City of Battle Ground, Washington

General Sewer Plan

FINAL DRAFT

March 2011
WE #1195A

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3/30/11

This plan revision completed in March 2011 includes revisions to "Appendix H – Wastewater Treatment and Effluent Disposal" and Section 8 – Regional and Local Treatment Facility Assessment as requested by the Washington Department of Ecology. Other minor changes include updates to Table 1.1 – 20-Year Collection System Cost Estimates, elimination of references to "Wastewater Facility Plan" in Sections 1 and 2, and updated Salmon Creek Treatment Plant capacity allocations in Sections 4 and 5. No changes were made to planning assumptions, implementation years, or to the collection system to reflect the current system. This revision remains a snapshot of the previous June 2009 FINAL DRAFT.

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City of Battle Ground
General Sewer Plan

Table of Contents

SECTION 1 – EXECUTIVE SUMMARY

1.1 Background 1-1
1.2 Study Area 1-1
1.3 Existing Sewerage System 1-1
1.4 Proposed Sewer Plan 1-1
1.5 Capital Improvement Plan 1-2

SECTION 2 – INTRODUCTION

2.1 Background 2-1
2.2 Authorization 2-1
2.3 Study Purpose 2-1
2.4 Scope 2-1

SECTION 3 – GENERAL INFORMATION

3.1 Study Area 3-1
3.2 Environmental Conditions 3-1
Topography 3-1
Climate 3-2
Soils 3-2
Groundwater 3-2
Surface Water 3-2
3.3 Land Use 3-4
3.4 Public Water System 3-4

SECTION 4 – EXISTING FACILITIES

4.1 History of the Sewerage System 4-1
4.2 Current Service Area 4-2
4.3 Collection System 4-4
Description 4-4
Collection System Capacity Evaluation 4-5
4.4 Treatment and Disposal Facilities 4-6
Description 4-6
4.5 Transmission System Facilities 4-7
Transmission Pumping Facilities 4-7
Force Main 4-8

SECTION 5 – PLANNING CRITERIA AND SEWERAGE SYSTEM REGULATIONS

5.1 General Considerations 5-1
5.2 Planning Period 5-1
5.3 Service Area 5-1
5.4 Collection System Design Criteria 5-1
5.5 Collection System Sizing Criteria 5-2
5.6 Treatment and Disposal Planning Criteria 5-2
5.7 Meadow Glade Service Area Planning Issues 5-2

SECTION 6 – EXISTING AND PROJECTED SEWER FLOWS

6.1 20-Year Planning Area and Land Use Projections 6-1
6.2 Population Projections 6-1
20-Year Population and EDU Projections 6-1
50-Year Land-Use, Population and EDU Projections 6-3
6.3 Existing Flow 6-3
6.4 Commercial and Industrial Wastewater 6-4
6.5 Infiltration and Inflow (I&I) 6-5
Historical Infiltration and Inflow Reduction Programs 6-6
Evaluation of Excessive Infiltration and Inflow Against EPA Benchmarks 6-7
Conclusions Regarding Infiltration and Inflow 6-9
6.6 Flow Projections 6-12

SECTION 7 – COLLECTION SYSTEM EVALUATION

7.1 Overview of Evaluation Process 7-1
7.2 Layout of Proposed Collection System Improvements 7-1
7.3 Basin EDU Allocation 7-2
Allocation of Existing EDUs 7-2
Allocation of Buildout EDUs 7-2
7.4 Modeling Assumptions 7-2
7.5 Existing Sewer System Evaluation 7-3
East Battle Ground Sewer Subsystem 7-3
West Battle Ground Sewer Subsystem 7-4
The Cedars Sewer Subsystem 7-7
Existing Collection System Summary 7-7
7.6 Capacity, Management, Operations and Maintenance (CMOM) Regulations 7-7
Status of CMOM Regulations 7-8
Implication for the City of Battle Ground 7-9
7.7 Proposed Collection System Improvements 7-9
West/Meadow Glade Service Area 7-11
Northwest Service Area 7-13
Northeast Service Area 7-15
Southeast Service Area 7-17

SECTION 8 – REGIONAL AND LOCAL TREATMENT FACILITY ASSESSMENT

8.1 Treatment and Disposal System Assessment Overview 8-1
8.2 Existing Transmission System 8-1
Headworks 8-2
Transmission (McClure) Pump Station 8-2
Equalization and Surge Basins 8-2
Force Main 8-2
Sulfide Control Facility 8-2
8.3 Regional System Evaluation 8-3

SECTION 9 – IMPLEMENTATION AND FINANCING

9.1 General 9-1
9.2 Institutional Responsibility 9-1
9.3 Implementation Schedule 9-1
9.4 Funding Options for Capital Improvements 9-4
Local Improvement District (LID) 9-4
Bonds 9-4
Connection Charges 9-5
Revolving Loan Fund Program 9-5
Developer Financing 9-5
State and Federal Funding Programs 9-5
9.5 Policy Issues Associated with Financing 9-6
Policy Issue #1 – Paying the Cost of Growth 9-6
Policy Issue #2 – Temporary Pump Stations 9-7
9.6 Funding Capital Facilities 9-8
9.7 Financing System Operation and Maintenance 9-8

SECTION 10 – ENVIRONMENTAL ASSESSMENT

10.1 General 10-1
10.2 SEPA Requirements 10-1
10.3 Comprehensive Growth Management Plan EIS 10-1

TABLES

Table 1.1 – 20-Year Collection System Cost Estimates 1-2
Table 1.2 – 6-Year Capital Improvements Summary 1-5
Table 4.1 – Sewage Pump Station Data Summary 4-4
Table 4.2 – Transmission Pump Station Pump Summary 4-7
Table 6.1 – Population and EDU Projections 6-2
Table 6.2 – Battle Ground 2000-2006 Influent Wastewater Flows 6-3
Table 6.3 – Battle Ground 2000-2006 Per Capita Flows 6-4
Table 6.4 – 2000-2006 Wet Weather Flows, 7-14 Day Low Rainfall Periods 6-7
Table 6.5 – 2000-2006 Maximum Flows 6-9
Table 6.6 – Battle Ground Population Equivalent Per Capita Flow Projections 6-12
Table 6.7 – Battle Ground Projected Wastewater Flows 6-13

Table 6.8 – Meadow Glade / Hockinson Flow Projections 6-14
Table 6.9 – Meadow Glade/Hockinson EDU & Combined Flow Projections 6-14
Table 6.10 – Transmission Main Flow Projections 6-15
Table 9.1 – Proposed Project Implementation Schedule 9-2

FIGURES

Figure 3.1 – Vicinity Map..... 3-3
Figure 3.2 – Comprehensive Plan Map..... 3-5
Figure 3.3 – Urban Growth Area Land Use Map 3-6
Figure 3.4 – Existing Water System Map..... 3-7
Figure 4.1 – Existing Sewer System..... 4-3
Figure 6.1 – 2006 Average Daily Influent Composition 6-5
Figure 6.2 – I&I Rehabilitation Areas 6-8
Figure 6.3 – Rainfall Data..... 6-11
Figure 7.1 – Proposed Collection System Improvements..... 7-10
Figure 7.2 – Proposed Collection System Improvements, West/Meadow Glade Subarea.. 7-12
Figure 7.3 – Proposed Collection System Improvements, Northwest Subarea 7-14
Figure 7.4 – Proposed Collection System Improvements, Northeast Subarea 7-16
Figure 7.5 – Proposed Collection System Improvements, Southeast Subarea 7-18

APPENDIXES

Appendix A – Collection System Evaluation

Figure A1 – Sewer Service Area Basin Map
Figure A2 – Collection System Working Map
Figure A3 – Collection System Schematic
Figure A4 – Aerial Working Map
Figure A5 – Existing Sewer System

Appendix B – Sewer System Modeling

B.1 Overview of the Sewer Model B-1
B.2 Existing Collection System B-1
Collection System.....B-1
Sewer Service Areas.....B-3
Land Use Areas.....B-3
Model Calibration.....B-6
Existing Model Run.....B-7
B.3 2026 Collection System B-7
Collection System.....B-7
Sewer Service Areas.....B-9
Land Use Areas.....B-9
2026 Model Run.....B-13
B.4 Buildout Collection System B-14
Collection System.....B-14
Sewer Service Areas.....B-14

Land Use Areas B-15
Buildout Model Run B-17

Figures:

Figure B1 – Existing Collection System Model B-2
Figure B2 – Existing Sewer Service Areas B-4
Figure B3 – Residential Diurnal Curve B-6
Figure B4 – 2026 & Buildout Collection System Model B-8
Figure B5 – 2026 & Buildout Sewer Service Areas B-10

Tables:

Table B1 – Pump Station Data B-3
Table B2 – Existing Land Use Area Data B-5
Table B3 – 2026 Pump Station Data B-9
Table B4 – 2026 Land Use Area Data B-11
Table B5 – Buildout Pump Station Data B-14
Table B6 – Buildout Land Use Area Data B-15

Existing Collection System Model
2026 Collection System Model
Buildout Collection System Model

Appendix C – Odor Control Studies

"Battle Ground Odor Control & Lagoon Assessment", Technical Memo from HDR dated May 2, 2005
"Battle Ground Surge Basin Facility Odor Control Study", Draft Technical Memo from HDR dated September 26, 2005

Appendix D – Miscellaneous Information

Figure 2-5 from Wastewater Engineering Treatment, Disposal and Reuse, Metcalf & Eddy Inc., Third Edition
Transmission System Hydraulic Profile

Appendix E – Interlocal Agreements

Contract Between Hazel Dell Sewer District and the City of Battle Ground for Sewage Treatment Capacity and Payment
Modification of Interlocal Agreements Among Clark County, the Hazel Dell Sewer District, and the City of Battle Ground
Addendum to the March 28th, 1995, Joint Contract Between the City of Battle Ground and the Hazel Dell Sewer District

Appendix F – Environmental Assessment

Environmental Checklist
EIS Summary

Appendix G – References

Appendix H – Wastewater Treatment and Effluent Disposal

H.1 Existing Wastewater Handling H-1
H.2 Alternatives H-4
Alternative Descriptions and Assumptions H-4
Alternatives Project Cost H-6
Development of Recommended Alternative H-9

Figures:

Figure H1 – Battle Ground and Clark County Transmission System Capabilities..... H-2
Figure H2 – Schematic of Battle Ground and Clark County Transmission System Purchase Capacity H-3

Tables:

Table H1 – SCTP Alternative H-7
Table H2 – City of Vancouver Alternative 1: St. Johns Road..... H-7
Table H3 – City of Vancouver Alternative 2: Klineline..... H-8
Table H4 – WRF Local Treatment H-8
Table H5 – Comparison of Capital Costs H-8
Table H6 – Planned Expansions to the SCTP..... H-10
Table H7 – Battle Ground 24-Inch Force Main..... H-12

SECTION 1

EXECUTIVE SUMMARY

1.1 BACKGROUND

State law (WAC 173-240-050) requires cities to have an adopted general sewer plan addressing all planned wastewater system upgrades or expansion, or an approved engineering report for each individual project proposed. The City of Battle Ground adopted a general sewer plan in 2005 [1]. This document updates that plan.

1.2 STUDY AREA

The study area generally includes the area within and adjacent to the existing city limits, plus the future growth area which is primarily to the north, south, and west of the existing Urban Growth Area. The growth area is shown in Figure 3.3 in Section 3.

1.3 EXISTING SEWERAGE SYSTEM

The existing sewer system consists of a network of gravity sewers along with eleven pump stations. This network currently discharges to the McClure Pump Station, which also receives wastewater from the Meadow Glade and Hockinson pressure sewer systems, which are owned and operated by the Clark Regional Wastewater District (CRWWD). From there, the wastewater is pumped to the Salmon Creek Wastewater Management System where it is conveyed to Clark County's Salmon Creek Wastewater Treatment Plant.

1.4 PROPOSED SEWER PLAN

This General Sewer Plan was prepared primarily for the wastewater collection system. Although general information is provided for the treatment plant, it is very conceptual. Existing and future wastewater transmission, treatment, and disposal are addressed in further detail in Appendix H.

Proposed collection system improvements include approximately 6.8 miles of gravity sewer ranging in size from 8-inch to 30-inch diameter, the upsizing of three existing pump stations, the construction of five new pump stations, and approximately 1.7 miles of force main ranging in size from 4-inch to 20-inch diameter.

1.5 CAPITAL IMPROVEMENT PLAN

The following capital improvement plan identifies the improvements proposed for the 20-year planning period. Gravity sewer, pump station and force main cost estimates are based on 2007 construction dollars. Wastewater transmission and treatment cost estimates are based on 2011 construction dollars.

Table 1.1
20-YEAR WASTEWATER SYSTEM COST ESTIMATES

Improvement Designation	Length (Ft)	Size (In) [a]	Facility Cost ($) [b]	Priority
Gravity Sewers				
South West/Meadow Glade Service Area				
S12-1	2200	12	276,000	1
S12-2	1700	8	268,000	1
S13-1	2600	24	1,049,000	3
S13-2	2600	21	968,000	3
S13-3	1900	15	259,000	2
S13-4	1350	15	184,000	1
S13-5	5300	15	722,000	2
S31-1	1275	10	219,000	1
Northwest				
S6-1	2950	24	833,000	1
S10-1	2550	21	668,000	2
S10-2	2550	18	389,000	2
S10-3	1300	18	301,000	2
S10-4	1400	18	324,000	1
S10-5	1350	18	312,000	1
S10-6	2675	15	548,000	3
S11-1	4700	18	1,352,000	2
S11-2	1225	12	379,000	2
S21-1	1700	15	526,000	1
S21-2	1400	15	287,000	1
S31-2	700	8	111,000	1
T2-2:T2-11	2150	12	269,000	2
T2-11:T2-16	1675	10	197,000	2
PS7-ALT	1650	12	307,000	3

Improvement Designation	Length (Ft)	Size (In) [a]	Facility Cost ($) [b]	Priority
Northeast				
S5-1	1350	15	184,000	1
S5-2	1325	15	180,000	1
S5-3	1900	15	389,000	1
S5-4	2350	8	600,000	1
S5-5	2150	8	549,000	1
S5-6	1350	8	367,000	2
S20-1	1700	15	526,000	2
S2-1	1750	12	503,000	1
S2-2	1800	10	518,000	1
I5-1	1350	10	389,000	1
S4-1	1900	21	326,000	1
S4-2	3500	21	601,000	3
Southeast				
S14-1	475	24	192,000	2
S14-2	1050	18	355,000	1
S14-3	2800	15	867,000	2
S15-1	3400	15	1,052,000	3
S15-2	1900	12	546,000	3
S16-1	3200	27	1,331,000	2
S16-2	1950	24	787,000	3
S16-3	2800	21	1,042,000	3
S16-4	2850	12	819,000	3
S16-5	2300	15	712,000	2
S16-6	2050	12	589,000	1
S16-7	2800	10	762,000	3
PS9-ALT	2050	8	524,000	3
Gravity Sewer Subtotal			**$25,458,000**	
Pump Stations/Force Mains				
FMPS2	3800	20	1,175,000	2
PS-T2			500,000	1
FM2	3050	6	369,000	1
PS-T10			1,300,000	1
FM10-1	2900	12	514,000	1

Improvement Designation	Length (Ft)	Size (In) [a]	Facility Cost ($) [b]	Priority
FM10-2	3370	12	593,000	1
FM10-3	3050	12	838,000	2
FM10-4	450	12	124,000	2
PS-T13			1,550,000	3
FM13	7150	12	1,306,000	3
PS-T15			1,450,000	2
FM-T15	3050	12	555,000	2
PS-T16			1,250,000	2
FM16	7150	14	1,852,000	2
PS-T20			450,000	3
FM20	850	4	116,000	3
PS/FM Total			**$13,942,000**	
20 Year Total			**$39,011,000**	
Wastewater Transmission and Treatment				
Purchase 2.76 MGD Additional Capacity			18,000,000	
Expand Flow EQ Basin / Increase PS Capacity			5,000,000	
Parallel Force Main			16,000,000	
Klineline Pump Station Improvements			2,000,000	
20 Year Total			**$41,000,000**	

Notes:

a. Gravity sewer sizing based on minimum slope, force main at 6-ft/sec velocity.

b. Gravity sewer, pump station and force main costs in 2007 dollars. Does not include 40% for engineering, tax and contingency.

Table 1.2
6 -YEAR CAPITAL IMPROVEMENTS SUMMARY

Proposed Construction Year	Capital Improvement	Cost ($)
2007	General Sewer Plan and Capital Facilities Plan	100,000
	Sewer Main S5-1 – 1350’ of 15-inch gravity sewer	184,000
	Sewer Main S5-2 – 1325’ of 15-inch gravity sewer	180,000
	Sewer Main S5-3 – 1900’ of 15-inch gravity sewer	389,000
	Sewer Main S5-4 – 2350’ of 15-inch gravity sewer	600,000
	Sewer Main S5-5 – 2150’ of 15-inch gravity sewer	549,000
2008	Sewer Main S10-5 – 1350’ of 18-inch gravity sewer	312,000
	Sewer Main S10-4 – 1400’ of 18-inch gravity sewer	324,000
	Sewer Main S21-1 – 1700’ of 15-inch gravity sewer	526,000
	Sewer Main S21-2 – 1400’ of 15-inch gravity sewer	287,000
	Sewer Main I5-1 – 1350’ of 10-inch gravity sewer	389,000
2009	Sewer Main S12-1 – 2200’ of 12-inch gravity sewer	276,000
	Sewer Main S12-2 – 1700’ of 8-inch gravity sewer	268,000
	Sewer Main S4-1 – 1900’ of 21-inch gravity sewer	326,000
	Force Main FM10-3 – 3050’ of 12-inch force main	838,000
	Force Main FM10-4 – 450’ of 12-inch force main	124,000
2010	Sewer Main S31-1 – 1275’ of 10-inch gravity sewer	219,000
	Sewer Main S2-1 – 1750’ of 12-inch gravity sewer	503,000
	Pump Station PS-T2 – 340 gpm capacity	500,000
	Force Main FM2 – 3050’ of 6-inch force main	369,000
	Trunk 2 Sewer – pipe bursting 1675’ of existing 8” sewer	197,000
2011	Sewer Main S31-2 – 700’ of 8-inch gravity sewer	111,000
	Sewer Main S2-2 – 1800’ of 10-inch gravity sewer	518,000
	Sewer Main S14-2 – 1050’ of 18-inch gravity sewer	355,000
	Sewer Main S16-6 – 2050’ of 12-inch gravity sewer	589,000
	WRF Phase 1 Improvements	24,800,000
2012	Sewer Main S13-4 – 1350’ of 15-inch gravity sewer	184,000
	Sewer Main S6-1 – 2950’ of 24-inch gravity sewer	833,000
	Pump Station PS-T10 – 4,090 gpm capacity	1,300,000

Proposed Construction Year	Capital Improvement	Cost ($)
2012	Force Main FM10-1 – 2,900’ of 16-inch force main	514,000
	Force Main FM10-2 – 3,370’ of 12-inch force main	593,000

SECTION 2

INTRODUCTION

2.1 BACKGROUND

The City of Battle Ground adopted a general sewer plan in 2005 [1]. Rapid growth since completion of that plan has necessitated an update. This document provides that update.

2.2 AUTHORIZATION

In March 2006, the City of Battle Ground authorized Wallis Engineering to complete this General Sewer Plan.

2.3 STUDY PURPOSE

The objective of this General Sewer Plan is to develop comprehensive long-range plans for the orderly development of adequate wastewater collection and treatment facilities for the City of Battle Ground's Urban Growth Area. The Plan has been written to meet the requirements of the Washington Administrative Code (WAC) 173-240-050(3), Requirements for General Sewer Plans.

2.4 SCOPE

Included within the scope of the General Sewer Plan are the following objectives:

1. Evaluation and review of the existing sewers.

2. Population determination and projections for the service area as defined by the Battle Ground Urban Growth Area.

3. Forecast of future flows and wasteloads.

4. Establishment of planning criteria for sewer collection.

5. Determination of a general plan for sewer collection facilities required to satisfy existing and future needs of the service area.

6. Development of cost estimates for proposed sewer facilities identified in the General Sewer Plan.

7. Addressing the financial and administrative issues related to the Plan and its implementation.

8. Providing general planning information to assist the City in finalizing growth management planning efforts.

SECTION 3

GENERAL INFORMATION

3.1 STUDY AREA

Located approximately 15 miles northeast of Vancouver, Washington, the City of Battle Ground and its UGA are located between the East Fork of the Lewis River and Salmon Creek. The study area is comprised of the city proper and the undeveloped areas surrounding the City, which includes rural housing, forest, and farms. Figure 3.1 represents the vicinity map for the City.

The study area includes the area within the existing City of Battle Ground incorporated city limits and the Urban Growth Area (UGA) designated in the *2006 Preferred Urban Growth Area Map* dated October 24, 2006. The UGA was established by Clark County following an extensive comprehensive planning effort completed in conjunction with the City. The UGA utilized in this plan is the preferred "October discussion boundary" used by Clark County during Growth Management Plan Review, plus an additional area identified by the City. Together, these two areas comprise the 2026 UGA.

Likely future UGA expansion areas outside the 20-year boundary have also been identified due to the rapid residential growth rate, which continues to exceed planning estimates. Detailed sewer planning is limited to the currently proposed UGA, with general discussions for areas outside the UGA.

3.2 ENVIRONMENTAL CONDITIONS

TOPOGRAPHY

The topography of the study area is relatively flat, slightly sloping to the south-southwest, with elevations ranging between 270 and 350 feet above Mean Sea Level. Tukes Mountain, located east of the City, provides the only steep slopes in the area. Rising over 600 feet in elevation, a significant portion of Tukes Mountain lies within the UGA.

The Woodin Creek, Salmon Creek, Mill Creek, and Lewis River drainages provide minor topographic relief to the north, south, and west of the City. For further discussion, see *Surface Water* later in this section.

CLIMATE

Battle Ground has a mild climate typical of the valleys between the Coast Range and Cascade Range in Oregon and Washington. Precipitation averages approximately 52 inches annually, most of which falls in a 6-month period, November through April.

SOILS

Based on the Soil Survey of Clark County, Washington [3], Dollar Loam and Hockinson Loam represent the majority of soil conditions within the study area. These soils, developed in deposits of old Columbia River alluvium, are characterized by their low permeability and moderate to high corrosivity. These soil characteristics are conducive to the development of wetlands, which are common in the Battle Ground area.

Tukes Mountain consists of soils in the Olympic Series. These soils are well-drained, gently sloping to moderately steep soils, underlain by basalt bedrock at a depth of 40 inches or more and are characterized by their moderately slow permeability and moderate to high corrosivity. These soils were formed in weathered igneous lava of the Boring Lava upwelling that formed Tukes Mountain.

GROUNDWATER

The groundwater resources in the Battle Ground area are generally good within the Pleistocene Alluvial Deposits, the Upper Troutdale formation, and the Sandy River Mudstone formation. The Upper Troutdale formation provides the bulk of the high quality water in the area, with a static water table near the 250-foot elevation.

Battle Ground is unique as compared to most other cities in the fact that groundwater (perched or otherwise), is shallow for much of the wet weather months. The City is located largely in an area that originally had significant wetlands. This has great significance relative to the City's problems with infiltration and inflow. Battle Ground's sewers, both main line and house laterals, are submerged for extended lengths of time during the wet weather months. In cases such as this, sewers are prone to high levels of infiltration, even if they are in relatively good condition. Another consequence of high groundwater is that during periods of wet weather, water often ponds in yards and under homes, which provides incentives for homeowners to make illegal connections to house sewers for the purpose of drainage.

SURFACE WATER

The main surface water features in the Battle Ground UGA are Woodin Creek and Salmon Creek. Woodin Creek flows north-south through the City and into Salmon Creek. Salmon Creek is located in the southeast corner of the UGA and flows from east to west, eventually discharging into the Columbia River. Mill Creek is located in the western portion of the UGA

NORTH

NOT TO SCALE

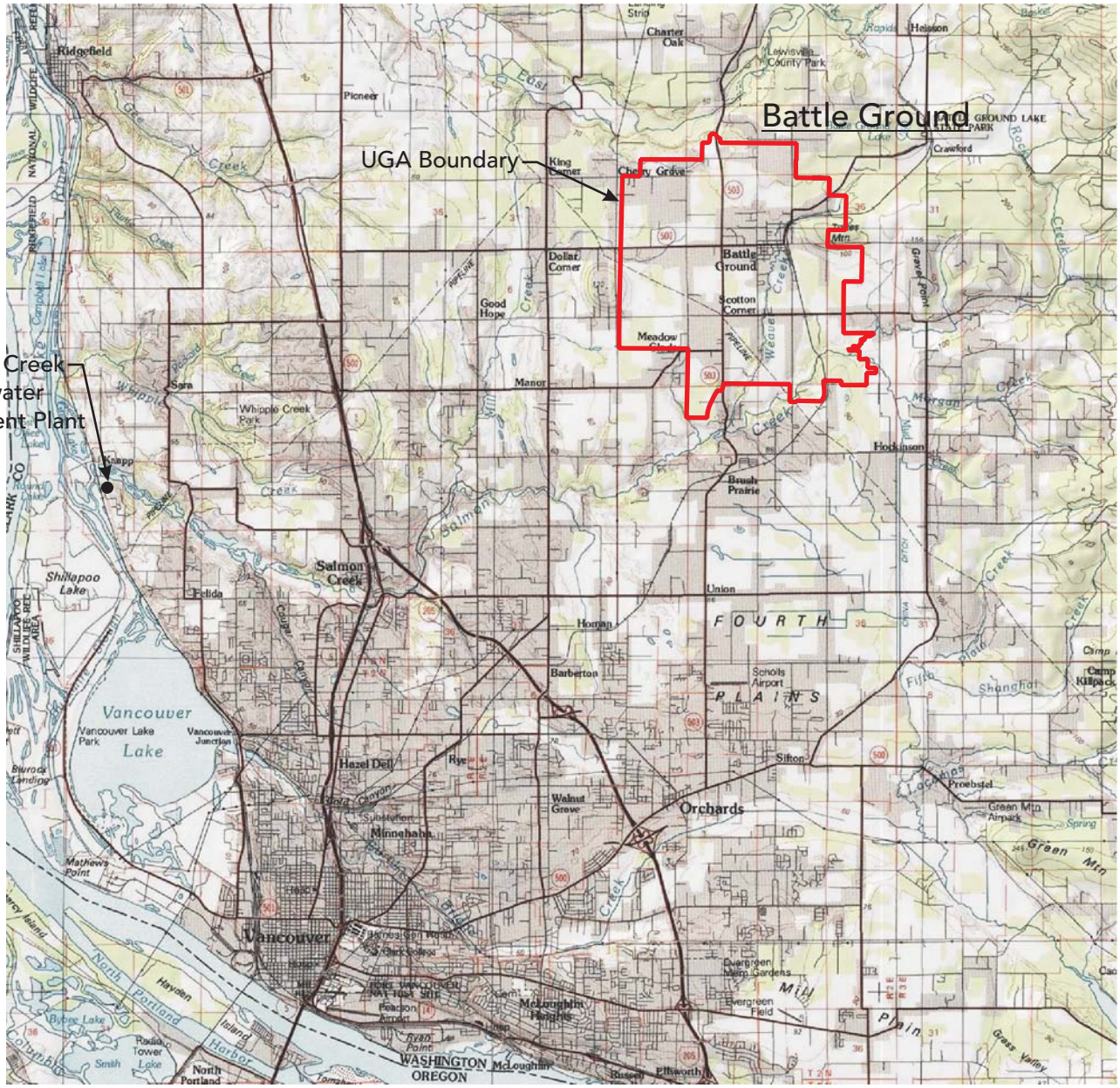

Figure 3.1: Vicinity Map

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and flows to the west. The East Fork of the Lewis River is located less than one mile north of the existing city limits but is outside the Battle Ground UGA.

3.3 Land Use

Land use within the boundaries of the City is established by zoning ordinance. Most of the area is residential. The majority of commercial activity is concentrated in the downtown core area along Main Street and Highway 503. Industrial development is generally located near the railroad tracks east of the commercial business area and in the southeast part of the City. The *2004 Comprehensive Plan* also provides for light industrial development in the southern corner of the UGA adjacent to Highway 503.

Land use within the Battle Ground UGA is addressed in the *2004 Comprehensive Plan*. The 2024 Land Use and UGA are presented in the comprehensive plan in Figure 3.2. The 2024 Land Use and UGA figure has been amended to reflect expected growth by 2026 and is reflected in Figure 3.3. The 2026 planning data was obtained through the City of Battle Ground.

Land use outside Battle Ground's UGA is currently governed by the Clark County Comprehensive Plan.

3.4 Public Water System

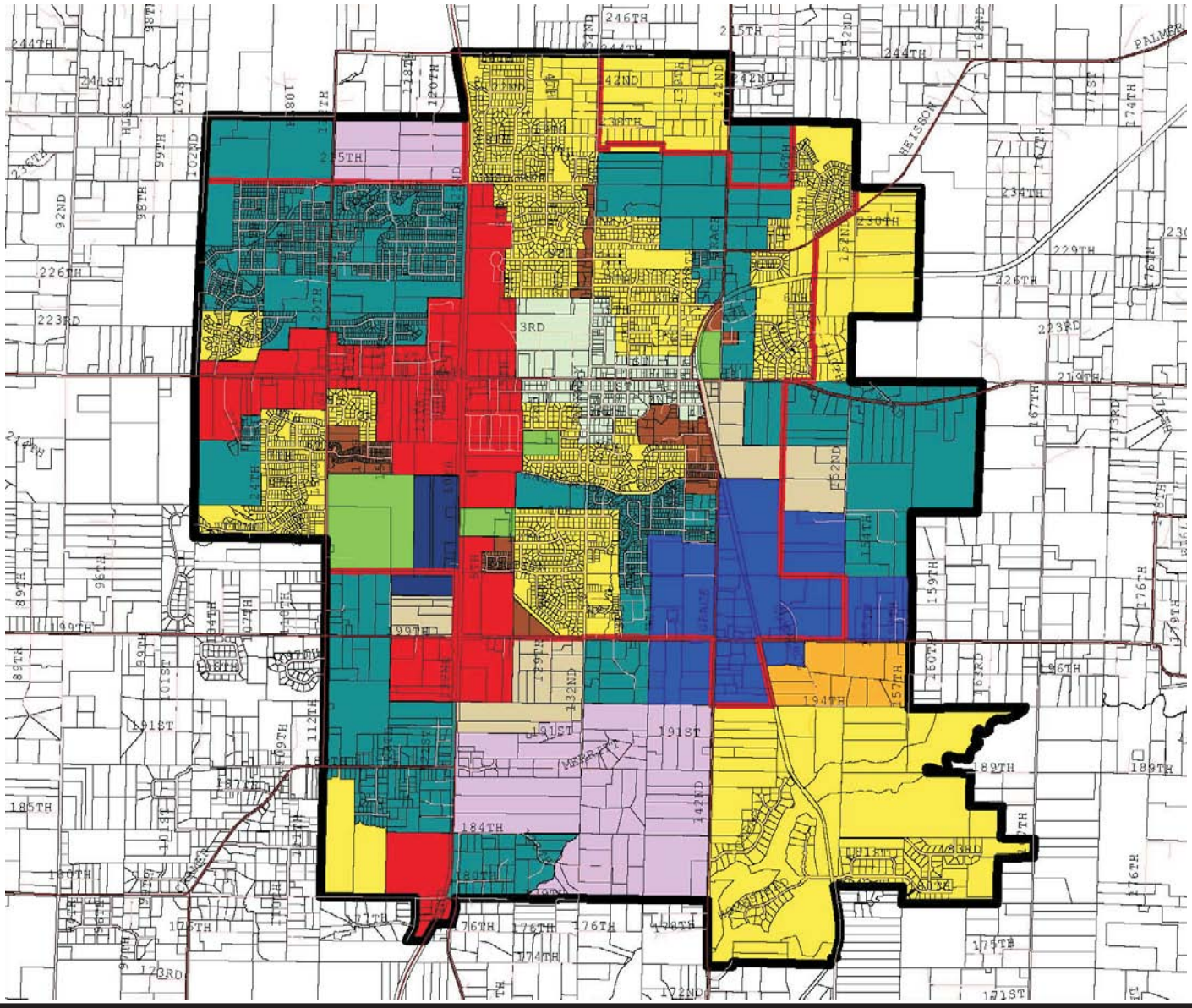
Since 1954, Battle Ground has owned and operated the water system that serves the City. Battle Ground's water system is shown in Figure 3.4. The water source for the system is groundwater obtained from eight production wells. In general, the wells are an excellent source of high quality water. In past years, the City has utilized interties with the Meadow Glade Water District, Clark Public Utilities, and the Battle Ground High School system to supplement their water supply. Treatment in the form of disinfection is provided by chlorination systems.

The distribution system consists of a network of pipelines ranging from 6 to 16 inches in diameter and six water storage reservoirs totaling 3.7 million gallons. Five of the reservoirs are located on Tukes Mountain, at an elevation that can adequately provide gravity service to the majority of the City's residents. The remaining storage reservoir is the Horse Thief Reservoir, which is a ground level tank with a booster pump station to supply water to the system.

The City's water system serves areas currently located outside the existing city limits. Residents in the rural areas surrounding Battle Ground also rely upon private wells for their water supply. Although there have been no detailed studies, there have been no known incidences of groundwater or well contamination problems. The location of the existing wastewater surge lagoon and transmission pump station is also shown in Figure 3.4, which shows the proximity to City wells. No private wells are known in close proximity to the existing wastewater surge lagoon.

NORTH

NOT TO SCALE



KEY

Major Roads
Roads
Final UGA Boundary
Municipal Jurisdiction
Unincorporated
Incorporated

Land use designation.shp
Downtown
Campus Emp
Light Ind
Mixed Use Emp
Mixed Use Res
Park
Regional Center
Urban High
Urban Low
Urban Medium
Airpark

Figure 3.2: Comprehensive Plan Map

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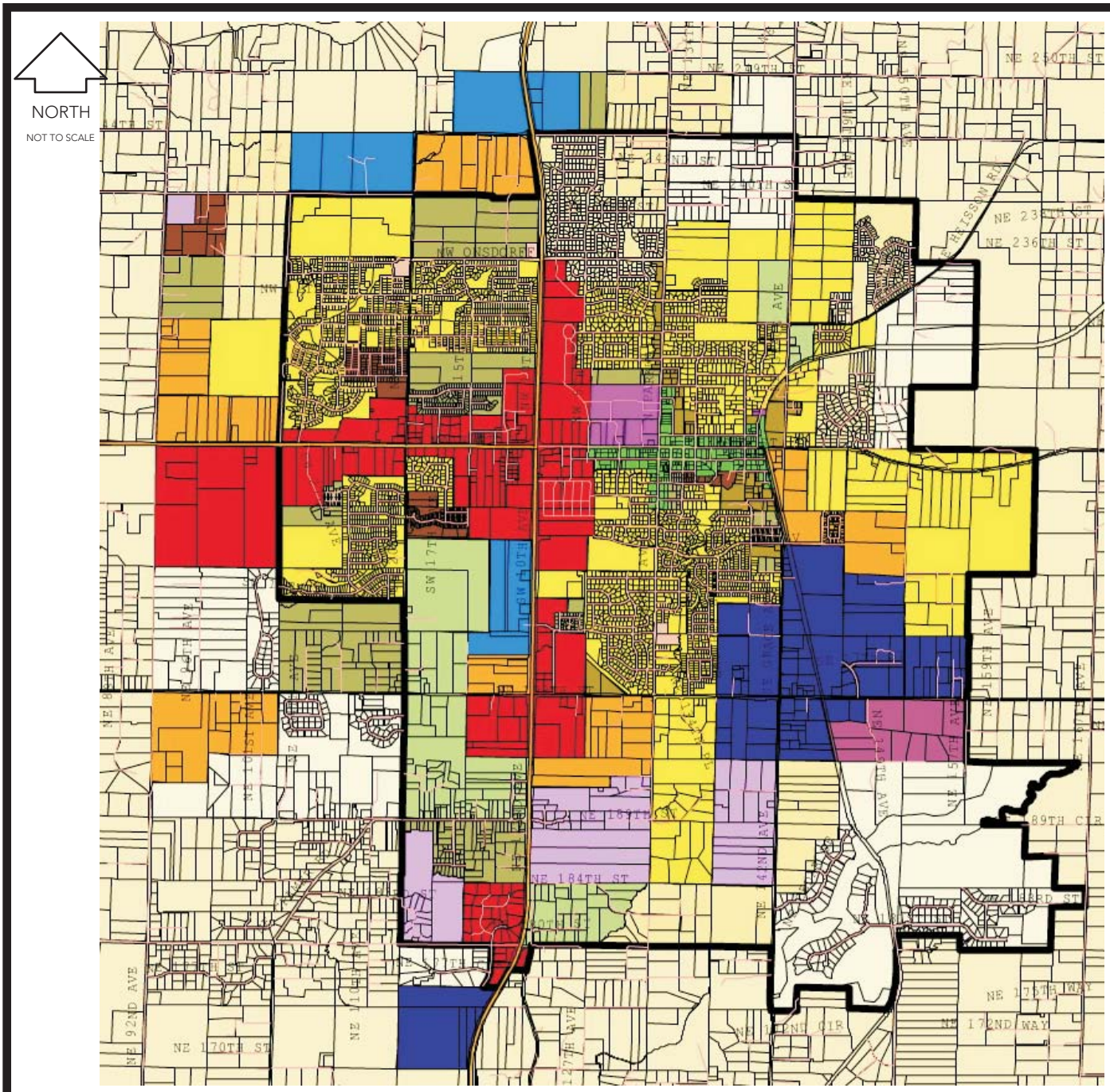

KEY

Major Roads
- State Route
- Interstate
- Arterial
- Roads
- Urban Growth Boundary

Zoning Districts

RC	MU-E	R12
CC	R3	R16
DC	R5	R20
NC	R7	MU-R
EC	R10	A
ML		

Figure 3.3: Urban Growth Area Land Use Map

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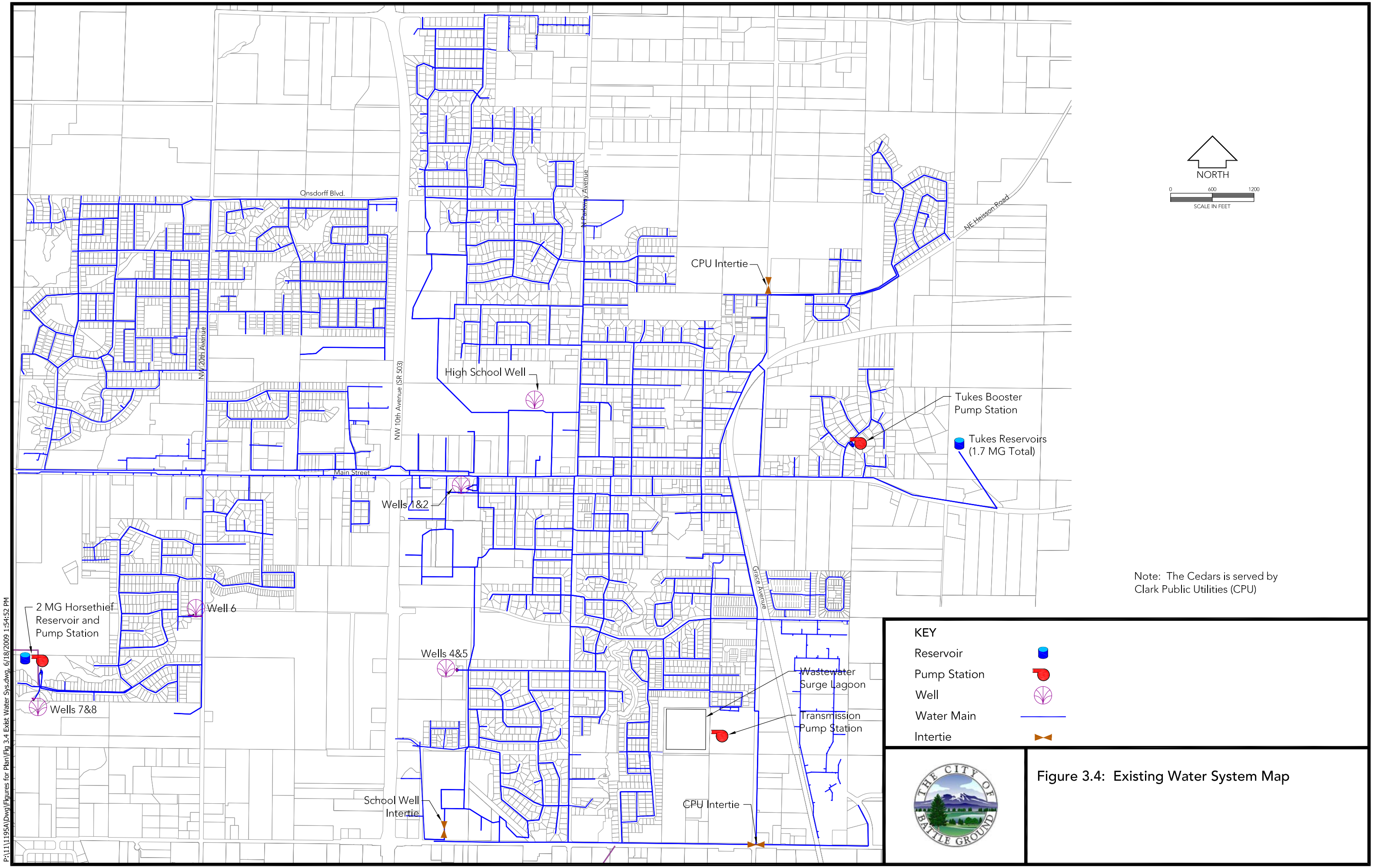

Figure 3.4: Existing Water System Map

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SECTION 4

EXISTING FACILITIES

4.1 HISTORY OF THE SEWERAGE SYSTEM

In 1958 the City of Battle Ground constructed the first portions of its sanitary sewer system, consisting of a collection system and a facultative lagoon. The sanitary sewer system has been expanded and upgraded to accommodate growth since 1958.

The City's treatment facility was upgraded twice following construction of the facultative lagoon in 1958. In 1976, the treatment facility was modified by adding a primary clarifier, rotating biological contactors, a secondary clarifier, and a chlorine contact chamber. The lagoon was utilized for sludge storage and as an overflow basin. The treatment plant was expanded in 1981 with the construction of additional rotating biological contactors, another secondary clarifier, and an expanded chlorine contact chamber. Following the 1981 expansion, the capacity of the treatment plant was 0.77 mgd.

The City's treatment facility discharged into Woodin Creek, a tributary to Salmon Creek. Woodin Creek is small, classified as a Class A stream, and has limited capacity to receive treatment plant effluent. Because of the characteristics of Woodin Creek, the City's waste discharge permit required that the effluent be treated to tertiary standards. Due to the increasing demands on the treatment facility, particularly with respect to hydraulic loading from I&I contributions, violations of the effluent standards were frequent.

Violations of the effluent standards resulted in DOE placing limitations on new sewer connections and requiring the City to evaluate available options for long-term sewer needs. From 1985 to mid-1989 the City was limited to a maximum of 50 equivalent residential sewer connections per year. Between 1989 and July 1992 a total of only 150 additional connections were allowed. After July 1992 a moratorium was placed on new connections to the City sewer system.

In May 1985 the *Infiltration/Inflow, Sewage, Treatment Plant and Receiving Stream Evaluation Report* by Whiteley, Jacobsen, and Associates was completed to evaluate alternatives for the long term sewer needs of the Battle Ground area. The report concluded that the City should discharge treatment plant effluent to the East Fork of the Lewis River. However, with stringent treatment requirements, public opposition, and environmental concerns, this alternative became undesirable. The final preferred alternative was to transport wastewater to the Clark County Salmon Creek Treatment Plant (SCTP). A significant factor in the City's decision to proceed with this option was a proposal by Clark County to sewer the Meadow Glade community with a pressure sewer extending nearly nine miles to the SCTP collection system. Clark County offered Battle Ground the opportunity to pay the cost of oversizing the Meadow Glade Pressure sewer, which thus greatly reduced Battle Ground's buy-in cost. The City opted to abandon its

wastewater treatment plant and construct a pumping station and force main to deliver wastewater flows to the County treatment facility.

An Interlocal Agreement was signed on December 21, 1988, between Clark County and the City of Battle Ground for the construction and operation of the wastewater facilities that would convey Battle Ground's wastewater to Clark County. By April 1993, the new pump station and force main were on-line, and the City's treatment facilities were abandoned or incorporated into the new wastewater transmission system. The moratorium on sewer connections was removed on April 15, 1993.

Since lifting the moratorium in April of 1993, growth has been extremely rapid. A General Sewer Plan was completed in 1995 based on a growth rate forecast at 6% a year. Actual growth far exceeded this estimate, forcing the City in early 1998 to stop accepting new residential land division applications. A sewer plan update was again approved by DOE in 2000 and 2003. These plan updates addressed this surge in population and re-examined impacts to the collection system, regional transmission system, and SCTP capacity allocations.

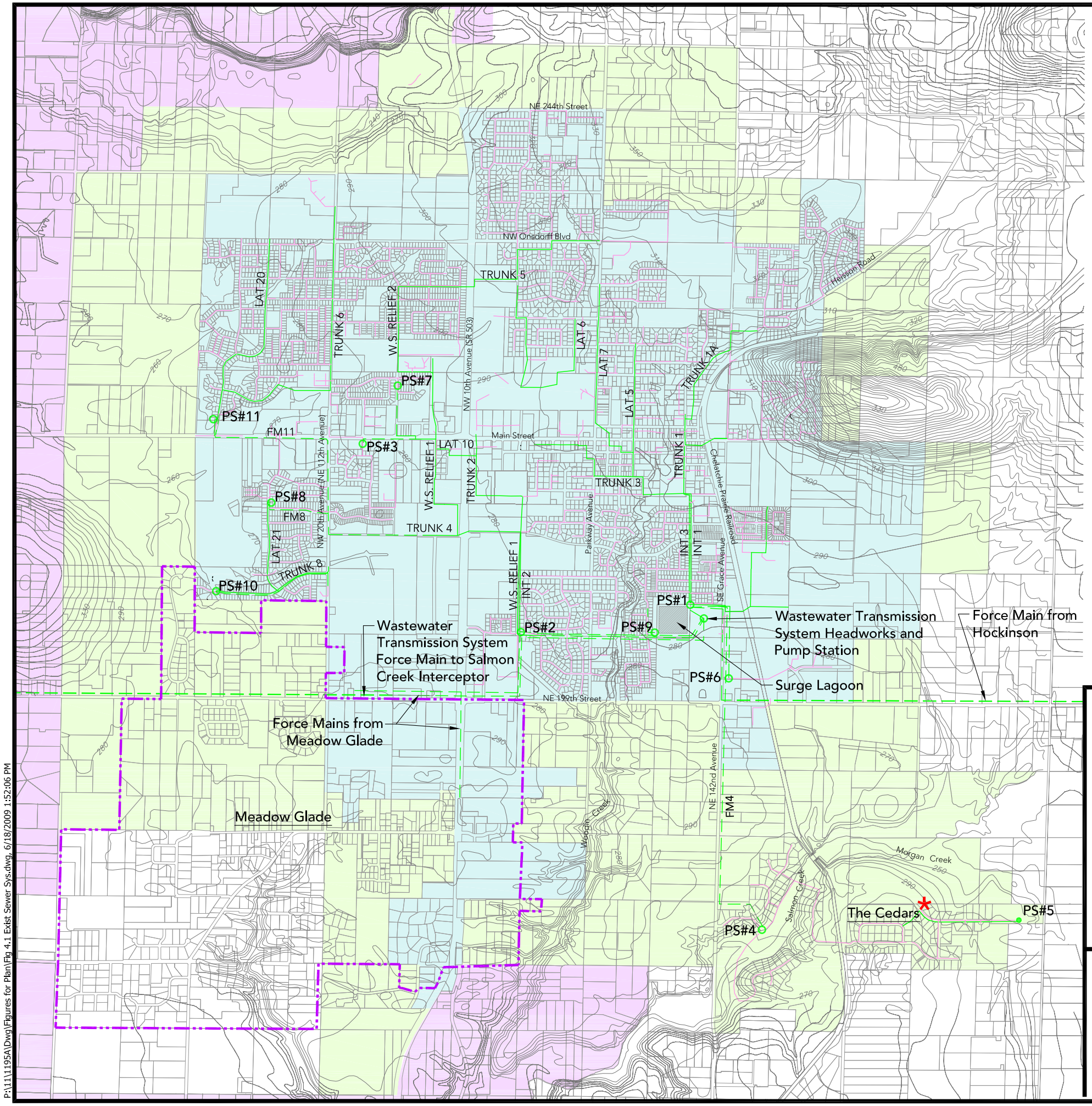
In March 2006 the City of Battle Ground authorized Wallis Engineering to update the General Sewer Plan. This update to the General Sewer Plan is being completed in conjunction with current comprehensive planning efforts.

4.2 Current Service Area

The area served by the City of Battle Ground's sewer system is outlined in the existing sewer system map, Figure 4.1. A more detailed existing collection system map is included in Appendix A, which includes line size information. The existing city limits and UGA boundary, which define the future service area extents for the 20-year planning period, are both shown in Figure 4.1. In the southeast corner of the UGA, outside the current city limits but within the UGA, is the Cedars subdivision. This development consists of housing and a golf course. By agreement, the City operates and maintains the Cedars wastewater collection and pumping facilities. The Cedars is the only area outside the existing city limits that is provided sewer service by the City of Battle Ground.

Two other areas outside the city limits, Meadow Glade and Hockinson, pump wastewater to the City's wastewater transmission system, which conveys it directly to the Salmon Creek Wastewater Management System. Both systems are operated by the Clark Regional Wastewater District (CRWWD). A portion of the Meadow Glade service area is located within the City's UGA. Should this area be annexed in the future, sewer service is assumed to transfer to the City.

As discussed in Section 5, the fact that the Meadow Glade area is served by a type of sewer system incompatible with urban development presents a serious challenge to the City in their effort to provide cost-effective sewer service to their community.



NORTH

NOT TO SCALE

KEY

20-Year Urban Growth Area/ Future Sewer Service Area	Existing Trunk Sewer Line
City Limits	Existing Lateral Sewer Line
Existing Meadow Glade Service Boundary	Existing Force Main
	Existing Pump Station

* Note: The Cedars is currently served by City of Battle Ground, but is outside city limits.

THE CITY OF BATTLE GROUND

Figure 4.1: Existing Sewer System

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4.3 COLLECTION SYSTEM

DESCRIPTION

The City of Battle Ground owns, operates, and maintains over 60 miles of sanitary sewer collection lines and mains.

The majority of the collection system consists of 8-inch diameter pipe with trunk sewers constructed of larger diameter pipe, ranging in size from 10 to 30-inch diameter. A large portion of the system was constructed in 1958 and 1966, and consists of concrete and asbestos cement pipe. More recent sewer construction consists of PVC sewer pipe. A detailed map of the existing collection system is included in Appendix A.

As discussed in Section 3, topography of the sewer service area is relatively flat, generally sloping to the south-southwest. A slight ridge traverses the City creating multiple drainage basins and the need for numerous pump stations to convey flow to the transmission pump station. In all, the collection system utilizes eleven sewage pumping stations and force mains. All pump stations, with the exception of Pump Stations No. 1 and No. 2, are duplex systems, with each pump capable of pumping the design capacity. Pump Stations No. 1 and No. 2 are triplex submersible facilities with equally sized pumps. All pump stations have a back-up power supply in the form of an on-site generator, except for Pump Station No. 6.

Over time, the City has completed several pump station improvement projects; the most recent one being the 2006 reconstruction of Pump Station No. 1. The City has also installed flow meters on all of the pump stations to provide basin specific flow monitoring to assist in the identification of future I&I reduction projects.

Table 4.1 summarizes the data for each pump station. The horsepower and capacities listed in Table 4.1 represent a single pump of the duplex pump stations.

Table 4.1
SEWAGE PUMP STATION DATA SUMMARY

Pump Station No.	Location	Pump (horsepower)	Design Capacity (gpm)	Emergency Generator
1	Treatment Plant	25 Hp	2,700[a] (triplex)	Diesel
2	Gardner	98 Hp	5,200[a] (triplex)	Diesel
3	Battle Ground West	12 Hp	250	Propane
4	Cedars	10 Hp	160	Propane

Pump Station No.	Location	Pump (horsepower)	Design Capacity (gpm)	Emergency Generator
5	Cedars East	Not Available		Propane
6	Industrial	5 Hp	235	None
7	Country Terrace	3 Hp	140	Propane
8	Winchester Ranch	5 Hp	220	Propane
9	Clover Meadows	3 Hp	125	Propane
10	Horse Thief Canyon	3.2 Hp	100	Propane
11	Lewisville Meadows	30 Hp	1,325	Propane

Notes:
a. Variable Speed Pumps

COLLECTION SYSTEM CAPACITY EVALUATION

The capacity of the existing collection system, particularly sections of the original sewers, are greatly influenced by I&I during extended periods of heavy rain when the groundwater level rises to ground level and submerges private sewer laterals. From television inspection, the main line sewers are in good condition. Components of the existing sewer system do surcharge during periods of high rainfall. According to City personnel, historical surcharge areas include the lower reaches of Interceptor 1, three sewers between Pump Station No. 1 and Rasmussen Blvd. Surcharging is also occasionally observed at the Lateral 10 connection to Trunk 2 south of Main Street.

The existing sewer system was hydraulically modeled using the techniques described in Appendix B and Section 7.4. The model identified surcharging in two areas: the segment of pipe immediately adjacent to Pump Station No. 1 and at the intersection of Trunk 4; and the force main from Lewisville and Winchester. Trunk 4 was assumed to be at a minimum slope, therefore the surcharging may not be a reality based upon actual invert elevations.

Overall, despite the surcharging, the collection system has capacity to accommodate current flows without overflow. A more detailed evaluation of existing collection system capacity is included in Section 7, based on projected 20-year flows.

4.4 TREATMENT AND DISPOSAL FACILITIES

DESCRIPTION

As previously discussed, the City conveys wastewater to the Salmon Creek Wastewater Treatment Plant (SCTP). This wastewater treatment plant facility is operated by Clark County Public Works. The City of Battle Ground wastewater transmission system consists of two major components: the pumping facilities, which include pretreatment and equalization/detention facilities, and the 16-inch force main. These facilities are currently owned, operated and maintained by the City of Battle Ground.

The Interlocal Agreement between Clark County and the City is the document which governs the treatment of Battle Ground's sewage by SCTP. This agreement originally allocated 18% of the treatment plant capacity to the City with a corresponding 18% investment in the capital costs to construct the various phases of the plant. The City must also pay for the operation and maintenance costs of the plant based upon its flow rate of sewage.

The SCTP has only two customers, Battle Ground and the Clark Regional Wastewater District (CRWWD). Therefore, the plant's flow capacities and costs, which are not allocated to the City, are allocated to the CRWWD. The City's current capacity allocation is based on the maximum monthly flow or 3.47 mgd as provided under the recently completed Phase 4 expansion. A copy of the Interlocal Agreements and addendums are included in Appendix E.

Another part of the Interlocal Agreement stipulates that the County will be responsible for the force main portion of the transmission system. This understanding has not been implemented as of the date of this report. The ownership, operation, and maintenance of the force main remains with the City.

Constructed in 1992-1993, the wastewater transmission system was activated in April 1993, at which time the existing Battle Ground Wastewater Treatment Plant was abandoned. Wastewater is delivered to the transmission system from the Battle Ground and Cedars collection systems. The wastewater transmission system also serves two systems operated by the CRWWD – Hockinson and Meadow Glade. Both of these systems are Septic Tank Effluent Pumping (STEP) systems. The City currently has no formal agreement with CRWWD or the County concerning the allocation of Meadow Glade and Hockinson wastewater flows with respect to transmission system, interceptor sewer, or treatment plant capacity. The current agreement only guarantees that the County will guarantee capacity of the line equal to the actual purchased capacity. The agreement allows for oversizing of the line at the expense of the City. This Plan recommends that the agreement be amended to include agreements discussing how increased flows from Hockinson and Meadow Glade are allocated.

4.5 TRANSMISSION SYSTEM FACILITIES

TRANSMISSION PUMPING FACILITIES

The transmission pumping facilities were constructed at the site of the City's existing wastewater treatment plant. Many features of the wastewater treatment plant were incorporated into the pumping facilities, which are owned and operated by the City.

The City recently constructed a new headworks structure to replace the previous headbox and comminutor. Existing force mains are connected to the new headworks, which includes a new grinder with a capacity of 7.0 mgd. In addition, the new facility includes a bypass channel for the future installation of a second grinder with equal capacity.

The transmission pump station building houses four variable speed drive pumps which are situated in the lower level of the pump building with the motors and electrical systems housed at ground level. A summary of the existing pump data is presented in Table 4.2.

Table 4.2
TRANSMISSION PUMP STATION PUMP SUMMARY

Pump Station No.	Pump (horsepower)	Design Capacity (gpm)
1	10 Hp	700 to 1,325 gpm (1 - 1.9 mgd)
2	10 Hp	700 to 1,325 gpm (1 - 1.9 mgd)
3	25 Hp	1,2500 to 1850 gpm (1.8 – 2.7 mgd)
4	75 Hp	1,625 to 2,900 gpm (2.3 – 4.2 mgd)

The operating speed of the pumps is regulated by a programmable logic controller, which monitors the discharge rate from the pump station and the water level in the wetwell. The discharge flow rate is measured by a magnetic flow meter located downstream of the pump station and the wetwell level is monitored by a bubbler system.

The equalization basins provide for the short-term storage of peak wastewater flows. Aeration is provided to keep the solids in suspension and to freshen the wastewater. The aeration system is a coarse bubble diffuser with air supply provided by two blowers that are alternately operated by a variable speed drive, with the speed based upon the depth of wastewater. When flows exceed the storage capacity of the equalization basins, automatic controls close the valve to the equalization basins and open the valve to the lagoon, allowing surplus wastewater to be stored in the lagoon.

The 8-acre lagoon provides for the temporary storage of flows that exceed system capacity. The lagoon has an overall depth of 6.5 feet. The volume needed for wastewater detention varies and is highly dependent on contributions from infiltration and inflow (I&I). Excess flow will enter the lagoon when either the flow exceeds the capacity of the headworks or when the equalization basins are full. When flows subside, the wastewater stored in the lagoon will drain back to the wetwell.

Past concerns regarding odors and groundwater contamination from the lagoon resulted in the City moving forward with flow equalization basin and transmission pump station improvements which will allow the City to abandon the surge lagoon. The work currently under construction includes a new 3.5 million gallon flow equalization basin constructed of reinforced concrete with an aluminum roof and new transmission pump station. The flow equalization basin floor will be sloped at a 2% grade to a center trench which will slope to the wetwell of the new transmission pump station (which is integral to the equalization basin). The equalization basin will be actively ventilated but not scrubbed for odor control. Provisions will be provided, however, for the future installation of both mixers and a scrubber. The new basin will be connected hydraulically to the existing equalization basin, thus providing a total storage capacity of 4.15 million gallons.

The existing transmission pump station will be decommissioned following construction of the new pump station facility. The new pump station will have a firm capacity of 4.6 mgd. The pump station will be an integral part of the new flow equalization basin, and will utilize submersible pumps. The new pump station will include emergency power provisions which will automatically start and stop a generator in response to power failure and restoration.

