMF99152	203.96	195.57	1997	0.003	FM16_DIURNAL	1.1	196.6	7.3	0.9	0	0.00
WWMG108005	183.37	177.08	1965	0.000	FM2_DIURNAL	0.1	177.1	6.2	0.0	0	0.00
WWMG108006	189.94	178.43	1965	0.000	FM2_DIURNAL	0.1	178.5	11.4	0.0	0	0.00
WWMG108007	192.96	178.60	1965	0.014	FM2_DIURNAL	0.2	178.8	14.2	0.0	0	0.00
WWMG108008	192.80	179.75	1965	0.003	FM3_DIURNAL	5.6	185.3	7.5	0.5	0	0.00
WWMG108009	191.30	180.80	1965	0.000	FM3_DIURNAL	4.6	185.4	5.9	0.6	0	0.00
WWMG108010	191.25	181.43	1965	0.000	FM3_DIURNAL	4.0	185.4	5.9	0.5	0	0.00
WWMG108011	191.59	181.53	1965	0.241	FM3_DIURNAL	3.9	185.4	6.2	0.5	0	0.00
WWMG108080	192.99	178.59	2000	0.003	FM3_DIURNAL	6.7	185.3	7.7	5.7	0	0.00
WWMG109046	191.61	179.31	2017	0.000	FM3_DIURNAL	6.4	185.7	5.9	5.3	0	0.00
WWMG109047	191.73	180.34	2017	0.031	FM3_DIURNAL	5.7	186.1	5.6	5.3	0	0.00
WWMG109048	192.23	181.12	2017	0.017	FM3_DIURNAL	5.3	186.4	5.8	5.3	0	0.00
WWMG109049	195.67	182.02	2017	0.003	FM3_DIURNAL	4.7	186.7	8.9	5.3	0	0.00
WWMG109050	202.56	186.00	2017	0.003	FM3_DIURNAL	0.9	186.9	15.6	5.3	0	0.00
WWMG109051	205.91	188.97	2017	0.003	FM3_DIURNAL	0.7	189.7	16.2	5.3	0	0.00
WWMG114000	141.22	135.51	1957	0.010	FM1_DIURNAL	3.1	138.6	2.6	5.6	0	0.00
WWMG114001	144.62	137.22	1960	0.002	FM1_DIURNAL	6.3	143.5	1.1	4.0	0	0.00
WWMG114002	144.74	138.28	1960	0.005	FM1_DIURNAL	6.5	144.7	0.0	4.2	0.338174	16.43
WWMG116235	186.74	172.55	2000	0.001	FM8_DIURNAL	6.8	179.4	7.4	10.0	0	0.00
WWMG116236	189.28	173.27	2000	0.003	FM8_DIURNAL	7.2	180.5	8.8	9.5	0	0.00
WWMG116237	190.20	173.99	2000	0.011	FM8_DIURNAL	7.4	181.4	8.8	9.0	0	0.00
WWMG116238	192.41	174.79	2000	0.001	FM8_DIURNAL	7.5	182.3	10.1	8.5	0	0.00
WWMG116239	192.87	175.11	2000	0.007	FM3_DIURNAL	7.7	182.8	10.0	8.5	0	0.00
WWMG116240	195.22	176.26	2000	0.003	FM3_DIURNAL	7.5	183.8	11.4	8.5	0	0.00
WWMG116241	194.63	176.56	2000	0.003	FM3_DIURNAL	7.4	184.0	10.7	8.5	0	0.00
WWMG117195	193.76	176.86	2000	0.003	FM3_DIURNAL	7.6	184.5	9.3	8.9	0	0.00
WWMG118004	184.85	174.35	1965	0.000	FM2_DIURNAL	0.1	174.4	10.4	0.0	0	0.00
WWMG118086	193.38	178.01	2017	0.014	FM3_DIURNAL	7.1	185.1	8.3	5.8	0	0.00
WWMG118104	194.06	184.64	2017	0.000	FM3_DIURNAL	0.8	185.4	8.6	3.4	0	0.00
WWMG123072	133.92	121.01	1956	0.002	FM1_DIURNAL	11.6	132.6	1.3	7.2	0	0.00
WWMG123073	133.66	122.28	1956	0.002	FM1_DIURNAL	11.3	133.6	0.1	6.0	0	0.00
WWMG123074	134.19	122.74	2017	0.002	FM1_DIURNAL	11.5	134.2	0.0	10.2	1.180209	17.59
WWMG123075	157.62	125.12	1957	0.002	FM1_DIURNAL	10.6	135.7	21.9	8.6	0	0.00
WWMG123076	136.92	125.36	2017	0.009	FM1_DIURNAL	11.0	136.4	0.5	8.6	0	0.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMG123077	137.48	125.89	1957	0.002	FM1_DIURNAL	10.9	136.8	0.7	7.0	0	0.00
WWMG123078	140.22	132.71	1957	0.007	FM1_DIURNAL	5.2	137.9	2.3	7.0	0	0.00
WWMG123079	144.47	135.01	1957	0.002	FM1_DIURNAL	3.6	138.6	5.9	5.6	0	0.00
WWMG126098	172.90	163.54	1922	0.001	FM8_DIURNAL	8.3	171.8	1.1	0.6	0	0.00
WWMG126102	171.25	164.40	1922	0.003	FM8_DIURNAL	6.9	171.3	0.0	1.0	0.015168	4.14
WWMG126147	182.25	174.04	1922	0.000	FM8_DIURNAL	3.4	177.4	4.8	0.3	0	0.00
WWMG126164	183.79	180.00	1922	0.001	FM8_DIURNAL	0.0	180.0	3.8	0.0	0	0.00
WWMG126200	170.67	164.87	1922	0.001	FM10_DIURNAL	3.8	168.7	2.0	2.3	0	0.00
WWMG126236	171.33	158.58	2000	0.002	FM8_DIURNAL	11.6	170.2	1.1	11.6	0	0.00
WWMG126237	171.90	161.43	2000	0.002	FM8_DIURNAL	10.0	171.4	0.5	11.6	0	0.00
WWMG126238	172.23	162.28	2000	0.001	FM8_DIURNAL	10.0	172.2	0.0	11.6	0.027234	2.42
WWMG126239	174.59	163.94	2000	0.001	FM8_DIURNAL	10.1	174.0	0.6	11.6	0	0.00
WWMG126240	177.02	165.66	2000	0.000	FM8_DIURNAL	8.9	174.6	2.4	11.5	0	0.00
WWMG126241	175.65	168.22	2000	0.002	FM8_DIURNAL	7.4	175.6	0.0	11.4	0.142725	4.45
WWMG126242	184.33	171.64	2017	0.000	FM8_DIURNAL	5.5	177.1	7.2	10.9	0	0.00
WWMG126243	183.79	171.83	2000	0.000	FM8_DIURNAL	6.4	178.2	5.6	10.4	0	0.00
WWMG127109	169.81	163.83	1988	0.001	FM10_DIURNAL	4.1	168.0	1.8	2.3	0	0.00
WWMG127110	169.22	164.26	1988	0.001	FM10_DIURNAL	4.0	168.2	1.0	2.3	0	0.00
WWMG127114	171.40	165.69	1922	0.001	FM10_DIURNAL	3.5	169.2	2.2	2.3	0	0.00
WWMG127133	174.28	168.63	1922	0.010	FM10_DIURNAL	0.9	169.5	4.8	0.1	0	0.00
WWMG127188	172.56	163.75	2017	0.004	FM8_DIURNAL	7.7	171.5	1.1	0.7	0	0.00
WWMG127195	175.81	166.36	2017	0.003	FM8_DIURNAL	8.9	175.2	0.6	10.6	0	0.00
WWMG136015	168.77	153.68	1987	0.006	FM8_DIURNAL	9.9	163.6	5.1	19.7	0	0.00
WWMG136016	169.06	155.01	2017	0.003	FM8_DIURNAL	13.9	168.9	0.2	19.0	0	0.00
WWMG136017	168.95	155.82	1987	0.008	FM8_DIURNAL	11.5	167.3	1.7	11.9	0	0.00
WWMG136018	169.04	156.39	1987	0.006	FM8_DIURNAL	11.1	167.5	1.5	11.3	0	0.00
WWMG136019	170.03	156.83	1987	0.000	FM8_DIURNAL	12.0	168.8	1.2	11.6	0	0.00
WWMG136020	169.14	155.24	1987	0.011	FM8_DIURNAL	13.7	169.0	0.2	13.9	0	0.00
WWMG136021	170.05	158.68	1987	0.002	FM8_DIURNAL	10.2	168.8	1.2	2.3	0	0.00
WWMG136035	166.04	157.45	2017	0.005	FM10_DIURNAL	8.6	166.0	0.0	3.7	0	0.00
WWMG136036	167.71	158.46	1962	0.000	FM10_DIURNAL	8.9	167.3	0.4	3.6	0	0.00
WWMG136037	169.93	159.28	1962	0.003	FM10_DIURNAL	10.7	169.9	0.0	3.6	0.000002	0.00
WWMG136038	168.40	160.06	1962	0.007	FM10_DIURNAL	8.3	168.4	0.0	2.6	0.000001	0.00
WWMG136039	166.31	161.22	1962	0.000	FM10_DIURNAL	5.1	166.3	0.0	2.5	0.028823	3.39
WWMG136050	169.82	154.69	1948	0.005	FM8_DIURNAL	8.9	163.6	6.2	6.3	0	0.00
WWMG136051	168.57	155.25	1948	0.003	FM8_DIURNAL	9.6	164.9	3.7	4.7	0	0.00
WWMG136053	169.28	156.74	1948	0.003	FM8_DIURNAL	10.8	167.5	1.7	4.2	0	0.00
WWMG136054	169.10	157.95	1948	0.003	FM8_DIURNAL	10.5	168.5	0.6	3.5	0	0.00
WWMG136064	169.61	159.97	1922	0.001	FM8_DIURNAL	9.4	169.4	0.3	2.0	0	0.00
WWMG136065	172.07	160.39	1922	0.003	FM8_DIURNAL	9.8	170.1	1.9	2.0	0	0.00
WWMG136066	173.75	160.79	1922	0.004	FM8_DIURNAL	10.1	170.9	2.8	2.0	0	0.00
WWMG136067	174.96	161.45	1922	0.001	FM8_DIURNAL	10.4	171.9	3.1	2.0	0	0.00
WWMG136068	174.21	162.01	1922	0.001	FM8_DIURNAL	10.1	172.1	2.1	1.0	0	0.00
WWMG136069	174.23	162.03	1922	0.000	FM8_DIURNAL	10.1	172.1	2.1	1.0	0	0.00
WWMG136070	172.10	162.60	2017	0.000	FM8_DIURNAL	9.5	172.1	0.0	1.0	0	0.00
WWMG136074	169.20	164.31	1922	0.005	FM8_DIURNAL	0.1	164.4	4.8	0.0	0	0.00
WWMG136095	168.48	162.53	2017	0.004	FM10_DIURNAL	4.7	167.2	1.3	2.3	0	0.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMG136097	169.32	160.50	2017	0.003	FM8_DIURNAL	8.8	169.3	0.0	0.7	0	0.00
WWMG136100	174.20	163.12	1922	0.000	FM8_DIURNAL	7.8	170.9	3.3	0.4	0	0.00
WWMG136254	170.01	159.70	2017	0.003	FM8_DIURNAL	8.8	168.5	1.5	0.7	0	0.00
WWMG136260	170.10	157.00	1987	0.000	FM8_DIURNAL	11.9	168.9	1.2	11.6	0	0.00
WWMG137106	168.49	161.89	1962	0.000	FM10_DIURNAL	4.9	166.8	1.7	2.3	0	0.00
WWMG137107	169.49	162.99	2017	0.000	FM10_DIURNAL	4.7	167.6	1.8	2.3	0	0.00
WWMG137183	169.27	163.12	2017	0.001	FM10_DIURNAL	4.5	167.7	1.6	2.3	0	0.00
WWMG137193	168.38	156.07	1948	0.004	FM8_DIURNAL	10.3	166.3	2.0	4.7	0	0.00
WWMG137194	166.98	158.03	2017	0.007	FM10_DIURNAL	9.0	167.0	0.0	3.6	0	0.00
WWMG137195	168.38	158.48	2017	0.009	FM10_DIURNAL	8.8	167.3	1.1	3.6	0	0.00
WWMG146012	169.80	152.08	2017	0.003	FM8_DIURNAL	12.2	164.3	5.5	6.7	0	0.00
WWMG146013	169.88	152.54	1987	0.002	FM8_DIURNAL	12.3	164.8	5.1	4.4	0	0.00
WWMG146014	168.98	152.58	1987	0.004	FM8_DIURNAL	10.1	162.7	6.3	19.7	0	0.00
WWMG146025	170.67	155.04	2017	0.029	FM10_DIURNAL	11.1	166.1	4.5	2.5	0	0.00
WWMG146030	170.00	157.00	2037			13.0	170.0	0.0	2.4	0.00008	0.00
WWMG146075	168.83	151.83	2015	0.002	FM8_DIURNAL	10.9	162.7	6.1	19.7	0	0.00
WWMG146076	168.97	151.13	2017	0.002	FM8_DIURNAL	11.6	162.8	6.2	22.1	0	0.00
WWMG146077	169.92	150.36	2015	0.003	FM8_DIURNAL	12.1	162.4	7.5	26.0	0	0.00
WWMG146078	170.02	154.03	2015	0.003	FM8_DIURNAL	8.4	162.4	7.6	5.1	0	0.00
WWMG146079	171.02	149.70	2015	0.003	FM8_DIURNAL	12.2	161.9	9.2	27.9	0	0.00
WWMG79032	225.97	218.21	1979	0.023	FM16_DIURNAL	0.8	219.0	7.0	0.8	0	0.00
WWMG79033	231.39	222.83	1979	0.002	FM16_DIURNAL	0.4	223.2	8.2	0.8	0	0.00
WWMG79034	232.65	224.69	1979	0.019	FM16_DIURNAL	0.4	225.1	7.5	0.8	0	0.00
WWMG79195	246.66	240.18	1996	0.000	FM17_DIURNAL	0.3	240.5	6.2	0.9	0	0.00
WWMG79196	248.13	240.58	1996	0.002	FM17_DIURNAL	0.5	241.1	7.0	0.9	0	0.00
WWMG79244	249.95	241.37	1996	0.001	FM17_DIURNAL	0.5	241.9	8.1	0.9	0	0.00
WWMG79245	250.59	242.09	1996	0.000	FM17_DIURNAL	0.5	242.6	8.0	0.9	0	0.00
WWMG79246	251.11	242.45	1996	0.041	FM17_DIURNAL	0.6	243.0	8.1	0.9	0	0.00
WWMG89076	227.29	218.83	1978	0.014	FM3_DIURNAL	0.1	218.9	8.4	0.0	0	0.00
WWMG89185	227.99	220.04	1995	0.000	FM3_DIURNAL	1.1	221.1	6.9	3.3	0	0.00
WWMG89186	229.62	220.50	1995	0.000	FM17_DIURNAL	0.8	221.3	8.3	1.0	0	0.00
WWMG89187	230.23	221.07	1995	0.001	FM17_DIURNAL	0.7	221.8	8.4	1.0	0	0.00
WWMG89189	231.53	222.20	1995	0.002	FM17_DIURNAL	0.6	222.8	8.8	1.0	0	0.00
WWMG89192	235.58	226.02	1995	0.000	FM17_DIURNAL	0.5	226.5	9.1	1.0	0	0.00
WWMG89193	237.71	228.02	1996	0.040	FM17_DIURNAL	0.4	228.4	9.3	1.0	0	0.00
WWMG89194	242.49	234.52	1996	0.013	FM17_DIURNAL	0.4	234.9	7.6	0.9	0	0.00
WWMG89250	227.31	220.40	2017	0.000	FM3_DIURNAL	0.4	220.8	6.5	1.0	0	0.00
WWMG89258	227.59	214.58	2003	0.021	FM3_DIURNAL	0.8	215.4	12.2	4.4	0	0.00
WWMG89259	227.27	216.37	2017	0.000	FM3_DIURNAL	0.8	217.2	10.1	4.4	0	0.00
WWMG89260	226.99	217.01	2017	0.000	FM3_DIURNAL	1.1	218.1	8.9	4.4	0	0.00
WWMG89261	228.20	217.97	2017	0.000	FM3_DIURNAL	0.9	218.8	9.4	3.3	0	0.00
WWMG99099	207.14	191.77	2017	0.003	FM3_DIURNAL	0.7	192.5	14.7	5.3	0	0.00
WWMG99100	208.65	197.15	2003	0.024	FM3_DIURNAL	0.6	197.7	10.9	5.3	0	0.00
WWMG99101	213.19	204.69	2017	0.000	FM3_DIURNAL	0.6	205.3	7.9	5.3	0	0.00
WWMG99102	222.20	208.50	2017	0.000	FM3_DIURNAL	0.7	209.2	13.0	5.3	0	0.00
WWMG99104	223.52	210.39	2003	0.198	FM3_DIURNAL	0.9	211.2	12.3	5.3	0	0.00
WWMG99105	225.44	212.56	2017	0.010	FM3_DIURNAL	0.8	213.4	12.1	4.4	0	0.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMH104008	161.15	146.86	1972	0.001	FM1_DIURNAL	8.5	155.3	5.8	1.8	0	0.00
WWMH104009	156.71	148.29	1972	0.001	FM1_DIURNAL	7.6	155.8	0.9	1.8	0	0.00
WWMH104010	159.65	150.28	2017	0.002	FM1_DIURNAL	5.8	156.0	3.6	1.8	0	0.00
WWMH104011	160.09	150.77	1972	0.017	FM1_DIURNAL	5.8	156.6	3.5	1.8	0	0.00
WWMH104012	161.27	151.90	1973	0.004	FM1_DIURNAL	5.2	157.1	4.2	1.8	0	0.00
WWMH104040	219.73	209.84	1960	0.000	FM19_DIURNAL	0.3	210.1	9.6	0.8	0	0.00
WWMH104041	218.44	210.12	1970	0.035	FM19_DIURNAL	0.6	210.7	7.7	0.8	0	0.00
WWMH104042	216.89	211.37	1970	0.006	FM19_DIURNAL	0.5	211.8	5.0	0.8	0	0.00
WWMH104043	222.04	213.21	1960	0.012	FM19_DIURNAL	0.5	213.7	8.4	0.8	0	0.00
WWMH104044	223.91	214.86	2017	0.055	FM19_DIURNAL	0.4	215.3	8.6	0.8	0	0.00
WWMH105001	166.19	152.88	1973	0.068	FM1_DIURNAL	4.4	157.2	9.0	1.7	0	0.00
WWMH105002	165.42	155.42	1973	0.001	FM1_DIURNAL	2.5	157.9	7.5	1.7	0	0.00
WWMH105003	166.74	157.69	2017	0.011	FM1_DIURNAL	0.7	158.4	8.3	1.7	0	0.00
WWMH105004	169.00	160.00	1973	0.001	FM1_DIURNAL	0.5	160.5	8.5	1.6	0	0.00
WWMH105005	170.73	162.03	1973	0.022	FM1_DIURNAL	0.5	162.5	8.2	1.6	0	0.00
WWMH105017	170.16	163.31	1973	0.001	FM1_DIURNAL	0.6	163.9	6.3	1.6	0	0.00
WWMH114003	147.33	140.08	1960	0.002	FM1_DIURNAL	7.3	147.3	0.0	4.5	0.358123	16.16
WWMH114004	155.60	140.80	2017	0.030	FM1_DIURNAL	9.6	150.4	5.2	2.8	0	0.00
WWMH114005	153.43	141.58	2017	0.002	FM1_DIURNAL	11.9	153.4	0.0	3.2	0.030416	4.73
WWMH114006	156.67	143.28	1972	0.001	FM1_DIURNAL	10.8	154.1	2.6	1.8	0	0.00
WWMH114007	161.60	145.32	1972	0.001	FM1_DIURNAL	9.5	154.8	6.8	1.8	0	0.00
WWMH114026	152.90	145.81	1958	0.002	FM19_DIURNAL	0.4	146.2	6.7	1.8	0	0.00
WWMH114027	157.65	153.65	1958	0.009	FM19_DIURNAL	0.4	154.0	3.6	1.8	0	0.00
WWMH114028	184.27	174.85	1958	0.000	FM19_DIURNAL	0.4	175.2	9.0	1.8	0	0.00
WWMH114029	187.00	176.84	1958	0.003	FM19_DIURNAL	4.0	180.8	6.2	1.8	0	0.00
WWMH114030	188.24	177.83	1978	0.006	FM19_DIURNAL	5.2	183.0	5.2	1.8	0	0.00
WWMH114031	190.00	180.15	1958	0.528	FM19_DIURNAL	9.9	190.0	0.0	2.2	0.069587	11.54
WWMH114033	200.82	190.84	1960	0.003	FM19_DIURNAL	0.3	191.1	9.7	0.9	0	0.00
WWMH114035	201.55	192.53	1960	0.000	FM19_DIURNAL	0.5	193.0	8.6	0.9	0	0.00
WWMH114036	202.46	193.10	1960	0.017	FM19_DIURNAL	0.5	193.6	8.9	0.9	0	0.00
WWMH114037	202.53	194.33	2017	0.009	FM19_DIURNAL	0.5	194.9	7.7	0.8	0	0.00
WWMH114038	211.82	201.80	2017	0.003	FM19_DIURNAL	0.3	202.1	9.7	0.8	0	0.00
WWMH114039	218.44	208.10	1960	0.000	FM19_DIURNAL	0.3	208.4	10.0	0.8	0	0.00
WWMH114127	152.90	142.30	1958	0.002	FM19_DIURNAL	0.5	142.8	10.1	1.8	0	0.00
WWMH114140	149.02	139.21	2017	0.005	FM1_DIURNAL	7.8	147.0	2.0	2.6	0	0.00
WWMH123003	167.83	157.32	2017	0.011	FM20_DIURNAL	0.3	157.6	10.2	2.6	0	0.00
WWMH123004	169.80	160.05	2017	0.010	FM20_DIURNAL	0.8	160.9	8.9	2.6	0	0.00
WWMH123005	174.74	163.03	2017	0.003	FM20_DIURNAL	0.8	163.8	10.9	2.5	0	0.00
WWMH123006	177.34	164.58	2017	0.039	FM20_DIURNAL	1.1	165.7	11.7	2.5	0	0.00
WWMH123007	181.08	167.07	2017	0.177	FM20_DIURNAL	0.8	167.9	13.2	2.5	0	0.00
WWMH123068	129.07	118.12	1956	0.002	FM1_DIURNAL	10.8	128.9	0.2	8.2	0	0.00
WWMH123069	132.54	118.70	1956	0.002	FM1_DIURNAL	10.7	129.4	3.2	7.2	0	0.00
WWMH123070	132.82	119.14	2017	0.039	FM1_DIURNAL	10.6	129.7	3.1	7.2	0	0.00
WWMH123071	130.54	119.89	1956	0.002	FM1_DIURNAL	10.7	130.5	0.0	8.8	0.403147	17.70
WWMH126133	169.82	161.52	1996	0.004	FM8_DIURNAL	2.4	163.9	5.9	1.0	0	0.00
WWMH131073	110.05	102.95	1970	0.002	FM1_DIURNAL	5.0	107.9	2.1	6.5	0	0.00
WWMH131074	111.91	103.87	1970	0.002	FM1_DIURNAL	7.5	111.4	0.5	6.5	0	0.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMH131075	113.89	106.08	1970	0.002	FM1_DIURNAL	7.8	113.9	0.0	6.1	0.203475	17.12
WWMH131080	118.92	107.40	1970	0.002	FM1_DIURNAL	9.7	117.1	1.9	6.1	0	0.00
WWMH131081	117.91	108.26	1970	0.036	FM1_DIURNAL	9.7	117.9	0.0	5.6	0.260911	19.31
WWMH131082	121.41	110.06	1970	0.002	FM1_DIURNAL	11.4	121.4	0.0	6.8	0.323081	19.75
WWMH131083	124.77	111.72	1994	0.002	FM1_DIURNAL	12.5	124.2	0.5	5.2	0	0.00
WWMH133000	126.34	115.16	1994	0.002	FM1_DIURNAL	9.2	124.3	2.0	6.4	0	0.00
WWMH133001	123.99	116.99	2017	0.002	FM20_DIURNAL	7.0	124.0	0.0	3.1	1.523232	20.29
WWMH133002	124.37	117.76	2017	0.002	FM20_DIURNAL	6.6	124.4	0.0	2.6	0.08355	7.40
WWMH133066	124.96	116.27	1956	0.002	FM1_DIURNAL	8.7	125.0	0.0	9.9	1.295916	19.57
WWMH133067	128.79	117.04	1956	0.002	FM1_DIURNAL	9.6	126.6	2.2	8.2	0	0.00
WWMH133096	125.99	114.54	1994	0.002	FM1_DIURNAL	9.8	124.3	1.7	6.4	0	0.00
WWMH136135	168.89	158.83	1996	0.002	FM8_DIURNAL	3.7	162.5	6.4	1.0	0	0.00
WWMH136204	169.50	159.79	1996	0.003	FM8_DIURNAL	3.7	163.4	6.1	1.0	0	0.00
WWMH136247	165.60	155.57	1996	0.002	FM8_DIURNAL	2.3	157.8	7.8	2.1	0	0.00
WWMH136248	168.62	156.42	1996	0.003	FM8_DIURNAL	4.3	160.8	7.9	2.1	0	0.00
WWMH136249	165.59	157.01	1998	0.007	FM8_DIURNAL	4.3	161.3	4.3	1.0	0	0.00
WWMH136250	163.00	157.81	1996	0.002	FM8_DIURNAL	3.8	161.6	1.4	1.0	0	0.00
WWMH136253	169.46	159.45	2001	0.005	FM8_DIURNAL	3.5	163.0	6.5	1.0	0	0.00
WWMH136262	169.50	161.48	2017	0.006	FM8_DIURNAL	8.0	169.5	0.0	0.5	0.000001	0.00
WWMH141000	115.54	91.24	1986	0.060	FM8_DIURNAL	2.2	93.5	22.1	43.6	0	0.00
WWMH141001	112.20	95.40	1986	0.002	FM1_DIURNAL	0.8	96.2	16.0	13.4	0	0.00
WWMH141002	111.85	96.14	1986	0.002	FM1_DIURNAL	1.6	97.8	14.1	13.4	0	0.00
WWMH141003	111.74	96.53	1986	0.002	FM1_DIURNAL	1.4	98.0	13.8	13.4	0	0.00
WWMH141004	111.43	97.06	1986	0.002	FM1_DIURNAL	1.6	98.6	12.8	13.3	0	0.00
WWMH141005	111.43	97.72	1970	0.002	FM1_DIURNAL	1.5	99.2	12.2	13.3	0	0.00
WWMH141006	130.02	119.82	1970	0.002	FM15_DIURNAL	0.4	120.2	9.8	5.5	0	0.00
WWMH141007	154.01	149.19	1970	0.002	FM15_DIURNAL	0.3	149.5	4.5	5.5	0	0.00
WWMH141071	110.74	101.64	1970	0.002	FM1_DIURNAL	2.3	104.0	6.8	8.0	0	0.00
WWMH141072	109.94	102.73	1970	0.002	FM1_DIURNAL	3.7	106.4	3.6	8.0	0	0.00
WWMH146000	117.26	92.54	1986	0.002	FM8_DIURNAL	2.1	94.6	22.7	30.0	0	0.00
WWMH146001	154.12	142.01	1988	0.002	FM8_DIURNAL	0.8	142.8	11.3	30.0	0	0.00
WWMH146002	163.76	143.45	1988	0.002	FM8_DIURNAL	3.3	146.8	17.0	30.0	0	0.00
WWMH146003	163.72	144.27	1988	0.002	FM8_DIURNAL	4.5	148.7	15.0	30.0	0	0.00
WWMH146004	166.10	145.38	1988	0.002	FM8_DIURNAL	5.6	151.0	15.1	30.0	0	0.00
WWMH146005	169.64	145.89	1988	0.021	FM8_DIURNAL	6.9	152.8	16.8	30.0	0	0.00
WWMH146006	168.68	146.57	1988	0.152	FM8_DIURNAL	7.6	154.2	14.5	30.0	0	0.00
WWMH146007	172.13	147.71	1988	0.008	FM8_DIURNAL	8.8	156.5	15.6	28.0	0	0.00
WWMH146008	172.32	148.65	1988	0.003	FM8_DIURNAL	10.2	158.8	13.5	28.0	0	0.00
WWMH146246	168.90	153.93	1996	0.002	FM8_DIURNAL	0.6	154.5	14.4	2.1	0	0.00
WWMH146247	171.99	148.89	2015	0.002	FM8_DIURNAL	12.3	161.2	10.8	28.0	0	0.00
WWMH95018	173.00	165.10	1992	0.045	FM1_DIURNAL	0.6	165.7	7.3	1.6	0	0.00
WWMH95019	173.00	166.45	1991	0.001	FM1_DIURNAL	0.4	166.9	6.1	1.6	0	0.00
WWMH95020	176.67	169.94	1991	0.002	FM1_DIURNAL	0.4	170.3	6.3	1.6	0	0.00
WWMH95021	205.65	187.21	1991	0.004	FM1_DIURNAL	0.2	187.4	18.2	1.5	0	0.00
WWMH95022	204.76	190.07	1991	0.006	FM1_DIURNAL	0.4	190.5	14.3	1.5	0	0.00
WWMH95023	207.20	191.85	1991	0.004	FM1_DIURNAL	0.5	192.3	14.9	1.5	0	0.00
WWMH95024	210.40	192.85	1991	0.117	FM1_DIURNAL	0.4	193.3	17.1	1.3	0	0.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMI102001	208.60	197.52	1976	0.000	FM12_DIURNAL	0.4	198.0	10.6	0.5	0	0.00
WWMI102002	218.13	198.62	1976	0.000	FM12_DIURNAL	0.4	199.1	19.1	0.5	0	0.00
WWMI102003	215.84	199.90	1976	0.199	FM12_DIURNAL	0.4	200.3	15.5	0.5	0	0.00
WWMI102066	210.77	203.23	1970	0.004	FM12_DIURNAL	0.5	203.7	7.1	2.2	0	0.00
WWMI102067	214.51	208.13	2017	0.005	FM12_DIURNAL	0.5	208.6	5.9	2.2	0	0.00
WWMI102068	219.20	212.88	2017	0.027	FM12_DIURNAL	0.5	213.4	5.8	2.2	0	0.00
WWMI102069	221.49	213.72	1970	0.000	FM12_DIURNAL	1.2	214.9	6.6	2.2	0	0.00
WWMI102070	219.80	214.21	1977	0.014	FM12_DIURNAL	1.2	215.4	4.4	2.2	0	0.00
WWMI102071	220.03	214.40	1977	0.002	FM12_DIURNAL	1.1	215.5	4.5	2.2	0	0.00
WWMI102072	223.35	216.64	1977	0.011	FM12_DIURNAL	0.7	217.3	6.0	2.2	0	0.00
WWMI102073	225.66	218.21	1977	0.011	FM12_DIURNAL	0.6	218.8	6.8	2.1	0	0.00
WWMI102131	225.87	219.28	1999	0.000	FM12_DIURNAL	1.2	220.4	5.4	2.1	0	0.00
WWMI102132	227.75	220.88	2017	0.000	FM12_DIURNAL	0.6	221.4	6.3	1.5	0	0.00
WWMI104050	232.35	222.32	2008	0.002	FM12_DIURNAL	0.6	222.9	9.4	1.5	0	0.00
WWMI104051	229.69	222.06	2017	0.000	FM12_DIURNAL	0.4	222.4	7.3	1.5	0	0.00
WWMI111032	193.30	179.27	1970	0.000	FM12_DIURNAL	5.1	184.3	9.0	3.5	0	0.00
WWMI111035	188.10	181.39	1970	0.005	FM12_DIURNAL	5.2	186.6	1.5	3.5	0	0.00
WWMI111036	203.57	182.78	1970	0.000	FM12_DIURNAL	4.7	187.5	16.1	3.5	0	0.00
WWMI111037	205.03	189.43	2017	0.023	FM12_DIURNAL	0.3	189.8	15.3	3.5	0	0.00
WWMI111040	193.00	180.54	1970	0.000	FM12_DIURNAL	5.1	185.7	7.3	3.5	0	0.00
WWMI111053	203.84	193.35	2017	0.043	FM12_DIURNAL	0.5	193.8	10.0	3.5	0	0.00
WWMI111099	202.79	195.95	2017	0.076	FM12_DIURNAL	0.8	196.7	6.1	2.8	0	0.00
WWMI112000	207.16	196.52	2017	0.000	FM12_DIURNAL	0.3	196.8	10.4	0.5	0	0.00
WWMI121026	177.80	171.05	1970	0.035	FM15_DIURNAL	6.8	177.8	0.0	4.7	0.506016	13.67
WWMI121027	179.87	172.17	1970	0.000	FM15_DIURNAL	7.6	179.7	0.1	4.6	0	0.00
WWMI121028	179.60	172.66	1970	0.030	FM15_DIURNAL	6.9	179.6	0.0	3.8	0.239458	12.76
WWMI121029	182.20	174.79	1970	0.000	FM12_DIURNAL	6.0	180.8	1.4	3.8	0	0.00
WWMI121030	185.90	176.89	1970	0.000	FM12_DIURNAL	5.2	182.1	3.8	3.7	0	0.00
WWMI121031	190.60	178.01	1970	0.002	FM12_DIURNAL	5.0	183.0	7.6	3.6	0	0.00
WWMI121100	186.60	177.06	1996	0.002	FM12_DIURNAL	5.2	182.2	4.4	3.6	0	0.00
WWMI121103	179.74	172.35	2001	0.000	FM15_DIURNAL	7.4	179.7	0.0	4.7	0.000027	0.01
WWMI131009	165.55	152.25	1970	0.001	FM15_DIURNAL	3.7	155.9	9.6	5.5	0	0.00
WWMI131010	167.11	153.52	1970	0.000	FM15_DIURNAL	5.2	158.7	8.4	5.5	0	0.00
WWMI131011	165.59	154.68	1970	0.000	FM15_DIURNAL	5.8	160.5	5.1	5.5	0	0.00
WWMI131012	164.21	154.97	1970	0.000	FM15_DIURNAL	6.1	161.1	3.1	5.5	0	0.00
WWMI131013	163.40	156.32	1970	0.000	FM15_DIURNAL	7.1	163.4	0.0	5.6	0.006658	3.83
WWMI131014	167.17	156.45	1970	0.002	FM15_DIURNAL	8.0	164.4	2.7	5.6	0	0.00
WWMI131017	173.93	157.55	1970	0.000	FM15_DIURNAL	8.1	165.7	8.3	4.4	0	0.00
WWMI131018	174.47	158.73	1970	0.016	FM15_DIURNAL	7.2	165.9	8.5	4.4	0	0.00
WWMI131019	173.04	160.63	1970	0.000	FM15_DIURNAL	6.9	167.5	5.5	4.4	0	0.00
WWMI131020	171.74	161.93	1970	0.000	FM15_DIURNAL	7.3	169.3	2.5	4.4	0	0.00
WWMI131021	174.05	163.74	1970	0.000	FM15_DIURNAL	7.4	171.2	2.9	4.4	0	0.00
WWMI131022	176.99	165.43	1970	0.000	FM15_DIURNAL	7.7	173.1	3.9	4.4	0	0.00
WWMI131023	177.45	166.71	1970	0.010	FM15_DIURNAL	8.0	174.8	2.7	4.4	0	0.00
WWMI131024	178.04	168.13	1970	0.000	FM15_DIURNAL	8.3	176.4	1.6	4.4	0	0.00
WWMI131025	177.79	169.55	1970	0.020	FM15_DIURNAL	7.6	177.2	0.6	3.7	0	0.00
WWMI131111	172.52	160.90	2017	0.000	FM15_DIURNAL	7.0	167.9	4.6	4.4	0	0.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input						Output					
Manhole ID	**Rim Elev.**	**Invert Elev.**	**Install Year**	**Avg DWF (cfs)**	**DWF Pattern**	**Max Depth (ft)**	**Max HGL (ft)**	**Freeboard (ft)**	**Max Inflow (cfs)**	**Total Flood Vol. (MG)**	**Time Flooded (hrs)**
WWMI141008	162.12	150.54	1970	0.002	FM15_DIURNAL	2.6	153.1	9.0	5.5	0	0.00
WWMI81	279.93	268.14	2009	0.000	FM12_DIURNAL	0.2	268.4	11.6	0.6	0	0.00
WWMI92143	265.85	257.49	2008	0.072	FM12_DIURNAL	0.4	257.9	8.0	1.1	0	0.00
WWMI92144	264.43	256.47	2008	0.000	FM12_DIURNAL	0.4	256.9	7.6	1.1	0	0.00
WWMI92146	263.91	254.54	2017	0.000	FM12_DIURNAL	1.7	256.2	7.7	1.1	0	0.00
WWMI92147	262.12	243.47	2017	0.000	FM12_DIURNAL	0.4	243.9	18.2	1.2	0	0.00
WWMI92148	251.71	241.52	2017	0.000	FM12_DIURNAL	0.3	241.8	9.9	1.2	0	0.00
WWMI92149	245.17	236.97	2017	0.100	FM12_DIURNAL	0.3	237.3	7.9	1.4	0	0.00
WWMI92150	241.50	229.75	2017	0.000	FM12_DIURNAL	0.3	230.0	11.5	1.4	0	0.00
WWMI92151	239.75	225.75	2017	0.130	FM12_DIURNAL	0.5	226.3	13.5	1.5	0	0.00
WWMI92152	234.71	223.96	2017	0.000	FM12_DIURNAL	0.4	224.4	10.3	1.5	0	0.00
WWMI92156	263.55	244.65	2017	0.000	FM12_DIURNAL	0.1	244.7	18.8	0.0	0	0.00
WWMI92157	260.95	245.57	2008	0.000	FM12_DIURNAL	0.1	245.7	15.3	0.0	0	0.00
WWMI92158	255.21	247.11	2017	0.000	FM12_DIURNAL	0.1	247.2	8.0	0.0	0	0.00
WWMI92159	253.49	248.10	2008	0.000	FM12_DIURNAL	0.1	248.2	5.3	0.0	0	0.00
WWMI92161	255.92	249.58	2017	0.038	FM12_DIURNAL	0.1	249.7	6.2	0.0	0	0.00
WWMJ102130	184.15	171.61	2037	0.027	FM20_DIURNAL	0.1	171.7	12.5	0.0	0	0.00
WWMJ102131	185.10	170.08	2037			0.4	170.4	14.6	1.0	0	0.00
WWMJ111043	194.89	184.33	2001	0.001	FM13_DIURNAL	0.2	184.6	10.3	0.6	0	0.00
WWMJ111047	185.59	176.73	2004	0.003	FM13_DIURNAL	2.5	179.3	6.3	1.9	0	0.00
WWMJ111056	204.04	191.76	2005	0.006	FM13_DIURNAL	0.2	192.0	12.0	0.6	0	0.00
WWMJ111061	183.35	168.54	2037			0.4	168.9	14.4	1.0	0	0.00
WWMJ111062	190.78	167.35	2037			0.3	167.7	23.1	0.8	0	0.00
WWMJ111063	186.84	165.36	2037			0.3	165.6	21.2	0.7	0	0.00
WWMJ111064	182.91	162.76	2037			0.3	163.0	19.9	0.7	0	0.00
WWMJ111094	184.62	177.95	2008	0.038	FM13_DIURNAL	0.4	178.4	6.2	0.7	0	0.00
WWMJ111103	185.08	176.58	2017	0.000	FM13_DIURNAL	1.2	177.8	7.3	1.0	0	0.00
WWMJ120001	175.85	163.63	2003	0.050	FM13_DIURNAL	0.4	164.0	11.9	0.2	0	0.00
WWMJ120009	173.82	163.22	2001	0.000	FM13_DIURNAL	0.8	164.0	9.8	1.4	0	0.00
WWMJ120010	164.76	153.07	2001	0.000	FM15_DIURNAL	0.2	153.3	11.5	1.4	0	0.00
WWMJ120012	177.26	160.24	2001	0.000	FM13_DIURNAL	1.0	161.2	16.1	1.4	0	0.00
WWMJ120013	175.25	161.35	2001	0.000	FM13_DIURNAL	0.6	162.0	13.3	1.4	0	0.00
WWMJ120014	174.68	162.10	2001	0.000	FM13_DIURNAL	0.7	162.8	11.9	1.4	0	0.00
WWMJ120015	176.85	164.04	2001	0.000	FM13_DIURNAL	0.0	164.0	12.8	0.0	0	0.00
WWMJ120016	147.26	124.42	2001	0.000	FM15_DIURNAL	0.3	124.8	22.5	2.2	0	0.00
WWMJ120017	140.24	122.37	2001	0.000	FM15_DIURNAL	0.3	122.7	17.6	2.2	0	0.00
WWMJ120018	140.24	135.90	2001	0.000	FM15_DIURNAL	0.0	135.9	4.3	0.0	0	0.00
WWMJ120021	176.02	166.16	2001	0.000	FM13_DIURNAL	0.5	166.7	9.4	1.3	0	0.00
WWMJ120022	179.00	168.60	2001	0.000	FM13_DIURNAL	0.6	169.2	9.8	1.3	0	0.00
WWMJ120023	183.04	172.55	2001	0.000	FM13_DIURNAL	0.4	172.9	10.1	0.6	0	0.00
WWMJ120024	187.12	177.01	2001	0.000	FM13_DIURNAL	0.3	177.3	9.8	0.6	0	0.00
WWMJ120025	179.01	174.85	2004	0.001	FM13_DIURNAL	2.0	176.9	2.1	0.8	0	0.00
WWMJ120026	178.93	174.41	2004	0.001	FM13_DIURNAL	2.3	176.7	2.3	0.7	0	0.00
WWMJ120027	183.34	176.14	2004	0.001	FM13_DIURNAL	2.3	178.4	4.9	0.8	0	0.00
WWMJ120032	183.73	172.89	2004	0.002	FM13_DIURNAL	0.6	173.5	10.2	0.8	0	0.00
WWMJ120033	182.16	171.58	2004	0.000	FM13_DIURNAL	0.5	172.0	10.1	1.3	0	0.00
WWMJ120034	141.74	124.85	2005	0.000	FM15_DIURNAL	0.4	125.2	16.5	1.0	0	0.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMJ120035	133.71	126.31	2017	0.000	FM15_DIURNAL	0.4	126.7	7.0	1.0	0	0.00
WWMJ120036	137.44	127.46	2005	0.000	FM14_DIURNAL	0.5	127.9	9.5	1.0	0	0.00
WWMJ120037	140.82	132.41	2005	0.002	FM14_DIURNAL	0.2	132.6	8.2	1.0	0	0.00
WWMJ120038	150.33	139.45	2017	0.000	FM14_DIURNAL	0.3	139.8	10.5	1.0	0	0.00
WWMJ120039	150.91	141.24	2005	0.000	FM14_DIURNAL	0.3	141.6	9.3	1.0	0	0.00
WWMJ120040	153.37	143.48	2005	0.000	FM14_DIURNAL	0.3	143.8	9.6	1.0	0	0.00
WWMJ120041	157.38	146.02	2005	0.004	FM14_DIURNAL	0.3	146.3	11.1	1.0	0	0.00
WWMJ120042	169.74	153.34	2005	0.094	FM14_DIURNAL	0.3	153.6	16.1	0.9	0	0.00
WWMJ120043	177.19	167.14	2017	0.000	FM13_DIURNAL	0.6	167.7	9.5	1.3	0	0.00
WWMJ120044	180.73	160.50	2037			0.3	160.8	20.0	0.6	0	0.00
WWMJ120045	168.92	157.75	2037			0.1	157.9	11.0	0.6	0	0.00
WWMJ120046	137.67	120.13	2037			0.5	120.6	17.1	0.6	0	0.00
WWMJ120047	141.37	119.80	2017	0.014	FM15_DIURNAL	0.0	119.8	21.6	0.6	0	0.00
WWMJ120048	178.45	159.33	2017	0.000	FM15_DIURNAL	0.4	159.7	18.8	1.4	0	0.00
WWMJ120060	152.36	136.72	2017	0.008	FM14_DIURNAL	0.3	137.0	15.3	1.0	0	0.00
WWMK120007	170.09	154.55	2005	0.002	FM14_DIURNAL	0.4	154.9	15.2	0.6	0	0.00
WWMK120008	172.35	154.54	2005	0.002	FM14_DIURNAL	0.7	155.3	17.1	0.6	0	0.00
WWMK120009	171.58	156.94	2005	0.021	FM14_DIURNAL	0.4	157.3	14.3	0.6	0	0.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input								Output							
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
A1-113	J-F102	J-F112	355.1	0.013	168.63	154.00	1.50	21.33	4.12	0.87	4.69	0.04	0.57
A1_100	WWMG136021	J-110	28.5	0.013	159.18	159.72	1.00	4.92	1.91	2.18	2.78	0.44	1.00
A1_108	J-F115	J-F102	1167.1	0.013	170.13	168.73	1.50	3.64	0.12	0.43	1.44	0.12	0.22
A1_111	J-F112	HWY240LS	254.1	0.013	153.90	153.00	1.50	6.25	0.35	0.97	2.60	0.15	1.00
C-F102	J-F103	J-F115	1104.4	0.013	182.92	172.00	0.83	2.18	0.99	0.43	3.10	0.20	0.30
C-F105	WWMG146030	WWMG146025	752.0	0.013	157.00	155.10	1.50	5.28	0.25	2.39	2.78	0.45	1.00
C-F106	J-F108_PROV_BASEFLOW	PROVIDENCEWW_F1	1728.5	0.013	167.08	160.17	0.67	0.76	0.40	0.50	2.46	0.66	0.57
C-F110	J-F110	RIVERFRONTWW_F2	878.3	0.013	159.00	149.00	0.67	1.29	1.14	0.65	3.70	0.50	0.50
C-F111	J-F111	RIVERFRONTWW_F2	2204.0	0.013	162.00	149.00	0.67	0.93	0.59	0.54	2.83	0.59	0.54
FM-101_PROVIDENCE	J-F107_PROVIDENCE	WWMJ102131	1145.3	0.013	165.00	170.08	0.50	0.53	0.44	0.96	6.21	1.82	0.87
FM-102_RIVERFRONT	J-F106_RIVERFRONT	WWMG146030	1176.0	0.013	149.00	157.10	0.67	1.41	0.69	2.39	6.85	1.69	1.00
R1_100	WWMG136018	WWMG136053	265.4	0.013	156.39	157.74	1.25	4.61	0.51	1.37	1.14	0.30	1.00
R1_101	WWMG136017	WWMG137193	265.9	0.013	155.82	157.07	1.25	4.43	0.47	0.61	0.50	0.14	1.00
R1_102	WWMG136015	WWMG136050	265.7	0.013	153.68	155.69	1.25	5.62	0.76	2.58	2.49	0.46	1.00
WWFM0026	J-140_CHEHAL	WWMG89250	3120.0	0.013	188.80	221.61	0.50	0.84	1.05	1.00	5.15	1.19	0.97
WWFM0028	J-130_CHAR	WWMG136039	995.0	0.013	151.20	161.27	0.33	0.29	1.01	0.40	4.62	1.39	1.00
WWFM0038	J-120_ANDR	WWMG136037	920.0	0.013	148.40	159.28	0.33	0.31	1.18	0.42	5.25	1.32	1.00
WWFM0039	J-210_SHER1	WWMF117018	495.0	0.013	152.94	157.78	0.33	0.28	0.98	0.24	2.75	0.85	1.00
WWFM0040	J-210_SHER1	WWMF117018	495.0	0.013	152.94	157.78	0.33	0.28	0.98	0.24	2.75	0.85	1.00
WWFM0041	J-160_DAY	WWMG136016	4000.0	0.013	107.00	155.11	1.00	5.46	1.20	3.59	6.03	0.66	1.00
WWFM0042	J-170_FERN1	WWMI121103	3290.0	0.013	137.60	173.53	1.00	5.18	1.09	2.73	3.47	0.53	1.00
WWFM0045	J-150_CREEKSD	WWMF109004	523.0	0.013	178.85	171.53	0.33	0.34	1.40	0.34	3.90	0.98	1.00
WWFM0048	J-190_HWY240_1	WWMG118104	2336.2	0.013	159.33	185.21	0.83	3.25	1.11	3.39	6.28	1.04	0.96
WWGM0002	WWMF118023	WWMF118002	232.9	0.013	169.65	166.04	0.83	2.73	1.55	0.02	1.54	0.01	0.53
WWGM0015	WWMG146013	WWMG146012	11.4	0.013	152.54	152.27	1.50	16.19	2.38	5.04	5.05	0.31	1.00
WWGM0152	WWMG123075	WWMG123074	221.5	0.013	125.12	122.95	1.50	10.40	0.98	8.60	4.87	0.83	1.00
WWGM0153	WWMG123076	WWMG123075	96.9	0.013	125.36	125.12	1.50	5.23	0.25	8.61	4.87	1.65	1.00
WWGM0154	WWMG123077	WWMG123076	105.3	0.013	125.89	125.58	1.50	5.70	0.29	7.00	3.96	1.23	1.00
WWGM0155	WWMG123079	WWMG123078	254.3	0.013	135.01	132.85	1.50	9.68	0.85	5.63	5.16	0.58	1.00
WWGM0156	WWMG114000	WWMG123079	20.2	0.013	135.51	135.38	1.50	8.42	0.64	5.62	4.80	0.67	1.00
WWGM0161	WWMH114127	WWMG114000	176.5	0.013	142.30	136.13	0.67	2.26	3.50	1.79	6.35	0.79	0.84
WWGM0162	WWMH114027	WWMH114026	137.8	0.013	153.65	145.99	0.67	2.85	5.57	1.79	8.62	0.63	0.57
WWGM0163	WWMH114028	WWMH114027	372.4	0.013	174.85	153.65	0.67	2.89	5.70	1.78	8.63	0.62	0.57
WWGM0164	WWMH114029	WWMH114028	244.1	0.013	176.84	175.07	0.67	1.03	0.73	1.78	5.17	1.73	0.96
WWGM0165	WWMG114001	WWMG114000	415.0	0.013	137.22	136.13	1.00	1.83	0.26	3.96	5.06	2.17	1.00
WWGM0166	WWMG114002	WWMG114001	326.7	0.013	138.28	137.32	1.00	1.93	0.29	3.16	4.02	1.64	1.00
WWGM0167	WWMH114140	WWMG114002	421.1	0.013	139.21	138.58	1.00	1.38	0.15	2.60	3.31	1.89	1.00
WWGM0168	WWMH114004	WWMH114003	183.5	0.013	140.80	140.18	0.83	1.27	0.34	2.83	5.20	2.23	1.00
WWGM0169	WWMH114005	WWMH114004	186.8	0.013	141.58	140.90	0.83	1.32	0.36	2.80	5.13	2.12	1.00
WWGM0170	WWMH114006	WWMH114005	235.2	0.013	143.28	141.62	1.00	2.99	0.71	1.79	2.28	0.60	1.00
WWGM0171	WWMH114007	WWMH114006	287.4	0.013	145.32	143.41	1.00	2.90	0.66	1.78	2.97	0.61	1.00
WWGM0173	WWMH104008	WWMH114007	218.6	0.013	146.86	145.48	1.00	2.83	0.63	1.78	2.98	0.63	1.00
WWGM0177	WWMG117195	WWMG116241	203.1	0.013	176.86	176.72	1.75	4.16	0.07	8.52	3.89	2.05	1.00
WWGM0182	WWMG116240	WWMG116239	324.0	0.013	176.26	175.44	1.75	7.97	0.25	8.53	4.12	1.07	1.00
WWGM0184	WWMG116239	WWMG116238	175.0	0.013	175.11	174.82	1.75	6.45	0.17	8.54	3.58	1.32	1.00
WWGM0191	WWMG118086	WWMG117195	481.3	0.013	178.01	177.21	1.75	6.46	0.17	5.84	3.01	0.90	1.00
WWGM0198	WWMG116238	WWMG116237	308.0	0.013	174.79	174.06	1.75	7.71	0.24	8.54	3.55	1.11	1.00
WWGM0206	WWMH141005	WWMH141004	268.5	0.013	97.72	97.06	2.50	20.35	0.25	13.35	4.23	0.66	0.61
WWGM0207	WWMH141006	WWMH141005	91.1	0.013	119.82	98.68	1.25	31.55	23.86	5.49	15.76	0.17	0.35
WWGM0208	WWMH141007	WWMH141006	88.7	0.013	149.19	120.52	1.25	37.75	34.15	5.49	21.59	0.15	0.26
WWGM0209	WWMI141008	WWMH141007	383.1	0.013	150.54	149.32	1.25	3.65	0.32	5.49	4.80	1.51	0.88
WWGM0210	WWMI131009	WWMI141008	386.6	0.013	152.25	150.54	1.25	4.30	0.44	5.48	4.47	1.28	1.00
WWGM0211	WWMH141071	WWMH141005	274.1	0.013	101.64	98.68	1.25	6.71	1.08	8.04	6.69	1.20	0.95
WWGM0212	WWMH141072	WWMH141071	157.2	0.013	102.73	101.74	1.25	5.13	0.63	8.03	6.55	1.57	1.00
WWGM0213	WWMH131073	WWMH141072	156.2	0.013	102.95	102.76	1.25	2.25	0.12	6.55	5.33	2.91	1.00
WWGM0214	WWMH131074	WWMH131073	353.7	0.013	103.87	102.95	1.25	3.29	0.26	6.54	5.33	1.99	1.00
WWGM0215	WWMH131075	WWMH131074	466.2	0.013	106.08	104.30	1.25	3.99	0.38	5.97	4.86	1.50	1.00
WWGM0232	WWMG126164	WWMG126243	19.0	0.013	180.00	179.48	0.83	3.63	2.74	0.00	1.07	0.00	0.02

