

# Barton and Murray

## Combined Sewer Overflow Control Facilities Plan

Volume 1



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February 2011



**King County**

Department of Natural Resources and Parks  
**Wastewater Treatment Division**



**Draft**  
**Barton and Murray Combined Sewer Overflow Control Facilities Plan**

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**KING COUNTY WASTEWATER TREATMENT DIVISION**

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN**

**TABLE OF CONTENTS**

VOLUME 1 OF 3

CHAPTER 1 Executive Summary

1.1	Background.....	1-1
1.2	Basis of Planning .....	1-3
1.3	Preliminary Alternative Development.....	1-4
1.4	Screening of Preliminary Alternatives.....	1-4
1.5	Refinement of Short-listed Alternatives .....	1-4
1.5.1	Murray CSO Basin.....	1-4
1.5.2	Barton CSO Basin .....	1-6
1.6	Final Evaluation and Selection Process .....	1-6
1.7	Proposed Alternative .....	1-11
1.7.1	Barton CSO Basin .....	1-11
1.7.2	Murray CSO Basin.....	1-12

CHAPTER 2 Introduction

2.1	Problem Identification .....	2-1
2.2	Project Background .....	2-1
2.2.1	CSO Control Requirements.....	2-1
2.2.2	History of CSO Control in King County.....	2-4
2.2.3	Current CSO Control Status in King County.....	2-5
2.2.4	Previous Studies.....	2-7
2.3	Current Project.....	2-11
2.3.1	Project Priority and Timeline.....	2-11
2.3.2	Planning Period .....	2-11
2.4	Facility Plan Requirements .....	2-11
2.5	Contact Information .....	2-15

CHAPTER 3 Existing Conditions

3.1	Human Environment.....	3-1
3.1.1	Land Use .....	3-1
3.1.2	Wastewater System.....	3-3
3.1.3	Public Health .....	3-9
3.1.4	Cultural Resources .....	3-9
3.2	Physical Environment .....	3-9
3.2.1	Land.....	3-9
3.2.2	Surface Water.....	3-15
3.2.3	Rainfall.....	3-16
3.2.4	Air .....	3-16
3.2.5	Sensitive Areas.....	3-16
3.3	Endangered/Threatened Species and Habitats.....	3-17

CHAPTER 4 Basis of Planning

4.1	System Modeling .....	4-1
4.1.1	Model Description.....	4-1
4.1.2	Data .....	4-2
4.1.3	Long-Term Simulations .....	4-4

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN**  
**TABLE OF CONTENTS**

4.2	CSO Control Approaches .....	4-4
4.2.1	Control Approach 1—Peak-Flow Storage .....	4-4
4.2.2	Control Approach 2—Convey and Treat .....	4-7
4.2.3	Control Approach 3—End-of-Pipe Treatment .....	4-9
4.2.4	Control Approach 4—Peak Flow Reduction.....	4-9
4.2.5	Control Approach 5—Combined Approach.....	4-9
4.3	Basis of Planning Criteria .....	4-9
CHAPTER 5 Methodology for Developing and Evaluating Alternatives		
5.1	Overview .....	5-1
5.2	Phase 1 .....	5-2
5.2.1	Step 1.1: Define Criteria Categories.....	5-2
5.2.2	Step 1.2: Identify Control Approaches.....	5-2
5.2.3	Step 1.3: Develop Initial Conceptual Alternatives .....	5-4
5.2.4	Step 1.4: Evaluation and Initial Results.....	5-4
5.3	Phase 2 .....	5-5
5.3.1	Step 2.1: Develop and Evaluate CSO Control Alternatives.....	5-5
5.3.2	Step 2.2: Alternatives Screening.....	5-13
5.3.3	Step 2.3: Selection of a Preferred Project.....	5-13
5.4	Basis of Design .....	5-15
CHAPTER 6 Preliminary Alternatives		
6.1	No Action Alternatives .....	6-1
6.2	Identification of Preliminary Sites .....	6-1
6.3	Preliminary Alternatives Overview.....	6-4
6.4	Preliminary Barton CSO Basin Alternatives .....	6-7
6.4.1	Alternatives Using Control Approach 1 – Peak-Flow Storage.....	6-7
6.4.2	Alternative Using Control Approach 3 - End of Pipe Treatment ..	6-10
6.4.3	Alternative Using Control Approach 4 – Peak-Flow Reduction ...	6-10
6.5	Preliminary Murray CSO Basin Alternatives.....	6-11
6.5.1	Alternatives Using Control Approach 1 – Peak-Flow Storage.....	6-11
6.5.2	Alternative Using Control Approach 2 – Convey and Treat.....	6-13
6.5.3	Alternative Using Control Approach 3 - End of Pipe Treatment ..	6-14
6.5.4	Alternative Using Control Approach 5 – Combined Approaches.	6-14
6.6	Refined Preliminary Alternatives .....	6-15
CHAPTER 7 Alternatives Evaluation and Selection		
7.1	Overview .....	7-1
7.2	Preliminary Short-List Development.....	7-1
7.2.1	Barton CSO Basin Preliminary Short-List.....	7-1
7.2.2	Murray CSO Basin Preliminary Short-List.....	7-2
7.3	Murray Basin Community Advisory Group Alternatives.....	7-3
7.3.1	Community Advisory Group Process .....	7-3
7.3.2	Community Advisory Group Alternatives.....	7-4
7.3.3	Community Advisory Group Recommendations .....	7-7
7.3.4	Coarse Screening of Murray Basin Alternatives.....	7-7
7.3.5	Murray Basin—Final Short List.....	7-11
7.4	Final Short-Listed Alternatives—Barton Basin .....	7-11
7.4.1	Refinement of Barton Alternatives.....	7-11
7.4.2	Barton Alternative 1E—Pipe Storage in Upper Fautleroy Way .	7-12
7.4.3	Barton Alternative 1F—Buried Rectangular Storage Tank, at Fautleroy School .....	7-14
7.4.4	Barton Alternative 4A (GSI)—Green Stormwater Infrastructure in Sub-Basin 416.....	7-17

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN**  
**TABLE OF CONTENTS**

7.5	Final Short-Listed Alternatives—Murray Basin .....	7-19
7.5.1	Refinement of Murray Alternatives .....	7-19
7.5.2	Murray Alternative 1A—Storage at Lowman Beach Park.....	7-20
7.5.3	Murray Alternative 1F—Beach Drive Area Underground Storage.....	7-22
7.5.4	Alternative CAG 2-a—Storage at Lincoln Park Lower Parking Lot.....	7-24
7.6	Selection of Proposed Projects.....	7-26
7.6.1	Refinement of the Evaluation Criteria.....	7-26
7.6.2	Evaluation Process.....	7-27
7.7	Proposed Alternatives for Further Environmental Review .....	7-31
CHAPTER 8 Proposed Alternative		
8.1	Barton CSO Basin Proposed Alternative Overview .....	8-1
8.1.1	Overflow Frequency and Volume .....	8-1
8.1.2	General Layout .....	8-2
8.1.3	Wet-Weather Flow Description.....	8-2
8.1.4	Facility Sizing.....	8-3
8.2	Murray CSO Basin Proposed Alternative Overview .....	8-6
8.2.1	Overflow Frequency and Volume .....	8-7
8.2.2	General Layout .....	8-7
8.2.3	Process Flow .....	8-12
8.2.4	Hydraulic Profile .....	8-14
8.2.5	Facility Sizing.....	8-14
8.3	Environmental Impacts .....	8-14
8.3.1	Barton GSI Alternative.....	8-14
8.3.2	Murray Alternative 1F .....	8-19
8.4	Design Life.....	8-24
8.4.1	Barton GSI Alternative.....	8-24
8.4.2	Murray Alternative 1F .....	8-24
8.5	Residuals Management.....	8-24
8.5.1	Barton GSI Alternative.....	8-24
8.5.2	Murray Alternative 1F .....	8-24
8.6	Ability to Expand.....	8-24
8.7	O&M and Staffing Needs.....	8-25
8.7.1	Barton GSI Alternative.....	8-25
8.7.2	Murray Alternative 1F .....	8-25
8.8	Design Guidelines.....	8-30
8.8.1	Site Design .....	8-30
8.8.2	Traffic.....	8-30
8.8.3	Structural/Geotechnical .....	8-30
8.8.4	Stormwater Management .....	8-30
8.8.5	Architecture/Landscaping .....	8-30
8.8.6	O&M and Facility Inspections .....	8-31
8.8.7	Reliability .....	8-31
8.8.8	Effects of Sea Level Rise .....	8-32
8.9	Feasibility of Implementation .....	8-33
8.9.1	Barton GSI Alternative.....	8-33
8.9.2	Murray Alternative 1F .....	8-34
CHAPTER 9 Financial Analysis		
9.1	Estimated Costs.....	9-1
9.1.1	Construction Cost Estimate .....	9-1
9.1.2	Project Cost Estimate .....	9-1
9.1.3	Operation and Maintenance Costs .....	9-2

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
TABLE OF CONTENTS**

9.1.4	Life-Cycle Cost Estimate .....	9-3
9.2	Project Financing.....	9-3
9.2.1	Financial Capability .....	9-3
9.2.2	Capital Financing Plan .....	9-4
9.2.3	Customer Charges .....	9-4
CHAPTER 10	Implementation Plan	
10.1	Project Schedule .....	10-1
10.2	Required Permits.....	10-1
10.3	Next Step Recommendations.....	10-2
CHAPTER 11	Miscellaneous Requirements	
11.1	Water Quality Management Plan Conformance .....	11-1
11.2	State Environmental Policy Act Compliance .....	11-1
11.3	State Environmental Review Process Compliance .....	11-1
11.3.1	National Historic Preservation Act/Archaeological and Historic Preservation Act .....	11-1
11.3.2	Clean Air Act .....	11-2
11.3.3	Coastal Zone Management Act.....	11-2
11.3.4	Endangered Species Act.....	11-2
11.3.5	Farmland Protection Policy Act .....	11-2
11.3.6	Fish and Wildlife Coordination Act .....	11-2
11.3.7	Executive Order 11988, Floodplain Management .....	11-2
11.3.8	Executive Order 11990, Protection of Wetlands .....	11-2
11.3.9	Wild and Scenic Rivers Act .....	11-2
11.4	Public Involvement and Outreach.....	11-3
11.4.1	Agency Stakeholder Engagement Process.....	11-3
11.4.2	Public Meetings and Briefings.....	11-3
11.4.3	Public Information.....	11-5
11.4.4	Comment Tracking and Response Process.....	11-6

**APPENDICES**

VOLUME 2 OF 3

APPENDIX A	FLOW MODELING AND CALIBRATION DOCUMENTATION	
	Modeling and Calibration Technical Reports	
	Flows and Storage Volumes	
	Technical Memorandum 600.5 CSO Beach Projects Demand Management Analysis	
	Green Stormwater Infrastructure Analysis	
	Summary of Technical Memorandums & SvR Recommendations	
	GSI Planning and Analysis Confirmation	
	Sensitivity Analysis for GSI Alternative Modeling	
	Addendum #2 to Technical memorandum 600.6	
	Volume Comparison and GSI Recommendations	

VOLUME 3 OF 3

APPENDIX B	ALTERNATIVE EVALUATION SUMMARY DOCUMENTATION
APPENDIX C	PUBLIC INVOLVEMENT DOCUMENTATION
APPENDIX D	STATE ENVIRONMENTAL POLICY ACT (SEPA) DOCUMENTATION <i>(To Be Provided When Available)</i>
APPENDIX E	PRELIMINARY GEOTECHNICAL/ENVIRONMENTAL DOCUMENTATION
APPENDIX F	COST DATA
APPENDIX G	ALTERNATIVE RISK REGISTERS

**LIST OF FIGURES**

Figure 1.1	Barton and Murray CSO Basins Vicinity .....	1-2
Figure 1.2	Barton CSO Basin Proposed Alternative 4A (GSI): GSI in Sub-Basin 416....	1-13
Figure 1.3	Murray CSO Basin Proposed Alternative 1F: Beach Drive Area Underground Storage .....	1-15
Figure 2.1	Barton and Murray CSO Basins Vicinity .....	2-2
Figure 2.2	King County CSO Control Program Overview .....	2-5
Figure 2.3	CSO Control Project Priorities .....	2-6
Figure 3.1	Barton and Murray CSO Basins Land Use .....	3-2
Figure 3.2	Local Sewer Collection System .....	3-4
Figure 3.3	Existing Barton CSO Basin CSO Control Structure .....	3-6
Figure 3.4	Existing Murray CSO Basin CSO Control Structure .....	3-7
Figure 3.5	CSO and Regional Conveyance System .....	3-8
Figure 3.6	Barton CSO Basin Geology .....	3-10
Figure 3.7	Murray CSO Basin Geology .....	3-11
Figure 3.8	Barton and Murray CSO Basins Topography .....	3-14
Figure 3.9	Barton CSO Basin Sensitive Areas .....	<i>after</i> 3-14
Figure 3.10	Murray CSO Basin Sensitive Areas .....	<i>after</i> 3-16
Figure 4.1	Barton CSO Basin Flow Meter Schematic .....	4-3
Figure 4.2	Murray CSO Basin Flow Meter Schematic .....	4-3
Figure 4.3	Sub-Basin Flow Distribution in Barton CSO Basin .....	4-6
Figure 4.4	Barton Mid-Basin Storage Calculation for Barton CSO Basin .....	4-7
Figure 4.5	Sub-Basin Flow Distribution in Murray CSO Basin .....	4-8
Figure 5.1	Basis of Design Typical Detail for Rectangular Storage Tanks .....	5-17
Figure 5.2	Basis of Design Typical Detail for Storage Pipe .....	5-18
Figure 5.3	Basis of Design Typical Detail for Pump Station .....	5-19
Figure 6.1	Candidate Sites .....	6-3
Figure 6.2	Barton CSO Basin Alternative 1A: Rectangular Storage at Bottom of Basin .....	<i>after</i> 6-6
Figure 6.3	Barton CSO Basin Alternative 1B: Circular Storage at Bottom of Basin..	<i>after</i> 6-8
Figure 6.4	Barton CSO Basin Alternative 1C: Pipe Storage at Bottom of Basin.....	<i>after</i> 6-8
Figure 6.5	Barton CSO Basin Alternative 1D: Pipe Storage in Right-of-Way at Bottom of Basin .....	<i>after</i> 6-8
Figure 6.6	Barton CSO Basin Alternative 1E: Pipe Storage in Upper Fauntleroy Way SW .....	<i>after</i> 6-8
Figure 6.7	Barton CSO Basin Alternative 1F: Storage in Vicinity of Fauntleroy School.....	<i>after</i> 6-8
Figure 6.8	Barton CSO Basin Alternative 1G: Rectangular Storage in Upper Basin .....	<i>after</i> 6-10
Figure 6.9	Barton CSO Basin Alternative 3A: End-of-Pipe Treatment at Bottom of Basin .....	<i>after</i> 6-10
Figure 6.10	Barton CSO Basin Alternative 4A: Peak Flow Reduction by Roof Drain Disconnection. ....	<i>after</i> 6-10
Figure 6.11	Murray CSO Basin Alternative 1A: Rectangular Storage at Bottom of Basin .....	<i>after</i> 6-10

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN**  
**TABLE OF CONTENTS**

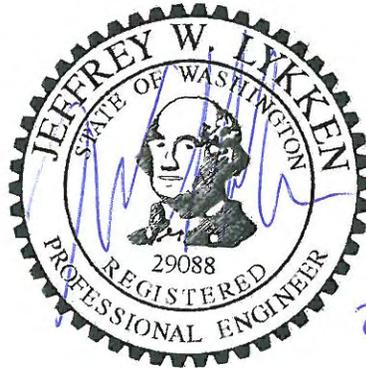
Figure 6.12	Murray CSO Basin Alternative 1B: Circular Storage in Vicinity of Murray Avenue and Lincoln Park Way.....	after 6-10
Figure 6.13	Murray CSO Basin Alternative 1C: Distributed Storage Along Beach Drive and Murray Avenue SW .....	after 6-12
Figure 6.14	Murray CSO Basin Alternative 1D: Pipe Storage at Bottom of Basin by Tunneling .....	after 6-12
Figure 6.15	Murray CSO Basin Alternative 1E: Upper Basin Storage .....	after 6-12
Figure 6.16	Murray CSO Basin Alternative 1F: Combined Pipe and Rectangular Storage at Bottom of Basin.....	after 6-12
Figure 6.17	Murray CSO Basin Alternative 2A: Convey and Treat at Alki .....	after 6-12
Figure 6.18	Murray CSO Basin Alternative 3A: End-of-Pipe Treatment at the Bottom of the Basin.....	after 6-14
Figure 6.19	Murray CSO Basin Alternative 5A: Peak Flow Reduction by Roof Drain Disconnection, Combined with Storage. ....	after 6-14
Figure 7.1	Final Barton Alternative 1E— Pipe Storage in Upper Fautleroy.....	after 7-12
Figure 7.2	Final Barton Alternative 1F— Buried Rectangular Storage Tank at Fautleroy School.....	after 7-14
Figure 7.3	Final Barton Alternative 4A (GSI)— Green Stormwater Infrastructure in Sub-Basin 416 .....	after 7-18
Figure 7.4	Final Murray Alternative 1A— Storage at Lowman Beach Park .....	after 7-20
Figure 7.5	Final Murray Alternative 1F— Beach Drive Area Underground Storage .....	after 7-22
Figure 7.6	Final Murray 2A— Storage at Lincoln Park Lower Parking Lot.....	after 7-24
Figure 8.1	Barton CSO Basin Proposed Alternative 4A (GSI): GSI in Sub-Basin 416.....	after 8-2
Figure 8.2	Modeled November 1-2, 1984 Design Storm Hydrograph at Barton Pump Station .....	8-4
Figure 8.3	Estimated Flows Captured by Rain Gardens and Diverted from the Barton Pump Station During Design Storms .....	8-5
Figure 8.4	Murray CSO Basin Proposed Alternative 1F: Beach Drive Area Underground Storage .....	after 8-8
Figure 8.5	Diversion Structure Plan and Sections.....	after 8-8
Figure 8.6	Storage Tank Conceptual Plan .....	after 8-10
Figure 8.7	Storage Tank Sections.....	after 8-10
Figure 8.8	Storage Tank Sections.....	after 8-10
Figure 8.9	Storage Tank Equipment Facility Plan and Sections .....	after 8-10
Figure 8.10	Murray Storage Tank Dry- and Moderately Wet-Weather Flow Operation ....	8-13
Figure 8.11	Murray Storage Tank High Wet-Weather Flow Operation .....	8-13
Figure 8.12	CSO Control System Process Flow Diagram.....	after 8-14
Figure 8.13	CSO Control System Hydraulic Profile.....	after 8-14

**LIST OF TABLES**

Table 1.1	Basis of Planning Criteria for Barton and Murray CSO Basins .....	1-3
Table 1.2	Barton CSO Basin Preliminary Alternatives.....	1-5
Table 1.3	Murray CSO Basin Preliminary Alternatives .....	1-5
Table 1.4	Barton Short Listed Alternatives Evaluation Summary Data.....	1-7
Table 1.5	Murray Short Listed Alternatives Evaluation Summary Data .....	1-9
Table 1.6	Project Cost Summary for Proposed Barton CSO Basin Project.....	1-14
Table 1.7	O&M Cost Summary for Proposed Barton CSO Basin Project.....	1-14
Table 1.8	Preliminary Project Schedule for Proposed Barton CSO Basin Project.....	1-14
Table 1.9	Project Cost Summary for Proposed Murray CSO Basin Project .....	1-16
Table 1.10	O&M Cost Summary for Proposed Murray CSO Basin Project .....	1-16
Table 1.11	Preliminary Project Schedule for Proposed Murray CSO Basin Project.....	1-16
Table 2.1	Facility Plan Requirements .....	2-12
Table 3.1	Land Use in Barton and Murray CSO Basins .....	3-1
Table 4.1	Basis of Planning Criteria for Barton and Murray CSO Basins .....	4-9
Table 5.1	Initial Evaluation Criteria .....	5-3
Table 5.2	Evaluation Category Development .....	5-6
Table 5.3	Evaluation Criteria, Questions and Rating Scale.....	5-7
Table 5.4	Screening Steps and Schedule for Shortlist of Alternatives .....	5-14
Table 5.5	Basis of Design Criteria .....	5-15
Table 6.1	Barton CSO Basin Preliminary Sites .....	6-2
Table 6.2	Murray CSO Basin Preliminary Sites.....	6-2
Table 6.3	Barton CSO Basin Preliminary Alternatives.....	6-5
Table 6.4	Murray CSO Basin Preliminary Alternatives .....	6-6
Table 7.1	Murray Community Advisory Group Meetings .....	7-5
Table 7.2	Murray Basin CSO Coarse Screening Matrix .....	7-8
Table 7.3	Barton Basin Short-Listed Alternatives Data .....	7-12
Table 7.4	Murray Basin Short-Listed Alternatives Data.....	7-19
Table 7.5	Barton Short Listed Alternatives Evaluation Summary Data.....	7-27
Table 7.6	Murray Short Listed Alternatives Evaluation Summary Data .....	7-29
Table 8.1	CSO Frequency and Volume from the Barton Basin .....	8-2
Table 8.2	Barton Basin CSO Facility Sizing .....	8-6
Table 8.3	CSO Frequency and Volume from the Murray Basin.....	8-7
Table 8.4	Murray CSO Basin CSO Facility Sizing .....	8-15
Table 8.5	Operation Activities for Barton GSI Alternative .....	8-26
Table 8.6	Maintenance Activities for Barton GSI Alternative .....	8-26
Table 8.7	Operation and Maintenance Activities for Murray Alternative 1F.....	8-27
Table 8.8	Puget Sound Sea-Level Rise Scenarios with Storm Surge .....	8-32
Table 9.1	Construction Cost Summary .....	9-2
Table 9.2	Project Cost Summary .....	9-2
Table 9.3	O&M Cost Summary .....	9-3
Table 10.1	Preliminary Project Schedule for Proposed Barton CSO Project.....	10-1
Table 10.2	Preliminary Project Schedule for Proposed Murray CSO Project.....	10-1

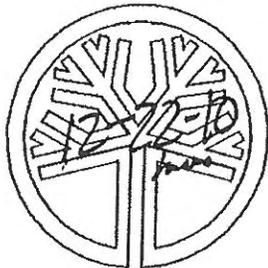
CERTIFICATION

The Barton and Murray Combined Sewer Overflow Control Facilities Plan has been prepared under the direction of the following Registered Professional Engineer:



2-11-2011

The landscape and civil engineering prepared by SvR Design Company for Green Stormwater Infrastructure Alternative analysis in the Barton Basin has been prepared under the direction of the following Registered Professional Landscape Architect and Civil Engineer, respectively:



STATE OF WASHINGTON  
REGISTERED  
LANDSCAPE ARCHITECT  
*Margaret Rose Staeheli*  
MARGARET ROSE STAEHEL  
CERTIFICATE NO. 456



12-22-2010



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## EXECUTIVE SUMMARY

King County has developed proposals to control combined sewer overflows (CSOs) at two locations in West Seattle—the Barton and Murray CSO basins. One project is the construction of a new 1.0-million-gallon storage tank on the east side of Beach Drive SW near Lowman Beach Park to control CSOs in the Murray CSO basin. The other is the installation of rain gardens in the right-of-way along 32 to 64 half-blocks in the Sunrise Heights and Westwood neighborhoods east of 35th Avenue SW to control overflows in the Barton CSO basin.

The *Barton and Murray Combined Sewer Overflow Control Facilities Plan* describes the reasons for these projects, the processes used to develop and evaluate alternatives, and the selection of proposed alternatives to advance for further environmental review.

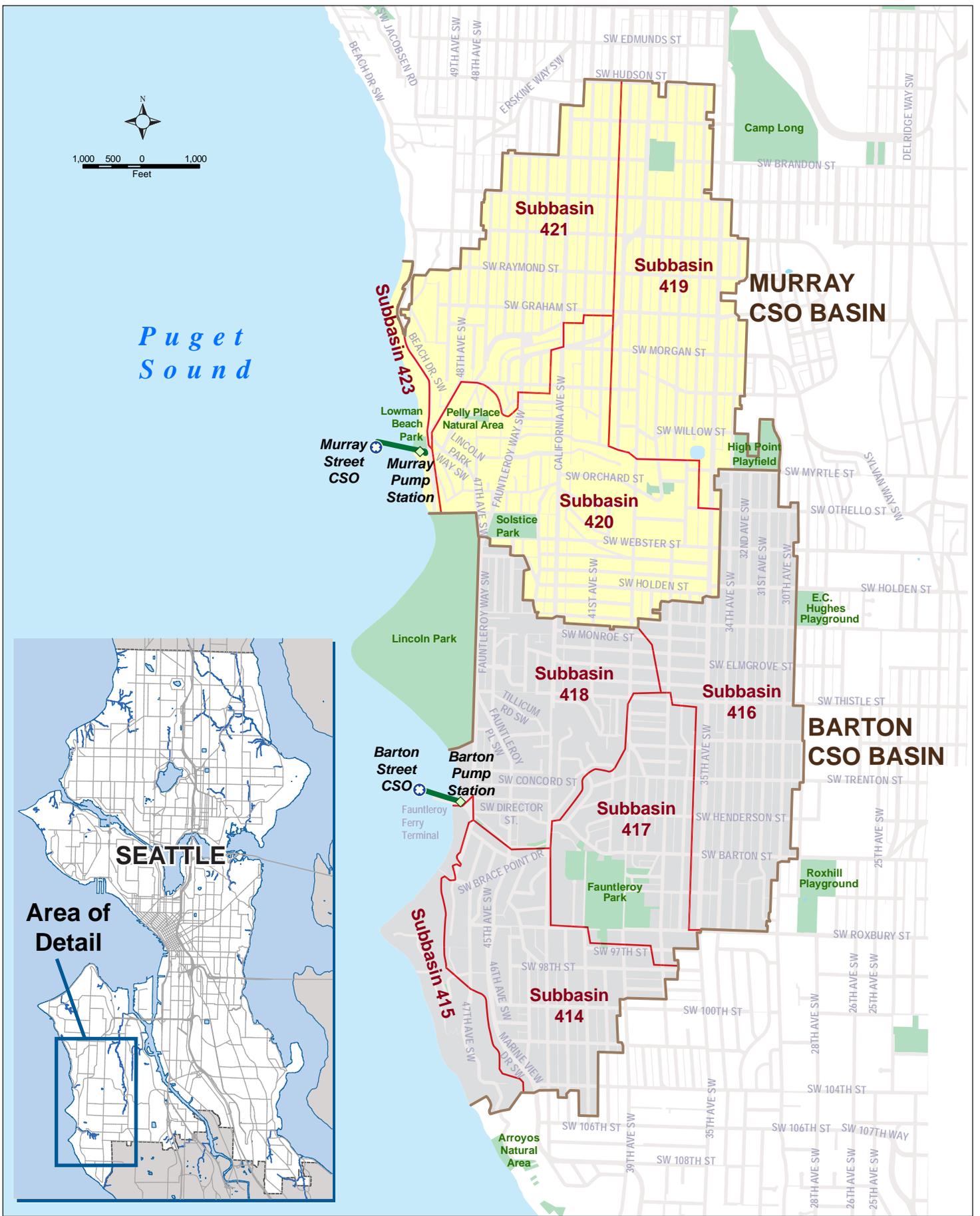
### 1.1 BACKGROUND

The Barton and Murray CSO basins cover 1,111 acres and 1,006 acres, respectively, along Puget Sound in West Seattle (see Figure 1.1). The basins drain to the Barton Pump Station near the Fautleroy Ferry Terminal and the Murray Pump Station at Lowman Beach Park, respectively. The Barton Pump Station pumps flows to the Murray Pump Station. In the Barton CSO basin, the peak wet-weather flow is approximately 93 million gallons per day (mgd) and the pump station's capacity is 26 mgd (with plans in place for increasing the capacity to 33 mgd). In the Murray CSO basin, the peak wet-weather flow is approximately 105 mgd and the pump station's capacity is 31.5 mgd.

When flows from the basins exceed the capacity of the pump stations, the excess is discharged untreated through CSO outfalls to Puget Sound. Between the years of 2000 and 2007, the Barton CSO basin experienced an average of four untreated overflows per year. During this same time period, the Murray CSO basin experienced an average of five untreated overflows per year.

In Washington State, the control of CSOs is governed by the following codes:

- **Revised Code of Washington (RCW) 90.48.480:** This law requires “the greatest reasonable reduction” of combined sewer overflows.
- **Washington Administrative Code (WAC) 173-245-020 (22):** This law defines “the greatest reasonable reduction” as “control of each CSO in such a way that an average of one untreated discharge may occur per year.”



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**Figure 1.1.**  
**BARTON AND MURRAY CSO BASINS VICINITY**

Under these requirements, CSOs must be controlled to an average of no more than one untreated discharge per year per outfall, based on a long-term average. This Facility Plan outlines improvements to the sewer systems serving the Barton and Murray CSO basins that are necessary to control CSOs in compliance with the RCW and WAC. The following general CSO control approaches were evaluated:

- Storage.
- Convey-and-Treat.
- End-of-Pipe Treatment.
- Peak-Flow Reduction.
- A combination of these approaches.

## 1.2 BASIS OF PLANNING

The Barton and Murray CSO basins flows were generated using a basin model that was calibrated against historical flow monitoring data. The calibrated models were used to determine peak wet-weather flows and volumes, which were derived from a 30-year long-term simulation for the period from January 1, 1978 to June 13, 2008. Based on the modeled flows, the required storage volume and peak flow rate were determined for the two basins. Table 1.1 summarizes the resulting basis-of-planning requirements.

<b>Table 1.1 Basis of Planning Criteria for Barton and Murray CSO Basins</b>		
	<b>Barton</b>	<b>Murray</b>
Required Capacity at Peak Flow	45 mgd <sup>(4)</sup>	60 mgd <sup>(4)</sup>
Existing Capacity	33 mgd <sup>(1)</sup>	31.5 mgd
	<b><i>Required Volume or Capacity<sup>4</sup></i></b>	
Storage Control Approach at Bottom of Basin	0.11 MG <sup>(4)</sup>	1.0 MG <sup>(4)</sup>
Storage Control Approach at Mid-Basin	0.22 MG <sup>(4)</sup>	N/A
Convey and Treat Control Approach	12 mgd <sup>(2)</sup>	28.5 mgd <sup>(2)</sup>
End of Pipe Treatment Control Approach	12 mgd <sup>(2)</sup>	28.5 mgd <sup>(2)</sup>
Peak Flow Reduction Control Approach – Impervious Disconnection	20% <sup>(3)</sup>	>75% <sup>(3)</sup>
Peak Flow Reduction Control Approach – Green Stormwater Infrastructure	Peak flow reduction of 14.6 mgd <sup>(4)</sup>	N/A
<ol style="list-style-type: none"> <li>1. Assumes upgrade to Barton Pump Station and that the Barton Pump Station discharges to the Murray Pump Station.</li> <li>2. Required capacity is the difference between "required capacity at peak flow" and "existing capacity."</li> <li>3. Represents the percentage of impervious surface currently connected to the combined sewer system in the basin that must be disconnected to eliminate the need for storage.</li> <li>4. Providing the required storage volume or flow capacity will meet the state criteria of one overflow per year.</li> </ol>		

### **1.3 PRELIMINARY ALTERNATIVE DEVELOPMENT**

Identification of preliminary alternatives included evaluation of suitable sites for facilities based on technical criteria. The initial screening resulted in identification of several parcels and right-of-way locations meeting the project requirements. Using these potential sites, preliminary alternatives were developed based on the defined control approaches and basis-of-planning requirements. Nine preliminary alternatives were developed for each basin as summarized in Tables 1.2 and 1.3.

### **1.4 SCREENING OF PRELIMINARY ALTERNATIVES**

The preliminary alternatives were refined and evaluated between August 2009 and February 2010, based upon the following criteria:

- Technical feasibility
- Environmental impacts
- Community impacts
- Land use and permitting impacts
- Property acquisition
- Cost
- Operations and maintenance.

The preliminary alternative development and evaluation process resulted in a shortlist of alternatives recommended for further evaluation: Alternatives 1E, 1F and 4A in the Barton CSO basin and Alternatives 1A, 1C and 1F in the Murray CSO basin.

### **1.5 REFINEMENT OF SHORT-LISTED ALTERNATIVES**

After the preliminary alternatives were short-listed to three alternatives per basin, the County held public meetings to present the short-listed alternatives and to receive comments and feedback. The Barton CSO basin public meeting was conducted on March 18, 2010 and the Murray CSO basin public meeting was conducted on March 29, 2010. The County also presented the short-listed alternatives at a regular meeting of the Morgan Junction Community Association on April 21, 2010.

#### **1.5.1 Murray CSO Basin**

The County received feedback from the Murray community strongly indicating that the short-listed alternatives were not acceptable. The key concerns involved the following:

- Impacts on Lowman Beach Park
- Impacts on private property
- Concerns that the Murray community was bearing an undue burden because storage facilities were sized to handle flows coming from the Barton Pump Station.

<b>Approach</b>	<b>Alternative</b>	<b>Description</b>
Centralized storage	1A	One 0.11-MG rectangular tank; construction footprint = 65' x 55' x 15'
	1B	One 0.11-MG circular tank, 52' diameter, 14' deep
	1C	One 0.11-MG storage pipe, 12' diameter, 150' long
	1D	One 0.11-MG storage pipe, 12' diameter, 150' long
	1E <sup>(1)</sup>	One 0.11-MG storage pipe, 12' diameter, 150 long
	1F <sup>(1)</sup>	One 0.11-MG rectangular tank; construction footprint = 65' x 55' x 15'
	1G <sup>(1)</sup>	One 0.11-MG rectangular tank; construction footprint = 65' x 55' x 15'
End-of-Pipe Treatment	3A	12-mgd Actiflo treatment plant; construction footprint = 120' x 60' x 15
Peak Flow Reduction	4A	26 acres of impervious roof and street right-of-way area disconnected from combined sewers
<p>1. Alternatives 1E, 1F and 1G are at locations in the mid or upper basin and require more storage than the bottom-of-basin alternatives; however, the mid/upper-basin storage requirement was not calculated prior to development of the preliminary alternatives, so sizing for the preliminary alternatives assumed storage volume equal to that of the bottom-of-basin alternatives</p>		

<b>Approach</b>	<b>Alternative</b>	<b>Description</b>
Centralized storage	1A	One 1-MG rectangular tank; construction footprint = 175' x 90' x 17'
	1B	One 1-MG circular tank, 110' diameter, 20' deep
	1D	One 1-MG storage pipe, 12' diameter, 1,250' long
	1E	One 28.5-mgd pump station and one 1-MG rectangular tank; tank construction footprint = 175' x 90' x 17'
Distributed Storage	1C	One 0.28-MG storage pipe, 12' diameter, 350' long; One 0.72-MG storage pipe, 12' diameter, 900' long
	1F	One rectangular tank (0.6 to 1.0 MG) and one storage pipe (0 to 0.4 MG)
Convey & Treat	2A	One 28.5-mgd pump station and 13,350' of new 42" force main
End-of-Pipe Treatment	3A	28.5-mgd Actiflo treatment plant; construction footprint = 160' x 80' x 20
Combination	5A	10 acres of impervious roof and street right-of-way area disconnected from combined sewers; one storage pipe, 12' diameter, 1,075' long (0.86 MG)

King County agreed to form a community advisory group (CAG) to help develop alternatives that would meet the County's CSO control needs, address the community's desire to reduce impacts at the bottom of the Murray basin, and provide a solution that meets the needs of both the Barton and Murray basins. The CAG met from June through September 2010 and identified nine new control alternatives. The project team developed technical details to better define these alternatives. These efforts resulted in a group of five CAG alternatives and two project-team alternatives that were evaluated by the CAG in September 2010.

### **1.5.2 Barton CSO Basin**

Between January 2010 and October 2010, the three short-listed alternatives for Barton were further developed by the project team. This included the development of control flows and volumes for mid-basin storage alternatives. The Alternative 4A impervious area disconnection option was refined and developed into a green stormwater infrastructure (GSI) alternative which uses a bioretention (rain garden) system to detain and infiltrate stormwater from the street right-of-way. This work occurred concurrently with the CAG process, although final evaluation of the Barton alternatives was not conducted until the CAG process was complete.

## **1.6 FINAL EVALUATION AND SELECTION PROCESS**

The project team convened several focus group meetings between May 2010 and October 2010. The team reviewed updated and new information about the alternatives. The team refined the criteria questions and evaluation ratings using the results of these meetings. The team then compiled evaluation results from the focus group meetings and convened two project implementation risk assessment workshops in November 2010. Results of the risk assessment were as follows:

- For the Barton CSO basin, Alternatives 1E and 1F had a number of potential high-impact and high-probability risks, as shown in Table 1.4. Barton Alternative 4A had no identified high-probability/high-impact risks.
- For the Murray CSO basin, Alternatives 1A, 1F, and CAG 2-a all had a number of potential high-impact and high-probability risks, as shown in Table 1.5. These risks result in higher cost and schedule risk for these alternatives.

Based on these results, the project team forwarded five alternatives, along with briefings and summary key evaluation considerations, to King County management for a final decision to move forward for further environmental review:

- For the Barton CSO basin:
  - Alternative 1F—Storage at Fautleroy School
  - Alternative 4A—Green Stormwater Infrastructure (GSI)
- For the Murray CSO basin:
  - Alternative 1A—Storage in Lowman Beach Park
  - Alternative 1F—Beach Drive Area Underground Storage
  - Alternative CAG 2-a—Storage in Lincoln Park Lower Parking Lot

**Table 1.4 Barton Short Listed Alternatives Evaluation Summary Data**

	<b>Alternative 1E: Pipe Storage in Upper Fautleroy Way</b>	<b>Alternative 1F: Tank Storage at Fautleroy School</b>	<b>Alternative 4A: GSI in Sub-basin 416</b>
<b>Overall Evaluation Ratings</b>	This alternative had the fewest low-impact scores and had some high impact ratings.	This alternative had the most mid-impact ratings and scored in the middle for low-impact ratings.	This alternative had the most low-impact ratings.
<b>Technical Considerations</b>	Mid-basin alternative that requires careful management of flows to ensure CSO control. Storage pipe and infrastructure similar to other county facilities. Shoring, groundwater, and physical space concerns for constructability. Street access required. Increased staffing and maintenance requirements for facilities in the right-of-way and cleaning of pipe configuration.	Mid-basin alternative that requires careful management of flows to ensure CSO control. Buried rectangular storage tank similar to other county facilities. Street access required for maintenance of drop structure and diversion structure. Concern about staff safety and street closure requirements.	Technically the simplest alternative—no wastewater equipment. Flow meter and telemetry optional dependent on desire to install flow meter for long term monitoring. This alternative has opportunity to expand for additional removal of impervious area flows. No significant construction issues or risks beyond typical landscape construction in right-of-way. Routine landscape maintenance and inspection required.
<b>Preliminary Cost Estimates</b>			
Construction	\$4,092,000	\$4,500,000	\$6,900,000 - \$8,900,000
Land/Easement	\$0	\$740,000	\$0
Street Use Fee	\$1,200,000	\$185,000	\$1,200,000
Additional Costs	\$3,728,000	\$4,100,000	\$5,100,000 - \$5,900,000
<b>Total</b>	<b>\$9,020,000</b>	<b>\$9,525,000</b>	<b>\$13,200,000 - \$16,000,000</b>
<b>Community Input</b>	Strong opposition to this alternative.	Support for this alternative from Fautleroy Community Association, some concerns about temporary parking impacts from tenants.	Although some community members have expressed support for this alternative, some have also raised concerns about increased risk of water intrusion into basements.

**Table 1.4 Barton Short Listed Alternatives Evaluation Summary Data**

	<b><u>Alternative 1E: Pipe Storage in Upper Fautleroy Way</u></b>	<b><u>Alternative 1F: Tank Storage at Fautleroy School</u></b>	<b><u>Alternative 4A: GSI in Sub-basin 416</u></b>
<b>Real Estate</b>	Concerns about loss of trees and impacts on view from Upper Fautleroy Way. May need private acquisition if additional space required to accommodate project.	Property owner amenable to providing an easement for siting the tank in the parking lot.	Concerns about loss of parking. Curb bulbs would be at end of blocks where parking is already prohibited.
<b>Land Use, Permits (in addition to typical construction permits)</b>	SDOT street use permit. Local construction permits. Exceptional tree permit.	Council Conditional Use Permit – review process would probably be straightforward. There is community support for this alternative.	SDOT street use (street improvement permit).
<b>Environmental Considerations</b>	Significant archaeological concerns.	Based on site characteristics, site has medium potential to contain archaeological resources.	No known environmental, issues of concern.
<b>Risk Analysis High Impact and High Probability Risks</b>	Archaeological resources found during construction, delaying project. Community protests removal of treasured roses and exceptional trees to County and City Council, delaying project.	Tenant at Fautleroy School objected to use of site because of fear of loss of business, delaying project.	No 'high-high' risks were identified during the risk analysis.

**Table 1.5 Murray Short Listed Alternatives Evaluation Summary Data**

	<b><u>Alternative 1A:</u> Rectangular Storage in Lowman Beach Park</b>	<b><u>Alternative 1F:</u> Beach Drive Area Underground Storage</b>	<b><u>CAG Alt. 2-a:</u> Storage in Lincoln Park Lower Parking Lot</b>
<b>Overall Evaluation Ratings</b>	This alternative had the most high-impact ratings.	This alternative had a mixture of mostly mid-impact and low-impact ratings.	This alternative had a mixture of mostly high-impact and mid-impact ratings.
<b>Technical Considerations</b>	Bottom-of-the-basin alternative that is the most reliable for capturing peak flows and ensuring CSO control. Buried rectangular storage tank similar to other county facilities. Shoring, groundwater, and physical space concerns for construction in park.	Bottom-of-the-basin alternative that is the most reliable for capturing peak flows and ensuring CSO control. Buried rectangular storage tank similar to other county facilities. Shoring, groundwater, and physical space concerns for construction on a small site without spare space for lay-down and staging.	Technically the most complicated alternative—Storage at two locations relying on telemetry and predictive control algorithms to divert flow to storage. Air management would be a challenge at the Lincoln Park parking lot storage tank. Emergency overflow to local sewer required. Fewer groundwater and excavation issues than at the bottom of the basin locations.
<b>Preliminary Cost Estimates</b>			
Construction	\$15,800,000	\$17,700,000	\$23,500,000
Land/Easement	\$9,000,000	\$6,400,000	\$1,800,000
Street Use Fee	\$1,800,000	\$1,700,000	\$140,000
Additional Costs	\$14,000,000	\$15,200,000	\$19,300,000
<b>Total</b>	<b>\$40,600,000</b>	<b>\$41,000,000</b>	<b>\$44,740,000</b>
<b>Community Input</b>	Strong opposition to this alternative. Seattle Ordinance 118477 requires council approval for construction in the park. Council decision is appealable.	Strong opposition by some community members.	Strong opposition to this alternative. Seattle Ordinance 118477 requires council approval for construction in the park. Council decision is appealable.
<b>Real Estate</b>	Concerns about loss of trees and impacts on view from Lowman Beach Park. Use of park.	Some property owners may not be willing to sell, which would require condemnation under eminent domain. Relocation of tenants.	Concerns about loss of parking and park use/access.

**Table 1.5 Murray Short Listed Alternatives Evaluation Summary Data**

	<b><u>Alternative 1A:</u> Rectangular Storage in Lowman Beach Park</b>	<b><u>Alternative 1F:</u> Beach Drive Area Underground Storage</b>	<b><u>CAG Alt. 2-a:</u> Storage in Lincoln Park Lower Parking Lot</b>
<b>Land Use, Permits (in addition to typical construction permits)</b>	Exceptional tree permit. Shoreline Permit Council Conditional Use Permit with DOE approval —The storage tank would be located in a city park designated “Conservancy Recreation” (CR) in Seattle’s Shoreline Master Program. Storage is considered a “Utility Service Use.” Utility Service Uses are prohibited.	Storage tank in Low-rise Multi-family zoning is allowed if construction can meet same standards identified for Institutions. Utility pipelines and associated underground diversion structure within the park would require a Shoreline Permit.	Council Conditional Use Permit. The storage tank would be located in a city park. The zoning is single-family residential and the overlying Shoreline designation is Conservancy Recreation (CR) and Conservancy Preservation (CP). Storage is considered a utility service use, which is allowed through City Council Conditional Use approval. Storage tanks are prohibited within the CR and CP Shoreline designation but utility pipelines are allowed as a special use.
<b>Environmental Considerations</b>	High probability for site to contain archaeological resources. No anticipated impacts on Pelly Creek.	Site has medium probability of containing archaeological resources. Construction would take place next to steep slopes.	No known archaeological sites but high probability of encountering resources in the proposed locations. Some construction within Shoreline but no construction in beach.
<b>Risk Analysis High Impact and High Probability Risks</b>	Permit appeal successful, delaying project. Rezoning required, delaying project. Park trees need to be removed, delaying project. Community successfully protests project, causing delays.	Differing site conditions encountered during excavation. Replacement of property substantially more expensive than planned.	Permit appeal successful, delaying project. Limited haul routes require substantial restoration and limitations on work hours, delay project completion and high expense. Loss of hydraulic capacity of Barton Pump Station because of flow transition to new storage facility, increase tank size and cost. Community successfully protests project, causing delays.

## **1.7 PROPOSED ALTERNATIVE**

King County management selected the proposed alternatives for further environmental review as described below.

### **1.7.1 Barton CSO Basin**

Barton Alternative 4A Green Stormwater Infrastructure (GSI) was selected for the following reasons:

- Least complex approach for reducing CSOs.
- Reduces the total volume of stormwater that needs to be conveyed and treated in the regional system.
- Responds to interest from some community members in green infrastructure.
- Minimal permitting/zoning issues.
- Property acquisition not required if all work is within right-of-way.

Barton Alternative 4A (GSI) would establish a system of bioretention/bioinfiltration facilities between the sidewalks and streets in the Sunrise Heights and Westwood neighborhoods (Sub-Basin 416). This basin was selected because the area had these following favorable characteristics for implementing GSI:

- Slopes less than 5 percent.
- Good soil conditions for infiltrating water.
- Good local drainage patterns.
- Adequate space within existing planting strips.
- Location on residential streets.

In this facilities plan, the term “rain garden” is used to describe these facilities. These small-scale vegetation-filled depressions use special soil and vegetation to attenuate storm flows and treat stormwater. The rain gardens will be constructed in City of Seattle public right of way and will reduce CSO overflows by capturing and infiltrating rainwater that would otherwise enter the combined sewer system. The project offers these benefits:

- Bioretention soil and vegetation allow stormwater runoff to infiltrate into the ground to reduce the volume of stormwater entering the combined sewer system.
- By maximizing the use of natural processes, the project supports the region's commitment to energy conservation and sustainability.
- King County will work with the neighborhoods to enhance the street's landscape aesthetics, minimize parking impacts, and respond to applicable neighborhood preferences for the project.

- The project will not require major operating facilities however it may be desirable to install flow metering to monitor effectiveness during storm events.
- This approach reduces the risk of combined sewer overflows at Barton and reduces flows to the Murray CSO basin.

Figure 1.2 shows the key elements of the GSI alternative. Tables 1.6 and 1.7 summarize the project and operation and maintenance (O&M) cost estimates. Table 1.8 outlines the approximate project schedule.

### **1.7.2 Murray CSO Basin**

Murray Alternative 1F was selected for the following reasons:

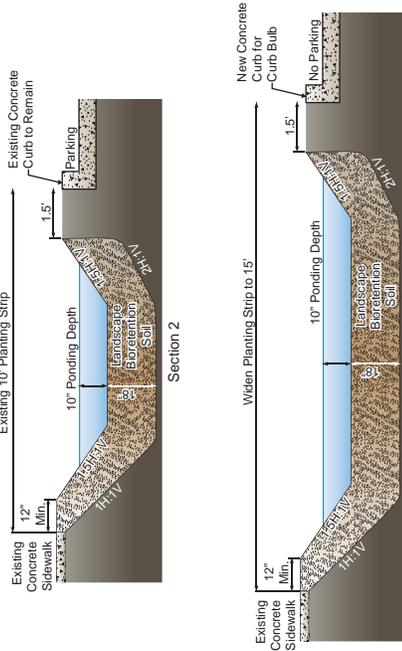
- Simple, reliable system in which gravity diversion of flow fills the storage tank.
- Does not involve tank construction on park property.
- Minimal permitting/zoning issues.
- Lowest schedule and cost risk.

Murray Alternative 1F includes a 1-MG underground storage tank on property that is currently in private ownership across Beach Drive SW from the existing Murray Pump Station. Ancillary facilities would be located on the same site. This alternative offers these advantages:

- There may be opportunities to enhance the surface of the site following construction in a way that benefits the neighborhood (for example, additional green space).
- Surface components of the project and related improvements will be constructed outside of Lowman Beach Park.
- The alternative provides for a single, reliable, facility near the existing pump station.
- The County has been planning upgrades to the Murray Pump Station's electrical and odor control facilities for several years. The proximity of the proposed site to the Murray Pump Station provides an opportunity to serve both the CSO tank and the pump station from a single odor control facility and electrical standby generator at the storage tank site. Combining service functions would reduce the impact on Lowman Beach Park.

Figure 1.3 shows the key elements of the GSI alternative. Tables 1.9 and 1.10 summarize the project and operation and maintenance (O&M) cost estimates. Table 1.11 outlines the approximate project schedule.

**Typical Cross-Sections**



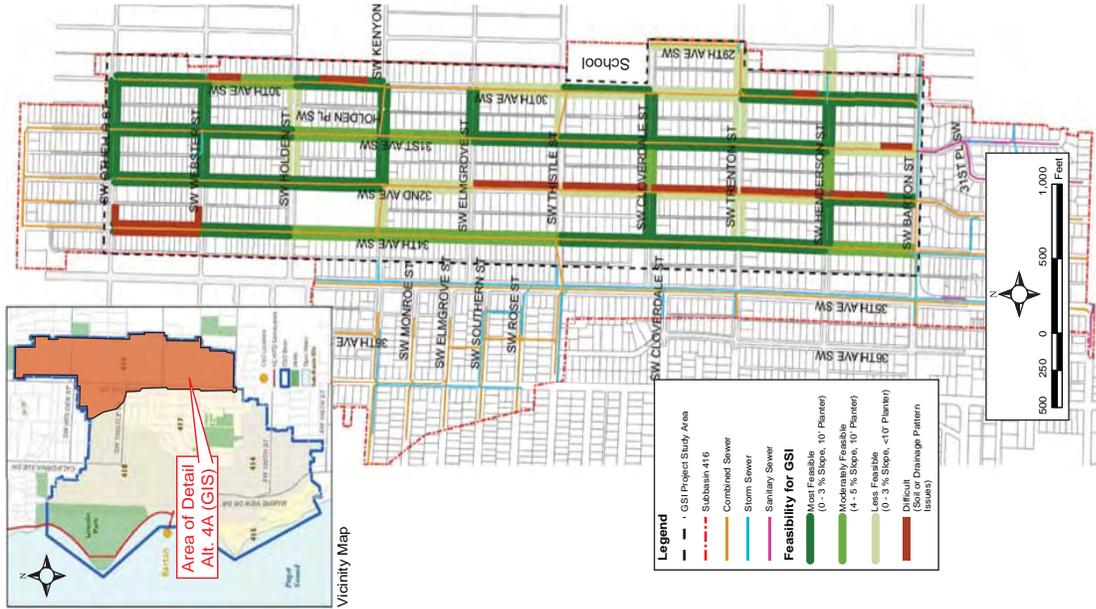
**Typical Planting Strip**



**Layout of Rain Garden Cells on a Typical Block**



**Location Feasibility Diagram**



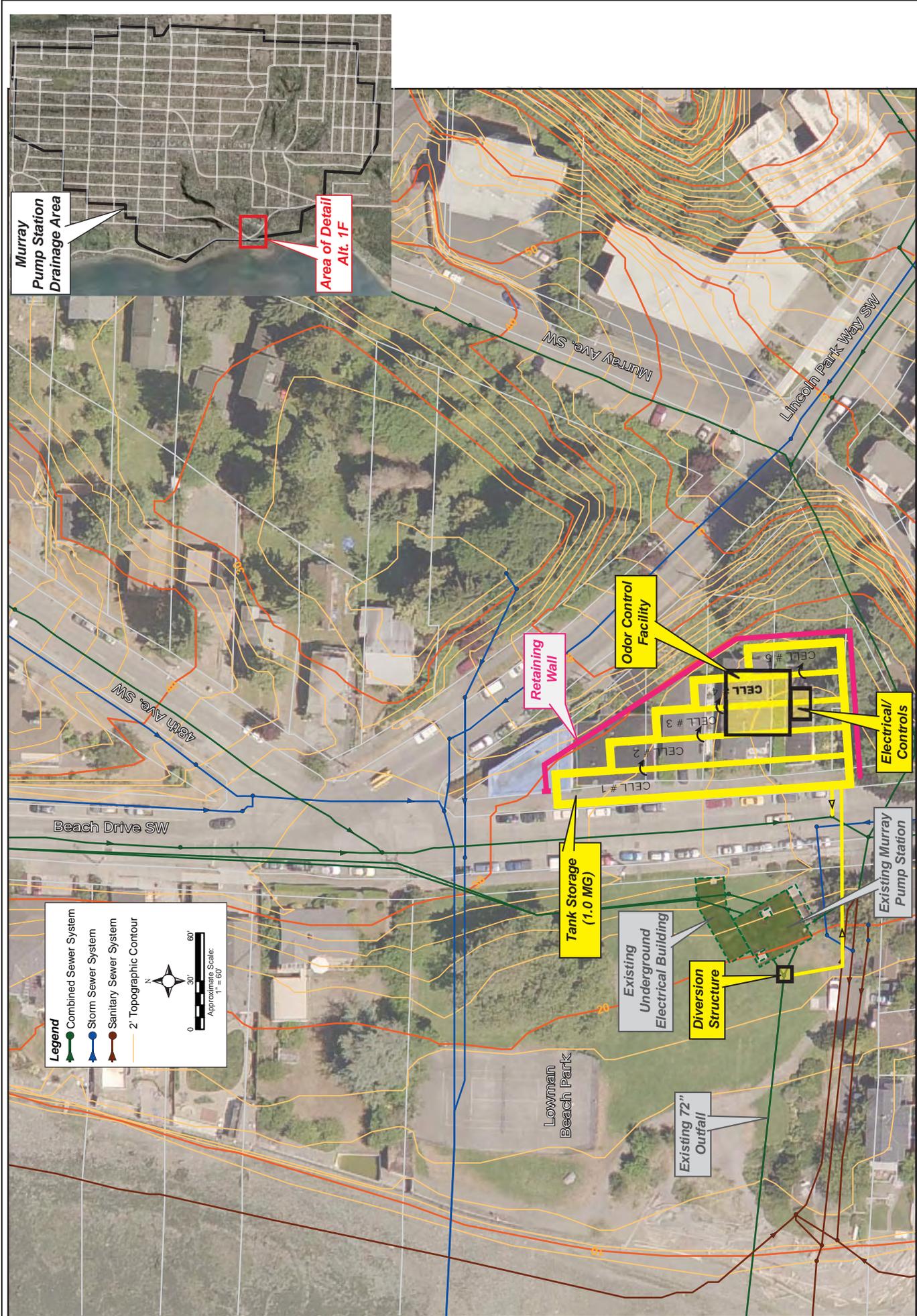
**Figure 1.2.**  
BARTON CSO BASIN PROPOSED ALTERNATIVE 4A (GSI): GSI IN SUB-BASIN 416



<b>Table 1.6 Project Cost Summary for Proposed Barton CSO Basin Project</b>	
<b>Item</b>	<b>Estimated Cost</b>
Construction	\$6.9 M - \$8.9 M
Land/Easement (Land, temporary construction easements and construction staging)	\$0
Street Use Fee	\$1.2 M
Additional Costs (Tax, allied costs, permit fees, and project contingency)	\$5.1 M - \$5.9 M
<b>Total</b>	<b>\$13.2 M - \$16.0 M</b>

<b>Table 1.7 O&amp;M Cost Summary for Proposed Barton CSO Basin Project</b>	
<b>Item</b>	<b>Annual Cost 2014 (\$/year)</b>
Operations and Maintenance Labor (Landscape maintenance, tank, diversion structure, ancillary facilities)	\$37,300
Flow Monitoring	\$7,000
Electricity (ventilation, power)	\$0
Chemicals (activated carbon replacement once per two years)	\$0
Standby Generator (fuel)	\$0
<b>Total</b>	<b>\$44,300</b>

<b>Table 1.8 Preliminary Project Schedule for Proposed Barton CSO Basin Project</b>	
<b>Activity</b>	<b>Anticipated Dates</b>
Facility Plan Development	November 2010 – December 2010
State Environmental Policy Act Threshold Determination	April 2011
Facility Plan Approval	June 2011
Permitting	June 2011 – September 2012
Final Design Consultant Selection	January 2011 – August 2011
Final Design	September 2011 – October 2012
Construction	October 2013 – September 2015
Commissioning	November 2015 – January 2017 (2 wet seasons)



**Legend**

- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 2' Topographic Contour

  
 0 30' 60'  
 Approximate Scale:  
 1" = 60'

**Murray Pump Station Drainage Area**

**Area of Detail Alt. 1F**

**Figure 1.3.**  
 MURRAY CSO BASIN PROPOSED ALTERNATIVE 1F:  
 BEACH DRIVE AREA UNDERGROUND STORAGE

<b>Table 1.9 Project Cost Summary for Proposed Murray CSO Basin Project</b>	
<b>Item</b>	<b>Estimated Cost</b>
Construction	\$17.7 M
Land/Easement (Land, temporary construction easements and construction staging)	\$6.4 M
Street Use Fee	\$1.7 M
Additional Costs (Tax, allied costs, permit fees, and project contingency)	\$15.2 M
<b>Total</b>	<b>\$41.0 M</b>

<b>Table 1.10 O&amp;M Cost Summary for Proposed Murray CSO Basin Project</b>	
<b>Item</b>	<b>Annual Cost 2014 (\$/year)</b>
Operations and Maintenance Labor (Landscape maintenance, tank, diversion structure, ancillary facilities)	\$29,300
Electricity (ventilation, power)	\$500
Chemicals (activated carbon replacement once per two years)	\$21,000
Standby Generator (fuel)	\$1,200
<b>Total</b>	<b>\$52,000</b>

<b>Table 1.11 Preliminary Project Schedule for Proposed Murray CSO Basin Project</b>	
<b>Activity</b>	<b>Anticipated Dates</b>
Facility Plan Development	November 2010 – December 2010
State Environmental Policy Act Threshold Determination	April 2011
Facility Plan Report Approval	June 2011
Property Acquisition	June 2011 – September 2012
Permitting	June 2011 – September 2012
Final Design Consultant Selection	January 2011 – September 2011
Final Design	September 2011 – December 2012
Construction	March 2013 – August 2015
Commissioning	October 2015 – May 2016 (2 wet seasons)

This facility plan summarizes preliminary engineering that has been completed by King County for improvements to control combined sewer overflows (CSOs) from the Barton and Murray CSO basins in West Seattle (see Figure 2.1). The goal of the improvements is to achieve CSO control objectives defined by the State of Washington and described in King County's June 2008 *CSO Control Plan Update*. The primary control objective is to limit overflows of untreated sewage to an average of no more than one per year at each overflow location.

## **2.1 PROBLEM IDENTIFICATION**

King County provides sewage treatment for a number of municipalities. The county's extensive regional conveyance system conveys wastewater from the municipalities to county treatment plants. The older sewer basins use combined sewers that convey sanitary and stormwater flow together in a common pipe. The stormwater flow component entering the sewer during and following a rain event can be significant and can exceed the system's conveyance capacity. Numerous overflow points in the combined system allow the excess flows (CSOs) to be diverted to a receiving water body. The county is working on projects to reduce the number of such overflow events.

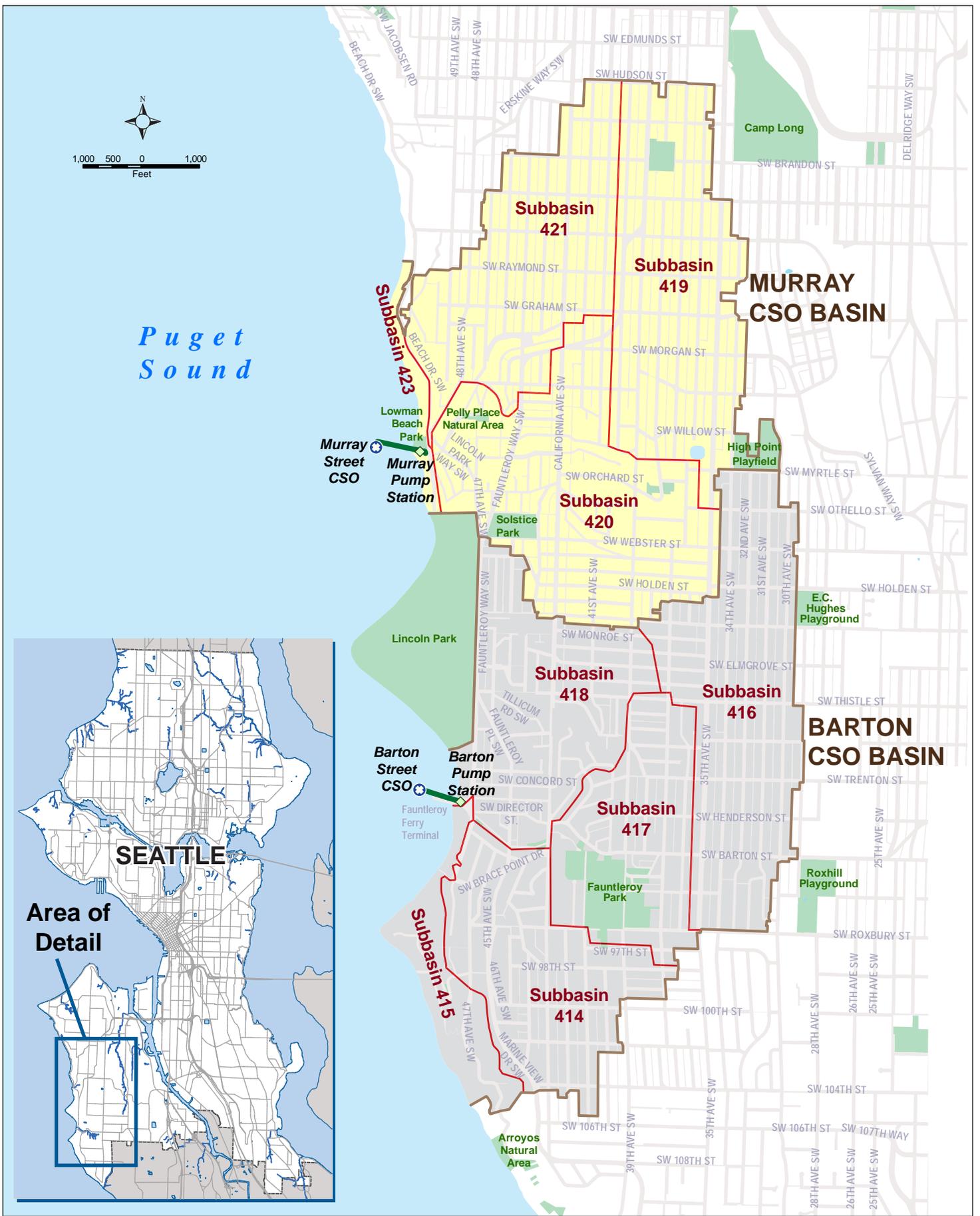
The existing King County conveyance system has inadequate capacity to convey all storm water and sewage flows from the Barton and Murray CSO basins in West Seattle to the West Point Treatment Plant during heavy rainfall events. When flows from these basins exceed the peak capacity of the Barton and Murray pump stations (near the Fauntleroy Ferry Terminal and Lowman Beach Park, respectively), the excess is discharged untreated through CSO outfalls to Puget Sound.

Between the years of 2000 and 2007, the Barton CSO basin experienced an average of four untreated overflows per year. During this same time period, the Murray CSO basin experienced an average of five untreated overflows per year.

## **2.2 PROJECT BACKGROUND**

### **2.2.1 CSO Control Requirements**

CSO control projects for the Barton and Murray CSO basins will be developed to meet established CSO control requirements. Specifically, the improvements will reduce untreated sewage overflows to an average of no more than one event per year on a long-term average.



3630023/Fig2-01\_VicinityMap.ai

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN**

DRAFT – February 2011

**Figure 2.1.**  
BARTON AND MURRAY CSO BASINS VICINITY

### **2.2.1.1 Federal Clean Water Act and National Pollutant Discharge Elimination System**

In 1972, the federal Clean Water Act (CWA) was adopted. The primary objective of the CWA is to restore and maintain the integrity of the nation's waters. This objective translates into two national goals: to eliminate the discharge of pollutants into the nation's waters; and to achieve and maintain fishable and swimmable waters. One way that the first goal is being achieved is through the National Pollutant Discharge Elimination System (NPDES) permit program. The second goal is being addressed by developing pollution control programs to meet specific water quality standards for water bodies.

The CWA requires all wastewater treatment facilities and industries that discharge effluent into surface waters to have an NPDES permit. In Washington State, NPDES permits are issued by the Washington State Department of Ecology. The permits define appropriate technologies for discharging to surface waters and establish limits on the quality and quantity of effluent discharged from point sources such as treatment plants, CSOs, and industrial facilities.

### **2.2.1.2 CSO Control Regulations**

#### **2.2.1.2.1 *State Regulation***

After adoption of the CWA and implementation of the NPDES program, CSOs were recognized as a unique category of discharge that was not adequately covered by the federal or state regulations. In 1984, Ecology introduced legislation requiring agencies with CSOs to develop plans for "the greatest reasonable reduction [of CSOs] at the earliest possible date." In January 1987, Ecology published a new regulation (WAC 173-245) that defined the greatest reasonable reduction in CSOs as "control of each CSO such that an average of one untreated discharge may occur per year." State water quality mixing zone standards allow a once-per-year exemption for the "one untreated discharge" from CSO facilities. The new regulation also defined standards for appropriate technology to use in treating CSOs, and water quality-based effluent limits apply to treated CSO discharges where needed.

### **Regulations that Affect CSO Control Planning**

**Clean Water Act (CWA)**—Adopted in 1972 to eliminate the discharge of pollutants into the nation's waters and to achieve and maintain fishable and swimmable waters.

**National Pollutant Discharge Elimination System (NPDES)**—The Washington State Department of Ecology implements the CWA by issuing NPDES permits to wastewater agencies and industries that discharge effluent (including CSOs) to water bodies.

**Water Quality Standards**—To implement the CWA, Ecology has developed biological, chemical, and physical criteria to assess a water body's health and to impose NPDES permit limits accordingly.

**State CSO Control Regulations**—Ecology requires agencies to develop plans for controlling CSOs so that an average of no more than one untreated discharge per year occurs at each location.

**Wet-Weather Water Quality Act of 2000**—The U.S. Environmental Protection Agency (EPA) requires agencies to implement Nine Minimum Controls and to develop long-term CSO control plans.

**Sediment Quality Standards**—Ecology developed chemical criteria to characterize healthy sediment quality and identified a threshold for sediment cleanup.

**Endangered Species Act (ESA)**—Multiple species that use local water bodies where CSOs occur have been listed as threatened under the ESA.

### **2.2.1.2.2 Federal Regulation**

The U.S. Environmental Protection Agency's (EPA's) 1994 CSO Control Policy was codified as the Wet Weather Water Quality Act of 2000 (H.R. 4577, 33 U.D.C. 1342(q)). This act requires implementation of "nine minimum controls" for CSOs and the development of long-term CSO control plans. The purpose of the nine minimum controls is to implement early actions that can improve water quality before more expensive capital projects in the control plan are built. Agencies must show that water quality standards are met after implementation of their CSO control plan. In King County, the requirements of this act are incorporated in the NPDES permit for the West Point plant.

### **2.2.1.2.3 King County Regional Wastewater Services Plan**

In 1999, King County adopted the Regional Wastewater Services Plan (RWSP; King County, 1999b), a 30-year wastewater comprehensive plan. Policies in the RWSP are intended to guide King County in controlling CSO discharges so that all CSO locations meet state and federal regulations. The policies call for regular assessment of CSO projects, priorities, and opportunities using the most current studies. Another CSO control policy addresses the cleanup of contaminated sediments near county CSOs. The policy directs the county to implement its long-range sediment management strategy and, where applicable, to participate with partners in sharing responsibilities and costs of cleaning up sites such as the Superfund sites in the Lower Duwamish Waterway.