Force Main

The 16-inch transmission system force main conveys wastewater from the Battle Ground pumping facility to the CRWWD interceptor sewer system, which in turn flows to Clark County's Salmon Creek Wastewater Treatment Plant. The force main flows southwest, nine miles to the point of discharge into the interceptor sewer located at Betts Road and Salmon Creek Avenue.

The force main is constructed of 16-inch DR-18 PVC pressure pipe with gasketed joints. The force main has six isolation and drain valve assemblies for the purpose of isolating specific sections of pipe and draining the section through a 4-inch drain pipe. Fifteen air release valves or combination air valves are located at the high points along the force main or at locations of major grade changes and where the hydraulic grade line is capable of being lower than the force main under operating conditions.

Pig launch stations are located at the pump station and two other points along the force main route. The stations consist of pipe and valve assemblies designed for the purpose of inserting a polyurethane pig into the force main to remove accumulated sediments and debris. A pig retrieving station is located at the end of the force main and consists of a hinged screen that can be positioned in the waste flow to catch the pig upon exiting the pipe. In July 1994, the City pigged the entire pipeline. The maintenance operation was successful and City personnel

observed no excessive build up of solids in the force main. Pigging of the lower one-third of the force main was completed in June 2003.

To maintain aerobic conditions, the transmission system was originally designed with an air injection system. This system included a duplex air compressor installation located in the pump station and 2-inch and 1-inch ABS air pipes installed along the entire length of force main connecting to five air injection stations along the force main route. The air injection stations included valving, piping and airflow meters located in a buried concrete vault. That system was abandoned in 2006 and replaced with a chemical feed system utilizing Bioxide. The chemical injection facility is located immediately south of McClure Pump Station.

SECTION 5

PLANNING CRITERIA AND SEWERAGE SYSTEM REGULATIONS

5.1 GENERAL CONSIDERATIONS

In order to evaluate alternatives for sewer service within the Battle Ground UGA and develop the General Sewer Plan, it is necessary to develop general planning criteria for the sewer system. The planning criteria presented in this section establishes the basis of the analysis of the system and recommended improvements. The planning criteria were developed based on the review of existing system studies and reports, applicable regulations, discussions with City personnel, and standard textbook design criteria. Also, general assumptions regarding growth and system operations were made to develop system criteria as identified within this section. It is important to note that the planning criteria are general. Detailed engineering reports are necessary to develop specific design criteria and to identify conditions that will influence the design and construction of specific facilities.

5.2 PLANNING PERIOD

For the purpose of this General Sewer Plan, the planning period is twenty years and the final year of the planning period is 2026.

5.3 SERVICE AREA

The service area boundary is shown in Figure 3.3. It comprises the area within the currently proposed Urban Growth Area. That proposed Urban Growth Area (UGA) has been developed as part of an ongoing process of updating the City's comprehensive plan. Land use zoning for the area within the UGA has been identified by the City as part of the ongoing comprehensive planning process. Zoning within the UGA is primarily divided into residential, commercial, industrial uses, and parks.

5.4 COLLECTION SYSTEM DESIGN CRITERIA

Standard textbook design criteria were used in the conceptual design of the collection facilities presented in the plan along with guidelines presented in the Washington State Department of Ecology's (DOE) Criteria for Sewage Works Design [4].

Gravity sewers are sized using a Manning's Roughness Coefficient of n = 0.013. Because final vertical alignment of proposed sewers is unknown, proposed sewers were sized assuming flow at two (2) feet per second.

5.5 COLLECTION SYSTEM SIZING CRITERIA

Gravity sewers are sized to accommodate their basins at build-out conditions under current zoning, assuming full-pipe flow conditions and no surcharge. The sizing of pump station and force main capacity is based on 20-year flow projections. Consideration was given to sizing wetwells for ultimate capacity, depending on the location of the pump station and possibility for future relocation.

Trunk sewers and pump station wetwells whose upstream drainage basins will likely expand with future UGA extensions are sized to accommodate those future UGA expansions as discussed in Section 6.

5.6 TREATMENT AND DISPOSAL PLANNING CRITERIA

This Plan does not address wastewater treatment and disposal. Currently, all of Battle Ground wastewater discharges to the Salmon Creek Wastewater Management System, which discharges to Clark County's Salmon Creek Wastewater Treatment Plant (SCTP) for treatment and disposal. Battle Ground participated in the expense of the most recent Phase 4 SCTP expansion and capacity upgrades to the Salmon Creek Interceptor system.

Battle Ground participation in upgrades to the Salmon Creek Interceptor will provide a maximum month flow capacity of 10.10 mgd. The Phase 4 SCTP expansion allocation provided Battle Ground with a maximum month flow capacity of 3.47 mgd. The following Phase 5 SCTP expansion will increase the Battle Ground treatment allocation to 4.47 mgd. Kennedy/Jenks Consultants has completed an alternatives analysis for future transmission, treatment, and disposal alternatives as presented in Appendix H

5.7 MEADOW GLADE SERVICE AREA PLANNING ISSUES

The Meadow Glade area is currently served by a pressure sewer system owned and operated by the CRWWD. There is a significant deficiency with that system related to the fact that the Meadow Glade area lies within the logical future urban area of Battle Ground, yet its pressure sewer system is not compatible with urban land use. That problem deficiency is more pronounced following Battle Ground's UGA expansion into a significant portion of the Meadow Glade service area.

It is a generally accepted fact that gravity sewer service is necessary to serve urban land use. In extending gravity sewers into an undeveloped area, or an area served by septic tanks, there is an incentive for property owners to pay all or part of the cost of sewer service. That incentive is greatly reduced in an area such as Meadow Glade, where large parcels are mixed in with small parcels served by pressure sewers.

Battle Ground and the CRWWD recently retained a consultant to prepare a report assessing the capacity of the Meadow Glade system. That report concluded that the existing sewer system

requires significant upgrades to accommodate the area at build-out under current zoning. The report did not address the land-use issues.

A supplemental planning effort is needed to address the conflict between land use and sewer service to the Meadow Glade area. Until that effort is completed, and an implementation plan for conversion of the area to gravity sewer services, it is recommended that a moratorium be placed upon further land division within the Meadow Glade area.

SECTION 6

EXISTING AND PROJECTED SEWER FLOWS

6.1 20-YEAR PLANNING AREA AND LAND USE PROJECTIONS

The planning area is the proposed City of Battle Ground Urban Growth Area (UGA) from on-going efforts to update the *2004 Comprehensive Growth Management Plan* Review as discussed in Section 3.1. The proposed UGA is the area in which growth is expected to occur through year 2026. Land use zoning for the area within the UGA is primarily divided into residential, commercial, industrial uses, and parks. The proposed UGA and city limits are shown in Figure 3.3.

6.2 POPULATION PROJECTIONS

20-YEAR POPULATION AND EDU PROJECTIONS

Wastewater flows are contributed by both residential land uses, and non-residential land uses, which include industrial and commercial uses. For purposes of sewer planning, flow and wasteload projections are based upon equivalent dwelling units (EDUs). An EDU represents the equivalent flow and wasteload from a typical single-family household.

As with the planning area, population and EDU projections were based upon the City's comprehensive planning efforts which have been on-going for more than four years. Originally, the target date for adoption of the comprehensive plan was 2004. Although the City did adopt a comprehensive plan in 2004, which included the 2004 UGA, that plan was never approved by the County. Since 2004, the City has been attempting to resolve planning issues with Clark County. In doing so, the City has proposed a 2006 UGA as well as 2006 population and EDU projections, which are the basis of those used in this general sewer plan.

In updating the adopted 2004 UGA to a proposed 2006 UGA, the following assumptions were utilized:

1. The year 2003 residential EDU total presented in the July 2004 *Wastewater Facilities Plan/General Sewer Plan* by CH2M Hill for the Salmon Creek Wastewater Management System (SCWMS) remains the starting point for residential EDU projections.
2. Years 2004 through 2006 EDU totals reflect actual building permits as tabulated in the November 13, 2006 *Sewer Connection Survey Memo* prepared by City Planning. Nonresidential EDU values were estimated using the year 2003 commercial/industrial and school figures presented in the July 2004 *Wastewater Facilities Plan/General Sewer Plan* by CH2M Hill for the SCWMS as a starting point. EDU projections for the 2007 to 2026 planning period were calculated based upon the following assumptions:

a. Average household size is 2.59 persons per unit (1 EDU = 2.59 people).
b. Residential EDUs are forecasted using a flat assumed growth rate of approximately 1090 new residents per year.
c. Nonresidential EDUs would retain current annual growth rates for schools and commercial/institutional users at 1.8% and 3.5% respectively.

Using these assumptions, the following Table 6.1 represents projected growth within the UGA. In reviewing this table, and others, it is important to note that the years shown are beginning of year dates, as opposed to calendar year dates shown in Tables 6.2 and 6.3. Table 6.1 is used throughout this section as the basis for all projected sewer flows.

Table 6.1
POPULATION AND EDU PROJECTIONS

Year	Actual Population	Residential (EDU)	School (EDU)	Comm/ Industrial (EDU)	Total (EDU)	Population Equivalent
2003	13,039	4,614	221	514	5,349	13,854
2004	14,220	4,935	225	532	5,692	14,742
2005	14,960	5,216	229	551	5,996	15,530
2006	15,810	5,337	233	570	6,140	15,903
2007	16,900	5,758	237	590	6,585	17,055
2008	17,990	6,179	242	610	7,031	18,210
2009	19,080	6,600	246	632	7,478	19,368
2010	20,170	7,020	250	654	7,924	20,523
2011	21,260	7,441	255	677	8,373	21,686
2012	22,350	7,862	259	701	8,822	22,849
2013	23,440	8,283	264	725	9,272	24,014
2014	24,530	8,704	269	750	9,723	25,183
2015	25,620	9,125	274	777	10,176	26,356
2016	26,710	9,545	279	804	10,628	27,527
2017	27,800	9,966	284	832	11,082	28,702
2018	28,890	10,387	289	861	11,537	29,881
2019	29,980	10,808	294	891	11,993	31,062
2020	31,070	11,229	299	922	12,450	32,246
2021	32,160	11,650	305	955	12,910	33,437
2022	33,250	12,071	310	988	13,369	34,626
2023	34,340	12,491	316	1,023	13,830	35,820
2024	35,445	12,918	321	1,059	14,298	37,032
2025	36,520	13,333	327	1,095	14,755	38,216
2026	37,610	13,754	333	1,133	15,220	39,420

50-Year Land-use, Population and EDU Projections

Although the planning period is 20 years, a 50-year planning boundary and related 50-year population and EDU projections were developed to assess the impacts of future UGA expansions upon those facilities proposed for the 20 year planning period. The 50-year EDU projection was estimated as discussed in Subsection 7.3

6.3 Existing Flow

Because there is no single influent flow meter, the determination of Battle Ground influent wastewater flow requires the analysis of multiple flow meters located throughout the distribution system. The flow records are summarized on monthly flow monitoring reports. Influent flow data from January 2000 to December 2006 has been compiled and reviewed to establish the wastewater flow characteristics, and are summarized in the following Table 6.2. These flows include only contributions from the Battle Ground collection system and the Cedars subdivision. Flows from Meadow Glade and Hockinson are not included. Also noted in Table 6.2 is annual rainfall data as recorded at the Battle Ground wastewater transmission site.

Table 6.2
Battle Ground 2000-2006 Influent Wastewater Flows
(not Including Meadow glade and Hockinson)

Parameter	2000	2001	2002	2003	2004	2005	2006
Annual Average Daily Flow (mgd)	0.93[a]	0.99	1.00	1.14	1.31	1.39	1.52[d]
Average Dry Weather Flow (mgd)[b]	0.71	0.73	0.73	0.88	1.16	1.21	1.31[d]
Average Wet Weather Flow (mgd)[c]	1.31[a]	1.21	1.38	1.49	1.59	1.42	1.73[d]
Maximum Monthly Flow (mgd)	1.39[a]	1.67	1.56	1.58	1.78	1.77	2.20[d]
Maximum 24-Hour Flow (mgd)	2.11[a]	2.61	2.65	3.63	2.45	3.08	3.20
Minimum 24-Hour Flow (mgd)	0.35[a]	0.57	0.63	0.67	0.75	0.87	0.38[d]
Annual Rainfall (inches)	41.1	45.4	42.2	51.5	46.2	49.9	61.9

Notes:
a. Flows do not include December 2000 flow records, which could not be located.
b. Dry Weather Period: July through September.
c. Wet Weather Period: January, February, and December.
d. Flows attained by subtracting Meadow Glade flows[e], Hockinson flows, and rainfall on the lagoon from McClure effluent flows.
e. Meadow Glade flows assumed during February through May to be a percentage of McClure effluent flows; percentages taken from 2005 data.
f. Flows do include the supernatant from the surge lagoon.

The following Table 6.3 presents the flow characteristics for Table 6.2 in terms of gallons per capita per day basis (gpcd) to assess recent flow trends.

Table 6.3
BATTLE GROUND 2000-2006 PER CAPITA FLOWS

Parameter	2000	2001	2002	2003	2004	2005	2006
Total Equivalent dwelling units	4,019	4,391	4,817	5,349	5,692	5,996	6,140
Equivalent Population	10,409	11,373	12,476	13,854	14,742	15,530	15,903
Hydraulic Loading (gpcd)							
Annual Average Daily Flow	90	87	80	82	89	90	96
Average Dry Weather Flow	68	64	58	63	79	78	83
Average Wet Weather Flow	126	108	111	107	108	92	109
Maximum Monthly Flow	134	146	125	114	121	114	138
Maximum 24-Hour Flow	203	230	212	262	166	198	201
Minimum 24-Hour Flow	33	50	50	49	51	56	24

6.4 COMMERCIAL AND INDUSTRIAL WASTEWATER

The City has a very limited industrial customer base. Non-residential sewer connections are primarily composed of commercial businesses with wastewater contributions typically domestic in nature. These commercial businesses are service oriented, including restaurants and stores. The City currently administers an industrial pre-treatment program in coordination with the Clark Regional Wastewater District (CRWWD). New potential industrial customers are identified during the site plan development review process.

Anderson Dairy is currently the largest industrial waste discharge. Effluent includes milk waste and washdown chemicals. A wastewater discharge permit application was submitted to DOE by Anderson Dairy in 1997, which addressed the discharge of effluent with a negative pH impact on the wastewater stream. This application addressed proposed process modifications to eliminate the acid/caustic cleaning system for low temperature cleaning operations and a caustic separator for high temperature equipment cleaning. DOE determined that Anderson Dairy is not considered a Significant Industrial User (SIU) and therefore the regulating jurisdiction is the City.

United Tempering Services and Ideal Foods are the only other identified industrial users discharging to the system. These industries have limited wastewater discharges, which likely fall outside the criteria of a Significant Industrial User. The City will continue to work with CRWWD regarding industrial discharge inspections. The inspection of existing identified industrial waste dischargers and potential dischargers will serve not only to help eliminate the potential discharge of harmful pollutants to the wastewater collection system, but serve as an educational outreach to City industrial and commercial customers.

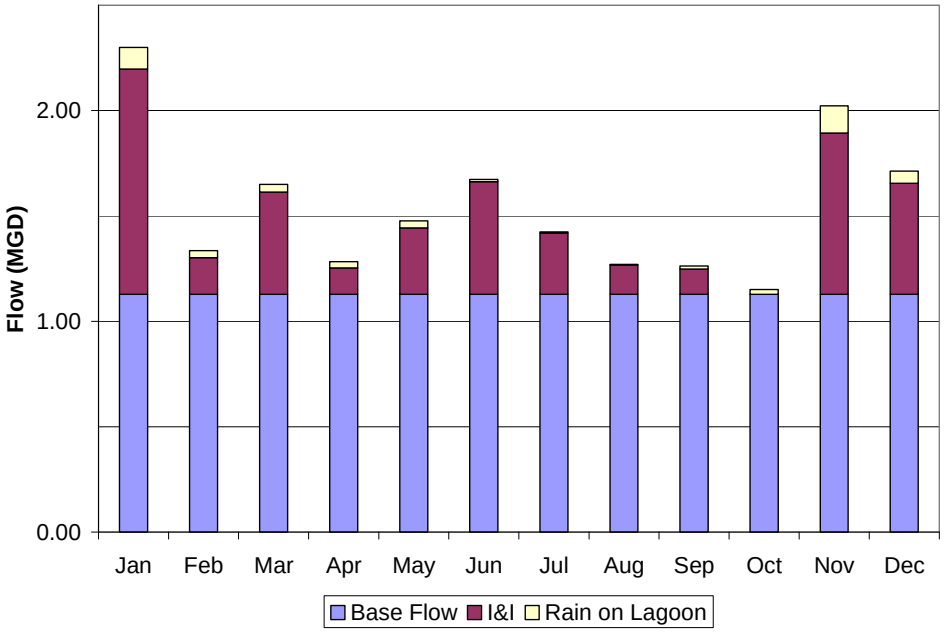
6.5 INFILTRATION AND INFLOW (I&I)

Infiltration is defined as subsurface water, which enters the wastewater collection system through cracks, joints, or other deficiencies in the collection system. It is directly influenced by the local groundwater table and the structural integrity of the collection system. All collection systems experience some degree of infiltration. Each system must plan and allow for additional capacity to accommodate this flow contribution.

Inflow is the component of I&I that is attributed to surface water, mainly stormwater runoff, entering the system through roof drains, storm drains, manhole covers, and other direct conduits to the sewer system. Inflow is directly influenced by storm events and usually occurs over a short period, during and after a storm event. Inflow is usually preventable by eliminating non-sewerage connections to the system. With older systems, however, identifying illegal sewer connections can be difficult.

From extensive I&I studies over a period of 20 years, it is apparent that infiltration is a major flow contributor to the Battle Ground wastewater collection system. The majority of the original wastewater collection system was installed in 1958 and 1966. Constructed primarily of concrete sewer pipe or asbestos cement pipe, the older portions of the system are prone to infiltration. This is compounded by the fact that the Battle Ground area has soils with low permeability, a seasonally high groundwater table, and poor drainage due to the relatively flat terrain. The impact of I&I on Battle Ground sewage flows is illustrated in the following Figure 6.1. This figure separates dry weather base flow, I&I, and rain falling on the wastewater transmission site surge lagoon for year 2006 influent flows.

Figure 6.1
2006 AVERAGE DAILY INFLUENT COMPOSITION



HISTORICAL INFILTRATION AND INFLOW REDUCTION PROGRAMS

For the past 20 years, the City has been actively involved in an I&I removal program. The first major effort was started in 1984. The May 1985 *Infiltration/Inflow, Sewage Treatment Plant and Receiving Stream Evaluation Report* included an evaluation of I&I. This evaluation utilized pump station operation records, wastewater treatment plant flow data, sewer main video inspections, and interviews with operations personnel to determine the extent and sources of I&I. The report concluded that I&I appears to be uniformly disbursed throughout the collection system originally constructed in the 1950s-80s, which is served by Pump Stations No. 1 and No. 2.

From 1985 to 1995, City efforts focused on the elimination of inflow sources. Extensive smoke testing was completed with follow-up disconnection of inflow sources. Extensive manhole repair efforts were also completed. A second *Infiltration and Inflow Report* was completed in 1995. This effort included field inspections of collection system manholes to identify areas suspected of elevated levels of I&I. Based on these observations, sewers in certain areas were recommended for television inspection. Technical memorandums were then completed summarizing observed leaks and recommended areas of repair.

The City initiated rehabilitation work to remedy problem areas identified in the 1995 report, including mainline cured-in-place rehabilitation, mainline slip lining, and dig and replace point repairs as shown in Figure 6.2. A pilot corrective program was also initiated for a small subarea identified as experiencing significant I&I, with flow monitoring before and after corrective work.

The initial conclusions from that study indicated that extensive rehabilitation may be cost effective.

Following 15 years of extensive efforts at correcting inflow problems and repairing mainline sewers, the City shifted its focus to repairing leaking lateral sewers. In 2001, the City implemented an ambitious infiltration and inflow reduction program that focused on the replacement of private laterals in older neighborhoods identified as suffering from high I&I. The first phase of construction began in 2002 and was followed by a second phase in 2003. Approximately 10,600 linear feet of sewer laterals on 278 properties were replaced between both phases, at a cost of approximately $1.4 million. An additional 90 cleanouts were installed to allow for the future inspection of laterals.

In 2003 the City purchased a television inspection truck with video recording capabilities and computer database functions, which will be used as part of an on-going program of identifying I&I, problem areas and follow-up inspection following repair work. In addition, the City installed permanent flow meters on all its pump stations for the purpose of long-term sub-basin flow analysis.

EVALUATION OF EXCESSIVE INFILTRATION AND INFLOW EVALUATION AGAINST EPA BENCHMARKS

EPA has established guidelines for evaluating sewer systems for excessive I&I. These guidelines have established fixed threshold flow values that apply to all systems. In light of the fact that infiltration is so dependent upon groundwater levels, which vary significantly among various cities, the logic of evaluating a sewer system against a fixed benchmark to determine whether I&I is excessive is questionable. Nonetheless, such a comparison has become accepted practice and is therefore included in this plan.

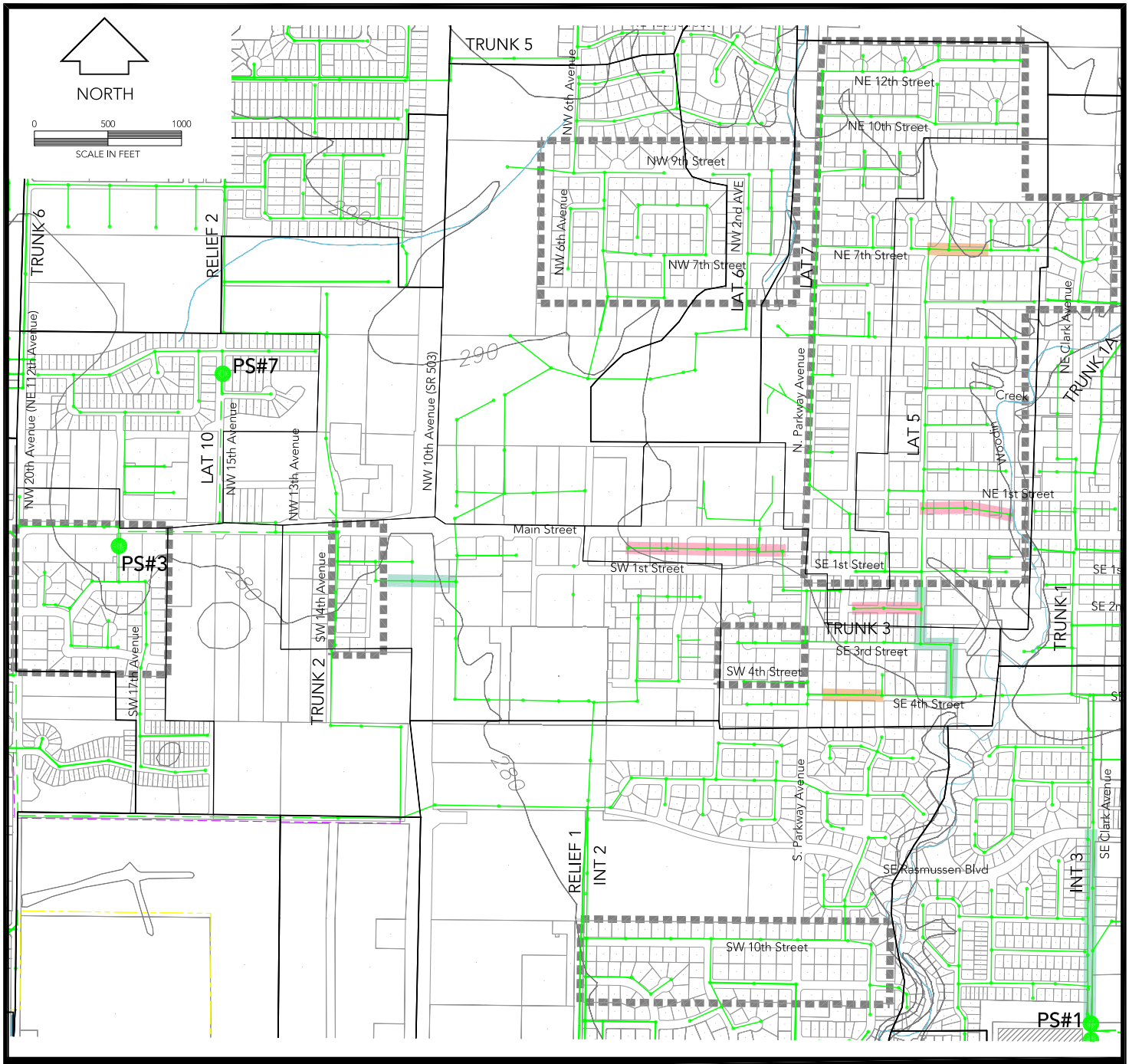
Infiltration

EPA guidelines define 120 gpcd as a threshold value for excessive infiltration, based on the average influent flow of a 7 to 14 day low rainfall period during the rainy season. Twelve low rainfall periods during 2000 – 2006 were identified to evaluate infiltration in the Battle Ground collection system as presented in Table 6.4.

Average flow values for the 7 to 14 day low rainfall periods were adjusted to deduct non-residential flow contributions. Historical EDU records indicate approximately 15% of the total EDUs are non-residential. Adjusted influent flow figures include a 15% reduction for non-residential services. Actual residential population was taken from the City of Battle Ground website statistics and used to determine per capita flows.

Table 6.4
2000-2006 WET WEATHER FLOWS, 7-14 DAY LOW RAINFALL PERIODS

Period	Days	Rainfall (inches)	Average Influent Flow (mgd)	Equivalent Population	gpcd
Feb 15 -24, 2000	10	0.05	1.06	10,409	102
Feb 5 - 15, 2001	11	0.04	1.03	11,373	91
Dec 20 – 29, 2001	10	0.04	1.21		106
Jan 8 – 15, 2002	8	0.04	1.41	12,476	113
Dec 2 – 9, 2002	8	0.06	0.77		62
Jan 13 – 20, 2003	8	0.04	1.24	13,854	90
Feb 2 – 14, 2003	13	0.01	1.24		90
Feb 4 – 14, 2004	10	0.06	1.37	14,742	93
Dec 12 – 24, 2004	13	0.07	1.39		94
Jan 1 -14, 2005	14	0.03	1.28	15,530	82
Dec 4 – 17, 2005	14	0.00	1.34		86
Dec 1 – 9, 2006	9	0.03	1.34	15,903	84
Average		0.04	1.22		91



KEY

Lateral Replacement Area	Identified Sewer Surcharge Area
Insituform Sliplining	Existing Sewer Line with Designation — TRUNK 3
Slipline/Point Repair	

Figure 6.2: I&I Rehabilitation Areas

P:\11\1195A\Dwg\Figures for Plan\Fig 6.2 I&I Rehab.dwg, 6/18/2009 1:56:55 PM

As shown in Table 6.4, per capita flows during low rainfall periods for the last five years have been well below EPA standards for excessive infiltration. Analysis completed in the 2000 GSP Update revealed per capita flows of 170 gpcd on average for the 1993 – 1994 period.

Inflow

EPA guidelines recommend 275 gpcd as a threshold value for evaluating excessive inflow. A comparison of peak flow and significant rainfall events shows a trend that is typical of the Battle Ground sewer system – rainfall has a direct influence on wastewater flows. Table 6.5 presents monthly maximum daily flows and peak 24-hour rainfall between May 2000 and December 2006.

Table 6.5
2000-2006 MAXIMUM FLOWS

Date	24-Hour Maximum Rainfall (inches)	Influent Flow (mgd)	Equivalent Population	gpcd
May 10, 2000	1.17	1.01	10,409	97
Dec 1, 2001	1.56 (11/30/01)	2.25	11,373	198
Dec 13, 2001	1.06	2.35		207
Jan 25, 2002	1.71 (1/24/02)	2.40	12,476	192
Mar 11, 2002	1.42	2.27		182
Jan 31, 2003	2.36 (1/30/03)	3.63	13,854	262
Mar 9, 2003	1.46 (3/6/03)	2.33		168
Jan 23, 2004	1.28	2.45	14,742	166
Jan 28, 2004	1.17	2.40		163
May 9, 2005	1.22	1.93	15,530	124
Sep 30, 2005	1.47	1.34		86
Nov 6, 2006	3.53	3.20	15,903	201
Dec 15, 2006	1.34 (12/14/06)	2.05		129
Average	1.59	2.27		167

Over the past few years, as shown above, it can be concluded that inflow is not excessive using the EPA benchmark. This analysis simply addresses I&I from the perspective of EPA benchmarks. A more detailed evaluation of I&I is addressed in the following section.

CONCLUSIONS REGARDING INFILTRATION AND INFLOW

A number of factors make it difficult to understand I&I in Battle Ground. These include: 1) very rapid growth, with considerable winter subdivision construction, which is particularly prone to

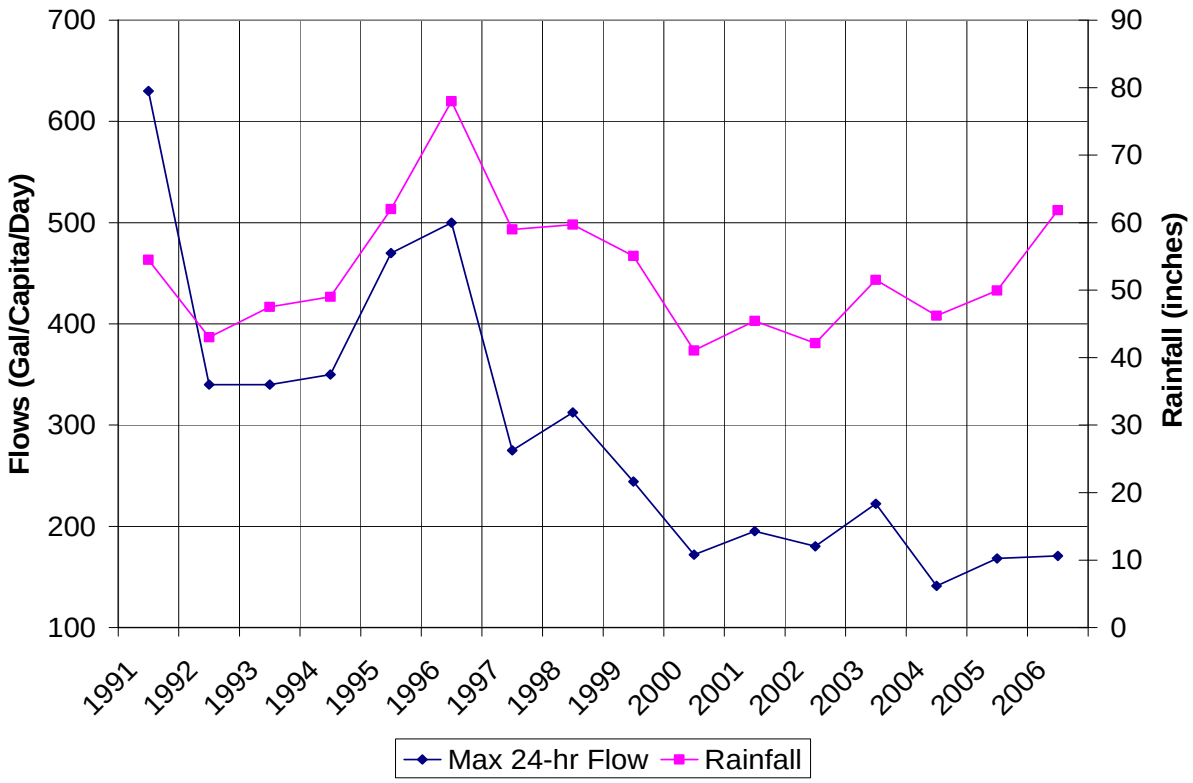
high inflow events, 2) uncertainties regarding actual population estimates at any one time, and 3) lack of flow monitoring points in the collection system prior to 2003. Given these factors, it has been very difficult to draw conclusions from historical flow data. Since the installation of flow meters at nearly all pump stations in late 2003 much more useful data has become available. Unfortunately, the meter installed at Pump Station No. 6 failed in June 2004 and has not been replaced. In addition, influent flow data was interrupted in 2006 between March and November due to construction at the headworks. Pump Station No. 1 had a meter installed in November 2006. Despite these interruptions there are some reasonable conclusions that can be drawn. It should be noted that additional flow data is needed to solidify the conclusions further.

1. Infiltration is highly dependent upon groundwater levels. Groundwater levels fluctuate approximately 12 feet throughout the year, from a late summer low level of approximately 15 feet below ground surface to a late winter high level of about 3 feet below ground surface during a year of average rainfall. This fluctuation is very gradual throughout the year in response to annual rainfall. Short duration rainfall events may impact the groundwater level, but only slightly. Heavy rainfall for periods of days, weeks, or even a month will cause a temporary rise in the groundwater level, but only a foot or two. That extra foot or two is significant, however, in light of the fact that it can submerge private laterals, and thus produce a surge of groundwater induced infiltration.

2. Studies over the past 20 years have repeatedly shown that infiltration varies with groundwater level. In the summer, groundwater levels are below most of the sewer laterals and mainline which means there is very little infiltration during the late summer months. As the groundwater level rises, infiltration increases.

3. In comparing flow versus rainfall, Battle Ground is unusual in that high wastewater flows correspond to high annual rainfall as opposed to high rainfall over periods of shorter duration. In other words, a heavy month of rainfall in a below normal rainfall year has less impact on peak daily flows than a light month of rainfall in an above normal rainfall year. The relationship between maximum day wastewater flow and yearly rainfall is shown in the following Figure 6.3.

Figure 6.3
RAINFALL DATA



4. A peak daily flow of 3.56 mgd was recorded in 1996. This peak daily flow total was approximately 3.0 mgd above the average dry weather base flow for the year. The annual rainfall total for 1996 was 78 inches, the wettest in 50 years. Average annual rainfall for Battle Ground is approximately 51 inches.
5. Historically, reliable flow records were only available at the combined influent flow meter at the wastewater transmission site. Since 2003 flow meters installed at six of the pump stations have provided a more accurate depiction of I&I. It is the trend when analyzing the three years of basin flows, that I&I is less in areas with new construction. Therefore, the previous conclusions that I&I is related to the age of the system is confirmed by analysis of the basins.

6. Typically the peak flow into a sewer system has little to do with the capacity of that system. This does not appear to be the case in Battle Ground. From an evaluation of rainfall and flow records, as the capacity of the sewer system increased, it appears to attenuate peak flows into the system. In attempting to understand this phenomena, it is believed that the older part of the sewer system performs as follows during those periods of very high infiltration.

    a. Prior to an unusually high rainfall event, the groundwater is high (within approximately 3 feet of the top of the ground surface.

b. Storm events of two to three days duration gradually raise the groundwater level to within a foot or so of the ground surface, progressively increasing infiltration rates as laterals are submerged. As infiltration rates increase, the sewer system surcharges.

c. Through the aforementioned period, base wastewater flows vary diurnally. During periods of diurnal peak flows, the surcharging increases.

d. As the surcharging increases, due to the combination of infiltration and diurnal peak wastewater flows, the infiltration rates decrease due to an equalization of head (pressure) over the empty pipes. In other words, as the diurnal wastewater flows go up, the infiltration rate goes down, basically resulting in a steady state condition with flow into the section of the surcharged sewer controlled by the discharge rate of the sewer under high surcharge.

6.6 FLOW PROJECTIONS

Future per capita flows were estimated based on existing per capita flows and the DOE guidelines. The following table contains the per capita average contribution from 2000-2006, the DOE recommended design values for new wastewater treatment facilities [4], and the value used for future population loading. DOE guidelines use direct population, which assumes a higher per capita flow contribution. The per capita values in Table 6.6 are based upon population equivalents. The projected per capita values are based on either the DOE Guidelines or historical averages, whichever is higher. Peak hourly projections are not included because current peak day flows maximize the collection system capacity, and peak hourly flows either surcharge or are routed to the equalization basin.

Table 6.6
BATTLE GROUND POPULATION EQUIVALENT PER CAPITA FLOW PROJECTIONS

Parameter (gal/day)	Historical Average	DOE Guideline	Future (2026)
Annual Average	88	100	100
Dry Average	70	n/a	80
Wet Average	109	n/a	110
Max Month	146[a]	n/a	150
Peak Day	262[a]	n/a	275

Notes:
a. The maximum monthly and peak daily values above are the highest recorded within the previous seven years. The "average" values are the average of the previous seven years.

To develop projected wastewater flows, population projections contained in Table 6.1 and future per capita projections contained in Table 6.6 were used. Future flow values presented in Table 6.7 were developed by calculating a direct projection of population equivalent times the "future" unit values from Table 6.6.

Table 6.7
BATTLE GROUND PROJECTED WASTEWATER FLOWS

	Years:	2006	2011	2016	2021	2026
	Population Equivalent:	**15,903**	**21,686**	**27,527**	**33,437**	**39,420**
Flow (mgd)	*Average Annual*	1.59	2.17	2.75	3.34	3.94
	Dry Average	1.27	1.73	2.20	2.67	3.15
	Wet Average	1.75	2.39	3.03	3.68	4.34
	Max Month	2.39	3.25	4.13	5.02	5.91
	Peak Day	4.37	5.96	7.57	9.20	10.84

The City's transmission system facilities receive flow contributions from both Meadow Glade and Hockinson. Both the Hockinson and Meadow Glade STEP systems are owned and operated by the CRWWD. The following Tables 6.8 and 6.9 provides a summary of Meadow Glade and Hockinson EDU and flow projections provided by CRWWD. The respective EDU figures include residential, commercial and school allotments, and were developed assuming that the EDU's within the Battle Ground UGA were incorporated within the EDU and flow projections for Battle Ground, thus the Meadow Glade flow values are for the remaining Meadow Glade service area outside of Battle Ground's UGA. The decrease in 2011 values presented in both Tables 6.8 and 6.9 for Meadow Glade are due to the removal of EDU's from the Meadow Glade service area due to the inclusion of those values within the City of Battle Ground's flow projections.

Table 6.8
MEADOW GLADE / HOCKINSON FLOW PROJECTIONS

Year	Meadow Glade[a] (mgd)				Hockinson (mgd)			
	Average Annual	Max Month	Peak Day	Peak Hour	Average Annual	Max Month	Peak Day	Peak Hour
2006	0.16	0.21	0.31	0.31	0.01	0.02	0.03	0.06
2011	0.15	0.20	0.27	0.29	0.01	0.02	0.04	0.07
2016	0.16	0.21	0.29	0.31	0.02	0.04	0.06	0.10
2021	0.17	0.23	0.31	0.33	0.03	0.05	0.09	0.15
2026	0.18	0.24	0.34	0.36	0.04	0.08	0.13	0.22

Notes:

a. Flow projections are for the portion of the Meadow Glade service area falling outside of Battle Ground's proposed year 2026 UGA.

Table 6.9
MEADOW GLADE / HOCKINSON EDU & COMBINED FLOW PROJECTIONS

Year	Meadow Glade EDU's	Hockinson EDU's	Total EDU's	Avg Annual Flow (mgd)	Max Month Flow (mgd)	Peak Day Flow (mgd)
2006	694	173	867	0.17	0.23	0.34
2011	650	204	854	0.16	0.22	0.31
2016	700	305	1005	0.18	0.25	0.35
2021	750	316	1066	0.20	0.28	0.40
2026	800	427	1227	0.22	0.32	0.46

The following Table 6.10 is the combined flow projections for the transmission system and proposed reuse facility. The values presented are the combined flow totals from Meadow Glade, Hockinson and Battle Ground.

Table 6.10
TRANSMISSION MAIN FLOW PROJECTIONS

Year	Max Month Flow (mgd)		
	Meadow Glade & Hockinson	Battle Ground	Total Flow
2006	0.23	2.39	2.62
2011	0.22	3.25	3.47
2016	0.25	4.13	4.38
2018[a]	0.26	4.49	4.75
2021	0.28	5.02	5.30
2026	0.32	5.91	6.23

Notes:

a. 2018 values were interpolated using strictly linear approximation between 2016 and 2021.

SECTION 7

COLLECTION SYSTEM EVALUATION

7.1 OVERVIEW OF EVALUATION PROCESS

In order to determine the adequacy of the existing collection system and completely evaluate alternatives for serving the Battle Ground UGA, the capacity of the existing system to accommodate projected 20-year flows was determined. See Figure 4.1 (Section 4) for the existing sewer map. Assumptions regarding the basis of collection system flow projections are outlined in Section 6. The scope of this evaluation only addresses the main sewer lines and projections for the existing service areas, as listed below.

The collection system evaluation was completed by a seven-step process as follows:

1. Three conditions of analysis were established: 1) existing, 2) 20-year (2026), and 3) 50-year (2056). EDU projections for each condition were calculated. The 50-year condition was selected to assist in determining trunk sewer sizes for those trunk sewers whose contributing basin was likely to grow beyond the proposed UGA.
2. A preliminary layout of trunk sewers was established to serve the year 2026 and 2056 UGAs.
3. Drainage basins were developed for each trunk sewer.
4. EDUs were allocated to each basin for the three conditions of analysis (existing, year 2026, and 50-year).
5. Existing sewers were evaluated for their capacity to accommodate existing and year 2026 flows.
6. For those components of the existing system that were found to be under-capacity within the 20-year planning period, bypass or upsizing improvement options were evaluated and a preferred option selected.
7. The improvements identified in step #6 above, along with the improvements necessary to serve the drainage basins within the future growth area of the year 2026 UGA, were sized for buildout flow conditions.

7.2 LAYOUT OF PROPOSED COLLECTION SYSTEM IMPROVEMENTS

Locations of proposed trunk sewers, pump stations, and force mains for the future growth areas were established with two goals: 1) to limit the number of pump stations; and 2) to minimize the length of force mains in order to reduce the potential for sulfide generation.

Ideally, gravity sewers would be extended through the low points of the drainageways. For most of the major drainage basins, the extension of gravity sewers through the low areas of the drainageway was not practical due to severe sideslopes and environmental constraints. For these basins, trunk sewers were assumed to extend along the top of the drainageways. Doing so typically requires more sewers (one on each side of the drainageway), however it allows gravity sewer service to most of the service areas.

7.3 Basin EDU Allocation

Allocation of Existing EDUs

An initial allocation of existing EDUs was completed using aerial photographs and field observation ("windshield" surveys) of recent construction in those areas undeveloped at the time of the aerial photograph. Flow record data from the various pump station flow meters was used to adjust the initial EDU allocation to match the total EDU count supplied by the City.

Allocation of Buildout EDUs

As discussed in Section 3, each trunk sewer is sized with capacity to serve its basin at build-out. For those trunk sewers whose basin extends past the UGA, or those which will likely receive effluent from pump stations discharging from basin areas outside of the 20-year UGA, build-out is defined as serving the 50-year UGA. The EDU allocation for the 50-year boundary was estimated as follows:

1. Total 50-year EDU estimates were estimated by assuming that the amount (not rate) of growth beyond the 20-year planning period would be 250% of what it was through the planning period. This equates to 22,700 EDUs, a growth rate from 2027 to 2056 of about 3% a year. In other words, growth in the 20 to 50 year period would be 250% of the 20-year growth.
2. Buildout EDU estimates within the proposed UGA were estimated by using an EDU density per zone and reducing the total EDU's by 25% to account for loss of developable land due to infrastructure and open space.
3. The 50-year EDU estimate less that allocated to the proposed year 2026 UGA was allocated to areas outside the year 2026 UGA on an average areal basis.
4. The 50-year planning area boundary was provided by the City and is included in Appendix A.

7.4 Modeling Assumptions

A hydraulic model of the City of Battle Ground's collection system was developed as part of the scope of this plan. The model output was used to evaluate the capacity of the existing collection system and to identify improvements that will be necessary to serve the projected populations.

The sewer system was modeled for existing, 20-year, and buildout flow conditions. A detailed discussion of modeling assumptions, inputs, and results are included in Appendix B.

The model was developed using Hydra 6.4 software, by Pizer, Inc. Hydra 6.4 was selected for its history and acceptance in the wastewater field, graphical interface and efficient calculation procedure.

7.5 EXISTING SEWER SYSTEM EVALUATION

The existing sewer system was evaluated at existing conditions as follows:

1. Existing sewer mains to be modeled were selected as those whose contributory (upstream) service area produced flows in excess of the flows that could be accommodated by an 8-inch diameter sewer at minimum slope.
2. For those existing mains, drainage basins were established for each sewer main to be evaluated.
3. Existing EDUs were allocated to each basin. These were utilized to project flows to each basin. EDU allocation relied extensively upon dry-weather pump station flow meter records.
4. Using wet-weather flow records from the pump stations, peak flow conditions were estimated by allocating I&I flows to the various basins.
5. Capacity of each sewer main was evaluated against the estimated flows.

The collection system is generally adequate to meet current conditions. Although the majority of the existing collection system has the capacity to accommodate the anticipated 20-year flow conditions, portions of it will become deficient in capacity and require upsizing.

The following paragraphs present a discussion of the maintenance and capacity deficiencies.

EAST BATTLE GROUND SEWER SUBSYSTEM

Pump Station No. 1 Sub-basins

The East Battle Ground Sewer Subsystem is generally characterized by the area served by Pump Station No. 1. This area has historically experienced significant I&I resulting in surcharging of the interceptor sewers as outlined in Figure 6.1. Following extensive television inspections of mainline sewers and individual home laterals in this area, the City completed several projects to reduce I&I, including slip lining and lateral replacements. That work was completed in 2003 and 2004. From flow monitoring during the heavy rainfall months in late 2006, it appears as though the lateral replacement projects did in fact substantially reduce the I&I.

The following is a summary of Pump Station No.1 collection system elements.

Lateral 1: This 8-inch sewer has adequate capacity to accommodate anticipated 20-year flows.

Trunk 1: This trunk sewer includes sections of 8, 10 and 12-inch sewer with sufficient capacity to accommodate the anticipated 20-year flows.

Lateral 5: This 8-inch sewer main has sufficient capacity to accommodate anticipated 20-year flows, despite sections installed with slopes less than the recommended minimum.

Lateral 7: According to system records, sections of this 8-inch sewer main were installed with slopes of 0.003, resulting in a reduced capacity. Even so, this sewer main has sufficient capacity based on 20-year flow projections.

Trunk 3: Projected 20-year flow conditions exceed the capacity of the sewer. The uppermost section exhibits the largest capacity deficiency of 0.12 mgd. No improvements are recommended since the maximum surcharge of 0.15 feet is negligible.

Interceptors 1 & 3: This section of the existing system consists of dual 12-inch gravity sewers discharging to Pump Station No.1. City personnel have identified sections of Interceptors 1 and 3 that experience surcharging during peak storm events. Although the 20-year flow projections exceed the capacity of these sewers the 0.52 foot surcharge does not warrant upgrades at this time.

Pump Station No. 1: Pump Station #1 was recently upgraded to provide a capacity of 3.8 mgd. It has capacity to accommodate projected 20-year flows.

WEST BATTLE GROUND SEWER SUBSYSTEM

The West Battle Ground Sewer Subsystem is generally characterized by the area served by Pump Station No. 2. This area has experienced significant growth over the last 8 years. Interceptor sewers receive flows from multiple sub-basins served by pump stations. The following is a summary of Pump Station No. 2 collection system elements broken down by sub-basin:

Pump Station No. 3 and No. 7 Sub-basins

Pump Station No. 3: This pump station, which was constructed in 2002 to replace an undersized station, serves the Battle Ground West neighborhood. The recently completed Main Street road improvement project included the relocation and reconstruction of this pump station, with a capacity upgrade to nearly 0.36 mgd. The most recent model conservatively modeled I&I at 6000 gallons per acre per day (gpad) and resulted in a peak hour flow of 0.55 mgd. Additional flow monitoring and analysis is needed to determine actual I&I. In addition, more detailed flow analysis including development of actual diurnal patterns for this basin are recommended.

Pump Station No. 7: This pump station serves an area including residential and commercial users with limited potential for growth. The existing pump station capacity of approximately 0.20 mgd has been adequate to satisfy existing flow conditions.

Lateral 10: Lateral 10 was divided into two sewers with the construction of the Westside Relief Sewer. A short section of Lateral 10, located in Main Street, receives the force main discharge from both Pump Stations No. 3 and No. 7 and connects directly to the Westside Relief Sewer. This sewer does not have adequate capacity to satisfy 20-year flow projections. However, improvements are not recommended since the approximate surcharge is only 2.3 feet. The remaining section of Lateral 10 serves the 14th Avenue residential area connecting to Trunk 2 as discussed below.

Pump Station No. 8 and No. 10 Sub-basin

Trunk 8: This 10-inch sewer main constructed with the Horse Thief Canyon development has sufficient capacity to accommodate anticipated 20-year flow projections.

Pump Station No. 10: The current capacity of Pump Station No. 10 is approximately 0.14 mgd. The 20-year flow projections within the service area exceed the installed pump capacity. However, a 12-inch force main was extended from the station to 20th Avenue for future use and a proposed gravity sewer extension from the proposed PS-T10 will allow for the abandonment of this facility.

Lateral 21: This 8-inch sewer main does not have sufficient capacity to accommodate anticipated 20-year flows. Improvements are not included in this plan since the maximum surcharge is less than 1 foot.

Pump Station No. 8: The current capacity of Pump Station No. 8 is approximately 0.32 mgd. The 20-year flow projections within the service area exceed the installed pump capacity. The 12-inch force main shared with Pump Station No. 11 has capacity to accommodate 20-year flow projections. A future gravity sewer extension from Pump Station No. 11 is proposed which will allow for the abandonment of this facility.

Pump Station No. 11 Sub-basin

Lateral 20: This 8-inch sewer main does not have sufficient capacity to accommodate anticipated 20-year flows. The total surcharge in this section of pipe is approximately 8 feet. It is recommended that more detailed evaluation of this sewer be made to confirm I&I estimates prior to implementing capital upgrades.

Trunk 6: This trunk sewer includes sections of 12, 15, and 18-inch sewer main construction. This sewer does not have sufficient capacity to accommodate anticipated 20-year flows. Improvements are not recommended for this sewer due to surcharges of less than 1 foot.

Pump Station No. 11: This pump station has an installed pump capacity of approximately 1.9 mgd. The pump station does not have sufficient capacity to accommodate anticipated 20-year flow projections, which will include bypassing Pump Station No. 8 to this pump station. Pump Station No. 11 discharges to a 12-inch force main, which has sufficient capacity to accommodate

anticipated 20-year flows. A more detailed evaluation of the existing wetwell is recommended to confirm that the existing wetwell has capacity to accommodate larger pumps.

Pump Station No. 2 Sub-basin

Lateral 6: This 8-inch sewer has sufficient capacity to accommodate the projected 20-year flow conditions. However, downstream conditions in Trunk 2 do cause surcharging within this sewer.

Trunk 2: Existing and projected 20-year flow projections exceed the capacity of segments of this 8 and 10-inch main. City personnel have identified past surcharging during peak storm events south of Main Street in the vicinity of the connection of Lateral 10. Capacity deficiencies are the result of significant I&I in the basin. Recent lateral replacement work was completed with the goal of reducing the impact of this flow component, the results of which have yet to be determined due to the lack of flow data. It is recommended that lower reaches of this sewer be upsized one size from T2-2 to T2-11.

Trunk 5: This 15-inch trunk sewer lacks sufficient capacity to accommodate the projected 20-year flow conditions beginning near T2-25. Surcharging does not exceed 1 foot and may not materialize at all due to I&I reduction work in the basin. Future flow analysis is recommended to determine if 20-year projections will create a capacity deficiency. Buildout flows, however, will lead to capacity deficiencies.

Westside Relief Sewer 2: This relief sewer, constructed in 2001 to further relieve capacity deficiencies in Trunk 2 and accommodate new growth to the north, includes sections of 18, 20, and 24-inch gravity sewer, extending from the end of the Westside Relief Sewer 1 at Main Street, north to a connection with Trunk 5 in NW 6th Avenue east of SR 503. This sewer has sufficient capacity to accommodate projected 20-year flow conditions.

Westside Relief Sewer 1 / Interceptor 2: The Westside Relief Sewer 1 was constructed in 1996 to address capacity deficiencies in Interceptor 2, and includes sections of 21 and 30-inch gravity sewer extending from Pump Station No. 2 to Main Street. This relief sewer runs parallel to the 12 and 15-inch Interceptor 2. Although the combined capacity of the two sewers has sufficient capacity to accommodate the projected 20-year flow conditions, surcharging occurs at the point in which Interceptor 2 transitions from a 15-inch sewer to a 12-inch sewer.

Future UGA expansions to the west beyond the 20-year planning period will result in capacity limitations between manholes T4-3 and R1-7, which includes the 30-inch section that runs east under SR 503 until it turns south paralleling Interceptor 2. As currently outlined, future growth areas to the west will be served by a pump station with continued force main discharge to the existing interceptor sewer.

Pump Station No. 2: Pump Station No. 2 was reconstructed in 2000, including a new wetwell and controls building, with a design capacity of nearly 7.5 mgd. The 20-year flow projections exceed the pump station capacity by nearly 20%; however, this projection does not account for any reduction of I&I resulting from recent lateral replacement projects. Future flow monitoring

will determine the effectiveness of I&I reduction work and the potential capacity deficiencies. The existing 14-inch asbestos concrete force main will require upsizing to satisfy 20-year flow conditions.

THE CEDARS SEWER SUBSYSTEM

Cedars Sewer Mains: The 8-inch collection system sewer mains have sufficient capacity to accommodate the 20-year flows of the existing service area.

Pump Station No. 4: Pump Station No. 4 was reconstructed in the year 2000, with the conversion of the original wetwell mounted, self-priming pump station to a submersible pump station. The capacity of the pump station is 0.23 mgd. The existing pump station has adequate capacity to serve the existing service area. However, the expansion of the UGA to include properties to the north of the existing Cedars development will exceed the capacity of this facility during the 20-year planning period.

EXISTING COLLECTION SYSTEM SUMMARY

The evaluation of the existing system demonstrates the significant impact of I&I on the system capacity and operations. Most of the areas where 20-year flows exceeded the capacity of existing sewer mains, projected peak flows include a substantial I&I component. The assumptions made regarding the volume of I&I, the "surge" flow experience in the original collection system and the distribution of I&I and surge flow throughout the original collection system, are discussed in detail in Section 4.

Numerous collection system improvements have been completed since the 2000 General Sewer Plan Update to relieve previously identified overcapacity sewers and pump stations. The West Battle Ground Sewer Subsystem in particular benefited from the construction of the Westside Relief Sewer and Pump Station No. 2 reconstructions, which eliminated past Interceptor 1 and Trunk 2 surcharging.
The East Battle Ground Sewer Subsystem is an example of successful I&I reduction. Although a few pipes within the basin continue to experience minor surcharging, the City's I&I reduction program which included slip-lining, point repairs, and home service lateral replacements was successful. More data is needed to further determine the long-term effectiveness of these projects.

7.6 CAPACITY, MANAGEMENT, OPERATIONS AND MAINTENANCE (CMOM) REGULATIONS

CMOM stands for "Capacity, Management, Operations, and Maintenance." These regulations were created by the Environmental Protection Agency (EPA) in order to reduce the occurrence of Sanitary Sewer Overflows (SSO's) nationwide. It was created as a framework for municipalities to identify and incorporate widely accepted wastewater industry practices in order to:

- Better manage, operate, and maintain collection systems
- Investigate capacity constrained areas of the collection system
- Respond to sanitary sewer overflow (SSO) events.

In CMOM planning, the utility selects performance goal targets, and designs CMOM activities to meet the goals. Information collection and management practices are used to track how well each CMOM activity is meeting the performance goals, and whether overall system efficiency is improving.

STATUS OF CMOM REGULATIONS

There are four major documentation requirements of the CMOM permit. These requirements vary based on the size and complexity of the municipal wastewater collection system and include a written summary of the CMOM Program; an Overflow Emergency Response Plan; a Program Audit Report; and a System Evaluation and Capacity Assurance Plan.

For municipalities to meet CMOM requirements the following, legal, administrative, and managements, elements will be required.

Legal Authority: Adopt a sewer use ordinance that requires proper design, installation, testing and inspection (including service lines) and includes pretreatment standards for fats, oils, and greases.

Information Management: Maintain up-to-date mapping of the collection system and establish a process to update maps with new development; maintain a database on pipes including size, material and date constructed; maintain overflow data, three years of work order history, complaint records, performance and implementation measures, and a list of system components with inadequate capacity.

Overflow Response Plan: Develop and implement a SSO response plan to stop and mitigate impacts as soon as possible. The plan must outline staff training in SSO response procedures, a process for plan review and updating, a public notification program, and steps for immediate notification of health official and the National Pollutant Discharge Elimination System (NPDES) authority.

Condition Assessments: Conduct periodic video pipe inspections and smoke testing to identify structural deficiencies and illicit connection. Update information management systems as needed based on the condition assessment.

Capacity Assurance: Identify deficient components of the system for both existing and future conditions through system modeling. Develop a master plan that includes a capital improvement plan to address deficiencies. Budget for capital improvements.

Construction Standards: Adopt and enforce defined design criteria that include evaluation of downstream impacts for new development, capital improvements, and rehabilitation. Require

proper review of construction drawings as well as acceptance tests and inspection, including laterals.

Staff Training: Provide a training program for operation and administrative personnel that includes all elements of the CMOM program. Develop a mandatory certification program.

Compliance Audits: Assign responsible staff to conduct a CMOM program audit report based on interviews with staff, observation of crews, SSO data records, and work order records. The audit review report is to identify apparent deficiencies, steps taken to address problems, and additional measures needed.

IMPLICATIONS FOR THE CITY OF BATTLE GROUND

The City of Battle Ground already has many elements of the CMOM program currently in place or in the process of being developed. The City has had an extensive I&I rehabilitation program in place for many years, and efforts are continually being made to decrease additional flow into the system. The adoption of this General Sewer Plan will meet many of the requirements of these regulations. It is recommended that the City assign staff to monitor the EPA's final adoption of CMOM regulations and eventually oversee the City's compliance.