20-Year Flows (2037), 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM0235	WWMH131080	WWMH131075	352.5	0.013	107.40	106.16	1.25	3.83	0.35	6.10	4.97	1.59	1.00
WWGM0238	WWMH131081	WWMH131080	182.1	0.013	108.26	107.50	1.25	4.17	0.42	5.61	4.57	1.34	1.00
WWGM0251	WWMG123074	WWMG123073	237.0	0.013	122.74	122.41	1.50	3.92	0.14	6.03	3.42	1.54	1.00
WWGM0253	WWMG123073	WWMG123072	350.6	0.013	122.28	121.33	1.50	5.47	0.27	6.04	3.63	1.10	1.00
WWGM0273	WWMH123007	WWMH123006	362.7	0.013	167.07	165.11	1.00	2.62	0.54	2.48	3.96	0.95	0.75
WWGM0276	WWMG89261	WWMG89260	130.2	0.013	217.97	217.62	1.50	5.45	0.27	3.34	3.62	0.61	0.52
WWGM0317	WWMF127015	WWMF127014	174.7	0.013	153.38	153.05	1.25	2.81	0.19	2.65	2.63	0.95	0.77
WWGM0354	WWMG116241	WWMG116240	65.5	0.013	176.56	176.26	1.75	10.72	0.46	8.53	4.07	0.80	1.00
WWGM0356	WWMG123072	WWMH123071	423.4	0.013	121.01	119.99	1.50	5.16	0.24	7.21	4.08	1.40	1.00
WWGM0357	WWMH123071	WWMH123070	218.3	0.013	119.89	119.30	1.50	5.46	0.27	7.19	4.07	1.32	1.00
WWGM0372	WWMH141000	OF-3	177.3	0.013	91.24	90.60	3.50	60.44	0.36	43.59	7.10	0.72	0.61
WWGM0373	WWMH146002	WWMH146001	341.1	0.013	143.45	142.81	2.50	17.77	0.19	30.02	6.60	1.69	0.87
WWGM0374	WWMH141001	WWMH141000	169.5	0.013	95.40	92.32	2.50	55.29	1.82	13.36	9.08	0.24	0.39
WWGM0375	WWMH146001	WWMH146000	248.6	0.013	142.01	96.56	2.00	97.55	18.59	30.02	27.19	0.31	0.38
WWGM0376	WWMH146000	WWMH141000	12.7	0.013	92.54	92.32	2.50	53.95	1.73	30.01	8.49	0.56	0.68
WWGM0377	WWMH141002	WWMH141001	338.4	0.013	96.14	95.50	2.50	17.84	0.19	13.35	4.63	0.75	0.57
WWGM0378	WWMH141003	WWMH141002	71.2	0.013	96.53	96.34	2.50	21.19	0.27	13.35	4.63	0.63	0.57
WWGM0379	WWMH141004	WWMH141003	214.7	0.013	97.06	96.68	2.50	17.23	0.18	13.35	4.58	0.77	0.57
WWGM0408	WWMG123078	WWMG123077	241.2	0.013	132.71	125.99	1.50	17.54	2.79	6.99	5.26	0.40	1.00
WWGM0409	WWMH114026	WWMH114127	91.2	0.013	145.81	142.30	0.67	2.37	3.85	1.79	7.31	0.75	0.67
WWGM0411	WWMJ120034	WWMJ120016	95.6	0.013	124.85	124.55	2.00	12.67	0.31	1.00	2.55	0.08	0.18
WWGM0416	WWMJ120010	WWMJ120016	150.3	0.013	153.07	125.35	1.00	15.43	18.77	1.44	12.27	0.09	0.21
WWGM0417	WWMG89185	WWMG89261	61.3	0.013	220.04	218.95	0.83	2.92	1.78	3.34	6.26	1.14	0.96
WWGM0467	WWMJ120039	WWMJ120038	83.6	0.013	141.24	139.90	0.83	2.77	1.60	0.96	4.62	0.35	0.41
WWGM0468	WWMI131019	WWMI131018	377.8	0.013	160.63	159.36	1.25	3.75	0.34	4.40	3.82	1.17	1.00
WWGM0478	WWMJ120033	WWMJ120022	233.1	0.013	171.58	168.94	0.83	2.33	1.13	1.35	4.43	0.58	0.55
WWGM0479	WWMI131017	WWMI131014	277.3	0.013	157.55	156.79	1.25	3.38	0.27	4.41	3.59	1.30	1.00
WWGM0481	WWMJ120043	WWMJ120021	136.8	0.013	167.14	166.38	0.83	1.63	0.56	1.35	3.49	0.83	0.67
WWGM0482	WWMI131012	WWMI131011	85.1	0.013	155.05	154.68	1.25	4.26	0.43	5.49	4.47	1.29	1.00
WWGM0487	WWMJ120012	WWMJ120048	300.7	0.013	160.24	159.95	1.00	1.11	0.10	1.44	2.35	1.30	0.73
WWGM0491	WWMH146004	WWMH146003	432.9	0.013	145.38	144.42	2.50	19.32	0.22	30.02	6.12	1.55	1.00
WWGM0492	WWMJ120016	WWMJ120017	72.7	0.013	124.42	122.53	2.00	36.48	2.60	2.18	6.38	0.06	0.17
WWGM0496	WWMJ120001	WWMJ120009	135.7	0.013	163.63	163.52	1.00	1.01	0.08	0.21	1.31	0.21	0.41
WWGM0506	WWMJ120038	WWMJ120060	126.8	0.013	139.45	137.33	0.83	2.83	1.67	0.96	4.70	0.34	0.40
WWGM0507	WWMI131014	WWMI131013	132.0	0.013	156.45	156.36	1.25	1.69	0.07	5.59	4.55	3.31	1.00
WWGM0510	WWMJ120032	WWMJ120033	210.9	0.013	172.89	172.22	0.67	0.68	0.32	0.72	2.49	1.05	0.77
WWGM0511	WWMJ120037	WWMJ120036	54.2	0.013	132.41	127.58	1.00	10.66	8.95	1.00	6.81	0.09	0.27
WWGM0514	WWMJ120021	WWMJ120009	298.0	0.013	166.16	163.57	0.83	2.04	0.87	1.35	4.00	0.66	0.59
WWGM0516	WWMJ120023	WWMJ120033	67.7	0.013	172.55	172.22	0.83	1.53	0.49	0.65	2.78	0.42	0.44
WWGM0519	WWMJ120036	WWMJ120035	200.7	0.013	127.46	126.51	1.00	2.45	0.47	1.00	3.04	0.41	0.44
WWGM0520	WWMI131022	WWMI131021	449.4	0.013	165.43	163.80	1.25	3.89	0.36	4.39	3.74	1.13	1.00
WWGM0526	WWMJ120022	WWMJ120043	163.3	0.013	168.60	167.62	0.83	1.70	0.60	1.35	3.56	0.79	0.66
WWGM0528	WWMJ120025	WWMJ120026	55.0	0.013	174.85	174.46	0.67	1.02	0.71	0.74	2.12	0.73	1.00
WWGM0530	WWMK120007	WWMJ120042	162.3	0.013	154.55	153.63	0.83	1.65	0.57	0.62	2.84	0.38	0.42
WWGM0531	WWMK120008	WWMK120007	150.4	0.013	154.54	154.67	0.83	0.64	0.09	0.61	1.63	0.95	0.65
WWGM0533	WWMI131024	WWMI131023	384.7	0.013	168.13	166.74	1.25	3.88	0.36	4.39	3.58	1.13	1.00
WWGM0536	WWMH146005	WWMH146004	339.5	0.013	145.89	145.46	2.50	14.60	0.13	30.02	6.11	2.06	1.00
WWGM0539	WWMJ120013	WWMJ120012	299.8	0.013	161.35	160.47	1.00	1.93	0.29	1.44	2.52	0.75	0.68
WWGM0540	WWMI131013	WWMI131012	332.9	0.013	156.32	154.97	1.25	4.11	0.41	5.49	4.47	1.33	1.00
WWGM0546	WWMJ120048	WWMJ120010	298.8	0.013	159.33	153.40	1.00	5.02	1.98	1.44	5.52	0.29	0.37
WWGM0555	WWMI131010	WWMI131009	382.6	0.013	153.52	152.35	1.25	3.57	0.31	5.48	4.47	1.54	1.00
WWGM0556	WWMJ120026	WWMJ120032	469.1	0.013	174.41	173.94	0.67	0.38	0.10	0.75	2.49	1.97	0.81
WWGM0558	WWMI131023	WWMI131022	389.7	0.013	166.71	166.12	1.25	2.51	0.15	4.40	3.83	1.75	1.00
WWGM0559	WWMI131021	WWMI131020	444.1	0.013	163.74	162.05	1.25	3.99	0.38	4.39	3.70	1.10	1.00
WWGM0565	WWMJ120042	WWMJ120041	243.6	0.013	153.34	146.17	0.83	3.76	2.94	0.95	5.74	0.25	0.34
WWGM0569	WWMK120009	WWMK120008	256.7	0.013	156.94	155.59	0.83	1.59	0.53	0.61	2.77	0.38	0.42
WWGM0580	WWMI131025	WWMI131024	397.1	0.013	169.55	168.16	1.25	3.82	0.35	3.66	3.42	0.96	1.00
WWGM0583	WWMI131020	WWMI131111	300.8	0.013	161.93	161.03	1.25	3.53	0.30	4.39	3.58	1.24	1.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM0584	WWMJ120035	WWMJ120034	182.1	0.013	126.31	125.09	1.00	2.92	0.67	1.00	3.36	0.34	0.40
WWGM0597	WWMJ120041	WWMJ120040	68.6	0.013	146.02	143.82	0.83	3.93	3.21	0.96	5.95	0.25	0.34
WWGM0598	WWMJ120024	WWMJ120023	299.3	0.013	177.01	172.94	0.83	2.56	1.36	0.65	3.91	0.25	0.34
WWGM0600	WWMJ120040	WWMJ120039	69.7	0.013	143.48	141.44	0.83	3.75	2.93	0.96	5.76	0.26	0.35
WWGM0601	WWMJ120014	WWMJ120013	300.3	0.013	162.10	161.35	1.00	1.78	0.25	1.44	2.58	0.81	0.67
WWGM0602	WWMJ120027	WWMJ120025	274.0	0.013	176.14	175.10	0.67	0.74	0.38	0.78	2.46	1.04	1.00
WWGM0604	WWMI131011	WWMI131010	248.7	0.013	154.68	153.66	1.25	4.14	0.41	5.49	4.47	1.33	1.00
WWGM0608	WWMH146003	WWMH146002	355.4	0.013	144.27	143.74	2.50	15.84	0.15	30.02	6.12	1.90	1.00
WWGM0612	WWMJ120018	WWMJ120017	36.1	0.013	135.90	122.53	2.00	142.74	39.81	0.00	0.00	0.00	0.04
WWGM0617	WWMJ120009	WWMJ120014	334.7	0.013	163.22	162.43	1.00	1.73	0.24	1.44	2.75	0.83	0.63
WWGM0651	WWMH114036	WWMH114035	142.3	0.013	193.10	192.59	1.00	2.13	0.36	0.85	2.70	0.40	0.42
WWGM0652	WWMH114037	WWMH114036	269.2	0.013	194.33	193.69	1.00	1.74	0.24	0.84	2.41	0.48	0.45
WWGM0653	WWMH114035	WWMH114033	401.0	0.013	192.53	191.06	1.00	2.16	0.37	0.85	2.72	0.40	0.42
WWGM0654	WWMH114033	WWMH114031	501.1	0.013	190.84	180.52	0.83	3.14	2.06	0.86	3.32	0.27	0.68
WWGM0661	WWMH114031	WWMH114030	331.2	0.013	180.15	177.84	0.67	1.01	0.70	1.77	5.06	1.75	1.00
WWGM0682	WWMI102001	WWMI112000	311.0	0.013	197.52	196.80	0.83	1.05	0.23	0.50	2.09	0.48	0.45
WWGM0691	WWMH114039	WWMH114038	385.7	0.013	208.10	201.86	0.83	2.79	1.62	0.82	4.45	0.30	0.37
WWGM0696	WWMH104041	WWMH104040	127.4	0.013	210.12	209.95	1.00	1.30	0.13	0.82	2.24	0.63	0.47
WWGM0699	WWMI112000	WWMI111099	35.8	0.013	196.52	196.17	0.83	2.17	0.98	0.50	2.65	0.23	0.50
WWGM0700	WWMI102003	WWMI102002	479.9	0.013	199.90	198.72	0.83	1.09	0.25	0.50	2.06	0.46	0.46
WWGM0711	WWMH104042	WWMH104041	314.4	0.013	211.37	210.45	1.00	1.93	0.29	0.78	2.50	0.41	0.42
WWGM0716	WWMH114038	WWMH114037	386.6	0.013	201.80	194.53	0.83	3.00	1.88	0.83	4.45	0.27	0.37
WWGM0717	WWMI102002	WWMI102001	342.7	0.013	198.62	197.76	0.83	1.10	0.25	0.50	2.13	0.46	0.45
WWGM0723	WWMH104040	WWMH114039	92.9	0.013	209.84	208.22	1.00	4.71	1.74	0.82	4.50	0.17	0.28
WWGM0734	WWMH104044	WWMH104043	421.9	0.013	214.86	213.33	1.00	2.15	0.36	0.76	2.63	0.36	0.40
WWGM0756	WWMH104011	WWMH104010	218.1	0.013	150.77	150.31	1.00	1.64	0.21	1.78	2.40	1.09	1.00
WWGM0760	WWMH104009	WWMH104008	208.7	0.013	148.29	146.88	1.00	2.93	0.68	1.78	3.09	0.61	1.00
WWGM0761	WWMH104010	WWMH104009	80.7	0.013	150.28	148.29	1.00	5.59	2.47	1.78	3.86	0.32	1.00
WWGM0762	WWMH104012	WWMH104011	194.5	0.013	151.90	150.79	1.00	2.69	0.57	1.76	2.61	0.65	1.00
WWGM0763	WWMG89187	WWMG89186	177.2	0.013	221.07	220.81	0.83	0.84	0.15	0.96	2.36	1.15	0.75
WWGM0801	WWMF99008	WWMF99007	81.6	0.013	178.31	178.07	1.00	1.93	0.29	2.96	3.77	1.53	1.00
WWGM0802	WWMF99011	WWMF99009	299.7	0.013	180.34	179.40	1.00	2.00	0.31	2.91	3.71	1.46	1.00
WWGM0826	WWMF99014	WWMF99013	273.8	0.013	188.32	186.28	0.83	1.89	0.74	2.74	5.02	1.45	1.00
WWGM0846	WWMF89021	WWMF89020	143.4	0.013	201.22	200.31	0.67	0.96	0.63	0.94	3.29	0.98	0.77
WWGM0855	WWMF99015	WWMF99014	137.3	0.013	189.24	188.44	0.83	1.67	0.58	2.74	5.02	1.64	1.00
WWGM0863	WWMG99101	WWMG99100	364.6	0.013	204.69	197.49	1.75	22.27	1.97	5.28	7.58	0.24	0.33
WWGM0867	WWMG89258	WWMG99105	356.9	0.013	214.58	212.84	1.50	7.33	0.49	4.35	4.40	0.59	0.55
WWGM0870	WWMG89259	WWMG89258	281.6	0.013	216.37	214.94	1.50	7.49	0.51	4.32	4.44	0.58	0.54
WWGM0880	WWMF89019	WWMF99152	352.5	0.013	199.16	197.43	0.67	0.85	0.49	0.94	3.00	1.11	0.85
WWGM0882	WWMF99152	WWMF99018	123.2	0.013	195.57	194.64	0.67	1.05	0.75	0.95	3.49	0.91	1.00
WWGM0884	WWMF89160	WWMF89022	378.6	0.013	204.27	201.78	0.67	0.98	0.66	0.90	2.59	0.92	1.00
WWGM0896	WWMG99100	WWMG99099	270.4	0.013	197.15	192.18	1.75	21.48	1.84	5.31	7.40	0.25	0.34
WWGM0898	WWMF89020	WWMF89019	15.5	0.013	200.18	199.28	0.67	2.91	5.82	0.94	5.09	0.32	0.70
WWGM0917	WWMG99102	WWMG99101	363.5	0.013	208.50	204.83	1.75	15.92	1.01	5.28	5.95	0.33	0.40
WWGM0940	WWMF89025	WWMF89024	268.4	0.013	212.45	208.40	0.67	1.48	1.51	0.85	4.40	0.57	0.54
WWGM0953	WWMG89189	WWMG89187	214.5	0.013	222.20	221.48	0.83	1.27	0.34	0.96	2.78	0.76	0.61
WWGM0991	WWMF99012	WWMF99011	60.3	0.013	180.58	180.41	1.00	1.89	0.28	2.91	3.71	1.54	1.00
WWGM0992	WWMF99013	WWMF99012	275.8	0.013	186.08	180.65	1.00	5.00	1.97	2.79	4.19	0.56	1.00
WWGM0993	WWMF89023	WWMF89160	85.0	0.013	205.30	204.46	0.67	1.20	0.98	0.90	3.73	0.75	0.96
WWGM0996	WWMF89026	WWMF89025	34.1	0.013	213.74	212.80	0.67	2.01	2.76	0.85	5.52	0.42	0.46
WWGM0998	WWMF89024	WWMF89023	240.0	0.013	208.19	205.30	0.67	1.33	1.21	0.89	3.88	0.67	0.76
WWGM1005	WWMF99009	WWMF99008	233.4	0.013	179.26	178.50	1.00	2.03	0.33	2.96	3.77	1.46	1.00
WWGM1033	WWMG89193	WWMG89192	152.0	0.013	228.02	226.44	0.83	2.23	1.04	0.96	3.94	0.43	0.46
WWGM1035	WWMG89192	WWMG89189	364.7	0.013	226.02	224.07	0.83	1.60	0.53	0.96	3.16	0.60	0.54
WWGM1039	WWMG89186	WWMG89185	115.6	0.013	220.50	220.14	0.83	1.22	0.31	0.98	2.55	0.80	1.00
WWGM1045	WWMH105017	WWMH105005	193.4	0.013	163.31	162.19	1.00	2.71	0.58	1.61	3.65	0.60	0.55
WWGM1046	WWMH105005	WWMH105004	264.4	0.013	162.03	160.05	1.00	3.08	0.75	1.65	3.99	0.53	0.52
WWGM1047	WWMH105004	WWMH105003	275.1	0.013	160.00	157.72	1.00	3.24	0.83	1.65	4.12	0.51	0.60

20-Year Flows (2037), 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1051	WWMH105003	WWMH105002	277.9	0.013	157.69	155.42	1.00	3.22	0.82	1.66	3.95	0.52	0.86
WWGM1052	WWMH105002	WWMH105001	341.6	0.013	155.42	152.93	1.00	3.04	0.73	1.66	3.79	0.55	1.00
WWGM1053	WWMH105001	WWMH104012	61.1	0.013	152.88	151.90	1.00	4.51	1.61	1.75	4.04	0.39	1.00
WWGM1054	WWMI102066	WWMI111099	425.2	0.013	203.23	196.17	1.00	4.59	1.66	2.22	5.42	0.48	0.53
WWGM1055	WWMI102067	WWMI102066	153.3	0.013	208.13	205.74	1.00	4.45	1.56	2.21	5.65	0.50	0.50
WWGM1056	WWMI102068	WWMI102067	295.6	0.013	212.88	208.27	1.00	4.45	1.56	2.21	5.65	0.50	0.50
WWGM1060	WWMI102069	WWMI102068	254.8	0.013	213.72	213.18	1.00	1.64	0.21	2.18	3.17	1.33	0.82
WWGM1061	WWMI102070	WWMI102069	123.0	0.013	214.21	213.73	1.00	2.23	0.39	2.18	2.77	0.98	1.00
WWGM1062	WWMI102071	WWMI102070	42.2	0.013	214.40	214.31	1.00	1.65	0.21	2.18	3.22	1.33	1.00
WWGM1069	WWMI102073	WWMI102072	115.9	0.013	218.21	216.84	0.83	2.38	1.18	2.15	4.94	0.90	0.74
WWGM1070	WWMI102131	WWMI102073	126.5	0.013	219.28	218.55	0.83	1.66	0.58	2.14	4.16	1.28	0.89
WWGM1071	WWMI102132	WWMI102131	195.8	0.013	220.88	219.42	0.83	1.89	0.75	1.52	3.48	0.80	0.84
WWGM1072	WWMI104051	WWMI102132	58.5	0.013	222.06	221.22	1.50	12.59	1.44	1.52	4.81	0.12	0.23
WWGM1075	WWMH95019	WWMH95018	134.7	0.013	166.45	165.40	1.50	9.29	0.78	1.55	3.90	0.17	0.28
WWGM1076	WWMH95020	WWMH95019	346.9	0.013	169.94	166.45	1.50	10.53	1.00	1.55	4.07	0.15	0.27
WWGM1077	WWMH95021	WWMH95020	218.5	0.013	187.21	170.61	1.50	29.00	7.62	1.55	8.72	0.05	0.16
WWGM1080	WWMH95022	WWMH95021	259.8	0.013	190.07	187.35	1.50	10.75	1.05	1.54	4.32	0.14	0.26
WWGM1081	WWMH95023	WWMH95022	376.0	0.013	191.85	190.15	1.50	7.06	0.45	1.54	3.23	0.22	0.31
WWGM1082	WWMH95024	WWMH95023	157.0	0.013	192.85	191.99	1.50	7.77	0.55	1.32	3.28	0.17	0.28
WWGM1090	WWMI92151	WWMI92152	344.6	0.013	225.75	224.65	1.50	5.94	0.32	1.52	2.96	0.26	0.33
WWGM1091	WWMI92150	WWMI92151	107.8	0.013	229.75	226.53	1.50	18.16	2.99	1.37	6.05	0.08	0.19
WWGM1104	WWMI92147	WWMI92148	349.7	0.013	243.47	242.07	1.50	6.65	0.40	1.17	2.91	0.18	0.28
WWGM1105	WWMI92148	WWMI92149	281.5	0.013	241.52	237.17	1.50	13.06	1.55	1.17	4.57	0.09	0.20
WWGM1106	WWMI92149	WWMI92150	500.5	0.013	236.97	229.90	1.50	12.49	1.41	1.37	4.64	0.11	0.22
WWGM1107	WWMI92161	WWMI92159	465.0	0.013	249.58	248.23	1.25	3.48	0.29	0.05	1.08	0.01	0.08
WWGM1108	WWMI92159	WWMI92158	128.4	0.013	248.10	247.76	1.25	3.32	0.26	0.05	1.06	0.01	0.08
WWGM1109	WWMI92158	WWMI92157	403.4	0.013	247.11	245.75	1.25	3.75	0.34	0.05	1.13	0.01	0.07
WWGM1110	WWMI92157	WWMI92156	182.5	0.013	245.57	245.13	1.25	3.17	0.24	0.05	1.02	0.01	0.08
WWGM1111	WWMI92156	WWMI92147	203.0	0.013	244.65	243.61	1.25	4.62	0.51	0.05	1.27	0.01	0.15
WWGM1113	WWMI81	WWMI92143	411.7	0.013	268.14	257.94	1.00	5.61	2.48	0.64	4.75	0.11	0.23
WWGM1114	WWMI92143	WWMI92144	108.8	0.013	257.49	256.50	1.00	3.40	0.91	1.13	3.88	0.33	0.40
WWGM1116	WWMI92144	WWMI92146	160.8	0.013	256.47	254.96	1.00	3.45	0.94	1.13	1.93	0.33	0.70
WWGM1117	WWMI92146	WWMI92147	136.7	0.013	254.54	255.51	1.00	3.00	0.71	1.13	1.88	0.38	0.71
WWGM1119	WWMH95018	WWMH105017	341.9	0.013	165.10	163.46	1.00	2.47	0.48	1.61	3.47	0.65	0.57
WWGM1129	WWMI102072	WWMI102071	423.4	0.013	216.64	214.42	1.00	2.58	0.52	2.16	3.25	0.84	0.85
WWGM1131	WWMI92152	WWMI104050	237.8	0.013	223.96	222.64	1.50	7.83	0.56	1.52	3.43	0.19	0.30
WWGM1132	WWMI104050	WWMI104051	65.3	0.013	222.32	222.24	1.50	3.68	0.12	1.52	2.67	0.41	0.36
WWGM1164	WWMJ111094	WWMJ111103	264.2	0.013	177.95	177.19	1.00	1.91	0.29	0.78	2.51	0.41	0.51
WWGM1165	WWMJ111047	WWMJ120027	138.4	0.013	176.73	176.33	0.67	0.65	0.29	0.79	2.46	1.21	1.00
WWGM1167	WWMJ111043	WWMJ120024	300.3	0.013	184.33	177.46	0.83	3.31	2.29	0.65	4.71	0.20	0.30
WWGM1168	WWMJ111056	WWMJ111043	236.2	0.013	191.76	184.80	0.83	3.76	2.95	0.65	5.16	0.17	0.28
WWGM1176	WWMJ120060	WWMJ120037	175.6	0.013	136.72	132.73	0.83	3.30	2.27	0.99	5.29	0.30	0.38
WWGM1177	WWMJ120046	WWMJ120047	435.7	0.013	120.13	119.80	2.00	6.23	0.08	0.59	2.81	0.09	0.12
WWGM1178	WWMJ120045	WWMJ120046	370.6	0.013	157.75	120.36	2.00	72.04	10.14	0.60	5.58	0.01	0.09
WWGM1179	WWMJ120044	WWMJ120045	500.6	0.013	160.50	157.88	2.00	16.37	0.52	0.60	2.48	0.04	0.13
WWGM1180	WWMJ111064	WWMJ120044	400.0	0.013	162.76	160.66	2.00	16.41	0.53	0.63	2.51	0.04	0.13
WWGM1181	WWMJ111063	WWMJ111064	493.8	0.013	165.36	162.76	2.00	16.40	0.53	0.68	2.69	0.04	0.14
WWGM1182	WWMJ111062	WWMJ111063	439.3	0.013	167.35	165.51	2.00	14.64	0.42	0.70	2.45	0.05	0.15
WWGM1183	WWMJ111061	WWMJ111062	394.4	0.013	168.54	167.55	2.00	11.33	0.25	0.78	2.22	0.07	0.17
WWGM1186	WWMJ102131	WWMJ111061	445.8	0.013	170.08	168.54	2.00	13.30	0.35	0.99	2.73	0.07	0.18
WWGM1187	WWMJ102130	WWMJ102131	101.1	0.013	171.61	170.08	2.00	27.83	1.51	0.05	1.86	0.00	0.11
WWGM1194	WWMJ120015	WWMJ120001	129.3	0.013	164.04	163.96	1.00	0.89	0.06	0.00	0.00	0.00	0.01
WWGM1200	WWMH136249	WWMH136248	255.9	0.013	157.01	156.62	0.83	0.86	0.15	1.03	1.90	1.21	1.00
WWGM1201	WWMH136248	WWMH136247	334.1	0.013	156.42	155.89	0.83	0.87	0.16	2.05	3.77	2.35	1.00
WWGM1202	WWMH136247	WWMH146246	312.0	0.013	155.57	154.41	0.83	1.34	0.37	2.05	4.02	1.54	0.89
WWGM1204	WWMH146006	WWMH146005	259.1	0.013	146.57	146.06	2.50	18.20	0.20	30.01	6.11	1.65	1.00
WWGM1205	WWMH146246	WWMH146006	62.4	0.013	153.93	149.33	0.83	5.96	7.39	2.23	9.50	0.37	0.86
WWGM1206	WWMI131018	WWMI131017	61.3	0.013	158.73	158.05	1.25	6.80	1.11	4.41	5.66	0.65	1.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1218	WWMH146007	WWMH146006	489.6	0.013	147.71	146.63	2.50	19.26	0.22	27.96	5.70	1.45	1.00
WWGM1234	WWMF109006	WWMF109005	292.6	0.013	175.99	173.63	1.00	3.20	0.81	3.20	4.50	1.00	1.00
WWGM1236	WWMF99007	WWMF109006	290.0	0.013	177.87	176.84	1.00	2.12	0.36	3.18	4.06	1.50	1.00
WWGM1242	WWMG108011	WWMG108010	145.8	0.013	181.53	181.43	1.00	0.93	0.07	0.51	2.27	0.55	1.00
WWGM1244	WWMG109046	WWMG108080	372.6	0.013	179.31	178.79	1.75	5.92	0.14	5.35	3.12	0.90	1.00
WWGM1245	WWMG108009	WWMG108008	368.6	0.013	180.80	179.80	1.00	1.86	0.27	0.53	2.17	0.29	1.00
WWGM1246	WWMG108010	WWMG108009	155.3	0.013	181.43	180.86	1.00	2.16	0.37	0.53	2.32	0.25	1.00
WWGM1247	WWMG108008	WWMG108080	32.5	0.013	179.75	179.04	1.00	5.27	2.18	0.89	4.27	0.17	1.00
WWGM1248	WWMG108080	WWMG118086	202.1	0.013	178.59	178.22	1.75	6.78	0.18	5.80	3.44	0.85	1.00
WWGM1249	WWMG108007	WWMG108006	411.5	0.013	178.60	178.44	1.00	0.70	0.04	0.03	0.48	0.04	0.12
WWGM1252	WWMF127016	WWMF127015	14.4	0.013	154.81	153.41	1.25	20.21	9.79	2.60	4.34	0.13	0.49
WWGM1253	WWMF127014	WWMF127013	423.4	0.013	152.96	152.22	1.25	2.70	0.17	2.65	2.90	0.98	0.70
WWGM1254	WWMF127013	WWMF127012	60.6	0.013	152.22	151.92	1.25	4.55	0.50	2.64	3.28	0.58	0.63
WWGM1255	WWMF127012	WWMF127011	403.9	0.013	151.90	150.91	1.25	3.20	0.25	2.66	2.99	0.83	0.68
WWGM1264	J-250_SHER_BASEFLOW	F118029	40.0	0.013	138.76	138.60	0.67	0.76	0.40	0.01	0.79	0.01	0.07
WWGM1266	WWMF127017	WWMF127016	310.0	0.013	156.17	155.05	1.25	3.88	0.36	2.60	3.60	0.67	0.57
WWGM1272	WWMF127044	WWMF127007	515.5	0.013	157.16	148.58	0.67	1.56	1.66	0.03	1.22	0.02	0.55
WWGM1273	J-260_CHAR_BASEFLOW	F137193	20.0	0.013	146.92	146.60	0.67	1.53	1.60	0.07	2.27	0.05	0.15
WWGM1289	WWMF137072	F137204	13.8	0.013	109.76	108.50	1.50	31.83	9.18	2.71	9.64	0.09	0.22
WWGM1290	WWMF137001	WWMF137072	126.8	0.013	125.96	110.35	1.50	36.99	12.40	2.68	12.16	0.07	0.18
WWGM1291	WWMF137002	WWMF137001	97.3	0.013	132.89	126.51	1.50	26.93	6.57	2.68	9.73	0.10	0.21
WWGM1292	WWMF137003	WWMF137002	348.1	0.013	144.94	133.22	1.50	19.28	3.37	2.68	7.67	0.14	0.25
WWGM1293	WWMF137004	WWMF137003	112.0	0.013	147.00	146.31	1.25	5.07	0.62	2.67	4.18	0.53	0.52
WWGM1294	WWMF137005	WWMF137004	334.5	0.013	147.32	147.10	1.25	1.66	0.07	2.67	2.68	1.61	0.76
WWGM1304	WWMG136067	WWMG136066	318.9	0.013	161.45	160.79	1.00	1.62	0.21	2.01	2.56	1.24	1.00
WWGM1306	WWMG136068	WWMG136067	324.9	0.013	162.01	161.46	1.00	1.47	0.17	1.05	1.44	0.72	1.00
WWGM1307	WWMG136069	WWMG136068	15.2	0.013	162.03	162.06	1.00	1.58	0.20	1.02	1.93	0.64	1.00
WWGM1308	WWMG136070	WWMG136069	238.7	0.013	162.60	162.23	1.00	1.40	0.15	1.00	2.14	0.71	1.00
WWGM1309	WWMG126098	WWMG136070	350.4	0.013	163.54	162.65	1.00	1.80	0.25	0.57	1.34	0.32	1.00
WWGM1313	WWMG126237	WWMG126236	363.7	0.013	161.43	160.29	1.75	8.87	0.31	11.55	4.80	1.30	1.00
WWGM1314	WWMG126238	WWMG126237	243.2	0.013	162.28	161.50	1.75	8.97	0.32	11.55	4.80	1.29	1.00
WWGM1316	WWMG126236	WWMG136260	371.1	0.013	158.58	157.50	1.75	8.55	0.29	11.56	4.81	1.35	1.00
WWGM1318	WWMG136064	WWMG136021	266.7	0.013	159.97	158.79	1.00	2.37	0.44	2.03	2.92	0.86	1.00
WWGM1319	WWMG136260	WWMG136019	27.7	0.013	157.00	157.13	1.75	10.86	0.47	11.58	4.81	1.07	1.00
WWGM1320	WWMG136019	WWMG136018	355.3	0.013	156.83	156.60	1.75	4.03	0.06	11.33	4.71	2.81	1.00
WWGM1321	WWMG136021	WWMG136019	18.6	0.013	158.68	157.07	1.50	30.99	8.70	1.09	1.96	0.04	1.00
WWGM1323	WWMG136054	WWMG136053	357.5	0.013	158.95	157.87	1.25	3.55	0.30	3.53	2.88	1.00	1.00
WWGM1324	WWMG136018	WWMG136017	353.6	0.013	156.39	155.92	1.75	5.78	0.13	10.53	4.38	1.82	1.00
WWGM1325	WWMG136016	WWMG136015	308.7	0.013	155.01	154.14	2.25	16.44	0.28	19.02	5.13	1.16	1.00
WWGM1326	WWMG136035	WWMG136016	273.2	0.013	157.45	156.86	1.25	3.00	0.22	3.72	3.22	1.24	1.00
WWGM1330	WWMG136015	WWMG146014	301.7	0.013	153.68	152.93	2.25	15.44	0.25	19.72	5.31	1.28	1.00
WWGM1331	WWMG136050	WWMG146078	299.1	0.013	155.69	155.03	1.25	3.03	0.22	5.13	4.18	1.69	1.00
WWGM1338	WWMH146247	WWMH146008	500.0	0.013	148.89	148.71	2.50	7.78	0.04	27.96	5.69	3.59	1.00
WWGM1339	WWMH146008	WWMH146007	492.1	0.013	148.65	147.73	2.50	17.73	0.19	27.96	5.70	1.58	1.00
WWGM1341	WWMG136020	WWMG136016	17.1	0.013	155.24	155.16	1.75	10.83	0.47	13.93	5.79	1.29	1.00
WWGM1342	WWMG136051	WWMG136050	311.8	0.013	156.25	155.69	1.25	2.74	0.18	4.70	3.83	1.72	1.00
WWGM1352	WWMG137193	WWMG136051	365.9	0.013	157.07	156.25	1.25	3.06	0.22	4.70	3.83	1.54	1.00
WWGM1353	WWMG136053	WWMG137193	351.0	0.013	157.74	157.09	1.25	2.78	0.19	4.24	3.45	1.52	1.00
WWGM1355	WWMG136017	WWMG136020	350.6	0.013	155.82	155.44	1.75	5.22	0.11	11.89	4.94	2.28	1.00
WWGM1356	WWMG126239	WWMG126238	402.9	0.013	163.94	162.54	1.75	9.34	0.35	11.55	4.80	1.24	1.00
WWGM1358	WWMG126240	WWMG126239	136.0	0.013	165.66	164.18	1.75	16.53	1.09	11.55	6.04	0.70	1.00
WWGM1368	WWMG126102	WWMG127188	280.1	0.013	164.40	163.76	1.00	1.70	0.23	0.59	1.17	0.34	1.00
WWGM1369	WWMG127188	WWMG126098	394.2	0.013	163.75	163.69	1.00	0.44	0.02	0.56	1.25	1.28	1.00
WWGM1371	WWMF127118	WWMF127117	137.1	0.013	168.96	168.71	0.83	0.94	0.18	1.08	1.99	1.16	1.00
WWGM1372	WWMF127117	WWMF127116	260.2	0.013	168.63	168.33	0.83	0.74	0.12	1.09	2.17	1.46	1.00
WWGM1373	WWMF127116	WWMF127115	383.8	0.013	168.23	167.52	1.00	1.53	0.18	1.22	2.24	0.80	1.00
WWGM1378	WWMF127008	WWMF127007	264.7	0.013	149.01	148.58	1.25	2.60	0.16	2.66	2.72	1.02	0.74
WWGM1379	WWMF127007	WWMF137006	197.4	0.013	148.57	148.06	1.25	3.28	0.26	2.68	2.89	0.82	0.72

20-Year Flows (2037), 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1380	WWMF137006	WWMF137005	304.8	0.013	148.06	147.32	1.25	3.18	0.24	2.67	2.36	0.84	0.87
WWGM1381	WWMF127011	WWMF127010	262.6	0.013	150.90	150.14	1.25	3.48	0.29	2.66	3.15	0.77	0.65
WWGM1382	WWMF127010	WWMF127009	188.0	0.013	150.14	149.57	1.25	3.56	0.30	2.66	3.02	0.75	0.68
WWGM1383	WWMF127009	WWMF127008	256.2	0.013	149.42	149.01	1.25	2.58	0.16	2.66	2.47	1.03	0.82
WWGM1389	WWMG137106	WWMG136039	319.7	0.013	161.89	161.27	1.25	2.84	0.19	2.35	2.60	0.83	1.00
WWGM1390	WWMG136039	WWMG136038	487.1	0.013	161.22	160.06	1.25	3.15	0.24	2.55	2.72	0.81	1.00
WWGM1401	WWMF127203	WWMF127118	309.4	0.013	169.66	169.21	0.83	0.84	0.15	1.07	2.18	1.28	1.00
WWGM1402	WWMF127220	WWMF127203	279.8	0.013	170.34	169.81	0.83	0.95	0.19	1.06	2.09	1.11	1.00
WWGM1403	WWMF127119	WWMF127220	6.1	0.013	170.40	170.39	0.83	0.89	0.16	1.06	2.21	1.20	1.00
WWGM1411	WWMF117018	WWMF127017	299.9	0.013	157.50	157.45	1.25	0.83	0.02	2.62	2.62	3.14	0.76
WWGM1419	WWMF117021	WWMF117020	303.3	0.013	160.66	159.88	1.25	3.28	0.26	2.48	2.94	0.76	0.65
WWGM1420	WWMF117022	WWMF117021	299.7	0.013	161.98	160.74	1.25	4.15	0.41	2.47	3.41	0.60	0.57
WWGM1422	WWMF117023	WWMF117022	323.4	0.013	163.58	162.10	1.25	4.37	0.46	2.47	3.78	0.57	0.53
WWGM1442	WWMG89194	WWMG89193	242.3	0.013	234.52	232.09	0.83	2.19	1.00	0.92	3.84	0.42	0.45
WWGM1447	WWMG79195	WWMG89194	361.0	0.013	240.18	234.89	1.00	4.31	1.47	0.91	4.35	0.21	0.31
WWGM1448	WWMG79196	WWMG79195	87.5	0.013	240.58	240.31	0.83	1.22	0.31	0.91	2.76	0.75	0.58
WWGM1449	WWMG79244	WWMG79196	136.6	0.013	241.37	240.83	0.83	1.38	0.40	0.91	2.88	0.66	0.56
WWGM1451	WWMG79245	WWMG79244	130.4	0.013	242.09	241.67	0.83	1.24	0.32	0.91	2.75	0.73	0.58
WWGM1452	WWMG79246	WWMG79245	103.7	0.013	242.45	242.24	0.83	0.99	0.20	0.86	2.51	0.87	0.60
WWGM1462	WWMF79030	WWMF79029	22.4	0.013	217.37	216.90	0.67	1.75	2.10	0.83	3.14	0.47	1.00
WWGM1463	WWMF79031	WWMF79030	108.5	0.013	218.07	217.49	0.67	0.88	0.53	0.82	3.05	0.93	0.81
WWGM1464	WWMG79032	WWMF79031	93.8	0.013	218.21	218.07	0.67	0.47	0.15	0.82	2.53	1.77	0.89
WWGM1465	WWMG79033	WWMG79032	338.1	0.013	222.83	218.65	0.67	1.34	1.24	0.79	4.00	0.59	0.55
WWGM1470	WWMF89022	WWMF89021	316.5	0.013	201.60	201.25	0.67	0.40	0.11	0.90	2.74	2.25	0.90
WWGM1476	WWMF79029	WWMF79028	79.0	0.013	216.75	216.67	0.67	0.38	0.10	0.83	2.37	2.15	1.00
WWGM1477	WWMF79028	WWMF89027	318.4	0.013	216.32	215.51	0.67	0.61	0.25	0.84	2.73	1.38	0.83
WWGM1480	WWMF89027	WWMF89026	129.8	0.013	215.21	213.96	0.67	1.19	0.96	0.85	3.70	0.72	0.63
WWGM1481	WWMG79034	WWMG79033	192.5	0.013	224.69	223.14	0.67	1.08	0.81	0.79	3.39	0.73	0.63
WWGM1529	WWMG99105	WWMG99104	313.1	0.013	212.56	210.77	1.50	7.94	0.57	4.36	4.60	0.55	0.53
WWGM1534	WWMG99104	WWMG99102	343.8	0.013	210.39	208.69	1.75	11.14	0.49	5.29	4.58	0.47	0.48
WWGM1539	J-240_CREEK_BASEFLOW	F109157	40.0	0.013	165.97	165.77	0.67	0.85	0.50	0.02	1.25	0.02	0.10
WWGM1547	WWMF109005	WWMF109004	286.3	0.013	173.61	171.64	1.00	2.96	0.69	3.15	4.02	1.07	1.00
WWGM1548	WWMF109040	WWMF109005	312.3	0.013	174.77	173.63	1.00	2.15	0.37	0.30	0.45	0.14	1.00
WWGM1551	WWMF109153	WWMF118026	185.5	0.013	166.55	166.13	1.25	3.07	0.23	3.35	3.30	1.09	1.00
WWGM1552	WWMF109000	WWMF109153	150.9	0.013	167.20	166.64	1.25	3.94	0.37	3.32	3.35	0.84	1.00
WWGM1553	WWMF109001	WWMF109000	19.1	0.013	167.76	167.35	1.25	9.47	2.15	3.72	5.45	0.39	1.00
WWGM1554	WWMF109150	WWMF109001	118.9	0.013	168.21	167.81	1.00	2.07	0.34	3.32	4.31	1.60	1.00
WWGM1555	WWMF109002	WWMF109150	98.1	0.013	168.39	168.17	1.00	1.69	0.22	3.32	4.22	1.97	1.00
WWGM1557	WWMF109003	WWMF109002	144.6	0.013	169.02	168.82	1.00	1.33	0.14	3.29	4.19	2.49	1.00
WWGM1560	WWMF109004	WWMF109003	439.3	0.013	171.53	170.03	1.00	2.08	0.34	3.29	4.19	1.58	1.00
WWGM1564	WWMF117024	WWMF117023	30.3	0.013	163.87	163.98	1.25	3.89	0.36	0.01	0.32	0.00	0.27
WWGM1565	WWMF117025	J-280_HWY240_WEIR	145.5	0.013	164.41	164.00	1.00	1.89	0.28	3.39	4.57	1.79	0.89
WWGM1566	WWMF117026	WWMF117025	205.2	0.013	164.30	164.49	1.25	1.97	0.09	3.38	2.76	1.72	1.00
WWGM1567	WWMF117027	WWMF117026	309.7	0.013	165.11	164.50	1.25	2.87	0.20	3.38	2.76	1.18	1.00
WWGM1568	WWMF117028	WWMF117027	109.5	0.013	165.19	165.27	1.25	1.75	0.07	3.38	2.75	1.93	1.00
WWGM1569	WWMF118001	WWMF117028	7.0	0.013	165.39	165.49	1.00	4.25	1.42	0.06	0.40	0.01	1.00
WWGM1570	WWMF118002	WWMF118001	97.7	0.013	165.74	165.59	1.00	1.40	0.15	0.05	0.59	0.04	1.00
WWGM1571	WWMF118026	WWMF117028	157.5	0.013	165.75	165.44	1.25	2.87	0.20	3.35	2.73	1.17	1.00
WWGM1572	WWMF118025	WWMF118026	63.1	0.013	166.25	166.13	0.83	0.96	0.19	0.11	0.70	0.12	1.00
WWGM1573	WWMF118024	WWMF118025	90.1	0.013	167.53	166.28	0.83	2.58	1.39	0.11	1.43	0.04	0.95
WWGM1574	WWMF118023	WWMF118024	104.3	0.013	169.65	167.58	0.83	3.09	1.98	0.03	1.75	0.01	0.46
WWGM1575	WWMF118003	WWMF118023	80.8	0.013	170.44	169.70	0.83	2.10	0.92	0.05	1.62	0.02	0.11
WWGM1590	WWMG137107	WWMG136095	352.4	0.013	162.99	162.63	1.25	2.06	0.10	2.34	2.21	1.13	1.00
WWGM1591	WWMG137183	WWMG137107	20.2	0.013	163.12	163.09	1.25	2.49	0.15	2.34	2.24	0.94	1.00
WWGM1592	WWMG127109	WWMG137183	378.9	0.013	163.83	163.22	1.25	2.59	0.16	2.33	2.39	0.90	1.00
WWGM1603	WWMG127133	WWMF127115	158.0	0.013	168.63	167.52	0.83	1.84	0.70	0.23	1.09	0.13	1.00
WWGM1604	WWMF127115	WWMG127114	114.6	0.013	167.50	165.93	1.00	4.17	1.37	2.33	5.20	0.56	1.00
WWGM1605	WWMG127110	WWMG127109	258.2	0.013	164.26	163.91	1.25	2.38	0.14	2.33	2.35	0.98	1.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input								Output						
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1606	WWMG126200	WWMG127110	395.2	0.013	164.87	164.33	1.25	2.39	0.14	2.33	2.25	0.98	1.00
WWGM1607	WWMG127114	WWMG126200	144.7	0.013	165.69	164.97	1.00	2.51	0.50	2.33	3.25	0.93	1.00
WWGM1614	WWMG126147	WWMG127195	520.6	0.013	174.04	167.46	0.83	2.46	1.26	0.32	0.79	0.13	1.00
WWGM1617	WWMG108006	WWMG108005	410.2	0.013	178.43	177.32	1.00	1.85	0.27	0.03	0.91	0.01	0.08
WWGM1618	WWMG108005	WWMG118004	141.8	0.013	177.08	174.65	0.83	2.87	1.71	0.03	1.63	0.01	0.07
WWGM1619	WWMG118004	WWMF118003	276.8	0.013	174.35	170.49	0.83	2.59	1.39	0.03	1.52	0.01	0.07
WWGM1639	WWMH131082	WWMH131081	491.9	0.013	110.06	108.31	1.25	3.85	0.36	5.55	4.52	1.44	1.00
WWGM1641	WWMH131083	WWMH131082	431.1	0.013	111.72	110.18	1.25	3.86	0.36	5.20	4.24	1.35	1.00
WWGM1642	WWMH133096	WWMH131083	28.8	0.013	114.54	113.17	1.50	22.92	4.76	5.21	9.82	0.23	1.00
WWGM1643	WWMH133000	WWMH133096	8.6	0.013	115.16	114.79	1.50	21.85	4.33	6.37	8.27	0.29	1.00
WWGM1644	WWMH133001	WWMH133096	178.1	0.013	116.99	114.79	1.00	3.96	1.24	1.24	3.25	0.31	1.00
WWGM1645	WWMH133002	WWMH133001	137.9	0.013	117.76	116.99	1.00	2.66	0.56	1.87	2.78	0.70	1.00
WWGM1646	WWMH133066	WWMH133000	199.1	0.013	116.27	115.71	1.50	5.57	0.28	6.37	3.88	1.14	1.00
WWGM1647	WWMH133067	WWMH133066	262.2	0.013	117.04	116.48	1.50	4.85	0.21	8.24	4.66	1.70	1.00
WWGM1648	WWMH123005	WWMH123004	499.4	0.013	163.03	160.10	1.00	2.73	0.59	2.54	3.97	0.93	0.76
WWGM1649	WWMH123004	WWMH123003	414.2	0.013	160.05	157.64	1.00	2.72	0.58	2.55	4.07	0.94	0.74
WWGM1650	WWMH123003	WWMH133002	218.2	0.013	157.32	118.02	1.00	15.25	18.31	2.57	8.95	0.17	0.64
WWGM1653	WWMH123068	WWMH133067	370.2	0.013	118.12	117.29	1.50	4.97	0.22	8.24	4.66	1.66	1.00
WWGM1654	WWMH123069	WWMH123068	123.6	0.013	118.70	118.42	1.50	5.00	0.23	7.24	4.10	1.45	1.00
WWGM1655	WWMH123070	WWMH123069	90.4	0.013	119.14	119.08	1.50	2.71	0.07	7.24	4.10	2.67	1.00
WWGM1660	J-270_ANDR_BASEFLOW	G146040	40.0	0.013	143.66	143.50	0.67	0.76	0.40	0.07	1.45	0.09	0.19
WWGM1669	WWMG136095	WWMG137106	424.2	0.013	162.53	161.89	1.25	2.51	0.15	2.35	2.30	0.93	1.00
WWGM1685	WWMH126133	WWMH136204	209.2	0.013	161.52	160.41	0.83	1.60	0.53	1.02	3.11	0.64	1.00
WWGM1689	WWMH104043	WWMH104042	449.2	0.013	213.21	211.83	1.00	1.97	0.31	0.78	2.52	0.39	0.42
WWGM1709	WWMI111099	WWMI111053	500.2	0.013	195.95	193.92	1.25	4.12	0.41	2.80	3.77	0.68	0.58
WWGM1710	WWMI111036	WWMI111035	289.1	0.013	182.78	181.39	1.25	4.48	0.48	3.51	3.34	0.78	1.00
WWGM1713	WWMH114030	WWMH114029	101.7	0.013	177.83	176.93	0.67	1.14	0.89	1.77	5.08	1.56	1.00
WWGM1718	WWMH123006	WWMH123005	305.9	0.013	164.58	163.32	1.00	2.29	0.41	2.53	3.59	1.11	0.84
WWGM1739	WWMI111053	WWMI111037	117.3	0.013	193.35	190.22	1.25	10.55	2.67	3.46	7.70	0.33	0.39
WWGM1740	WWMI111037	WWMI111036	53.8	0.013	189.43	183.25	1.25	21.96	11.56	3.49	12.04	0.16	0.63
WWGM1742	WWMG136254	WWMG136054	261.9	0.013	159.70	158.92	1.00	1.94	0.30	0.67	1.06	0.34	1.00
WWGM1743	WWMG136097	WWMG136254	257.5	0.013	160.50	159.70	1.00	1.99	0.31	0.66	0.87	0.33	1.00
WWGM1753	WWMG136065	WWMG136064	267.0	0.013	160.39	159.99	1.00	1.38	0.15	2.03	2.59	1.47	1.00
WWGM1755	WWMG136066	WWMG136065	260.3	0.013	160.79	160.39	1.00	1.40	0.15	2.02	2.57	1.45	1.00
WWGM1756	WWMG136100	WWMG136066	198.2	0.013	163.12	160.79	1.00	3.86	1.18	0.43	0.78	0.11	1.00
WWGM1760	WWMG136038	WWMG136037	352.2	0.013	160.06	159.28	1.25	3.04	0.22	2.57	2.10	0.84	1.00
WWGM1762	WWMG136037	WWMG137195	338.6	0.013	159.28	158.68	1.25	2.72	0.18	3.55	2.89	1.31	1.00
WWGM1763	WWMG137194	WWMG136035	319.2	0.013	158.03	157.53	1.25	2.56	0.16	3.70	3.01	1.45	1.00
WWGM1764	WWMG136074	WWMG136050	250.6	0.013	164.31	163.74	0.83	1.05	0.23	0.01	0.69	0.01	0.07
WWGM1766	WWMH136250	WWMH136249	137.8	0.013	157.81	157.38	0.83	1.22	0.31	1.03	2.44	0.84	1.00
WWGM1767	WWMH136135	WWMH136250	405.9	0.013	158.83	157.93	0.83	1.03	0.22	1.03	2.23	1.00	1.00
WWGM1768	WWMH136253	WWMH136135	199.3	0.013	159.45	159.02	0.83	1.02	0.22	1.03	2.41	1.01	1.00
WWGM1769	WWMH136204	WWMH136253	223.9	0.013	159.79	159.68	0.83	0.49	0.05	1.02	2.03	2.11	1.00
WWGM1770	WWMH136262	WWMG136097	336.6	0.013	161.48	160.50	1.00	1.92	0.29	0.48	0.74	0.25	1.00
WWGM1771	WWMF117019	WWMF117018	281.5	0.013	158.59	157.78	1.25	3.46	0.29	2.50	2.74	0.72	0.72
WWGM1773	WWMF117020	WWMF117019	458.0	0.013	159.73	158.77	1.25	2.96	0.21	2.50	3.02	0.84	0.64
WWGM1779	WWMG109049	WWMG109048	306.6	0.013	182.02	181.21	1.75	8.14	0.26	5.28	3.44	0.65	1.00
WWGM1780	WWMG109050	WWMG109049	279.0	0.013	186.00	182.32	1.75	18.20	1.32	5.27	6.16	0.29	0.76
WWGM1781	WWMG109051	WWMG109050	272.6	0.013	188.97	186.45	1.75	15.24	0.92	5.31	5.76	0.35	0.41
WWGM1782	WWMG99099	WWMG109051	272.6	0.013	191.77	189.26	1.75	15.20	0.92	5.31	5.76	0.35	0.41
WWGM1788	WWMG116237	WWMG116236	301.4	0.013	173.99	173.53	1.75	6.19	0.15	9.02	3.75	1.46	1.00
WWGM1790	WWMI121026	WWMI131025	351.3	0.013	171.05	170.10	1.25	3.36	0.27	3.61	3.51	1.07	1.00
WWGM1791	WWMI121027	WWMI121026	336.7	0.013	172.17	171.05	1.25	3.73	0.33	4.58	3.73	1.23	1.00
WWGM1792	WWMI121103	WWMI121027	23.1	0.013	172.36	172.37	1.25	1.65	0.06	4.60	3.75	2.79	1.00
WWGM1793	WWMI121028	WWMI121103	38.1	0.013	172.66	172.36	1.25	5.78	0.80	3.99	3.66	0.69	1.00
WWGM1794	WWMI121029	WWMI121028	365.6	0.013	174.79	172.66	1.25	4.93	0.58	3.75	3.77	0.76	1.00
WWGM1795	WWMI121030	WWMI121029	347.9	0.013	176.89	174.79	1.25	5.02	0.60	3.77	3.87	0.75	1.00
WWGM1796	WWMI121100	WWMI121030	59.7	0.013	177.06	176.89	1.25	3.41	0.28	3.66	3.40	1.07	1.00