## **2.2.2 History of CSO Control in King County**

In 1958, the Municipality of Metropolitan Seattle (Metro) was formed to clean up the waters of Lake Washington and the Seattle waterfront. In the 1960s, Metro assumed ownership of the City of Seattle's wastewater treatment plants and portions of its sewer system and then built large pipes, called interceptors, to carry regional wastewater from local systems to the treatment plants. In 1994, King County assumed Metro's responsibilities for regional wastewater management. Regional improvements in collecting, conveying, and treating wastewater that were made after the formation of Metro continue to be effective despite decades of population growth and development.

Metro adopted the *Combined Sewer Overflow Control Program* in 1979. Since adoption of this first program, CSO control plans have been updated as needed to respond to evolving CSO regulations, including Ecology's control standard of no more than an average of one untreated discharge per year at each CSO location. The most recent update to the King County CSO Control Program is described in the June 2008 *CSO Control Plan Update* and the 2008 RWSP Annual Report.

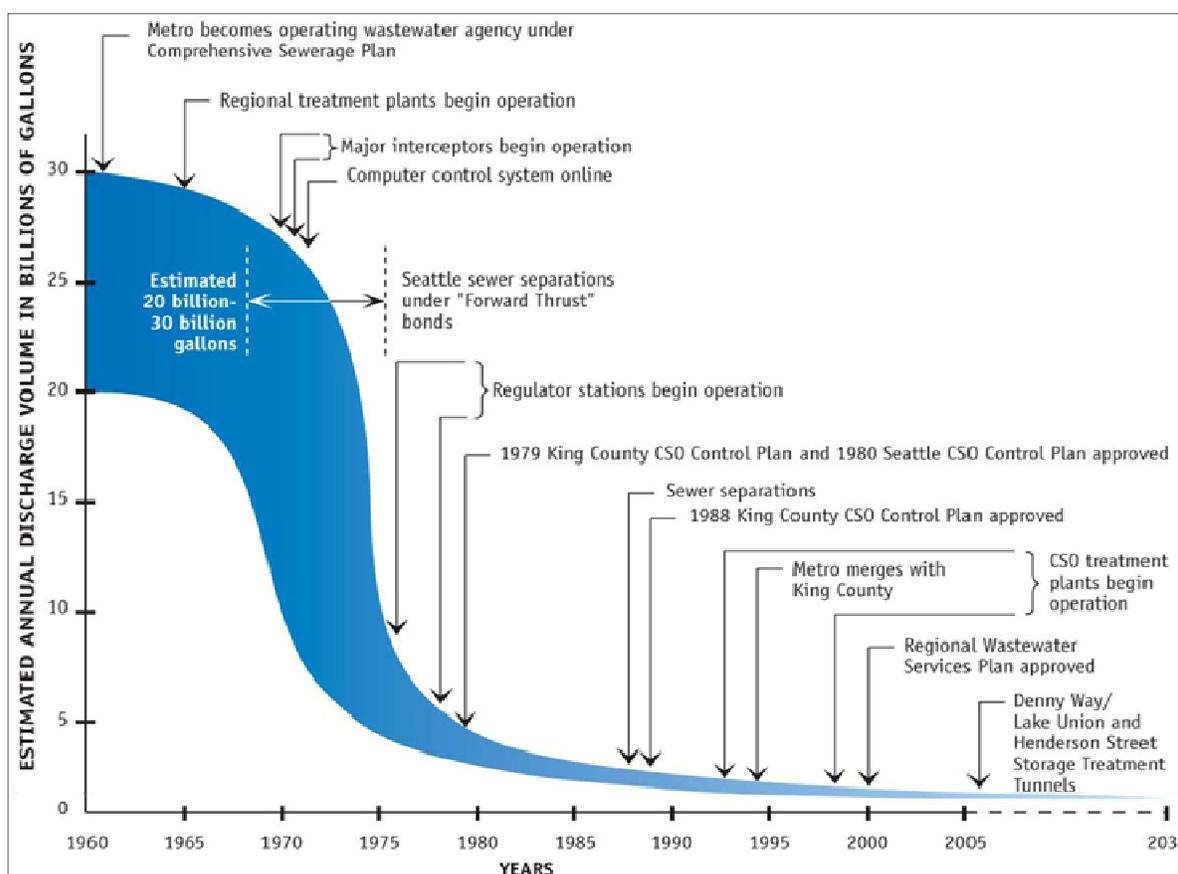
Strategies for reducing or mitigating the effects of CSOs include pollution prevention through source control, stormwater management, and operational controls to transfer as much CSO flow as possible to regional treatment plants; upgrades of existing facilities; and construction of CSO control facilities.

Construction of CSO control facilities in the region began in the late 1970s. So far, about \$360 million (2008 dollars) has been spent to control CSOs and another \$400 million is

planned to implement the CSO control projects in the long-term control plan approved in 1999 as part of the RWSP. Many early projects involved sewer separation, flow diversion, and storage tunnels. Most current and future projects involve construction of conveyance improvements, storage tanks, and treatment facilities.

### 2.2.3 Current CSO Control Status in King County

Since 1988, when systematic monitoring and measuring of CSO flows began, King County's CSO control efforts have reduced CSO volumes from an estimated 2.4 billion gallons per year to approximately 900 MG per year (see Figure 2.2). Control facilities that were under construction prior to RWSP adoption—the Mercer/Elliott West and the Henderson/Norfolk CSO control systems—were brought online in 2005.



**Figure 2.2 King County CSO Control Program Overview**

According to the 2008 RWSP annual report, 16 of King County's 38 CSOs are controlled to Ecology's standard and two others (Denny and Dexter) are expected to achieve control after startup adjustments and modifications are made to the system. The remaining 20 uncontrolled CSOs will meet state standards as capital improvement projects are completed between 2013 and 2030. In setting schedules for implementing CSO control projects, the RWSP gives highest priority to locations with the greatest potential to impact human health, bathing beaches, and species listed under the Endangered Species Act. Figure 2.3 shows CSO control project priorities, as taken from the 2008 CSO Control Plan Update.



Figure 2.3 CSO Control Project Priorities

## **2.2.4 Previous Studies**

King County and its predecessor agency Metro (the Municipality of Metropolitan Seattle) have consistently relied on scientific information to inform their wastewater management decisions. When information has not been available, they have initiated or participated in special studies to develop the needed data. This section describes the foundational studies that have shaped King County's decisions on CSO control.

### **2.2.4.1 1958 Metropolitan Seattle Wastewater and Drainage Study**

Beginning with the 1958 *Metropolitan Seattle Wastewater and Drainage Study*, regional agencies have collaborated on studies to identify major environmental protection needs and to identify and prioritize corrective actions. This study recognized that providing better wastewater management would result in the most environmental improvement. As part of a larger three-stage schedule of projects, this study recommended a program of sewer separation and storage, as needed, to control overflows in the City of Seattle.

### **2.2.4.2 1978 Area-Wide Section 208 Water Quality Plan**

In the late 1970s, Metro completed a two-year water quality investigation under Section 208 of the CWA. Toxic chemicals were identified as one of the five main water quality problems facing the Seattle-King County region. The plan recommended CSO control as part of improved wastewater management and identified the need for more understanding of the toxic impacts of CSOs on the local environment.

### **2.2.4.3 1979–1984 Toxicant Pretreatment Planning Study**

In 1979, Metro, with the support of the EPA and Ecology, initiated a 5-year, \$7-million (in 1979 dollars) study—the *Toxicant Pretreatment Planning Study*—to develop a better understanding of what toxic chemicals were present in the local environment and wastewater, what the impacts of these toxicants were, and the treatability of these flows. A scientific advisory panel provided advice, oversight, and review during the study. The study recommended that CSO control should be part of a coordinated Elliott Bay Action Plan and that source control, including enhancing Metro's pretreatment program, should be a priority.

### **2.2.4.4 1983 Water Quality Assessment of the Duwamish Estuary**

Because of potential conflict among uses of the Duwamish Waterway, the EPA and Ecology have classified this estuary as a high-priority study area. In 1982, both agencies identified the Duwamish as having one of the four worst water quality problems in Washington.

As the designated water quality management agency for the Green/Duwamish basin, Metro was awarded a grant to inventory pollutants impacting the waterway and to develop a strategy for improved pollution control. The 1983 *Water Quality Assessment of the Duwamish Estuary* documented this work. This assessment synthesized the findings of the Duwamish studies performed through July 1982. Public input and interagency task force review comments were considered in developing a ranked list of beneficial uses for the estuary. Mass balances were performed for 20 parameters to identify pollutant impacts on beneficial uses.

Upstream sources were found to contribute more than two-thirds of the total sediment, iron, and mercury load, as well as much of the organic carbon and pesticides. Major negative impacts on beneficial uses were attributed to ammonia, residual chlorine, copper, lead, mercury, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs). Temperature, dissolved oxygen demand, nitrite, cadmium, DDT, pathogens, and sediments were found to produce only minor effects.

The Renton Treatment Plant (now called the South Treatment Plant) was found to contribute nearly 80 percent of the total ammonia load. The planned 1986 diversion of plant effluent out of the Duwamish was expected to result in marked reductions in ammonia, chlorine, dissolved oxygen demand, nitrite, and cadmium impacts on the Duwamish. Although CSOs were found to be a source of all the pollutants measured, their contribution was comparatively small. While concentrations of toxicants in the CSO flows were found to be relatively high, the small annual overflow volume made them only a minor source of contaminants. One exception was fecal coliform bacteria. An estimated 80 percent of the total pathogens released to the estuary were estimated to originate from CSOs.

The most significant finding was that most metal and organic toxicants in the estuary could not be attributed to documented sources. This shifted attention to the heavy industrial and commercial activity along the river. CSOs were identified as a minor contributor to the larger pollution problem and CSO control was recommended as a part of the solution.

#### **2.2.4.5 1988 Draft Elliott Bay Action Plan**

In 1985, the Puget Sound Estuary Program was formed to minimize toxic chemical contamination of Puget Sound and to protect its living resources. The Urban Bay Action Program, an element of the Puget Sound Estuary Program, developed the *1988 Action Plan* (King County, 1988) for the Elliott Bay Action Program. Its objectives were as follows:

- Identify specific toxic areas of concern in Elliott Bay and the Duwamish Waterway based on chemical contamination-associated adverse biological effects.
- Identify historical and ongoing sources of contamination.
- Rank toxic problem areas and sources (to the extent possible) in terms of priority for development of corrective actions.
- Implement corrective actions to reduce or eliminate sources of ongoing pollution and restore polluted areas to support natural resources and beneficial uses.

Through early accomplishments of the Elliott Bay Action Program, most known direct industrial discharges to the bay and river were terminated or routed to the municipal sewer system under permits. The remaining ongoing contaminant sources were believed to include contaminated groundwater, storm drains, CSOs, and a few unidentified direct discharges.

To characterize contaminant inputs from CSOs and storm drains, sediment was collected from the downstream end of seven CSOs, 20 storm drains, and 15 combination CSO/storm drains. These in-line sediments were compared to offshore sediments to evaluate CSO and storm drain contributions to the contamination in priority areas and stations. Ten priority

drainages were identified for source-control activities. Control of direct discharges and stormwater sources were identified as the greatest needs; these controls were expected to improve CSO discharge quality.

#### **2.2.4.6 1988–1996 Metro Receiving Water Monitoring Program**

In Administrative Order DE-84-577, Ecology instructed Metro to develop and implement a plan for monitoring receiving waters in the vicinity of its primary treatment plants—West Point, Alki, Carkeek, and Richmond Beach—and in other point-source discharge areas. (The Renton plant provided secondary treatment.) The proposed plan included quarterly to biennial monitoring at a range of stations near the treatment plants as follows:

- Water column surveys of fecal coliform and enterococcus bacteria.
- Sub-tidal sediment surveys including benthic taxonomy and amphipod bioassays.
- Analysis of conventional constituents (particle size distribution, total organic carbon, oil, and grease), metals, and extractable organic priority pollutants, plus a survey.
- Intertidal monitoring of water for bacteria, and monitoring of sediments for metals and extractable organic priority pollutants.
- Analysis of clam and algae tissue samples for the presence of bacteria, metals, and extractable organic priority pollutants.

This monitoring program was approved by Ecology on April 5, 1988. Data were reported to Ecology as quality assurance/quality control was completed and were summarized in annual status reports. The monitoring program was implemented until the 1996 NPDES permit was issued for the West Point plant, which was upgraded to provide secondary treatment after closure of the Richmond Beach plant. Since 1996, Metro has focused its monitoring program on collecting data on key parameters that could be used in long-term trend assessments. In parallel, an ambient monitoring program was implemented to provide background data that could be compared to the point-source monitoring data.

These monitoring efforts affirmed that, while CSO control should be part of the solution, it would not bring the largest benefit.

#### **2.2.4.7 1988–1997 Metro/King County CSO Discharge and Sediment Characterization Study**

In approving Metro's 1988 CSO control plan, Ecology required CSO and sediment characterization in order to obtain additional information for setting site-control priorities and a control project schedule. The approved monitoring plan called for taking four discharge samples at five active overflow sites per year until all the sites had been sampled. This sampling was completed in 1994. Sediment sampling was also completed at the rate of five sites per year. Additional sediment sampling was completed in 1997 to meet new state Sediment Management Standards and attendant testing protocols.

Sediment sampling confirmed that local sediments had been significantly impacted by contamination from many sources. To improve understanding of sediment contamination, the

county made it a focus of both the 1999 CSO *Water Quality Assessment for the Duwamish River and Elliott Bay* and the 1999 *Sediment Management Plan*.

#### **2.2.4.8 1999 Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay**

King County completed the 1999 CSO *Water Quality Assessment for the Duwamish River and Elliott Bay* with support from a large stakeholder group and a peer-review panel. The assessment reviewed the health of the Duwamish River and Elliott Bay and the effects of CSO discharges. A computer model was developed to predict existing and future water and sediment quality conditions, and a risk assessment was undertaken to identify risks to aquatic life, wildlife, and human health.

The Water Quality Assessment affirmed that CSO pollution is a small part of a larger problem, mainly because of the low pollutant concentrations in CSOs and the brief and infrequent exposure of the estuary to CSOs. It recommended that CSO control continue to meet state regulations and helped determine the priority of CSO projects. It recommended that locations with greater potential for human contact—the Puget Sound beaches—be controlled first.

#### **2.2.4.9 1999 Sediment Management Plan**

The *Sediment Management Plan* (King County, 1999) assessed areas near seven county CSOs listed on the Washington State list of contaminated sites. These areas were assessed for their risk, preferred cleanup approach, partnering opportunities, and potential for recontamination after remediation.

The *Sediment Management Plan* highlighted the need for more information about CSOs as a contributor to contamination. The Sediment Management Program was formed to implement the Plan and any subsequent projects developed in the broader context of wastewater planning. The program addresses sediment quality issues near CSO discharges and treatment plant outfalls, evaluates and addresses wastewater treatment sediment quality issues, and incorporates sediment quality considerations into the County's comprehensive long-term planning.

#### **2.2.4.10 1999 Regional Wastewater Services Plan**

King County's 1999 RWSP presents policies to guide the County in controlling CSO discharges so that all CSO locations meet state and federal regulations, as described in Section 2.2.1 of this facility plan.

#### **2.2.4.11 2000 and 2008 CSO Control Plan Updates**

The 2000 *CSO Control Plan* (King County, 2000) documents King County's compliance with state and federal CSO requirements and updates the CSO Control Plan from the RWSP. Updates include the following:

- Redefining the definition of a CSO event.
- Studying alternative methods for CSO control and treatment.

- Researching potential total maximum daily load requirements.
- Developing watershed management programs.
- Studying sediment contamination.
- Developing a sediment management plan.
- Developing a CSO posting and notification program.
- Listing Chinook salmon under the Endangered Species Act.

The 2008 *CSO Control Plan Update* (King County, 2008) provides required updates to the 2000 *CSO Control Plan*. An Ecology CSO regulation (WAC 173-245) requires that updates coincide with each NPDES permit renewal for the West Point Treatment Plant. Updates are intended to document progress on implementing the county's previous CSO control program, identify the plan for the next five years, and provide a vehicle for making changes in the overall long-term program.

## **2.3 CURRENT PROJECT**

### **2.3.1 Project Priority and Timeline**

The Barton and Murray CSO Control Projects are among four Priority 1 projects identified by the 2008 CSO control program update and RWSP annual report. Predesign on these four projects, collectively called the Puget Sound Beach Projects, began in 2008 (the other two projects included are in South Magnolia and North Beach). Construction is expected to begin in late 2013.

### **2.3.2 Planning Period**

The Barton and Murray CSO control project planning is based on the requirements of the 2008 CSO Control Program update. Proposed facilities described in this report have been evaluated based on a construction start date in 2013 and a project life of 50 years. CSO control volumes to meet the CSO control requirements have been determined in this report based on computer modeling that was calibrated to historical flow monitoring by King County as of December 2009. The control volume is the volume of wastewater flow for which storage, conveyance or diversion capacity must be provided in order to achieve CSO goals.

## **2.4 FACILITY PLAN REQUIREMENTS**

The Barton and Murray CSO Control Project Facility Plan was prepared by Tetra Tech, Inc. and Carollo Engineers under Contract E00022E06 with the Wastewater Treatment Division of the King County Department of Natural Resources and Parks. It was developed to meet Washington requirements for wastewater engineering reports (Washington Administrative Code (WAC) 173-240-060) as well as facility plan requirements defined in Washington's August 2008 *Criteria for Sewage Works Design* ("The Orange Book" Section C3), and Code of Federal Regulations Title 40 Part 35 (40 CFR 35, Section 35.917-1). The requirements of these two documents are presented in Table 2.1, along with the chapter in which each requirement is addressed in this facilities plan.

**Table 2.1 Facility Plan Requirements**

<b>WAC 173-240-060 Requirement</b>	<b>Location Addressed</b>
<ul style="list-style-type: none"> <li>• The name, address, and telephone number of the owner of the proposed facilities, and the owner’s authorized representative.</li> </ul>	Chapter 2
<ul style="list-style-type: none"> <li>• A project description that includes a location map and a map of the present and proposed service area.</li> </ul>	Chapter 2
<ul style="list-style-type: none"> <li>• A statement of the present and expected future quantity and quality of wastewater, including any industrial wastes that may be present or expected in the sewer system.</li> </ul>	Chapter 4
<ul style="list-style-type: none"> <li>• The degree of treatment required based upon applicable permits and rules, the receiving body of water, the amount and strength of wastewater to be treated, and other influencing factors.</li> </ul>	Chapters 2 and 4
<ul style="list-style-type: none"> <li>• A description of the receiving water, applicable water quality standards, and how water quality standards will be met outside any applicable dilution zone.</li> </ul>	Chapters 2, 3, and 4
<ul style="list-style-type: none"> <li>• The type of treatment process proposed, based upon the character of the wastewater to be handled, the method of disposal, the degree of treatment required, and a discussion of the alternatives evaluated and the reasons they are unacceptable.</li> </ul>	Chapters 4 – 8
<ul style="list-style-type: none"> <li>• The basic design data and sizing calculations of each unit of the treatment works, expected efficiencies of each unit and of the entire plant, and anticipated effluent character.</li> </ul>	Chapters 4 – 8
<ul style="list-style-type: none"> <li>• Discussion of the various sites available and the advantages and disadvantages of the site or sites recommended. The proximity of residences or developed areas to any treatment plant site and the various plant units.</li> </ul>	Chapter 5 – 7
<ul style="list-style-type: none"> <li>• A flow diagram that shows general layout of the various units, the location of the effluent discharge, and a hydraulic profile of the system that is the subject of the facility plan and any hydraulic related portions.</li> </ul>	Chapter 8
<ul style="list-style-type: none"> <li>• A discussion of infiltration and inflow problems, overflows and bypasses, and proposed corrections and controls.</li> </ul>	Chapters 4 – 7
<ul style="list-style-type: none"> <li>• A discussion of any special provisions for treating industrial wastes, including any pretreatment requirements for significant industrial sources.</li> </ul>	Not Applicable

<b>Table 2.1 Facility Plan Requirements</b>	
<b>WAC 173-240-060 Requirement</b>	<b>Location Addressed</b>
<ul style="list-style-type: none"> <li>• Detailed outfall analysis or other disposal method selected.</li> </ul>	Not Applicable
<ul style="list-style-type: none"> <li>• A discussion of the method of final sludge disposal and any alternatives considered.</li> </ul>	Not Applicable
<ul style="list-style-type: none"> <li>• Provisions for future needs.</li> </ul>	Chapter 8
<ul style="list-style-type: none"> <li>• Staffing and testing requirements for the facilities.</li> </ul>	Chapter 8
<ul style="list-style-type: none"> <li>• An estimate of the cost and expenses of the proposed facility and the method of assessing these costs and expenses. The total amount shall include both capital and operations and maintenance costs for the life of the project, and must be presented in terms of the total annual cost and present worth.</li> </ul>	Chapter 9
<ul style="list-style-type: none"> <li>• A statement regarding compliance with any applicable state or local water quality management plan or any plan adopted under the Federal Water Pollution Control Act as amended.</li> </ul>	Chapter 11
<ul style="list-style-type: none"> <li>• A statement regarding compliance with the State Environmental Policy Act (SEPA) and the National Environmental Policy Act (NEPA), if applicable.</li> </ul>	Chapters 8 and 11
<b>Orange Book Requirement</b>	<b>Location Addressed</b>
<ul style="list-style-type: none"> <li>• Well documented site description, problem identification, and map.</li> </ul>	Chapter 2
<ul style="list-style-type: none"> <li>• Well documented description of discharge standards.</li> </ul>	Chapter 2
<ul style="list-style-type: none"> <li>• Background information including:                             <ul style="list-style-type: none"> <li>– Existing environment (water, air, sensitive areas, flood plains, shore lands, wetlands, endangered species/habitats, public health, prime or unique farmland, archaeological and historical sites, any federally recognized “wild and scenic rivers,” threatened species).</li> </ul> </li> </ul>	Chapters 3 and 6
<ul style="list-style-type: none"> <li> <ul style="list-style-type: none"> <li>– Demographic and land use (current population, present wastewater treatment, advanced-treatment need evaluated, infiltration and inflow [I/I] studies, CSOs, sanitary surveys for unsewered areas, determination that I/I is not excessive).</li> </ul> </li> </ul>	Chapters 3 and 4

<b>Table 2.1 Facility Plan Requirements</b>	
<b>Orange Book Requirement</b>	<b>Location Addressed</b>
<ul style="list-style-type: none"> <li>• Future conditions, including appropriateness of population data source, zoning changes, future domestic and industrial flows, and flow reduction options, future flows and loading, reserved capacity, future environment without project, discussion of whether recreation and open space alternatives could be incorporated.</li> </ul>	Chapter 4
<ul style="list-style-type: none"> <li>• Alternatives: list of specific alternative categories, including no action, collection system alternatives, sludge management/use alternatives, flow reduction, costs, environmental impacts, public acceptability, rank order, recommended alternative, description of innovative and alternative technologies.</li> </ul>	Chapter 5 – 7
<ul style="list-style-type: none"> <li>• Final recommended alternative: site layout, flow diagram, sizing, environmental impacts, design life, sludge management, ability to expand, operation and maintenance/staffing needs, design parameters, feasibility of implementation.</li> </ul>	Chapter 8
<ul style="list-style-type: none"> <li>• Financial Analysis: costs, user charges, financial capability, capital financing plan, implementation plan.</li> </ul>	Chapters 9 and 10
<ul style="list-style-type: none"> <li>• Other:               <ul style="list-style-type: none"> <li>– Conformance to water quality management plan.</li> </ul> </li> </ul>	Chapter 11
<ul style="list-style-type: none"> <li>– State Environmental Policy Act approval, list required permits, environmental issues analysis.</li> </ul>	Chapters 8, 10 and 11
<ul style="list-style-type: none"> <li>– State Environmental Review Process compliance.</li> </ul>	Chapter 11
<ul style="list-style-type: none"> <li>– Documentation that the project is identified in a sewer general plan.</li> </ul>	Chapters 2 and 11
<ul style="list-style-type: none"> <li>– Capital improvement plan.</li> </ul>	Chapter 9
<ul style="list-style-type: none"> <li>– Documentation of adequate public involvement process.</li> </ul>	Chapter 11

## **2.5 CONTACT INFORMATION**

The owner of this project is King County. The project representative is:

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### **REFERENCES:**

King County. 1988. Urban Bay Action Program 1988 Action Plan.  
King County. 1999. Sediment Management Plan  
King County. 1999b. Regional Wastewater Services Plan. November 1999.  
King County. 2000. CSO Control Plan. June 2000.  
King County. 2008. CSO Control Plan Update. June 2008.  
King County. 2010. Combined Sewer Overflow Control Program 2009 Annual Report.  
July 2010.



**EXISTING CONDITIONS**

The Barton and Murray CSO basins are adjacent to one another along the shore of Puget Sound in West Seattle (see Figure 2.1). The approximate eastern edge of the Barton CSO basin is 30th Avenue SW; the southern boundary extends from about SW 106th Street on the west side of the basin to SW Roxbury Street on the east side. The Murray CSO basin is immediately north of the Barton CSO basin. Its eastern boundary is near 34th and 35th Avenues SW. On the north, the basin boundary follows a diagonal from about SW Raymond Street on the west side to about SW Hudson on the east side. The Barton CSO basin is 1,112 acres and the Murray CSO basin is 992 acres.

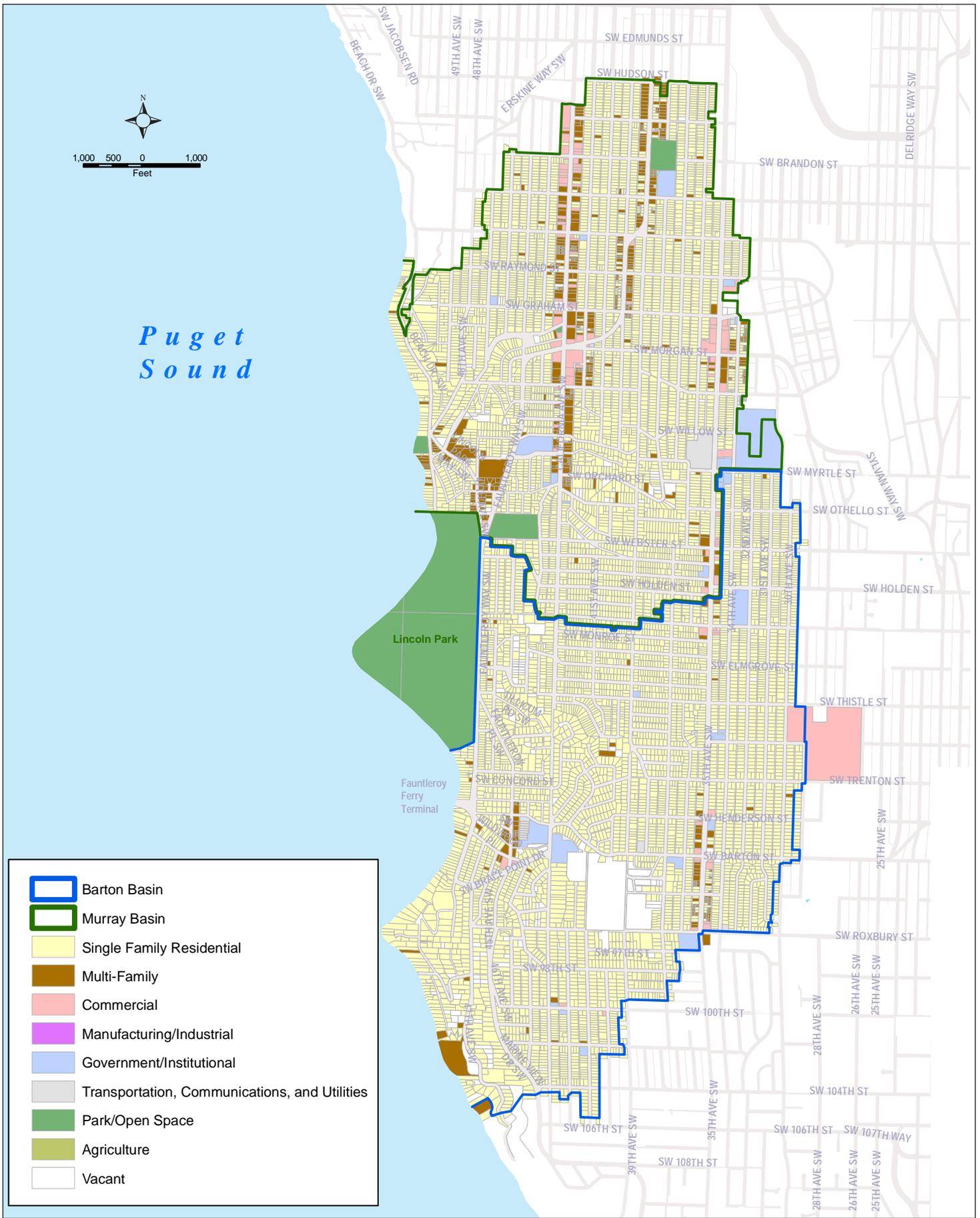
**3.1 HUMAN ENVIRONMENT****3.1.1 Land Use**

The Barton and Murray CSO basins are almost completely developed, predominantly with single-family residential homes. One of Seattle's largest parks, Lincoln Park (135 acres), is located on Puget Sound at the west edge of the two basins.

In the Barton CSO basin, the Fauntleroy Ferry Terminal is located just south of Lincoln Park. In the Murray CSO basin, the Pelly Creek ravine extends from nearly California Avenue SW down to the shoreline at Lowman Beach Park. California Avenue SW is a major north-south arterial that bisects the Murray CSO basin. Neighborhood commercial development and low-rise multifamily housing are located along California Avenue SW. Table 3-1 lists land uses in the two basins and Figure 3.1 shows the current zoning.

Land Use	Barton CSO Basin		Murray CSO Basin	
	Area (acres)	Percent of Total	Area (acres)	Percent of Total
Single-Family Residential	641.27	57.7%	562.36	59.1%
Multi-Family Residential	20.60	1.9%	66.24	7.3%
Commercial	2.57	0.2%	21.13	2.2%
Institutional	13.58	1.2%	22.20	3.0%
Manufacturing/Industrial	0	0%	1.66	0.2%
Parks/Open Space	0	0	25.53	2.5%
Vacant	144.45	13.0%	17.60	3.4%
Public/Utility	1.70	0.2%	5.63	0.6%
ROW	287	25.8%	284.14	28.2%
<b>Total</b>	<b>1,111</b>	<b>100%</b>	<b>1,006</b>	<b>100%</b>

a. Source: 2009 King County Zoning Data.



3630023/Fig3-01\_LandUse.ai

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN**

DRAFT - February 2011

**Figure 3.1.**  
BARTON AND MURRAY CSO BASINS LAND USE

### **3.1.2 Wastewater System**

King County conveyance facilities convey wastewater north from the Barton and Murray CSO basins to King County's 63rd Avenue Pump Station. From there, flows are conveyed through the West Seattle Tunnel to the Duwamish conveyance system. They then continue north through the Elliott Bay Interceptor to the West Point Treatment Plant in Magnolia. When conveyance capacity is limited through the West Seattle Tunnel, flows are diverted to the Alki Wet Weather Treatment Plant, where excess volumes are treated and discharged to Puget Sound.

#### **3.1.2.1 Local Collection System**

The local collection systems in the Barton and Murray CSO basins (see Figure 3.2) are owned and maintained by Seattle Public Utilities (SPU) and serve primarily residential (single-family and multi-family) and commercial customers. The systems consist of 8- to 42-inch-diameter gravity sewer pipes and SPU-operated pump stations (three in the Barton CSO basin and one in the Murray CSO basin).

In the Barton CSO basin, a majority of the collection system has been partially separated: municipal separated stormwater sewer systems (MS4) serve streets and some private properties, but a portion of rooftops and private property impervious areas are still connected to the combined sewer system (CSS). Approximately 1,500 residential properties and 80 non-residential properties are connected to the CSS in the Barton CSO basin. Additionally, most of Subbasin 416 (see Figure 2.1) is fully connected (i.e., all impervious area—residential and roads—is connected to the CSS). There are approximately 35 blocks in Subbasin 416.

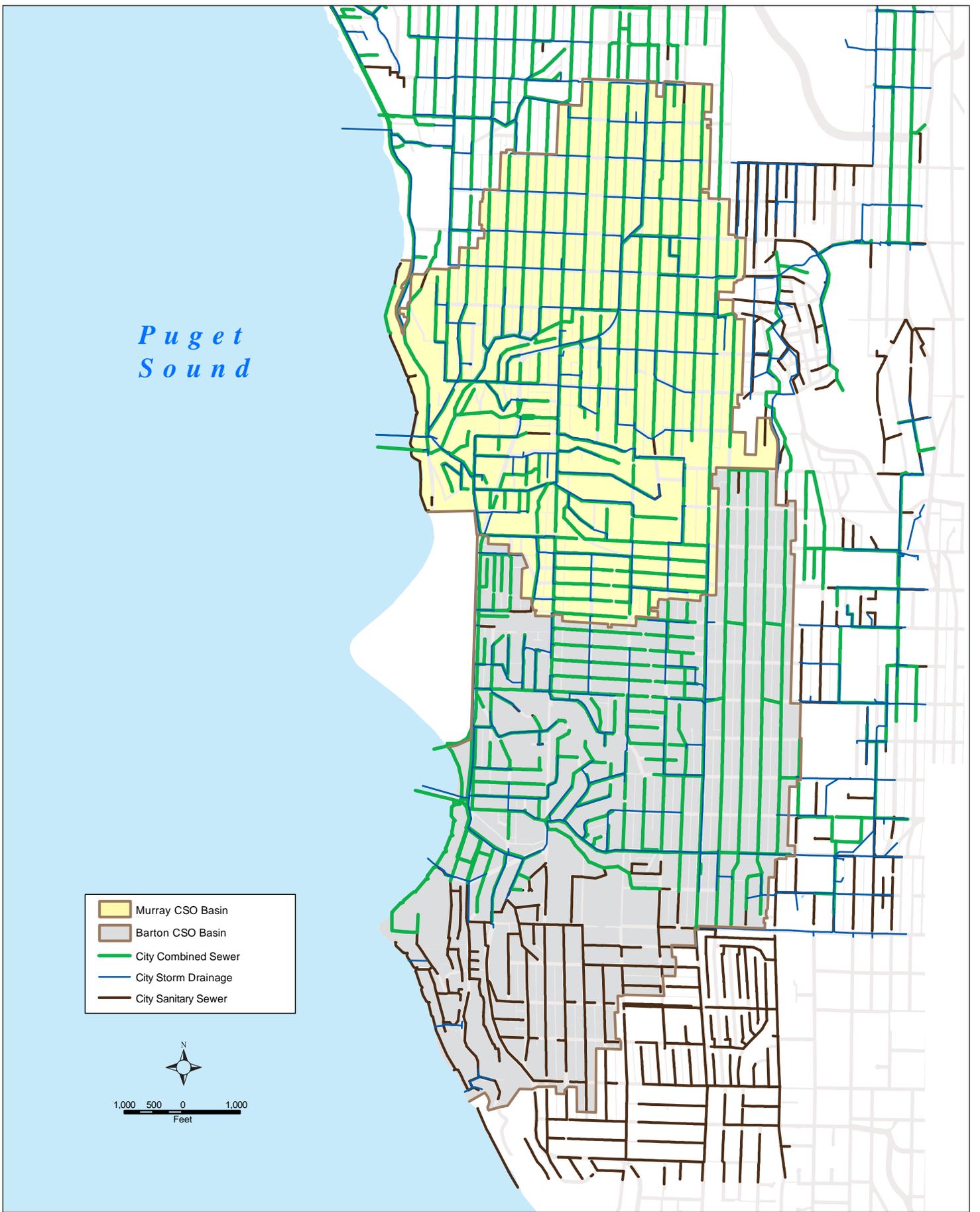
In the Murray CSO basin, an area of approximately eight blocks is fully connected to the CSS (i.e., all impervious area – residential and roads – is connected to the CSS). The remainder of the basin is partially separated, with an MS4 system serving streets and private property impervious area connected to the CSS. Approximately 1,200 residential and 230 non-residential properties are connected to the CSS in the Murray CSO basin.

#### **3.1.2.2 King County Pump Stations in the Barton and Murray CSO Basins**

King County's Barton and Murray Pump Stations are the connection points of the local collection system to King County's regional conveyance system.

In the Barton CSO basin, flows are collected at the Barton Pump Station. Currently, the Barton Pump Station has a peak rated capacity of 26 million gallons per day (mgd) (pump tests in 2009 indicated actual peak capacity of 22 mgd). The pump station discharges flows through two 24-inch-diameter force mains and a gravity sewer section (30-inch to 42-inch diameter) to the Murray Pump Station.

At the Barton Pump Station, improvements are scheduled to be implemented in 2012. The improvement project was initially conceived only to bring aging structures and equipment into compliance with current electrical, mechanical and structural codes; however, the final design also includes an increase in pumping capacity to help control CSOs.



**BARTON AND MURRAY COMBINED SEWER  
OVERFLOW CONTROL FACILITIES PLAN**

DRAFT – February 2011

**Figure 3.2.**  
**LOCAL SEWER COLLECTION SYSTEM**

The increased pumping capacity for the Barton Pump Station upgrade was selected to meet several criteria: no significant increase in cost, no additional building space required, and no capacity significantly above that of the downstream Murray Pump Station. Based on these criteria, the selected new capacity for the upgraded pump station is 33 mgd. All analyses of CSO control requirements for this facilities plan assume that the Barton Pump Station will have the increased pumping capacity.

At the Murray Pump Station, flows from the Murray CSO basin are combined with the Barton flows to be conveyed to the 63rd Avenue Pump Station. The Murray Pump Station has a peak capacity of 31.5 mgd. The conveyance system between the Murray and 63rd Avenue Pump Stations consists of dual 27-inch-diameter force mains and 36-inch to 54-inch-diameter gravity pipeline.

### **3.1.2.3 CSO Control Structures and Outfalls**

The CSO control structure for the Barton CSO basin is a fixed overflow weir and channel in the Barton Pump Station wet well, as shown in Figure 3.3. If flow into the pump station exceeds the pump station's capacity, the water elevation in the wet well rises. Once the water elevation exceeds 11.4 feet (1988 North American Vertical Datum (NAVD 88)), combined sewage overtops the weir and excess flows are discharged to Puget Sound through a 60-inch diameter CSO outfall. The outfall is approximately 620 feet long and discharges at an elevation of -15.3 feet (NAVD88) (approximately 24 feet deep).

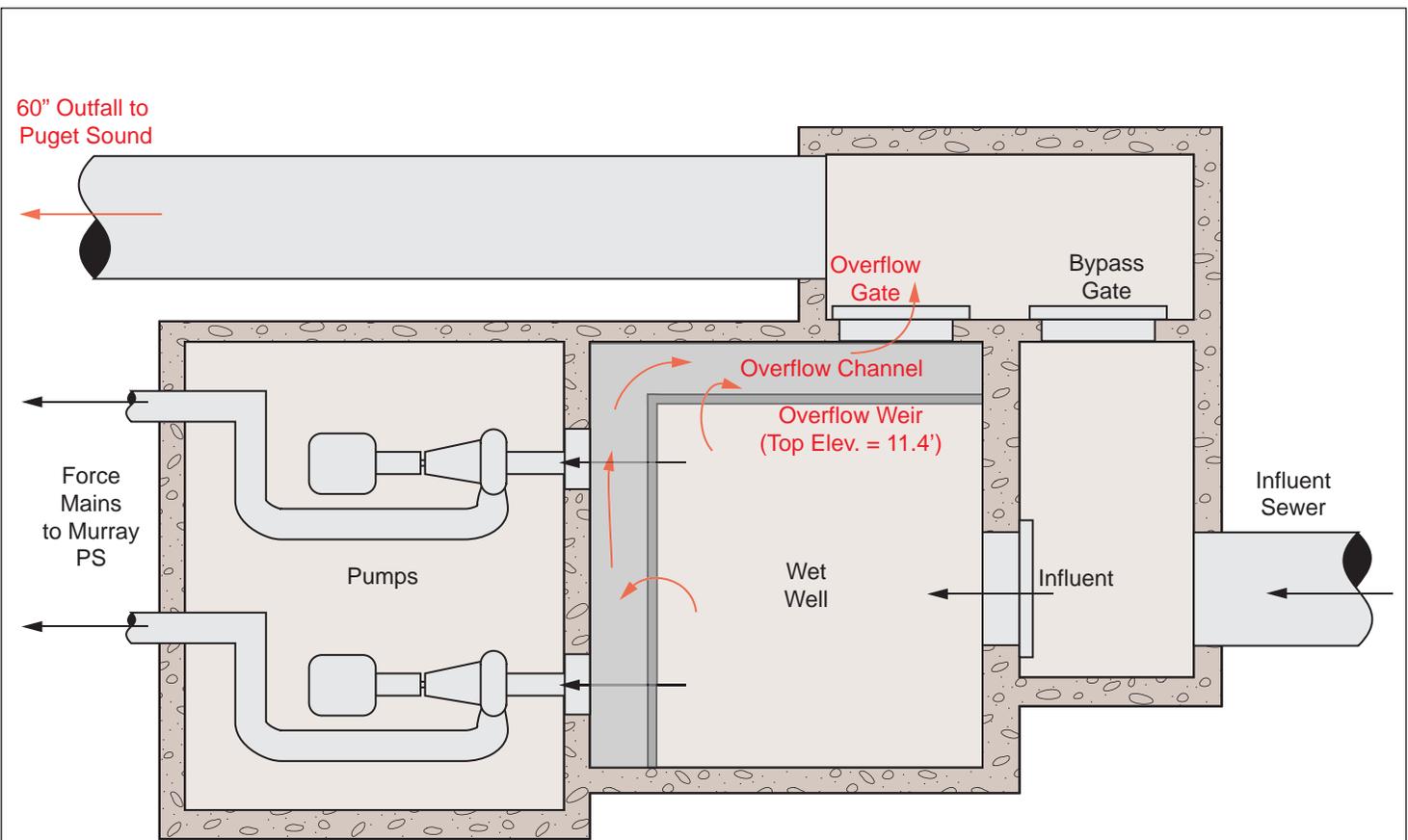
The Murray Pump Station's CSO control structure is a fixed overflow weir and channel in the Murray Pump Station wet well, as shown in Figure 3.4. When flow into the Murray Pump Station exceeds the pump station's capacity, the level in the wet well rises and combined sewage overtops the weir, discharging excess flow through two 48-inch pipelines. The weir elevation is at 11.65 feet (NAVD 88). The two pipelines converge shortly downstream of the pump station at a junction chamber with a 72-inch outfall discharging to Puget Sound. The outfall is approximately 800 feet long and discharges at an elevation of -15.4 feet (NAVD88) (approximately 24 feet deep).

Another CSO control structure is in place downstream of the Murray Pump Station at SW Alaska Street. Flows from the Murray conveyance system must be limited in order to maintain control at this CSO. The Murray Pump Station's peak rated capacity of 31.5 mgd is near the maximum flow that can be discharged from the pump station without exceeding overflow limits at SW Alaska Street CSO structures; which are currently under control.

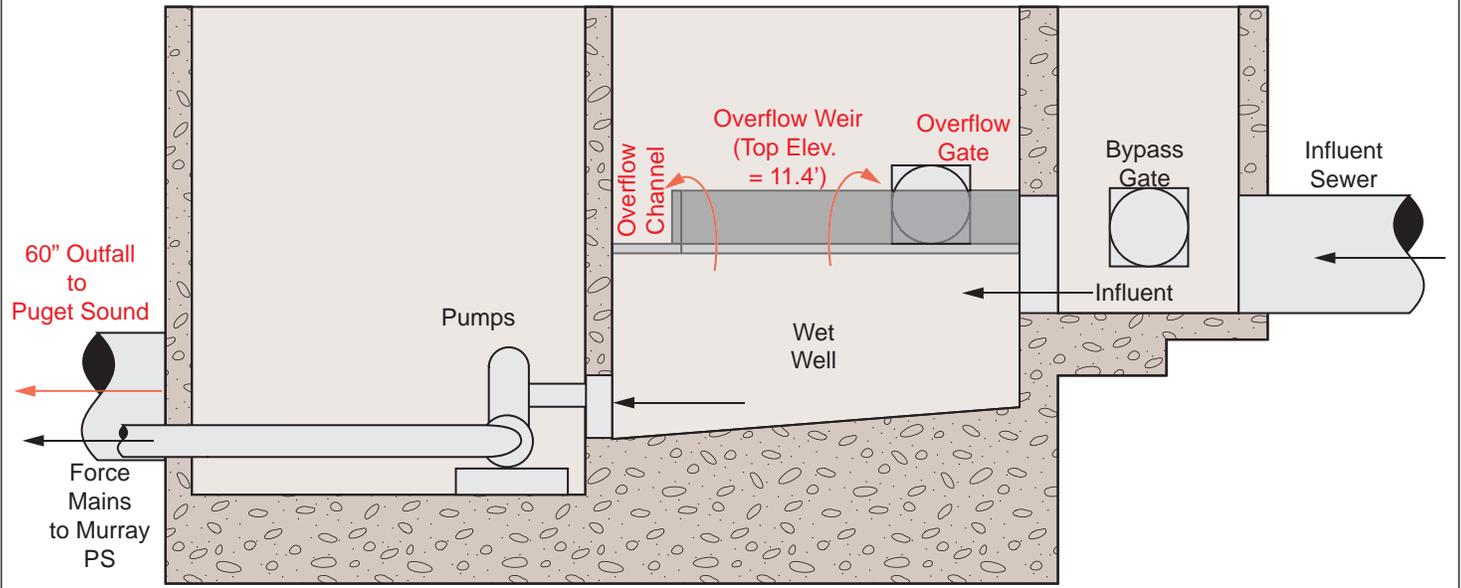
Figure 3.5 shows the CSO and regional conveyance facilities in the Barton and Murray CSO basins and vicinity.

### **3.1.2.4 Flow and Loads**

Flow to the Barton Pump Station varies from an average dry-weather flow of 2 mgd to a peak wet-weather flow of over 93 mgd (King County modeling). The Barton Pump Station averages four untreated CSO events per year. The total annual volume of discharge from these events averages 4 MG per year.



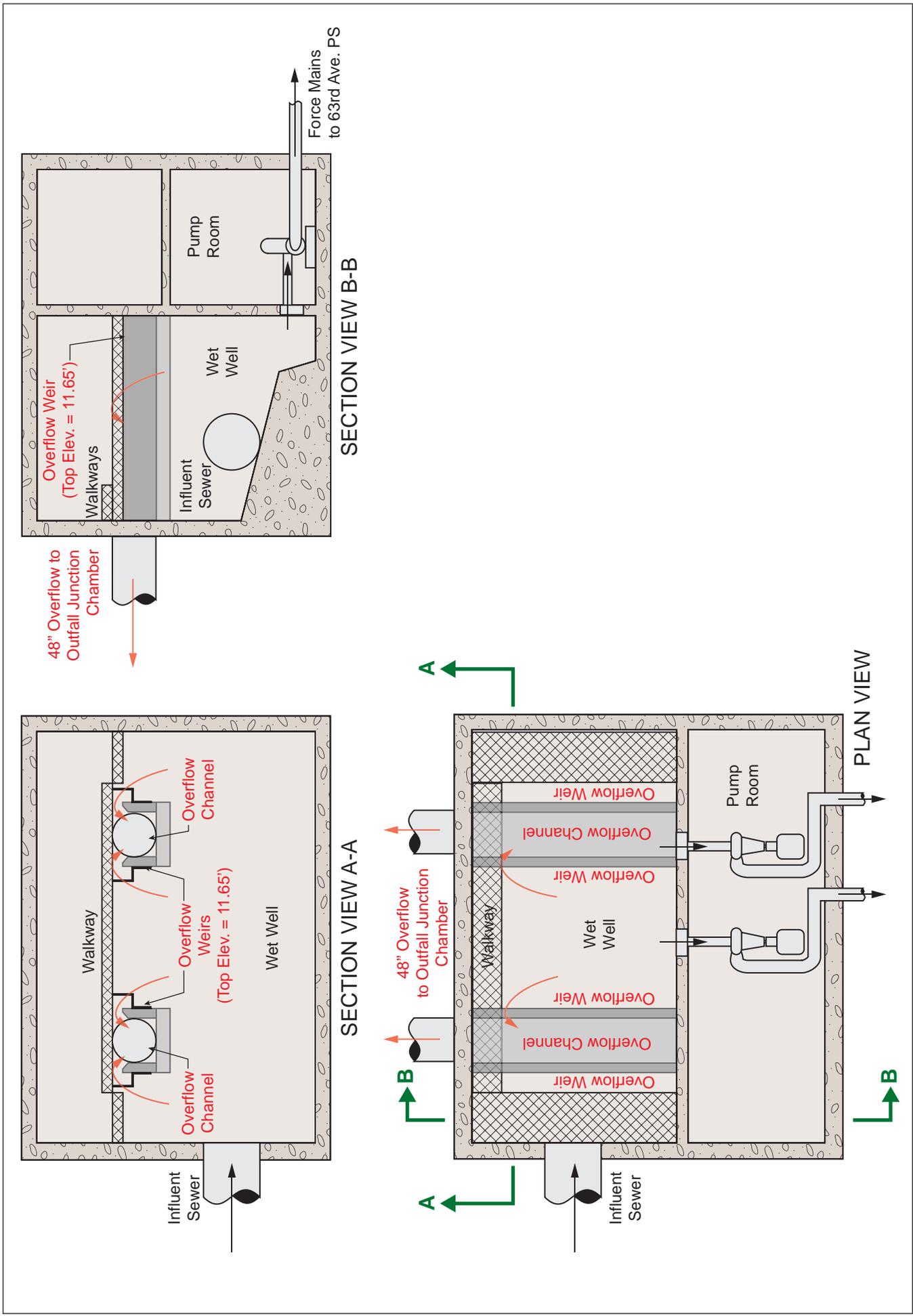
PLAN VIEW



SECTION VIEW

3630023/Fig3-03\_BartonCSOControlStructure.ai

**Figure 3.3.**  
EXISTING CSO CONTROL STRUCTURE  
AT BARTON PUMP STATION

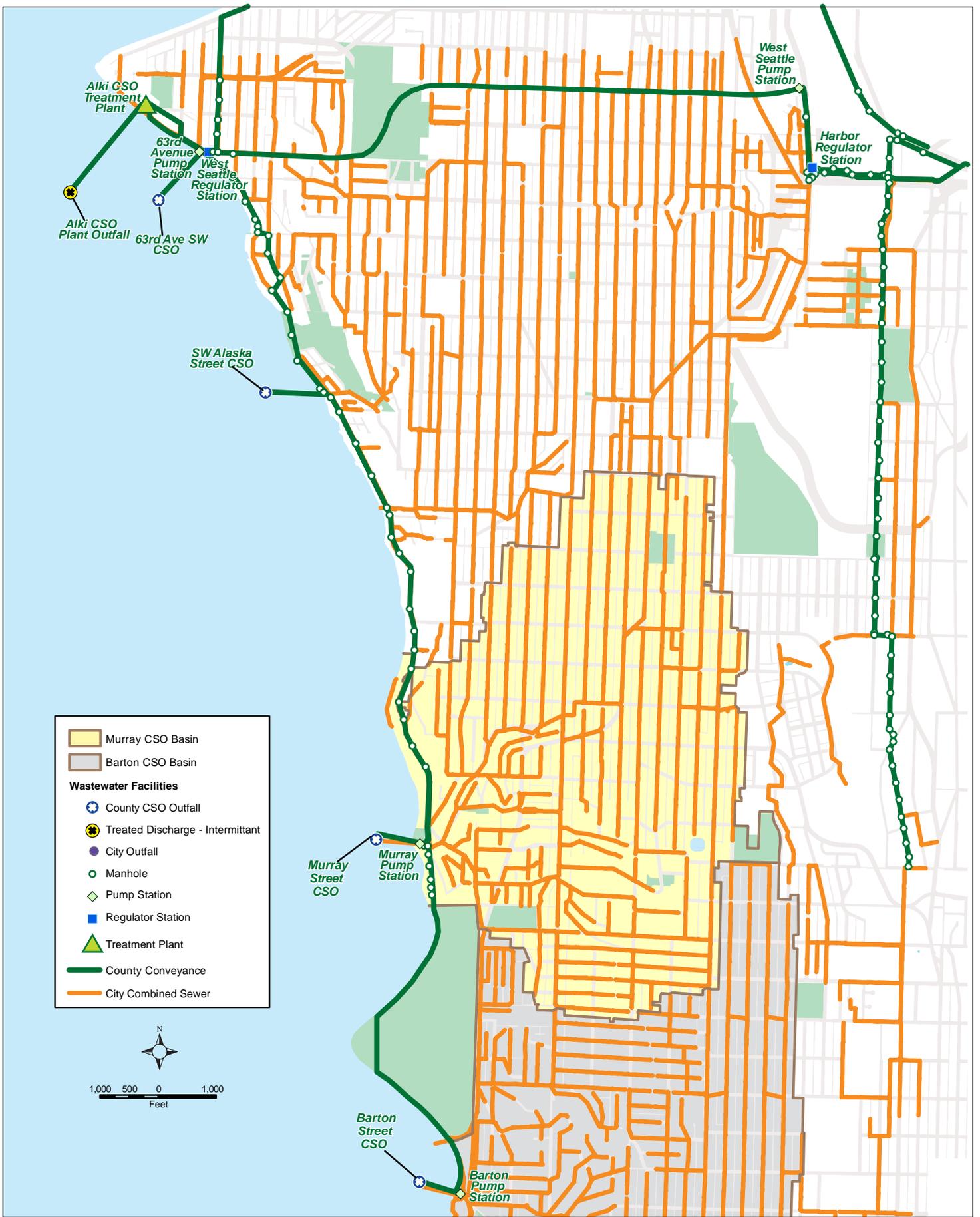


3630023/Fig3-04\_MurrayCSOControlStructure.ai

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN**

**Figure 3.4.**  
 EXISTING CSO CONTROL STRUCTURE AT MURRAY PUMP STATION

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3630023/Fig3-05\_RegionalSystem.ai

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN**

DRAFT – February 2011

**Figure 3.5.**  
CSO AND REGIONAL CONVEYANCE SYSTEM

Flow to the Murray Pump Station varies from an average dry-weather flow of 3 mgd to a peak wet-weather flow of over 105 mgd (King County modeling). The Murray Pump Station averages five untreated CSO events per year. The total annual volume of discharge from these events averages 5 MG per year.

### **3.1.3 Public Health**

CSOs are a public health concern since they carry pollutants into water bodies, primarily in the form of untreated sewage and stormwater. These pose a threat to aquatic life and the natural environment. CSOs also pose a threat to human health through potential contact with water or the consumption of fish/shellfish harvested from areas of recent CSO discharge. Regulation of CSOs can reduce and control these threats.

### **3.1.4 Cultural Resources**

A review of known and potential cultural, archaeological, and historic resources in the Barton and Murray CSO basins was conducted in 2009 by Cascadia Archaeology. The review found the following:

- Numerous historic properties exist throughout the Barton and Murray CSO basins.
- The area of Upper Fauntleroy Way, east of the Fauntleroy Ferry Terminal, has a high probability of containing archaeological resources. Significant archaeological resources have been uncovered in this area in the past.
- The former Fauntleroy School may be nominated as a Seattle landmark.
- No other known archaeological sites were identified in the Barton CSO basin.
- No known archaeological sites or historic structures have been identified in the vicinity of Lowman Beach Park. However, based on site characteristics and location, this area has a high probability of containing archaeological resources.

## **3.2 PHYSICAL ENVIRONMENT**

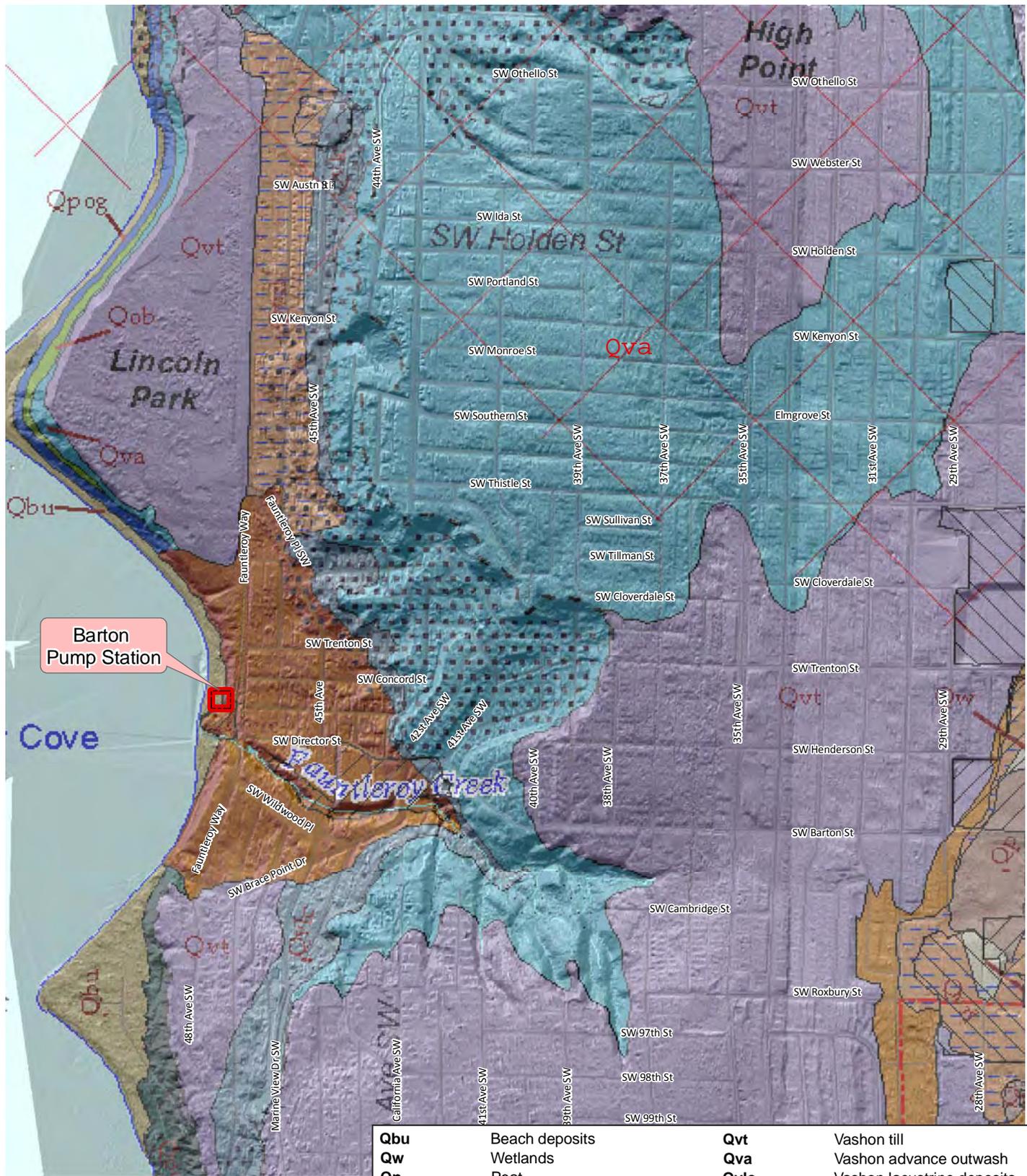
### **3.2.1 Land**

#### **3.2.1.1 Soils/Geology**

Geologic maps of the Barton and Murray CSO basins are shown in Figures 3.6 and 3.7. Details are provided below.

##### **3.2.1.1.1 *Barton CSO Basin***

Soil conditions in the Barton CSO basin are the result of nonglacial and glacial processes during the Pleistocene, post-glacial geological processes, and human modification of the ground surface. The ridge on the eastern end of the Barton CSO basin is underlain by Vashon Till and Vashon Advance Outwash deposited during the last glaciation in the Puget Lowland. Locally, these very dense soils are overlain by a relatively thin layer of recessional outwash and weathered topsoil zones.

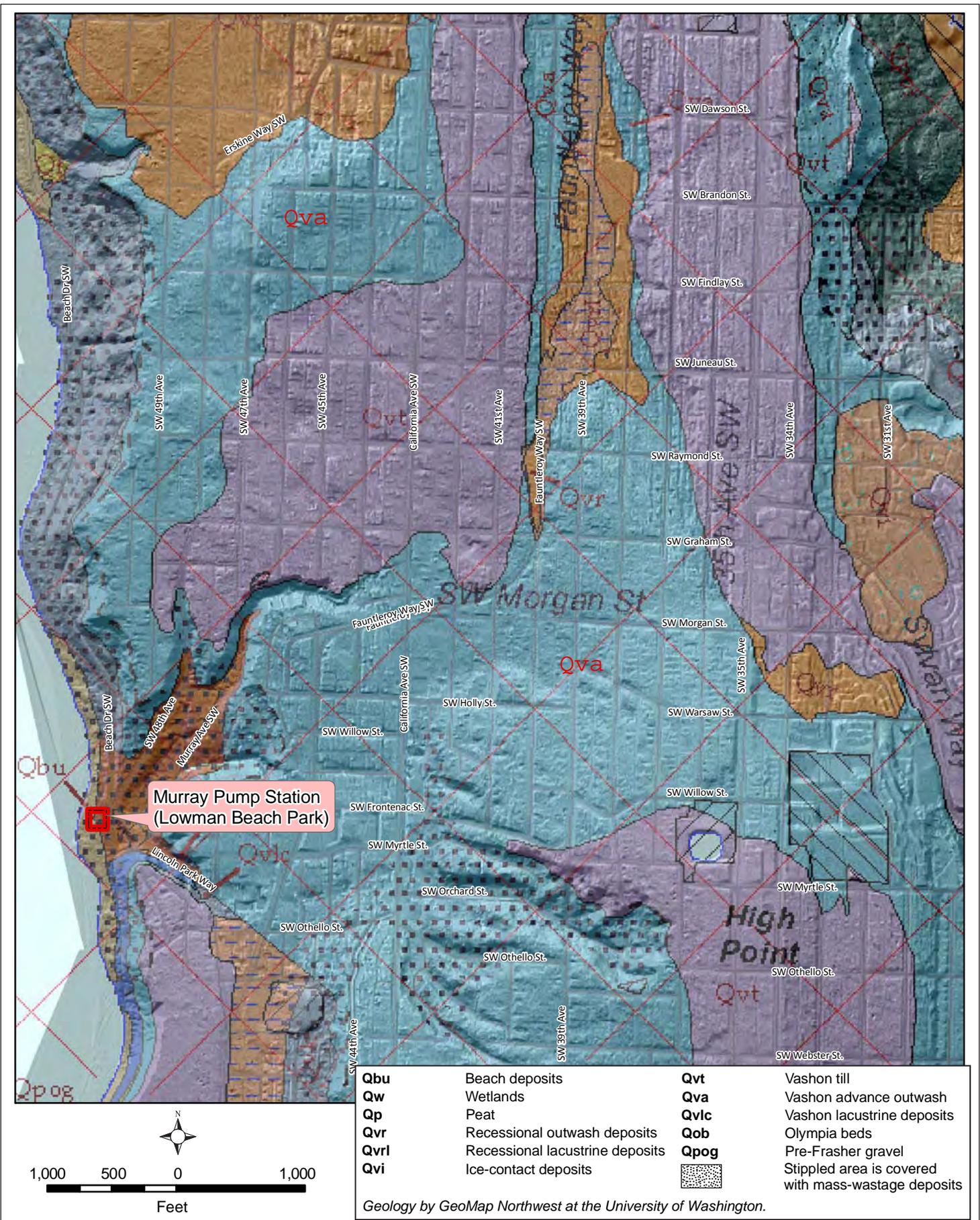


<b>Qbu</b>	Beach deposits	<b>Qvt</b>	Vashon till
<b>Qw</b>	Wetlands	<b>Qva</b>	Vashon advance outwash
<b>Qp</b>	Peat	<b>Qvlc</b>	Vashon lacustrine deposits
<b>Qvr</b>	Recessional outwash deposits	<b>Qob</b>	Olympia beds
<b>Qvrl</b>	Recessional lacustrine deposits	<b>Qpog</b>	Pre-Fraser gravel
<b>Qvi</b>	Ice-contact deposits		Stippled area is covered with mass-wastage deposits

*Geology by GeoMap Northwest at the University of Washington.*

3630023/Fig3-06\_GeologyBarton.ai

**Figure 3.6.**  
**BARTON CSO BASIN GEOLOGY**



3630023/Fig3-07\_GeologyMurray.ai

**BARTON AND MURRAY COMBINED SEWER  
OVERFLOW CONTROL FACILITIES PLAN**

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**Figure 3.7.**  
**MURRAY CSO BASIN GEOLOGY**



**King County**

Department of Natural Resources and Parks  
**Wastewater Treatment Division**

Based upon boring logs obtained for this area, this relatively thin layer is loose to medium dense and is typically 0 to 2 feet thick; however, locally, it may be 5 to 10 feet thick and may have as much as 25 feet of fill material placed over it. Near SW Barton Street and 29th Avenue SW, post-glacial depression deposits consist of a mixture of soft peat and loose to medium dense silt and sand. Both the advance and recessional outwash deposits are relatively pervious, whereas the Vashon Till is relatively impervious. Permeability of the post-glacial depression deposits is highly variable.

In the lower, western part of the Barton CSO basin, the surficial deposit is primarily recessional outwash sand and gravel. This loose to medium dense soil covers glacial clay and till deposits from the early and late Pleistocene. Holocene beach deposits dominate the shoreline area. All of the steep slope areas in the basin are covered with colluvium to depths of 3 to 10 or more feet. This deposit is the result of past landslide and erosional events on the slopes.

### **3.2.1.1.2 Murray CSO Basin**

The surface of the upper, eastern portion of the Murray CSO basin is primarily covered with Vashon Till or Vashon Advance Outwash. The north-oriented swale that follows approximately 39th Avenue SW and 40th Avenue SW is filled with glacial recessional outwash and pond deposits.

The lower part of the ravine system is covered with recessional outwash to the west of 46th Avenue SW, and, in general, the steep slopes of the ravines are covered with 10 or more feet of colluvium. The centers of the ravines contain sand and gravel alluvium, deposited by the small creeks that ran in the bottoms of the declivities. The strip along the shoreline is underlain by beach deposits. Underlying these natural deposits near the shoreline are older glacial deposits of clay, sand, and gravel.

The ground has been modified significantly for the construction of roads, residences, and the existing pump station. In and east of Lowman Beach Park, the original ground has been filled to depths ranging from 7 to 12 feet. The fill consists mostly of loose to dense, silty, slightly sandy gravel and gravelly sand; however, one boring encountered clayey soils. Many of these fill soils contain some organics, wood, boulders and foreign debris.

Underlying the fill are about 10 to 30 feet of very loose to medium dense alluvium (sand and gravel) with organic materials in their matrices, and soft peat layers that were deposited after the disappearance of the last glacial ice. In two recently completed borings, a 2- to 3- foot-thick layer of soft to medium stiff, organic silt was encountered at about sea level. The recent soils are underlain at depths of 21 to 40 feet by medium dense to very dense recessional outwash, consisting of slight silty to silty, gravelly sand and sandy gravel. In a boring in the middle of Lowman Beach Park, hard glacial clay was encountered at a depth of about 34 feet; however, in other adjacent borings, recessional outwash continued down to the bottoms of the borings at 46.5 and 54 feet. Glacially overridden soil was not encountered in these borings. Along Beach Drive SW, the centerline is all in a cut. Adjacent borings to the western side of the road indicate that 5 to 10 feet of fill are underlain by glacially overridden lake silt. The ground surface may also be covered by a thin layer of colluvium, the result of past landslide activity.

### **3.2.1.2 Topography, Steep Slopes and Landslides**

Topography basins is shown in Figure 3.8. Details are provided below.