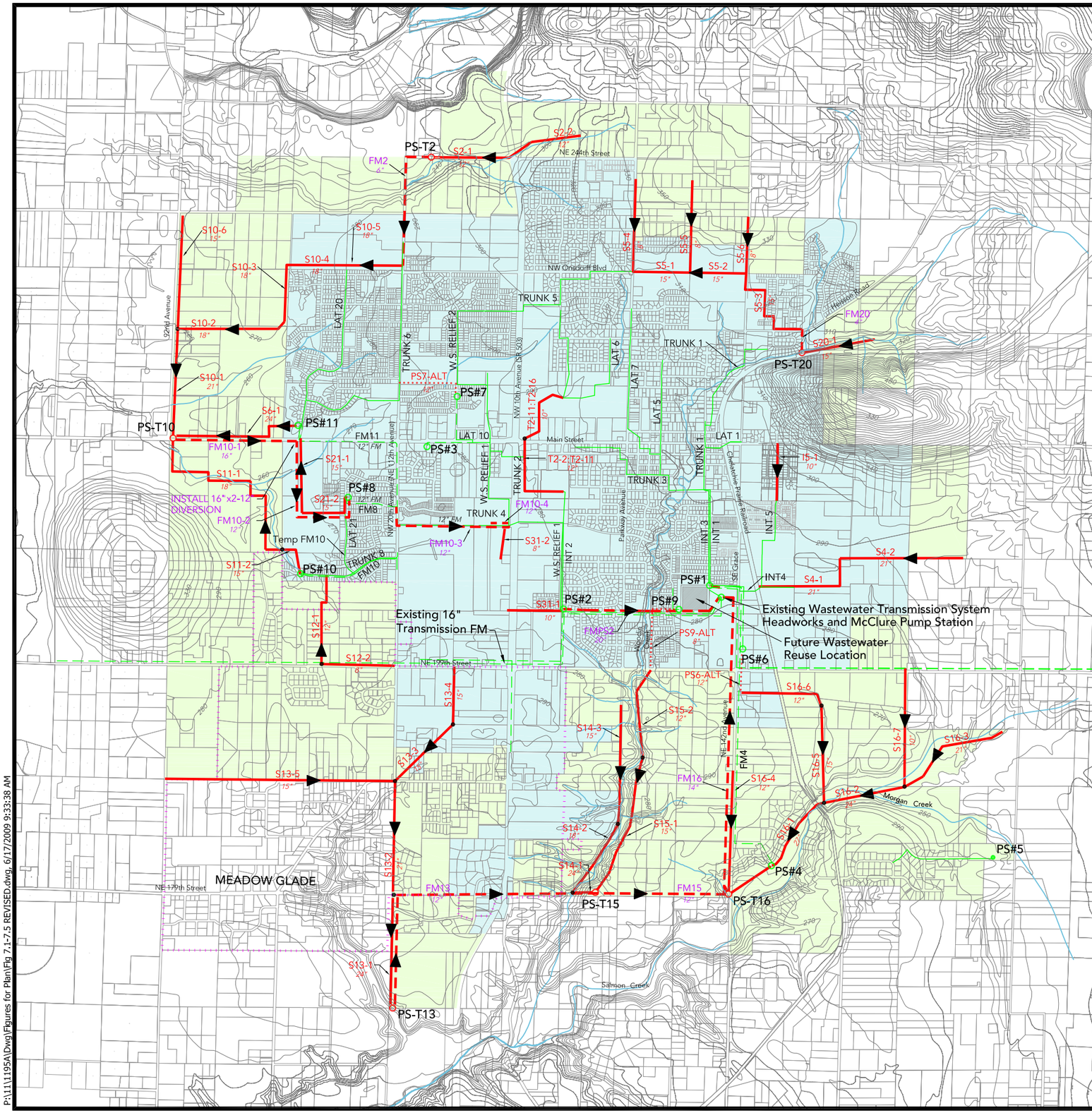
7.7 PROPOSED COLLECTION SYSTEM IMPROVEMENTS

As a result of the evaluation of the collection system outlined above, several improvements to the collection system are proposed. The collection system improvements recommended in the Plan consist of gravity sewers, pump stations, and force mains that will be required to accommodate estimated flows in the Battle Ground UGA. A complete discussion of the improvements are included below and shown in Figure 7.1.

Because much of the UGA currently not served by the City's sewer system is largely undeveloped, with few roads, it is important to understand that the locations of sewers and other proposed facilities discussed in the General Sewer Plan are approximate. The final location of sewer facilities will depend upon the development of the road system and the nature of land development for specific areas. For sewer mains located down drainageways, it is likely that the sewers will need to be constructed in easements along the back of lot lines.

The layout of all collection system improvements assumes that the wastewater reuse facility will be located at the same location as the existing surge lagoon and transmission pump station.

Development activities may require the construction of temporary pump stations as development continues toward the edge of the UGA. Temporary pump stations and their force mains should be constructed in a matter that allows for efficient development and the eventual construction of the improvements included in this plan.



KEY

Current Urban Growth Area	
City Limits	
Existing Meadow Glade Service Area Boundary	
Direction of Flow	▶
Size Break	●
10' Contour	
Drainage Way	

Abbreviations:

FM	Force Main
PS	Pump Station

	Existing	Proposed
Sanitary Sewer		line size
Force Main		line size
Pump Station	○	○

THE CITY OF BATTLE GROUND

Figure 7.1: Proposed Collection System Improvements

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To simplify the description of the recommended improvements and service areas, UGA has been divided in four sub-areas – West/Meadow Glade, Northwest, Northeast, and Southeast.

A working map is included in Appendix A that provides information regarding existing, 2026 and capacity EDU's as well as basin designations at specific points along the proposed and existing collection system.

WEST/MEADOW GLADE SERVICE AREA

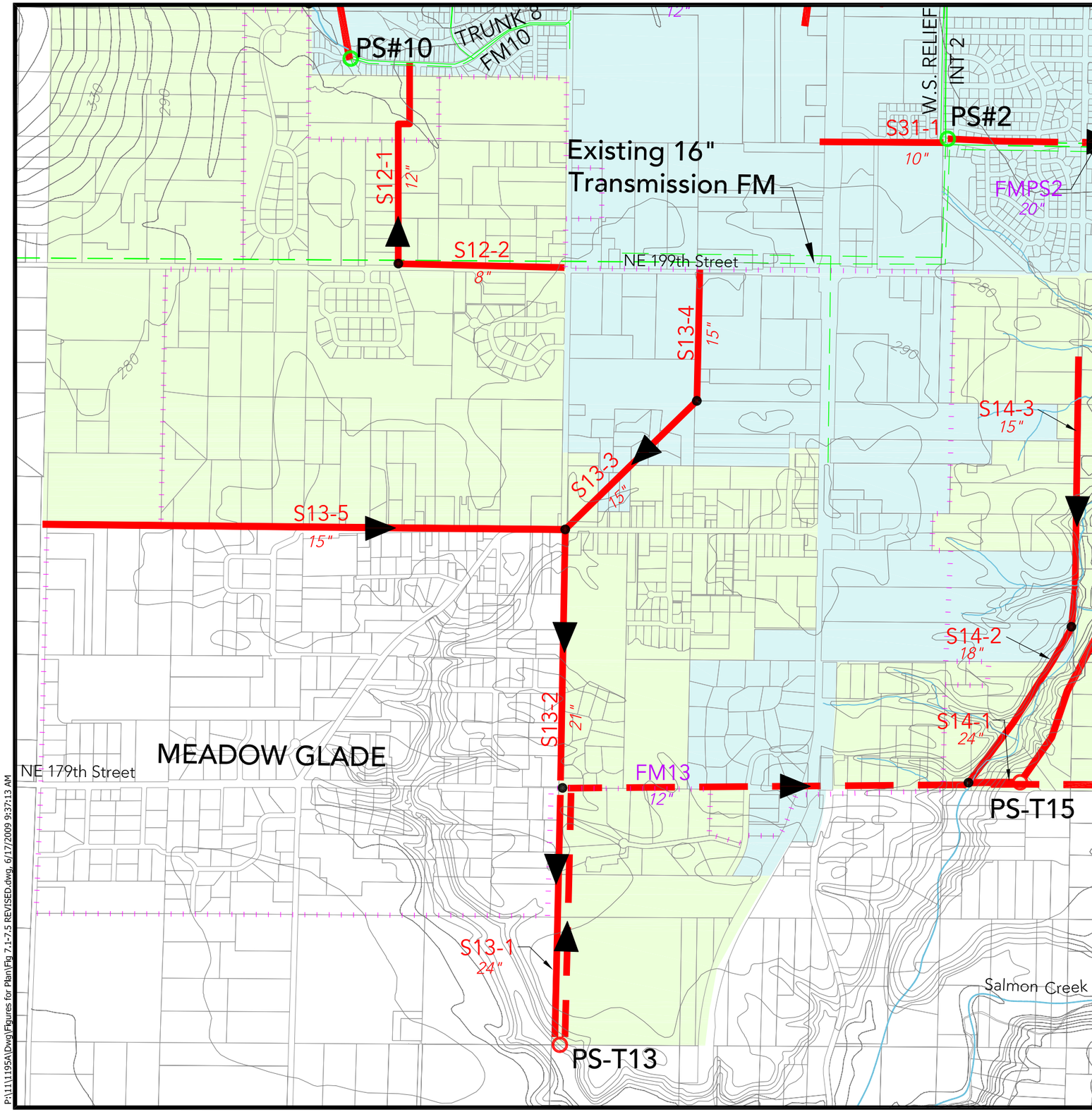
This area comprises the region of the UGA that coincides with the Meadow Glade service area and the region just north of Meadow Glade contributing to Trunk 8 and Pump Station #10. It is recommended that the area be served by gravity sewers and two new pump stations as shown in Figure 7.2.

1. Based upon the proposed land use included in Figure 3.3 it is recommended that gravity sewers be extended through the existing Meadow Glade Service Area. Proposed 24, 15, and 12-inch gravity sewers designated as S13-# are extended along the UGA boundary line to NE 199th Street to serve West/Meadow Glade Service Area. The proposed trunk sewer would discharge into proposed pump station PS-T13, eventually discharging into the proposed PS-T15 pump station through a 12" force main.

2. The region just north of NE 199th Street will be served by a new 12 and 8-inch trunk sewer. The trunk sewer designated as S12-1 and S12-2 will discharge into Trunk 8 and eventually into PS #10.

3. Recent expansions to the UGA to the west and north resulted in 20-year peak flow projections of 9.07 mgd, which exceeds the capacity of the existing Pump Station No. 2. For the purpose of this plan, upgrades to the existing pump station and force main are proposed for the continued discharge of wastewater back to the transmission pump station and reuse facility site. A new 18-inch force main, designated as FM-PS2, will be routed parallel to and will replace the existing 14-inch AC concrete force main back to the transmission site.

4. Also shown in Figure 7.2 is S31-1, one of the two proposed alternate sewers to serve basin 31. Basin 31 is particularly difficult to serve due to generally flat terrain and shallow existing sewers. Without detailed survey information this plan presents two alternative sewers, S31-1 and S31-2. Use of one or both would be sufficient to serve the demand created by the proposed zoning density of Basin 31.



NORTH

NOT TO SCALE

Note: Existing system capacity analysis is limited to 20-year flow projections. Required improvements beyond 20-year planning period are not shown.

KEY

Current Urban Growth Area

City Limits

Existing Meadow Glade Service Area Boundary

Direction of Flow

Size Break

10' Contour

Drainage Way

Abbreviations:

FM	Force Main
PS	Pump Station

	Existing	Proposed
Sanitary Sewer		line size
Force Main		line size
Pump Station		

Figure 7.2: Proposed Collection System Improvements, West/Meadow Glade Subarea

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NORTHWEST SERVICE AREA

This area comprises the northwest corner of the UGA and western improvements north of 11th Street. It is recommended that the area be served by gravity sewers and two new pump stations as shown in Figure 7.3.

1. Future growth immediately south of the existing Pump Station No. 11 is served with a 15-inch sewer designated as S21-1 and S21-2. This line is sized to allow for the abandonment of Pump Station No. 8 and to discharge into the existing 12-inch sewer in Main Street. While 20-year flow projections exceed the capacity of Pump Station No. 8, it is assumed that this bypass sewer will be constructed prior to the need for pump upgrades. Further evaluation of the 12-inch sewer in Main Street will need to be analyzed for available capacity.

2. Sewer S31-2 is shown in this quadrant to serve Basin 31 as discussed above.

3. The existing Lateral 20 is too shallow to serve the northwest corner of the UGA, designated as Basin 5, and has limited capacity to serve the northern upland region within the 20-year planning period. Immediate development in this region can be accomplished by construction of a temporary Pump Station, or gravity main that would discharge into Trunk 6. Capacity analysis of Trunk 6 at the time of construction is required to verify capacity remains available. The temporary pump station would be abandoned when the proposed gravity sewer line S10 is constructed.

4. Drainage Basins 4, 5 and 6 will be served by 24, 21, 18 and 15-inch trunk lines. The 24 and 21-inch lines are sized to allow for the abandonment of PS-#11. The trunk lines will discharge into PS-T10 which discharges through FM10.

5. The existing Trunk 6 has limited capacity to serve the northern upland areas remaining to be developed. Connections beyond available capacity should be routed to the proposed PS-T10. Routing this area to PS-T10 will require the construction of 12 and 10-inch gravity sewers discharging into proposed pump station PS-T2, and eventually into S10-5. When S10 is constructed, sewers north of the trunk line should be diverted into S10-5.

6. The projected 20-year flows for Pump Station No. 11 exceed the current available capacity. For planning purposes it is assumed that pump upgrades will be sufficient improvements. A detailed analysis should be completed if the existing 8-foot diameter wetwell can accommodate larger pumps. A 24-inch interceptor sewer designated as S6-1 would run west from Pump Station No. 11, parallel to SR 502, to the western edge of the UGA. The sewer would be sized for the abandonment of Pump Station No. 11.

7. Development south of Main Street will be served by 18 and 15-inch mains designated as S11-1 and S11-2. This main will discharge into the proposed pump station PS-T10 and be sized for the abandonment of pump station PS #10.

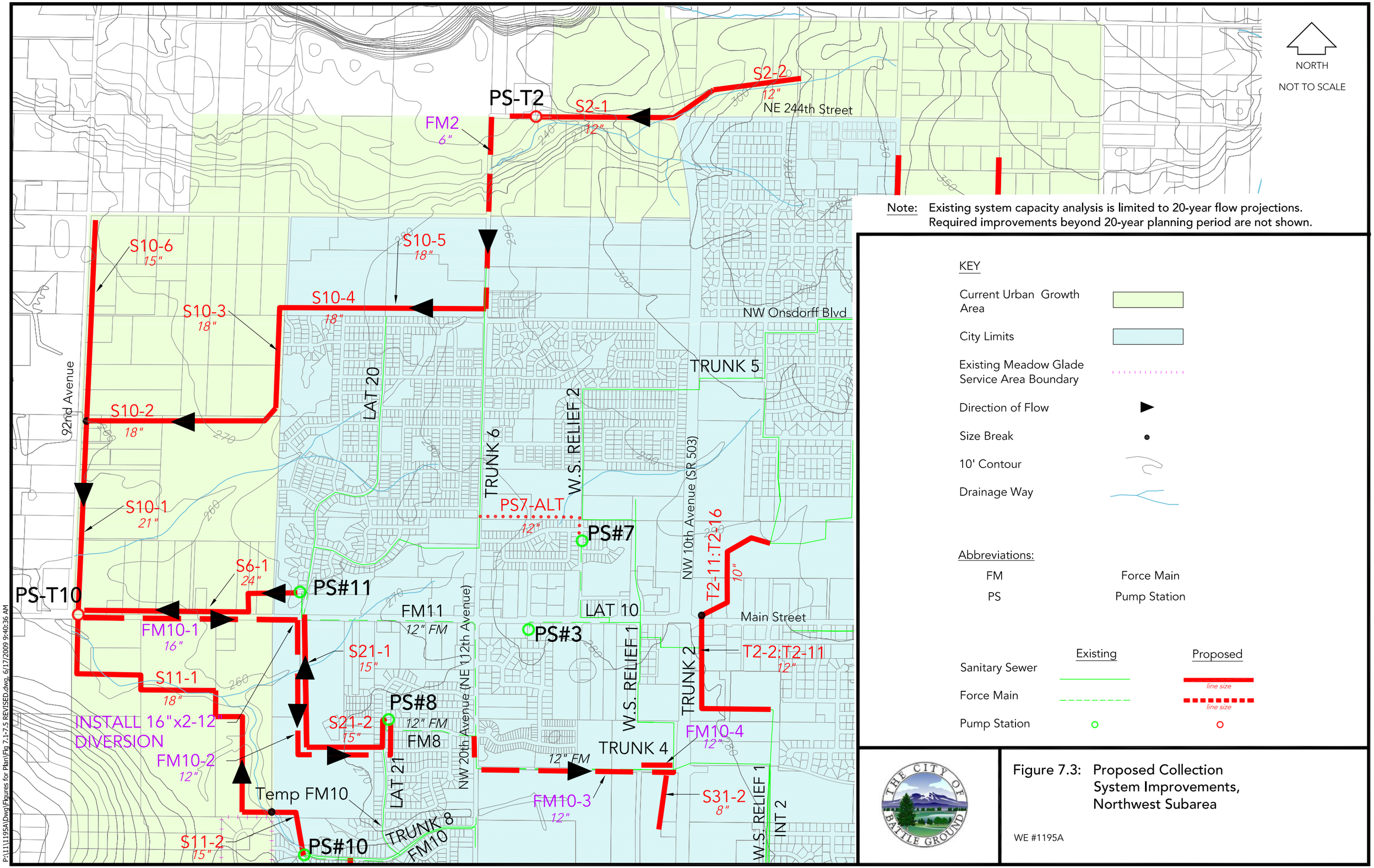

Figure 7.3: Proposed Collection System Improvements, Northwest Subarea

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8. The proposed Pump Station PS-T10 would require a capacity of approximately 9.23 mgd to accommodate the ultimate peak flow projections for the delineated service area. The existing 12-inch force main from Pump Station No. 11 does not have sufficient capacity. Proposed force main improvements include the construction of a 16-inch force main designated as FM10-1 extending from PS-T10 to the existing 12-inch main in Main Street. From there a diversion would be installed and a new 12-inch force main would be constructed paralleling trunk S21 and eventually tie into the existing FM8. An additional force main will also be constructed, designated FM10-3 paralleling the existing FM 11 where FM8 and FM11 currently join and will need to continue to the connection at the West Side Relief Sewer. Note capacities are based upon 8 fps for Pump Station PS-T10, engineering analysis during design will be necessary based upon actual head and pump performance.

9. An alternative sewer designated PS7-ALT is located such that Pump Station No. 7 can be abandoned. Trunk 6 has capacity to receive the 20-year flow projections. The additional flow increases the surcharge in Trunk 6. It is recommended if constructed to also upsize Trunk 6 from the existing 12” to 15” between manholes T6-8 and T6-10.

NORTHEAST SERVICE AREA

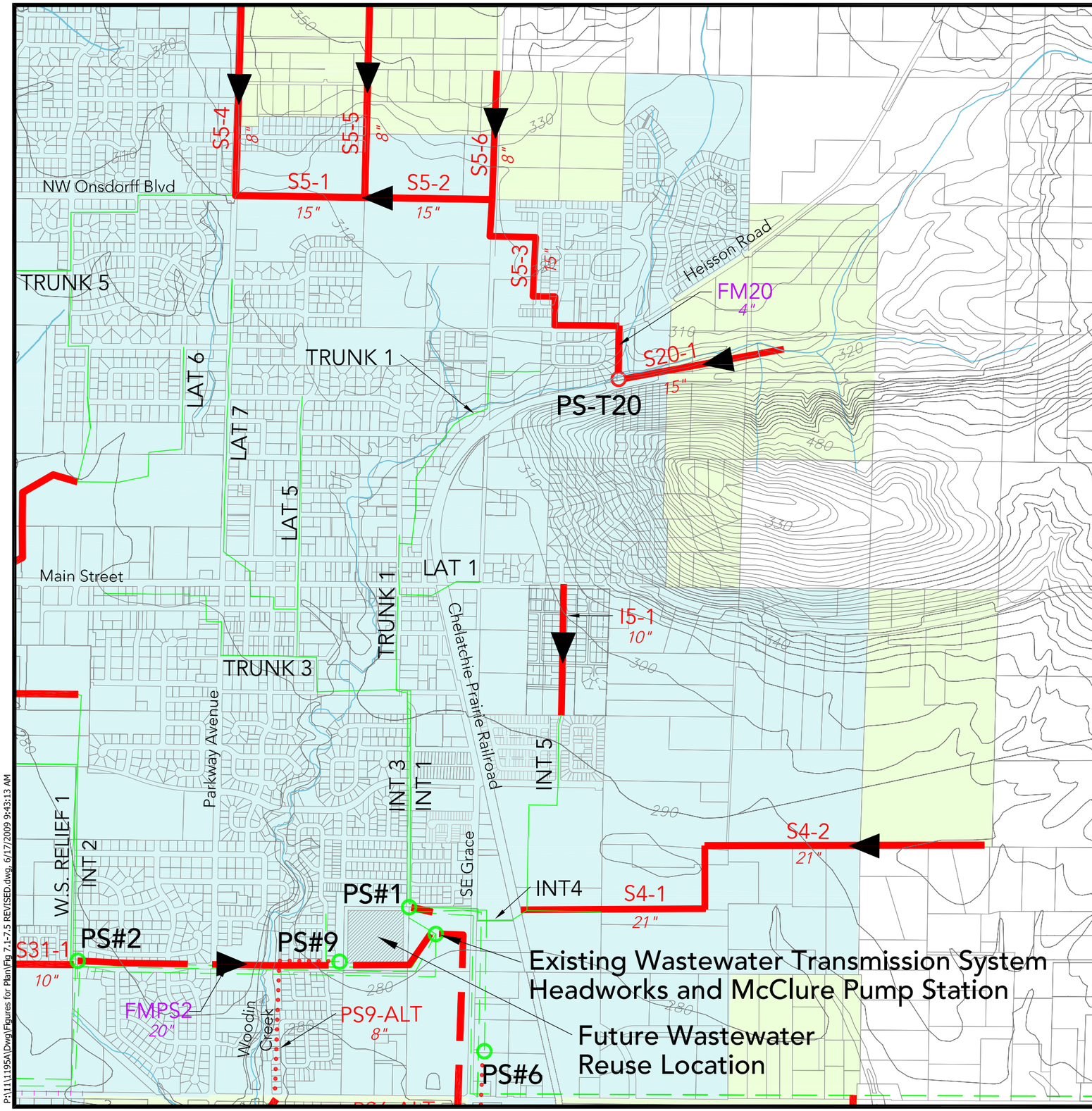
This area comprises the northeast corner of the UGA as described in Section 7. It is recommended that this area be served by a series of gravity sewers and one pump station as shown in Figure 7.4.

1. Capacity analysis of the existing collection system of Pump Station No. 1 indicates that additional flows will need to be routed through the collection system of Pump Station No. 2.

2. To accommodate growth in the northeast area, an extension of Trunk 5 is necessary. That extension is designated as S5-1 through S5-6. These 15 and 8-inch sewers will collect flows from parts of Basins 7, 8, 9 and 10. The improvements have adequate capacity for 20-years. However, buildout conditions may cause surcharging in a section of Trunk 5 which could require a parallel sewer.

3. Development to the east will be accommodated by the proposed gravity sewer S20-1 and Pump Station PS-T20. PS-T20 will discharge into S5-3 and eventually to Pump Station No. 2. S20-1 is oversized to accommodate for future growth to the east. More in-depth analysis of future growth shall be considered at time of development.

4. Development south of Tukes Mountain will be accommodated by proposed 21-inch sewer mains designated as S4-1 and S4-2. These mains were oversized to accommodate for additional UGA expansion eastward.



NORTH

NOT TO SCALE

Note: Existing system capacity analysis is limited to 20-year flow projections. Required improvements beyond 20-year planning period are not shown.

KEY

Current Urban Growth Area

City Limits

Existing Meadow Glade Service Area Boundary

Direction of Flow

Size Break

10' Contour

Drainage Way

Abbreviations:

FM	Force Main
PS	Pump Station

	Existing	Proposed
Sanitary Sewer		line size
Force Main		line size
Pump Station		

Figure 7.4: Proposed Collection System Improvements, Northeast Subarea

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5. Bypassing of existing Lateral 1 flows with the extension of the 10-inch I5-1 sewer will provide additional relief to the downstream Interceptor 1 and 3 sewers currently at capacity. Topographic data for this area is limited. Additional survey and detailed engineering analysis is recommended to verify the feasibility of this alternative. Developments south of the proposed I5-1 installed only portions of 10-inch lines and the remaining south to north pieces were constructed as 8-inch gravity sewer. Conceptual modeling shows that installing S5-1 as a 10-inch line will adequately diminish the surcharge for the 20-year flow projections. However, upsizing of the downstream links will be required under buildout conditions.

SOUTHEAST SERVICE AREA

This area comprises the south and southeast corner of the UGA. It is recommended that this area be served by a series of gravity sewers and two pump stations as shown in Figure 7.5.

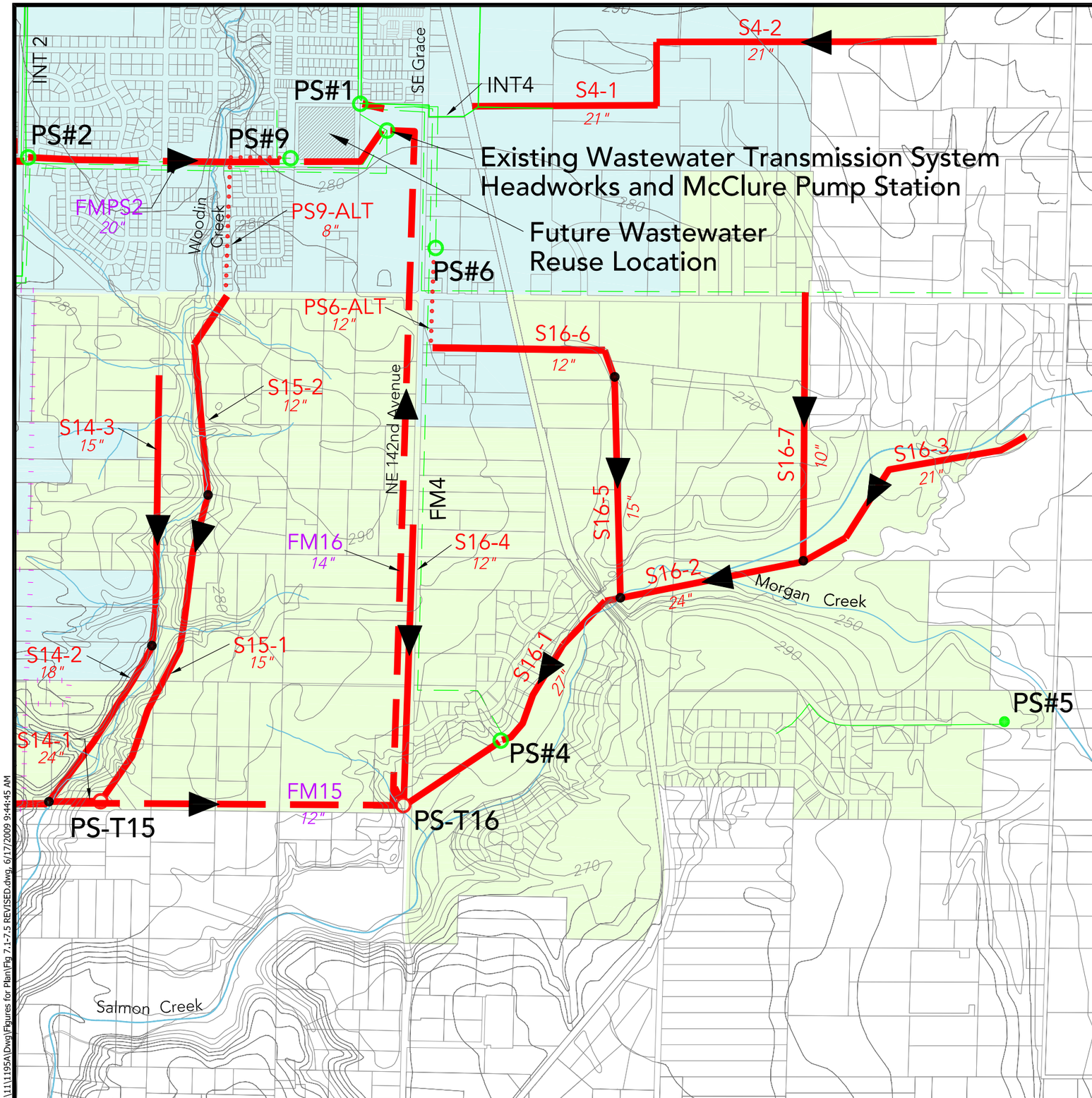
1. The lower southeast portion of the service area, including the Cedars Subdivision, is characterized by steep drainageways to Salmon Creek. The proposed system would include the construction of 27, 24, and 21-inch interceptor sewers extending east from NE 142nd Avenue. These gravity sewers designated S16-1, S16-2, and S16-3 are oversized to accommodate future UGA expansions east.

2. Sewers S16-5 and S16-6 would extend north from the interceptor sewer to serve basins 44 and 46. The sewers are sized for the abandonment of Pump Station No. 6.

3. A 10-inch trunk sewer designated S16-7 is proposed to extend north from the interceptor to serve basin 47.

4. Projected 20-year flows exceed the capacity of the existing Pump Station No. 4. A new pump station PS-T16 is shown at NE 142 Avenue and would be sized to accommodate flows from the existing and proposed pump station in the south area of the UGA. The existing force main does not have capacity to accommodate 20-year flows, therefore the construction of the 14-inch FM16 routed north on NE 142nd back to the transmission pump station is proposed.

5. The south central sub area is characterized by Woodin Creek Drainage. The extension of gravity sewers down this area is recommended. The deep meandering channel complicates construction of a single sewer. To accommodate the terrain and homeowners, gravity sewers will be constructed on both sides of the drainage. 18, 15, and 12-inch gravity sewers will be used to serve basins 41, 42, and 43. These sewers will discharge into the proposed pump station PS-T15 which discharges through a 12” force main into PS-T16. S15-2 is sized to accommodate extension to PS #9 and allow for the abandonment of that facility.



Note: Existing system capacity analysis is limited to 20-year flow projections. Required improvements beyond 20-year planning period are not shown.

KEY

- Current Urban Growth Area
- City Limits
- Existing Meadow Glade Service Area Boundary
- Direction of Flow
- Size Break
- 10' Contour
- Drainage Way

Abbreviations:

FM	Force Main
PS	Pump Station

	Existing	Proposed
Sanitary Sewer		line size
Force Main		line size
Pump Station		

Figure 7.5: Proposed Collection System Improvements, Southeast Subarea

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6. Trunk sewers S16-4, S16-1 and FM15 would discharge into a new pump station PS-T16 which will discharge to the transmission pump station site.

7. Two alternative sewers are recommended that would allow for the abandonment of Pump Stations No. 9 and No. 6. The receiving trunk sewers are sized to allow for the abandonment of these pump station, and abandonment would reduce annual operation and maintenance costs.

SECTION 8

REGIONAL AND LOCAL TREATMENT FACILITY ASSESSMENT

8.1 TREATMENT AND DISPOSAL SYSTEM ASSESSMENT OVERVIEW

As previously discussed, the City of Battle Ground currently disposes of all its wastewater to Clark County's regional wastewater conveyance and treatment system. The City is currently constructing transmission system improvements including a new flow equalization basin and transmission pump station to allow for the abandonment of the existing surge lagoon and increase conveyance system pumping capacity. For the purpose of long-term wastewater treatment and disposal, an evaluation of alternatives has been completed by Kennedy Jenks Consultants included as Appendix H.

8.2 EXISTING TRANSMISSION SYSTEM

The Battle Ground Wastewater Transmission System consists of five major components:

1. A headworks including comminutor which receives flows from pump stations in the Meadow Glade, Hockinson, and Battle Ground collection systems.
2. The McClure Pump Station which receives gravity flow from the headworks.
3. An uncovered 8-acre surge lagoon which temporarily stores surge flows during long-duration high rainfall events.
4. A nine-mile long 16-inch diameter PVC force main which conveys flow from the McClure Pump Station to the Salmon Creek Interceptor.
5. A sulfide control facility which injects Bioxide into the force main.

As previously noted, flow equalization basin and transmission pump station improvements are currently under construction. The new 3.5 million gallon flow equalization basin will be constructed of reinforced concrete with an aluminum roof. The basin floor will be sloped at 2% grade to a center trench which will slope to the wetwell of the new transmission pump station (which is integral to the equalization basin). The equalization basin will be actively ventilated but not scrubbed for odor control or mixed. Provisions will be provided, however, for the future installation of both mixers and a scrubber. The new basin will be connected hydraulically to the existing equalization basin, thus providing a total storage capacity of 4.15 million gallons. The engineering report and final plans / specifications were approved by DOE July 2, 2010. Basin construction is scheduled for completion in October 2011.

The following paragraphs summarize an assessment of the existing transmission system facilities and the new flow equalization basin and transmission pump station upgrades currently under construction.

HEADWORKS

A second comminutor will be installed at the headworks in conjunction with the current improvements project, bringing the total comminution capacity to 16.0 mgd.

TRANSMISSION (MCCLURE) PUMP STATION

The existing transmission pump station has four installed pumps with capacities as noted in Table 4.2. The current peak flow capacity of the facility is estimated at 4.2 mgd. Assuming the largest pump out of service, capacity is reduced to approximately 2.7 mgd. Original station design and construction did not provide 100% standby capacity over the entire range of expected flows due to initial low flow conditions.

The McClure Pump Station will be decommissioned following construction of the new transmission pump station. The new pump station will have a firm capacity of 4.6 mgd. The pump station will be an integral part of the new flow equalization basin, and will utilize submersible pumps.

EQUALIZATION AND SURGE BASINS

The existing McClure Pump Station operates in conjunction with an equalization basin and the 8-acre surge lagoon. The surge lagoon was dredged in 2010 and will be decommissioned following completion of the new 3.5 million-gallon covered concrete equalization basin. The existing concrete lined equalization basin will be retained and will provide an additional 650,000 gallons of storage capacity. A future expansion of the surge basin to 5 million gallons and pumping improvements to 8 mgd will be constructed to accommodate year 2026 design flows as outline in Appendix H.

FORCE MAIN

The existing 16-inch diameter force main has the capacity to accommodate design flows for the current transmission pump station upgrade. A future second parallel 24-inch diameter force main will be constructed to accommodate year 2026 design flows as outline in Appendix H.

SULFIDE CONTROL FACILITY

A new, automated feed system for Bioxide will be implemented in conjunction with the transmission pump station improvements.

8.3 REGIONAL SYSTEM EVALUATION

As discussed in Chapter 4, the City currently discharges its wastewater via a 16-inch force main which discharges to the Clark County Salmon Creek Interceptor where it is conveyed to the Salmon Creek Treatment Plant (SCTP) for treatment and disposal.

Planning issues related to the regional system are being addressed by Clark County and the CRWWD. Current agreements between these agencies and the City are in effect to address regional conveyance and treatment of Battle Ground wastewater. With the completion of the SCTP Phase 4 improvements, the City capacity allocation in the regional facilities includes interceptor system capacity of 10.1 mgd, pump station capacity of 4.47 mgd, force main capacity of 6.3 mgd and treatment / outfall capacity of 3.47 mgd.

Appendix H presents an evaluation of multiple options for future regional treatment versus the option of local treatment. The result of this evaluation is the recommendation of continued participation in regional wastewater conveyance and treatment capacity upgrades. See Appendix H for the detailed analysis of this recommended alternative.

SECTION 9

IMPLEMENTATION AND FINANCING

9.1 GENERAL

The implementation of the General Sewer Plan is highly dependent on a number of factors: rate of growth and associated management policies, costs of improvements, method of financing, and regulator input. Of these, funding is the primary factor under the control of the City, and is thus the focus of discussion in this section of the plan.

9.2 INSTITUTIONAL RESPONSIBILITY

The City of Battle Ground owns and operates the collection system serving the area within the Battle Ground UGA and the Wastewater Transmission System. The City has sole responsibility for the operation, maintenance and improvement activities associated with the collection system and transmission system. It is logical to assume that the City will continue to own and be responsible for the sewer system and its growth throughout the 20-year planning period. Monthly sewer service charges and sewer connection fees are established and collected by the City.

9.3 IMPLEMENTATION SCHEDULE

The following Table 9.1 presents a tentative schedule for proposed improvements. The schedule was based on projected growth rate from the Comprehensive Plan. The schedule was estimated by comparing the capacity of the proposed improvements with the growth rate in their respective basins. Most of the proposed collection system improvements are needed to serve residential growth in areas with large subdivisions under construction. Due to uncertainties regarding the time it will take for homes to build and connect, close monitoring of the growth in the various basins is recommended. As mentioned previously, close monitoring of the growth rate is also recommended for the proposed treatment plant expansion.

Table 9.1
PROPOSED PROJECT IMPLEMENTATION SCHEDULE

Proposed Construction Year	Capital Improvement	Cost ($)
6-Year Capital Improvement Plan		
2007	Sewer Main S5-1 – 1350' of 15-inch gravity sewer	184,000
	Sewer Main S5-2 – 1325' of 15-inch gravity sewer	180,000
	Sewer Main S5-3 – 1900' of 15-inch gravity sewer	389,000
	Sewer Main S5-4 – 2350' of 8-inch gravity sewer	600,000
	Sewer Main S5-5 – 2150' of 8-inch gravity sewer	549,000
2008	Sewer Main S10-5 – 1350' of 18-inch gravity sewer	312,000
	Sewer Main S10-4 – 1400' of 18-inch gravity sewer	324,000
	Sewer Main S21-1 – 1700' of 15-inch gravity sewer	526,000
	Sewer Main S21-2 – 1400' of 15-inch gravity sewer	287,000
	Sewer Main I5-1 – 1350' of 10-inch gravity sewer	389,000
2009	Sewer Main S12-1 – 2200' of 12-inch gravity sewer	276,000
	Sewer Main S12-2 – 1700' of 8-inch gravity sewer	268,000
	Sewer Main S4-1 – 1900' of 21-inch gravity sewer	326,000
	Force Main FM10-3 – 3050' of 12-inch force main	838,000
	Force Main FM10-4 – 450' of 12-inch force main	124,000
2010	Sewer Main S31-1 – 1275' of 10-inch gravity sewer	219,000
	Sewer Main S2-1 – 1750' of 12-inch gravity sewer	503,000
	Pump Station PS-T2 – 340 gpm capacity	500,000
	Force Main FM2 – 3050' of 6-inch force main	369,000
	Trunk 2 Sewer – pipe bursting 1675' of existing 10" sewer	197,000
2011	Sewer Main S31-2 – 700' of 8-inch gravity sewer	111,000
	Sewer Main S2-2 – 1800' of 12-inch gravity sewer	518,000
	Sewer Main S14-2 – 1050' of 18-inch gravity sewer	355,000
	Sewer Main S16-6 – 2050' of 12-inch gravity sewer	589,000
	WRF Phase 1 Improvements	24,800,00
2012	Sewer Main S13-4 – 1350' of 15-inch gravity sewer	184,000
	Sewer Main S6-1 – 2950' of 24-inch gravity sewer	833,000

Proposed Construction Year	Capital Improvement	Cost ($)
2012	Pump Station PS-T10 – 4,090 gpm capacity	1,300,000
	Force Main FM10-1 – 2,900’ of 16-inch force main	514,000
	Force Main FM10-2 – 3,370’ of 12-inch force main	593,000
2013 to 2026 Improvements		
2013 to 2016	Sewer Main S5-6 – 1350’ of 10-inch gravity sewer	367,000
	Sewer Main S10-1 – 2550’ of 21-inch gravity sewer	668,000
	Sewer Main S10-2 – 2550’ of 18-inch gravity sewer	389,000
	Sewer Main S10-3 – 1300’ of 18-inch gravity sewer	301,000
	Sewer Main S11-1 – 4000’ of 18-inch gravity sewer	1,352,000
	Sewer Main S11-2 – 1225’ of 12-inch gravity sewer	379,000
	Sewer Main S14-3 – 2800’ of 15-inch gravity sewer	867,000
	Trunk 2 Sewer – pipe bursting 2150’ of existing 10” sewer	269,000
	PS7-ALT – 1650’ of 12” gravity sewer	307,000
2017 to 2020	Sewer Main S10-6 – 2675’ of 15-inch gravity sewer	548,000
	Sewer Main S13-3 – 1900’ of 15-inch gravity sewer	259,000
	Sewer Main S13-5 – 5300’ of 15-inch gravity sewer	722,000
	Sewer Main S14-1 – 475’ of 24-inch gravity sewer	192,000
	Sewer Main S15-1 – 3400’ of 15-inch gravity sewer	1,052,000
	Sewer Main S15-2 – 1900’ of 12-inch gravity sewer	546,000
	Sewer Main S16-5 – 2300’ of 15-inch gravity sewer	712,000
	Sewer Main S20-1 – 1700’ of 15-inch gravity sewer	526,000
	Pump Station PS-T20 – 50 gpm capacity	450,000
	Force Main FM20 – 850’ of 4-inch force main	116,000
	PS9-ALT – 2050’ of 8” gravity sewer	524,000
	WRF Phase 2 Improvements	13,400,000
2021 to 2024	Sewer Main S4-2 – 3500’ of 21-inch gravity sewer	601,000
	Sewer Main S13-1 – 2600’ of 24-inch gravity sewer	1,049,000
	Sewer Main S13-2 – 2600’ of 21-inch gravity sewer	968,000
	Pump Station PS-T13 – 1215 gpm capacity	1,550,000
	Force Main FM13 – 7150’ of 12-inch force main	1,306,000

Proposed Construction Year	Capital Improvement	Cost ($)
2021 to 2024	Sewer Main S16-1 – 3200' of 27-inch gravity sewer	1,331,000
	Sewer Main S16-2 – 1950' of 24-inch gravity sewer	787,000
	Sewer Main S16-3 – 2800' of 21-inch gravity sewer	1,042,000
	Sewer Main S16-4 – 2850' of 12-inch gravity sewer	819,000
	Sewer Main S16-7 – 2800' of 10-inch gravity sewer	762,000
	Pump Station PS-T16 – 3200 gpm capacity	1,250,000
	Force Main FM16 – 7150' of 14-inch force main	1,852,000
	Pump Station PS-T15 – 1900 gpm capacity	1,450,000
	Force Main FM15 – 3050' of 12-inch force main	555,000
	Force Main FMPS2 – 3800' of 18 -inch force main	1,175,000

Notes:
1. Gravity sewer sizing based on minimum slope, force main at 6-ft/sec velocity.
2. Costs in 2007 dollars. Does not include 40% for engineering, tax and contingency.

9.4 FUNDING OPTIONS FOR CAPITAL IMPROVEMENTS

Funding issues regarding the City's sewerage facilities have historically been addressed in an independent rate study. Connection fees have been utilized to fund new capital improvements that increase system capacity, while monthly rate revenues have been utilized to fund operation and maintenance costs. While this funding structure will likely continue, additional funding options are summarized in the following paragraphs.

LOCAL IMPROVEMENT DISTRICT (LID)

For wastewater collection system expansions, a local improvement district (LID) can be formed for the area to be served. In the LID method of financing, a benefit area is established, and those parcels of property within that area share the cost of improvements constructed to serve the area. Revenue bonds finance the improvements, and property owners within the LID benefit area share in the cost of bond retirement.

BONDS

Wastewater facilities typically require a large one-time expenditure, such as a wastewater treatment plant expansion. These improvements can be financed by a general obligation or revenue bond that is repaid during the life of the new facility. The bond is normally repaid from revenues derived from monthly service charges. Normally, all customers share in the bond

repayment. If bond payments are made from monthly utility charges, the existing citizens effectively finance a proportionate share of the growth. If bond payments are made from future impact fees, then growth pays for itself. Where system development charges are used to retire the bond, these charges should be set sufficiently high to also pay for other system capacity upgrades that will be needed to restore the capacity lost as a result of that development.

CONNECTION CHARGES

Revenues have historically been generated for utility system improvements through the collection of connection charges. As connections to the system are made, a connection fee is charged. Although some of the connection fee may be used to recover costs associated with making the service connection, most of the fee is used to finance capacity upgrades. The rationale behind these fees is that the existing system has a limited amount of excess capacity and that new demands upon the system should pay the cost of providing new capacity. In Battle Ground, connection fees are classified as System Development Charges (SDCs). When charging SDCs, it is important that they be used exclusively for capacity expansions, as opposed to maintenance upgrades.

REVOLVING LOAN FUND PROGRAM

The State of Washington has a program whereby the City can obtain low interest loans to finance utility system improvements. The loan could be paid back with a funding program similar to that used to retire bonds.

DEVELOPER FINANCING

Utility distribution, collection, or even treatment facility improvements could be developer financed. This method of financing for utility line extensions is often used in conjunction with system development charges, whereby the developer is reimbursed for expenditures from future SDCs.

Developer financing typically is used for small collection system upgrades serving the immediate needs of a project. It is difficult to implement major trunk or interceptor sewer construction using developer financing. This relates to the fact that the schedule of a developer project is often much shorter than the time needed to obtain easements and environmental permits for gravity sewers down drainageways.

STATE AND FEDERAL FUNDING PROGRAMS

There are a number of State and Federal funding programs available to finance sewerage facility expansions. The nature of these programs varies with the political climate. The recent trend has been for the availability of funds from these programs to decrease. Another recent trend has been for the funds to be limited to current needs and environmental improvement projects, rather than to finance expansions for future growth.

9.5 POLICY ISSUES ASSOCIATED WITH FINANCING

POLICY ISSUE #1 – PAYING THE COST OF GROWTH

This Plan recommends that elected officials, through a public process, formally adopt a policy in regards to the cost of growth – how the cost of growth should be proportioned between existing taxpayers (ratepayers in the case of sewerage facilities) and new development.

Historically, federal and state funds have been utilized to finance major sewer system expansions. The recent trend has been towards a decreasing availability of federal and state funds. When federal and state grants were utilized for sewer system expansions, the end result was that existing residents helped to finance growth. Often, given the nature of the tax structure, people were unaware that they were financing growth. In many cases, the issue was viewed as one of "water quality" rather than "paying for growth." Now that state and federal funds are limited, there is sensitivity to the question of who pays for growth. It is becoming very important to address sewer-funding issues so that the public can distinguish between those expenditures, which benefit all citizens equally, and those expenditures that exclusively serve new growth.

Operation and maintenance costs clearly benefit all ratepayers, as do capital expenditures for repairs and maintenance-related replacement of existing facilities. The benefit of capital expenditures for capacity upgrades of existing facilities, and collection system expansions into new service areas, is clearly limited to the new ratepayers being served by those expansions. The issue of who pays for growth is clearly a "policy" issue. Although policies vary from one community to next, the most common one is to have growth pay for itself. In such cases, revenue from monthly sewer bills is used to pay for operation and maintenance costs, and utility extensions are funded by either LID, or developer financed with over-sizing for regional needs reimbursed by latecomer agreement or reimbursement of system development charges.

As stated previously, for sewer planning purposes, implementation of the proposed facilities will be dependent upon financing. The method of financing selected by the City largely depends upon two fundamental policy issues associated with the City's role in financing growth: 1) how much, if any, should existing ratepayers pay for the cost of growth; and 2) if a policy of growth paying for itself is adopted by the City, how much risk are existing ratepayers willing to take regarding debt financing?

If elected officials adopt the policy of having growth pay for itself, the issues are simplified. If elected officials adopt a policy of having existing ratepayers finance growth, the issue becomes more complicated when considering the question of the share existing ratepayers should pay.

The method by which existing ratepayers pay for the cost of growth is quite simple – through monthly service charges. Capital improvements are either funded directly through accumulated revenue from service charges, or debt financed with debt retirement from monthly service charges.

Funding programs meeting the requirements of a policy of having growth pay for itself are much more complicated, particularly for collection system improvements. The simplest method of having growth pay for itself is to calculate the improvements necessary to accommodate growth, to calculate the growth in terms of equivalent dwelling units, and to set a system development fee equal to the cost divided by the EDUs. If other methods of financing such as LID or developer financing are utilized, the developer can be credited the proportional amount of system development charge.

Where a policy of growth paying for itself using system development charges is adopted, and a community is faced with a very rapid rate of growth, the issue of "debt" risk becomes important. High growth rates often mean that major expenditures must be made for capital improvements, which results in significant debt. Commonly, the intent is to have that debt retired from revenue generated by future system development fees. If growth and SDC revenue slows, the debt payments must be paid through monthly service charges. Faced with raising monthly sewer fees to help with debt payments, elected officials tend to take action to encourage growth. In such cases, it is often difficult for a community to impose strict development standards. This is why the issue of risk is an important policy issue. If a community adopts a policy of having growth pay for itself, said policy should also address the debt load a community is willing to accept.

POLICY ISSUE #2 – TEMPORARY PUMP STATIONS

This Plan recommends that elected officials, through a public process, formally adopt a policy in regards to the use of temporary pump stations to serve new growth areas.

Wastewater can be either conveyed by gravity sewer, or pump station and force main. Conveyance by gravity sewer is highly preferred, due to the fact that it avoids the high cost of operating and maintaining a pump station and its force main. Considering the cost of operation, maintenance, and equipment replacement, a small pump station costs the City about $20,000 per year. If the force main is long, which requires sulfide control, the cost can approach $50,000 per year. Larger pump stations cost even more.

In some cases, pump stations cannot be avoided. This Plan identifies those pump stations that cannot be reasonably replaced by gravity sewers. It also identifies the location of force mains. The City will almost certainly be faced with developers wanting to serve their developments with temporary pump stations. Given the topography of the area, and the fact that so much of the growth area is currently developed in 5 to 10 acre large lots, allowing temporary pump stations could very easily result in a situation where the City must maintain up to 30 temporary pump stations at an annual cost in excess of $500,000. Therefore, one option is to allow temporary pump stations to facilitate development at the expense of ratepayers. The other option is not to allow temporary pump stations at the expense of landowners wanting to develop their property.

9.6 FUNDING CAPITAL FACILITIES

Currently, Battle Ground finances capital improvements associated with capacity expansion with SDC revenue. This General Sewer Plan, once adopted, will be the basis for a revised calculation of the SDCs based upon the Capital Facilities Plan component of the Comprehensive Plan.

The current SDC for the collection system is $2,068 per EDU. In addition to these charges, there is a Regional Facilities Charge adopted by Clark County for expansion of the Salmon Creek Wastewater Treatment Plant. Currently, this charge is $4,077. The current total connection charge (Regional Facility Charge and General Facility Charge) is $6,145.

Battle Ground previously collected an SDC from Hockinson, but not Meadow Glade. This rate structure was recently revised so that no SDC is charged to either user; however, a usage rate was implemented as a capital and maintenance charge for the wastewater transmission facilities. This rate is billed at $0.29 per 100 cu. ft., which is billed directly to CRWWD based on monthly flow meter recordings.

Although Battle Ground currently relies completely upon SDC financing to fund capacity related capital improvements, it is suggested that consideration be given to LID financing for those improvements associated with gravity sewer extensions down drainage ways. The reason that LID financing may be the best option for these sewers is that it could avoid the cost of interim pump stations. As it stands, a vacant parcel in the basin served by the proposed sewer has one of two options: 1) wait until sufficient demand in the basin develops to join with others and implement developer financing to complete the sewer, 2) construct an interim pump station and the upstream sewer segment needed for that particular parcel, or 3) wait until the city generates the funds to construct the entire sewer. Given the very lengthy time associated with obtaining easements and related environmental permits for sewers down these drainageways, there are significant challenges associated with each of these options. LID financing would avoid many of these challenges.

9.7 FINANCING SYSTEM OPERATION AND MAINTENANCE

Like connection fees, monthly sewer rates are separated into two categories: 1) fees allocated to regional facilities, and 2) fees allocated to local facilities.

The regional component of the monthly operating cost is for wastewater treatment plant operation, including administration costs. The current Clark County monthly charge is $10.74 per EDU. Fees allocated to local facilities (Battle Ground's portion of the monthly service charge) are a function of water usage. Current monthly charges are $14.92 per EDU with an additional charge of $1.10 per 100 cubic feet of water consumption.

Wastewater flows from Hockinson and Meadow Glade are discharged to Battle Ground for transmission to the Salmon Creek Wastewater Management System. As previously discussed,

CRWWD is billed on a monthly basis a flat rate of $0.29 per 100 cu. ft. based on monthly flow meter recordings.

Battle Ground relies upon periodic rate studies to determine the adequacy of rates. Currently, revenue is adequate to cover operating expenses and depreciation. Rates will continue to be updated periodically to provide the necessary revenue for increases in operating costs.

SECTION 10

ENVIRONMENTAL ASSESSMENT

10.1 GENERAL

The environmental impacts associated with the General Sewer Plan will primarily be those related to construction of the proposed collection system and transmission system improvements as identified in this Plan.

10.2 SEPA REQUIREMENTS

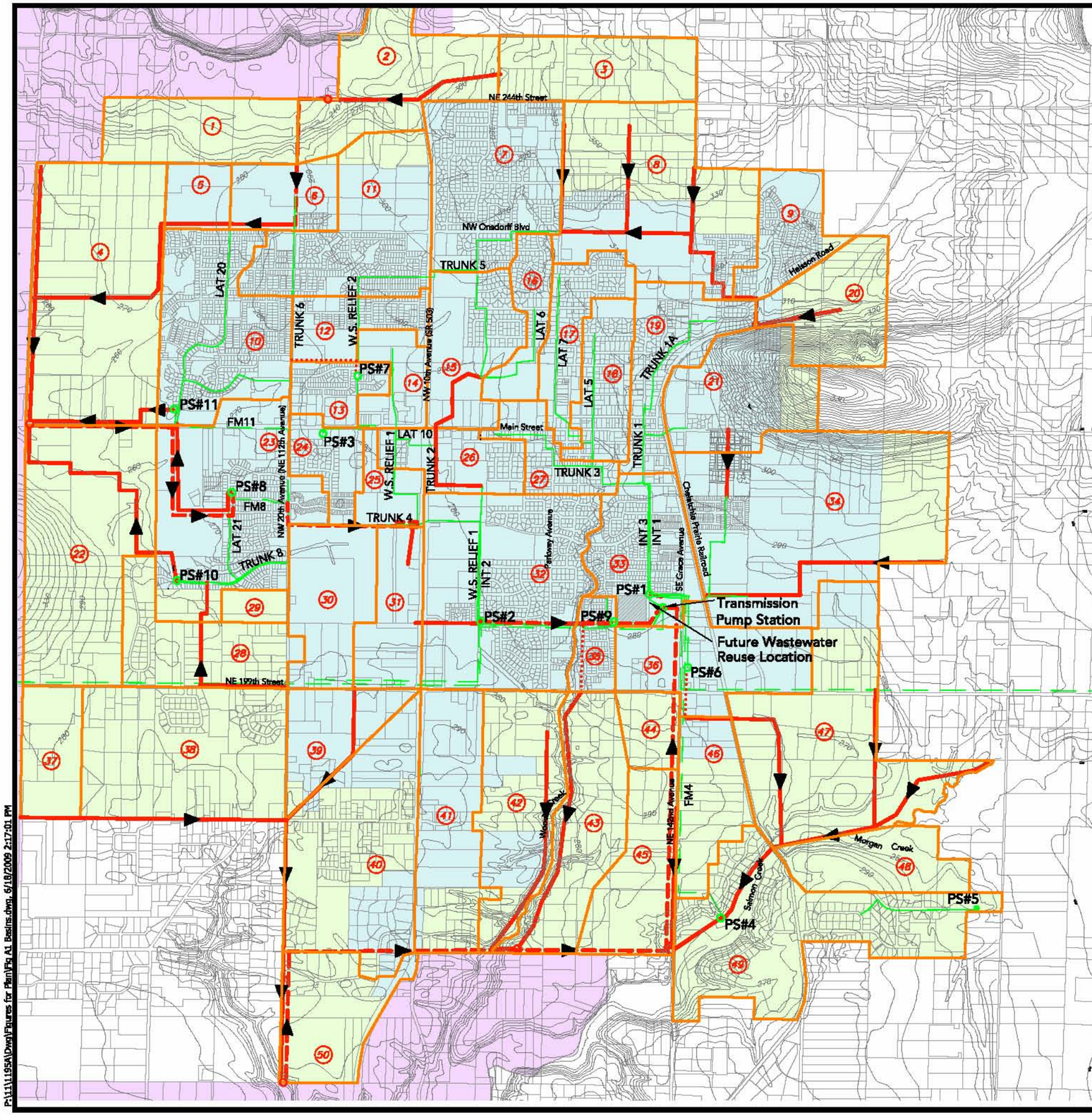
An environmental checklist has been prepared and sent to the proper governmental agencies. A copy of the SEPA checklist and Determination of Non-Significance is included in Appendix F.

10.3 COMPREHENSIVE GROWTH MANAGEMENT PLAN EIS

An Environmental Impact Statement was completed by Clark County in conjunction with the Growth Management planning process. A copy of the EIS Summary is included in Appendix F. The complete EIS document can be viewed at the following link: http://www.co.clark.wa.us/longrangeplan/review/adoption/feis.html.