20-Year Flows (2037), 5-year, 24-hour storm event

Input								Output						
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1798	WWMI121031	WWMI121100	342.8	0.013	178.01	177.06	1.25	3.41	0.28	3.57	2.96	1.05	1.00
WWGM1799	WWMI111032	WWMI121031	450.4	0.013	179.27	178.01	1.25	3.42	0.28	3.56	2.95	1.04	1.00
WWGM1800	WWMI111040	WWMI111032	452.8	0.013	180.54	179.27	1.25	3.42	0.28	3.54	2.98	1.04	1.00
WWGM1802	WWMI111035	WWMI111040	306.3	0.013	181.39	180.54	1.25	3.40	0.28	3.53	2.99	1.04	1.00
WWGM1810	WWMF99016	WWMF99015	147.1	0.013	190.51	189.39	0.83	1.91	0.76	0.98	2.63	0.51	1.00
WWGM1811	WWMF99017	WWMF99016	75.7	0.013	191.25	190.62	0.83	2.00	0.83	0.98	3.49	0.49	1.00
WWGM1812	WWMF99018	WWMF99017	160.5	0.013	192.94	191.30	0.83	2.21	1.02	0.98	3.82	0.44	1.00
WWGM1828	WWMG146025	WWMG146013	253.0	0.013	155.04	152.57	1.50	10.38	0.98	2.59	4.06	0.25	1.00
WWGM1834	WWMG126242	WWMG126241	303.3	0.013	171.64	168.53	1.75	16.05	1.03	10.92	6.85	0.68	1.00
WWGM1835	WWMG126241	WWMG127195	139.7	0.013	168.22	167.46	1.75	11.69	0.54	10.44	5.48	0.89	1.00
WWGM1837	WWMG126243	WWMG126242	254.9	0.013	171.83	171.74	1.75	2.98	0.04	10.44	4.34	3.51	1.00
WWGM1839	WWMG116235	WWMG126243	292.4	0.013	172.55	172.04	1.75	6.62	0.17	9.97	4.14	1.51	1.00
WWGM1840	WWMG127195	WWMG126240	187.0	0.013	166.36	165.81	1.75	8.59	0.29	10.61	4.75	1.24	1.00
WWGM1842	WWMG116236	WWMG116235	299.3	0.013	173.27	172.84	1.75	6.01	0.14	9.50	3.95	1.58	1.00
WWGM1967	WWMJ120017	J120019	23.4	0.013	122.37	121.60	2.00	41.02	3.29	2.18	6.92	0.05	0.16
WWGM2024	J-230_CHEHAL_BASEFLOW	F89189	40.0	0.013	186.09	185.93	0.67	0.76	0.40	0.51	2.59	0.67	0.55
WWGM2025	WWMJ120047	J120019	32.1	0.013	119.80	119.60	24.00	0.00	0.62	0.60	-1.00	-1.00	-1.00
WWGM2026	WWMG89260	WWMG89259	285.5	0.013	217.01	216.37	1.50	4.97	0.22	4.36	3.70	0.88	0.64
WWGM2035	WWMG109047	WWMG109046	377.4	0.013	180.34	179.71	1.75	6.47	0.17	5.34	3.45	0.83	1.00
WWGM2037	WWMG109048	WWMG109047	349.8	0.013	181.12	180.53	1.75	6.51	0.17	5.30	3.28	0.81	1.00
WWGM2039	J-110	WWMG136054	228.4	0.013	159.72	158.95	1.00	2.07	0.34	2.19	2.79	1.06	1.00
WWGM2053	WWMG89250	WWMG89260	19.4	0.013	220.40	220.10	0.67	1.50	1.55	1.03	4.61	0.68	0.61
WWGM2054	WWMG89076	WWMG89260	43.7	0.013	218.83	218.00	0.67	1.66	1.90	0.03	1.83	0.02	0.14
WWGM2073	WWMG118104	WWMG117195	36.0	0.013	184.64	184.46	1.25	4.57	0.50	3.31	4.23	0.72	0.61
WWGM2074	J-100	WWMF117024	15.3	0.013	164.00	163.89	1.00	3.02	0.72	0.00	0.13	0.00	0.32
WWGM2075	J-280_HWY240_WEIR	WWMF118050	45.7	0.013	163.80	163.06	1.00	4.53	1.62	3.38	4.90	0.75	0.82
WWGM2076	WWMF118050	WWMF118049	85.0	0.013	162.98	162.58	1.00	2.44	0.47	3.38	4.57	1.38	0.89
WWGM2077	WWMF118049	WWMF118048	138.0	0.013	162.17	154.99	1.00	8.13	5.21	3.63	5.91	0.45	0.73
WWGM2078	WWMF118048	HWY240LS	20.0	0.013	154.99	155.00	1.00	0.80	0.05	3.64	4.64	4.57	1.00
WWGM2093	WWMG136036	WWMG137194	61.3	0.013	158.51	158.08	1.25	5.41	0.70	3.62	3.26	0.67	1.00
WWGM2094	WWMG137195	WWMG136036	88.7	0.013	158.48	158.46	1.25	0.97	0.02	3.57	3.14	3.68	1.00
WWGM2110	WWMH114003	WWMH114140	66.3	0.013	140.08	139.38	1.00	3.66	1.06	2.60	3.31	0.71	1.00
WWGM2119	WWMI131111	WWMI131019	95.9	0.013	160.90	160.63	1.25	3.43	0.28	4.40	3.58	1.28	1.00
WWGM2137	WWMJ111103	WWMJ111047	30.1	0.013	177.19	176.75	1.00	4.31	1.46	1.91	3.18	0.44	0.77
WWGM2146	WWMG146012	WWMG146076	311.7	0.013	152.08	151.46	1.50	4.69	0.20	4.83	2.73	1.03	1.00
WWGM2147	WWMG146075	WWMG146076	9.4	0.013	151.83	152.31	3.00	151.15	5.14	19.69	4.94	0.13	1.00
WWGM2148	WWMG146014	WWMG146075	9.1	0.013	152.58	152.68	2.25	32.47	1.10	19.70	5.96	0.61	1.00
WWGM2149	WWMG146076	WWMG146077	275.8	0.013	151.13	150.91	3.00	18.84	0.08	22.14	4.34	1.18	1.00
WWGM2150	WWMG146078	WWMG146077	26.9	0.013	154.74	152.10	1.25	20.27	9.85	5.13	7.13	0.25	1.00
WWGM2151	WWMG146077	WWMG146079	380.7	0.013	150.36	149.98	3.00	21.07	0.10	25.98	3.78	1.23	1.00
WWGM2152	WWMG146079	WWMH146247	372.3	0.013	149.70	149.05	3.00	27.87	0.17	27.96	3.96	1.00	1.00

Appendix D3:
Buildout System
Model Data

Buildout Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
J-100	172.40	164.00	2017			1.76	165.76	6.64	1.51	0	0.00
J-110	170.05	158.70	2017			11.35	170.05	0.00	2.19	0	0.00
J-120_ANDR	150.60	148.40	2017			42.54	190.94	-40.34	0.41	0	0.00
J-130_CHAR	154.10	151.20	2017			42.16	193.36	-39.26	1.24	0	0.00
J-140_CHEHAL	196.10	177.10	2017			141.05	318.15	-122.05	1.47	0	0.00
J-150_CREEKSD	174.60	160.60	2017			20.38	180.98	-1.79	0.42	0	0.00
J-160_DAY	113.50	107.00	2017			707.37	814.37	-700.87	5.79	0	0.00
J-170_FERN1	140.60	137.60	2017			87.79	225.39	-84.79	2.73	0	0.00
J-190_HWY240_1	165.00	143.00	2017			85.14	228.14	-63.14	3.48	0	0.00
J-210_SHER1	156.60	132.60	2017			57.48	190.08	-33.48	0.51	0	0.00
J-230_CHEHAL_BASEFLOW	196.10	186.09	2017	0.175	FM3_DIURNAL	0.48	186.57	9.53	0.68	0	0.00
J-240_CREEK_BASEFLOW	174.60	165.97	2017	0.011	FM2_DIURNAL	0.07	166.04	8.56	0.02	0	0.00
J-250_SHER_BASEFLOW	156.60	138.76	2017	0.004	FM9_DIURNAL	0.05	138.81	17.79	0.01	0	0.00
J-260_CHAR_BASEFLOW	154.10	146.92	2017	0.025	FM10_DIURNAL	0.10	147.02	7.08	0.07	0	0.00
J-270_ANDR_BASEFLOW	150.60	143.66	2017	0.023	FM10_DIURNAL	0.14	143.80	6.80	0.07	0	0.00
J-280_HWY240_WEIR	172.40	163.80	2008			1.99	165.79	6.61	3.31	0	0.00
J-F102	177.00	168.63	2037	0.033	FM3_DIURNAL	0.33	172.23	4.77	1.52	0	0.00
J-F103	188.00	182.92	2037	0.059	FM3_DIURNAL	0.43	181.09	6.91	0.81	0	0.00
J-F104	201.00	184.56	2047	0.050	FM2_DIURNAL	0.32	184.88	16.12	0.48	0	0.00
J-F105	180.00	175.00	2047	0.032	FM2_DIURNAL	0.34	175.34	4.66	0.37	0	0.00
J-F106_RIVERFRONT	152.00	149.00	2037			108.48	257.48	-105.48	3.75	0	0.00
J-F107_PROVIDENCE	168.00	165.00	2037			128.50	293.50	-125.50	1.52	0	0.00
J-F108_PROV_BASEFLOW	182.00	167.08	2037	0.136	FM12_DIURNAL	0.43	167.51	14.49	0.51	0	0.00
J-F110	164.00	159.00	2037	0.053	FM10_DIURNAL	0.33	159.33	4.67	0.65	0	0.00
J-F111	167.00	162.00	2037	0.056	FM10_DIURNAL	0.37	162.37	4.63	0.55	0	0.00
WWMF109000	175.61	167.20	1978	0.000	FM2_DIURNAL	2.58	169.78	5.83	4.00	0	0.00
WWMF109001	175.70	167.76	1978	0.000	FM2_DIURNAL	2.07	169.83	5.87	3.24	0	0.00
WWMF109002	175.26	168.39	1980	0.014	FM2_DIURNAL	3.15	171.54	3.72	3.24	0	0.00
WWMF109003	178.18	169.02	1978	0.000	FM2_DIURNAL	3.67	172.69	5.49	3.22	0	0.00
WWMF109004	183.87	171.53	1978	0.042	FM2_DIURNAL	4.58	176.11	7.76	3.22	0	0.00
WWMF109005	187.09	173.61	1978	0.032	FM2_DIURNAL	4.36	177.97	9.12	3.26	0	0.00
WWMF109006	188.45	175.99	1994	0.014	FM2_DIURNAL	4.33	180.32	8.13	3.21	0	0.00
WWMF109040	177.87	174.77	1980	0.000	FM2_DIURNAL	3.10	177.87	0.00	0.40	0.014351	3.30
WWMF109150	174.88	168.17	1995	0.000	FM2_DIURNAL	2.59	170.76	4.12	3.24	0	0.00
WWMF109153	172.73	166.55	2017	0.023	FM2_DIURNAL	2.86	169.41	3.32	3.27	0	0.00
WWMF117018	168.07	157.50	1976	0.001	FM9_DIURNAL	5.53	163.03	5.04	3.94	0	0.00
WWMF117019	170.98	158.59	1976	0.004	FM9_DIURNAL	4.97	163.56	7.42	3.84	0	0.00
WWMF117020	167.67	159.73	1976	0.016	FM9_DIURNAL	4.47	164.20	3.47	3.84	0	0.00
WWMF117021	166.65	160.66	1976	0.004	FM9_DIURNAL	3.92	164.58	2.07	3.81	0	0.00
WWMF117022	169.11	161.98	1976	0.000	FM9_DIURNAL	2.92	164.90	4.21	3.80	0	0.00
WWMF117023	173.64	163.58	1976	0.000	FM2_DIURNAL	2.18	165.76	7.88	3.81	0	0.00
WWMF117024	172.69	163.87	1976	0.000	FM2_DIURNAL	1.90	165.77	6.92	1.64	0	0.00
WWMF117025	170.57	164.41	1976	0.000	FM2_DIURNAL	2.57	166.98	3.59	3.31	0	0.00
WWMF117026	173.30	164.30	1976	0.000	FM2_DIURNAL	3.20	167.50	5.80	3.31	0	0.00
WWMF117027	176.97	165.11	1978	0.005	FM2_DIURNAL	3.16	168.27	8.70	3.32	0	0.00
WWMF117028	173.99	165.19	2017	0.000	FM2_DIURNAL	3.36	168.55	5.44	3.32	0	0.00
WWMF118001	173.89	165.39	2017	0.000	FM2_DIURNAL	3.16	168.55	5.34	0.10	0	0.00

Buildout Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMF118002	170.94	165.74	1978	0.000	FM2_DIURNAL	2.81	168.55	2.39	0.11	0	0.00
WWMF118003	182.24	170.44	1992	0.014	FM2_DIURNAL	0.09	170.53	11.71	0.05	0	0.00
WWMF118023	179.54	169.65	2003	0.000	FM2_DIURNAL	0.06	169.71	9.83	0.05	0	0.00
WWMF118024	174.53	167.53	2003	0.000	FM2_DIURNAL	1.44	168.97	5.56	0.11	0	0.00
WWMF118025	170.14	166.25	2017	0.000	FM2_DIURNAL	2.70	168.95	1.19	0.11	0	0.00
WWMF118026	169.96	165.75	2003	0.014	FM2_DIURNAL	3.20	168.95	1.01	3.30	0	0.00
WWMF118048	164.64	154.99	2010	0.000	FM2_DIURNAL	9.65	164.64	0.00	2.80	0.011726	2.67
WWMF118049	172.54	162.17	2010	0.157	FM2_DIURNAL	3.16	165.33	7.21	2.84	0	0.00
WWMF118050	173.02	162.98	2017	0.000	FM2_DIURNAL	2.66	165.64	7.38	2.59	0	0.00
WWMF127007	162.68	148.57	1922	0.004	FM9_DIURNAL	3.83	152.40	10.28	4.03	0	0.00
WWMF127008	161.46	149.01	1962	0.001	FM9_DIURNAL	4.72	153.73	7.73	4.00	0	0.00
WWMF127009	155.12	149.42	1962	0.001	FM9_DIURNAL	5.53	154.95	0.17	3.99	0	0.00
WWMF127010	158.39	150.14	1962	0.001	FM9_DIURNAL	5.65	155.79	2.60	3.98	0	0.00
WWMF127011	160.70	150.90	1962	0.000	FM9_DIURNAL	6.00	156.90	3.80	3.98	0	0.00
WWMF127012	163.01	151.90	1962	0.017	FM9_DIURNAL	6.63	158.53	4.48	3.98	0	0.00
WWMF127013	163.38	152.22	1962	0.000	FM9_DIURNAL	6.52	158.74	4.64	3.98	0	0.00
WWMF127014	171.41	152.96	1962	0.000	FM9_DIURNAL	7.16	160.12	11.29	3.99	0	0.00
WWMF127015	171.72	153.38	1980	0.044	FM9_DIURNAL	7.36	160.74	10.98	4.01	0	0.00
WWMF127016	170.94	154.81	1980	0.000	FM9_DIURNAL	6.00	160.81	10.13	3.96	0	0.00
WWMF127017	166.06	156.17	2017	0.025	FM9_DIURNAL	5.79	161.96	4.10	3.97	0	0.00
WWMF127044	165.32	157.16	1922	0.013	FM9_DIURNAL	0.06	157.22	8.10	0.03	0	0.00
WWMF127115	172.54	167.50	1922	0.001	FM10_DIURNAL	2.99	170.49	2.05	2.44	0	0.00
WWMF127116	173.89	168.23	1922	0.001	FM10_DIURNAL	1.68	169.91	3.98	1.07	0	0.00
WWMF127117	174.12	168.63	1922	0.003	FM10_DIURNAL	1.88	170.51	3.61	1.07	0	0.00
WWMF127118	173.08	168.96	1922	0.000	FM10_DIURNAL	1.87	170.83	2.25	1.05	0	0.00
WWMF127119	176.51	170.40	1922	0.014	FM10_DIURNAL	1.78	172.18	4.33	1.05	0	0.00
WWMF127203	177.79	169.66	2017	0.001	FM10_DIURNAL	1.87	171.53	6.26	1.06	0	0.00
WWMF127220	176.26	170.34	2017	0.000	FM10_DIURNAL	1.84	172.18	4.08	1.06	0	0.00
WWMF137001	135.40	125.96	1996	0.000	FM9_DIURNAL	0.33	126.29	9.11	3.99	0	0.00
WWMF137002	140.83	132.89	1996	0.001	FM9_DIURNAL	0.39	133.28	7.55	4.00	0	0.00
WWMF137003	157.74	144.94	1962	0.005	FM9_DIURNAL	0.46	145.40	12.34	4.02	0	0.00
WWMF137004	158.00	147.00	1962	0.000	FM9_DIURNAL	0.84	147.84	10.16	4.05	0	0.00
WWMF137005	160.72	147.32	1962	0.000	FM9_DIURNAL	2.40	149.72	11.00	4.05	0	0.00
WWMF137006	162.06	148.06	1962	0.000	FM9_DIURNAL	3.29	151.35	10.71	4.04	0	0.00
WWMF137072	114.53	109.76	2017	0.019	FM9_DIURNAL	0.53	110.29	4.24	4.03	0	0.00
WWMF79028	227.32	216.32	1989	0.012	FM16_DIURNAL	1.30	217.62	9.70	0.85	0	0.00
WWMF79029	224.60	216.75	1979	0.000	FM16_DIURNAL	1.24	217.99	6.61	0.83	0	0.00
WWMF79030	224.89	217.37	1979	0.000	FM16_DIURNAL	0.69	218.06	6.83	0.82	0	0.00
WWMF79031	224.55	218.07	1979	0.000	FM16_DIURNAL	0.52	218.59	5.96	0.82	0	0.00
WWMF89019	213.10	199.16	1978	0.000	FM16_DIURNAL	0.94	200.10	13.00	0.94	0	0.00
WWMF89020	211.27	200.18	1978	0.000	FM16_DIURNAL	0.26	200.44	10.83	0.94	0	0.00
WWMF89021	211.58	201.22	1997	0.028	FM16_DIURNAL	0.56	201.78	9.80	0.94	0	0.00
WWMF89022	215.49	201.60	1978	0.000	FM16_DIURNAL	1.83	203.43	12.06	0.90	0	0.00
WWMF89023	214.29	205.30	1978	0.005	FM16_DIURNAL	0.62	205.91	8.38	0.90	0	0.00
WWMF89024	217.25	208.19	1995	0.028	FM16_DIURNAL	0.40	208.59	8.66	0.89	0	0.00
WWMF89025	222.97	212.45	1989	0.000	FM16_DIURNAL	0.36	212.81	10.16	0.85	0	0.00
WWMF89026	224.97	213.74	1989	0.000	FM16_DIURNAL	0.30	214.04	10.93	0.85	0	0.00

Buildout Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMF89027	226.06	215.21	1989	0.009	FM16_DIURNAL	0.42	215.63	10.43	0.85	0	0.00
WWMF89160	214.29	204.27	1978	0.003	FM16_DIURNAL	1.27	205.54	8.75	0.91	0	0.00
WWMF99007	190.72	177.87	1978	0.133	FM2_DIURNAL	4.74	182.61	8.11	3.19	0	0.00
WWMF99008	190.47	178.31	1978	0.000	FM2_DIURNAL	4.86	183.17	7.30	2.96	0	0.00
WWMF99009	190.76	179.26	1978	0.028	FM2_DIURNAL	5.53	184.79	5.97	2.96	0	0.00
WWMF99011	189.86	180.34	1978	0.000	FM2_DIURNAL	6.43	186.77	3.09	2.91	0	0.00
WWMF99012	189.63	180.58	1978	0.051	FM2_DIURNAL	6.60	187.18	2.45	2.91	0	0.00
WWMF99013	193.15	186.08	1978	0.032	FM2_DIURNAL	2.76	188.84	4.31	2.79	0	0.00
WWMF99014	196.47	188.32	1978	0.000	FM2_DIURNAL	4.76	193.08	3.39	2.74	0	0.00
WWMF99015	198.21	189.24	1978	0.023	FM2_DIURNAL	5.96	195.20	3.01	2.74	0	0.00
WWMF99016	201.32	190.51	1978	0.002	FM16_DIURNAL	4.99	195.50	5.82	0.98	0	0.00
WWMF99017	200.59	191.25	1978	0.000	FM16_DIURNAL	4.39	195.64	4.95	0.97	0	0.00
WWMF99018	203.24	192.94	1978	0.019	FM16_DIURNAL	3.00	195.94	7.30	0.98	0	0.00
WWMF99152	203.96	195.57	1997	0.003	FM16_DIURNAL	1.08	196.65	7.31	0.95	0	0.00
WWMG108005	183.37	177.08	1965	0.000	FM2_DIURNAL	0.06	177.14	6.23	0.03	0	0.00
WWMG108006	189.94	178.43	1965	0.000	FM2_DIURNAL	0.09	178.52	11.42	0.03	0	0.00
WWMG108007	192.96	178.60	1965	0.014	FM2_DIURNAL	0.16	178.76	14.20	0.03	0	0.00
WWMG108008	192.80	179.75	1965	0.003	FM3_DIURNAL	7.38	187.13	5.67	0.78	0	0.00
WWMG108009	191.30	180.80	1965	0.000	FM3_DIURNAL	6.36	187.16	4.14	0.60	0	0.00
WWMG108010	191.25	181.43	1965	0.000	FM3_DIURNAL	5.74	187.17	4.08	0.51	0	0.00
WWMG108011	191.59	181.53	1965	0.241	FM3_DIURNAL	5.66	187.19	4.40	0.51	0	0.00
WWMG108080	192.99	178.59	2000	0.003	FM3_DIURNAL	8.52	187.11	5.88	6.22	0	0.00
WWMG109046	191.61	179.31	2017	0.000	FM3_DIURNAL	8.28	187.59	4.02	5.80	0	0.00
WWMG109047	191.73	180.34	2017	0.031	FM3_DIURNAL	7.71	188.05	3.68	5.79	0	0.00
WWMG109048	192.23	181.12	2017	0.017	FM3_DIURNAL	7.36	188.48	3.75	5.73	0	0.00
WWMG109049	195.67	182.02	2017	0.003	FM3_DIURNAL	6.86	188.88	6.79	5.70	0	0.00
WWMG109050	202.56	186.00	2017	0.003	FM3_DIURNAL	3.22	189.22	13.34	5.67	0	0.00
WWMG109051	205.91	188.97	2017	0.003	FM3_DIURNAL	0.74	189.71	16.20	5.66	0	0.00
WWMG114000	141.22	135.51	1957	0.010	FM1_DIURNAL	3.11	138.62	2.60	5.61	0	0.00
WWMG114001	144.62	137.22	1960	0.002	FM1_DIURNAL	6.26	143.48	1.14	3.98	0	0.00
WWMG114002	144.74	138.28	1960	0.053	FM1_DIURNAL	6.46	144.74	0.00	4.30	0.355633	16.50
WWMG116235	186.74	172.55	2000	0.001	FM8_DIURNAL	7.43	179.98	6.76	10.80	0	0.00
WWMG116236	189.28	173.27	2000	0.003	FM8_DIURNAL	7.98	181.25	8.03	10.33	0	0.00
WWMG116237	190.20	173.99	2000	0.011	FM8_DIURNAL	8.41	182.40	7.80	9.85	0	0.00
WWMG116238	192.41	174.79	2000	0.001	FM8_DIURNAL	8.68	183.47	8.94	9.37	0	0.00
WWMG116239	192.87	175.11	2000	0.007	FM3_DIURNAL	8.97	184.08	8.79	9.37	0	0.00
WWMG116240	195.22	176.26	2000	0.003	FM3_DIURNAL	8.98	185.24	9.98	9.36	0	0.00
WWMG116241	194.63	176.56	2000	0.003	FM3_DIURNAL	8.92	185.48	9.15	9.35	0	0.00
WWMG117195	193.76	176.86	2000	0.003	FM3_DIURNAL	9.27	186.13	7.63	9.64	0	0.00
WWMG118004	184.85	174.35	1965	0.000	FM2_DIURNAL	0.06	174.41	10.44	0.03	0	0.00
WWMG118086	193.38	178.01	2017	0.014	FM3_DIURNAL	8.82	186.83	6.55	6.29	0	0.00
WWMG118104	194.06	184.64	2017	0.000	FM3_DIURNAL	1.58	186.22	7.84	3.48	0	0.00
WWMG123072	133.92	121.01	1956	0.002	FM1_DIURNAL	11.57	132.58	1.34	7.21	0	0.00
WWMG123073	133.66	122.28	1956	0.002	FM1_DIURNAL	11.28	133.56	0.10	6.04	0	0.00
WWMG123074	134.19	122.74	2017	0.002	FM1_DIURNAL	11.45	134.19	0.00	10.23	1.181829	17.64
WWMG123075	157.62	125.12	1957	0.002	FM1_DIURNAL	10.60	135.72	21.90	8.61	0	0.00
WWMG123076	136.92	125.36	2017	0.009	FM1_DIURNAL	11.01	136.37	0.55	8.62	0	0.00

Buildout Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMG123077	137.48	125.89	1957	0.002	FM1_DIURNAL	10.93	136.82	0.66	6.99	0	0.00
WWMG123078	140.22	132.71	1957	0.007	FM1_DIURNAL	5.18	137.89	2.33	6.99	0	0.00
WWMG123079	144.47	135.01	1957	0.002	FM1_DIURNAL	3.55	138.56	5.91	5.63	0	0.00
WWMG126098	172.90	163.54	1922	0.001	FM8_DIURNAL	8.43	171.97	0.93	0.81	0	0.00
WWMG126102	171.25	164.40	1922	0.003	FM8_DIURNAL	6.85	171.25	0.00	1.15	0.023402	5.33
WWMG126147	182.25	174.04	1922	0.000	FM8_DIURNAL	4.81	178.85	3.40	0.29	0	0.00
WWMG126164	183.79	180.00	1922	0.001	FM8_DIURNAL	0.02	180.02	3.77	0.00	0	0.00
WWMG126200	170.67	164.87	1922	0.001	FM10_DIURNAL	4.67	169.54	1.13	2.33	0	0.00
WWMG126236	171.33	158.58	2000	0.002	FM8_DIURNAL	12.64	171.22	0.11	11.50	0	0.00
WWMG126237	171.90	161.43	2000	0.002	FM8_DIURNAL	10.47	171.90	0.00	11.51	0	0.00
WWMG126238	172.23	162.28	2000	0.001	FM8_DIURNAL	9.95	172.23	0.00	11.50	0.049638	4.02
WWMG126239	174.59	163.94	2000	0.001	FM8_DIURNAL	10.19	174.13	0.46	11.51	0	0.00
WWMG126240	177.02	165.66	2000	0.000	FM8_DIURNAL	9.04	174.70	2.32	11.50	0	0.00
WWMG126241	175.65	168.22	2000	0.002	FM8_DIURNAL	7.43	175.65	0.00	12.20	0.267711	6.10
WWMG126242	184.33	171.64	2017	0.000	FM8_DIURNAL	5.70	177.34	6.99	11.72	0	0.00
WWMG126243	183.79	171.83	2000	0.000	FM8_DIURNAL	6.76	178.59	5.20	11.28	0	0.00
WWMG127109	169.81	163.83	1988	0.001	FM10_DIURNAL	5.16	168.99	0.82	2.32	0	0.00
WWMG127110	169.22	164.26	1988	0.001	FM10_DIURNAL	4.96	169.22	0.00	2.33	0	0.00
WWMG127114	171.40	165.69	1922	0.001	FM10_DIURNAL	4.29	169.98	1.42	2.34	0	0.00
WWMG127133	174.28	168.63	1922	0.010	FM10_DIURNAL	0.90	169.53	4.75	0.09	0	0.00
WWMG127188	172.56	163.75	2017	0.004	FM8_DIURNAL	7.93	171.68	0.88	1.17	0	0.00
WWMG127195	175.81	166.36	2017	0.003	FM8_DIURNAL	8.93	175.29	0.52	10.61	0	0.00
WWMG136015	168.77	153.68	1987	0.006	FM8_DIURNAL	11.81	165.49	3.28	20.80	0	0.00
WWMG136016	169.06	155.01	2017	0.003	FM8_DIURNAL	14.05	169.06	0.00	20.76	0.000001	0.00
WWMG136017	168.95	155.82	1987	0.008	FM8_DIURNAL	12.63	168.45	0.50	12.05	0	0.00
WWMG136018	169.04	156.39	1987	0.006	FM8_DIURNAL	11.77	168.16	0.88	11.38	0	0.00
WWMG136019	170.03	156.83	1987	0.000	FM8_DIURNAL	13.20	170.03	0.00	11.50	0	0.00
WWMG136020	169.14	155.24	1987	0.011	FM8_DIURNAL	13.90	169.14	0.00	13.98	0.000002	0.00
WWMG136021	170.05	158.68	1987	0.002	FM8_DIURNAL	11.37	170.05	0.00	2.25	0	0.00
WWMG136035	166.04	157.45	2017	0.005	FM10_DIURNAL	8.59	166.04	0.00	3.71	0.000006	0.00
WWMG136036	167.71	158.46	1962	0.000	FM10_DIURNAL	9.25	167.71	0.00	3.49	0	0.00
WWMG136037	169.93	159.28	1962	0.003	FM10_DIURNAL	8.80	168.08	1.85	3.47	0	0.00
WWMG136038	168.40	160.06	1962	0.007	FM10_DIURNAL	7.51	167.57	0.83	2.45	0	0.00
WWMG136039	166.31	161.22	1962	0.000	FM10_DIURNAL	5.09	166.31	0.00	2.50	0.05606	4.82
WWMG136050	169.82	154.69	1948	0.005	FM8_DIURNAL	9.18	163.87	5.95	7.00	0	0.00
WWMG136051	168.57	155.25	1948	0.003	FM8_DIURNAL	9.85	165.10	3.47	4.69	0	0.00
WWMG136053	169.28	156.74	1948	0.003	FM8_DIURNAL	11.33	168.07	1.21	4.15	0	0.00
WWMG136054	169.10	157.95	1948	0.003	FM8_DIURNAL	11.15	169.10	0.00	3.57	0	0.00
WWMG136064	169.61	159.97	1922	0.001	FM8_DIURNAL	9.64	169.61	0.00	2.04	0.000012	0.01
WWMG136065	172.07	160.39	1922	0.003	FM8_DIURNAL	10.00	170.39	1.68	2.04	0	0.00
WWMG136066	173.75	160.79	1922	0.004	FM8_DIURNAL	10.34	171.13	2.62	2.02	0	0.00
WWMG136067	174.96	161.45	1922	0.001	FM8_DIURNAL	10.68	172.13	2.83	2.01	0	0.00
WWMG136068	174.21	162.01	1922	0.001	FM8_DIURNAL	10.60	172.61	1.60	1.03	0	0.00
WWMG136069	174.23	162.03	1922	0.000	FM8_DIURNAL	10.55	172.58	1.65	1.02	0	0.00
WWMG136070	172.10	162.60	2017	0.000	FM8_DIURNAL	9.50	172.10	0.00	1.02	0.000001	0.00
WWMG136074	169.20	164.31	1922	0.005	FM8_DIURNAL	0.08	164.39	4.81	0.01	0	0.00
WWMG136095	168.48	162.53	2017	0.004	FM10_DIURNAL	5.70	168.23	0.25	2.25	0	0.00

Buildout Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMG136097	169.32	160.50	2017	0.003	FM8_DIURNAL	8.82	169.32	0.00	0.77	0.000001	0.00
WWMG136100	174.20	163.12	1922	0.000	FM8_DIURNAL	8.02	171.14	3.06	0.51	0	0.00
WWMG136254	170.01	159.70	2017	0.003	FM8_DIURNAL	9.74	169.44	0.57	0.77	0	0.00
WWMG136260	170.10	157.00	1987	0.000	FM8_DIURNAL	13.10	170.10	0.00	11.50	0	0.00
WWMG137106	168.49	161.89	1962	0.006	FM10_DIURNAL	5.27	167.16	1.33	2.32	0	0.00
WWMG137107	169.49	162.99	2017	0.000	FM10_DIURNAL	6.06	169.05	0.44	2.29	0	0.00
WWMG137183	169.27	163.12	2017	0.001	FM10_DIURNAL	5.96	169.08	0.19	2.31	0	0.00
WWMG137193	168.38	156.07	1948	0.004	FM8_DIURNAL	11.33	167.40	0.98	4.67	0	0.00
WWMG137194	166.98	158.03	2017	0.007	FM10_DIURNAL	8.95	166.98	0.00	3.60	0.000004	0.00
WWMG137195	168.38	158.48	2017	0.009	FM10_DIURNAL	9.52	168.00	0.38	3.49	0	0.00
WWMG146012	169.80	152.08	2017	0.003	FM8_DIURNAL	17.31	169.39	0.41	5.47	0	0.00
WWMG146013	169.88	152.54	1987	0.002	FM8_DIURNAL	17.34	169.88	0.00	3.10	0.000002	0.00
WWMG146014	168.98	152.58	1987	0.004	FM8_DIURNAL	12.21	164.79	4.19	20.66	0	0.00
WWMG146025	170.67	155.04	2017	0.029	FM10_DIURNAL	13.34	168.38	2.29	2.50	0	0.00
WWMG146030	170.00	157.00	2037			13.00	170.00	0.00	2.91	0.00037	0.02
WWMG146075	168.83	151.83	2015	0.002	FM8_DIURNAL	13.08	164.91	3.92	20.59	0	0.00
WWMG146076	168.97	151.13	2017	0.002	FM8_DIURNAL	13.76	164.89	4.08	22.53	0	0.00
WWMG146077	169.92	150.36	2015	0.003	FM8_DIURNAL	14.11	164.47	5.45	26.58	0	0.00
WWMG146078	170.02	154.03	2015	0.003	FM8_DIURNAL	9.57	163.60	6.42	5.73	0	0.00
WWMG146079	171.02	149.70	2015	0.003	FM8_DIURNAL	14.34	164.04	6.98	28.15	0	0.00
WWMG79032	225.97	218.21	1979	0.023	FM16_DIURNAL	0.80	219.01	6.96	0.82	0	0.00
WWMG79033	231.39	222.83	1979	0.002	FM16_DIURNAL	0.37	223.20	8.19	0.79	0	0.00
WWMG79034	232.65	224.69	1979	0.019	FM16_DIURNAL	0.42	225.11	7.54	0.79	0	0.00
WWMG79195	246.66	240.18	1996	0.000	FM17_DIURNAL	0.37	240.55	6.11	1.23	0	0.00
WWMG79196	248.13	240.58	1996	0.002	FM17_DIURNAL	0.67	241.25	6.88	1.23	0	0.00
WWMG79244	249.95	241.37	1996	0.001	FM17_DIURNAL	0.64	242.01	7.94	1.23	0	0.00
WWMG79245	250.59	242.09	1996	0.000	FM17_DIURNAL	0.69	242.78	7.81	1.23	0	0.00
WWMG79246	251.11	242.45	1996	0.095	FM17_DIURNAL	0.62	243.07	8.04	0.92	0	0.00
WWMG89076	227.29	218.83	1978	0.014	FM3_DIURNAL	0.06	218.89	8.40	0.03	0	0.00
WWMG89185	227.99	220.04	1995	0.000	FM3_DIURNAL	1.41	221.45	6.54	3.65	0	0.00
WWMG89186	229.62	220.50	1995	0.000	FM17_DIURNAL	1.32	221.82	7.80	1.29	0	0.00
WWMG89187	230.23	221.07	1995	0.001	FM17_DIURNAL	1.34	222.41	7.82	1.30	0	0.00
WWMG89189	231.53	222.20	1995	0.002	FM17_DIURNAL	0.93	223.13	8.40	1.29	0	0.00
WWMG89192	235.58	226.02	1995	0.000	FM17_DIURNAL	0.59	226.61	8.97	1.29	0	0.00
WWMG89193	237.71	228.02	1996	0.040	FM17_DIURNAL	0.45	228.47	9.24	1.29	0	0.00
WWMG89194	242.49	234.52	1996	0.013	FM17_DIURNAL	0.45	234.97	7.52	1.25	0	0.00
WWMG89250	227.31	220.40	2017	0.000	FM3_DIURNAL	0.42	220.82	6.49	1.00	0	0.00
WWMG89258	227.59	214.58	2003	0.021	FM3_DIURNAL	0.88	215.46	12.13	4.67	0	0.00
WWMG89259	227.27	216.37	2017	0.000	FM3_DIURNAL	0.86	217.23	10.04	4.67	0	0.00
WWMG89260	226.99	217.01	2017	0.000	FM3_DIURNAL	1.17	218.18	8.81	4.68	0	0.00
WWMG89261	228.20	217.97	2017	0.000	FM3_DIURNAL	0.90	218.87	9.33	3.65	0	0.00
WWMG99099	207.14	191.77	2017	0.003	FM3_DIURNAL	0.74	192.51	14.63	5.66	0	0.00
WWMG99100	208.65	197.15	2003	0.024	FM3_DIURNAL	0.61	197.76	10.89	5.65	0	0.00
WWMG99101	213.19	204.69	2017	0.000	FM3_DIURNAL	0.60	205.29	7.90	5.62	0	0.00
WWMG99102	222.20	208.50	2017	0.000	FM3_DIURNAL	0.72	209.22	12.98	5.62	0	0.00
WWMG99104	223.52	210.39	2003	0.198	FM3_DIURNAL	0.88	211.27	12.25	5.62	0	0.00
WWMG99105	225.44	212.56	2017	0.010	FM3_DIURNAL	0.83	213.39	12.05	4.69	0	0.00

Buildout Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMH104008	161.15	146.86	1972	0.001	FM1_DIURNAL	8.47	155.33	5.82	1.78	0	0.00
WWMH104009	156.71	148.29	1972	0.001	FM1_DIURNAL	7.56	155.85	0.86	1.79	0	0.00
WWMH104010	159.65	150.28	2017	0.002	FM1_DIURNAL	5.77	156.05	3.60	1.78	0	0.00
WWMH104011	160.09	150.77	1972	0.017	FM1_DIURNAL	5.82	156.59	3.50	1.78	0	0.00
WWMH104012	161.27	151.90	1973	0.004	FM1_DIURNAL	5.17	157.07	4.20	1.76	0	0.00
WWMH104040	219.73	209.84	1960	0.000	FM19_DIURNAL	0.28	210.12	9.61	0.82	0	0.00
WWMH104041	218.44	210.12	1970	0.035	FM19_DIURNAL	0.57	210.69	7.75	0.82	0	0.00
WWMH104042	216.89	211.37	1970	0.006	FM19_DIURNAL	0.47	211.84	5.05	0.78	0	0.00
WWMH104043	222.04	213.21	1960	0.012	FM19_DIURNAL	0.46	213.67	8.37	0.78	0	0.00
WWMH104044	223.91	214.86	2017	0.055	FM19_DIURNAL	0.43	215.29	8.62	0.77	0	0.00
WWMH105001	166.19	152.88	1973	0.068	FM1_DIURNAL	4.34	157.22	8.97	1.75	0	0.00
WWMH105002	165.42	155.42	1973	0.001	FM1_DIURNAL	2.51	157.93	7.49	1.67	0	0.00
WWMH105003	166.74	157.69	2017	0.011	FM1_DIURNAL	0.72	158.41	8.33	1.66	0	0.00
WWMH105004	169.00	160.00	1973	0.001	FM1_DIURNAL	0.50	160.50	8.50	1.65	0	0.00
WWMH105005	170.73	162.03	1973	0.022	FM1_DIURNAL	0.52	162.55	8.18	1.65	0	0.00
WWMH105017	170.16	163.31	1973	0.001	FM1_DIURNAL	0.56	163.87	6.29	1.61	0	0.00
WWMH114003	147.33	140.08	1960	0.002	FM1_DIURNAL	7.25	147.33	0.00	4.46	0.358218	16.16
WWMH114004	155.60	140.80	2017	0.030	FM1_DIURNAL	9.63	150.43	5.17	2.83	0	0.00
WWMH114005	153.43	141.58	2017	0.002	FM1_DIURNAL	11.85	153.43	0.00	3.19	0.030411	4.73
WWMH114006	156.67	143.28	1972	0.001	FM1_DIURNAL	10.78	154.06	2.61	1.79	0	0.00
WWMH114007	161.60	145.32	1972	0.001	FM1_DIURNAL	9.46	154.78	6.82	1.79	0	0.00
WWMH114026	152.90	145.81	1958	0.002	FM19_DIURNAL	0.43	146.24	6.66	1.79	0	0.00
WWMH114027	157.65	153.65	1958	0.009	FM19_DIURNAL	0.38	154.04	3.61	1.79	0	0.00
WWMH114028	184.27	174.85	1958	0.000	FM19_DIURNAL	0.38	175.23	9.04	1.78	0	0.00
WWMH114029	187.00	176.84	1958	0.003	FM19_DIURNAL	3.99	180.83	6.17	1.78	0	0.00
WWMH114030	188.24	177.83	1978	0.006	FM19_DIURNAL	5.17	183.00	5.24	1.77	0	0.00
WWMH114031	190.00	180.15	1958	0.528	FM19_DIURNAL	9.85	190.00	0.00	2.19	0.069592	11.55
WWMH114033	200.82	190.84	1960	0.003	FM19_DIURNAL	0.30	191.14	9.68	0.86	0	0.00
WWMH114035	201.55	192.53	1960	0.000	FM19_DIURNAL	0.45	192.98	8.57	0.85	0	0.00
WWMH114036	202.46	193.10	1960	0.017	FM19_DIURNAL	0.45	193.55	8.91	0.85	0	0.00
WWMH114037	202.53	194.33	2017	0.009	FM19_DIURNAL	0.53	194.86	7.67	0.84	0	0.00
WWMH114038	211.82	201.80	2017	0.003	FM19_DIURNAL	0.30	202.10	9.72	0.83	0	0.00
WWMH114039	218.44	208.10	1960	0.000	FM19_DIURNAL	0.31	208.41	10.03	0.82	0	0.00
WWMH114127	152.90	142.30	1958	0.002	FM19_DIURNAL	0.46	142.76	10.14	1.79	0	0.00
WWMH114140	149.02	139.21	2017	0.005	FM1_DIURNAL	7.82	147.03	1.99	2.60	0	0.00
WWMH123003	167.83	157.32	2017	0.011	FM20_DIURNAL	0.28	157.60	10.23	2.57	0	0.00
WWMH123004	169.80	160.05	2017	0.010	FM20_DIURNAL	0.80	160.85	8.95	2.55	0	0.00
WWMH123005	174.74	163.03	2017	0.003	FM20_DIURNAL	0.77	163.80	10.94	2.54	0	0.00
WWMH123006	177.34	164.58	2017	0.039	FM20_DIURNAL	1.08	165.66	11.68	2.54	0	0.00
WWMH123007	181.08	167.07	2017	0.177	FM20_DIURNAL	0.82	167.89	13.19	2.49	0	0.00
WWMH123068	129.07	118.12	1956	0.002	FM1_DIURNAL	10.76	128.88	0.19	8.24	0	0.00
WWMH123069	132.54	118.70	1956	0.002	FM1_DIURNAL	10.67	129.37	3.17	7.24	0	0.00
WWMH123070	132.82	119.14	2017	0.039	FM1_DIURNAL	10.61	129.75	3.07	7.23	0	0.00
WWMH123071	130.54	119.89	1956	0.002	FM1_DIURNAL	10.65	130.54	0.00	8.84	0.403243	17.73
WWMH126133	169.82	161.52	1996	0.004	FM8_DIURNAL	2.39	163.91	5.91	1.02	0	0.00
WWMH131073	110.05	102.95	1970	0.002	FM1_DIURNAL	4.98	107.93	2.12	6.55	0	0.00
WWMH131074	111.91	103.87	1970	0.002	FM1_DIURNAL	7.53	111.40	0.51	6.54	0	0.00

