Dayton Street and SR 104
Storm Drainage Alternatives Study

City of Edmonds

August 2013

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Storm Drainage Alternatives Study

City of Edmonds

July 2013

SAIC

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City of Edmonds

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Section 1
INTRODUCTION, BACKGROUND AND PURPOSE

The intersection of Dayton Street and State Route (SR) 104 in downtown Edmonds has flooded on numerous occasions in recent years resulting in disruptions to traffic and ferry operations. Figure 1-1 shows the location of the intersection and the general vicinity. The intersection is in a low-lying area and is drained by a pipe system extending west along Dayton Street to outfall to Puget Sound. The outfall is equipped with a valve to prevent tidal flow from backing up into the drainage system.

The intersection is located just north of the Edmonds Marsh, a contiguous low-lying area. Shellabarger Creek crosses SR 104 and enters into the marsh about 1,000-feet south of the intersection. The flow from Shellabarger Creek through the crossing is affected by a number of factors that can inhibit flow entering the marsh such as tidal conditions, sediment and debris accumulation, and an abundance of vegetation that clogs the creek channel. As such, during storm events, flow through the culvert backs up causing water levels on the east side of SR 104 to rise. The high water levels cause Shellabarger Creek to inundate a low lying wetland on the east side of SR 104 and then overflow north to the Dayton Street and SR 104 intersection. This flow, in combination with the runoff from other tributary area to the intersection, can overwhelm the existing Dayton Street stormwater conveyance system and result in periodic flooding, particularly when high tides coincide with heavy rainfall. Figures 1-2, 1-3, and 1-4 show the intersection and adjacent area flooding during three recent large storm events. High water levels in the marsh have also contributed to flooding of portions of the parking area and two structures at the nearby Port of Edmonds' Harbor Square development.

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1"=325'

325 0 325 650

Scale Feet

Creek/Ditch

Pipe/Culvert

Figure 1-1
Project Area

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Figure 1-2. Dayton St/SR 104 Intersection looking south, Dec 03, 2007

Figure 1-3. Salish Crossing Parking Lot adjacent to Dayton Street/SR 104 Intersection looking NW, Dec 12, 2010

Figure 1-4. Salish Crossing Parking Lot and Dayton Street/SR 104 Intersection looking NW, November 19, 2012

The intersection and surrounding area is an economic and transportation focal point for the City, with the Harbor Square development, the west access to the Edmonds waterfront, the ferry traffic queuing area, and future development opportunities to the northwest of the intersection (Salish Crossing). The Edmonds Marsh offers a rich and diverse environmental amenity that is an attraction for the community. As such, recurrent flooding of the area is a major concern.

The purpose of this investigation is to perform field topographic survey and hydrologic and hydraulic analyses to help determine the cause(s) of flooding as well as to identify and evaluate alternative improvements to reduce flooding. As a separate project, the City of Edmonds working with staff at Earthcorps (formerly operating as People for Puget Sound) to explore the feasibility of maximizing Chinook salmon rearing habitat in the Edmonds Marsh through daylighting the connection between Willow Creek and Puget Sound. The project is partially funded by the Washington State Recreation and Conservation Office (RCO). Some of the survey and hydrologic and hydraulic modeling data developed as part of this flood study was used as a part of the fish habitat study. In addition, alternative improvements developed for flood hazard reduction were identified in many cases to be consistent with improvements being proposed as a part of the daylighting project.

Existing System Description

The focus of this study is on two drainage systems that become interconnected during high flows, the Dayton Street drainage system and the Edmonds Marsh. These systems are described in more detail below. Figure 1-5 presents a graphic of the existing drainage systems in the project area. Figure 1-6 depicts drainage basin boundaries tributary to the project area drainage systems.

The Dayton Street system drains an approximate 33.5-acre area that extends east as far as 3rd Avenue S and as far north as Main Street. From the intersection with SR 104, the system extends west along Dayton to Admiral Way, where it continues west through an easement on Port of Edmonds property. At the outlet to Puget Sound, the system includes a tide gate (tide flex valve) that prevents flows backing up in the system during high tides.

Approximately 80-feet west of Admiral Way the drainage system was modified in 2004 to include a water quality facility. This construction changed the system profile and added a swirl concentrator water quality treatment facility. While water quality has been improved with this facility, a disadvantage is that it backs up water (about five-feet high) upstream of its location so much of the system is constantly under water.

The intersection for Dayton Street and SR 104 is low-lying and the low point of the road is at about elevation 10, whereas high tides are often in the range of 9 to 11-feet (NAVD88) and sometimes higher during extreme tides. The intersection receives flow from both the north and the south. Drainage from the north includes both SR 104 to about Main Street as well as drainage from the Washington State Ferry's north queuing area. The drainage from the south includes overflows from a wetland area on the east side of SR 104 that enters a pipe system located between SR 104 and the City of Edmonds wastewater treatment plant.

One of the smaller contributing pipe systems that connect to the Dayton Street system near its west end (west of Admiral Way) collects runoff from low-lying paved parking areas. The low-lying parking areas were subject to ponding during very high tides, so the City installed both a small (approximate 0.5 cfs) pump station and a tide flex valve where it connects to the Dayton Street system. The small pump station only operates during very high tides and discharges directly west to Puget Sound.

There are two small areas that lie adjacent to Dayton Street but to do not drain to the Dayton Street drainage system. These include a portion of the Salish Crossing property which is located north of Dayton Street and west of SR 104 (See Subbasin 420 on Figure 1-6) and Harbor Square which is located south of Dayton Street and west of SR 104 (See subbasin 410 on Figure 1-6). The drainage from the southwestern portion of Salish Crossing is directed south across Dayton Street and connects to a pipe system within Harbor Square. The Harbor Square drainage system includes storm drains that extend south and west to the Edmonds Marsh.

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N

1"=300'–0"

300 0 300 600

Scale Feet

Figure 1-5
Study Area Drainage System

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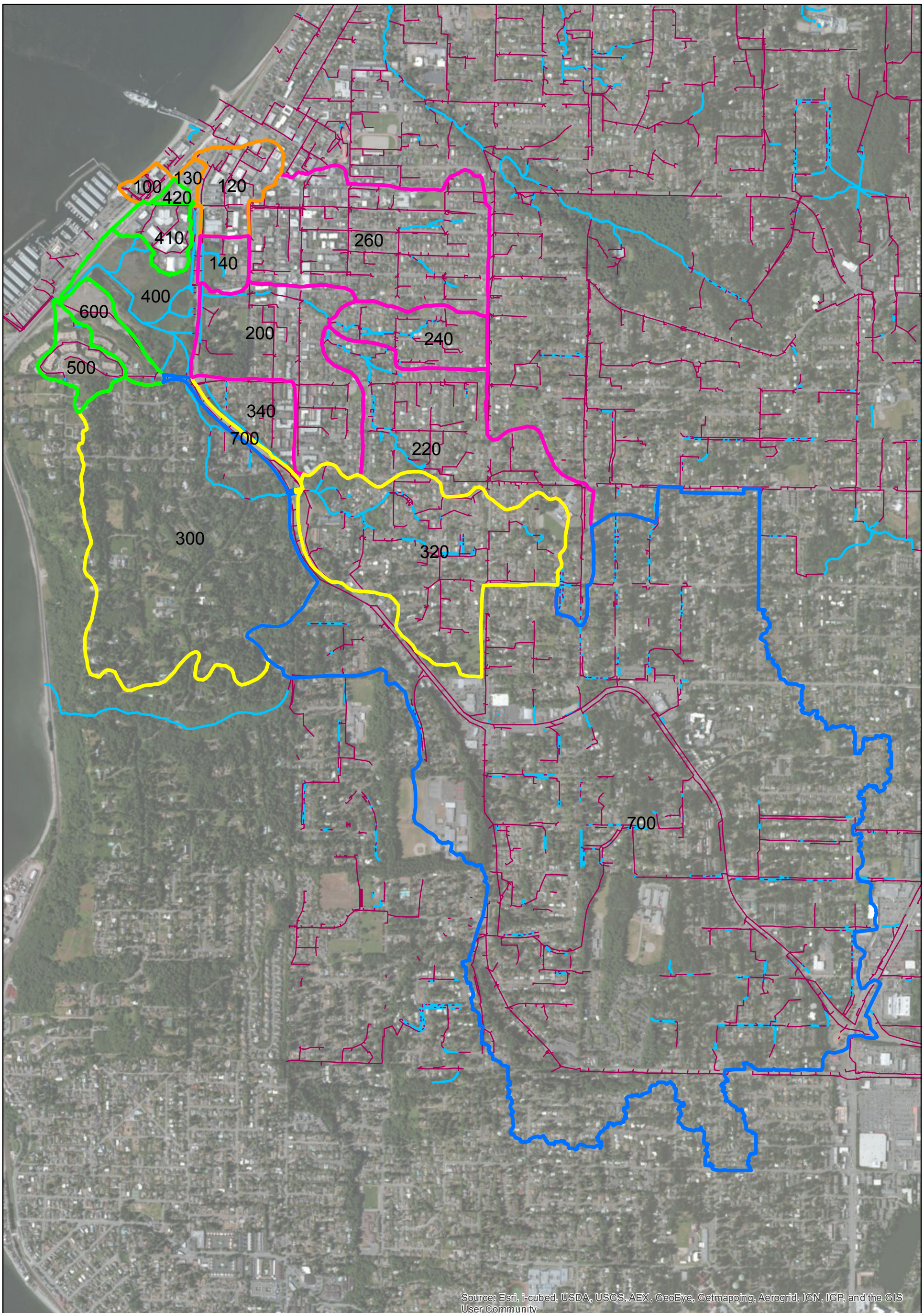