Appendix A

Collection System Evaluation



NORTH

NOT TO SCALE

KEY

20-Year Urban Growth Area / Urban Reserve		Sewer Service Area Basin Designation	AA
City Limits		Existing Contours	270
Existing Meadow Glade Service Boundary		Existing Sewer Line	
Drainage Basin Boundary		Existing Force Main	
		Existing Pump Station	

THE CITY OF BATTLE GROUND

Figure A1: Sewer Service Area Basin Map

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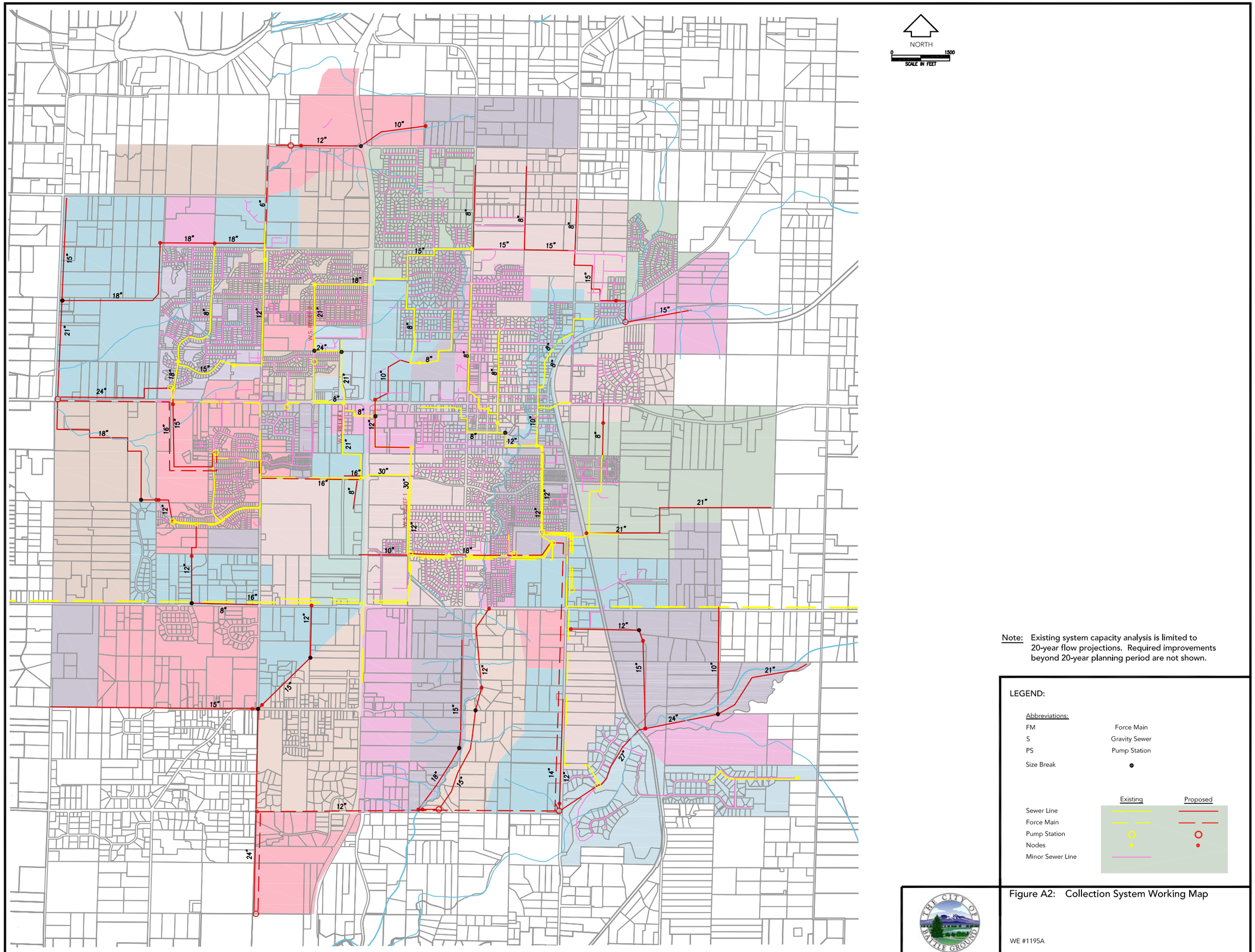

Figure A2: Collection System Working Map

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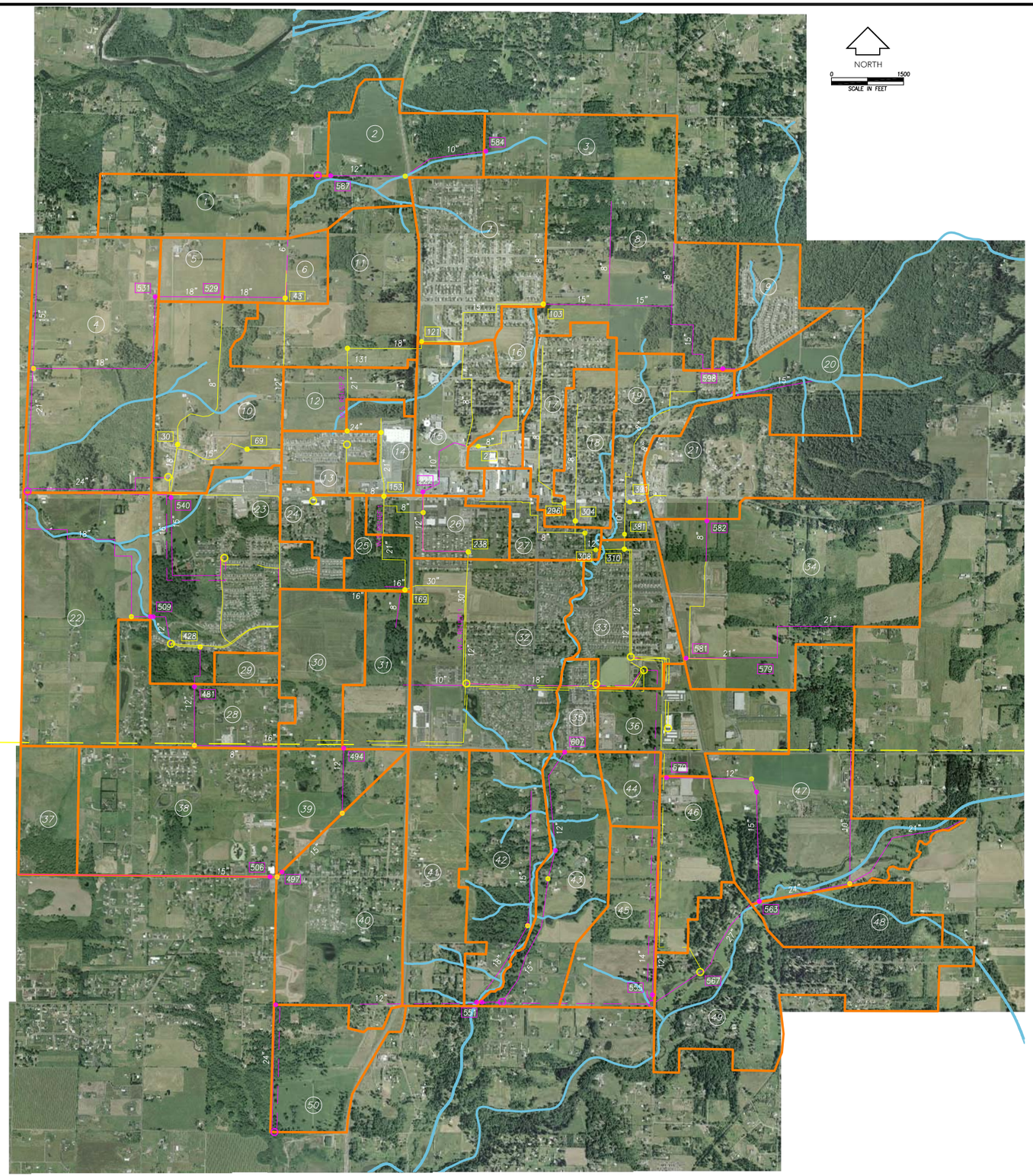

Note: Existing system capacity analysis is limited to 20-year flow projections. Required improvements beyond 20-year planning period are not shown.

LEGEND:

Abbreviations:

FM	Force Main
S	Gravity Sewer
PS	Pump Station

	Existing	Proposed
Basin Number	48	
Basin Boundary		
Size Break		
Sewer Line		
Force Main		
Pump Station		
Nodes		

Figure A4: Aerial Working Map

WE #1195A

Figure A5
Existing Sewer System
Battle Ground General Sewer Plan

June 2009

Legend

- UGA Boundary
- Existing City Limits
- Existing Meadow Glade Service Area Boundary
- Existing Contours
- Existing Sewer Line (size noted)
- Existing Force Main
- Existing Pump Station
- Existing Manhole (ID noted)

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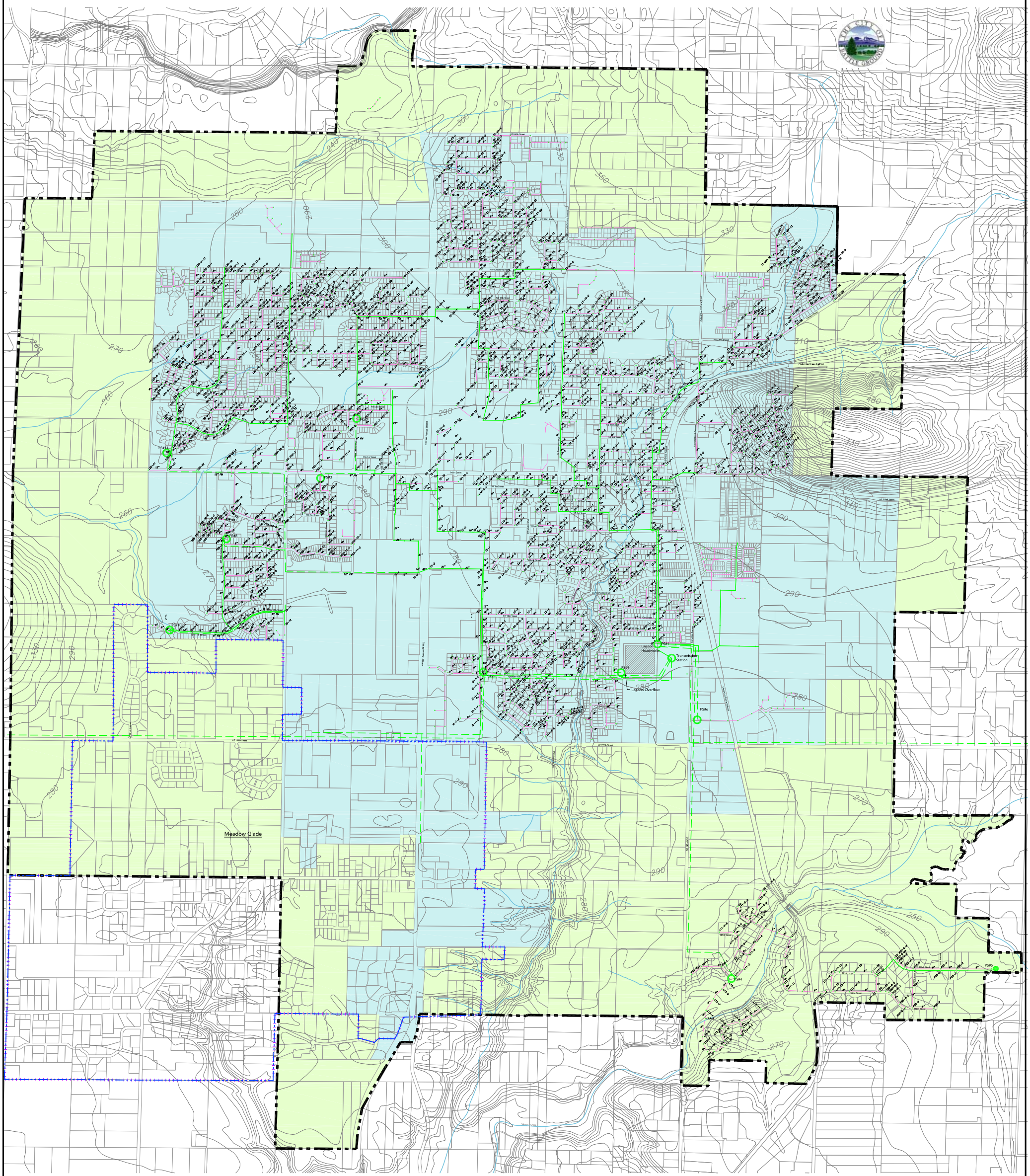
SCALE IN FEET



Appendix B

Sewer System Modeling

APPENDIX B

SEWER SYSTEM MODELING

B.1 OVERVIEW OF THE SEWER MODEL

The collection system was modeled using the modeling program Hydra 6.4. The model was run for three main conditions, the existing collection system, the 20-year collection system, and finally the 20-year collection system was modeled under buildout conditions.

The major components in the model are the collection system, sewer service areas, and land use areas. The collection system component describes the systems conveyance and pump systems. The service area component outlines the hydraulic basins served by each branch of the collection system. The land use component describes the areas of the city, chosen by typography that divides the city into larger hydraulic basins.

B.2 EXISTING COLLECTION SYSTEM

COLLECTION SYSTEM

Information about gravity sewers, manholes, pump stations, and force mains was entered into a collection system database. Information was taken from as-built drawings and from previous models. Where as-built information was not available the pipes were assumed to be at minimum slope.

The model includes 235 gravity pipes, 234 manholes, 1 diversion structure, 4 force mains, and 3 pumps. Hydra assigned a unique ID number to each item in the collection system. A map highlighting the modeled collection is shown as Figure B1.

Data on existing pump station capacities, wetwell volumes and float switch settings were entered into the model. Where pump station information was not known, reasonable estimations were substituted. The pump station information entered into the model is summarized in Table B1.

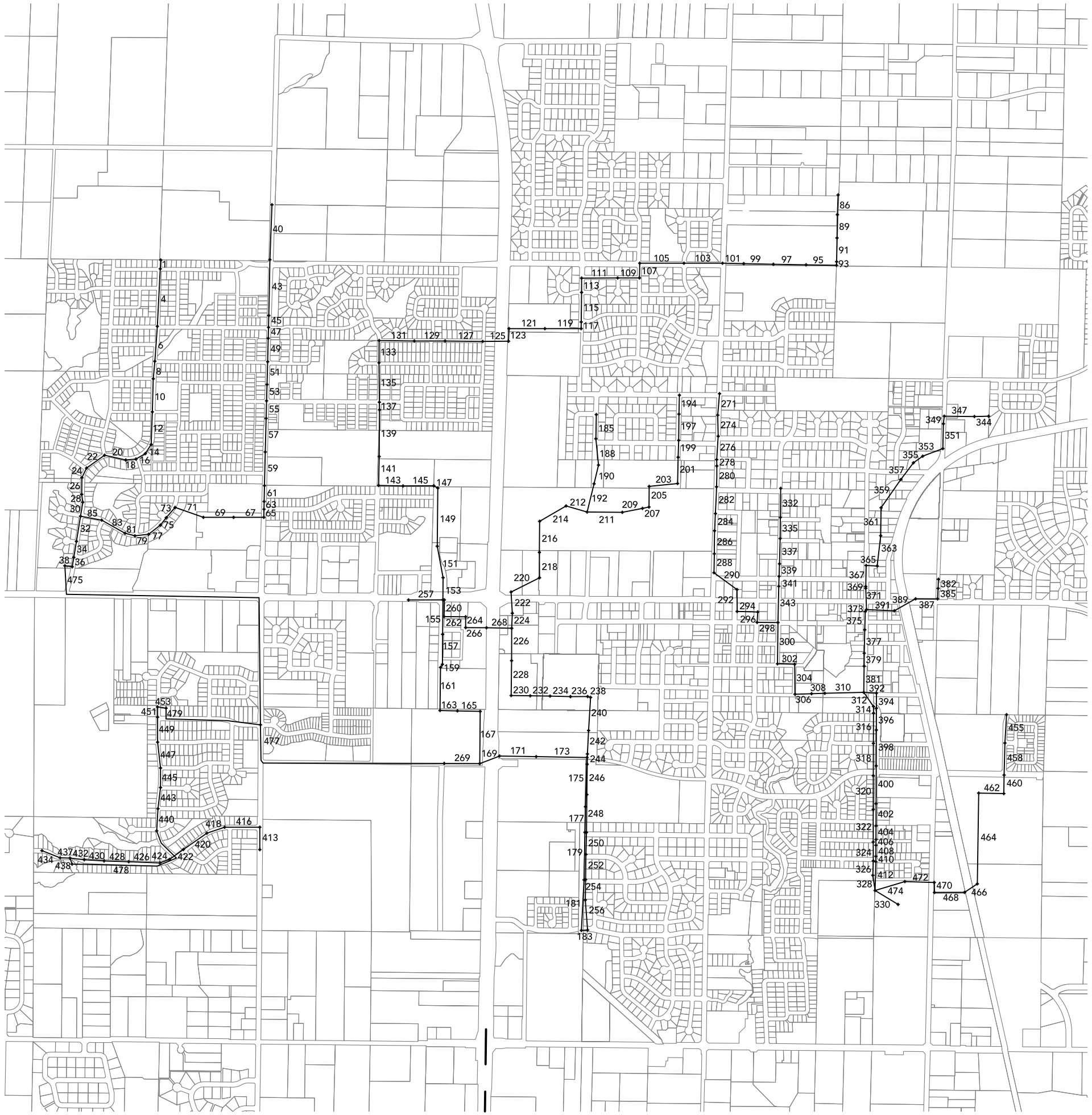


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Figure B1: Existing Collection System Model

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Table B1
PUMP STATION DATA

Pump Station	Capacity (cfs)	Wetwell Volume (gal)	Lead Pump On Volume (cf)	Pumps Off Volume (cf)
Lewisville Meadows	2.95	10,000[a]	1062[a]	20[a]
Winchester Ranch	0.49	486[a]	49[a]	20[a]
Horse Thief Canyon	0.22	264[a]	11[a]	5[a]

Notes:
a. Assumed values

SEWER SERVICE AREAS

A service area defines a discrete drainage basin that discharges to a single pipe or manhole. In unsewered areas, a service area is estimated based on topography, while in sewered areas it is defined by the layout of the system.

The City of Battle Ground hydraulic model contains a service area database with 139 records, representing 139 different locations at which flow is injected into the collection system. Each record contains a field with a unique ID number assigned by Hydra, and a field with the ID number of the collection system item into which the service area injects its flow. A map detailing the modeled sewer service areas is shown as Figure B2.

LAND USE AREAS

The land use areas have been set up as broad drainage basins that serve either major sewer mains, or pump stations. More accurate flow data enabled the model the development of a constant per capita flows and I&I was estimated based upon actual flow data. The land use areas were assigned a residential population based upon EDU distributions and given the constant 80 gpcd. Recent developed areas were assigned 1500 gallons per acre per day (gpad) of I&I where older areas were assigned 2500 gpad of I&I. The only exception occurred in the Battle Ground West (Pump Station No. 3) basin where flow records confirmed I&I larger than 2500 gpad; therefore the Battle Ground West basin was modeled with 6000 gpad of I&I.

In the model, Hydra distributed flows from each land use area to all of the service area contained within the land use area, on an area-proportionate basis. Flows from each service were then injected into the corresponding collection system component. A map of the land use areas was included in Appendix A, with the land use areas being synonymous with drainage basins.

The Battle Ground hydraulic model's land use area database contains 50 records, representing 50 regions of known or determined flow and I&I as determined by pump station records and

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THE CITY OF BATTLE GROUND

Figure B2: Existing Sewer Service Areas

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topography of the proposed 20-year UGA. The existing collection system model only utilizes 20 records.

Each land use area was assigned a population as described in Section 6 and an I&I allocation. Land use characteristics used in the existing system model are summarized in Table B2.

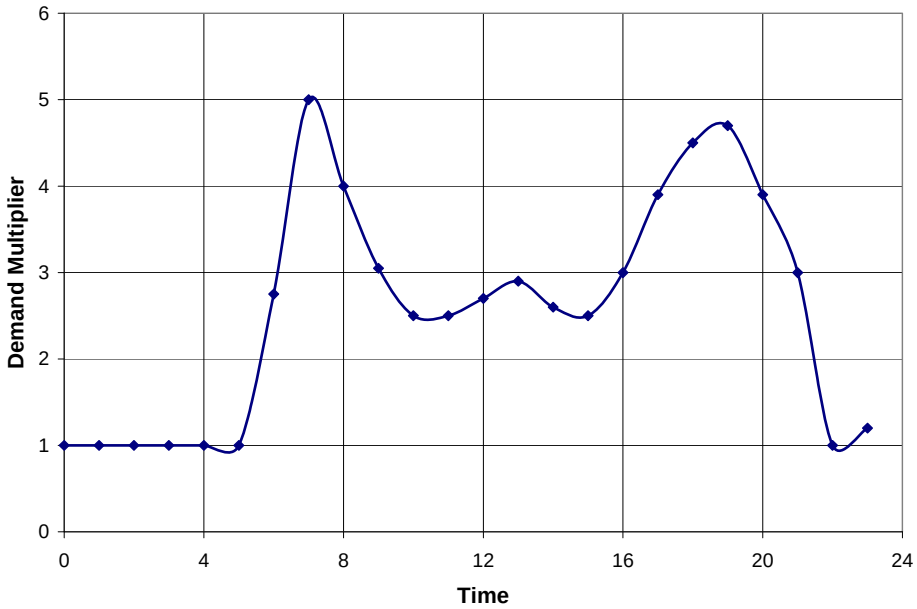
Table B2
EXISTING LAND USE AREA DATA

Drainage Basin	Gross Area (acres)	EDU Allocation	I&I Allocation	
			Developed Acres	Allocation (gpad)
6	69	2	5	1500
7	195	570	154	1500
9	79	200	46	1500
10	198	683	173	1500
11	194	498	111	1500
12	65	164	45	1500
13	47	219	36	2500
14	53	448	28	1500
15	117	373	117	2500
16	57	173	56	2500
17	82	162	79	2500
18	79	169	71	2500
19	113	195	75	1500
21	140	208	82	1500
23	260	469	152	1500
24	52	190	49	6000
26	75	185	70	2500
27	56	88	56	2500
33	127	450	107	2500
35	37	136	34	1500

In addition to population information, each land use are in Hydra is associated with a diurnal flow pattern to simulate peak wastewater production during a dry weather day. A more rigorous approach to modeling would involve flow monitoring at different locations to estimate diurnal

flow patterns in different parts of the city. If more precise results are desired in the future then the hydraulic model can easily be modified to incorporate site-specific flow monitoring results. However, Battle Ground flow monitoring data is only available on the discharge point of the pump stations, so the model used a diurnal flow pattern that was modified from the City of Kalama General Sewer Plan, prepared by Gray & Osborne Inc. A graph of the diurnal curve pattern used is shown in Figure B3.

Figure B3
RESIDENTIAL DIURNAL CURVE



MODEL CALIBRATION

The existing system model was calibrated by comparing the actual peak day flow to the average flow produced by Hydra. The highest recorded rainfall for Battle Ground was 78 inches, and the highest rainfall within the period of complete flow records was 62 inches. The flows produced from Hydra were calibrated to be at least 15% greater than actual flow data to account for the 78-inch rainfall event.

For existing conditions, sewer mains selected for modeling were those whose upstream capacity at 20-year design flow conditions exceeded the capacity of an 8-inch main at minimum slope.

For the 20-year and 50-year flow conditions, sewer main extensions and pump stations were located to fit topographic conditions. Upon final selection of the preferred siting option, proposed sewers were modeled using similar methodologies of allocating EDU's and allocating I&I. The gravity sewers were generally installed at minimum slope and sized for buildout conditions, and pump station and force mains were sized for 20-year projections.

EXISTING MODEL RUN

The existing system model was run in two scenarios. The first scenario was modeled as is, without any improvements. The second scenario modeled Trunk 2 as though the pipe bursting of the sections of pipe was constructed. The two scenarios were compared to ensure that improvements would adequately mitigate the modeled surcharge events. The modeled collection system is shown in Figure B1, and the sewer service areas are shown in Figure B2. The model printout is included in the end of this Appendix.

B.3 2026 COLLECTION SYSTEM

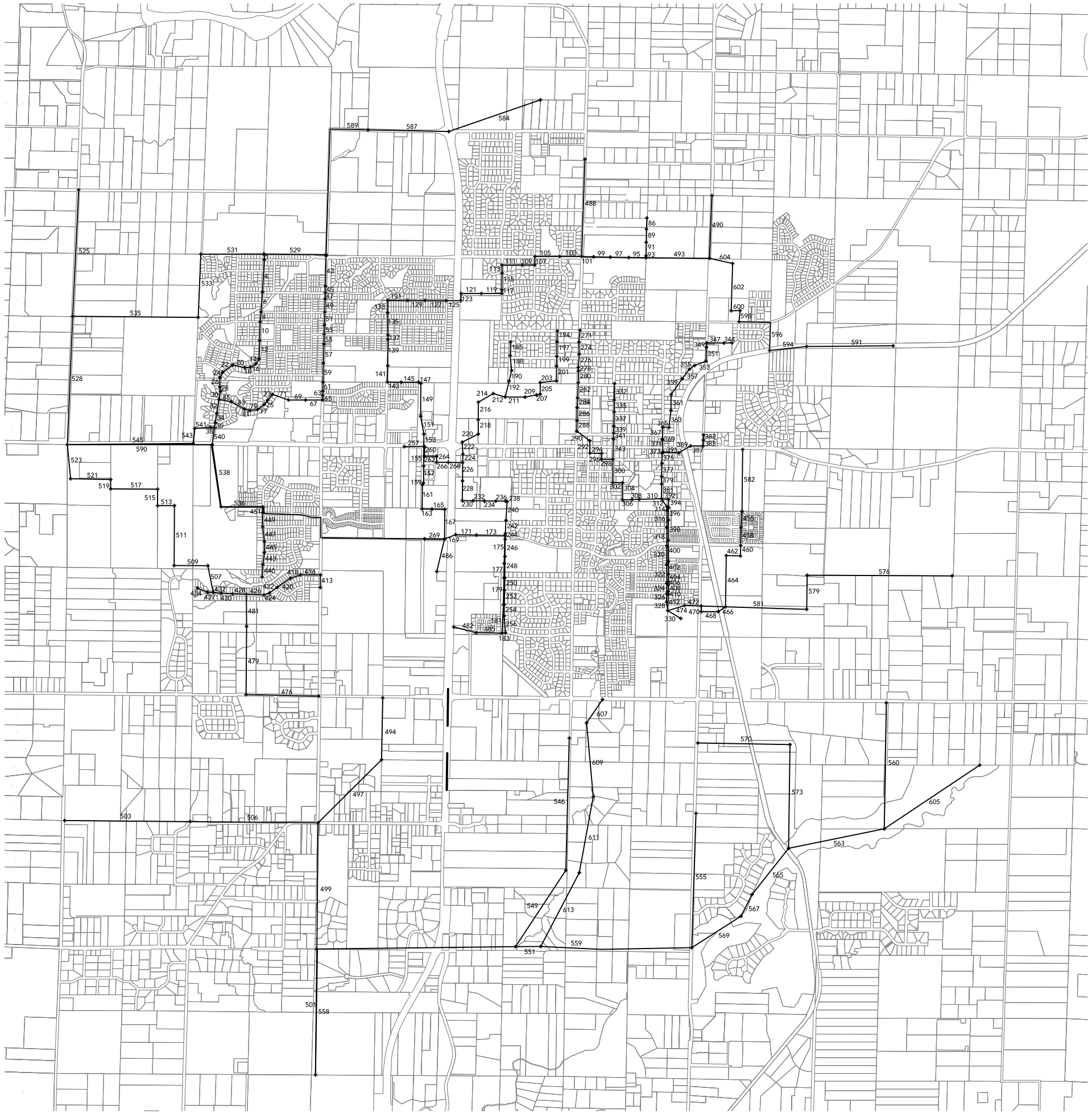
The major existing sewers and proposed improvements were modeled under the 20-year flow conditions. The EDU's were allocated to the land use areas as included in Table B4. EDU growth rate in the developed basins was evaluated based upon current zoning densities and proportioned with the undeveloped land. Existing basins, without developable land were assumed to densify by 10% within 20-years.

Allocation of EDU's beyond the existing city limits were based upon expected developments. It was assumed that the western area of Battle Ground would likely develop at a faster pace than the eastern portions of the UGA. Topographic conditions as well as drainage paths were considered when allocating EDU's to the growth area.

COLLECTION SYSTEM

The 2026 Collection System consists of 296 pipes, 294 manholes, 5 pumps, 5 force mains, and 1 diversion structure. The 20-year model was run first to analyze adequate capacity of the existing system under 20-year flows, and again with the recommended improvements to Trunk 2. A map indicating the modeled 2026 collection system is shown as Figure B4.

The 5 modeled pump stations are proposed pump stations. Thorough engineering design is necessary to size the wetwell, determine pumping capacity and on and off volumes. The assumed values are included in Table B3. The values used were such that the force mains did not exhibit a friction head greater than 50 feet, and with a sufficient capacity so that the flow into the pump station would be transferred downstream to the receiving gravity sewers.



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THE CITY OF BATTLE GROUND

Figure B4: 2026 & Buildout Collection System Model

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Table B3
2026 PUMP STATION DATA

Pump Station	Capacity (cfs)	Wetwell Volume (gal)	Lead Pump On Volume (cf)	Pumps Off Volume (cf)
PS-T2	0.60[a]	1,000[a]	75[a]	20[a]
PS-T10	8.00[a]	1,000[a]	500[a]	20[a]
PS-T13	3.00[a]	1,000[a]	500[a]	20[a]
PS-T15	4.75[a]	1,000[a]	500[a]	20[a]
PS-T20	0.50[a]	1,000 [a]	75[a]	20[a]

Notes:
a. Assumed values

SEWER SERVICE AREAS

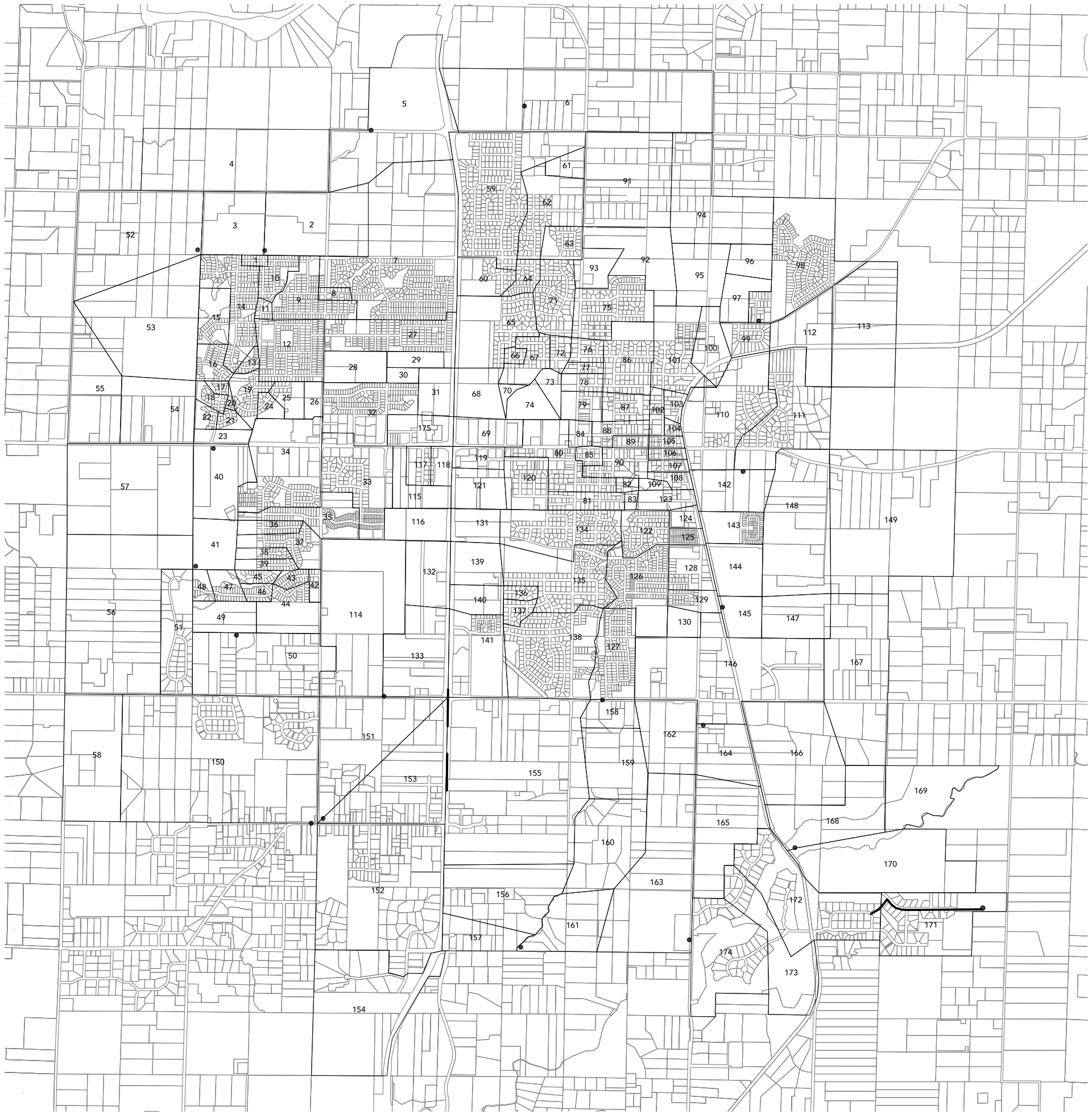
The City of Battle Ground hydraulic model contains a service area database with 175 records, representing 175 different locations at which flow is injected into the collection system. Each record contains a field with a unique ID number assigned by Hydra, and a field with the ID number of the collection system item into which the service area injects its flow. A map detailing the modeled sewer service areas is shown as Figure B5.

LAND USE AREAS

The land use areas have been set up as broad drainage basins that serve either major sewer mains, or pump stations. More accurate flow data enabled the model the development of a constant per capita flows and I&I was estimated based upon actual flow data. The land use areas were assigned a residential population based upon EDU distributions and given the constant 80 gpcd. Recent developed areas were assigned a 1500 gpad of I&I where older areas were assigned 2500 gpad of I&I. The only exception occurred in the Battle Ground West (Pump Station No. 3) basin where flow records confirmed I&I larger than 2500 gpad; therefore the Battle Ground West basin was modeled with 6000 gpad of I&I.

In the model, Hydra distributed flows from each land use area to all of the service area contained within the land use area, on an area-proportionate basis. Flows from each service were then injected into the corresponding collection system component. A map of the land use areas was included in Appendix A, with the land use areas being synonymous with drainage basins.

The Battle Ground hydraulic model's land use area database contains 50 records, representing 50 regions of known or determined flow and I&I as determined by pump station records and typography of the proposed 20-year UGA. The 2026 collection system model utilizes all 50 land use areas.



NORTH

NTS

THE CITY OF BATTLE GROUND

Figure B5: 2026 & Buildout Sewer Service Areas

WE #1195A

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Table B4
2026 LAND USE AREA DATA

Drainage Basin	Gross Area (acres)	EDU Allocation	I&I Allocation	
			Old Developed Acres New Developed Acres	Old Allocation (gpad) New Allocation (gpad)
1	119	150	0 53	2500 1500
2	165	150	0 51	2500 1500
3	120	75	0 23	2500 1500
4	323	1000	0 200	2500 1500
5	40	150	0 28	2500 1500
6	69	2	5 33	2500 1500
7	195	570	154 41	2500 1500
8	281	787	0 185	2500 1500
9	79	200	46 4	2500 1500
10	198	683	173 17	2500 1500
11	194	498	111 55	2500 1500
12	65	164	45 9	2500 1500
13	47	219	36 5	2500 1500
14	53	448	28 3	2500 1500
15	117	373	117 0	2500 1500
16	57	173	56 1	2500 1500
17	82	162	79 3	2500 1500
18	79	169	71 8	2500 1500

Drainage Basin	Gross Area (acres)	EDU Allocation	I&I Allocation	
			Old Developed Acres New Developed Acres	Old Allocation (gpad) New Allocation (gpad)
19	113	195	75 15	2500 1500
20	114	50	0 20	2500 1500
21	140	208	82 24	2500 1500
22	281	350	0 152	2500 1500
23	260	469	152 107	2500 1500
24	52	190	49 3	6000 1500
25	41	75	0 32	2500 1500
26	75	185	70 5	2500 1500
27	56	88	56 0	2500 1500
28	126	300	0 51	2500 1500
29	20	140	0 18	2500 1500
30	117	200	0 22	2500 1500
31	84	120	0 48	2500 1500
32	297	913	222 75	2500 1500
33	127	450	107 18	2500 1500
34	391	900	0 215	2500 1500
35	37	136	34 1	2500 1500
36	138	180	50 27	2500 1500
37	75	30	0 11	2500 1500

Drainage Basin	Gross Area (acres)	EDU Allocation	I&I Allocation	
			Old Developed Acres New Developed Acres	Old Allocation (gpad) New Allocation (gpad)
38	254	300	0 127	2500 1500
39	83	300	0 41	2500 1500
40	255	800	0 143	2500 1500
41	157	400	0 83	2500 1500
42	165	150	0 33	2500 1500
43	159	150	0 32	2500 1500
44	41	75	0 29	2500 1500
45	118	150	0 39	2500 1500
46	96	150	0 44	2500 1500
47	294	250	0 119	2500 1500
48	94	50	0 22	2500 1500
49	277	183	244 24	2500 1500
50	115	60	0 26	2500 1500

2026 MODEL RUN

The 2026 collection system was modeled under two different scenarios. The first scenario allocated the flows from Basin 24 to Lateral 10 through the current force main, and the second scenario modeled the system as though the flows from Pump Station No. 7 were diverted through a new 12” gravity sewer into Trunk 6. The 2026 model does not include all of the upsizing as recommended by the GSP, but is based off of expected 2026 flows. Also, the model was run with the pipe bursting being completed on Trunk 2, therefore assuming project completion within 20-years. The two runs were analyzed and the maximum or worst case scenarios are presented in the model output at the end of this Appendix.

B.4 BUILDOUT COLLECTION SYSTEM

The buildout condition model is set up in the same method that the 2026 model was run, with the exception that the pipe sizing does include upsizing for future expansion, and the results are used to size the proposed improvements. The EDU's per basin were calculated by taking zoning and assumed EDU density per acres and reducing the numbers by 25% for loss due to open space, wetlands, and infrastructure. The EDU's were then inputted into Table B6 with the I&I allocations.

COLLECTION SYSTEM

The buildout collection system consists of 296 pipes, 294 manholes, 5 pumps, 5 force mains, and 1 diversion structure. The model for the buildout model is the same as the 2026 and is included as Figure B.4.

The 5 modeled pump stations are proposed pump stations. Thorough engineering design is necessary to size the wetwell, determine pumping capacity and on and off volumes. The assumed values are included in Table B3. The values used were such that the force mains did not exhibit a friction head greater than 50', and with a sufficient capacity so that the flow into the pump station would be transferred downstream to the receiving gravity sewers.

Table B5
BUILDOUT PUMP STATION DATA

Pump Station	Capacity (cfs)	Wetwell Volume (gal)	Lead Pump On Volume (cf)	Pumps Off Volume (cf)
PS-T2	2.50[a]	1,000[a]	75[a]	20[a]
PS-T10 (dual pumps)	6.00[a] 6.00[a]	1,000[a]	500[a]	20[a]
PS-T13	6.00[a]	1,000[a]	500[a]	20[a]
PS-T15 (dual pumps)	6.00[a] 6.00[a]	1,000[a]	500[a]	20[a]
PS-T20	2.50[a]	1,000 [a]	75[a]	20[a]

Notes:
a. Assumed values

SEWER SERVICE AREAS

The sewer service areas as described above for the 2026 model were utilized for the buildout model.

LAND USE AREAS

The land use areas as described above for the 2026 model were utilized for the buildout model.

Table B6
BUILDOUT LAND USE DATA

Drainage Basin	Gross Area (acres)	EDU Allocation	I&I Allocation	
			Old Developed Acres New Developed Acres	Old Allocation (gpad) New Allocation (gpad)
1	119	334	53 66	2500 1500
2	165	479	51 114	2500 1500
3	120	391	23 97	2500 1500
4	323	1612	200 123	2500 1500
5	40	211	28 12	2500 1500
6	69	417	38 31	2500 1500
7	195	725	195 0	2500 1500
8	281	1194	185 96	2500 1500
9	79	296	50 29	2500 1500
10	198	1182	190 8	2500 1500
11	194	1057	166 28	2500 1500
12	65	391	54 11	2500 1500
13	47	261	41 6	2500 1500
14	53	196	31 22	2500 1500
15	117	395	117 0	2500 1500
16	57	280	57 0	2500 1500

Drainage Basin	Gross Area (acres)	EDU Allocation	I&I Allocation	
			Old Developed Acres New Developed Acres	Old Allocation (gpad) New Allocation (gpad)
17	82	1347	82 0	2500 1500
18	79	400	79 0	2500 1500
19	113	681	90 23	2500 1500
20	114	282	20 94	2500 1500
21	140	692	106 34	2500 1500
22	281	645	152 129	2500 1500
23	260	1347	260 0	2500 1500
24	52	257	52 0	6000 1500
25	41	95	32 9	2500 1500
26	75	217	75 0	2500 1500
27	56	230	56 0	2500 1500
28	126	738	51 75	2500 1500
29	20	153	18 2	2500 1500
30	117	1057	22 95	2500 1500
31	84	208	48 36	2500 1500
32	297	1431	297 0	2500 1500
33	127	824	125 2	2500 1500
34	391	1628	215 176	2500 1500
35	37	196	35 2	2500 1500

Drainage Basin	Gross Area (acres)	EDU Allocation	I&I Allocation	
			Old Developed Acres New Developed Acres	Old Allocation (gpad) New Allocation (gpad)
36	138	321	77 61	2500 1500
37	75	201	11 64	2500 1500
38	254	599	127 127	2500 1500
39	83	598	41 42	2500 1500
40	255	1422	143 112	2500 1500
41	157	751	83 74	2500 1500
42	165	730	0 33	2500 1500
43	159	739	32 127	2500 1500
44	41	104	29 12	2500 1500
45	118	452	39 79	2500 1500
46	96	322	44 52	2500 1500
47	294	614	119 175	2500 1500
48	94	211	22 72	2500 1500
49	277	623	268 9	2500 1500
50	115	265	26 89	2500 1500

BUILDOUT MODEL RUN

The buildout collection system was modeled under one scenario. The model does include the upsizing of Trunk 2 conditions as recommended in the plan. The model assumes that the improvements to abandon Pump Station No. 7 were not completed, but that the improvement PS9-Alt was constructed. Also, the model assumed that the pipe bursting of Trunk 2 was also completed. The model run is included at the end of this Appendix.

Pipe ID	G_ID	Lateral	Length (ft)	Existing Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)			New Diameter	Comments
							2006	Surcharge	Surcharge (w/ Improvements)		
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
1	2	Lateral 20	105	8	0.004	0.7469	0.4146	0	0	0	
4	4	Lateral 20	683	8	0.004	0.7978	0.4675	0	0	0	
6	6	Lateral 20	416	8	0.004	0.8033	0.4849	0	0	0	
8	8	Lateral 20	208	8	0.005	0.8183	0.4848	0	0	0	
10	10	Lateral 20	394	8	0.004	0.7767	0.6661	0	0	0	
12	12	Lateral 20	386	8	0.003	0.6258	0.6748	0.114	0.114	10	Surcharge less than 3' is acceptable
14	14	Lateral 20	129	8	0.003	0.7157	0.6737	0	0	10	
16	16	Lateral 20	128	8	0.004	0.7786	0.6727	0	0	0	
18	18	Lateral 20	122	8	0.004	0.79	0.6781	0	0	0	
20	20	Lateral 20	258	8	0.004	0.7733	0.6767	0.376	0.376	10	Surcharge less than 3' is acceptable
22	22	Lateral 20	262	8	0.004	0.7481	0.8395	0.576	0.576	10	Surcharge less than 3' is acceptable
24	24	Lateral 20	127	8	0.004	0.7678	0.952	0.515	0.515	10	Surcharge less than 3' is acceptable
26	26	Lateral 20	198	8	0.004	0.7888	0.9685	0.44	0.44	10	Surcharge less than 3' is acceptable
28	28	Lateral 20	93	8	0.007	0.9792	0.9651	0.239	0.239	10	Surcharge less than 3' is acceptable
30	30	Lateral 20	169	8	0.004	0.7223	0.9815	0.082	0.082	10	Surcharge less than 3' is acceptable
32	78	Lateral 20	302	18	0.003	5.28	2.0868	0	0	0	
34	80	Lateral 20	193	18	0.002	4.7378	2.0595	0	0	0	
36	82	Lateral 20	113	18	0.003	5.325	2.1159	0	0	0	
38	84	Lateral 20	89	18	0.004	6.4235	2.0978	0	0	0	
40	32	Trunk 6	653	10	0.002	0.9826	0.0147	0	0	0	
43	34	Trunk 6	662	12	0.002	1.5978	0.7388	0	0	0	
45	36	Trunk 6	140	12	0.000	0	0.7505	0	0	0	
47	38	Trunk 6	130	12	0.000	0	0.7497	0	0	0	
49	40	Trunk 6	278	12	0.003	2.0867	0.8587	0	0	0	
51	42	Trunk 6	272	12	0.002	1.734	0.8562	0	0	0	
53	44	Trunk 6	193	12	0.004	2.119	0.8525	0	0	0	
55	46	Trunk 6	208	12	0.002	1.6792	1.1607	0	0	0	
57	48	Trunk 6	399	12	0.003	1.8842	1.1542	0	0	0	
59	50	Trunk 6	400	12	0.003	1.8311	1.1434	0	0	0	
61	52	Trunk 6	188	12	0.003	1.859	1.1299	0	0	0	
63	54	Trunk 6	93	12	0.003	1.9603	1.1383	0	0	0	
65	56	Trunk 6	95	12	0.003	1.8646	1.1295	0	0	0	
67	58	Trunk 6	359	12	0.003	1.9683	1.1605	0	0	0	
69	60	Trunk 6	359	12	0.002	1.7381	1.1402	0	0	0	
71	62	Trunk 6	356	12	0.002	1.5496	1.1412	0	0	0	
73	64	Trunk 6	161	12	0.003	1.8865	1.1161	0	0	0	
75	66	Trunk 6	111	15	0.003	3.5794	1.1233	0	0	0	
77	68	Trunk 6	178	15	0.002	2.6585	1.1199	0	0	0	
79	70	Trunk 6	163	15	0.003	3.4781	1.1172	0	0	0	
81	72	Trunk 6	122	15	0.004	4.1005	1.1359	0	0	0	
83	74	Trunk 6	319	15	0.002	3.0789	1.1407	0	0	0	
85	76	Trunk 6	255	15	0.002	3.1941	1.1376	0	0	0	
86	88	Trunk 5	234	6	0.001	0.1631	0	0	0	0	
89	90	Trunk 5	277	6	0.002	0.2513	0	0	0	0	
91	92	Trunk 5	282	6	0.002	0.2515	0.0012	0	0	0	
93	94	Trunk 5	42	6	0.002	0.2442	0.0012	0	0	0	
95	96	Trunk 5	361	6	0.002	0.2513	0.0012	0	0	0	
97	98	Trunk 5	389	6	0.002	0.2516	0.0028	0	0	0	
99	100	Trunk 5	352	8	0.002	0.5416	0.0027	0	0	0	
101	102	Trunk 5	251	8	0.002	0.5419	0.0027	0	0	0	

Pipe ID	G_ID	Lateral	Length (ft)	Existing Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)			New Diameter	Comments
							2006	Surcharge	Surcharge (w/ Improvements)		
103	104	Trunk 5	458	15	0.002	2.8221	0.0883	0	0	0	
105	106	Trunk 5	524	15	0.001	2.1912	0.4446	0	0	0	
107	108	Trunk 5	175	15	0.002	2.7248	0.6591	0	0	0	
109	110	Trunk 5	259	15	0.002	2.8434	0.6677	0	0	0	
111	112	Trunk 5	428	15	0.002	2.7109	0.9817	0	0	0	
113	114	Trunk 5	170	15	0.002	2.5819	0.9958	0	0	0	
115	116	Trunk 5	351	15	0.002	2.7857	1.02	0	0	0	
117	118	Trunk 5	78	15	0.004	3.8786	1.0137	0	0	0	
119	120	Trunk 5	430	18	0.004	6.8144	1.0094	0	0	0	
121	122	Trunk 5	427	18	0.004	6.6676	1.0372	0	0	0	
123	124	Trunk 5	150	18	0.003	6.0225	1.0245	0	0	0	
125	126	W.S. Relief 2	307	18	0.004	6.7691	1.0171	0	0	0	
127	128	W.S. Relief 2	446	18	0.003	5.645	1.0048	0	0	0	
129	130	W.S. Relief 2	366	18	0.004	6.4692	0.9818	0	0	0	
131	132	W.S. Relief 2	418	18	0.003	5.8255	0.971	0	0	0	
133	134	W.S. Relief 2	263	18	0.003	5.8101	0.9674	0	0	0	
135	136	W.S. Relief 2	468	18	0.003	5.7619	0.9613	0	0	0	
137	138	W.S. Relief 2	91	18	0.001	3.4853	0.9474	0	0	0	
139	140	W.S. Relief 2	554	20	0.001	5.0266	0.9568	0	0	0	
141	142	W.S. Relief 1	344	20	0.001	4.5144	1.0267	0	0	0	
143	144	W.S. Relief 1	290	24	0.001	7.9954	1.0237	0	0	0	
145	146	W.S. Relief 1	365	24	0.001	7.7845	1.0184	0	0	0	
147	148	W.S. Relief 1	55	24	0.001	6.8129	1.0087	0	0	0	
149	150	W.S. Relief 1	691	21	0.001	5.5723	1.0313	0	0	0	
151	152	W.S. Relief 1	380	21	0.002	7.6069	1.0501	0	0	0	
153	154	W.S. Relief 1	263	21	0.002	7.7141	1.0609	0	0	0	
155	198	W.S. Relief 1	408	21	0.002	6.4848	2.0256	0	0	0	
157	200	W.S. Relief 1	357	21	0.002	6.7268	2.0268	0	0	0	
159	202	W.S. Relief 1	43	21	0.026	25.4592	2.0025	0	0	0	
161	204	W.S. Relief 1	512	21	0.002	6.7738	1.9971	0	0	0	
163	206	W.S. Relief 1	207	21	0.002	7.563	1.9665	0	0	0	
165	208	W.S. Relief 1	270	21	0.002	6.6981	1.9465	0	0	0	
167	210	Trunk 4	621	21	0.002	7.0433	1.9392	0	0	0	
169	424	Trunk 4	252	30	0.002	18.868	5.3514	0	0	0	
171	426	Trunk 4	435	30	0.001	14.2136	5.3214	0	0	0	
173	428	Trunk 4	603	30	0.001	14.2134	5.0455	0	0	0	
175	430	W.S. Relief 1	585	30	0.003	21.6412	4.9719	0	0	0	
177	432	W.S. Relief 1	304	30	0.005	28.976	4.9533	0	0	0	
179	434	W.S. Relief 1	564	30	0.002	18.733	4.9401	0	0	0	
181	436	W.S. Relief 1	601	30	0.003	23.4872	4.9374	0	0	0	
183	438	W.S. Relief 1	74	30	0.002	16.549	4.9843	0	0	0	
185	156	Trunk 2	287	8	0.004	0.7637	0.7342	8.808	0.116	10	Improvements reduce surcharge to acceptable limits
188	158	Trunk 2	314	8	0.004	0.7676	0.7342	8.954	0.266	10	Improvements reduce surcharge to acceptable limits
190	160	Trunk 2	229	8	0.005	0.8699	0.7337	9.333	0.648	0	Improvements reduce surcharge to acceptable limits
192	162	Trunk 2	345	8	0.003	0.7058	0.7539	9.333	0.688	10	Improvements reduce surcharge to acceptable limits
194	164	Lateral 6	225	8	0.005	0.858	0.3111	0	0	0	
197	166	Lateral 6	312	8	0.017	1.5844	0.3315	1.199	0	0	Surcharge less than 3' is acceptable
199	168	Lateral 6	200	8	0.005	0.8269	0.3313	2.28	0	0	Surcharge less than 3' is acceptable
201	170	Lateral 6	312	8	0.006	0.9458	0.3547	3.912	0	0	Improvements reduce surcharge to acceptable limits
203	172	Lateral 6	339	8	0.005	0.8193	0.3544	5.292	0	0	Improvements reduce surcharge to acceptable limits
205	174	Lateral 6	245	8	0.004	0.8	0.3843	6.214	0	0	Improvements reduce surcharge to acceptable limits

Pipe ID	G_ID	Lateral	Length (ft)	Existing Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)			New Diameter	Comments
							2006	Surcharge	Surcharge (w/ Improvements)		
207	176	Lateral 6	80	8	0.005	0.8351	0.3833	7.344	0	0	Improvements reduce surcharge to acceptable limits
209	178	Lateral 6	243	8	0.004	0.7657	0.3824	8.122	0	0	Improvements reduce surcharge to acceptable limits
211	180	Lateral 6	418	8	0.004	0.7679	0.4139	9.353	0.541	0	Improvements reduce surcharge to acceptable limits
212	182	Trunk 2	260	8	0.004	0.7594	1.164	10.417	0.685	10	Improvements reduce surcharge to acceptable limits
214	184	Trunk 2	364	8	0.003	0.629	1.2257	11.591	0.725	12	Improvements reduce surcharge to acceptable limits
216	186	Trunk 2	369	8	0.003	0.6909	1.3244	11.906	0.614	12	Improvements reduce surcharge to acceptable limits
218	188	Trunk 2	301	8	0.004	0.7743	1.3184	11.492	0.642	12	Improvements reduce surcharge to acceptable limits
220	190	Trunk 2	378	8	0.003	0.6936	1.3136	12.546	0.652	12	Improvements reduce surcharge to acceptable limits
222	192	Trunk 2	252	10	0.002	0.9185	1.3514	9.68	0.521	15	Improvements reduce surcharge to acceptable limits
224	194	Trunk 2	179	10	0.014	2.5663	1.3425	11.017	2.726	0	Improvements reduce surcharge to acceptable limits
226	222	Trunk 2	385	10	0.003	1.1471	1.9141	11.043	2.726	15	Improvements reduce surcharge to acceptable limits
228	224	Trunk 2	413	10	0.003	1.1688	1.9503	10.183	2.733	15	Improvements reduce surcharge to acceptable limits
230	226	Trunk 2	227	10	0.003	1.1002	1.9381	8.131	2.745	15	Improvements reduce surcharge to acceptable limits
232	228	Trunk 2	235	10	0.003	1.1097	1.9293	6.97	2.71	15	Improvements reduce surcharge to acceptable limits
234	230	Trunk 2	242	10	0.002	1.0932	1.9204	5.795	2.693	15	Improvements reduce surcharge to acceptable limits
236	232	Trunk 2	204	10	0.002	0.9737	1.9921	4.581	2.67	15	Improvements reduce surcharge to acceptable limits
238	234	Trunk 2	36	10	0.003	1.1556	1.9827	3.405	2.574	15	Improvements reduce surcharge to acceptable limits
240	236	Trunk 2	395	12	0.002	1.6959	1.9784	3.294	2.819	15	Improvements reduce surcharge to acceptable limits
242	238	Trunk 2	278	12	0.002	1.6022	2.216	2.971	2.573	15	Surcharge less than 3' is acceptable
244	240	Interceptor 2	122	12	0.001	1.0234	2.3256	2.559	2.223	18	Surcharge less than 3' is acceptable
246	242	Interceptor 2	360	12	0.002	1.7552	2.3146	2.262	1.955	15	Surcharge less than 3' is acceptable
248	244	Interceptor 2	449	12	0.002	1.6767	2.4578	1.528	1.308	15	Surcharge less than 3' is acceptable
250	246	Interceptor 2	261	15	0.001	2.5032	2.4395	0.158	0.078	18	Surcharge less than 3' is acceptable
252	248	Interceptor 2	299	15	0.002	2.5121	2.5564	0.158	0.088	18	Surcharge less than 3' is acceptable
254	250	Interceptor 2	243	15	0.001	2.4229	2.5366	0.142	0.088	18	Surcharge less than 3' is acceptable
256	252	Interceptor 2	356	15	0.001	2.4983	2.7416	0.06	0.027	18	Surcharge less than 3' is acceptable
257	196	Lateral 10	409	8	0.002	0.5684	1.0907	2.529	2.529	12	Surcharge less than 3' is acceptable
260	212	Lateral 10	199	8	0.006	0.9531	0	0	0	0	
262	214	Lateral 10	257	8	0.005	0.8808	0.3078	8.841	2.02	0	Improvements reduce surcharge to acceptable limits
264	216	Lateral 10	129	8	0.004	0.7482	0.5786	9.078	2.257	0	Improvements reduce surcharge to acceptable limits
266	218	Lateral 10	247	8	0.003	0.6805	0.5786	9.333	2.512	0	Improvements reduce surcharge to acceptable limits
268	220	Lateral 10	300	8	0.004	0.7636	0.5784	11.183	3.059	0	Improvements reduce surcharge to acceptable limits
269	422	Trunk 4	422	12	0.017	4.6388	3.8453	0	0	0	
271	254	Lateral 7	254	8	0.004	0.7369	0.406	0	0	0	
274	256	Lateral 7	251	8	0.005	0.875	0.426	0	0	0	
276	258	Lateral 7	278	8	0.005	0.8839	0.4259	0	0	0	
278	260	Lateral 7	76	8	0.005	0.8676	0.4365	0	0	0	
280	262	Lateral 7	247	8	0.004	0.751	0.4608	0	0	0	
282	264	Lateral 7	318	8	0.004	0.7542	0.4604	0	0	0	
284	266	Lateral 7	205	8	0.006	0.9119	0.4845	0	0	0	
286	268	Lateral 7	273	8	0.004	0.7894	0.4837	0	0	0	
288	270	Lateral 7	224	8	0.003	0.6371	0.4985	0	0	0	
290	272	Lateral 7	339	8	0.003	0.7114	0.4967	0	0	0	
292	274	Lateral 7	260	8	0.003	0.6246	0.5064	0	0	0	
294	276	Lateral 7	245	8	0.003	0.662	0.5036	0	0	0	
296	278	Lateral 7	123	8	0.003	0.6993	0.5004	0	0	0	
298	280	Lateral 7	248	8	0.003	0.6617	0.4981	0	0	0	
300	294	Trunk 3	490	10	0.002	1.0122	0.9779	0	0	12	No surcharge does not require immediate attention
302	296	Trunk 3	205	12	0.002	1.6567	1.1855	0	0	0	
304	298	Trunk 3	356	12	0.002	1.5953	1.1788	0	0	0	
306	300	Trunk 3	197	12	0.003	1.8713	1.2745	0	0	0	

Pipe ID	G_ID	Lateral	Length (ft)	Existing Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)			New Diameter	Comments
							2006	Surcharge	Surcharge (w/ Improvements)		
308	302	Trunk 3	157	12	0.002	1.6123	1.2794	0	0	0	
310	304	Interceptor 3	462	12	0.002	1.5495	1.2736	0	0	0	
312	459	Interceptor 3	204	12	0.003	1.87	1.4456	0	0	0	
314	461	Interceptor 3	78	12	0.008	3.2639	1.4384	0.444	0.444	0	Surcharge less than 3' is acceptable
316	463	Interceptor 3	359	12	0.001	1.2933	1.5284	0.444	0.444	15	Surcharge less than 3' is acceptable
318	465	Interceptor 3	385	12	0.002	1.618	1.5125	0.146	0.146	15	Surcharge less than 3' is acceptable
320	467	Interceptor 3	399	12	0.002	1.599	1.4951	0.266	0.266	15	Surcharge less than 3' is acceptable
322	469	Interceptor 3	387	12	0.002	1.6235	1.4763	0.424	0.424	15	Surcharge less than 3' is acceptable
324	471	Interceptor 3	224	12	0.002	1.637	1.4674	0.542	0.542	15	Surcharge less than 3' is acceptable
326	473	Interceptor 3	172	12	0.002	1.5651	1.8858	0.542	0.542	15	Surcharge less than 3' is acceptable
328	475	Interceptor 3	182	12	0.000	0.7937	1.8747	0.053	0.053	18	Surcharge less than 3' is acceptable
330	477	Interceptor 1	320	48	0.020	203.4608	3.4101	0	0	0	
332	282	Lateral 5	345	8	0.009	1.1244	0.4023	0	0	0	
335	284	Lateral 5	251	8	0.005	0.8444	0.4023	0	0	0	
337	286	Lateral 5	300	8	0.005	0.8593	0.4021	0	0	0	
339	288	Lateral 5	148	8	0.003	0.6609	0.427	0	0	0	
341	290	Lateral 5	119	8	0.003	0.6393	0.4267	0	0	0	
343	292	Lateral 5	430	8	0.003	0.6346	0.4707	0	0	0	
344	306	Trunk 1	169	8	0.002	0.542	0.598	0.235	0.235	10	Surcharge less than 3' is acceptable
347	308	Trunk 1	358	8	0.002	0.5395	0.6304	0.131	0.131	10	Surcharge less than 3' is acceptable
349	310	Trunk 1	91	8	0.027	1.9838	0.6296	0	0	0	
351	312	Trunk 1	295	8	0.005	0.876	0.629	0	0	0	
353	314	Trunk 1	256	8	0.005	0.8903	0.6271	0	0	0	
355	316	Trunk 1	136	8	0.005	0.8889	0.6262	0	0	0	
357	318	Trunk 1	251	8	0.007	0.9816	0.7061	0	0	0	
359	320	Trunk 1	407	8	0.005	0.8646	0.7213	0	0	0	
361	322	Trunk 1	331	8	0.004	0.7875	0.7171	0	0	10	No surcharge does not require immediate attention
363	324	Trunk 1	362	8	0.005	0.8937	0.7125	0	0	0	
365	326	Trunk 1	131	8	0.006	0.9172	0.7068	0	0	0	
367	328	Trunk 1	249	10	0.004	1.3997	0.7177	0	0	0	
369	330	Trunk 1	22	10	0.004	1.4203	0.7251	0	0	0	
371	332	Trunk 1	254	10	0.004	1.3933	0.7228	0	0	0	
373	344	Trunk 1	28	10	0.002	1.0199	1.1829	0.002	0.002	12	Surcharge less than 3' is acceptable
375	346	Trunk 1	216	12	0.004	2.1593	1.1798	0	0	0	
377	348	Trunk 1	278	12	0.003	2.0782	1.1963	0	0	0	
379	350	Trunk 1	154	12	0.004	2.3718	1.1862	0	0	0	
381	352	Trunk 1	311	12	0.003	2.0568	1.2306	0	0	0	
382	334	Lateral1	109	8	0.008	1.0525	0.2522	0	0	0	
385	336	Lateral1	125	8	0.006	0.9588	0.446	0	0	0	
387	338	Lateral1	262	8	0.007	1.0245	0.4537	0	0	0	
389	340	Lateral1	289	8	0.005	0.8522	0.4534	0	0	0	
391	342	Lateral1	331	8	0.009	1.1532	0.4519	0	0	0	
392	354	Interceptor 1	151	12	0.004	2.1748	1.4456	0	0	0	
394	356	Interceptor 1	178	12	0.002	1.5845	1.4384	0	0	15	No surcharge does not require immediate attention
396	358	Interceptor 1	260	12	0.002	1.5824	1.4626	0	0	15	No surcharge does not require immediate attention
398	360	Interceptor 1	426	12	0.002	1.6058	1.4769	0.021	0.021	15	Surcharge less than 3' is acceptable
400	362	Interceptor 1	448	12	0.002	1.5657	1.4599	0.132	0.132	15	Surcharge less than 3' is acceptable
402	364	Interceptor 1	264	12	0.002	1.5247	1.5309	0.132	0.132	15	Surcharge less than 3' is acceptable
404	366	Interceptor 1	162	12	0.002	1.4849	1.5153	0.148	0.148	15	Surcharge less than 3' is acceptable
406	368	Interceptor 1	68	12	0.001	1.2245	1.505	0.146	0.146	15	Surcharge less than 3' is acceptable
408	370	Interceptor 1	132	12	0.002	1.5856	1.4949	0.134	0.134	15	Surcharge less than 3' is acceptable