Buildout Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	**Rim Elev.**	**Invert Elev.**	**Install Year**	**Avg DWF (cfs)**	**DWF Pattern**	**Max Depth (ft)**	**Max HGL (ft)**	**Freeboard (ft)**	**Max Inflow (cfs)**	**Total Flood Vol. (MG)**	**Time Flooded (hrs)**
WWMH131075	113.89	106.08	1970	0.002	FM1_DIURNAL	7.81	113.89	0.00	6.11	0.203474	17.11
WWMH131080	118.92	107.40	1970	0.002	FM1_DIURNAL	9.67	117.07	1.85	6.11	0	0.00
WWMH131081	117.91	108.26	1970	0.036	FM1_DIURNAL	9.65	117.91	0.00	5.61	0.260908	19.31
WWMH131082	121.41	110.06	1970	0.002	FM1_DIURNAL	11.35	121.41	0.00	6.77	0.323143	19.77
WWMH131083	124.77	111.72	1994	0.002	FM1_DIURNAL	12.51	124.23	0.54	5.22	0	0.00
WWMH133000	126.34	115.16	1994	0.002	FM1_DIURNAL	9.19	124.35	1.99	6.36	0	0.00
WWMH133001	123.99	116.99	2017	0.002	FM20_DIURNAL	7.00	123.99	0.00	3.10	1.525669	20.34
WWMH133002	124.37	117.76	2017	0.002	FM20_DIURNAL	6.61	124.37	0.00	2.57	0.083547	7.35
WWMH133066	124.96	116.27	1956	0.002	FM1_DIURNAL	8.69	124.96	0.00	9.87	1.298632	19.63
WWMH133067	128.79	117.04	1956	0.002	FM1_DIURNAL	9.57	126.61	2.18	8.24	0	0.00
WWMH133096	125.99	114.54	1994	0.002	FM1_DIURNAL	9.75	124.29	1.70	6.39	0	0.00
WWMH136135	168.89	158.83	1996	0.002	FM8_DIURNAL	3.71	162.54	6.35	1.03	0	0.00
WWMH136204	169.50	159.79	1996	0.003	FM8_DIURNAL	3.69	163.48	6.02	1.02	0	0.00
WWMH136247	165.60	155.57	1996	0.002	FM8_DIURNAL	2.26	157.83	7.77	2.06	0	0.00
WWMH136248	168.62	156.42	1996	0.009	FM8_DIURNAL	4.35	160.77	7.85	2.06	0	0.00
WWMH136249	165.59	157.01	1998	0.007	FM8_DIURNAL	4.34	161.35	4.24	1.04	0	0.00
WWMH136250	163.00	157.81	1996	0.002	FM8_DIURNAL	3.86	161.67	1.33	1.03	0	0.00
WWMH136253	169.46	159.45	2001	0.005	FM8_DIURNAL	3.51	162.96	6.50	1.03	0	0.00
WWMH136262	169.50	161.48	2017	0.006	FM8_DIURNAL	8.02	169.50	0.00	0.56	0.000006	0.00
WWMH141000	115.54	91.24	1986	0.060	FM8_DIURNAL	2.21	93.45	22.09	43.61	0	0.00
WWMH141001	112.20	95.40	1986	0.002	FM1_DIURNAL	0.84	96.24	15.96	13.36	0	0.00
WWMH141002	111.85	96.14	1986	0.002	FM1_DIURNAL	1.62	97.76	14.09	13.35	0	0.00
WWMH141003	111.74	96.53	1986	0.002	FM1_DIURNAL	1.43	97.96	13.78	13.35	0	0.00
WWMH141004	111.43	97.06	1986	0.002	FM1_DIURNAL	1.59	98.65	12.78	13.35	0	0.00
WWMH141005	111.43	97.72	1970	0.002	FM1_DIURNAL	1.48	99.20	12.23	13.35	0	0.00
WWMH141006	130.02	119.82	1970	0.002	FM15_DIURNAL	0.35	120.17	9.85	5.49	0	0.00
WWMH141007	154.01	149.19	1970	0.002	FM15_DIURNAL	0.33	149.52	4.49	5.49	0	0.00
WWMH141071	110.74	101.64	1970	0.002	FM1_DIURNAL	2.33	103.97	6.77	8.04	0	0.00
WWMH141072	109.94	102.73	1970	0.002	FM1_DIURNAL	3.65	106.38	3.56	8.03	0	0.00
WWMH146000	117.26	92.54	1986	0.002	FM8_DIURNAL	2.05	94.59	22.67	30.03	0	0.00
WWMH146001	154.12	142.01	1988	0.002	FM8_DIURNAL	0.77	142.78	11.34	30.03	0	0.00
WWMH146002	163.76	143.45	1988	0.002	FM8_DIURNAL	3.38	146.83	16.93	30.03	0	0.00
WWMH146003	163.72	144.27	1988	0.002	FM8_DIURNAL	4.54	148.81	14.91	30.03	0	0.00
WWMH146004	166.10	145.38	1988	0.002	FM8_DIURNAL	6.21	151.59	14.51	30.02	0	0.00
WWMH146005	169.64	145.89	1988	0.021	FM8_DIURNAL	7.80	153.69	15.95	30.02	0	0.00
WWMH146006	168.68	146.57	1988	0.152	FM8_DIURNAL	8.63	155.20	13.48	30.01	0	0.00
WWMH146007	172.13	147.71	1988	0.008	FM8_DIURNAL	10.36	158.07	14.06	28.16	0	0.00
WWMH146008	172.32	148.65	1988	0.003	FM8_DIURNAL	12.14	160.79	11.53	28.16	0	0.00
WWMH146246	168.90	153.93	1996	0.002	FM8_DIURNAL	0.62	154.55	14.35	2.06	0	0.00
WWMH146247	171.99	148.89	2015	0.002	FM8_DIURNAL	14.48	163.37	8.62	28.15	0	0.00
WWMH95018	173.00	165.10	1992	0.045	FM1_DIURNAL	0.61	165.71	7.29	1.61	0	0.00
WWMH95019	173.00	166.45	1991	0.001	FM1_DIURNAL	0.41	166.87	6.13	1.55	0	0.00
WWMH95020	176.67	169.94	1991	0.002	FM1_DIURNAL	0.39	170.33	6.34	1.55	0	0.00
WWMH95021	205.65	187.21	1991	0.004	FM1_DIURNAL	0.24	187.45	18.20	1.55	0	0.00
WWMH95022	204.76	190.07	1991	0.006	FM1_DIURNAL	0.38	190.45	14.31	1.54	0	0.00
WWMH95023	207.20	191.85	1991	0.004	FM1_DIURNAL	0.48	192.33	14.87	1.54	0	0.00
WWMH95024	210.40	192.85	1991	0.117	FM1_DIURNAL	0.42	193.27	17.13	1.32	0	0.00

Buildout Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMI102001	208.60	197.52	1976	0.000	FM12_DIURNAL	0.45	197.97	10.63	0.51	0	0.00
WWMI102002	218.13	198.62	1976	0.000	FM12_DIURNAL	0.44	199.06	19.07	0.51	0	0.00
WWMI102003	215.84	199.90	1976	0.208	FM12_DIURNAL	0.44	200.34	15.50	0.51	0	0.00
WWMI102066	210.77	203.23	1970	0.004	FM12_DIURNAL	0.56	203.79	6.98	2.80	0	0.00
WWMI102067	214.51	208.13	2017	0.005	FM12_DIURNAL	0.57	208.70	5.81	2.79	0	0.00
WWMI102068	219.20	212.88	2017	0.027	FM12_DIURNAL	0.57	213.45	5.75	2.79	0	0.00
WWMI102069	221.49	213.72	1970	0.000	FM12_DIURNAL	1.83	215.55	5.94	2.76	0	0.00
WWMI102070	219.80	214.21	1977	0.014	FM12_DIURNAL	2.08	216.29	3.51	2.77	0	0.00
WWMI102071	220.03	214.40	1977	0.002	FM12_DIURNAL	2.15	216.55	3.48	2.75	0	0.00
WWMI102072	223.35	216.64	1977	0.011	FM12_DIURNAL	2.41	219.05	4.30	2.75	0	0.00
WWMI102073	225.66	218.21	1977	0.011	FM12_DIURNAL	2.63	220.84	4.82	2.73	0	0.00
WWMI102131	225.87	219.28	1999	0.000	FM12_DIURNAL	3.51	222.79	3.08	2.72	0	0.00
WWMI102132	227.75	220.88	2017	0.000	FM12_DIURNAL	3.70	224.58	3.17	3.08	0	0.00
WWMI104050	232.35	222.32	2008	0.002	FM12_DIURNAL	2.30	224.62	7.73	2.10	0	0.00
WWMI104051	229.69	222.06	2017	0.000	FM12_DIURNAL	2.54	224.60	5.09	2.19	0	0.00
WWMI111032	193.30	179.27	1970	0.000	FM12_DIURNAL	6.23	185.50	7.80	4.00	0	0.00
WWMI111035	188.10	181.39	1970	0.005	FM12_DIURNAL	6.71	188.10	0.00	4.09	0.011889	4.61
WWMI111036	203.57	182.78	1970	0.000	FM12_DIURNAL	6.53	189.31	14.26	4.08	0	0.00
WWMI111037	205.03	189.43	2017	0.023	FM12_DIURNAL	0.36	189.79	15.24	4.08	0	0.00
WWMI111040	193.00	180.54	1970	0.000	FM12_DIURNAL	6.52	187.06	5.94	4.00	0	0.00
WWMI111053	203.84	193.35	2017	0.043	FM12_DIURNAL	0.54	193.89	9.95	4.05	0	0.00
WWMI111099	202.79	195.95	2017	0.076	FM12_DIURNAL	0.91	196.86	5.93	3.39	0	0.00
WWMI112000	207.16	196.52	2017	0.000	FM12_DIURNAL	0.33	196.85	10.32	0.51	0	0.00
WWMI121026	177.80	171.05	1970	0.035	FM15_DIURNAL	6.75	177.80	0.00	4.68	0.524004	14.24
WWMI121027	179.87	172.17	1970	0.000	FM15_DIURNAL	7.52	179.69	0.18	4.61	0	0.00
WWMI121028	179.60	172.66	1970	0.030	FM15_DIURNAL	6.94	179.60	0.00	4.06	0.426004	12.99
WWMI121029	182.20	174.79	1970	0.000	FM12_DIURNAL	6.31	181.10	1.10	4.02	0	0.00
WWMI121030	185.90	176.89	1970	0.000	FM12_DIURNAL	5.61	182.50	3.40	3.99	0	0.00
WWMI121031	190.60	178.01	1970	0.002	FM12_DIURNAL	5.93	183.94	6.66	4.00	0	0.00
WWMI121100	186.60	177.06	1996	0.014	FM12_DIURNAL	5.67	182.73	3.87	4.01	0	0.00
WWMI121103	179.74	172.35	2001	0.000	FM15_DIURNAL	7.38	179.74	0.00	4.74	0.000086	0.01
WWMI131009	165.55	152.25	1970	0.001	FM15_DIURNAL	3.67	155.92	9.63	5.48	0	0.00
WWMI131010	167.11	153.52	1970	0.000	FM15_DIURNAL	5.14	158.66	8.45	5.49	0	0.00
WWMI131011	165.59	154.68	1970	0.000	FM15_DIURNAL	5.75	160.43	5.16	5.49	0	0.00
WWMI131012	164.21	154.97	1970	0.000	FM15_DIURNAL	6.09	161.06	3.15	5.48	0	0.00
WWMI131013	163.40	156.32	1970	0.000	FM15_DIURNAL	7.08	163.40	0.00	5.59	0.006667	3.82
WWMI131014	167.17	156.45	1970	0.002	FM15_DIURNAL	7.98	164.43	2.74	5.59	0	0.00
WWMI131017	173.93	157.55	1970	0.000	FM15_DIURNAL	8.09	165.64	8.29	4.41	0	0.00
WWMI131018	174.47	158.73	1970	0.016	FM15_DIURNAL	7.18	165.91	8.56	4.41	0	0.00
WWMI131019	173.04	160.63	1970	0.000	FM15_DIURNAL	6.91	167.54	5.50	4.40	0	0.00
WWMI131020	171.74	161.93	1970	0.000	FM15_DIURNAL	7.30	169.23	2.51	4.39	0	0.00
WWMI131021	174.05	163.74	1970	0.000	FM15_DIURNAL	7.41	171.15	2.90	4.39	0	0.00
WWMI131022	176.99	165.43	1970	0.000	FM15_DIURNAL	7.76	173.19	3.80	4.39	0	0.00
WWMI131023	177.45	166.71	1970	0.010	FM15_DIURNAL	8.20	174.91	2.54	4.39	0	0.00
WWMI131024	178.04	168.13	1970	0.000	FM15_DIURNAL	8.41	176.54	1.50	4.38	0	0.00
WWMI131025	177.79	169.55	1970	0.020	FM15_DIURNAL	7.72	177.27	0.52	3.77	0	0.00
WWMI131111	172.52	160.90	2017	0.000	FM15_DIURNAL	7.05	167.95	4.57	4.39	0	0.00

Buildout Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMI141008	162.12	150.54	1970	0.002	FM15_DIURNAL	2.60	153.14	8.98	5.49	0	0.00
WWMI81	279.93	268.14	2009	0.021	FM12_DIURNAL	0.23	268.37	11.56	0.66	0	0.00
WWMI92143	265.85	257.49	2008	0.072	FM12_DIURNAL	0.42	257.91	7.94	1.28	0	0.00
WWMI92144	264.43	256.47	2008	0.000	FM12_DIURNAL	0.42	256.89	7.54	1.28	0	0.00
WWMI92146	263.91	254.54	2017	0.000	FM12_DIURNAL	1.75	256.29	7.62	1.28	0	0.00
WWMI92147	262.12	243.47	2017	0.000	FM12_DIURNAL	0.53	244.00	18.12	1.76	0	0.00
WWMI92148	251.71	241.52	2017	0.000	FM12_DIURNAL	0.37	241.89	9.82	1.76	0	0.00
WWMI92149	245.17	236.97	2017	0.100	FM12_DIURNAL	0.40	237.37	7.80	1.97	0	0.00
WWMI92150	241.50	229.75	2017	0.000	FM12_DIURNAL	0.33	230.08	11.42	1.96	0	0.00
WWMI92151	239.75	225.75	2017	0.130	FM12_DIURNAL	0.64	226.39	13.36	2.12	0	0.00
WWMI92152	234.71	223.96	2017	0.000	FM12_DIURNAL	0.70	224.66	10.05	2.12	0	0.00
WWMI92156	263.55	244.65	2017	0.000	FM12_DIURNAL	0.27	244.92	18.63	0.49	0	0.00
WWMI92157	260.95	245.57	2008	0.000	FM12_DIURNAL	0.35	245.92	15.03	0.49	0	0.00
WWMI92158	255.21	247.11	2017	0.000	FM12_DIURNAL	0.32	247.43	7.78	0.49	0	0.00
WWMI92159	253.49	248.10	2008	0.000	FM12_DIURNAL	0.34	248.44	5.05	0.49	0	0.00
WWMI92161	255.92	249.58	2017	0.100	FM12_DIURNAL	0.33	249.91	6.01	0.49	0	0.00
WWMJ102130	184.15	171.61	2037	0.027	FM20_DIURNAL	0.06	171.67	12.47	0.05	0	0.00
WWMJ102131	185.10	170.08	2037			0.37	170.45	14.65	1.00	0	0.00
WWMJ111043	194.89	184.33	2001	0.001	FM13_DIURNAL	0.25	184.58	10.31	0.65	0	0.00
WWMJ111047	185.59	176.73	2004	0.003	FM13_DIURNAL	2.01	178.74	6.85	1.93	0	0.00
WWMJ111056	204.04	191.76	2005	0.006	FM13_DIURNAL	0.23	191.99	12.05	0.65	0	0.00
WWMJ111061	183.35	168.54	2037			0.38	168.92	14.43	0.99	0	0.00
WWMJ111062	190.78	167.35	2037			0.30	167.65	23.12	0.78	0	0.00
WWMJ111063	186.84	165.36	2037			0.28	165.64	21.19	0.70	0	0.00
WWMJ111064	182.91	162.76	2037			0.27	163.03	19.87	0.69	0	0.00
WWMJ111094	184.62	177.95	2008	0.038	FM13_DIURNAL	0.45	178.40	6.22	0.71	0	0.00
WWMJ111103	185.08	176.58	2017	0.000	FM13_DIURNAL	1.21	177.79	7.29	1.08	0	0.00
WWMJ120001	175.85	163.63	2003	0.050	FM13_DIURNAL	0.36	163.99	11.86	0.21	0	0.00
WWMJ120009	173.82	163.22	2001	0.000	FM13_DIURNAL	0.76	163.98	9.84	1.44	0	0.00
WWMJ120010	164.76	153.07	2001	0.000	FM15_DIURNAL	0.21	153.28	11.48	1.44	0	0.00
WWMJ120012	177.26	160.24	2001	0.000	FM13_DIURNAL	0.95	161.19	16.07	1.44	0	0.00
WWMJ120013	175.25	161.35	2001	0.000	FM13_DIURNAL	0.64	161.99	13.26	1.44	0	0.00
WWMJ120014	174.68	162.10	2001	0.000	FM13_DIURNAL	0.69	162.79	11.89	1.44	0	0.00
WWMJ120015	176.85	164.04	2001	0.000	FM13_DIURNAL	0.00	164.04	12.81	0.00	0	0.00
WWMJ120016	147.26	124.42	2001	0.000	FM15_DIURNAL	0.33	124.75	22.51	2.18	0	0.00
WWMJ120017	140.24	122.37	2001	0.000	FM15_DIURNAL	0.31	122.68	17.56	2.18	0	0.00
WWMJ120018	140.24	135.90	2001	0.000	FM15_DIURNAL	0.00	135.90	4.34	0.00	0	0.00
WWMJ120021	176.02	166.16	2001	0.000	FM13_DIURNAL	0.49	166.65	9.37	1.34	0	0.00
WWMJ120022	179.00	168.60	2001	0.000	FM13_DIURNAL	0.57	169.17	9.83	1.34	0	0.00
WWMJ120023	183.04	172.55	2001	0.000	FM13_DIURNAL	0.38	172.93	10.11	0.65	0	0.00
WWMJ120024	187.12	177.01	2001	0.000	FM13_DIURNAL	0.29	177.30	9.82	0.65	0	0.00
WWMJ120025	179.01	174.85	2004	0.001	FM13_DIURNAL	1.97	176.82	2.19	0.78	0	0.00
WWMJ120026	178.93	174.41	2004	0.001	FM13_DIURNAL	2.19	176.60	2.33	0.74	0	0.00
WWMJ120027	183.34	176.14	2004	0.001	FM13_DIURNAL	2.14	178.28	5.06	0.78	0	0.00
WWMJ120032	183.73	172.89	2004	0.002	FM13_DIURNAL	0.63	173.52	10.21	0.76	0	0.00
WWMJ120033	182.16	171.58	2004	0.000	FM13_DIURNAL	0.45	172.03	10.13	1.35	0	0.00
WWMJ120034	141.74	124.85	2005	0.000	FM15_DIURNAL	0.39	125.24	16.50	1.00	0	0.00

Buildout Flows, 5-year, 24-hour storm event

Input						Output					
Manhole ID	**Rim Elev.**	**Invert Elev.**	**Install Year**	**Avg DWF (cfs)**	**DWF Pattern**	**Max Depth (ft)**	**Max HGL (ft)**	**Freeboard (ft)**	**Max Inflow (cfs)**	**Total Flood Vol. (MG)**	**Time Flooded (hrs)**
WWMJ120035	133.71	126.31	2017	0.000	FM15_DIURNAL	0.40	126.71	7.00	1.00	0	0.00
WWMJ120036	137.44	127.46	2005	0.000	FM14_DIURNAL	0.45	127.91	9.53	1.00	0	0.00
WWMJ120037	140.82	132.41	2005	0.002	FM14_DIURNAL	0.21	132.62	8.20	1.00	0	0.00
WWMJ120038	150.33	139.45	2017	0.000	FM14_DIURNAL	0.33	139.78	10.55	0.96	0	0.00
WWMJ120039	150.91	141.24	2005	0.000	FM14_DIURNAL	0.34	141.58	9.33	0.96	0	0.00
WWMJ120040	153.37	143.48	2005	0.000	FM14_DIURNAL	0.29	143.77	9.60	0.96	0	0.00
WWMJ120041	157.38	146.02	2005	0.004	FM14_DIURNAL	0.28	146.30	11.08	0.96	0	0.00
WWMJ120042	169.74	153.34	2005	0.094	FM14_DIURNAL	0.29	153.63	16.11	0.95	0	0.00
WWMJ120043	177.19	167.14	2017	0.000	FM13_DIURNAL	0.59	167.73	9.46	1.34	0	0.00
WWMJ120044	180.73	160.50	2037			0.26	160.76	19.97	0.63	0	0.00
WWMJ120045	168.92	157.75	2037			0.13	157.88	11.04	0.61	0	0.00
WWMJ120046	137.67	120.13	2037			0.47	120.60	17.07	0.61	0	0.00
WWMJ120047	141.37	119.80	2017	0.014	FM15_DIURNAL	0.00	119.80	21.57	0.60	0	0.00
WWMJ120048	178.45	159.33	2017	0.000	FM15_DIURNAL	0.37	159.70	18.75	1.44	0	0.00
WWMJ120060	152.36	136.72	2017	0.008	FM14_DIURNAL	0.31	137.03	15.33	0.99	0	0.00
WWMK120007	170.09	154.55	2005	0.002	FM14_DIURNAL	0.36	154.91	15.18	0.62	0	0.00
WWMK120008	172.35	154.54	2005	0.002	FM14_DIURNAL	0.74	155.28	17.07	0.61	0	0.00
WWMK120009	171.58	156.94	2005	0.021	FM14_DIURNAL	0.36	157.30	14.28	0.61	0	0.00

Buildout Flows, 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
A1_100	WWMG136021	J-110	28.5	0.013	159.18	159.72	1.00	4.92	1.91	2.22	2.82	0.45	1.00
A1_108	J-F115	J-F102	1167.1	0.013	170.13	168.73	1.50	3.64	0.12	0.80	1.76	0.22	0.31
A1_111	J-F112	HWY240LS	254.1	0.013	153.90	153.00	1.50	6.25	0.35	1.59	2.89	0.25	1.00
A1-113	J-F102	J-F112	355.1	0.013	168.63	154.00	1.50	21.33	4.12	1.52	5.02	0.07	0.59
C-F102	J-F103	J-F115	1104.4	0.013	182.92	172.00	0.83	2.18	0.99	0.81	3.70	0.37	0.42
C-F103	J-F104	J-F103	760.7	0.013	184.56	180.76	0.83	1.02	0.22	0.48	1.91	0.47	0.47
C-F104	J-F105	J-F102	1226.4	0.013	175.00	172.06	1.00	1.74	0.24	0.37	1.88	0.21	0.30
C-F105	WWMG146030	WWMG146025	752.0	0.013	157.00	155.10	1.50	5.28	0.25	2.36	2.80	0.45	1.00
C-F106	J-F108_PROV_BASEFLOW	PROVIDENCEWW_F1	1728.5	0.013	167.08	160.17	0.67	0.76	0.40	0.50	2.46	0.66	0.57
C-F110	J-F110	RIVERFRONTWW_F2	878.3	0.013	159.00	149.00	0.67	1.29	1.14	0.65	3.70	0.50	0.50
C-F111	J-F111	RIVERFRONTWW_F2	2204.0	0.013	162.00	149.00	0.67	0.93	0.59	0.54	2.83	0.59	0.54
FM-101_PROVIDENCE	J-F107_PROVIDENCE	WWMJ102131	1145.3	0.013	165.00	170.08	0.50	0.53	0.44	0.96	6.21	1.82	0.87
FM-102_RIVERFRONT	J-F106_RIVERFRONT	WWMG146030	1176.0	0.013	149.00	157.10	0.67	1.41	0.69	2.39	6.85	1.69	1.00
R1_100	WWMG136018	WWMG136053	265.4	0.013	156.39	157.74	1.25	4.61	0.51	1.28	1.05	0.28	1.00
R1_101	WWMG136017	WWMG137193	265.9	0.013	155.82	157.07	1.25	4.43	0.47	0.59	0.48	0.13	1.00
R1_102	WWMG136015	WWMG136050	265.7	0.013	153.68	155.69	1.25	5.62	0.76	2.75	2.40	0.49	1.00
WWFM0026	J-140_CHEHAL	WWMG89250	3120.0	0.013	188.80	221.61	0.50	0.84	1.05	1.00	5.15	1.19	0.97
WWFM0028	J-130_CHAR	WWMG136039	995.0	0.013	151.20	161.27	0.33	0.29	1.01	0.40	4.62	1.39	1.00
WWFM0038	J-120_ANDR	WWMG136037	920.0	0.013	148.40	159.28	0.33	0.31	1.18	0.41	5.23	1.32	1.00
WWFM0039	J-210_SHER1	WWMF117018	495.0	0.013	152.94	157.78	0.33	0.28	0.98	0.24	2.73	0.84	1.00
WWFM0040	J-210_SHER1	WWMF117018	495.0	0.013	152.94	157.78	0.33	0.28	0.98	0.24	2.73	0.84	1.00
WWFM0041	J-160_DAY	WWMG136016	4000.0	0.013	107.00	155.11	1.00	5.46	1.20	8.52	10.85	1.56	1.00
WWFM0042	J-170_FERN1	WWMI121103	3290.0	0.013	137.60	173.53	1.00	5.18	1.09	2.73	3.48	0.53	1.00
WWFM0045	J-150_CREEKSD	WWMF109004	523.0	0.013	178.85	171.53	0.33	0.34	1.40	0.34	3.90	0.97	1.00
WWFM0048	J-190_HWY240_1	WWMG118104	2336.2	0.013	159.33	185.21	0.83	3.25	1.11	3.39	6.29	1.04	0.97
WWGM0002	WWMF118023	WWMF118002	232.9	0.013	169.65	166.04	0.83	2.73	1.55	0.02	1.54	0.01	0.53
WWGM0015	WWMG146013	WWMG146012	11.4	0.013	152.54	152.27	1.50	16.19	2.38	5.38	4.63	0.33	1.00
WWGM0152	WWMG123075	WWMG123074	221.5	0.013	125.12	122.95	1.50	10.40	0.98	8.60	4.87	0.83	1.00
WWGM0153	WWMG123076	WWMG123075	96.9	0.013	125.36	125.12	1.50	5.23	0.25	8.61	4.87	1.65	1.00
WWGM0154	WWMG123077	WWMG123076	105.3	0.013	125.89	125.58	1.50	5.70	0.29	7.01	3.96	1.23	1.00
WWGM0155	WWMG123079	WWMG123078	254.3	0.013	135.01	132.85	1.50	9.68	0.85	5.64	5.17	0.58	1.00
WWGM0156	WWMG114000	WWMG123079	20.2	0.013	135.51	135.38	1.50	8.42	0.64	5.62	4.80	0.67	1.00
WWGM0161	WWMH114127	WWMG114000	176.5	0.013	142.30	136.13	0.67	2.26	3.50	1.79	6.35	0.79	0.84
WWGM0162	WWMH114027	WWMH114026	137.8	0.013	153.65	145.99	0.67	2.85	5.57	1.79	8.62	0.63	0.57
WWGM0163	WWMH114028	WWMH114027	372.4	0.013	174.85	153.65	0.67	2.89	5.70	1.78	8.63	0.62	0.57
WWGM0164	WWMH114029	WWMH114028	244.1	0.013	176.84	175.07	0.67	1.03	0.73	1.78	5.17	1.73	0.96
WWGM0165	WWMG114001	WWMG114000	415.0	0.013	137.22	136.13	1.00	1.83	0.26	3.97	5.08	2.18	1.00
WWGM0166	WWMG114002	WWMG114001	326.7	0.013	138.28	137.32	1.00	1.93	0.29	3.18	4.05	1.65	1.00
WWGM0167	WWMH114140	WWMG114002	421.1	0.013	139.21	138.58	1.00	1.38	0.15	2.60	3.31	1.89	1.00
WWGM0168	WWMH114004	WWMH114003	183.5	0.013	140.80	140.18	0.83	1.27	0.34	2.83	5.20	2.23	1.00
WWGM0169	WWMH114005	WWMH114004	186.8	0.013	141.58	140.90	0.83	1.32	0.36	2.80	5.13	2.12	1.00
WWGM0170	WWMH114006	WWMH114005	235.2	0.013	143.28	141.62	1.00	2.99	0.71	1.79	2.28	0.60	1.00
WWGM0171	WWMH114007	WWMH114006	287.4	0.013	145.32	143.41	1.00	2.90	0.66	1.79	2.97	0.61	1.00
WWGM0173	WWMH104008	WWMH114007	218.6	0.013	146.86	145.48	1.00	2.83	0.63	1.78	2.97	0.63	1.00
WWGM0177	WWMG117195	WWMG116241	203.1	0.013	176.86	176.72	1.75	4.16	0.07	9.13	3.91	2.19	1.00
WWGM0182	WWMG116240	WWMG116239	324.0	0.013	176.26	175.44	1.75	7.97	0.25	9.14	4.07	1.15	1.00
WWGM0184	WWMG116239	WWMG116238	175.0	0.013	175.11	174.82	1.75	6.45	0.17	9.15	3.80	1.42	1.00
WWGM0191	WWMG118086	WWMG117195	481.3	0.013	178.01	177.21	1.75	6.46	0.17	6.30	3.04	0.98	1.00
WWGM0198	WWMG116238	WWMG116237	308.0	0.013	174.79	174.06	1.75	7.71	0.24	9.14	3.80	1.19	1.00
WWGM0206	WWMH141005	WWMH141004	268.5	0.013	97.72	97.06	2.50	20.35	0.25	13.35	4.22	0.66	0.61
WWGM0207	WWMH141006	WWMH141005	91.1	0.013	119.82	98.68	1.25	31.55	23.86	5.49	15.68	0.17	0.35
WWGM0208	WWMH141007	WWMH141006	88.7	0.013	149.19	120.52	1.25	37.75	34.15	5.49	21.59	0.15	0.26
WWGM0209	WWMI141008	WWMH141007	383.1	0.013	150.54	149.32	1.25	3.65	0.32	5.49	4.80	1.51	0.88
WWGM0210	WWMI131009	WWMI141008	386.6	0.013	152.25	150.54	1.25	4.30	0.44	5.48	4.47	1.28	1.00
WWGM0211	WWMH141071	WWMH141005	274.1	0.013	101.64	98.68	1.25	6.71	1.08	8.03	6.69	1.20	0.95
WWGM0212	WWMH141072	WWMH141071	157.2	0.013	102.73	101.74	1.25	5.13	0.63	8.03	6.55	1.57	1.00
WWGM0213	WWMH131073	WWMH141072	156.2	0.013	102.95	102.76	1.25	2.25	0.12	6.55	5.33	2.91	1.00
WWGM0214	WWMH131074	WWMH131073	353.7	0.013	103.87	102.95	1.25	3.29	0.26	6.54	5.33	1.99	1.00

Buildout Flows, 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM0215	WWMH131075	WWMH131074	466.2	0.013	106.08	104.30	1.25	3.99	0.38	5.97	4.86	1.50	1.00
WWGM0232	WWMG126164	WWMG126243	19.0	0.013	180.00	179.48	0.83	3.63	2.74	0.00	1.07	0.00	0.02
WWGM0235	WWMH131080	WWMH131075	352.5	0.013	107.40	106.16	1.25	3.83	0.35	6.11	4.97	1.59	1.00
WWGM0238	WWMH131081	WWMH131080	182.1	0.013	108.26	107.50	1.25	4.17	0.42	5.61	4.57	1.34	1.00
WWGM0251	WWMG123074	WWMG123073	237.0	0.013	122.74	122.41	1.50	3.92	0.14	6.04	3.42	1.54	1.00
WWGM0253	WWMG123073	WWMG123072	350.6	0.013	122.28	121.33	1.50	5.47	0.27	6.04	3.64	1.10	1.00
WWGM0273	WWMH123007	WWMH123006	362.7	0.013	167.07	165.11	1.00	2.62	0.54	2.48	3.96	0.95	0.75
WWGM0276	WWMG89261	WWMG89260	130.2	0.013	217.97	217.62	1.50	5.45	0.27	3.65	3.71	0.67	0.54
WWGM0317	WWMF127015	WWMF127014	174.7	0.013	153.38	153.05	1.25	2.81	0.19	2.65	2.63	0.94	0.77
WWGM0354	WWMG116241	WWMG116240	65.5	0.013	176.56	176.26	1.75	10.72	0.46	9.14	4.10	0.85	1.00
WWGM0356	WWMG123072	WWMH123071	423.4	0.013	121.01	119.99	1.50	5.16	0.24	7.21	4.08	1.40	1.00
WWGM0357	WWMH123071	WWMH123070	218.3	0.013	119.89	119.30	1.50	5.46	0.27	7.20	4.07	1.32	1.00
WWGM0372	WWMH141000	OF-3	177.3	0.013	91.24	90.60	3.50	60.44	0.36	43.62	7.10	0.72	0.61
WWGM0373	WWMH146002	WWMH146001	341.1	0.013	143.45	142.81	2.50	17.77	0.19	30.04	6.61	1.69	0.87
WWGM0374	WWMH141001	WWMH141000	169.5	0.013	95.40	92.32	2.50	55.29	1.82	13.36	9.18	0.24	0.39
WWGM0375	WWMH146001	WWMH146000	248.6	0.013	142.01	96.56	2.00	97.55	18.59	30.03	27.20	0.31	0.38
WWGM0376	WWMH146000	WWMH141000	12.7	0.013	92.54	92.32	2.50	53.95	1.73	30.03	8.49	0.56	0.68
WWGM0377	WWMH141002	WWMH141001	338.4	0.013	96.14	95.50	2.50	17.84	0.19	13.35	4.63	0.75	0.57
WWGM0378	WWMH141003	WWMH141002	71.2	0.013	96.53	96.34	2.50	21.19	0.27	13.35	4.62	0.63	0.57
WWGM0379	WWMH141004	WWMH141003	214.7	0.013	97.06	96.68	2.50	17.23	0.18	13.35	4.58	0.77	0.57
WWGM0408	WWMG123078	WWMG123077	241.2	0.013	132.71	125.99	1.50	17.54	2.79	6.99	5.27	0.40	1.00
WWGM0409	WWMH114026	WWMH114127	91.2	0.013	145.81	142.30	0.67	2.37	3.85	1.79	7.31	0.75	0.67
WWGM0411	WWMJ120034	WWMJ120016	95.6	0.013	124.85	124.55	2.00	12.67	0.31	1.00	2.55	0.08	0.18
WWGM0416	WWMJ120010	WWMJ120016	150.3	0.013	153.07	125.35	1.00	15.43	18.77	1.44	12.28	0.09	0.21
WWGM0417	WWMG89185	WWMG89261	61.3	0.013	220.04	218.95	0.83	2.92	1.78	3.65	6.75	1.25	0.97
WWGM0467	WWMJ120039	WWMJ120038	83.6	0.013	141.24	139.90	0.83	2.77	1.60	0.96	4.62	0.35	0.41
WWGM0468	WWMI131019	WWMI131018	377.8	0.013	160.63	159.36	1.25	3.75	0.34	4.40	3.82	1.18	1.00
WWGM0478	WWMJ120033	WWMJ120022	233.1	0.013	171.58	168.94	0.83	2.33	1.13	1.35	4.43	0.58	0.55
WWGM0479	WWMI131017	WWMI131014	277.3	0.013	157.55	156.79	1.25	3.38	0.27	4.42	3.60	1.31	1.00
WWGM0481	WWMJ120043	WWMJ120021	136.8	0.013	167.14	166.38	0.83	1.63	0.56	1.35	3.49	0.83	0.67
WWGM0482	WWMI131012	WWMI131011	85.1	0.013	155.05	154.68	1.25	4.26	0.43	5.49	4.47	1.29	1.00
WWGM0487	WWMJ120012	WWMJ120048	300.7	0.013	160.24	159.95	1.00	1.11	0.10	1.44	2.35	1.30	0.73
WWGM0491	WWMH146004	WWMH146003	432.9	0.013	145.38	144.42	2.50	19.32	0.22	30.03	6.12	1.55	1.00
WWGM0492	WWMJ120016	WWMJ120017	72.7	0.013	124.42	122.53	2.00	36.48	2.60	2.18	6.38	0.06	0.17
WWGM0496	WWMJ120001	WWMJ120009	135.7	0.013	163.63	163.52	1.00	1.01	0.08	0.21	1.31	0.21	0.41
WWGM0506	WWMJ120038	WWMJ120060	126.8	0.013	139.45	137.33	0.83	2.83	1.67	0.96	4.70	0.34	0.40
WWGM0507	WWMI131014	WWMI131013	132.0	0.013	156.45	156.36	1.25	1.69	0.07	5.59	4.56	3.32	1.00
WWGM0510	WWMJ120032	WWMJ120033	210.9	0.013	172.89	172.22	0.67	0.68	0.32	0.72	2.49	1.05	0.77
WWGM0511	WWMJ120037	WWMJ120036	54.2	0.013	132.41	127.58	1.00	10.66	8.95	1.00	6.81	0.09	0.27
WWGM0514	WWMJ120021	WWMJ120009	298.0	0.013	166.16	163.57	0.83	2.04	0.87	1.35	4.00	0.66	0.59
WWGM0516	WWMJ120023	WWMJ120033	67.7	0.013	172.55	172.22	0.83	1.53	0.49	0.65	2.78	0.42	0.44
WWGM0519	WWMJ120036	WWMJ120035	200.7	0.013	127.46	126.51	1.00	2.45	0.47	1.00	3.04	0.41	0.44
WWGM0520	WWMI131022	WWMI131021	449.4	0.013	165.43	163.80	1.25	3.89	0.36	4.40	3.74	1.13	1.00
WWGM0526	WWMJ120022	WWMJ120043	163.3	0.013	168.60	167.62	0.83	1.70	0.60	1.35	3.56	0.80	0.66
WWGM0528	WWMJ120025	WWMJ120026	55.0	0.013	174.85	174.46	0.67	1.02	0.71	0.74	2.12	0.73	1.00
WWGM0530	WWMK120007	WWMJ120042	162.3	0.013	154.55	153.63	0.83	1.65	0.57	0.62	2.84	0.38	0.42
WWGM0531	WWMK120008	WWMK120007	150.4	0.013	154.54	154.67	0.83	0.64	0.09	0.61	1.63	0.95	0.65
WWGM0533	WWMI131024	WWMI131023	384.7	0.013	168.13	166.74	1.25	3.88	0.36	4.39	3.58	1.13	1.00
WWGM0536	WWMH146005	WWMH146004	339.5	0.013	145.89	145.46	2.50	14.60	0.13	30.03	6.12	2.06	1.00
WWGM0539	WWMJ120013	WWMJ120012	299.8	0.013	161.35	160.47	1.00	1.93	0.29	1.44	2.52	0.75	0.68
WWGM0540	WWMI131013	WWMI131012	332.9	0.013	156.32	154.97	1.25	4.11	0.41	5.48	4.47	1.33	1.00
WWGM0546	WWMJ120048	WWMJ120010	298.8	0.013	159.33	153.40	1.00	5.02	1.98	1.44	5.52	0.29	0.37
WWGM0555	WWMI131010	WWMI131009	382.6	0.013	153.52	152.35	1.25	3.57	0.31	5.48	4.47	1.54	1.00
WWGM0556	WWMJ120026	WWMJ120032	469.1	0.013	174.41	173.94	0.67	0.38	0.10	0.75	2.49	1.96	0.81
WWGM0558	WWMI131023	WWMI131022	389.7	0.013	166.71	166.12	1.25	2.51	0.15	4.40	3.91	1.75	1.00
WWGM0559	WWMI131021	WWMI131020	444.1	0.013	163.74	162.05	1.25	3.99	0.38	4.40	3.70	1.10	1.00
WWGM0565	WWMJ120042	WWMJ120041	243.6	0.013	153.34	146.17	0.83	3.76	2.94	0.95	5.74	0.25	0.34
WWGM0569	WWMK120009	WWMK120008	256.7	0.013	156.94	155.59	0.83	1.59	0.53	0.61	2.77	0.38	0.42

Buildout Flows, 5-year, 24-hour storm event

Input								Output						
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM0580	WWMI131025	WWMI131024	397.1	0.013	169.55	168.16	1.25	3.82	0.35	3.75	3.51	0.98	1.00
WWGM0583	WWMI131020	WWMI131111	300.8	0.013	161.93	161.03	1.25	3.53	0.30	4.40	3.59	1.25	1.00
WWGM0584	WWMJ120035	WWMJ120034	182.1	0.013	126.31	125.09	1.00	2.92	0.67	1.00	3.36	0.34	0.40
WWGM0597	WWMJ120041	WWMJ120040	68.6	0.013	146.02	143.82	0.83	3.93	3.21	0.96	5.95	0.25	0.34
WWGM0598	WWMJ120024	WWMJ120023	299.3	0.013	177.01	172.94	0.83	2.56	1.36	0.65	3.91	0.25	0.34
WWGM0600	WWMJ120040	WWMJ120039	69.7	0.013	143.48	141.44	0.83	3.75	2.93	0.96	5.76	0.26	0.35
WWGM0601	WWMJ120014	WWMJ120013	300.3	0.013	162.10	161.35	1.00	1.78	0.25	1.44	2.58	0.81	0.67
WWGM0602	WWMJ120027	WWMJ120025	274.0	0.013	176.14	175.10	0.67	0.74	0.38	0.78	2.46	1.04	1.00
WWGM0604	WWMI131011	WWMI131010	248.7	0.013	154.68	153.66	1.25	4.14	0.41	5.49	4.47	1.33	1.00
WWGM0608	WWMH146003	WWMH146002	355.4	0.013	144.27	143.74	2.50	15.84	0.15	30.03	6.12	1.90	1.00
WWGM0612	WWMJ120018	WWMJ120017	36.1	0.013	135.90	122.53	2.00	142.74	39.81	0.00	0.00	0.00	0.04
WWGM0617	WWMJ120009	WWMJ120014	334.7	0.013	163.22	162.43	1.00	1.73	0.24	1.44	2.75	0.83	0.63
WWGM0651	WWMH114036	WWMH114035	142.3	0.013	193.10	192.59	1.00	2.13	0.36	0.85	2.70	0.40	0.42
WWGM0652	WWMH114037	WWMH114036	269.2	0.013	194.33	193.69	1.00	1.74	0.24	0.84	2.41	0.48	0.45
WWGM0653	WWMH114035	WWMH114033	401.0	0.013	192.53	191.06	1.00	2.16	0.37	0.85	2.72	0.40	0.42
WWGM0654	WWMH114033	WWMH114031	501.1	0.013	190.84	180.52	0.83	3.14	2.06	0.86	3.32	0.27	0.68
WWGM0661	WWMH114031	WWMH114030	331.2	0.013	180.15	177.84	0.67	1.01	0.70	1.77	5.06	1.75	1.00
WWGM0682	WWMI102001	WWMI112000	311.0	0.013	197.52	196.80	0.83	1.05	0.23	2.42	4.44	2.30	1.00
WWGM0691	WWMH114039	WWMH114038	385.7	0.013	208.10	201.86	0.83	2.79	1.62	0.82	4.45	0.30	0.37
WWGM0696	WWMH104041	WWMH104040	127.4	0.013	210.12	209.95	1.00	1.30	0.13	0.82	2.24	0.63	0.47
WWGM0699	WWMI112000	WWMI111099	35.8	0.013	196.52	196.17	0.83	2.17	0.98	2.42	4.44	1.12	1.00
WWGM0700	WWMI102003	WWMI102002	479.9	0.013	199.90	198.72	0.83	1.09	0.25	2.42	4.44	2.23	1.00
WWGM0711	WWMH104042	WWMH104041	314.4	0.013	211.37	210.45	1.00	1.93	0.29	0.78	2.50	0.41	0.42
WWGM0716	WWMH114038	WWMH114037	386.6	0.013	201.80	194.53	0.83	3.00	1.88	0.83	4.45	0.27	0.37
WWGM0717	WWMI102002	WWMI102001	342.7	0.013	198.62	197.76	0.83	1.10	0.25	2.42	4.44	2.20	1.00
WWGM0723	WWMH104040	WWMH114039	92.9	0.013	209.84	208.22	1.00	4.71	1.74	0.82	4.50	0.17	0.28
WWGM0734	WWMH104044	WWMH104043	421.9	0.013	214.86	213.33	1.00	2.15	0.36	0.76	2.63	0.36	0.40
WWGM0756	WWMH104011	WWMH104010	218.1	0.013	150.77	150.31	1.00	1.64	0.21	1.78	2.40	1.09	1.00
WWGM0760	WWMH104009	WWMH104008	208.7	0.013	148.29	146.88	1.00	2.93	0.68	1.78	3.09	0.61	1.00
WWGM0761	WWMH104010	WWMH104009	80.7	0.013	150.28	148.29	1.00	5.59	2.47	1.78	3.85	0.32	1.00
WWGM0762	WWMH104012	WWMH104011	194.5	0.013	151.90	150.79	1.00	2.69	0.57	1.76	2.61	0.65	1.00
WWGM0763	WWMG89187	WWMG89186	177.2	0.013	221.07	220.81	0.83	0.84	0.15	1.29	2.62	1.54	1.00
WWGM0801	WWMF99008	WWMF99007	81.6	0.013	178.31	178.07	1.00	1.93	0.29	2.97	3.78	1.54	1.00
WWGM0802	WWMF99011	WWMF99009	299.7	0.013	180.34	179.40	1.00	2.00	0.31	2.91	3.71	1.46	1.00
WWGM0826	WWMF99014	WWMF99013	273.8	0.013	188.32	186.28	0.83	1.89	0.74	2.74	5.02	1.45	1.00
WWGM0846	WWMF89021	WWMF89020	143.4	0.013	201.22	200.31	0.67	0.96	0.63	0.94	3.29	0.98	0.77
WWGM0855	WWMF99015	WWMF99014	137.3	0.013	189.24	188.44	0.83	1.67	0.58	2.74	5.03	1.64	1.00
WWGM0863	WWMG99101	WWMG99100	364.6	0.013	204.69	197.49	1.75	22.27	1.97	5.62	7.71	0.25	0.34
WWGM0867	WWMG89258	WWMG99105	356.9	0.013	214.58	212.84	1.50	7.33	0.49	4.67	4.49	0.64	0.57
WWGM0870	WWMG89259	WWMG89258	281.6	0.013	216.37	214.94	1.50	7.49	0.51	4.64	4.53	0.62	0.56
WWGM0880	WWMF89019	WWMF99152	352.5	0.013	199.16	197.43	0.67	0.85	0.49	0.94	3.00	1.11	0.85
WWGM0882	WWMF99152	WWMF99018	123.2	0.013	195.57	194.64	0.67	1.05	0.75	0.96	3.49	0.91	1.00
WWGM0884	WWMF89160	WWMF89022	378.6	0.013	204.27	201.78	0.67	0.98	0.66	0.90	2.59	0.92	1.00
WWGM0896	WWMG99100	WWMG99099	270.4	0.013	197.15	192.18	1.75	21.48	1.84	5.65	7.53	0.26	0.35
WWGM0898	WWMF89020	WWMF89019	15.5	0.013	200.18	199.28	0.67	2.91	5.82	0.94	5.09	0.32	0.70
WWGM0917	WWMG99102	WWMG99101	363.5	0.013	208.50	204.83	1.75	15.92	1.01	5.62	6.04	0.35	0.41
WWGM0940	WWMF89025	WWMF89024	268.4	0.013	212.45	208.40	0.67	1.48	1.51	0.85	4.40	0.57	0.54
WWGM0953	WWMG89189	WWMG89187	214.5	0.013	222.20	221.48	0.83	1.27	0.34	1.29	2.92	1.02	1.00
WWGM0991	WWMF99012	WWMF99011	60.3	0.013	180.58	180.41	1.00	1.89	0.28	2.91	3.71	1.54	1.00
WWGM0992	WWMF99013	WWMF99012	275.8	0.013	186.08	180.65	1.00	5.00	1.97	2.79	4.18	0.56	1.00
WWGM0993	WWMF89023	WWMF89160	85.0	0.013	205.30	204.46	0.67	1.20	0.98	0.90	3.73	0.75	0.96
WWGM0996	WWMF89026	WWMF89025	34.1	0.013	213.74	212.80	0.67	2.01	2.76	0.85	5.52	0.43	0.46
WWGM0998	WWMF89024	WWMF89023	240.0	0.013	208.19	205.30	0.67	1.33	1.21	0.89	3.88	0.67	0.76
WWGM1005	WWMF99009	WWMF99008	233.4	0.013	179.26	178.50	1.00	2.03	0.33	2.96	3.77	1.46	1.00
WWGM1033	WWMG89193	WWMG89192	152.0	0.013	228.02	226.44	0.83	2.23	1.04	1.29	4.24	0.58	0.55
WWGM1035	WWMG89192	WWMG89189	364.7	0.013	226.02	224.07	0.83	1.60	0.53	1.29	3.39	0.80	0.66
WWGM1039	WWMG89186	WWMG89185	115.6	0.013	220.50	220.14	0.83	1.22	0.31	1.30	2.85	1.06	1.00
WWGM1045	WWMH105017	WWMH105005	193.4	0.013	163.31	162.19	1.00	2.71	0.58	1.61	3.65	0.60	0.55