#### **3.2.1.2.1 *Barton CSO Basin***

Ground surface elevations in the Barton CSO basin range from roughly 500 feet in the area near High Point Park to 10 to 12 feet at the shoreline near the Barton Pump Station and along the beach near Lincoln Park. The head of the drainage system in the Barton CSO basin is at about 38th Avenue SW, between SW Henderson Street and SW Cloverdale Street. The slopes are steep and covered with vegetation or retaining walls. No landslides are recorded in this area in the Seattle landslide database. The drainage divide in this area is 38th Avenue SW.

The most extensive and deepest ravines in the Barton CSO basin are located west of 37th Avenue SW between approximately SW Barton Street and SW Roxbury Street. The slopes of this ravine are steep and exhibit characteristics of unstable slopes. Many residences are built close to the top-of-slope around the perimeter of this ravine system. Two landslides are reported in the Seattle Landslide database on the northern edge of the ravine system, to the south of SW Barton Street.

The City of Seattle critical area map folio indicates areas of steep slopes at the west edge of Upper Fauntleroy Way (refer to Figure 3.9). The northern portion of the parking lot at the former Fauntleroy School is designated as a potential landslide area. However, observations of the parking lot and surrounding area in the immediate vicinity did not reveal any steep slope areas. Steep slopes and landslide hazard areas are mapped on Figure 3.9.

#### **3.2.1.2.2 *Murray CSO Basin***

The topography of the Murray CSO basin rises fairly steeply east from the water, and a steep slope/potential landslide band parallels the shoreline above Beach Drive. Ground surface elevations in the Murray CSO basin range from over 500 feet in the area near High Point Park to 10 to 12 feet in the area of Lowman Beach Park. Drainage in the basin terminates at Lowman Beach Park and originates to the southeast, east, northeast, and north. The basin was originally a three-prong drainage system that originated between about 34th Avenue SW and 35th Avenue SW. Much of the system has been modified by street and residential development, particularly in the middle of the basin:

- Lowman Beach Park is the low point of the ravine system prior to its reaching the beach of Puget Sound. The modest fan offshore of the park was built by the streams that formerly flowed in the ravines and emptied into the Sound at the park location. Lowman Beach Park is now relatively level, having been filled in many years ago.
- From the park, the ground rises gently to the north along Beach Drive SW. Beach Drive SW is a relatively gently sloping surface because of the cuts and fills that were made for the road grade. Because of the steep topography to the north, the cuts range from about 10 to 34 feet. Much of the western side of the road is cut, but two small swales were filled to depths of 2 to 6 feet.

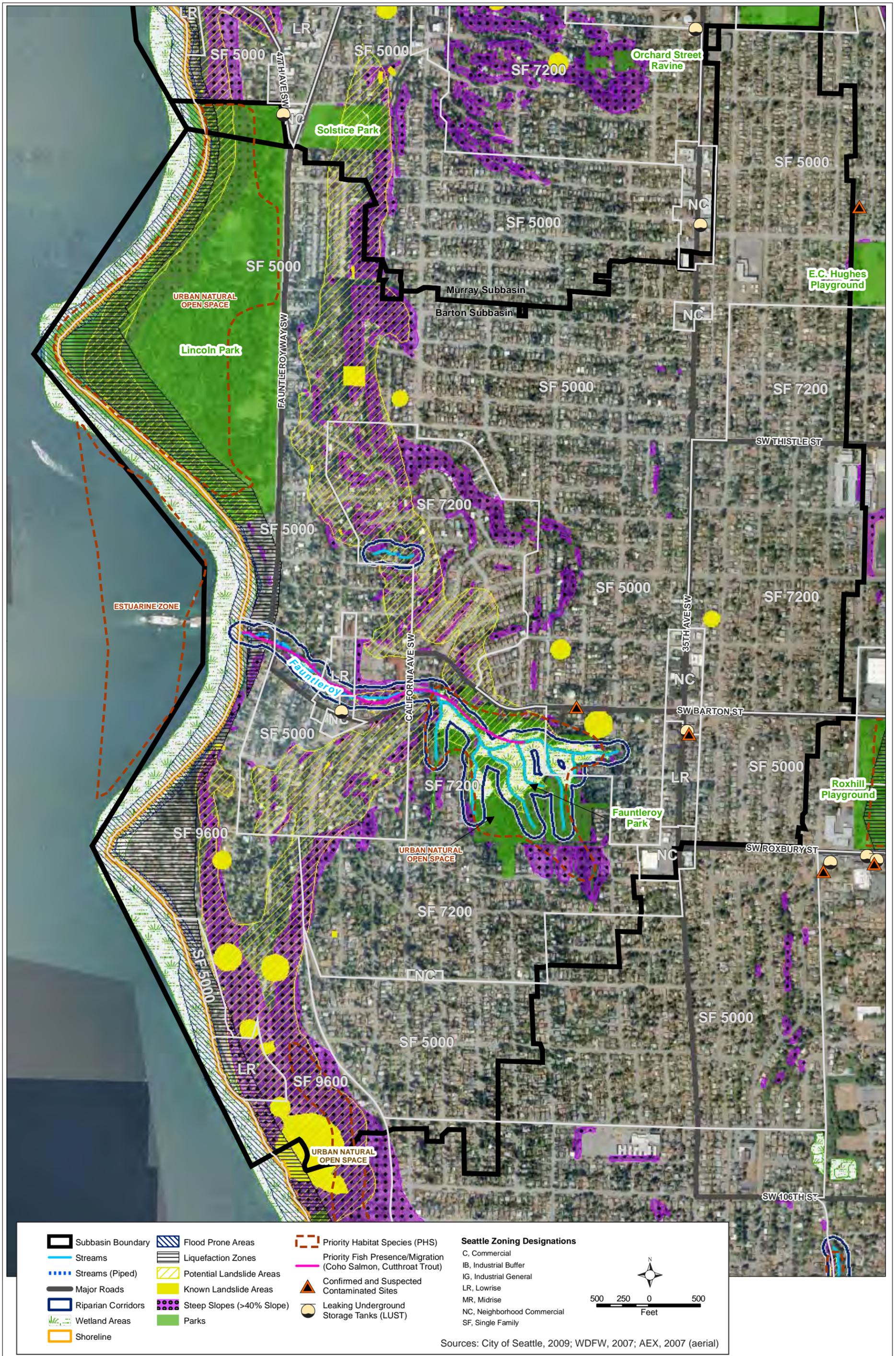


3630023/Fig3-08\_Topography.ai

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN**

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**Figure 3.8.**  
BARTON AND MURRAY CSO BASINS TOPOGRAPHY



**Figure 3.9.**  
BARTON CSO BASIN SENSITIVE AREAS



- Northeast from Lowman Beach Park at the bottom of the basin, 48th Avenue SW is built on the western side slope of a major ravine. Cuts 5 to 15 feet high on the western side and fills 0 to 5 feet deep on the eastern side were used to build this road as it climbs the side of the ravine.
- Murray Avenue SW is located on the eastern side of the same ravine, and appears to have been mostly filled for its subgrade.
- Lincoln Park Way SW rises at a relatively steep gradient to the southeast between its intersection with Murray Avenue SW and its intersection with 47th Avenue SW, the result of a fill embankment as high as about 20 to 25 feet on its western side.

The Sunrise Heights neighborhood is on a ridge that is bounded on the west by steep slopes in three areas. The 30- to 40- foot-high head of a west-facing drainage system is located at SW Othello Street and 36th Avenue SW. One landslide is recorded in this area in the Seattle landslide database. Eleven additional landslides are located on the steep slopes of the ravine system, according to the landslide database. One landslide in the database in the 6700 block of Beach Drive SW occurred in 1932. Steep slopes and landslide hazard areas are mapped on Figure 3.10.

### **3.2.1.3 Soil or Groundwater Contamination**

In general, there are few areas in the basins that are known to contain soil or groundwater contamination. These are typically associated with commercial land uses along major arterials. The Washington Department of Ecology maintains databases of contaminated sites. Figures 3.9 and 3.10 depict the sites that have confirmed or suspected contamination or have leaking underground storage tanks according to the Ecology databases. Phase 1 Environmental Site Assessments have been conducted as part of both the Barton and Murray Pump Station Upgrade projects.

### **3.2.1.4 Liquefaction**

Areas of potential liquefaction within each subbasin are depicted on Figures 3.9 and 3.10. In general, this corresponds with the shoreline area of each basin.

### **3.2.2 Surface Water**

In the Barton CSO basin there is one major stream, Fauntleroy Creek, which descends west from headwaters in Fauntleroy Park to the shoreline near the midpoint of the basin at the Fauntleroy Ferry Terminal (see Figure 3.9). The creek is piped for a segment in the lower reaches where it crosses Fauntleroy Way SW and daylights on the south side of the Fauntleroy Ferry terminal. Surface water in the upper basin drains east to Longfellow Creek.

In the Murray CSO basin, most of the surface streams no longer exist. A former widespread system of small creeks has been filled or culverted over the 100 years or more of land development. Surface water in the upper basin drains east to Longfellow Creek.

Pelly Creek in the Murray CSO basin is not indicated as a stream or shown as containing listed fish species by Salmonscape mapping (WDFW, 2009). Priority Habitats and Species

mapping indicates Pelly Creek as a stream (see Figure 3.10) but does not indicate any listed fish species (WDFW, 2010). The lower portions of Pelly Creek have been contained in a pipe. Fish access appeared to be unavailable to the piped outlet of Pelly Creek along the Puget Sound shoreline within Lowman Beach Park.

It was observed that surface flow originated from the Pelly Creek Natural Area to the east of Murray Avenue SW. Immediately east of the roadway, the flow spread out into a small (approximately 400 square foot) wetland area before entering a culvert that conveys it south along the east side of Murray Avenue SW. After about 450 feet, the culvert appeared to pass under Murray Avenue SW and discharge into a surface channel that flows generally west across a vacant lot. Wetland areas were observed adjacent to the stream on this lot. Surface water flow was observed entering a culvert on the west edge of this property. A piped outflow with flowing water was observed in the seawall at Lowman Beach Park, at approximately the same location as indicated by Seattle Critical Areas mapping.

### **3.2.3 Rainfall**

Average rainfall in Seattle is between 36 and 37 inches per year. Heaviest rainfall occurs in the winter months, with November, December and January averaging 5 to 6 inches per month. June, July, and August each average 1 inch per month.

### **3.2.4 Air**

Puget Sound weather is largely a result of maritime influences and diverse topography. The jet stream typically supplies the area with a steady supply of cool, fresh air off the ocean. This marine flow not only contributes to the mild climate, but also mixes the air, which helps keep pollution from building up.

Air quality in King County and the City of Seattle is monitored and regulated by the Puget Sound Clean Air Agency. According to data published in 2007 by the Clean Air Agency (the most recent published data), the air quality in King County was good 78 percent of the time and moderate 21 percent of the time.

### **3.2.5 Sensitive Areas**

#### **3.2.5.1 Wetlands and Streams**

Wetlands and streams in the Barton CSO basin are shown on Figure 3.9. Mapped areas include the headwaters of Fauntleroy Creek and adjacent to the shoreline. Fauntleroy Creek is the main stream, located in the central portion of the basin (Figure 3.9). Headwaters of the stream are located in Fauntleroy Park. The stream flow west toward Puget Sound. A section of the stream is piped where it crosses Fauntleroy Way SW and then daylights south of the ferry terminal.

In the Murray CSO basin, Pelly Creek is generally conveyed via pipe down the hillside from the upper basin. It emerges from a pipe on the west side of Murray Avenue, traverses a vacant site, and is again directed into a pipe through Lowman Beach Park to Puget Sound. There are wetlands associated with the open portion of the stream through this vacant lot (refer to Figure 3.10).

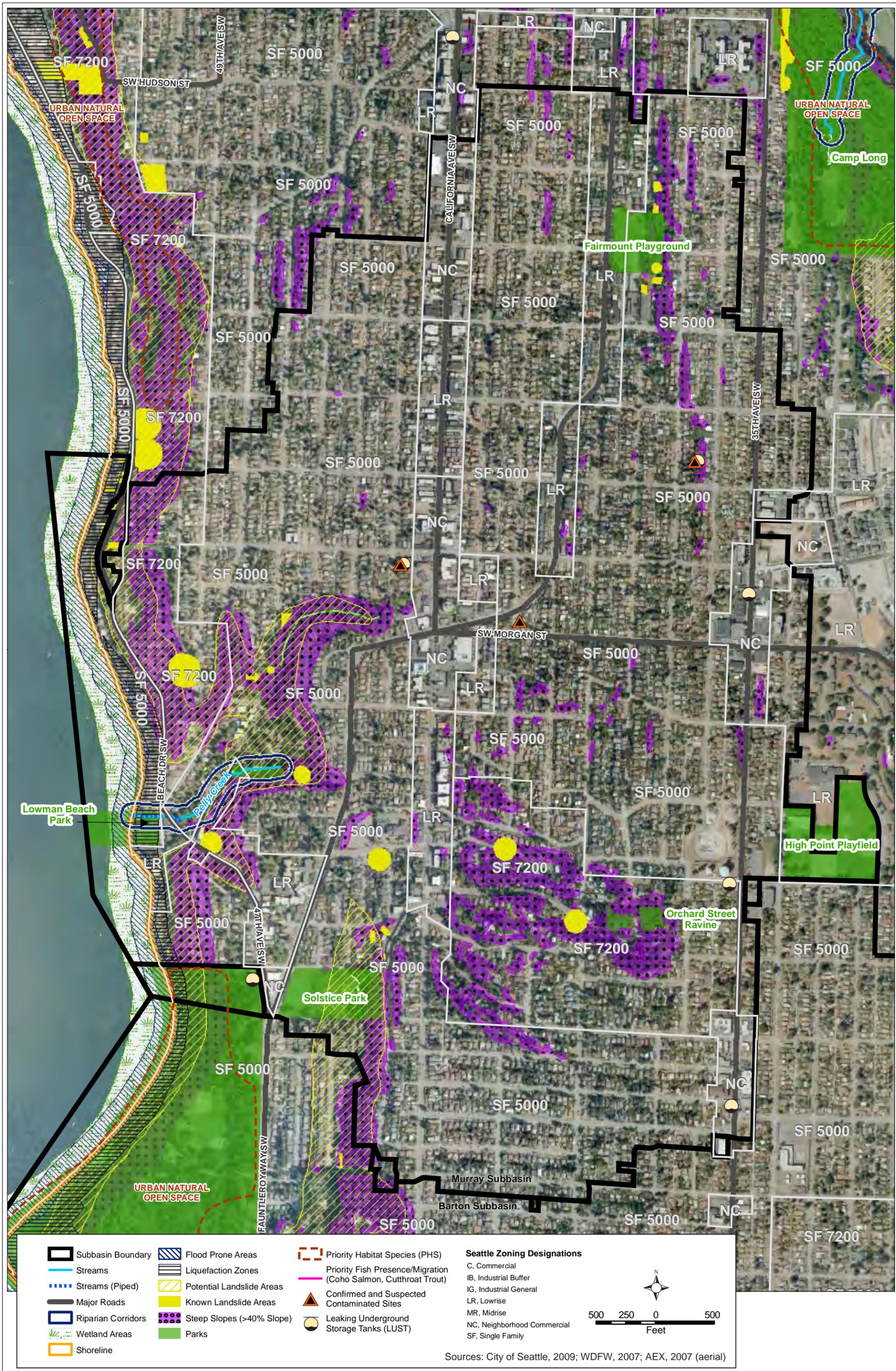


Figure 3.10. MURRAY CSO BASIN SENSITIVE AREAS



### **3.2.5.2 Shorelines**

The Puget Sound shoreline lies at the bottom of the Barton and Murray CSO basins. Land use along the shoreline is primarily residential. Lincoln Park provides a natural cobble beach area along the northern shoreline of the Barton CSO basin. Immediately south of Lincoln Park is the Fauntleroy Ferry Terminal, operated by Washington State Ferries. The shoreline along both basins is a mix of natural beach, managed beachfront supplemented with sand by the U.S. Army Corp of Engineers, riprap, and bulkhead.

### **3.2.5.3 Floodplains**

The City of Seattle has mapped flood-prone areas in each basin (refer to Figures 3.9 and 3-10). These areas generally correspond to the shoreline of Puget Sound.

## **3.3 ENDANGERED/THREATENED SPECIES AND HABITATS**

Figures 3.9 and 3.10 depict mapped priority habitat species areas and priority fish migration and/or presence areas. In the Barton CSO basin, Lincoln Park and an area in the southern part of the basin are mapped as priority habitat species areas. Fauntleroy Creek contains priority habitat for coho salmon and cutthroat trout. In the Murray CSO basin, Lincoln Park is mapped as a priority habitat species area. Puget Sound contains numerous threatened and endangered species, including Chinook salmon, bull trout, steelhead, canary rockfish, yelloweye rockfish, Bocaccio rockfish, green sturgeon, orca whale, Steller sea lion, and marbled murrelet.

Critical habitat for Chinook salmon, bull trout, and killer whale occurs within the project vicinity. Critical habitat for steelhead, canary rockfish, yelloweye rockfish, bocaccio rockfish, green sturgeon, Steller sea lion, and marbled murrelet is not present in the project vicinity. Designated essential fish habitat for the Pacific salmon fishery and groundfish occurs in the vicinity of the proposed project. A biological evaluation will be prepared for the project in accordance with the requirements of the Endangered Species Act.

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### **REFERENCES:**

WDFW. 2010. Priority Habitats and Species GIS. Washington Department of Fish and Wildlife Habitat Program. Olympia, Washington. 2010.  
WDFW. 2009. Data on occurrence of listed threatened and endangered fish species and designated critical habitat; searched from <http://wdfw.wa.gov/mapping/salmonscape>.



This chapter details modeling performed, control approaches considered, and basis of planning criteria established for developing the improvements to control CSOs from the Barton and Murray CSO basins.

Planning criteria were developed based on regulatory requirements for control of CSOs, system modeling, and viable control approaches. This project was initiated to address the following:

- **Revised Code of Washington (RCW) 90.48.480:** This law requires “the greatest reasonable reduction of combined sewer overflows.”
- **Washington Administrative Code (WAC) 173-245-020 (22):** This law defines “the greatest reasonable reduction” as control of each CSO so that no more than an average of one untreated discharge may occur per year.

According to these regulatory requirements, CSOs must be controlled to an average of no more than one untreated discharge per year per outfall based on a long-term average.

## **4.1 SYSTEM MODELING**

Computer modeling was performed to estimate wastewater flows in the CSO basins and their sub-basins. The software selected, the input data used, and the model calibration and verification processes are described in the following sections.

### **4.1.1 Model Description**

King County Wastewater Treatment Division’s computer modeling program Runoff/Transport was selected for evaluating flows in the Barton and Murray CSO basins. A second model, the Mike Urban model, was also developed to a preliminary level, but the Runoff/Transport model was then identified as a better model for this project, as described later in this chapter.

The Runoff/Transport model incorporates both a hydrologic and hydraulic model, and simulates base sewer flow and the rainfall/runoff response during rain events. It is customized to the existing physical parameters of the basin and the conveyance system, such as basin area, slope, impervious area, pervious area, and pipe sizes. Actual historical rainfall data is run through the model to compare the output hydrographs with the observed flow data hydrograph. The model is then calibrated (adjusted) until the two hydrographs match. At that point, the model is ready to perform simulations to help determine the volume of wastewater flow that needs to be controlled to achieve CSO limits, either by storage or by diverting flow to prevent it from entering the conveyance system (such as with “green stormwater infrastructure,” or GSI, approaches that divert the flow to groundwater).

Three technical reports describing the model development and calibration process for the Barton and Murray Basins are included in Appendix A:

- *Barton Pump Station Service Basin Calibration, King County, January 2009*
- *Murray Pump Station Service Basin Calibration, King County, January 2009*
- *Comparing Modeled Flow Events Against Observed Events: Determining Preferred Model for Estimating CSO Storage Volumes, King County, June 2010*

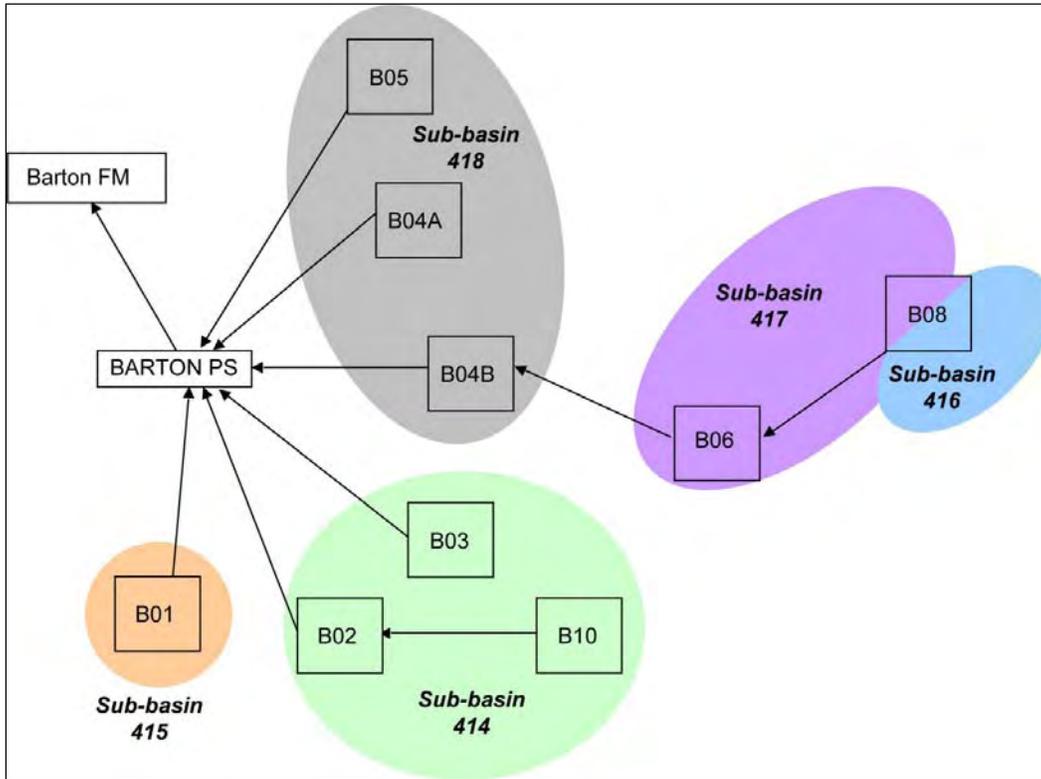
#### **4.1.2 Data**

##### **4.1.2.1 Flow Data**

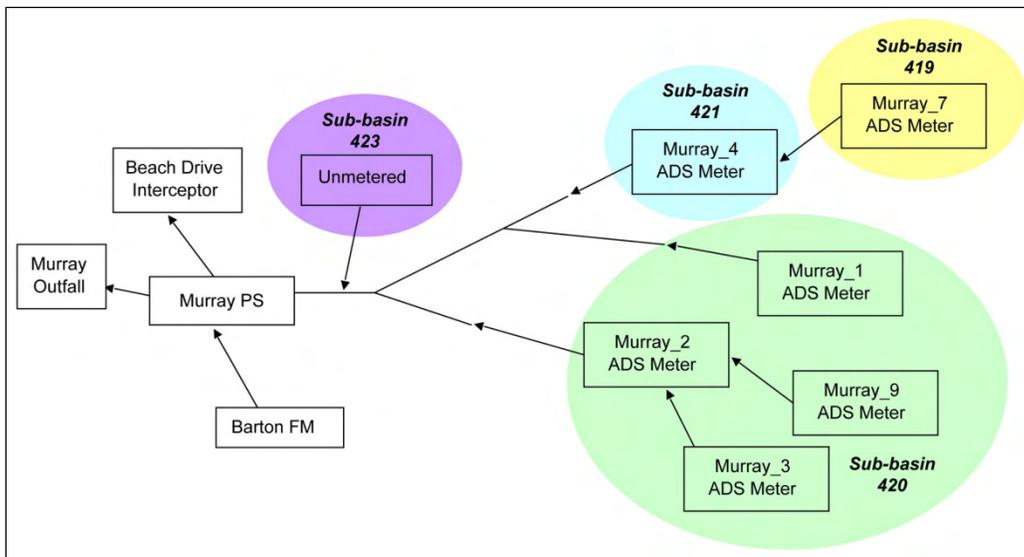
Flow data for model setup and calibration came from King County and ADS Environmental Services. King County monitors pump station flows in the basins, and also monitors sewer flows, levels and overflows at select points within the system.

The majority of the county flow data came from meters at the pump stations at the bottom of the basins. For the Murray CSO basin, total basin flow was calculated by subtracting the measured Barton Pump Station discharge flow from the measured Murray Pump Station discharge flow, since flows from both basins enter the Murray Pump Station. The pump stations operate in a fill/draw mode during dry weather.

ADS Environmental Services conducted a flow monitoring survey in 2007/2008 to supplement county data. ADS monitored nine flow meters in the Barton CSO basin and six flow meters in the Murray CSO basin (see Figures 4.1 and 4.2). The meters were deployed from December 2007 through June 2008. The details of the ADS flow-monitoring program are summarized in a report by ADS (ADS, 2008).



**Figure 4.1 Barton CSO Basin Flow Meter Schematic**



**Figure 4.2 Murray CSO Basin Flow Meter Schematic**

**4.1.2.2 Rainfall Records**

The City of Seattle maintains rain gauges throughout the city. The rain data for the Barton CSO basin was provided from Rain Gauge #5. The model for the Murray CSO basin used rain data from Rain Gauges #5 and #14.

### **4.1.3 Long-Term Simulations**

A 30-year time series of precipitation and evaporation data was input to the calibrated hydrologic models to simulate response to 30 years of historical data, which was taken from City of Seattle Rain Gauge #5 and #14. The 30-year simulation produces a time series of flows at the basin outlet, representing base wastewater flow plus rainfall-dependent inflow and infiltration conveyed to the pump stations.

This step was performed with calibrate versions of the Runoff/Transport model and the Mike Urban model. Both models' results for overflow events and overflow durations were compared to historical data. As described in the King County modeling reports in Appendix A, a judgment was made that the Runoff/Transport model had a closer match to the historically recorded number and duration of overflow events. Therefore, it was used for sizing the Barton and Murray CSO facilities.

An upgraded capacity of 33 mgd was assumed for the Barton Pump Station. All peak flows above 33 mgd during the 30-year simulation were marked for analysis. Volumes of the events that exceeded the 33 mgd were ranked by storm event. A list of the resulting overflow volumes and peak flow rates are shown in Tables A-1 and A-2 in Appendix A. For the 30-year simulation, the 30th largest CSO volume was selected as the control volume (i.e., the volume of wastewater flow for which storage, conveyance or diversion capacity must be provided in order to achieve CSO goals).

For the Barton Basin, several storms around the 1-year storm (by volume) were investigated to see which would be the most challenging to control with storage at a mid-basin location rather than at the basin outlet. The November 2, 1984 storm was identified as the most appropriate storm and was used for developing a control strategy for sizing mid-basin storage.

For a green stormwater infrastructure approach that diverts flows to rain gardens in the upper Barton basin, the November 2, 1984 storm also presented the most challenging storm (near a 1-year storm) to control. This is because there was a significant amount of rain on the previous day that would use some of the available rain garden storage. This storm was selected to ensure that a GSI alternative would have a high likelihood of controlling a 1-year CSO event, even if it follows very wet antecedent conditions.

## **4.2 CSO CONTROL APPROACHES**

Four broad approaches to controlling overflows were considered during the planning process. A combination of the four broad approaches was assessed as a fifth approach. Development and evaluation of these approaches is described in detail in Chapter 5. The five approaches are summarized below.

### **4.2.1 Control Approach 1—Peak-Flow Storage**

The peak-flow storage control approach involves capturing and storing flows that exceed the system's conveyance capacity during precipitation events. Stored flow is pumped back to the combined system for conveyance and treatment at existing facilities following the

event. This approach requires new storage tanks, tunnels, or pipes with enough storage volume to achieve the control objective. Tank storage on private property and pipeline storage in the public right of way were considered. Alternatives with a single facility are referred to as centralized storage; alternatives with more than one storage facility are referred to as distributed storage.

Storage could be located anywhere in the basin or out of the basin. It could be at the CSO control location where the flows already are conveyed (“bottom-of-basin”), or it could include a pump station to pump wastewater from the collection system to a storage site elsewhere. The required storage volume varies depending on whether or not the storage facility is located at the bottom of the basin. The sections below describe the effects of locating storage in the mid- or upper basin.

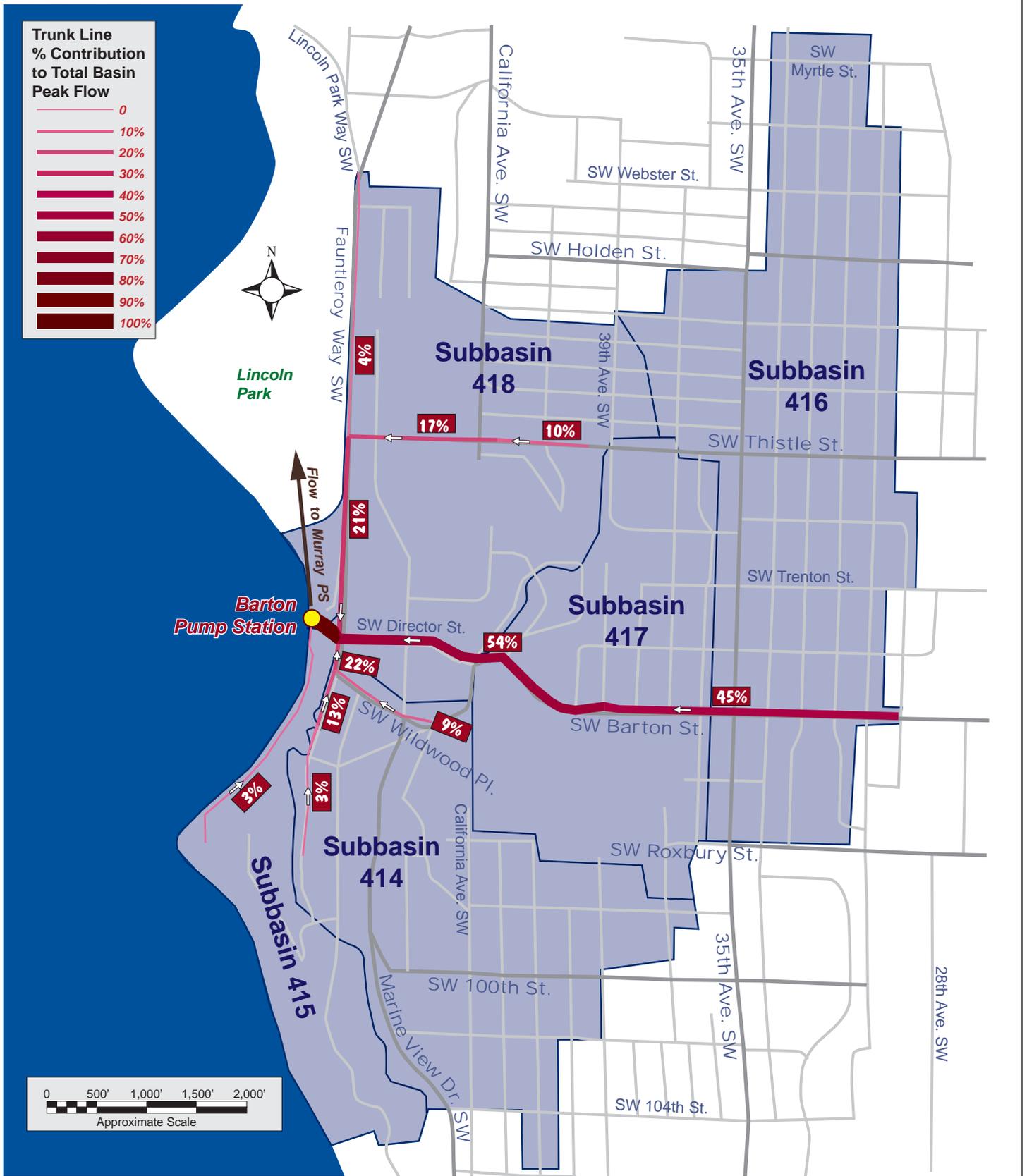
#### **4.2.1.1 Mid- or Upper Basin Storage for Barton CSO Basin**

In the Barton CSO basin, flow monitoring showed that individual sub-basin flow contributions account for 3 to 45 percent of the total basin flow and that 54 percent of peak flows come from Sub-basins 416 and 417 (see Figure 4.3). Flows from these sub-basins are routed downstream along SW Barton Street and SW Director Street to the Barton Pump Station. The contribution of flow from these upper sub-basins is sufficient to allow centralized storage in the middle or upper basin to be effective in controlling CSOs.

To determine the storage requirement for a mid-basin storage facility, the November 2, 1984 hydrograph for the Barton CSO basin was disaggregated and scaled by 54 percent to represent the peak flow along Director Street from Sub-basins 416 and 417 (see Figure 4.4). The peak flow along Director Street to control CSOs was then calculated as follows:

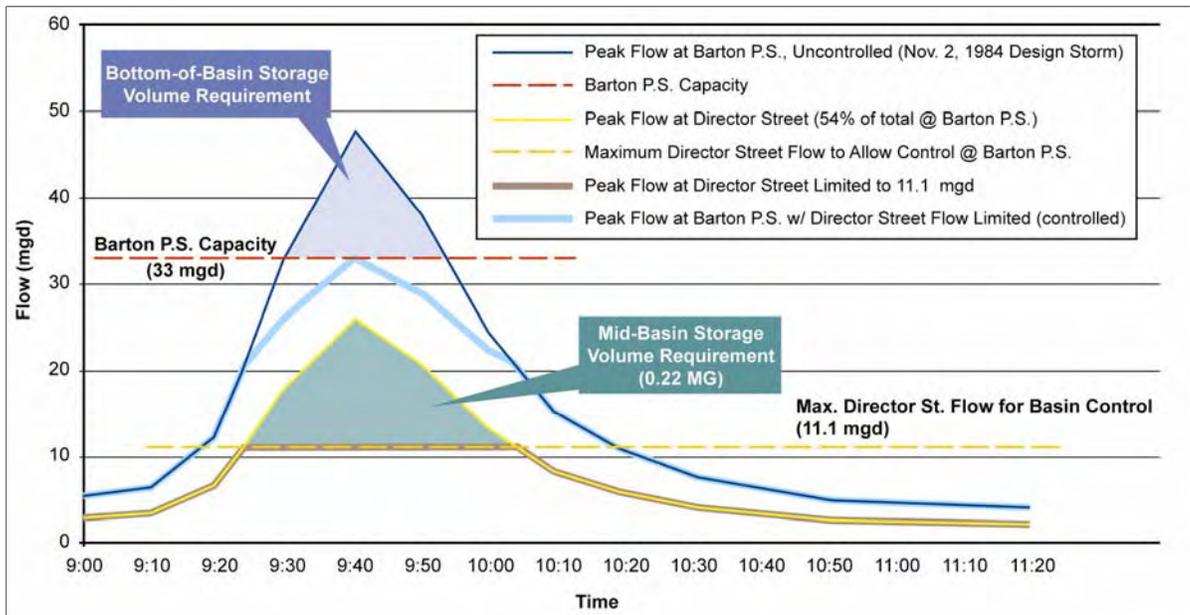
- Peak flow during design storm = 47.7 mgd
- Peak flow contribution along Director Street = 54 percent of 47.7 mgd = 25.8 mgd
- Peak flow contribution from all other basins = 47.7 mgd – 25.8 mgd = 21.9 mgd
- Barton Pump Station peak flow capacity = 33 mgd (with planned upgrade)
- Peak flow along Director Street to Control Basin = 33 mgd – 21.9 mgd = 11.1 mgd.

In order to provide control during the peak of the design storm, flow rates along Director Street to the bottom of the basin cannot exceed 11.1 mgd. Thus, all flow along the Director Street sewer above 11.1 mgd must be routed to storage. As shown in Figure 4.4, a line was drawn across the Director Street hydrograph representing 11.1 mgd. The area between this line and the peak-flow hydrograph, representing the required storage volume, was determined to be 0.22 MG. By comparison, a bottom-of-basin storage facility would require a volume equal to the area between the 33-mgd pumping capacity shown on the figure and the uncontrolled basin peak flow, which is roughly half that required mid-basin.



3630023/Fig4-03\_BartonFlowDistribution.ai

**Figure 4.3.**  
SUB-BASIN FLOW DISTRIBUTION  
IN BARTON CSO BASIN



**Figure 4.4** Barton Mid-Basin Storage Calculation for Barton CSO Basin

**4.2.1.2** Mid- or Upper Basin Storage for Murray CSO Basin

In the Murray CSO basin, flow monitoring showed that flow contributions from individual trunk lines account for 4 to 26 percent of the total basin flow (not accounting for the 33 mgd of flow coming into the Murray Pump Station from the Barton Pump Station) (see Figure 4.5). Sub-basin flows converge immediately upstream of the Murray Pump Station.

Furthermore, the peak capacity of the Murray Pump Station is 31.5 mgd and the peak flow of the Barton Pump Station will be 33 mgd after a planned capacity upgrade; so some storage volume will be required at the bottom of the basin to accommodate the excess 1.5 mgd of peak flow from the Barton Pump Station.

For all these reasons, centralized mid-basin storage was determined to be infeasible for the Murray CSO basin. For distributed storage, at least one storage facility would have to be located at the bottom of the basin to address the Barton CSO basin flows.

**4.2.2** **Control Approach 2—Convey and Treat**

The convey-and-treat control approach involves conveyance of peak flows out of the basins to existing facilities for treatment prior to discharge. This approach may require increasing the capacity of existing facilities for pumping, conveyance or treatment.

For the Barton CSO basin, the convey-and-treat approach involves increasing the capacity of the Barton Pump Station and force main by supplementing or replacing the existing infrastructure. The Murray Pump Station’s capacity also would need to be increased by supplementing its capacity or replacing the existing infrastructure.



The conveyance pipeline downstream from the Murray Pump Station also would need to be upgraded, and the Alki Wet-Weather Treatment Facility would need to be expanded to accommodate higher peak flows from these upstream basins.

#### **4.2.3 Control Approach 3—End-of-Pipe Treatment**

The end-of-pipe treatment control approach involves capturing peak flows in excess of the existing conveyance capacity during precipitation events and treating the flows prior to discharge. This approach requires new treatment facilities, including solids capture and disinfection, at or near the existing CSO location.

End-of-pipe treatment would involve construction of a high-rate clarification and disinfection treatment facility within the basin. Discharge would be through the existing CSO outfall, as the peak rate of discharge would be identical to the existing system.

#### **4.2.4 Control Approach 4—Peak Flow Reduction**

Peak flow reduction entails reducing basin-wide flow to the combined system during precipitation events to a level that the system is able to convey without exceeding CSO control limits. This is achieved through one or both of the following techniques:

- **Green Stormwater Infrastructure**—Stormwater is separated from the combined sewer system and routed to facilities such as rain gardens, bio-swales, etc.; or stormwater is infiltrated into the ground through GSI techniques such as permeable pavement. Technical memorandums establishing criteria for GSI are provided in Appendix A.
- **Inflow and Infiltration (I/I) Improvements**—Inflow improvements involve taking stormwater from impervious areas (e.g., rooftops, roadways, etc.) that currently goes to the combined sewer system and re-routing it to new or existing storm sewer pipes and outfalls. Infiltration improvements involve rehabilitating sewer laterals and mains to eliminate stormwater/groundwater infiltration into the sewer system.

#### **4.2.5 Control Approach 5—Combined Approach**

A combined approach involves using any of the above CSO control approaches together to minimize impacts and costs (e.g., I/I improvements to reduce the required volume of storage at the bottom of the basin).

### **4.3 BASIS OF PLANNING CRITERIA**

Table 4.1 summarizes the basis of planning criteria for the Barton and Murray CSO basins resulting from the long-term simulation to meet these regulatory requirements.

<b>Table 4.1 Basis of Planning Criteria for Barton and Murray CSO Basins</b>		
	<b>Barton</b>	<b>Murray</b>
Required Capacity at Peak Flow	45 mgd <sup>(4)</sup>	60 mgd <sup>(4)</sup>
Existing Capacity	33 mgd <sup>(1)</sup>	31.5 mgd
	<b>Required Volume or Capacity<sup>4</sup></b>	
Storage Control Approach at Bottom of Basin	0.11 MG <sup>(4)</sup>	1.0 MG <sup>(4)</sup>
Storage Control Approach at Mid-Basin	0.22 MG <sup>(4)</sup>	N/A
Convey and Treat Control Approach	12 mgd <sup>(2)</sup>	28.5 mgd <sup>(2)</sup>
End of Pipe Treatment Control Approach	12 mgd <sup>(2)</sup>	28.5 mgd <sup>(2)</sup>
Peak Flow Reduction Control Approach – Impervious Disconnection	20% <sup>(3)</sup>	>75% <sup>(3)</sup>
Peak Flow Reduction Control Approach – Green Stormwater Infrastructure	Peak flow reduction of 14.6 mgd <sup>(4)</sup>	N/A
<b>Notes:</b>		
1. Based on planned upgrade to Barton Pump Station		
2. Required capacity is the difference between "required capacity at peak flow" and "existing capacity."		
3. Represents the percentage of impervious surface currently connected to the combined sewer system in the basin that must be disconnected to eliminate the need for storage.		
4. Capacity and storage requirement based on November 2, 1984 storm and will meet state criteria of one overflow per year.		

**REFERENCES:**

ADS. 2008. ADS Environmental Services, Temporary Flow Monitoring Report.  
 SvR, 2010. SvR Design Company, Summary of Technical Memorandums and SvR  
 Recommendations, GSI Planning and Analysis Confirmation, June 30, 2010.

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## METHODOLOGY FOR DEVELOPING AND EVALUATING ALTERNATIVES

### 5.1 OVERVIEW

This chapter describes the process used to develop and evaluate alternatives for meeting the CSO control objective for the Barton and Murray CSO basins. Alternatives that could achieve the objective were developed for the broad CSO control approaches described in Chapter 4: storage, treatment, conveyance, peak flow reduction, or a combination of these. Each alternative was evaluated for technical merit, ability to be implemented, and cost. The number of alternatives was reduced to a shortlist of most feasible options. New alternatives were then developed based on public input, and a recommendation for each basin was chosen from the shortlisted and public-input alternatives.

Phase 1 of the project began in January 2007 with review of county-produced flow projections, assessment of the broad CSO control approaches, and development of initial criteria for evaluating alternatives. In Phase 1, work included the following:

- County-produced flow data was reviewed, which indicated that fieldwork was needed to better define the origin of peak flows.
- Flow monitoring was conducted between December 2007 and June 2008.
- Hydraulic models were developed between March 2008 and June 2009.
- The flow monitoring and modeling results were used to help define peak flow contributions from discrete sub-basins and to confirm previous county modeling.
- Using the modeling results, CSO control volumes were developed for sub-basins, and overall control volumes for the basins were refined.
- The modeling results were used to determine peak-flow projections, control volumes, and impervious-area disconnection requirements at the sub-basin level. This information was used to create and evaluate alternatives.

Phase 2 of the project included creating and evaluating a preliminary suite of alternatives. The work included the following:

- Development and evaluation of preliminary alternatives
- Selection of a shortlist of alternatives for further evaluation
- Development of public-input alternatives and refinement of the shortlisted alternatives using expanded information
- Recommendation of a proposed CSO control alternative.

Documentation of the evaluation and selection of alternatives is presented in Appendix B.

## **5.2 PHASE 1**

Phase 1 consisted of development of initial criteria to screen control approaches and identify initial alternatives that respond to the criteria. During this phase, the project boundaries were established, as depicted in Figure 2.1.

The process of developing CSO control approaches as described in Chapter 4 was initiated in 2007 based on existing county documentation, modeling data, and basin-specific fieldwork. Preliminary evaluations of potential approaches were performed, including constraints and opportunities in each basin. During this effort, it was recognized that additional information relating to the distribution of peak flows in each sub-basin was needed to fully evaluate the feasibility of distributed control approaches or approaches away from the bottom of the basin. Therefore, a flow monitoring and modeling program was implemented to obtain data for smaller areas in each basin. Phase 1 included the steps described below.

### **5.2.1 Step 1.1: Define Criteria Categories**

Criteria that were used to determine viability of CSO control approaches were defined by the project team. Seven criteria categories were selected, as illustrated in Table 5.1.

### **5.2.2 Step 1.2: Identify Control Approaches**

The CSO control approaches evaluated are described in detail in Technical Memorandum 202.1 (Carollo, 2007a) and in Chapter 4 of this facility plan. The approaches are as follows:

- **Control Approach 1, Peak Flow Storage.** Store peak flows that exceed conveyance capacity in the basin during each storm event, and use existing pumping and piping facilities to convey stored flow downstream once the rainfall event has subsided.
- **Control Approach 2, Convey and Treat Peak Flows.** Convey peak flows out of the basin by increasing pumping and force main capacity, or the capacity of the gravity sewer system. This approach may also require treatment upgrades at the point where the peak flows are discharged, as the capacity of existing treatment facilities may not be adequate for additional flows and loads.
- **Control Approach 3, End of Pipe Treatment for Peak Flows.** Treat and discharge peak flows at or near the current CSO locations. The typical treatment process used for end of pipe treatment includes high rate clarification (HRC) and ultraviolet (UV) disinfection.
- **Control Approach 4, Peak Flow Reduction.** Reduce the magnitude of the flow in the collection system through infiltration and inflow (I/I) reduction in separated systems, or by disconnecting impervious areas in combined systems.
- **Control Approach 5, Combined Approach.** Reduce peak flows within the basin by implementing a combination of two or more of the previously mentioned CSO approaches.

<b>Table 5.1 Initial Evaluation Criteria</b>	
<b>Cost Effectiveness</b>	<ul style="list-style-type: none"> <li>- Capital cost</li> <li>- Life cycle costs</li> <li>- Use of existing facilities</li> <li>- Grants/loan ranking</li> </ul>
<b>Operations and Maintenance Feasibility</b>	<ul style="list-style-type: none"> <li>- Reliably meet CSO objectives</li> <li>- Wastewater Treatment Division (WTD) automation</li> <li>- Ease of start-up/shut-down</li> <li>- Ease of maintenance</li> <li>- No adverse impacts –on County or City</li> <li>- Ease of regulatory reporting</li> </ul>
<b>Technical Feasibility</b>	<ul style="list-style-type: none"> <li>- Compatible with existing system</li> <li>- Technically feasible</li> <li>- Can be permitted</li> <li>- Land is available</li> <li>- Minimize federal &amp; state permit constraints</li> </ul>
<b>Public Health and Environmental Benefits</b>	<ul style="list-style-type: none"> <li>- Meet CSO requirements</li> <li>- Minimize public exposure</li> <li>- Minimal environmental footprint</li> <li>- Minimize environmental risks</li> <li>- Minimize or avoid contact with endangered species</li> <li>- Consistency with Puget Sound environmental goals and policies.</li> </ul>
<b>Flexibility</b>	<ul style="list-style-type: none"> <li>- Future regulations</li> <li>- Climate change</li> <li>- Implementation</li> </ul>
<b>Community</b>	<ul style="list-style-type: none"> <li>- Neighborhood equity</li> <li>- Cost allocation</li> <li>- Minimal shoreline impacts</li> <li>- Minimal property disruption</li> <li>- Minimal implementation impacts</li> <li>- Minimal operations impacts</li> <li>- Minimal disturbance of archeological areas</li> </ul>
<b>Compatibility with Other Programs and Initiatives</b>	<ul style="list-style-type: none"> <li>- Seattle departments: Planning and Development (DPD), Parks and Recreation, Public Utilities (SPU), and Transportation (SDOT)</li> <li>- Sediment management plan</li> <li>- County-wide planning policies</li> <li>- Stormwater management responsibilities</li> <li>- Conveyance system improvement policies</li> <li>- WTD productivity initiative</li> <li>- WTD CSO Program</li> </ul>

### **5.2.3 Step 1.3: Develop Initial Conceptual Alternatives**

Initial alternatives were developed in order to assess each control approach. Each alternative identified necessary infrastructure and locations chosen based on proximity to the CSO and the feasibility of using gravity sewers for flow to and from the new infrastructure. Storage alternatives identified in this phase were all centralized; dispersed storage options were identified in Phase 2, after flow monitoring and modeling were completed.

### **5.2.4 Step 1.4: Evaluation and Initial Results**

Following the development of initial alternatives, an assessment of the viability of each control approach or a combination of control approaches was completed considering the constraints of the Barton and Murray CSO basins (topography, land use, downstream capacity, and peak-flow sources). The conclusions of this assessment were as follows:

- **Peak-Flow Storage Approach.** The topography of the Barton and Murray CSO basins is such that few locations exist for siting storage facilities at the bottom of basin. Each potential site identified faces construction challenges (available space, existing land use, proximity to Puget Sound, and geotechnical concerns). In the Barton CSO basin, there is no land available immediately adjacent to the existing Barton Pump Station; any construction near the pump station would require removal of several private properties and would involve significant disruption of traffic to the ferry terminal. However, the Barton CSO basin is suitable for a mid-basin storage facility that can achieve CSO control at the bottom of the basin. In Murray, storage facilities must be located at the bottom of the basin to reliably provide control. The topography and land use provide few opportunities to site the required facilities. Some identified sites involve park property or private property. A preliminary geotechnical investigation of the basins recommended that a geotechnical evaluation be conducted on the recommended alternatives for each basin as part of preliminary design.
- **Convey and Treat Approach.** The convey and treat control approach was determined to be technically infeasible because of capacity limitations of the Alki Wet Weather Treatment Plant.
- **End-of-Pipe Treatment Approach.** End-of-pipe treatment was determined to be technically feasible. It was recommended that a geotechnical analysis of soil conditions be conducted to determine the feasibility of locating facilities near the Barton and Murray Pump Stations.
- **Peak-Flow Reduction Approach.** Evaluation of peak-flow reduction using impervious area disconnection indicated that it would not be sufficient by itself to reduce CSOs to one event per year in the Murray CSO basin.
- **Combination of Approaches.** Peak-flow reduction could be used in combination with storage to meet the CSO regulations in this basin. There is enough connected impervious area in Barton Sub-basin 416 for disconnection to provide control for the

Barton CSO basin, once the proposed capacity upgrade of the Barton Pump Station is completed.

These are initial assessments of the viability of each control approach. Further consideration was given in Phase 2 to control approaches identified here as not viable. Approaches were reviewed with agency stakeholders at an Agency Workshop on May 7, 2009. Input from the workshop was used to help develop and refine the alternatives and criteria for Phase 2.

## **5.3 PHASE 2**

Phase 2 comprised re-evaluation and refinement of CSO approaches and development of preliminary alternatives following completion of flow monitoring and hydraulic modeling. Community information meetings and briefings with citizens in late 2007 and early 2009 elicited comments on community concerns and support or opposition to approaches.

### **5.3.1 Step 2.1: Develop and Evaluate CSO Control Alternatives**

The August 19, 2009 team memoranda, “Developing Criteria for Evaluating CSO Alternatives” (Carollo Engineers) and “Selecting Candidate Sites for CSO Control Approaches” (Carollo Engineers) describe the process for developing and evaluating alternatives. The process is summarized below.

#### **5.3.1.1 Step 2.1A: Criteria Development**

“Category Leads” were designated for each of seven categories of selection criteria to be used in evaluating alternatives. The Category Leads developed criteria as follows:

- Select up to five criteria for each final category shown in Table 5.2. In the operations and maintenance (O&M) category, for example, one criterion might be “Reliability,” another might be “Site Access,” etc. As part of this process, the seven categories developed in Phase 1 were refined. During refinement, some categories were combined and renamed as shown in Table 5.2. Two initial categories, “Flexibility” and “Compatibility with other Programs and Initiatives” were combined with other categories due to their interrelationship. The “Land Use / Acquisition / Permitting” category was subdivided into two categories in recognition of differences between land acquisition and project permitting.
- Develop questions to be answered for each criterion. These questions were used to “test” the impact of a particular alternative on the criteria being considered. For example, one question for the “Reliability” criterion was, “Does the alternative rely on complex automation for successful operation?” Another question may be, “Has the alternative proven to be a reliable CSO control method in other installations?”
- Develop a description of how the criterion will be measured using the rating scale (i.e. Low, Moderate, and High impact). For the question, “Does the alternative rely on complex automation for successful operation?” a “High” score would be described by, “The alternative requires substantial automation of mechanical equipment for

performance.” A “Low” score would be described by, “The alternative is relatively simple and requires limited automation and equipment for performance.”

<b>Table 5.2 Evaluation Category Development</b>	
<b>Initial Category (June 2007)</b>	<b>Final Category (September 2009)</b>
<p align="center">Cost Effectiveness</p> <p align="center">Ease of Operations and Maintenance</p> <p align="center">Technical Feasibility and Compatibility</p> <p align="center">Public Health and Environmental</p> <p align="center">Community Considerations</p> <p align="center">Flexibility<sup>(1)</sup></p> <p align="center">Compatibility with other Programs and Initiatives<sup>(1)</sup></p>	<p align="center">Cost</p> <p align="center">Operations and Maintenance (O&amp;M)</p> <p align="center">Technical</p> <p align="center">Environmental</p> <p align="center">Community Impact</p> <p align="center">Land Use / Acquisition<sup>(2)</sup></p> <p align="center">Permitting<sup>(2)</sup></p>
<p><u>Notes:</u></p> <p>1. Criteria combined with other categories in final criteria category list.</p> <p>2. Category added following initial criteria category development.</p>	

The final criteria, questions, and rating scales developed through this process are included in Appendix B and summarized in Table 5.3.

**5.3.1.2 Step 2.1B: Alternatives Development**

Site suitability criteria for the evaluation were developed and then used together with GIS data to identify potential preliminary sites. Available land areas where new system components could be sited and constructed were identified based on the “technical feasibility” of the resulting alternative. “Technical feasibility” was defined as follows:

- Availability of Peak Flows. The resulting alternative must be sited in a location that allows sufficient peak flows to be captured and routed to the new facility.
- Constructability. The resulting alternative (and associated system components) must be constructible on the site. In order for an alternative to be constructible, the site where components would be built must be of sufficient size, with reasonable access for construction activities (staging, shoring, excavation, tank construction, etc.).
- Operational Performance. The resulting alternative (and system components) must be capable of meeting the intended performance within the existing hydraulic profile of the CSO outfall and combined sewer system.

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
METHODOLOGY FOR DEVELOPING AND EVALUATING ALTERNATIVES**

<b>Table 5.3 Evaluation Criteria, Questions and Rating Scale</b>			
Questions	Rating Scale		
	Low Impact (rating of 3)	Moderate Impact (rating of 2)	High Impact (rating of 1)
<b>LAND USE AND PERMITTING CRITERIA</b>			
<b>Criterion 1. City of Seattle Comprehensive Plan</b>			
1. Project location consistent with Seattle planning policies?	Yes	Partly consistent	Potentially inconsistent
<b>Criterion 2. Seattle Municipal Code</b>			
1. Construction location and type consistent with Municipal Code and Growth Management Act?	Yes	Partly consistent	Inconsistent
<b>Criterion 3. Shoreline Master Program</b>			
1. Project location consistent with the Shoreline Master Program?	Not located in shoreline zone	Located in shoreline zone, generally consistent	Located in shoreline zone, potentially inconsistent
<b>Criterion 4. Permitting Complexity</b>			
1. Discretionary permits required?	SEPA and local permits	Shoreline substantial development permit, and/or discretionary land use permit	3 – 4 required with Public Notice. Shoreline and critical area reviews required
2. Project changes NPDES permit requirements?	Meets baseline reporting requirements		Requires additional monitoring and/or reporting
3. Project requires marine access or in-water work? Multiple work closures due to habitat?	No marine access required. No known fish or wildlife impact.	Marine access may be required. Fish and wildlife impacts low to moderate.	Marine access required. Fish and wildlife impacts higher and more certain.
4. Significant traffic and noise impacts?	Roadways not affected, or only low-volume roads.	Project requires attention to traffic control and access	Major traffic and access issues.
<b>Criterion 5. Property Acquisition Complexity</b>			
1. Property rights can be acquired within project timeline?	King County has ownership.	Voluntary seller identified or use of ROW	Ability to acquire property rights unknown
2. Potential acquisition variables that impact cost?	Owner and King County agree on price	Owner requests additional compensation	Significant costs of acquisition probable
3. Impacts on stakeholders & current use?	No conflict w/ current use	Owners /tenants require relocation	Strong opposition from stakeholders
<b>ENVIRONMENT CRITERIA</b>			
<b>Criterion 1. Cultural Resources</b>			
1. Construction impact on archaeological resources?	No known archaeological resource sites in or near site and potential is low.	Site contains no known archaeological resources but there is potential.	Project area contains or is adjacent to known archaeological sites.
2. Construction impact on historic resources?	No historic properties in or near the project area.	Historic properties in or near project area, but no construction impact on them.	Historic properties in or near project area, and likely construction impact on them.
<b>Criterion 2. Fish and Wildlife</b>			
1. Project construction or operation will adversely affect fish, wildlife or habitat?	Benefit or no adverse impact.	Potential adverse impact.	Likely adverse impact.
<b>Criterion 3. Wetlands, Streams, and Shoreline</b>			
1. Project construction impact on wetlands, streams or shorelines?	Project unlikely to impact wetlands, streams, buffers or shorelines.	Likely direct impact on buffer, but not wetlands, streams or shorelines.	Likely direct impact on wetlands, streams or shorelines.

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
METHODOLOGY FOR DEVELOPING AND EVALUATING ALTERNATIVES**

<b>Table 5.3 Evaluation Criteria, Questions and Rating Scale</b>			
Questions	Rating Scale		
	Low Impact (rating of 3)	Moderate Impact (rating of 2)	High Impact (rating of 1)
<b>ENVIRONMENT CRITERIA (continued)</b>			
<b>Criterion 4. Soils and Sediments</b>			
1. Will construction disturb contaminated soils?	Project area has no known contaminated soils and potential for contaminated soils on the site is low.	Project area has no known contaminated soils but there is potential for contaminated soils on the site.	The project site area is known to contain contaminated soils.
2. Will construction disrupt steep slopes or increase landslide risk?	No likely effect.	Temporary effect.	Long-term effect.
<b>Criterion 5. Water Quality</b>			
1. Will operation result in a new discharge of untreated stormwater to a surface water?	No	Possibly	Yes
<b>TECHNICAL CRITERIA</b>			
<b>Criterion 1. Technical Complexity</b>			
1. Does project require complex controls and infrastructure to direct flow? Will it reliably meet CSO control objectives?	Measurement and control for flow routing is simple. Project is near or within existing infrastructure.	Requires remote measurement of flows and controlled routing of flows. Modifications to infrastructure are simple.	More than two locations require flow control. Complex controls required to route flow. New pipelines of significant length may be needed.
2. How many individual sites are included? Are technical and construction approaches consistent across sites?	Only one site. All controls and infrastructure are located on the site or on adjacent right of way or county-owned property.	Two non-adjacent sites, potentially with differing construction methods. Structures may be needed adjacent to sites.	Multiple non-adjacent sites. Two or more construction technologies may be required.
<b>Criterion 2. Compatibility with Existing Wastewater System</b>			
1. Do standards of other agencies affect project design and operation?	King county design standards are the only applicable standards.	Flow routing structures may be located in City of Seattle infrastructure, and be subject to City standards. No City access permissions needed.	Major structures within City infrastructure, where City standards apply. Permissions and coordination needed for normal O&M access.
2. Does the project affect other parts of the wastewater system?	The project is stand-alone. Peak flows at West Point are not affected.	Project may require modifications to county infrastructure. Peak flows at West Point may be affected.	The project requires modification of City of Seattle and county infrastructure and operational methods for both.
<b>Criterion 3. Flexibility/ Adaptive Management</b>			
1. Can the project meet changing control criteria?	Yes	Possibly	No
2. Can the project be easily modified to meet future flow conditions?	Yes	Possibly	No
<b>Criterion 4. Constructability/Implementation Schedule</b>			
1. Significant construction risks associated with groundwater, steep slopes, or soil materials?	Project is on stable, low-slope site with no effect from groundwater.	Site may have low to moderate slope, require some dewatering and foundations.	Site has steep slopes, groundwater and soil conditions that increase instability. High erosion potential. Special measures needed to stabilize site.
2. Significant construction risks associated with access, staging, specialty contractors, power, etc.?	No constraints. Adequate area for access, staging and operation of equipment.	Contractor may have to provide offsite staging and operations.	Construction requires offsite staging and operations, and sequencing to accommodate specialty contractors.
3. Can project meet the schedule?	Yes	Possibly	No

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
METHODOLOGY FOR DEVELOPING AND EVALUATING ALTERNATIVES**

<b>Table 5.3 Evaluation Criteria, Questions and Rating Scale</b>			
Questions	Rating Scale		
	Low Impact (rating of 3)	Moderate Impact (rating of 2)	High Impact (rating of 1)
<b>O&amp;M CRITERIA</b>			
<b>Criterion 1. Staffing</b>			
1. Can the facility be started up easily and operate autonomously under design conditions?	Yes	Facility can be automatically started but requires attention during design conditions.	Facility requires operator attention during startup and design conditions.
2. What level of staffing is required for peak operation and for shutdown?	Facility can be remotely operated. Peak staffing less than 1 FTE. Facility can be shut down with minimal staff time. Cleanup is automated or can be integrated with other duties.	Operation requires operator periodically. Peak staffing is 1-2 FTE. Facility can be shut down with minimal staff time. Most cleanup is automated and can be integrated with other duties, but 1-2 FTE may be required.	Facility requires operator attention. Peak staffing is 2 or more. Significant effort required for shut down. Cleanup work is generally manual; 2 or more FTE for more than one day.
3. Does the project impact downstream treatment facility processes?	No impact on downstream secondary processes or secondary treatment bypass frequency.	Impact on downstream secondary processes but no effect on permit compliance. Increased secondary treatment bypass frequency within permit limits.	Impact on downstream secondary processes that may affect permit compliance. Increased secondary treatment bypass frequency not within permit limits.
<b>Criterion 2. Training</b>			
1. How much staff training is required? Is existing staff familiar with the technology?	Minimal training required. Staff is familiar with the technology and similar processes are used at other CSO projects.	Minimal training is required. Staff does not routinely operate similar processes or the processes are distinctly different from those used at other CSO projects.	Significant training is required. Staff does not routinely operate similar processes and the processes are distinctly different from those used at other CSO projects.
2. Are similar control approaches specified with identical components? Can the facilities be used to simulate an event for testing and training?	Similar control approaches are specified with identical components at each facility. Control procedures are similar to existing facilities. Facilities can be used to simulate an event for testing and training.	Somewhat similar control approaches are specified at each facility, with some differences. Control procedures are not similar to existing facilities. Facilities can be used to simulate an event for testing and training.	Different control approaches are specified at each facility. Control procedures are not similar to existing facilities. Facilities cannot be used to simulate an event for testing and training.
<b>Criterion 3. Reliability</b>			
1. How complex is the system? How complex are the startup procedures and controls? Are redundant control systems provided? Is dedicated backup power available?	The project has minimal components. Startup is passive or automated remotely with redundant control systems and backup power.	The project has several components. Startup is automated locally with redundant control systems and backup power.	The project has numerous components. Startup is generally automated locally but may require operator action, with redundant control systems. No backup power.
2. Proven technology? Are the control systems routinely used for similar facilities and similar applications?	Project uses processes commonly used by King County and the industry. Control requirements are minimal and routinely used for similar facilities.	Project uses processes commonly used within the industry. Control requirements may be significant but are routinely used for similar facilities.	Project uses processes not commonly used within the industry. Control requirements may be significant and unique.

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
METHODOLOGY FOR DEVELOPING AND EVALUATING ALTERNATIVES**

<b>Table 5.3 Evaluation Criteria, Questions and Rating Scale</b>			
Questions	Rating Scale		
	Low Impact (rating of 3)	Moderate Impact (rating of 2)	High Impact (rating of 1)
<b>O&amp;M CRITERIA (continued)</b>			
<b>Criterion 4. Maintenance</b>			
1. What is the level of normal maintenance? How many mechanical/instrumentation components are required?	Annual preventive maintenance. Minimal mechanical/ instrumentation components.	Monthly maintenance. Moderate level of mechanical/ instrumentation components.	Monthly maintenance. High level of mechanical/ instrumentation components.
2. Are facility components accessible? Access and staging available for maintenance vehicles? Traffic control required for routine maintenance?	The facilities are accessible.	Facilities are accessible for routine O&M. Special procedures or traffic control may be required for irregular maintenance.	Facilities have restricted access for routine O&M. Special procedures or traffic control may be required for irregular maintenance.
3. Do the facilities require interaction with other agencies (Seattle Parks, etc.) for O&M?	No	Not for operation, but for some routine maintenance	Yes
<b>Criterion 5. Safety</b>			
1. Does the facility have right-of-way access requirements or require confined space entry? Are traffic control procedures required? Does access require street use permit or lane closure?	No right-of-way access requirements, confined space entry or traffic control required for O&M.	Right of way access requirements, confined space entry or traffic control required for non-routine O&M.	Right of way access requirements, confined space entry or traffic control required for routine O&M.
<b>COST EFFECTIVENESS CRITERIA</b>			
<b>Criterion 1. Project Costs</b>			
1. Are project costs predictable and quantifiable for design, permitting and mitigation?	Technology and construction methods of are common. Costs for design and construction are controllable within the expertise of the county. Construction schedule, sequencing, and site constraints are low.	Technology and construction methods include both well-known and somewhat new to elements. Cost experience of other local agencies or the designer is adequate to control costs. Construction schedule, sequencing, and site constraints are quantifiable.	New technologies with complex controls and multi agency interactions create project cost variables that are not within the county's or designer's experience. Schedule, site constraints, and sequencing add variables that are hard to control.
2. What is the relative premium to provide flexibility and durability to meet future uncertainty?	Technology is modular and can be easily expanded in the future.	Design to meet future needs requires extra measures, but additions for capacity or performance are modular.	Technology is not amenable to future changes. Planning for separate future projects may be needed.