Legend

- Dayton Street
- Shellabarger Creek
- Willow Creek
- Edmonds Marsh
- WSDOT/Edmonds Way
- Stormwater System
- Streams and Ditches

N

0 625 1,250 2,500 Feet

Figure 1-6.
HSPF Basins

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R:\Seattle\001772 Edmonds WA, City of\2651211002 Dayton St SR104 Alternatives Study

In addition to recurrent flooding, stormwater quality within the Dayton Street system is also a concern. While the treatment system near the outfall has certainly resulted in some improvements, the City has noted that heavy oil accumulations have been observed in the drainage system in catch basins near the intersection of SR 104 and Dayton Street. A likely contributing factor is the ferry system holding lanes that have a high volume of cars (that often have engines idling as they move through the queuing lanes or are parked for extended periods waiting for the next ferry boat).

The Edmonds Marsh is generally bound by Harbor Square to the north, the BNSF railroad to the west, SR 104 to the east, and the Union Oil Company of California (Unocal) property to the south. Union Oil Company of California is a wholly owned subsidiary of Chevron. For the purposes of this report, the property ownership will be referred to as the "Unocal" property. The marsh is owned by the City. It receives drainage from Shellabarger Creek and Willow Creek plus adjacent local area that drain directly to the marsh. Most of the basin lies within the City of Edmonds. However, a portion of the Willow Creek basin lies within the Town of Woodway. Shellabarger Creek enters the marsh through two parallel 48-inch by 72-inch arch culverts under SR 104, located about 1,000-feet south of Dayton Street. Willow Creek enters the marsh through a culvert at Pine Street west of SR 104 near the Trout Unlimited hatchery. It joins with Shellabarger Creek within the marsh. Both Shellabarger Creek and Willow Creek historically flowed in defined channels that joined and ran northwest along the Unocal property. However, over time sediment deposition and extensive cattail growth has choked and filled in these former creek alignments, such that the creeks disperse and spread out as they enter the south and east sides of the marsh. This has eliminated an open creek channel that would allow fish to move between the creeks and the downstream estuarine marsh.

The sediment built up has affected the Shellabarger Creek culverts crossing of SR 104 such that they have approximately 1.3-2-feet of sediment built up at the inlet and outlet. It was also noted that the elevations of the sediment build up downstream of the culvert (at elevation 9.2 +/-) is higher than the pipe system that connects the fresh water wetland on the east side of SR 104 to the Dayton Street system (See node 18 on Figure 1-5). As a result, Shellabarger Creek low flows are often diverted north to the Dayton Street system rather than follow its historic path into the marsh. The sediment deposition also reduces the culverts conveyance capacity.

The western side of the marsh predominately estuarine and is drained by Willow Creek as it extends south approximately 600-feet between the Unocal property and the BNSF railroad. Along this section of open stream channel, the creek receives drainage from the Unocal property which includes discharges from two stormwater detention ponds under the Unocal property industrial stormwater permit SO-002953C (Chevron, 2013). The Unocal site has residual contamination resulting from historic operations, and is being managed under an Agreed Order with the Washington State Department of Ecology.

Near the south end of this open channel, Willow Creek passes through a short embankment that has two culverts including a 36-inch CMP culvert and a 22-inch diameter steel culvert. The two culverts are placed within a short berm crossing

Willow Creek (See Nodes 29 and 30 on Figure 1-5). The purpose of these culverts and gates is not specifically known and the ownership of these culverts and gates, although located on the Unocal property, is being evaluated. One of the gates is partially closed and the other is fully closed.

At the outlet of these culverts, Willow Creek turns west and crosses the railroad through dual 42-inch diameter culverts. These culverts discharge to a short section of open channel on the west side of the railroad where the creek enters a 600-foot-long 48-inch diameter CMP pipe extending south to a stormwater vault south of the Edmonds marina. The pipe in the vault is equipped with a 48-inch tide (flap) gate which is controlled by a manually operated pulley system (see node 34 on Figure 1-5 and Figure 1-7). During the wet season from November to mid-March, the tide gate is closed to prevent flow entering the system during high tides and exacerbating high water levels in the winter. The tide gate is opened during the drier part of the year, mid-March to November. From this tide gate vault, the 48-inch pipe system extends another approximate 1000-feet to outfall in Puget Sound.

The overall tributary to the marsh is 833 acres with approximately 378 acres from the Shellabarger Creek basin and 393 acres from the Willow Creek basin. The Shellabarger Creek basin is heavily developed with single and multifamily land use, the stream passes through culverts in many locations, and most of the open reaches are located in landscaped residential areas. The Willow Creek basin is less densely developed than the Shellabarger basin.

The marsh offers a unique, valuable and diverse salt water habitat community. There have been a number of studies regarding the marsh. Some of these include:

- Biological Condition of the Edmonds Waterfront and Preliminary Feasibility Considerations for Nearshore Ecosystem Restoration (2009, People For Puget Sound)
- Evaluation of Habitat Benefits and Impacts Associated with the Proposed Daylighting of the Outlet from Edmonds Marsh (1998, Pentec)
- Edmonds Stream Inventory and Assessment (2002, Pentec)
- Marsh Topographic Surveys (2008, WSDOT)

A separate system, the WSDOT Edmonds Way pipe drainage system, extends west crossing underneath Willow Creek near its entrance to the 48-inch diameter outfall pipe. At this location, the Edmonds Way pipe system is 72-inch diameter and roughly parallels the Willow Creek outfall pipe to outfall in Puget Sound. The Edmonds Way drainage basin comprises 870 acres and collects runoff from Edmonds Way east of the Shellabarger and Willow Creek basins (shown as basin 700 on Figure 1-6). One of the manhole structures along this pipe system is located near Willow Creek as it enters its outfall pipe system. This system is of interest to Willow Creek because it is known to overflow into Willow Creek during storm events. The manhole has been observed to be “geysering” and the City also notes that its manhole cover is often off the manhole following large storms. It is of interest to Willow Creek and the marsh because it can contribute runoff volume.

Figure 1-7. Tide Gate at Edmonds Marsh Outfall to Puget Sound (open)

As previously noted there is a separate ongoing study to explore the feasibility of maximizing Chinook salmon rearing habitat in Edmonds Marsh through daylighting the connection between Willow Creek and Puget Sound. The Willow Creek Daylighting Study, (S&W, 2013) reports that pocket estuaries, such as the Edmonds Marsh, can provide invaluable juvenile Chinook with rearing, feeding, shelter, and physiological transition zones. However, the current system outlet conditions, that include a tide gate and long pipe, severely limit fish passage into the creek/marsh system. The Willow Creek Daylighting project represents a rare restoration opportunity, and further, that the Willow Creek Daylighting Project is currently on the Water Resource Inventory Area (WIRA) 8 three-year habitat work schedule (I.D. M3223) and is listed as a Tier 1 project. Tier 1 designation includes the highest quality remaining habitat, and the greatest Chinook use (S&W, 2013).