Buildout Flows, 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1046	WWMH105005	WWMH105004	264.4	0.013	162.03	160.05	1.00	3.08	0.75	1.65	3.99	0.53	0.52
WWGM1047	WWMH105004	WWMH105003	275.1	0.013	160.00	157.72	1.00	3.24	0.83	1.65	4.12	0.51	0.60
WWGM1051	WWMH105003	WWMH105002	277.9	0.013	157.69	155.42	1.00	3.22	0.82	1.66	3.95	0.52	0.86
WWGM1052	WWMH105002	WWMH105001	341.6	0.013	155.42	152.93	1.00	3.04	0.73	1.67	3.79	0.55	1.00
WWGM1053	WWMH105001	WWMH104012	61.1	0.013	152.88	151.90	1.00	4.51	1.61	1.76	4.04	0.39	1.00
WWGM1054	WWMI102066	WWMI111099	425.2	0.013	203.23	196.17	1.00	4.59	1.66	2.80	4.36	0.61	0.78
WWGM1055	WWMI102067	WWMI102066	153.3	0.013	208.13	205.74	1.00	4.45	1.56	2.79	5.98	0.63	0.57
WWGM1056	WWMI102068	WWMI102067	295.6	0.013	212.88	208.27	1.00	4.45	1.56	2.79	5.98	0.63	0.57
WWGM1060	WWMI102069	WWMI102068	254.8	0.013	213.72	213.18	1.00	1.64	0.21	2.76	3.86	1.68	0.86
WWGM1061	WWMI102070	WWMI102069	123.0	0.013	214.21	213.73	1.00	2.23	0.39	2.76	3.52	1.24	1.00
WWGM1062	WWMI102071	WWMI102070	42.2	0.013	214.40	214.31	1.00	1.65	0.21	2.75	3.51	1.67	1.00
WWGM1069	WWMI102073	WWMI102072	115.9	0.013	218.21	216.84	0.83	2.38	1.18	2.74	5.02	1.15	1.00
WWGM1070	WWMI102131	WWMI102073	126.5	0.013	219.28	218.55	0.83	1.66	0.58	2.72	4.99	1.64	1.00
WWGM1071	WWMI102132	WWMI102131	195.8	0.013	220.88	219.42	0.83	1.89	0.75	2.10	3.85	1.11	1.00
WWGM1072	WWMI104051	WWMI102132	58.5	0.013	222.06	221.22	1.50	12.59	1.44	3.10	5.02	0.25	1.00
WWGM1075	WWMH95019	WWMH95018	134.7	0.013	166.45	165.40	1.50	9.29	0.78	1.55	3.90	0.17	0.28
WWGM1076	WWMH95020	WWMH95019	346.9	0.013	169.94	166.45	1.50	10.53	1.00	1.55	4.07	0.15	0.27
WWGM1077	WWMH95021	WWMH95020	218.5	0.013	187.21	170.61	1.50	29.00	7.62	1.55	8.72	0.05	0.16
WWGM1080	WWMH95022	WWMH95021	259.8	0.013	190.07	187.35	1.50	10.75	1.05	1.54	4.32	0.14	0.26
WWGM1081	WWMH95023	WWMH95022	376.0	0.013	191.85	190.15	1.50	7.06	0.45	1.54	3.23	0.22	0.31
WWGM1082	WWMH95024	WWMH95023	157.0	0.013	192.85	191.99	1.50	7.77	0.55	1.32	3.28	0.17	0.28
WWGM1090	WWMI92151	WWMI92152	344.6	0.013	225.75	224.65	1.50	5.94	0.32	2.12	3.25	0.36	0.40
WWGM1091	WWMI92150	WWMI92151	107.8	0.013	229.75	226.53	1.50	18.16	2.99	1.96	6.72	0.11	0.22
WWGM1104	WWMI92147	WWMI92148	349.7	0.013	243.47	242.07	1.50	6.65	0.40	1.76	3.27	0.26	0.34
WWGM1105	WWMI92148	WWMI92149	281.5	0.013	241.52	237.17	1.50	13.06	1.55	1.76	5.15	0.13	0.25
WWGM1106	WWMI92149	WWMI92150	500.5	0.013	236.97	229.90	1.50	12.49	1.41	1.96	5.15	0.16	0.27
WWGM1107	WWMI92161	WWMI92159	465.0	0.013	249.58	248.23	1.25	3.48	0.29	0.49	2.14	0.14	0.24
WWGM1108	WWMI92159	WWMI92158	128.4	0.013	248.10	247.76	1.25	3.32	0.26	0.49	2.11	0.15	0.24
WWGM1109	WWMI92158	WWMI92157	403.4	0.013	247.11	245.75	1.25	3.75	0.34	0.49	2.23	0.13	0.24
WWGM1110	WWMI92157	WWMI92156	182.5	0.013	245.57	245.13	1.25	3.17	0.24	0.49	2.05	0.15	0.25
WWGM1111	WWMI92156	WWMI92147	203.0	0.013	244.65	243.61	1.25	4.62	0.51	0.49	1.96	0.11	0.27
WWGM1113	WWMI81	WWMI92143	411.7	0.013	268.14	257.94	1.00	5.61	2.48	0.66	4.79	0.12	0.23
WWGM1114	WWMI92143	WWMI92144	108.8	0.013	257.49	256.50	1.00	3.40	0.91	1.28	4.02	0.38	0.42
WWGM1116	WWMI92144	WWMI92146	160.8	0.013	256.47	254.96	1.00	3.45	0.94	1.28	2.14	0.37	0.71
WWGM1117	WWMI92146	WWMI92147	136.7	0.013	254.54	255.51	1.00	3.00	0.71	1.28	2.09	0.43	0.73
WWGM1119	WWMH95018	WWMH105017	341.9	0.013	165.10	163.46	1.00	2.47	0.48	1.61	3.47	0.65	0.57
WWGM1129	WWMI102072	WWMI102071	423.4	0.013	216.64	214.42	1.00	2.58	0.52	2.75	3.50	1.06	1.00
WWGM1131	WWMI92152	WWMI104050	237.8	0.013	223.96	222.64	1.50	7.83	0.56	2.10	3.71	0.27	0.73
WWGM1132	WWMI104050	WWMI104051	65.3	0.013	222.32	222.24	1.50	3.68	0.12	2.18	2.91	0.59	1.00
WWGM1164	WWMJ111094	WWMJ111103	264.2	0.013	177.95	177.19	1.00	1.91	0.29	0.77	2.49	0.40	0.50
WWGM1165	WWMJ111047	WWMJ120027	138.4	0.013	176.73	176.33	0.67	0.65	0.29	0.83	2.46	1.28	1.00
WWGM1167	WWMJ111043	WWMJ120024	300.3	0.013	184.33	177.46	0.83	3.31	2.29	0.65	4.71	0.20	0.30
WWGM1168	WWMJ111056	WWMJ111043	236.2	0.013	191.76	184.80	0.83	3.76	2.95	0.65	5.16	0.17	0.28
WWGM1176	WWMJ120060	WWMJ120037	175.6	0.013	136.72	132.73	0.83	3.30	2.27	0.99	5.29	0.30	0.38
WWGM1177	WWMJ120046	WWMJ120047	435.7	0.013	120.13	119.80	2.00	6.23	0.08	0.59	2.82	0.09	0.12
WWGM1178	WWMJ120045	WWMJ120046	370.6	0.013	157.75	120.36	2.00	72.04	10.14	0.60	5.58	0.01	0.09
WWGM1179	WWMJ120044	WWMJ120045	500.6	0.013	160.50	157.88	2.00	16.37	0.52	0.60	2.48	0.04	0.13
WWGM1180	WWMJ111064	WWMJ120044	400.0	0.013	162.76	160.66	2.00	16.41	0.53	0.63	2.51	0.04	0.13
WWGM1181	WWMJ111063	WWMJ111064	493.8	0.013	165.36	162.76	2.00	16.40	0.53	0.68	2.69	0.04	0.14
WWGM1182	WWMJ111062	WWMJ111063	439.3	0.013	167.35	165.51	2.00	14.64	0.42	0.70	2.45	0.05	0.15
WWGM1183	WWMJ111061	WWMJ111062	394.4	0.013	168.54	167.55	2.00	11.33	0.25	0.78	2.22	0.07	0.17
WWGM1186	WWMJ102131	WWMJ111061	445.8	0.013	170.08	168.54	2.00	13.30	0.35	0.99	2.72	0.07	0.18
WWGM1187	WWMJ102130	WWMJ102131	101.1	0.013	171.61	170.08	2.00	27.83	1.51	0.05	1.87	0.00	0.11
WWGM1194	WWMJ120015	WWMJ120001	129.3	0.013	164.04	163.96	1.00	0.89	0.06	0.00	0.00	0.00	0.01
WWGM1200	WWMH136249	WWMH136248	255.9	0.013	157.01	156.62	0.83	0.86	0.15	1.03	1.90	1.21	1.00
WWGM1201	WWMH136248	WWMH136247	334.1	0.013	156.42	155.89	0.83	0.87	0.16	2.06	3.77	2.36	1.00
WWGM1202	WWMH136247	WWMH146246	312.0	0.013	155.57	154.41	0.83	1.34	0.37	2.06	4.03	1.54	0.89
WWGM1204	WWMH146006	WWMH146005	259.1	0.013	146.57	146.06	2.50	18.20	0.20	30.02	6.12	1.65	1.00

Buildout Flows, 5-year, 24-hour storm event

Input								Output						
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1205	WWMH146246	WWMH146006	62.4	0.013	153.93	149.33	0.83	5.96	7.39	2.27	9.41	0.38	0.88
WWGM1206	WWMI131018	WWMI131017	61.3	0.013	158.73	158.05	1.25	6.80	1.11	4.42	5.69	0.65	1.00
WWGM1218	WWMH146007	WWMH146006	489.6	0.013	147.71	146.63	2.50	19.26	0.22	27.98	5.70	1.45	1.00
WWGM1234	WWMF109006	WWMF109005	292.6	0.013	175.99	173.63	1.00	3.20	0.81	3.21	4.50	1.00	1.00
WWGM1236	WWMF99007	WWMF109006	290.0	0.013	177.87	176.84	1.00	2.12	0.36	3.18	4.06	1.50	1.00
WWGM1242	WWMG108011	WWMG108010	145.8	0.013	181.53	181.43	1.00	0.93	0.07	0.51	2.26	0.55	1.00
WWGM1244	WWMG109046	WWMG108080	372.6	0.013	179.31	178.79	1.75	5.92	0.14	5.79	3.16	0.98	1.00
WWGM1245	WWMG108009	WWMG108008	368.6	0.013	180.80	179.80	1.00	1.86	0.27	0.52	2.17	0.28	1.00
WWGM1246	WWMG108010	WWMG108009	155.3	0.013	181.43	180.86	1.00	2.16	0.37	0.51	2.32	0.24	1.00
WWGM1247	WWMG108008	WWMG108080	32.5	0.013	179.75	179.04	1.00	5.27	2.18	0.71	4.27	0.14	1.00
WWGM1248	WWMG108080	WWMG118086	202.1	0.013	178.59	178.22	1.75	6.78	0.18	6.26	3.44	0.92	1.00
WWGM1249	WWMG108007	WWMG108006	411.5	0.013	178.60	178.44	1.00	0.70	0.04	0.03	0.48	0.04	0.12
WWGM1252	WWMF127016	WWMF127015	14.4	0.013	154.81	153.41	1.25	20.21	9.79	2.61	4.34	0.13	0.49
WWGM1253	WWMF127014	WWMF127013	423.4	0.013	152.96	152.22	1.25	2.70	0.17	2.64	2.90	0.98	0.70
WWGM1254	WWMF127013	WWMF127012	60.6	0.013	152.22	151.92	1.25	4.55	0.50	2.64	3.29	0.58	0.62
WWGM1255	WWMF127012	WWMF127011	403.9	0.013	151.90	150.91	1.25	3.20	0.25	2.66	2.99	0.83	0.68
WWGM1264	J-250_SHER_BASEFLOW	F118029	40.0	0.013	138.76	138.60	0.67	0.76	0.40	0.01	0.79	0.01	0.07
WWGM1266	WWMF127017	WWMF127016	310.0	0.013	156.17	155.05	1.25	3.88	0.36	2.61	3.60	0.67	0.57
WWGM1272	WWMF127044	WWMF127007	515.5	0.013	157.16	148.58	0.67	1.56	1.66	0.03	1.22	0.02	0.55
WWGM1273	J-260_CHAR_BASEFLOW	F137193	20.0	0.013	146.92	146.60	0.67	1.53	1.60	0.07	2.27	0.05	0.15
WWGM1289	WWMF137072	F137204	13.8	0.013	109.76	108.50	1.50	31.83	9.18	2.71	9.64	0.09	0.22
WWGM1290	WWMF137001	WWMF137072	126.8	0.013	125.96	110.35	1.50	36.99	12.40	2.68	12.16	0.07	0.18
WWGM1291	WWMF137002	WWMF137001	97.3	0.013	132.89	126.51	1.50	26.93	6.57	2.68	9.72	0.10	0.21
WWGM1292	WWMF137003	WWMF137002	348.1	0.013	144.94	133.22	1.50	19.28	3.37	2.68	7.67	0.14	0.25
WWGM1293	WWMF137004	WWMF137003	112.0	0.013	147.00	146.31	1.25	5.07	0.62	2.67	4.18	0.53	0.52
WWGM1294	WWMF137005	WWMF137004	334.5	0.013	147.32	147.10	1.25	1.66	0.07	2.67	2.68	1.61	0.76
WWGM1304	WWMG136067	WWMG136066	318.9	0.013	161.45	160.79	1.00	1.62	0.21	2.00	2.55	1.24	1.00
WWGM1306	WWMG136068	WWMG136067	324.9	0.013	162.01	161.46	1.00	1.47	0.17	1.06	1.44	0.72	1.00
WWGM1307	WWMG136069	WWMG136068	15.2	0.013	162.03	162.06	1.00	1.58	0.20	1.01	1.92	0.64	1.00
WWGM1308	WWMG136070	WWMG136069	238.7	0.013	162.60	162.23	1.00	1.40	0.15	1.00	2.12	0.71	1.00
WWGM1309	WWMG126098	WWMG136070	350.4	0.013	163.54	162.65	1.00	1.80	0.25	0.74	1.33	0.41	1.00
WWGM1313	WWMG126237	WWMG126236	363.7	0.013	161.43	160.29	1.75	8.87	0.31	11.67	4.85	1.32	1.00
WWGM1314	WWMG126238	WWMG126237	243.2	0.013	162.28	161.50	1.75	8.97	0.32	11.66	4.85	1.30	1.00
WWGM1316	WWMG126236	WWMG136260	371.1	0.013	158.58	157.50	1.75	8.55	0.29	11.67	4.85	1.37	1.00
WWGM1318	WWMG136064	WWMG136021	266.7	0.013	159.97	158.79	1.00	2.37	0.44	2.03	2.86	0.86	1.00
WWGM1319	WWMG136260	WWMG136019	27.7	0.013	157.00	157.13	1.75	10.86	0.47	11.69	4.86	1.08	1.00
WWGM1320	WWMG136019	WWMG136018	355.3	0.013	156.83	156.60	1.75	4.03	0.06	11.40	4.74	2.83	1.00
WWGM1321	WWMG136021	WWMG136019	18.6	0.013	158.68	157.07	1.50	30.99	8.70	1.21	1.95	0.04	1.00
WWGM1323	WWMG136054	WWMG136053	357.5	0.013	158.95	157.87	1.25	3.55	0.30	3.57	2.91	1.01	1.00
WWGM1324	WWMG136018	WWMG136017	353.6	0.013	156.39	155.92	1.75	5.78	0.13	10.58	4.40	1.83	1.00
WWGM1325	WWMG136016	WWMG136015	308.7	0.013	155.01	154.14	2.25	16.44	0.28	19.05	5.13	1.16	1.00
WWGM1326	WWMG136035	WWMG136016	273.2	0.013	157.45	156.86	1.25	3.00	0.22	3.65	3.17	1.22	1.00
WWGM1330	WWMG136015	WWMG146014	301.7	0.013	153.68	152.93	2.25	15.44	0.25	19.97	5.36	1.29	1.00
WWGM1331	WWMG136050	WWMG146078	299.1	0.013	155.69	155.03	1.25	3.03	0.22	5.17	4.21	1.70	1.00
WWGM1338	WWMH146247	WWMH146008	500.0	0.013	148.89	148.71	2.50	7.78	0.04	27.98	5.70	3.59	1.00
WWGM1339	WWMH146008	WWMH146007	492.1	0.013	148.65	147.73	2.50	17.73	0.19	27.98	5.70	1.58	1.00
WWGM1341	WWMG136020	WWMG136016	17.1	0.013	155.24	155.16	1.75	10.83	0.47	14.08	5.85	1.30	1.00
WWGM1342	WWMG136051	WWMG136050	311.8	0.013	156.25	155.69	1.25	2.74	0.18	4.58	3.73	1.67	1.00
WWGM1352	WWMG137193	WWMG136051	365.9	0.013	157.07	156.25	1.25	3.06	0.22	4.58	3.73	1.50	1.00
WWGM1353	WWMG136053	WWMG137193	351.0	0.013	157.74	157.09	1.25	2.78	0.19	4.23	3.45	1.52	1.00
WWGM1355	WWMG136017	WWMG136020	350.6	0.013	155.82	155.44	1.75	5.22	0.11	11.96	4.97	2.29	1.00
WWGM1356	WWMG126239	WWMG126238	402.9	0.013	163.94	162.54	1.75	9.34	0.35	11.66	4.85	1.25	1.00
WWGM1358	WWMG126240	WWMG126239	136.0	0.013	165.66	164.18	1.75	16.53	1.09	11.66	6.07	0.71	1.00
WWGM1368	WWMG126102	WWMG127188	280.1	0.013	164.40	163.76	1.00	1.70	0.23	0.62	1.16	0.36	1.00
WWGM1369	WWMG127188	WWMG126098	394.2	0.013	163.75	163.69	1.00	0.44	0.02	0.64	1.24	1.46	1.00
WWGM1371	WWMF127118	WWMF127117	137.1	0.013	168.96	168.71	0.83	0.94	0.18	1.08	1.98	1.15	1.00
WWGM1372	WWMF127117	WWMF127116	260.2	0.013	168.63	168.33	0.83	0.74	0.12	1.09	2.17	1.46	1.00
WWGM1373	WWMF127116	WWMF127115	383.8	0.013	168.23	167.52	1.00	1.53	0.18	1.19	2.24	0.78	1.00

Buildout Flows, 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1378	WWMF127008	WWMF127007	264.7	0.013	149.01	148.58	1.25	2.60	0.16	2.65	2.72	1.02	0.74
WWGM1379	WWMF127007	WWMF137006	197.4	0.013	148.57	148.06	1.25	3.28	0.26	2.68	2.89	0.82	0.72
WWGM1380	WWMF137006	WWMF137005	304.8	0.013	148.06	147.32	1.25	3.18	0.24	2.67	2.36	0.84	0.87
WWGM1381	WWMF127011	WWMF127010	262.6	0.013	150.90	150.14	1.25	3.48	0.29	2.66	3.14	0.77	0.65
WWGM1382	WWMF127010	WWMF127009	188.0	0.013	150.14	149.57	1.25	3.56	0.30	2.66	3.01	0.75	0.68
WWGM1383	WWMF127009	WWMF127008	256.2	0.013	149.42	149.01	1.25	2.58	0.16	2.65	2.47	1.03	0.82
WWGM1389	WWMG137106	WWMG136039	319.7	0.013	161.89	161.27	1.25	2.84	0.19	2.34	2.59	0.82	1.00
WWGM1390	WWMG136039	WWMG136038	487.1	0.013	161.22	160.06	1.25	3.15	0.24	2.47	2.72	0.78	1.00
WWGM1401	WWMF127203	WWMF127118	309.4	0.013	169.66	169.21	0.83	0.84	0.15	1.07	2.18	1.28	1.00
WWGM1402	WWMF127220	WWMF127203	279.8	0.013	170.34	169.81	0.83	0.95	0.19	1.06	2.09	1.11	1.00
WWGM1403	WWMF127119	WWMF127220	6.1	0.013	170.40	170.39	0.83	0.89	0.16	1.08	2.15	1.22	1.00
WWGM1411	WWMF117018	WWMF127017	299.9	0.013	157.50	157.45	1.25	0.83	0.02	2.62	2.62	3.14	0.76
WWGM1419	WWMF117021	WWMF117020	303.3	0.013	160.66	159.88	1.25	3.28	0.26	2.48	2.94	0.76	0.65
WWGM1420	WWMF117022	WWMF117021	299.7	0.013	161.98	160.74	1.25	4.15	0.41	2.47	3.41	0.60	0.57
WWGM1422	WWMF117023	WWMF117022	323.4	0.013	163.58	162.10	1.25	4.37	0.46	2.47	3.78	0.57	0.53
WWGM1442	WWMG89194	WWMG89193	242.3	0.013	234.52	232.09	0.83	2.19	1.00	1.25	4.15	0.57	0.54
WWGM1447	WWMG79195	WWMG89194	361.0	0.013	240.18	234.89	1.00	4.31	1.47	1.23	4.74	0.29	0.37
WWGM1448	WWMG79196	WWMG79195	87.5	0.013	240.58	240.31	0.83	1.22	0.31	1.23	3.02	1.01	0.70
WWGM1449	WWMG79244	WWMG79196	136.6	0.013	241.37	240.83	0.83	1.38	0.40	1.23	3.12	0.90	0.68
WWGM1451	WWMG79245	WWMG79244	130.4	0.013	242.09	241.67	0.83	1.24	0.32	1.23	2.97	0.99	0.71
WWGM1452	WWMG79246	WWMG79245	103.7	0.013	242.45	242.24	0.83	0.99	0.20	0.92	2.37	0.94	0.69
WWGM1462	WWMF79030	WWMF79029	22.4	0.013	217.37	216.90	0.67	1.75	2.10	0.83	3.14	0.47	1.00
WWGM1463	WWMF79031	WWMF79030	108.5	0.013	218.07	217.49	0.67	0.88	0.53	0.82	3.05	0.93	0.81
WWGM1464	WWMG79032	WWMF79031	93.8	0.013	218.21	218.07	0.67	0.47	0.15	0.82	2.53	1.77	0.89
WWGM1465	WWMG79033	WWMG79032	338.1	0.013	222.83	218.65	0.67	1.34	1.24	0.79	4.00	0.59	0.55
WWGM1470	WWMF89022	WWMF89021	316.5	0.013	201.60	201.25	0.67	0.40	0.11	0.90	2.74	2.25	0.90
WWGM1476	WWMF79029	WWMF79028	79.0	0.013	216.75	216.67	0.67	0.38	0.10	0.83	2.37	2.15	1.00
WWGM1477	WWMF79028	WWMF89027	318.4	0.013	216.32	215.51	0.67	0.61	0.25	0.84	2.73	1.38	0.83
WWGM1480	WWMF89027	WWMF89026	129.8	0.013	215.21	213.96	0.67	1.19	0.96	0.85	3.70	0.72	0.63
WWGM1481	WWMG79034	WWMG79033	192.5	0.013	224.69	223.14	0.67	1.08	0.81	0.79	3.39	0.73	0.63
WWGM1529	WWMG99105	WWMG99104	313.1	0.013	212.56	210.77	1.50	7.94	0.57	4.69	4.68	0.59	0.55
WWGM1534	WWMG99104	WWMG99102	343.8	0.013	210.39	208.69	1.75	11.14	0.49	5.62	4.66	0.50	0.50
WWGM1539	J-240_CREEK_BASEFLOW	F109157	40.0	0.013	165.97	165.77	0.67	0.85	0.50	0.02	1.08	0.02	0.10
WWGM1547	WWMF109005	WWMF109004	286.3	0.013	173.61	171.64	1.00	2.96	0.69	3.15	4.01	1.07	1.00
WWGM1548	WWMF109040	WWMF109005	312.3	0.013	174.77	173.63	1.00	2.15	0.37	0.30	0.54	0.14	1.00
WWGM1551	WWMF109153	WWMF118026	185.5	0.013	166.55	166.13	1.25	3.07	0.23	3.35	3.30	1.09	1.00
WWGM1552	WWMF109000	WWMF109153	150.9	0.013	167.20	166.64	1.25	3.94	0.37	3.31	3.35	0.84	1.00
WWGM1553	WWMF109001	WWMF109000	19.1	0.013	167.76	167.35	1.25	9.47	2.15	3.74	5.44	0.39	1.00
WWGM1554	WWMF109150	WWMF109001	118.9	0.013	168.21	167.81	1.00	2.07	0.34	3.32	4.29	1.61	1.00
WWGM1555	WWMF109002	WWMF109150	98.1	0.013	168.39	168.17	1.00	1.69	0.22	3.32	4.22	1.97	1.00
WWGM1557	WWMF109003	WWMF109002	144.6	0.013	169.02	168.82	1.00	1.33	0.14	3.30	4.20	2.49	1.00
WWGM1560	WWMF109004	WWMF109003	439.3	0.013	171.53	170.03	1.00	2.08	0.34	3.29	4.20	1.58	1.00
WWGM1564	WWMF117024	WWMF117023	30.3	0.013	163.87	163.98	1.25	3.89	0.36	0.01	0.32	0.00	0.27
WWGM1565	WWMF117025	J-280_HWY240_WEIR	145.5	0.013	164.41	164.00	1.00	1.89	0.28	3.38	4.57	1.79	0.89
WWGM1566	WWMF117026	WWMF117025	205.2	0.013	164.30	164.49	1.25	1.97	0.09	3.38	2.76	1.72	1.00
WWGM1567	WWMF117027	WWMF117026	309.7	0.013	165.11	164.50	1.25	2.87	0.20	3.38	2.76	1.18	1.00
WWGM1568	WWMF117028	WWMF117027	109.5	0.013	165.19	165.27	1.25	1.75	0.07	3.38	2.75	1.93	1.00
WWGM1569	WWMF118001	WWMF117028	7.0	0.013	165.39	165.49	1.00	4.25	1.42	0.08	0.40	0.02	1.00
WWGM1570	WWMF118002	WWMF118001	97.7	0.013	165.74	165.59	1.00	1.40	0.15	0.08	0.60	0.06	1.00
WWGM1571	WWMF118026	WWMF117028	157.5	0.013	165.75	165.44	1.25	2.87	0.20	3.35	2.73	1.17	1.00
WWGM1572	WWMF118025	WWMF118026	63.1	0.013	166.25	166.13	0.83	0.96	0.19	0.10	0.70	0.11	1.00
WWGM1573	WWMF118024	WWMF118025	90.1	0.013	167.53	166.28	0.83	2.58	1.39	0.11	1.43	0.04	0.95
WWGM1574	WWMF118023	WWMF118024	104.3	0.013	169.65	167.58	0.83	3.09	1.98	0.03	1.75	0.01	0.45
WWGM1575	WWMF118003	WWMF118023	80.8	0.013	170.44	169.70	0.83	2.10	0.92	0.05	1.62	0.02	0.11
WWGM1590	WWMG137107	WWMG136095	352.4	0.013	162.99	162.63	1.25	2.06	0.10	2.33	2.20	1.13	1.00
WWGM1591	WWMG137183	WWMG137107	20.2	0.013	163.12	163.09	1.25	2.49	0.15	2.33	2.23	0.94	1.00
WWGM1592	WWMG127109	WWMG137183	378.9	0.013	163.83	163.22	1.25	2.59	0.16	2.33	2.39	0.90	1.00
WWGM1603	WWMG127133	WWMF127115	158.0	0.013	168.63	167.52	0.83	1.84	0.70	0.19	1.09	0.10	1.00

Buildout Flows, 5-year, 24-hour storm event

	Input							Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1604	WWMF127115	WWMG127114	114.6	0.013	167.50	165.93	1.00	4.17	1.37	2.32	5.20	0.56	1.00
WWGM1605	WWMG127110	WWMG127109	258.2	0.013	164.26	163.91	1.25	2.38	0.14	2.33	2.35	0.98	1.00
WWGM1606	WWMG126200	WWMG127110	395.2	0.013	164.87	164.33	1.25	2.39	0.14	2.32	2.24	0.97	1.00
WWGM1607	WWMG127114	WWMG126200	144.7	0.013	165.69	164.97	1.00	2.51	0.50	2.32	3.24	0.92	1.00
WWGM1614	WWMG126147	WWMG127195	520.6	0.013	174.04	167.46	0.83	2.46	1.26	0.31	0.67	0.13	1.00
WWGM1617	WWMG108006	WWMG108005	410.2	0.013	178.43	177.32	1.00	1.85	0.27	0.03	0.91	0.01	0.08
WWGM1618	WWMG108005	WWMG118004	141.8	0.013	177.08	174.65	0.83	2.87	1.71	0.03	1.63	0.01	0.07
WWGM1619	WWMG118004	WWMF118003	276.8	0.013	174.35	170.49	0.83	2.59	1.39	0.03	1.52	0.01	0.07
WWGM1639	WWMH131082	WWMH131081	491.9	0.013	110.06	108.31	1.25	3.85	0.36	5.56	4.53	1.44	1.00
WWGM1641	WWMH131083	WWMH131082	431.1	0.013	111.72	110.18	1.25	3.86	0.36	5.21	4.25	1.35	1.00
WWGM1642	WWMH133096	WWMH131083	28.8	0.013	114.54	113.17	1.50	22.92	4.76	5.22	9.83	0.23	1.00
WWGM1643	WWMH133000	WWMH133096	8.6	0.013	115.16	114.79	1.50	21.85	4.33	6.37	8.24	0.29	1.00
WWGM1644	WWMH133001	WWMH133096	178.1	0.013	116.99	114.79	1.00	3.96	1.24	1.23	3.24	0.31	1.00
WWGM1645	WWMH133002	WWMH133001	137.9	0.013	117.76	116.99	1.00	2.66	0.56	1.87	2.76	0.70	1.00
WWGM1646	WWMH133066	WWMH133000	199.1	0.013	116.27	115.71	1.50	5.57	0.28	6.38	3.91	1.14	1.00
WWGM1647	WWMH133067	WWMH133066	262.2	0.013	117.04	116.48	1.50	4.85	0.21	8.24	4.66	1.70	1.00
WWGM1648	WWMH123005	WWMH123004	499.4	0.013	163.03	160.10	1.00	2.73	0.59	2.54	3.97	0.93	0.76
WWGM1649	WWMH123004	WWMH123003	414.2	0.013	160.05	157.64	1.00	2.72	0.58	2.55	4.07	0.94	0.74
WWGM1650	WWMH123003	WWMH133002	218.2	0.013	157.32	118.02	1.00	15.25	18.31	2.57	8.89	0.17	0.64
WWGM1653	WWMH123068	WWMH133067	370.2	0.013	118.12	117.29	1.50	4.97	0.22	8.24	4.66	1.66	1.00
WWGM1654	WWMH123069	WWMH123068	123.6	0.013	118.70	118.42	1.50	5.00	0.23	7.24	4.10	1.45	1.00
WWGM1655	WWMH123070	WWMH123069	90.4	0.013	119.14	119.08	1.50	2.71	0.07	7.24	4.10	2.68	1.00
WWGM1660	J-270_ANDR_BASEFLOW	G146040	40.0	0.013	143.66	143.50	0.67	0.76	0.40	0.07	1.45	0.09	0.19
WWGM1669	WWMG136095	WWMG137106	424.2	0.013	162.53	161.89	1.25	2.51	0.15	2.34	2.29	0.93	1.00
WWGM1685	WWMH126133	WWMH136204	209.2	0.013	161.52	160.41	0.83	1.60	0.53	1.02	3.11	0.64	1.00
WWGM1689	WWMH104043	WWMH104042	449.2	0.013	213.21	211.83	1.00	1.97	0.31	0.78	2.52	0.39	0.42
WWGM1709	WWMI111099	WWMI111053	500.2	0.013	195.95	193.92	1.25	4.12	0.41	5.30	4.66	1.29	0.87
WWGM1710	WWMI111036	WWMI111035	289.1	0.013	182.78	181.39	1.25	4.48	0.48	5.99	4.88	1.34	1.00
WWGM1713	WWMH114030	WWMH114029	101.7	0.013	177.83	176.93	0.67	1.14	0.89	1.77	5.08	1.56	1.00
WWGM1718	WWMH123006	WWMH123005	305.9	0.013	164.58	163.32	1.00	2.29	0.41	2.53	3.59	1.11	0.84
WWGM1739	WWMI111053	WWMI111037	117.3	0.013	193.35	190.22	1.25	10.55	2.67	5.97	8.82	0.57	0.60
WWGM1740	WWMI111037	WWMI111036	53.8	0.013	189.43	183.25	1.25	21.96	11.56	6.00	12.53	0.27	1.00
WWGM1742	WWMG136254	WWMG136054	261.9	0.013	159.70	158.92	1.00	1.94	0.30	0.71	0.90	0.37	1.00
WWGM1743	WWMG136097	WWMG136254	257.5	0.013	160.50	159.70	1.00	1.99	0.31	0.71	1.03	0.36	1.00
WWGM1753	WWMG136065	WWMG136064	267.0	0.013	160.39	159.99	1.00	1.38	0.15	2.03	2.59	1.47	1.00
WWGM1755	WWMG136066	WWMG136065	260.3	0.013	160.79	160.39	1.00	1.40	0.15	2.02	2.57	1.45	1.00
WWGM1756	WWMG136100	WWMG136066	198.2	0.013	163.12	160.79	1.00	3.86	1.18	0.52	1.00	0.13	1.00
WWGM1760	WWMG136038	WWMG136037	352.2	0.013	160.06	159.28	1.25	3.04	0.22	2.47	2.07	0.81	1.00
WWGM1762	WWMG136037	WWMG137195	338.6	0.013	159.28	158.68	1.25	2.72	0.18	3.58	2.92	1.32	1.00
WWGM1763	WWMG137194	WWMG136035	319.2	0.013	158.03	157.53	1.25	2.56	0.16	3.64	2.96	1.42	1.00
WWGM1764	WWMG136074	WWMG136050	250.6	0.013	164.31	163.74	0.83	1.05	0.23	0.01	0.69	0.01	0.07
WWGM1766	WWMH136250	WWMH136249	137.8	0.013	157.81	157.38	0.83	1.22	0.31	1.03	2.44	0.84	1.00
WWGM1767	WWMH136135	WWMH136250	405.9	0.013	158.83	157.93	0.83	1.03	0.22	1.03	2.23	1.00	1.00
WWGM1768	WWMH136253	WWMH136135	199.3	0.013	159.45	159.02	0.83	1.02	0.22	1.03	2.41	1.01	1.00
WWGM1769	WWMH136204	WWMH136253	223.9	0.013	159.79	159.68	0.83	0.49	0.05	1.02	2.03	2.11	1.00
WWGM1770	WWMH136262	WWMG136097	336.6	0.013	161.48	160.50	1.00	1.92	0.29	0.59	1.06	0.31	1.00
WWGM1771	WWMF117019	WWMF117018	281.5	0.013	158.59	157.78	1.25	3.46	0.29	2.50	2.75	0.72	0.72
WWGM1773	WWMF117020	WWMF117019	458.0	0.013	159.73	158.77	1.25	2.96	0.21	2.50	3.02	0.84	0.64
WWGM1779	WWMG109049	WWMG109048	306.6	0.013	182.02	181.21	1.75	8.14	0.26	5.69	3.42	0.70	1.00
WWGM1780	WWMG109050	WWMG109049	279.0	0.013	186.00	182.32	1.75	18.20	1.32	5.68	6.15	0.31	1.00
WWGM1781	WWMG109051	WWMG109050	272.6	0.013	188.97	186.45	1.75	15.24	0.92	5.66	5.84	0.37	0.71
WWGM1782	WWMG99099	WWMG109051	272.6	0.013	191.77	189.26	1.75	15.20	0.92	5.66	5.85	0.37	0.42
WWGM1788	WWMG116237	WWMG116236	301.4	0.013	173.99	173.53	1.75	6.19	0.15	9.63	4.00	1.56	1.00
WWGM1790	WWMI121026	WWMI131025	351.3	0.013	171.05	170.10	1.25	3.36	0.27	3.94	3.57	1.17	1.00
WWGM1791	WWMI121027	WWMI121026	336.7	0.013	172.17	171.05	1.25	3.73	0.33	4.58	3.73	1.23	1.00
WWGM1792	WWMI121103	WWMI121027	23.1	0.013	172.36	172.37	1.25	1.65	0.06	4.60	3.98	2.79	1.00
WWGM1793	WWMI121028	WWMI121103	38.1	0.013	172.66	172.36	1.25	5.78	0.80	4.08	3.87	0.71	1.00
WWGM1794	WWMI121029	WWMI121028	365.6	0.013	174.79	172.66	1.25	4.93	0.58	4.02	4.15	0.82	1.00

Buildout Flows, 5-year, 24-hour storm event

Input								Output						
Pipe ID	**Upstream MH**	**Downstream MH**	**Length (ft)**	**Roughness**	**US Invert (ft)**	**DS Invert (ft)**	**Diameter (ft)**	**Full Flow (cfs)**	**Slope (%)**	**Max Flow (cfs)**	**Max Velocity (ft/s)**	**Max.Flow/Full Flow**	**Max.Depth/Full Depth**
WWGM1795	WWMI121030	WWMI121029	347.9	0.013	176.89	174.79	1.25	5.02	0.60	4.02	4.16	0.80	1.00
WWGM1796	WWMI121100	WWMI121030	59.7	0.013	177.06	176.89	1.25	3.41	0.28	4.04	3.67	1.19	1.00
WWGM1798	WWMI121031	WWMI121100	342.8	0.013	178.01	177.06	1.25	3.41	0.28	3.99	3.25	1.17	1.00
WWGM1799	WWMI111032	WWMI121031	450.4	0.013	179.27	178.01	1.25	3.42	0.28	3.99	3.25	1.17	1.00
WWGM1800	WWMI111040	WWMI111032	452.8	0.013	180.54	179.27	1.25	3.42	0.28	3.99	3.25	1.17	1.00
WWGM1802	WWMI111035	WWMI111040	306.3	0.013	181.39	180.54	1.25	3.40	0.28	3.99	3.25	1.17	1.00
WWGM1810	WWMF99016	WWMF99015	147.1	0.013	190.51	189.39	0.83	1.91	0.76	0.98	2.63	0.51	1.00
WWGM1811	WWMF99017	WWMF99016	75.7	0.013	191.25	190.62	0.83	2.00	0.83	0.98	3.49	0.49	1.00
WWGM1812	WWMF99018	WWMF99017	160.5	0.013	192.94	191.30	0.83	2.21	1.02	0.98	3.82	0.44	1.00
WWGM1828	WWMG146025	WWMG146013	253.0	0.013	155.04	152.57	1.50	10.38	0.98	2.58	4.02	0.25	1.00
WWGM1834	WWMG126242	WWMG126241	303.3	0.013	171.64	168.53	1.75	16.05	1.03	11.53	6.90	0.72	1.00
WWGM1835	WWMG126241	WWMG127195	139.7	0.013	168.22	167.46	1.75	11.69	0.54	10.53	5.49	0.90	1.00
WWGM1837	WWMG126243	WWMG126242	254.9	0.013	171.83	171.74	1.75	2.98	0.04	11.05	4.59	3.71	1.00
WWGM1839	WWMG116235	WWMG126243	292.4	0.013	172.55	172.04	1.75	6.62	0.17	10.59	4.40	1.60	1.00
WWGM1840	WWMG127195	WWMG126240	187.0	0.013	166.36	165.81	1.75	8.59	0.29	10.74	4.79	1.25	1.00
WWGM1842	WWMG116236	WWMG116235	299.3	0.013	173.27	172.84	1.75	6.01	0.14	10.11	4.20	1.68	1.00
WWGM1967	WWMJ120017	J120019	23.4	0.013	122.37	121.60	2.00	41.02	3.29	2.18	6.92	0.05	0.16
WWGM2024	J-230_CHEHAL_BASEFLOW	F89189	40.0	0.013	186.09	185.93	0.67	0.76	0.40	0.68	2.81	0.89	0.65
WWGM2025	WWMJ120047	J120019	32.1	0.013	119.80	119.60	24.00	0.00	0.62	0.60	-1.00	-1.00	-1.00
WWGM2026	WWMG89260	WWMG89259	285.5	0.013	217.01	216.37	1.50	4.97	0.22	4.67	3.75	0.94	0.68
WWGM2035	WWMG109047	WWMG109046	377.4	0.013	180.34	179.71	1.75	6.47	0.17	5.78	3.46	0.89	1.00
WWGM2037	WWMG109048	WWMG109047	349.8	0.013	181.12	180.53	1.75	6.51	0.17	5.73	3.28	0.88	1.00
WWGM2039	J-110	WWMG136054	228.4	0.013	159.72	158.95	1.00	2.07	0.34	2.21	2.81	1.06	1.00
WWGM2053	WWMG89250	WWMG89260	19.4	0.013	220.40	220.10	0.67	1.50	1.55	1.03	4.61	0.68	0.61
WWGM2054	WWMG89076	WWMG89260	43.7	0.013	218.83	218.00	0.67	1.66	1.90	0.03	1.83	0.02	0.18
WWGM2073	WWMG118104	WWMG117195	36.0	0.013	184.64	184.46	1.25	4.57	0.50	3.32	4.23	0.73	0.94
WWGM2074	J-100	WWMF117024	15.3	0.013	164.00	163.89	1.00	3.02	0.72	0.00	0.13	0.00	0.32
WWGM2075	J-280_HWY240_WEIR	WWMF118050	45.7	0.013	163.80	163.06	1.00	4.53	1.62	3.38	4.90	0.75	0.82
WWGM2076	WWMF118050	WWMF118049	85.0	0.013	162.98	162.58	1.00	2.44	0.47	3.38	4.57	1.38	0.89
WWGM2077	WWMF118049	WWMF118048	138.0	0.013	162.17	154.99	1.00	8.13	5.21	3.69	6.04	0.45	0.74
WWGM2078	WWMF118048	HWY240LS	20.0	0.013	154.99	155.00	1.00	0.80	0.05	3.70	4.71	4.65	1.00
WWGM2093	WWMG136036	WWMG137194	61.3	0.013	158.51	158.08	1.25	5.41	0.70	3.62	3.26	0.67	1.00
WWGM2094	WWMG137195	WWMG136036	88.7	0.013	158.48	158.46	1.25	0.97	0.02	3.60	3.14	3.72	1.00
WWGM2110	WWMH114003	WWMH114140	66.3	0.013	140.08	139.38	1.00	3.66	1.06	2.60	3.31	0.71	1.00
WWGM2119	WWMI131111	WWMI131019	95.9	0.013	160.90	160.63	1.25	3.43	0.28	4.41	3.59	1.29	1.00
WWGM2137	WWMJ111103	WWMJ111047	30.1	0.013	177.19	176.75	1.00	4.31	1.46	1.89	3.22	0.44	0.77
WWGM2146	WWMG146012	WWMG146076	311.7	0.013	152.08	151.46	1.50	4.69	0.20	4.90	2.77	1.05	1.00
WWGM2147	WWMG146075	WWMG146076	9.4	0.013	151.83	152.31	3.00	151.15	5.14	19.99	4.84	0.13	1.00
WWGM2148	WWMG146014	WWMG146075	9.1	0.013	152.58	152.68	2.25	32.47	1.10	20.00	6.01	0.62	1.00
WWGM2149	WWMG146076	WWMG146077	275.8	0.013	151.13	150.91	3.00	18.84	0.08	22.34	4.32	1.19	1.00
WWGM2150	WWMG146078	WWMG146077	26.9	0.013	154.74	152.10	1.25	20.27	9.85	5.18	7.58	0.26	1.00
WWGM2151	WWMG146077	WWMG146079	380.7	0.013	150.36	149.98	3.00	21.07	0.10	26.00	3.78	1.23	1.00
WWGM2152	WWMG146079	WWMH146247	372.3	0.013	149.70	149.05	3.00	27.87	0.17	27.98	3.96	1.00	1.00

Appendix D4:

CIP System

Model Data

CIP System, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
J-100	172.40	164.00	2017			0.27	164.27	8.13	0.00	0	0.00
J-110	170.05	159.72	2017			0.58	160.30	9.75	0.83	0	0.00
J-124	168.00	163.00	2100			0.68	163.68	4.32	6.27	0	0.00
J-160_DAY	113.50	107.00	2017			656.50	763.50	-650.00	2.90	0	0.00
J-170_FERN1	140.60	137.60	2017			94.50	232.10	-91.50	2.86	0	0.00
J-190_HWY240_1	165.00	143.00	2017			511.99	654.99	-489.99	6.89	0	0.00
J-210_SHER1	156.60	132.60	2017			96.27	228.87	-72.27	0.48	0	0.00
J-230_CHEHAL_BASEFLOW	196.10	184.12	2017	0.175	FM3_DIURNAL	0.46	184.58	11.52	0.68	0	0.00
J-240_CREEK_BASEFLOW	174.60	165.77	2017	0.011	FM2_DIURNAL	0.10	165.87	8.73	0.06	0	0.00
J-250_SHER_BASEFLOW	156.60	138.76	2017	0.004	FM9_DIURNAL	0.05	138.81	17.79	0.01	0	0.00
J-260_CHAR_BASEFLOW	154.10	146.92	2017	0.025	FM10_DIURNAL	0.13	147.05	7.05	0.07	0	0.00
J-270_ANDR_BASEFLOW	150.60	143.66	2017	0.023	FM10_DIURNAL	1.46	145.12	5.48	0.07	0	0.00
J-280_HWY240_WEIR	172.40	163.80	2008			0.66	164.46	7.94	3.45	0	0.00
J-F102	177.00	168.63	2037	0.033	FM3_DIURNAL	0.33	168.96	8.04	2.20	0	0.00
J-F103	188.00	182.92	2037	0.059	FM3_DIURNAL	0.35	183.27	4.73	0.81	0	0.00
J-F104	201.00	191.00	2047	0.050	FM2_DIURNAL	0.29	191.29	9.71	0.48	0	0.00
J-F105	180.00	175.00	2047	0.032	FM2_DIURNAL	0.34	175.34	4.66	0.37	0	0.00
J-F106_RIVERFRONT	152.00	149.00	2037			125.38	274.38	-122.38	3.75	0	0.00
J-F107_PROVIDENCE	168.00	165.00	2037			132.77	297.77	-129.77	1.52	0	0.00
J-F108_PROV_BASEFLOW	182.00	167.08	2037	0.136	FM12_DIURNAL	0.43	167.51	14.49	0.51	0	0.00
J-F109	160.00	141.61	2100			0.24	141.84	18.16	0.14	0	0.00
J-F110	164.00	159.00	2037	0.053	FM10_DIURNAL	0.33	159.33	4.67	0.65	0	0.00
J-F111	167.00	162.00	2037	0.056	FM10_DIURNAL	0.37	162.37	4.63	0.55	0	0.00
J-F112	159.00	153.90	2037			0.61	154.51	4.49	2.24	0	0.00
J-F113	175.00	164.09	2100			0.11	164.20	10.80	0.06	0	0.00
J-F115	185.00	170.13	2037	0.000	FM2_DIURNAL	0.76	170.89	14.11	1.48	0	0.00
J-F116	188.00	171.04	2100			0.39	171.43	16.57	0.68	0	0.00
J-F117	189.00	171.40	2100			0.44	171.84	17.16	0.68	0	0.00
J-F118	188.00	171.97	2100			0.46	172.43	15.57	0.68	0	0.00
J-F119	192.00	178.16	2100			0.47	178.63	13.37	0.68	0	0.00
J-F120	186.00	178.84	2100			0.45	179.29	6.71	0.68	0	0.00
J-F121	187.00	181.90	2100			0.47	182.37	4.63	0.68	0	0.00
J-F122	186.00	170.30	2100			1.44	171.74	14.26	6.37	0	0.00
J-F123	172.00	168.00	0			1.00	169.00	3.00	6.29	0	0.00
WWMF109000	175.61	167.20	1978	0.000	FM2_DIURNAL	1.14	168.34	7.27	3.33	0	0.00
WWMF109001	175.70	167.76	1978	0.000	FM2_DIURNAL	0.51	168.27	7.43	3.33	0	0.00
WWMF109002	175.26	168.39	1980	0.014	FM2_DIURNAL	2.20	170.59	4.67	3.33	0	0.00
WWMF109003	178.18	169.02	1978	0.000	FM2_DIURNAL	2.82	171.84	6.34	3.31	0	0.00
WWMF109004	183.87	171.53	1978	0.042	FM2_DIURNAL	4.10	175.63	8.24	3.31	0	0.00
WWMF109005	187.09	173.61	1978	0.020	FM2_DIURNAL	4.41	178.02	9.07	3.24	0	0.00
WWMF109006	188.45	175.99	1994	0.014	FM2_DIURNAL	4.37	180.36	8.09	3.20	0	0.00
WWMF109040	177.87	174.77	1980	0.024	FM2_DIURNAL	0.08	174.85	3.02	0.04	0	0.00
WWMF109150	174.88	168.17	1995	0.000	FM2_DIURNAL	1.57	169.74	5.14	3.34	0	0.00
WWMF109153	172.73	166.55	2017	0.023	FM2_DIURNAL	1.45	168.00	4.73	3.37	0	0.00
WWMF117018	168.07	157.50	1976	0.001	FM9_DIURNAL	1.30	158.80	9.27	2.97	0	0.00
WWMF117019	170.98	158.59	1976	0.004	FM9_DIURNAL	0.79	159.38	11.60	2.50	0	0.00
WWMF117020	167.67	159.73	1976	0.016	FM9_DIURNAL	0.96	160.69	6.98	2.50	0	0.00