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
METHODOLOGY FOR DEVELOPING AND EVALUATING ALTERNATIVES**

<b>Table 5.3 Evaluation Criteria, Questions and Rating Scale</b>			
Questions	Rating Scale		
	Low Impact (rating of 3)	Moderate Impact (rating of 2)	High Impact (rating of 1)
<b>COST EFFECTIVENESS CRITERIA</b>			
<b>Criterion 2. Operation Costs</b>			
1. Are operational costs predictable and quantifiable?	Few components require O&M attention. Activities are predictable, can be scheduled, have annual frequency, and use familiar procedures and technology. Operation is easily remotely controlled.	3-4 components require O&M attention. Activities are predictable, can be scheduled, have monthly frequency, and use procedures and technology that may require training. Operation may require attention to confirm performance. Maintenance access may be restricted.	More than 4 components require O&M attention. Activities are predictable, can be scheduled, have monthly or greater frequency, and use procedures and technology that require special training and staffing. Operation requires attention to confirm performance. Maintenance access may be restricted.
2. Are costs for training, energy, staffing, and external agency activities high or low?	Project does not require special training; no chemicals or significant power are required, and there are no routine external agency costs.	Project requires additional training within existing skill sets; no chemicals or significant power are required. There are annual costs associated with external agency coordination.	Project requires additional training for new skill sets; chemicals and significant power are required. There are frequent costs associated with external agency coordination.
3. Are additional staff positions required for operation?	No	Limited additional staff needed for maintenance.	Additional staff needed for operation and maintenance.
<b>Criterion 3. Maintenance Costs</b>			
1. Does the project require significant maintenance resources?	Maintenance is limited to annual cycle with existing staff resources.	Maintenance is monthly with increased staff resources and increased complexity.	Maintenance is monthly with increased staff resources and complex processes.
2. Does the project require maintenance skills beyond the County's typical expertise?	No	Requires additional training within existing skill sets.	Project requires additional training within new skill sets.
3. Does maintenance cost increase with capacity?	No	Capacity increases require more mechanical or electrical maintenance and more cleaning, not directly proportional to capacity.	Mechanical or electrical maintenance and additional cleaning are directly proportional to capacity increase.
<b>Criterion 4. External Costs</b>			
1. How does the cost of land and land development compare with other alternatives?	County owns the land.	County must purchase ground lease but does not have to acquire the land.	County must purchase the land and mitigate or replace displaced resources.
2. Are extra costs imposed by design standards or durability requirements of external agencies or stakeholders?	County controls all design requirements.	County has to provide additional design elements to meet standards.	County has to invest heavily into meeting external standards and costs are not controllable.
3. Are there extra costs for durability elements to insure successful operation and maintenance?	No	Some parts of the project are under external agency control for design standards, durability, or operation.	All parts of the project will be constructed and operated by others.
<b>Criterion 5. Grant Opportunities</b>			
1. Does the project have attributes that make it more amenable to grant funding ("green" technology, public benefits, etc.)?	The project has several such components.	Some components of the project may help to win grants.	No

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
METHODOLOGY FOR DEVELOPING AND EVALUATING ALTERNATIVES**

<b>Table 5.3 Evaluation Criteria, Questions and Rating Scale</b>			
Questions	Rating Scale		
	Low Impact (rating of 3)	Moderate Impact (rating of 2)	High Impact (rating of 1)
<b>COMMUNITY IMPACT CRITERIA</b>			
<b>Criterion 1. Location</b>			
1. Does facility change or impede surrounding land and marine uses?	No	Facility requires design elements to limit changes or impediments to surrounding uses.	Facility changes or impedes surrounding uses and changes cannot be addressed in design.
<b>Criterion 2. Potential Community Impacts</b>			
1. Is use compatible with community vision of itself at project outset?	Facility is consistent with or does not affect community's vision of itself.	Facility and grounds can be designed to remain consistent with community's vision of itself.	Facility is not in character with community's vision of area and difference cannot be addressed in design.
2. What are the impacts of O&M activities on the surrounding community?	Minimal staff will be present infrequently and maintenance is carried out within facilities.	Routine maintenance will be needed, and staff may be onsite round the clock to check facilities. Some special equipment may be necessary, but disruptions are minor.	Routine maintenance will be needed, and multiple staff will be present around the clock. Parking, traffic or access disruptions during maintenance operations.
<b>Criterion 3. Construction Impacts</b>			
1. What is the construction schedule/duration?	Short term project in residential area, long term project in business/ industrial area, or longer term project on alignment.	Project extends over 1 year on a site near residences of any kind, or over two years on an alignment.	Project extends several years, or follows another substantial construction project in one area.
2. Will construction be carried out in public access areas?	Project on site with no public access, or public access can be maintained during construction.	Project located in public access area; access may be reduced, but some access can be maintained during construction.	Project lasts a year or more, in heavy use roadway, park or beach area , with serious and unavoidable area closures.
3. What are anticipated construction impacts on neighbors? What are the traffic disruptions?	Neighbors will experience limited impacts.	Construction will be near residences and businesses, but impacts will be limited to ordinary work hours and can be mitigated with reasonable effort.	Construction will be adjacent to residences and businesses, and it will be difficult to mitigate impacts. Environmental monitoring will be necessary.
4. How will truck traffic affect area?	Limited amount of hauling required; roadways sufficient to support traffic.	Moderate level of hauling that may occur on residential streets but can be scheduled to avoid conflicts.	High-volume, long-term truck traffic on constricted roadways that cannot be done on a restricted schedule or route.
5. What is construction area requirement?	Construction can be carried out on facility site, with limited offsite area required.	Construction can be carried out on facility site, but additional offsite areas will be required.	Additional property or extensive easements must be obtained for the project to be constructed. Multiple offsite areas will be required, with ongoing transport of materials to primary site.

A hierarchy of technical considerations was used to judge “technical feasibility” and identify potential sites for the CSO control approaches. They are listed in order from most favorable to less favorable as follows:

1. Favor locations and facility configurations at the bottom of the basin near the existing CSO outfall.
  - a. Provides ability to capture 100 percent of the flow in the basin and route it to the new facility.
  - b. Reduces complexity of control system required to route flows to new facility; thereby reducing risks of future overflows.
  - c. Minimizes conveyance system construction requirements.
2. Favor locations along existing combined sewer trunk lines through which 50 percent or more of the total basin peak flow is conveyed.
  - a. Helps ensure sufficient volumes are captured to adequately reduce peak flows and volumes at the bottom of the basin at the existing CSO outfall.
3. Favor locations and facility configurations that allow a passive diversion of peak flows to the new facility (e.g., over a weir wall) rather than more complex control systems requiring telemetry or SCADA (supervisory control and data acquisition).
  - a. Increases reliability by eliminating the need for power and control system (e.g., automated gates).
  - b. Reduces the potential need to oversize the facility to limit overflows.
4. Favor locations and facility configurations where the bottom of new structures will not exceed a depth of 30 feet below the ground surface elevation.
  - a. Minimizes shoring and dewatering requirements.
  - b. Requires less area for construction and staging.
  - c. Shallower facilities are easier to access.
  - d. Avoids excessive structural requirements for tanks and treatment facilities.
  - e. Increases feasibility of cut-and-cover construction for storage pipes vs. riskier and more expensive tunneled construction.

### **5.3.2 Step 2.2: Alternatives Screening**

This step involved screening the alternatives to develop a shortlist for detailed evaluation. Step 2.2 was completed in a series of non-technical and technical meetings. The screening process for reducing the preliminary alternatives to three is described in two technical memoranda (Carollo, 2009g and Carollo, 2009h) and summarized in Table 5.4. During the development of a shortlist of alternatives, potential sites were further refined so the project team could focus on the characteristics of specific sites and how they would affect the implementation of each alternative.

### **5.3.3 Step 2.3: Selection of a Preferred Project**

Between January 2010 and December 2010, two concurrent processes were used for developing alternatives and arriving at recommended projects for the Barton and Murray CSO basins:

- In the Barton CSO basin, the shortlisted alternatives were further developed for final evaluation. Detailed information is provided in the project memorandum *Barton Basin Alternatives Update Information* (Tetra Tech, 2010).

<b>Meeting Date</b>	<b>Meeting Purpose</b>	<b>Alternative Version</b>	<b>Description</b>
<b>August 2009</b>	Present preliminary alternatives for initial comment.	V1	Preliminary cut at alternatives by Consultant.
<b>September 2009</b>	Non-technical focus meetings to identify information needed to complete alternative review matrices.	V2	Revisions to V1 based on comments received from CSO Team (non-technical focus).
<b>October 2009</b>	Technical focus meetings to add detail for O&M issues (layouts, configurations, etc.).	V3	Revisions to V2 based on comments received from CSO Team (technical focus).
<b>November 2009</b>	Team workshop to complete review matrices for each alternative.	V4	Revisions to V3 based on comments received from CSO Team
<b>December 2009</b>	Team workshops to select 3 alternatives.	V5	Select 3 alternatives by an initial straw poll and subsequent meetings to iteratively select the 3 alternatives.

- In the Murray Basin, the County and the consultant team entered into a public participation process with a Community Advisory Group empanelled by the County. This was to respond community concerns about potential impacts on parks and the proximity of proposed facilities to residences. The charter of this group was to become educated about the requirements of the CSO program and to work together with the county and consultant team to identify possible alternatives that would fulfill the CSO program requirements and address or relieve the community’s concerns. This process brought forward some new alternatives, which were screened through the processes outlined for Step 2.2.

During the Community Advisory Group process for the Murray CSO basin, the Barton CSO basin evaluation was put on hold because the two basins are hydraulically inter-related, and a decision on a Barton CSO control project could have an effect on a decision for the Murray CSO basin.

Step 2.3 was completed in a series of non-technical and technical meetings to identify information needed to complete the alternative review and prepare evaluation matrices for each alternative.

Following the evaluation process, the project team forwarded to King County management a list of key evaluation points for three shortlisted projects in each of the Barton and Murray CSO basins. County management used this information for a final review and selection of proposed CSO control projects for the two basins. King County management made a final selection of a project on December 8, 2010.

## 5.4 BASIS OF DESIGN

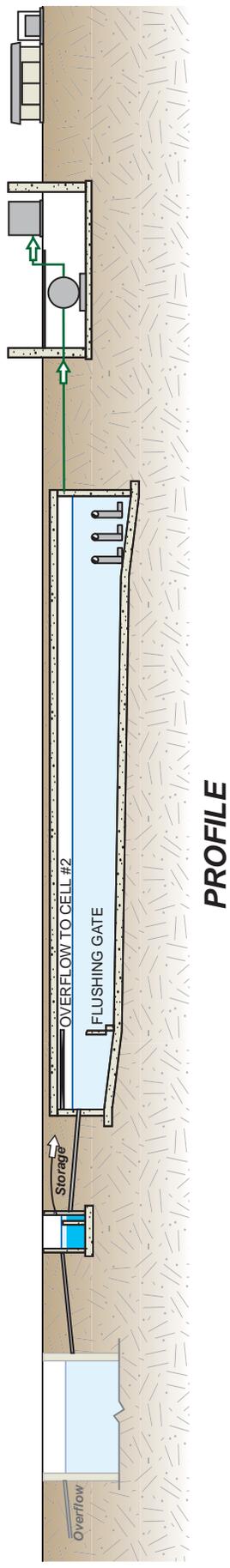
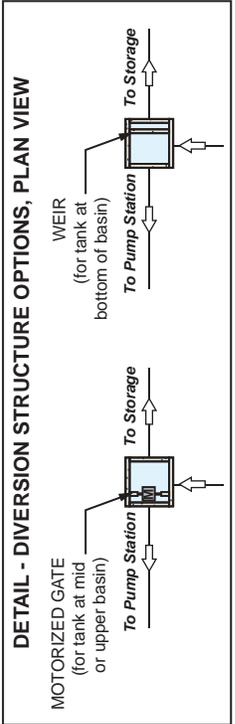
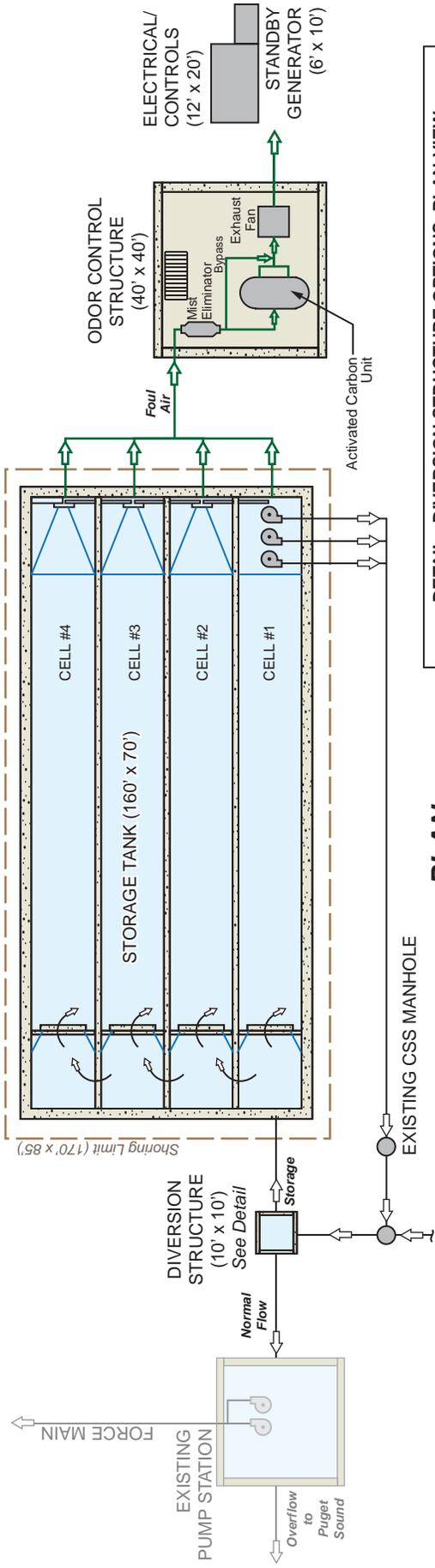
The basis of planning for control of the Barton and Murray CSO basins is presented in Chapter 4 of this facility plan (see Table 4.1). This information was used to size facilities for each CSO control approach.

The basis of design criteria are key criteria for sizing equipment and laying out facilities. Consistency of design criteria is important for evaluating alternatives. Documenting the design criteria also provides key input for final design of the improvements. Figures 5.1 through 5.3 illustrate typical details for potential facilities common to many of the alternatives developed, including storage (rectangular and pipeline), conveyance (pump station), and end of pipe treatment. Table 5.5 highlights key design criteria for these facilities.

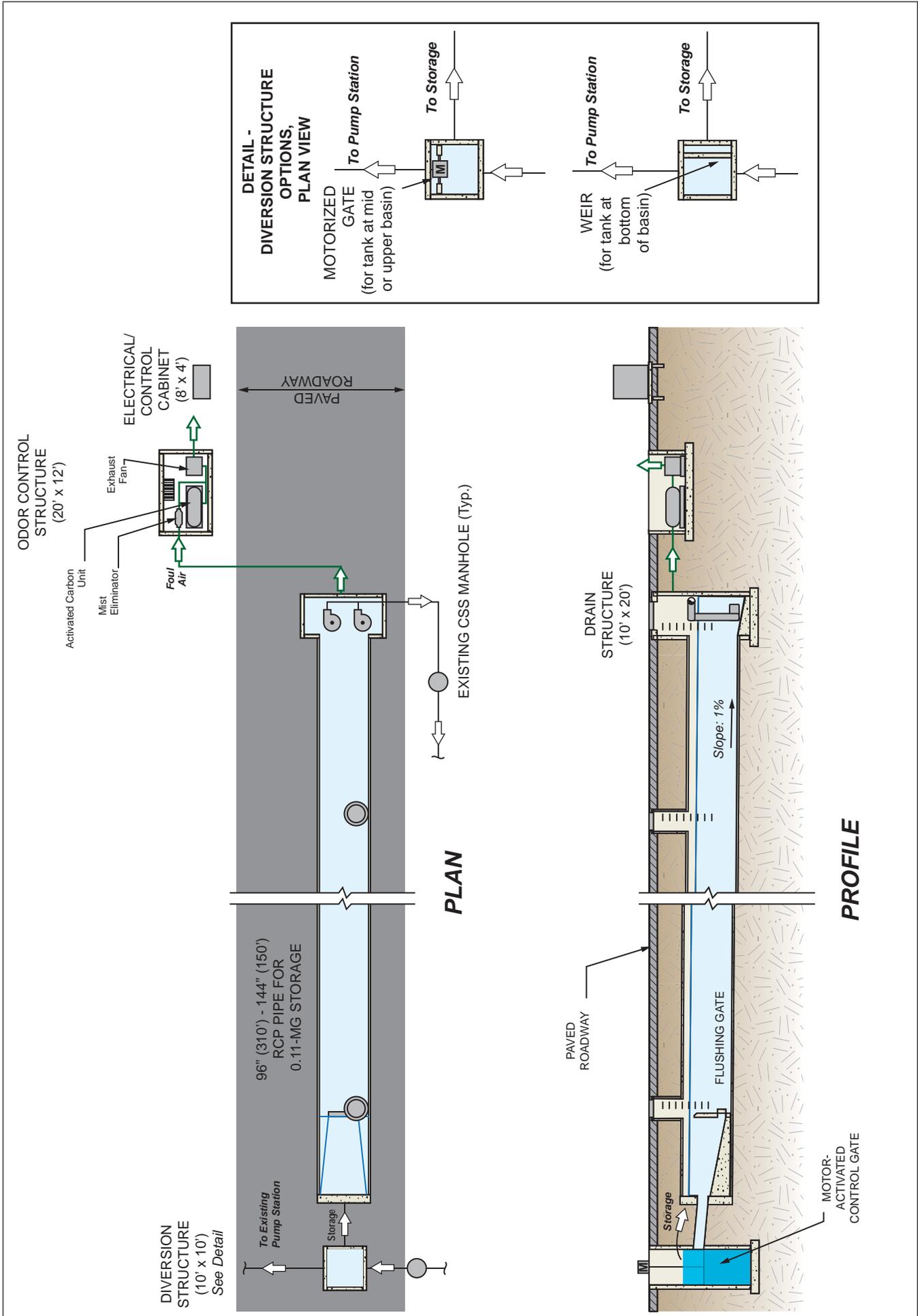
<b>Table 5.5 Basis of Design Criteria</b>	
<b>Facility</b>	<b>Design Criteria</b>
<b><u>Storage (Rectangular or Pipeline)</u></b>	
Number of Cells	Rectangular - 2 to 4; Pipeline - 1
Floor Slope	1%
Minimum Freeboard	2 feet
Number of Drain Pumps	3 duty
Type of Pumps	Submersible
Maximum Time to Drain Storage	12 hours
Odor Control	Peak air displacement rate (peak flow to storage) or 2 air changes per hour (whichever is greater)
Air Treatment	Activated carbon; 1 pass; 50 fpm; constant speed fan/blower
Occupied Space Ventilation	12 air changes per hour
Standby Generator	Total estimated load; diesel w/ 24-hour capacity + 20% free capacity for future expansion.
Access	Every 200 feet (maximum); outside right-of-way
Equipment Materials	Corrosion resistant (304/316 stainless steel or fiberglass reinforced pipe)
<b><u>Pump Station</u></b>	
Number of Pumps	3 duty + 1 standby (per stage <sup>1</sup> )
Type of Pumps	Centrifugal
Firm Capacity	Required conveyance capacity <sup>2</sup>
Wet well	Self-cleaning with modeling for proper design
Odor Control	2 air changes per hour (wet well)
Air Treatment	Activated carbon; 1 pass; 50 fpm; constant speed fan/blower
Occupied Space Ventilation	12 air changes per hour
Standby Generator	Total estimated load; diesel w/ 36 hour capacity
Force Main	10 feet per second up to 12 feet per second with permission (maximum)
Equipment Materials	Corrosion resistant (304/316 stainless steel or fiberglass reinforced pipe)

**Table 5.5 Basis of Design Criteria**

Facility	Design Criteria
<b><u>End of Pipe Treatment</u></b>	
<i>Influent Screening</i>	
Type	Perforated plate
Number of Screens	2
Screen Spacing	6 mm
<i>High Rate Clarification</i>	
Number of Trains	2
Total Suspended Solids Removal	85% or 10 mg/L (maximum)
Biochemical Oxygen Demand Removal	50% or 10 mg/L (maximum)
Chemical Feed Systems	Coagulant and Polymer
<i>Ultraviolet Disinfection</i>	
Number of Channels	1
Transmittance @254 nm	70%
Minimum Dose	40 mJ/sq. cm
Odor Control	2 air changes per hour (process basins)
Air Treatment	Activated carbon; 1 pass; 50 fpm; constant speed fan/blower
Occupied Space Ventilation	12 air changes per hour
Standby Generator	Total estimated load; diesel w/ 36 hour capacity
Equipment Materials	Corrosion resistant (316 stainless steel or fiberglass reinforced pipe)
<b><u>Notes:</u></b>	
1	Total head above 200 feet requires 2-stage pumping for solids pumps.
2	See Table 4.1.

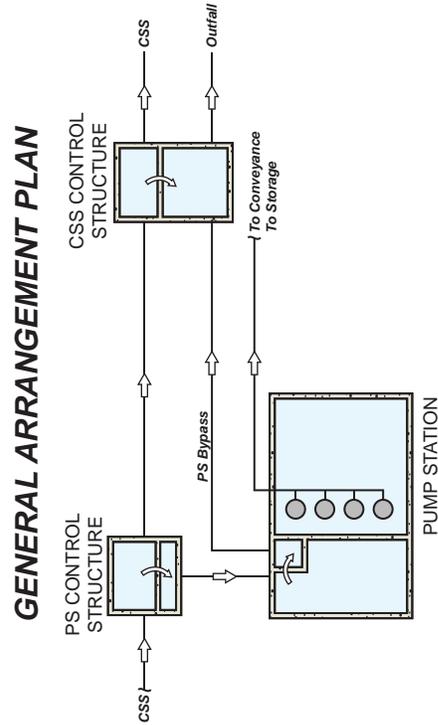
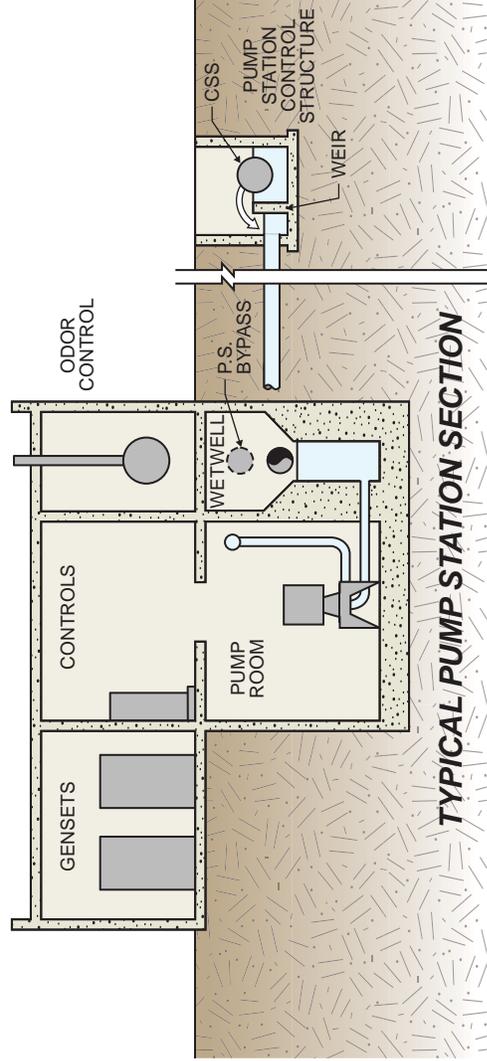
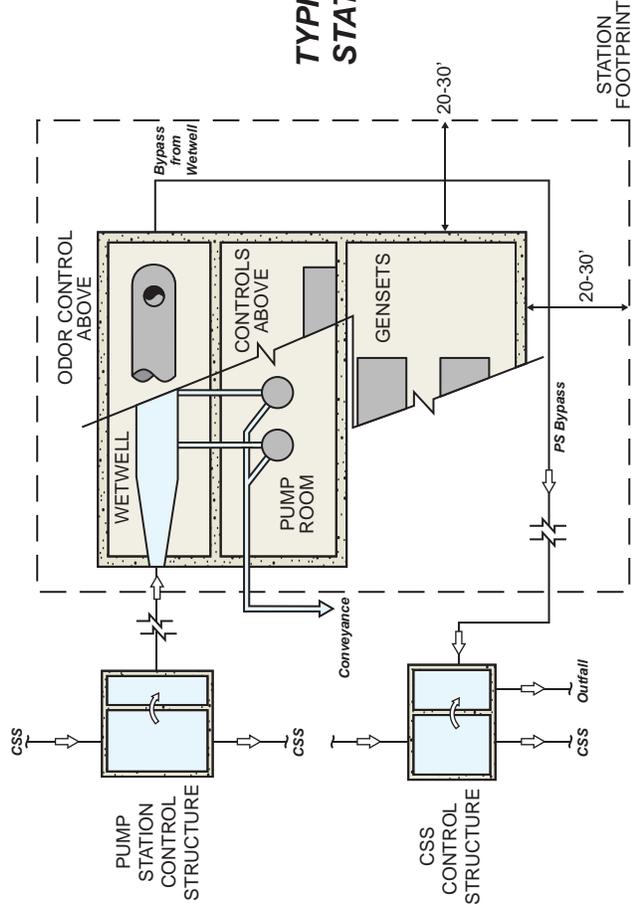


**Figure 5.1.**  
BASIS OF DESIGN TYPICAL DETAIL FOR RECTANGULAR STORAGE TANK



3630023\Fig5-02\_StoragePipeSchematic.ai

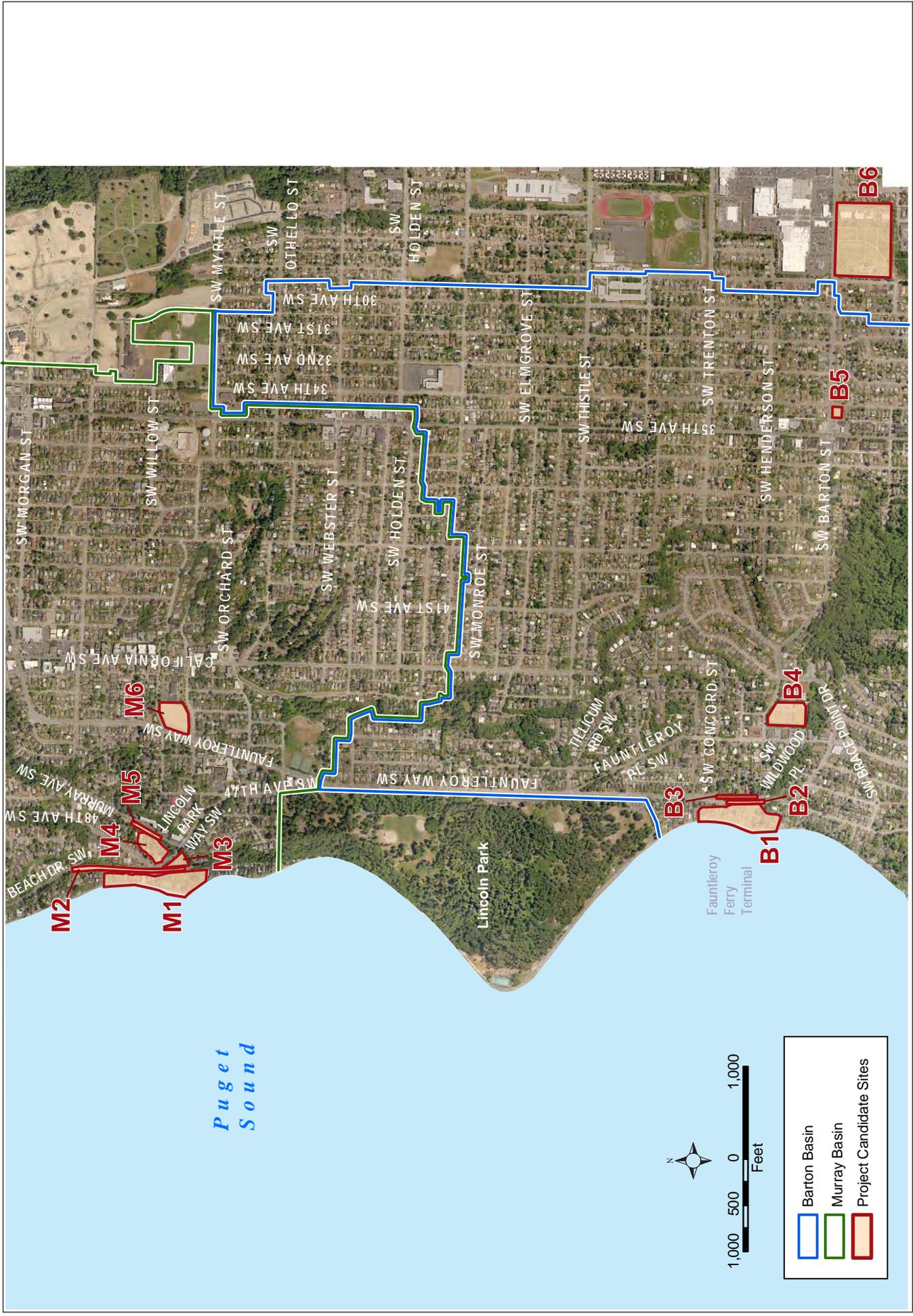
**Figure 5.2.**  
 BASIS OF DESIGN TYPICAL DETAIL FOR STORAGE PIPE



**Figure 5.3.**  
BASIS OF DESIGN TYPICAL DETAIL FOR PUMP STATION

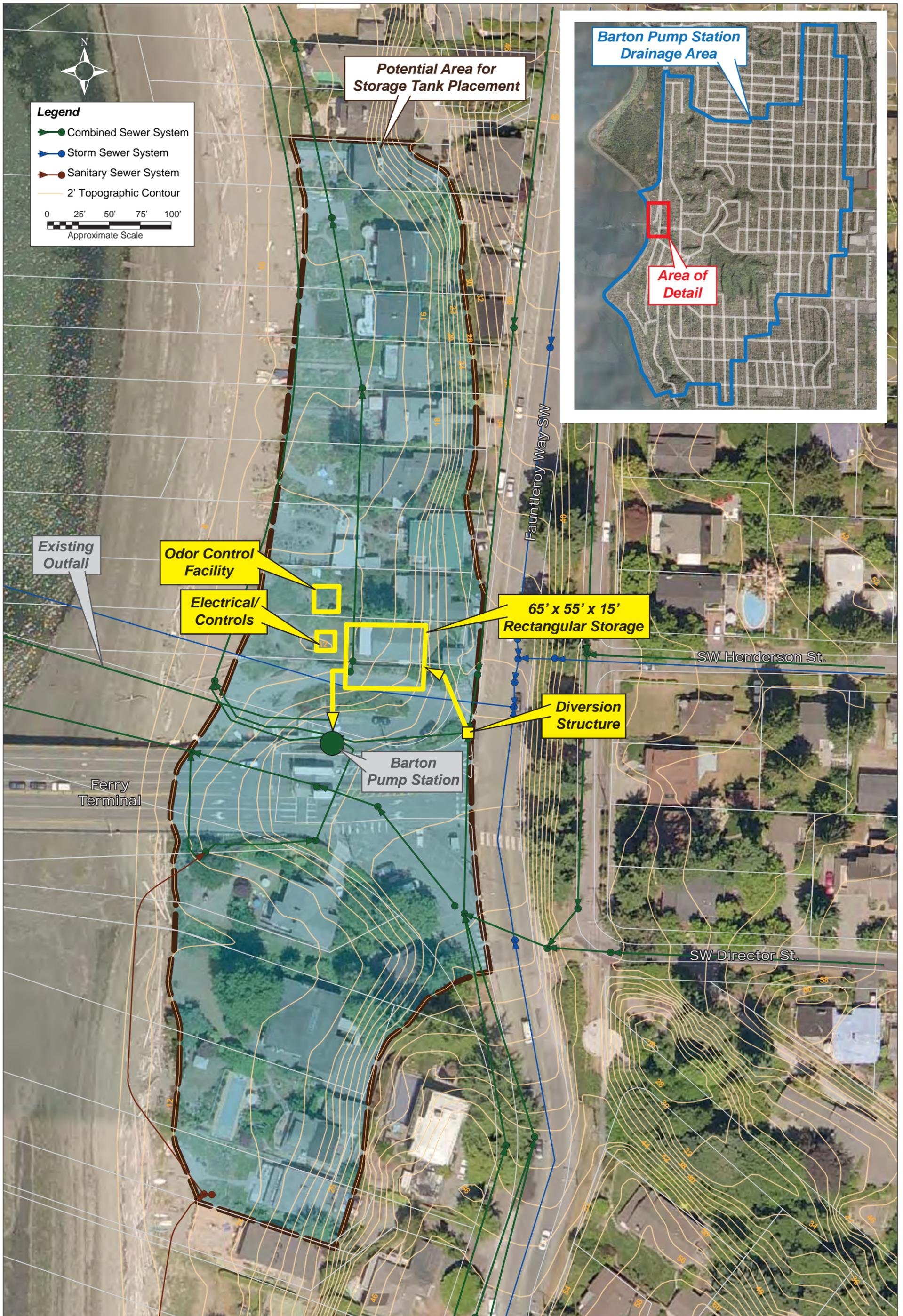
**REFERENCES:**

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- Carollo. 2007b. TM 203.1 Barton, Murray, South Magnolia, and North Beach CSO Facility Selection Criteria. Carollo Engineers, August 2007.
- Carollo. 2009a. Alternative Analysis Framework and Decision Flow. Carollo Engineers, 5/9/09.
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- Carollo. 2009g. CSO Control Alternatives Review and Comment Procedure. Carollo Engineers, 9/22/09.
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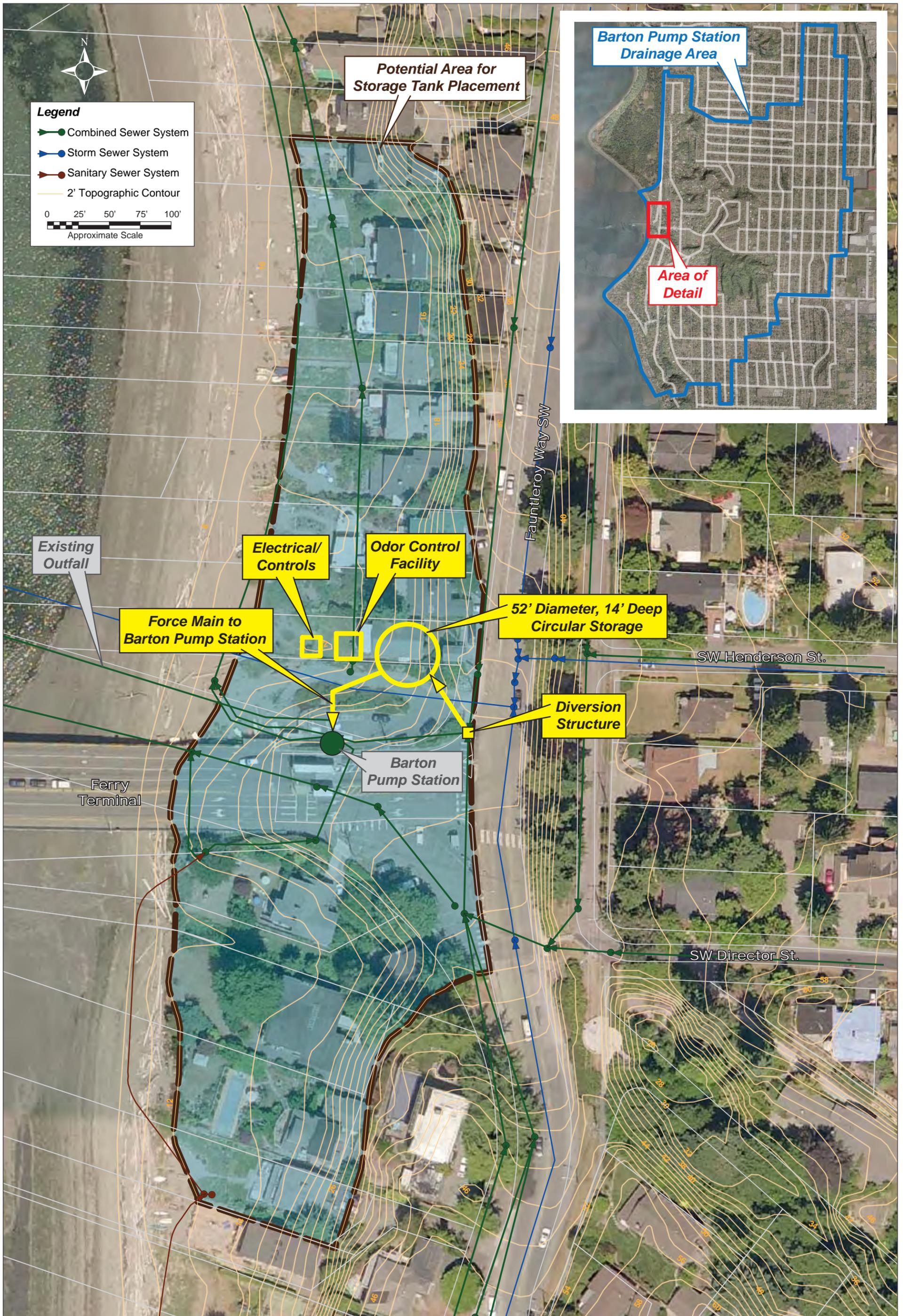
**Figure 6.1.**  
 CANDIDATE SITES



3630023/Fig6-02\_Barton\_Alt1A.ai

Figure 6.2. BARTON CSO BASIN ALTERNATIVE 1A: RECTANGULAR STORAGE AT BOTTOM OF BASIN

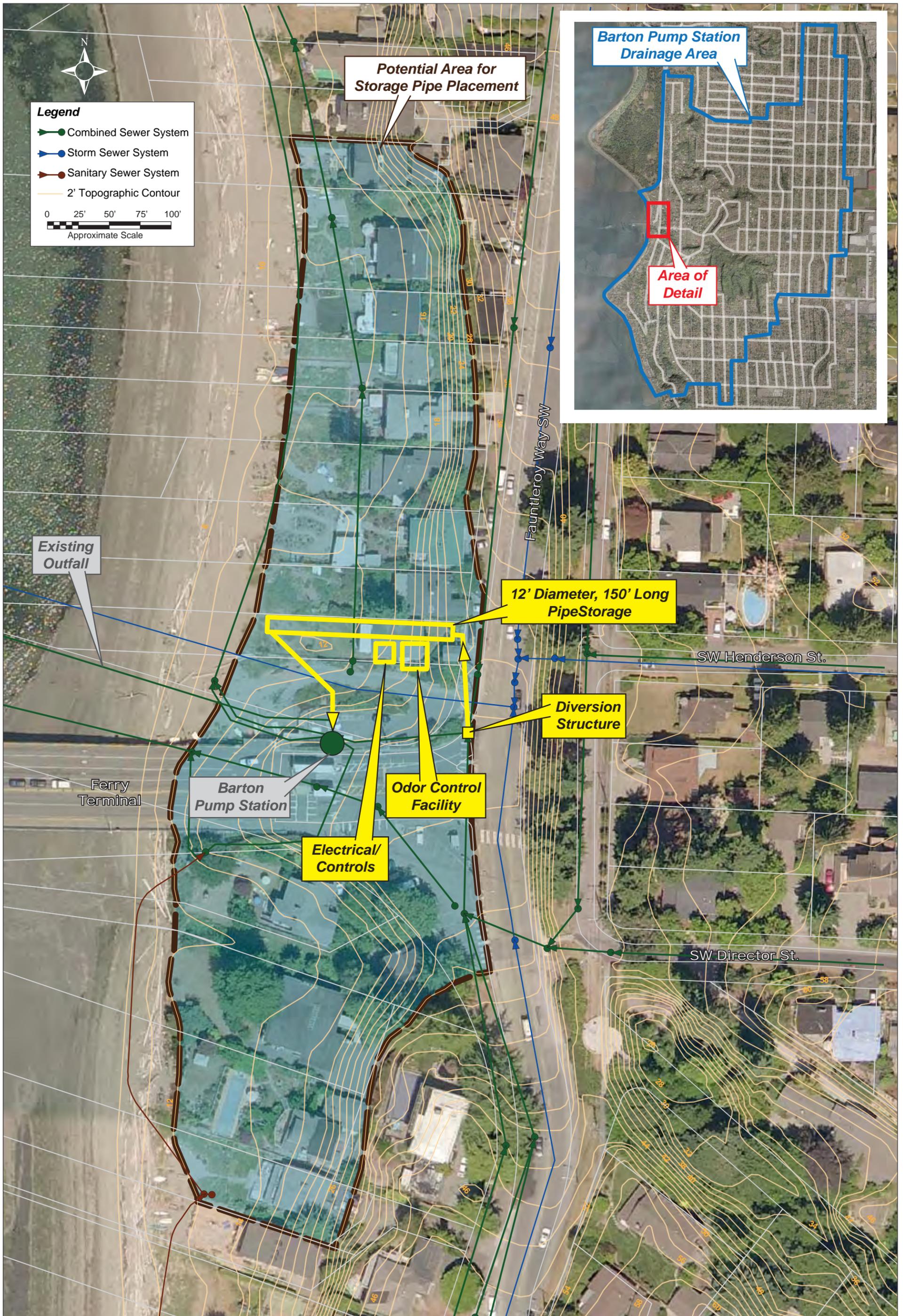




3630023/Fig6-03\_Barton\_Alt1B.ai

Figure 6.3. BARTON CSO BASIN ALTERNATIVE 1B: CIRCULAR STORAGE AT BOTTOM OF BASIN





3630023/Fig6-04\_Barton\_Alt1C.ai

Figure 6.4. BARTON CSO BASIN ALTERNATIVE 1C: PIPE STORAGE AT BOTTOM OF BASIN



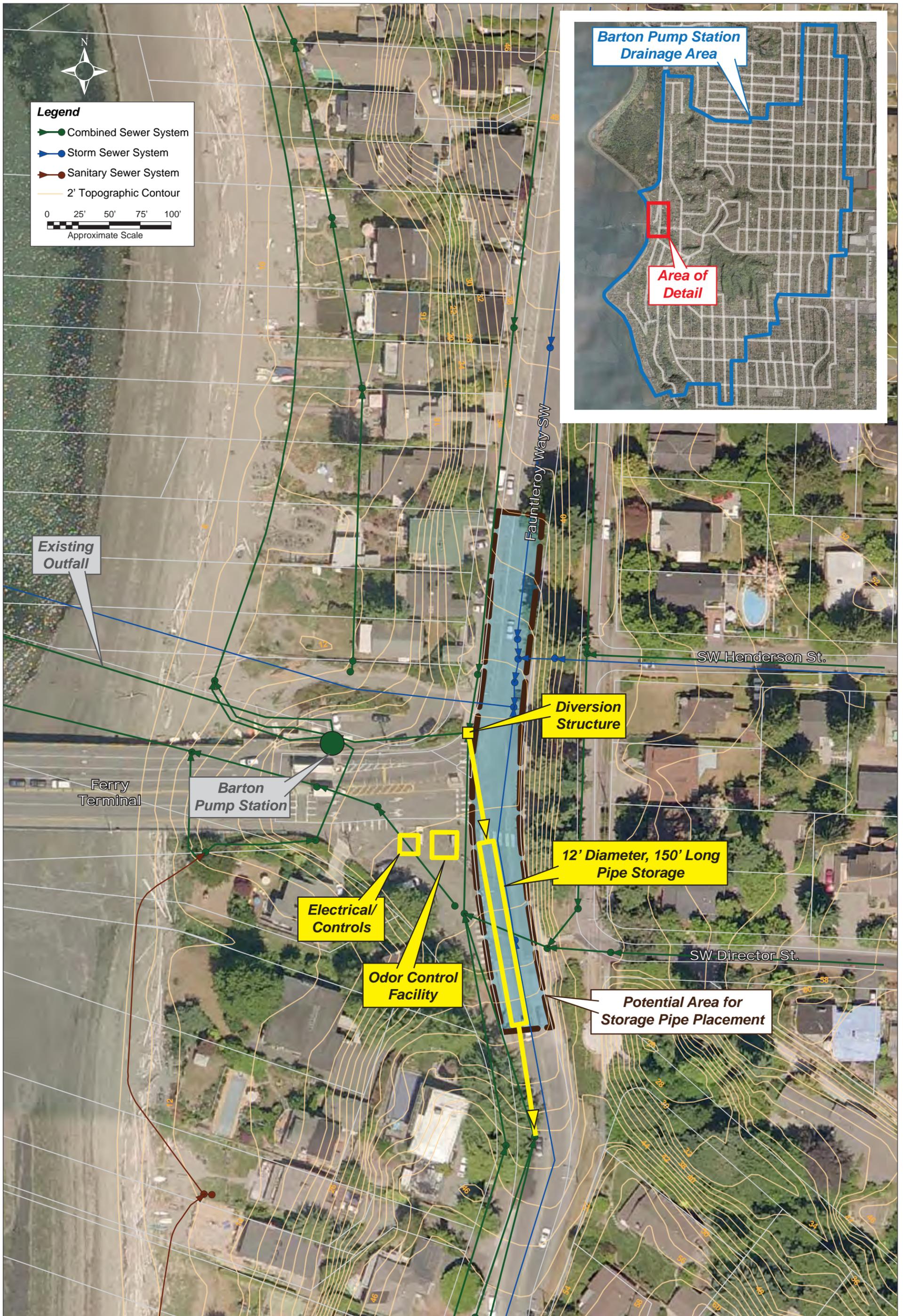
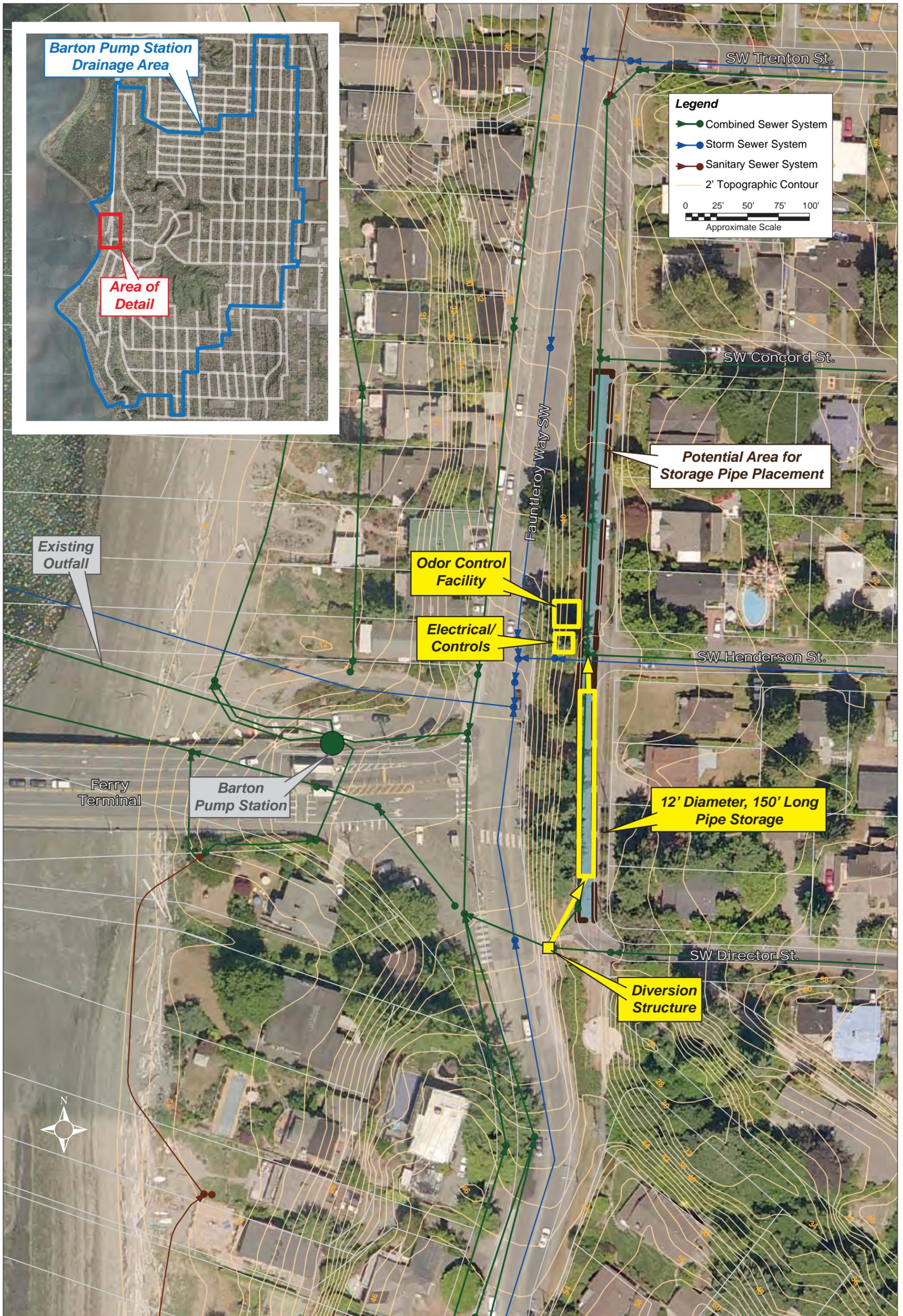


Figure 6.5. BARTON CSO BASIN ALTERNATIVE 1D: PIPE STORAGE IN RIGHT-OF-WAY AT BOTTOM OF BASIN

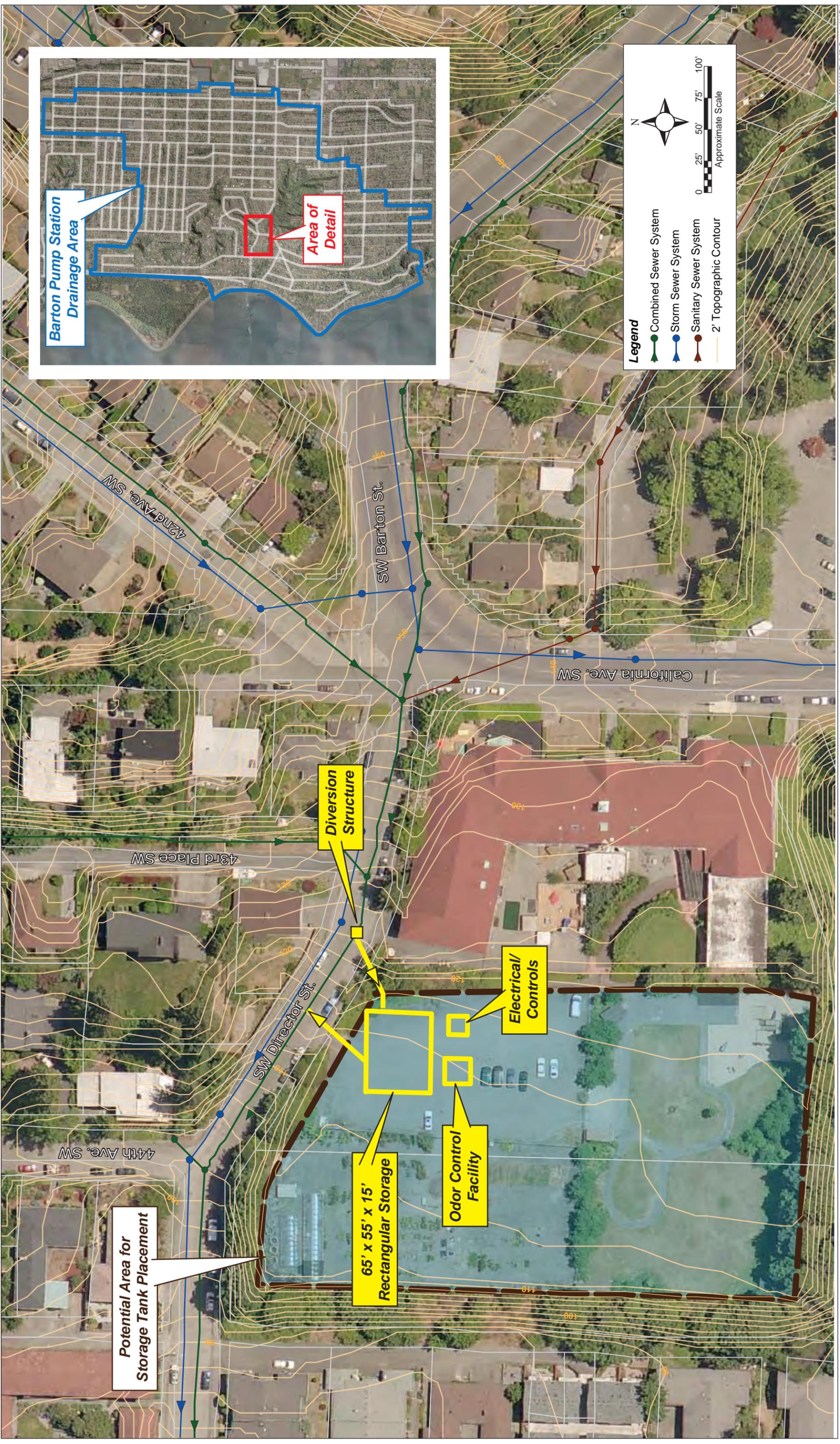




3630023/Fig6-06\_Barton\_Alt1E.ai

Figure 6.6. BARTON CSO BASIN ALTERNATIVE 1E: PIPE STORAGE IN UPPER FAUNTLEROY WAY SW

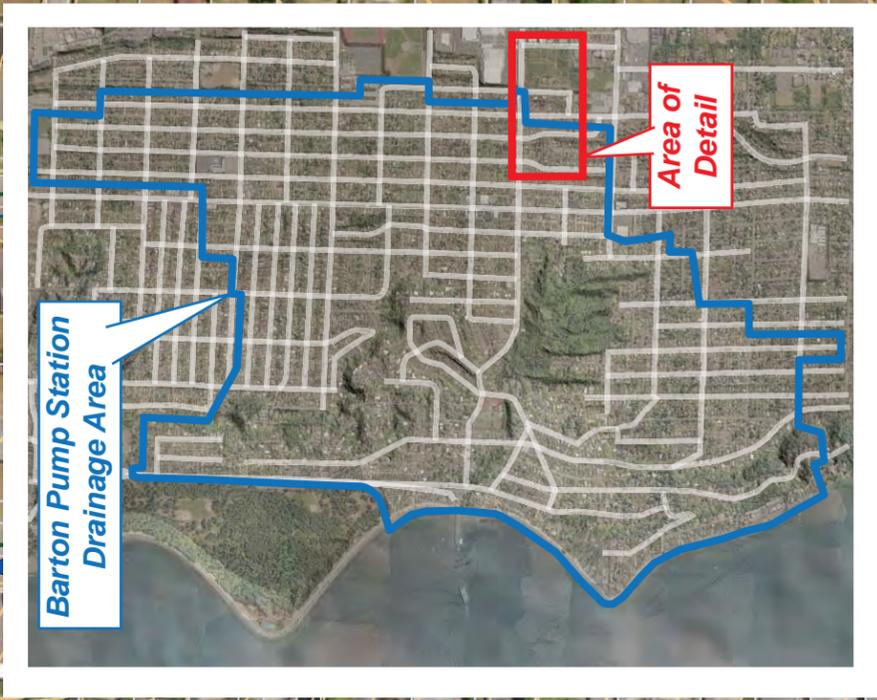
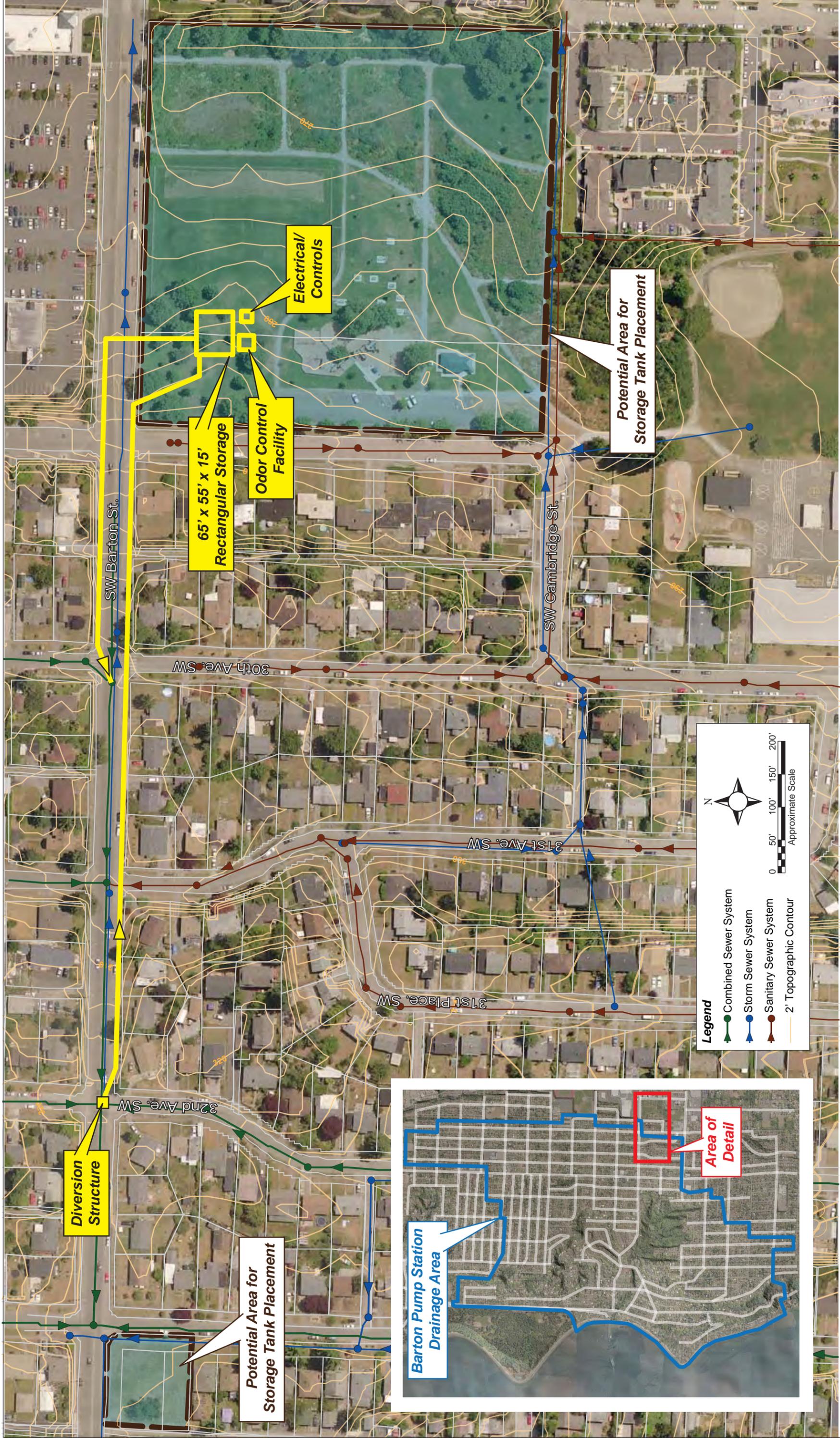




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**Figure 6.7.**  
BARTON CSO BASIN ALTERNATIVE 1F: STORAGE IN VICINITY OF FAUNTLEROY SCHOOL





3630023\Figs-08\_Barton\_AltG.ai

**Figure 6.8.**  
 BARTON CSO BASIN ALTERNATIVE 1G: RECTANGULAR STORAGE IN UPPER BASIN



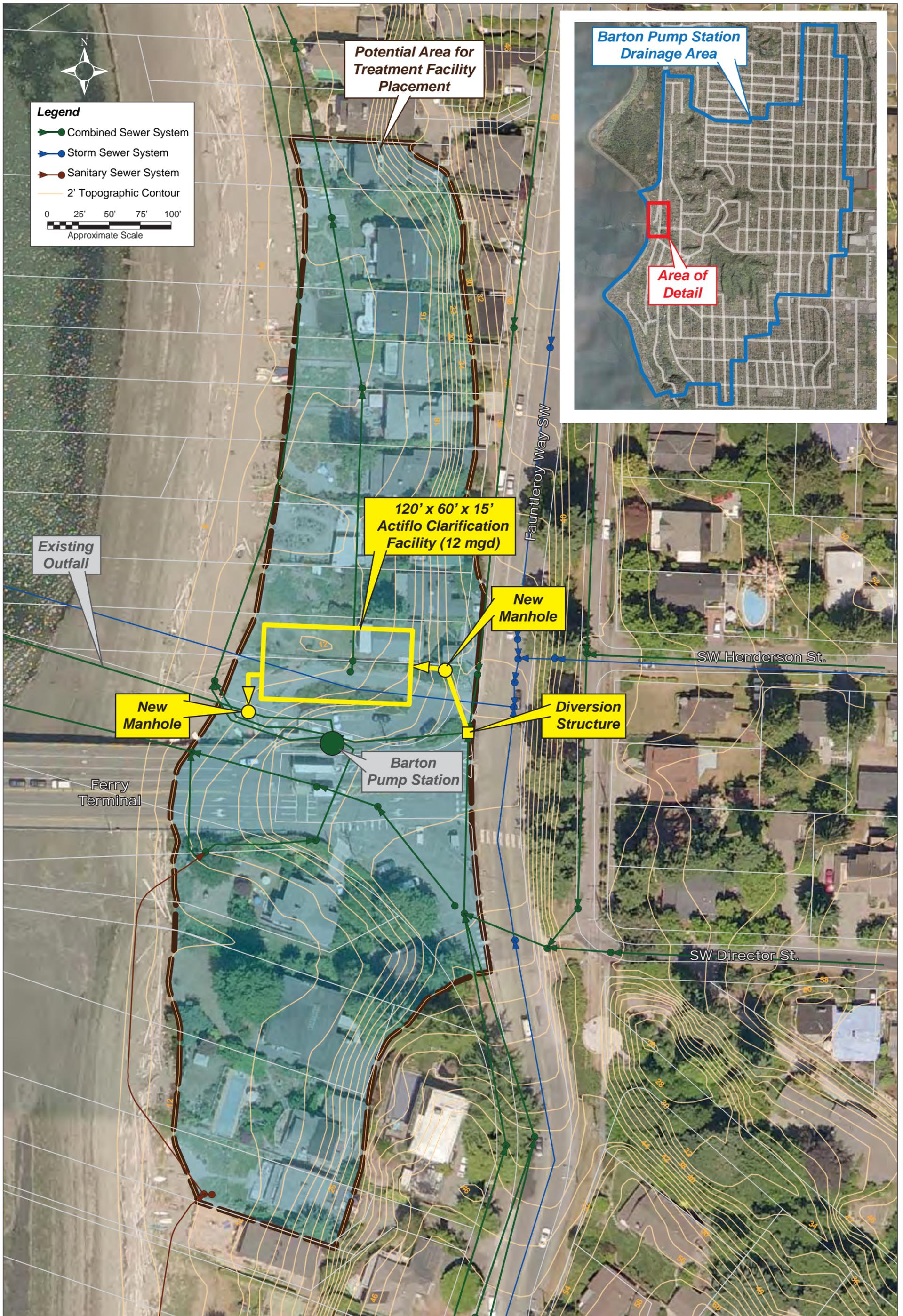
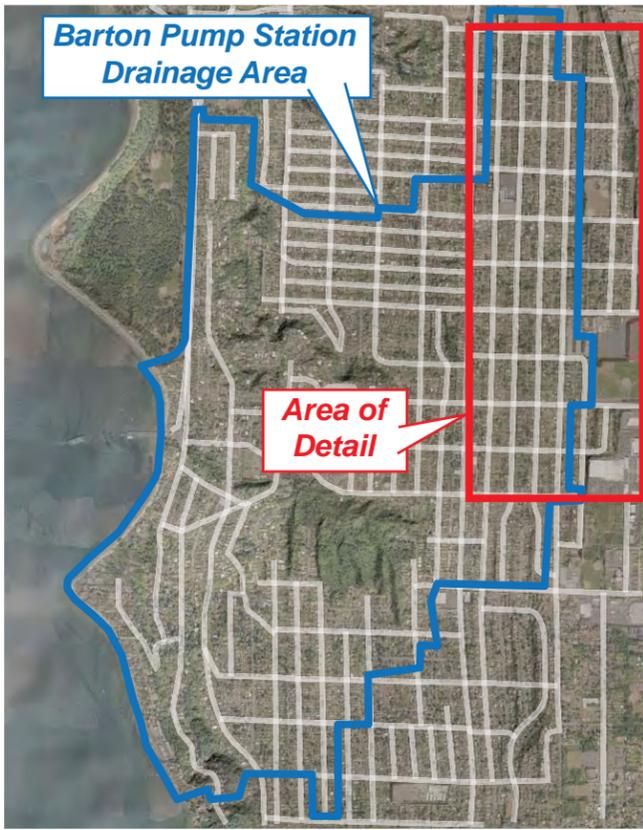


Figure 6.9.  
BARTON CSO BASIN ALTERNATIVE 3A: END-OF-PIPE TREATMENT AT BOTTOM OF BASIN

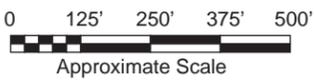
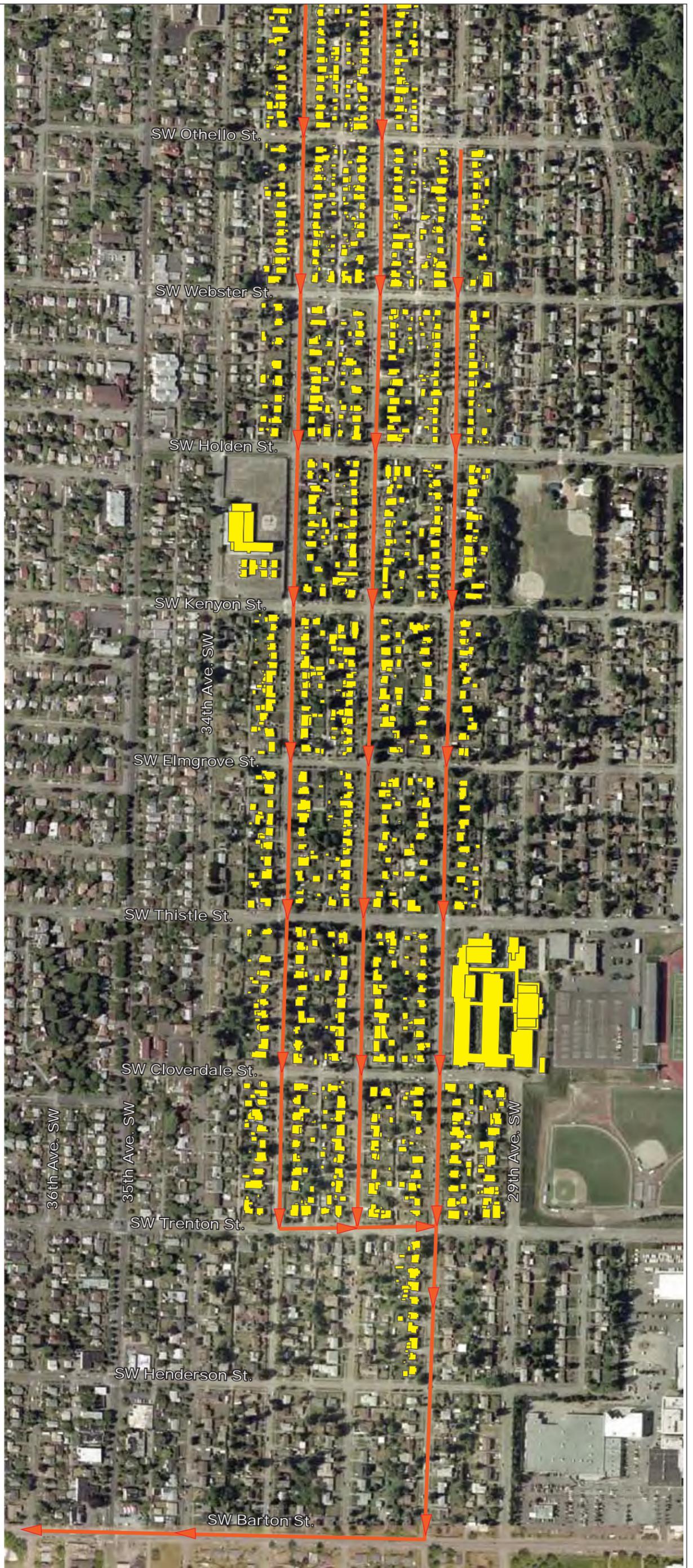




**Legend**

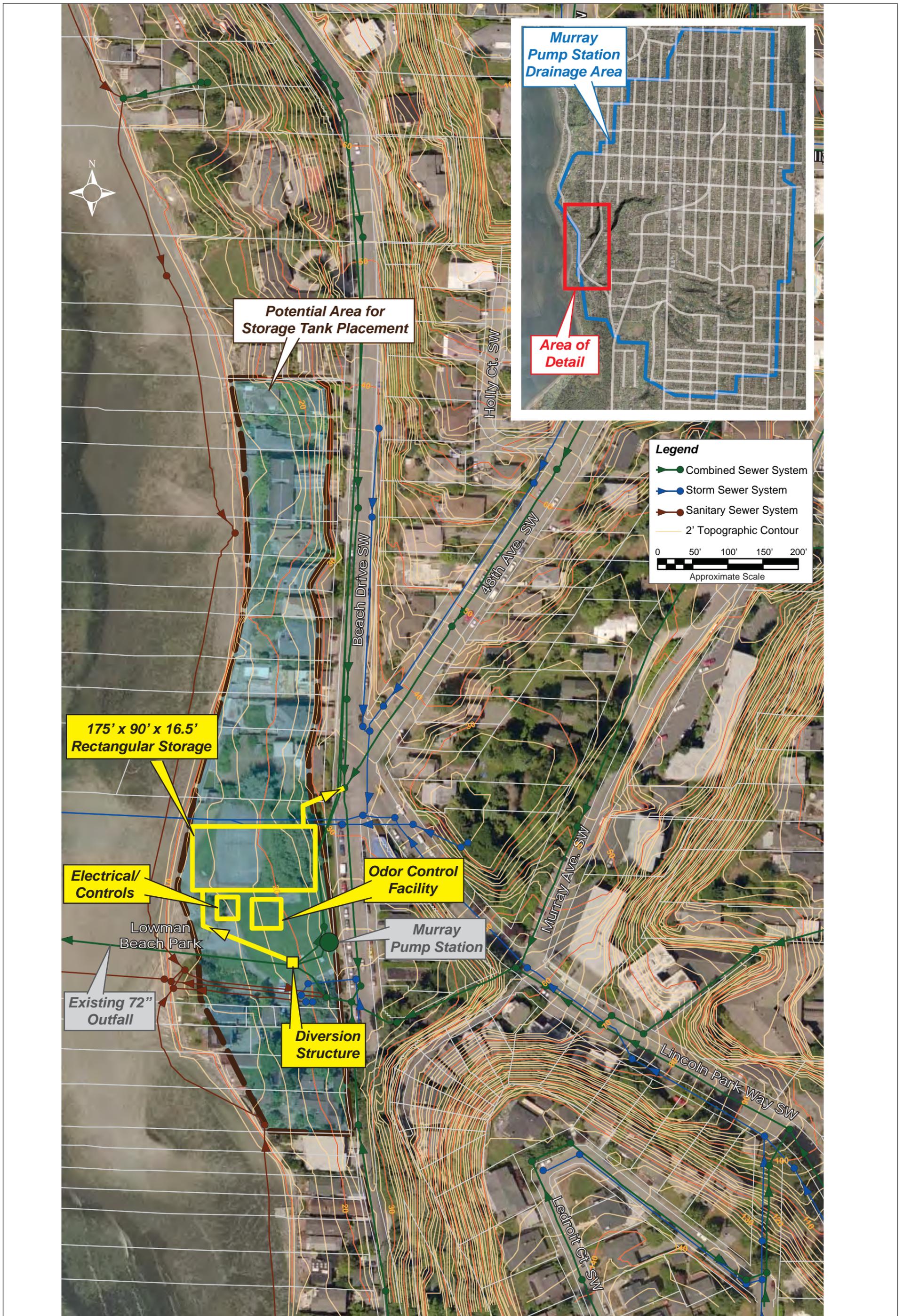
- Roof to Be Disconnected from Combined Sewer System
- New Storm Drain

26 acres of impervious roof and street right-of-way area disconnected from combined sewer system. No storage required.