Other notable features are bridge crossings of the BNSF/Sound Transit Railroad in anticipation of the Willow Creek Daylighting Project. The bridge crossings were constructed around 2010 by Sound Transit as part of mitigation for loss of wetland and streams filled as a result of Sound Transit's third commuter rail improvements with BNSF for the Sounder Train. The location of the culverts is shown on Figure 1-1. These culverts are not in use at the present time.

Investigations and Findings

This section includes a discussion of the study findings with respect to the existing flooding conditions. The identification of possible alternatives to reduce flood hazards is discussed in the next section.

Field Survey

In order to provide data for hydraulic modeling of the Dayton Street and Edmonds Marsh systems, field survey was necessary. The City had some information from prior engineering studies and system designs. However, additional information was necessary.

The field survey work included some cross sections through the Edmonds Marsh in order to validate a prior 2008 survey that was completed by the Washington State Department of Transportation (WSDOT) as well as specific pipe system information where City as-built information was unavailable. The specific data source and supplement survey information collected is described in Appendix A. The actual survey results are contained within Appendix B.

Hydrologic and Hydraulic Modeling

The Hydrologic Simulation Program - FORTRAN (HSPF) model was developed to generate a long term time series of runoff tributary to both the Dayton Street drainage system and the Edmonds Marsh. Major tributary systems include Shellabarger Creek, Willow Creek and portions of urban drainage systems north of Dayton Street. The time series of runoff from the different systems was developed in order to be routed through an unsteady state hydraulic model, XP-SWMM, to examine historical coincidence of high tides, high rainfall events and flooding, and to examine the performance of alternative improvements to reduce flood hazards within the study area. The advantage to using long-term hydrology with unsteady state hydraulic modeling is that it can inherently account for the interaction of tidally influenced flood events by using historical tides along with historical precipitation.

HSPF is a continuous hydrologic model for watersheds that produces a long-term time history of runoff based upon historical precipitation and runoff from different soil types and land uses. HSPF routes flow downstream through stream reaches (defined as FTABLEs that include relationships between stage, storage and discharge) that account for attenuation from system storage but do not account for the effects of dynamic routing such as tidal impacts on the Edmonds Marsh and Dayton Street systems. Thus the application of HSPF for this study is to develop long-term time history of flows to both the Dayton Street drainage system and the Edmonds Marsh which are then routed through the XP-SWMM hydraulic model. Appendix A contains a complete description of the hydrologic and hydraulic model development. The detailed system modeled is shown on Figure 1-5 and includes both the Dayton Street system west of the intersection with SR 104 and Edmonds Marsh from where Shellabarger Creek enters the low-lying wetland on the east side of SR 104 to the Willow Creek outlet.

The area contributing runoff to the Edmonds Marsh and Dayton Street systems was divided into sixteen subbasins using GIS maps showing aerial photographs, contours and the City of Edmond surface water drainage system. The subbasins are presented on Figure 1-6. The Edmonds Way Basin was also included in order to assess the potential for overflows from the WSDOT trunk line near Willow Creek.

Precipitation data used in the hydrology model was obtained from the Alderwood rain gauge located approximately 5.5 miles northeast of the intersection of Dayton St/SR 104. The City of Edmonds has daily rain gage data from 2000 to the present. This data was compared with the Alderwood rain gage and it was concluded that the data from the Alderwood gauge is acceptable for the analysis (See discussion in Appendix A). Other input data (such as evaporation data, runoff parameters from soil characteristics, soil water storage, and soil interflow) were taken from the Scriber Creek HSPF model in the City of Lynnwood. The Scriber Creek HSPF modeling was undertaken as a significant modeling effort initially by Snohomish County, and then later updated by the City of Lynnwood.

Land use and subbasin characteristics were developed using GIS analysis tools and GIS shapefiles for soil, slope and vegetation and impervious cover. Each subbasin is described by a unique combination of soil, slope and land cover. Tables A-1 and A-2 in Appendix A list the subbasins and their areas with the unique soil, slope and land cover combination.

Once the HSPF model was complete, continuous runoff hydrographs were developed and exported so that they could be routed by the SWMM hydraulic model. In addition to flow as data input, the SWMM model requires tidal data. Tidal data was downloaded from NOAA's historic database at the Puget Sound station 9447130 located in Seattle. The datum for these elevations is NAVD88. In order to determine whether an adjustment for elevation differences between Seattle and Edmonds was necessary, both a comparison of NOAA predicted tides for one year was done and a comparison between gaged tides were done. The NOAA predicted tides comparison generally predicted a difference of about 0.4 ft lower tide in Edmonds than in Seattle. However, as a part of the Willow Creek Daylighting project, a gage was installed in the Port of Edmonds Marina. A comparison of gaged Edmonds and Seattle tides showed the Edmonds high tides being closer to the gaged Seattle tide than the 0.4 ft reduction. As a result, the Seattle gaged tidal data was used in the analysis.

One of the key elements of the SWMM model is that the outflows from the marsh are controlled by a tide gate in the system (See Figure 1-5 for location and Figure 1-7 for Photograph). As previously noted the gate is manually operated by the City and is set in the closed position between November and mid-March and in the open position the remainder of the year.

Once the SWMM model was set up and HSPF flows were routed through the model, specific storm periods were run in order to provide a validation of model results. To do this a review of historical observed high water marks and comparison with simulated model results was performed. Identifying historical observed high water levels included a review of flooding records, discussions with maintenance staff, obtaining input from Washington State Department of Ferries, and reviewing gage

data available from the Willow Creek Daylighting Project. In general, there were limited historical events having clearly accurate known elevations of flooding. These included the following:

- December 3, 2007 Flood. Two records of high water marks were obtained which matched well with each other. These included anecdotal reports of flooding just above the finish floor of the ferry toll booths (which were subsequently surveyed), and surveyed elevation collected by Reid Middleton in the vicinity of the Harbor Square buildings (documented in a November 12, 2009 memorandum to the City of Edmonds).
- December 12, 2010 Flood. A photograph taken during the storm was used to get an approximate high water mark. It was noted that following this storm event, the City determined that some debris in the pipe might have affected the system response. This storm was still used for validation, recognizing that there is some uncertainty about the system performance and the time the photo was taken.
- November 19, 2012 Flood. As a part of the Willow Creek Daylighting Project, three gages had been installed at various locations in the project vicinity. These locations are shown on Figure 1-5. One of the locations is on Shellabarger Creek on the east side of SR 104; one is in the west portion of the marsh, and one in the Edmonds Marina. In addition, field measurements of flooding depth were taken by SAIC staff during this flood.

Table 1-1 provides the validation results.

Table 1-1:
SWMM Model Validation Runs

Storm Date	Observed High Water Mark	Maximum High Tide (NAVD88)	Simulated Elevation in the Marsh	Simulated Flooding at OHWM Location	Low point at Intersection	Simulated Depth of Flooding at Intersection
12/3/2007	12.43[1]/12.4[2]	11.34	11.93	12.26	10.1	2.16
12/12/2010[3]	10.54[4]	10.52	9.66	11.26	10.1	1.16
11/19/2012	11.5[5]	11.21	10	11.42	10.1	1.32
11/19/2012	11.85[6]	11.21	10	11.95	10.1	1.32
11/19/2012	10.39[7]	11.21	10	10	10.1	1.32

(1) Based on data collected by Reid Middleton (11/12/09) in vicinity of Harbor Square Buildings
(2) Based on reported standing water in WSDOT ferry toll booth (inches above floor); floor surveyed at 12.2
(3) Note there may have been partial blockages in Dayton System that could have affected flows
(4) Observed high water from Dayton Roadway Shoulder, photograph and survey by Perteet 2012
(5) Based on field measurement by SAIC staff on Dayton Street south of Salish Crossing
(6) Gaged flow with data logger (LTC#3) near the SR 104 culvert inlet
(7) Gaged flow with data logger (LTC#2) on the west side of the marsh

Figure A-4 in Appendix A shows a graph of the simulated water levels in the marsh and Shellabarger Creek in comparison to the gaged water levels for the 11/19/12 flood. While there are some differences between the marsh water levels (0.4 ft at the peak), the water levels at the Shellabarger Creek entrance to the SR 104 culvert were very close (within 0.1 ft). In addition, the simulation response through the overall storm event shows a good representation of the gaged data. While some improvements in the system response could be made, it would be difficult without more gaged data of storm events. Therefore, for the purposes of this study, it was concluded that the model reflects a valid representation of the system and can be used for evaluating alternatives.