CIP System, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMF117021	166.65	160.66	1976	0.004	FM9_DIURNAL	0.81	161.47	5.18	2.48	0	0.00
WWMF117022	169.11	161.98	1976	0.000	FM9_DIURNAL	0.69	162.67	6.44	2.47	0	0.00
WWMF117023	173.64	163.58	1976	0.000	FM2_DIURNAL	0.69	164.27	9.37	2.48	0	0.00
WWMF117024	172.69	163.87	1976	0.000	FM2_DIURNAL	0.40	164.27	8.42	0.01	0	0.00
WWMF117025	170.57	164.15	1976	0.000	FM2_DIURNAL	1.20	165.35	5.22	3.45	0	0.00
WWMF117026	173.30	164.30	1976	0.000	FM2_DIURNAL	1.58	165.88	7.42	3.45	0	0.00
WWMF117027	176.97	165.11	1978	0.005	FM2_DIURNAL	1.69	166.80	10.17	3.45	0	0.00
WWMF117028	173.99	165.19	2017	0.000	FM2_DIURNAL	1.91	167.10	6.89	3.45	0	0.00
WWMF118001	173.89	165.39	2017	0.000	FM2_DIURNAL	1.71	167.10	6.79	0.06	0	0.00
WWMF118002	170.94	165.74	1978	0.000	FM2_DIURNAL	1.33	167.07	3.87	0.04	0	0.00
WWMF118003	182.24	170.44	1992	0.014	FM2_DIURNAL	0.09	170.53	11.71	0.05	0	0.00
WWMF118023	179.54	169.65	2003	0.000	FM2_DIURNAL	0.06	169.71	9.83	0.05	0	0.00
WWMF118024	174.53	167.53	2003	0.000	FM2_DIURNAL	0.06	167.59	6.94	0.03	0	0.00
WWMF118025	170.14	166.25	2017	0.000	FM2_DIURNAL	1.31	167.56	2.58	0.03	0	0.00
WWMF118026	169.96	165.75	2003	0.014	FM2_DIURNAL	1.76	167.51	2.45	3.42	0	0.00
WWMF118048	164.64	154.99	2010	0.000	FM2_DIURNAL	1.12	156.11	8.53	3.76	0	0.00
WWMF118049	172.54	162.17	2010	0.157	FM2_DIURNAL	0.48	162.65	9.89	3.76	0	0.00
WWMF118050	173.02	162.98	2017	0.000	FM2_DIURNAL	1.26	164.24	8.78	3.45	0	0.00
WWMF127007	162.68	148.57	1922	0.004	FM9_DIURNAL	0.86	149.43	13.25	2.68	0	0.00
WWMF127008	161.46	149.01	1962	0.001	FM9_DIURNAL	1.01	150.02	11.44	2.66	0	0.00
WWMF127009	155.12	149.42	1962	0.001	FM9_DIURNAL	1.04	150.46	4.66	2.66	0	0.00
WWMF127010	158.39	150.14	1962	0.001	FM9_DIURNAL	0.81	150.95	7.44	2.66	0	0.00
WWMF127011	160.70	150.90	1962	0.000	FM9_DIURNAL	0.82	151.72	8.98	2.66	0	0.00
WWMF127012	163.01	151.90	1962	0.017	FM9_DIURNAL	0.89	152.79	10.22	2.66	0	0.00
WWMF127013	163.38	152.22	1962	0.000	FM9_DIURNAL	0.69	152.91	10.47	2.65	0	0.00
WWMF127014	171.41	152.96	1962	0.000	FM9_DIURNAL	1.05	154.01	17.40	2.65	0	0.00
WWMF127015	171.72	153.38	1980	0.044	FM9_DIURNAL	0.96	154.34	17.38	2.66	0	0.00
WWMF127016	170.94	154.81	1980	0.000	FM9_DIURNAL	0.30	155.11	15.83	2.60	0	0.00
WWMF127017	166.06	156.17	2017	0.025	FM9_DIURNAL	0.78	156.95	9.11	2.64	0	0.00
WWMF127044	165.32	157.16	1922	0.013	FM9_DIURNAL	0.06	157.22	8.10	0.03	0	0.00
WWMF127115	172.54	167.50	1922	0.001	FM10_DIURNAL	0.50	168.00	4.54	2.10	0	0.00
WWMF127116	173.89	168.23	1922	0.001	FM10_DIURNAL	0.66	168.89	5.00	1.06	0	0.00
WWMF127117	174.12	168.63	1922	0.003	FM10_DIURNAL	0.89	169.52	4.60	1.06	0	0.00
WWMF127118	173.08	168.96	1922	0.000	FM10_DIURNAL	0.86	169.82	3.26	1.05	0	0.00
WWMF127119	176.51	170.40	1922	0.014	FM10_DIURNAL	0.71	171.11	5.40	1.05	0	0.00
WWMF127203	177.79	169.66	2017	0.001	FM10_DIURNAL	0.84	170.50	7.29	1.05	0	0.00
WWMF127220	176.26	170.34	2017	0.000	FM10_DIURNAL	0.76	171.10	5.16	1.05	0	0.00
WWMF137001	135.40	125.96	1996	0.000	FM9_DIURNAL	0.27	126.23	9.17	2.68	0	0.00
WWMF137002	140.83	132.89	1996	0.001	FM9_DIURNAL	0.32	133.21	7.62	2.68	0	0.00
WWMF137003	157.74	144.94	1962	0.005	FM9_DIURNAL	0.38	145.32	12.42	2.67	0	0.00
WWMF137004	158.00	147.00	1962	0.000	FM9_DIURNAL	0.64	147.64	10.36	2.67	0	0.00
WWMF137005	160.72	147.32	1962	0.000	FM9_DIURNAL	1.24	148.56	12.16	2.67	0	0.00
WWMF137006	162.06	148.06	1962	0.000	FM9_DIURNAL	0.93	148.99	13.07	2.68	0	0.00
WWMF137072	114.53	109.76	2017	0.019	FM9_DIURNAL	0.37	110.13	4.40	2.71	0	0.00
WWMF79028	227.32	216.32	1989	0.012	FM16_DIURNAL	1.31	217.63	9.69	0.85	0	0.00
WWMF79029	224.60	216.75	1979	0.000	FM16_DIURNAL	1.24	217.99	6.61	0.83	0	0.00
WWMF79030	224.89	217.37	1979	0.000	FM16_DIURNAL	0.69	218.06	6.83	0.82	0	0.00

CIP System, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMF79031	224.55	218.07	1979	0.000	FM16_DIURNAL	0.52	218.59	5.96	0.82	0	0.00
WWMF89019	213.10	199.16	1978	0.000	FM16_DIURNAL	0.94	200.10	13.00	0.94	0	0.00
WWMF89020	211.27	200.18	1978	0.000	FM16_DIURNAL	0.26	200.44	10.83	0.94	0	0.00
WWMF89021	211.58	201.22	1997	0.028	FM16_DIURNAL	0.56	201.78	9.80	0.94	0	0.00
WWMF89022	215.49	201.60	1978	0.000	FM16_DIURNAL	1.83	203.43	12.06	0.90	0	0.00
WWMF89023	214.29	205.30	1978	0.005	FM16_DIURNAL	0.62	205.92	8.37	0.90	0	0.00
WWMF89024	217.25	208.19	1995	0.028	FM16_DIURNAL	0.40	208.59	8.66	0.89	0	0.00
WWMF89025	222.97	212.45	1989	0.000	FM16_DIURNAL	0.36	212.81	10.16	0.85	0	0.00
WWMF89026	224.97	213.74	1989	0.000	FM16_DIURNAL	0.30	214.04	10.93	0.85	0	0.00
WWMF89027	226.06	215.21	1989	0.009	FM16_DIURNAL	0.42	215.63	10.43	0.86	0	0.00
WWMF89160	214.29	204.27	1978	0.003	FM16_DIURNAL	1.27	205.54	8.75	0.90	0	0.00
WWMF99007	190.72	177.87	1978	0.133	FM2_DIURNAL	4.80	182.67	8.05	3.18	0	0.00
WWMF99008	190.47	178.31	1978	0.000	FM2_DIURNAL	4.91	183.22	7.25	2.96	0	0.00
WWMF99009	190.76	179.26	1978	0.028	FM2_DIURNAL	5.56	184.82	5.94	2.96	0	0.00
WWMF99011	189.86	180.34	1978	0.000	FM2_DIURNAL	6.50	186.84	3.02	2.92	0	0.00
WWMF99012	189.63	180.58	1978	0.051	FM2_DIURNAL	6.66	187.24	2.39	2.92	0	0.00
WWMF99013	193.15	186.08	1978	0.032	FM2_DIURNAL	2.82	188.90	4.25	2.80	0	0.00
WWMF99014	196.47	188.32	1978	0.000	FM2_DIURNAL	4.83	193.15	3.32	2.75	0	0.00
WWMF99015	198.21	189.24	1978	0.023	FM2_DIURNAL	6.02	195.26	2.95	2.75	0	0.00
WWMF99016	201.32	190.51	1978	0.002	FM16_DIURNAL	5.05	195.56	5.76	0.98	0	0.00
WWMF99017	200.59	191.25	1978	0.000	FM16_DIURNAL	4.45	195.70	4.89	0.98	0	0.00
WWMF99018	203.24	192.94	1978	0.019	FM16_DIURNAL	3.05	195.99	7.25	0.98	0	0.00
WWMF99152	203.96	195.57	1997	0.003	FM16_DIURNAL	1.11	196.68	7.28	0.95	0	0.00
WWMG108005	183.37	177.08	1965	0.000	FM2_DIURNAL	0.06	177.14	6.23	0.03	0	0.00
WWMG108006	189.94	178.43	1965	0.000	FM2_DIURNAL	0.09	178.52	11.42	0.03	0	0.00
WWMG108007	192.96	178.60	1965	0.014	FM2_DIURNAL	0.16	178.76	14.20	0.03	0	0.00
WWMG108008	192.80	179.75	1965	0.003	FM3_DIURNAL	6.59	186.34	6.46	0.79	0	0.00
WWMG108009	191.30	180.80	1965	0.000	FM3_DIURNAL	5.65	186.45	4.85	0.96	0	0.00
WWMG108010	191.25	181.43	1965	0.000	FM3_DIURNAL	5.84	187.27	3.98	0.70	0	0.00
WWMG108011	191.59	181.53	1965	0.241	FM3_DIURNAL	6.16	187.69	3.90	0.75	0	0.00
WWMG108080	192.99	178.59	2000	0.003	FM3_DIURNAL	7.74	186.33	6.66	5.64	0	0.00
WWMG109046	191.61	179.31	2017	0.000	FM3_DIURNAL	7.29	186.60	5.01	5.28	0	0.00
WWMG109047	191.73	180.34	2017	0.031	FM3_DIURNAL	6.60	186.94	4.79	5.28	0	0.00
WWMG109048	192.23	181.12	2017	0.017	FM3_DIURNAL	7.65	188.77	3.46	5.23	0	0.00
WWMG109049	195.67	182.02	2017	0.003	FM3_DIURNAL	7.24	189.26	6.41	5.21	0	0.00
WWMG109050	202.56	186.00	2017	0.003	FM3_DIURNAL	1.48	187.48	15.08	4.69	0	0.00
WWMG109051	205.91	188.97	2017	0.003	FM3_DIURNAL	0.67	189.64	16.27	4.68	0	0.00
WWMG114000	141.22	135.51	1957	0.010	FM1_DIURNAL	0.77	136.28	4.94	4.42	0	0.00
WWMG114001	144.62	137.22	1960	0.002	FM1_DIURNAL	1.10	138.32	6.30	4.42	0	0.00
WWMG114002	144.74	138.28	1960	0.053	FM1_DIURNAL	0.99	139.27	5.47	4.44	0	0.00
WWMG116235	186.74	172.55	2000	0.001	FM8_DIURNAL	5.05	177.60	9.14	12.28	0	0.00
WWMG116236	189.28	173.27	2000	0.003	FM8_DIURNAL	5.98	179.25	10.03	11.80	0	0.00
WWMG116237	190.20	173.99	2000	0.011	FM8_DIURNAL	6.77	180.76	9.44	11.31	0	0.00
WWMG116238	192.41	174.79	2000	0.001	FM8_DIURNAL	7.40	182.19	10.22	10.84	0	0.00
WWMG116239	192.87	175.11	2000	0.007	FM3_DIURNAL	7.88	182.99	9.88	10.84	0	0.00
WWMG116240	195.22	176.26	2000	0.003	FM3_DIURNAL	8.24	184.50	10.72	10.83	0	0.00
WWMG116241	194.63	176.56	2000	0.003	FM3_DIURNAL	8.25	184.81	9.82	10.82	0	0.00

CIP System, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMG117195	193.76	176.86	2000	0.003	FM3_DIURNAL	8.81	185.67	8.09	54.00	0	0.00
WWMG118004	184.85	174.35	1965	0.000	FM2_DIURNAL	0.06	174.41	10.44	0.03	0	0.00
WWMG118086	193.38	178.01	2017	0.014	FM3_DIURNAL	8.15	186.16	7.22	5.66	0	0.00
WWMG118104	194.06	184.64	2017	0.000	FM3_DIURNAL	1.35	185.99	8.07	6.89	0	0.00
WWMG123076	136.92	125.36	2017	0.009	FM1_DIURNAL	0.39	125.75	11.17	5.92	0	0.00
WWMG123077	137.48	125.89	1957	0.002	FM1_DIURNAL	1.19	127.08	10.40	5.91	0	0.00
WWMG123078	140.22	132.71	1957	0.007	FM1_DIURNAL	0.60	133.31	6.91	5.91	0	0.00
WWMG123079	144.47	135.01	1957	0.002	FM1_DIURNAL	0.71	135.72	8.75	4.42	0	0.00
WWMG126098	172.90	163.54	1922	0.001	FM8_DIURNAL	0.50	164.04	8.86	0.50	0	0.00
WWMG126102	171.25	164.40	1922	0.003	FM8_DIURNAL	0.37	164.77	6.48	0.49	0	0.00
WWMG126147	182.25	174.04	1922	0.000	FM8_DIURNAL	0.00	174.04	8.21	0.00	0	0.00
WWMG126164	183.79	180.00	1922	0.001	FM8_DIURNAL	0.02	180.02	3.77	0.00	0	0.00
WWMG126200	170.67	164.87	1922	0.001	FM10_DIURNAL	0.91	165.78	4.89	2.10	0	0.00
WWMG126236	171.33	158.58	2000	0.002	FM8_DIURNAL	2.16	160.74	10.59	14.64	0	0.00
WWMG126237	171.90	161.43	2000	0.002	FM8_DIURNAL	1.48	162.91	8.99	14.64	0	0.00
WWMG126238	172.23	162.28	2000	0.001	FM8_DIURNAL	2.84	165.12	7.11	14.64	0	0.00
WWMG126239	174.59	163.94	2000	0.001	FM8_DIURNAL	4.61	168.55	6.04	14.64	0	0.00
WWMG126240	177.02	165.66	2000	0.000	FM8_DIURNAL	4.05	169.71	7.31	14.64	0	0.00
WWMG126241	175.65	168.22	2000	0.002	FM8_DIURNAL	3.92	172.14	3.51	13.67	0	0.00
WWMG126242	184.33	171.64	2017	0.000	FM8_DIURNAL	2.59	174.23	10.10	13.27	0	0.00
WWMG126243	183.79	171.83	2000	0.000	FM8_DIURNAL	4.01	175.84	7.95	12.76	0	0.00
WWMG127109	169.81	163.83	1988	0.001	FM10_DIURNAL	0.87	164.70	5.11	2.11	0	0.00
WWMG127110	169.22	164.26	1988	0.001	FM10_DIURNAL	0.90	165.16	4.06	2.11	0	0.00
WWMG127114	171.40	165.69	1922	0.001	FM10_DIURNAL	0.70	166.39	5.01	2.10	0	0.00
WWMG127133	174.28	168.63	1922	0.010	FM10_DIURNAL	0.07	168.70	5.58	0.03	0	0.00
WWMG127188	172.56	163.75	2017	0.004	FM8_DIURNAL	0.66	164.41	8.15	0.50	0	0.00
WWMG127195	175.81	166.36	2017	0.003	FM8_DIURNAL	4.74	171.10	4.71	13.67	0	0.00
WWMG136015	168.77	153.68	1987	0.006	FM8_DIURNAL	5.05	158.73	10.04	25.33	0	0.00
WWMG136016	169.06	155.01	2017	0.003	FM8_DIURNAL	4.48	159.49	9.57	26.04	0	0.00
WWMG136017	168.95	155.82	1987	0.008	FM8_DIURNAL	3.98	159.80	9.15	18.70	0	0.00
WWMG136018	169.04	156.39	1987	0.006	FM8_DIURNAL	3.66	160.05	8.99	17.05	0	0.00
WWMG136019	170.03	156.83	1987	0.000	FM8_DIURNAL	3.52	160.35	9.68	17.03	0	0.00
WWMG136020	169.14	155.24	1987	0.011	FM8_DIURNAL	4.19	159.43	9.71	20.27	0	0.00
WWMG136021	170.05	158.68	1987	0.002	FM8_DIURNAL	1.64	160.32	9.73	3.22	0	0.00
WWMG136035	166.04	157.45	2017	0.005	FM10_DIURNAL	2.39	159.84	6.20	3.52	0	0.00
WWMG136036	167.71	158.46	1962	0.000	FM10_DIURNAL	2.29	160.75	6.96	3.48	0	0.00
WWMG136037	169.93	159.28	1962	0.003	FM10_DIURNAL	2.14	161.42	8.51	3.45	0	0.00
WWMG136038	168.40	160.06	1962	0.007	FM10_DIURNAL	2.04	162.10	6.30	2.28	0	0.00
WWMG136039	166.31	161.22	1962	0.000	FM10_DIURNAL	0.79	162.01	4.30	2.13	0	0.00
WWMG136050	169.82	155.69	1948	0.005	FM8_DIURNAL	2.53	158.22	11.60	4.55	0	0.00
WWMG136051	168.57	156.25	1948	0.003	FM8_DIURNAL	2.50	158.75	9.82	2.88	0	0.00
WWMG136053	169.28	157.74	1948	0.003	FM8_DIURNAL	2.24	159.98	9.30	2.78	0	0.00
WWMG136054	169.10	158.85	1948	0.003	FM8_DIURNAL	1.38	160.23	8.87	2.46	0	0.00
WWMG136064	169.61	159.97	1922	0.001	FM8_DIURNAL	1.13	161.10	8.51	2.02	0	0.00
WWMG136065	172.07	160.39	1922	0.003	FM8_DIURNAL	1.51	161.90	10.17	2.02	0	0.00
WWMG136066	173.75	160.79	1922	0.004	FM8_DIURNAL	1.86	162.65	11.10	2.02	0	0.00
WWMG136067	174.96	161.45	1922	0.001	FM8_DIURNAL	2.13	163.58	11.38	2.01	0	0.00

CIP System, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMG136068	174.21	162.01	1922	0.001	FM8_DIURNAL	1.81	163.82	10.39	1.05	0	0.00
WWMG136069	174.23	162.03	1922	0.000	FM8_DIURNAL	1.81	163.84	10.39	1.04	0	0.00
WWMG136070	172.10	162.60	2017	0.000	FM8_DIURNAL	1.41	164.01	8.09	1.04	0	0.00
WWMG136074	169.20	164.31	1922	0.005	FM8_DIURNAL	0.08	164.39	4.81	0.01	0	0.00
WWMG136095	168.48	162.53	2017	0.004	FM10_DIURNAL	0.89	163.42	5.06	2.12	0	0.00
WWMG136097	169.32	160.50	2017	0.003	FM8_DIURNAL	0.07	160.57	8.75	0.02	0	0.00
WWMG136100	174.20	163.12	1922	0.000	FM8_DIURNAL	0.00	163.12	11.08	0.00	0	0.00
WWMG136254	170.01	159.70	2017	0.003	FM8_DIURNAL	0.54	160.24	9.77	0.17	0	0.00
WWMG136260	170.10	157.00	1987	0.000	FM8_DIURNAL	3.39	160.39	9.71	15.31	0	0.00
WWMG137106	168.49	161.89	1962	0.006	FM10_DIURNAL	0.83	162.72	5.77	2.13	0	0.00
WWMG137107	169.49	162.99	2017	0.000	FM10_DIURNAL	0.99	163.98	5.51	2.11	0	0.00
WWMG137183	169.27	163.12	2017	0.001	FM10_DIURNAL	0.89	164.01	5.26	2.11	0	0.00
WWMG137193	168.38	157.07	1948	0.004	FM8_DIURNAL	2.50	159.57	8.81	2.87	0	0.00
WWMG137194	166.98	158.03	2017	0.007	FM10_DIURNAL	2.58	160.61	6.37	3.51	0	0.00
WWMG137195	168.38	158.48	2017	0.009	FM10_DIURNAL	2.43	160.91	7.47	3.47	0	0.00
WWMG146012	169.80	152.08	2017	0.003	FM8_DIURNAL	14.07	166.15	3.65	7.61	0	0.00
WWMG146013	169.88	152.54	1987	0.002	FM8_DIURNAL	5.98	158.52	11.36	5.15	0	0.00
WWMG146014	168.98	152.58	1987	0.004	FM8_DIURNAL	5.70	158.28	10.70	26.44	0	0.00
WWMG146025	170.67	155.04	2017	0.029	FM10_DIURNAL	3.98	159.02	11.65	2.30	0	0.00
WWMG146030	170.00	157.00	2037			1.42	158.42	11.58	2.39	0	0.00
WWMG146075	168.83	151.83	2015	0.002	FM8_DIURNAL	6.43	158.26	10.57	41.56	0	0.00
WWMG146076	168.97	151.13	2017	0.002	FM8_DIURNAL	7.07	158.20	10.77	43.38	0	0.00
WWMG146077	169.92	150.36	2015	0.003	FM8_DIURNAL	9.15	159.51	10.41	37.29	0	0.00
WWMG146078	170.02	154.74	2015	0.003	FM8_DIURNAL	2.88	157.62	12.40	3.54	0	0.00
WWMG146079	171.02	149.70	2015	0.003	FM8_DIURNAL	7.21	156.91	14.11	31.95	0	0.00
WWMG79032	225.97	218.21	1979	0.023	FM16_DIURNAL	0.80	219.01	6.96	0.82	0	0.00
WWMG79033	231.39	222.83	1979	0.002	FM16_DIURNAL	0.37	223.20	8.19	0.79	0	0.00
WWMG79034	232.65	224.69	1979	0.019	FM16_DIURNAL	0.42	225.11	7.54	0.79	0	0.00
WWMG79195	246.66	240.18	1996	0.000	FM17_DIURNAL	0.37	240.55	6.11	1.23	0	0.00
WWMG79196	248.13	240.58	1996	0.002	FM17_DIURNAL	0.67	241.25	6.88	1.23	0	0.00
WWMG79244	249.95	241.37	1996	0.001	FM17_DIURNAL	0.64	242.01	7.94	1.23	0	0.00
WWMG79245	250.59	242.09	1996	0.000	FM17_DIURNAL	0.69	242.78	7.81	1.23	0	0.00
WWMG79246	251.11	242.45	1996	0.095	FM17_DIURNAL	0.62	243.07	8.04	0.92	0	0.00
WWMG89076	227.29	218.83	1978	0.014	FM3_DIURNAL	0.06	218.89	8.40	0.03	0	0.00
WWMG89185	227.99	220.04	1995	0.000	FM3_DIURNAL	1.40	221.44	6.55	3.65	0	0.00
WWMG89186	229.62	220.50	1995	0.000	FM17_DIURNAL	1.31	221.81	7.81	1.29	0	0.00
WWMG89187	230.23	221.07	1995	0.001	FM17_DIURNAL	1.34	222.41	7.82	1.30	0	0.00
WWMG89189	231.53	222.20	1995	0.002	FM17_DIURNAL	0.93	223.13	8.40	1.29	0	0.00
WWMG89192	235.58	226.02	1995	0.000	FM17_DIURNAL	0.59	226.61	8.97	1.29	0	0.00
WWMG89193	237.71	228.02	1996	0.040	FM17_DIURNAL	0.45	228.47	9.24	1.29	0	0.00
WWMG89194	242.49	234.52	1996	0.013	FM17_DIURNAL	0.45	234.97	7.52	1.25	0	0.00
WWMG89250	227.31	220.40	2017	0.000	FM3_DIURNAL	0.00	220.40	6.91	0.00	0	0.00
WWMG89258	227.59	214.58	2003	0.021	FM3_DIURNAL	0.76	215.34	12.25	3.70	0	0.00
WWMG89259	227.27	216.37	2017	0.000	FM3_DIURNAL	0.74	217.11	10.16	3.67	0	0.00
WWMG89260	226.99	217.01	2017	0.000	FM3_DIURNAL	0.99	218.00	8.99	3.67	0	0.00
WWMG89261	228.20	217.97	2017	0.000	FM3_DIURNAL	0.90	218.87	9.33	3.65	0	0.00
WWMG99099	207.14	191.77	2017	0.003	FM3_DIURNAL	0.67	192.44	14.70	4.68	0	0.00

CIP System, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMG99100	208.65	197.15	2003	0.024	FM3_DIURNAL	0.55	197.70	10.95	4.67	0	0.00
WWMG99101	213.19	204.69	2017	0.000	FM3_DIURNAL	0.54	205.23	7.96	4.64	0	0.00
WWMG99102	222.20	208.50	2017	0.000	FM3_DIURNAL	0.65	209.15	13.05	4.64	0	0.00
WWMG99104	223.52	210.39	2003	0.198	FM3_DIURNAL	0.79	211.18	12.34	4.64	0	0.00
WWMG99105	225.44	212.56	2017	0.010	FM3_DIURNAL	0.72	213.28	12.16	3.72	0	0.00
WWMH104008	161.15	146.86	1972	0.001	FM1_DIURNAL	3.18	150.04	11.11	1.81	0	0.00
WWMH104009	156.71	148.29	1972	0.001	FM1_DIURNAL	2.11	150.40	6.31	1.79	0	0.00
WWMH104010	159.65	150.28	2017	0.002	FM1_DIURNAL	0.39	150.67	8.98	1.79	0	0.00
WWMH104011	160.09	150.77	1972	0.017	FM1_DIURNAL	0.89	151.66	8.43	1.79	0	0.00
WWMH104012	161.27	151.90	1973	0.004	FM1_DIURNAL	0.59	152.49	8.78	1.77	0	0.00
WWMH104040	219.73	209.84	1960	0.000	FM19_DIURNAL	0.28	210.12	9.61	0.82	0	0.00
WWMH104041	218.44	210.12	1970	0.035	FM19_DIURNAL	0.57	210.69	7.75	0.82	0	0.00
WWMH104042	216.89	211.37	1970	0.006	FM19_DIURNAL	0.47	211.84	5.05	0.78	0	0.00
WWMH104043	222.04	213.21	1960	0.012	FM19_DIURNAL	0.46	213.67	8.37	0.78	0	0.00
WWMH104044	223.91	214.86	2017	0.055	FM19_DIURNAL	0.43	215.29	8.62	0.77	0	0.00
WWMH105001	166.19	152.88	1973	0.068	FM1_DIURNAL	0.43	153.31	12.88	1.76	0	0.00
WWMH105002	165.42	155.42	1973	0.001	FM1_DIURNAL	0.53	155.95	9.47	1.67	0	0.00
WWMH105003	166.74	157.69	2017	0.011	FM1_DIURNAL	0.51	158.20	8.54	1.66	0	0.00
WWMH105004	169.00	160.00	1973	0.001	FM1_DIURNAL	0.50	160.50	8.50	1.65	0	0.00
WWMH105005	170.73	162.03	1973	0.022	FM1_DIURNAL	0.52	162.55	8.18	1.65	0	0.00
WWMH105017	170.16	163.31	1973	0.001	FM1_DIURNAL	0.56	163.87	6.29	1.62	0	0.00
WWMH114003	147.33	140.08	1960	0.002	FM1_DIURNAL	2.57	142.65	4.68	2.86	0	0.00
WWMH114004	155.60	140.80	2017	0.030	FM1_DIURNAL	5.01	145.81	9.79	2.86	0	0.00
WWMH114005	153.43	141.58	2017	0.002	FM1_DIURNAL	7.35	148.93	4.50	2.82	0	0.00
WWMH114006	156.67	143.28	1972	0.001	FM1_DIURNAL	6.02	149.30	7.37	1.81	0	0.00
WWMH114007	161.60	145.32	1972	0.001	FM1_DIURNAL	4.40	149.72	11.88	1.81	0	0.00
WWMH114029	187.00	176.84	1958	0.003	FM19_DIURNAL	1.01	177.85	9.15	2.20	0	0.00
WWMH114030	188.24	177.83	1978	0.006	FM19_DIURNAL	0.59	178.42	9.82	2.19	0	0.00
WWMH114031	190.00	180.15	1958	0.528	FM19_DIURNAL	0.64	180.79	9.21	2.19	0	0.00
WWMH114033	200.82	190.84	1960	0.003	FM19_DIURNAL	0.28	191.12	9.70	0.86	0	0.00
WWMH114035	201.55	192.53	1960	0.000	FM19_DIURNAL	0.45	192.98	8.57	0.85	0	0.00
WWMH114036	202.46	193.10	1960	0.017	FM19_DIURNAL	0.45	193.55	8.91	0.85	0	0.00
WWMH114037	202.53	194.33	2017	0.009	FM19_DIURNAL	0.53	194.86	7.67	0.84	0	0.00
WWMH114038	211.82	201.80	2017	0.003	FM19_DIURNAL	0.28	202.08	9.74	0.83	0	0.00
WWMH114039	218.44	208.10	1960	0.000	FM19_DIURNAL	0.29	208.39	10.05	0.82	0	0.00
WWMH114140	149.02	139.21	2017	0.005	FM1_DIURNAL	2.98	142.19	6.83	2.87	0	0.00
WWMH123004	169.80	154.86	2017	0.010	FM20_DIURNAL	1.53	156.39	13.41	13.73	0	0.00
WWMH123005	174.74	156.46	2017	0.003	FM20_DIURNAL	1.56	158.02	16.72	13.72	0	0.00
WWMH123006	177.34	164.58	2017	0.039	FM20_DIURNAL	1.08	165.66	11.68	2.54	0	0.00
WWMH123007	181.08	167.07	2017	0.177	FM20_DIURNAL	0.82	167.89	13.19	2.49	0	0.00
WWMH123084	164.50	159.40	2100	0.039	FM1_DIURNAL	1.38	160.78	3.72	11.74	0	0.00
WWMH123087	174.00	168.90	2100			0.89	169.79	4.21	10.22	0	0.00
WWMH123088	183.00	175.91	2100	0.023	FM19_DIURNAL	0.53	176.44	6.56	2.89	0	0.00
WWMH126133	169.82	161.52	1996	0.004	FM8_DIURNAL	1.13	162.65	7.17	1.02	0	0.00
WWMH126167	168.00	151.51	2100	0.017	FM20_DIURNAL	1.83	153.34	14.66	16.66	0	0.00
WWMH131073	110.05	102.95	1970	0.002	FM1_DIURNAL	1.82	104.77	5.28	19.59	0	0.00
WWMH136135	168.89	158.83	1996	0.002	FM8_DIURNAL	2.42	161.25	7.64	1.03	0	0.00

CIP System, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMH136204	169.50	159.79	1996	0.003	FM8_DIURNAL	2.39	162.18	7.32	1.02	0	0.00
WWMH136247	165.60	155.57	1996	0.002	FM8_DIURNAL	0.66	156.23	9.37	2.06	0	0.00
WWMH136248	168.62	156.42	1996	0.009	FM8_DIURNAL	3.08	159.50	9.12	2.06	0	0.00
WWMH136249	165.59	157.01	1998	0.007	FM8_DIURNAL	3.05	160.06	5.53	1.03	0	0.00
WWMH136250	163.00	157.81	1996	0.002	FM8_DIURNAL	2.58	160.39	2.61	1.03	0	0.00
WWMH136253	169.46	159.45	2001	0.005	FM8_DIURNAL	2.25	161.70	7.76	1.03	0	0.00
WWMH136262	169.50	161.48	2017	0.006	FM8_DIURNAL	0.06	161.54	7.96	0.01	0	0.00
WWMH136266	164.06	148.97	2100			1.84	150.81	13.25	18.11	0	0.00
WWMH136268	163.04	148.40	2100			0.88	149.28	13.76	19.59	0	0.00
WWMH141000	115.54	91.24	1986	0.060	FM8_DIURNAL	2.72	93.96	21.58	58.77	0	0.00
WWMH141001	112.20	95.40	1986	0.002	FM1_DIURNAL	1.21	96.61	15.59	26.05	0	0.00
WWMH141002	111.85	96.14	1986	0.002	FM1_DIURNAL	2.74	98.88	12.97	26.06	0	0.00
WWMH141003	111.74	96.53	1986	0.002	FM1_DIURNAL	2.64	99.17	12.57	26.06	0	0.00
WWMH141004	111.43	97.06	1986	0.002	FM1_DIURNAL	2.99	100.05	11.38	26.05	0	0.00
WWMH141005	111.43	97.72	1970	0.002	FM1_DIURNAL	3.39	101.11	10.32	26.05	0	0.00
WWMH141006	130.02	119.82	1970	0.002	FM15_DIURNAL	0.52	120.34	9.68	11.38	0	0.00
WWMH141007	154.01	149.19	1970	0.002	FM15_DIURNAL	0.48	149.67	4.34	11.38	0	0.00
WWMH141071	110.74	101.64	1970	0.002	FM1_DIURNAL	1.09	102.73	8.01	19.59	0	0.00
WWMH141072	109.94	102.73	1970	0.002	FM1_DIURNAL	1.26	103.99	5.95	19.59	0	0.00
WWMH146000	117.26	92.54	1986	0.002	FM8_DIURNAL	1.83	94.37	22.89	33.82	0	0.00
WWMH146001	154.12	142.01	1988	0.002	FM8_DIURNAL	0.82	142.83	11.29	33.82	0	0.00
WWMH146002	163.76	143.45	1988	0.002	FM8_DIURNAL	3.88	147.33	16.43	33.82	0	0.00
WWMH146003	163.72	144.27	1988	0.002	FM8_DIURNAL	5.55	149.82	13.90	33.81	0	0.00
WWMH146004	166.10	145.38	1988	0.002	FM8_DIURNAL	5.98	151.36	14.74	33.82	0	0.00
WWMH146005	169.64	145.89	1988	0.021	FM8_DIURNAL	6.02	151.91	17.73	33.82	0	0.00
WWMH146006	168.68	146.57	1988	0.152	FM8_DIURNAL	6.02	152.59	16.09	33.79	0	0.00
WWMH146007	172.13	147.71	1988	0.008	FM8_DIURNAL	7.07	154.78	17.35	31.96	0	0.00
WWMH146008	172.32	148.65	1988	0.003	FM8_DIURNAL	6.23	154.88	17.44	31.95	0	0.00
WWMH146246	168.90	153.93	1996	0.002	FM8_DIURNAL	0.34	154.27	14.63	2.06	0	0.00
WWMH146247	171.99	148.89	2015	0.002	FM8_DIURNAL	7.15	156.04	15.95	31.95	0	0.00
WWMH95018	173.00	165.10	1992	0.045	FM1_DIURNAL	0.61	165.71	7.29	1.62	0	0.00
WWMH95019	173.00	166.45	1991	0.001	FM1_DIURNAL	0.41	166.87	6.13	1.55	0	0.00
WWMH95020	176.67	169.94	1991	0.002	FM1_DIURNAL	0.39	170.33	6.34	1.55	0	0.00
WWMH95021	205.65	187.21	1991	0.004	FM1_DIURNAL	0.24	187.45	18.20	1.55	0	0.00
WWMH95022	204.76	190.07	1991	0.006	FM1_DIURNAL	0.38	190.45	14.31	1.54	0	0.00
WWMH95023	207.20	191.85	1991	0.004	FM1_DIURNAL	0.48	192.33	14.87	1.54	0	0.00
WWMH95024	210.40	192.85	1991	0.117	FM1_DIURNAL	0.42	193.27	17.13	1.32	0	0.00
WWMI102001	208.60	197.52	1976	0.000	FM12_DIURNAL	4.99	202.51	6.09	2.42	0	0.00
WWMI102002	218.13	198.62	1976	0.000	FM12_DIURNAL	8.07	206.69	11.44	2.42	0	0.00
WWMI102003	215.84	199.90	1976	0.208	FM12_DIURNAL	12.63	212.53	3.31	2.42	0	0.00
WWMI102066	210.77	203.23	1970	0.004	FM12_DIURNAL	0.56	203.79	6.98	2.80	0	0.00
WWMI102067	214.51	208.13	2017	0.005	FM12_DIURNAL	0.57	208.70	5.81	2.79	0	0.00
WWMI102068	219.20	212.88	2017	0.027	FM12_DIURNAL	0.57	213.45	5.75	2.79	0	0.00
WWMI102069	221.49	213.72	1970	0.000	FM12_DIURNAL	1.83	215.55	5.94	2.76	0	0.00
WWMI102070	219.80	214.21	1977	0.014	FM12_DIURNAL	2.08	216.29	3.51	2.77	0	0.00
WWMI102071	220.03	214.40	1977	0.002	FM12_DIURNAL	2.15	216.55	3.48	2.75	0	0.00
WWMI102072	223.35	216.64	1977	0.011	FM12_DIURNAL	2.41	219.05	4.30	2.75	0	0.00

CIP System, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMI102073	225.66	218.21	1977	0.011	FM12_DIURNAL	2.63	220.84	4.82	2.73	0	0.00
WWMI102131	225.87	219.28	1999	0.000	FM12_DIURNAL	3.52	222.80	3.07	2.72	0	0.00
WWMI102132	227.75	220.88	2017	0.000	FM12_DIURNAL	3.71	224.59	3.16	3.05	0	0.00
WWMI104050	232.35	222.32	2008	0.002	FM12_DIURNAL	2.30	224.62	7.73	2.10	0	0.00
WWMI104051	229.69	222.06	2017	0.000	FM12_DIURNAL	2.55	224.61	5.08	2.15	0	0.00
WWMI111032	193.30	179.27	1970	0.000	FM12_DIURNAL	1.10	180.37	12.93	6.00	0	0.00
WWMI111035	188.10	181.39	1970	0.005	FM12_DIURNAL	2.72	184.11	3.99	6.00	0	0.00
WWMI111036	203.57	182.78	1970	0.000	FM12_DIURNAL	3.80	186.58	16.99	5.99	0	0.00
WWMI111037	205.03	189.43	2017	0.023	FM12_DIURNAL	0.45	189.88	15.15	5.99	0	0.00
WWMI111040	193.00	180.54	1970	0.000	FM12_DIURNAL	1.09	181.63	11.37	6.00	0	0.00
WWMI111053	203.84	193.35	2017	0.043	FM12_DIURNAL	0.67	194.02	9.82	5.97	0	0.00
WWMI111099	202.79	195.95	2017	0.076	FM12_DIURNAL	2.36	198.31	4.48	5.30	0	0.00
WWMI112000	207.16	196.52	2017	0.000	FM12_DIURNAL	2.21	198.73	8.43	2.42	0	0.00
WWMI121026	177.80	171.05	1970	0.035	FM15_DIURNAL	3.58	174.63	3.17	3.39	0	0.00
WWMI121027	179.87	172.17	1970	0.000	FM15_DIURNAL	1.73	173.90	5.97	3.36	0	0.00
WWMI121028	179.60	172.66	1970	0.030	FM15_DIURNAL	1.36	174.02	5.58	6.19	0	0.00
WWMI121029	182.20	174.79	1970	0.000	FM12_DIURNAL	0.89	175.68	6.52	6.01	0	0.00
WWMI121030	185.90	176.89	1970	0.000	FM12_DIURNAL	0.86	177.75	8.15	6.01	0	0.00
WWMI121031	190.60	178.01	1970	0.002	FM12_DIURNAL	1.11	179.12	11.48	6.00	0	0.00
WWMI121100	186.60	177.06	1996	0.014	FM12_DIURNAL	1.06	178.11	8.49	6.01	0	0.00
WWMI121103	179.74	172.16	2001	0.000	FM15_DIURNAL	1.77	173.93	5.81	11.86	0	0.00
WWMI131009	165.55	152.25	1970	0.001	FM15_DIURNAL	3.01	155.26	10.29	5.15	0	0.00
WWMI131010	167.11	153.52	1970	0.000	FM15_DIURNAL	4.18	157.70	9.41	5.15	0	0.00
WWMI131011	165.59	154.68	1970	0.000	FM15_DIURNAL	4.61	159.29	6.30	5.16	0	0.00
WWMI131012	164.21	154.97	1970	0.000	FM15_DIURNAL	4.85	159.82	4.39	5.15	0	0.00
WWMI131013	163.40	156.32	1970	0.000	FM15_DIURNAL	5.62	161.94	1.46	5.16	0	0.00
WWMI131014	167.17	156.45	1970	0.002	FM15_DIURNAL	6.32	162.77	4.40	5.16	0	0.00
WWMI131017	173.93	157.55	1970	0.000	FM15_DIURNAL	6.20	163.75	10.18	3.96	0	0.00
WWMI131018	174.47	158.73	1970	0.016	FM15_DIURNAL	5.24	163.97	10.50	4.10	0	0.00
WWMI131019	173.04	160.63	1970	0.000	FM15_DIURNAL	4.63	165.26	7.78	4.01	0	0.00
WWMI131020	171.74	161.93	1970	0.000	FM15_DIURNAL	4.74	166.67	5.07	4.09	0	0.00
WWMI131021	174.05	163.74	1970	0.000	FM15_DIURNAL	4.45	168.19	5.86	4.12	0	0.00
WWMI131022	176.99	165.43	1970	0.000	FM15_DIURNAL	4.32	169.75	7.24	4.16	0	0.00
WWMI131023	177.45	166.71	1970	0.010	FM15_DIURNAL	4.39	171.10	6.35	4.16	0	0.00
WWMI131024	178.04	168.13	1970	0.000	FM15_DIURNAL	5.73	173.86	4.18	4.15	0	0.00
WWMI131025	177.79	169.55	1970	0.020	FM15_DIURNAL	4.32	173.87	3.92	3.55	0	0.00
WWMI131111	172.52	160.90	2017	0.000	FM15_DIURNAL	4.70	165.60	6.92	4.06	0	0.00
WWMI141008	162.12	150.54	1970	0.002	FM15_DIURNAL	2.26	152.80	9.32	5.16	0	0.00
WWMI81	279.93	268.14	2009	0.021	FM12_DIURNAL	0.23	268.37	11.56	0.66	0	0.00
WWMI92143	265.85	257.49	2008	0.072	FM12_DIURNAL	0.42	257.91	7.94	1.28	0	0.00
WWMI92144	264.43	256.47	2008	0.000	FM12_DIURNAL	0.42	256.89	7.54	1.28	0	0.00
WWMI92146	263.91	254.54	2017	0.000	FM12_DIURNAL	1.75	256.29	7.62	1.28	0	0.00
WWMI92147	262.12	243.47	2017	0.000	FM12_DIURNAL	0.53	244.00	18.12	1.76	0	0.00
WWMI92148	251.71	241.52	2017	0.000	FM12_DIURNAL	0.37	241.89	9.82	1.76	0	0.00
WWMI92149	245.17	236.97	2017	0.100	FM12_DIURNAL	0.40	237.37	7.80	1.97	0	0.00
WWMI92150	241.50	229.75	2017	0.000	FM12_DIURNAL	0.33	230.08	11.42	1.96	0	0.00
WWMI92151	239.75	225.75	2017	0.130	FM12_DIURNAL	0.64	226.39	13.36	2.12	0	0.00

CIP System, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMI92152	234.71	223.96	2017	0.000	FM12_DIURNAL	0.70	224.66	10.05	2.12	0	0.00
WWMI92156	263.55	244.65	2017	0.000	FM12_DIURNAL	0.27	244.92	18.63	0.49	0	0.00
WWMI92157	260.95	245.57	2008	0.000	FM12_DIURNAL	0.35	245.92	15.03	0.49	0	0.00
WWMI92158	255.21	247.11	2017	0.000	FM12_DIURNAL	0.32	247.43	7.78	0.49	0	0.00
WWMI92159	253.49	248.10	2008	0.000	FM12_DIURNAL	0.34	248.44	5.05	0.49	0	0.00
WWMI92161	255.92	249.58	2017	0.100	FM12_DIURNAL	0.33	249.91	6.01	0.49	0	0.00
WWMJ102130	184.15	171.61	2037	0.027	FM20_DIURNAL	0.06	171.67	12.47	0.05	0	0.00
WWMJ102131	185.10	170.08	2037			0.35	170.43	14.67	0.99	0	0.00
WWMJ111043	194.89	184.33	2001	0.001	FM13_DIURNAL	0.25	184.58	10.31	0.65	0	0.00
WWMJ111047	185.59	176.73	2004	0.003	FM13_DIURNAL	5.98	182.71	2.88	1.88	0	0.00
WWMJ111056	204.04	191.76	2005	0.006	FM13_DIURNAL	0.23	191.99	12.05	0.65	0	0.00
WWMJ111061	183.35	168.54	2037			0.34	168.88	14.47	0.85	0	0.00
WWMJ111062	190.78	167.35	2037			0.28	167.63	23.15	0.64	0	0.00
WWMJ111063	186.84	165.36	2037			0.26	165.62	21.22	0.59	0	0.00
WWMJ111064	182.91	162.76	2037			0.25	163.02	19.89	0.58	0	0.00
WWMJ111094	184.62	177.95	2008	0.038	FM13_DIURNAL	0.45	178.40	6.22	0.71	0	0.00
WWMJ111103	185.08	176.58	2017	0.000	FM13_DIURNAL	1.23	177.81	7.27	1.07	0	0.00
WWMJ120001	175.85	163.63	2003	0.050	FM13_DIURNAL	0.36	163.99	11.86	0.21	0	0.00
WWMJ120009	173.82	163.22	2001	0.000	FM13_DIURNAL	0.76	163.98	9.84	1.44	0	0.00
WWMJ120010	164.76	153.07	2001	0.000	FM15_DIURNAL	0.21	153.28	11.48	1.44	0	0.00
WWMJ120012	177.26	160.24	2001	0.000	FM13_DIURNAL	0.95	161.19	16.07	1.44	0	0.00
WWMJ120013	175.25	161.35	2001	0.000	FM13_DIURNAL	0.65	162.00	13.25	1.44	0	0.00
WWMJ120014	174.68	162.10	2001	0.000	FM13_DIURNAL	0.70	162.80	11.88	1.44	0	0.00
WWMJ120015	176.85	164.04	2001	0.000	FM13_DIURNAL	0.00	164.04	12.81	0.00	0	0.00
WWMJ120016	147.26	124.42	2001	0.000	FM15_DIURNAL	0.33	124.75	22.51	2.15	0	0.00
WWMJ120017	140.24	122.37	2001	0.000	FM15_DIURNAL	0.31	122.68	17.56	2.15	0	0.00
WWMJ120018	140.24	135.90	2001	0.000	FM15_DIURNAL	0.00	135.90	4.34	0.00	0	0.00
WWMJ120021	176.02	166.16	2001	0.000	FM13_DIURNAL	0.49	166.65	9.37	1.35	0	0.00
WWMJ120022	179.00	168.60	2001	0.000	FM13_DIURNAL	0.57	169.17	9.83	1.35	0	0.00
WWMJ120023	183.04	172.55	2001	0.000	FM13_DIURNAL	0.38	172.93	10.11	0.65	0	0.00
WWMJ120024	187.12	177.01	2001	0.000	FM13_DIURNAL	0.29	177.30	9.82	0.65	0	0.00
WWMJ120025	179.01	174.85	2004	0.001	FM13_DIURNAL	3.48	178.33	0.68	0.78	0	0.00
WWMJ120026	178.93	174.41	2004	0.001	FM13_DIURNAL	3.45	177.86	1.07	0.74	0	0.00
WWMJ120027	183.34	176.14	2004	0.001	FM13_DIURNAL	5.43	181.57	1.77	0.80	0	0.00
WWMJ120032	183.73	172.89	2004	0.002	FM13_DIURNAL	0.63	173.52	10.21	0.76	0	0.00
WWMJ120033	182.16	171.58	2004	0.000	FM13_DIURNAL	0.45	172.03	10.13	1.35	0	0.00
WWMJ120034	141.74	124.85	2005	0.000	FM15_DIURNAL	0.39	125.24	16.50	1.00	0	0.00
WWMJ120035	133.71	126.31	2017	0.000	FM15_DIURNAL	0.40	126.71	7.00	1.00	0	0.00
WWMJ120036	137.44	127.46	2005	0.000	FM14_DIURNAL	0.45	127.91	9.53	1.00	0	0.00
WWMJ120037	140.82	132.41	2005	0.002	FM14_DIURNAL	0.21	132.62	8.20	1.00	0	0.00
WWMJ120038	150.33	139.45	2017	0.000	FM14_DIURNAL	0.33	139.78	10.55	0.96	0	0.00
WWMJ120039	150.91	141.24	2005	0.000	FM14_DIURNAL	0.34	141.58	9.33	0.96	0	0.00
WWMJ120040	153.37	143.48	2005	0.000	FM14_DIURNAL	0.29	143.77	9.60	0.96	0	0.00
WWMJ120041	157.38	146.02	2005	0.004	FM14_DIURNAL	0.28	146.30	11.08	0.96	0	0.00
WWMJ120042	169.74	153.34	2005	0.094	FM14_DIURNAL	0.29	153.63	16.11	0.95	0	0.00
WWMJ120043	177.19	167.14	2017	0.000	FM13_DIURNAL	0.59	167.73	9.46	1.35	0	0.00
WWMJ120044	180.73	160.50	2037			0.25	160.75	19.98	0.56	0	0.00

CIP System, 5-year, 24-hour storm event

Input						Output					
Manhole ID	Rim Elev.	Invert Elev.	Install Year	Avg DWF (cfs)	DWF Pattern	Max Depth (ft)	Max HGL (ft)	Freeboard (ft)	Max Inflow (cfs)	Total Flood Vol. (MG)	Time Flooded (hrs)
WWMJ120045	168.92	157.75	2037			0.12	157.87	11.04	0.55	0	0.00
WWMJ120046	137.67	120.13	2037			0.45	120.58	17.08	0.55	0	0.00
WWMJ120047	141.37	119.80	2017	0.014	FM15_DIURNAL	0.00	119.80	21.57	0.57	0	0.00
WWMJ120048	178.45	159.33	2017	0.000	FM15_DIURNAL	0.37	159.70	18.75	1.44	0	0.00
WWMJ120060	152.36	136.72	2017	0.008	FM14_DIURNAL	0.31	137.03	15.33	0.99	0	0.00
WWMK120007	170.09	154.55	2005	0.002	FM14_DIURNAL	0.36	154.91	15.18	0.62	0	0.00
WWMK120008	172.35	154.54	2005	0.002	FM14_DIURNAL	0.74	155.28	17.07	0.61	0	0.00
WWMK120009	171.58	156.94	2005	0.021	FM14_DIURNAL	0.36	157.30	14.28	0.61	0	0.00