Pipe ID	G_ID	Lateral	Length (ft)	Existing Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)			New Diameter	Comments
							2006	Surcharge	Surcharge (w/ Improvements)		
410	372	Interceptor 1	64	12	0.002	1.4169	1.5262	0.134	0.134	15	Surcharge less than 3' is acceptable
412	374	Interceptor 1	343	12	0.001	1.3648	1.5162	0.051	0.051	15	Surcharge less than 3' is acceptable
413	376	Trunk 8	266	8	0.002	0.5418	0.0774	0	0	0	
416	378	Trunk 8	416	12	0.005	2.4513	0.0774	0	0	0	
418	380	Trunk 8	223	12	0.005	2.4158	0.0888	0	0	0	
420	382	Trunk 8	340	12	0.003	1.8289	0.0887	0	0	0	
422	384	Trunk 8	204	12	0.005	2.6204	0.1021	0	0	0	
424	386	Trunk 8	120	12	0.002	1.5966	0.1019	0	0	0	
426	388	Trunk 8	370	12	0.003	2.0766	0.1128	0	0	0	
428	390	Trunk 8	293	12	0.002	1.7585	0.1473	0	0	0	
430	392	Trunk 8	235	12	0.002	1.5791	0.1464	0	0	0	
432	394	Trunk 8	171	12	0.004	2.2867	0.1453	0	0	0	
434	396	Trunk 8	232	8	0.002	0.5419	0.0431	0	0	0	
437	398	Trunk 8	117	8	0.001	0.4186	0.0431	0	0	0	
438	400	Trunk 8	76	12	0.041	7.2199	0.1873	0	0	0	
440	404	Lateral 21	263	8	0.005	0.8385	0.5155	0	0	0	
443	406	Lateral 21	253	8	0.002	0.5496	0.5401	0	0	10	No surcharge does not require immediate attention
445	408	Lateral 21	232	8	0.005	0.8222	0.5866	0	0	0	
447	410	Lateral 21	309	8	0.004	0.7616	0.6243	0	0	0	
449	412	Lateral 21	298	8	0.004	0.7463	0.6219	0	0	0	
451	414	Lateral 21	121	8	0.005	0.8533	0.7063	0	0	0	
453	416	Lateral 21	102	8	0.006	0.9682	0.9371	0	0	10	No surcharge does not require immediate attention
455	440	Interceptor 5	337	8	0.002	0.502	0	0	0	0	
458	442	Interceptor 5	380	8	0.002	0.5064	0	0	0	0	
460	444	Interceptor 5	220	10	0.002	0.8693	0	0	0	0	
462	446	Interceptor 5	298	10	0.002	0.9039	0	0	0	0	
464	448	Interceptor 5	1077	10	0.002	0.9603	0	0	0	0	
466	450	Interceptor 5	182	10	0.001	0.8303	0	0	0	0	
468	452	Interceptor 4	357	10	0.002	0.9149	0	0	0	0	
470	454	Interceptor 4	118	10	0.002	0.9899	0	0	0	0	
472	456	Interceptor 4	350	12	0.002	1.478	0	0	0	0	
474	458	Interceptor 4	369	12	0.002	1.5977	0.0507	0	0	0	

Notes:

[1] "Tag" field generated by Hydra 6.4 in the Existing Pipe Results Report; cross references Figures B1 and B4
[2] Unique identifier generated by Hydra
[3] Lateral in which the link is part of
[4] Length (in feet) of the link
[5] Existing diameter (in inches) of the link; for proposed improvements it is the modeled diameter
[6] Slope of the link (in ft/ft), as calculated from invert elevations
[7] Capacity of the pipe in full flow in which d/D is 1.0
[8] Peak hour design flow
[9] Surcharge in feet without improvements to Trunk 2
[10] Surcharge in feet with improvements to Trunk 2
[11] Recommended improved diameter, as generated by Hydra
[12] Comments provided by Wallis Engineering addressing the results provided by Hydra

Pipe ID	G_ID	Lateral	Length (ft)	Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter (in)	Comments
							2026 Max	Max Surcharge		
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
1	2	Lateral 20	105	8	0.004	0.7469	0.7192	7.098	10	Additional flow monitoring recommended to determine I&I
4	4	Lateral 20	683	8	0.004	0.7978	0.7765	7.49	10	Additional flow monitoring recommended to determine I&I
6	6	Lateral 20	416	8	0.004	0.8033	0.7909	7.805	10	Additional flow monitoring recommended to determine I&I
8	8	Lateral 20	208	8	0.005	0.8183	0.7907	7.996	10	Additional flow monitoring recommended to determine I&I
10	10	Lateral 20	394	8	0.004	0.7767	0.9886	8.126	10	Additional flow monitoring recommended to determine I&I
12	12	Lateral 20	386	8	0.003	0.6258	0.9878	7.308	12	Additional flow monitoring recommended to determine I&I
14	14	Lateral 20	129	8	0.003	0.7157	0.987	6.529	10	Additional flow monitoring recommended to determine I&I
16	16	Lateral 20	128	8	0.004	0.7786	1.0044	6.143	10	Additional flow monitoring recommended to determine I&I
18	18	Lateral 20	122	8	0.004	0.79	1.0034	5.99	10	Additional flow monitoring recommended to determine I&I
20	20	Lateral 20	258	8	0.004	0.7733	1.0023	5.87	10	Additional flow monitoring recommended to determine I&I
22	22	Lateral 20	262	8	0.004	0.7481	1.2588	5.353	12	Additional flow monitoring recommended to determine I&I
24	24	Lateral 20	127	8	0.004	0.7678	1.3136	3.719	12	Additional flow monitoring recommended to determine I&I
26	26	Lateral 20	198	8	0.004	0.7888	1.3215	2.934	12	Surcharge less than 3' is acceptable
28	28	Lateral 20	93	8	0.007	0.9792	1.3186	1.624	10	Surcharge less than 3' is acceptable
30	30	Lateral 20	169	8	0.004	0.7223	1.3167	0.022	12	Surcharge less than 3' is acceptable
32	328	Lateral 20	302	18	0.003	5.28	3.5859	0	0	
34	330	Lateral 20	193	18	0.002	4.7378	3.5742	0.218	0	Surcharge less than 3' is acceptable
36	332	Lateral 20	113	18	0.003	5.325	3.573	0.608	0	Surcharge less than 3' is acceptable
38	334	Lateral 20	89	18	0.004	6.4235	4.9838	0.949	0	Surcharge less than 3' is acceptable
43	284	Trunk 6	662	12	0.002	1.5978	1.3149	0.114	0	Surcharge less than 3' is acceptable
45	286	Trunk 6	140	12	0.000	0	1.3356	0.114	0	Surcharge less than 3' is acceptable
47	288	Trunk 6	130	12	0.000	0	1.3341	0	0	
49	290	Trunk 6	278	12	0.003	2.0867	1.4867	0	0	
51	292	Trunk 6	272	12	0.002	1.734	1.4843	0	0	
53	294	Trunk 6	193	12	0.004	2.119	1.6416	0.112	0	Surcharge less than 3' is acceptable
55	296	Trunk 6	208	12	0.002	1.6792	1.8321	0.112	15	Surcharge less than 3' is acceptable
57	298	Trunk 6	399	12	0.003	1.8842	1.9025	0.084	15	Surcharge less than 3' is acceptable
59	300	Trunk 6	400	12	0.003	1.8311	1.8906	0.221	15	Surcharge less than 3' is acceptable
61	302	Trunk 6	188	12	0.003	1.859	2.0246	0.341	15	Surcharge less than 3' is acceptable
63	304	Trunk 6	93	12	0.003	1.9603	2.3112	0.245	15	Surcharge less than 3' is acceptable
65	306	Trunk 6	95	12	0.003	1.8646	2.2989	0.042	15	Surcharge less than 3' is acceptable
67	308	Trunk 6	359	15	0.003	3.5687	2.3181	0	0	
69	310	Trunk 6	359	15	0.002	3.1514	2.3476	0	0	
71	312	Trunk 6	356	15	0.002	2.8097	2.3254	0	0	
73	314	Trunk 6	161	15	0.003	3.4204	2.2923	0	0	
75	316	Trunk 6	111	15	0.003	3.5794	2.3017	0	0	
77	318	Trunk 6	178	15	0.002	2.6585	2.2838	0	0	
79	320	Trunk 6	163	15	0.003	3.4781	2.2657	0	0	
81	322	Trunk 6	122	15	0.004	4.1005	2.3158	0	0	
83	324	Trunk 6	319	15	0.002	3.0789	2.2966	0	0	
85	326	Trunk 6	255	15	0.002	3.1941	2.2723	0	0	
86	32	Trunk 5	234	6	0.001	0.1631	0.2766	0.78	8	Surcharge less than 3' is acceptable
89	34	Trunk 5	277	6	0.002	0.2513	0.2766	0.508	8	Surcharge less than 3' is acceptable
91	36	Trunk 5	282	6	0.002	0.2515	0.2756	0.492	8	Surcharge less than 3' is acceptable
93	38	Trunk 5	42	6	0.002	0.2442	0.4297	0.478	8	Surcharge less than 3' is acceptable
95	484	Trunk 5	361	15	0.002	2.8936	1.8855	0	0	
97	486	Trunk 5	389	15	0.002	2.8971	1.8592	0	0	
99	488	Trunk 5	352	15	0.002	2.8954	1.8753	0	0	
101	490	Trunk 5	251	15	0.002	2.8968	1.8333	0.016	0	Surcharge less than 3' is acceptable
103	492	Trunk 5	458	15	0.002	2.8221	2.5897	0.253	18	Surcharge less than 3' is acceptable
105	494	Trunk 5	524	15	0.001	2.1912	2.5719	0.253	18	Surcharge less than 3' is acceptable
107	496	Trunk 5	175	15	0.002	2.7248	2.6884	0.153	18	Surcharge less than 3' is acceptable

Pipe ID	G_ID	Lateral	Length (ft)	Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter (in)	Comments
							2026 Max	Max Surcharge		
109	498	Trunk 5	259	15	0.002	2.8434	2.7051	0.18	18	Surcharge less than 3' is acceptable
111	500	Trunk 5	428	15	0.002	2.7109	2.6707	0.204	18	Surcharge less than 3' is acceptable
113	502	Trunk 5	170	15	0.002	2.5819	3.1544	0.304	18	Surcharge less than 3' is acceptable
115	504	Trunk 5	351	15	0.002	2.7857	3.1298	0.066	18	Surcharge less than 3' is acceptable
117	506	Trunk 5	78	15	0.004	3.8786	3.0931	0	0	
119	508	Trunk 5	430	18	0.004	6.8144	3.0825	0	0	
121	510	Trunk 5	427	18	0.004	6.6676	3.047	0	0	
123	512	Trunk 5	150	18	0.003	6.0225	3.0112	0	0	
125	514	Trunk 5	307	18	0.004	6.7691	2.9875	0	0	
127	516	W.S. Relief 2	446	18	0.003	5.645	2.9749	0	0	
129	518	W.S. Relief 2	366	18	0.004	6.4692	2.9663	0	0	
131	520	W.S. Relief 2	418	18	0.003	5.8255	2.9532	0	0	
133	522	W.S. Relief 2	263	18	0.003	5.8101	2.9357	0	0	
135	524	W.S. Relief 2	468	18	0.003	5.7619	2.9189	0	0	
137	526	W.S. Relief 2	91	18	0.001	3.4853	2.9157	0	0	
139	528	W.S. Relief 2	554	20	0.001	5.0266	2.9292	0	0	
141	530	W.S. Relief 2	344	20	0.001	4.5144	3.033	0	0	
143	532	W.S. Relief 2	290	24	0.001	7.9954	3.0177	0	0	
145	534	W.S. Relief 1	365	24	0.001	7.7845	3.0157	0	0	
147	536	W.S. Relief 1	55	24	0.001	6.8129	3.0467	0	0	
149	538	W.S. Relief 1	691	21	0.001	5.5723	3.0419	0	0	
151	540	W.S. Relief 1	380	21	0.002	7.6069	3.0617	0	0	
153	542	W.S. Relief 1	263	21	0.002	7.7141	3.0555	0	0	
155	544	W.S. Relief 1	408	21	0.002	6.4848	3.8205	0	0	
157	546	W.S. Relief 1	357	21	0.002	6.7268	3.807	0	0	
159	548	W.S. Relief 1	43	21	0.026	25.4592	3.7972	0.26	0	Surcharge less than 3' is acceptable
161	550	W.S. Relief 1	512	21	0.002	6.7738	3.8987	0	0	
163	552	W.S. Relief 1	207	21	0.002	7.563	3.9163	0	0	
165	554	W.S. Relief 1	270	21	0.002	6.6981	3.9099	0	0	
167	556	Trunk 4	621	21	0.002	7.0433	3.9	0	0	
169	558	Trunk 4	252	30	0.002	18.868	11.9803	0	0	
171	560	Trunk 4	435	30	0.001	14.2136	12.521	0	33	No surcharge does not require immediate attention
173	562	Trunk 4	603	30	0.001	14.2134	12.5085	0	33	No surcharge does not require immediate attention
175	564	W.S. Relief 1	585	30	0.003	21.6412	12.4779	0	0	
177	566	W.S. Relief 1	304	30	0.005	28.976	12.5484	0.35	0	Surcharge less than 3' is acceptable
179	568	W.S. Relief 1	564	30	0.002	18.733	12.558	0	0	
181	570	W.S. Relief 1	601	30	0.003	23.4872	12.5208	0	0	
183	572	W.S. Relief 1	74	30	0.002	16.549	12.7167	0	0	
185	40	Trunk 2	287	8	0.004	0.7637	0.6736	0.43	10	Surcharge less than 3' is acceptable
188	42	Trunk 2	314	8	0.004	0.7676	0.6736	0.761	10	Surcharge less than 3' is acceptable
190	44	Trunk 2	229	8	0.005	0.8699	0.7468	1.113	0	Surcharge less than 3' is acceptable
192	46	Trunk 2	345	8	0.003	0.7058	0.756	1.153	10	Surcharge less than 3' is acceptable
194	48	Lateral 6	225	8	0.005	0.858	0.3751	0	0	
197	50	Lateral 6	312	8	0.017	1.5844	0.3751	0	0	
199	52	Lateral 6	200	8	0.005	0.8269	0.3748	0	0	
201	54	Lateral 6	312	8	0.006	0.9458	0.4038	0	0	
203	56	Lateral 6	339	8	0.005	0.8193	0.4034	0	0	
205	58	Lateral 6	245	8	0.004	0.8	0.4026	0	0	
207	60	Lateral 6	80	8	0.005	0.8351	0.4654	0	0	
209	62	Lateral 6	243	8	0.004	0.7657	0.4641	0	0	
211	64	Trunk 2	418	8	0.004	0.7679	0.462	0.999	0	Surcharge less than 3' is acceptable
212	66	Trunk 2	260	10	0.004	1.3768	1.2139	1.079	12	Surcharge less than 3' is acceptable

Pipe ID	G_ID	Lateral	Length (ft)	Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter (in)	Comments
							2026 Max	Max Surcharge		
214	68	Trunk 2	364	10	0.003	1.1405	1.3074	1.119	12	Surcharge less than 3' is acceptable
216	70	Trunk 2	369	10	0.003	1.2527	1.2997	0.849	12	Surcharge less than 3' is acceptable
218	72	Trunk 2	301	10	0.004	1.4039	1.3787	0.809	12	Surcharge less than 3' is acceptable
220	74	Trunk 2	378	10	0.003	1.2576	1.3687	0.819	12	Surcharge less than 3' is acceptable
222	76	Trunk 2	252	12	0.002	1.4935	1.3983	0.516	15	Surcharge less than 3' is acceptable
224	78	Trunk 2	179	12	0.014	4.1731	1.3854	2.697	0	Surcharge less than 3' is acceptable
226	92	Trunk 2	385	12	0.003	1.8653	1.8055	2.762	15	Surcharge less than 3' is acceptable
228	94	Trunk 2	413	12	0.003	1.9005	1.7857	2.938	15	Surcharge less than 3' is acceptable
230	96	Trunk 2	227	12	0.003	1.789	1.7637	2.993	15	Surcharge less than 3' is acceptable
232	98	Trunk 2	235	12	0.003	1.8046	1.7457	3.071	15	Additional flow monitoring recommended to determine I&I
234	100	Trunk 2	242	12	0.002	1.7776	1.7264	3.145	15	Additional flow monitoring recommended to determine I&I
236	102	Trunk 2	204	12	0.002	1.5833	1.7227	3.185	15	Additional flow monitoring recommended to determine I&I
238	104	Trunk 2	36	12	0.003	1.8792	1.7705	3.231	15	Additional flow monitoring recommended to determine I&I
240	106	Trunk 2	395	12	0.002	1.6959	1.9634	3.481	15	Additional flow monitoring recommended to determine I&I
242	108	Trunk 2	278	12	0.002	1.6022	2.449	3.177	15	Additional flow monitoring recommended to determine I&I
244	110	Interceptor 2	122	12	0.001	1.0234	2.4347	2.527	18	Surcharge less than 3' is acceptable
246	112	Interceptor 2	360	12	0.002	1.7552	2.4207	2.18	15	Surcharge less than 3' is acceptable
248	114	Interceptor 2	449	12	0.002	1.6767	2.4835	1.304	15	Surcharge less than 3' is acceptable
250	116	Interceptor 2	261	15	0.001	2.5032	2.4805	0	18	No surcharge does not require immediate attention
252	118	Interceptor 2	299	15	0.002	2.5121	2.4573	0.011	18	Surcharge less than 3' is acceptable
254	120	Interceptor 2	243	15	0.001	2.4229	2.4614	0.011	18	Surcharge less than 3' is acceptable
256	122	Interceptor 2	356	15	0.001	2.4983	2.457	0	18	No surcharge does not require immediate attention
257	80	Lateral 10	409	8	0.002	0.5684	1.0281	1.517	12	Surcharge less than 3' is acceptable
260	82	Lateral 10	199	8	0.006	0.9531	0.3153	0	0	
262	84	Lateral 10	257	8	0.005	0.8808	0.3153	0.998	0	Surcharge less than 3' is acceptable
264	86	Lateral 10	129	8	0.004	0.7482	0.3454	1.424	0	Surcharge less than 3' is acceptable
266	88	Lateral 10	247	8	0.003	0.6805	0.3452	2.043	0	Surcharge less than 3' is acceptable
268	90	Lateral 10	300	8	0.004	0.7636	0.3449	3.03	0	
269	124	Trunk 4	422	12	0.017	4.6388	0	0	0	
271	126	Lateral 7	254	8	0.004	0.7369	0.4161	0	0	
274	128	Lateral 7	251	8	0.005	0.875	0.4384	0	0	
276	130	Lateral 7	278	8	0.005	0.8839	0.4382	0	0	
278	132	Lateral 7	76	8	0.005	0.8676	0.4495	0	0	
280	134	Lateral 7	247	8	0.004	0.751	0.4707	0	0	
282	136	Lateral 7	318	8	0.004	0.7542	0.5034	0	0	
284	138	Lateral 7	205	8	0.006	0.9119	0.5025	0	0	
286	140	Lateral 7	273	8	0.004	0.7894	0.5016	0	0	
288	142	Lateral 7	224	8	0.003	0.6371	0.5179	0	0	
290	144	Lateral 7	339	8	0.003	0.7114	0.516	0	0	
292	146	Lateral 7	260	8	0.003	0.6246	0.5255	0	0	
294	148	Lateral 7	245	8	0.003	0.662	0.5225	0	0	
296	150	Lateral 7	123	8	0.003	0.6993	0.5191	0	0	
298	152	Lateral 7	248	8	0.003	0.6617	0.5166	0.003	0	Surcharge less than 3' is acceptable
300	166	Trunk 3	490	10	0.002	1.0122	1.062	0.043	12	Surcharge less than 3' is acceptable
302	168	Trunk 3	205	12	0.002	1.6567	1.3637	0	0	
304	170	Trunk 3	356	12	0.002	1.5953	1.3932	0	15	No surcharge does not require immediate attention
306	172	Trunk 3	197	12	0.003	1.8713	1.3816	0	0	
308	174	Trunk 3	157	12	0.002	1.6123	1.3814	0	0	
310	176	Trunk 3	462	12	0.002	1.5495	1.3749	0	15	No surcharge does not require immediate attention
312	583	Interceptor 3	204	12	0.003	1.87	1.3421	0	0	
314	585	Interceptor 3	78	12	0.008	3.2639	1.3357	0.118	0	Surcharge less than 3' is acceptable
316	587	Interceptor 3	359	12	0.001	1.2933	1.3328	0.118	15	Surcharge less than 3' is acceptable

Pipe ID	G_ID	Lateral	Length (ft)	Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter (in)	Comments
							2026 Max	Max Surcharge		
318	589	Interceptor 3	385	12	0.002	1.618	1.4199	0.06	15	Surcharge less than 3' is acceptable
320	591	Interceptor 3	399	12	0.002	1.599	1.4039	0.263	15	Surcharge less than 3' is acceptable
322	593	Interceptor 3	387	12	0.002	1.6235	1.3867	0.499	0	Surcharge less than 3' is acceptable
324	595	Interceptor 3	224	12	0.002	1.637	1.7872	0.519	15	Surcharge less than 3' is acceptable
326	597	Interceptor 3	172	12	0.002	1.5651	1.7724	0.428	15	Surcharge less than 3' is acceptable
328	599	Interceptor 3	182	12	0.000	0.7937	1.7626	0.027	18	Surcharge less than 3' is acceptable
330	601	Interceptor 1	320	48	0.020	203.4608	4.9656	0	0	
332	154	Lateral 5	345	8	0.009	1.1244	0.4476	0	0	
335	156	Lateral 5	251	8	0.005	0.8444	0.4476	0	0	
337	158	Lateral 5	300	8	0.005	0.8593	0.4826	0	0	
339	160	Lateral 5	148	8	0.003	0.6609	0.4817	0	0	
341	162	Lateral 5	119	8	0.003	0.6393	0.4813	0	0	
343	164	Lateral 5	430	8	0.003	0.6346	0.5505	0.153	0	Surcharge less than 3' is acceptable
344	178	Trunk 1	169	8	0.002	0.542	0.3611	0	0	
347	180	Trunk 1	358	8	0.002	0.5395	0.415	0	0	
349	182	Trunk 1	91	8	0.027	1.9838	0.4149	0	0	
351	184	Trunk 1	295	8	0.005	0.876	0.4148	0	0	
353	186	Trunk 1	256	8	0.005	0.8903	0.4147	0	0	
355	188	Trunk 1	136	8	0.005	0.8889	0.4144	0	0	
357	190	Trunk 1	251	8	0.007	0.9816	0.5181	0	0	
359	192	Trunk 1	407	8	0.005	0.8646	0.5173	0	0	
361	194	Trunk 1	331	8	0.004	0.7875	0.5315	0	0	
363	196	Trunk 1	362	8	0.005	0.8937	0.5369	0	0	
365	198	Trunk 1	131	8	0.006	0.9172	0.5345	0	0	
367	200	Trunk 1	249	10	0.004	1.3997	0.5502	0	0	
369	202	Trunk 1	22	10	0.004	1.4203	0.5588	0	0	
371	204	Trunk 1	254	10	0.004	1.3933	0.5578	0	0	
373	216	Trunk 1	28	10	0.002	1.0199	0.7988	0	0	
375	218	Trunk 1	216	12	0.004	2.1593	0.7972	0	0	
377	220	Trunk 1	278	12	0.003	2.0782	0.8047	0	0	
379	222	Trunk 1	154	12	0.004	2.3718	0.8148	0	0	
381	224	Trunk 1	311	12	0.003	2.0568	0.8193	0	0	
382	206	Lateral1	109	8	0.008	1.0525	0.2342	0	0	
385	208	Lateral1	125	8	0.006	0.9588	0.2342	0	0	
387	210	Lateral1	262	8	0.007	1.0245	0.2341	0	0	
389	212	Lateral1	289	8	0.005	0.8522	0.2334	0	0	
391	214	Lateral1	331	8	0.009	1.1532	0.2327	0	0	
392	226	Interceptor 1	151	12	0.004	2.1748	1.3421	0	0	
394	228	Interceptor 1	178	12	0.002	1.5845	1.3357	0	0	
396	230	Interceptor 1	260	12	0.002	1.5824	1.3642	0	0	
398	232	Interceptor 1	426	12	0.002	1.6058	1.3859	0	0	
400	234	Interceptor 1	448	12	0.002	1.5657	1.3706	0	15	No surcharge does not require immediate attention
402	236	Interceptor 1	264	12	0.002	1.5247	1.4568	0.011	15	Surcharge less than 3' is acceptable
404	238	Interceptor 1	162	12	0.002	1.4849	1.4434	0.047	15	Surcharge less than 3' is acceptable
406	240	Interceptor 1	68	12	0.001	1.2245	1.4345	0.057	15	Surcharge less than 3' is acceptable
408	242	Interceptor 1	132	12	0.002	1.5856	1.4258	0.076	15	Surcharge less than 3' is acceptable
410	244	Interceptor 1	64	12	0.002	1.4169	1.417	0.076	15	Surcharge less than 3' is acceptable
412	246	Interceptor 1	343	12	0.001	1.3648	1.4644	0.018	15	Surcharge less than 3' is acceptable
413	248	Trunk 8	266	8	0.002	0.5418	0.1648	0	0	
416	250	Trunk 8	416	12	0.005	2.4513	0.1802	0	0	
418	252	Trunk 8	223	12	0.005	2.4158	0.201	0	0	
420	254	Trunk 8	340	12	0.003	1.8289	0.201	0	0	

Pipe ID	G_ID	Lateral	Length (ft)	Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter (in)	Comments
							2026 Max	Max Surcharge		
422	256	Trunk 8	204	12	0.005	2.6204	0.3975	0	0	
424	258	Trunk 8	120	12	0.002	1.5966	0.4598	0	0	
426	260	Trunk 8	370	12	0.003	2.0766	0.4593	0	0	
428	348	Trunk 8	293	12	0.002	1.7585	0.9192	0	0	
430	350	Trunk 8	235	12	0.002	1.5791	0.9044	0	0	
432	352	Trunk 8	171	12	0.004	2.2867	0.8896	0	0	
434	262	Trunk 8	232	8	0.002	0.5419	0.1425	0	0	
437	264	Trunk 8	117	8	0.001	0.4186	0.1425	0	0	
440	266	Lateral21	263	8	0.005	0.8385	0.6895	0.552	0	Surcharge less than 3' is acceptable
443	268	Lateral21	253	8	0.002	0.5496	0.719	0.772	10	Surcharge less than 3' is acceptable
445	270	Lateral21	232	8	0.005	0.8222	0.7449	0.712	10	Surcharge less than 3' is acceptable
447	272	Lateral21	309	8	0.004	0.7616	0.854	0.912	10	Surcharge less than 3' is acceptable
449	274	Lateral21	298	8	0.004	0.7463	0.9737	0.649	10	Surcharge less than 3' is acceptable
451	276	Lateral21	121	8	0.036	2.3107	0.973	0.68	0	Surcharge less than 3' is acceptable
455	430	Interceptor 5	337	8	0.002	0.502	0.6154	0.513	10	Surcharge less than 3' is acceptable
458	432	Interceptor 5	380	8	0.002	0.5064	0.6151	0.17	10	Surcharge less than 3' is acceptable
460	434	Interceptor 5	220	10	0.002	0.8693	0.6133	0	0	
462	436	Interceptor 5	298	10	0.002	0.9039	0.6863	0	0	
464	438	Interceptor 5	1077	10	0.002	0.9603	0.6793	0.1	0	
466	440	Interceptor 5	182	10	0.001	0.8303	0.667	0.292	0	Surcharge less than 3' is acceptable
468	442	Interceptor 4	357	10	0.002	0.9149	0.6636	0.686	0	Surcharge less than 3' is acceptable
470	444	Interceptor 4	118	10	0.002	0.9899	0.6559	0.91	0	Surcharge less than 3' is acceptable
472	446	Interceptor 4	350	12	0.002	1.478	1.9835	0.745	15	Surcharge less than 3' is acceptable
474	448	Interceptor 4	369	12	0.002	1.5977	1.9518	0.177	15	Surcharge less than 3' is acceptable
476	342	S12-2	1533	8	0.002	0.5421	0.3858	0	0	
479	344	S12-1	1253	12	0.002	1.5975	0.4655	0	0	
481	346	S12-1	675	12	0.002	1.5968	0.4607	0	0	
482	372	S31-1	489	8	0.002	0.542	0.3443	0.388	0	Modeled at 8", plan recommends 10-inch
485	374	S31-1	541	8	0.002	0.5414	0.344	1.173	0	Modeled at 8", plan recommends 10-inch
486	376	S31-2	704	8	0.002	0.5412	0.1051	0.973	0	Surcharge less than 3' is acceptable
488	378	S5-4	2050	8	0.002	0.5418	0.7303	2.572	10	Surcharge less than 3' is acceptable
490	380	S5-6	1321	10	0.002	0.9823	0.702	0	0	
493	482	S5-2	1336	15	0.002	2.8968	1.491	0	0	
494	382	S13-3	1302	10	0.002	0.9823	0.8116	0	0	
497	384	S13-3	1880	12	0.002	1.598	1.1277	0.06	0	Modeled at 12", plan recommends 15-inch
499	390	S13-2	2660	15	0.002	2.8962	2.6962	0	18	
501	392	S13-1	2644	15	0.002	2.8962	2.7164	0	18	
503	386	S13-5	2637	8	0.002	0.5418	0.4617	0	0	
506	388	S13-5	2696	10	0.002	0.9824	0.7536	0.227	0	Modeled at 10-inch, plan recommends 15-inch
507	354	S11-2	571	12	0.002	1.5977	1.0215	0	0	
509	356	S11-2	710	12	0.002	1.5974	1.0781	0	0	
511	358	S11-1	1260	15	0.002	2.8968	1.6381	0	0	
513	360	S11-1	354	15	0.002	2.8951	1.7409	0	0	
515	362	S11-1	345	15	0.002	2.8956	1.7095	0	0	
517	364	S11-1	987	15	0.002	2.8965	1.6859	0	0	
519	366	S11-1	196	15	0.002	2.8973	1.6776	0	0	
521	368	S11-1	844	15	0.002	2.8952	1.6623	0	0	
523	370	S11-1	721	15	0.002	2.8957	1.652	0	0	
525	396	S10-6	2662	8	0.002	0.5418	0.8796	2.333	12	Modeled at 8", plan recommends 15-inch
528	464	S10-1	2699	18	0.002	4.7099	2.4774	0	0	
529	456	S10-5	1308	12	0.002	1.5974	0.9396	0	0	
531	458	S10-4	1326	12	0.002	1.5973	1.1928	0	0	

Pipe ID	G_ID	Lateral	Length (ft)	Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter (in)	Comments
							2026 Max	Max Surcharge		
533	460	S10-3	1332	15	0.002	2.8966	1.1921	0	0	
535	462	S10-2	2639	15	0.002	2.8965	1.5981	0	0	
536	278	S21-2	873	15	0.001	2.3464	1.2628	0.91	0	
538	280	S21-1	1322	12	0.002	1.5973	1.4176	1.72	15	Modeled at 12", plan recommends 15-inch
540	282	S21-1	353	12	0.002	1.5957	1.4501	1.318	15	Modeled at 12", plan recommends 15-inch
541	336	S6-1	327	18	0.002	4.7066	4.9684	0.949	21	Modeled at 18", plan recommends 24-inch
543	338	S6-1	318	18	0.002	4.7054	5.0966	0.874	21	Modeled at 18", plan recommends 24-inch
545	340	S6-1	2647	18	0.002	4.7097	5.0364	0.764	21	Modeled at 18", plan recommends 24-inch
546	398	S14-3	2782	10	0.002	0.9824	0.7513	0	0	
549	400	S14-2	1923	10	0.002	0.9823	0.9134	0.327	12	Modeled at 10", plan recommends 18-inch
551	402	S14-1	531	18	0.002	4.7091	3.8621	0	0	
555	414	S16-4	2827	8	0.002	0.5418	0.4953	0	10	Modeled at 8", plan recommends 12-inch
560	416	S16-7	2653	10	0.002	0.9824	0.3822	0	0	
563	576	S16-2	2053	10	0.002	0.9823	0.4745	0	0	
565	578	S16-1	1238	15	0.002	2.8961	1.3667	0	0	
567	580	S16-1	513	15	0.002	2.8953	2.4109	0	0	
569	582	S16-1	1228	15	0.002	2.8965	2.4238	0	0	
570	418	S16-6	1938	10	0.002	0.9825	0.7189	0	0	
573	420	S16-5	2181	10	0.002	0.9824	0.8124	0	0	
576	422	S4-2	3050	12	0.002	1.5974	1.0134	0	0	
579	424	S4-1	717	12	0.002	1.5979	1.265	0	0	
581	426	S4-1	2220	12	0.002	1.5976	1.3716	0.744	0	Modeled at 12", plan recommends 21-inch oversizing
582	428	S5-1	1301	8	0.002	0.5418	0.5586	0.679	10	Modeled at 8", plan recommends 10-inch
584	450	S21-2	2041	8	0.020	1.6964	0.194	0	0	
587	452	S21-1	1699	8	0.024	1.8592	0.7734	0	0	
591	468	S20-2	1820	8	0.002	0.5419	0.0892	0	0	
594	470	S20-1	783	8	0.002	0.5418	0.1079	0	0	
598	474	S5-3	238	8	0.002	0.5412	0.4584	1.946	0	Modeled at 8", plan recommends 15-inch
600	476	S5-3	187	8	0.002	0.5419	0.6816	1.946	10	Modeled at 8", plan recommends 15-inch
602	478	S5-3	995	8	0.002	0.5418	0.6696	1.694	10	Modeled at 8", plan recommends 15-inch
604	480	S5-3	498	8	0.002	0.5419	0.6903	0.533	10	Modeled at 8", plan recommends 15-inch
605	574	S16-3	2412	8	0.002	0.5483	0.0439	0	0	
607	404	S15-2	596	8	0.002	0.5415	0.1533	0	0	
609	406	S15-2	1557	8	0.002	0.5418	0.2785	0	0	
611	408	S15-1	1626	8	0.002	0.5419	0.3451	0	0	
613	410	S15-1	1751	8	0.002	0.5418	0.3824	0	0	

Notes:

[1] "Tag" field generated by Hydra 6.4 in the Existing Pipe Results Report; cross references Figures B1 and B4
[2] Unique identifier generated by Hydra
[3] Lateral in which the link is part of
[4] Length (in feet) of the link
[5] Existing diameter (in inches) of the link; for proposed improvements it is the modeled diameter
[6] Slope of the link (in ft/ft), as calculated from invert elevations
[7] Capacity of the pipe in full flow in which d/D is 1.0
[8] Maximum peak hour design flow; compared to flows with routing of PS7 to Trunk 10 and Trunk 6
[9] Maximum surcharge in feet; compared to flows with routing of PS7 to Trunk 10 and Trunk 6
[10] Recommended improved diameter, as generated by Hydra
[11] Comments provided by Wallis Engineering addressing the results provided by Hydra

Pipe ID	G_ID	Lateral	Length (ft)	Existing Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter	Comments
							BuildOut	Surcharge		
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
1	2	Lateral 20	105	8	0.004	0.7469	0.7739	9.641	10	
4	4	Lateral 20	683	8	0.004	0.7978	0.8642	9.851	10	
6	6	Lateral 20	416	8	0.004	0.8033	0.8867	9.727	10	
8	8	Lateral 20	208	8	0.005	0.8183	0.8865	9.38	10	
10	10	Lateral 20	394	8	0.004	0.7767	1.1979	11.236	10	
12	12	Lateral 20	386	8	0.003	0.6258	1.1965	12.062	12	
14	14	Lateral 20	129	8	0.003	0.7157	1.1952	10.068	12	
16	16	Lateral 20	128	8	0.004	0.7786	1.2227	10.019	10	
18	18	Lateral 20	122	8	0.004	0.79	1.2212	9.951	10	
20	20	Lateral 20	258	8	0.004	0.7733	1.2195	10.636	12	
22	22	Lateral 20	262	8	0.004	0.7481	1.623	12.18	12	
24	24	Lateral 20	127	8	0.004	0.7678	1.7092	8.667	12	
26	26	Lateral 20	198	8	0.004	0.7888	1.723	6.847	12	
28	28	Lateral 20	93	8	0.007	0.9792	1.7188	3.884	12	
30	30	Lateral 20	169	8	0.004	0.7223	1.7158	2.883	12	
32	328	Lateral 20	302	18	0.003	5.28	4.4298	0	0	
34	330	Lateral 20	193	18	0.002	4.7378	4.4261	0	21	
36	332	Lateral 20	113	18	0.003	5.325	4.4334	0	0	
38	334	Lateral 20	89	24	0.004	13.8338	6.4422	0	0	
43	284	Trunk 6	662	12	0.002	1.5978	1.7772	7.737	15	
45	286	Trunk 6	140	12	0.000	0	1.8065	7.422	0	
47	288	Trunk 6	130	12	0.000	0	1.8044	7.044	0	
49	290	Trunk 6	278	12	0.003	2.0867	2.0203	6.756	15	
51	292	Trunk 6	272	12	0.002	1.734	2.0169	6.886	15	
53	294	Trunk 6	193	12	0.004	2.119	2.3314	6.869	15	
55	296	Trunk 6	208	12	0.002	1.6792	2.5552	6.725	15	
57	298	Trunk 6	399	12	0.003	1.8842	2.6983	6.179	15	
59	300	Trunk 6	400	12	0.003	1.8311	2.6856	5.171	15	
61	302	Trunk 6	188	12	0.003	1.859	2.6697	4.15	15	
63	304	Trunk 6	93	12	0.003	1.9603	2.6569	3.607	15	
65	306	Trunk 6	95	12	0.003	1.8646	2.7003	3.372	15	
67	308	Trunk 6	359	12	0.003	1.9683	2.6934	3.246	15	
69	310	Trunk 6	359	12	0.002	1.7381	2.7503	2.433	18	
71	312	Trunk 6	356	12	0.002	1.5496	2.7249	1.673	18	
73	314	Trunk 6	161	12	0.003	1.8865	2.6953	0.171	15	
75	316	Trunk 6	111	15	0.003	3.5794	2.7169	0	0	
77	318	Trunk 6	178	15	0.002	2.6585	2.6956	0.009	18	
79	320	Trunk 6	163	15	0.003	3.4781	2.6739	0	0	
81	322	Trunk 6	122	15	0.004	4.1005	2.7596	0	0	
83	324	Trunk 6	319	15	0.002	3.0789	2.7371	0	18	
85	326	Trunk 6	255	15	0.002	3.1941	2.7112	0	0	
86	32	Trunk 5	234	6	0.001	0.1631	0.4195	10.608	10	Surcharge due to existing system capacity deficiencies
89	34	Trunk 5	277	6	0.002	0.2513	0.4195	10.475	8	Development Proposes 6", Install to 8"
91	36	Trunk 5	282	6	0.002	0.2515	0.4188	9.911	8	Development Proposes 6", Install to 8"
93	38	Trunk 5	42	6	0.002	0.2442	0.6512	9.021	10	Surcharge due to existing system capacity deficiencies
95	484	Trunk 5	361	15	0.002	2.8936	3.4863	7.812	18	Surcharge due to existing system capacity deficiencies
97	486	Trunk 5	389	15	0.002	2.8971	3.4569	7.578	18	Surcharge due to existing system capacity deficiencies
99	488	Trunk 5	352	15	0.002	2.8954	3.4998	7.343	18	Surcharge due to existing system capacity deficiencies
101	490	Trunk 5	251	15	0.002	2.8968	3.4605	7.115	18	Surcharge due to existing system capacity deficiencies
103	492	Trunk 5	458	15	0.002	2.8221	4.2887	6.999	21	
105	494	Trunk 5	524	15	0.001	2.1912	4.2448	5.859	21	
107	496	Trunk 5	175	15	0.002	2.7248	4.3827	4.305	21	

Pipe ID	G_ID	Lateral	Length (ft)	Existing Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter	Comments
							BuildOut	Surcharge		
109	498	Trunk 5	259	15	0.002	2.8434	4.3907	3.793	21	
111	500	Trunk 5	428	15	0.002	2.7109	4.3576	3.099	21	
113	502	Trunk 5	170	15	0.002	2.5819	4.8414	2.01	21	
115	504	Trunk 5	351	15	0.002	2.7857	4.8057	1.33	21	
117	506	Trunk 5	78	15	0.004	3.8786	4.7707	0.032	18	
119	508	Trunk 5	430	18	0.004	6.8144	4.7555	0	0	
121	510	Trunk 5	427	18	0.004	6.6676	4.7042	0	0	
123	512	Trunk 5	150	18	0.003	6.0225	4.6524	0	0	
125	514	Trunk 5	307	18	0.004	6.7691	4.6181	0	0	
127	516	W.S. Relief 2	446	18	0.003	5.645	4.5994	0	0	
129	518	W.S. Relief 2	366	18	0.004	6.4692	4.5934	0	0	
131	520	W.S. Relief 2	418	18	0.003	5.8255	4.5792	0	0	
133	522	W.S. Relief 2	263	18	0.003	5.8101	4.5586	0	0	
135	524	W.S. Relief 2	468	18	0.003	5.7619	4.5415	0	0	
137	526	W.S. Relief 2	91	18	0.001	3.4853	4.5118	0.004	21	
139	528	W.S. Relief 2	554	20	0.001	5.0266	4.5126	0	21	
141	530	W.S. Relief 2	344	20	0.001	4.5144	4.6876	0.019	24	
143	532	W.S. Relief 2	290	24	0.001	7.9954	4.6723	0	0	
145	534	W.S. Relief 1	365	24	0.001	7.7845	4.6562	0	0	
147	536	W.S. Relief 1	55	24	0.001	6.8129	4.6648	0	0	
149	538	W.S. Relief 1	691	21	0.001	5.5723	4.6581	0	0	
151	540	W.S. Relief 1	380	21	0.002	7.6069	4.6852	0	0	
153	542	W.S. Relief 1	263	21	0.002	7.7141	4.6772	0	0	
155	544	W.S. Relief 1	408	21	0.002	6.4848	5.5931	0	0	
157	546	W.S. Relief 1	357	21	0.002	6.7268	5.5816	0	0	
159	548	W.S. Relief 1	43	21	0.026	25.4592	5.5703	0.918	0	
161	550	W.S. Relief 1	512	21	0.002	6.7738	5.7476	0.248	0	
163	552	W.S. Relief 1	207	21	0.002	7.563	5.7713	0.644	0	
165	554	W.S. Relief 1	270	21	0.002	6.6981	5.764	0.869	0	
167	556	Trunk 4	621	21	0.002	7.0433	5.7526	1.474	0	
169	558	Trunk 4	252	30	0.002	18.868	17.9302	0.876	33	
171	560	Trunk 4	435	30	0.001	14.2136	18.5694	0.876	36	
173	562	Trunk 4	603	30	0.001	14.2134	18.5572	0.121	36	
175	564	W.S. Relief 1	585	30	0.003	21.6412	18.5563	0.203	0	
177	566	W.S. Relief 1	304	30	0.005	28.976	18.7585	1.18	0	
179	568	W.S. Relief 1	564	30	0.002	18.733	18.8127	0.01	33	
181	570	W.S. Relief 1	601	30	0.003	23.4872	18.7942	0	0	
183	572	W.S. Relief 1	74	30	0.002	16.549	19.2248	0.006	36	
185	40	Trunk 2	287	8	0.004	0.7637	0.6734	4.535	10	
188	42	Trunk 2	314	8	0.004	0.7676	0.6734	4.866	10	
190	44	Trunk 2	229	8	0.005	0.8699	0.7465	5.219	0	
192	46	Trunk 2	345	8	0.003	0.7058	0.7557	5.259	10	
194	48	Lateral 6	225	8	0.005	0.858	0.4461	0	0	
197	50	Lateral 6	312	8	0.017	1.5844	0.4461	0	0	
199	52	Lateral 6	200	8	0.005	0.8269	0.4457	0	0	
201	54	Lateral 6	312	8	0.006	0.9458	0.4866	0.899	0	
203	56	Lateral 6	339	8	0.005	0.8193	0.486	2.023	0	
205	58	Lateral 6	245	8	0.004	0.8	0.4849	2.799	0	
207	60	Lateral 6	80	8	0.005	0.8351	0.5734	3.83	0	
209	62	Lateral 6	243	8	0.004	0.7657	0.5716	4.309	0	
211	64	Trunk 2	418	8	0.004	0.7679	0.5686	5.106	0	
212	66	Trunk 2	260	10	0.004	1.3768	1.3188	5.043	12	
214	68	Trunk 2	364	10	0.003	1.1405	1.4109	5.083	12	

Pipe ID	G_ID	Lateral	Length (ft)	Existing Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter	Comments
							BuildOut	Surcharge		
216	70	Trunk 2	369	10	0.003	1.2527	1.4037	4.601	12	
218	72	Trunk 2	301	10	0.004	1.4039	1.4839	4.303	12	
220	74	Trunk 2	378	10	0.003	1.2576	1.4737	4.167	12	
222	76	Trunk 2	252	12	0.002	1.4935	1.5068	3.576	15	
224	78	Trunk 2	179	12	0.014	4.1731	1.4936	5.705	0	
226	92	Trunk 2	385	12	0.003	1.8653	1.9235	5.705	15	
228	94	Trunk 2	413	12	0.003	1.9005	1.9029	5.677	15	
230	96	Trunk 2	227	12	0.003	1.789	1.8792	5.713	15	
232	98	Trunk 2	235	12	0.003	1.8046	1.8597	5.694	15	
234	100	Trunk 2	242	12	0.002	1.7776	1.8388	5.696	15	
236	102	Trunk 2	204	12	0.002	1.5833	1.8288	5.694	15	
238	104	Trunk 2	36	12	0.003	1.8792	1.8889	5.665	15	
240	106	Trunk 2	395	12	0.002	1.6959	2.1945	5.914	15	
242	108	Trunk 2	278	12	0.002	1.6022	2.7435	5.313	18	
244	110	Interceptor 2	122	12	0.001	1.0234	2.7281	4.329	21	
246	112	Interceptor 2	360	12	0.002	1.7552	2.7129	3.838	15	
248	114	Interceptor 2	449	12	0.002	1.6767	2.822	2.537	18	
250	116	Interceptor 2	261	15	0.001	2.5032	2.8279	0.47	18	
252	118	Interceptor 2	299	15	0.002	2.5121	2.8022	0.362	18	
254	120	Interceptor 2	243	15	0.001	2.4229	2.818	0.252	18	
256	122	Interceptor 2	356	15	0.001	2.4983	2.7903	0.06	18	
257	80	Lateral 10	409	8	0.002	0.5684	1.2847	2.208	12	
260	82	Lateral 10	199	8	0.006	0.9531	0.3254	2.825	0	
262	84	Lateral 10	257	8	0.005	0.8808	0.3254	4.039	0	
264	86	Lateral 10	129	8	0.004	0.7482	0.3556	4.459	0	
266	88	Lateral 10	247	8	0.003	0.6805	0.3554	5.066	0	
268	90	Lateral 10	300	8	0.004	0.7636	0.355	6.038	0	
269	124	Trunk 4	422	12	0.017	4.6388	0	0	0	
271	126	Lateral 7	254	8	0.004	0.7369	0.616	8.096	0	
274	128	Lateral 7	251	8	0.005	0.875	0.6787	8.617	0	
276	130	Lateral 7	278	8	0.005	0.8839	0.6782	9.205	0	
278	132	Lateral 7	76	8	0.005	0.8676	0.7098	9.333	0	
280	134	Lateral 7	247	8	0.004	0.751	0.7698	9.378	10	
282	136	Lateral 7	318	8	0.004	0.7542	0.8617	9.483	10	
284	138	Lateral 7	205	8	0.006	0.9119	0.8596	9.333	10	
286	140	Lateral 7	273	8	0.004	0.7894	0.8574	9.495	10	
288	142	Lateral 7	224	8	0.003	0.6371	0.9037	9.962	10	
290	144	Lateral 7	339	8	0.003	0.7114	0.9003	10.039	10	
292	146	Lateral 7	260	8	0.003	0.6246	0.9298	10.174	10	
294	148	Lateral 7	245	8	0.003	0.662	0.9229	10.024	10	
296	150	Lateral 7	123	8	0.003	0.6993	0.9149	9.626	10	
298	152	Lateral 7	248	8	0.003	0.6617	0.909	9.757	10	
300	166	Trunk 3	490	10	0.002	1.0122	1.7106	9.203	15	
302	168	Trunk 3	205	12	0.002	1.6567	2.1012	7.173	15	
304	170	Trunk 3	356	12	0.002	1.5953	2.165	6.974	15	
306	172	Trunk 3	197	12	0.003	1.8713	2.1467	6.515	15	
308	174	Trunk 3	157	12	0.002	1.6123	2.1461	6.344	15	
310	176	Trunk 3	462	12	0.002	1.5495	2.1327	6.096	15	
312	583	Interceptor 3	204	12	0.003	1.87	2.2149	6.226	15	
314	585	Interceptor 3	78	12	0.008	3.2639	2.2011	6.354	0	
316	587	Interceptor 3	359	12	0.001	1.2933	2.1947	6.354	18	
318	589	Interceptor 3	385	12	0.002	1.618	2.3354	5.26	15	
320	591	Interceptor 3	399	12	0.002	1.599	2.3112	4.422	15	

Pipe ID	G_ID	Lateral	Length (ft)	Existing Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter	Comments
							BuildOut	Surcharge		
322	593	Interceptor 3	387	12	0.002	1.6235	2.2846	3.569	15	
324	595	Interceptor 3	224	12	0.002	1.637	2.8806	2.804	18	
326	597	Interceptor 3	172	12	0.002	1.5651	2.8604	1.817	18	
328	599	Interceptor 3	182	12	0.000	0.7937	2.8404	0.062	21	
330	601	Interceptor 1	320	48	0.020	203.4608	8.727	0	0	
332	154	Lateral 5	345	8	0.009	1.1244	0.6103	7.823	0	
335	156	Lateral 5	251	8	0.005	0.8444	0.6103	8.507	0	
337	158	Lateral 5	300	8	0.005	0.8593	0.6793	9.176	0	
339	160	Lateral 5	148	8	0.003	0.6609	0.6775	9.296	10	
341	162	Lateral 5	119	8	0.003	0.6393	0.6768	9.374	10	
343	164	Lateral 5	430	8	0.003	0.6346	0.8134	10.01	10	
344	178	Trunk 1	169	8	0.002	0.542	0.5044	0.258	10	
347	180	Trunk 1	358	8	0.002	0.5395	0.6614	0.311	10	
349	182	Trunk 1	91	8	0.027	1.9838	0.6612	1.159	0	
351	184	Trunk 1	295	8	0.005	0.876	0.6609	2.222	0	
353	186	Trunk 1	256	8	0.005	0.8903	0.6604	3.041	0	
355	188	Trunk 1	136	8	0.005	0.8889	0.6597	3.369	0	
357	190	Trunk 1	251	8	0.007	0.9816	0.9616	3.433	10	
359	192	Trunk 1	407	8	0.005	0.8646	0.9598	3.433	10	
361	194	Trunk 1	331	8	0.004	0.7875	1.002	3.049	10	
363	196	Trunk 1	362	8	0.005	0.8937	1.0195	2.28	10	
365	198	Trunk 1	131	8	0.006	0.9172	1.0153	1.883	10	
367	200	Trunk 1	249	10	0.004	1.3997	1.0622	2.384	0	
369	202	Trunk 1	22	10	0.004	1.4203	1.0901	2.621	0	
371	204	Trunk 1	254	10	0.004	1.3933	1.0878	3.219	0	
373	216	Trunk 1	28	10	0.002	1.0199	1.6893	3.559	15	
375	218	Trunk 1	216	12	0.004	2.1593	1.6855	3.796	0	
377	220	Trunk 1	278	12	0.003	2.0782	1.7144	4.295	0	
379	222	Trunk 1	154	12	0.004	2.3718	1.7484	4.805	0	
381	224	Trunk 1	311	12	0.003	2.0568	1.7646	5.077	0	
382	206	Lateral1	109	8	0.008	1.0525	0.577	0	0	
385	208	Lateral1	125	8	0.006	0.9588	0.577	0	0	
387	210	Lateral1	262	8	0.007	1.0245	0.5766	0	0	
389	212	Lateral1	289	8	0.005	0.8522	0.5749	0	0	
391	214	Lateral1	331	8	0.009	1.1532	0.5739	0.896	0	
392	226	Interceptor 1	151	12	0.004	2.1748	2.2149	5.467	15	
394	228	Interceptor 1	178	12	0.002	1.5845	2.2011	5.375	15	
396	230	Interceptor 1	260	12	0.002	1.5824	2.2414	5.059	15	
398	232	Interceptor 1	426	12	0.002	1.6058	2.2679	4.545	15	
400	234	Interceptor 1	448	12	0.002	1.5657	2.2421	3.688	15	
402	236	Interceptor 1	264	12	0.002	1.5247	2.3725	2.783	15	
404	238	Interceptor 1	162	12	0.002	1.4849	2.3534	2.119	18	
406	240	Interceptor 1	68	12	0.001	1.2245	2.334	1.706	18	
408	242	Interceptor 1	132	12	0.002	1.5856	2.3254	1.495	15	
410	244	Interceptor 1	64	12	0.002	1.4169	2.3066	1.195	18	
412	246	Interceptor 1	343	12	0.001	1.3648	2.386	0.273	18	
413	248	Trunk 8	266	8	0.002	0.5418	0.2011	0	0	
416	250	Trunk 8	416	12	0.005	2.4513	0.2257	0	0	
418	252	Trunk 8	223	12	0.005	2.4158	0.2589	0	0	
420	254	Trunk 8	340	12	0.003	1.8289	0.2589	0	0	
422	256	Trunk 8	204	12	0.005	2.6204	0.4853	0	0	
424	258	Trunk 8	120	12	0.002	1.5966	0.5877	0	0	
426	260	Trunk 8	370	12	0.003	2.0766	0.587	0	0	

Pipe ID	G_ID	Lateral	Length (ft)	Existing Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter	Comments
							BuildOut	Surcharge		
428	348	Trunk 8	293	12	0.002	1.7585	1.7494	0	15	
430	350	Trunk 8	235	12	0.002	1.5791	1.723	0.088	15	
432	352	Trunk 8	171	12	0.004	2.2867	1.6951	0	0	
434	262	Trunk 8	232	8	0.002	0.5419	0.3302	0	0	
437	264	Trunk 8	117	8	0.001	0.4186	0.3302	0	0	
440	266	Lateral21	263	8	0.005	0.8385	0.8395	3.998	10	
443	268	Lateral21	253	8	0.002	0.5496	0.8865	4.213	12	
445	270	Lateral21	232	8	0.005	0.8222	0.9279	3.499	10	
447	272	Lateral21	309	8	0.004	0.7616	1.1022	3.404	10	
449	274	Lateral21	298	8	0.004	0.7463	1.2931	0.242	12	
451	276	Lateral21	121	8	0.036	2.3107	1.2921	0.253	0	
455	430	Interceptor 5	337	8	0.002	0.502	1.001	5.006	12	
458	432	Interceptor 5	380	8	0.002	0.5064	1.0004	3.379	12	
460	434	Interceptor 5	220	10	0.002	0.8693	0.9985	1.378	12	
462	436	Interceptor 5	298	10	0.002	0.9039	1.1331	1.362	12	
464	438	Interceptor 5	1077	10	0.002	0.9603	1.1261	0.602	12	
466	440	Interceptor 5	182	10	0.001	0.8303	1.0929	0.535	12	Surcharge less than 3' is acceptable
468	442	Interceptor 4	357	10	0.002	0.9149	1.0767	0.458	12	Surcharge less than 3' is acceptable
470	444	Interceptor 4	118	10	0.002	0.9899	1.0744	0.309	12	Surcharge less than 3' is acceptable
472	446	Interceptor 4	350	21	0.002	6.5732	3.8812	0	0	
474	448	Interceptor 4	369	21	0.002	7.1055	3.8426	0	0	
476	342	S12-2	1533	10	0.002	0.9828	1.0268	0.284	12	Surcharge less than 3' is acceptable
479	344	S12-1	1253	12	0.002	1.5975	1.1542	0	0	
481	346	S12-1	675	12	0.002	1.5968	1.1385	0	0	Surcharge less than 3' is acceptable
482	372	S31-1	489	10	0.002	0.9826	0.6025	1.019	0	Surcharge less than 3' is acceptable
485	374	S31-1	541	10	0.002	0.9816	0.6022	1.709	0	Surcharge less than 3' is acceptable
486	376	S31-2	704	8	0.002	0.5412	0.2201	2.658	0	Surcharge less than 3' is acceptable
488	378	S5-4	2050	8	0.002	0.5418	0.7937	3.853	10	Surcharge due to existing system capacity deficiencies
490	380	S5-6	1321	10	0.002	0.9823	1.3496	10.586	12	Surcharge due to existing system capacity deficiencies
493	482	S5-2	1336	15	0.002	2.8968	2.8998	7.819	18	Surcharge due to existing system capacity deficiencies
494	382	S13-3	1302	15	0.002	2.8962	2.7021	0	18	
497	384	S13-3	1880	18	0.002	4.7114	3.2526	0.08	0	Surcharge less than 3' is acceptable
499	390	S13-2	2660	21	0.002	7.1039	7.0182	0	24	Surcharge less than 3' is acceptable
501	392	S13-1	2644	24	0.002	10.1426	7.3725	0	0	
503	386	S13-5	2637	15	0.002	2.8964	1.244	0	0	
506	388	S13-5	2696	15	0.002	2.8963	2.0105	0.33	0	Surcharge less than 3' is acceptable
507	354	S11-2	571	15	0.002	2.8969	2.0046	0	0	
509	356	S11-2	710	15	0.002	2.8962	2.0922	0	0	
511	358	S11-1	1260	18	0.002	4.7106	3.3621	0	0	
513	360	S11-1	354	18	0.002	4.7078	3.5705	0	0	
515	362	S11-1	345	18	0.002	4.7086	3.526	0	0	
517	364	S11-1	987	18	0.002	4.71	3.4812	0	0	
519	366	S11-1	196	18	0.002	4.7114	3.4355	0	0	
521	368	S11-1	844	18	0.002	4.7079	3.427	0	0	
523	370	S11-1	721	18	0.002	4.7088	3.3914	0	0	
525	396	S10-6	2662	15	0.002	2.8965	1.7264	0.13	0	Surcharge less than 3' is acceptable
528	464	S10-1	2699	21	0.002	7.1046	6.0403	0	0	
529	456	S10-5	1308	18	0.002	4.7098	3.2577	0	0	
531	458	S10-4	1326	18	0.002	4.7094	3.6541	0	0	
533	460	S10-3	1332	18	0.002	4.7103	3.6363	0	0	
535	462	S10-2	2639	18	0.002	4.7101	4.227	0	21	Surcharge less than 3' is acceptable
536	278	S21-2	873	15	0.001	2.3464	1.7549	0	0	
538	280	S21-1	1322	15	0.002	2.8962	2.002	0.154	0	Surcharge less than 3' is acceptable

Pipe ID	G_ID	Lateral	Length (ft)	Existing Diameter (in)	Slope (ft/ft)	Capacity (cfs)	Design Peak Flows (cfs)		New Diameter	Comments
							BuildOut	Surcharge		
540	282	S21-1	353	15	0.002	2.8932	2.0579	0	0	
541	336	S6-1	327	24	0.002	10.1363	6.4224	0	0	
543	338	S6-1	318	24	0.002	10.1336	6.6481	0	0	
545	340	S6-1	2647	24	0.002	10.1429	6.568	0	0	
546	398	S14-3	2782	15	0.002	2.8964	2.2678	0	0	
549	400	S14-2	1923	18	0.002	4.7094	2.6885	0.1	0	Surcharge less than 3' is acceptable
551	402	S14-1	531	24	0.002	10.1417	8.7871	0	0	
555	414	S16-4	2827	12	0.002	1.5974	1.4208	0	15	Surcharge less than 3' is acceptable
560	416	S16-7	2653	10	0.002	0.9824	1.1243	1.651	12	Surcharge less than 3' is acceptable
563	576	S16-2	2053	24	0.002	10.1419	1.4736	0	0	
565	578	S16-1	1238	27	0.002	13.8847	3.4851	0	0	
567	580	S16-1	513	27	0.002	13.8812	4.7103	0	0	
569	582	S16-1	1228	27	0.002	13.8865	4.8358	0	0	
570	418	S16-6	1938	12	0.002	1.5976	1.2652	0	0	
573	420	S16-5	2181	15	0.002	2.5428	1.4951	0	0	
576	422	S4-2	3050	21	0.002	7.1042	2.166	0	0	
579	424	S4-1	717	21	0.002	7.1066	2.6258	0	0	
581	426	S4-1	2220	21	0.002	7.105	2.839	0	0	
582	428	S5-1	1301	10	0.002	0.9824	0.8983	4.84	12	10" size based upon possible pipe bursting 8"
584	450	S21-2	2041	10	0.020	3.0757	0.9401	0	0	
587	452	S21-1	1699	12	0.024	5.4817	2.6448	0	0	
591	468	S20-2	1820	15	0.002	2.8966	0.5332	0	0	
594	470	S20-1	783	15	0.002	2.8965	0.6411	0	0	
598	474	S5-3	238	15	0.002	2.8933	1.0319	5.202	0	Surcharge due to existing system capacity deficiencies
600	476	S5-3	187	15	0.002	2.8966	1.3496	5.495	0	Surcharge due to existing system capacity deficiencies
602	478	S5-3	995	15	0.002	2.8965	1.3395	7.059	0	Surcharge due to existing system capacity deficiencies
604	480	S5-3	498	15	0.002	2.8966	1.4092	7.819	0	Surcharge due to existing system capacity deficiencies
605	574	S16-3	2412	21	0.002	7.1896	0.1077	0	0	
607	404	S15-2	596	12	0.002	1.5966	0.2327	0	0	
609	406	S15-2	1557	12	0.002	1.5975	0.8994	0	0	
611	408	S15-1	1626	15	0.002	2.8966	1.2298	0	0	
613	410	S15-1	1751	15	0.002	2.8962	1.4598	0	0	

Notes:

[1] "Tag" field generated by Hydra 6.4 in the Existing Pipe Results Report; cross references Figures B1 and B4
[2] Unique identifier generated by Hydra
[3] Lateral in which the link is part of
[4] Length (in feet) of the link
[5] Existing diameter (in inches) of the link; for proposed improvements it is the modeled diameter
[6] Slope of the link (in ft/ft), as calculated from invert elevations
[7] Capacity of the pipe in full flow in which d/D is 1.0
[8] Peak Hour design flow under buildout conditions
[9] Surcharge in feet
[10] Recommended improved diameter, as generated by Hydra
[11] Comments provided by Wallis Engineering addressing the results provided by Hydra

Appendix C

Odor Control Studies

“Battle Ground Odor Control & Lagoon Assessment”,
Technical Memo from HDR dated May 2, 2005

HDR | ONE COMPANY Many Solutions℠

Technical Memo

To:	Sam Adams, Steven Rommel, Rob Charles		
From:	Mark Smith		
CC:			
Date:	May 2, 2005		
Project:	Battle Ground Odor Control Assessment	Project No:	19022/4.1.1
RE:	xxxxxx		

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TECHNICAL MEMORANDUM SUMMARY

Introduction

For several years, the City of Battle Ground and the Hazel Dell Sewer District have received hydrogen sulfide (H_2S) related odor complaints along N.E. Salmon Creek Avenue. Previous attempts to prevent the stripping of gas phase H_2S at the forcemain discharge vault on N.E. Salmon Creek Road have been largely unsuccessful. These attempts have included the separate addition of ferrous chloride and ferric chloride.