Upon concluding that the model simulations reflect a reasonable simulation of the system in comparison with historical observations, the SWMM model was then used to simulate 30 years of flows to conduct frequency analysis of water levels in the marsh. The frequency analysis was done at three locations within the model:

- Node 60. Representing the marsh west of SR 104
- Node 40. Representing Shellabarger Creek east of SR 104
- Node 15. Representing the intersection of Dayton Street and SR 104

The results are presented in Table 1-2. This table also includes the high tide during each flooding event and its time of occurrence for comparison with the time of maximum water surfaces at other locations.

Table 1-2:
SWMM Model Results

HY	Hide Tide*	Time of High Tide	Max WSE at Inter-section	Time of Max at Intersection	Max WSE at SR 104 culvert	Max WSE in Marsh	Time of Max in Marsh	Gate Open?
2012	10.96	11/19/2012 10:00 AM	11.42	11/19/2012 2:15 PM	11.95	10.00	11/19/2012 9:30 PM	No
2011	10.35	12/12/2010 10:00 AM	11.26	12/12/2010 12:15 PM	11.68	9.66	12/12/2010 2:45 PM	No
2010	9.27	5/28/2010 7:00 PM	10.38	5/28/2010 3:00 PM	11.21	8.77	5/28/2010 10:00 PM	Yes
2009	9.78	11/12/2008 3:00 PM	10.48	11/12/2008 3:00 PM	11.25	8.71	11/12/2008 5:00 PM	No
2008	11.34	12/3/2007 1:00 PM	12.26	12/3/2007 3:00 PM	12.35	11.93	12/3/2007 3:00 PM	No
2007	8.42	12/15/2006 3:00 AM	10.66	12/15/2006 6:15 PM	11.53	9.11	12/15/2006 6:00 AM	No
2006	11.42	1/30/2006 6:00 AM	11.17	1/30/2006 7:30 AM	11.38	10.19	1/30/2006 5:45 PM	No
2005	9.21	11/2/2004 9:00 AM	10.45	11/2/2004 10:00 AM	11.26	8.94	11/2/2004 1:00 PM	No
2004	9.85	10/20/2003 3:00 PM	10.87	10/20/2003 5:00 PM	11.60	9.12	10/20/2003 8:00 PM	No
2003	11.24	1/2/2003 6:00 AM	10.42	1/2/2003 7:00 AM	11.05	8.68	1/2/2003 5:15 PM	No
2002	10.96	1/7/2002 11:00 AM	10.49	1/7/2002 12:15 PM	11.35	9.15	1/7/2002 2:30 PM	No
2001	9.81	8/22/2001 8:00 PM	10.35	8/22/2001 8:00 PM	11.03	8.62	8/22/2001 10:00 PM	Yes
2000	9.63	11/12/1999 8:00 AM	10.33	11/12/1999 10:00 AM	10.93	8.50	11/12/1999 6:00 PM	No
1999	10.76	12/1/1998 2:00 PM	10.41	12/1/1998 3:00 PM	11.09	8.64	12/1/1998 6:00 PM	No
1998	9.23	1/23/1998 12:00 PM	10.40	1/23/1998 1:30 PM	11.20	8.91	1/23/1998 5:30 PM	No
1997	11.66	1/1//1997 10:00 AM	11.14	1/1/1997 12:30 AM	11.63	11.04	1/1/1997 12:30 AM	No
1996	10.08	4/23/1996 11:00 PM	10.82	4/23/1996 4:00 PM	11.51	9.52	4/24/1996 1:30 AM	No
1995	11.04	12/20/1994 7:00 AM	10.47	12/20/1994 8:00 AM	11.11	9.07	12/20/1994 10:30 AM	No
1994	10.72	12/13/1993 6:00 AM	10.34	12/13/1993 7:00 AM	11.03	8.93	12/13/1993 9:00 AM	No
1993	8.96	8/23/1993 10:00 PM	10.37	8/23/1993 10:30 PM	11.06	8.45	8/24/1993 12:00 AM	Yes
1992	10.01	1/31/1992 4:00 AM	10.35	1/31/1992 5:00 AM	10.88	8.81	1/31/1992 3:00 PM	No
1991	11.05	12/4/1990 7:00 AM	10.84	12/4/1990 9:00 AM	11.23	9.05	12/4/1990 6:15 PM	No
1990	9.57	1/9/1990 2:00 PM	10.37	1/9/1990 2:30 PM	11.02	8.89	1/9/1990 5:15 PM	No
1989	10.00	1/9/1989 7:00 PM	10.25	1/9/1989 8:00 PM	10.74	7.94	1/9/1989 10:30 PM	No
1988	11.02	12/6/1987 7:00 AM	10.50	12/6/1987 9:00 AM	11.06	9.21	12/6/1987 6:30 AM	No
1987	11.86	2/1/1987 7:00 AM	10.62	2/1/1987 9:00 AM	10.92	8.75	2/1/1987 7:00 AM	No
1986	10.30	1/18/1986 10:00 AM	11.24	1/19/1986 1:00 AM	11.77	10.48	1/19/1986 1:00 AM	No
1985	10.36	12/14/1984 10:00 AM	10.48	12/14/1984 3:00 PM	11.24	8.30	12/14/1984 10:15 PM	No
1984	10.19	11/20/1983 5:00 AM	10.38	11/20/1983 6:30 AM	11.02	9.05	11/20/1983 5:30 AM	No
1983	11.16	12/3/1982 7:00 AM	10.41	12/3/1982 8:30 AM	10.90	8.90	12/3/1982 7:00 PM	No
1982	11.08	12/5/1981 11:00 AM	10.40	12/5/1981 12:30 PM	10.95	8.62	12/5/1981 2:30 PM	No

*Nearest high tide to time of max at intersection.

Using the elevations in Table 1-2, frequency analysis was performed for each the three locations. The frequency analysis was done using the log-Pearson Type III probability distribution best-fit line through the yearly simulated water levels. The log-Pearson Type III distribution is a statistical technique used in hydrologic studies for fitting a best-fit curve through a series of yearly peak data (e.g. elevations or flows) to predict the design flood for a site. Typically, it is desirable to have a long (e.g., 30-year record of peak elevations) to be used as the input data for a high level of confidence in the analysis results. The probabilities of floods of various magnitudes can hence be extracted from the log-Pearson Type III best-fit curve. Additionally, this curve enables the extrapolation of the values for events with return periods beyond the observed flood events. The frequency analysis results and the predicted 2-year, 10-year, 25-year and 100-year elevations at the three study points are shown in Table 1-3 (Figures of the frequency plot are included in Appendix A).

Table 1-3:
Frequency Analysis for Design Events Water Surface Elevations
(ft, NAVD88)

Node	Location	2-year	10-year	25-year	100-year
60	Marsh West of SR 104	8.95	10.20	10.93	12.11
40	Marsh/Wetland East of SR 104	11.19	11.73	12.00	12.40
15	Intersection of Dayton St/SR 104(1)	10.53	11.21	11.62	12.27

(1) Flooding begins to occur at elevation 10.0.

Some of the conclusions that can be drawn from these results and a review of the modeling are as follows:

- The intersection floods frequently. The simulations indicate some ponding occurred in all of the 30 years and it is likely that it occurred multiple times in any given year (the results only show the worst flooding of the year).
- The marsh west of SR 104 is simulated to have water surface elevations, in particular between the 2-year and 25-year event are lower than east of the SR 104 Shellabarger Creek crossing. The conclusion that can be drawn from this is that if the Shellabarger SR 104 culvert was cleaned and/or upsized and the channel downstream of the culvert was restored to allow free flow west of the culvert it would reduce the overflows from Shellabarger Creek that extend north to the intersection that exacerbates flooding.
- Marsh flooding is not necessarily always coincident with extreme high tides. Only three of the top seven floods (in terms of elevations in the marsh) coincide with high tides in excess of 10-feet. Storm events having significant runoff volume can result in the severe flooding without high tides.
- The WSDOT pipe system overflows into the marsh. However, the overflows (which are in the range of a maximum 10 to 15 cfs), do not have much effect on increasing water levels in the main area of the marsh.