CIP System, 5-year, 24-hour storm event

Input								Output					
Pipe ID	**Upstream MH**	**Downstream MH**	**Length (ft)**	**Roughness**	**US Invert (ft)**	**DS Invert (ft)**	**Diameter (ft)**	**Full Flow (cfs)**	**Slope (%)**	**Max Flow (cfs)**	**Max Velocity (ft/s)**	**Max.Flow/Full Flow**	**Max.Depth/Full Depth**
A1_100	WWMG136021	J-110	28.5	0.013	159.18	159.72	1.25	8.92	1.91	0.83	1.18	0.09	0.69
A1_101	J-230_CHEHAL_BASEFLOW	J-F121	875.0	0.013	184.12	182.00	1.00	1.75	0.24	0.68	2.17	0.39	0.42
A1_102	J-F121	J-F120	1222.5	0.013	181.90	178.94	1.00	1.75	0.24	0.68	2.20	0.39	0.41
A1_103	J-F120	J-F119	240.8	0.013	178.84	178.26	1.00	1.75	0.24	0.68	2.21	0.39	0.41
A1_104	J-F119	J-F118	2515.0	0.013	178.16	172.07	1.00	1.75	0.24	0.68	2.18	0.39	0.42
A1_105	J-F118	J-F117	197.6	0.013	171.97	171.50	1.00	1.74	0.24	0.68	2.29	0.39	0.40
A1_106	J-F117	J-F116	104.2	0.013	171.40	171.14	1.00	1.78	0.25	0.68	2.37	0.38	0.39
A1_107	J-F116	J-F115	336.8	0.013	171.04	170.23	1.25	3.17	0.24	0.68	1.41	0.21	0.42
A1_108	J-F115	J-F102	1060.8	0.013	170.13	168.73	1.50	3.82	0.13	1.48	2.19	0.39	0.41
A1_110	J-F113	J-F112	1136.0	0.013	164.09	154.00	0.67	1.14	0.89	0.06	1.66	0.06	0.45
A1_111	J-F112	HWY240LS	231.0	0.013	153.90	153.00	1.50	6.56	0.39	2.24	3.47	0.34	0.39
A1_112	J-240_CREEK_BASEFLOW	J-F113	202.5	0.01	165.77	164.49	0.67	1.25	0.63	0.06	1.88	0.05	0.15
A1_114	WWMH114029	WWMH123088	553.1	0.013	176.84	176.01	1.25	2.50	0.15	2.19	2.65	0.88	0.64
A1_115	WWMH123088	WWMH123087	495.4	0.013	175.91	169.00	1.25	7.63	1.40	2.89	5.08	0.38	0.53
A1_116	WWMH123087	WWMH123084	782.0	0.013	168.90	159.50	2.00	24.80	1.20	10.21	5.86	0.41	0.54
A1_117	WWMH123084	WWMH123005	947.1	0.013	159.40	156.56	2.25	16.96	0.30	11.74	4.47	0.69	0.63
A1_118	WWMH123004	WWMH126167	1084.0	0.013	154.86	151.61	2.25	16.96	0.30	13.72	4.48	0.81	0.72
A1_119	WWMH126167	WWMH136266	814.0	0.013	151.51	149.07	2.25	16.96	0.30	16.65	4.92	0.98	0.79
A1_120	WWMH136266	WWMH136268	155.0	0.013	148.97	148.50	2.25	17.05	0.30	18.11	5.74	1.06	0.74
A1_121	WWMH136268	WWMH131073	1192.2	0.013	148.40	103.05	2.25	60.43	3.81	19.59	8.23	0.32	0.58
A1_122	WWMI121103	J-F122	1454.4	0.013	172.16	170.41	1.75	5.49	0.12	6.37	2.89	1.16	0.88
A1_123	J-F122	J-F123	1090.0	0.013	170.30	168.10	1.75	7.12	0.20	6.29	3.64	0.88	0.67
A1_124	WWMF109040	J-240_CREEK_BASEFLOW	613.2	0.013	174.77	165.97	0.67	1.45	1.44	0.04	1.87	0.03	0.12
A1-113	J-F102	J-F112	355.1	0.013	168.63	154.00	1.50	21.33	4.12	2.20	5.44	0.10	0.28
A2_FM100	WWMG123076	WWMH123087	564.5	0.01	125.36	168.90		0.00	-7.74	5.92	-1.00	-1.00	-1.00
C-118	J-F123	J-124	1149.8	0.013	168.00	163.10	1.75	10.34	0.43	6.27	4.63	0.61	0.55
C-128	J-124	WWMH141007	888.0	0.013	163.00	149.29	1.75	19.69	1.54	6.26	7.27	0.32	0.39
C-F102	J-F103	J-F115	1104.4	0.013	182.92	172.00	0.83	2.18	0.99	0.81	3.70	0.37	0.42
C-F103	J-F104	J-F103	760.7	0.013	191.00	183.02	0.67	1.24	1.05	0.48	3.32	0.39	0.43
C-F104	J-F105	J-F102	1226.4	0.013	175.00	172.00	1.00	1.76	0.24	0.37	1.89	0.21	0.30
C-F105	WWMG146030	WWMG146025	752.0	0.013	157.00	155.10	1.50	5.28	0.25	2.15	2.82	0.41	0.97
C-F106	J-F108_PROV_BASEFLOW	PROVIDENCEWW_F1	1728.5	0.013	167.08	160.17	0.67	0.76	0.40	0.50	2.46	0.66	0.57
C-F107	J-260_CHAR_BASEFLOW	J-F109	1009.6	0.013	146.92	141.61	0.67	0.88	0.53	0.07	1.62	0.08	0.28
C-F108	J-270_ANDR_BASEFLOW	J-F109	845.4	0.013	144.99	141.61	0.67	0.76	0.40	0.07	1.05	0.09	0.28
C-F109	J-F109	RIVERFRONTWW_F2	976.3	0.013	141.61	138.87	0.67	0.64	0.28	0.14	1.57	0.22	0.31
C-F110	J-F110	RIVERFRONTWW_F2	878.3	0.013	159.00	149.00	0.67	1.29	1.14	0.65	3.70	0.50	0.50
C-F111	J-F111	RIVERFRONTWW_F2	2204.0	0.013	162.00	149.00	0.67	0.93	0.59	0.54	2.83	0.59	0.54
FM-101_PROVIDENCE	J-F107_PROVIDENCE	WWMJ102131	1145.3	0.013	165.00	170.08	0.50	0.53	0.44	0.95	6.19	1.79	0.85
FM-102_RIVERFRONT	J-F106_RIVERFRONT	WWMG146030	1176.0	0.013	149.00	157.10	0.67	1.41	0.69	2.39	6.85	1.69	1.00
R1_100	WWMG136018	WWMG136053	265.4	0.013	156.39	157.74	1.25	4.61	0.51	1.19	1.35	0.26	1.00
R1_101	WWMG136017	WWMG137193	265.9	0.013	155.82	157.07	1.25	4.43	0.47	0.87	0.78	0.20	1.00
R1_102	WWMG136015	WWMG136050	265.7	0.013	153.68	155.69	1.25	5.62	0.76	1.68	1.79	0.30	1.00
WWFM0039	J-210_SHER1	WWMF117018	495.0	0.013	152.94	157.78	0.33	0.28	0.98	0.24	2.76	0.85	1.00
WWFM0040	J-210_SHER1	WWMF117018	495.0	0.013	152.94	157.78	0.33	0.28	0.98	0.24	2.76	0.85	1.00
WWFM0041	J-160_DAY	WWMG136016	4000.0	0.013	107.00	155.11	1.00	5.46	1.20	5.81	7.48	1.07	1.00
WWFM0042	J-170_FERN1	WWMI121103	3290.0	0.013	137.60	173.53	1.00	5.18	1.09	2.86	4.44	0.55	0.77
WWFM0048	J-190_HWY240_1	WWMG118104	2336.2	0.013	159.33	185.21	0.83	3.25	1.11	3.45	6.39	1.06	0.97
WWFM0049	J-190_HWY240_1	WWMG118104	2340.8	0.013	159.33	185.21	0.83	3.25	1.11	3.44	6.38	1.06	0.97
WWGM0002	WWMF118023	WWMF118002	232.9	0.013	169.65	166.04	0.83	2.73	1.55	0.02	1.54	0.01	0.53
WWGM0015	WWMG146013	WWMG146012	11.4	0.013	152.54	152.27	1.50	16.19	2.38	6.69	5.30	0.41	1.00
WWGM0154	WWMG123077	WWMG123076	105.3	0.013	125.89	125.58	1.50	5.70	0.29	5.91	4.40	1.04	0.71
WWGM0155	WWMG123079	WWMG123078	254.3	0.013	135.01	132.85	1.50	9.68	0.85	4.42	5.35	0.46	0.47
WWGM0156	WWMG114000	WWMG123079	20.2	0.013	135.51	135.38	1.50	8.42	0.64	4.42	4.82	0.52	0.51
WWGM0165	WWMG114001	WWMG114000	415.0	0.013	137.22	136.13	1.50	5.38	0.26	4.41	3.74	0.82	0.63
WWGM0166	WWMG114002	WWMG114001	326.7	0.013	138.28	137.32	1.50	5.69	0.29	4.42	3.56	0.78	0.66
WWGM0167	WWMH114140	WWMG114002	421.1	0.013	139.21	138.58	1.00	1.38	0.15	2.87	3.99	2.09	0.86
WWGM0168	WWMH114004	WWMH114003	183.5	0.013	140.80	140.18	0.83	1.27	0.34	2.86	5.24	2.25	1.00
WWGM0169	WWMH114005	WWMH114004	186.8	0.013	141.58	140.90	0.83	1.32	0.36	2.82	5.17	2.13	1.00
WWGM0170	WWMH114006	WWMH114005	235.2	0.013	143.28	141.62	1.00	2.99	0.71	1.81	2.30	0.60	1.00

CIP System, 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM0171	WWMH114007	WWMH114006	287.4	0.013	145.32	143.41	1.00	2.90	0.66	1.81	3.62	0.62	1.00
WWGM0173	WWMH104008	WWMH114007	218.6	0.013	146.86	145.48	1.00	2.83	0.63	1.80	3.66	0.64	1.00
WWGM0177	WWMG117195	WWMG116241	203.1	0.013	176.86	176.72	1.75	4.16	0.07	10.82	4.50	2.60	1.00
WWGM0182	WWMG116240	WWMG116239	324.0	0.013	176.26	175.44	1.75	7.97	0.25	10.83	4.50	1.36	1.00
WWGM0184	WWMG116239	WWMG116238	175.0	0.013	175.11	174.82	1.75	6.45	0.17	10.84	4.51	1.68	1.00
WWGM0191	WWMG118086	WWMG117195	481.3	0.013	178.01	177.21	1.75	6.46	0.17	5.66	3.09	0.88	1.00
WWGM0198	WWMG116238	WWMG116237	308.0	0.013	174.79	174.06	1.75	7.71	0.24	10.83	4.50	1.40	1.00
WWGM0206	WWMH141005	WWMH141004	268.5	0.013	97.72	97.06	2.50	20.35	0.25	26.05	5.31	1.28	1.00
WWGM0207	WWMH141006	WWMH141005	91.1	0.013	119.82	98.68	1.25	31.55	23.86	11.38	15.51	0.36	0.71
WWGM0208	WWMH141007	WWMH141006	88.7	0.013	149.19	120.52	1.25	37.75	34.15	11.38	26.43	0.30	0.38
WWGM0209	WWMI141008	WWMH141007	383.1	0.013	150.54	149.32	1.25	3.65	0.32	5.16	4.56	1.41	0.87
WWGM0210	WWMI131009	WWMI141008	386.6	0.013	152.25	150.54	1.25	4.30	0.44	5.15	4.20	1.20	1.00
WWGM0211	WWMH141071	WWMH141005	274.1	0.013	101.64	98.68	3.00	69.31	1.08	19.59	7.61	0.28	0.59
WWGM0212	WWMH141072	WWMH141071	157.2	0.013	102.73	101.74	3.00	52.94	0.63	19.59	6.93	0.37	0.42
WWGM0213	WWMH131073	WWMH141072	156.2	0.013	102.95	102.76	3.00	23.26	0.12	19.59	5.03	0.84	0.54
WWGM0232	WWMG126164	WWMG126243	19.0	0.013	180.00	179.48	0.83	3.63	2.74	0.00	1.07	0.00	0.02
WWGM0273	WWMH123007	WWMH123006	362.7	0.013	167.07	165.11	1.00	2.62	0.54	2.48	3.96	0.95	0.75
WWGM0276	WWMG89261	WWMG89260	130.2	0.013	217.97	217.62	1.50	5.45	0.27	3.65	3.71	0.67	0.54
WWGM0317	WWMF127015	WWMF127014	174.7	0.013	153.38	153.05	1.25	2.81	0.19	2.65	2.63	0.94	0.77
WWGM0354	WWMG116241	WWMG116240	65.5	0.013	176.56	176.26	1.75	10.72	0.46	10.82	4.85	1.01	1.00
WWGM0372	WWMH141000	OF-3	177.3	0.013	91.24	90.60	3.50	60.44	0.36	58.76	7.78	0.97	0.73
WWGM0373	WWMH146002	WWMH146001	341.1	0.013	143.45	142.81	2.50	17.77	0.19	33.82	7.30	1.90	0.90
WWGM0374	WWMH141001	WWMH141000	169.5	0.013	95.40	92.32	2.50	55.29	1.82	26.05	10.39	0.47	0.57
WWGM0375	WWMH146001	WWMH146000	248.6	0.013	142.01	96.56	2.00	97.55	18.59	33.82	28.08	0.35	0.41
WWGM0376	WWMH146000	WWMH141000	12.7	0.013	92.54	92.32	2.50	53.95	1.73	33.82	10.73	0.63	0.62
WWGM0377	WWMH141002	WWMH141001	338.4	0.013	96.14	95.50	2.50	17.84	0.19	26.05	5.87	1.46	0.85
WWGM0378	WWMH141003	WWMH141002	71.2	0.013	96.53	96.34	2.50	21.19	0.27	26.05	5.31	1.23	1.00
WWGM0379	WWMH141004	WWMH141003	214.7	0.013	97.06	96.68	2.50	17.23	0.18	26.06	5.31	1.51	1.00
WWGM0408	WWMG123078	WWMG123077	241.2	0.013	132.71	125.99	1.50	17.54	2.79	5.91	5.75	0.34	0.56
WWGM0411	WWMJ120034	WWMJ120016	95.6	0.013	124.85	124.55	2.00	12.67	0.31	1.00	2.55	0.08	0.18
WWGM0416	WWMJ120010	WWMJ120016	150.3	0.013	153.07	125.35	1.00	15.43	18.77	1.44	12.27	0.09	0.21
WWGM0417	WWMG89185	WWMG89261	61.3	0.013	220.04	218.95	0.83	2.92	1.78	3.65	6.75	1.25	0.97
WWGM0467	WWMJ120039	WWMJ120038	83.6	0.013	141.24	139.90	0.83	2.77	1.60	0.96	4.62	0.35	0.41
WWGM0468	WWMI131019	WWMI131018	377.8	0.013	160.63	159.36	1.25	3.75	0.34	4.08	3.81	1.09	1.00
WWGM0478	WWMJ120033	WWMJ120022	233.1	0.013	171.58	168.94	0.83	2.33	1.13	1.35	4.43	0.58	0.55
WWGM0479	WWMI131017	WWMI131014	277.3	0.013	157.55	156.79	1.25	3.38	0.27	3.96	3.22	1.17	1.00
WWGM0481	WWMJ120043	WWMJ120021	136.8	0.013	167.14	166.38	0.83	1.63	0.56	1.35	3.49	0.83	0.67
WWGM0482	WWMI131012	WWMI131011	85.1	0.013	155.05	154.68	1.25	4.26	0.43	5.16	4.20	1.21	1.00
WWGM0487	WWMJ120012	WWMJ120048	300.7	0.013	160.24	159.95	1.00	1.11	0.10	1.44	2.35	1.30	0.73
WWGM0491	WWMH146004	WWMH146003	432.9	0.013	145.38	144.42	3.00	31.41	0.22	33.81	4.78	1.08	1.00
WWGM0492	WWMJ120016	WWMJ120017	72.7	0.013	124.42	122.53	2.00	36.48	2.60	2.15	6.36	0.06	0.16
WWGM0496	WWMJ120001	WWMJ120009	135.7	0.013	163.63	163.52	1.00	1.01	0.08	0.21	1.31	0.21	0.41
WWGM0506	WWMJ120038	WWMJ120060	126.8	0.013	139.45	137.33	0.83	2.83	1.67	0.96	4.70	0.34	0.40
WWGM0507	WWMI131014	WWMI131013	132.0	0.013	156.45	156.36	1.25	1.69	0.07	5.16	4.20	3.06	1.00
WWGM0510	WWMJ120032	WWMJ120033	210.9	0.013	172.89	172.22	0.67	0.68	0.32	0.72	2.49	1.05	0.77
WWGM0511	WWMJ120037	WWMJ120036	54.2	0.013	132.41	127.58	1.00	10.66	8.95	1.00	6.81	0.09	0.27
WWGM0514	WWMJ120021	WWMJ120009	298.0	0.013	166.16	163.57	0.83	2.04	0.87	1.35	4.00	0.66	0.59
WWGM0516	WWMJ120023	WWMJ120033	67.7	0.013	172.55	172.22	0.83	1.53	0.49	0.65	2.78	0.42	0.44
WWGM0519	WWMJ120036	WWMJ120035	200.7	0.013	127.46	126.51	1.00	2.45	0.47	1.00	3.04	0.41	0.44
WWGM0520	WWMI131022	WWMI131021	449.4	0.013	165.43	163.80	1.25	3.89	0.36	4.12	3.75	1.06	1.00
WWGM0526	WWMJ120022	WWMJ120043	163.3	0.013	168.60	167.62	0.83	1.70	0.60	1.35	3.56	0.79	0.66
WWGM0528	WWMJ120025	WWMJ120026	55.0	0.013	174.85	174.46	0.67	1.02	0.71	0.74	2.12	0.73	1.00
WWGM0530	WWMK120007	WWMJ120042	162.3	0.013	154.55	153.63	0.83	1.65	0.57	0.62	2.84	0.38	0.42
WWGM0531	WWMK120008	WWMK120007	150.4	0.013	154.54	154.67	0.83	0.64	0.09	0.61	1.63	0.95	0.65
WWGM0533	WWMI131024	WWMI131023	384.7	0.013	168.13	166.74	1.25	3.88	0.36	4.15	3.38	1.07	1.00
WWGM0536	WWMH146005	WWMH146004	339.5	0.013	145.89	145.46	3.00	23.74	0.13	33.82	4.78	1.42	1.00
WWGM0539	WWMJ120013	WWMJ120012	299.8	0.013	161.35	160.47	1.00	1.93	0.29	1.44	2.52	0.75	0.68
WWGM0540	WWMI131013	WWMI131012	332.9	0.013	156.32	154.97	1.25	4.11	0.41	5.15	4.20	1.25	1.00
WWGM0546	WWMJ120048	WWMJ120010	298.8	0.013	159.33	153.40	1.00	5.02	1.98	1.44	5.52	0.29	0.37

CIP System, 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM0555	WWMI131010	WWMI131009	382.6	0.013	153.52	152.35	1.25	3.57	0.31	5.15	4.20	1.44	1.00
WWGM0556	WWMJ120026	WWMJ120032	469.1	0.013	174.41	173.94	0.67	0.38	0.10	0.75	2.50	1.97	0.81
WWGM0558	WWMI131023	WWMI131022	389.7	0.013	166.71	166.12	1.25	2.51	0.15	4.16	3.79	1.65	1.00
WWGM0559	WWMI131021	WWMI131020	444.1	0.013	163.74	162.05	1.25	3.99	0.38	4.09	3.70	1.03	1.00
WWGM0565	WWMJ120042	WWMJ120041	243.6	0.013	153.34	146.17	0.83	3.76	2.94	0.95	5.74	0.25	0.34
WWGM0569	WWMK120009	WWMK120008	256.7	0.013	156.94	155.59	0.83	1.59	0.53	0.61	2.77	0.38	0.42
WWGM0580	WWMI131025	WWMI131024	397.1	0.013	169.55	168.16	1.25	3.82	0.35	3.21	2.99	0.84	1.00
WWGM0583	WWMI131020	WWMI131111	300.8	0.013	161.93	161.03	1.25	3.53	0.30	4.06	3.48	1.15	1.00
WWGM0584	WWMJ120035	WWMJ120034	182.1	0.013	126.31	125.09	1.00	2.92	0.67	1.00	3.36	0.34	0.40
WWGM0597	WWMJ120041	WWMJ120040	68.6	0.013	146.02	143.82	0.83	3.93	3.21	0.96	5.95	0.25	0.34
WWGM0598	WWMJ120024	WWMJ120023	299.3	0.013	177.01	172.94	0.83	2.56	1.36	0.65	3.91	0.25	0.34
WWGM0600	WWMJ120040	WWMJ120039	69.7	0.013	143.48	141.44	0.83	3.75	2.93	0.96	5.76	0.26	0.35
WWGM0601	WWMJ120014	WWMJ120013	300.3	0.013	162.10	161.35	1.00	1.78	0.25	1.44	2.58	0.81	0.67
WWGM0602	WWMJ120027	WWMJ120025	274.0	0.013	176.14	175.10	0.67	0.74	0.38	0.78	2.46	1.04	1.00
WWGM0604	WWMI131011	WWMI131010	248.7	0.013	154.68	153.66	1.25	4.14	0.41	5.15	4.20	1.25	1.00
WWGM0608	WWMH146003	WWMH146002	355.4	0.013	144.27	143.74	2.50	15.84	0.15	33.82	6.89	2.14	1.00
WWGM0612	WWMJ120018	WWMJ120017	36.1	0.013	135.90	122.53	2.00	142.74	39.81	0.00	0.00	0.00	0.04
WWGM0617	WWMJ120009	WWMJ120014	334.7	0.013	163.22	162.43	1.00	1.73	0.24	1.44	2.75	0.83	0.63
WWGM0651	WWMH114036	WWMH114035	142.3	0.013	193.10	192.59	1.00	2.13	0.36	0.85	2.70	0.40	0.42
WWGM0652	WWMH114037	WWMH114036	269.2	0.013	194.33	193.69	1.00	1.74	0.24	0.84	2.41	0.48	0.45
WWGM0653	WWMH114035	WWMH114033	401.0	0.013	192.53	191.06	1.00	2.16	0.37	0.85	2.72	0.40	0.42
WWGM0654	WWMH114033	WWMH114031	501.1	0.013	190.84	180.52	1.00	5.11	2.06	0.86	4.83	0.17	0.28
WWGM0661	WWMH114031	WWMH114030	331.2	0.013	180.15	177.84	1.00	2.98	0.70	2.19	4.15	0.73	0.64
WWGM0682	WWMI102001	WWMI112000	311.0	0.013	197.52	196.80	0.83	1.05	0.23	2.42	4.44	2.30	1.00
WWGM0691	WWMH114039	WWMH114038	385.7	0.013	208.10	201.86	1.00	4.53	1.62	0.82	4.38	0.18	0.29
WWGM0696	WWMH104041	WWMH104040	127.4	0.013	210.12	209.95	1.00	1.30	0.13	0.82	2.24	0.63	0.47
WWGM0699	WWMI112000	WWMI111099	35.8	0.013	196.52	196.17	0.83	2.17	0.98	2.42	4.44	1.12	1.00
WWGM0700	WWMI102003	WWMI102002	479.9	0.013	199.90	198.72	0.83	1.09	0.25	2.42	4.43	2.23	1.00
WWGM0711	WWMH104042	WWMH104041	314.4	0.013	211.37	210.45	1.00	1.93	0.29	0.78	2.50	0.41	0.42
WWGM0716	WWMH114038	WWMH114037	386.6	0.013	201.80	194.53	1.00	4.89	1.88	0.83	4.20	0.17	0.30
WWGM0717	WWMI102002	WWMI102001	342.7	0.013	198.62	197.76	0.83	1.10	0.25	2.42	4.44	2.20	1.00
WWGM0723	WWMH104040	WWMH114039	92.9	0.013	209.84	208.22	1.00	4.71	1.74	0.82	4.50	0.17	0.28
WWGM0734	WWMH104044	WWMH104043	421.9	0.013	214.86	213.33	1.00	2.15	0.36	0.76	2.63	0.36	0.40
WWGM0756	WWMH104011	WWMH104010	218.1	0.013	150.77	150.31	1.00	1.64	0.21	1.79	2.91	1.09	0.73
WWGM0760	WWMH104009	WWMH104008	208.7	0.013	148.29	146.88	1.00	2.93	0.68	1.80	3.84	0.62	1.00
WWGM0761	WWMH104010	WWMH104009	80.7	0.013	150.28	148.29	1.00	5.59	2.47	1.79	4.82	0.32	0.69
WWGM0762	WWMH104012	WWMH104011	194.5	0.013	151.90	150.79	1.00	2.69	0.57	1.77	2.86	0.66	0.73
WWGM0763	WWMG89187	WWMG89186	177.2	0.013	221.07	220.81	0.83	0.84	0.15	1.29	2.62	1.54	1.00
WWGM0801	WWMF99008	WWMF99007	81.6	0.013	178.31	178.07	1.00	1.93	0.29	2.97	3.78	1.53	1.00
WWGM0802	WWMF99011	WWMF99009	299.7	0.013	180.34	179.40	1.00	2.00	0.31	2.92	3.71	1.46	1.00
WWGM0826	WWMF99014	WWMF99013	273.8	0.013	188.32	186.28	0.83	1.89	0.74	2.75	5.04	1.45	1.00
WWGM0846	WWMF89021	WWMF89020	143.4	0.013	201.22	200.31	0.67	0.96	0.63	0.94	3.29	0.98	0.77
WWGM0855	WWMF99015	WWMF99014	137.3	0.013	189.24	188.44	0.83	1.67	0.58	2.75	5.05	1.65	1.00
WWGM0863	WWMG99101	WWMG99100	364.6	0.013	204.69	197.49	1.75	22.27	1.97	4.64	7.31	0.21	0.31
WWGM0867	WWMG89258	WWMG99105	356.9	0.013	214.58	212.84	1.50	7.33	0.49	3.70	4.21	0.50	0.50
WWGM0870	WWMG89259	WWMG89258	281.6	0.013	216.37	214.94	1.50	7.49	0.51	3.67	4.24	0.49	0.49
WWGM0880	WWMF89019	WWMF99152	352.5	0.013	199.16	197.43	0.67	0.85	0.49	0.94	3.00	1.12	0.85
WWGM0882	WWMF99152	WWMF99018	123.2	0.013	195.57	194.64	0.67	1.05	0.75	0.96	3.49	0.91	1.00
WWGM0884	WWMF89160	WWMF89022	378.6	0.013	204.27	201.78	0.67	0.98	0.66	0.90	2.59	0.92	1.00
WWGM0896	WWMG99100	WWMG99099	270.4	0.013	197.15	192.18	1.75	21.48	1.84	4.67	7.14	0.22	0.32
WWGM0898	WWMF89020	WWMF89019	15.5	0.013	200.18	199.28	0.67	2.91	5.82	0.94	5.09	0.32	0.70
WWGM0917	WWMG99102	WWMG99101	363.5	0.013	208.50	204.83	1.75	15.92	1.01	4.64	5.74	0.29	0.37
WWGM0940	WWMF89025	WWMF89024	268.4	0.013	212.45	208.40	0.67	1.48	1.51	0.85	4.40	0.58	0.54
WWGM0953	WWMG89189	WWMG89187	214.5	0.013	222.20	221.48	0.83	1.27	0.34	1.29	2.92	1.02	1.00
WWGM0991	WWMF99012	WWMF99011	60.3	0.013	180.58	180.41	1.00	1.89	0.28	2.92	3.71	1.54	1.00
WWGM0992	WWMF99013	WWMF99012	275.8	0.013	186.08	180.65	1.00	5.00	1.97	2.80	4.19	0.56	1.00
WWGM0993	WWMF89023	WWMF89160	85.0	0.013	205.30	204.46	0.67	1.20	0.98	0.90	3.73	0.75	0.97
WWGM0996	WWMF89026	WWMF89025	34.1	0.013	213.74	212.80	0.67	2.01	2.76	0.85	5.52	0.43	0.46
WWGM0998	WWMF89024	WWMF89023	240.0	0.013	208.19	205.30	0.67	1.33	1.21	0.89	3.88	0.67	0.77

CIP System, 5-year, 24-hour storm event

Input								Output							
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1005	WWMF99009	WWMF99008	233.4	0.013	179.26	178.50	1.00	2.03	0.33	2.96	3.77	1.46	1.00
WWGM1033	WWMG89193	WWMG89192	152.0	0.013	228.02	226.44	0.83	2.23	1.04	1.29	4.24	0.58	0.55
WWGM1035	WWMG89192	WWMG89189	364.7	0.013	226.02	224.07	0.83	1.60	0.53	1.29	3.39	0.80	0.66
WWGM1039	WWMG89186	WWMG89185	115.6	0.013	220.50	220.14	0.83	1.22	0.31	1.30	2.85	1.06	1.00
WWGM1045	WWMH105017	WWMH105005	193.4	0.013	163.31	162.19	1.00	2.71	0.58	1.62	3.65	0.60	0.55
WWGM1046	WWMH105005	WWMH105004	264.4	0.013	162.03	160.05	1.00	3.08	0.75	1.65	3.99	0.53	0.52
WWGM1047	WWMH105004	WWMH105003	275.1	0.013	160.00	157.72	1.00	3.24	0.83	1.65	4.15	0.51	0.50
WWGM1051	WWMH105003	WWMH105002	277.9	0.013	157.69	155.42	1.00	3.22	0.82	1.66	4.04	0.52	0.52
WWGM1052	WWMH105002	WWMH105001	341.6	0.013	155.42	152.93	1.00	3.04	0.73	1.66	3.96	0.55	0.53
WWGM1053	WWMH105001	WWMH104012	61.1	0.013	152.88	151.90	1.00	4.51	1.61	1.76	4.35	0.39	0.51
WWGM1054	WWMI102066	WWMI111099	425.2	0.013	203.23	196.17	1.00	4.59	1.66	2.80	4.36	0.61	0.78
WWGM1055	WWMI102067	WWMI102066	153.3	0.013	208.13	205.74	1.00	4.45	1.56	2.79	5.98	0.63	0.57
WWGM1056	WWMI102068	WWMI102067	295.6	0.013	212.88	208.27	1.00	4.45	1.56	2.79	5.98	0.63	0.57
WWGM1060	WWMI102069	WWMI102068	254.8	0.013	213.72	213.18	1.00	1.64	0.21	2.76	3.86	1.68	0.86
WWGM1061	WWMI102070	WWMI102069	123.0	0.013	214.21	213.73	1.00	2.23	0.39	2.76	3.52	1.24	1.00
WWGM1062	WWMI102071	WWMI102070	42.2	0.013	214.40	214.31	1.00	1.65	0.21	2.75	3.50	1.67	1.00
WWGM1069	WWMI102073	WWMI102072	115.9	0.013	218.21	216.84	0.83	2.38	1.18	2.74	5.02	1.15	1.00
WWGM1070	WWMI102131	WWMI102073	126.5	0.013	219.28	218.55	0.83	1.66	0.58	2.72	4.99	1.64	1.00
WWGM1071	WWMI102132	WWMI102131	195.8	0.013	220.88	219.42	0.83	1.89	0.75	2.10	3.85	1.11	1.00
WWGM1072	WWMI104051	WWMI102132	58.5	0.013	222.06	221.22	1.50	12.59	1.44	3.05	5.02	0.24	1.00
WWGM1075	WWMH95019	WWMH95018	134.7	0.013	166.45	165.40	1.50	9.29	0.78	1.55	3.90	0.17	0.28
WWGM1076	WWMH95020	WWMH95019	346.9	0.013	169.94	166.45	1.50	10.53	1.00	1.55	4.07	0.15	0.27
WWGM1077	WWMH95021	WWMH95020	218.5	0.013	187.21	170.61	1.50	29.00	7.62	1.55	8.71	0.05	0.16
WWGM1080	WWMH95022	WWMH95021	259.8	0.013	190.07	187.35	1.50	10.75	1.05	1.54	4.32	0.14	0.26
WWGM1081	WWMH95023	WWMH95022	376.0	0.013	191.85	190.15	1.50	7.06	0.45	1.53	3.23	0.22	0.31
WWGM1082	WWMH95024	WWMH95023	157.0	0.013	192.85	191.99	1.50	7.77	0.55	1.32	3.28	0.17	0.28
WWGM1090	WWMI92151	WWMI92152	344.6	0.013	225.75	224.65	1.50	5.94	0.32	2.12	3.25	0.36	0.40
WWGM1091	WWMI92150	WWMI92151	107.8	0.013	229.75	226.53	1.50	18.16	2.99	1.96	6.72	0.11	0.22
WWGM1104	WWMI92147	WWMI92148	349.7	0.013	243.47	242.07	1.50	6.65	0.40	1.76	3.27	0.26	0.34
WWGM1105	WWMI92148	WWMI92149	281.5	0.013	241.52	237.17	1.50	13.06	1.55	1.76	5.15	0.13	0.25
WWGM1106	WWMI92149	WWMI92150	500.5	0.013	236.97	229.90	1.50	12.49	1.41	1.96	5.15	0.16	0.27
WWGM1107	WWMI92161	WWMI92159	465.0	0.013	249.58	248.23	1.25	3.48	0.29	0.49	2.14	0.14	0.24
WWGM1108	WWMI92159	WWMI92158	128.4	0.013	248.10	247.76	1.25	3.32	0.26	0.49	2.11	0.15	0.24
WWGM1109	WWMI92158	WWMI92157	403.4	0.013	247.11	245.75	1.25	3.75	0.34	0.49	2.23	0.13	0.24
WWGM1110	WWMI92157	WWMI92156	182.5	0.013	245.57	245.13	1.25	3.17	0.24	0.49	2.05	0.15	0.25
WWGM1111	WWMI92156	WWMI92147	203.0	0.013	244.65	243.61	1.25	4.62	0.51	0.49	1.96	0.11	0.27
WWGM1113	WWMI81	WWMI92143	411.7	0.013	268.14	257.94	1.00	5.61	2.48	0.66	4.79	0.12	0.23
WWGM1114	WWMI92143	WWMI92144	108.8	0.013	257.49	256.50	1.00	3.40	0.91	1.28	4.02	0.38	0.42
WWGM1116	WWMI92144	WWMI92146	160.8	0.013	256.47	254.96	1.00	3.45	0.94	1.28	2.14	0.37	0.71
WWGM1117	WWMI92146	WWMI92147	136.7	0.013	254.54	255.51	1.00	3.00	0.71	1.28	2.09	0.43	0.73
WWGM1119	WWMH95018	WWMH105017	341.9	0.013	165.10	163.46	1.00	2.47	0.48	1.62	3.47	0.65	0.57
WWGM1129	WWMI102072	WWMI102071	423.4	0.013	216.64	214.42	1.00	2.58	0.52	2.75	3.50	1.06	1.00
WWGM1131	WWMI92152	WWMI104050	237.8	0.013	223.96	222.64	1.50	7.83	0.56	2.10	3.71	0.27	0.73
WWGM1132	WWMI104050	WWMI104051	65.3	0.013	222.32	222.24	1.50	3.68	0.12	2.15	2.91	0.58	1.00
WWGM1164	WWMJ111094	WWMJ111103	264.2	0.013	177.95	177.19	1.00	1.91	0.29	0.78	2.50	0.41	0.52
WWGM1165	WWMJ111047	WWMJ120027	138.4	0.013	176.73	176.33	0.67	0.65	0.29	0.79	2.46	1.22	1.00
WWGM1167	WWMJ111043	WWMJ120024	300.3	0.013	184.33	177.46	0.83	3.31	2.29	0.65	4.71	0.20	0.30
WWGM1168	WWMJ111056	WWMJ111043	236.2	0.013	191.76	184.80	0.83	3.76	2.95	0.65	5.16	0.17	0.28
WWGM1176	WWMJ120060	WWMJ120037	175.6	0.013	136.72	132.73	0.83	3.30	2.27	0.99	5.29	0.30	0.38
WWGM1177	WWMJ120046	WWMJ120047	435.7	0.013	120.13	119.80	2.00	6.23	0.08	0.55	2.77	0.09	0.11
WWGM1178	WWMJ120045	WWMJ120046	370.6	0.013	157.75	120.36	2.00	72.04	10.14	0.55	5.36	0.01	0.09
WWGM1179	WWMJ120044	WWMJ120045	500.6	0.013	160.50	157.88	2.00	16.37	0.52	0.55	2.42	0.03	0.13
WWGM1180	WWMJ111064	WWMJ120044	400.0	0.013	162.76	160.66	2.00	16.41	0.53	0.56	2.43	0.03	0.13
WWGM1181	WWMJ111063	WWMJ111064	493.8	0.013	165.36	162.76	2.00	16.40	0.53	0.58	2.48	0.04	0.13
WWGM1182	WWMJ111062	WWMJ111063	439.3	0.013	167.35	165.51	2.00	14.64	0.42	0.59	2.33	0.04	0.13
WWGM1183	WWMJ111061	WWMJ111062	394.4	0.013	168.54	167.55	2.00	11.33	0.25	0.64	2.09	0.06	0.15
WWGM1186	WWMJ102131	WWMJ111061	445.8	0.013	170.08	168.54	2.00	13.30	0.35	0.85	2.48	0.06	0.17
WWGM1187	WWMJ102130	WWMJ102131	101.1	0.013	171.61	170.08	2.00	27.83	1.51	0.05	1.85	0.00	0.10
WWGM1194	WWMJ120015	WWMJ120001	129.3	0.013	164.04	163.96	1.00	0.89	0.06	0.00	0.00	0.00	0.01

CIP System, 5-year, 24-hour storm event

Input								Output						
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1200	WWMH136249	WWMH136248	255.9	0.013	157.01	156.62	0.83	0.86	0.15	1.03	1.90	1.21	1.00
WWGM1201	WWMH136248	WWMH136247	334.1	0.013	156.42	155.89	0.83	0.87	0.16	2.06	4.03	2.36	0.89
WWGM1202	WWMH136247	WWMH146246	312.0	0.013	155.57	154.41	1.25	3.94	0.37	2.06	3.41	0.52	0.49
WWGM1204	WWMH146006	WWMH146005	259.1	0.013	146.57	146.06	3.00	29.59	0.20	33.79	4.78	1.14	1.00
WWGM1205	WWMH146246	WWMH146006	62.4	0.013	153.93	149.33	0.83	5.96	7.39	2.06	9.85	0.35	0.70
WWGM1206	WWMI131018	WWMI131017	61.3	0.013	158.73	158.05	1.25	6.80	1.11	3.96	5.56	0.58	1.00
WWGM1218	WWMH146007	WWMH146006	489.6	0.013	147.71	146.63	3.00	31.33	0.22	31.96	4.73	1.02	1.00
WWGM1234	WWMF109006	WWMF109005	292.6	0.013	175.99	173.63	1.00	3.20	0.81	3.20	4.48	1.00	1.00
WWGM1236	WWMF99007	WWMF109006	290.0	0.013	177.87	176.83	1.00	2.13	0.36	3.18	4.05	1.49	1.00
WWGM1242	WWMG108011	WWMG108010	145.8	0.013	181.53	181.43	1.00	0.93	0.07	0.58	2.27	0.62	1.00
WWGM1244	WWMG109046	WWMG108080	372.6	0.013	179.31	178.79	1.75	5.92	0.14	5.28	3.01	0.89	1.00
WWGM1245	WWMG108009	WWMG108008	368.6	0.013	180.80	179.80	1.00	1.86	0.27	0.79	2.17	0.42	1.00
WWGM1246	WWMG108010	WWMG108009	155.3	0.013	181.43	180.86	1.00	2.16	0.37	0.77	2.32	0.36	1.00
WWGM1247	WWMG108008	WWMG108080	32.5	0.013	179.75	179.04	1.00	5.27	2.18	1.03	4.27	0.20	1.00
WWGM1248	WWMG108080	WWMG118086	202.1	0.013	178.59	178.22	1.75	6.78	0.18	5.64	3.32	0.83	1.00
WWGM1249	WWMG108007	WWMG108006	411.5	0.013	178.60	178.44	1.00	0.70	0.04	0.03	0.48	0.04	0.12
WWGM1252	WWMF127016	WWMF127015	14.4	0.013	154.81	153.41	1.25	20.21	9.79	2.60	4.34	0.13	0.49
WWGM1253	WWMF127014	WWMF127013	423.4	0.013	152.96	152.22	1.25	2.70	0.17	2.65	2.90	0.98	0.70
WWGM1254	WWMF127013	WWMF127012	60.6	0.013	152.22	151.92	1.25	4.55	0.50	2.64	3.29	0.58	0.62
WWGM1255	WWMF127012	WWMF127011	403.9	0.013	151.90	150.91	1.25	3.20	0.25	2.66	2.99	0.83	0.68
WWGM1264	J-250_SHER_BASEFLOW	F118029	40.0	0.013	138.76	138.60	0.67	0.76	0.40	0.01	0.79	0.01	0.07
WWGM1266	WWMF127017	WWMF127016	310.0	0.013	156.17	155.05	1.25	3.88	0.36	2.60	3.60	0.67	0.57
WWGM1272	WWMF127044	WWMF127007	515.5	0.013	157.16	148.58	0.67	1.56	1.66	0.03	1.22	0.02	0.55
WWGM1289	WWMF137072	F137204	13.8	0.013	109.76	108.50	1.50	31.83	9.18	2.71	9.64	0.09	0.22
WWGM1290	WWMF137001	WWMF137072	126.8	0.013	125.96	110.35	1.50	36.99	12.40	2.68	12.15	0.07	0.18
WWGM1291	WWMF137002	WWMF137001	97.3	0.013	132.89	126.51	1.50	26.93	6.57	2.68	9.72	0.10	0.21
WWGM1292	WWMF137003	WWMF137002	348.1	0.013	144.94	133.22	1.50	19.28	3.37	2.67	7.67	0.14	0.25
WWGM1293	WWMF137004	WWMF137003	112.0	0.013	147.00	146.31	1.25	5.07	0.62	2.67	4.18	0.53	0.52
WWGM1294	WWMF137005	WWMF137004	334.5	0.013	147.32	147.10	1.25	1.66	0.07	2.67	2.68	1.61	0.76
WWGM1304	WWMG136067	WWMG136066	318.9	0.013	161.45	160.79	1.00	1.62	0.21	2.01	2.56	1.24	1.00
WWGM1306	WWMG136068	WWMG136067	324.9	0.013	162.01	161.46	1.00	1.47	0.17	1.04	1.44	0.71	1.00
WWGM1307	WWMG136069	WWMG136068	15.2	0.013	162.03	162.06	1.00	1.58	0.20	1.04	1.97	0.66	1.00
WWGM1308	WWMG136070	WWMG136069	238.7	0.013	162.60	162.23	1.00	1.40	0.15	1.04	2.19	0.74	1.00
WWGM1309	WWMG126098	WWMG136070	350.4	0.013	163.54	162.65	1.00	1.80	0.25	0.55	1.36	0.31	0.75
WWGM1313	WWMG126237	WWMG126236	363.7	0.013	161.43	160.29	2.50	22.96	0.31	14.64	5.24	0.64	0.55
WWGM1314	WWMG126238	WWMG126237	243.2	0.013	162.28	161.50	1.75	8.97	0.32	14.64	6.40	1.63	0.91
WWGM1316	WWMG126236	WWMG136260	371.1	0.013	158.58	157.50	2.50	22.13	0.29	15.31	4.57	0.69	0.93
WWGM1318	WWMG136064	WWMG136021	266.7	0.013	159.97	158.79	1.00	2.37	0.44	2.16	3.62	0.91	1.00
WWGM1319	WWMG136260	WWMG136019	27.7	0.013	157.00	156.93	2.50	20.62	0.25	16.81	3.42	0.82	1.00
WWGM1320	WWMG136019	WWMG136018	355.3	0.013	156.83	156.60	2.50	10.44	0.06	17.04	3.73	1.63	1.00
WWGM1321	WWMG136021	WWMG136019	18.6	0.013	158.68	157.07	1.50	30.99	8.70	4.39	3.16	0.14	1.00
WWGM1323	WWMG136054	WWMG136053	357.5	0.013	158.95	157.87	1.25	3.55	0.30	2.71	3.21	0.76	1.00
WWGM1324	WWMG136018	WWMG136017	353.6	0.013	156.39	155.92	2.50	14.95	0.13	16.94	3.73	1.13	1.00
WWGM1325	WWMG136016	WWMG136015	308.7	0.013	155.01	154.14	3.00	35.41	0.28	25.32	5.69	0.72	1.00
WWGM1326	WWMG136035	WWMG136016	273.2	0.013	157.45	156.86	1.25	3.00	0.22	3.57	3.34	1.19	1.00
WWGM1330	WWMG136015	WWMG146014	301.7	0.013	153.68	152.93	3.00	33.25	0.25	26.44	5.71	0.80	1.00
WWGM1331	WWMG136050	WWMG146078	299.1	0.013	155.69	155.03	1.25	3.03	0.22	3.53	2.96	1.16	1.00
WWGM1338	WWMH146247	WWMH146008	500.0	0.013	148.89	148.71	3.00	12.66	0.04	31.95	4.52	2.52	1.00
WWGM1339	WWMH146008	WWMH146007	492.1	0.013	148.65	147.73	3.00	28.84	0.19	31.95	4.79	1.11	1.00
WWGM1341	WWMG136020	WWMG136016	17.1	0.013	155.24	155.16	2.50	28.04	0.47	20.21	5.83	0.72	1.00
WWGM1342	WWMG136051	WWMG136050	311.8	0.013	156.25	155.69	1.25	2.74	0.18	2.88	3.14	1.05	1.00
WWGM1352	WWMG137193	WWMG136051	365.9	0.013	157.07	156.25	1.25	3.06	0.22	2.87	2.59	0.94	1.00
WWGM1353	WWMG136053	WWMG137193	351.0	0.013	157.74	157.09	1.25	2.78	0.19	2.70	2.26	0.97	1.00
WWGM1355	WWMG136017	WWMG136020	350.6	0.013	155.82	155.44	2.50	13.50	0.11	18.70	4.54	1.38	1.00
WWGM1356	WWMG126239	WWMG126238	402.9	0.013	163.94	162.54	1.75	9.34	0.35	14.64	6.09	1.57	1.00
WWGM1358	WWMG126240	WWMG126239	136.0	0.013	165.66	164.18	1.75	16.53	1.09	14.64	6.09	0.89	1.00
WWGM1368	WWMG126102	WWMG127188	280.1	0.013	164.40	163.76	1.00	1.70	0.23	0.49	1.25	0.29	0.51
WWGM1369	WWMG127188	WWMG126098	394.2	0.013	163.75	163.69	1.00	0.44	0.02	0.50	1.35	1.13	0.49
WWGM1371	WWMF127118	WWMF127117	137.1	0.013	168.96	168.71	0.83	0.94	0.18	1.05	1.93	1.12	0.99