The City has contracted with HDR Engineering, Inc. to assess and make recommendations on current odor control practices for the Battle Ground Pump Station/Forcemain and the wet weather overflow lagoon facility. This summary of the Technical Memorandum provides a brief description of the sampling efforts and subsequent data analysis. Conclusions and recommendations are made based on this analysis and are summarized herein.

Data Collection

HDR collected data on the following wastewater characteristics over a two-day period in the forcemain wet well and discharge vault:

- pH
- Temperature (degrees Fahrenheit)
- Dissolved Sulfide (mg/L)
- Orthophosphate (mg/L)

HDR collected data on the following vapor phase odor characteristics over a two-day period in the forcemain wet well and discharge vault:

- Hydrogen Sulfide (ppm)
- Ammonia (ppm)
- Mercaptan (ppm)

- Pilot the use of ferric chloride and calcium nitrate to determine most cost effective chemical for odor control on the forcemain. Calcium nitrate is recommended for the pilot test for the following reasons:
  - Its usefulness as an odor control chemical is not affected by the presence of any known wastewater constituents
  - Treatment plant processes would be unaffected
  - It is non-corrosive and relatively safe to handle
- Combine the information from a pilot with results from the sulfide model that was created for data analysis on this project to design a PLC-based optimized chemical feed system. This system would provide the following benefits:
  - Continuously monitor wastewater characteristic fluctuations and adjust chemical feed accordingly
  - Risk of overfeeding chemical would be greatly diminished. This would result in long-term O&M cost savings to the city.
- During warm weather months sample for odors on the above-ground headworks facility and near the fence line along the north end of the plant. Continuously monitor H_2S at the headworks and take low level H_2S grab samples near the fence line. Also, send gas-filled Tedlar bag samples to an outside laboratory for gas chromatography analysis to determine organic odor compounds, if any, released by the lagoon itself.
  - If the headworks facility proves to be a major source of warm weather odors, cover the open air channels and forcibly ventilate the air through a bioscrubber or biofilter.
  - If the lagoon proves to be a major source of warm weather odors, jar test the use of ferric chloride to remove orthophosphate nutrient source in lagoon. A bioassay should be performed by an outside laboratory to determine the effect that such nutrient removal would have on the existing algae population.
  - If jar testing of ferric chloride addition proves to be successful at reducing the algae count in the samples, a pilot test of chemical addition in the lagoon should be performed.

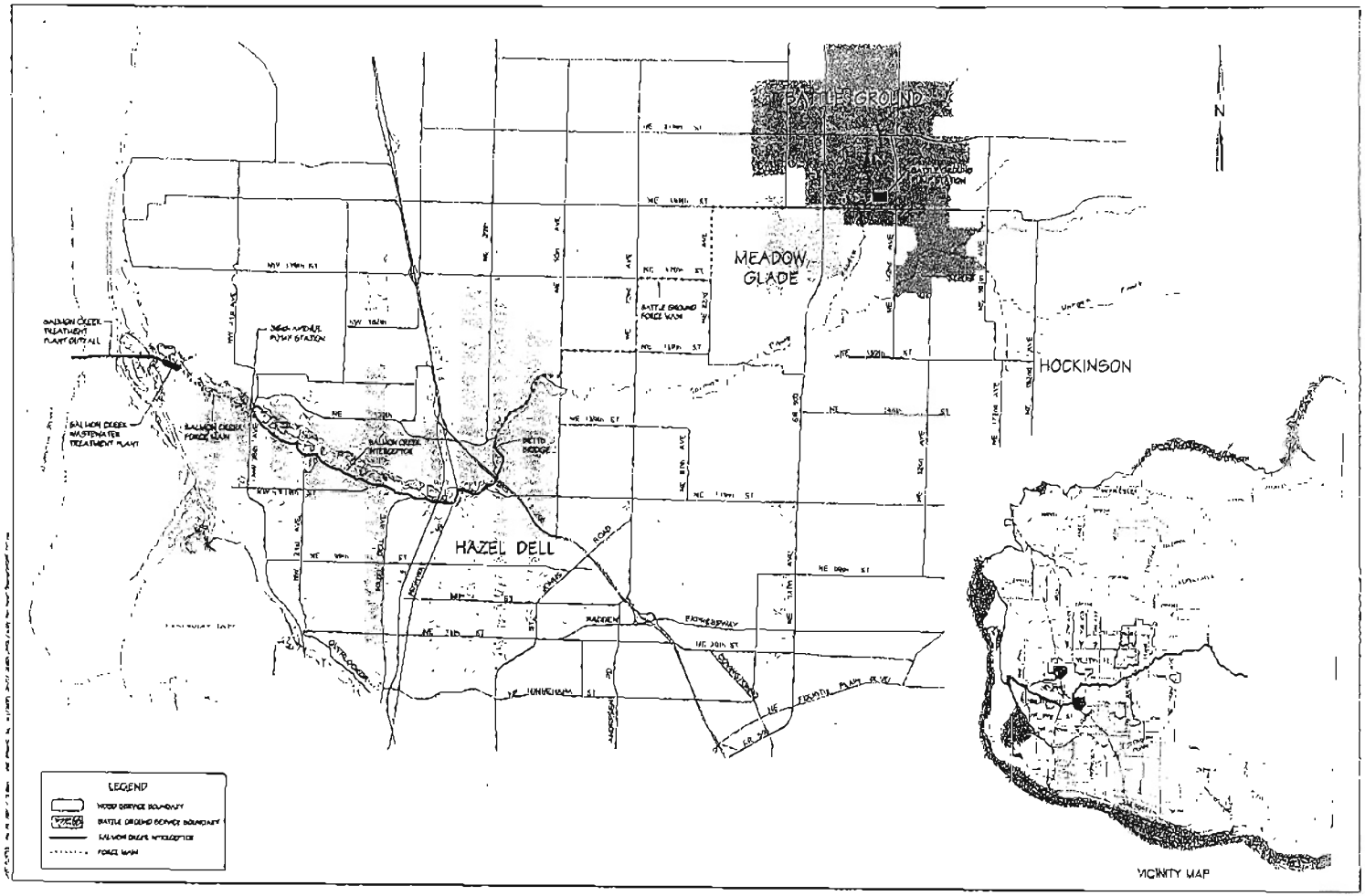


FIGURE 1

OVERALL MAP OF COLLECTION SYSTEM SERVICE AREA

- Surface area of pipe wall and/or wet well
- Detention time
- Wastewater turbulence

Dissolved Oxygen. When the dissolved oxygen level is below approximately 1.0 mg/L, as it is in most municipal waste streams, sulfate reduction will occur. Sulfate is present in abundance in most municipal waste streams. This reduction is performed by bacteria residing in the so-called "slime layer" that lies beneath the wastewater surface on the inside wall of the sewer pipe or wet well.

pH. The reduced sulfate exists as sulfide (S^{2-}), bi-sulfide (HS^-) and H_2S in varying concentrations, depending on pH of the wastewater. For example, at or above a pH of 8, most of the reduced sulfate exists as S_2. and HS-. At a pH at or below 7.1, the reduced sulfate exists as HS^- and H_2S. **Figure 3** below presents a chart of the percentage of each constituent as a function of wastewater pH.

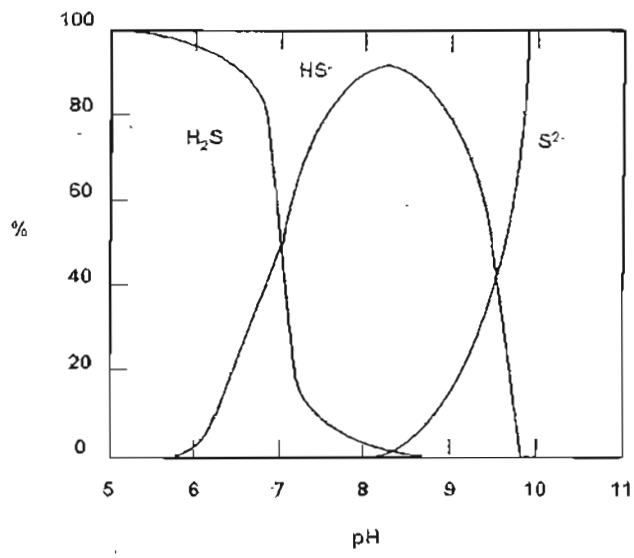


FIGURE 3
EFFECT OF WASTEWATER pH ON
SULFIDE-HYDROGEN SULFIDE EQUILIBRIUM

Concentration of Organic Material. Sulfate reducing bacteria in the slime layer utilize organic matter in the process of reducing sulfate to sulfide. It is generally accepted that the amount of organic material in wastewater is proportional to the five-day biochemical oxygen demand (BOD_5) and can be estimated by measuring BOD_5.

Temperature. Temperature has a direct impact on biological activity of the sulfate reducing bacteria that reside in the slime layer. As wastewater temperature increases, bioactivity increases. As wastewater temperature decreases, bioactivity decreases.

TABLE 1
SUMMARY OF SAMPLING RESULTS
12/20-12/21/04

Wet Well Location

Date	Time	pH	Sample Temp	S^{2-}	H_2S	$(PO_4)^{3-}$	R-SH	NH_3	R-NH_2
12/20/04	9:45 am	7.14, 7.24	57.7, 58.3	0.5, 0.5	ND, ND	---	ND, ND	ND, ND	ND, ND
12/20/04	2:20 pm	7.37, 7.41	57.9, 58.9	0.5, 0.5	ND, ND	---	ND, ND	ND, ND	ND, ND
12/21/04	9:20 am	7.10, 7.17	54.8, 53.7	0.5, 0.5	ND, ND	11.6, 11.2	ND, ND	ND, ND	ND, ND
12/21/04	4:00 pm	7.22	57.5	0.5, 0.5	ND, ND	12.0	ND, ND	ND, ND	ND, ND

Discharge Vault Location

Date	Time	pH	Sample Temp	S^{2-}	H_2S	$(PO_4)^{3-}$	R-SH	NH_3	R-NH_2
12/20/04	10:45 am	6.7, 6.75	56, 53.5	2.0, 2.0	ND, ND	---	ND, ND	ND, ND	ND, ND
12/20/04	3:45pm	7.01, 6.99	56.6, 57.2	1.5, 1.5	5.0, 2.0	---	ND, ND	ND, ND	ND, ND
12/21/04	10:30 am	6.85, 6.87	50.1, 50.8	1.8, 2.0	ND, ND	10.0, 10.1	ND, ND	ND, ND	ND, ND
12/21/04	4:35 pm	6.98	54.9	2.0	5.0	12.8	---	---	---

Lagoon Location

Date	Time	pH	Sample Temp	S^{2-}	$(PO_4)^{3-}$	NO_4	DO
12/20/04	1:30 pm	6.98, 7.07	53.0, 53.0	<0.5, <0.5	10.0, 9.8	2.0	1.4, 1.0
12/21/04	8:45 am	6.98	43.4	2.0, 2.0, 1.5	12, 11.2	2.0, 2.0	0.8, 1.4

Notes:
S^{2-} - dissolved sulfide (mg/L)
H_2S – hydrogen sulfide (ppm)
$(PO_4)^{3-}$ - orthophosphate (mg/L)
R-SH – mercaptans (ppm)
NH_3 – ammonia (ppm)
R-NH_2 – amines (ppm)
ND – Not detectable

Sample Temp, °F

DATA ANALYSIS

Liquid Phase Wet Well and Discharge Vault Data

Dissolved Sulfide

The dissolved sulfide concentration in the wet well remained constant at 0.5 mg/L during the two day sampling effort. The concentration of dissolved sulfide at the discharge vault, however, ranged from 1.5 to 2.0 mg/L. This increase is not surprising given the 8-mile length and 5 to 6 hour wastewater detention time in the pipe.

An analysis of the vertical alignment of the forcemain showed that there are several locations where the crown of the pipe is above the hydraulic grade line (HGL). This would result in pockets of air in which stripping of H_2S likely occurs and thiobacillus bacteria would thrive on the crown of the pipe. See **Figure 4** for a graphic example of this phenomenon. These bacteria oxidize the H_2S into sulfuric acid (H_2SO_4).

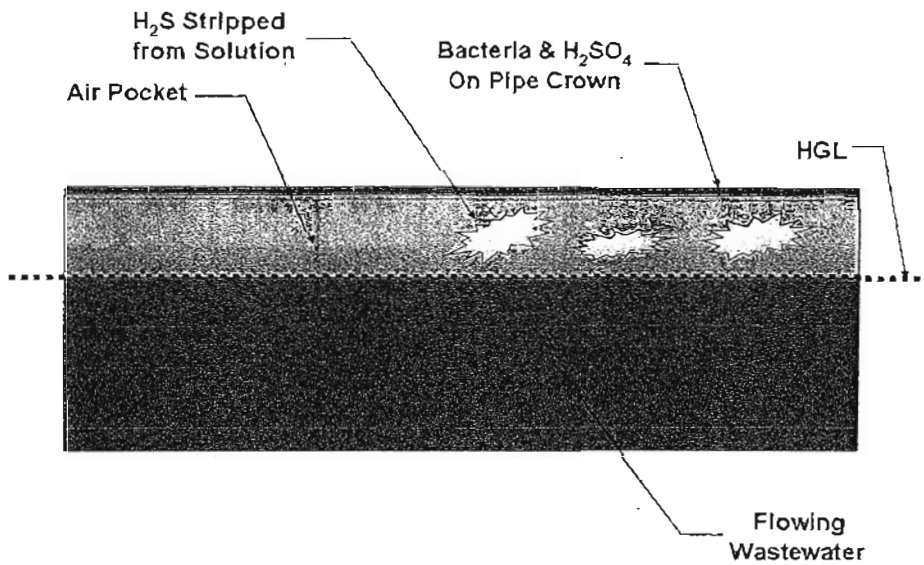


FIGURE 4
SECTION VIEW OF AIR POCKET IN FORCEMAIN WHERE PIPE CROWN LIES ABOVE HYDRAULIC GRADE LINE

The previous study was performed in the summer of 2003 by a third party. A sulfide generation model was run during the 2003 study. The resultant values were compared to the data that was obtained in the field as part of the sampling effort. A sulfide generation model on the 16-inch

Season	WW Temp. (°C)	pH	BOD_5 (mg/L)	Dissolved Sulfide In Wet Well (mg/L)
Summer	21	7.2	250	1.0
Winter	15	7.2	250	0.5

The model input parameters listed in **Table 3** were all based on actual field measured data. The dissolved sulfide grab sampling results obtained during the current study and the 2003 study closely resemble those predicted by the sulfide model that takes the HGL effect into account. The sulfide concentration predicted by the HGL enhanced model at the vault during summer temperature conditions was 2.2 mg/L. Grab samples of 3.0 mg/L and 5.0 mg/L were taken at the vault during the summer of 2003. The winter temperature version of the sulfide model that takes the HGL effect into account predicted a dissolved sulfide concentration of 1.4 mg/L. Grab sample sulfide concentrations between 1.5 and 2.0 mg/L were taken at the vault during the recent sampling effort.

Note that the recent summer version of the model that was run without the HGL effect closely resembles the sulfide concentration predicted by the model used in the 2003 study. Both models significantly overstate the predicted concentration (8.9 and 10.0 mg/L, respectively) versus the actual concentrations measured in the field in 2003 (3.0 and 5.0 mg/L) and 2004 (1.5-2.0 mg/L). **Figures 5, 6, 7 and 8** provide charts that show predicted and measured sulfide concentrations along the entire length of the 16-inch diameter force main. **Figures 5 and 6** represent data from the sulfide model that was run using the HGL effect on sulfide stripping for winter and summer conditions, respectively. **Figures 7 and 8** represent data from the sulfide model that was run **without** the HGL effect on hydrogen sulfide stripping. Plots are included on each chart to compare the modeled results with the data that was measured at the discharge vault in the field.

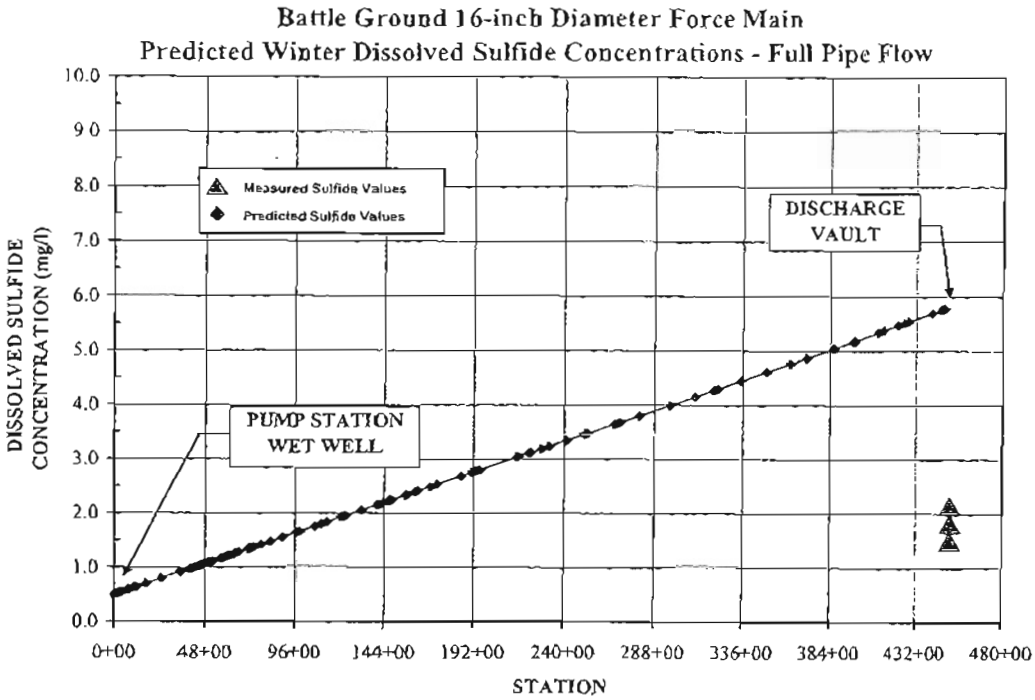


FIGURE 7

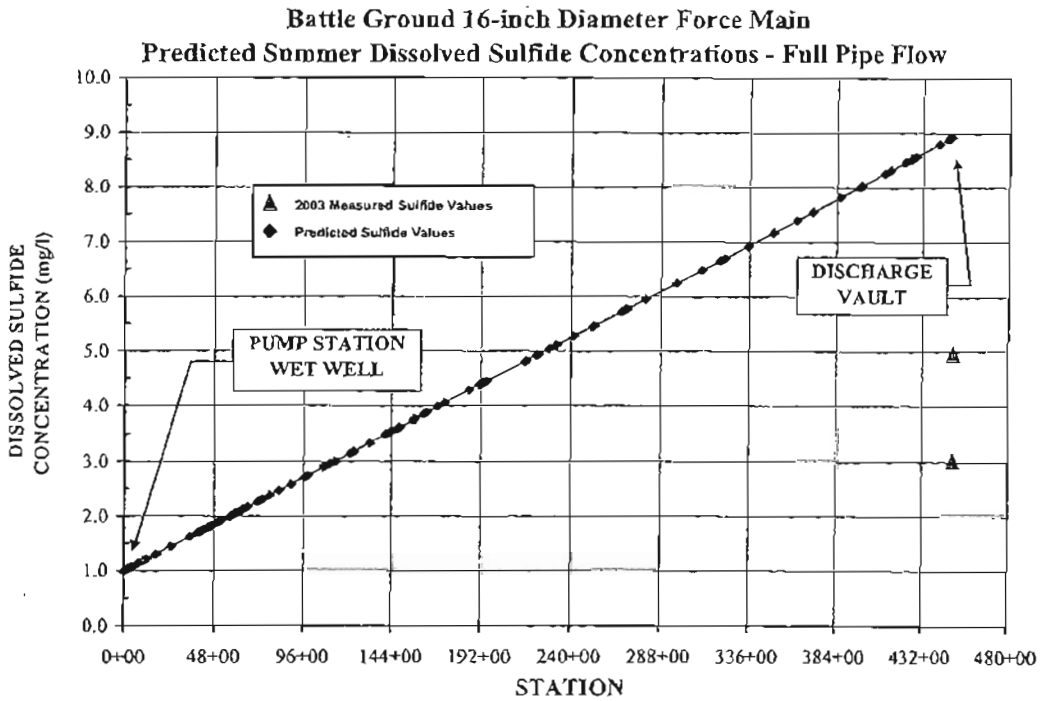


FIGURE 8

The results of the orthophosphate sampling in the wet well and discharge vault are significant when one considers the poor performance of the iron salts (ferrous and ferric chloride) used for odor control on the 16-inch diameter forcemain and the chemical mechanism by which iron salts work for odor control. The purpose of iron feed for odor control is to precipitate dissolved sulfide from the waste stream before it can be stripped from solution as odorous hydrogen sulfide. In order for this to occur, enough of the ferric cation must remain available to bond with the dissolved sulfide anion as the sulfide is reduced from sulfates by bacteria along the length of the forcemain. At the Battle Ground Pump Station, ferric chloride is introduced into the wastewater at the wet well in the presence of (among other compounds) three negatively charged ions: orthophosphates, sulfates and a small amount (0.5 – 1.0 mg/L) of dissolved sulfide.

The ferric ion will tend to bond with those negatively charged ions that will form the least soluble compounds in water. In the presence of sulfate, dissolved sulfide and orthophosphate the ferric ion will form ferric sulfide (Fe2S3) and ferric orthophosphate (FePO4). The ferric ion will precipitate very little (if any) of the sulfate due to the solubility of this compound in water. The sulfate is therefore carried into the forcemain with the wastewater. Because of the precipitation of the ferric sulfide and ferric phosphate, there is less iron available than is required to precipitate the dissolved sulfide that will be produced from sulfate by the bacteria in the forcemain. Sulfide is produced in the forcemain and hydrogen sulfide is stripped from solution at the discharge vault due to the turbulence of the incoming wastewater. **Figure 9** presents a graphic depiction of this situation.

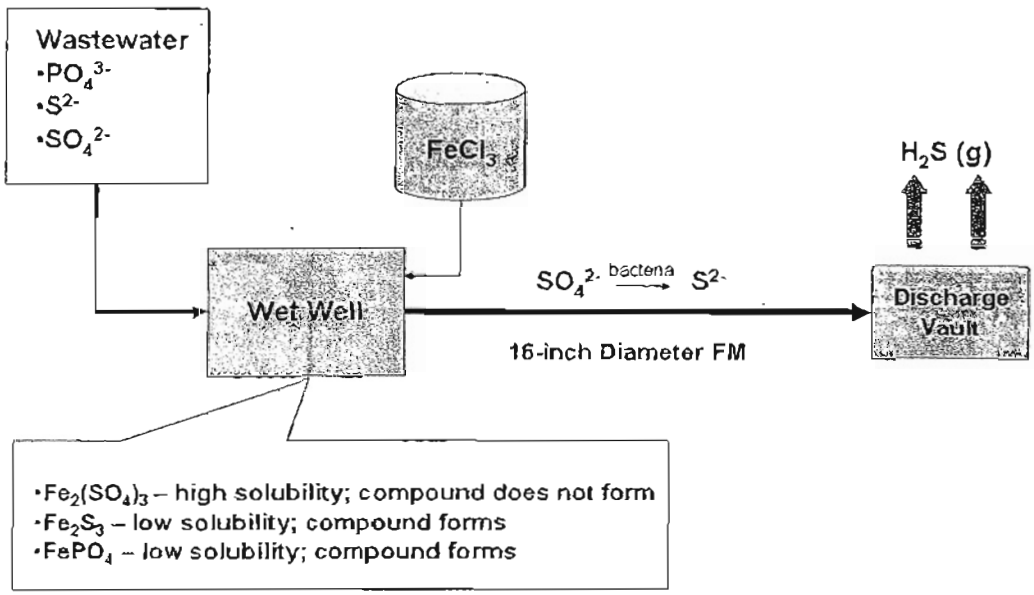


FIGURE 9
SCHEMATIC DEPICTION OF CHEMICAL MECHANISMS AT WORK IN WET WELL, FORCEMAIN AND DISCHARGE VAULT

Orthophosphate samples were taken at manholes 4, 5 and 6. The first sample was taken at manhole 4. An orthophosphate concentration of 7.75 mg/L was recorded. The next sample was taken at manhole 5 approximately 15 minutes later. This manhole is located approximately 50 feet upstream of manhole 4 on the 8-inch diameter sewer. The orthophosphate concentration recorded there was 4.4 mg/L. The last sample was taken at manhole 6 approximately 10 minutes later. Manhole 6 is located approximately 250 feet upstream of manhole 5 and is the next manhole upstream on the 8-inch diameter sewer. The orthophosphate concentration measured in manhole 6 was 2.4 mg/L. It should be noted that manhole 6 is located approximately 100 feet downstream of the upstream end of the 8-inch diameter sewer and approximately 200 feet downstream of the upstream end of a 6-inch diameter sewer. It appears that very little flow (compared to that in manhole 4) passes through manhole 6.

pH and Temperature

The pH and wastewater temperature values measured during grab sampling are within the normal range for domestic wastewater. pH values were consistently lower at the discharge vault than at the wet well. This is to be expected given the higher concentrations of dissolved sulfide (in the form of acidic hydrogen sulfide) that were measured at this location. Any of the sulfuric acid that makes its way back into the wastewater from exposed pipe crown segments could also depress the pH of the wastewater, depending on the wastewater alkalinity and amount of sulfuric acid produced in these locations.

Gas Phase Wet Well and Discharge Vault Data

As stated previously, gas phase concentration grab samples were taken of H_2S, mercaptans, amines and ammonia. As shown in **Table 1**, very little of any of these odor constituents were detected. A few H_2S grab sample concentrations were on the order of 5 ppm at the discharge vault. This low concentration is not surprising given the known, diurnal H_2S concentration trends such as those shown in **Figure 2**. It is also not surprising that no H_2S was detected in the pump station wet well. There was very little wastewater turbulence or evidence of corrosion observed in this structure during the sampling period. Presumably, very little H_2S stripping occurs here. It is not a known source of odors at this facility.

Lagoon Sampling

As discussed previously, four liquid samples were taken from the wet weather overflow lagoon between December 20 and 21, 2004. A summary of the parameters measured in the field is presented in **Table 6.** A summary of algae enumeration and identification results is presented in **Table 7**.

Based on observations and sampling made during site visits, the above-ground lagoon headworks structure appears to present the greatest potential for the offsite detection of H_2S on the grounds of the facility. This is apparent for several reasons, which include the following:

- It carries wastewater directly from the collection system which has been shown by others to contain a minimum of 1.0 mg/L of dissolved sulfide in the warm weather months
- The flow is quite turbulent as it is released from the forcemain to the open channel portion of the structure
- The flow channel is open to the atmosphere
- It is within close proximity to residential developments on the north side of the facility grounds

Grab samples of approximately 5 ppm of H_2S were taken just above the turbulent areas of the open channel. It is probable that this concentration is much higher in the warm weather months.

While the pump station wet well and lagoon both contained approximately 0.5 mg/L of dissolved sulfide during the sampling period, the wastewater contained in these facilities was observed to be quiescent. No H_2S was detected being stripped from the wastewater held by either of these structures.

The presence of algae in a water body such as the lagoon can elicit odor complaints that are described as musty-earthy type smells. Algae that produce these odors are typically most active during warm weather months. The odors are the product of substances left behind by the algae during metabolic processes.

Orthophosphate Sampling throughout Collection System

A summary of the orthophosphate and BOD_5 data collected in the wastewater collection system on February 24 and 25, 2005 is presented in **Table 8**. **Figures 11, 12, 13 and 14** present schematic maps showing the locations and corresponding orthophosphate data collected. All orthophosphate sampling results on the maps are circled and are in units of mg/L.

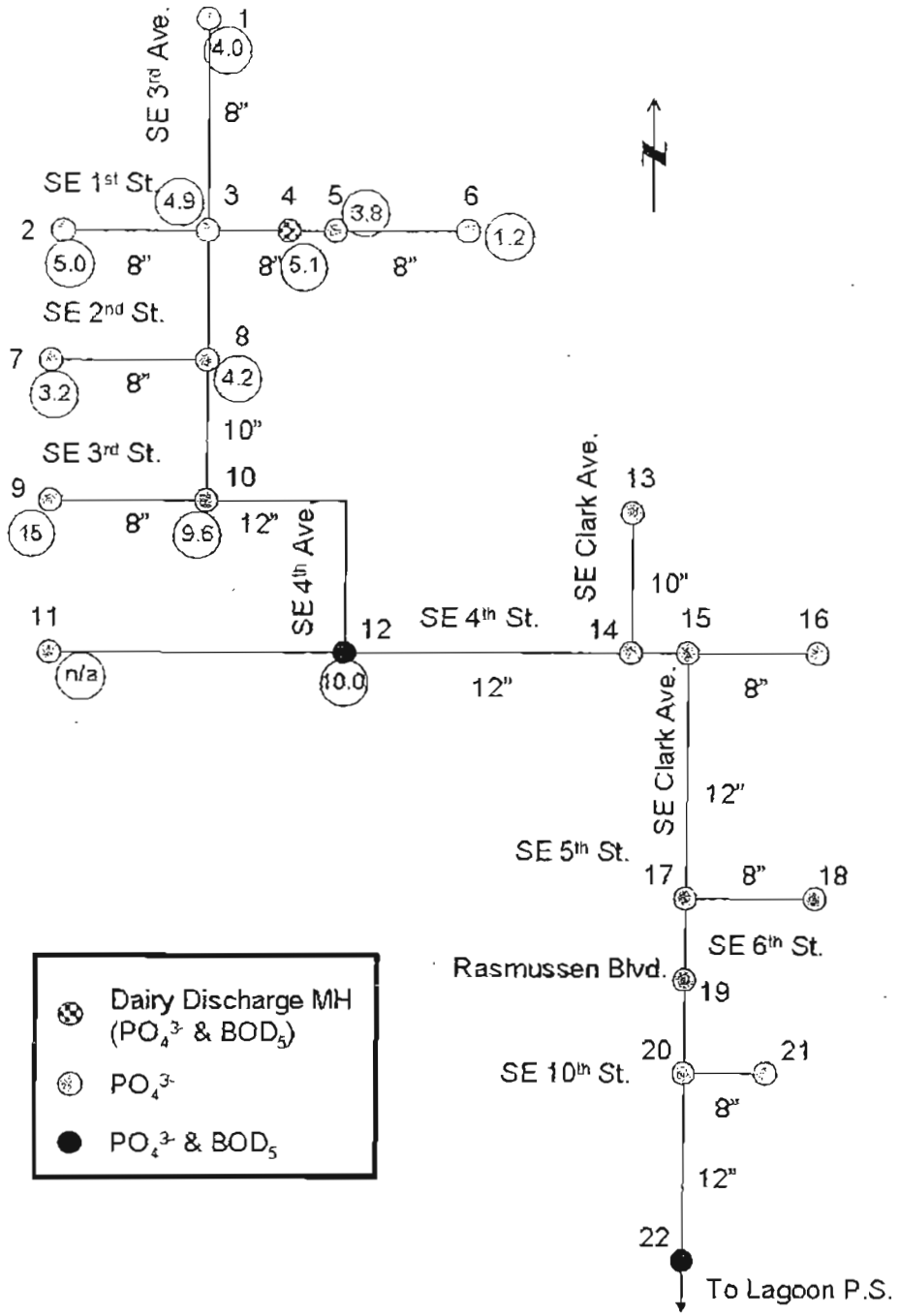


FIGURE 11
DAY 1 OF ORTHOPHOSPHATE SAMPLING
MORNING SESSION

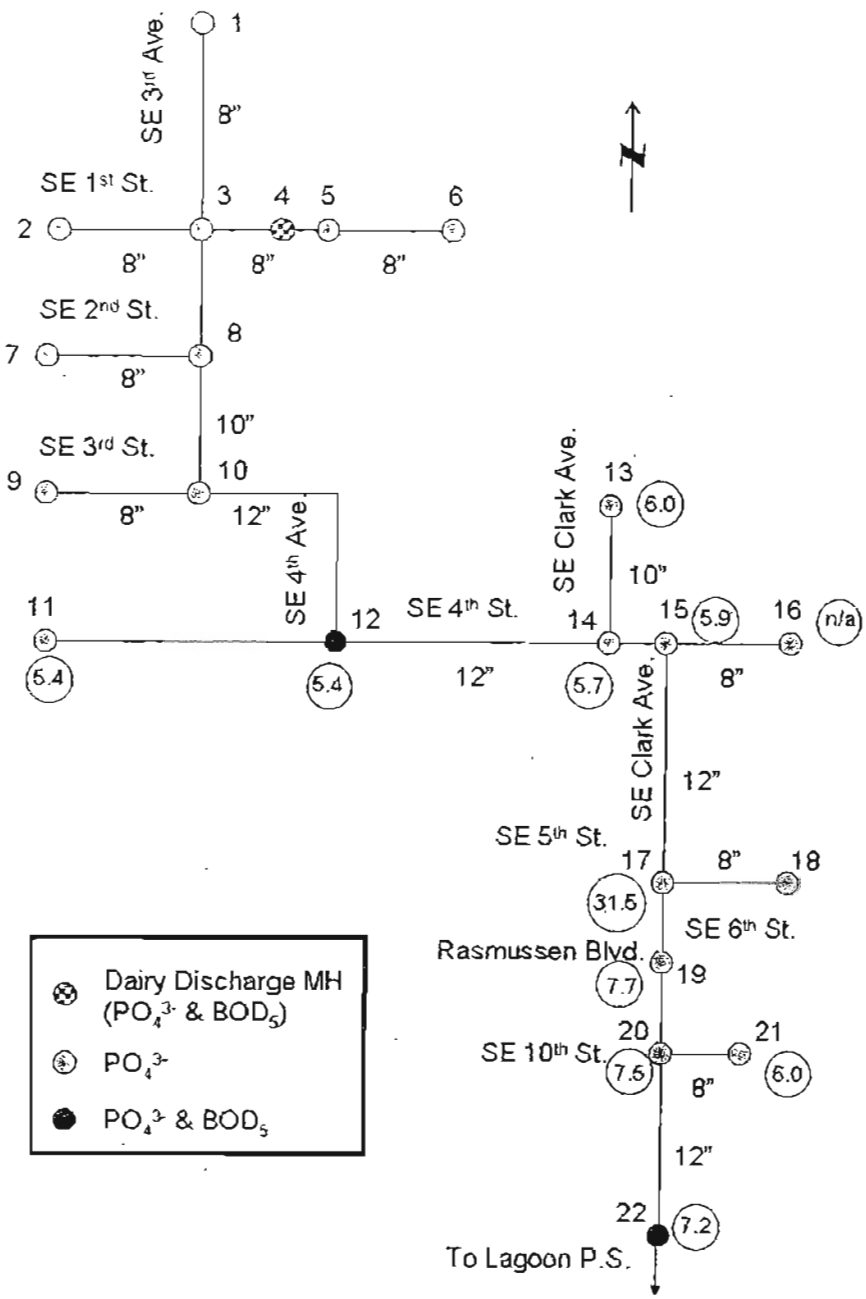


FIGURE 13
DAY 2 OFORTHOPHOSPHATE SAMPLING
MORNING SESSION

The data shown in **Figures 11 and 14** indicate that extremely high orthophosphate concentrations were measured on both days in the reach of sewer between SE 3rd Street and the intersection of SE 4th Street and SE 4th Avenue (i.e. between manholes 9 and 13). Given that more moderate concentration levels were measured in the other locations of the collection system it would appear that the high concentrations that were measured in the 12-inch diameter sewer along SE Clark Avenue were contributed by the flow that is discharged from the 8-inch sewer along S.E. 3rd Street.

The BOD_5 concentrations also fluctuated throughout the collection system. Measurements ranged between 330 and 1,200 mg/L. The wastewater sample containing 1,200 mg/L was taken at manhole 12. This sample was very cloudy and white and looked very similar to wastewater that was seen to be discharged into manhole 4 approximately 10 minutes before the sample was taken at manhole 12.

Ferric Depletion Jar Testing

Jar testing was performed on three wastewater samples taken from the wet well in an effort to determine the extent of potential ferric iron depletion due to the presence of orthophosphate. The samples were taken by HDR. The testing was performed by a third party laboratory. The procedure was as follows:

- Add 4 microliters of 42% ferric chloride to 1 liter of sample wastewater
- Following ferric addition, each sample was mixed for a different period of time according to the following schedule:
  - 1 sample mixed for 1.5 minutes
  - 1 sample mixed for 1 hour
  - 1 sample mixed for 2 hours
  - Measure the orthophosphate concentrations after mixing

A feed rate of 4 microliters of ferric chloride per liter of wastewater is equivalent to 2 gallons per hour of ferric chloride added to 1.3 MGD of wastewater.

Each sample consisted of a known orthophosphate concentration of 6.0 mg/L. The resulting orthophosphate concentrations, percentage removal and corresponding ferric iron depletion percentages are presented in **Table 9**.

TABLE 9

RESULTS OF FERRIC DEPLETION ANALYSIS

Sample Number	Initial $(PO_4)^{3-}$ Concentration (mg/L)	Mixing Duration	Final $(PO_4)^{3-}$ Concentration (mg/L)	% $(PO_4)^{3-}$ Removal	% Ferric Iron Depletion
1	6.0	1.5 minutes	3.5	42	17
2	6.0	1 hour	3.1	48	20
3	6.0	2 hours	3.0	50	20

- It is a chemical that provides a preferred oxygen source to the bacteria that are responsible for sulfide reduction in the slime layer of the sewer. The bacteria prefer nitrate over sulfate. Because of this mechanism, its usefulness as an odor control chemical is not affected by the presence of other wastewater constituents
- No detrimental effects would be registered at Salmon Creek Wastewater Treatment Plant due to its use as an odor control chemical in the forcemain. It should be noted that the Hazel Dell Sewer District is currently using calcium nitrate successfully to control odors in a forcemain in its collection system
- It is non-corrosive and relatively safe to handle
- Although the unit cost of calcium nitrate (approximately $1.70/gal) is greater than that for ferric chloride (approximately $0.90/gal) the possibility exists that less calcium nitrate would be required for odor prevention than ferric chloride.

The pilot testing for both chemicals should be performed before a decision is made for the purchase of chemical for the upcoming warm weather "odor season".

- The information and analysis that results from the pilot testing should be combined with sulfide model prediction data to design an optimized, PLC-based chemical feed system at the Battle Ground Pump Station. Depending on which chemical is chosen for odor control, the feed system should be designed to measure certain wastewater characteristics at the wet well and send a feed signal to the PLC system to properly regulate the amount of chemical that is fed. Such a system would provide the following benefits:
  - To continuously monitor changing wastewater conditions that directly affect both the generation of odor-producing sulfide in the forcemain and the effectiveness of corresponding chemical treatment
  - By optimizing the chemical feed, the risk of overfeeding chemical would be greatly diminished. This would likely result in a long term chemical cost savings to the City.
- The City should conduct additional, simple odor analyses on the lagoon and headworks structure during the warm weather months. This could include continuously monitoring H_2S at the upstream (i.e. turbulent) end of the above-ground headworks using an OdaLog device, grab sampling at the plant fence line using a low-level Jerome 631-X H_2S sampling instrument and sending Tedlar bag-filled gas samples from the north and west end of the lagoon facility (i.e. near the lagoon) to an outside laboratory for gas chromatography analysis. The GC analysis would provide information on organic, gas phase compounds (if any) released from the lagoon that would be detectable by persons outside the fence line.
- If the above-ground headworks structure proves to be the prime source of odors from the facility, the City should cover the open-air channels on the structure. The channel would also need to be force ventilated through an odor scrubbing device such as a bioscrubber, biofilter, etc.
- If the lagoon itself proves to be a significant contributor of odors from the facility, jar testing should be conducted to determine the effectiveness and feasibility of ferric chloride addition to remove orthophosphate from the lagoon. The test could consist of dosing the chemical in various amounts and performing a bioassay to determine the effect on the algae population.
  - If jar testing with ferric chloride proves effective at reducing the algae population in the samples, a full scale pilot test should be performed on site to confirm the jar test

“Battle Ground Surge Basin Facility Odor Control Study”,
Draft Technical Memo from HDR dated September 26, 2005

HDR | ONE COMPANY *Many Solutions*℠

Draft Technical Memo

To:	Sam Adams, Rob Charles, Steven Rommel – City of Battle Ground		
From:	Mark Smith		
CC:			
Date:	September 26, 2005		
Project:	Battle Ground Surge Basin Facility Odor Control Study	Project No:	21680/Task 5
RE:			

INTRODUCTION

An 8-acre surge basin is located next to the Battle Ground Pump Station (BGPS). This facility is used primarily as a wet weather retention facility to store sewage upstream of the Battle Ground Force Main (BGFM). Odors routinely emanate from the surge basin. Additionally, operators downstream at the Salmon Creek Wastewater Treatment Plant (SCWWTP) report that algae periodically enter their plant following the release of wastewater from the surge basin into the BGFM. The data obtained from this analysis will assist in developing recommendations for surge basin algae and odor control.

Prior to entering the BGPS, influent wastewater passes through an on-site, two-cell aerated flow equalization basin. High levels of turbulence have been observed in the flow equalization basin due to the aeration provided by two 1,200 cfm blowers. Each blower aerates a single cell.

SUMMARY OF SAMPLING EFFORTS

Over a two day period, gas phase grab samples were collected at the surface of the surge basin, the surface of the flow equalization basin, and at the west and north fence lines of the surge basin/BGPS property (see Figure 1 on the following page). Laboratory analyses were performed by two third party laboratories to determine the following odor characteristics:

- TO-12 total gaseous nonmethane organic compounds (TGNMO)
- Detection threshold
- Recognition threshold
- Intensity
- Character
- Hedonic tone
- Persistency

All lab analyses, except the TGNMO, were performed with the use of an odor panel.

Grab samples were also taken for hydrogen sulfide concentrations at several points around the west and north fence lines. Values for these samples were determined in the field using a Jerome 631-X hydrogen sulfide gas analyzer.

Hydrogen Sulfide Grab Sampling

Grab samples for hydrogen sulfide were taken at numerous locations on the grounds of the surge basin site. The results of this sampling are summarized graphically in **Figure 2**. Several hydrogen sulfide grab samples were also taken approximately one foot above the open air discharge point on the headworks structure. These results are summarized in **Table 2**.

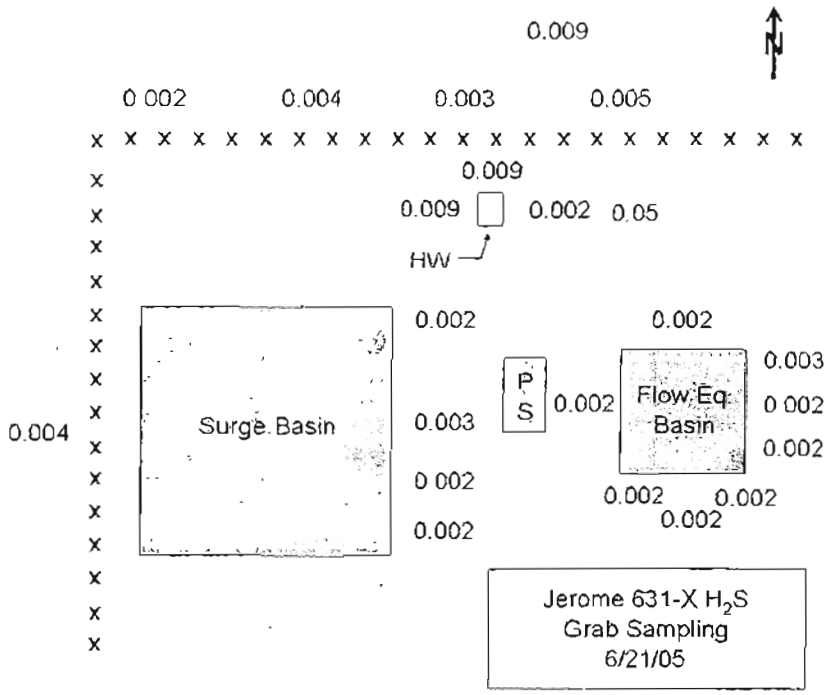


Figure 2
Hydrogen Sulfide Sampling Results

Table 2
Hydrogen Sulfide Grab Samples at Headworks Open Air Discharge Point
6/21/05, 1:00pm

$[H_2S]$ (ppm)	Headworks Pump On/Off
0.16	off
0.04	off
4.7	on
6.2	on
0.15	off
0.38	off
0.11	off
0.40	on

DISCUSSION OF SAMPLING RESULTS

Total Gaseous Nonmethane Organic Compounds (TGNMO)

The results of the organic compound analysis show that the surge basin is likely the prime source of organic odor compounds. The grab sample that was analyzed produced a total organic nonmethane organic compound concentration of 1.8 ppm. The flow equalization basin sample, while not insignificant, produced a less concentrated organic compound value of 1.03 ppm. Note also that a concentration of 1.04 ppm was measured at the north fence line, just outside the surge basin site grounds.

Odor Panel Analysis

The odor panel data indicate that odors from the surge basin and aboveground, open air headworks discharge constitute the highest concentrated and most persistent odors. In addition, the hedonic tones of the odors from these two sources indicate they are considered to be the two most unpleasant of the air samples tested.

Hydrogen Sulfide Grab Sampling

Most of the hydrogen sulfide samples recorded on or near the surge basin site grounds were well below the human detection limit for hydrogen sulfide. This value is typically regarded to be approximately 6 parts per billion (0.006 ppm). The only areas of the surge basin site where grab samples exceeded this threshold were in and around the headworks structure (see **Figure 2** and **Table 2**). Hydrogen sulfide concentrations between 0.11 and 4.7 ppm were recorded in the headspace just above the discharge of the headworks structure. These values are several orders of magnitude greater than the detection threshold for hydrogen sulfide.

DISCUSSION OF ODOR EMISSION RATES

The three likeliest sources of odor emissions at the surge basin site are the surge basin, headworks, and flow equalization basin. Each of these facilities releases odorous compounds to the atmosphere by different means. The flow equalization basin releases odors due to the turbulence induced by the two 1,200 cfm blowers that are employed to aerate each of the two basins. The headworks releases odors from the open air, aboveground channel due to the action of the pump that raises the flow into the channel from the wet well. The surge basin releases odors from its surface by the least turbulent (and consequently least effective) method, namely wind-induced surface turbulence.

Once an understanding of odor unit concentration, facility geometry, and odor stripping mechanisms are understood, it is possible to calculate an "odor emission rate" from each of the three facilities. This provides a true measure of the most likely source(s) of odorous air from the surge basin site grounds. **Table 4** presents a summary of odor emission rates from the surge basin, flow equalization basin, and aboveground headworks channel structure.

Table 4
Summary of Odor Unit Emission Rate Estimates for Each Facility

Location	Reported DT	Blower Rate (cms)	Assumed Air Velocity (m/s)	Flux Rate (cms)	Emission Rate (OU/sec)
Headworks channel	4200	n/a	1	1.9	7980
Surge basin	3200	n/a	n/a	1.5	4800
Flow equalization basin	50	0.54	n/a	n/a	27

Notes:
CMS – cubic meters per second
OU – odor units

achieved with a ferric chloride feed system, the potential for significant odor control does not necessarily exist by utilizing this technology alone.

Dissolved Air Floatation (DAF) Facility

DAF facilities have been successfully used for algae reduction. Such a facility could be designed to treat and remove algae from the surge basin before it is released to the wastewater collection system. The high capital cost (approximately $1M) would have to be weighed against the fact that the surge basin will be relocated in the near future. The DAF would only have a useful life of about five years.

Floating Cover

An opaque floating cover would provide two significant benefits for the existing surge basin:

- Algae and duckweed control (due to the blockage of sunlight, thereby reducing the photosynthetic activity of organisms)
- Complete odor control; any fugitive odors ordinarily released from the water body would remain under the floating cover.

High capital cost (approximately $1M) would have to be weighed against the fact that the surge basin will be relocated in the near future. For comparison purposes, the new facility has been conceptualized as being totally enclosed with a structural cover. The new facility has also been conceptualized with a forced air ventilation odor control system.

The new surge basin could be designed to use a floating cover transferred from the existing site, thereby negating the need for forced air ventilation from the new surge basin. Also, it should be noted that the capital cost of a structural cover for a new surge basin constructed of cast-in-place concrete and aluminum could cost approximately $2M - $4M dollars.

Table 5 summarizes the issues related to each of the algae abatement options discussed above.

Table 5
Summary of Existing Surge Basin Algae and Odor Abatement Options

Option	Relative Cost	Algae Reduction Potential	Odor Reduction Potential	Additional Issues
$CuSO_4$ feed	Moderate	Significant	Small to moderate	Short life span
$FeCl_3$ feed	Moderate	Significant	Small to moderate	Short life span
DAF facility	High	Significant	None	Short life span
Floating cover	High	Significant	High	Potential to transfer use to new facility

CONCLUSIONS

The conclusions that follow are based on the results of the odor sampling and analysis. Also, the following assumptions were made in reaching these conclusions:

- The aboveground headworks facility will be abandoned and relocated to a new site on the surge basin site grounds. Odor control consisting of forced air ventilation through an odor scrubber will be provided.
- The existing surge basin will be abandoned. A new 8-acre surge basin will be designed and built (relocated well off-site) within five years' time.

Headworks Channel

This structure is a significant contributor of foul air. Turbulence induced by the pumps as the wastewater is lifted to the channel strips H2S and malodorous organic compounds from the solution. Winds from the southerly direction carry this odorous air toward houses on the north side of the surge basin site. The redesign

Appendix D

Miscellaneous Information

Figure 2-5 from Wastewater Engineering Treatment, Disposal and Reuse, Metcalf & Eddy Inc., Third Edition

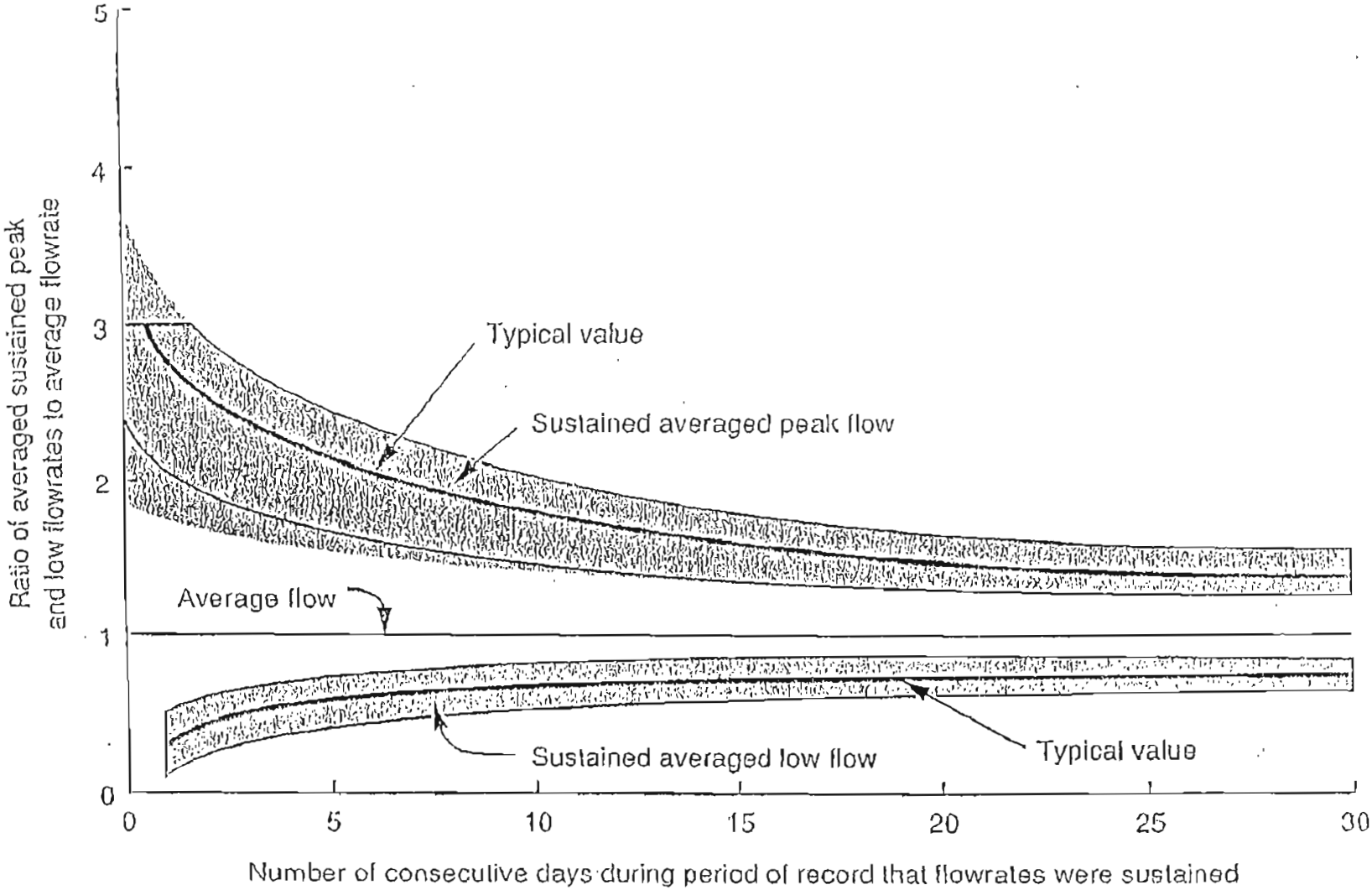
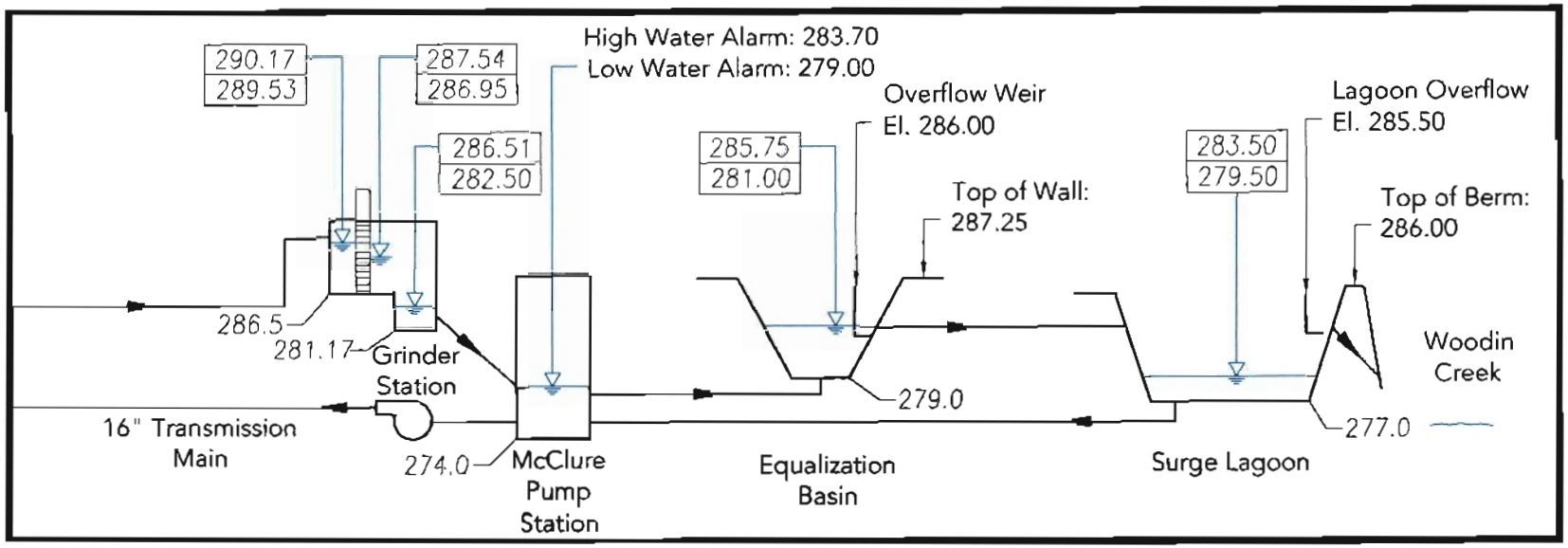


FIGURE 2-5

Typical ratios of averaged sustained peak and low daily flowrates to average annual daily flowrates for time periods up to 30 days.