Selection of Design Event

The frequency analysis was used to develop design events that are specific to this system. The design events are needed to be used to the evaluation of potential alternative improvements. Design events were selected for the 25-year and 100-year recurrence intervals. Node 60, representing the water levels in the marsh west of SR 104, was selected as the location of interest. This is because its location is less impacted by the capacity restrictions at the Shellabarger crossing of SR 104, and thus more accurately reflects the relationship between tides and storage build up in the marsh.

The design event is created by taking a historical precipitation event that produces a maximum flood level that is close to the flood level predicted by the frequency analysis. When these elevations vary, the historical precipitation is factored up or down as required until the simulated water surface elevation matches the frequency analysis. Table A-5 presents the results of this analysis.

Table 1-4:
Design Events

Design Event	Date	Maximum Simulated WSE (NAVD88)	Water Surface Elevation Predicted by Frequency Analysis (NAVD88)	Factor Needed to Apply to Flows
25-year	1-1-97	11.04	10.93	No correction[1]
100-year	12-3-07	11.93	12.11	1.05

(1) No correction factor was applied because the values were very close.

Section 2
ALTERNATIVE IDENTIFICATION AND EVALUATION

Screening of Potential Alternatives

Following the modeling and assessment of the existing drainage system, the Consultant team began the process of identifying potential solutions to reduce flood hazards. This process is summarized in Appendix C and included developing an initial preliminary listing of potential alternatives and then presenting these potential alternatives to a group of affected agencies and property owners (stakeholders). The meeting with the potential stakeholders including several City department representatives and the Washington State Department of Transportation WSDOT (both Roads and Ferries), Washington State Department of Fish and Wildlife (WDFW), Port of Edmonds, and a representative of the Salish Crossing property (one of the adjacent properties west of SR 104 and north of Dayton Street subject to recurrent flooding). Appendix C contains a summary of the meeting minutes and presentation materials.

Using this stakeholder meeting input, the draft preliminary list of alternatives was narrowed down with input from City staff to a reduced set of four alternatives shown in Table 2-1.

The development of the alternatives considered the future planned project for daylighting Willow Creek between the Edmonds Marsh and Puget Sound. Because ultimate funding and implementation of this separate project are not certain, it was important to consider some alternatives that do not include daylighting the creek. Conversely, combining the daylighting of the creek with other improvements can result in mutual benefits that simultaneously reduce flooding and offer synergies by improving habitat and restoring the natural ecosystem. For example, removing cattails and performing some excavation in the south sides of the marsh that has built up over time could increase available flood storage and also expand the portions of the salt water marsh and restore fish access to Shellabarger Creek and Willow Creek.

Alternative Descriptions

Four alternatives were identified through the screening process described above. Each alternative consists of an array of elements that would work together to help reduce the existing flood hazard at the intersection and along Dayton Street. In addition, some alternative elements include environmental benefits such as fish habitat restoration in the Edmonds Marsh and water quality improvements to the Dayton Street drainage system.

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Table 2-1:
Alternatives For Detailed Alternative Evaluation

Alternative		Preliminary Description
Alternative 1	Dayton Pump Station and Shellabarger Creek Restoration with Edmonds Marsh Expansion	▪ Use berming and/or plugging pipe System on east side of SR 104 to isolate Dayton System from Shellabarger Creek and to isolate Harbor Square from marsh. ▪ Add small pump station to evacuate Dayton system during high tides and high flows ▪ Divert drainage from the southwest portion of Salish Crossing to the Dayton system (to reduce flows to marsh and take advantage of new pump station capacity) ▪ Restore Shellabarger Creek between SR 104 and Willow Creek. This would include lowering channel, re-establishing a steeper gradient to Willow Creek, and channel restoration with habitat and planting features. To be consistent with the Willow Creek Daylighting Study, it also includes restoring Willow Creek and realigning both creeks into a more natural entry into the salt water portion of the marsh. ▪ Excavate areas on east side of marsh and cattail removal to create more flood storage. This could include areas deep enough to provide salt marsh habitat. This would also include habitat and planting features. ▪ Incorporate in-line sediment trap on Shellabarger creek just upstream of the SR 104 culvert crossing (to capture larger sediment prior to marsh)(this element included in all alternatives) ▪ Install overflow systems from Harbor Square to Dayton to allow Harbor Square to drain to the Dayton pump station during high water levels in the marsh. ▪ Water quality improvements to address very poor water quality in the Dayton System (primarily coming from ferry queuing lanes)(this element included in all alternatives) ▪ Remove the existing 36-inch/22-inch culverts near the Willow Creek crossing of the BNSF railroad (an abandoned drainage feature that causes a hydraulic restriction) (this element included in all alternatives)
Alternative 2	Alternative 1 Improvements Plus Daylighting Willow Creek	▪ Same elements as Alternative 1, Plus: ▪ Daylight Willow Creek to existing BNSF/Sound Transit bridge and construct new channel outfall to Puget Sound (consistent with Willow Creek Daylighting study) ▪ Include manual/automated tide gate to function during combination of high tides and storm events ▪ Keep existing outfall to act as outlet from marsh. This would act as a second outlet when water levels in marsh are higher than tide. This could be done with the construction of a weir.
Alternative 3	Daylighting Willow Creek and Edmonds Marsh Pump Station (Without Significant Marsh Expansion)	▪ Daylight Willow Creek to existing BNSF culvert and construct new channel outfall (same as Alternative 2) ▪ Include manual/automated tide gate to function during combination of high tides and storm events (Same as Alternative 2) ▪ Large pump station for the marsh that uses existing outfall as discharge piping. A fish screen would be required to prevent fish access to pump system. ▪ Restore Shellabarger Creek between SR 104 and Willow Creek (same as in Alternative 1) ▪ Pipe Improvements between Dayton Street system and marsh (modify connection between Dayton System and marsh to allow Dayton system to overflow to marsh during high flows) ▪ Incorporate in-line sediment trap on Shellabarger creek just upstream of the SR 104 culvert crossing ▪ Water quality improvements to address very poor water quality in the Dayton System ▪ Use berming and/or plugging pipe System on east side of SR 104 to isolate Dayton System from Shellabarger Creek ▪ Remove the existing 36-inch/22-inch culverts near the Willow Creek crossing of the BNSF railroad
Alternative 4	Large Dayton Street Pump Station and Minor Marsh Modifications	▪ Large pump station on Dayton Street closer to intersection that pumps flows from both Dayton and marsh overflows to Puget Sound. This would include a new force main and outfall to Puget Sound ▪ Conveyance upgrade near the intersection of Dayton Street and SR 104 to allow more flow to extend north from marsh to pump station. ▪ Restore Shellabarger Creek and Willow Creek (same as Alternative 1) ▪ Incorporate in-line sediment trap on Shellabarger creek just upstream of the SR 104 culvert crossing ▪ Water quality improvements to address very poor water quality in the Dayton System (primarily coming from ferry queuing lanes)(this element is included in all alternatives) ▪ Remove the existing 36-inch/22-inch culverts near the Willow Creek crossing of the BNSF railroad

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Each of the alternatives was modeled by making modifications to the existing hydraulic model described in Section 1. Hydraulic modeling was used to size the alternative elements and to evaluate the effectiveness of the alternative. Both the 25-year and 100-year events were used for the analysis.

The following paragraphs describe the alternatives in greater detail.

Alternative 1. Dayton Street Pump Station and Shellabarger Creek Restoration with Edmonds Marsh Expansion

In general, this alternative includes a combination of stormwater conveyance improvements, water quality enhancements, stream habitat restoration, and modifications to the Edmonds Marsh that would add flood storage and increase habitat by expanding the salt water portions of the marsh and improving fish access. It is presented on Figure 2-1 (located at the end of this section) and includes the following elements:

- Isolating the two main drainage systems, the Dayton Street system and the Edmonds Marsh by a combination of improvements:
  - Plugging the existing 24-inch pipe that extends along the east side of SR 104 along with some berming near the inlet of this pipe to reduce the extent of overflows from Shellabarger Creek to the north and into the Dayton Street System. In addition, a short berm (0.5 to 1 ft) is included for a short distance along the east side of SR 104 near this culvert entrance.
  - Berming or use of a short concrete flood wall (1 to 2 ft) near the west end of the Harbor Square property to reduce the potential for marsh overflows into the Harbor Square development.
- Construct a new pump station to evacuate the Dayton Street drainage system during high tides and high flows. Even if the Dayton Street drainage system is isolated from the marsh system, it was determined that the intersection would flood during high tides and large storms. The pump station capacity would need to be about 13 cfs to provide flood protection for the 100-year event. It would be designed to only be used during high tides so that the existing gravity system would be used during most times. A potential location for the pump station is the Beach Place parking lot jointly owned by the City and the Port of Edmonds, more specifically, within existing paved areas (and landscaped island) west of the BNSF railroad. A below grade pump station would be proposed to avoid eliminating as much parking as possible.