**Figure 6.10.**  
BARTON CSO BASIN ALTERNATIVE 4A:  
PEAK-FLOW REDUCTION BY ROOF DRAIN DISCONNECTION

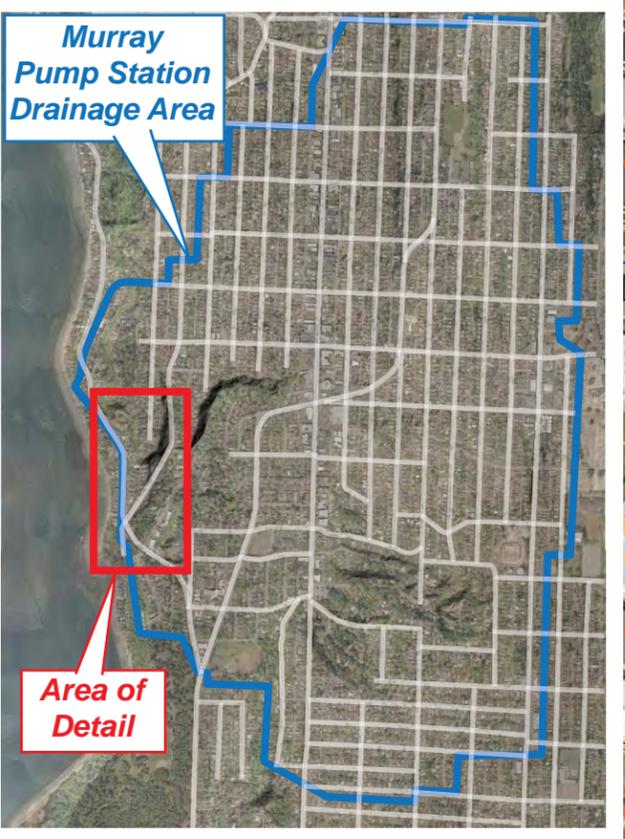
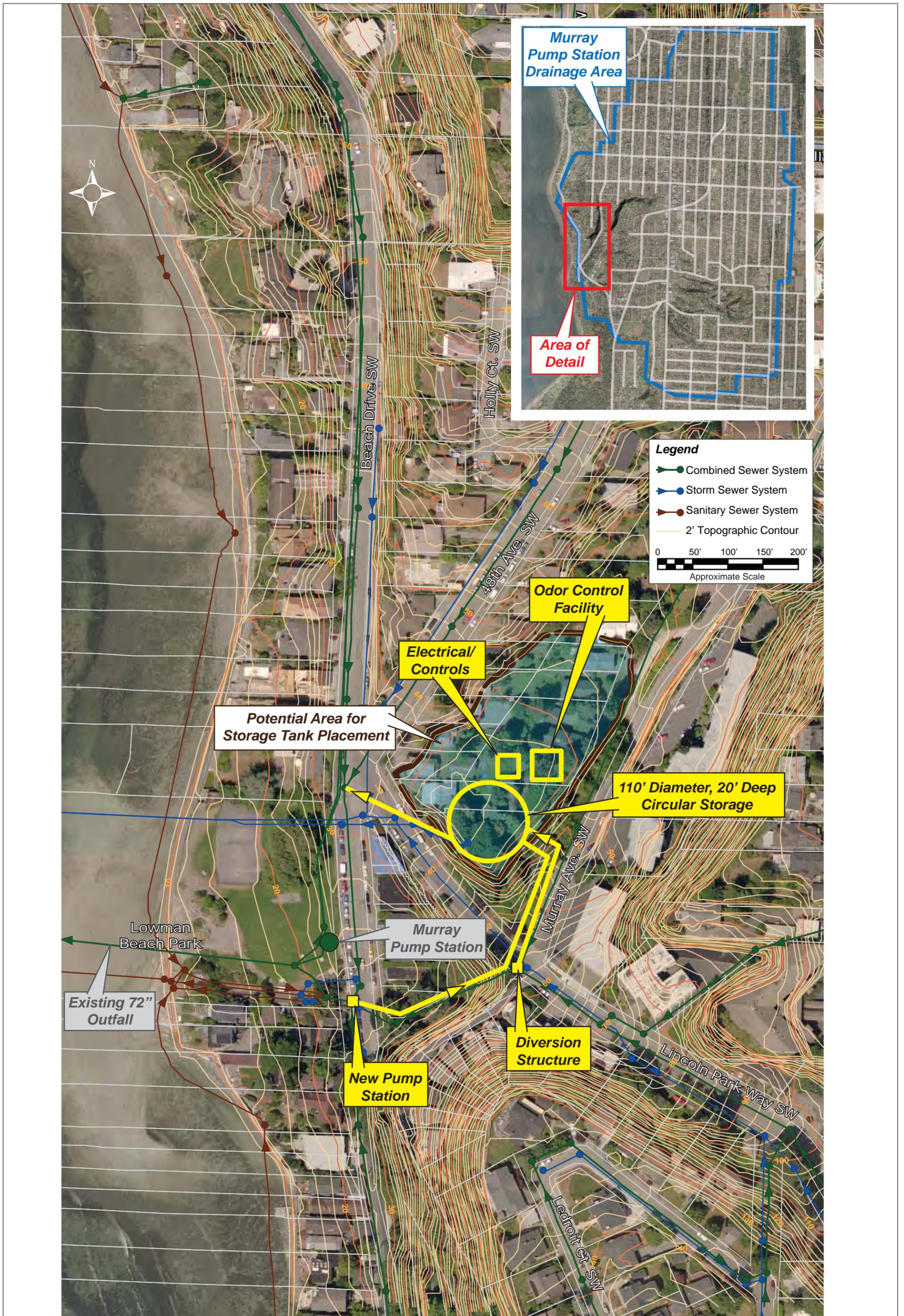




3630023/Fig6-11\_Murray\_Alt1A.ai

Figure 6.11. MURRAY CSO BASIN ALTERNATIVE 1A: RECTANGULAR STORAGE AT BOTTOM OF BASIN





**Legend**

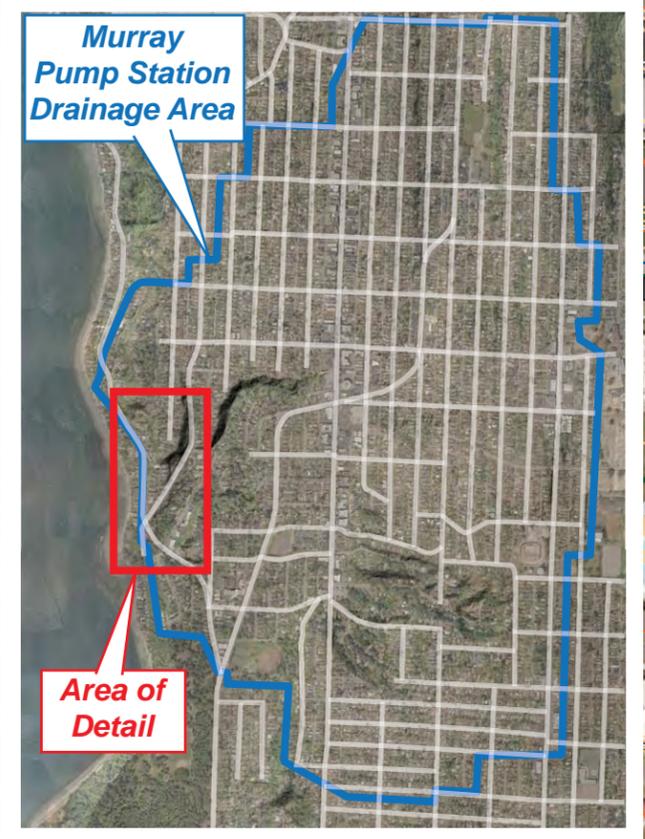
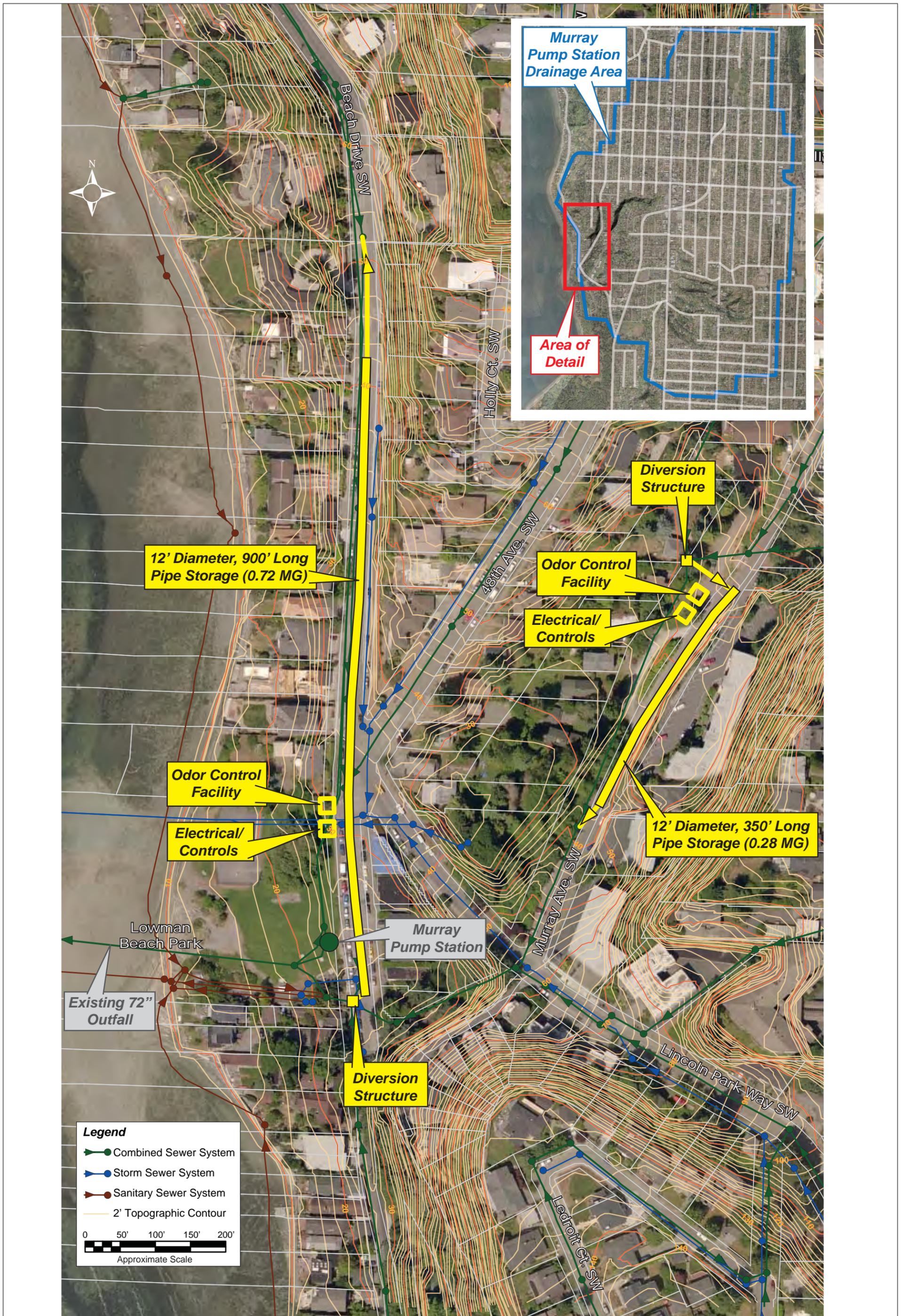
- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 2' Topographic Contour

0 50' 100' 150' 200'

Approximate Scale

**Figure 6.12.**  
 MURRAY CSO BASIN ALTERNATIVE 1B:  
 CIRCULAR STORAGE IN VICINITY OF MURRAY AVENUE AND LINCOLN PARK WAY





**Legend**

- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 2' Topographic Contour

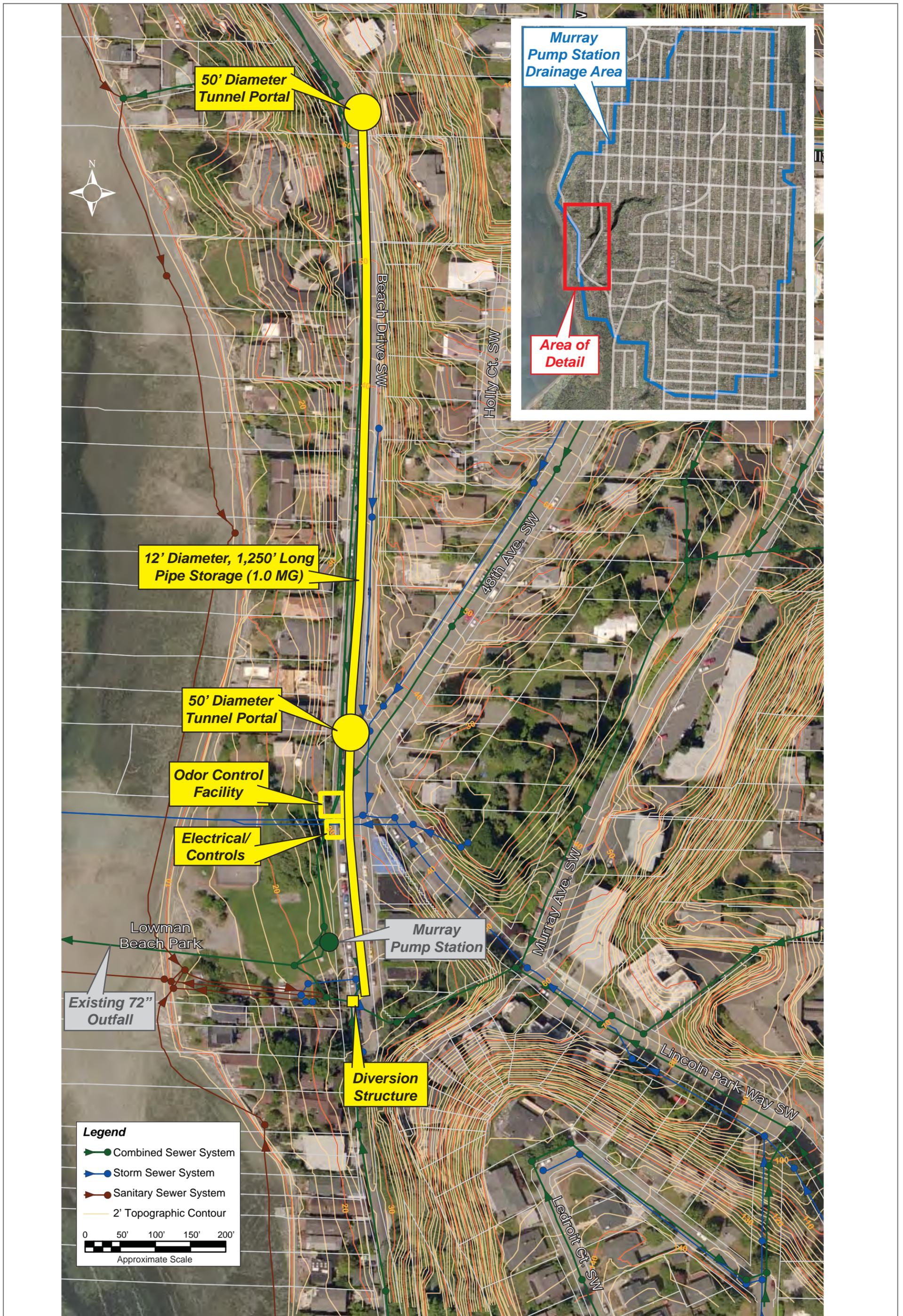
0 50' 100' 150' 200'

Approximate Scale

**Figure 6.13.**  
 MURRAY CSO BASIN ALTERNATIVE 1C:  
 DISTRIBUTED STORAGE ALONG BEACH DRIVE AND MURRAY AVENUE SW

3630023/Fig6-13\_Murray\_Alt1C.ai

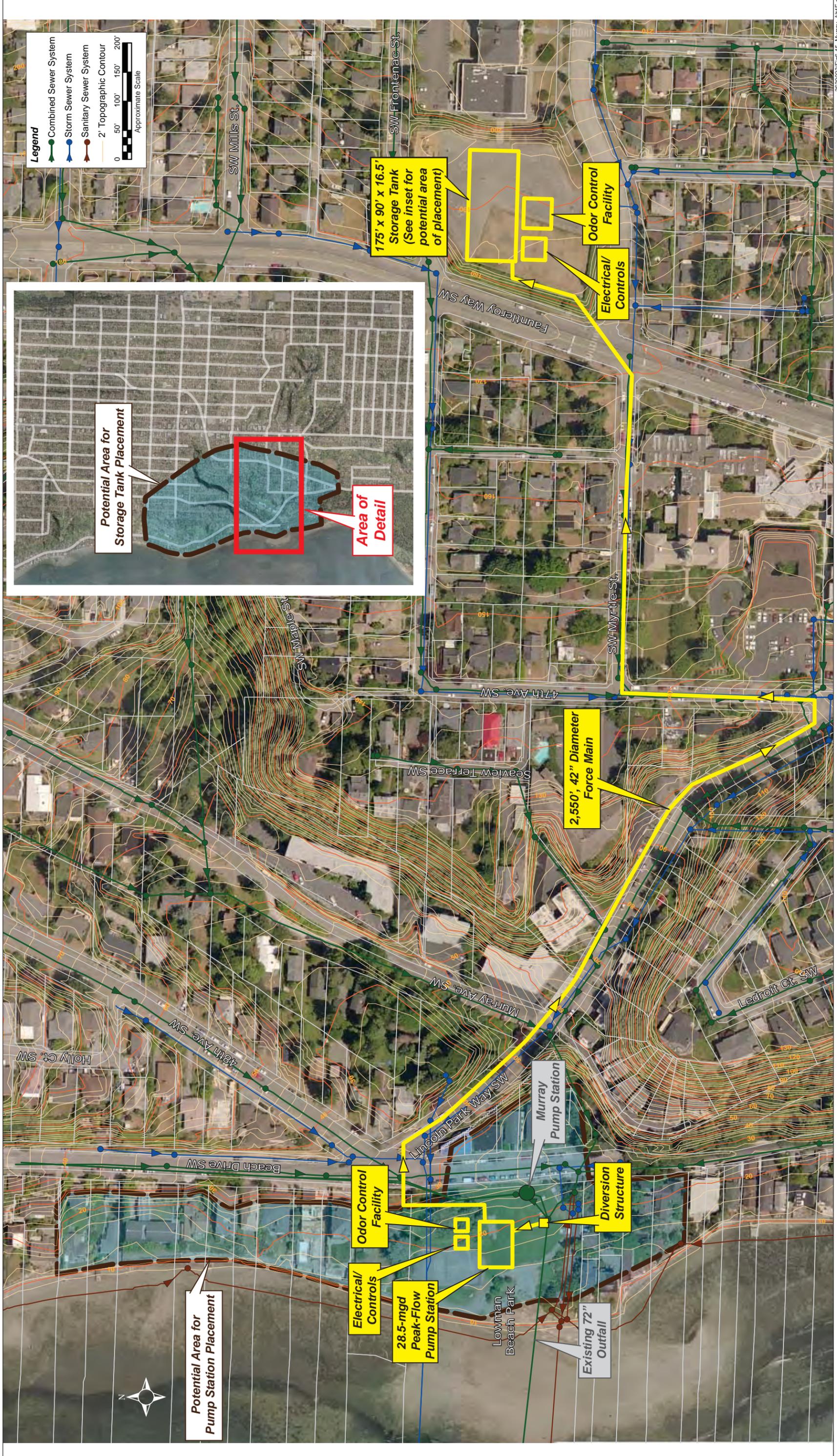




3630023/Fig6-14\_Murray\_Alt1D.ai

Figure 6.14. MURRAY CSO BASIN ALTERNATIVE 1D: PIPE STORAGE AT BOTTOM OF BASIN BY TUNNELING





**Legend**

- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 2' Topographic Contour

0 50' 100' 150' 200'  
Approximate Scale

Potential Area for Storage Tank Placement

Area of Detail

175' x 90' x 16.5' Storage Tank (See inset for potential area of placement)

2,550' 42" Diameter Force Main

Potential Area for Pump Station Placement

28.5-mgd Peak-Flow Pump Station

Existing 72" Outfall

Murray Pump Station

Odor Control Facility

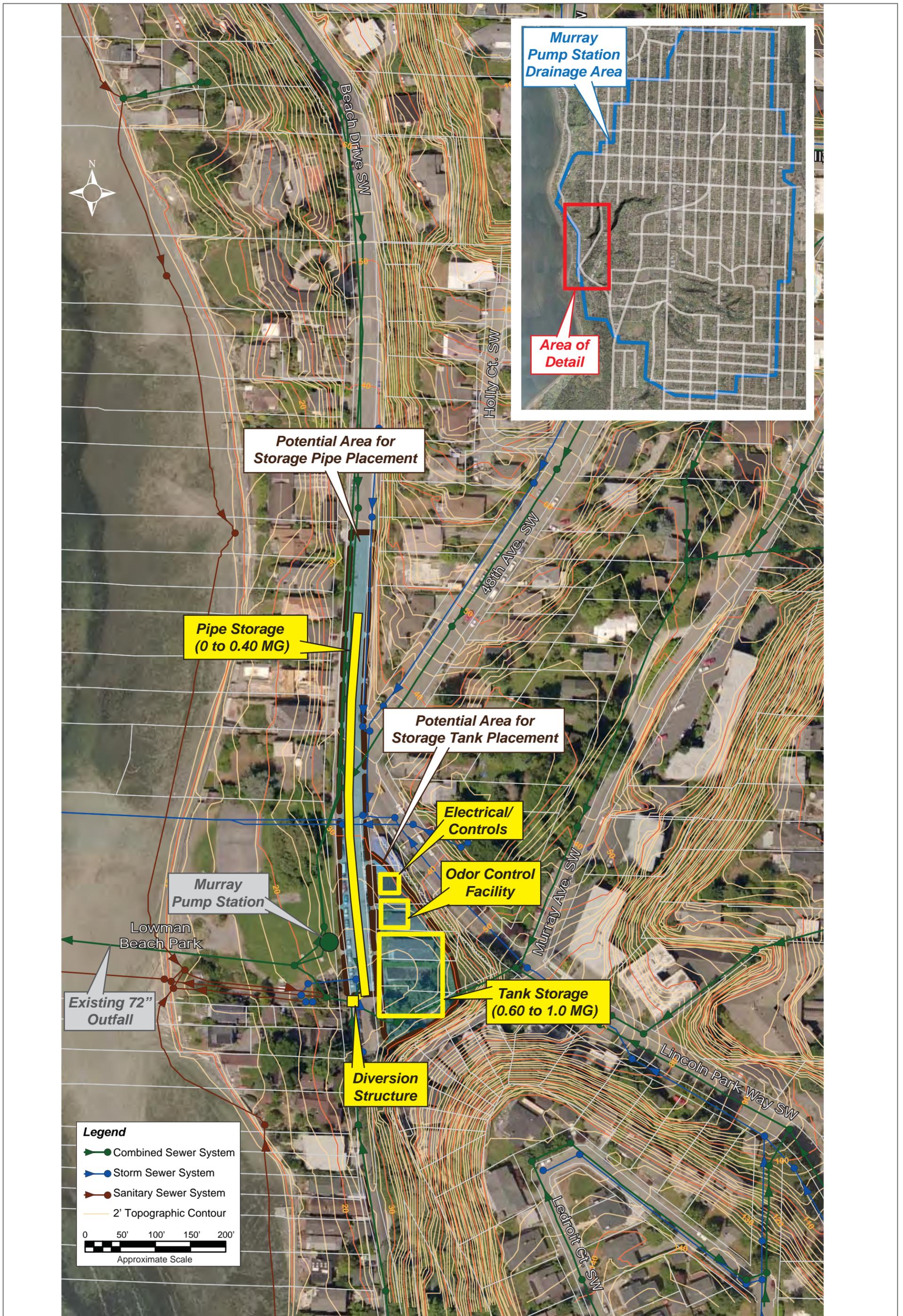
Diversion Structure

Odor Control Facility

Electrical/ Controls

Figure 6.15.  
MURRAY CSO BASIN ALTERNATIVE 1E: UPPER BASIN STORAGE





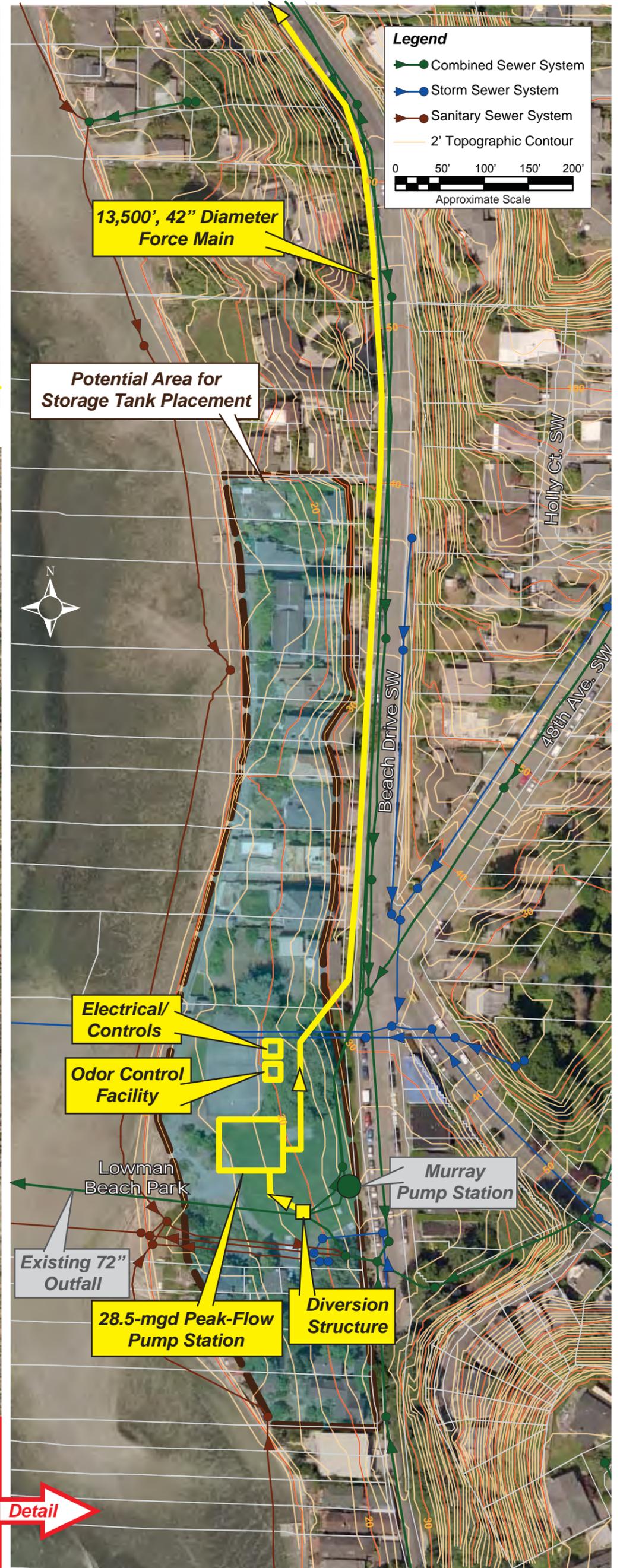




Detail



13,500', 42" Diameter Force Main



**Legend**

- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 2' Topographic Contour

0 50' 100' 150' 200'

Approximate Scale

13,500', 42" Diameter Force Main

Potential Area for Storage Tank Placement

Electrical/Controls

Odor Control Facility

28.5-mgd Peak-Flow Pump Station

Murray Pump Station

Existing 72" Outfall

Diversion Structure

Detail



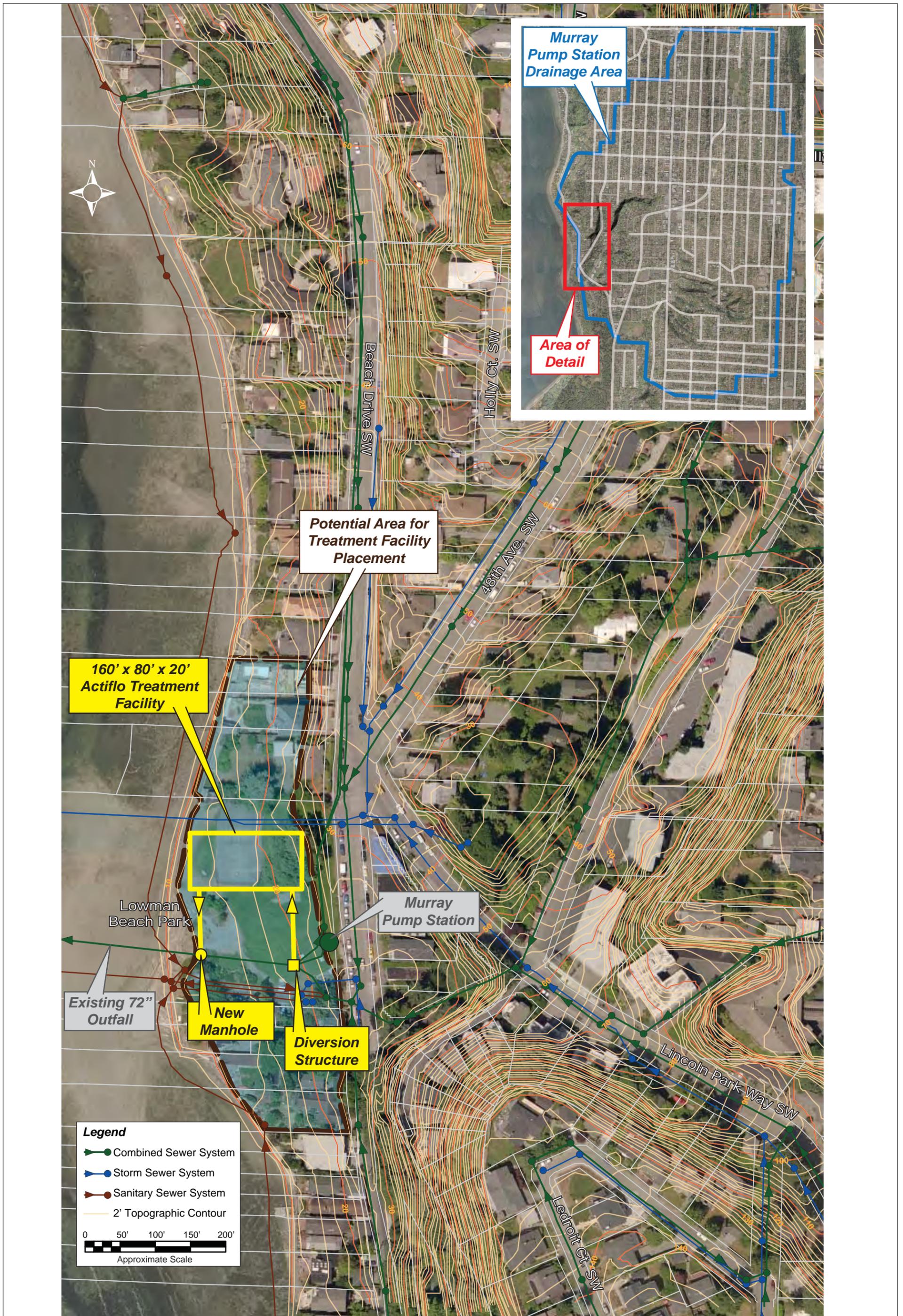
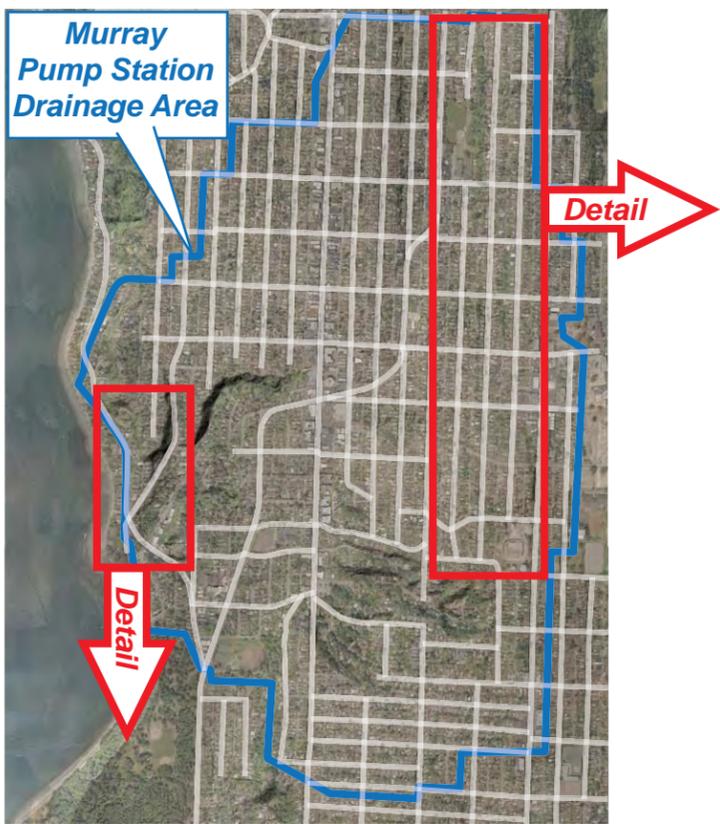


Figure 6.18.  
MURRAY CSO BASIN ALTERNATIVE 3A: END-OF-PIPE TREATMENT AT BOTTOM OF BASIN





**Figure 6.19.**  
MURRAY CSO BASIN ALTERNATIVE 5A:  
PEAK-FLOW REDUCTION BY ROOF DRAIN DISCONNECTION, COMBINED WITH STORAGE

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## ALTERNATIVES EVALUATION AND SELECTION

This chapter provides a detailed description of the alternatives screening performed under Phase 2 Steps 2.2 and 2.3 (as described in Section 5.3). The screening process is described in detail in memoranda titled “CSO Control Alternative Review and Comment Procedure” (Carollo Engineers, September 2009) and “Alternative Narrowing Process” (Tetra Tech, November 2009).

### 7.1 OVERVIEW

Each of the preliminary alternatives in the Barton and Murray Basins was evaluated for technical merit, ability to be implemented (impacts on the community, environmental impact, etc.), and cost. Between August and November 2009, the number of alternatives was reduced from nine for each basin to a shortlist of three for each basin. After public meetings in March and April 2010, the County established a community advisory group to address concerns raised by the public regarding the shortlisted Murray CSO basin alternatives. Meetings throughout the summer and fall of 2010 resulted in nine new alternatives that were developed and evaluated. The alternatives refinement process was occurring during this time. During the alternatives refinement process, the project team modified Barton Alternative 4A to use green stormwater infrastructure (GSI) for disconnecting impervious area from the combined sewer system rather installing storm drains.

The County engaged in a final evaluation process to assess the key technical, environmental and permitting issues, public impacts, and costs. Two alternatives for Barton and two for Murray were forwarded to management with a summary of key considerations resulting from the technical evaluation. King County management made the final decision on which CSO reduction projects would move forward for further environmental review.

### 7.2 PRELIMINARY SHORT-LIST DEVELOPMENT

The preliminary alternatives for the Barton and Murray CSO basins, refined as described in Section 6.6, were reviewed King County and project-team staff in a series of workshops in December 2009. The workshop summary and documentation is in Appendix B.

#### 7.2.1 Barton CSO Basin Preliminary Short-List

Based on the workshop results, the following short list of Barton CSO basin alternatives was recommended for further refinement and evaluation:

- **Barton Alternative 1E—Pipe Storage, Upper Fautleroy Way SW:**
  - A buried, 12-foot-diameter off-line storage pipe approximately 150 feet long with 0.22 MG of storage volume, in Upper Fautleroy Way from the intersection of SW Director Street to north of the intersection with SW Henderson Street.
  - Gravity flow into the storage facility and pumped flow out.
  - Above-grade odor control and electrical facilities.

- A diversion structure at the intersection of Fautleroy Way and Director Street to control peak flow rates downstream to the Barton Pump Station and direct excess flows to the storage pipe.
- **Barton Alternative 1F—Rectangular Storage in the Vicinity of Fautleroy School:**
  - A buried, rectangular concrete storage tank with 0.22 MG of storage volume, near the Fautleroy School parking lot.
  - Gravity flow into the storage facility and pumped flow out.
  - Above-grade odor control and electrical facilities.
  - A diversion structure in Director Street to control peak flow rates downstream to the Barton Pump Station and direct excess flows to the storage pipe.
- **Barton Alternative 4A—Peak Flow Reduction, Sub-Basin 416:**
  - New storm sewers throughout Barton Sub-basin 416 to disconnect street runoff from the combined sewer system (no disconnection of rooftops and other private property storm flows from the combined system).
  - Stormwater treatment to meet stormwater regulations and permitting requirements.
  - During the alternatives refinement process, this alternative was developed in to a GSI alternative.

### **7.2.2 Murray CSO Basin Preliminary Short-List**

Based on the workshop results, the following short list of Murray CSO basin alternatives was recommended for further refinement and evaluation:

- **Murray Alternative 1A—Rectangular Storage, Bottom of the Basin:**
  - A buried, rectangular concrete storage tank with 1.0 MG of storage volume, adjacent to the existing Murray Pump Station in Lowman Beach Park.
  - Gravity flow into the storage facility and pumped flow out.
  - Above-grade odor control and electrical facilities.
  - Modification of the existing CSO control structure to add a diversion control structure with weirs and gravity piping to storage.
- **Alternative 1C—Distributed Storage in Beach Drive & Murray Avenue:**
  - Two 12-foot diameter off-line storage pipes with a total storage volume of 1.0 MG, in Murray Avenue SW from the intersection with Lincoln Park Way (approximately 350 feet long) and in Beach Drive extending northward from Lowman Beach Park (approximately 900 foot long).
  - Gravity flow into the storage facilities and pumped flow out.
  - Above-grade odor control and electrical facilities.

- One diversion structure on Murray Avenue SW upstream of the intersection with Lincoln Park Way and one on Beach Drive adjacent to the pump station.
- During the alternatives refinement process, it was determined that the storage pipes cannot be installed using open trench methods because required excavation depths would be greater than 30 feet. Tunneling or other trenchless methods would be required, making this alternative infeasible. Therefore, Murray Alternative 1C was removed from further consideration.
- **Alternative 1F—Combined Pipe and Tank Storage, Bottom of the Basin:**
  - A buried, rectangular concrete storage tank on private properties near the Murray Pump Station and a 12-foot diameter buried off-line storage pipe in Beach Drive.
  - A storage volume of 1.0 MG would be distributed between the two facilities. If 1.0 MG of storage cannot be provided on the private properties, the difference would be made up with the storage pipe in Beach Drive.
  - The tank would have a minimum volume of 0.6 MG and the pipe would have a maximum volume of 0.4 MG.
  - Gravity flow into the storage facilities and pumped flow out.
  - Above-grade odor control and electrical facilities.
  - Modification of the existing CSO control structure to add a diversion control structure with weirs and gravity piping to storage.

## **7.3 MURRAY BASIN COMMUNITY ADVISORY GROUP ALTERNATIVES**

### **7.3.1 Community Advisory Group Process**

After the preliminary alternatives were short-listed to three alternatives per basin, the County held public meetings to inform the public of the short-listed alternatives and to receive comments and feedback. The Barton CSO basin public meeting was conducted on March 18, 2010 and the Murray CSO basin public meeting was conducted on March 29, 2010. The County also presented the short-listed alternatives at a regular meeting of the Morgan Junction Community Association on April 21, 2010.

The County received comments and feedback from the Murray and Morgan Junction Community strongly indicating that the short-listed alternatives were not acceptable. The community's key concerns involved the following:

- Impacts on Lowman Beach Park
- Impacts on private property
- Concerns that the Murray community was bearing an undue burden because storage facilities were sized to handle flows coming to the Murray Pump Station from the Barton Pump Station.

In response to the concerns and opposition from the community, King County agreed to form a community advisory group (CAG) to help develop alternatives that would meet the County's CSO control needs, address the community's desire to reduce impacts at the bottom of the Murray basin, and provide a solution that meets the needs of both the Barton and Murray basins. A report summarizing the chartering and development of the CAG is in Appendix C. Part of the alternative development process involved providing education and background on CSO control in these two basins. A review of the project team's development of preliminary alternatives and the initial screening was provided.

The CAG met from June through September 2010. The meeting schedule and topics discussed are shown in Table 7.1. The schedule for evaluating the Barton alternatives was paused during the Murray CAG process because the two basins are hydraulically linked, so CSO control decisions for the two basins needed to be considered together.

### **7.3.2 Community Advisory Group Alternatives**

The CAG initially brainstormed approaches to controlling CSOs in the Murray basin. This brainstorming effort identified nine initial CAG alternatives. These initial CAG alternatives used peak flow storage, peak flow conveyance, impervious area disconnection and a combination of these methods to control CSOs. Some included improvements in the Barton basin as part of the recommendation to control CSOs in the Murray basin.

The project team developed technical details to better define the initial CAG alternatives and identify key technical requirements. An initial evaluation was conducted and some alternatives were removed from further consideration because they were not technically feasible or they were similar to project-team alternatives that had been removed from consideration during preliminary screening (such as conveyance of peak flows to Alki). The CAG reviewed the nine project-team alternatives to determine which should be included with the CAG-developed alternatives for the CAG's evaluation. The CAG selected a modified version of Murray Alternative 1B (renamed Murray 1B-b) and Murray Alternative 1F.

These efforts resulted in a group of five CAG alternatives and two project-team alternatives that were evaluated by the CAG in September 2010 (see Appendix C for figures of all alternatives evaluated by the CAG):

- **CAG 2—Storage in Lincoln Park Near Colman Pool:**
  - A buried, rectangular concrete storage tank with 1.25 MG of storage, next to the Colman Pool in Lincoln Park.
  - A flow diversion vault with motorized control valves and telemetry.
  - Peak flows pumped to the 1.25 MG tank from the Barton Pump Station and pumped out of the tank to the Barton Pump Station force main.
  - Below-grade odor control and electrical facilities.
  - 0.1 MG of storage at the bottom of the Murray Basin.
  - Flow diverted to the 0.1-MG storage facility from a gravity diversion structure and pumped out.

**Table 7.1 Murray Community Advisory Group Meetings**

Focus	Topics
<u>CAG Meeting 1, June 9, 2010</u>	
Introduction and Objectives	Introduction of the CAG members. Overview of the goals and objectives. Discussion of work plan and list of items to discuss.
<u>Technical Session, June 19, 2010</u>	
Technical Session	Review of the previous work on the CSO project by the County and project team. Review of the preliminary alternatives and their development. Some suggestions regarding community-generated alternatives were developed.
<u>CAG Meeting 2, June 24, 2010</u>	
Washington State CSO Regulations	The CAG was introduced to the state's CSO regulations and requirements. The Department of Ecology representative discussed permit requirements and associated fines
<u>CAG Meeting 3, July 13, 2010</u>	
City of Seattle CSO Program/ Modeling and Sizing of CSO facilities	Developed an understanding of the City's CSO program and how the County and City coordinate CSO planning efforts. King County's modeling group described collection system modeling and how it is used to determine storage and conveyance requirements to control CSOs.
<u>CAG Meeting 4, August 3, 2010</u>	
City of Seattle Park Department Policies & Green Stormwater Infrastructure	Seattle Parks discussed policies regarding non-park uses and an explanation of Initiative 42 and City of Seattle Ordinance 118477, which restricts non-park uses within City Parks. King County and the project team discussed the use of green stormwater infrastructure as a CSO control measure. It was discussed how this alternative may be used to control CSOs in the Barton basin, but would not be a feasible alternative to control CSOs in the Murray basin.
<u>CAG Meeting 5, August 19, 2010</u>	
Guiding Principles and Alternatives Development	The project team provided a technical presentation of the initial CAG-developed alternatives. The CAG developed guiding principles for further development and evaluation of alternatives.
<u>CAG Meeting 6, August 30, 2010</u>	
Presentation of Guiding Principles and Level of Achievability Analysis for Alternatives	CAG members deliberated and agreed on a set of guiding principles. The project team presented a level-of-achievability analysis for the CAG-developed alternatives. Planning level comparative cost estimates for the CAG-developed alternatives were presented.
<u>Workshop, September 9, 2010</u>	
Alternative Optimization and Definition	This workshop involved technical discussions to optimize final alternatives for a final evaluation. Some alternatives initially proposed were deemed technically infeasible and were removed from consideration. The list of CAG-developed alternatives and project-team alternatives was set for evaluation in the next CAG meeting.

<b>Table 7.1 Murray Community Advisory Group Meetings</b>	
<b>Focus</b>	<b>Topics</b>
<u>CAG Meeting 7, September 15, 2010</u>	
Alternatives Presentation and Screening	This meeting involved presentation of the CAG alternatives and selected project-team alternatives for evaluation by CAG. The CAG initiated the screening process by applying the guiding principles to each alternative and determining which alternatives needed to be eliminated from consideration.
<u>CAG Meeting 7.5, September 27, 2010</u>	
Final Screening of Alternatives (Additional Meeting)	CAG members screened the list of 16 alternatives down to five. The CAG received comments and input from the public to be used in a final report of findings and recommendations to be submitted to King County.
<u>CAG Meeting 8</u>	
Final Recommendation	The CAG prioritized the five remaining alternatives and developed recommendations for the County to consider in its final evaluation for a CSO control project in the Murray and Barton basins.

- **CAG 2-a—Storage in Lincoln Park Lower Parking Lot:**
  - Same as CAG 2 except that the buried, rectangular 1.25-MG concrete storage tank would be located in the Lincoln Park Lower Parking lot.
- **CAG 2-b—Storage Tunnel in Lincoln Park:**
  - Same as CAG 2 except that Barton basin storage would be provided by a large-diameter storage tunnel in Lincoln Park between Colman Pool and the lower parking lot, with storage up to 2 MG, depending on diameter.
- **CAG 8—Upper Basin Storage for Murray Peak Flows:**
  - Distributed storage, with up to four tanks at various up-basin sites to control tributary peak flows and a bottom-of-basin storage facility to reliably control overflows.
  - Exact storage volumes to be confirmed through extensive modeling; it was estimated that 0.5 MG would be required at the bottom of the basin and 1 MG of total storage volume would be required up-basin.
  - Telemetry and control to actively divert flows to storage when peak flow events and potential overflows are predicted.
  - Stored volumes pumped out of each facility to the local sewer after the peak event has past.
- **CAG 9—Combined Storage, Pumping & Disconnection Improvements:**
  - Increased storage volume for the Barton basin (to 0.5 MG from 0.22 MG)
  - Barton Pump Station peak flow capacity limited to 26 mgd

- 0.86 MG of storage in the vicinity of Lincoln Park Way and Murray Avenue
- A 10-mgd peak flow pump station adjacent to the existing Murray Pump Station to lift peak flow volumes from the bottom of the basin to storage.
- On-site disconnection throughout the Murray basin to reduce storage requirements.
- **Murray Alternative 1B-b—Storage in the Vicinity of Lincoln Park Way and Murray Avenue SW:**
  - A 0.6-MG rectangular storage tank on the vacant lot at the northwest corner of the intersection of Lincoln Park Way and Murray Avenue SW
  - A 0.4-MG 12-foot-diameter storage pipe in Murray Avenue SW.
  - Two diversion structures to send peak flows to the storage pipe and storage tank
  - A 10-mgd peak flow pump station adjacent the existing Murray Pump Station to lift peak flow volumes from Barton to storage.
- **Murray Alternative 1F—Combined Pipe and Rectangular Storage at the Bottom of the Basin**
  - This is the same alternative as described in Section 7.2.2.

### **7.3.3 Community Advisory Group Recommendations**

Through evaluation and deliberation, the CAG removed Alternatives CAG 2-b and CAG 9 from consideration. Alternative CAG 2-b was removed because of the high costs and impacts of tunneling in the park. Alternative CAG 9 was removed because of high cost, low reliability, and difficulty in effectively implementing on-site roof disconnection.

The CAG recommended Alternative CAG 2-a in its October 2010 report to King County. The group identified Murray Alternative 1B-b as a “fallback” alternative if the County determined that Alternative CAG 2-a was not feasible. The group did not eliminate any of the other alternatives from consideration, but advanced them to the County for the project team’s consideration during a final selection process.

### **7.3.4 Coarse Screening of Murray Basin Alternatives**

In December 2009, the project team conducted an evaluation and coarse screening of the five alternatives forwarded by the CAG (CAG 2, CAG 2-a, CAG 8, Murray 1B-b, and Murray 1F) and one remaining preliminary alternative short-listed by the project team (Murray Alternative 1A) The coarse screening assessed whether any alternatives should be removed from consideration because of significant technical challenges or costs. Table 7.2 summarizes the key evaluation points and considerations of the coarse screening evaluation.

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
ALTERNATIVES EVALUATION AND SELECTION**

**Table 7.2. Murray Basin CSO Coarse Screening Matrix**

What are the significant challenges associated with this alternative?					Why should alternative move forward?
Community Impact	Technical	Environmental	O&M	Land Use/ Permitting	
<b>CAG 2 – Storage in Lincoln Park Near Colman Pool</b>					
<ol style="list-style-type: none"> <li>1. Long-term impact associated with siting a CSO facility in a high-use park setting.</li> <li>2. Not accepted by the Barton community. Very likely will appeal all permits.</li> <li>3. Impacts on ferry traffic and Fauntleroy traffic during construction.</li> <li>4. Concurrent construction impacts on the Fauntleroy community for 5-7 years from multiple construction projects (Barton PS upgrade; CAG 2; and Barton CSO project).</li> <li>5. Surface features will affect existing park users.</li> <li>6. Construction right next to pool will increase safety concerns and other impacts of nearby park users.</li> <li>7. ADA access restrictions for community to pool</li> <li>8. Is an Olmsted park designation.</li> </ol>	<ol style="list-style-type: none"> <li>1. Very difficult to construct due to limited site space and distant access from streets for construction crews and equipment.</li> <li>2. Requires complex control scheme for flow diversion. Reliable flow control is uncertain because King County does not have experience or familiarity with this type of flow control.</li> <li>3. Results in two storage structures for Murray Basin. Reduces the storage size at Murray, but does not eliminate the need for storage and all associated site impacts.</li> <li>4. County still has to build a facility for odor control and generator by Lowman Park.</li> <li>5. Limits on construction period; may be closed to construction during summer months for pool.</li> <li>6. Lots of manpower/flagging needs during construction.</li> <li>7. Geotech issues – close to ground water/saline water.</li> <li>8. Not maximizing capacity of conveyance.</li> </ol>	<ol style="list-style-type: none"> <li>1. Possible tree removal.</li> <li>2. Restoration area/volunteer grants for restoration.</li> <li>3. Historic status of pool.</li> </ol>	<ol style="list-style-type: none"> <li>1. Serious concerns over complexity of routing flows out of Barton PS force mains and facility located between two pump stations.</li> <li>2. County has no previous experience with motorized valves and predictive ability to use these valves.</li> <li>3. Access to tank – pedestrian hazards on path.</li> </ol>	<ol style="list-style-type: none"> <li>1. The park is in CR zoning. The proposed use is prohibited and will require code amendment or rezoning.</li> <li>2. Would have to demonstrate no other feasible alternative.</li> </ol>	Not recommended for further evaluation.
<b>CAG 2-a – Storage at Lincoln Park Lower Parking Lot</b>					
<ol style="list-style-type: none"> <li>1. Impacts on ferry traffic and Fauntleroy traffic during construction.</li> <li>2. Concurrent construction impacts on the Fauntleroy community for 5-7 years from multiple construction projects (Barton PS upgrade; CAG 2; and Barton CSO project).</li> <li>3. Odor concerns in parking lot; trapped air/pressure to gravity.</li> <li>4. Parking disruption for O&amp;M activities</li> <li>5. ADA access</li> <li>6. May need additional odor control by Lowman Park.</li> <li>7. Parking reduction and traffic detours will impact large organized events, in addition to typical park users, at this regional park.</li> </ol>	<ol style="list-style-type: none"> <li>1. Requires complex control scheme for flow diversion. Reliable flow control is uncertain because King County does not have experience or familiarity with this type of flow control.</li> <li>2. Results in two storage structures for Murray Basin. Reduces the storage size at Murray, but does not eliminate the need for storage and all associated site impacts.</li> <li>3. County still has to build a facility for odor control and generator by Lowman Park.</li> <li>4. Not maximizing use of conveyance.</li> <li>5. Adjacent arterial access facilitates construction.</li> <li>6. Better location for constructing deep excavation from geo tech perspective.</li> </ol>	<ol style="list-style-type: none"> <li>1. Possible impact on trees.</li> <li>2. Vegetated areas around park disrupted.</li> </ol>	<ol style="list-style-type: none"> <li>1. Not first choice due to complexity factor (but solvable).</li> <li>2. Risk of reliability needs quantifying.</li> <li>3. Safety for access in parking lot</li> </ol>	<ol style="list-style-type: none"> <li>1. Lengthy, uncertain process associated with allowing use of existing park property for CSO facility. However, siting majority of facilities within existing parking area may mitigate this issue.</li> <li>2. Differentiator being under parking lot as opposed to traditional park use.</li> <li>3. Can restore park use to close to what was originally there.</li> <li>4. Staging in park.</li> </ol>	The impacts on the community are well documented. Limiting facilities to within existing parking areas may reduce the impact on parks, making this alternative more feasible from a land use perspective.

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
ALTERNATIVES EVALUATION AND SELECTION**

**Table 7.2. Murray Basin CSO Coarse Screening Matrix**

What are the significant challenges associated with this alternative?					Why should alternative move forward?
Community Impact	Technical	Environmental	O&M	Land Use/ Permitting	
<b>CAG 8 – Upper Basin Storage</b>					
<ul style="list-style-type: none"> <li>1. Long-term impact associated with siting numerous CSO facilities throughout the neighborhood. The proposed sites require siting in two parks.</li> <li>2. New stakeholders that will need to be engaged.</li> <li>3. High traffic impacts in multiple locations.</li> </ul>	<ul style="list-style-type: none"> <li>1. Multiple diversion and storage points throughout the upper portion of collection increases system complexity, thereby decreasing the certainty of reliable flow control.</li> <li>2. Upper basin storage requires larger storage facilities than bottom-of-basin storage in order to increase the certainty of flow control.</li> <li>3. Does not eliminate the need for bottom-of-basin storage.</li> <li>4. Construction – concurrent or sequential both present high challenges due to limited site space for construction and staging.</li> <li>5. Greater uncertainty in predicting flows higher in basin.</li> <li>6. As many storage tanks as rest of the entire program.</li> <li>7. Storage higher in the basin increases the potential to surcharge the collection system and the possibility of local sewer backups.</li> </ul>	<ul style="list-style-type: none"> <li>1. Two parks involved.</li> <li>2. Traffic, noise, disruption throughout community.</li> <li>3. High potential for encountering soil contamination (dry cleaner)</li> </ul>	<ul style="list-style-type: none"> <li>1. Multiple facilities for O&amp;M staff to maintain; increases staffing requirements and reduces overall system reliability.</li> </ul>	<ul style="list-style-type: none"> <li>1. Lengthy, uncertain process associated with property acquisition at multiple sites. This includes parks again.</li> <li>2. Parks locations will require council approval.</li> </ul>	<p>Not recommended for further evaluation.</p>
<b>Murray Alternative 1A –Storage at Lowman Beach Park</b>					
<ul style="list-style-type: none"> <li>1. Long-term impact associated with siting a CSO facility in a high-use park setting. Lowman Beach Park zoned Conservancy Recreation with prohibited utility service use.</li> <li>2. Surface features may affect park users.</li> <li>3. Strong opposition from CAG/community.</li> <li>4. Could threaten schedule due to resistance.</li> </ul>	<ul style="list-style-type: none"> <li>1. Best technical alternative, as well as for future odor/generator. Close to existing facility.</li> <li>2. The scheme in Alternatives 1A and 1F is the simplest and most predictable to operate based on prior experience. Highest certainty of performing reliable flow control.</li> </ul>	<ul style="list-style-type: none"> <li>1. Loss of old trees.</li> <li>2. Conservancy zone.</li> </ul>	<ul style="list-style-type: none"> <li>1. The park is in CR zoning. The proposed use is prohibited and will require code amendment or rezoning.</li> <li>2. Would have to demonstrate no other feasible alternative.</li> </ul>	<p>The impacts on the community are well documented. However, this alternative is a very cost-effective, reliable alternative for CSO control.</p>	

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
ALTERNATIVES EVALUATION AND SELECTION**

**Table 7.2. Murray Basin CSO Coarse Screening Matrix**

What are the significant challenges associated with this alternative?					Why should alternative move forward?
Community Impact	Technical	Environmental	O&M	Land Use/ Permitting	
<b>Murray Alternative 1B-b –Storage in Vicinity of Murray Ave. &amp; Lincoln Park Way</b>					
1. CAG #2 choice (after CAG 2A) 2. Requires another large pump station in the park area. 3. May require property acquisition. 4. Construction in street as well as in the triangle; extensive impacts on the community.	1. The site at Murray Ave and Lincoln Ave is difficult to access and build on. 2. Peak flow PS needed (10 mgd) near existing Murray PS. 3. Two storage facilities needed; increases construction. 4. Opportunity to avoid building diversion structure and connect to existing PS, although a larger peak flow pump station would be needed.	1. The site contains wetlands and an associated stream. The feasibility of obtaining environmental approvals for this alternative is highly uncertain. 2. Lengthy council review (minimum 12 months).	1. Complex operations. 2. Reliability concerns. 3. Multiple facilities required for stable control.	1. Lengthy, uncertain process associated with allowing use of existing park property for new pump station if sited in park. 2. Private property acquisition potentially required for new pump station. 3. Storage tank permitting/ approval requires City Council approved revisions to the Critical Areas Ordinance.	Not recommended for further evaluation.
<b>Murray Alternative 1F – Storage on Private Property in the Beach Drive Area</b>					
1. Community expressed long-term impact associated with changing the character of the neighborhood residential area. 2. Work will extend into ROW. 3. Cannot rebuild homes. 4. Property acquisition required (15 units, ~ 30 people).	1. Nearby steeply sloped areas present technical and geotechnical challenges during design and construction. 2. The scheme in Alternatives 1A and 1F are the simplest and most predictable to operate based on prior experience. Highest certainty of performing reliable flow control.			1. Requires acquisition of up to six privately owned properties. 2. Facility extends into ROW.	Although there are technical challenges, the planning team is confident that these can be reasonably dealt with during design. This alternative is a cost-effective, reliable alternative for CSO control.

Based on the coarse screening, the project team recommended removing the following alternatives from consideration:

- Alternative CAG 2** – This alternative was removed from consideration due to its location in Lincoln Park and its proximity to the shoreline. This alternative would have long-term impacts on a high-use park setting and would be difficult to construct due to limited site space and distant access to streets. It would require a complex control scheme for diversion of peak flows and would not be as reliable as other alternatives located at the bottom of the basin. Access to the tank for maintenance purposes would be difficult, because pedestrian traffic is high at the proposed location.

- **Alternative CAG 8**—This alternative was removed from consideration due to concerns about reliability and because of the cost associated with siting four separate facilities throughout the basin in addition to a facility at the bottom of the basin. This alternative would require complicated telemetry and predictive control algorithms to divert flows in the upper basin to storage. The challenge associated with accurately and reliably predicting when to divert flows to storage results in the need for a storage facility at the bottom of the basin. Because this alternative is less reliable and more costly, and does not result in the elimination of a storage facility at the bottom of basin; it was removed from consideration.
- **Murray Alternative 1B-b**—This alternative was removed from consideration because the proposed location of the rectangular storage facility is on an undeveloped parcel that has an unpiPED section of Pelly Creek running through it. City of Seattle Real Estate Services confirmed that there are wetlands on this property. Field investigation confirmed that these wetlands are associated with the creek. The creek, wetland, and wetland buffer take up a majority of the developable land on this parcel. Seattle Development Code prohibits development on buffers of wetlands associated with a creek or stream. The alternative also requires a large peak-flow pump station at the bottom of the basin that would need to be sited in the vicinity of the existing Murray Pump Station.

### **7.3.5 Murray Basin—Final Short List**

Based on the CAG evaluation and the project team’s subsequent coarse screening, the final short-listed alternatives for the Murray Basin are as follows:

- Alternative 1A— Rectangular Storage at Bottom of Basin in Lowman Beach Park.
- Alternative 1F—Rectangular and Pipe Storage on Private Property at Bottom of Basin.
- CAG Alternative 2-a—Storage in Lincoln Park Lower Parking Lot.

## **7.4 FINAL SHORT-LISTED ALTERNATIVES—BARTON BASIN**

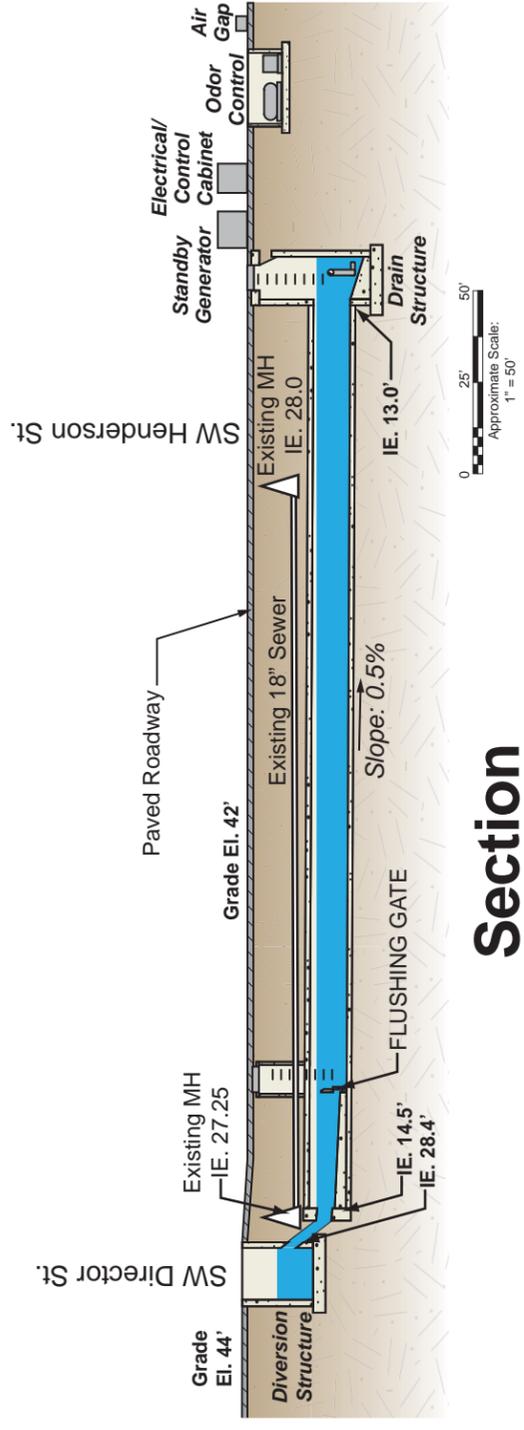
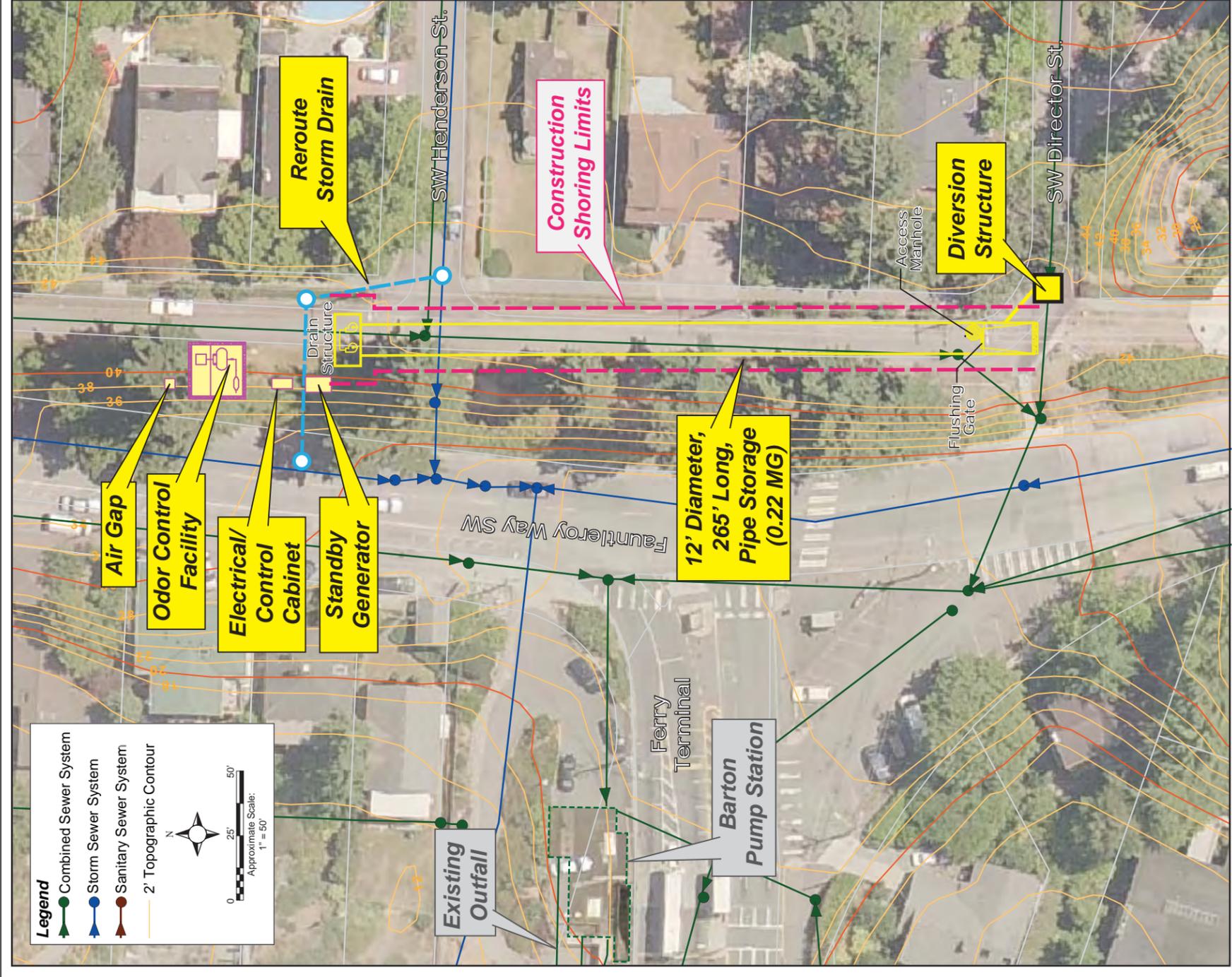
### **7.4.1 Refinement of Barton Alternatives**

Between January 2010 and October 2010, the three short-listed alternatives for Barton were further developed by the project team. This included the development of control flows and volumes for mid-basin storage alternatives, as described in Section 4.2.1. This work occurred concurrently with the CAG process, although final evaluation of the Barton alternatives was not conducted until the CAG process was complete. Table 7.3 summarizes pertinent data for the final short-listed Barton alternatives. Details are provided in the following sections.