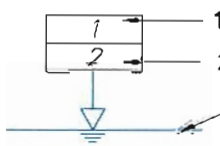
Source: Wastewater Engineering Treatment, Disposal and Reuse, Metcalf & Eddy Inc., Third Edition.

Transmission System Hydraulic Profile



Legend:

Flow Direction



12 MGD Peak Flow Water Surface Elevation (Feet)

2.96 MGD Design Flow Water Surface Elevation (Feet)

Water Surface

Assumptions:

1. Surge Lagoon and Equalization Basin are full under peak flow conditions.
2. Under low flow conditions 2 feet of water in Surge Lagoon and Equalization Basin.

Transmission System Hydraulic Profile

Appendix E

Interlocal Agreements

Contract Between Hazel Dell Sewer District and the City of Battle Ground for Sewage Treatment Capacity and Payment

CONTRACT BETWEEN
HAZEL DELL SEWER DISTRICT
AND THE
CITY OF BATTLE GROUND
FOR SEWAGE TREATMENT CAPACITY AND PAYMENT

THIS CONTRACT is effective as of the 28th day of March, 1995, by and between the Hazel Dell Sewer District (the "District") and the City of Battle Ground, Washington (the "City"), (collectively, the "Participants").

WHEREAS, the District and the City currently are served with sewage treatment disposal and transport services for their Wastewater by Clark County, Washington (the "County"); and

WHEREAS, the State of Washington, Department of Ecology, has enforced both federal and state statutes by issuing Compliance Order No. WE93WQ-5330 dated February 10, 1993, requiring the County to provide planning and the schedule for both short- and long-term expansion and upgrading of its treatment plant and related facilities; and

WHEREAS, the County has entered into a contract with the District and the City, dated March 28, 1995 (the "Joint Contract"), whereby the County will receive all Wastewater from the District and the City and transport that Wastewater to the County's Salmon Creek Sewage Treatment Facilities (the "Facilities") for treatment and disposal, and under that contract the District and City assume the responsibility for delivering such Wastewater within the quantity and quality standards and limitations under the Joint Contract and the District obligates itself to pay Sewage Treatment Charges to the County as provided in the Joint Contract; and

WHEREAS, the City wishes to contract with the District, and

by this Contract to transmit to the Facilities, measured in volume. Volume shall be measured by metered Wastewater flow expressed in MGD's of AADF unless another method is approved by the Board of County Commissioners after review and recommendation by the WWMAB.

1.4 "City" means the City of Battle Ground, Washington, a municipal corporation located in Clark County, Washington.

1.5 "Contract" means this Contract by and between the City and District for Sewage Treatment, Disposal and Transport Services.

1.6 "County" means Clark County, Washington, a body corporate and municipal corporation.

1.7 "Customer" means any user of the Internal Systems.

1.8 "Debt Service" means required principal, interest and sinking fund or mandatory redemption payments due to be made during a specified period on the Sewer Revenue Bonds and all Other County Obligations.

1.9 "Direct Costs" means those costs identified with and attributed to the Facilities in the absence of which those costs would not exist.

1.10 "District" means Hazel Dell Sewer District, a municipal corporation, located in Clark County, Washington.

1.11 "Domestic Sewage" means sanitary wastes normally

Exhibit A of the Joint Contract, and incorporated herein by reference, as amended from time to time.

1.13 "Facilities" means the County's Salmon Creek wastewater treatment plant and includes the influent transmission lines used by the District and the City (Salmon Creek interceptor and Battle Ground transmission line), the 36th Avenue pump station, the outfall, the diffuser, and, upon construction of the Project or any component, the Improvements.

1.14 "Improvements" means those modifications to the Facilities set forth in the 1994 Expansion Program dated February, 1994 and the Master Plan/Engineering Report for the Phase 3 Expansion Program, dated January, 1995, and that will be described in the engineering plans and specifications approved by DOE, and the County, as amended, and are generally described in Exhibit B, of the Joint Contract and incorporated herein by this reference, and approved change orders carried out in accordance with the Joint Contract. For purposes of construction timing, the Improvements are sometimes divided and referred to as Component 1 and Component 2 of Phase 3.

1.15 "Index of Cost Increases" means the Engineering News Record (ENR) Construction Index or such other commonly accepted construction cost index adopted

1.19 "Joint Contract" means that contract, dated March 28, 1995, between the County, the City and the District under which the County agrees to treat and dispose of Wastewater discharged into the Facilities by the District and the City, and the District agrees to pay Sewage Treatment Charges, and which contains other provisions.

1.20 "Maintenance and Operation Expenses" means all expenses incurred by the County in causing the Facilities to be operated and maintained in good repair, working order and condition, including without limitation payments to other entities for the operation of any portion of the Facilities or for the transmission, treatment or disposal of Wastewater and including Direct Costs and Indirect Costs (see Exhibit C of the Joint Contract) but not including any depreciation, Debt Service, County-levied taxes or payments to the County in lieu of taxes.

1.21 "Maximum Monthly Flow" or "MMF" is a measurement of flow expressed in MGD representing the highest average monthly flow and is calculated by taking the total flow of Wastewater discharged into the Facilities measured in millions of gallons for a given calendar month divided by the total number of days in that month.

1.22 "MGD" means million gallons per day, referring to a

1.26 "Participant" means either the City or the District.

1.27 "Parties" means the County, the District and the City.

1.28 "Permitted Capacity" means the maximum AADF or MMF of Wastewater that the District and City may transmit to the Facilities without exceeding the County's NPDES permit levels or the engineering design levels for the Facilities.

1.29 "Project" means the Improvements and activities needed to implement the Improvements.

1.30 "Project Costs" in accordance with the approved budget, means (1) the cost of preparing the planning studies, engineering reports, and engineering plans and specifications for the Improvements; (2) the amounts paid to contractors for work performed under contracts for the Project; (3) the recorded pay and expenses of employees of the County directly related to the Project; (4) the cost of materials, equipment and supplies directly related to the Project; (5) the cost of acquiring and condemning land, easements and rights-of-way for or related to the Project; (6) the cost of legal, engineering and other professional services related to the financing, planning, acquisition, design, construction, installation and inspection of the Project and to the resolving of any disputes

Revenue Bonds may be issued in more than one series and over a period of time.

1.35 "Single Family Residence" means one structure, all connected and under the same roof, located on a lot or tract of real property having a separate and individual property description, with no other structure used for human occupancy located on that tract or lot, and which structure is occupied by a single family.

1.36 "Wastewater" means Domestic Sewage and other water flows in the sewers of the District or City or the Facilities.

1.37 "Wastewater Management Advisory Board" or "WWMAB" means the committee of that name recognized in Section 8 of the Joint Contract.

2. Discharge of Sewage Into Facilities. The City shall discharge all Wastewater collected by its Internal System into the Facilities at the Influent Point on the Battle Ground transmission line specified in Exhibit A.

The District shall discharge the Wastewater collected by its Internal System that the District intends to be treated by the Facilities into the Facilities at the Influent Point or points specified in Exhibit A.

3. Allocation of Capacity.

3.1 Capacity Allocation Calculation. The Allocated Capacity in the existing Facilities (based on a total Permitted Capacity of 5.63 MMF) is set forth

Allocated Capacity for the District is 8.33 MMF and the City is 1.97 MMF for a grand total of 10.3 MMF.

3.2 Capacity Limit. No Participant may discharge, pursuant to this Contract, Wastewater greater than its Allocated Capacity, as set out in Table I and Table II, into the Facilities and it is understood that the County may refuse to accept and treat any amounts in excess of the Participants's Allocated Capacity of Wastewater. If the County determines that the amount of either Participant's Wastewater discharge is in excess of that Participants' Allocated Capacity causing the Facilities discharge to exceed the Permitted Capacity, that Participant shall pay, in addition to its ordinary charges described in Section 7 of the Joint Contract, any additional costs incurred by the County to treat the excess Wastewater. Costs for treating Wastewater flows beyond the Permitted Capacity or the Allocated Capacity without prior arrangements such as an agreement to transfer capacity shall be charged according to the methodologies described in Section 3.4 of this Contract. Under the Joint Contract, the County is to provide an accounting for its additional costs to both Participants. Payments by the City shall be made to the District and, in turn, by the District to the County.

The terms of any transfer arrangement shall be reasonable and subject to review by the WWMAB.

The Participants shall notify the County of all pending and final transfers of capacity and of all terms of such transfer, in writing.

3.4.1 Cost of Permanent Capacity Transfer. The cost of transferring such capacity shall be determined by the future value method, which is based on the principle that the capacity purchaser should reimburse the capacity seller for all previous payments for Sewage Treatment Charges (excluding Maintenance and Operation Expenses) which the seller has made for the transferred capacity, and for the compounded cost of such payments as defined by an interest rate that the selling Participant could have expected to receive by investing these payments. The capacity purchaser shall be responsible for payment for future bond or debt payments associated with the capacity purchased.

3.4.2 Temporary Capacity Transfers. Temporary Capacity Transfers will be permitted, for a period not exceeding five years, from the Participant having excess capacity to the Participant needing capacity on the

5.1.1 Budget/Monthly Payments. As provided in Sec. 7.1.1 of the Joint Contract, the County shall provide the City and the District with a proposed budget for the following year. The District shall bill the City monthly for the City's share of the Sewage Treatment Charges. The City shall pay in immediate funds to the District within 20 days after receiving the District's billing the full amount of the City's share of the Budget.

Based on the full accounting to be provided by the County relative to all Wastewater flows for the previous year, as well as a separate summary of the actual Maintenance and Operation Expenses incurred by the County, the District shall provide the City with final actual expense/flow allocations no later than April 1 of the current calendar year.

If the total amount paid by the City during the calendar year is different from the amount due and

Maintenance and Operation Expenses. The City's monthly payments shall be due at the earliest date depending on the City's accounts payable cycle. If the City's payment is received more than 20 days after receipt of District's bill, the District shall be entitled to a late payment surcharge equal to the interest which the payment would have earned for the period in excess of 20 days, based on an interest rate received by the District for investments during that period.

5.2 Adjustment of Participant's Shares. A Participant's share of the Sewage Treatment Charges shall be adjusted, permanently or for a temporary period, for the following reasons and in the following ways.

When the Allocated Capacity is changed pursuant to Section 3.4, the Participants' shares shall be changed to the new percentages of Allocated Capacities and remain at those percentages until the Allocated Capacities are changed again. The Participants shall also make the additional payments or reimbursements required with respect to the adjustments described in

System and other money legally available to the City. The City covenants that its Sewage Treatment Charges payments to the District shall be deemed a part of the expenses of maintenance and operation of the City's Internal System as the expense of treating and disposing of Wastewater discharged by it into the Facilities prior and superior to any charge or lien of any revenue bonds issued or other obligations incurred heretofore (if permitted by law and covenants of currently outstanding sewer or water and sewer revenue obligations of the City) and hereafter by the City that are payable from the revenues of its Internal System, and such priority shall be stated expressly in every obligation payable from its revenues hereafter issued or incurred. The City covenants that it shall establish rates and collect fees and charges for sewer service in amounts at least sufficient to pay for (a) the maintenance and operation of the City's Internal System, including the City's payments to the District set out in this Section 5 and (b) the principal of, interest on and coverage requirements for any and all City revenue obligations that constitute a charge on the revenue of the City's Internal System.

6. Sale or Transfer of City's Collection Facilities/First Right of Refusal. In the event the City decides to transfer or is

control. However, the Participants by agreement may waive arbitration. The venue of the arbitration shall be Clark County, unless the disputing Participants agree otherwise. The arbitrator's fees and costs shall be paid by the nonprevailing Participant.

8. Successors and Assigns. This Contract shall inure to the benefit of and be binding upon successors in interest and assigns of the Participants and is not intended to confer rights or benefits upon any third party except for owners of the Sewer Revenue Bonds and Other County Obligations and as otherwise expressly stated herein.

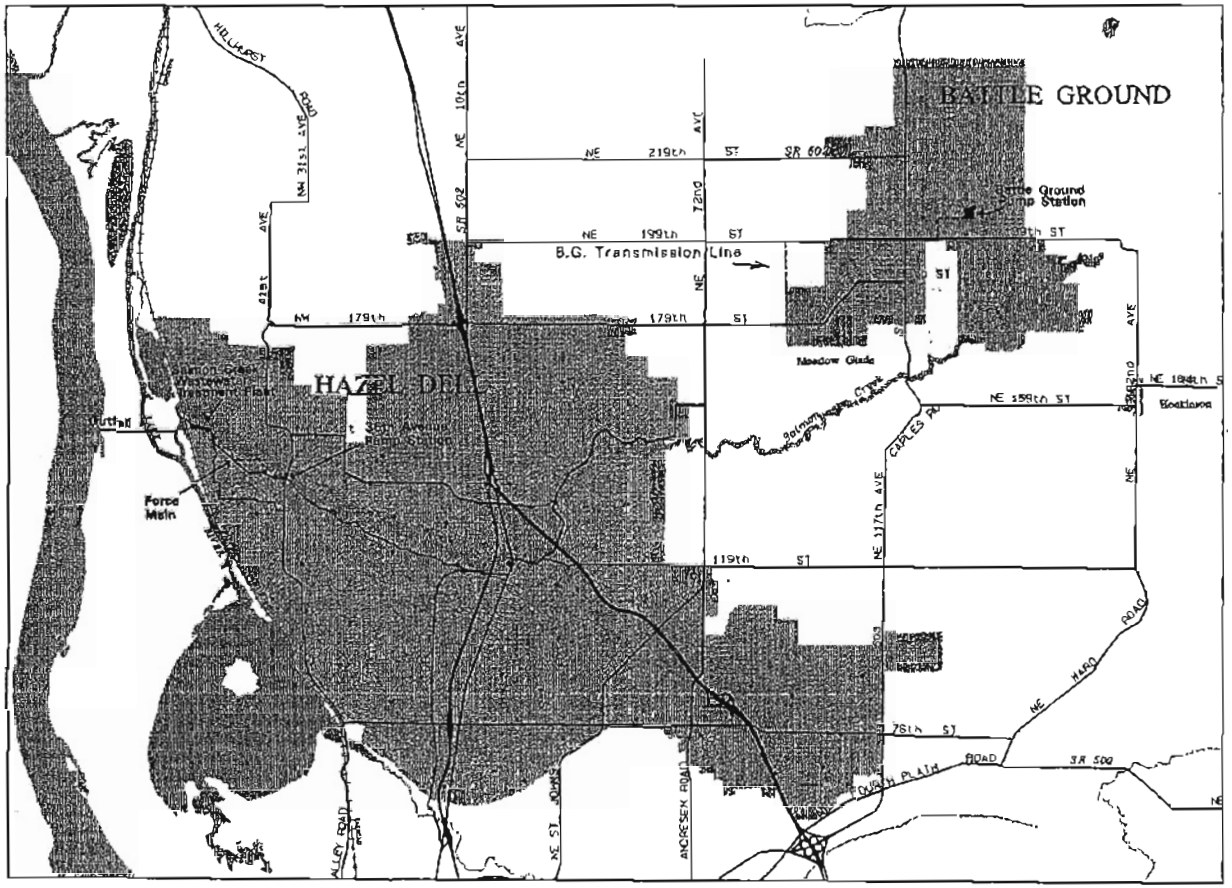
9. Amendment or Modification. No amendment or modification of this Contract, including any addition or deletion thereto, shall be effective unless approved and executed by the affected Participants in the same form and manner as, and subject to the remaining provisions of this Contract. No amendments shall adversely affect the payment of Sewage Treatment Charges or the covenants of the District relating to the Sewer Revenue Bonds and Other County Obligations.

10. Governing Laws. This Contract shall be governed and construed in accordance with the laws of the State of Washington. Venue in connection with any legal proceeding affecting this Contract shall be in the Superior Court of the State of Washington for Clark County.

11. Number and Gender. Whenever applicable, the use of the singular number shall include the plural, the use of the plural number shall include the singular and the use of any gender shall

Salmon Creek Wastewater Treatment Plant Collection System

EXHIBIT A



LEGEND

- Hazel Dell Sewer District
- Battle Ground Sewer District
- Gravity Mains
- Force Mains
- Clark County Interceptor System
- Force Main
- Gravity
- Pump Station

Meadow Glade and Hockinson are STEP pressure collection systems

Scale 1:95000

CLARK COUNTY WASHINGTON

Department of Assessment and GIS

Plotted: April 20, 1995

Modification of Interlocal Agreements Among Clark County, the Hazel Dell Sewer District, and the City of Battle Ground

SE 99-122

MODIFICATION OF INTERLOCAL AGREEMENTS AMONG CLARK COUNTY, THE HAZEL DELL SEWER DISTRICT, AND THE CITY OF BATTLE GROUND

THIS AGREEMENT, entered into this 16th day of November, 1999 among Clark County, hereinafter referred to as the "County", the Hazel Dell Sewer District, hereinafter referred to as the "District", and the City of Battle Ground, hereinafter referred to as the "City".

WITNESSETH:

WHEREAS, the County and the District entered into an Interlocal Agreement providing for the management of the Meadow Glade sewer service area on April 1st, 1993 and a subsequent modification on December 21st, 1993, and

WHEREAS, the County, the District, and the City executed an Interlocal Agreement delegating the authority to the County to establish and update the fee charged for new connections to the Salmon Creek Wastewater Treatment Plant and its regional facilities to defray the cost of providing capacity (Regional Facilities Charge) on May 16th, 1994, and

WHEREAS, the parties have agreed to modify these agreements as follows,

NOW, THEREFORE, in consideration of payments, covenants, and agreements, hereinafter mentioned, to be made and performed by the parties hereto, the parties covenant and agree as follows:

I. MODIFICATIONS:

The County, the District, and the City hereby agree to the following modifications of the original Agreements.

A. Clark County will continue to update the Regional Facilities Charge in accord with the original Interlocal Agreement dated May 16th, 1994. The District and the City agree to be responsible for, and determine the amount of wastewater usage that is attributed to all uses excluding single family residences, that is, the number of Equivalent Residential Units (ERU) attributed to such uses. Paragraph 2.2 is modified to the extent necessary to accomplish this result.

B. The County delegates and the District accepts and shall be responsible for, and determine the amount of wastewater usage that is attributed to all uses excluding single family residences, that is, the number of Equivalent Residential Units (ERU's) attributed to such uses based in the Meadow Glade sewer service area. Paragraph I.B. of the Modification of Agreement between the District and the County executed on December 21st, 1993 is modified to the extent necessary to accomplish this result.

These modifications do not alter nor modify any of the remaining provisions of the original Agreements.

II. REASONS FOR MODIFICATIONS:

This Interlocal Agreement clarifies the role of the County in establishing the Regional Facilities Charge to ensure sufficient funds are raised to pay the parties' proportionate share of debt service on the bonds funding improvements to the Salmon Creek Wastewater Treatment Plant for new connections to the regional facilities. It is incumbent upon the District and the City to determine the amount of capacity needed by nonresidential uses.

The County no longer desires to calculate wastewater capacity demands for non-residential uses in the Meadow Glade sewer service area and the District will now make those calculations based on its adopted schedules.

III. ENTIRE AGREEMENT

The parties agree that this Agreement is the complete expression of the terms hereto and any oral representations or understanding not incorporated herein are excluded. Further, any modification of this Agreement shall be in writing and signed by both parties.

IV. DOCUMENT TO BE RECORDED.

Pursuant to Chapter 39.34 RCW, this agreement shall be recorded with the Clark County Auditor.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed the day and year first hereinabove written.

Approved as to form for
CLARK COUNTY:

Deputy Prosecuting Attorney

BOARD OF COUNTY COMMISSIONERS
FOR CLARK COUNTY, WASHINGTON

Judie Stanton, Chair

Betty Sue Morris, Commissioner

Attest:

Clerk to the Board

Craig A. Pridemore, Commissioner

CITY OF BATTLE GROUND,
WASHINGTON

By

HAZEL DELL SEWER DISTRICT

By

Approved as to form for
CITY OF BATTLE GROUND:

Approved as to form for
HAZEL DELL SEWER DISTRICT:

Addendum to the March 28th, 1995, Joint Contract Between the City of Battle Ground and the Hazel Dell Sewer District

ADDENDUM

TO THE

MARCH 28th, 1995

JOINT CONTRACT BETWEEN

THE CITY OF BATTLE GROUND

AND

THE HAZEL DELL SEWER DISTRICT

THIS ADDENDUM is effective as of the ----------day of ----------, 2003 by and between the City of Battle Ground (the "City"), a municipal corporation of the State of Washington and Hazel Dell Sewer District (the "District"), a municipal corporation of the State of Washington.

WHEREAS, the City and the District have a joint contract agreement dated March 28th, 1995 (1995 Agreement) for sewage treatment capacity and payment, whereby the County will receive all Wastewater from the District and the City and transport that Wastewater to the County's Salmon Creek Sewage Treatment Facilities for treatment and disposal, and under that contract the City and District assume the responsibility for delivering such Wastewater within the quantity and quality standards and limitations under the agreement.

WHEREAS, the City had exceeded their allocated maximum monthly flow (MMF) of 1.97 million gallons in the month of December in the year 2001, and per section 3.4 of said 1995 Agreement must purchase permanent or temporary capacity from the other participant, if other participant has and is willing to transfer said capacity either permanently or temporarily.

WHEREAS, the City desires to increase their current allocated capacity of 1.97 mgd maximum monthly flows (MMF) measured in million gallons to the Clark County owned and operated sewer trunk line system and sewage treatment plant on a temporary basis.

WHEREAS, the District has an allocated system capacity of 8.33 mgd MMF, and has capacity available to temporarily lease a portion of that capacity to the City on an as-needed basis.

1. Temporary Capacity Transfer: In the event the City needs to increase sewage discharges to the Salmon Creek system and plant, a temporary transfer of capacity will be permitted, for a period not to exceed six months, from the District to the City in any given year. The parties shall notify the County of the terms of their arrangement for the temporary transfer. In no event shall the temporary capacity transfer become permanent to the City and in no event shall the total allocated capacity of the wastewater of the District and City exceed the total capacity of the Salmon Creek system and treatment facility operated by Clark County. This total system capacity is defined as 10.3 mgd MMF based on the Phase 3 Expansion project. In no case shall the transfer established be a guarantee of transfer for the following year.

2. Usage-Based Charge The District shall charge the City for the temporary leased capacity transfer at a rate of $0.003 per gallon for each gallon discharged above the City's current allocation of 1.97 million gallons per day (mgd) on a maximum monthly basis to the system. Flow will be measured from and by the existing discharge meter located at the City's sewer headworks or a combination of meters if the City elects to divert flow through the emergency connection at the Gardner Pump Station.

The District shall invoice monthly with the regular monthly billing currently established for the treatment charge.

3. Waste Water Treatment The City shall be responsible for, in additional to its ordinary charges, any costs incurred by the Clark County Salmon Creek Waste Water Treatment Plant and attributed to the excess lease capacity flow from the City.

4. Payment The City shall reimburse the District by the 15th of each month for the previous monthly use of temporary capacity.

5. Liability In the event that flows above the City's 1.97 mgd MMF allocation cause the system to exceed the system wide capacity of 10.3 mgd MMF, the City agrees to assume all legal and financial liabilities associated with the system operating above capacity. In the event that flows above the City's 1.97 mgd MMF allocation do not cause the system to exceed the system wide capacity of 10.3 mgd MMF, the City agrees to assume all legal and financial liabilities for only those flows contributed by the City.

6. Terms The terms of this addendum shall be for 5 years from its effective date.

EXHIBIT A
To Phase IV Interlocal Agreement

CAPACITY AND CAPITAL COST ALOCATION SUMMARY

Salmon Creek Wastewater Management System (SCWMS)
Phase 4 Expansion Program
Capacity and Capital Cost Allocation Summary

System Component	Phase 3 Existing Capacity (MMF)	Phase 4 Added Capacity (MMF)	Phase 4 Total Capacity (MMF)	Design Basis
	(MGD)	(MGD)	(MGD)	
Interceptor System				
Existing Interceptor System				
District Allocation	8.33	0.00	8.33	No Increase in Flow, No Work Planned
City Allocation	1.97	0.00	1.97	No Increase in Flow, No Work Planned
New Interceptor System				
District Allocation	0.00	19.75	19.75	Ultimate Buildout Projection
City Allocation	0.00	8.13	8.13	Ultimate Buildout Projection
Combined Interceptor System				
District Allocation	8.33	19.75	28.08	Ultimate Buildout Projection
City Allocation	1.97	8.13	10.10	Ultimate Buildout Projection
Total System			38.18	Ultimate Buildout Projection
Pump Station System				
Existing 36th Avenue Pump Station				
District Allocation	5.95	0.00	5.95	No Increase in Flow, R&R Work Planned
City Allocation	1.45	0.00	1.45	No Increase in Flow, R&R Work Planned
New Klineline Pump Station Facility				
District Allocation	0.00	14.11	14.11	20-Year Projection
City Allocation	0.00	4.85	4.85	20-Year Projection
Klineline Pump Station Pumping Equipment				
District Allocation	0.00	7.62	7.62	10-Year Projection
City Allocation	0.00	3.02	3.02	10-Year Projection
Combined Pump Station System				
District Allocation	5.95	7.62	13.57	10-Year Projection
City Allocation	1.45	3.02	4.47	10-Year Projection
Total System			18.04	10-Year Projection
Force Main System				
Existing 36th Avenue Pump Station Force Main				
District Allocation	5.95	0.00	5.95	No Increase in Flow, No Work Planned
City Allocation	1.45	0.00	1.45	No Increase in Flow, No Work Planned
New Klineline Pump Station Force Main				
District Allocation	0.00	14.11	14.11	20-Year Projection
City Allocation	0.00	4.85	4.85	20-Year Projection
Combined Force Main System				
District Allocation	5.95	14.11	20.06	20-Year Projection
City Allocation	1.45	4.85	6.30	20-Year Projection
Total System			26.36	20-Year Projection
Salmon Creek Wastewater Treatment Plant and Outfall/Diffuser				
Existing Plant/Outfall Capacity				
District Allocation	8.33	0.00	8.33	No Increase in Flow, R&R Work Planned
City Allocation	1.97	0.00	1.97	No Increase in Flow, R&R Work Planned
New Plant/Outfall Capacity				
District Allocation	0.00	3.15	3.15	5-Year Projection
City Allocation	0.00	1.50	1.50	5-Year Projection
Total Plant/Outfall Capacity				
District Allocation	8.33	3.15	11.48	5-Year Projection
City Allocation	1.97	1.50	3.47	5-Year Projection
Total System			14.95	5-Year Projection

Notes:
1. Capital costs for all components will be allocated in proportion to the 'Phase 4 Total Capacity' flow values indicated.

Interlocal Agreement
Concerning Phase IV Sewer Treatment Plant Improvements Between Clark County, the Hazel Dell Sewer District and the City of Battle Ground

This Interlocal Agreement Concerning Phase IV Sewer Treatment Plant Improvements (the "Phase IV Agreement") is by and among the Hazel Dell Sewer District (the "District"), the City of Battle Ground (the "City") and Clark County (the "County") (collectively, the "Parties"), each a municipal corporation of the State of Washington.

The District, the City and the County hereby agree as follows:

1. Recitals

1.1. Various of the Parties are parties to: (a) The Joint Contract Among Clark County, the City of Battle Ground and Hazel Dell Sewer District for Sewage Treatment, Disposal and Transport Services, effective as of March 28, 1995 (the "3-Way Agreement"); the Contract Between Hazel Dell Sewer District and the City of Battle Ground for Sewage Treatment Capacity and Payment, effective as of March 28, 1995 (the "2-Way Agreement"); and the Memorandum of Understanding Pertaining to Continuing Authorization and Continuing Funding for the Phase 4 Expansion of the Salmon Creek Wastewater Management System, entered into on December 24, 2004 (the "MOU").

1.2. Paragraph 4 of the 3-Way Agreement provides that if "the County is required to upgrade the Facilities beyond the Improvements to provide a higher level of Wastewater treatment, to modify the methods or locations of effluent discharge, or to comply with applicable laws or regulations, the District shall pay the cost of providing such Additional Improvements or adding needed equipment, and acquiring land, whether by purchase or lease."

1.3. Paragraph 5.3 of the 2-Way Agreement provides that the "City shall be responsible to pay to the District its share of the cost of Additional Improvements made in accordance with Section 4 of the [3-Way Agreement]."

1.4. Because of Department of Ecology ("DOE") requirements, other applicable legal requirements and the requirements of increased growth and development, the Parties have jointly concluded that there is a need to carry out the improvements described in Exhibit A attached and incorporated herein by reference (the "Phase IV Improvements") at an estimated cost of $71,000,000 in 2005 dollars. The Parties agree that the Phase IV Improvements constitute required improvements for which the Parties are responsible under Paragraph 4 of the 3-Way Agreement and Paragraph 5.3 of the 2-Way Agreement.

1.5. The Parties are engaged in a process of evaluating the preferred approach for ownership and operation of the sewage treatment Facilities on a long-term basis, and recognize that they may desire to revise or replace the 3-Way Agreement and the 2-Way Agreement at a future time and as permitted by applicable bond covenants. The purpose of this Phase IV Agreement is to establish a common understanding concerning the allocation of costs for the Phase IV Improvements, the allocation of capacity after those improvements are completed, and to proceed with financing and construction of the Phase IV Improvements while maintaining the ability to provide for future adjustments in ownership and operation of the Facilities.

2. **Definitions**

2.1. Unless another meaning is clearly intended, for the purposes of this Phase IV Agreement capitalized terms shall have the meanings given in the 3-Way Agreement, or, if not defined in the 3-Way Agreement, the meanings given in the 2-Way Agreement. The Phase IV Improvements shall constitute a "Project" as defined in the 3-Way Agreement, and the costs of

carrying out the Phase IV Improvements shall constitute "Project Costs" as defined in the 3-Way Agreement.

3. **Scope of Phase IV Agreement**

3.1 This Phase IV Agreement supplements and amends the 3-Way Agreement and the 2-Way Agreement for the limited purpose of providing for the financing and construction of the Phase IV Improvements. Except as otherwise provided herein or as the various Parties may later agree, both the 3-Way Agreement and the 2-Way Agreement, including all provisions not expressly amended herein or subsequently amended, shall remain in full force and effect.

4. **Phase IV Improvements**

4.1 The County shall administer the planning, design, acquisition, construction and construction management of the Project comprising the Phase IV Improvements, carrying out the same role that the County performed under Paragraph 2 of the 3-Way Agreement.

5. **Financing of the Phase IV Improvements**

5.1 The estimated Project Cost of the Phase IV Improvements is estimated to be $71,000,000 in 2005 dollars. The exact cost of the Phase IV Improvements shall be determined by the County, acting reasonably, after construction, installation and acceptance of the Project and the resolution of any disputes relating thereto.

5.2 As between the District and the City, upon completion of the Phase IV Improvements, it is currently estimated that the District will be responsible for 73% of the Project Costs of the Phase IV Improvements and the City will be responsible for 27% of the Project Costs. The final allocation of Project Costs will be determined based on the total actual costs of each of the elements of the Phase IV Improvements, prorated based on the District's and the City's respective capacity in each element as described in Exhibit A attached and

incorporated herein by reference. The final allocation shall be determined by the County after completion of construction. The County shall not be directly responsible for any Project Costs. The City shall provide for its share of the Project Costs by paying that share to the District, and that amount shall be promptly transmitted to the County. The District and the City will each provide for its respective share in periodic payments during development and construction of the Phase IV Improvements, as and in the amounts requested by the County by ten days notice. The District and the City may make their payments from available cash, borrowings or grants.

5.3 In order to satisfy the requirement in Section 7.1 of the 3-Way Agreement that the District pay Sewer Treatment Charges (including "amounts necessary to satisfy the Coverage Requirement" as a component of Other Bond Costs), the District agrees with the County that Sewer Treatment Charges shall include amounts sufficient to provide 1.15 times Aggregate Annual Debt Service on the County's outstanding Parity Bonds (as the terms "Aggregate Annual Debt Service" and "Parity Bonds" are defined in the resolutions authorizing the issuance of the County's outstanding sewer revenue bonds). Amounts paid by the District to the County to provide for the County's Coverage Requirement, but in excess of the amount needed for debt service on the County's Parity Bonds in any year, shall be deposited in an appropriate County fund or account for repairs and replacement of the Facilities; such excess amounts shall be credited against the District's obligation to provide for repair and replacement costs through Sewer Treatment Charges.

5.4 Each of the Parties shall use its best efforts to obtain grants and low interest loans to pay for the Phase IV Improvements Project Costs. To the extent that the District or the City obtains grants, the amount of such grants shall reduce that Party's obligation for its share of Project Costs. Low interest loans obtained by the District or the City (*e.g.* Public Works Trust

Fund loans) shall remain the sole obligation of the District or the City, respectively, and shall reduce that Party's obligation for its share of Project Costs. Low interest loans obtained by the County for the Project shall reduce the District's proportionate share of responsibility for Project Costs and shall be repaid through Sewage Treatment Charges.

6. **Allocation of Capacity**

6.1 The District and the City agree that upon the completion of the Phase IV Improvements, the interest in the Allocated Capacity in the Facilities shall be as set forth in Exhibit A.

7. **Term**

7.1 This amendatory Phase IV Agreement shall be effective to 2016 or so long as the 3-Way Agreement and/or the 2-Way Agreement (as such agreements may be amended or replaced) are in effect.

EXECUTED IN TRIPLICATE this 28 day of June, 2005, or such later effective date as may be required under Chapter 39.34 RCW, if applicable.

HAZEL DELL SEWER DISTRICT

By _____

CITY OF BATTLE GROUND, WASHINGTON

By _____

CLARK COUNTY

By _____

50515914.06

Appendix F

Environmental Assessment

Environmental Checklist

Date Published: September 21, 2004

Date: September 21, 2004

Please find enclosed an environmental Mitigated Determination of Non-Significance (DNS) issued pursuant to the State Environmental Policy Act (SEPA) Rules (Chapter 197-11, Washington Administrative Code). The enclosed review comments reflect evaluation of the environmental checklist by the lead agency as required by WAC 197-11-330 (1)(a)(i). You may comment on this determination within fifteen (15) days of its issuance, after which the DNS will be reviewed in light of the comments received.

Please address any correspondence to:

City of Battle Ground
Attn: Brian Carrico
109 SW 1st Street, Suite 127
Battle Ground, WA 98604
(360) 342-5044 [ph]
(360) 342-5049 [fx]
E-Mail: brian.carrico@ci.battle-ground.wa.us

DISTRIBUTION:

Federal Agencies:	U.S. Army Corps of Engineers
	Environmental Protection Agency
	National Marine Fisheries Service
	Washington State Dept. of Fish and Wildlife Service
State Agencies:	Department of Ecology
	Department of Transportation
	DSHS - Waste Section and Water Supply
	Department of Health, Water Division
	Department of Natural Resources
	Office of Archaeology and Historic Preservation
	Southwest Clean Air Agency
Regional Agencies:	Fort Vancouver Regional Library
	Clark County Health District
	Battle Ground Public Library
Local Agencies:	City of Battle Ground
	Public Works Department
	Police Department
	Fire District #11
	Clark County Sheriff's Office
	Boundary Review Board
	Community Development
	Public Works
	Dept. of Public Services
Special Purpose Agencies:	Battle Ground School District
	Hazel Dell Sewer District
Other:	Applicant
	Owner
	The Reflector
	The Columbian
	The Oregonian
	Clark County Natural Resource Council
	C-TRAN
	PGP Valuation Inc.

City of Battle Ground

City Hall • Planning Department

109 S.W. 1st Street, Suite 127 • Battle Ground, WA 98604 • (360) 342-5047 • Fax (360) 342-5049

DETERMINATION OF NONSIGNIFICANCE

Description of proposal: The non-project proposal includes the adoption of a revised comprehensive plan, development regulations, plan map, zoning map and critical areas ordinance for the City of Battle Ground.

Proponent: City of Battle Ground
109 SW 1st Street, Suite 127
Battle Ground, WA 98604

Location of proposal, including street address, if any: The limits of the City of Battle Ground, Washington and the urban growth area surrounding the city as adopted by Clark County.

Lead agency: City of Battle Ground, Washington.

The lead agency for this proposal has determined that it does not have a probable significant adverse impact on the environment. An environmental impact statement (EIS) is not required under RCW 43.21C.030(2)(c). This decision was made after review of a completed environmental checklist and other information on file with the lead agency. This information is available to the public on request.

This DNS is issued under WAC 197-11-340(2); the lead agency will not act on this proposal for 15 days from the date below. Comments must be submitted by, **October 5, 2004**

Responsible Official: Brian Carrico, City of Battle Ground
Position/title: Community Development Director
Address: 109 SW 1st Street/Suite 127, Battle Ground, WA 98604
Phone: 360-342-5044
Date: September 13, 2004

Signature: _____
Brian Carrico, Community Development Director

WAC 197-11-960 Environmental checklist.

ENVIRONMENTAL CHECKLIST

Purpose of checklist:

The State Environmental Policy Act (SEPA), chapter 43.21C RCW, requires all governmental agencies to consider the environmental impacts of a proposal before making decisions. An environmental impact statement (EIS) must be prepared for all proposals with probable significant adverse impacts on the quality of the environment. The purpose of this checklist is to provide information to help you and the agency identify impacts from your proposal (and to reduce or avoid impacts from the proposal, if it can be done) and to help the agency decide whether an EIS is required.

Instructions for applicants:

This environmental checklist asks you to describe some basic information about your proposal. Governmental agencies use this checklist to determine whether the environmental impacts of your proposal are significant, requiring preparation of an EIS. Answer the questions briefly, with the most precise information known, or give the best description you can.

You must answer each question accurately and carefully, to the best of your knowledge. In most cases, you should be able to answer the questions from your own observations or project plans without the need to hire experts. If you really do not know the answer, or if a question does not apply to your proposal, write "do not know" or "does not apply." Complete answers to the questions now may avoid unnecessary delays later.

Some questions ask about governmental regulations, such as zoning, shoreline, and landmark designations. Answer these questions if you can. If you have problems, the governmental agencies can assist you.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

Use of checklist for nonproject proposals:

Complete this checklist for nonproject proposals, even though questions may be answered "does not apply." IN ADDITION, complete the SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS (part D).

For nonproject actions, the references in the checklist to the words "project," "applicant," and "property or site" should be read as "proposal," "proposer," and "affected geographic area," respectively.

A. BACKGROUND

1. Name of proposed project, if applicable:
City of Battle Ground Comprehensive Plan rewrite for 2004

2. Name of applicant: City of Battle Ground

3. Address and phone number of applicant and contact person:

Dennis Osborn

Deputy City Manager

109SW1st Street

Battle Ground WA, 98604

360-342-5000

4. Date checklist prepared: September 7, 2004

5. Agency requesting checklist: City of Battle Ground

6. Proposed timing or schedule (including phasing, if applicable):

Project Completion for adoption is scheduled for October 2004

7. **Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal?** If yes, explain. Yes, as required by state law the City will undergo mandatory updates as prescribed in statute. In addition, the City may undertake updates or revision prior to mandated updates as allowed by law.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

Clark County 2003 FEIS for the Clark County Comprehensive Growth Management Plans. In addition, the City of Battle ground is revising its Critical Areas Ordinance as a part of the Comprehensive Plan rewrite. Also, there is an Environment element to the Comprehensive Land Use Plan.

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

The Comprehensive Plan and associated regulations will require a public hearing process before the City Planning Commission. The Commission will make a recommendation to Council after completion of the Public Hearing Process. The City Council will then hold Public Hearings and provide a 60-day comment period on the draft plans and then adopt by Ordinance the plans, regulations and maps (land use and zoning).

10. List any government approvals or permits that will be needed for your proposal, if known.

Battle Ground Planning Commission providing recommendation.

Battle Ground City Council will need to pass an ordinance to approve the plans, regulations and maps.

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The project is a rewrite of the Battle Ground Comprehensive Land Use Plan, Land Use Map, zoning map, Critical Areas Ordinance, Update of Facility Plans and revisions to the development code. More specifically:

Land Use

Housing

Environmental

Public facilities including, storm water, sanitary sewer, water, parks, and transportation

Capital Facilities

Economic Development

Land Use Map

Zoning Map

Critical Areas Ordinance

Development Regulations

And other associated codes, and polices in order to implement the revision and update of the aformentiond planning documents.

12. **Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.**

The City of Battle Ground Corporate limits and proposed urban growth boundary. (Please see attached map)

TO BE COMPLETED BY APPLICANT

EVALUATION FOR AGENCY USE ONLY

B. ENVIRONMENTAL ELEMENTS

1. **Earth**

a. **General description of the site (circle one):** Flat, rolling, hilly, steep slopes, mountainous, other . . . . ..

The City of Battle Ground is flat with the exception of Tukes Mountain and Sand Hill, which may have slopes as steep as 30 %.

b. **What is the steepest slope on the site (approximate percent slope)?** 30%+/-

c. **What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.**

According to the US Soil Conservation Survey of Clark County, the following soils are found within the project area:

HtA: Hockinson loam 0-3% slopes

HIE: Hillsboro loam 15-20% slopes

DoB: Dollar loam 0-5% slopes

CVA: Cove silty clay loam 0-3% slopes

OeD: Olequa silt loam 3-20% slopes

d. **Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.**

The following information is from the US Soil Conservation Survey of Clark County

HtA has a slight possibility of erosion

HIE has an erosion of moderate to severe if the soils are left bare through the winter months

DoB has a slight erosion hazard

CVA has no hazard of erosion

OeD has a slight to moderate erosion capability.

According to the Geologic Hazard map for Battle Ground prepared by Clark County there are no mapped or historical mapped landslide areas in the project area.

e. **Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.**

Normal filling and grading would be related to development activity that would follow the rules and regulations outlined in the project.

f. **Could erosion occur as a result of clearing, construction, or use? If so, generally describe.**

The adoption of the plans will not have directly result in clearing or grading. Erosion control practices as outlined in the project may have to implemented depending upon the proposed development project.

g. **About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?**

Adoption of the project would not directly create impervious surface.

h. **Proposed measures to reduce or control erosion, or other impacts to the earth, if any:**

The project includes a geologically hazard section as well as erosion control practices that would may have to be implemented during actual site development.

2. Air

a. **What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known.**

The adoption of the project would not result in direct emissions to the air. However, the policies and regulations have an impact as to what development is allowed to occur within the project area. In addition, the additional population accommodated by the plan will result in additional pollutants from typical residential sources. These impacts are typical of development regardless of its location.

b. **Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.**

The proposed project in itself would not be impacted by off-site sources.

c. **Proposed measures to reduce or control emissions or other impacts to air, if any:**

The allowed industrial/commercial uses were reviewed to determine the potential impacts of industrial pollutants to the air. The Southwest Washington Clean Air Authority controls point sources and would be involved in the permitting of air pollution generators..

3. Water

a. Surface:

1) **Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.**

Woodin, Mill, Salmon and Jewel Creeks are located in the city or urban growth area. These creeks ultimately flow to the Columbia River.

2) **Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.**

The adoption of the plans will not require any work over, in or adjacent to these creeks. However, development activity may have some level of impact.

3) **Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.**

None

4) **Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.**

No

5) **Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.**

There are 100 year flood plains identified for Woodin and Salmon Creeks.

6) **Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.**

There will be discharge of storm water as development occurs. Again, the project itself will not have discharge of water.

b. Ground:

1) **Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known.**

The plan anticipates the drilling of 7 additional wells to serve domestic and industrial uses. Well 9 = 500 gpm, well 10 = 500 gpm, well 11 = 1,200 gpm and wells 13,14,15 = 600 gpm each.

2) **Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals . . . agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.**

Domestic and industrial waste water are handled by the City's municipal wastewater system which utilizes the Salmon Creek Treatment Plant for treatment and discharge to the Columbia River.

c. **Water runoff (including stormwater):**

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

As part of this project, there is a storm water element that deals with storm water runoff.

2) Could waste materials enter ground or surface waters? If so, generally describe.

The storm water plan is designed to minimize pollutants or waste materials from entering the storm or ground water.

d. **Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:**

The City has adopted the Puget Sound Manual for the treatment and control of stormwater.

4. **Plants**

a. **Check or circle types of vegetation found on the site:**

__X__ deciduous tree: alder, maple, aspen, other

__X__ evergreen tree: fir, cedar, pine, other

__X__ shrubs

__X__ grass

__X__ pasture

_____ crop or grain

__X__ wet soil plants: cattail, buttercup, bullrush, skunk cabbage, other

__X__ water plants: water lily, eelgrass, milfoil, other

__X__ other types of vegetation

b. **What kind and amount of vegetation will be removed or altered?**

Adoption of this project will cause no direct removal of vegetation.

c. **List threatened or endangered species known to be on or near the site.**

d. **Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:**

Landscaping requirements are outline within the project. Specifically the development code deals with landscaping requirements for certain development activity that may occur after adoption of this project.

5. **Animals**

a. **Circle any birds and animals which have been observed on or near the site or are known to be on or near the site:**

birds: hawk, heron, eagle, songbirds, other:

Mammals: deer, bear, elk, beaver, other: raccoons, and other small wildlife associated with an urban environment

Fish: bass, salmon, trout, herring, shellfish, other:

b. **List any threatened or endangered species known to be on or near the site.**

Salmon Creek and the East Fork of the Lewis River and its tributaries provide habitat for a variety of endangere or threatened salmonids

c. **Is the site part of a migration route? If so, explain.**

Parts of Clark County are within the Pacific Flyway, which is used by migratory waterfowl. Anadramous fish may utilize streams within the city.

d. **Proposed measures to preserve or enhance wildlife, if any:**

The draft of the plan includes polices to ensure protection of the environment while recognizing that the application of such protection measures are within an urban environment. The Critical Areas Ordinance contains regulations for the protection of wetlands and fish and wildlife habitat.

6. **Energy and natural resources**

a. **What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.**

Typically energy consumption associated with an urban setting including natural gas and electric.

b. **Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.**

No.

c. **What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:**

The City has adopted and implemented the Washington State Energy Code.

7. **Environmental health**

a. **Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste that could occur as a result of this proposal? If so, describe.**

This non-project activity will not involve the generation or use of hazardous materials or waste

1) **Describe special emergency services that might be required.**

There are none anticipated

2) **Proposed measures to reduce or control environmental health hazards, if any:**

None proposed.

b. Noise

1) **What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?**

Typical urban noise levels and types occur within the project's vicinity.

2) **What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.**

The project itself would create no noise. The proposed plan calls for typical urban land uses that would create noise during and upon there development.

3) **Proposed measures to reduce or control noise impacts, if any:**
Motor vehicles, public transit, outside group activities and the like all constitute noise levels that are typical within an urban setting. The project anticipates growth in population. Given this there could be an expected increase in the land area for urban noise levels but there is no expected increase in a concentrated urban setting.

8. **Land and shoreline use**

a. **What is the current use of the site and adjacent properties?**
The City is a mix of residential densities and commercial activities with minor industrial activities. Other areas within the planning area are developed at rural densities and used for rural residential purposes with some minor agricultural activities.

b. **Has the site been used for agriculture? If so, describe.**
Portions of the planning area have been used for agricultural purposes. However, there is no medium to large agricultural activities of a commercial basis within the City or its proposed urban growth Boundary.

c. **Describe any structures on the site.**
The City has several thousand structures that are primarily residential in nature with some commercial and less industrial.

d. **Will any structures be demolished? If so, what?**
There is the possibility that as this plan is implemented, that structures may be demolished in order to erect new buildings.

e. **What is the current zoning classification of the site?**
The site has a variety of residential, commercial, industrial and rural zoning designations

f. **What is the current comprehensive plan designation of the site?**
The site has a variety of residential, commercial, industrial and rural plan designations

g. **If applicable, what is the current shoreline master program designation of the site?**
N/A

h. **Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.**
This proposal designates wetlands, aquifer recharge areas, geologically hazardous areas, and floodplains as environmentally sensitive. The City's proposed critical areas ordinance provides regulations for protecting such areas.

i. **Approximately how many people would reside or work in the completed project?**
24,775 residents and 10,000 employees

j. **Approximately how many people would the completed project displace?**
No displacement is anticipated

k. **Proposed measures to avoid or reduce displacement impacts, if any:**
Ensure that there is an adequate urban growth boundary to handle the projected growth.

l. **Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:**

The project is a rewrite of the existing plans and an update of the development code. The plan reflects the 50-year community visioning process that the City had gone through. In addition, the plan reflects the requirements of state law, countywide policies, and the input from the community, the planning commission and city Council. The regulations, being proposed reflect the policy guidance that is in the plans.

9. **Housing**

a. **Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.**

4,500 - mostly middle income units.

b. **Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.**

The project does not propose to eliminate any housing. However, redevelopment of existing structures may occur.

c. **Proposed measures to reduce or control housing impacts, if any:**

The project has a housing element that addresses housing stock including affordable housing. In addition, the project must accommodate the projected population as prescribed by Clark County for the 20-year planning period.

10. **Aesthetics**

a. **What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?**

The project does not propose to construct any structures in and of itself.

b. **What views in the immediate vicinity would be altered or obstructed?**

The project would no obstruct any views. Typical urban development will change the views of the landscaping from rural to urban.

c. **Proposed measures to reduce or control aesthetic impacts, if any:**

None proposed.

11. **Light and glare**

a. **What type of light or glare will the proposal produce? What time of day would it mainly occur?**

The project would not produce any light or glare. Urban development anticipated by the plan will likely incorporate typical urban lighting.

b. **Could light or glare from the finished project be a safety hazard or interfere with views?**

If not property controlled urban lighting can create hazards for traffic and reduce views of the night sky.

c. **What existing off-site sources of light or glare may affect your proposal?**

Not applicable to the project itself.

d. **Proposed measures to reduce or control light and glare impacts, if any:**

Proposed development standards contain specific standards to reduce light and glare impacts.

12. **Recreation**

a. **What designated and informal recreational opportunities are in the immediate vicinity?**

There are currently 2 pocket parks, 6 neighborhood parks and 5 community parks within the planning area. Two regional parks are located in close proximity. The Remy site, which is undeveloped at this time, but its future

development is covered within the Park Plan. The second park is the Lewisville County Park located just north of the city on the west side of SR503 along the East Fork of the Lewis River.

b. Would the proposed project displace any existing recreational uses? If so, describe.

No

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

The proposal includes the City's park plan. This plan notes that the City actually has more than enough land owned by the City and identified for park use. The Plan also covers cost of development of these parks and will provide a revenue source for construction of these parks.

13. Historic and cultural preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

None known.

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

None known.

c. Proposed measures to reduce or control impacts, if any:

None proposed.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

SR 503 bisects the planning area and SR 502 terminates at 503 inside the city. In addition other major streets are 199th, Parkway, Main Street, Onsdorff, Rasmussen, Scotten Way as well as other local streets in the City.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

Yes C-TRAN services Battle Ground with two routes.

c. How many parking spaces would the completed project have? How many would the project eliminate?

The proposal does not address on or off site parking directly. However, the development code section of the project prescribes the standards for when off street parking shall be provided.

d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

Yes, the transportation plan will identify additional collectors and arterials as well as additional connections to SR 503 and 502.

e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

The project itself will not use these facilties. However, the growth projected by the project will utilize these facilities. There is the Clark County owned Rail system that runs north-south through the east end of town. This facility runs adjacent to an industrial area of town. As industry grows, the potential for greater use of the real may grow accordingly. Portland International Airport is located about 25 minutes south of the City of Battle Ground.

f. **How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.**

There will be an increase in traffic volumes due to the projected increase in housing and population. The projected population will increase approximately 20,000 people. However, this is expected to occur over a 20-year period. The peak times will be 6 to 8 am and 5 to 7 pm.

g. **Proposed measures to reduce or control transportation impacts, if any:**

The City will have a concurrency ordinance as part of this proposal that determines how the City measures impacts to the traffic system. It will be a policy decision by City Council as to what level of service will be maintained and what is the appropriate time to spend in traffic to get from point a to point b. Given this, the transportation plan will identify major transportation corridors and the improvements needed to move traffic at this set level and identify the associated costs. Finally, new projects will not be allowed to move forward that would drop the traffic below the prescribed LOS unless mitigation could maintain the set LOS.

15. **Public services**

a. **Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.**

The project will have an impact on public service since the project anticipates the City to grow from its present population 14,220 to just over 24,700.

b. **Proposed measures to reduce or control direct impacts on public services, if any.**

The project facility plans identifies the new demands created on the public facilities and provides an analysis of what capital improvements would be needed in order to maintain adequate levels of service.

16. Utilities

a. **Circle utilities currently available at the site:** electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other.

b. **Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity, which might be needed.**

The project has a utility element that gives policy direction to share with private and public utility purveyors the expected growth for the life of the project. In addition, the project has a Capital Facilities Element that describes the needs for the projected growth a funding component.

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: .....

Date Submitted: .....10-8-09.....

D. SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS

(do not use this sheet for project actions)

Because these questions are very general, it may be helpful to read them in conjunction with the list of the elements of the environment.

When answering these questions, be aware of the extent the proposal, or the types of activities likely to result from the proposal, would affect the item at a greater intensity or at a faster rate than if the proposal were not implemented. Respond briefly and in general terms.

1. How would the proposal be likely to increase discharge to water; emissions to air; production, storage, or release of toxic or hazardous substances; or production of noise?

The proposed plan would accommodate additional population above what is currently planned for. This increase in population would likely lead to increases the above activities. If the project were not in place, Growth would occur absent any regulatory control to deal with the protection of aquifer (groundwater discharge), types of industry (emission to air and production, storage of hazardous substance and creation of noise).

Proposed measures to avoid or reduce such increases are:
Specific development regulations are proposed to reduce the impacts of such emissions including stormwater control and treatment, requirements to connect to the public water and sewer systems, specific standards for uses and critical areas ordinances.

2. How would the proposal be likely to affect plants, animals, fish, or marine life?
The project itself will not have any impacts other than protection measures within the project. However, the project does regulate growth and development meaning there will be growth and the opportunity to impact plants, fish and wildlife. Urban development typically reduces habitat for animals and destroys plants.

Proposed measures to protect or conserve plants, animals, fish, or marine life are:
The project has an environment section that identifies polices to protect such areas of the environment. In addition, the project contains the Critical Areas Ordinance that has provisions for protecting wetlands, and fish and wildlife habitats.

3. How would the proposal be likely to deplete energy or natural resources?
The growth that the project accommodates will result in additional energy and natural resource use.

Proposed measures to protect or conserve energy and natural resources are:
The City has adopted the Washington State Energy Code

4. How would the proposal be likely to use or affect environmentally sensitive areas or areas designated (or eligible or under study) for governmental protection; such as parks, wilderness, wild and scenic rivers, threatened or endangered species habitat, historic or cultural sites, wetlands, floodplains, or prime farmlands?

The projected growth expected from the implementation of this project will have impacts on these resources if no regulations were in place to ensure protection of these resources.

Proposed measures to protect such resources or to avoid or reduce impacts are:
Implementation of the City's Critical Areas Ordinance, which identifies protection measures for Wetlands, riparian areas, Frequently flooded areas, Aquifer Recharge, Geologically hazardous and Fish and Wildlife Habitat.

5. **How would the proposal be likely to affect land and shoreline use, including whether it would allow or encourage land or shoreline uses incompatible with existing plans?**
The impacts to the land are going to be how growth is allowed to develop. If the project did not move forward the existing land use and zoning maps would dictate development patterns. However the existing plans would not accommodate the projected growth. This project does not include a shoreline master program. However, the project does have a Critical Areas Ordinance that protects riparian areas.

Proposed measures to avoid or reduce shoreline and land use impacts are:
Implementation of this project would ensure that the densities and development patterns projected to be experienced over the 20-year planning period develop in a livable sustainable community fashion that anticipates when and where growth impacts may affect different facilities and services.

6. **How would the proposal be likely to increase demands on transportation or public services and utilities?**
Because the project allows for additional growth, there will be increased demands on the transportation network as well as public services and utilities. The projected growth will increase traffic, increase demand on police and fire, and increase demand on water, sanitary and storm sewer.

Proposed measures to reduce or respond to such demand(s) are:
The City has plans as part of this project that identifies these impacts and provides a narrative on what facilities need to be constructed and ways to pay for these improvements. In addition, the project has a concurrency ordinance that establishes minimum level of service. Any development proposed that would lower the set LOS must mitigate to maintain the established LOS or the project cannot move forward.

7. **Identify, if possible, whether the proposal may conflict with local, state, or federal laws or requirements for the protection of the environment.**

The proposal will comply with state and local laws as well as federal. The Growth Management Act is the controlling regulation for this project. The project has addressed all the required elements as well as addressed some optional elements. In addition, the Critical Areas element does not conflict with the U.S. Army Corps of Engineers responsibility to regulate all wetlands. The plan complies with the County Wide Planning Policies

EIS Summary

SUMMARY

I. PURPOSE OF AND NEED FOR THE PROJECT[1]

The Growth Management Act (GMA) (RCW 36.70A) requires rapidly growing counties and cities in the state to plan to manage growth in a way that allows for the efficient use of land and resources. Counties and cities planning under the GMA must adopt comprehensive plans that address land use, housing, public facilities and services, utilities, rural development, and transportation. Clark County and local cities adopted their current plans in 1994. Figure 1, Regional Location, shows Clark County and its cities in relationship to other counties in Washington State.