  For the analysis, it was assumed the pump station would include a new 18-inch diameter force main and outfall to the Sound located near the existing outfall. Two other options are mentioned here but neither appear to be as favorable as a new outfall adjacent to the existing outfall. These are discussed below but further investigations would be needed to assess their viability.

  - The first option is to use the existing 48-inch Willow Creek outfall pipe once Willow Creek is daylighted and the pipe outfall is no longer needed. The

advantage of this is that permitting a new outfall would not be needed. The disadvantage is that it would require 1,500 lineal-feet of additional outfall pipe, and that the pump station improvements could not be implemented until after the daylighting project, which due to its complexities, is not expected for several years.

– The second option is to use the Dayton Street system's former 24-inch outfall abandoned when the City installed the water quality swirl concentrator and new outfall in the 1990s. The advantage of this option is it might be easier to permit because it could be considered as an existing outfall upgrade. The disadvantage is that it is reported to be in very poor condition and would be very costly to repair.

It is also noted that some initial investigation was done to consider the possibility diverting a portion of the basin tributary to the pump station to another drainage system in order to reduce the size of the pump station. Initial investigations indicated that some portion of the Dayton Street system (approximately 33.5 acres) may be diverted to the north to discharge to the Main Street outfall. Such a diversion would require the construction of approximately 600-feet of new pipe. Diverting some flow from the Dayton Street System could reduce the size of pump for the proposed pump station (e.g., from 13 cfs to 11 cfs). The reduction in pump size is likely not large enough to change other elements of the pump station design (such as the forcemain), so it was not proposed as a part of this element, however, it could be considered in the future.

- Divert drainage from Salish Crossing to the Dayton system. Currently an approximately 2.2-acre area within the Salish Crossing drains to a pipe system that crosses Dayton Street without connecting to the Dayton Street system. Rather, it continues south connecting to the Harbor Square pipe system then discharges to the marsh. The rationale for this element is that with the proposed pump station, it can be size to easily handle the extra flow from this small area and reduce flood volumes to the marsh.

- Restore Shellabarger Creek and Willow Creek connection to the marsh. As previously noted, the southeastern portion of the marsh has been subject to significant deposition and buildup of vegetation over time. This channel choking is a contributing factor in flooding of the Dayton Street intersection and also preventing natural stream flows from entering the marsh. Even during low flow periods, a portion of Shellabarger Creek flows is diverted north to the Dayton drainage system. This element would include excavation and re-alignment of the two creeks to be reconfigured into a more natural estuary confluence configuration with large wood installed to maintain the channels and provide habitat features. The area would be replanted with native species adapted to conditions associated with the revised elevations, expected resulting tidal exchange, and proximity to the streams. This element of the alternative is consistent with what is being proposed as part of the Willow Creek Daylighting Study. Included in this element is the assumption that the SR 104 culvert

crossing would be maintained to the new "lowered" depth of Shellabarger Creek.

- Cattail Removal and excavation of southeast portion of marsh. This element would include removal of cattails and excavation in the southeastern portion of the marsh to both increase flood storage and extend the area of salt marsh. One concept for this approach is to generally have the restored Shellabarger and Willow Creek grades fairly constant through this portion of the marsh to maintain flow velocities and sediment transport, but have the adjacent excavation of the freshwater emergent at a bit deeper elevation to provide additional flood storage and salt water marsh habitat. The excavation would leave a bench between the channel and excavated area, similar to a natural stream bench. The excavated areas would be replanted with native species adapted to conditions associated with the revised elevations. Habitat structure such as rootwads and perches would be added.

  The preliminary analysis looked at the excavation of approximately 19,000 cy of material (12 ac-ft). Most of the excavation material would be between elevation 6 and 8.

- Incorporate an in-line sediment trap on Shellabarger Creek upstream of the SR 104 culvert crossing. The goal of this element would be to capture larger sediment prior to being transported into the marsh and allow a location for easy access for maintenance. For cost estimating purposes, the size of the pond was assumed to be 40-feet wide by 60-feet long and a depth of 3-feet. The proposed location is immediately upstream of the culvert. This would require a portion of the pond to be on private property and the City would need to get a permanent easement (approximately 0.25 acre).

- Install two system overflow connections from Harbor Square drainage system to the Dayton Street system. Under existing conditions, the Harbor Square pipe system drains to the marsh and the outlets are equipped with backflow preventers. The objective of this element is to take advantage of the Dayton Street pump station capacity included in this alternative. This could help reduce runoff volumes to the marsh. This element could be accomplished by adding four catch basins, two of which would contain overflow weirs. The overflow elevation would be set at about elevation 9.

- Water Quality improvements to the ferry queuing lanes prior to discharging to the Dayton Street system. As noted previously, this area is known for very poor water quality. On a preliminary basis, the water quality improvements include a coalescing plate oil/water separator followed by media type filtration. The selection of treatment type must consider that the media will frequently be inundated when tides are high (and prior to when the pump station is engaged for Alternative 1). One system that is Ecology approved is the Ecostorm Plus filter system (an up-flow system). For cost estimates, it was assumed that the system would include a coalescing plate oil/water separator (in an underground vault) followed by an Ecostorm Plus filter system in an underground vault). Some consideration was given to adding treatment retrofits to the intersection of

SR 104 and Dayton Street as well. However, this system is very low and is inundated with water continuously (because of the downstream treatment near the outfall). As such, it is more difficult to treat with typical filter treatment systems that require some head drop.

- Remove the existing 36-inch/22-inch culverts and gates near the existing Willow Creek crossing of BNSF railroad. This is a current capacity restriction and the culverts/gates are believed to be abandoned and not used. The work would include removal of the culverts as well as the existing embankment and restoring approximately a 30 foot section of creek.

Alternative 2. Alternative 1 Improvements Plus Daylighting Willow Creek

In general, this alternative would include all of the elements of Alternative 1 plus the daylighting of Willow Creek as proposed under the Willow Creek Daylighting Study. Figure 2-2 (located at the end of this section) presents the different elements of Alternative 2. Additional details about the Willow Creek Daylighting are provided below.

- Willow Creek would be daylighted from its current location of where it crosses the BNSF railroad south along the railroad to the existing BNSF/Sound Transit bridge crossing. Based on the Willow Creek Daylighting study, the daylighted channel would be trapezoidal with a 14-ft bottom width and 2H:1V side slopes. Between the BNSF/Sound Transit bridges and the Sound, the new channel alignment would have to extend through either the Marina Beach Park or the off leash dog park area (Figure 2-2 only shows the alignment through the north edge of the dog park. For either alignment, the work would need to include a new pedestrian crossing to provide public access to the existing City Park area. More detailed information about this daylighting the Creek is presented in the Willow Creek Daylighting Study (S&W, 2013).

  It was noted that an existing water line crosses the proposed channel approximately 100-feet northeast of the BNSF bridges. This line serves the Marina and the Point Edwards Development, and would likely have to be relocated at a deeper depth underneath the new channel.

  The portion of the channel upstream of the BNSF/Sound Transit bridges to be located on the Unocal site. It is understood that Unocal entered into an escrow agreement to transfer the ownership of the property to WSDOT upon completion of the site remediation. The City would need to work with WSDOT to obtain approvals for this portion of the channel work. Additional research is recommended to more fully understand the requirements for property acquisition.

- A tide gate is assumed to be included along the daylighted channel to reduce potential for aggravating flooding during the combination of high tides and large precipitation events. The Willow Creek Daylighting study identified the potential of having a self-regulating (SRT) tidegate at the pedestrian bridge crossing. This would be fitted onto a large diameter culvert(s). For modeling purposes, a 4-foot diameter culvert was assumed for this culvert. This was

based on expected peak flows through the system and sizing the culvert to have a reasonable low headloss.