<b>Table 7.3 Barton Basin Short-Listed Alternatives Data</b>			
	<b>Alternative 1E</b>	<b>Alternative 1F</b>	<b>Alternative 4A (GSI)</b>
Type of Facility	Buried, Off-Line Storage Pipe	Buried, Rectangular Tank	Roadside Rain Gardens
Facility Dimensions	12' diameter, 265' length	38' x 68' area, 15' deep	N/A
# Internal Channels	1	2	N/A
Sewer	48" diameter	48" diameter, 80' length; open-cut w/drop structure for diversion	N/A
Excavation Limits to Shoring	300' x 16' area, 30' deep	80' x 60' area, 30' deep	~10' – 15' wide; swale depth ~6" – 10"
Diversion Control Structure Dims:	15' x 15' area, 15' deep	20' x 20' area, 15' deep	N/A
Odor Control/Electrical Footprint	60' x 20' area, 13' to 15' high	50' x 20' area, 13' to 15' high	N/A
Land acquisition	In right-of-way	6,000 square feet (tank)	In right-of-way
Construction Limits, Staging	40' x 350' on site (14,000 square feet); contractor to find off site staging	20,000 square feet potentially available	Within planter strips between existing curbs and sidewalks, along 32-65 half-blocks in Sub-basin 416
Street Use	See Property Acquisition Plan	See Property Acquisition Plan	See Property Acquisition Plan

#### **7.4.2 Barton Alternative 1E—Pipe Storage in Upper Fautleroy Way**

This alternative (see Figure 7.1) features a diversion structure and a 12-foot-diameter, 265-foot-long concrete storage pipe with a capacity of 0.22 MG, inlet and drain structures at the pipe ends, a flushing gate for cleaning, and submersible pumps for draining. The storage pipe would be located in Upper Fautleroy Way SW between the intersections of SW Director Street and SW Henderson Street. It would be constructed by cut-and-cover methods. Excavation up to 30 feet deep would require shoring. This section of street right of way would be impassable during construction, but temporary access for adjacent properties and detour routes for traffic would be provided.



## Section

Figure 7.1.  
FINAL BARTON ALTERNATIVE 1E: PIPE STORAGE IN UPPER FAUNTLEROY



The new diversion structure would replace an existing manhole along the SW Director Street sewer. It would have a restrictive flow apparatus such as an orifice or a gate that would limit downstream flow to approximately 11 mgd to provide control at the bottom of the basin. Excess flows above 11 mgd would be diverted through a 48- inch sewer to the storage facility, which would retain the required volume until rainfall has ceased for a pre-set time. At that time, submersible drain pumps would pump the stored contents back to the local sewer in SW Henderson Street over a 12-hour period.

The storage facility would be equipped with carbon scrubber odor control, electrical equipment, and a backup generator, housed in a separate above-grade structure within the right of way, set back from the traveled roadway. The storage facility would be accessed from the top, within the roadway. Access ways would be located at the ends of the pipe for maintenance. Cleaning equipment would be flushing gates.

This alternative was evaluated using the criteria shown in Appendix B. The following sections describe evaluation considerations.

#### **7.4.2.1 Land Use and Permitting**

The site for Alternative 1E is within a street right-of-way in a residentially zoned area, and adjacent to a community open space. The project would require local permit only.

#### **7.4.2.2 Property Acquisition**

The alternative identifies ancillary facilities as being located within the right-of-way outside of the paved roadway. Depending upon final design requirements, ancillary facilities may need to be located on easements from one or two private parcels.

#### **7.4.2.3 Environmental**

There are no historic resources in the project area, but the area has a high probability of containing archaeological resources. Significant archaeological resources have been found adjacent to the project area in the past. Excavation for the pipeline will likely extend into native soils.

There are no wetlands, streams, or shorelines within the project area, but Fauntleroy Creek is approximately 100 feet to the south. Fauntleroy Creek is used by coho and cutthroat for spawning and rearing. Construction most likely would require removal of Douglas fir and Pacific madrona along the west edge of Upper Fauntleroy Way, which may meet the Seattle Municipal Code (SMC) definition of exceptional trees. There are no known contaminated sites near the proposed project location.

#### **7.4.2.4 Technical**

This is considered a mid-basin alternative and will require careful management of flows to ensure that bottom-of-basin flow quantities do not exceed the Barton Pump Station's capacity. This alternative requires a complex diversion structure to divert flows to storage using a restrictive flow device rather than a simple overflow weir at the bottom of the basin.

There may be opportunity to lengthen the storage pipe to the north in the future and expand capacity for flexible adaptability.

There may be construction difficulties with groundwater, archaeological conditions, and excavation. The existing right of way is narrow and there will be issues associated with construction sequencing and residential access during construction. There is limited area available for staging and material lay-down.

#### **7.4.2.5 Operation and Maintenance**

A large-diameter pipe storage facility is familiar to the county for operations. However, this alternative requires street access through hatches for maintenance. Traffic control procedures would be required, involving street use/closure permits for major maintenance activities. Routine access of electrical and odor control equipment may be within the right-of-way but outside the traveled roadway. There would be more limited access to this facility because of the street and topography.

#### **7.4.2.6 Costs**

This alternative is the least costly of the short-listed alternatives; at this level of estimating, its cost is essentially equal to that of Alternative 1F. See Appendix B for a summary of comparative costs.

#### **7.4.2.7 Community**

Construction at this site would have three substantial impacts on the community:

- Short-term impacts from approximately 650 truck trips for removal of excavated materials and import of construction materials. The haul route would include Fauntleroy Way, which has substantial ferry traffic, and an upgrade project for the Barton Pump Station immediately adjacent to this proposed site.
- Short-term impacts from reduction of parking and restriction of access to the six residences along Upper Fauntleroy Way.
- Intermittent traffic interruptions for the six property owners on Upper Fauntleroy Way due to major maintenance activities (approximately once every five years).

#### **7.4.3 Barton Alternative 1F—Buried Rectangular Storage Tank, at Fauntleroy School**

This alternative (see Figure 7.2) features a 20-by-20-foot diversion structure, 80 feet of 48-inch-diameter gravity sewer, and a 0.22-MG rectangular, buried, cast-in-place concrete storage tank with a tank cleaning mechanism and submersible pumps for tank draining. The tank would be located in the parking lot west of the Fauntleroy School.

The diversion structure would be located in SW Director Street. It would have a restrictive flow apparatus such as an orifice or a gate that would limit the downstream flow to

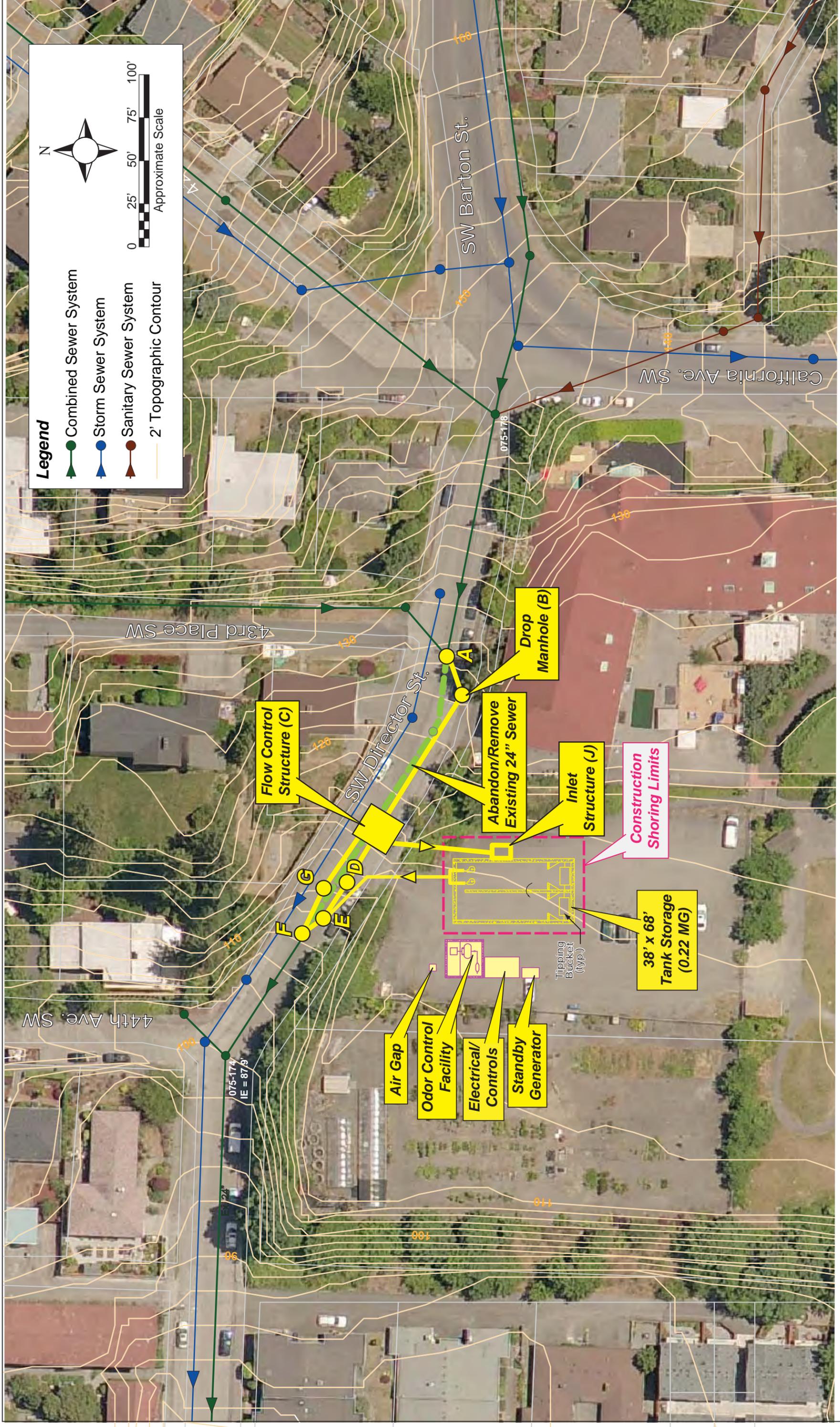


Figure 7.2.  
FINAL BARTON ALTERNATIVE 1F: BURIED RECTANGULAR STORAGE TANK AT FAUNTLEROY SCHOOL



approximately 11 mgd to provide control at the bottom of the basin. Flows beyond 11 mgd would be diverted through the 48-inch sewer to the storage facility.

The storage facility would retain the required volume, depending on the total peak storm volume, until rainfall has ceased for a pre-set time. At that time, submersible drain pumps would pump the stored contents back into the local sewer in SW Director Street over a 12-hour period.

The tank would have an area of 38 feet by 68 feet and a water depth of 15 feet. It would be constructed by cut-and-cover methods. A shored excavation in level ground would be required. It is anticipated that the tank would be covered by 2 to 4 feet of earth and gravel or asphalt pavement. A 20-by-50-foot above-grade structure would house carbon scrubber odor control, electrical equipment, and a backup generator.

The tank would be accessed from the top at the ends for maintenance. Cleaning equipment would consist of flushing gates or tipping buckets, to be determined during detailed design.

This alternative was evaluated using the criteria shown in Appendix B. The following sections describe evaluation considerations.

#### **7.4.3.1 Land Use and Permitting**

Zoning of the project site is single-family residential. Existing use is a parking lot for the Fauntleroy Community Center. The diversion structure would be located in street right-of-way. Only local permits would be required. No federal or state permits would be required.

Because there would be local traffic impacts for construction of the diversion structure, temporary and emergency access provisions would be required. Above-grade structures would be below height limits prescribed in SMC (Seattle Municipal Code).

#### **7.4.3.2 Property Acquisition**

King County would need to acquire a permanent easement from the Fauntleroy Community Association for the tank, as well as a temporary construction easement. The area required for the easement is listed as the land acquisition requirement in Table 7.3.

The Seattle School District is renting out the parcel to the west, which is being used as a nursery area. Access is through the existing parking lot. A temporary construction easement from Seattle School District may be necessary for access during construction.

#### **7.4.3.3 Environmental**

There are no known archaeological resources in the project area, but based on site characteristics, the area has a medium probability of containing such resources. Fauntleroy School may be nominated as a Seattle Landmark. Excavation for the tank construction will likely extend into native soils.

No impacts are anticipated on fish or wildlife. Fauntleroy Creek is approximately 300 feet south of the south edge of the parking lot, which may have construction activity. Fauntleroy

Creek is used by coho and cutthroat for juvenile rearing. No impacts are anticipated on the creek or the creek buffer. There are no wetlands or shoreline within the proposed project area. There are no known contaminated sites within the project area.

#### **7.4.3.4 Technical**

This is considered a mid-basin alternative and will require careful management of flows to ensure that bottom-of-basin flow quantities do not exceed the Barton Pump Station's capacity. This alternative requires a complex diversion structure to divert flows to storage using a restrictive flow device rather than a simple overflow weir at the bottom of the basin. There is additional room on this site for expansion if flows are greater than currently predicted.

This alternative is relatively straightforward to construct and operate. The storage tank site is on flat ground with easy access from SW Director Street. However, construction of the drop structure and diversion structure would require deep excavation (30 to 35 feet deep) within the SW Director Street right of way.

#### **7.4.3.5 Operation and Maintenance**

This alternative would have the best access for tank, odor control and electrical facility maintenance of the short-listed storage alternatives. The tank site would be easily accessed from Director Street and there would be adequate space around the tank for maintenance. The tank is a familiar concept for the county. Access and maintenance of the drop structure and diversion structure in SW Director Street would require traffic control and flagging.

#### **7.4.3.6 Costs**

This alternative is the second least costly of the short-listed alternatives; at this level of estimating its cost is essentially equal to that of Alternative 1E. See Appendix B for a summary of comparative costs.

#### **7.4.3.7 Community**

Construction at this site has two substantial impacts on the community:

- Short-term impacts from approximately 600 truck trips for removal of excavated materials and import of construction materials. The haul route would be along SW Director Street, SW Barton Street and Delridge Way SW.
- 14 to 18 months of construction impacts on local residents and the businesses and tenants of the Fauntleroy Community Center; from traffic disruption to reduction of parking and restriction of access to the Fauntleroy Community Center.
- Intermittent traffic interruptions for local traffic on SW Director Street due to intermittent maintenance of the drop structure and diversion structure. There would be major maintenance activities (approximately once every five years) for the storage tank, which would restrict use of the parking lot during those times. Intermittent maintenance

of the odor control facility would require routine access through the parking lot, but should not result in significant loss of use.

#### **7.4.4 Barton Alternative 4A (GSI)—Green Stormwater Infrastructure in Sub-Basin 416**

During the alternative refinement process, the project team modified Alternative 4A to use GSI techniques for addressing impervious area runoff rather than using a conventional sewer separation approach involving installation of storm drains. GSI captures rainfall runoff in facilities that retain and/or infiltrate it into the ground. GSI was selected based on capital cost, community support, and ongoing operation and maintenance requirements. The capital cost to disconnect street drains and install storm drains throughout Sub-basin 416 would be considerable because construction would be complex and extensive. Current codes could require stormwater treatment, which would add to the capital costs and require ongoing operation and maintenance. The County received considerable positive feedback for GSI from the community during public meetings and outreach efforts. For these reasons, the project team developed technical refinements to scope Alternative 4A as a GSI alternative.

The refined alternative features bioretention/bioinfiltration facilities (roadside rain gardens) in Barton Sub-basin 416 within planting strips between the curb and sidewalk or within new curb bulbs at street ends (see Figure 7.3). Stormwater runoff from the street right-of-way would be diverted to the rain gardens to provide additional storage and allow a portion of the runoff water to infiltrate. Enough stormwater would be diverted and infiltrated or stored to achieve CSO control at the pump station. Rain gardens would be installed in 32 to 65 half blocks, to be determined by final modeling. The alternative would provide 2.0 MG of volume reduction and 14.6 mgd of peak flow reduction during the design storm event.

This alternative was evaluated using the criteria shown in Appendix B. The following sections describe evaluation considerations.

##### **7.4.4.1 Land Use and Permitting**

This alternative is not within the Shoreline zone and would not require a Shorelines permit. Right-of-way permits would be required. Affected roadways have moderate traffic volume in residential and neighborhood commercial land uses. Work hours may be restricted; construction would require careful traffic planning to maintain access as a condition of the required permits.

##### **7.4.4.2 Property Acquisition**

No property acquisition would be required; SDOT would likely consider this a street beautification project. Since there would be no pipes or structures within the street right-of-way street, use fees should be minimal.

##### **7.4.4.3 Environmental**

There are no known archaeological sites or cultural resources identified in the Sub-basin 416 area, and, based on area characteristics, the sites for rain gardens have a low probability of

containing such resources. This project involves limited excavation and minimal or no disturbance of native soils.

Construction of this alternative would not affect fish, wildlife, or their habitat. This alternative would create new habitat and would likely increase dry-weather flows to Longfellow Creek. There are no wetlands, streams or shorelines in the project area. There are no known contaminated sites in the project area. The project area is not within a liquefaction zone. There are no steep slopes or potential or known landslide areas.

#### **7.4.4.4 Technical**

This is the simplest of the Barton alternatives considered for operation. The rain gardens would be passive and would not require staff for startup. There would be regular and periodic maintenance of the rain gardens to ensure their ability to divert, infiltrate, and store stormwater. This would involve plant maintenance and soil maintenance in addition to maintenance levels of weeding and debris removal.

This alternative would require further modeling to determine the number of rain gardens and the number of affected streets in Sub-basin 416. Additionally, extensive geotechnical and hydrogeological studies would be conducted to fully understand effects on groundwater and the fate of diverted stormwater locally and within the area. This alternative is easily expandable should additional control be required.

There should be no significant construction related issues or risks beyond typical landscape construction in right-of-way. Construction would require temporary traffic control and the accommodation of temporary access.

#### **7.4.4.5 Operation and Maintenance**

The rain gardens would operate passively and would not require staff for startup. Periodic maintenance would be required to ensure effective operation during storm events. Maintenance would be low tech compared to a conventional wastewater facility and would be relative straightforward (garden maintenance and periodic soil/plant replacement). Maintenance would require working alongside a traveled roadway but would not require significant traffic control or workers in the traveled right-of-way.

#### **7.4.4.6 Costs**

Costs for this project would be highest of the evaluated alternatives. However, this alternative would not require property or easement acquisition, which can bring budgetary uncertainty to the other alternatives. See Appendix B for a summary of comparative costs.

#### **7.4.4.7 Community**

This alternative provides streetscape beautification, traffic calming along streets using curb bulbs, habitat enhancement and enhancement of neighborhood identity. It would require coordination with property owners during rain garden installation. Public outreach efforts would be required so that the County can partner with property owners regarding the rights and responsibilities associated with rain gardens (i.e., they will be County-maintained

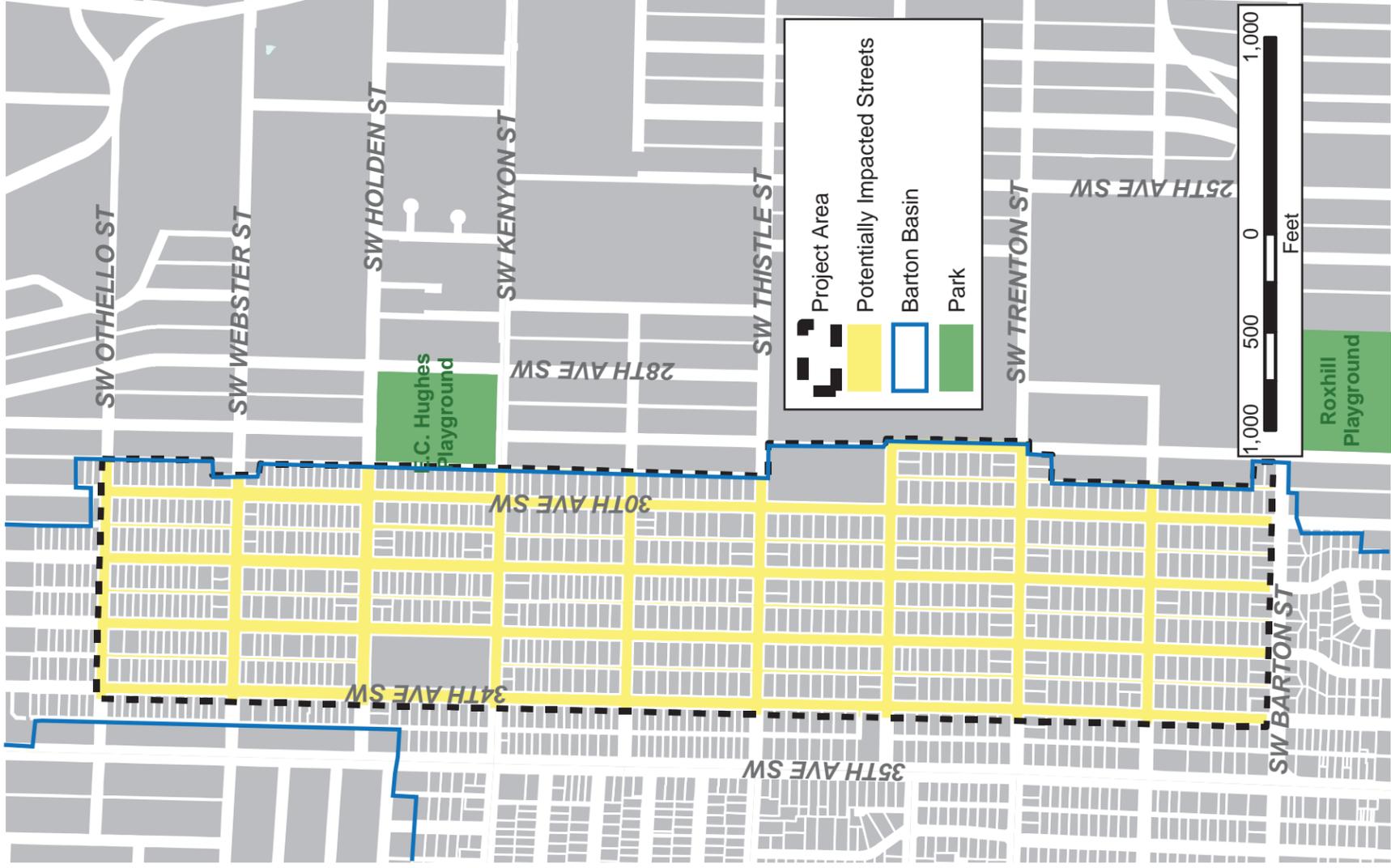


Figure 7.3.  
FINAL BARTON ALTERNATIVE 4A (GSI): GREEN STORMWATER INFRASTRUCTURE IN SUB-BASIN 416



facilities and the property owners will need to work cooperatively with the County regarding planting, or customization of the rain gardens) and level of maintenance.

## 7.5 FINAL SHORT-LISTED ALTERNATIVES—MURRAY BASIN

### 7.5.1 Refinement of Murray Alternatives

The project team and the CAG developed and refined alternatives as described in Section 7.3, resulting in three short-listed alternatives for final evaluation. Table 7.4 summarizes pertinent data; the alternatives are described in detail in the following sections.

	<b>Alternative 1A</b>	<b>Alternative 1F</b>	<b>CAG Alt. 2-a</b>
Type of Facility	Buried, Rectangular Tank,	Buried, Rectangular Tank,	Buried Rectangular Tank in Lincoln Park Lower Parking Lot; Storage pipe at Lowman Park.
Facility Dimensions	72' x 155' area, 15' deep	Cell length varies (180', 150', 120', 95', 60'); cell width 15'; depth 15'	Tank: 76' x 144' are, 20' deep Pipe: 12' diameter 125' length
# Internal Channels	4	5	4 (tank)
Sewer	48" diameter, 80' length; open-cut w diversion structure	48" diameter, 140' length; open-cut w diversion structure	Dual 24" diameter force mains, 600' length; open-cut
Excavation Limits to Shoring	80' x 165' area, 35' deep (max)	100' wide x 190' to 70' long	Tank: ~85' x 152' area, 40' deep (max) Pipe: 20' x 130'
Diversion Control Structure Dims:	31' x 23' area, 25' deep	31' x 23' area, 25' deep	Tank: 31' x 23' area, 25' deep Pipe: 20' x 20'
Odor Control/Electrical Footprint	40' x 40' (below-grade odor control) 12' X 20' (below-grade elect.)	40' x 40' odor control 12' x 20' elect. (both above grade)	40' x 40' (below-grade odor control) 12' x 20' (below-grade elect.)
Land acquisition	25,000 square feet in Lowman Beach Park, easement	20,000 square feet purchased	50,000 square feet in Lincoln Park and right of way near Lowman Beach Park, easements
Construction Limits, Staging	150,000 square feet	85,000 square feet (Contractor to find additional staging off site)	95, 000 square feet
Street Use	See Property Acquisition Plan	See Property Acquisition Plan	See Property Acquisition Plan

## **7.5.2 Murray Alternative 1A—Storage at Lowman Beach Park**

This alternative features a diversion structure, 80 feet of 48-inch-diameter gravity sewer, a 1.0-MG rectangular, buried, cast-in-place concrete storage tank, a tank cleaning mechanism, and submersible pumps for tank draining (see Figure 7.4). The diversion structure would be west of the existing Murray Pump Station, connected near the existing CSO outfall. It would have an overflow weir to divert flows exceeding the pump station's 31.5-mgd capacity through a new 48-inch sewer to the storage tank. The storage tank would retain the overflows until rainfall has ceased for a pre-set time. At that time, submersible drain pumps would pump the stored contents back to the Murray Pump Station over a 12-hour period.

The tank would be located in Lowman Beach Park, adjacent to the existing Murray Pump Station. It would have an area of 72 feet by 155 feet and a water depth of 15 feet. It would be constructed by cut-and-cover methods. A shored excavation in level ground would be required. It is anticipated that the tank would be covered by 2 to 4 feet of earth and the park would be restored on top of the tank. The tank would be accessed from the top at the ends for maintenance. Cleaning equipment would likely consist of either flushing gates or tipping buckets, to be determined during detailed design. A 110-by-25-foot below-grade structure would house carbon scrubber odor control, electrical equipment, and a backup generator.

This alternative was evaluated using the criteria shown in Appendix B. The following sections describe evaluation considerations.

### **7.5.2.1 Land Use and Permitting**

Seattle's comprehensive plan strongly discourages the location of utilities in Seattle parks. The area is zoned single-family residential and the overlying Shoreline designation is Conservancy Recreation (CR). Utility service uses, including storage tanks, are prohibited in the CR zone; allowed uses are limited to utility lines only. City Council and Department of Ecology approval of a code amendment would likely be required.

This alternative would require a Shoreline permit. A piped portion of Pelly Creek runs along the north boundary of the park; a Hydraulic Project Approval may be required if the piped portion needs to be relocated. Construction of this alternative would require careful traffic planning because there is restricted access along Beach Drive for residences south of Lowman Beach Park.

The design would include measures to minimize impacts on existing land use. This alternative is located on park property and would be difficult to mitigate with in-kind replacement (may require acquisition of private properties.). Seattle Ordinance 118477 requires approval from Seattle City Council if King County intends to acquire park property for utility use.

### **7.5.2.2 Environmental**

No archaeological or historic resources have been identified in the project area, but, based on site characteristics, the project area has a high probability of containing such resources.

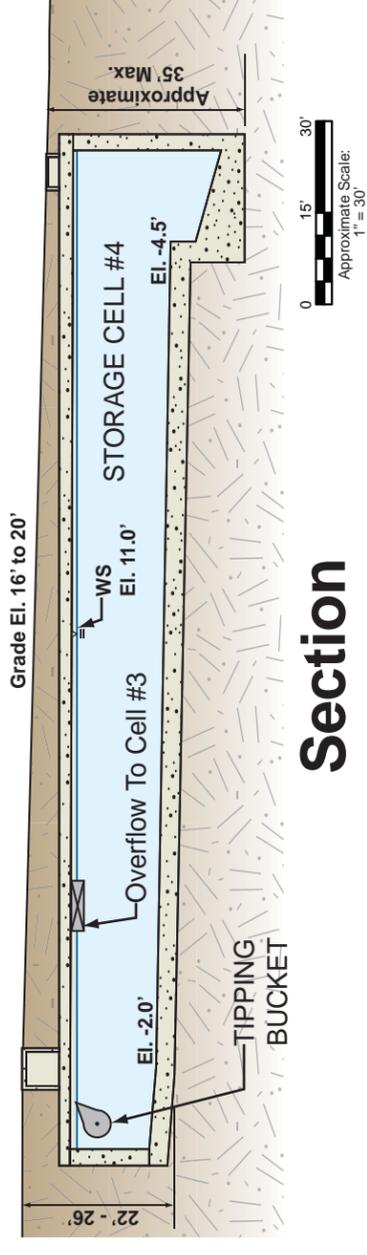
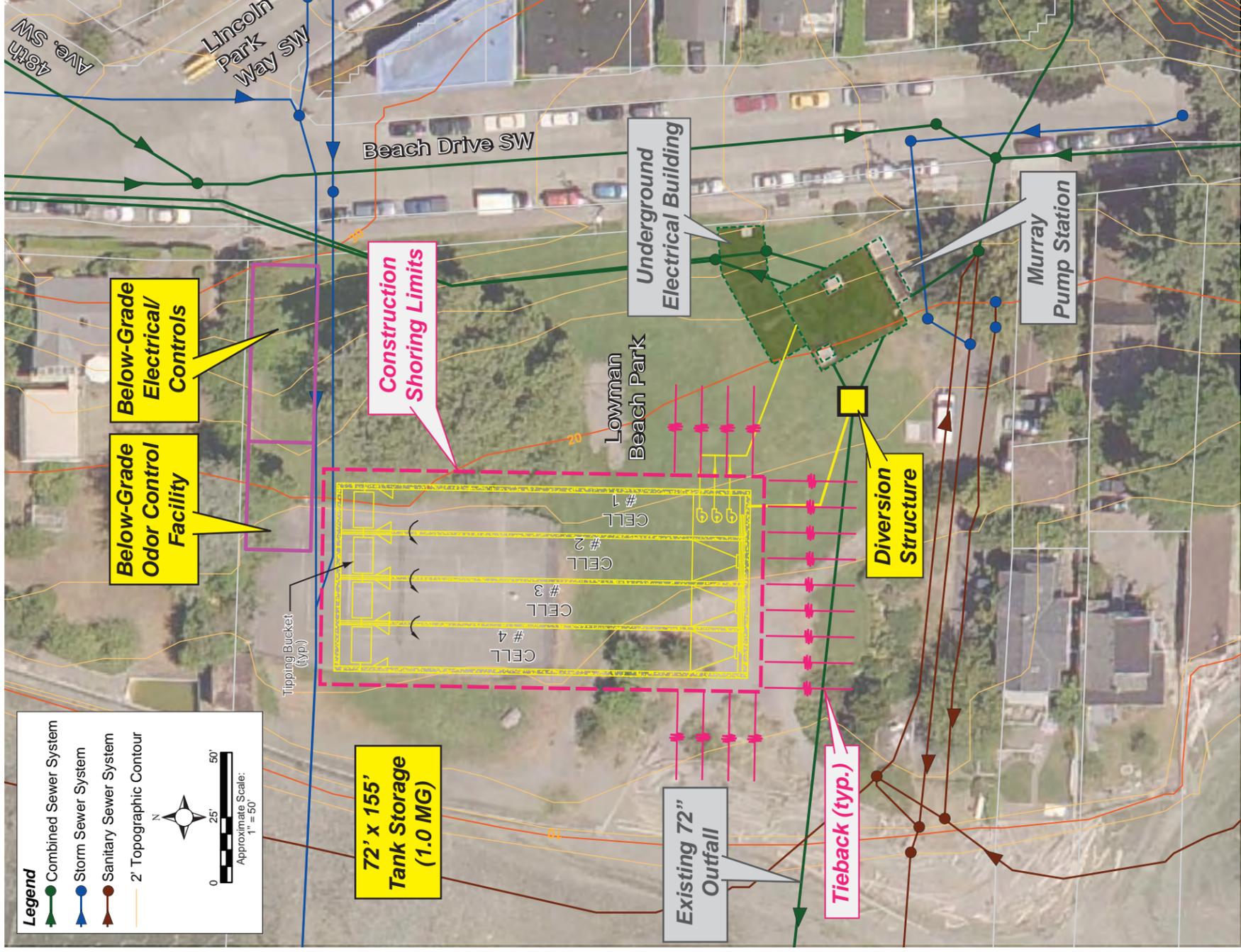


Figure 7.4.  
FINAL MURRAY ALTERNATIVE 1A: STORAGE AT LOWMAN BEACH PARK



It is assumed that Pelly Creek is not a fish-bearing stream. Construction and operation of this alternative would have a minimal effect on fish and wildlife and their habitat. Construction would require the removal of two American sycamores and a Douglas fir that appear to meet the definition of exceptional trees under the SMC.

The project area is located within the shoreline zone. Construction on the beach is not anticipated. No wetlands have been identified in the project area.

### **7.5.2.3 Technical**

This is a bottom of the basin alternative and is considered highly reliable in capturing peak flows that exceed the Murray Pump Station's capacity. This alternative requires a simple diversion structure with a weir to divert flows to storage through a gravity pipeline. There is limited room on this site to expand the facility in the future.

There may be construction difficulties with groundwater, liquefaction conditions, and excavation. Space in the park is limited for staging and material lay-down.

### **7.5.2.4 Operation and Maintenance**

Access for tank, odor control and electrical facility maintenance would be straightforward and familiar to County operations staff. The tank and diversion structure would be easily accessed from Beach Drive and there would be adequate space around the tank for maintenance. Maintenance of the odor control and electrical systems would require below-grade entry. Access for major maintenance intervals of the tank would require park closure.

### **7.5.2.5 Costs**

This alternative is the least costly of the short-listed alternatives; at this level of estimating its cost is essentially equal to that of Alternative 1F. See Appendix B for a summary of comparative costs.

### **7.5.2.6 Community**

The community has expressed concern over construction of a storage facility under Lowman Beach Park. Construction at this site would have the following substantial impacts on the community:

- Short-term impacts from approximately 1,150 truck trips for removal of excavated materials and import of construction materials. The haul route would be along Beach Drive, Lincoln Park Way and Fauntleroy Way, which has substantial ferry traffic.
- Loss of park use during construction (24 to 36 months).
- Existing trees in the park may need to be removed to provide room for construction.
- Access hatches and penetrations such as vents may cause reduction in park use.

### **7.5.3 Murray Alternative 1F—Beach Drive Area Underground Storage**

This alternative features a diversion structure, 80 feet of 48-inch diameter gravity sewer and a 1.0-MG rectangular, buried, cast-in-place concrete storage tank with a tank cleaning mechanism and submersible pumps for tank draining (see Figure 7.5). The tank would be located on private properties across Beach Drive from Lowman Beach Park and the existing Murray Pump Station. The tank would have multiple cells and the facility's footprint would be trapezoidal so it could fit on the proposed site. A retaining wall along the east edge of the property (along Lincoln Park Way SW) would provide slope stability and maximize the usable area within the proposed site.

The diversion structure would be located west of the pump station, connected near the existing CSO outfall. It would have an overflow weir to divert flows exceeding the pump station's 31.5-mgd capacity through the 48-inch sewer to the storage facility. The storage facility would retain the stored volume until rainfall has ceased for a pre-set time. At that time, submersible drain pumps would pump the stored contents back to the Murray Pump Station over a 12-hour period.

The tank would consist of five 15-foot-wide cells, from 60 to 180 feet long. It would be constructed by cut-and-cover methods, with secant-pile shoring on all sides. The tank would be covered by 2 to 4 feet of earth and the surface would be restored on top of the tank. A 40-foot by 60-foot above-grade structure would house carbon scrubber odor control, electrical equipment, and a backup generator. The tank would be accessed from the top at the ends of each cell for maintenance. Cleaning equipment would likely consist of either flushing gates or tipping buckets, to be determined during detailed design.

Restoration requirements over the tank area and adjacent to the existing pump station would be established during final design.

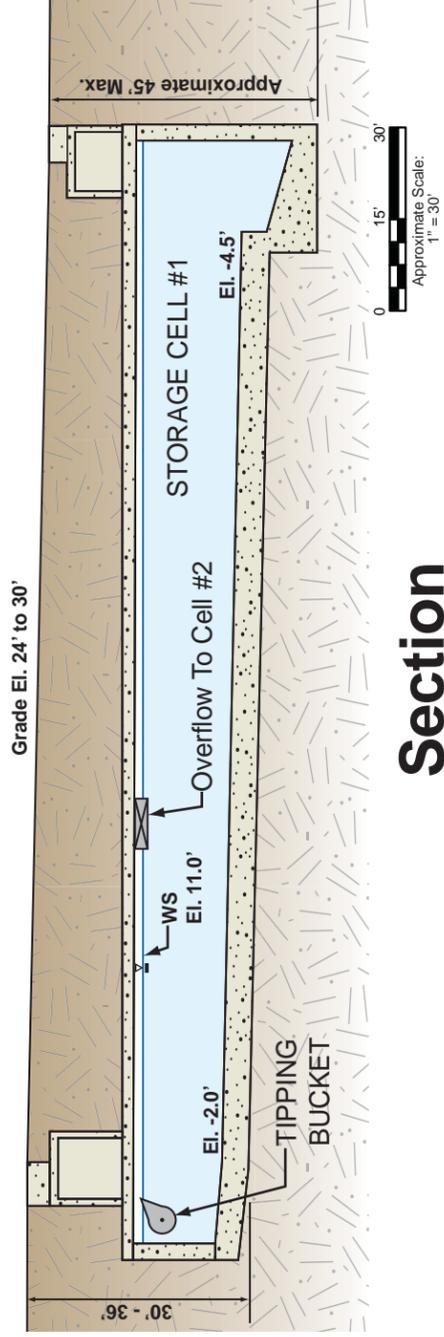
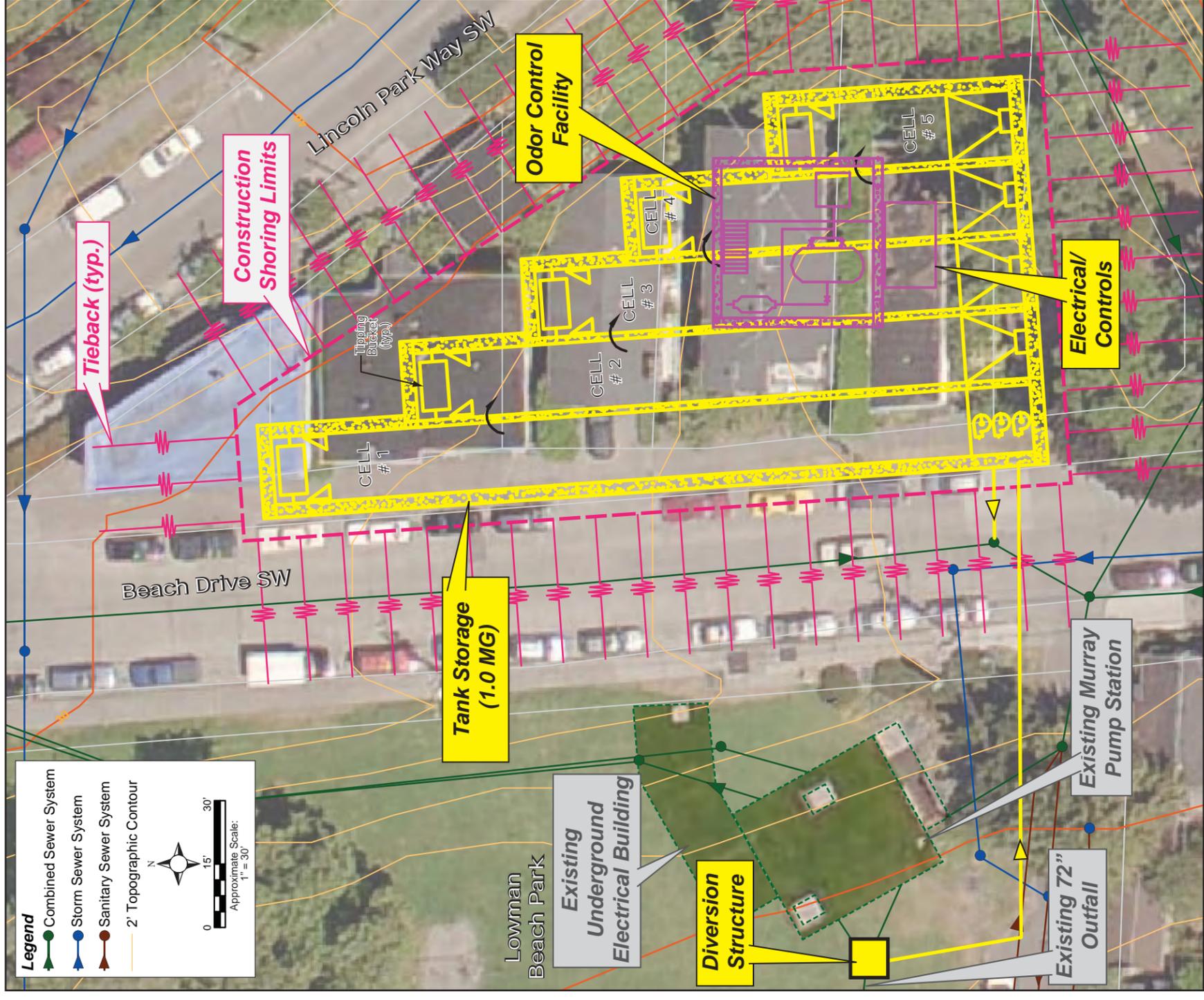
This alternative was evaluated using the criteria shown in Appendix B. The following sections describe evaluation considerations.

#### **7.5.3.1 Land Use and Permitting**

Construction of this alternative would require property acquisition and demolition of six residential structures. Construction of the diversion structure west of the existing pump station in Lowman Beach Park would require approvals from Seattle Parks and the Seattle Department of Planning and Development (DPD).

The diversion structure would be located within the Shoreline District and will likely be considered an expansion of the existing pump station facility. The storage tank would be located outside the shoreline zone.

It is anticipated that one discretionary Shoreline permit would be required. Local permits would be required from SDOT and DPD. A parks review would also be required. It is anticipated that no federal or state permits would be required. Because of temporary traffic impacts during construction for local residents, provisions for temporary and emergency access would be required as a permit condition.



**Section**

Figure 7.5.  
 FINAL MURRAY ALTERNATIVE 1F: BEACH DRIVE AREA UNDERGROUND STORAGE



### **7.5.3.2 Environmental**

No archaeological or historic resources have been identified in the project area, but based on site characteristics, the project area has a high probability of containing such resources.

Construction of this alternative would require clearing of forested area on the private properties, which may affect fish and wildlife. There are large Douglas fir trees and a flowering cherry tree on the site, which may meet the definition of exceptional trees in SMC.

Part of this project is located within the Shoreline zone. Construction on the beach is not anticipated. No wetlands have been identified in the project area.

### **7.5.3.3 Technical**

This is a bottom-of-the-basin alternative and would be highly reliable in capturing peak flows that exceed the Murray Pump Station's capacity. This alternative requires a simple diversion structure with a weir to divert flows to storage through a gravity pipeline. There is limited room on the site to expand the facility in the future.

There may be construction difficulties with groundwater, liquefaction conditions, and excavation. It is anticipated that a secant pile shoring system and a retaining wall for Lincoln Park Way SW would need to be constructed to effectively use the site and construct the storage facility. Construction staging and lay-down in portions of the park would be required. Electrical and odor control facilities can be located at grade, on top of the tank.

### **7.5.3.4 Operation and Maintenance**

Access for tank, odor control and electrical facility maintenance is straightforward and familiar to County operations staff. The tank and diversion structure would be easily accessed from Beach Drive and there would be adequate space around the tank for maintenance. Maintenance of the odor control and electrical systems would use above-grade entry. Access for major maintenance intervals of the tank would not require park closure.

### **7.5.3.5 Costs**

This alternative is the second least costly of the short-listed alternatives; at this level of estimating its cost is essentially equal to that of Alternative 1A. See Appendix B for a summary of comparative costs.

### **7.5.3.6 Community**

The community has expressed concern about construction of a storage facility on private properties at the bottom of the basin because of the concern for removing housing. Construction at this site would have the following substantial impacts on the community:

- Requires the acquisition of six residential properties and the relocation of 15 residents.
- Short-term impacts from approximately 1,500 truck trips for removal of excavated materials and import of construction materials. The likely haul route would be along

Beach Drive, Lincoln Park Way, and Fauntleroy Way, which has substantial ferry traffic.

- Intermittent loss of park use and some limits to park access during construction (12 to 24 months).

#### **7.5.4 Alternative CAG 2-a—Storage at Lincoln Park Lower Parking Lot**

This alternative features two storage facilities: a 1.25-MG buried rectangular storage tank under Lincoln Park's lower parking lot (near the far south end of the park); and a 0.1-MG, 12-foot-diameter storage pipe at the bottom of the Murray basin adjacent to the existing pump station, most likely in Beach Drive (see Figure 7.6.). For the Lincoln Park storage facility, there would be a force main diversion to the facility off the existing Barton Pump Station force mains. There would be tank-cleaning mechanisms and submersible pumps for tank draining. For the pipe storage adjacent to the Murray Pump Station, there would be a gravity diversion structure, a flushing gate mechanism for cleaning, and submersible pumps for tank draining.

When flows to the Murray Pump Station approach a level at which an overflow is likely to occur (estimated near 15 mgd since approximately half of the flow during a peak event is coming from the Barton Pump Station to the Murray Pump Station), flows from the Barton Pump Station would be diverted to the storage facility in Lincoln Park, so that only flows from the Murray CSO basin would continue to the Murray Pump Station. Excess flows beyond the Murray Pump Station's 31.5-mgd capacity would be diverted through a 48-inch sewer to the new large-diameter storage pipe at the bottom of the Murray basin. Both storage facilities would retain stored flows until rainfall has ceased for a pre-set time. At that time, submersible drain pumps would pump the stored contents back in to the Barton Pump Station force main and Murray Pump Station over a 12-hour period.

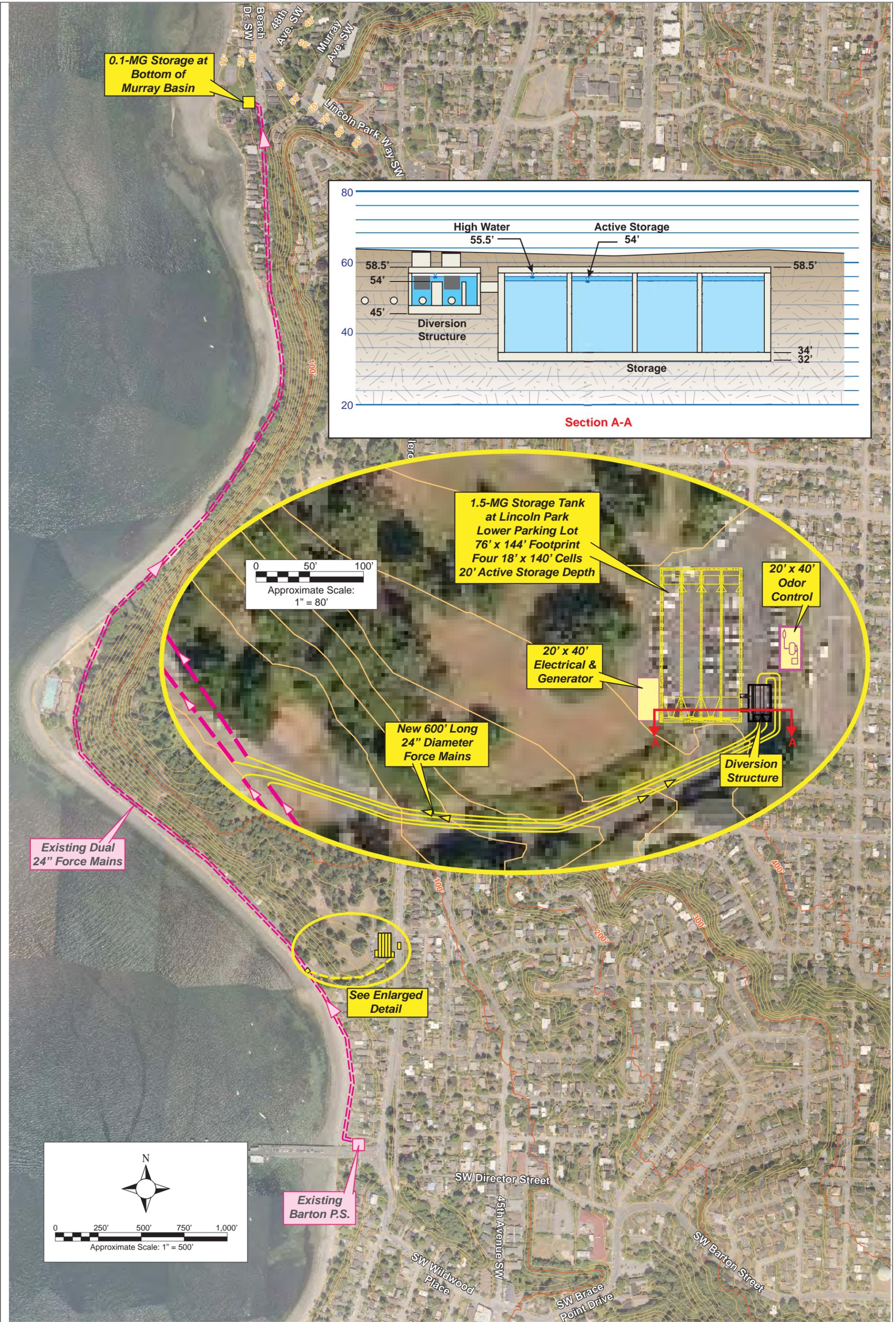
The Lincoln Park tank would have an area of 76 feet by 144 feet and a water depth of 20 feet. A shored excavation in level ground would be required. The tank would be covered by 4 to 8 feet of earth and the parking lot would be restored on top of it. Separate 20-by-40-foot below-grade structures would house the electrical facilities and the carbon scrubber odor control facility. The large-diameter storage pipe adjacent to Lowman Beach Park would be 125 feet long and would have a below-grade or above-grade odor control and electrical facility, depending on where it was sited. The odor control and electrical facilities would both have dimensions of approximately 20 feet by 40 feet.

The storage facilities would be accessed from the top at the ends for maintenance. Cleaning equipment would likely consist of either flushing gates or tipping buckets, to be determined during detailed design.

This alternative was evaluated using the criteria shown in Appendix B. The following sections describe evaluation considerations.

##### **7.5.4.1 Land Use and Permitting**

The project area is zoned single-family residential and a conditional use permit may be required for constructing utility services within the park. Seattle's comprehensive plan



3630023/Fig7-06\_Murray\_FinalCAG2A.ai



strongly discourages the location of utilities in city parks. The Shoreline designation is Conservancy Recreation (CR) and Conservancy Preservation (CP). Utility lines are allowed as a special use within the CR designation, but are prohibited in the CP designation. An approval from Seattle Parks and Recreation would be required to allow a utility service use (storage tank) beneath the parking lot of Lincoln Park. The storage tank would be located outside of the Shoreline District and would be allowed through a City Council Conditional Use Approval, provided the parks department approves of the project.

#### **7.5.4.2 Property Acquisition**

This alternative is located on park property and may be difficult to mitigate with in-kind replacement. Sections of Lincoln Park and the parking lot would be needed for permanent easements and temporary easements. Seattle Ordinance 118477 requires approval from the Seattle City Council if King County intends to acquire the park property for utility use.

#### **7.5.4.3 Environmental**

No archaeological or historic resources have been identified in the project area, but based on site characteristics, part of the project area has a high probability of containing archaeological resources. The Lincoln Park Concession & Comfort Station is located more than 200 feet northwest of the lower parking lot but would not be impacted by the project. No historic resources have been identified in other project areas.

The project area is located within the shoreline zone (diversion structures and force main). Construction on the beach is not anticipated. No wetlands have been identified in the project area.

#### **7.5.4.4 Technical**

This alternative requires siting storage at two locations in order to achieve control at the Murray Pump Station. Diverting flows to the storage facility at the bottom of the Murray basin would be by gravity overflow and would be highly reliable. Diverting flows to storage at Lincoln Park would use a complex diversion structure relying on telemetry and possibly predictive algorithms. Telemetry signals would activate motorized gates (or valves) to divert flow to storage during a peak flow event. There would be continuous need for air management at the diversion structure because force main flows would be released to atmosphere in the storage facility.

This alternative would require an emergency overflow in the event of telemetry and control failure; the overflow would likely be routed to the existing SPU sewer in Fauntleroy Way (or a new overflow pipe back to the Barton Pump Station would need to be constructed). There is limited space available in Lincoln Park's lower parking lot for expansion of the tank if additional capacity is needed. Property is limited at the bottom of the basin and ability to expand the smaller 0.1 MG storage facility in the future could also be problematic.

#### **7.5.4.5 Operation and Maintenance**

Operation and maintenance of rectangular and pipe storage facilities is familiar to King County staff. However, King County operations staff has limited familiarity with predictive algorithms used to divert flow to storage to prevent CSOs.

Maintenance of the odor control and electrical systems would require below-grade entry. Access for major maintenance intervals of the tank would require parking lot closure and street closure along Beach Drive.

#### **7.5.4.6 Costs**

This alternative is the most costly of the short-listed alternatives; but at this level of estimating its cost is essentially equal to that of Alternative 1A and Alternative 1F.

#### **7.5.4.7 Community**

The Barton and Murray communities have been split with support for or concerns about this alternative. The Murray community is more supportive of this alternative because it lessens the impact on Lowman Beach Park and properties at the bottom of the Murray Basin. The Barton community is concerned about the loss of use of the Lincoln Park lower parking lot during construction, 5 to 7 years of multiple construction projects in the immediate vicinity, and limitations to parking during heavy maintenance intervals in the future. Construction at this site would have the following substantial impacts on the community:

- Short-term impacts from approximately 2,000 truck trips for removal of excavated materials and import of construction materials. The haul routes would be along Beach Drive, Lincoln Park Way, and Fauntleroy Way, which has substantial ferry traffic.
- Loss of park use during construction (24 to 36 months).
- Trees in Lincoln Park may need to be removed to provide room for construction.
- Access hatches and penetrations such as vents may result in permanent loss of some parking spaces.

### **7.6 SELECTION OF PROPOSED PROJECTS**

This section describes the selection of the proposed project for the Barton and Murray CSO basins. Detailed evaluation matrices are provided in Appendix B.

#### **7.6.1 Refinement of the Evaluation Criteria**

The evaluation template used by the project team to evaluate these alternatives is in Appendix B. It describes the team's comments on the various factors affecting selection of the proposed projects.

**7.6.2 Evaluation Process**

**7.6.2.1 Screening Analysis**

The project team convened several focus group meetings between May 2010 and October 2010. The team reviewed updated and new information about the alternatives. The team refined the criteria questions and evaluation ratings using the results of these meetings.

The team then compiled evaluation results from the focus group meetings and convened two workshops in November 2010 to condense the most salient evaluation factors to carry forward to King County management to assist in making a final selection. Tables 7.5 and 7.6 summarize the project team’s analysis of the shortlisted alternatives for Barton and Murray.

**7.6.2.2 Risk Analysis**

In November 2010, the project team conducted project implementation risk assessment workshops for the short-listed alternatives. The resulting risk assessment matrices are in Appendix G. For the Barton CSO basin, Alternatives 1E and 1F had a number of potential high-impact and high-probability risks, as shown in Table 7.5. For the Murray CSO basin, Alternatives 1A, 1F, and CAG 2-a all had a number of potential high-impact and high-probability risks, as shown in Table 7.6. These risks result in higher cost and schedule risk for these alternatives.

Barton Alternative 4A (GSI) had no identified high-probability/high-impact risks.

<b>Table 7.5 Barton Short Listed Alternatives Evaluation Summary Data</b>			
	<b>Alternative 1E: Pipe Storage in Upper Fauntleroy Way</b>	<b>Alternative 1F: Tank Storage at Fauntleroy School</b>	<b>Alternative 4A: GSI in Sub-basin 416</b>
<b>Overall Evaluation Ratings</b>	This alternative had the fewest low-impact scores and had some high impact ratings.	This alternative had the most mid-impact ratings and scored in the middle for low-impact ratings.	This alternative had the most low-impact ratings.
<b>Technical Considerations</b>	Mid-basin alternative that requires careful management of flows to ensure CSO control. Storage pipe and infrastructure similar to other county facilities. Shoring, groundwater, and physical space concerns for constructability. Street access required. Increased staffing and maintenance requirements for facilities in the right-of-way and cleaning of pipe configuration.	Mid-basin alternative that requires careful management of flows to ensure CSO control. Buried rectangular storage tank similar to other county facilities. Street access required for maintenance of drop structure and diversion structure. Concern about staff safety and street closure requirements.	Technically the simplest alternative—no wastewater equipment. This alternative has opportunity to expand for additional removal of impervious area flows. No significant construction issues or risks beyond typical landscape construction in right-of-way. Routine landscape maintenance and inspection required.

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
ALTERNATIVES EVALUATION AND SELECTION**

<b>Table 7.5 Barton Short Listed Alternatives Evaluation Summary Data</b>			
	<b>Alternative 1E: Pipe Storage in Upper Fauntleroy Way</b>	<b>Alternative 1F: Tank Storage at Fauntleroy School</b>	<b>Alternative 4A: GSI in Sub-basin 416</b>
<b>Preliminary Cost Estimates</b>			
Project	\$7,820,000	\$8,600,000	\$12,000,000 - \$14,800,000
Land (including easements)	\$0	\$740,000	\$0
Street Use Permits	\$1,200,000	\$185,000	\$1,200,000
<b>Total</b>	<b>\$9,020,000</b>	<b>\$9,525,000</b>	<b>\$13,200,000 - \$16,000,000</b>
<b>Community Input</b>	Strong opposition to this alternative.	Support for this alternative from Fauntleroy Community Association, some concerns about temporary parking impacts from tenants.	Although some community members have expressed support for this alternative, some have also raised concerns about increased risk of water intrusion into basements.
<b>Real Estate</b>	Concerns about loss of trees and impacts on view from Upper Fauntleroy Way. May need private acquisition if additional space required to accommodate project.	Property owner amenable to providing an easement for siting the tank in the parking lot.	Concerns about loss of parking. Curb bulbs would be at end of blocks where parking is already prohibited.
<b>Land Use, Permits (in addition to typical construction permits)</b>	SDOT street use permit. Local construction permits. Exceptional tree permit.	Council Conditional Use Permit – review process would probably be straightforward. There is community support for this alternative.	SDOT street use (street improvement permit).
<b>Environmental Considerations</b>	Significant archaeological concerns.	Based on site characteristics, site has medium potential to contain archaeological resources.	No known environmental, issues of concern.
<b>Risk Analysis High Impact and High Probability Risks</b>	Archaeological resources found during construction, delaying project. Community protests removal of treasured roses and exceptional trees to County and City Council, delaying project.	Tenant at Fauntleroy School objected to use of site because of fear of loss of business, delaying project.	No 'high-high' risks were identified during the risk analysis.

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
ALTERNATIVES EVALUATION AND SELECTION**

**Table 7.6 Murray Short Listed Alternatives Evaluation Summary Data**

	<b>Alternative 1A: Rectangular Storage in Lowman Beach Park</b>	<b>Alternative 1F: Beach Drive Area Underground Storage</b>	<b>CAG Alt. 2-a: Storage in Lincoln Park Lower Parking Lot</b>
<b>Overall Evaluation Ratings</b>	This alternative had the most high-impact ratings.	This alternative had a mixture of mostly mid-impact and low-impact ratings.	This alternative had a mixture of mostly high-impact and mid-impact ratings.
<b>Technical Considerations</b>	Bottom-of-the-basin alternative that is the most reliable for capturing peak flows and ensuring CSO control. Buried rectangular storage tank similar to other county facilities. Shoring, groundwater, and physical space concerns for construction in park.	Bottom-of-the-basin alternative that is the most reliable for capturing peak flows and ensuring CSO control. Buried rectangular storage tank similar to other county facilities. Shoring, groundwater, and physical space concerns for construction on a small site without spare space for lay-down and staging.	Technically the most complicated alternative—Storage at two locations relying on telemetry and predictive control algorithms to divert flow to storage. Air management would be a challenge at the Lincoln Park parking lot storage tank. Emergency overflow to local sewer required. Fewer groundwater and excavation issues than at the bottom of the basin locations.
<b>Preliminary Cost Estimates</b>			
Project	\$29,800,000	\$32,900,000	\$42,800,000
Land Acquisition (including easements)	\$9,000,000	\$6,400,000	\$1,800,000
Street Us Permits	\$1,800,000	\$1,700,000	\$140,000
<b>Total</b>	<b>\$40,600,000</b>	<b>\$41,000,000</b>	<b>\$44,740,000</b>
<b>Community Input</b>	Strong opposition to this alternative. Seattle Ordinance 118477 requires council approval for construction in the park. Council decision is appealable.	Strong opposition by some community members.	Strong opposition to this alternative. Seattle Ordinance 118477 requires council approval for construction in the park. Council decision is appealable.
<b>Real Estate</b>	Concerns about loss of trees and impacts on view from Lowman Beach Park. Use of park.	Some property owners may not be willing to sell, which would require condemnation under eminent domain. Relocation of tenants.	Concerns about loss of parking and park use/access.

**BARTON AND MURRAY COMBINED SEWER OVERFLOW CONTROL FACILITIES PLAN  
ALTERNATIVES EVALUATION AND SELECTION**

**Table 7.6 Murray Short Listed Alternatives Evaluation Summary Data**

	<b><u>Alternative 1A:</u> Rectangular Storage in Lowman Beach Park</b>	<b><u>Alternative 1F:</u> Beach Drive Area Underground Storage</b>	<b><u>CAG Alt. 2-a:</u> Storage in Lincoln Park Lower Parking Lot</b>
<b>Land Use, Permits (in addition to typical construction permits)</b>	Exceptional tree permit. Shoreline Permit Council Conditional Use Permit with DOE approval — The storage tank would be located in a city park designated “Conservancy Recreation” (CR) in Seattle’s Shoreline Master Program. Storage is considered a “Utility Service Use.” Utility Service Uses are prohibited.	Storage tank in Low-rise Multi-family zoning is allowed if construction can meet same standards identified for Institutions. Utility pipelines and associated underground diversion structure within the park would require a Shoreline Permit.	Council Conditional Use Permit. The storage tank would be located in a city park. The zoning is single-family residential and the overlying Shoreline designation is Conservancy Recreation (CR) and Conservancy Preservation (CP). Storage is considered a utility service use, which is allowed through City Council Conditional Use approval. Storage tanks are prohibited within the CR and CP Shoreline designation but utility pipelines are allowed as a special use.
<b>Environmental Considerations</b>	High probability for site to contain archaeological resources. No anticipated impacts on Pelly Creek.	Site has medium probability of containing archaeological resources. Construction would take place next to steep slopes.	No known archaeological sites but high probability of encountering resources in the proposed locations. Some construction within Shoreline but no construction in beach.
<b>Risk Analysis High Impact and High Probability Risks</b>	Permit appeal successful, delaying project. Rezoning required, delaying project. Park trees need to be removed, delaying project. Community successfully protests project, causing delays.	Differing site conditions encountered during excavation. Replacement of property substantially more expensive than planned.	Permit appeal successful, delaying project. Limited haul routes require substantial restoration and limitations on work hours, delay project completion and high expense. Loss of hydraulic capacity of Barton Pump Station because of flow transition to new storage facility, increase tank size and cost. Community successfully protests project, causing delays.

## **7.7 PROPOSED ALTERNATIVES FOR FURTHER ENVIRONMENTAL REVIEW**

The project team forwarded five alternatives, along with briefings and summary key evaluation considerations, to King County management for a final decision to move forward for further environmental review:

- For the Barton CSO basin:
  - Alternative 1F—Storage at Fauntleroy School
  - Alternative 4A—Green Stormwater Infrastructure
- For the Murray CSO basin:
  - Alternative 1A—Storage in Lowman Beach Park
  - Alternative 1F—Beach Drive Area Underground Storage
  - Alternative CAG 2-a—Storage in Lincoln Park Lower Parking Lot

King County management selected the following as proposed alternatives for further environmental review:

- Barton Alternative 4A—Green Stormwater Infrastructure. This alternative was selected for the following reasons:
  - Least complex approach for reducing CSOs.
  - Reduces the total volume of stormwater that needs to be conveyed and treated in the regional system.
  - Response to the interests from some community members in green infrastructure
  - Minimal permitting/zoning issues.
  - Property acquisition not required if all work is within right-of-way.
- Murray Alternative 1F—Beach Drive Area Underground Storage. This alternative was selected for the following reasons:
  - Simple, reliable system in which gravity diversion of flow fills the storage tank.
  - Does not involve tank construction on park property.
  - Minimal permitting/zoning issues.
  - Lowest schedule and cost risk.

Chapter 8 describes the proposed alternatives in detail.



This chapter provides design details and environmental information to provide a complete description of the proposed alternatives for the Barton and Murray CSO basins.

## **8.1 BARTON CSO BASIN PROPOSED ALTERNATIVE OVERVIEW**

Barton Alternative 4A (GSI) would establish a system of bioretention/bioinfiltration facilities between the sidewalks and streets in the Sunrise Heights and Westwood neighborhoods in Sub-basin 416 to reduce overflows at the Barton Pump Station. Bioretention/bioinfiltration facilities are dispersed small-scale landscape features using bioretention soil and vegetation designed to attenuate storm flows and treat stormwater. They are typically vegetation-filled depressions with a drainage function. They are often located in median strips, in parking lots, in planting strips along streets, or in other landscape areas. In this facilities plan, the term “rain garden” is used to describe these facilities.

The Sunrise Heights and Westwood neighborhoods are suited for this project because of their gentle topography and current connection of street drains to the combined sewer system. The rain gardens will be surface improvements constructed in City of Seattle public right of way. They will reduce CSO overflows by capturing and infiltrating rainwater that would otherwise enter the combined sewer system.

The project offers these benefits:

- Bioretention soil and vegetation allow stormwater runoff to infiltrate into the ground to reduce the volume of stormwater entering the combined sewer system.
- By maximizing the use of natural processes, the project supports the region's commitment to energy conservation and sustainability.
- King County will work with the neighborhoods to enhance the street's landscape aesthetics, minimize parking impacts, and respond to applicable neighborhood preferences for the project.
- The project will not require major operating facilities however it may be desirable to install flow metering to monitor effectiveness during storm events.
- This approach reduces the risk of combined sewer overflows at Barton and reduces flows to the Murray CSO basin.

### **8.1.1 Overflow Frequency and Volume**

Table 8.1 shows CSO frequency and volume from the Barton Basin both prior to project implementation and anticipated after implementation. The CSO frequency and volumes indicated in the table are shown for both modeled results over 30 years and actual monitored data collected at the outfall location between the years of 2000 and 2007.

<b>Table 8.1 CSO Frequency and Volume from the Barton Basin</b>			
<b>CSO Frequency and Volume</b>	<b>Monitored Prior To Project Implementation (2000 – 2007)</b>	<b>Model-Simulated Project Impacts</b>	
		<b>Prior To Project Implementation<sup>1</sup></b>	<b>Anticipated After Project Implementation<sup>2</sup></b>
Annual Frequency	4 Overflows/year	4.9 Overflows/year	1 Overflow/year
Annual Volume	4.3 MG	1.8 MG	0.5 MG
<u>Notes:</u>			
1. Based on a 30-yr King County Runoff simulation model and Barton Pump Station capacity of 22 MGD.			
2. Based on a 30-yr King County Runoff simulation model and Barton Pump Station capacity of 33 MGD.			