CIP System, 5-year, 24-hour storm event

Input								Output						
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1372	WWMF127117	WWMF127116	260.2	0.013	168.63	168.33	0.83	0.74	0.12	1.06	2.17	1.42	0.84
WWGM1373	WWMF127116	WWMF127115	383.8	0.013	168.23	167.52	1.00	1.53	0.18	1.06	2.28	0.69	0.57
WWGM1378	WWMF127008	WWMF127007	264.7	0.013	149.01	148.58	1.25	2.60	0.16	2.65	2.72	1.02	0.74
WWGM1379	WWMF127007	WWMF137006	197.4	0.013	148.57	148.06	1.25	3.28	0.26	2.68	2.89	0.82	0.72
WWGM1380	WWMF137006	WWMF137005	304.8	0.013	148.06	147.32	1.25	3.18	0.24	2.67	2.36	0.84	0.87
WWGM1381	WWMF127011	WWMF127010	262.6	0.013	150.90	150.14	1.25	3.48	0.29	2.66	3.14	0.77	0.65
WWGM1382	WWMF127010	WWMF127009	188.0	0.013	150.14	149.57	1.25	3.56	0.30	2.66	3.02	0.75	0.68
WWGM1383	WWMF127009	WWMF127008	256.2	0.013	149.42	149.01	1.25	2.58	0.16	2.65	2.47	1.03	0.82
WWGM1389	WWMG137106	WWMG136039	319.7	0.013	161.89	161.27	1.25	2.84	0.19	2.13	2.70	0.75	0.62
WWGM1390	WWMG136039	WWMG136038	487.1	0.013	161.22	160.06	1.25	3.15	0.24	2.27	2.71	0.72	0.82
WWGM1401	WWMF127203	WWMF127118	309.4	0.013	169.66	169.21	0.83	0.84	0.15	1.05	2.18	1.26	0.86
WWGM1402	WWMF127220	WWMF127203	279.8	0.013	170.34	169.81	0.83	0.95	0.19	1.05	2.09	1.10	0.87
WWGM1403	WWMF127119	WWMF127220	6.1	0.013	170.40	170.39	0.83	0.89	0.16	1.05	2.16	1.19	0.85
WWGM1411	WWMF117018	WWMF127017	299.9	0.013	157.50	157.45	1.25	0.83	0.02	2.62	2.62	3.14	0.76
WWGM1419	WWMF117021	WWMF117020	303.3	0.013	160.66	159.88	1.25	3.28	0.26	2.48	2.94	0.76	0.65
WWGM1420	WWMF117022	WWMF117021	299.7	0.013	161.98	160.74	1.25	4.15	0.41	2.47	3.41	0.60	0.57
WWGM1422	WWMF117023	WWMF117022	323.4	0.013	163.58	162.10	1.25	4.37	0.46	2.47	3.78	0.57	0.53
WWGM1442	WWMG89194	WWMG89193	242.3	0.013	234.52	232.09	0.83	2.19	1.00	1.25	4.15	0.57	0.54
WWGM1447	WWMG79195	WWMG89194	361.0	0.013	240.18	234.89	1.00	4.31	1.47	1.23	4.74	0.29	0.37
WWGM1448	WWMG79196	WWMG79195	87.5	0.013	240.58	240.31	0.83	1.22	0.31	1.23	3.02	1.01	0.70
WWGM1449	WWMG79244	WWMG79196	136.6	0.013	241.37	240.83	0.83	1.38	0.40	1.23	3.12	0.90	0.68
WWGM1451	WWMG79245	WWMG79244	130.4	0.013	242.09	241.67	0.83	1.24	0.32	1.23	2.97	0.99	0.71
WWGM1452	WWMG79246	WWMG79245	103.7	0.013	242.45	242.24	0.83	0.99	0.20	0.92	2.37	0.94	0.69
WWGM1462	WWMF79030	WWMF79029	22.4	0.013	217.37	216.90	0.67	1.75	2.10	0.83	3.14	0.47	1.00
WWGM1463	WWMF79031	WWMF79030	108.5	0.013	218.07	217.49	0.67	0.88	0.53	0.82	3.05	0.93	0.81
WWGM1464	WWMG79032	WWMF79031	93.8	0.013	218.21	218.07	0.67	0.47	0.15	0.82	2.53	1.77	0.89
WWGM1465	WWMG79033	WWMG79032	338.1	0.013	222.83	218.65	0.67	1.34	1.24	0.79	4.00	0.59	0.55
WWGM1470	WWMF89022	WWMF89021	316.5	0.013	201.60	201.25	0.67	0.40	0.11	0.90	2.74	2.25	0.90
WWGM1476	WWMF79029	WWMF79028	79.0	0.013	216.75	216.67	0.67	0.38	0.10	0.83	2.37	2.15	1.00
WWGM1477	WWMF79028	WWMF89027	318.4	0.013	216.32	215.51	0.67	0.61	0.25	0.84	2.73	1.38	0.83
WWGM1480	WWMF89027	WWMF89026	129.8	0.013	215.21	213.96	0.67	1.19	0.96	0.85	3.70	0.72	0.63
WWGM1481	WWMG79034	WWMG79033	192.5	0.013	224.69	223.14	0.67	1.08	0.81	0.79	3.39	0.73	0.63
WWGM1529	WWMG99105	WWMG99104	313.1	0.013	212.56	210.77	1.50	7.94	0.57	3.72	4.42	0.47	0.48
WWGM1534	WWMG99104	WWMG99102	343.8	0.013	210.39	208.69	1.75	11.14	0.49	4.64	4.42	0.42	0.45
WWGM1547	WWMF109005	WWMF109004	286.3	0.013	173.61	171.64	1.00	2.96	0.69	3.24	4.12	1.10	1.00
WWGM1551	WWMF109153	WWMF118026	182.2	0.013	166.55	166.13	1.25	3.10	0.23	3.37	3.46	1.09	1.00
WWGM1552	WWMF109000	WWMF109153	150.9	0.013	167.20	166.64	1.25	3.94	0.37	3.33	3.39	0.85	0.96
WWGM1553	WWMF109001	WWMF109000	19.1	0.013	167.76	167.35	1.25	9.47	2.15	3.33	5.53	0.35	0.60
WWGM1554	WWMF109150	WWMF109001	118.9	0.013	168.21	167.81	1.00	2.07	0.34	3.33	4.51	1.61	0.89
WWGM1555	WWMF109002	WWMF109150	98.1	0.013	168.39	168.17	1.00	1.69	0.22	3.34	4.25	1.98	1.00
WWGM1557	WWMF109003	WWMF109002	144.6	0.013	169.02	168.82	1.00	1.33	0.14	3.31	4.21	2.50	1.00
WWGM1560	WWMF109004	WWMF109003	439.3	0.013	171.53	170.03	1.00	2.08	0.34	3.31	4.21	1.59	1.00
WWGM1564	WWMF117024	WWMF117023	30.3	0.013	163.87	163.98	1.25	3.89	0.36	0.01	0.32	0.00	0.27
WWGM1565	WWMF117025	J-280_HWY240_WEIR	145.5	0.013	164.15	164.00	1.25	2.06	0.10	3.45	3.36	1.67	0.78
WWGM1566	WWMF117026	WWMF117025	205.2	0.013	164.30	164.15	1.25	1.76	0.07	3.45	2.83	1.96	0.98
WWGM1567	WWMF117027	WWMF117026	309.7	0.013	165.11	164.50	1.25	2.87	0.20	3.45	2.81	1.20	1.00
WWGM1568	WWMF117028	WWMF117027	109.5	0.013	165.19	165.11	1.25	1.75	0.07	3.44	2.81	1.97	1.00
WWGM1569	WWMF118001	WWMF117028	7.0	0.013	165.39	165.49	1.00	4.25	1.42	0.06	0.25	0.01	1.00
WWGM1570	WWMF118002	WWMF118001	97.7	0.013	165.74	165.59	1.00	1.40	0.15	0.06	0.59	0.04	1.00
WWGM1571	WWMF118026	WWMF117028	157.5	0.013	165.75	165.44	1.25	2.87	0.20	3.42	2.92	1.19	1.00
WWGM1572	WWMF118025	WWMF118026	63.1	0.013	166.25	166.13	0.83	0.96	0.19	0.05	0.70	0.05	1.00
WWGM1573	WWMF118024	WWMF118025	90.1	0.013	167.53	166.28	0.83	2.58	1.39	0.03	1.43	0.01	0.53
WWGM1574	WWMF118023	WWMF118024	104.3	0.013	169.65	167.58	0.83	3.09	1.98	0.03	1.75	0.01	0.07
WWGM1575	WWMF118003	WWMF118023	80.8	0.013	170.44	169.70	0.83	2.10	0.92	0.05	1.62	0.02	0.11
WWGM1590	WWMG137107	WWMG136095	352.4	0.013	162.99	162.63	1.25	2.06	0.10	2.11	2.27	1.02	0.71
WWGM1591	WWMG137183	WWMG137107	20.2	0.013	163.12	163.09	1.25	2.49	0.15	2.11	2.27	0.85	0.71
WWGM1592	WWMG127109	WWMG137183	378.9	0.013	163.83	163.22	1.25	2.59	0.16	2.11	2.45	0.81	0.66
WWGM1603	WWMG127133	WWMF127115	158.0	0.013	168.63	167.52	0.83	1.84	0.70	0.03	1.09	0.02	0.33
WWGM1604	WWMF127115	WWMG127114	114.6	0.013	167.50	165.93	1.00	4.17	1.37	2.10	5.32	0.50	0.50

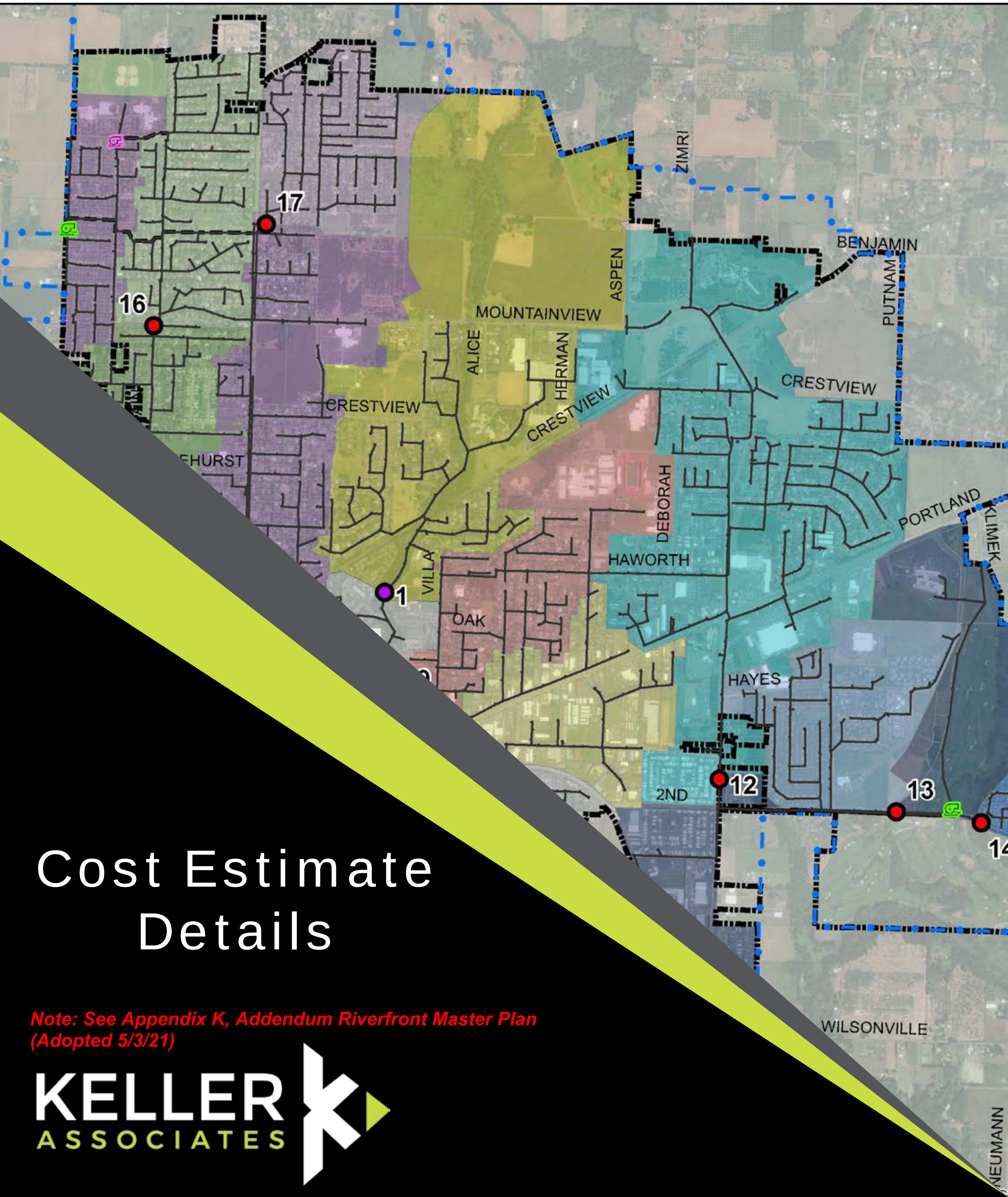
CIP System, 5-year, 24-hour storm event

Input								Output						
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1605	WWMG127110	WWMG127109	258.2	0.013	164.26	163.91	1.25	2.38	0.14	2.11	2.39	0.89	0.67
WWGM1606	WWMG126200	WWMG127110	395.2	0.013	164.87	164.33	1.25	2.39	0.14	2.10	2.31	0.88	0.70
WWGM1607	WWMG127114	WWMG126200	144.7	0.013	165.69	164.97	1.00	2.51	0.50	2.10	3.30	0.84	0.76
WWGM1614	WWMG126147	WWMG127195	520.6	0.013	174.04	167.46	0.83	2.46	1.26	0.00	0.00	0.00	0.50
WWGM1617	WWMG108006	WWMG108005	410.2	0.013	178.43	177.32	1.00	1.85	0.27	0.03	0.91	0.01	0.08
WWGM1618	WWMG108005	WWMG118004	141.8	0.013	177.08	174.65	0.83	2.87	1.71	0.03	1.63	0.01	0.07
WWGM1619	WWMG118004	WWMF118003	276.8	0.013	174.35	170.49	0.83	2.59	1.39	0.03	1.52	0.01	0.07
WWGM1648	WWMH123005	WWMH123004	499.4	0.013	156.46	154.96	2.25	16.97	0.30	13.71	4.89	0.81	0.66
WWGM1669	WWMG136095	WWMG137106	424.2	0.013	162.53	161.89	1.25	2.51	0.15	2.12	2.36	0.85	0.69
WWGM1685	WWMH126133	WWMH136204	209.2	0.013	161.52	160.41	0.83	1.60	0.53	1.02	3.14	0.64	1.00
WWGM1689	WWMH104043	WWMH104042	449.2	0.013	213.21	211.83	1.00	1.97	0.31	0.78	2.52	0.39	0.42
WWGM1709	WWMI111099	WWMI111053	500.2	0.013	195.95	193.92	1.25	4.12	0.41	5.30	4.66	1.29	0.87
WWGM1710	WWMI111036	WWMI111035	289.1	0.013	182.78	181.39	1.25	4.48	0.48	5.99	4.88	1.34	1.00
WWGM1713	WWMH114030	WWMH114029	101.7	0.013	177.83	176.93	1.00	3.35	0.89	2.19	3.46	0.65	0.75
WWGM1718	WWMH123006	WWMH123005	305.9	0.013	164.58	163.32	1.00	2.29	0.41	2.53	3.59	1.11	0.84
WWGM1739	WWMI111053	WWMI111037	117.3	0.013	193.35	190.22	1.25	10.55	2.67	5.97	8.86	0.57	0.54
WWGM1740	WWMI111037	WWMI111036	53.8	0.013	189.43	183.25	1.25	21.96	11.56	5.99	12.86	0.27	0.68
WWGM1742	WWMG136254	WWMG136054	261.9	0.013	159.70	158.92	1.00	1.94	0.30	0.32	0.63	0.17	0.77
WWGM1743	WWMG136097	WWMG136254	257.5	0.013	160.50	159.70	1.00	1.99	0.31	0.02	0.75	0.01	0.29
WWGM1753	WWMG136065	WWMG136064	267.0	0.013	160.39	159.99	1.00	1.38	0.15	2.02	2.79	1.46	1.00
WWGM1755	WWMG136066	WWMG136065	260.3	0.013	160.79	160.39	1.00	1.40	0.15	2.02	2.57	1.44	1.00
WWGM1756	WWMG136100	WWMG136066	198.2	0.013	163.12	160.79	1.00	3.86	1.18	0.00	0.00	0.00	0.50
WWGM1760	WWMG136038	WWMG136037	352.2	0.013	160.06	159.28	1.25	3.04	0.22	2.43	2.10	0.80	1.00
WWGM1762	WWMG136037	WWMG137195	338.6	0.013	159.28	158.68	1.25	2.72	0.18	3.45	2.87	1.27	1.00
WWGM1763	WWMG137194	WWMG136035	319.2	0.013	158.03	157.53	1.25	2.56	0.16	3.51	2.90	1.37	1.00
WWGM1764	WWMG136074	WWMG136050	250.6	0.013	164.31	163.74	0.83	1.05	0.23	0.01	0.69	0.01	0.07
WWGM1766	WWMH136250	WWMH136249	137.8	0.013	157.81	157.38	0.83	1.22	0.31	1.03	2.44	0.84	1.00
WWGM1767	WWMH136135	WWMH136250	405.9	0.013	158.83	157.93	0.83	1.03	0.22	1.03	2.23	1.00	1.00
WWGM1768	WWMH136253	WWMH136135	199.3	0.013	159.45	159.02	0.83	1.02	0.22	1.03	2.40	1.01	1.00
WWGM1769	WWMH136204	WWMH136253	223.9	0.013	159.79	159.68	0.83	0.49	0.05	1.02	2.05	2.11	1.00
WWGM1770	WWMH136262	WWMG136097	336.6	0.013	161.48	160.50	1.00	1.92	0.29	0.01	0.63	0.01	0.07
WWGM1771	WWMF117019	WWMF117018	281.5	0.013	158.59	157.78	1.25	3.46	0.29	2.50	2.78	0.72	0.72
WWGM1773	WWMF117020	WWMF117019	458.0	0.013	159.73	158.77	1.25	2.96	0.21	2.50	3.02	0.84	0.64
WWGM1779	WWMG109049	WWMG109048	306.6	0.013	182.02	181.21	1.75	8.14	0.26	5.20	3.35	0.64	1.00
WWGM1780	WWMG109050	WWMG109049	279.0	0.013	186.00	182.32	1.75	18.20	1.32	5.20	6.02	0.29	0.92
WWGM1781	WWMG109051	WWMG109050	272.6	0.013	188.97	186.45	1.75	15.24	0.92	4.68	5.57	0.31	0.48
WWGM1782	WWMG99099	WWMG109051	272.6	0.013	191.77	189.26	1.75	15.20	0.92	4.68	5.56	0.31	0.38
WWGM1788	WWMG116237	WWMG116236	301.4	0.013	173.99	173.53	1.75	6.19	0.15	11.31	4.70	1.83	1.00
WWGM1790	WWMI121026	WWMI131025	351.3	0.013	171.05	170.10	1.25	3.36	0.27	3.47	3.48	1.03	1.00
WWGM1791	WWMI121027	WWMI121026	336.7	0.013	172.17	171.05	1.25	3.73	0.33	3.30	3.29	0.89	1.00
WWGM1792	WWMI121103	WWMI121027	23.1	0.013	172.36	172.37	1.25	1.65	0.06	3.36	3.70	2.04	1.00
WWGM1793	WWMI121028	WWMI121103	38.1	0.013	172.66	172.36	1.75	14.17	0.80	9.14	5.19	0.64	0.80
WWGM1794	WWMI121029	WWMI121028	365.6	0.013	174.79	172.66	1.75	12.09	0.58	6.15	5.21	0.51	0.63
WWGM1795	WWMI121030	WWMI121029	347.9	0.013	176.89	174.79	1.75	12.31	0.60	6.01	5.05	0.49	0.50
WWGM1796	WWMI121100	WWMI121030	59.7	0.013	177.06	176.89	1.75	8.36	0.28	6.01	4.45	0.72	0.55
WWGM1798	WWMI121031	WWMI121100	342.8	0.013	178.01	177.06	1.75	8.36	0.28	6.00	3.84	0.72	0.62
WWGM1799	WWMI111032	WWMI121031	450.4	0.013	179.27	178.01	1.75	8.38	0.28	6.00	3.76	0.72	0.63
WWGM1800	WWMI111040	WWMI111032	452.8	0.013	180.54	179.27	1.75	8.39	0.28	6.00	3.79	0.71	0.63
WWGM1802	WWMI111035	WWMI111040	306.3	0.013	181.39	180.54	1.25	3.40	0.28	6.00	5.02	1.76	0.94
WWGM1810	WWMF99016	WWMF99015	147.1	0.013	190.51	189.39	0.83	1.91	0.76	0.98	2.63	0.52	1.00
WWGM1811	WWMF99017	WWMF99016	75.7	0.013	191.25	190.62	0.83	2.00	0.83	0.98	3.49	0.49	1.00
WWGM1812	WWMF99018	WWMF99017	160.5	0.013	192.94	191.30	0.83	2.21	1.02	0.98	3.82	0.44	1.00
WWGM1828	WWMG146025	WWMG146013	253.0	0.013	155.04	152.57	1.50	10.38	0.98	2.47	4.09	0.24	1.00
WWGM1834	WWMG126242	WWMG126241	303.3	0.013	171.64	168.53	1.75	16.05	1.03	13.18	7.08	0.82	1.00
WWGM1835	WWMG126241	WWMG127195	139.7	0.013	168.22	167.46	1.75	11.69	0.54	13.67	5.85	1.17	1.00
WWGM1837	WWMG126243	WWMG126242	254.9	0.013	171.83	171.74	1.75	2.98	0.04	12.80	5.62	4.30	1.00
WWGM1839	WWMG116235	WWMG126243	292.4	0.013	172.55	172.04	1.75	6.62	0.17	12.28	5.10	1.86	1.00
WWGM1840	WWMG127195	WWMG126240	187.0	0.013	166.36	165.81	1.75	8.59	0.29	13.67	5.68	1.59	1.00
WWGM1842	WWMG116236	WWMG116235	299.3	0.013	173.27	172.84	1.75	6.01	0.14	11.80	4.90	1.96	1.00

CIP System, 5-year, 24-hour storm event

Input								Output					
Pipe ID	Upstream MH	Downstream MH	Length (ft)	Roughness	US Invert (ft)	DS Invert (ft)	Diameter (ft)	Full Flow (cfs)	Slope (%)	Max Flow (cfs)	Max Velocity (ft/s)	Max.Flow/Full Flow	Max.Depth/Full Depth
WWGM1967	WWMJ120017	J120019	23.4	0.013	122.37	121.60	2.00	41.02	3.29	2.15	6.89	0.05	0.16
WWGM2025	WWMJ120047	J120019	32.1	0.013	119.80	119.60	24.00	0.00	0.62	0.57	-1.00	-1.00	-1.00
WWGM2026	WWMG89260	WWMG89259	285.5	0.013	217.01	216.37	1.50	4.97	0.22	3.67	3.46	0.74	0.58
WWGM2035	WWMG109047	WWMG109046	377.4	0.013	180.34	179.71	1.75	6.47	0.17	5.28	3.32	0.82	1.00
WWGM2037	WWMG109048	WWMG109047	349.8	0.013	181.12	180.53	1.75	6.51	0.17	5.23	3.20	0.80	1.00
WWGM2039	J-110	WWMG136054	228.4	0.013	159.72	158.85	1.00	2.20	0.38	0.82	1.35	0.37	0.79
WWGM2053	WWMG89250	WWMG89260	19.4	0.013	220.40	220.10	0.67	1.50	1.55	0.00	0.00	0.00	0.00
WWGM2054	WWMG89076	WWMG89260	43.7	0.013	218.83	218.00	0.67	1.66	1.90	0.03	1.83	0.02	0.09
WWGM2073	WWMG118104	WWMG117195	36.0	0.013	184.64	184.46	1.25	4.57	0.50	50.50	1198.00	11.05	0.99
WWGM2074	J-100	WWMF117024	15.3	0.013	164.00	163.89	1.00	3.02	0.72	0.00	0.13	0.00	0.32
WWGM2075	J-280_HWY240_WEIR	WWMF118050	45.7	0.013	163.80	163.06	1.00	4.53	1.62	3.45	4.96	0.76	0.83
WWGM2076	WWMF118050	WWMF118049	85.0	0.013	162.98	162.58	1.00	2.44	0.47	3.45	4.65	1.41	0.90
WWGM2077	WWMF118049	WWMF118048	138.0	0.013	162.17	154.99	1.00	8.13	5.21	3.76	6.04	0.46	0.74
WWGM2078	WWMF118048	HWY240LS	20.0	0.013	154.99	155.00	1.00	0.80	0.05	3.76	5.00	4.72	0.91
WWGM2093	WWMG136036	WWMG137194	61.3	0.013	158.51	158.08	1.25	5.41	0.70	3.49	3.22	0.65	1.00
WWGM2094	WWMG137195	WWMG136036	88.7	0.013	158.48	158.46	1.25	0.97	0.02	3.48	3.13	3.59	1.00
WWGM2110	WWMH114003	WWMH114140	66.3	0.013	140.08	139.38	1.00	3.66	1.06	2.87	3.65	0.78	1.00
WWGM2119	WWMI131111	WWMI131019	95.9	0.013	160.90	160.63	1.25	3.43	0.28	4.01	3.41	1.17	1.00
WWGM2137	WWMJ111103	WWMJ111047	30.1	0.013	177.19	176.75	1.00	4.31	1.46	1.87	3.11	0.43	0.79
WWGM2146	WWMG146012	WWMG146076	311.7	0.013	152.08	151.46	1.50	4.69	0.20	4.52	2.56	0.96	1.00
WWGM2147	WWMG146075	WWMG146076	9.4	0.013	151.83	151.23	3.00	169.06	6.42	40.69	8.49	0.24	1.00
WWGM2148	WWMG146014	WWMG146075	9.1	0.013	152.58	151.93	3.00	178.49	7.16	41.56	16.30	0.23	1.00
WWGM2149	WWMG146076	WWMG146077	275.8	0.013	151.13	150.91	3.00	18.84	0.08	36.75	5.74	1.95	1.00
WWGM2150	WWMG146078	WWMG146077	26.9	0.013	154.74	152.10	1.25	20.27	9.85	3.54	4.39	0.17	1.00
WWGM2151	WWMG146077	WWMG146079	380.7	0.013	150.36	149.98	3.00	21.07	0.10	30.43	4.78	1.44	1.00
WWGM2152	WWMG146079	WWMH146247	372.3	0.013	149.70	149.05	3.00	27.87	0.17	31.95	4.52	1.15	1.00

Appendix E



Cost Estimate Details

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

KELLER ASSOCIATES

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-1: Hess Creek Alternative A O&M Costs

	Quantity	Unit	Unit Price	Amount	Comments
Cleaning & CCTV Inspection (parallel line)	10,400	LF	$ 1.50	$ 93,600	Labor and equipment costs; clean & inspect 1x/5yr
Cleaning & CCTV Inspection (Hess Creek line)	5,510	LF	$ 1.50	$ 33,060	Labor and equipment costs; clean & inspect 1x/3yr
Maintenance and Repairs	15,910	LF	$ 0.10	$ 32,905	
Access Road Maintenance	1	LS	$ 5,000	$ 100,000	
			Annual O&M	**$ 13,000**	
			20-year O&M	**$ 230,000**	

Table E-2: Hess Creek Alternative A Capital Costs

Alternative	Item	Unit	Unit Price	Quantity	Cost
A	Parallel gravity main				
	24-inch new pipe	LF	$ 205	2,500	$ 512,500
	21-inch new pipe	LF	$ 195	4,900	$ 955,500
	12-inch pipe replacement (Villa Rd)	LF	$ 160	1,900	$ 304,000
	Highway boring	LF	$ 600	160	$ 96,000
	Re-grading pipe	LF	$ 135	2,400	$ 324,000
	Re-connect laterals	EA	$ 500	10	$ 5,000
	Re-connect manholes	EA	$ 1,500	35	$ 52,000
	Roadway restoration	LF	$ 30	10,400	$ 312,000
	Install access road	LF	$ 60	1,300	$ 78,000
	Manhole 72-inch - >18-inch pipe	EA	$ 5,500	5	$ 27,500
	Existing pipe rehab/replacement				
	36-inch pipe replacement	LF	$ 245	700	$ 171,500
	24-inch pipe replacement	LF	$ 205	2,800	$ 574,000
	18-inch pipe replacement	LF	$ 185	800	$ 148,000
	Re-connect manholes	EA	$ 1,500	16	$ 24,000
	Install access road	LF	$ 60	4,300	$ 258,000
	Soil restoration	LF	$ 5	4,300	$ 21,500
	Pathway/landscaping restoration	LF	$ 30	825	$ 24,750
	CIPP, 8-18-inch[1]	LF	$ 98	8,400	$ 819,000
	Hess Creek constructability	%	150	-	$ 1,832,625
	Bypass pumping	LS	$ 350,000	1	$ 350,000
				Subtotal (rounded)	$ 6,890,000
	Mobilization	%	5	-	$ 344,500
				Subtotal (rounded)	$ 7,235,000
	Contingency	%	30	-	$ 2,170,500
				Subtotal (rounded)	$ 9,406,000
	Engineering and CMS	%	25	-	$ 2,351,500
	Floodplain hydraulic study	LS	$ 40,000	1	$ 40,000
	Easement	AC	$ 30,000	2.75	$ 82,500
	Permitting & wetland mitigation	LS	$ 474,000	1	$ 474,000
				Project Total Cost (rounded):	**$ 12,354,000**

[1]CIPP costs increased by 30% for accessibility constraints in the Hess Creek Canyon.

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-3: Hess Creek Alternative C O&M Costs

	Quantity	Unit	Unit Price	Amount	Comments
Pump Station Power Costs	20	1	$ 3,650	$ 72,990	Based on approx. AADF, 50% pump efficiency, running 1/3 of time
Pump Station Worker Costs	20	208	$ 60	$ 249,600	2 hours troubleshooting/maintenance/observation per week (52 weeks) - 2 people for work
Pump Station Equipment Costs	3	1	$ 100,000	$ 300,000	3 pumps replaced once ($100K each pump/motor)
Cleaning & CCTV Inspection	11,100	LF	$ 1.50	$ 66,600	Labor and equipment costs; clean & inspect 1x/5yr
Maintenance and Repairs	11,100	LF	$ 0.103	$ 22,957	
			Annual O&M	**$ 36,000**	
			20-year O&M	**$ 637,000**	

Table E-4: Hess Creek Alternative C Capital Costs

Alternative	Item	Unit	Unit Price	Quantity	Cost
C	Lift Station, 2700-gpm	EA	$ 960,000	1	$ 960,000
	12-inch force main	LF	$ 90	650	$ 58,500
	Highway Boring	LF	$ 600	160	$ 96,000
	Local grinder pump	EA	$ 9,500	1	$ 9,500
	Parallel gravity main				
	27-inch new pipe	LF	$ 220	5,300	$ 1,166,000
	24-inch new pipe	LF	$ 205	900	$ 184,500
	15-inch new pipe	LF	$ 170	1,200	$ 204,000
	12-inch pipe replacement (Villa Rd)	LF	$ 160	1,900	$ 304,000
	Re-grading pipe	LF	$ 135	2,400	$ 324,000
	Re-connect laterals	EA	$ 500	210	$ 105,000
	Re-connect manholes	EA	$ 1,500	35	$ 52,000
	Roadway restoration	LF	$ 30	10,400	$ 312,000
	Install access road	LF	$ 60	1,300	$ 78,000
	Manhole 72-inch - >18-inch pipe	EA	$ 5,500	5	$ 27,500
	Existing pipe rehab/replacement				
	36-inch pipe replacement	LF	$ 245	700	$ 171,500
	18-inch pipe replacement	LF	$ 185	800	$ 148,000
	Re-connect manholes	EA	$ 1,500	7	$ 10,500
	Install access road	LF	$ 60	1,500	$ 90,000
	Soil restoration	LF	$ 5	1,500	$ 7,500
	CIPP, 8-18-inch[1]	LF	$ 98	7,500	$ 731,250
	Hess Creek constructability	%	150	-	$ 641,250
	Bypass pumping	LS	$ 50,000	1	$ 50,000
				Subtotal (rounded)	$ 5,731,000
	Mobilization	%	5	-	$ 286,550
				Subtotal (rounded)	$ 6,018,000
	Contingency	%	30	-	$ 1,805,400
				Subtotal (rounded)	$ 7,824,000
	Engineering and CMS	%	25	-	$ 1,956,000
	Floodplain hydraulic study	LS	$ 20,000	1	$ 20,000
	Easement	AC	$ 30,000	1.20	$ 36,000
	Permitting & wetland mitigation	LS	$ 165,000	1	$ 165,000
				Project Total Cost (rounded):	**$ 10,001,000**

[1]CIPP costs increased by 30% for accessibility constraints in the Hess Creek Canyon.

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-5: Hess Creek Alternative D O&M Costs

	Quantity	Unit	Unit Price	Amount	Comments
Cleaning & CCTV Inspection (Hess Creek line)	5,510	LF	$ 1.50	$ 49,590	Labor and equipment costs; clean & inspect 1x/3yr
Maintenance and Repairs	5,510	LF	$ 0.103	$ 11,396	
Access Road Maintenance	1	LS	$ 5,000	$ 100,000	
			Annual O&M	**$ 9,000**	
			20-year O&M	**$ 160,000**	

Table E-6: Hess Creek Alternative D Costs

Alternative	Item	Unit	Unit Price	Quantity	Cost
D	Existing pipe rehab/replacement				
	36-inch pipe replacement	LF	$ 245	1,800	$ 441,000
	30-inch pipe replacement	LF	$ 230	2,000	$ 460,000
	27-inch pipe replacement	LF	$ 220	1,200	$ 264,000
	21-inch pipe replacement	LF	$ 195	500	$ 97,500
	18-inch pipe replacement	LF	$ 185	900	$ 166,500
	15-inch pipe replacement	LF	$ 170	400	$ 68,000
	12-inch pipe replacement (Villa Rd)	LF	$ 160	2,600	$ 416,000
	Boring (Fulton Street Crossing)	LF	$ 600	115	$ 69,000
	Re-connect laterals	EA	$ 500	60	$ 30,000
	Re-connect manholes	EA	$ 1,500	31	$ 47,000
	Roadway restoration (Villa Rd)	LF	$ 30	2,600	$ 78,000
	Install access road	LF	$ 60	6,000	$ 360,000
	Pathway/landscaping restoration	LF	$ 30	1,700	$ 51,000
	Soil restoration	LF	$ 5	6,800	$ 34,000
	CIPP, 8-18-inch[1]	LF	$ 98	6,000	$ 585,000
	Hess Creek constructability	%	150	-	$ 3,072,000
	Bypass pumping	LS	$ 500,000	1	$ 500,000
				Subtotal (rounded)	$ 6,739,000
	Mobilization	%	5	-	$ 336,950
				Subtotal (rounded)	$ 7,076,000
	Contingency	%	30	-	$ 2,122,800
				Subtotal (rounded)	$ 9,199,000
	Engineering and CMS	%	25	-	$ 2,299,750
	Floodplain hydraulic study	LS	$ 40,000	1	$ 40,000
	Easement	AC	$ 30,000	2.75	$ 82,500
	Permitting & wetland mitigation	LS	$ 601,000	1	$ 601,000
				Project Total Cost (rounded):	**$ 12,223,000**

[1]CIPP costs increased by 30% for accessibility constraints in the Hess Creek Canyon.

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-7: Springbrook Road Alternatives Costs

Alternative	Item	Unit	Unit Price	Quantity	Cost
A	Upsize existing				
	24-inch new pipe	LF	$ 205	6,500	$ 1,332,500
	21-inch new pipe	LF	$ 195	2,100	$ 409,500
	Highway boring	LF	$ 600	135	$ 81,000
	Re-connect laterals	EA	$ 500	13	$ 6,500
	Re-connect manholes	EA	$ 1,500	29	$ 43,000
	Roadway restoration (full lane)	LF	$ 60	8,600	$ 516,000
	Traffic Control (Highway)	LF	$ 10	4,500	$ 45,000
	Control density backfill	LF	$ 165	4,500	$ 742,500
				Subtotal (rounded)	$ 3,176,000
	Mobilization	%	5	-	$ 158,800
				Subtotal (rounded)	$ 3,335,000
	Contingency	%	30	-	$ 1,000,500
				Subtotal (rounded)	$ 4,336,000
	Engineering and CMS	%	25	-	$ 1,084,000
				Project Total Cost (rounded):	**$ 5,420,000**
B	Parallel gravity main				
	21-inch new pipe	LF	$ 195	5,100	$ 994,500
	Manhole 72-inch - >18-inch pipe	EA	$ 5,500	17	$ 93,500
	Highway boring	LF	$ 600	135	$ 81,000
	Roadway restoration (full lane)	LF	$ 60	1,600	$ 96,000
	Soil restoration	LF	$ 5	3,500	$ 17,500
	Upsize existing				
	21-inch new pipe	LF	$ 195	2,100	$ 409,500
	Re-connect laterals	EA	$ 500	3	$ 1,500
	Re-connect manholes	EA	$ 1,500	7	$ 10,500
	Roadway restoration (full lane)	LF	$ 60	2,100	$ 126,000
	Traffic Control (Highway)	LF	$ 10	2,100	$ 21,000
	Control density backfill	LF	$ 165	2,100	$ 346,500
				Subtotal (rounded)	$ 2,198,000
	Mobilization	%	5	-	$ 109,900
				Subtotal (rounded)	$ 2,308,000
	Contingency	%	30	-	$ 692,400
				Subtotal (rounded)	$ 3,001,000
	Engineering and CMS	%	25	-	$ 750,250
	Easement	AC	$ 30,000	2.0	$ 60,000
				Project Total Cost (rounded):	**$ 3,812,000**

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-8: Priority 1 Recommended Lift Station Condition Improvements

Site	Recommended Improvement	Recommended Completion Time	Cost
Charles Lift Station	Add manhole cover lock	1-5 Years	$1,500
	Install removable bollards in front for traffic protection	1-5 Years	$1,800
		Subtotal	*$3,300*
Chehalem	Upgrade generator maintenance records	1-2 Years	$800
		Subtotal	*$800*
Creekside Lift Station	Install bollards for traffic protection	1-5 Years	$1,800
	Replace heater with heat tape in the valve enclosure for freeze protection	1-5 Years	$1,200
	Remount wash water backflow preventer at least 12-inches aboveground	1-5 Years	$3,200
	Relocate the portable generator connection point so it is 34 inches aboveground	1-5 Years	$1,300
	Add fencing around the station	1-5 years	$7,500
		Subtotal	*$15,000*
Fernwood Lift Station	Verify pump operating point and adjust operation (if needed) to improve capacity	Year 1	$1,200
	Check and correct (if needed) hazardous area seal-offs	1-2 Years	$1,800
	Install steel safety grating at the valve vault	1-5 Years	$1,400
	Install flow directing inlet at the influent pipe to the wet well	1-5 Years	$7,800
	Remove unused equipment from the building	1-5 Years	$1,300
	Repaint building doors	1-5 Years	$800
		Subtotal	*$14,300*
Highway 240 Lift Station	Install steel safety grating at the valve vault	1-5 Years	$1,400
	Repaint building doors	1-5 Years	$800
	Install flow directing inlet at the influent pipe to the wet well	1-5 Years	$7,800
	Install steel safety grating at the flow meter vault	1-5 Years	$1,400
		Subtotal	*$11,400*
Sheridian Lift Station	Add strip heater unit in electrical enclosure	1-2 Years	$300
	Replace burnt-out LED lights for depth display in control panel	1-5 Years	$2,200
	Remount wash water backflow preventer at least 12-inches aboveground	1-5 Years	$3,200
	Add fencing around the station	1-5 years	$7,500
	Replace heat tape with electrical heater	1-5 Years	$900
		Subtotal	*$14,100*
		Lift Station Improvements Subtotal	*$58,900*
		Contingency (30%)	$17,700
		Engineering (20%)	$15,400
		Administration (2%)	$1,600
Dayton Lift Station	Lift Station Replacement (Construction cost from City; includes contingency, engineering, admin)	1-5 Years	$1,335,000
		Subtotal	*$1,335,000*
		Lift Station Total Costs (rounded)	**$1,429,000**

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-9: Priority 2 Recommended Lift Station Condition Improvements

Site	Recommended Improvement	Recommended Completion Time	Cost
Fernwood Lift Station	Add video monitoring	11-20 Years	$38,000
	Add flow meter on the discharge pipe	1-10 years	$23,000
	Install backflow control on overflow	1-10 Years	$5,600
		Subtotal	*$66,600*
Highway 240 Lift Station	Add video monitoring	11-20 Years	$38,000
	Replace pump guide rails	5-10 Years	$5,000
		Subtotal	*$43,000*
Sheridian Lift Station	Replace conductive level sensor with pressure transducer level sensor	11-20 Years	$6,500
	Add video monitoring	11-20 Years	$38,000
	Install backflow control on overflow	1-10 Years	$5,600
	Remove mixing valve	1-10 Years	$1,100
	Install pressure gauges on discharge pipes	5-10 Years	$1,800
	Add flow meter on the discharge pipe	5-10 years	$23,000
	Install a permanent ladder in the valve vault	5-10 Years	$5,600
	Install a dedicated standby generator	5-10 Year	$45,000
		Subtotal	*$126,600*
		Subtotal	$236,200
		Contingency (30%)	$70,900
		Engineering (20%)	$61,500
		Administration (2%)	$6,200
		Lift Station Total Costs (rounded)	**$375,000**

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-10: Hess Creek Recommended Improvements Phased Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
Phase 1					
	CIPP, 8-18-inch[1]	LF	$ 98	7,500	$ 731,250
	Flow monitoring	LS	$ 20,000	1	$ 20,000
				Subtotal (rounded)	$ 752,000
	Mobilization	%	5	-	$ 37,600
				Subtotal (rounded)	$ 790,000
	Contingency	%	10	-	$ 79,000
				Subtotal (rounded)	$ 869,000
	Engineering and CMS	%	15	-	$ 130,350
				Phase 1 Cost (rounded):	**$ 1,000,000**
Phase 2					
	Parallel gravity main				
	27-inch new pipe	LF	$ 220	5,300	$ 1,166,000
	24-inch new pipe	LF	$ 205	900	$ 184,500
	15-inch new pipe	LF	$ 170	1,200	$ 204,000
	12-inch pipe replacement (Villa Rd)	LF	$ 160	1,900	$ 304,000
	Re-grading pipe	LF	$ 135	2,400	$ 324,000
	Re-connect laterals	EA	$ 500	210	$ 105,000
	Re-connect manholes	EA	$ 1,500	35	$ 52,000
	Roadway restoration	LF	$ 30	10,400	$ 312,000
	Install access road	LF	$ 60	1,300	$ 78,000
	Manhole 72-inch - >18-inch pipe	EA	$ 5,500	5	$ 27,500
	Existing pipe rehab/replacement				
	36-inch pipe replacement	LF	$ 245	700	$ 171,500
	18-inch pipe replacement	LF	$ 185	800	$ 148,000
	Re-connect manholes	EA	$ 1,500	7	$ 10,500
	Install access road	LF	$ 60	1,500	$ 90,000
	Soil restoration	LF	$ 5	1,500	$ 7,500
	Hess Creek constructability	%	$ 150	-	$ 641,250
	Bypass pumping	LS	$ 50,000	1	$ 50,000
				Subtotal (rounded)	$ 3,876,000
	Mobilization	%	5	-	$ 193,800
				Subtotal (rounded)	$ 4,070,000
	Contingency	%	30	-	$ 1,221,000
				Subtotal (rounded)	$ 5,291,000
	Engineering and CMS	%	25	-	$ 1,322,750
	Floodplain hydraulic study	LS	$ 20,000	1	$ 20,000
	Permitting	LS	$ 15,000	1	$ 15,000
				Phase 2 Cost (rounded):	**$ 6,649,000**
Phase 3					
	Lift Station, 2700-gpm	EA	$ 960,000	1	$ 960,000
	12-inch force main	LF	$ 90	650	$ 58,500
	Highway Boring	LF	$ 600	160	$ 96,000
	Local grinder pump	EA	$ 9,500	1	$ 9,500
				Subtotal (rounded)	$ 1,124,000
	Mobilization	%	5	-	$ 56,200
				Subtotal (rounded)	$ 1,181,000
	Contingency	%	30	-	$ 354,300
				Subtotal (rounded)	$ 1,536,000
	Engineering and CMS	%	25	-	$ 384,000
	Easement	AC	$ 30,000	1.20	$ 36,000
	Permitting & wetland mitigation	LS	$ 165,000	1	$ 165,000
				Phase 3 Cost (rounded):	**$ 2,121,000**
				Project Total Cost (rounded):	**$ 9,770,000**

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-11: Pinehurst Court Recommended Improvements Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
	Cap and abandon line	EA	$ 1,500	1	$ 1,500
	8-inch new pipe	LF	$ 135	300	$ 40,500
	Re-grading pipe	LF	$ 135	400	$ 54,000
	Manhole 48-inch	EA	$ 4,500	2	$ 9,000
	Re-connect laterals	EA	$ 500	9	$ 4,500
	Re-connect manholes	EA	$ 1,500	4	$ 6,000
	Roadway restoration (full lane)	LF	$ 60	440	$ 26,400
	Landscape restoration	LF	$ 20	260	$ 5,200
				Subtotal (rounded)	$ 148,000
	Mobilization	%	5	-	$ 7,400
				Subtotal (rounded)	$ 156,000
	Contingency	%	30	-	$ 46,800
				Subtotal (rounded)	$ 203,000
	Engineering and CMS	%	25	-	$ 50,750
	Easement	AC	$ 30,000	0.12	$ 3,600
				Project Total Cost (rounded):	**$ 258,000**

Table E-12: South River Street Recommended Improvements Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
	36-inch new pipe	LF	$ 245	3,200	$ 784,000
	30-inch new pipe	LF	$ 230	1,900	$ 437,000
	Re-connect laterals	EA	$ 500	51	$ 25,500
	Manhole 72-inch - >18-inch pipe	EA	$ 5,500	8	$ 44,000
	Re-connect manholes	EA	$ 1,500	7	$ 9,755
	Roadway restoration (full lane)	LF	$ 60	5,100	$ 306,000
				Subtotal (rounded)	$ 1,607,000
	Mobilization	%	5	-	$ 80,350
				Subtotal (rounded)	$ 1,688,000
	Contingency	%	30	-	$ 506,400
				Subtotal (rounded)	$ 2,195,000
	Engineering and CMS	%	25	-	$ 548,750
	Flow monitoring	LS	$ 20,000	1	$ 20,000
				Project Total Cost (rounded):	**$ 2,764,000**

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-13: North Main and Wynooski Streets Recommended Improvements Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
North Main Street Improvements					
	15-inch pipe replacement	LF	$ 170	150	$ 25,500
	Re-grading pipe (15-inch)	LF	$ 170	350	$ 59,500
	Re-connect laterals	EA	$ 500	5	$ 2,500
	Re-connect manholes	EA	$ 1,500	6	$ 9,000
	Roadway restoration (full lane)	LF	$ 60	150	$ 9,000
	Landscape restoration	LF	$ 20	350	$ 7,000
				Subtotal (rounded)	$ 113,000
	Mobilization	%	5	-	$ 5,650
				Subtotal (rounded)	$ 119,000
	Contingency	%	30	-	$ 35,700
				Subtotal (rounded)	$ 155,000
	Engineering and CMS	%	25	-	$ 38,750
				Project Total Cost (rounded):	**$ 194,000**
Wynooski Street Improvements					
	15-inch pipe replacement	LF	$ 170	320	$ 54,400
	Re-connect laterals	EA	$ 500	2	$ 1,000
	Re-connect manholes	EA	$ 1,500	2	$ 3,000
	Roadway restoration (full lane)	LF	$ 60	320	$ 19,200
				Subtotal (rounded)	$ 78,000
	Mobilization	%	5	-	$ 3,900
				Subtotal (rounded)	$ 82,000
	Contingency	%	30	-	$ 24,600
				Subtotal (rounded)	$ 107,000
	Engineering and CMS	%	25	-	$ 26,750
				Project Total Cost (rounded):	**$ 134,000**

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-14: Providence Future Infrastructure Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
	10-inch new pipe	LF	$ 150	2,000	$ 300,000
	Manhole 48-inch	EA	$ 4,500	7	$ 31,500
	Highway boring	LF	$ 600	160	$ 96,000
	Soil restoration	LF	$ 5	1,840	$ 9,200
	Lift station, 375 gpm	EA	$ 350,000	1	$ 350,000
	6-inch force main	LF	$ 60	1,300	$ 78,000
				Subtotal (rounded)	$ 865,000
	Mobilization	%	5	-	$ 43,250
				Subtotal (rounded)	$ 909,000
	Contingency	%	30	-	$ 272,700
				Subtotal (rounded)	$ 1,182,000
	Engineering and CMS	%	25	-	$ 295,500
	Easement	AC	$ 30,000	1.63	$ 48,800
				Project Total Cost (rounded):	**$ 1,527,000**

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-15: Chehalem Drive Future Infrastructure and Lift Station Displacement Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
Phase 1 (20-year)					
	18-inch new pipe	LF	$ 185	2,000	$ 370,000
	10-inch new pipe	LF	$ 150	1,300	$ 195,000
	Bridge crossing	EA	$ 135,000	1	$ 135,000
	Manhole 48-inch	EA	$ 4,500	11	$ 49,500
	Roadway restoration (full lane)	LF	$ 60	3,300	$ 198,000
				Subtotal (rounded)	$ 948,000
	Mobilization	%	5	-	$ 47,400
				Subtotal (rounded)	$ 996,000
	Contingency	%	30	-	$ 298,800
				Subtotal (rounded)	$ 1,295,000
	Engineering and CMS	%	25	-	$ 323,750
				Phase 1 Cost (rounded):	**$ 1,619,000**
Phase 2 (buildout)					
	12-inch new pipe	LF	$ 160	1,400	$ 224,000
	8-inch new pipe	LF	$ 135	900	$ 121,500
	Manhole 48-inch	EA	$ 4,500	8	$ 36,000
	Roadway restoration (full lane)	LF	$ 60	2,300	$ 138,000
				Subtotal (rounded)	$ 520,000
	Mobilization	%	5	-	$ 26,000
				Subtotal (rounded)	$ 546,000
	Contingency	%	30	-	$ 163,800
				Subtotal (rounded)	$ 710,000
	Engineering and CMS	%	25	-	$ 177,500
				Phase 2 Cost (rounded):	**$ 888,000**
Phase 3 (Chehalem and Creekside LS displacement)					
	15-inch new pipe	LF	$ 170	500	$ 85,000
	12-inch new pipe	LF	$ 160	6,300	$ 1,008,000
	8-inch new pipe	LF	$ 135	1,900	$ 256,500
	Bore (creek crossing)	LF	$ 600	100	$ 60,000
	Manhole 48-inch	EA	$ 4,500	29	$ 130,500
	Roadway restoration (full lane)	LF	$ 60	700	$ 42,000
	Soil restoration	LF	$ 5	8,000	$ 40,000
	Rock Allowance	LS	$ 300,000	1	$ 300,000
	Lift station demolition/removal (including building)	LS	$ 20,000	1	$ 20,000
	Lift station demolition/removal (no building)	LS	$ 10,000	1	$ 10,000
				Subtotal (rounded)	$ 1,952,000
	Mobilization	%	5	-	$ 97,600
				Subtotal (rounded)	$ 2,050,000
	Contingency	%	30	-	$ 615,000
				Subtotal (rounded)	$ 2,665,000
	Engineering and CMS	%	25	-	$ 666,250
	Environmental Permitting and Mitigation	LS	$ 50,000	1	$ 50,000
	Easement	AC	$ 30,000	3.67	$ 110,200
				Phase 3 Cost (rounded):	**$ 3,492,000**
				Project Total Cost (rounded):	**$ 5,999,000**

Note: See Appendix K, Addendum Riverfront Master Plan (Adopted 5/3/21)

Table E-16: Riverfront Future Infrastructure and Lift Station Displacement Cost Estimate

	Item	Unit	Unit Price	Quantity	Cost
Phase 1 (20-year)					
	18-inch pipe replacement	LF	$ 185	1,500	$ 277,500
	8-inch new pipe	LF	$ 135	3,400	$ 459,000
	Re-connect laterals	EA	$ 500	15	$ 7,500
	Re-connect manholes	EA	$ 1,500	5	$ 7,500
	Manhole 48-inch	EA	$ 4,500	12	$ 54,000
	Roadway restoration	LF	$ 30	3,900	$ 117,000
	Soil restoration	LF	$ 5	1,000	$ 5,000
	Lift station, 950 gpm	EA	$ 450,000	1	$ 450,000
	8-inch force main	LF	$ 70	350	$ 24,500
				Subtotal (rounded)	$ 1,402,000
	Mobilization	%	5	-	$ 70,100
				Subtotal (rounded)	$ 1,473,000
	Contingency	%	30	-	$ 441,900
				Subtotal (rounded)	$ 1,915,000
	Engineering and CMS	%	25	-	$ 478,750
	Easement	AC	$ 30,000	0.57	$ 17,100
				Phase 1 Cost (rounded):	**$ 2,411,000**
Phase 2 (Charles and Andrew LS displacement)					
	8-inch new pipe	LF	$ 135	3,200	$ 432,000
	Manhole 48-inch	EA	$ 4,500	11	$ 48,000
	Bore (creek crossing)	LF	$ 600	100	$ 60,000
	Bore (railroad crossing)	LF	$ 600	100	$ 60,000
	Roadway restoration	LF	$ 30	600	$ 18,000
	Soil restoration	LF	$ 5	2,600	$ 13,000
	Lift station demolition/removal (no building)	LS	$ 10,000	2	$ 20,000
				Subtotal (rounded)	$ 651,000
	Mobilization	%	5	-	$ 32,550
				Subtotal (rounded)	$ 684,000
	Contingency	%	30	-	$ 205,200
				Subtotal (rounded)	$ 890,000
	Engineering and CMS	%	25	-	$ 222,500
	Environmental Permitting and Mitigation	LS	$ 165,000	1	$ 165,000
	Easement	AC	$ 30,000	1.47	$ 44,100
				Phase 2 Cost (rounded):	**$ 1,322,000**
				Project Total Cost (rounded):	**$ 3,733,000**