- The existing 48-inch outfall pipe for Willow Creek could be kept in place and function as an overflow (for example by placing a weir at its entrance), or be temporally capped. The Willow Creek Daylighting study indicates that the existing outfall would be abandoned, however, there could be some advantages to keeping it functional, such as for use as an overflow, or possibility a future pumped system outfall as sea level rise impacts the system into the next century. For cost estimating, it was assumed that a weir would be placed upstream of the system entrance.

Alternative 3. Willow Creek Daylighting and Edmonds Marsh Pump Station.

In general, this alternative would include the Willow Creek daylighting and a new stormwater pump station near the existing Willow Creek entrance into the outfall pipe system. It would not include the significant excavation planned for the southeast portion of the wetland. The idea of this alternative is that it presents an option that weighs the cost and environmental impacts of the large marsh excavation versus a stormwater pump station. The regrading of Shellabarger Creek would still be necessary to remove the current vegetation and sediment build blockages on the Shellabarger Creek culvert crossing of SR 104. The elements of Alternative 3 are presented on Figure 2-3 (located at the end of this section), and our further described below.

- Willow Creek would be daylighted very similar to the Alternative 2 description. Again, for this analysis a tide gate was assumed.
- A new pump station would be constructed near the inlet location of the existing 48-inch outfall pipe system within the Port of Edmonds property. The capacity of the pump station (50 cfs) was determined using the hydraulic model and sizing it to provide a 100-year level of protection. Under normal conditions, it would not be used. It would initiate pumping during high tides and large precipitation events. The approximate footprint of the pump station facility would be about 40-feet by 20-feet. To prevent fish from entering the pump station, a fish screen would be required. Based on preliminary criteria from National Marine Fishery Service (for fry), the screen length would need to be about 140-feet long. The screen would need to be constructed of stainless steel. The overall area that could be taken up by the screen would be about 70-feet by 20-feet.

  It is assumed that the pump station would be a below grade type using submersible pumps to reduce the loss of existing parking. Diesel or natural gas pumps would be an option however, they would require above grade structures and additional loss of parking. The fish screen would need to be an open channel arrangement of some type to allow for easier access. This would eliminate some parking and possibly the Port of Edmonds access driveway to a parking lot.

For cost estimating, it was assumed that the City would purchase an emergency generator as a part of this alternative to ensure system reliability during power outages.

- Restore Shellabarger Creek and Willow Creek connection to the marsh as presented in Alternative 1.
- Plugging the existing pipe system on the east side of SR 104 to prevent high flows from Shellabarger Creek extending north to the intersection as presented in Alternative 1.
- Pipe system improvements between Dayton Street and the marsh. Under this alternative, the Dayton Street system would not include its own pump station. Therefore, to solve flooding of Dayton Street, conveyance improvements to the marsh are needed. Initially, consideration was given to conveyance improvements along the west side of SR 104. However, this wouldn't reduce water levels in Dayton Street sufficiently. A second approach consisted of replacing an existing storm drain through Harbor Square with a 30-inch pipe and providing an overflow connection from the Dayton Street system. This approach provided more reduction in water levels in the Dayton Street System since the overflow connection was to the lower portions of the marsh (i.e. elevation 6-feet) rather than through the ditch along SR 104.
- Water Quality improvements to the ferry queuing lanes as described in Alternative 1.
- Incorporate an in-line sediment trap on Shellabarger creek upstream of the SR 104 culvert crossing as described in Alternative 1.

Alternative 4. Large Dayton Street Pump Station and Minor Marsh Modifications

This alternative would include a larger Dayton Street pump station located closer to the intersection with SR 104 and not include the Willow Creek Daylighting or the large excavation in the marsh. The reasoning behind this alternative is that it presents an option that does not include the significant excavation in the marsh and that could also be pursued should the Willow Creek daylighting not be viable. It does include minor marsh modifications as the regrading of Shellabarger Creek would still be necessary to remove the current vegetation and sediment buildup on the Shellabarger Creek culvert crossing of SR 104. The removal of the existing 36-inch/22-inch culverts near the marsh outlet would also be necessary to provided better drainage from the marsh. The elements of Alternative 4 are presented on Figure 2-4 (located at the end of this section), and are further described below.

- A new pump station would be constructed near the intersection of Dayton Street and SR 104. The proposed location is within Harbor Square west of the intersection. An easement would be required. The capacity of the pump station (30 cfs) was determined using hydraulic modeling and was sized to provide a 100-year level of protection. Under normal conditions, it would not be used. It would initiate pumping when system elevations exceed elevation 9-feet. The approximate footprint of the structure would be about 35-feet by 15-feet. It is

assumed that a submersible pump station would be used to limit the amount of parking to be eliminated.

An 1,100-feet long force main would be required from the pump station to the outfall in the Sound. The force main was sized at 30-inches in diameter. It would cross the BNSF railroad and likely require boring and jacking this crossing and possibly a carrier pipe. The alignment assumed is along Dayton Street adjacent to the existing storm drain.

For cost estimating, it was assumed that the City would purchase an emergency generator as a part of this alternative to ensure system reliability during power outages.

- Conveyance improvements would be included along SR 104 and from the intersection to the pump station. The 24-inch pipe on the east side of SR 104 would be extended to connect to the Dayton Street system so that overflows from Shellabarger Creek and the freshwater wetland are picked up by the pump station. Within this segment of pipe one of the existing manhole would be modified to include a weir (elevation 9.5) so that under most conditions Shellabarger Creek would be conveyed across SR 104 into its channel.
- Restore Shellabarger Creek and Willow Creek connection to the marsh as presented in Alternative 1.
- Water Quality improvements to the ferry queuing lanes as described in Alternative 1.
- Incorporate an in-line sediment trap on Shellabarger creek upstream of the SR 104 culvert crossing as described in Alternative 1.
- Remove the existing 36-inch/22-inch culverts and gates near the existing Willow Creek crossing of BNSF railroad. As noted previously, this is a current capacity restriction and the culverts/gates are believed to be abandoned and not used. The work would include removal of the culverts as well as the existing embankment and restoring approximately a 30 foot section of creek.

Alternative Evaluation

This section includes an evaluation of the alternatives described above. Alternatives were reviewed using several evaluation criteria which are described below.

Evaluation Criteria a briefly summarized in Table 2-2. Following this table is a brief discussion comparing the alternatives for each criteria.

Table 2-2:
Alternative Evaluation Criteria

Hydraulic Performance	Effectiveness in reducing flood hazards – This criteria generally presents how the combined set of alternative elements act together to reduce flooding. Data presented includes the predicted flood elevations at 3 locations for the 25-year and 100-year flood events. The locations include the Intersection of Dayton Street and SR 104, Shellabarger Creek east of SR 104, and within the Edmonds Marsh.
Costs	Cost estimates were developed for each alternative. This was done by estimating costs for each alternative element and adding them together. Costs include both estimated capital costs and soft costs (design and construction engineering, permitting, management, and land acquisition). Cost estimates are included in Appendix D. Unit costs were developed based on recent bid prices where data was available. The cost estimate includes a significant contingency (30 percent), considered appropriate for the conceptual level of the alternatives. Soft cost include 20 percent for survey and design, 10 percent for permitting, 5 percent administration, and 15 percent for construction management and inspection.
Environmental Implications and Permitting	This criteria weighs some of the key environmental considerations with respect of each alternative and discusses permit requirements.
Constructability	This criteria weighs some of the risks associated with constructability, such as the potential for encountering contaminated materials, or other construction challenges.
Maintenance	This criteria qualitatively considers the increase of long-term maintenance demands likely anticipated from the alternative improvements. An example of a larger maintenance demand is what would be required for a pump station.
Utility Conflict Potential	This criteria considers the potential for risks that utility conflicts would preclude or significantly increase the cost of alternative implementation.
Compatibility with other Site Uses	This criteria considers how proposed site improvements would be compatible with other site uses within the specific areas impacted.
Future Compatibility with Sea Level Rise	In recognition that current studies project continued increases in sea level, this criteria was included in recognition that some of the alternative may be better suited to address future sea level rise.
Other Considerations	this criteria was intended to provide a category to capture other major advantages, disadvantages, or other considerations not covered by the other criteria. An example of an advantage is if one alternative has higher potential to receive grant/loan funding.