The annual frequency of overflows matches very closely for both the modeled and monitored results. Differences between modeled and monitored annual overflow volumes prior to project implementation can be due to a number of factors, including:

- Over-estimated overflow volumes due to limited sensitivities of level sensors and overflow calculations at the Barton Pump Station.
- Differing rainfall over the basin than that indicated by the rain gauges.
- Inaccuracies in the model.
- Monitoring period being different from the model period, with corresponding different rainfall events.

The 30-year simulation of the calibrated model provides the best engineering estimate of flow volumes to be expected, and is therefore used for sizing CSO facilities.

### **8.1.2 General Layout**

The GSI alternative consists of rain gardens installed over multiple blocks (32 – 64 half blocks depending upon final design conditions) in planting strips or in new curb bulbs along the street. Figure 8.1 shows the key elements of the GSI alternative.

### **8.1.3 Wet-Weather Flow Description**

Rain gardens along the street will be retrofitted within the existing right-of-way in Sub-basin 416 to intercept surface drainage that is currently routed to the combined sewer. The rain gardens will infiltrate and store some of the runoff, thereby reducing the volume and peak flow that enters the combined system and is conveyed to the downstream Barton Pump Station. The rain gardens will be used in areas with an existing curb and gutter system. Existing planter strips will be modified. In some locations this may include moving the curb out into the parking area of the roadway for a short distance. Figure 8.1 shows a sample image of an existing street in Sub-basin 416 before and after a hypothetical rain garden installation in the planting strip.





Surface runoff that is currently directed along the curb and gutter system will be routed to the rain gardens through curb cuts. Some runoff will infiltrate through the bottom of the rain garden. When the rate of runoff that is being routed to a rain garden exceeds the infiltration capacity of the facility, the water will begin ponding within the rain garden. Once the ponding depth exceeds 10 inches, runoff will begin to overflow back onto the gutter-line and into the catch basin connected to the combined system. Standard rain garden cross sections are shown in Figure 8.1. Section 2 shows a standard cross section for a rain garden that is installed within the existing 10-foot planting strip. Section 3 shows a widened cross section where the rain garden is extended into the street using a curb-bulb, increasing the facility's infiltration and storage capacity.

#### **8.1.4 Facility Sizing**

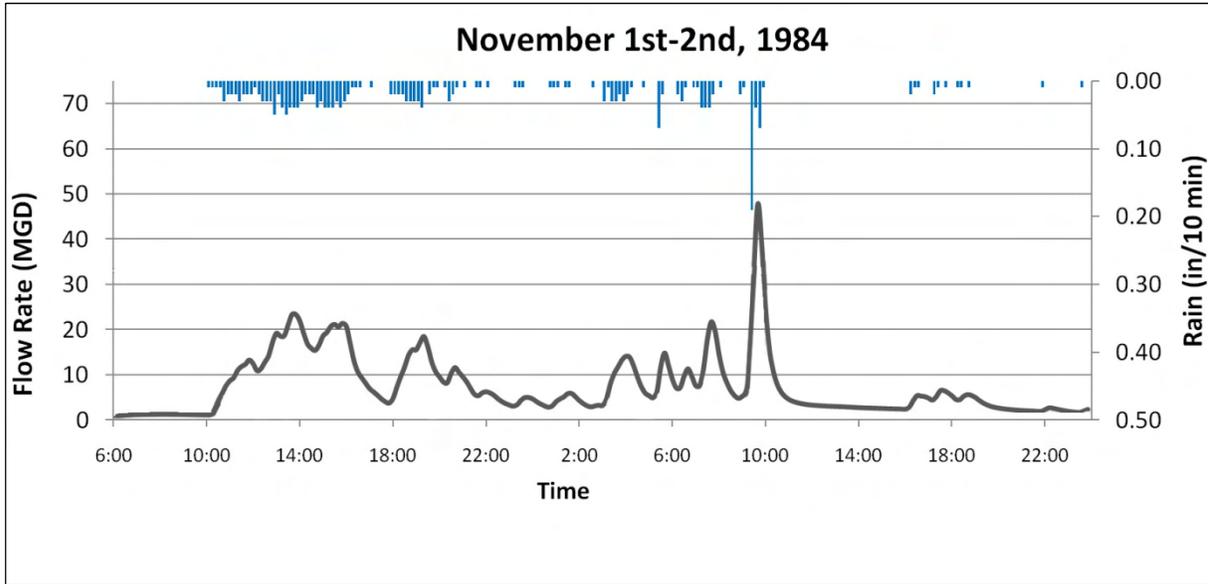
A Runoff/Transport model was used to determine the design storm events that would produce a combined sewer overflow (CSO) and to calculate the size of storage needed to control CSOs in the system. Details of the evaluation are included in Appendix A. The Runoff/Transport model allows for analysis in 10-minute time increments to account for different intensities of rain during the event. The results of the Runoff/Transport model design storm events were given in precipitation per 10 minute time increments. Rain garden sizing and distribution are related to soil infiltration rates and the volume of preceding rainfall during storms. These two factors affect the occurrence of sharp peaks during storm events.

The proposed GSI alternative was evaluated and sized using the November 1-2, 1984 storm as the design storm event and targeting a peak flow reduction of 14.6 mgd. This storm is near a 1-year event and has a higher peak flow rate and higher CSO volume than the long-term 1-year storm event. This storm was selected as the design storm because it is more challenging to control and is near a 1-year CSO volume. The modeled event lasted from 10:00 a.m. on November 1 through 9:50 a.m. on November 2 (see Figure 8.2).

The November 1-2, 1984 storm was a long storm with a sudden peak. Two additional storms were also analyzed (See King County Technical Memorandum 600.5 in Appendix A for analysis):

- The November 21 – 22, 1988 storm was short, with an extended dry period before the heavy rain started.
- The March 1–2, 1987 storm included an extended period of rain before the peak of the storm.

The precipitation record of the rainfall event was entered into a mass balance model that was used to determine the amount of Sub-basin 416 that needs to be mitigated to control the CSO design storm event. Sub-basin 416 was modeled as individual half-block catchment areas rather than as a single catchment. Each half block consists of half a residential block, from the alley to the right-of-way. This includes half the right-of-way along one north/south street and one-quarter of the right-of-way along two east/west streets. The hydrograph for the half block catchment area was then routed through rain gardens to determine the peak flow reduction produced by the assumed rain garden cells (See TM 600.6 in Appendix A for further information).



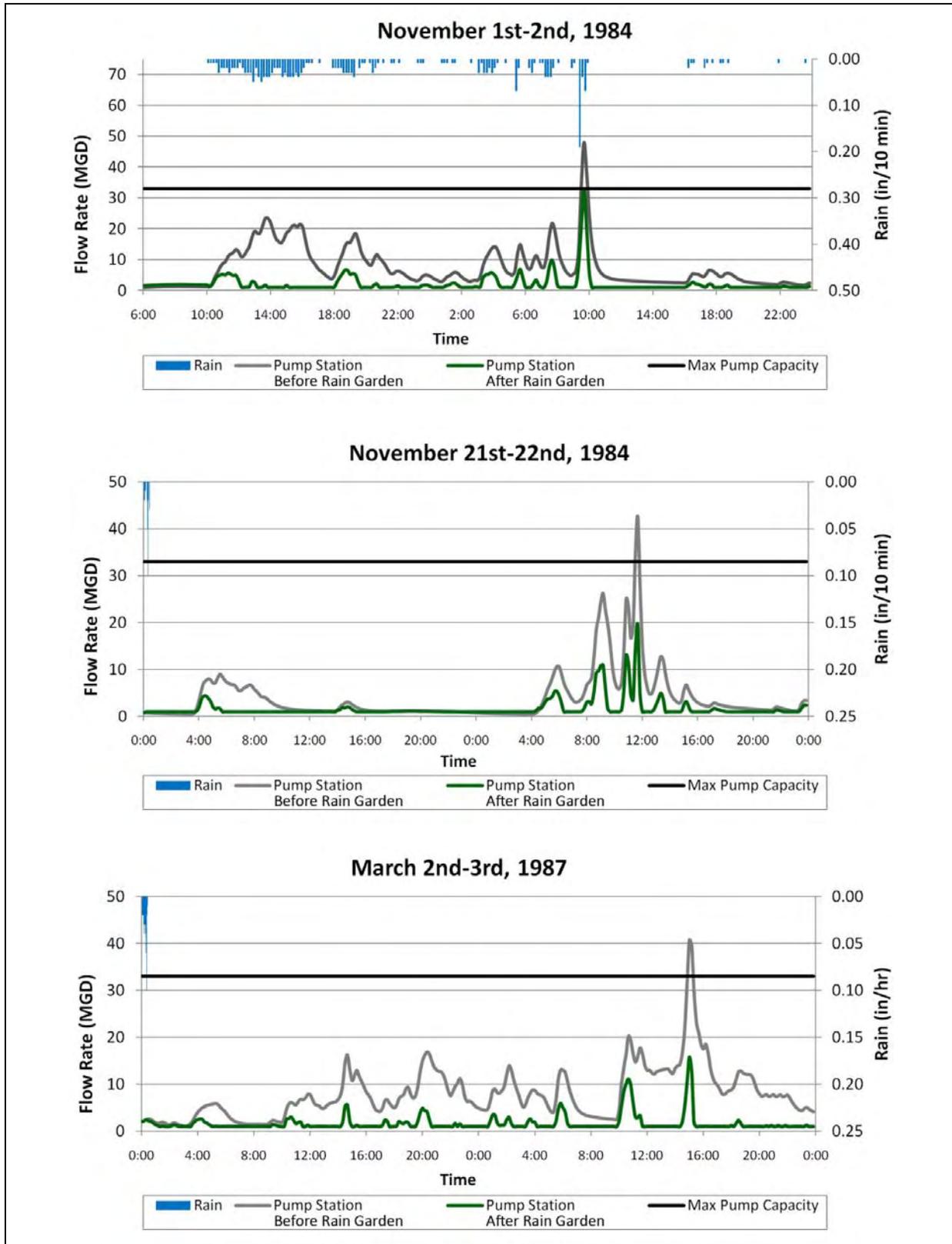
**Figure 8.2** Modeled November 1-2, 1984 Design Storm Hydrograph at Barton Pump Station (See TM 600.5 in Appendix A)

The layout of rain garden cells on a typical block is shown in Figure 8.1 with a typical half-block delineated in red. This approach distributes runoff flows and rain gardens across the sub-basin and more closely defines how flows and storage will behave during a storm event. The model indicated that 32 half-blocks of rain gardens in Sub-basin 416 would achieve the peak flow reduction target of 14.6 mgd for the 1984 design storm event. Figure 8.3 shows the resulting flow hydrograph for the design storm event. See King County TM 600.5 in Appendix A for review of the 1987 and 1988 storm events.

The sub-basin was assessed for feasible rain garden locations. Locations were considered difficult for implementing rain gardens if they possessed any of the following conditions:

- Slopes greater than 5 percent.
- Poor soils as described in geotechnical evaluation by Shannon & Wilson dated March 26, 2010.
- Problematic drainage patterns (e.g. existing buildings are below adjacent street grade).
- Space constrained by planting strip width, road width and/or driveways.
- Location on an arterial street.

Feasible locations were ranked as most feasible, moderately feasible, or less feasible. The assessment indicates that there are approximately 57 feasible half-blocks within the GSI project study area, providing contingency if it is determined during final design that additional rain gardens are needed beyond the estimated 32 half-block requirement. Feasible rain garden locations are shown in Figure 8.1.



**Figure 8.3** *Estimated Flows Captured by Rain Gardens and Diverted from the Barton Pump Station During Design Storms (from King County TM 600.5, May 2010, Appendix A)*

Table 8.2 presents major requirements and design assumptions for the GSI alternative.

<b>Table 8.2 Barton Basin CSO Facility Sizing</b>	
<b>Facility Component</b>	<b>Design Assumptions<sup>1</sup></b>
<b><i>Rain Gardens</i></b>	
Number of Half-Blocks of Rain Gardens Installed	32
Approximate Rain Garden Area per Half-Block	7,060 square feet
Ponding Depth	10 inches
Total Rain Garden Storage Volume Provided	2 million gallons
Design Infiltration Rate	0.5 inches/hour
Rain Garden Cross Section	See Figure 8.1 for soil depth and side slopes.
<b><i>Planning Criteria</i></b>	
Disconnected Area	52 acres
Peak Flow Reduction	14.6 mgd <sup>2</sup>
<b>Notes:</b>	
1. Design assumptions are preliminary and may be revised during final design.	
2. Peak flow reduction criterion assumes the existing Barton Pump Station will be upgraded from 26 mgd to 33 mgd as part of the upgrade project currently under design.	

## **8.2 MURRAY CSO BASIN PROPOSED ALTERNATIVE OVERVIEW**

Murray Alternative 1F includes a 1-MG underground storage tank on property that is currently in private ownership across Beach Drive SW from the existing Murray Pump Station. Ancillary facilities would be located on the same site. This alternative offers these advantages:

- There may be opportunities to enhance the surface of the site following construction in a way that benefits the neighborhood (for example, additional green space).
- Surface components of the project and related improvements will be constructed outside of Lowman Beach Park.
- The alternative provides for a single, reliable, facility near the existing pump station.
- The County has been planning upgrades to the Murray Pump Station's electrical and odor control facilities for several years. The proximity of the proposed site to the Murray Pump Station provides an opportunity to serve both the CSO tank and the pump station from a single odor control facility and electrical standby generator at the storage tank site. Combining service functions would reduce the impact on Lowman Beach Park.

facilities. Opportunities to combine service functions would reduce the impact on Lowman Beach Park.

### 8.2.1 Overflow Frequency and Volume

Table 8.3 shows CSO frequency and volume from the Murray Basin both prior to project implementation and anticipated after implementation.

<b>Table 8.3 CSO Frequency and Volume from the Murray Basin</b>			
<b>CSO Frequency and Volume</b>	<b>Monitored Prior To Project Implementation (2000 – 2007)</b>	<b>Model-Simulated Project Impacts</b>	
		<b>Prior To Project Implementation<sup>1</sup></b>	<b>Anticipated After Project Implementation<sup>2</sup></b>
Annual Frequency	5 Overflows/year	6.2 Overflows/year	1 Overflow/year
Annual Volume	5.2 MG	2.7 MG	2.0 MG
<b>Notes:</b>			
1. Based on King County Runoff model and Barton Pump Station capacity of 22 MGD, 30-yr simulation.			
2. Based on King County Runoff model, upgraded Barton Pump Station capacity of 33 MGD, and Murray Pump Station capacity of 31.5 MGD, 30-yr simulation.			

The CSO frequency and volumes indicated in the table are shown for both modeled results and actual monitored results at the outfall location between the years of 2000 and 2007. The annual frequency of overflows matches very closely for both the modeled and monitored results. Differences between modeled and monitored annual overflow volumes prior to project implementation can be due to a number of factors, including:

- Over-estimated overflow volumes due to limited sensitivities of level sensors and overflow calculations at the Murray Pump Station.
- Differing rainfall over the basin than that indicated by the rain gauges.
- Inaccuracies in the model.
- The overflow record covered a time period of 8 years while the modeling covered a time period of 30 years, which included 22 years of additional and different rainfall data.

The 30-year simulation of the calibrated model provides the best engineering estimate of flow volumes to be expected, and is therefore used for sizing CSO storage facilities.

### 8.2.2 General Layout

A general layout of Murray Alternative 1F location is shown in Figure 8.4. This alternative includes the following elements:

- A new diversion structure in Lowman Beach Park west of the existing Murray Pump Station to redirect peak flows from the sewer to storage.
- A new 1.0-MG buried, self-cleaning storage facility with the following features:
  - A 48-inch gravity influent sewer and isolation gate.
  - Five cells that will fill sequentially.
  - Drain pumps to empty the tank contents over a 12-hour period following a wet-weather event.
  - A flushing system to facilitate tank cleaning.
  - Access features for routine and long-term operation and maintenance (O&M).
  - A 12-inch effluent line to the local combined sewers.
  - Variable cell lengths
- Secant pile shoring on all sides of the tank
- Piles below the structure for uplift resistance and to prevent liquefaction-induced settlement
- A retaining wall to protect the existing hillside along the east side edge of the property.
- An ancillary equipment facility for odor control, mechanical, and electrical equipment including:
  - Control panels and motor control centers.
  - Standby power generator.
  - Odor control system including mist eliminator, carbon scrubbers, and fans.
  - Ventilation system.
  - Utility water system including backflow preventer, air gap tank, pumps, and hydropneumatic tank.

#### **8.2.2.1 Diversion Structure**

Peak flow in excess of the Murray Pump Station's capacity will be routed through a new diversion structure and sent to storage. Figure 8.5 shows a conceptual plan and section view of diversion structure. During wet-weather, the water level in the Murray Pump Station wet well will rise when flows to the pump station exceed the station's peak capacity of 31.5 mgd. The rising water level will overtop the existing overflow weirs in the pump station (at Elevation 108.05 feet (Metro Datum)) and will be channeled through an overflow pipe outside the pump station and into the new diversion structure. Flows will then be diverted from this structure, through a 48-inch pipeline, to the inlet of the storage tank on the other side of Beach Drive.

When the maximum water surface elevation in the storage tank is reached (Elevation 107.2 feet (Metro Datum)), the water will back up within the conveyance pipe and diversion structure and overtop a weir (Elevation 107.2 feet (Metro Datum)). Excess flows will then go through the existing 72-inch diameter CSO outfall to Puget Sound.

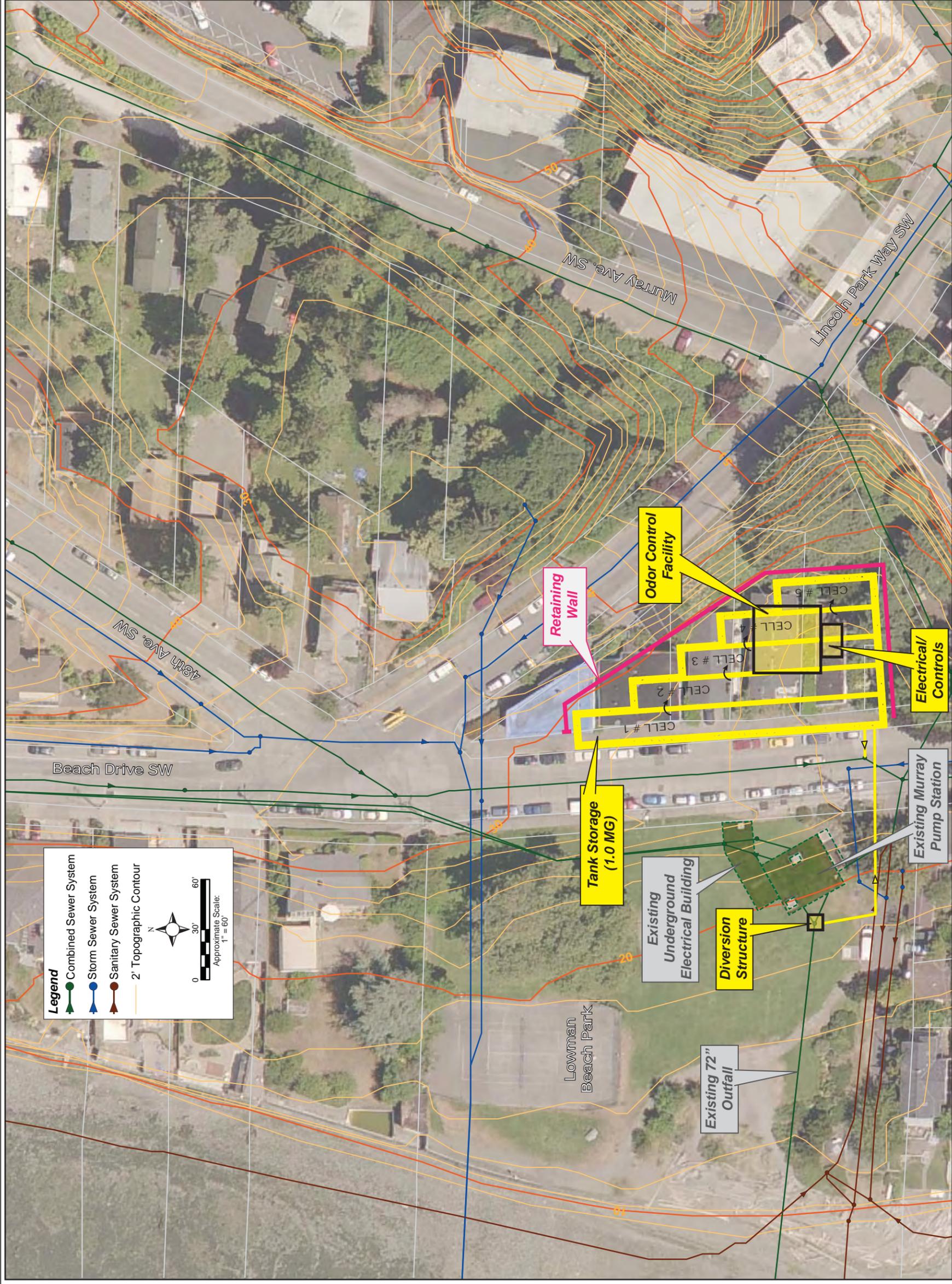
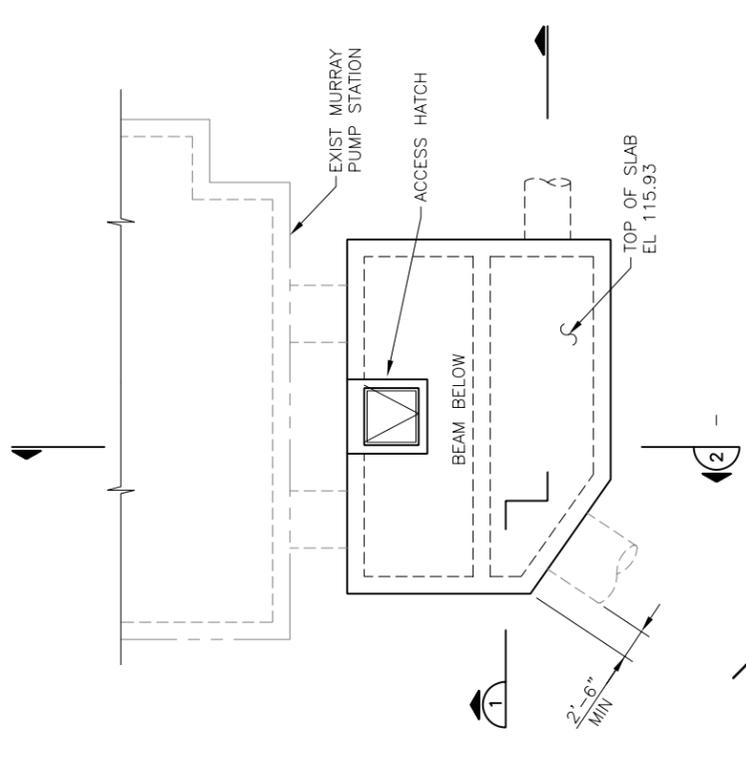
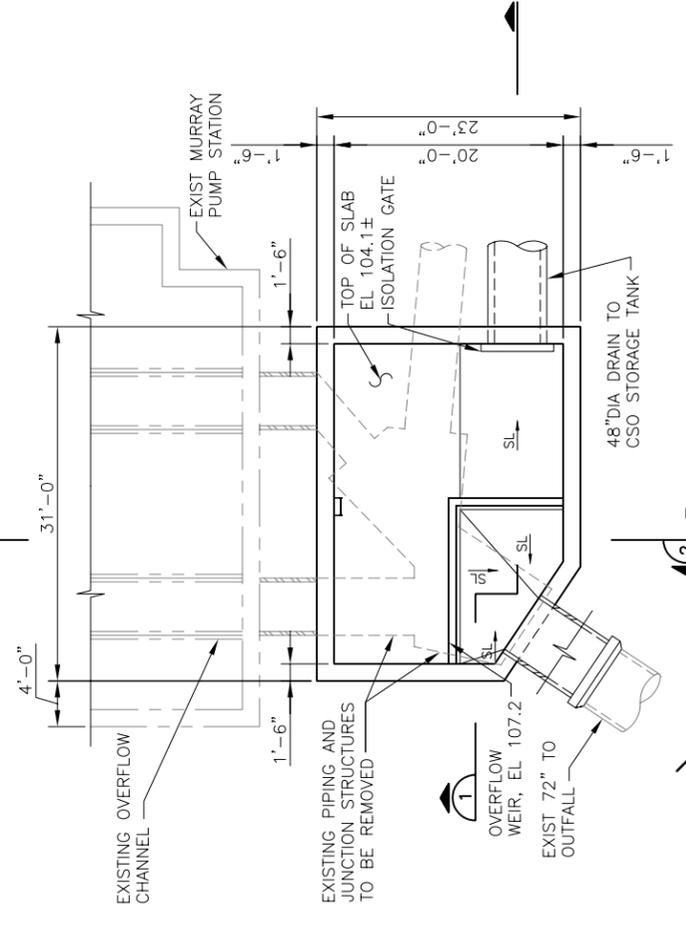


Figure 8.4.  
MURRAY CSO BASIN PROPOSED ALTERNATIVE 1F: BEACH DRIVE AREA UNDERGROUND STORAGE

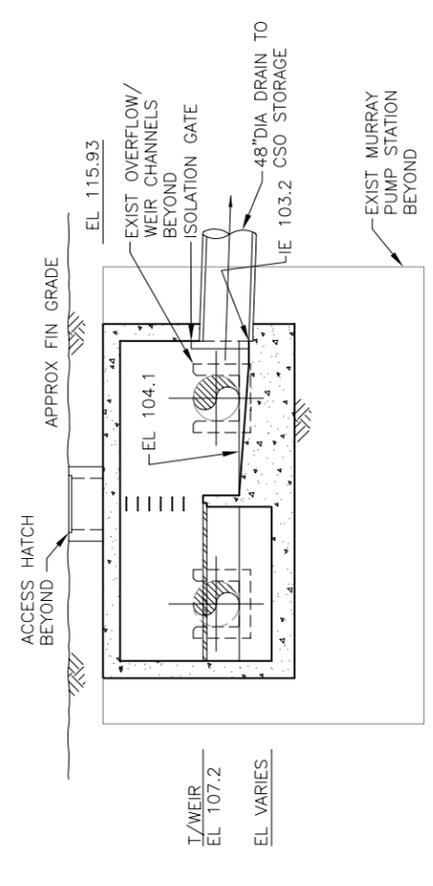




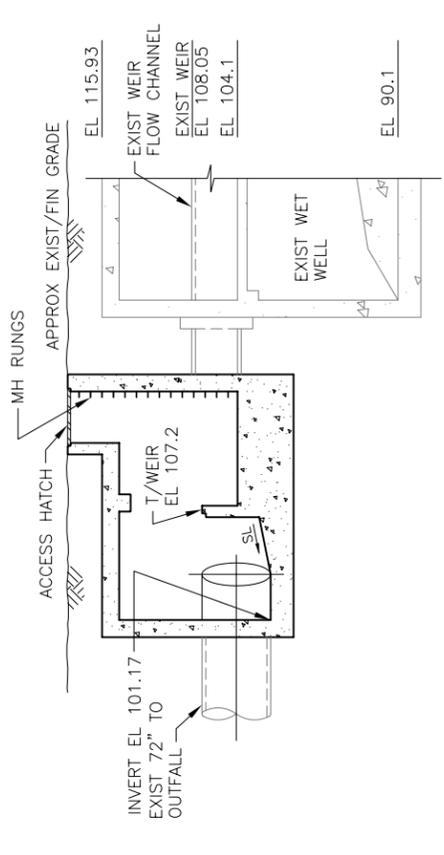
TOP PLAN  
SCALE: 1/8"=1'-0"



BOTTOM PLAN  
SCALE: 1/8"=1'-0"



SECTION 1  
SCALE: 1/8"=1'-0"



SECTION 2  
SCALE: 1/8"=1'-0"

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WASTEWATER TREATMENT DIVISION  
MURRAY STORAGE TANK  
BEACH DRIVE AREA UNDERGROUND STORAGE

**FIGURE 8.5**  
DIVERSION STRUCTURE  
PLAN AND SECTIONS

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The diversion structure will be below grade and include access hatches for visual inspection and maintenance. Utility water will be provided from within the pump station for washdown of the weir and flow channels within the diversion structure. The structure will also house a level sensor for remote monitoring of water levels.

#### **8.2.2.2 Storage Tank**

The proposed CSO storage facility is a buried five-cell tank, with each cell 15 feet wide and ranging in length from 60 feet to 180 feet. Figure 8.6 shows a conceptual plan and Figures 8.7 and 8.8 show section views of this storage tank. The tank will be equipped with carbon scrubber odor control, electrical equipment, and a backup generator, housed in a separate structure on the ground surface above the tank. The tank will be accessed from the top for maintenance at entry structures and access hatches over both ends of each cell. Equipment at the entry structures includes level sensors, tipping buckets (or flushing gates, as to be determined in final design), utility water valving for cleaning, and submersible pumps and valving to drain the tank.

The tank will begin to fill by gravity once CSOs overtop the weir at the diversion structure and are conveyed through the 48-inch influent pipe, which will discharge to the sump at the low end of Cell 1. Water will then fill Cell 1 until it reaches the elevation of the overflow opening to Cell 2. At that point, additional flow will fill Cell 2 until the Cell 2 water elevation reaches the overflow to Cell 3. The same process will then fill Cells 3, 4 and 5. When all cells are full, water will back up in the influent line and the diversion structure, ultimately overflowing through the CSO outfall.

When system flows drop below the capacity of the Murray Pump Station, the storage tank drain pumps will be activated. Three submersible pumps located in the sump of Cell 1 will lift stored flows back into the sewer system via a 12-inch force main to a local manhole in Beach Drive. The maximum pumping rate will be 1,400 gpm to drain the tank in 12 hours. Drain pump flows will be metered and monitored to ensure that the peak flow capacity of the Murray Pump Station is not exceeded during the tank draining process. After Cell 1 is drained, a drainage gate in Cell 2 will be opened to allow the stored water in that cell to flow to the sump of Cell 1 and be pumped to the sewer system. Cells 3, 4 and 5 similarly will be drained in sequence by opening the gates to allow their stored flow to drain to Cell 1.

For Cells 2, 3, 4 and 5, the automated flushing system using a flushing gate or tipping bucket will be activated to remove solids after each cell is drained. Flushing water will be sent through the cell, scouring the solids on the cell floor. After each flush, the water will be collected in the sump of Cell 1 and pumped by the submersible drain pumps. The same force main used to pump stored flows will convey the flush water from the tank to the sewer system. Cell 1 will be flushed after all cells in the tank have been drained and flushed.

Access to the storage tank will be through lift slabs and hatches. The accesses will have ladders, stairways or additional access equipment for routine maintenance. The entry structures will be isolated from the storage tank and ventilated as required to allow for routine O&M, such as level sensor calibration and pump exercising. The access hatches would be embedded into large, concrete removable panels that could be lifted by boom truck or crane to allow for infrequent repairs or manual cleaning.

### **8.2.2.3 Ancillary Equipment Facility**

The ancillary equipment facility, shown in Figure 8.9, contains the odor control system, mechanical equipment, and electrical equipment to support the storage tank. The exterior dimensions of the facility will be 70 feet long by 44 feet wide. The facility will be no more than one story, as allowed by Seattle Municipal Code. It will be located on the site such that it will provide adequate access and to minimize its visual presence.

The odor control system will consist primarily of a carbon adsorption scrubber vessel, mist eliminator, and fan. Additional instruments and smaller components would also be required, but are not considered major equipment. The tank ventilation rate would be 2 air changes per hour (ac/hr) or maximum fill rate (43 mgd), whichever is greater, to control odors. There are also provisions, including a variable speed drive for the odor control fan and bypass ductwork, for 6 ac/hr to bypass the carbon scrubber and to facilitate manned entry into the storage tank.

The odor control system will be directly connected to the storage tank with buried corrosion-resistant ductwork or piping. Treated-air discharge ductwork would be routed to a location and height on the site as determined during final design.

The building also will house HVAC equipment for the ancillary equipment facility and the storage tank entry structures. The ventilation rate for the occupied spaces would be 12 air changes per hour (ac/hr) continuously.

To provide water for the flushing system and other facility needs, water drawn from a new service water line will be routed through an above-grade backflow preventer and air break tank as required by health codes. The air break tank will be a 1,500-gallon reservoir inside the ancillary equipment facility. Utility water pumps would draw from the reservoir and pump the water into a hydropneumatic tank to pressurize the utility water system.

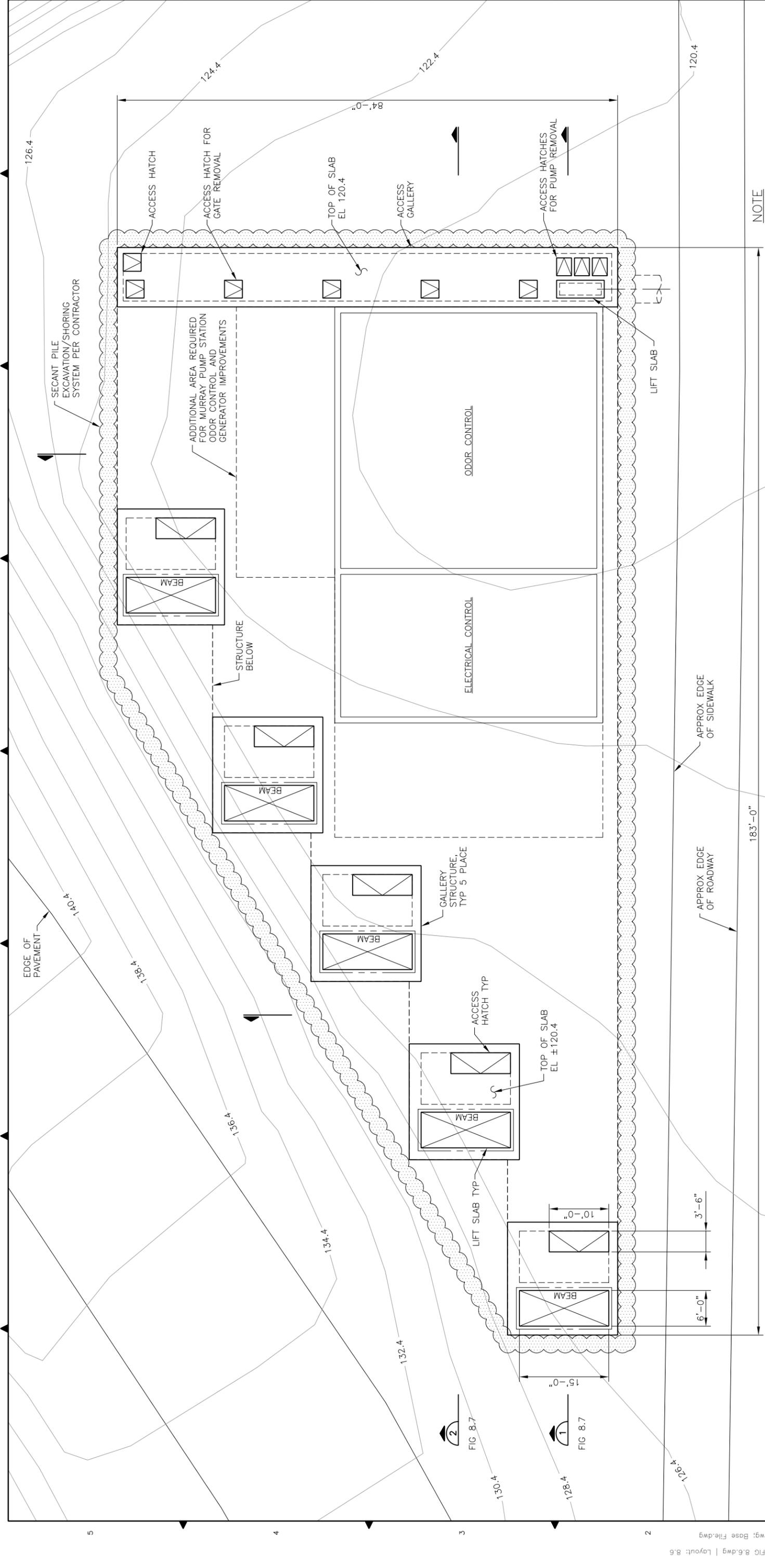
King County has also been planning upgrades to the electrical and odor control facilities for the Murray Pump Station for several years. They may choose to co-locate these improvements with the storage tank odor control and electrical systems to reduce construction impacts in Lowman Beach Park. The area of the ancillary equipment facility would need to expand by roughly 50% as shown on Figure 8.6 to accommodate these additional improvements.

### **8.2.2.4 Site Improvements**

#### **8.2.2.4.1 *Access to Proposed Facilities***

Access to the storage facility site will be from Beach Drive SW. It is anticipated that the site will be partially or entirely fenced for security purposes. All access hatches would be rated for HS20 loading. Removable lifting slabs will be configured over the tipping buckets and access gallery to provide a larger opening for less frequent maintenance activities.

The Murray Pump Station has access from Beach Drive and Pump Station Road. The pump station is accessed from the surface through hatches and a stairway. The proposed diversion structure would be below grade and would have access hatches at the ground surface for maintenance.



**NOTE**

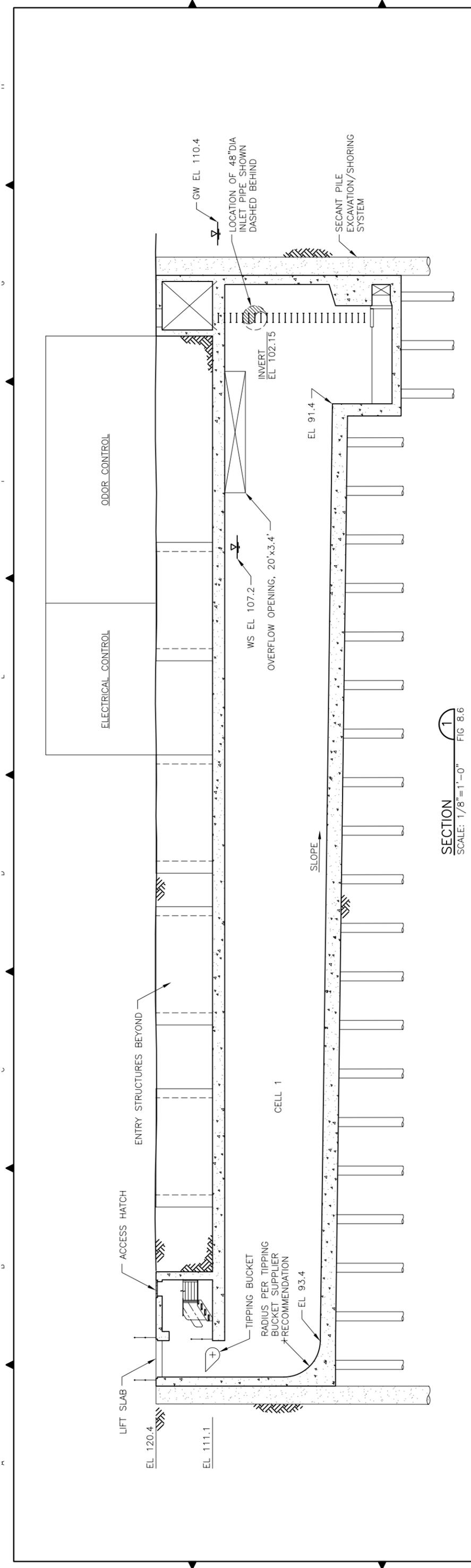
- THESE PLANS DO NOT ADDRESS SLOPE/HILLSIDE STABILITY WHICH SHOULD BE CONSIDERED DURING FINAL DESIGN.
- ALL ELEVATIONS SHOWN ARE METRO DATUM.

**GROUND LEVEL PLAN**  
SCALE: 1/8"=1'-0"

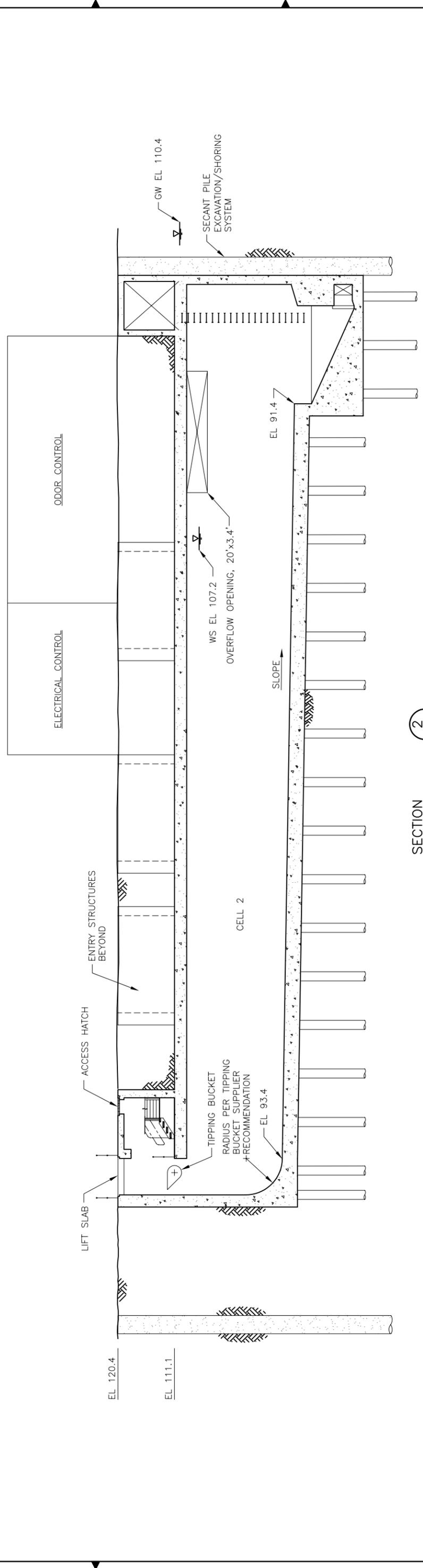
**FIG 8.8**

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<p>DESIGNED/DRAWN: GCB PROJECT ENGINEER: GCB DESIGN APPROVAL: [Signature] PROJECT ACCEPTANCE: [Signature] PROJECT MANAGER: [Signature]</p>				
<p>QA/QC: [Signature] SCALE: 1/8"=1'-0" DESIGN APPROVAL: [Signature] CONTRACT NO: [Number] CONTRACT NUMBER: [Number]</p>				
<p>DEPARTMENT OF NATURAL RESOURCES &amp; PARKS WASTEWATER TREATMENT DIVISION MURRAY STORAGE TANK BEACH DRIVE AREA UNDERGROUND STORAGE</p>				
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**SECTION 1**  
SCALE: 1/8"=1'-0"  
FIG 8.6



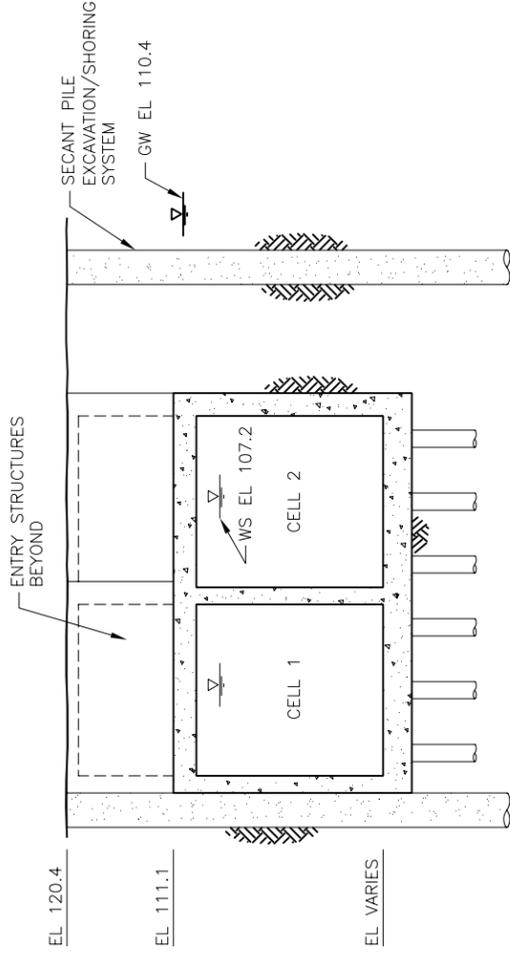
**SECTION 2**  
SCALE: 1/8"=1'-0"  
FIG 8.6

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PROJECT ACCEPTANCE:		PROJECT MANAGER		
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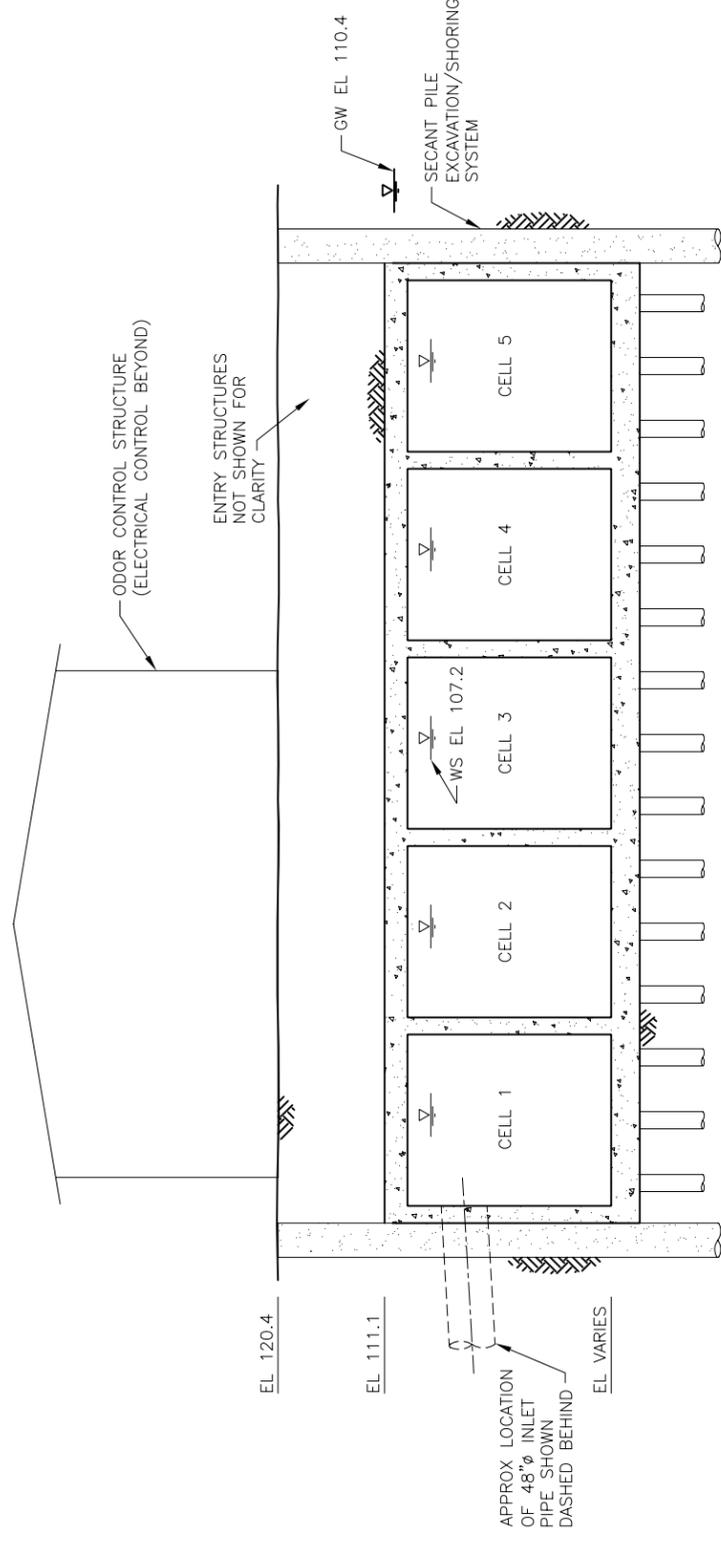
**FIGURE 8.7**  
**STORAGE TANK SECTIONS**







SECTION 1  
 SCALE: 1/8"=1'-0" FIG 8.6



SECTION 2  
 SCALE: 1/8"=1'-0" FIG 8.6

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PROJECT ACCEPTANCE: PROJECT MANAGER	CONTRACT NO: CONTRACT NUMBER

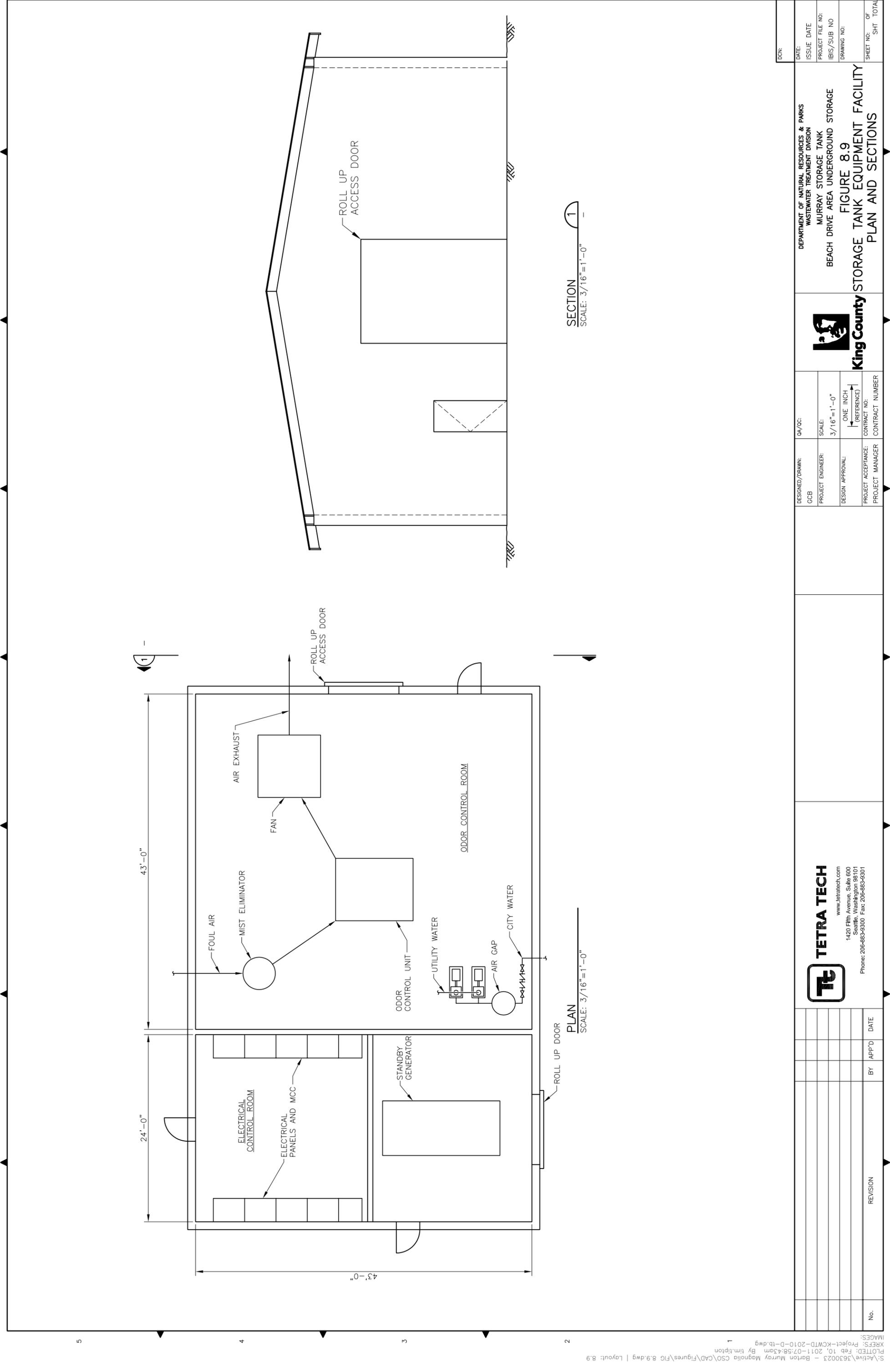


DEPARTMENT OF NATURAL RESOURCES & PARKS  
 WASTEWATER TREATMENT DIVISION  
 MURRAY STORAGE TANK  
 BEACH DRIVE AREA UNDERGROUND STORAGE

FIGURE 8.8  
 STORAGE TANK SECTIONS

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DEPARTMENT OF NATURAL RESOURCES & PARKS  
 WASTEWATER TREATMENT DIVISION  
 MURRAY STORAGE TANK  
 BEACH DRIVE AREA UNDERGROUND STORAGE  
**King County** STORAGE TANK EQUIPMENT FACILITY  
 PLAN AND SECTIONS

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CCB	SCALE:
PROJECT ENGINEER:	3/16" = 1'-0"
DESIGN APPROVAL:	ONE INCH (REFERENCE)
PROJECT ACCEPTANCE:	CONTRACT NO:
PROJECT MANAGER	CONTRACT NUMBER

SECTION  
SCALE: 3/16" = 1'-0"

PLAN  
SCALE: 3/16" = 1'-0"



#### **8.2.2.4.2 Revisions to the Existing Site**

Six private residential multifamily properties would be acquired in order to construct the storage facility. Six structures would be demolished and the site prepared for excavation and construction of the underground concrete tank and ancillary facilities.

Stormwater control and treatment will be required per the Seattle Municipal Code. If feasible, stormwater bioretention will be placed around the site adjacent to paved surfaces, and runoff will be directed to these locations for treatment prior to discharge to the storm drain system.

In Lowman Beach Park, part of the existing lawn will be disturbed for excavation and construction of the diversion structure and conveyance pipeline to the storage facility. The pipe will cross Beach Drive SW and will require cutting of a pipe trench. The grass area will be restored and there will be an access hatch at the surface for the diversion structure. Roadway will be restored as described below.

#### **8.2.2.4.3 Right-of-Way Improvements**

In this scenario, the right-of-way in the project area will be repaved following construction to meet current SDOT pavement and street restoration requirements. Applicability of the following codes would be verified during final design:

- Development projects must provide full street improvements (Ordinance 122615 Sidewalks Improvement Initiative).
- Pavement removal and restoration in the right-of-way must conform to SDOT Director's Rule 2004-02.
- Any new landscaping must be in accordance with City of Seattle standards.
- Stormwater requirements must conform to Seattle Department of Planning and Development Director's Rule 17-2009 (SMC Chapters 22.800 – 22.808).

#### **8.2.2.4.4 Stormwater Requirements**

Due to improvements both within the right-of-way and on a parcel, if implemented this alternative would be classified as a "Joint Project" under Seattle Municipal Code, requiring that both parcel-based and roadway stormwater requirements be met (SMC 22.805.070). The area of impact for the proposed alternative includes more than 13,000 square feet of new or replaced impervious surface. Therefore, for site stormwater control, according to the November 2009 Directors' Rules for the Seattle Stormwater Code (SMC Chapters 22.800-22.808), runoff from the site will require water quality treatment. The design water quality treatment volume is equal to 91 percent of the total volume of the simulation period using an approved continuous model (SMC 22.805.090.B1.a).

The site discharges to a storm system that drains to Puget Sound, which is classified as a designated receiving water and will not require the project to implement flow control.

This location is not designated as "capacity-constrained," which would require peak flow control (SMC 22.805.080.B4). However, as a "large" project (replacing 5,000 square feet or more of impervious surface), this project would require an analysis of the downstream system within 1/4-mile of the site to ensure sufficient capacity of the drainage system (SMC

22.805.020.I). Should the downstream system be determined to have insufficient capacity for the peak flow with a 4-percent annual probability (a 25-year recurrence interval), peak flow control or improvements to the drainage system may be necessary.

This alternative will implement green stormwater infrastructure best management practices (BMPs) as much as feasible (SMC 22.805.020.F), including, but not limited to, permeable surfacing and bioretention for water quality treatment. Under the City's current standards for design of low impact development (LID) concepts, the size of the treatment facility will be based on the percent of existing impervious surface and on the technology used.

#### **8.2.2.4.5 Landscaping**

Areas disturbed in Lowman Beach Park for construction of the diversion structure and conveyance pipeline will be restored with lawn and pavement to original conditions.

The tank site will be restored with landscaping and hard surfaces where needed for maintenance equipment access and to reduce congestion in the right-of-way. Landscape areas will be planted with drought-tolerant or native plantings, or both, as developed during final design. Landscaping will be in accordance with City of Seattle standards. The County will work with the community to develop the landscaping plan, as this area is adjacent to Lowman Beach Park, which is a local community amenity. Temporary irrigation systems would be employed during the plant establishment period (typically 1 to 2 years) to reduce plant mortality.

### **8.2.3 Process Flow**

This section describes how the proposed Murray CSO control facilities would operate during dry-weather flow and wet-weather events.

#### **8.2.3.1 Dry- and Moderately Wet-Weather Flow Description**

Figure 8.10 is a schematic of average dry-weather and moderately wet-weather flow operation (defined as flow up to 31.5 mgd, which is the capacity of the Murray Pump Station). These flows will pass through the Murray Pump Station and no flows will be diverted to storage. All flow will be conveyed to the 63rd Avenue Pump Station and, ultimately, the West Point Treatment Plant.

#### **8.2.3.2 High Wet-Weather Flow Description**

Figure 8.11 is a schematic of high wet-weather flow operation. High wet-weather flow is defined as flow greater than 31.5 mgd, which exceeds the capacity of the Murray Pump Station. Under high wet-weather flow conditions, flows exceeding the pump station's capacity will enter the diversion structure and be sent to storage. The Murray Pump Station will continue to send flows up to 31.5 mgd to the 63rd Avenue Pump Station.

Flow exceeding the pump station capacity will overflow a weir in the pump station wet well, enter the diversion structure, and flow by gravity to the storage tank. If the capacity of the influent pipe (up to 100 mgd) or tank storage (1 MG) is exceeded, flows will back up in the diversion structure, overtop a weir and flow through the 72-inch CSO outfall to Puget Sound.

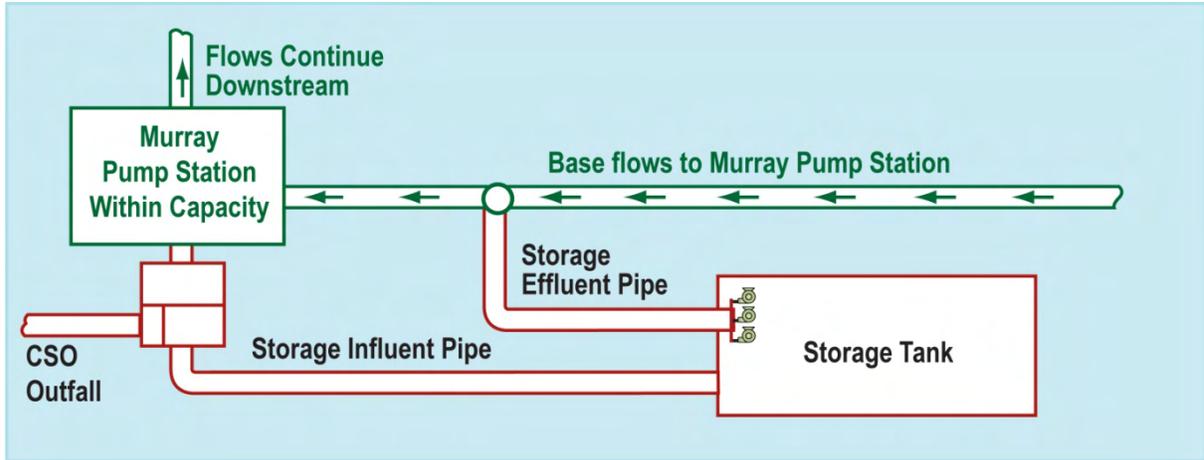


Figure 8.10 Murray Storage Tank Dry-Weather and Moderately Wet-Weather Flow Operation

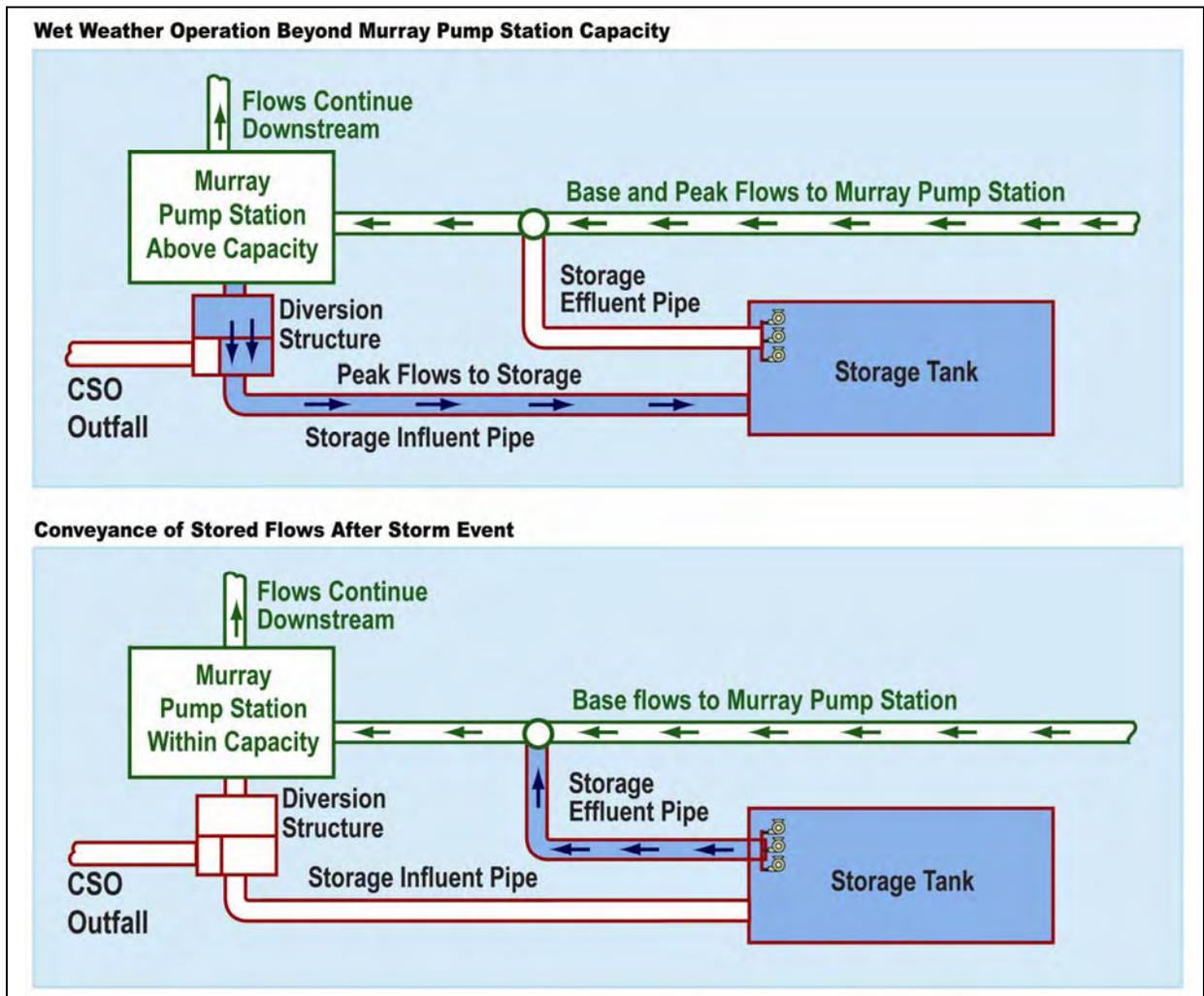


Figure 8.11 Murray Storage Tank High Wet-Weather Flow Operation

At the conclusion of the high wet-weather event, when system flows subside to less than 31.5 mgd, drain pumps will empty the storage tank. The pumps will be sized to drain the storage tank in 12 hours (capacity). The flow rate of the drain pumps will be regulated so that the peak flow capacity of the Murray Pump Station is not exceeded during tank draining.

### **8.2.3.3 Process Flow Diagram**

Figure 8.12 shows a process flow diagram of the Murray CSO control system. Instrumentation and control strategies will be developed during final design. The SCADA system will provide the operator with applicable control set points and will generate level alarms when the storage facility approaches and reaches its fill level and when flows overtop weirs. Appropriate control actions will be implemented for the following situations:

- Power failure and restore.
- Communications failure and restore.
- PLC self-diagnostics alarms and restore.
- Level measure calibration, out of range (high and low), and restore.
- Set point entry range checking.

### **8.2.4 Hydraulic Profile**

The hydraulic profile of the Murray CSO control system is shown in Figure 8.13.

### **8.2.5 Facility Sizing**

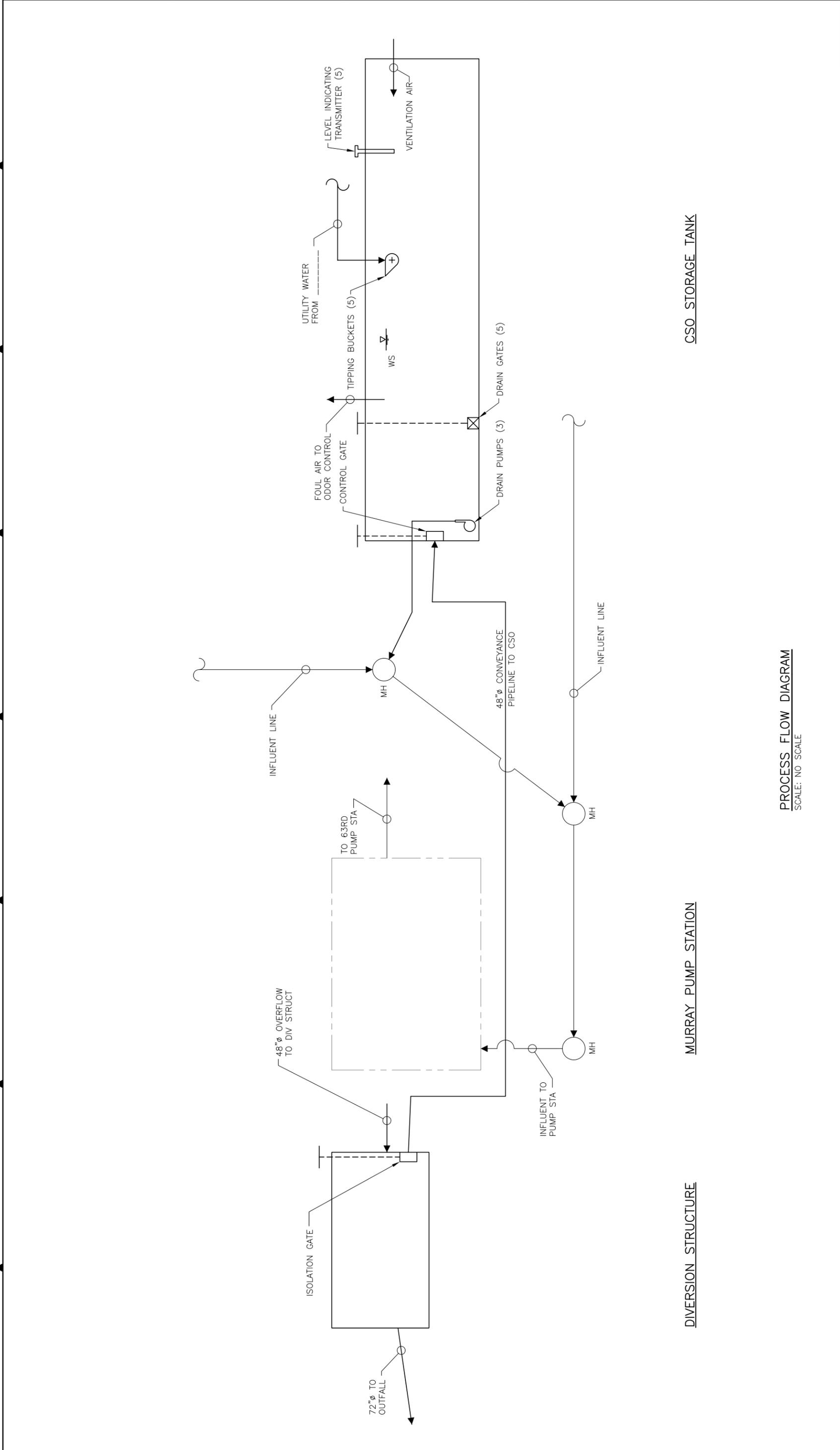
Major project dimensions and sizes are provided in Table 8.4.