The GMA requires review and update of comprehensive plans every seven years to ensure that the plan and regulations still comply. Any changes that are made to a comprehensive plan during the review process must be consistent with the GMA, including any amendments that have been made since the adoption of the comprehensive plan. Each county that designates urban growth areas (UGA) is required to review those areas at least every ten years to ensure that there is an adequate amount of land to accommodate the 20-year growth projections for population, jobs, and housing.

Clark County (the County) and local cities chose to review both their plans and UGAs for the full 20-year planning horizon. The County identified five alternatives for accommodating growth from 2003 to 2023, four of which called for UGA expansions. Using Washington's State Environmental Policy Act (SEPA) review process to solicit public and agency input on the five alternatives, the County evaluated the five alternatives and out of them created a sixth Proposed Alternative. Under SEPA, actions such as the adoption or revision of plans, programs, policies, and plan maps are known as non-project or programmatic actions, as distinguished from project-level or site-specific actions. The following section discusses how comprehensive plans are evaluated under SEPA. This Final Environmental Impact Statement (FEIS) assesses the potential environmental impacts of the Proposed Alternative.

II. PURPOSE OF NON-PROJECT EIS

The review of the comprehensive plans of Clark County and its cities is a programmatic action under SEPA. Clark County determined that the revision of the 1994 comprehensive plan and the UGA could have a significant impact on the environment. That determination of significance automatically requires that an Environmental Impact Statement (EIS) be prepared to assess the possible impacts of different alternatives. Since programmatic actions are broader and less specific than project actions, analysis of their environmental impacts under SEPA is also broader and is framed as a discussion of the alternative courses of action that can accomplish a stated objective.

SEPA states that an EIS discussion of alternatives for comprehensive plans should be limited to a general discussion of the impacts of alternative policies. The lead agency is not required to examine all conceivable policies, designations, or implementation measures but should cover a range of topics (WAC 197-11-442).

III. DEIS AND FEIS

The Draft EIS (DEIS) issued on March 19, 2003 analyzed the environmental impacts of the five alternative concepts that were developed for managing growth over the next twenty years for Clark County and its cities. The five alternatives (shown together on Figure 2, All Alternatives and described in detail in the DEIS) consist of two No Action Alternatives and three Action Alternatives. Each alternative would have

[1] *The Draft Environmental Impact Statement (DEIS) provides a more detailed summary of GMA and its requirements for updating comprehensive plans. This is an abbreviated version of that summary.*

In 2000, OFM indicated that Clark County could expect to reach a population of 465,591 to 600,693 over the next 20 years. In 2001, the BOCC considered historic growth trends in the county and region, other locally approved growth assumptions, and the condition of the regional economy and decided to plan for an average annual population growth rate of 1.5 percent and an average household size of 2.66 persons per single-family household and 1.9 persons per multi-family household.

Following public comment on the five alternatives evaluated in the DEIS, the BOCC elected to plan for an average annual population growth rate of 1.83 percent (similar to the growth rate under Alternative 1) and an average household size of 2.69 persons per household. Projecting from OFM's End of Year 2002 Population estimate for the county of 370,463, a 1.83 percent growth rate means 163,728 new people (60,866 new households) over the next 20 years. (The Population, Housing and Land Use section of the DEIS discusses historic and projected growth trends in the county and cities.) The total population of 534,191 is slightly above the OFM medium forecast of 530,962 which OFM considers most likely for Clark County.

Employment growth forecasts were developed with the help of the Washington Employment Security Department (ESD) and the Columbia River Economic Development Council (CREDC). To reduce traffic congestion in the region and improve the county tax base, the BOCC decided that the County should plan to increase the ratio of jobs to population within the county and bring the jobs-to-population ratio more in line with the regional Portland-Vancouver ratio. Currently, the jobs-to-population ratio in Clark County is 1 to 2.9; the jobs-to-population ratio in the Portland Vancouver Metropolitan area is about 1 to 2. The Proposed Alternative would result in a jobs-to-population ratio of 1 to 1.75 for the anticipated increment of growth over the next 20 years in order to reach a goal of 1:2 at full build-out.

The amount of land needed to accommodate projected growth in housing and employment depends on the gross density at which development occurs, that is, the number of housing units or jobs per acre. Gross density includes estimates of the percent of land used for roads and other infrastructure needs and how much is unlikely to develop for other reasons (e.g., environmental constraints). The alternatives under consideration reflected a range of assumptions about residential, commercial, and industrial development, as well as the locations where it would most likely occur. The assumptions for the Proposed Alternative reflect the result of the DEIS public process. This FEIS focuses on a summary and description of the Proposed Alternative, its potential impacts and proposed mitigation.

The GMA plans adopted by the County and cities in 1994 provided land within the UGAs sufficient to accommodate 20 years of growth plus a margin of extra land to accommodate development market uncertainties. Although seven years have passed since the adoption of the plans, a substantial amount of vacant and underutilized land remains within UGAs. Regardless of the alternative selected, the majority of growth over the next 20 years is expected to occur within currently designated UGA boundaries.

Table 1 compares the alternatives and Figures 2 through 8 illustrate them. A more detailed discussion of Alternatives 1 through 5 is presented in Chapter 1 of the DEIS. This FEIS primarily evaluates potential impacts of the Proposed Alternative (Figure 8) compared to the other five alternatives.

B. Proposed Alternative

The Proposed Alternative combines several aspects of the five alternatives in the DEIS. The growth rate is similar to that proposed under Alternative 1 while the total additional acreage proposed is slightly less than that proposed under Alternative 2. Significant urban growth boundary expansions are proposed for the unincorporated area between the cities of Camas and Vancouver; the east side of 162nd Avenue north of 39th Street in east Vancouver; the south side of 119th Street between Curtin Creek and 152nd Avenue in the Orchards area; north of 119th Street between 50th and 72nd avenues in the Pleasant Valley area; the Fairgrounds area; and south and west of Battle Ground. The key aspects are:

- Use of an annual average growth rate of 1.83 percent over the next 20 years, resulting in 163,728 additional residents (16,373 rural residents and 147,355 urban residents). The total population would be 534,191 in 2023.
- Expansion of UGAs by 9,461 acres.
- Use of an employment growth rate higher than historical rates in Clark County, which would create 84,203 new jobs at an employment density of nine employees per acre for industrial development and 20 employees per acre for business park and commercial development.
- Assumption of 2.69 persons per household based on 2000 Census data; higher than any DEIS alternative; 60,866 new households would be created over the next 20 years.
- Use of varying density targets for residential development in the cities: Camas, Ridgefield, Washougal, and Battle Ground—a target of 6 residential dwelling units per acre; La Center—4 units per acre; and Vancouver—8 units per acre. (No density target was set for Yacolt, due to its lack of a public wastewater treatment system.) The Proposed Alternative has an average density target for UGAs of about 7 units per acre.
- Use of a market factor of 25 percent for commercial and business park land and 50 percent for industrial land. No market factor for residential land.
- Use of an infrastructure factor of 25 percent for commercial and industrial development, and 27.5 percent for residential development, similar to observed experience.
- Planning to accommodate 90% of the growth in urban areas (54,779 households) and 10% in rural areas (6,087) households.

C. No Action Alternatives 1 and 3

The No Action Alternatives under consideration in the DEIS are Alternatives 1 and 3. (SEPA requires that the implications of not changing the comprehensive plan be considered.) Under Alternative 1 the policies and growth assumptions contained in the *20-Year Clark County Comprehensive Growth Management Plan* would remain in effect and UGAs would be expanded. Alternative 1 uses a growth rate of 1.83 percent. Under Alternative 3, the UGAs as proposed in the 1994 plan (with a growth rate of 1.5 percent) would remain in effect and no expansion would occur.

D. Action Alternatives 2, 4, and 5

Alternatives 2, 4, and 5 assumed an annual average growth rate of 1.5 percent over the next 20 years. Alternative 2 reflects the GMA planning decisions made by the BOCC in April 2001. Alternative 4 represented a composite of the preliminary proposals from the cities of Battle Ground, Camas, La Center, Ridgefield, Vancouver, Washougal, and Yacolt for how they want to manage their growth. Alternative 5 reflected economic development strategies proposed by the Columbia River Economic Development Council (CREDC) to make large tracts of land available for employment development along I-5.

Table 2. Summary of Impacts

	Proposed Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Earth						
Soils and Geology Criteria: acres of ag or forest soil converted	2,758 acres of ag land 0 acres forest land	8,648 acres of ag land 145 acres of forest land	2,207 acres of ag land	No conversion of ag or forest land	3,178 acres of ag land 68 acres of forest land	3,589 acres of ag land
Topography Criteria: Earthquake zone A: highest hazard Acres of land over 40% slope Acres of landslide hazard areas	105 acres in Zone A 1.6 acres steep slopes 177 acres of landslide hazard	214 acres in Zone A 194 acres of steep slopes 1410 acres of landslide hazard	88 ac in Zone A 46 acres of steep slopes 469 acres of landslide hazard	No changes to existing lands designated for development.	149 acres in Zone A 75 acres of steep slopes 483 acres of landslide hazard	54 acres of Zone A 11 acres of steep slopes 329 acres of landslide hazard
Air						
Climate & air quality	All alternatives have the potential to affect the air quality and climate. Impacts can be related to the balance between emissions from automobile use (vehicle miles traveled or VMT), emissions from unregulated private sources (e.g. gas lawnmowers), federal regulations through the Clean Air Act, and conversion of rural and resource land to urban land with less vegetative cover For differences in VMT (full build-out capacity, not planned growth) see Transportation Impacts. For conversion of rural to urban land see the Rural and Resource land impacts.					
Water						
Surface waters Criteria. miles of streams added to UGAs	20 miles of streams Creeks: Fifth Plain, Gee, Lacamas, Mill, Spring Branch, Weaver, Whipple	100 miles of streams Creeks: Gee, Lacamas, Whipple, Salmon, Mill & Fifth Plain	28 miles of streams Creeks: Gee, Whipple, Weaver, Salmon, & Mill	No additional miles of streams	33 miles of streams Creeks: Lacamas, Gee, Curtin, Mill, Salmon, Weaver, and Whipple	32 miles of streams Creeks: Gee, Mill, Salmon and Whipple
Stormwater Criteria: new impervious surface	3,076 acres of new impervious surface	7,800 acres of new impervious surface	3,200 acres of new impervious surface	No additional acres	3,098 acres of new impervious surface	3,355 acres of new impervious surface
Shorelines Criteria: acres of environment affected	244 acres of shorelines	737 acres of shorelines	191 acres of shorelines	No additional acres	480 acres of shorelines	119 acres of shorelines
Floodplains Criteria: flood fringe area added to UGAs	638 acres of floodway fringe	1,385 acres of floodway fringe	269 acres of floodway fringe	No additional acres	589 acres of floodway fringe	230 acres of floodway fringe
Groundwater & Aquifer Recharge						
Criteria: New impervious surface in new UGAs	3,076 acres of new impervious surface	7,800 acres of new impervious surface	3,200 acres of new impervious surface	No additional acres	3,098 acres of new impervious surface	3,355 acres of new impervious surface
Acres of wellhead protection areas in new UGAs	9,467 acres of wellhead protection area	28,841 acres of wellhead protection area	9,745 acres of wellhead protection areas	No additional acres	12,552 acres of wellhead protection areas	12,300 acres of wellhead protection areas

	Proposed Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Energy	Impacts on energy and natural resources are not quantitatively comparable. Energy use will increase as the number of people and jobs in the county increases. The pattern of growth will affect the amount of energy used by each household and business. Compact development tends to reduce VMT and therefore energy use. However, the total population growth has the potential to increase VMT as well. Alternative 1 and the Proposed Alternative project the most population growth. Assessing impacts based on planned growth can underestimate potential impacts. Growth based on capacity for new households would be greatest under Alternative 1, followed by Alternatives 5, 2, Proposed, 4, , and 3]. Impacts from VMT on energy (petroleum) use based on capacity for growth (full build-out) can be found in Transportation Impacts.					
Scenic resources Criteria: Conversion of rural land to urban land	All alternatives except Alternative 3 would convert rural and resource land to urban uses. Alternative 1 would convert most acres (28,845), followed by Alternative 4 (12,554), Alternative 5 (12,303), Alternative 2 (9,749), and the Proposed Alternative (5,900).					
Noise	Impacts from noise not quantitatively compared. Higher noise impacts expected from increased traffic (see Transportation), from expansion of diverse urban uses into formerly rural areas (see Land Use, and Rural and Resource land comparisons)					
Land Use, Population, and Housing						
Criteria: Urban residential land capacity[1] (Difference between the number of planned households and number of households at build-out: actual land capacity)	Planned # of households would occupy **96%** of actual land capacity Households: build-out capacity: 56,925 planned: 54,779	Planned # of households would occupy **68%** of actual land capacity Households: build-out capacity: 90,155 planned: 61,323	Planned # of households would occupy **68%** of actual land capacity Households: build-out capacity: 57,048 planned: 38,587	Planned # of households would occupy **87%** of actual land capacity Households: build-out capacity: 44,933 planned: 39,070	Planned # of households would occupy **80%** of actual land capacity Households: build-out capacity: 48,536 planned: 38,587	Planned # of households would occupy **68%** of actual land capacity Households: build-out capacity: 57,103 planned: 38,587
Rural residential land capacity[1] (Difference between the number of planned households and number of households at build-out; actual land capacity)	Planned # of households would occupy **50%** of actual rural land capacity Households: build-out capacity: 12,093 planned: 6,087	Planned # of households would occupy **130%** of actual rural land capacity (shortfall) Households: build-out capacity: 11,056 planned: 14,384	Planned # of households would occupy **72%** of actual rural land capacity Households: build-out capacity: 12,379 planned: 9,051	Planned # of rural households would occupy **69%** of actual land capacity Households: build-out capacity: 13,299 planned: 9,164	Planned # of rural households would occupy **75%** of actual land capacity Households: build-out capacity: 11,996 planned: 9,051	Planned # of rural households would occupy **75%** of actual land capacity Households: build-out capacity: 12,056 planned: 9,051
Rural Lands Criteria: Acres of rural land brought into new UGAs	2,913 rural acres converted to urban	12,088 rural acres converted to urban	2,106 rural acres converted to urban	0 rural acres converted to urban	4,775 rural acres converted to urban	4,046 rural acres converted to urban
Resource Lands Criteria: Total into new UGAs	2,953 acres of resource land converted	9,168 acres of resource land converted	2,493 acres of resource land converted	0 acres of resource land converted	3,435 acres of resource land converted	3,778 acres of resource land converted
Agricultural land	2,758 acres of ag land	8,648 acres of ag land	2,207 acres of ag land	0 acres of ag land	3,178 acres of ag land	3,589 acres of ag land
Forest land	0 acres of forest land	145 acres of forest land	0 acres of forest land	0 acres of forest land	68 acres of forest land	0 acres of forest land
Mineral land	195 acres of mineral land	375 acres of mineral land	286 acres of mineral land	0 acres of mineral land	189 acres of mineral land	189 acres of mineral land

	Proposed Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Public Schools Criteria: Total additional students New schools needed	20,038 new students 30 new schools	33,424 new students 49 new schools	22,500 new students 34 new schools	16,132 new students 24 new schools	18,234 new students 27 new schools	
Parks and Recreational Facilities Criteria: New park land needed	1,804 acres of additional parks	2,524 acres for additional parks	1,926 acres for additional parks	1,590 acres for additional parks	1,612 acres for additional parks	1,932 acres for additional parks
Libraries	Demand for library services increases with population growth and access to facilities is affected by the location of the growth. Proposed Alternative 1 would have greatest population growth but less total area added than the other alternatives. Urban/rural split under Proposed Alternative, may result in higher than anticipated rural level of service and lower level of service for urban areas than currently planned by FVRLD					
Sewer Criteria: Additional demand at build-out	22,065,413 gallons per day	30,833,259 gallons per day	27,797,653 gallons per day	14,639,207 gallons per day	17,835,751 gallons per day	32,288,115 gallons per day
Cost to upgrade facilities	$96.7 million	$106 million	$64.5 million	$33.3 million	$64.7 million	$127.5 million
Solid waste	Facilities have capacity to handle growth beyond 20-year plan period.					
Public water supplies Criteria: Additional water demand at capacity build-out	24,278,333 gallons per day	30,833,259 gallons per day	27,797,653 gallons per day	14,639,207 gallons per day	17,835,751 gallons per day	32,288,115 gallons per day
Cost to build facilities to meet demand	$28.4 million	$60.7 million	$31.9 million	$22.4 million	$34.6 million	$42.3 million
Other Public Buildings/Facilities	Alternatives 1, 4, and 5 and the Proposed could require additional government building space for the City of Battle Ground. The cities of Camas and Washougal will expand or remodel existing facilities to accommodate growth under all alternatives.					
Electricity	Electrical service is a "pay as you go" service and system upgrades are paid for by new development directly (in the form of system connection fees) and by utility rates paid by CPU customers. Clark Public Utilities expects to be able to expand the electrical system to serve development, regardless of alternative. Availability of electricity is not expected to be a limiting factor for new development.					

Notes to Table 2:

1. GMA requires sufficient land to be available to accommodate projected population and employment. Having insufficient land to accommodate projected population or employment would not be consistent with the requirements of GMA. Having a large amount of urban land that exceeds the amount needed to accommodate projected urban population and employment would not be consistent with the intent of GMA to limit inappropriate conversion of rural land to urban land and to prevent inefficient land use patterns.

2. Having a good balance of jobs to population is one of the goals adopted by the Board of County Commissioners. There are two numbers because the projected or planned population and job numbers are lower than the number of people and jobs that could actually be accommodated by the land capacity under each alternative (full build-out)

3. Focused Public Investment Areas. These areas are targeted for public investment based on cost-effectiveness of the investment in potentially attracting new employers (see text of Economy section of DEIS for explanation).

Element	Mitigation Measures
Wetlands	Intent of mitigation is to comply with CWA and minimize loss of wetlands and compensate for filling through wetland creation or enhancement. The protection of wetlands is accomplished primarily by federal Clean Water Act, Section 404 regulations. State regulations that provide for the mitigation of impacts to wetlands include the Shoreline Management Act, Hydraulic Project Approval, State Environmental Policy Act, and The Floodplain Management Program. The County and the cities have adopted wetland protection ordinances.
Renewable and Non-Renewable Energy Sources	Intent of mitigation is to promote energy conservation by protecting access to solar energy collection and reducing vehicle miles traveled. The primary energy conservation measure available to local jurisdictions is to adopt a compact urban form that supports alternative, energy efficient transportation. Most comprehensive plans and local ordinances do not directly address energy conservation, but some have provisions for protecting access to solar energy.
Scenic Resources	Intent of mitigation is to comply with federal regulations for the Columbia Gorge National Scenic Area and further explore how scenic views can be protected: Clark County has designated 2 scenic routes and implements the provisions of the Columbia River Gorge National Scenic Area Act in its code requirements. Battle Ground has adopted interim policies to protect and promote significant views. Camas' municipal code also allows for the protection of scenic resources. Other local codes do not directly address scenic resources.
Noise	Intent of mitigation is to preserve livability by regulating noise impacts. Federal and state regulations that limit noise exposure in different classes of land use provide for some mitigation of noise impacts. Noise impacts are also considered in SEPA environmental review. Vancouver proposes to adopt a modification of the state noise ordinance.
Land Use, Population, and Housing	Primary mitigation would be the selection of an alternative that minimizes adverse impacts by using land efficiently. Alternatives can be modified by changing assumptions to reduce projected impacts.
Rural Lands	Intent of mitigation is to comply with GMA and prevent unplanned conversion of rural lands to urban uses. Clark County's comprehensive plan has policies that protect rural lands. Development on rural lands is also regulated by the county's zoning code, which establishes rural districts and permitted uses.
Resource Lands	Intent of mitigation is to comply with GMA and prevent unplanned conversion of resource lands to urban uses. Clark County's comprehensive plan policies protect resource lands from incompatible uses and from conversion to urban land. The zoning code regulates the intensity and nature of development that can occur on and adjacent to resource lands. City comprehensive plans contain policies that direct development away from productive forest and farm land.
Historic and Cultural Resources	Intent of mitigation is to protect historic and cultural resources from disturbance or destruction. Clark County and the cities of Battle Ground, Camas, La Center, Ridgefield, and Vancouver have policies and/or ordinances that require these jurisdictions to identify and protect historic and cultural resources. Washougal's comprehensive plan does not directly discuss historic and cultural resources.

VI. UNAVOIDABLE ADVERSE IMPACTS AND IRRETRIEVABLE COMMITMENT OF RESOURCES

RCW 43.21C.030(2)(c)(I) requires local governments to include a discussion of any adverse environmental effects that cannot be avoided should a proposal be implemented, the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. The following discussion summarizes unavoidable adverse impacts and whether they are expected to be significant. Irreversible and irretrievable commitments of resources are discussed where applicable. At the end of this section is a brief discussion of the trade-offs between short-term and long-term environmental costs and benefits to productivity.

A. Soils

Health department regulations govern construction of septic systems and require specific engineering geared to soil types so public health and environmental impacts are generally avoided or mitigated at the construction stage. Consequently, the issue of soils not supporting septic systems is less of an issue than conversion of resource lands and soils that offer only weak support for foundations Conversion of prime agricultural land to urban uses under all alternatives except Alternative 3 is an unavoidable impact; however, it is discussed more under Resource Lands.

B. Geology & Topography

In areas susceptible to landslides, activities such as septic system construction, the watering of lawns, and the redirection of stormwater runoff as a result of development could lead to the saturation of otherwise stable soils and may cause the loss of internal slope stability, resulting in landslides. These could be significant impacts. Most jurisdictions in Clark County have adopted ordinances to require geotechnical studies prior to development in areas where slopes exceed 15%. If the potential for slope failure exists, the recommendations of the geotechnical report are incorporated in the design of the development.

Nothing can be done to control the magnitude or location of earthquakes. However, local jurisdictions can control the type of development that occurs in areas where earthquake damage is likely to be severe (unconsolidated fill and soils subject to liquefaction, for example). Development that is not designed to withstand the seismic event projected for the region can result in unavoidable impacts to the environment. For example, in urbanized areas, the greatest earthquake-related damage is often caused by secondary events, such as fires that result from ruptured natural gas lines or flooding caused by ruptured water lines or storage tanks, or spills of hazardous materials from damaged containers. This can be considered a significant adverse impact. However, no new fuel lines are proposed with this EIS and new development would be required to meet building code standards for seismic safety. The greatest risk is from older buildings that do not meet current seismic safety codes. Sanitary sewer line ruptures could create significant adverse impacts on surface water quality.

C. Climate

The amount of land that is urbanized, the extent to which resource, rural, and open space areas are preserved, and the efficiency of the transportation system reflected in the number of vehicle miles traveled have the potential to make an incremental contribution to climate change on a larger scale over a longer period of time. In this respect, compact development patterns are less likely to increase VMT and more likely to support travel by alternative modes (transit, bicycle, walking). It is likely that any growth in consumption and emissions is likely to result in unavoidable impacts on climate, although the

occur from violations of the ordinances. Penalties may be not be large enough to protect against willful violations.

F. Groundwater

Clark County's nearly exclusive source of drinking water comes from underground aquifers. Protection of groundwater depends on comprehensive plan policies and local ordinances that place a priority on protecting groundwater quality from contamination and that require on-site infiltration to recharge aquifers. The ordinances must be compliant in demonstrating BAS measures for protecting groundwater by December 2004. As jurisdictions update their CAOs as needed to comply with the GMA requirement, groundwater quality will also be more protected. However, until that occurs interim development could increase the risk of impacts on groundwater. The impacts include more impervious surfaces in critical recharge areas and greater risk of contamination. More rural residential development increases the eventual risk septic system failures that can contaminate private well water and public water sources.

G. Fish, Wildlife, and Migratory Species Habitat

Requirements for protecting critical habitats are found in the GMA, ESA, and the SMA. All Clark County jurisdictions have implemented requirements to protect critical areas, which include fish and wildlife habitat, but most are out of date. GMA requires that they be updated by December 2004. As jurisdictions update their CAOs to comply with GMA requirements to apply BAS, critical fish and wildlife habitats will be more protected. There is little mitigation available, however, for the general loss of fish and wildlife habitat to development. Native plants and animals are displaced by development. As with the potential unavoidable impacts on surface and ground water, mitigation in the form of local regulation of impacts is expected to be the most effective available following adoption of the BAS, but not all impacts from urbanization can realistically be eliminated. Alternatives that propose less land expansion (e.g., Alternatives 2 and 3 and the Proposed Alternative) have the potential to reduce impacts.

H. Threatened & Endangered (T&E) Species

Species listed as threatened and endangered under the federal Endangered Species Act or as threatened, endangered or sensitive species by the State of Washington are protected under CAO developed by each local jurisdiction. These ordinances are being updated to comply with the GMA requirement to incorporate best available science in the mapping and protection of critical fish and wildlife habitat. However, protecting habitat and T&E species from new development does not restore habitat lost to previous development or reduce the unavoidable conversion of native vegetation to urban use that occurs with development.

I. Wetlands

All alternatives except Alternative 3 propose inclusion of additional wetlands within expansion areas. The filling of wetlands is regulated at the federal and local levels. Unavoidable adverse impacts on wetlands occur if mitigation proposed to offset the loss of wetland area and function does not produce the intended results. Therefore, unavoidable adverse impacts have the potential to occur both with conversion of rural land to urban uses, inclusion of wetlands in UGAs and with potential lapses in long-term monitoring and enforcement to ensure compliance with the permit conditions. Due to the current strength of state regulations that will result in adoption of Best Available Science in local ordinances, these potential adverse impacts are not considered to be significant.

N. Economy

Policies of no net loss of industrial land protect the conversion of industrial land to other non-industrial uses. To the extent that the health of the local economy is dependent on an adequate supply of vacant industrial land, the impact of conversion of industrial land could be significant. However, under certain circumstances, such rezoning requests can be approved through a public hearing process, so some conversion is possible and would result in permanent loss of industrial land.

O. Historic and Cultural Resources

Each of the action alternatives would include areas identified as having a high probability for archaeological resources. Local, state and federal regulations protect cultural resources from disturbance; however, the likelihood of encountering such resources increases with addition of undeveloped areas to urban uses. Many programs to protect historic resources exempt individual property owners or allow voluntary registration. Regulations cannot protect against deliberate violations that result in disturbance of historic or cultural resources, although they penalize the perpetrator.

P. Transportation

The major unavoidable adverse impact of growth in the region would be increased congestion unless additional capacity is provided. Additional capacity could be provided by transit as well as road improvements. If additional capacity is not available, the resulting congestion could significantly, unavoidably, and adversely affect air quality.

A policy to allow 4-lane rural collectors may alter the rural quality of the areas in those corridors.

Q. Fire and Police Protection Services

Inevitably population and employment growth would result in increased demand for EMS and fire protection. Unavoidable adverse impacts are related to the expenditure of resources to serve that growth. To the extent that one growth pattern uses resources less efficiently than another and increased revenue is not an option, those resources must be funded at the expense of other services or programs. This is not considered a significant impact providing the economy stays at current growth rates or better.

R. Schools

If revenue-generating uses are not distributed equitably among the school districts, school districts with a smaller tax base can experience unavoidable adverse funding impacts from having to serve their enrollments with less revenue.

S. Parks and Recreation

Current deficits in acreages of developed urban parks and of regional parks would continue under all alternatives due to population growth and funding constraints.

T. Libraries

If the proposed expansion of library space does not occur as planned, the level of service would drop and adversely affect the quantity of materials, and quality of library services on a per capita basis. This would occur no matter how the region grows.

- How much growth to plan for, and
- How to accommodate that growth.

A. How Much Growth Should Be Planned For?

1. Growth Rate

Clark County grew rapidly during the 1990's (averaging approximately 3% annually). This was higher than the Portland-Vancouver metropolitan region as a whole, and one of the fastest growth rates in Washington. Proponents of continuing to plan for a higher rate of growth than the average forecast by OFM (that is, 2% per year or greater) argue that failure to plan for growth that can realistically be expected to occur will result in a scarcity of housing to meet demand and therefore, higher prices (home prices that are not affordable by the majority of Clark County residents). Also, major capital facilities (such as sewage treatment plants and water supply facilities) could be planned and built too small to accommodate all the growth that in fact would occur.

Those who advocate for planning for a low to moderate growth rate (1.5 to 1.9%) point to the overall growth rate for the Portland-Vancouver region (1.8%) for the past 20 years and several events that are not likely to be repeated (e.g., completion of the I-205 bridge opening access to east Clark County for people working in Portland). They also argue that the rapid growth in Clark County in the 1990's was mostly due to policies in the Oregon part of the region designed to capture the majority of employment growth (which generally generates more in tax revenue than it costs to serve) but not the majority of population growth (which generally generates more demand for services than is covered by tax revenue). They also point out that, although the plans are designed to accommodate 20 years of growth, state law requires local jurisdictions to update them every 10 years, effectively giving a 50% margin of error and making it unlikely that land supply would ever become so constrained that it would affect housing prices.

2. Market Factor

The overall amount of land available for development is only one factor affecting whether development occurs and what type it is. Equally important is the demand (who is buying what) in relation to what is actually for sale at any given time. If the land that is available does not meet the requirements of the buyer (including size, location, price or availability of infrastructure, etc.), then the development will not occur. And just because a piece of land is "vacant", does not mean that it is available for development. Parcels that are included in the inventory of land available for development include those that are used (e.g., as a pasture for a favorite horse, or a cherished garden), as well as those not for sale for a variety of reasons.

In recognition of these facts, and in order to avoid creating an artificial scarcity of land that would inhibit the ability of the region to attract businesses, the BOCC included a market factor in the calculation of land needed to accommodate growth in the 1994 Plan. The market factors were 25% for residential and commercial land and 50% for industrial land. This factor was challenged, and the Western Washington Growth Management Hearings Board (WWGMHB) agreed that the market factor could simply be a way to avoid meeting the intent of GMA. They were particularly concerned that the industrial market factor was so large. In order to satisfy the WWGMHB, Clark County adopted a no-net-loss-of-industrial-land policy.

Those who oppose the use of market factors (including the City of Vancouver) point out that, although the plan must provide room for 20 years of forecasted growth, they are updated every 10 years, effectively providing a 50% margin of error. They are also concerned that the law requires local jurisdictions to use consistent assumptions for planning. This is difficult to do when the planned growth used to generate revenues is different than the actual capacity of the land. With the changes in local government financing

2. Redevelopment and Infill vs. Development at the Fringes

Given constrained local finances, most cities would rather see growth occur in areas that are already provided with urban infrastructure and services. They have made an investment in roads, water and sewer lines, parks, etc. and they would like to see these used efficiently rather than shoulder the obligation to fund and build new facilities while existing facilities have remaining capacity. This infrastructure was sized to support locally developed comprehensive plans, and the cities would like to see the plans fully implemented.

Also, some facilities and services require a certain level of development in order to operate efficiently: for example, transit service. If development patterns are lower density or intensity than planned, then there are not enough users to support them. Vancouver is planning for high capacity transit (extension of light rail from Portland or an internal streetcar system) as well as continued C-TRAN service to provide mobility and accessibility to the community This requires a compact development pattern, not large-lot residential development or auto-dependent shopping centers.

The City of Vancouver has been pursuing an active program of encouraging redevelopment and infill in Downtown Vancouver. The downtown is well served by roads, water, sewer, parks and other facilities and services. The redevelopment program has been very successful, and the city would like to continue its success and expand to other underutilized or rundown areas. Similar revitalization efforts are underway in Camas and in the unincorporated community of Hazel Dell.

However, redevelopment and infill are more of a hassle and can be more expensive for the developer because of the need to remove existing structures and work within a constrained area. That is why cities typically provide incentives for infill and redevelopment. In order to have the funding to pursue this strategy, local government cannot afford to take on the obligation to extend service to large new areas. Expanding the urban growth areas, particularly to include a large market factor, will compete for developers and for public funding with efforts to revitalize Downtown Vancouver, Hazel Dell and downtown Camas. That is why most cities requested small or modest UGA expansion. (Battle Ground is the exception.) The UGA expansion requested by Vancouver is much less than that shown in the preferred alternative.

However, much of this controversy does not have to do with facts, but with preferences. Advocates for redevelopment and infill prefer a city to look compact and have a mix of uses within easy walking distance. They prefer a clear distinction between urban and rural areas. Those who advocate developing new businesses and homes at the fringes of the existing UGA prefer lower density campus-style development and the freedom of access and mobility granted by personal automobiles. Unfortunately, these two preferences are in conflict, given that demand is finite and there are limited resources to provide services to support development.

Appendix G

References

APPENDIX G

REFERENCES

[1] City of Battle Ground Sewer Plan Update, Wallis Engineering, March 2005.

[2] City of Battle Ground Comprehensive Plan, December 2004.

[3] Soil Survey of Clark County, Washington, November 1972.

[4] Criteria for Sewage Works Design. State of Washington, Department of Ecology. Revised October 1985.

Appendix H

Wastewater Treatment and Effluent Disposal

APPENDIX H

WASTEWATER HANDLING

H.1 EXISTING WASTEWATER HANDLING

All of the City's wastewater is presently sent to the Salmon Creek Treatment Plant (SCTP). The City has purchased 3.47 million gallons per day (MGD) of maximum month flow capacity at the SCTP, and intends to own and use this capacity into the future. The SCTP is part of the Salmon Creek Wastewater Management System which is owned and operated by Clark County. The City has purchased conveyance and treatment capacity through an interlocal agreement with the Clark Regional Wastewater District (CRWWD) and Clark County (copies of various phases of this agreement are provided in Appendix E). The interlocal agreement identifies the maximum month capacity of the facilities allocated to the City. The maximum month capacities of the facilities purchased by the City through Phase 4 of the Salmon Creek Wastewater Management System include:

- Interceptor System 10.1 MGD
- Pump Stations 4.47 MGD
- Force Main Systems 6.3 MGD
- SCTP Treatment / Outfall 3.47 MGD

These facilities are presented in greater detail, with component locations and purchased capacities on Figure H.1. Figure H.2 illustrates these components in schematic form.

In addition, the City is currently constructing a new 3.5-MGal flow equalization basin and a new 4.6-MGD pump station. These facilities will be on line in Fall 2011.

Based on the projected flows discussed in Section 6, the City has maximum month capacity until the following years for each of the systems:

- Interceptor System 2050 (Extrapolated from current Projections)
- Pump Stations 2016
- Force Main Systems 2026
- SCTP Treatment / Outfall 2011[1]

The limiting facilities are those for treatment and discharge. The Interceptor and Force Main Systems have the capacity to carry the City through the planning period. The City needs to develop additional treatment and discharge capacity in order to provide sewer services through the planning period. The predicted maximum month flow rate in 2026 is 6.23 MGD. Therefore

[1] The City's treatment and outfall capacity is likely to be sufficient for five or more years beyond 2011 based on recent slowing in growth trends. However, based on the City's official comprehensive plan growth projections, the capacity would be utilized fully in 2011.

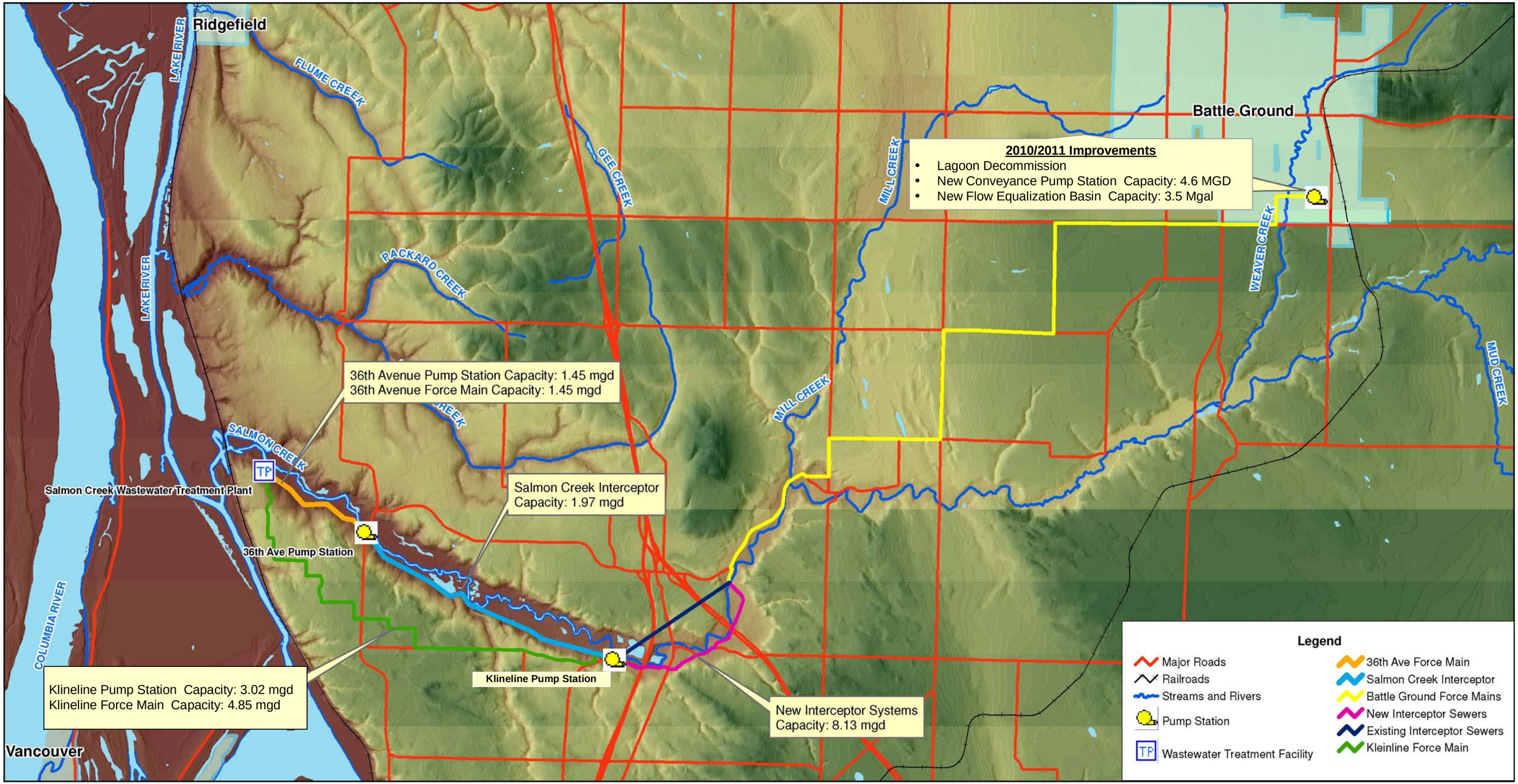


Figure H.1: Battle Ground and Clark County Transmission System Capabilities

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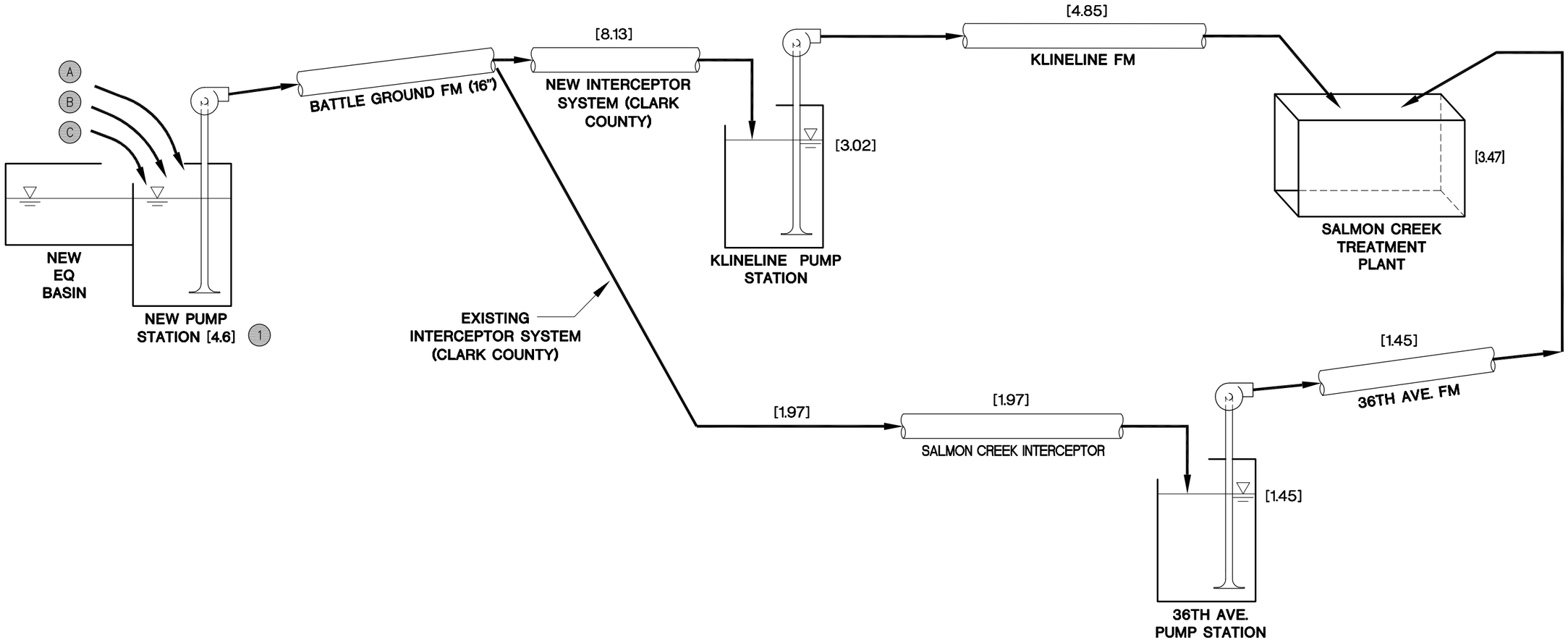

LEGEND

A	BATTLE GROUND SEWER SYSTEM
B	MEADOW GLADE SEWER SYSTEM
C	HOCKINSON SEWER SYSTEM
1	CONSTRUCTION TO BE COMPLETED FALL 2011
[CAPACITY]	CITY CAPACITY ALLOCATION PER (MAX MO.) INTERLOCAL AGREEMENT (APPENDIX)

SCHEMATIC: BATTLE GROUND AND CLARK COUNTY TRANSMISSION SYSTEM PURCHASED CAPACITY

FIGURE H.2

the City will need to purchase or construct 2.76 MGD of treatment and discharge capacity beyond the current capacity of 3.47 MGD in order to meet projected requirements to 2026. Additional pumping capacity will also be required. Note that the actual growth rate will be greater or less than projected, and thus implementation of planned improvements may be accelerated or delayed depending on the actual grow rate.

H.2 ALTERNATIVES

Three regional alternatives and one local alternative are considered for increasing treatment and disposal capacity to 6.23 MGD. The first regional alternative involves staying within the Salmon Creek Wastewater Management System and continuing to purchase additional treatment capacity as outlined in the SCTP Facility Plan/General Sewer Plan. The other regional alternatives involve conveyance of wastewater to the City of Vancouver's Westside Treatment Facility and the purchase of capacity in that facility. Note that the City's new flow equalization basin and new conveyance pump station, currently under construction, are not included as part of any alternative.

H.2.1 ALTERNATIVE DESCRIPTIONS AND ASSUMPTIONS

H.2.1.1 SCTP Alternative

The City would purchase additional treatment, outfall, and pump station capacity and would construct a new parallel force main from the City's Operations Center to the I-205 bridge structure. This alternative would require the City to make the following capital improvements over the planning period:

- Purchase 2.76 MGD additional capacity via SCTP Expansions: Phases 5, 6, 7, 8, 9
- Expand Flow Equalization (FE) Basin to 5 million gallons (MGal) from 3.5 MGal
- Increase Battle Ground Pump Station Capacity to 8 MGD from 4.6 MGD
- Construct Parallel Force Main (24-inch)
- Increase Klineline Pump Station Capacity

This alternative is based on the following assumptions:

- The required total capacity is based on a 2026 maximum month flow of 6.23 MGD
- No additional interceptor sewer capacity will be required.
- No additional County force main capacity will be required.

H.2.1.2 City of Vancouver Alternative 1: Via St. John's Road

In this alternative, the City would enter into an agreement with the City of Vancouver for treatment of future wastewater flow and would construct a new force main and interceptor system to convey wastewater to the City of Vancouver's Westside Treatment Facility. Sewage would be pumped from the expanded Battle Ground pump station / FE basin via a new pipeline that would end at N.E. 99th and NE. 117th. Sewage would then be pumped to the Westside plant by a new pump station and through a new pipeline that would follow St. John's Avenue.

This alternative would require the City to make the following improvements:

- Expand Flow Equalization Basin to 5 MGal from 3.5 MGal
- Increase Battle Ground Pump Station Capacity to 8 MGD from 4.6 MGD
- Construct new mid-way pumping station
- Construct new pressure (and gravity) pipeline sections
- Purchase treatment capacity at Vancouver's Westside Treatment Facility

This alternative is based on the following assumptions:

- The required total capacity is based on a 2026 maximum month flow of 6.23 MGD
- The City of Vancouver would be in agreement with this approach
- There would be no cost sharing from other communities in the project.

H.2.1.3 City of Vancouver Alternative 2: Via Klineline Interceptor

In this alternative also, the City would enter into an agreement with the City of Vancouver for treatment at the City of Vancouver's Westside Treatment Facility. The City also would construct a new parallel force main from the City to the I-205 bridge structure and expand capacities of the flow equalization basin / pump station, participate in the upgrades at the Klineline pump station, and participate in the construction of a new interceptor system to the Westside Treatment Facility.

This alternative is based on the following assumptions:

- The required total capacity will be based on a 2026 maximum month flow of 6.23 MGD
- The City of Vancouver is in agreement with this approach
- There could be cost sharing from other communities in the project and the City would be responsible for only a portion of the costs associated with upgrading the Klineline Pump Station and conveyance improvements from that pump station to the Westside Treatment Facility.

H.2.1.4 Local WRF Alternative

This alternative, discussed above, is based on developing a local water reclamation facility (WRF) which would produce a Class A effluent and would meet reclaimed water requirements of RCW 90.46. It is anticipated that a membrane bioreactor (MBR) would be utilized. Effluent from the WRF would be discharged into infiltration basins constructed on a 15-acre parcel of land in Manor Trough. As an alternative, there is potential for utilizing land parcels in the Venersborg / Hockinson areas, east or southeast of Battle Ground. A new pump station and a 16-inch force main would be constructed to transmit effluent to the infiltration basins. The WRF would be located within the existing lagoon site.

The unit processes of an MBR WRF for Battle Ground would include:

- Primary Treatment
  - Fine Screening
  - Grit Removal

- Secondary and Tertiary Treatment
  - Anoxic Basin
  - Mixed Liquor Pumping
  - Aerobic Basin
  - MBR Basins
  - Membrane Clean-in-Place System
  - Permeate Pumping
  - RAS Pumping

- Disinfection
  - Ultraviolet Disinfection and Standby Chlorination

- Biosolids Handling

This alternative would require the City to make the following capital improvements:

- Construct WRF (2.76 MGD)

- Effluent Disposal

- Solids Handling Facilities

This alternative is based on the following assumptions:

- Geology in either the Venersborg or Manor Trough areas is conducive to an infiltration system.

- The Washington State Department of Ecology (Ecology) would issue approval of the effluent disposal approach, and corresponding permits.

- The required total capacity is based on a 2026 maximum month flow of 6.23 MGD

- No additional Interceptor sewer capacity or County force main capacity will be required

- A new pump station and force main will be required to route WRF effluent to the selected application site.

H.2.2 ALTERNATIVES PROJECT COSTS

Tables H.1 through H.4 show the total project costs for each of the four alternatives. Collection system costs are not included, as they are discussed in Section 9.

Project costs for the SCTP Alternative are shown in Table H.1. It is assumed that the City would share in planned expansions to the plant, as required to provide capacity to 2026; this would involve expansion phases 5, 6, 7, 8, and 9. Costs for a new force main were estimated

assuming a 24-inch pipeline (of approx. 9 miles) from the Battle Ground Pump Station to the I-205 bridge crossing.

TABLE H.1
SCTP ALTERNATIVE

System Component	$ Million
Purchase 2.76 MGD Additional Capacity	18
Expand Flow Equalization Basin and Increase Battle Ground Pump Station Capacity	5
Parallel Force Main	16
Klineline Pump Station Improvements	2
Capital Cost Estimate:	**41**

Project costs for Vancouver Alternative 1 are shown in Table H.2. It is assumed that the City would pay $6.50 per gallon for treatment capacity at Vancouver's Westside Treatment Facility.

TABLE H.2
CITY OF VANCOUVER ALTERNATIVE 1: ST. JOHNS ROAD

System Component	$ Million
Expand Flow Equalization Basin and Increase Battle Ground Pump Station Capacity	5
New mid-way pumping station	3
Pressure (and gravity) flow pipeline sections	30
Westside WWTP capacity	18
Capital Cost Estimate:	**56**

Project costs for Vancouver Alternative 2 are shown in Table H.3. It is assumed that the City would pay $6.50 per gallon for treatment capacity at Vancouver's Westside Treatment Facility. The parallel force main costs were estimated as for the SCTP Alternative.

TABLE H.3
CITY OF VANCOUVER ALTERNATIVE 2: KLINELINE

System Component	$ Million
Expand Flow Equalization Basin and Increase Battle Ground Pump Station Capacity	5
Parallel Force Main	17
Gravity Sewer, Klineline to Vancouver	15
Westside WWTP capacity	18
Klineline Pump Station Upgrades	2
Capital Cost Estimate:	**57**

Project costs for the WRF Alternative are shown in Table H.4.

TABLE H.4
WRF LOCAL TREATMENT

System Component	$ Million
WRF	28
Effluent Disposal: Pipeline / Pump Station, Land, Permitting	10
Solids Handling Facilities	5
Capital Cost Estimate:	**43**

A comparison of estimated cost of the four alternatives is shown in Table H.5.

TABLE H.5
COMPARISON OF CAPITAL COSTS

Treatment Alternatives	Project Cost, Phases 1&2 ($ Millions)
SCTP	41
City of Vancouver 1 (St. Johns)	56
City of Vancouver 2 (Klineline)	57
WRF Local Treatment	43

The SCTP alternative carries the lowest capital cost. The local WRF alternative has a slightly higher capital cost, however its operational cost is significantly higher. This alternative also requires approval of the effluent disposal approach, and corresponding permits from Ecology. The two Vancouver alternatives have a significantly-higher capital cost. For these reasons, the SCTP alternative is recommended.

If the recent slowing in growth rates continues, then facility improvements could be postponed. In this case it may be feasible to reevaluate the local WRF alternative at a future time. A reevaluation may be warranted if relative importance of the selection criteria were to change in the interim period. Factors affecting alternative selection which may change in the future include: federal and state reclaimed water regulations; the regulatory / permitting environment in general; the cost of treatment and discharge from a local WRF and/or from the regional SCTP; and efficacy of MBR treatment technology.

The City and Kennedy/Jenks Consultants have investigated the local WRF alternative over the last few years. In particular, the subject of subsurface discharge of WRF Class A effluent has been evaluated and discussed with Ecology at length. This prior work should facilitate progress if the local WRF alternative were to be selected in the future.

H.2.3 DEVELOPMENT OF RECOMMENDED ALTERNATIVE

As described above, this alternative consists of expanding transmission facilities and purchasing additional capacity at the SCTP, in order to handle increasing sewage flows during the course of the planning period. Facility improvements associated with this alternative are described below.

H.2.3.1 Use of SCTP Treatment and Discharge Capacity

The SCTP currently has a maximum month rated capacity of 14.95 MGD. Additional expansion of the facility will be required to address anticipated permit requirements and to handle anticipated flows during the planning horizon. Flows to the SCTP will continue to be generated from customers in the Battle Ground and Clark Regional Wastewater District service areas, as well as potentially from the City of Ridgefield.

A Sewer Coalition Planning Study was completed in November 2009 with the participation of all sewer utilities in the County. This Study resulted in the development of a Regional General Sewer Plan outlining a long-term vision for sewer service in the County, and recommending that four agencies (Battle Ground, Ridgefield, Clark County, and Clark Regional Wastewater District) form a partnership to provide major conveyance and treatment for sewage from each agency's service area. The Regional Plan also determined that treatment of flow from Ridgefield could be provided more cost effectively at the SCTP rather than through further expansion of the Ridgefield WWTP.

The improvements required to convey flow from Ridgefield to the SCTP and the capital improvements required to accommodate the additional flow and load at the SCTP are being addressed in detail in an Engineering Report for the City of Ridgefield and in an update to the Salmon Creek Treatment Plant Facility Plan. At the time of preparation of this document, it was anticipated that five expansions to the SCTP will be required to serve the needs of the Clark Regional Wastewater District, Battle Ground, and Ridgefield. Table H-6 summarizes planned unit process improvements for each phase of expansion, along with estimates of total project costs and costs to Battle Ground.

TABLE H.6
PLANNED EXPANSIONS TO THE SCTP

	Repair Project (2012)	Estimated Cost	Phase 5 EDUs* : 41,874 (2012-2013)**	Estimated Cost	Phase 6 EDUs* : 47,227 (2015-2017)**	Estimated Cost	Phase 7 EDUs* : 56,044 (2019-2020)**	Estimated Cost	Phase 8 EDUs* : 63,645 (2022-2023)**	Estimated Cost	Phase 9 EDUs* : 72,951 (2025-2027)**	Estimated Cost	Total Cost
	Dewatering Upgrades	$1,500,000	Aeration Basin 7	$4,880,000	1 New Screen (25 mgd capacity)	$450,000	Primary Clarifier 5	$2,970,000	Primary Clarifier 6	$2,970,000	Aeration Basin 11	$4,880,000	
			Site Improvements	$244,000	Cover Primary Clarifiers (Odor)	$3,220,000	Aeration Basin 9	$4,880,000	Aeration Basin 10	$4,880,000	Anaerobic Digester 3	$4,480,000	
			New Outfall	$10,780,000	Aeration Basin 8	$4,880,000	1 New Large Blower	$1,380,000	1 New Large Blower	$1,380,000	Site Improvements	$1,310,400	
					1 New Large Blower	$1,380,000	Site Improvements	$462,000	Secondary Clarifier 6 (140')	$3,940,000			
					Secondary Clarifier 5 (140')	$3,940,000			Demolish Secondary Clarifier 2	$50,000			
					New Ras/WAS Pump Station	$3,140,000			Site Improvements	$661,000			
					1 New UV Disinfection Channel	$3,360,000							
					Anaerobic Digester 3	$4,480,000							
					Demolish Secondary Clarifier 1	$50,000							
					Site Improvements	$350,000							
SCTP Capacity (MMF, MGD)		14.95 (existing)	16.5		20.2		23.4		25.3		29.0		
Estimated Expansion Cost ($M)		(1.5)		15.9		25.25		9.69		13.88		10.67	76.89
Estimated Battle Ground Share of Cost ($M)		(0.3)		5.5		4.9		1.7		4.1		1.6	**18.1**

* Systemwide EDUs

** Improvements will be coordinated with EDUs / flowrates; timelines will be adjusted accordingly

It is anticipated that the City would participate in Phases 5 through 9, with a total cost to the City of approximately $18 million. This would provide an additional 2.95 MGD of capacity to the City, raising its total capacity share to 6.42 MGD, or 0.19 MGD beyond the required 6.23 MGD on a maximum month basis. If flow from the City of Ridgefield is not sent to the SCTP, the Phase 9 expansion would not be required within the planning horizon, and the timeline for implementation of Phases 5 through 8 would be extended.

H.2.3.2 Force Main

A 24-inch force main would be constructed to carry sewage from the City's pump station at the Operations Center to the newer section of Salmon Creek Interceptor near the I-205 Bridge. This pipeline would parallel the City's existing 16-inch force main, following the 9-mile route shown on Figure H.1. The capacity of this force main would handle projected requirements well beyond the planning period.

The force main would be constructed of polyvinyl chloride (PVC) (C905). It would contain a boring beneath a highway (SR 503), a crossing at Salmon Creek, and a crossing at Betts Bridge. It would also contain several vaults for sewer air/vacuum valves.

The estimated cost of the new force main is approximately $16 million. Table H-7 presents a list of items included in this pipeline construction. It is expected that timing of construction would coincide with a maximum month flowrate of 4.4 MGD.

H.2.3.3 Expansion of Pump Station and Equalization Basin

The flow equalization basin and pump station currently under construction (December 2010) were designed with the assumption that toward the end of the planning period, a WRF would handle 3.4 MGD of flow (on a maximum month basis).[2] For the SCTP alternative, a WRF will not be constructed, thus it will necessary to expand the basin and pumping capacity in order to provide storage and pumping capacity for the full inflow to be delivered to the City's Operations Center.

The flow equalization basin is being constructed with a volume of 3.5 MGal. For the SCTP alternative, this basin would be expanded to 5.0 MGal. (The current basin was designed and located so as to accommodate a future expansion to 5.0 MGal.)

The pump station is being constructed with a firm capacity of 4.6 MGD. For the SCTP alternative, the pump station would be expanded to a firm capacity of 8.0 MGD.

The estimated cost of these upgrades is $5 million, and it is expected that timing of construction would coincide with a maximum month flowrate of 3.4 MGD.

H.2.3.4 Increased Capacity from Klineline Pump Station

The City's capacity share in the existing Klineline Pump Station is 3.02 MGD. For the SCTP alternative, it would be necessary to increase this capacity to at least 4.85 MGD in order to match the City's capacity share in the Klineline Force Main. This would allow a delivery of 4.85 MGD to the SCTP, with an additional 1.97 MGD delivered to the SCTP by the 36th Ave. pump station and force main, as depicted on Figure H.2.

The estimated cost of these upgrades is $2 million.

[2] Engineering Report for Flow Equalization System Improvements at City of Battle Ground, Washington (January 2010), Kennedy/Jenks Consultants.

TABLE H.7
BATTLE GROUND 24-INCH FORCE MAIN

ITEM	QUANTITY	UNIT	ITEM DESCRIPTION
1	1	LS	MOBILIZATION
2	1	LS	TRAFFIC CONTROL
3	32013	SY	CONSTRUCTION GEOTEXTILE FOR SEPARATION
4	7403	TON	CRUSHED SURFACING BASE COURSE
5	2468	TON	CRUSHED SURFACING TOP COURSE
6	8203	TON	HMA CL. 1/2 INCH PG 64-22
7	1	EA	PIG LAUNCH VAULT
8	1	LS	UPSTREAM BG TIE IN
9	1	LS	DOWNSTREAM TIE IN
10	6	EA	AIR-VACUUM VAULT AND ASSEMBLY
11	47520	LF	TRENCH SAFETY SYSTEM
12	48020	LF	TESTING SEWER PIPE
13	47520	LF	SEWER FORCE MAIN, 24 INCH DIA. C 905
14	48020	LF	LOCATOR WIRE
15	47520	LF	LOCATE TAPE
16	288120	SF	GRIND 1 LANE FOR OVERLAY
17	300	LF	SEWER BORE, 24 INCH DIA. DR 13.5 HDPE At SR 503
18	350	LF	SEWER CROSSING At SAL CR, 24 INCH DIA. DR 13.5 HDPE
19	1	LS	BRIDGE CROSSING & CONNECTION -BETTS
20	97	EA	LOCATOR STATION
21	1	LS	TEMPORARY EROSION CONTROL
22	1	LS	PERMANENT EROSION CONTROL AND LANDSCAPING
TOTAL ESTIMATED PROJECT COST: $16 Million			