## **8.3 ENVIRONMENTAL IMPACTS**

The proposed alternatives would reduce the volume and frequency of untreated overflows to Puget Sound, enhancing water quality and wildlife habitat. The County is preparing a SEPA Environmental Checklist in accordance with WAC 197-11 and plans to issue a threshold determination in April 2011. A copy of the Environmental Checklist and threshold determination will be provided in Appendix D when available.

### **8.3.1 Barton GSI Alternative**

The primary project area for the GSI alternative consists of street rights of way within approximately 200 developed residential acres between 29th and 34th Avenues SW and SW Barton and Othello Streets. Documentation provided in Appendix E describes existing environmental conditions in the project area. A preliminary geologic/geotechnical evaluation (Shannon & Wilson, Inc., March 26 2010) of the Barton CSO basin alternatives also is provided in Appendix E. The evaluation included an assessment of geologic conditions and geotechnical limitations in the project area. A detailed geotechnical evaluation will be conducted during final design.



**PROCESS FLOW DIAGRAM**  
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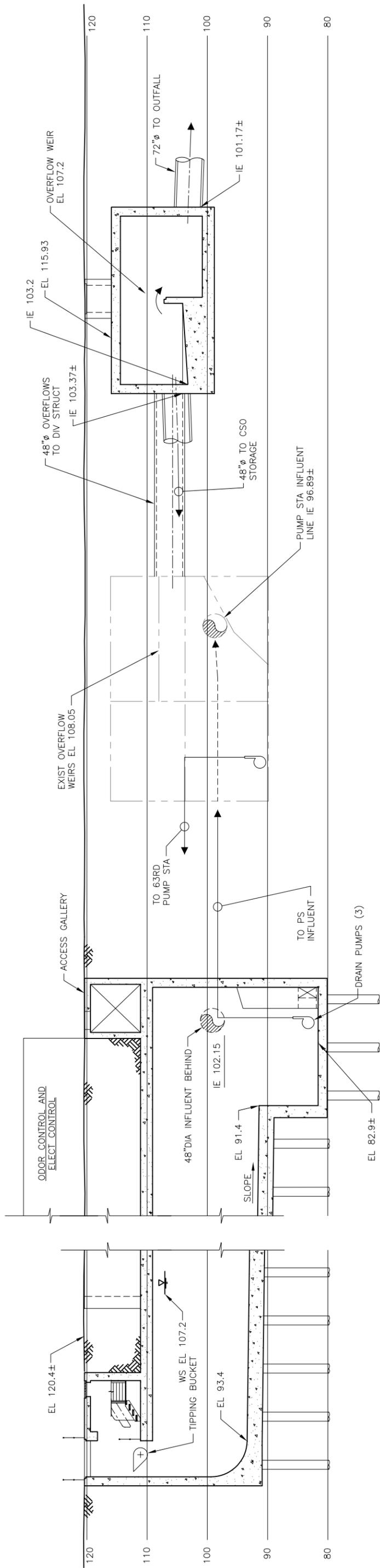
CSO STORAGE TANK

MURRAY PUMP STATION

DIVERSION STRUCTURE

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DATE:	ISSUE DATE	
PROJECT FILE NO.:	PROJECT FILE NO.	
DRAWING NO.:	DRAWING NO.	
SHEET NO. OF TOTAL	SHEET NO. OF TOTAL	
		
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CSO STORAGE TANK

MURRAY PUMP STATION

DIVERSION STRUCTURE

HYDRAULIC PROFILE

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PROJECT ENGINEER:		SCALE: NONE		CONTRACT NUMBER
DESIGN APPROVAL:		ONE INCH (REFERENCE)		
PROJECT ACCEPTANCE:		PROJECT MANAGER		
<p>DEPARTMENT OF NATURAL RESOURCES &amp; PARKS          WASTEWATER TREATMENT DIVISION          MURRAY STORAGE TANK          BEACH DRIVE AREA UNDERGROUND STORAGE  <b>FIGURE 8.13</b>          CSO CONTROL SYSTEM          HYDRAULIC PROFILE</p>				
DCN:	DATE:	ISSUE DATE:	PROJECT FILE NO:	IBIS/SUB NO:
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**Table 8.4 Murray CSO Basin CSO Facility Sizing**

Facility Component	Design Criteria <sup>1</sup>
<b><i>Diversions Structure</i></b>	
Structure Dimensions	31 feet by 23 feet
Structure Depth	20 feet
Weir Length	26 feet
<b><i>Storage Tank</i></b>	
Number of Cells	Five
Width of Cells	15 feet
Length of Cells	180 feet to 64 feet
Total Volume	1 MG
Floor Slope	3%
Minimum Freeboard	1 foot
Number of Drain Pumps	2 duty + 1 standby
Drain Pump Type	Submersible
Drain Pump Capacity	700 gpm each
Diameter of Effluent Pipe	12 inch
Maximum Time to Drain Storage	12 hours
Access	Two per cell plus one hatch for each of three drain pumps
Equipment Materials	Corrosion resistant (316 SS or FRP)
<b><i>Ancillary Equipment Facility</i></b>	
Odor Control	Peak air displacement rate (43-mgd peak-flow to storage) or 2 air changes/hr (whichever is greater)
Air Treatment	Activated carbon; 1 pass; 50 fpm; variable speed fan/blower
Occupied Space Ventilation	12 air changes /hr
Standby Generator	Total estimated load; diesel w/ 24 hr capacity
Backflow Preventer	4 inch
Air Gap Tank	1,500 gal
Number of Utility Water Pumps	1 duty + 1 standby
Utility Water Pump Type	End-suction centrifugal
Utility Water Pump Capacity	100 - 250 gpm
Facility Footprint	63 feet by 42.5 feet
<b><u>Notes:</u></b>	
1. Design criteria are preliminary and may be revised during final design.	

### **8.3.1.1 Existing Ecosystems**

#### **8.3.1.1.1 *Wetlands***

According to the City of Seattle Critical Areas Map (Figure 3.9), there are no wetlands on or immediately adjacent to the project area.

#### **8.3.1.1.2 *Streams and Ditches***

The City of Seattle Critical Areas Map (Figure 3.9) shows no streams or ditches in the project area.

#### **8.3.1.1.3 *Fish Resources***

There are no fish bearing streams in the vicinity of the proposed project. This project would limit combined sewer overflows to Puget Sound, which should enhance water quality and wildlife habitat. Therefore, no negative impact on fish resources is expected.

### **8.3.1.2 Groundwater and Surface Water**

Because of spotty distribution and variable thickness of weathered till and overlying recessional outwash on top of the relatively impermeable till in the proposed project area, increased groundwater levels due to infiltration at rain gardens could result in changes to moisture levels in residential yards, basements, and crawl spaces on the subject and adjacent properties.

To reduce the potential risk, sites noted in the geotechnical evaluation or in the field as having poor soils and/or poor drainage patterns were classified as infeasible locations for GSI and eliminated from the analysis. Further, all proposed rain gardens are located so that the basements of adjacent properties will be outside of the zone of influence. This zone of influence is a rough estimate of how the infiltrating water from the proposed facilities will travel. For this analysis it was assumed that if the adjacent basement bottom elevation was above the zone of influence of the bioretention soil, which is measured by a 45-degree angle downward from the bottom edge of the bioretention soil, then the basement is outside the zone of groundwater influence.

Puget Sound lies to the west of the project area. However, no impact on the Sound is expected. The project will have a long-term beneficial impact on water resources since it will achieve the CSO control objective of allowing no more than one untreated event per year on average.

### **8.3.1.3 Earth Resources**

#### **8.3.1.3.1 *Soils***

The long, broad ridge on which the GSI alternative is proposed to be constructed is underlain by Vashon till and advance outwash. These very dense soils are overlain by a relatively thin layer (typically 0 to 2 feet thick) of loose to medium dense recessional outwash or weathered and topsoil zones. In the southeastern corner of the project area near SW Barton Street and 29th Avenue SW, post-glacial depression deposits consist of a mixture of soft peat and loose

to medium dense silt and sand. The advance and recessional outwash deposits are relatively pervious, whereas the Vashon till is relatively impervious. Permeability of the postglacial depression deposits is highly variable.

Impacts on soils during construction of the rain gardens will include minor erosion from excavation activities, which will be mitigated using construction best management practices (BMPs).

#### **8.3.1.3.2 Geologic Hazards**

According to a review of a Department of Ecology database, there are no geologic hazards on or near the proposed project area.

#### **8.3.1.3.3 Soil and Groundwater Contamination**

There are no known contaminated areas in the vicinity of the project.

#### **8.3.1.4 Land Use**

The 200-acre neighborhood identified for the GSI alternative is a single-family area with a regular street grid pattern near the upper reaches of the Barton CSO basin. The rain gardens associated with the alternative would be constructed in public street right of way (typically the landscape strips between the curb and the sidewalk). Some loss of parking where curb bulbs will be installed is the only permanent land use impact anticipated.

#### **8.3.1.5 Recreational Resources**

There are no recreational resources within the proposed project area; although the project boundary does border E.C. Hughes Playground. Roxhill playground is located outside the project area near the intersection of Barton and 25th Avenue SW, There would be no long-term impact anticipated on recreational resources.

#### **8.3.1.6 Utilities**

Existing public utilities are not expected to be significantly impacted. Service lines from the right of way to homes may need to be relocated or replaced as part of the installation of rain gardens in the planter strips. Existing residential services for sewer, drainage, power, gas, water and telecommunications services would be maintained through temporary and/or permanent relocation of utility services, as required by the final design.

#### **8.3.1.7 Transportation**

There will be temporary local impacts on traffic and access during construction of rain gardens. It is not anticipated that any streets will be closed during construction, but traffic may be restricted to one lane, requiring traffic control measures and street parking restrictions during some of the construction activities. Longer traffic queuing times are not anticipated. Access restrictions to residences are anticipated to be minimal and temporary.

Rain gardens will be installed in residential streets on a progressive schedule. The peak number of daily construction vehicle trips during construction would be about 10 trips per

day. There may be additional traffic in the area during peak shopping seasons because the Westwood Village Shopping Center is east of the project area.

During construction, the contractor would be required to submit a traffic control plan detailing the haul route for construction traffic. Additional traffic control measures, such as warning signs and flaggers, may be a requirement of the haul route approval.

Measures to reduce or control transportation impacts by the completed project would not be required.

On-street parking removals will vary dependent on the final design. The final design will adhere to traffic regulations and City of Seattle parking requirements. The loss of on-street parking could range from about 3 parking stalls per street to approximately 20 (roughly 50-percent of the on-street parking).

#### **8.3.1.8 Odor and Air Quality**

Air quality impacts from earth-moving activities during construction are typical for large construction projects. BMPs would be implemented for dust control, including street sweeping, watering exposed soil surfaces, and covering soil stockpiles to help minimize the amount of fugitive dust and particulate pollution to the surrounding areas. Similar BMPs might be employed by the contractor to minimize dust. Construction activities often concentrate heavy equipment powered by gas or diesel engines in a particular location. Air pollution from engines could increase during certain activities, such as queuing trucks for loading and offloading of materials, or during excavation. Provisions to limit idling of mechanical equipment typically are included in King County projects and would be employed during construction to minimize the amount of air pollution generated from gas- and diesel-engine-driven machinery, as well as to limit greenhouse gas effects.

There would be no odor emissions from the rain gardens except related to initial landscape installation.

#### **8.3.1.9 Noise**

Noise impacts during construction would be mitigated by contract documents requiring compliance with noise regulations and the local jurisdictional codes. Variances may be obtained if the schedule requires working additional hours beyond current ordinance allowances.

Equipment operation after the rain gardens are in operation would produce little if any noticeable noise. This would include vehicles associated with landscape maintenance. Larger equipment may be used for major maintenance intervals where soil and related plantings are removed and replaced. For budgeting purposes this is estimated at every 15 years.

#### **8.3.1.10 Cultural Resources**

No known archaeological resources have been identified in the upper sub-basin location of the GSI Alternative, and the project area has a low probability of containing archaeological

resources due to shallow excavation anticipated at less than 4 feet deep. The sub-basin contains no known historic structures.

#### **8.3.1.11 Endangered/Threatened Species or Habitats**

There are no threatened or endangered species known to be on or immediately adjacent to the project site. Long-term effects of the project would be beneficial to listed species in Puget Sound, as water quality would be improved with a reduction in combined sewer overflow events.

#### **8.3.1.12 Prime or Unique Farmland**

There is no farmland within the project area, so there would be no impacts on prime or unique farmland.

### **8.3.2 Murray Alternative 1F**

The primary project area for Murray Alternative 1F consists of currently privately-owned parcels south of the intersection of Beach Drive SW and Lincoln Park Way SW. Documentation provided in Appendix E describes existing environmental conditions in the project area. A preliminary geologic/geotechnical evaluation (Shannon & Wilson, Inc., March 26, 2010) of the Murray CSO basin alternatives also is provided in Appendix E. The evaluation included an assessment of the geologic conditions and geotechnical limitations in the project area. A detailed geotechnical evaluation will be conducted during final design.

#### **8.3.2.1 Existing Ecosystems**

##### **8.3.2.1.1 *Wetlands***

According to the City of Seattle Critical Areas Map (Figure 3.10), there are no wetlands on or immediately adjacent to the project site.

##### **8.3.2.1.2 *Streams and Ditches***

The City of Seattle Critical Areas Map (Figure 3.10) indicates that the proposed project area contains riparian corridor surrounding a piped portion of Pelly Creek, which would likely be moved during construction if necessary.

##### **8.3.2.1.3 *Fish Resources***

There are no fish bearing streams in the vicinity of the project. This project would limit combined sewer overflows to Puget Sound, which should enhance water quality and wildlife habitat. Therefore, no negative impact on fish resources is expected.

#### **8.3.2.2 Groundwater and Surface Water**

The proposed storage tank would involve a 45-foot-deep excavation near the toe of an existing steep slope and would likely require the use of relatively impermeable shoring. Considerable dewatering and groundwater recharge requirements to control groundwater-drawdown induced settlements. Given the presence of very loose soils, the presence of

organic soils and peat, and the proximity of existing structures, utilities, and other improvements, a driven or vibrated sheet pile shoring system could result in unacceptable vibrations and settlements. The proposed secant pile system would reduce the likelihood of impacts on adjacent structures and reduce the dewatering requirements.

Available subsurface data does not indicate the presence of a suitable groundwater cutoff layer. Therefore, some dewatering and potentially some groundwater recharge will likely be required even if relatively impermeable shoring is used. The shoring could be assumed to extend to twice the excavation depth to help control groundwater. Caving soils may cause difficulties during excavation of the shoring.

Provisions to control uplift may also be required depending on the depth, size, and design of the structure. Given the proposed structure footprint size, uplift piles or anchors may be needed.

Puget Sound lies to the west of the project area and no impact on the Sound is expected. The project will have a long-term beneficial impact on water resources since it will achieve the CSO control objective of allowing no more than one untreated event per year on average.

### **8.3.2.3 Earth Resources**

#### **8.3.2.3.1 *Soils***

The original ground at the project site has been filled to depths ranging from 7 to 12 feet. The fill consists mostly of loose to dense, silty, slightly sandy gravel and gravelly sand; however, one boring encountered clayey soils. Many of these fill soils contain some organics, wood, boulders, and foreign debris. Underlying the fill are about 10 to 30 feet of very loose to medium dense sands and gravels with organic materials, and soft peat layers. In two recent borings, a 2- to 3-foot-thick layer of soft to medium stiff, organic silt was encountered at about sea level. The recent soils are underlain at depths of 21 to 40 feet by medium dense to very dense recessional outwash, consisting of slightly silty to silty, gravelly sand and sandy gravel.

Impacts on soils during construction of the CSO facilities will include erosion from excavation activities, which will be mitigated using construction BMPs. A majority of the soils excavated for the storage tank would be hauled off-site to approved locations.

#### **8.3.2.3.2 *Geologic Hazards***

The City of Seattle Critical Areas Map (Figure 3.10) shows potential landslide hazard areas and slopes greater than 40 percent to the south and east of the proposed project site, and a liquefaction zone to the west. Uplift piles, if required, could limit liquefaction-induced settlement of the tanks; otherwise, deep foundation elements would likely be required. As an alternative, ground improvement could be performed, such as compaction grouting, creating confining cells of improved ground under the tank footprint, or installing stone columns or vertical drains.

### **8.3.2.3 Soil and Groundwater Contamination**

There are no known contaminated areas in the vicinity of the project.

### **8.3.2.4 Land Use**

The triangular parcel of land east of Lowman Beach Park where the proposed storage tank would be constructed, bounded by Beach Drive SW and Lincoln Park Way SW, is occupied by several low-rise multifamily buildings. These buildings would be acquired and removed.

### **8.3.2.5 Recreational Resources**

The project site is immediately east of Lowman Beach Park, a 4.1-acre waterfront park. It includes lawn/open space, a tennis court, and a tidal beach area on Puget Sound. Construction of the facilities would impact access to the park by recreational users during construction. Parking immediately adjacent to the park will not be available and part of the park may be used for construction staging and material lay-down. These areas would be restored, and there would be no long-term impact on recreational resources.

### **8.3.2.6 Utilities**

There are existing utilities within the Beach Drive SW right-of-way that may need to be relocated as part of project construction. Existing sewer, drainage, power, gas, and telecommunications services would be maintained through temporary and/or permanent relocation of utilities as required by the final design.

### **8.3.2.7 Transportation**

There will be impacts on traffic, parking, and access during construction within Beach Drive SW and SW Lincoln Park Way. Potential delays and detours during construction could have temporary, indirect impacts. Longer traffic queuing times are not anticipated.

Temporary lane closures would occur on Beach Drive SW and SW Lincoln Park Way within the construction area for construction of the influent pipe, storage tank, effluent pipe and utilities required for the storage tank. There are nearby alternate routes available to SW Lincoln Park Way. However, there are no alternative routes for properties south of the construction site along Beach Drive SW. Access will need to be maintained throughout construction. The length of traffic disruption is anticipated to be 12 to 18 months.

In addition to lane closures and detours during construction, there will be increased construction traffic to and from the project site. The peak number of daily construction trips would occur during excavation and backfilling of the storage tank and asphalt paving and are estimated at 30 trips per day. During other phases of construction, the number of daily construction trips is likely to be less than 30 per day. It is likely that the general construction traffic would have little impact on the level of service in the area.

During construction, the contractor would be required to submit a traffic control plan detailing the haul route for construction traffic. Additional traffic control measures, such as warning signs and flaggers, may be a requirement of the haul route approval.

Measures to reduce or control transportation impacts by the completed project would not be required.

There may be a net permanent loss of up to two parking spaces on the east side of Beach Drive SW in front of the facility site. This would be associated with a driveway entrance on to the proposed site. There currently is one residential driveway entrance serving one of the residential properties

#### **8.3.2.8 Odor and Air Quality**

Air quality impacts from earth-moving activities during construction are typical for large construction projects. BMPs would be implemented for dust control, including street sweeping, watering exposed soil surfaces, and covering soil stockpiles to help minimize the amount of fugitive dust and particulate pollution to the surrounding areas. Other similar BMPs might be employed by the contractor to minimize dust. Construction activities often concentrate heavy equipment powered by gas or diesel engines in a particular location. Air pollution from engines could increase during certain activities, such as queuing trucks for loading and offloading of materials, or during heavy excavation. Provisions to limit idling of mechanical equipment typically are included in King County projects and would be employed during construction to minimize the amount of air pollution generated from gas- and diesel-engine-driven machinery, as well as to limit greenhouse gas effects.

Long-term impacts (continuous emissions) from odors associated with operation of the facilities would be minimized and mitigated through several design features. Odor generation in the new diversion structure would be minimized by limiting turbulence and keeping the hatches to the structure closed. Odors generated at the storage tank would be minimized through the automated flushing system installed to clean settled solids from the tank after each storage event. Periodic manual wash-down of the accessible portions of the tank walls could be used to minimize odorous gas formation in the tank further; however, the current design prioritizes the automated flushing system. Any odors generated within the tank from stored wastewater or solids not removed from the wash-down system would be mitigated through operation of the planned odor control facility.

Instrumentation to measure inlet and outlet gas concentrations at the odor control facility would help determine the functional performance and life remaining on the carbon filter media to more accurately schedule carbon replacement. Active monitoring ensures that foul odors are controlled to the extent possible by the installed system.

#### **8.3.2.9 Noise**

Noise impacts during construction would be mitigated by contract documents requiring compliance with noise regulations and the local jurisdictional codes. Variances may be obtained if the schedule requires working additional hours beyond current ordinance allowances.

Equipment operation after the facility is in operation would produce little if any noticeable noise. Pumps in the storage tank are submersible and would not produce noticeable noise. All functional noise controls, such as insulation under access hatches, would be implemented

so that noise levels at the property line would not exceed limits established for the site's current zoning.

In this alternative odor control equipment, pump motor starters and a standby generator are housed in a facility on the storage tank site. Additional noise mitigation measures such as louver baffles, acoustical shrouds, and exhaust stack silencers would be included as necessary to provide minimum noise conditions at the site's property line. Additional measures such as cabinet acoustical insulation or noise-suppressing insulation inside the structure may be required if noise levels at the site became unacceptable to the adjacent residents.

#### **8.3.2.10 Vibration**

Vibration during construction of the facilities would be monitored at nearby residences. Standards of care would be applied and specified in the contract documents.

During normal operation of the storage tank and completed facility equipment, vibrations would be localized to the degree that only those persons standing near the equipment enclosure or on hatches directly adjacent to equipment would notice vibrations. Pumps currently sized for this facility are not large enough to create vibration issues, particularly given the mass of the new storage facility. Odor control equipment and standby generator would be fitted with anti-vibration components in the equipment anchoring systems specified for the project.

#### **8.3.2.11 Cultural Resources**

There have been no archaeological or cultural resources identified in the proposed project area, but its location and site characteristics indicate a medium probability of containing archaeological resources.

#### **8.3.2.12 Endangered/Threatened Species or Habitats**

There are no threatened or endangered species known to be on or immediately adjacent to the project site. Construction related noise may impact marbled murrelets, but are not expected to adversely affect them. A biological assessment will be prepared for the proposed project. Project construction would be approximately 220 to 330 feet east of Puget Sound (diversion structure construction activities will be closer to Puget Sound). Long-term effects of the project would be beneficial to listed species in Puget Sound, as water quality would be improved with a reduction in combined sewer overflow events.

#### **8.3.2.13 Prime or Unique Farmland**

There is no farmland within the project area, so there would be no impacts on prime or unique farmland.

## **8.4 DESIGN LIFE**

### **8.4.1 Barton GSI Alternative**

GSI is a living system and therefore the definition of useful design life needs further clarification. Rain garden repair, such as plant replacement and isolated soil removals would be considered to be major maintenance. In general a residential rain garden facility under best management practices would be expected to exceed a 50-year design life.

### **8.4.2 Murray Alternative 1F**

The design life of the storage facility is based on a 50-year life cycle, and the primary equipment design life is based on a 20-year life cycle. Routine maintenance of the facility and replacement of equipment would occur as needed to obtain the design life.

## **8.5 RESIDUALS MANAGEMENT**

### **8.5.1 Barton GSI Alternative**

Plant materials and soils will contain certain amounts of oils, metals, and roadway contaminants. Based on current data, removed plant materials and soils should be categorized as non-hazardous waste and will be disposed of accordingly.

### **8.5.2 Murray Alternative 1F**

The proposed storage tank will include a flushing system so that solids can be cleaned out of the tank following a CSO event and will not accumulate in the tank. Utility water would also be provided at the diversion structure from the existing Murray Pump station to flush the influent pipeline to storage. Therefore, sludge management should not be a concern here. The storage tank will be designed to allow for access and cleaning by O&M staff, should additional cleaning be needed.

## **8.6 ABILITY TO EXPAND**

It is not anticipated that the Barton or Murray CSO basin will experience any significant demographic or land use changes in the future. The area is considered built-out and population levels are anticipated to remain relatively constant. The need for the proposed projects is not due to anticipated population growth or increase in sewered areas (connecting on-site systems to sewer system); therefore, it is not anticipated that future demographics, land use, or population growth will increase the CSO control volume required to meet current Ecology requirements.

In the event that the proposed alternatives fail to provide sufficient CSO control, the primary option to provide additional CSO reduction is reduction of inflow and infiltration, including a focus on the City of Seattle's Residential RainWise Program. Due to the age of the collection system in the Barton and Murray CSO basins, it is likely that many locations experience inflow and infiltration; the majority of the inflow and infiltration is likely occurring on private property. Key aspects of these additional CSO control measures would be as follows:

- The City's Residential RainWise Program aims to reduce the amount of stormwater runoff (inflow) from private properties into the sewer collection system. By removing residential stormwater connections from the combined system, the volume and flow rate of wet-weather peak flows are reduced. This reduction allows the existing facilities to convey a higher percentage of the flows from the basin.
- For the City-owned collection sewers, additional investigation would be required to identify and locate points of infiltration in the system. It is difficult to predict the level of reduction that could be achieved with infiltration reduction projects, and the projects are unreliable in achieving the reductions of flow required for CSO control. Other combined sewer agencies across the nation, including many in the Northwest, consider infiltration reduction a good asset management practice but do not rely upon it to achieve compliance with CSO reduction requirements. Infiltration reduction is usually a secondary benefit of rehabilitating the pipe.

## **8.7 O&M AND STAFFING NEEDS**

### **8.7.1 Barton GSI Alternative**

The proposed GSI alternative would require periodic maintenance to ensure that proper operation occurs and that the design life of the facility is met. Tables 8.5 and 8.6 show the likely types of operation and maintenance activities, respectively, the frequency of each activity, staffing requirements to perform those activities and equipment required. Key issues for O&M include the following:

- Exploration of partnership opportunities for GSI maintenance with public agencies or possible third party contractors.
- Definition of operational protocols.

### **8.7.2 Murray Alternative 1F**

The proposed alternative would need regular maintenance to ensure that the design life of the facility is met and proper operation occurs. Table 8.7 shows the types of O&M activities that could occur, the frequency of each activity, and staffing requirements to perform those activities. Key issues for O&M include the following:

- Monitor the system remotely during a wet-weather event and for equipment condition during dry weather.
- Design the system for ease of operation and maintenance, including post-wet weather event cleaning.
- Design so that maintenance staff will not need to routinely enter the storage tank.
- Provide provisions for entry to storage tank and maintenance, if needed.
- Visually integrate the ancillary facility with the surrounding neighborhood.

	<b>Activity</b>	<b>Frequency</b>	<b>Staff Needed</b>	<b>Equipment Needed</b>
<b>Before Major Storm</b> (Forecast of heavy downpour or approximately one inch of rainfall in 24 hours)	Inspection/maintenance to ensure gutter inlets/curb cuts are clear of litter, debris and built-up sediment	Varies. Estimate 4 times a year on average	1-2	Rakes/Gardening Tools, Truck to haul debris
<b>After Major Storm</b> (Heavy downpour or approximately one inch of rainfall in 24 hours)	Inspection/maintenance to ensure gutter inlets/curb cuts are clear of litter, debris and built-up sediment	Varies. Estimate 4 times a year on average	1-2	Rakes/Gardening Tools, Truck to haul debris

	<b>Activity</b>	<b>Frequency</b>	<b>Staff Needed</b>	<b>Equipment Needed</b>
<b>General Maintenance</b>	Pruning, Weeding	2 times per year	2	Rakes/Gardening tools, Truck to haul material.
<b>Irrigation</b>	Watering of vegetation	Summer Months	none	Automated system
<b>Minor Maintenance</b>	Inspection of rain gardens	1/month	1	Rakes/Gardening tools
<b>Maintenance</b>	Removal of debris during wet weather/fall leaf drop	2 times a week for two months	1-2	Rakes/Gardening Tools
<b>Maintenance</b>	Replace Mulch	Every 3 years	2	Excavation equipment, Trucks, Rakes/Gardening tools
<b>Repair Maintenance</b>	Replace required plants and soils upon evaluation	every 15 years	3	Excavation equipment, Trucks, Rakes/Gardening tools

<b>Table 8.7 Operation and Maintenance Activities for Murray Alternative 1F</b>				
<b>Component</b>	<b>Activity</b>	<b>Frequency</b>	<b>Staff Needed</b>	<b>Special Equipment Needed</b>
<b><i>Diversion Structure</i></b>				
Access Hatches	Inspect hatches for wear and tear from surface by opening access hatches and visually assess conditions; replace worn or damaged components.	Annually	2	Repair components from manufacturer/supplier
Gates	Grease riser stems, adjust seats, etc. depending on type of gate.	Semi-annually or per manufacturer recommendations	2	None
	Exercise gates/actuators	Monthly	1	None
	Replace gates.	As needed	6	Confined space entry equipment
Operators/ Actuators	Grease riser stems, packing, seats, etc., depending on type of operator/actuator.	Semi-annually or per manufacturer recommendations	2	None
Level Gauges	Inspect and take readings.	Weekly	1	None
	Calibrate.	Annually	1	None
	Repair/Replace gauges.	Semi-annually	2	None
<b><i>Storage Tank</i></b>				
Access Hatches	Inspect hatches for wear and tear from surface by opening access hatches and visually assess conditions; replace worn or damaged components.	Semi-annually	2	Repair components from manufacturer/supplier
Flushing Gate	Inspect flushing gate for wear and tear from surface by opening access hatches to view and visually assess conditions.	Semi-annually	2	None
Flushing Filling System	Inspect for damage to filling system; replace worn or damaged components.	Semi-annually	2	Repair components from manufacturer/supplier
Storage Cells	Surface inspection – open hatches and inspect visible areas with surface-supplied lighting to monitor for debris accumulation.	After each event for first year. Thereafter, annually.	2	Surface direction lighting
	Manned structural inspection – perform manned entry into tank to inspect concrete structure.	10-year cycle/post-seismic event	5	Confined space entry equipment, fire department standby
	Survey of existing structure for settlement.	10-year cycle/post-seismic event	4	Survey crew and equipment

<b>Table 8.7 Operation and Maintenance Activities for Murray Alternative 1F</b>				
<b>Component</b>	<b>Activity</b>	<b>Frequency</b>	<b>Staff Needed</b>	<b>Special Equipment Needed</b>
Pumps	Routine maintenance – bearings, sensors – can be done at surface.	Quarterly	3	None
	Pump Start/Stop cycling; operate pumps manually to ensure start/stop.	Weekly	2	None
	Clearing rags, blockages; can be done at surface.	As needed	3	None
	Slide rail/level controller – inspect for wear and tear.	Annually/when manned structural inspection is performed	5	Confined space entry equipment, fire department standby
Valves	Grease riser stems, packing, seats, etc., depending on type of valves.	Semi-annually or per manufacturer recommendations	3	None
	Replace valves.	As needed	3	None
Gates	Grease riser stems, adjust seats, etc., depending on type of gate.	Semi-annually or per manufacturer recommendations	3/5	None/confined space entry equipment
	Exercise gates/actuators	Monthly	1	None
	Replace gates.	As needed	6	Confined space entry equipment
Operators/ Actuators	Grease riser stems, packing, seats, etc., depending on type of operator/actuator.	Semi-annually or per manufacturer recommendations	3	None
Flow Meter	Inspect and take readings.	Post event	1	None
	Calibrate.	Semi-annually	1	None
	Repair/Replace gauges.	As needed	2	None
Level Gauges	Inspect and take readings.	Post event	1	None
	Calibrate.	Semi-annually	1	None
	Repair/Replace gauges.	As needed	2	None
<b>Electrical Room</b>				
Panels	Routine inspection and maintenance.	Semi-annually or per manufacturer	1	None
Variable Frequency Drives	Routine inspection and maintenance.	Semi-annually or per manufacturer	1	None
Programmable Logic Controller	Routine inspection and maintenance.	Semi-annually or per manufacturer	1	None
Motor Control Center	Routine inspection and maintenance.	Semi-annually or per manufacturer	1	None
Motor Starters	Routine inspection and maintenance.	Semi-annually or per manufacturer	1	None

<b>Table 8.7 Operation and Maintenance Activities for Murray Alternative 1F</b>				
<b>Component</b>	<b>Activity</b>	<b>Frequency</b>	<b>Staff Needed</b>	<b>Special Equipment Needed</b>
Standby Generator	Routine inspection and maintenance.	Monthly or per manufacturer	2	None
	Routine testing under load.	Monthly	2	None
<b>Mechanical Room</b>				
Air Gap Tank	Visually inspect for leaks, corrosion and fouled contacts on instruments/floats.	Annually	1	None
Air Gap Tank Filling System	Visually inspect for leaks, manually operate valves or system by hand-adjusting floats/level controllers.	Weekly	1	None
HVAC	Belts and Bearings – Inspect and replace as needed.	Annually or per manufacturer	1	None
Carbon Filter Media	Sample carbon for saturation; collect analytical sample for analysis by vendor/laboratory.	Quarterly	1	None
	Inspect filter bed for crusting/fouling – use rake/hand tools to break up fouled surface (horizontal bed only).	Annually or as indicated by pressure gauges across filter bed	1	None
	Replace carbon media.	On 5-year intervals or as indicated by carbon testing results	3	Vacuum truck, boom truck or lifting equipment if facility not equipped
Fan – Odor Control Fan	Belts and Bearings - Inspect and replace as needed.	Semi-annually or per manufacturer	1	None
Fan – HVAC	Belts and Bearings - Inspect and replace as needed.	Semi-annually or per manufacturer	1	None
Grease/Mist Eliminator	Remove fouled media filters and replace with clean filters; clean fouled filters off-site and store.	Annually or as indicated by pressure gauges across filter bed	2	Flatbed truck to haul filters, lifting equipment if facility is not equipped
Pressure Gauges	Inspect all gauges and record readings.	Monthly based on visits to facility	1	None
	Repair/Replace gauges.	As needed	1	None
Fiberglass Ductwork	Visually inspect all ductwork for cracking or leaks.	Semi-annually and after seismic events	1	None
Dampers	Visually inspect all dampers and actuators for damage or wear and tear.	Semi-annually	1	None
Silencer	Visually inspect silencer for damage or wear and tear.	Annually	1	None

## **8.8 DESIGN GUIDELINES**

### **8.8.1 Site Design**

The finished design of the proposed projects must provide for adequate traffic movement and safety while providing adequate access, working space, and parking for maintenance of the facilities. Minimizing impact on existing land uses is an important design parameter.

### **8.8.2 Traffic**

It is important to minimize lane closures and impacts on traffic during construction. Once the proposed projects are completed, King County O&M staff will periodically be required to visit the sites. Disruption to traffic will need to be minimized during O&M activities.

### **8.8.3 Structural/Geotechnical**

Shoring for earthwork should be of a type appropriate for the available space and other site conditions. Shoring for earthwork must adequately support the sides of the excavation and protect adjacent areas and structures.

Anticipated groundwater levels at the Murray proposed alternative site would require dewatering during construction of the tank, piping and diversion structure. The structural design of the storage tank would also need to counteract buoyancy due to groundwater.

Rain gardens should be located where infiltrated water will not affect building foundations or slopes.

### **8.8.4 Stormwater Management**

Stormwater design will follow the City of Seattle Stormwater Code for water quality treatment for runoff. The design water quality treatment volume will be equal to 91 percent of the total volume of the simulation period using an approved continuous model (SMC 22.805.090.B1.a). The stormwater design for the proposed Murray alternative also will incorporate GSI concepts to the extent feasible including, but not limited to, the use of permeable surfacing and bioretention.

### **8.8.5 Architecture/Landscaping**

The ancillary equipment facility in the Murray proposed alternative will be architecturally designed to be visually integrated with the surrounding neighborhood. Architectural consideration will be given to retaining walls, exhaust stacks, intake and exhaust plenum vaults, and other exposed above-grade features to ensure compatibility with the existing site's aesthetic characteristics.

Landscape design in the Murray proposed alternative will be compatible with the surrounding neighborhood and park, will utilize native or drought-tolerant plants, and will minimize irrigation and maintenance requirements.

Landscaping of the proposed rain gardens for the Barton CSO basin will be compatible with the surrounding neighborhood and will meet the technical requirements for GSI and CSO control in the Barton basin.

### **8.8.6 O&M and Facility Inspections**

An important objective in the design of the projects is to allow simple, reliable and safe operation and maintenance. This includes avoiding the need to routinely enter the storage tank to perform O&M activities by including a post-event flushing system and other design features.

The Murray Alternative storage tank would be maintainable from entry structures on the ground surface whenever possible, including the post-event solids removal activities. Entry structures would be located so that O&M crews can access the equipment and storage cells, if needed.

Provisions would be made for personnel and equipment to enter the tank. For example, removable concrete panels would be incorporated into the design to allow large equipment to be placed inside or removed. Smaller access hatches would also be provided to allow access for routine O&M. Furthermore, the overall facility would be remotely monitored during operation to verify that mechanical systems are working properly.

Pumps would be used to drain the storage facility rather than draining it by gravity. When downstream capacity is available, the storage facility would drain at the maximum flow rate possible without overloading the downstream conveyance system. The pumps would be rail-guided submersible pumps to minimize the need for entry for maintenance.

The odor control system can assist in ventilation for maintenance activities. The ventilation rate is 2 ac/hr to control odors, with provisions for 12 ac/hr with a bypass around the carbon scrubber prior to entry into the storage facility. Auxiliary portable ventilation equipment could be employed for infrequent entrance into the tank.

O&M of the proposed rain gardens for the Barton CSO basin will not involve any special provisions other than landscape and surface work along the roadside planting strip. Minimal traffic control would be required for routine maintenance activities. Lane closure and traffic control would be required during heavy maintenance intervals involving removal and replacement of soil and plant materials.

### **8.8.7 Reliability**

The location of the proposed Murray alternative site allows for filling of storage by gravity. Existing outfalls provide a relief point in the event that flow rates or volumes exceed the capacity of the storage tank and influent piping.

The odor control equipment, drain pumps, and other items requiring power are not considered critical to storing flows to prevent CSOs, since the storage tank would fill by gravity. Loss of power would prevent the storage facility from being drained by the pumps after an event; however, this would not prevent the sewer collection system from continuing to operate. It is anticipated that the storage facility will only be used a few times a year and

that the likelihood of back-to-back uses is very low. However, the design does include on-site standby power. Final design will investigate the use of the standby generator at the proposed storage facility to provide emergency power to the existing Murray Pump Station in lieu of a installing a separate generator in Lowman Beach Park.

The GSI alternative is a decentralized facility located over multiple blocks of Barton Sub-basin 416. Since this removes stormwater from a large area, there is no single point of failure, which makes this alternative highly reliable. There are emergency overflows within the rain gardens to prevent localized flooding if the design storm is exceeded and the storage volume of the rain gardens has been reached.

### **8.8.8 Effects of Sea Level Rise**

In March 2006, the King County Executive issued an executive order on Global Warming Preparedness directing all agencies to prepare for the effects of climate change, including adaptation, mitigation and sequestration. The Wastewater Treatment Division is evaluating the effects of rising sea levels associated with climate change. Sea level rise (SLR) scenarios were developed by combining prediction of future SLR and storm surge from statistical analysis. The three main sources for the scenarios came from the University of Washington's Climate Impacts Group, Department of Ecology Report *Sea Level Rise in the Coastal Waters of Washington State* (2008) and *Response of Extreme Storm Tide Levels to Long-Term Sea Level Change* (C.E. Zervas, 2005).

To give a broad array of possibilities 1-, 2-, 10-, and 100-year storm events were considered for each SLR scenario. Table 8.8 shows the values used for possible future sea-level conditions with storm events.

<b>Table 8.8 Puget Sound Sea-Level Rise Scenarios with Storm Surge</b>					
<b>Storm Surge (Metro datum in feet)</b>					
<b>Sea-Level Rise Scenarios</b>	<b>No Storm</b>	<b>1-Year (1.48')</b>	<b>2-Year (2.27')</b>	<b>10-Year (2.79')</b>	<b>100-Year (3.19')</b>
Current Conditions (MHHW)	105.36	106.84	107.63	108.15	108.55
Medium SLR 2050 (6")	105.86	107.34	108.13	108.65	109.05
Medium SLR 2100 (13")	106.44	107.92	108.71	109.23	109.63
Very High SLR 2050 (22")	107.19	108.67	109.46	109.98	110.38
Very High SLR 2100 (50")	109.53	111.01	111.8	112.32	112.72

#### **8.8.8.1 Barton Basin Vulnerabilities**

The proposed area for GSI is high in the basin. The Barton Pump Station was identified as being vulnerable to storm surge and sea level rise in the *Vulnerability of Major Wastewater Facilities to Flooding from Sea Level Rise* Report (July 2008). The overflow weir is at elevation 107.75 feet (Metro) and the facility is at elevation 109.3 feet (Metro). This facility has flooded during storm surges in the past.

The Barton Pump Station upgrade includes several measures that will improve the reliability of the pump station under flooded conditions that would result from tidal surges or sea level rise. Those measures include installing new raw sewage pumps that are submersible and able to operate in flooded conditions; replacing and relocating the pump station's electrical equipment to a higher elevation that is less likely to flood; and modifying the pump station structure so that key components for operating the pump station are at a higher elevation. The hatch on top of the dry well will be raised to a higher elevation, thereby reducing the likelihood of the drywell being inundated by a storm surge.

In April 2010, a flap gate was installed between the overflow weir and overflow pipe, greatly reducing saltwater entering the wet well from the overflow pipe.

The outfall flow rate could be diminished under future SLR scenarios. This is being evaluated for the entire combined sewer system, and adaptation plans will be evaluated under a separate project.

#### **8.8.8.2 Murray Basin Vulnerabilities**

Components of the CSO facilities would be vulnerable to sea level rise. The storage tank and ancillary facilities are located away from the shoreline at elevation 120.3 feet (Metro) and are not vulnerable to sea level rise or storm surge. The existing Murray Pump Station and new diversion structure are located at elevation 116.3 feet (Metro) and are not vulnerable to sea level rise or storm surge.

The pump station/wet well overflow weir is at elevation 108 feet (Metro) and the overflow weir in the new diversion structure would also be located at elevation 108 feet (Metro) to allow for gravity flow. The weir elevation makes the facility vulnerable to saltwater intrusion through the overflow pipe. The facility has had saltwater intrusion in the past. Due to the arrangement of the existing overflow weirs in the Murray Pump Station, there is not a feasible option to prevent this from occurring until an upstream assessment of influent sewer connections is assessed to determine if the weir elevations can be raised.

The outfall flow rate could be diminished under future SLR scenarios. This is being evaluated for the entire combined sewer system, and adaptation plans will be evaluated under a separate project.

It is recommended that the design for the new diversion structure to the CSO storage tank in the Murray Basin incorporate a flap gate on the outfall discharge side to reduce saltwater intrusion from storm surge and/or sea level rise.

## **8.9 FEASIBILITY OF IMPLEMENTATION**

### **8.9.1 Barton GSI Alternative**

Based on an evaluation of land use/permitting, environmental impacts, engineering, operation and maintenance, and community impacts, implementation of the proposed Barton GSI alternative appears to be feasible, with no identification of fatal flaws.

### **8.9.2 Murray Alternative 1F**

Based on an evaluation of land use/permitting, environmental impacts, engineering, operation and maintenance, and community impacts, implementation of the proposed Murray storage tank alternative appears to be feasible, with no identification of fatal flaws.

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## FINANCIAL ANALYSIS

This chapter includes financial information for the proposed CSO control alternatives for the Barton and Murray CSO basins. Estimated project costs are provided, including construction, engineering, property acquisition, and operation and maintenance (O&M). This chapter also provides life-cycle costs and project financing information.

### 9.1 ESTIMATED COSTS

Planning-level estimates for construction, engineering, property acquisition, and O&M costs for the proposed alternatives are presented below in 2010 dollars. Estimated quantities are based on the conceptual design presented in Chapter 8. Estimates will be updated during project design.

#### 9.1.1 Construction Cost Estimate

The planning-level cost estimate is based on cost curve data supplemented by quantity takeoffs. Cost curves were developed using data from the design and construction of similar facilities and/or using Tabula 2.0, the County's cost-estimating database. General contractor overhead and profit, estimating contingency, and allied costs (including engineering, legal, and administrative costs) were added to the construction cost estimate to develop total project costs.

The estimating contingency of 30 percent is derived from the cost estimate classification system defined by the Association for Advancement of Cost Engineering (AACE) International. Class 4 estimate accuracy ranges from -30 percent to +50 percent due to the preliminary nature of project data and engineering. The estimating contingency of 30 percent reflects the recommended standard contingency for the preliminary stage of the project.

Key cost factors include:

- Year: 2010.
- Engineering News Record Construction Cost Index: 8645.
- AACE Cost Estimate Classification: 4.

Table 9.1 summarizes the construction cost estimate for the proposed alternative. A more detailed estimate is provided in Appendix F.

#### 9.1.2 Project Cost Estimate

Table 9.2 summarizes the total project cost estimate including engineering, construction management, and County administrative costs.

<b>Table 9.1 Construction Cost Summary</b>			
<b>Item</b>	<b>Description</b>	<b>Barton</b>	<b>Murray</b>
Base Cost	Construction costs including contractor's overhead, profit, and general conditions	\$5.3M - \$6.8M	\$13.6M
Construction Contingency	30%	\$1.6M - \$2.1M	\$4.1M
<b>Total</b>		<b>\$6.9M – \$8.9M<sup>1</sup></b>	<b>\$17.7M</b>

<b>Table 9.2 Project Cost Summary</b>			
<b>Item</b>	<b>Description</b>	<b>Barton</b>	<b>Murray</b>
Construction	See Table 9.1	\$6.9M - \$8.9M	\$17.7M
Land/Easement	Includes land purchase and temporary construction easement for staging	0	\$6.4M
Street Use Fee		\$1.2M	\$1.7M
Additional Costs	Tax, Allied costs, permit fees and project contingency	\$5.1M-\$5.9M	\$15.2M
<b>Total</b>		<b>\$13.2M-\$16.0M</b>	<b>\$41.0M</b>

### 9.1.3 Operation and Maintenance Costs

The basis of O&M costs for the purpose of developing planning-level estimates and calculating life-cycle costs was developed using information supplied by the county (*South Sammamish Basin Conveyance Facility O&M Assumptions*, T. Giesbrecht, Brown and Caldwell, March 2002). Relevant information and assumptions include the following:

- Engineering News Record Construction Cost Index: 7341.
- Labor: \$32/hour
- Storage Tank, \$/MG:
  - Cleaning: \$6,600/year
  - Inspection: \$6,600/year
  - Maintenance: \$4,300/year
- Gravity Sewers: \$1/foot/year
- Force Mains: \$0.02/foot/year
- Ancillary Facilities:

<sup>1</sup> Cost range represents difference between 32 half-blocks and 64 half blocks, which is the estimated range of area needed for CSO control, depending upon final design conditions.

- One inspection time per week or 4 hours per week based on half the general maintenance and inspection required for regulator stations.

Based on the assumptions above and the conceptual design, approximately 630 hours per year is required for O&M. This estimate includes supplemental manual cleaning of the storage pipeline (assumed every three years) with O&M hours normalized over the life of the facility. The initial labor rate in 2014 is estimated to be \$53 per hour. Table 9.3 summarizes O&M costs for the first year of operation. Subsequent years are escalated at approximately 3 percent per annum for the life-cycle cost calculations.

<b>Table 9.3 O&amp;M Cost Summary</b>		
<b>Item</b>	<b>Annual Cost 2014 (\$/year)</b>	
	<b>Barton</b>	<b>Murray</b>
Operations and Maintenance Labor (Landscape maintenance, tank, diversion structure, ancillary facilities)	\$37,300	\$29,300
Flow Monitoring	\$7,000	\$0
Electricity (ventilation, power)	\$0	\$500
Chemicals (activated carbon replacement once per two years)	\$0	\$21,000
Standby Generator (fuel)	\$0	\$1,200
<b>Total</b>	<b>\$44,300</b>	<b>\$52,000</b>

#### **9.1.4 Life-Cycle Cost Estimate**

Life-cycle costs are based on a 20-year capital cost repayment, and operations and maintenance over a 35-year project life (2015-2049) using a Wastewater Treatment Division Business Case Evaluation calculation method (King County, 2009). The nominal discount rate is 5.5 percent and the real discount rate is 2.7 percent.

The net life-cycle cost is estimated to be \$14.3 million to \$17.1 million for the proposed Barton project and \$42.8M for the proposed Murray project. The average project annual cost is estimated to be between \$640,000 and \$765,000 for the proposed Barton project and \$1,915,000 for the proposed Murray project.<sup>2</sup>

## **9.2 PROJECT FINANCING**

### **9.2.1 Financial Capability**

The County's Wastewater Treatment Division (WTD) capital improvement program (CIP) is funded primarily through proceeds from sewer revenue bond sales, variable-rate short-term borrowing, capacity charge revenues, and transfers from the operating fund. Additionally,

<sup>2</sup> These costs are summarized from the WTD Business Case Evaluation Results sheets for the Barton and Murray Alternatives. These sheets are located in Appendix F.

some low-interest loan programs such as the State Revolving Fund and the Public Works Trust Fund are available to fund all or part of the proposed projects. However, loan applications must go through a competitive ranking process and rank high enough to receive available loan funds. Approximately 84 percent of WTD's total operating revenues are from monthly sewer charges collected from WTD's component agencies. Transfers of operating funds to the capital program are the result of the additional cash generated to meet the financial policy requirement of maintaining a debt service coverage ratio of no less than 1.15 times all debt service requirements. WTD uses these transfers to reduce the amount of borrowing necessary to finance the capital program.

Standard & Poor's and Moody's Investor Services are financial firms that rate corporate stocks and municipal bonds according to risk profiles. In 2009, the firms confirmed the ratings to the Wastewater Treatment Division's bonds, citing:

- Strong management practices.
- Continued positive financial performance.
- Solid rate base and large service area.
- Commitment to a capital improvement plan.

The Moody's rating for WTD's sewer revenue bonds, as well as similar bonds issued in the past, remained at Aa3 while the Standard and Poor's rating remained at AA+. These favorable credit ratings lower the cost of borrowing by reducing the amount of debt service, which, in turn, reduces impacts on user rates.

### **9.2.2 Capital Financing Plan**

The capital costs associated with the Barton and Murray CSO projects will be financed through the resources available for capital improvements in accordance with the financial policies of the County and the WTD. The actual financing mix and cost of these instruments will reflect economic and financial conditions, WTD's financial position, and the appropriateness of the project for securing below-market-rate resources.

### **9.2.3 Customer Charges**

The costs associated with construction plus operation and maintenance of the proposed facilities will be reimbursed or supported through user charges. These include the regular monthly sewer rate and the capacity charge that is levied on customers establishing new connections to the system. The monthly rate is a uniform amount levied on all system customers. The capacity charge is levied on new connections to the system for a period of 15 years, with the option of payoff at a discount.

Annually, the County Executive proposes a sewer rate and capacity charge reflecting the current forecast of monetary requirements. In accordance with long-term contracts with the component sewer agencies, the monthly sewer rate must be adopted by the King County Council by June 30 of each year. In June 2010, the County Council adopted a monthly wholesale sewer rate of \$36.10 and a capacity charge of \$50.45 commencing January 1, 2011. In accordance with the financial plan associated with the 2011 adopted sewer rate and

the proposed 2011 capital budget for the period from 2011 to 2016, the revenues generated by this rate and capacity charge and subsequent planned increases in each will provide the funding for the construction of the proposed projects.



## IMPLEMENTATION PLAN

### 10.1 PROJECT SCHEDULE

The preliminary project schedule for the proposed Barton GSI project is summarized in Table 10.1. The preliminary project schedule for the proposed Murray project is summarized in Table 10.2.

<b>Table 10.1 Preliminary Project Schedule for Proposed Barton CSO Project</b>	
<b>Activity</b>	<b>Anticipated Dates</b>
Facility Plan Development	November 2010 – December 2010
State Environmental Policy Act Threshold Determination	April 2011
Facility Plan Approval	June 2011
Permitting	June 2011 – September 2012
Final Design Consultant Selection	January 2011 – August 2011
Final Design	September 2011 – October 2012
Construction	October 2013 – September 2015
Commissioning	November 2015 – January 2017 (2 wet seasons)

<b>Table 10.2 Preliminary Project Schedule for Proposed Murray CSO Project</b>	
<b>Activity</b>	<b>Anticipated Dates</b>
Facility Plan Development	November 2010 – December 2010
State Environmental Policy Act Threshold Determination	April 2011
Facility Plan Report Approval	June 2011
Property Acquisition	June 2011 – September 2012
Permitting	June 2011 – September 2012
Final Design Consultant Selection	January 2011 – September 2011
Final Design	September 2011 – December 2012
Construction	March 2013 – August 2015
Commissioning	October 2015 – May 2016 (2 wet seasons)

## **10.2 REQUIRED PERMITS**

The following construction-related permits are anticipated for the proposed Barton CSO project:

- Washington Department of Ecology:
  - NPDES Construction Stormwater General Permit.
- Seattle Department of Transportation:
  - Street Use Permit.
  - Street Improvement Permit.

The following construction-related permits are anticipated for the proposed Murray CSO project:

- Washington Department of Ecology:
  - NPDES Construction Stormwater General Permit.
- Revision of West Point NPDES Operating Permit # WA-002918-1
- Seattle Department of Planning and Development:
  - Master Use Permit:
    - i) Shoreline Permit
    - ii) Clear and Grade Permit
    - iii) Demolition Permit
    - iv) Construction Permit
    - v) City Council Conditional Use Approval
- Seattle Department of Transportation:
  - Street Use Permit.
  - Utility or Street Improvement Permit.
- King County:
  - Industrial Waste Discharge Permit.
- Puget Sound Clean Air Agency:
  - Air Quality Permit.

Environmental review will be completed for the proposed project in accordance with the State Environmental Policy Act (SEPA) and State Environmental Review Process (SERP)

## **10.3 NEXT STEP RECOMMENDATIONS**

The following items are recommended as initial next steps in the implementation of the Barton GSI alternative:

- Contributing Area Analysis – Conduct block scale field reconnaissance and flow monitoring to refine assumptions made regarding the amount of runoff contributed by the study area (right-of-way only vs parcel plus right-of-way).
- Modeling – During design, consider using an EPA-SWMM or other appropriate network basin model that is suitable for GSI implementation on a block scale which can take in to account the routing of each block.
- Location Selection – Selection of rain garden locations should start with a detailed in-field assessment of the locations identified on the Location Feasibility Map (See Appendix A - Overview Update Report, November 22, 2010, SvR Design Company). Location assessment should be prioritized starting with the most feasible locations. The following considerations should be taken in to account;
  - Planting strip longitudinal slope;
  - Variations in projected subsurface soil infiltration rates and in-field infiltration tests;
  - Parking constraints;
  - Existing utility services and mature trees to preserve in the planting strip;
  - Adjacent property owner/occupant acceptance;
  - The presence of disconnected downspouts within the block and Seattle’s Rainwise program implementation;
  - Pedestrian, bike and vehicle traffic safety issues such as sight lines.
- Develop and implement a public involvement and outreach plan throughout the design and construction phases of the project.

The following items are recommended as initial next steps in the implementation of the Murray 1F Storage Alternative:

- Conduct field geotechnical investigation to obtain site specific geotechnical data to confirm shoring and foundation requirements.
- Determine additional footprint requirements to provide standby power and odor control capacity for the Murray Pump Station from the storage facility site.
- Confirm existing overflow weir elevations within the Murray Pump Station in order to verify maximum allowable water surface elevation within the storage facility (elevations are shown from record drawings, but it is recommended they be field verified during site survey).
- Develop and implement a public involvement and outreach plan throughout the design and construction phases of the project.



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## MISCELLANEOUS REQUIREMENTS

This chapter documents miscellaneous facility plan requirements from the State of Washington's *Criteria for Sewage Works Design* ("The Orange Book," Ecology, August 2008), including information on water quality management plan conformance, SEPA/SERP compliance, and public involvement.

### 11.1 WATER QUALITY MANAGEMENT PLAN CONFORMANCE

King County's Regional Wastewater Services Plan (RWSP) addresses water quality management with respect to the sewer system and CSOs. The RWSP identifies wastewater projects to be built through 2030 to protect human health and the environment, serve population growth, and meet regulatory requirements.

The RWSP includes a CSO Control Plan that consists of the amended 1988 CSO Control Plan (1995 Plan Update), identification of 21 CSO control projects, and a goal for achieving control at each CSO location by 2030. The *2000 CSO Control Plan Update* was included in the West Point NPDES permit application. The *2008 CSO Control Plan Update* submitted to Ecology as part of the West Point NPDES permit identified the Barton and Murray CSO projects among four high-priority projects.

### 11.2 STATE ENVIRONMENTAL POLICY ACT COMPLIANCE

Compliance with the State Environmental Policy Act (SEPA) is a prerequisite for obtaining any permits/approvals for a CSO project. SEPA allows agencies to consider and mitigate for environmental impacts of proposals as well as to provide opportunities for public participation prior to any final decision. King County, as SEPA lead agency, will conduct SEPA review for this project. SEPA documents will be provided in Appendix D when available.

### 11.3 STATE ENVIRONMENTAL REVIEW PROCESS COMPLIANCE

All projects that receive financial assistance from the State Water Pollution Control Revolving Loan Fund must meet the provisions of the State Environmental Review Process (SERP) (WAC 173-98-100). SERP compliance helps ensure that environmentally sound alternatives are selected that satisfy the state's responsibility to ensure compliance with the National Environmental Policy Act. The following sections summarize compliance with the applicable federal regulations under SERP. King County will complete SERP for the proposed project, including preparation of a SERP Environmental Information Checklist.

#### 11.3.1 National Historic Preservation Act/Archaeological and Historic Preservation Act

The National Historic Preservation Act requires federal agencies to evaluate the effects of federal undertakings on historical, archaeological, and cultural resources, and to consult with

the State Historic Preservation Officer regarding possible adverse cultural resources impacts. A review of historic, archaeological, and cultural resources that could be impacted by the proposed alternatives is summarized in Chapter 8.

### **11.3.2 Clean Air Act**

The Clean Air Act establishes a comprehensive program for improving and maintaining air quality throughout the United States. A review of air quality issues for the proposed alternatives is summarized in Chapter 8.

### **11.3.3 Coastal Zone Management Act**

The proposed projects are not within designated shorelines. Therefore, the Coastal Zone Management Act regulations and requirements are not applicable.

### **11.3.4 Endangered Species Act**

Section 7 of the Endangered Species Act prohibits federal agency actions from jeopardizing listed species or adversely modifying designated critical habitat. A review of endangered/threatened species and habitats in the project areas is summarized in Chapter 8.

### **11.3.5 Farmland Protection Policy Act**

The proposed alternative areas are not located on the inventory of prime or unique farmlands and will not impact or convert any existing farmlands to non-agricultural uses. Therefore, the Farmland Protection Policy Act regulations and requirements are not applicable.

### **11.3.6 Fish and Wildlife Coordination Act**

There are no fish-bearing streams or water bodies within the project areas. Therefore, the Fish and Wildlife Coordination Act regulations and requirements are not applicable.

### **11.3.7 Executive Order 11988, Floodplain Management**

The proposed alternative project areas are not within a mapped Federal Emergency Management Agency floodplain. Therefore, the regulations and requirements of Executive Order 11988 are not applicable.

### **11.3.8 Executive Order 11990, Protection of Wetlands**

The proposed alternative project areas do not include any wetlands. Therefore, the regulations and requirements of Executive Order 11990 are not applicable.

### **11.3.9 Wild and Scenic Rivers Act**

The purpose of the Wild and Scenic Rivers Act is to preserve the scenic, cultural, historic, recreational, and geologic values of selected rivers. No federally recognized wild and scenic rivers are in the project areas. Therefore, the regulations and requirements of this act are not applicable.

## **11.4 PUBLIC INVOLVEMENT AND OUTREACH**

The goal of public involvement and outreach was to inform interested citizens about the Barton and Murray CSO basin control projects and to provide opportunities for meaningful involvement in the CSO control planning process. The objectives were as follows:

- Provide timely and clear information to stakeholders and the public about the purpose of the project and their opportunities to participate.
- Conduct a clear, systematic and objective process for identifying and evaluating alternatives for CSO control and associated wastewater infrastructure and selecting preferred alternatives and sites.
- Obtain input from stakeholders and the public on the alternatives and criteria before proposed alternatives and sites are selected by King County.

### **11.4.1 Agency Stakeholder Engagement Process**

To facilitate stakeholder input, a workshop for local and state agency staff and tribal entities was held on May 7, 2009 to describe the development of the CSO control alternatives and their evaluation criteria. This workshop covered the North Beach, South Magnolia, Murray, and Barton basins. Agencies and tribes were sent a letter of invitation and a reminder email. A meeting summary was sent to all attendees.

Workshop participants reviewed the CSO program, the range of approaches the County considered to address CSOs in the four basins, and the public outreach approach. Participants provided input on the approaches, existing conditions, current and future projects, plans and opportunities for coordination and methods for public outreach. The project team used this input to guide development of the range of alternatives that would be considered as well as to modify the existing public involvement plan where appropriate.

A technical memorandum was sent in early 2010 to agency stakeholders as the alternatives were narrowed from nine to three. The memo explained how the short list of alternatives was determined and solicited written comments to inform the identification of an alternative for environmental review. Agencies were also notified via email of all public meetings. Stakeholders will receive a letter explaining how their input was used to inform the process, as well as provide information about the upcoming SEPA process.

Elected officials (King County Executive, King County Councilmembers Jan Drago and Joe McDermott, Seattle City Councilmember Tom Rasmussen), agencies (Department of Ecology, Seattle Public Utilities and Seattle Public Utilities and Neighborhoods Committee, Suquamish, Muckleshoot and Tulalip Tribes) and regional committees (Metropolitan Water Pollution Abatement Advisory Committee and Regional Water Quality Committee) were briefed at key milestones for each basin.

### **11.4.2 Public Meetings and Briefings**

King County hosted public meetings, community group meetings and briefings between 2007 and 2010 to provide information about the development of CSO control alternatives and to

facilitate public participation in the planning process. In advance of the public meetings, postcards or newsletters were mailed to property owners in the basin area, people who had joined the mailing list, and representatives of community organizations who had expressed interest in the planning process. Email notifications were sent to the County's contact lists and community organizations with listservs for additional distribution. Notices of public meetings were available on the project and King County websites and were provided to local and regional media through press releases.

#### **11.4.2.1 Barton Basin Public Meetings**

- June 27, 2007: A joint public meeting was held for the Barton and Murray communities to explain the overall CSO control project and discuss the alternative means for controlling CSOs.
- October 8, 2009: A public open house was held to provide an overview of the CSO control problem in the Barton basin, explain approaches identified to control CSOs, provide information on how to stay up to date on progress, and solicit input.
- March 18, 2010: A public meeting was held to present the three preferred CSO control alternatives and solicit public input.
- August 5, 2010: A technical information session was held to provide additional information about the green stormwater infrastructure alternative to residents in Sub-basin 416.
- November 1, 2010: A public meeting was held to present a community-generated alternative proposing a CSO facility sited in Lincoln Park and to solicit feedback on this alternative.

#### **11.4.2.2 Barton Basin Community Group Meetings and Briefings**

- 2007 – 2008: Several community briefings were given at the request of the Fautleroy Community Association during regularly scheduled board meetings.
- November 10, 2009: The Fautleroy Community Association board held a meeting to discuss concurrent projects including the Barton Pump Station upgrade, the proposed CSO control project, and beach sand replacement in Fautleroy Cove.
- During 2010, King County public involvement staff attended several Fautleroy Community Association Board meetings to discuss the CSO control project and the schedule for selecting alternatives.

#### **11.4.2.3 Murray Basin Public Meetings**

- June 27, 2007: A community briefing was held for the West Seattle community to inform citizens of the CSO control project.
- October 7, 2009: A public open house was held to provide residents with broad background on the CSO control problem in the Murray CSO basin, explain approaches

identified to control CSOs, provide information on how to stay up to date on progress, and solicit input.

- March 29, 2010: A public meeting was held to present the three preferred CSO control alternatives and solicit public input.
- June 19, 2010: A technical information session was held to respond to citizens' requests for technical information and information about the process to identify and screen CSO control alternatives.
- November 1, 2010: A public meeting was held to present a community-generated alternative proposing a CSO facility sited in Lincoln Park in the Barton basin, and to solicit feedback on this alternative.

#### **11.4.2.4 Murray Basin Community Group Meetings and Briefings**

- Between 2007 and 2009, County staff attended two Fauntleroy Community Association board meetings to keep neighbors informed and updated on the project.
- October 21, 2009: The Morgan Community Association hosted a community meeting to discuss CSO control approaches and the public participation process.
- April 21, 2010: The Morgan Junction Community Association hosted a presentation on CSO control alternatives.
- June – September, 2010: Due to significant concern, King County convened the Murray community advisory group (CAG) to better understand and explore options for CSO control in the Murray CSO basin. This group consisted of 12 residents, four alternates, and several ex-officio members. Eight meetings of the Murray CAG were held to debate and discuss CSO control alternatives.

Public input from all meetings and briefings was used to identify an alternative for further review. While most community members recognized the need to deal with CSO control problems in the Murray basin, few members supported the three alternatives presented by the County. Neighbors of Lowman Beach Park submitted a statement with more than 700 signatures opposed to siting an underground storage facility in Lowman Beach Park. Community members considered Lowman Beach Park a treasured space, but they were also against using private property for a storage site. The in-street control option was also opposed due to possible lengthy street closures and traffic disruptions. The Murray CAG was established in response to community objection to the Lowman Beach Park alternative. The Murray CAG issued a report in October recommending storage in Lincoln Park, triggering strong opposition from the Barton/Fauntleroy Community.

### **11.4.3 Public Information**

#### **11.4.3.1 Project Website**

In 2009 a project website, [www.kingcounty.gov/CSObeachprojects](http://www.kingcounty.gov/CSObeachprojects), was established to make information on the development of the CSO control approaches available to the public. A link

to the project website was made available on the Wastewater Treatment Division's homepage and provided to the public in meeting notices, press releases, newsletters and emails and at meetings.

Notice of all public meetings and stakeholder workshops were posted on the website. After public meetings, written summaries, presentations, and handouts were made available on the website. Interested parties were able to sign up for the project mailing list and were provided a phone and email contact for King County staff.

Technical information was made available on the website as a separate link (<http://www.kingcounty.gov/environment/wtd/Construction/Seattle/BeachCSO/Library/TechInfo.aspx>) to allow interested citizens opportunities to better understand the decision process. Individuals could request CD copies of the technical information as needed.

#### **11.4.3.2 Project Mailings**

A newsletter was mailed to about 5,000 basin residents in fall 2009 with information about the upcoming decision process for CSO control projects and options for community involvement and participation. The newsletter included a mail-in form to sign up for email updates and/or hard copies of web materials. A second newsletter was sent in spring 2010 to announce the three selected alternatives for CSO control and provide information about a public meeting to discuss the alternatives. Newsletters were also provided as a PDF by email and mailed to local and state agencies and tribes. A technical information session flier was sent in July 2010 to residents within the upper basin that would be affected by the GSI solution. In October 2010, a flier was sent to residents in the Fauntleroy neighborhood to announce the November 1, 2010 public meeting. Sandwich boards were placed throughout Lincoln Park to ensure maximum attendance at the meeting.

In addition to targeted mailings, news releases were sent at key milestones to local and regional media, including blogs, and to city and state agencies for distribution.

#### **11.4.4 Comment Tracking and Response Process**

Members of the public submitted feedback or input in a variety of ways. Stakeholders and members of the public were invited to ask questions and provide comments at all of the stakeholder workshops and public meetings. The consultant team and representatives of King County responded to comments and questions during those meetings. A summary of public comment and response from each meeting was posted in the meeting summary available on the project website, and a 'frequently asked questions' page was included on the website.

King County community relations planning staff received the comments that were submitted via the website, an online survey, email and phone. The comments were saved by County staff for their records. Some comments were intended to inform the CSO control decision process and did not require a response. For questions and comments that did require a response, King County staff responded via email or phone. The West Seattle blog, <http://westseattleblog.com/>, a media resource used extensively by the Barton and Murray communities, provided extensive coverage of options, discussions, decisions and process.

Public input from all meetings, briefings, and comments was used to identify an alternative for further review. Based on the strong level of public input during the decision-making process, specific requests from stakeholders, and King County's commitment to public involvement, the County is planning continued public outreach throughout the design and construction phases. An updated public involvement plan will be developed for design and construction to keep the community and stakeholders engaged and informed, and to respond to concerns during design, environmental review and construction.