Hydraulic Performance

Table 2-3 summarizes the results of the alternative modeling for each alternative. Results are presented for both the 25-year and 100-year events at 3 locations: the Dayton Street/SR 104 intersection, the main area of the marsh, and Shellabarger Creek upstream of the SR 104 crossing. Some of the key observations developed during the modeling are described below.

- All alternatives provided protection up to the 100-year storm. However in order to accomplish this, some of the alternatives had to include a short berm/wall along the east side of SR 104 near the north end of the fresh water wetland. The highway is relatively low in comparison to the Shellabarger Creek culvert. While the culverts are not a hydraulic restriction (assuming cleaned), their relatively high elevation makes it difficult to lower water levels on the east side

of SR 104. The analysis assumed that when cleaned the bottom one-foot of the culvert would be filled with streambed sediment (in accordance with WDFW fish passage for culverts). One option available to consider is working with WDFW to see if an approach could be used to allow the culverts to be more fully open. This would help lower the water levels on the east side of SR 104.

- The Willow Creek daylighting would result in significant water level reduction in the marsh reduction in the marsh (approximately 1.3 to 1.5-feet during significant events).
- The alternative element that includes significant excavation in the marsh to provide flood storage does not result in a significant reduction in marsh water levels. This is due in part because most of the added flood storage volume is obtained within the elevation range of 6 to 8-feet. During the simulation for the 100-year event, the marsh becomes filled to elevation 8 prior to the time of the peak storm inflows. This element has a significant cost, so an option to look at could be to eliminate it from Alternative 1 and 2.
- Under Alternative 3, the pump station needs to be large enough to lower the marsh levels below the other alternatives. This is in order to create enough fall for the Dayton Street system to be able to drain.
- Removing the 36-inch/22-inch culvert near the existing Willow Creek entrance to the BNSF culvert crossing results a pretty significant benefit in lowering marsh water levels compared to its cost. As such this element was included in all alternatives.

Table 2-3:
Results of Alternative Modeling

Alternative	Description	25-Year Storm			100-Year Storm		
		Max WSE at Dayton / SR 104 Intersection	Max WSE in Marsh	Max WSE East of SR 104	Max WSE at Dayton / SR 104 Intersection	Max WSE in Marsh	Max WSE East of SR 104
	Existing Conditions	11.14	11.04	11.63	12.32	12.14	12.41
1	Dayton Street Pump Station and Shellabarger Creek Restoration with Edmonds Marsh Expansion	9.10	10.15	10.98	9.32	12.08	12.14
2	Alternative 1 Improvements Plus Daylighting Willow Creek	9.10	8.81	10.98	9.32	10.65	11.10
3	Willow Creek Daylighting and Edmonds Marsh Pump Station	9.21	8.23	11.15	9.86	9.84	11.31
4	Large Dayton Street Pump Station with Minor Marsh Modifications	9.10	10.48	10.64	9.29	11.77	11.89

Cost Estimates

A cost estimate summary by alternative and alternative element is presented in Table 2-4 Appendix D contains more detailed cost breakdown for each alternative element.

For elements being proposed as part of the Willow Creek Daylighting study, cost estimates prepared by Shannon & Wilson were incorporated to this study. As previously noted, there has been some contaminated soil and groundwater at the former Unocal site. One of the assumptions made in the Willow Creek Daylighting Study was that approximately “one half” of the excavated material within the marsh and associated with the Willow Creek daylighting will need special disposal requirements.

Table 2-4:
Cost Estimate Summary

Alternative	Element Description	Cost
1	Dayton Street Pump Station and Shellabarger Creek Restoration with Edmonds Marsh Expansion	
	Isolating Marsh System from Dayton	$167,000
	Dayton Street Pump Station	1,173,000
	Shellabarger Creek Sediment Pond	323,000
	Divert Salish Crossing to Dayton Street System	73,000
	Restore Shellabarger and Willow Creek to Marsh (1)	421,000
	Remove Cattails and Excavate South Portion of Marsh	3,525,000
	Divert Harbor Square Overflows to Dayton Pump Station	112,000
	Ferry Queuing Area Water Quality Treatment	442,000
	Remove 36"/22" Culverts and Embankment	122,000
	Total	$6,236,000
2	Alternative 1 Improvements Plus Daylighting Willow Creek	
	Isolating Marsh System from Dayton	135,000
	Dayton Street Pump Station	1,173,000
	Shellabarger Creek Sediment Pond	323,000
	Divert Salish Crossing to Dayton Street System	73,000
	Restore Shellabarger and Willow Creek to Marsh	421,000
	Remove Cattails and Excavate South Portion of Marsh	3,525,000
	Divert Harbor Square Overflows to Dayton Pump Station	112,000
	Ferry Queuing Area Water Quality Treatment	442,000
	Remove 36"/22" Culverts and Embankment	122,000
	Daylight Channel Construction (1)	5,032,000
	Self-Regulating Tide Gate and Structure (1)	567,000
	Existing 48-inch Willow Creek Outlet Pipe Modifications	55,000
	Total	$11,980,000
3	Willow Creek Daylighting and Edmonds Marsh Pump Station	
	Isolating Marsh System from Dayton	93,000
	Shellabarger Creek Sediment Pond	323,000
	Restore Shellabarger and Willow Creek to Marsh	421,000
	Ferry Queuing Area Water Quality Treatment	442,000
	Daylight Channel Construction (1)	5,032,000
	Self-Regulating Tide Gate and Structure (1)	567,000
	Edmonds Marsh Pump Station	3,695,000
	Pipe Improvements Between Dayton and Marsh	576,000
	Total	$10,573,000

Table 2-4:
Cost Estimate Summary

Alternative	Element Description	Cost
4	Large Dayton Street Pump Station with Minor Marsh Modifications	
	Dayton Street/SR 104 Pump Station	$2,944,000
	Shellabarger Creek Sediment Pond	323,000
	Restore Shellabarger and Willow Creek to Marsh (1)	421,000
	Ferry Queuing Area Water Quality Treatment	442,000
	Berming Marsh at Harbor Square and SR 104	161,000
	Remove 36"/22" Culverts and Embankment	122,000
	Pipe Improvements At Intersection of Dayton Street and SR 104	186,000
	Total	$4,413,000

Notes:
(1) Source Shannon & Wilson, 2013.

It is noted that for land cost, several of the alternatives would involve construction work within the Port of Edmonds property or WSDOT property. Costs of easement acquisition have not been included at this time. In general, the improvements implemented would help alleviate flooding within Port of Edmonds properties, so there may be incentives for the Port of Edmonds to be flexible with easements.

It is noted that the same soft costs were used on each alternative element (i.e., 20 percent for survey and design, 10 percent for permitting, 5 percent administration, and 15 percent for construction management and inspection). If an alternative element is implemented as a standalone design and permitting project, these percentages could very significantly, in particular for small projects where the costs of design and permitting become higher.

For Alternatives 2 and 3 that include large pump stations, the cost of a portable generator is included.

Overall, the Cost of Alternative 2 is higher than the other alternatives. Alternatives 1 and 4 are significantly lower than Alternatives 2 and 3. One of the higher cost elements is the large excavation in the marsh for Alternatives 1 and 2, which, as previously noted discussed, did not result is significant water level reduction. Part of the high cost of this element is the assumption of contaminated materials. Further investigation as to whether this is an appropriate assumption is recommended.

Environmental Implications and Permitting

In general, the most significant permitting aspects of the alternatives being considered are the grading actions proposed within Edmonds Marsh (which is included in all alternatives). Due to the area of impact (over 1/2 acre) and as a project goal is to reduce flooding, dredging in the marsh (either to re-establish Shellabarger Creek and

Willow Creek or to conduct major excavation in the marsh) will exceed the impact area permissible under the Corps of Engineers' (COE) Nationwide Permit criteria for compliance with the Clean Water Act (Section 404). As such, the City would be required to apply for an Individual Permit.

The requirements for an individual permit are more stringent than Nationwide permits, including a public comment period and an alternative analysis that demonstrates that the preferred alternative is the least environmentally damaging practicable alternative (LEDPA). The alternatives presented would provide the structure for this analysis. As one of the primary purposes and needs of the proposal is to reduce flooding and not restore the marsh, other alternatives with fewer wetland impacts would be prioritized by the COE. However, given the significant restoration benefits of the proposal, the application of the alternatives may be more flexible than the rigid structure applied to projects without significant restoration components. The application of this discretion is within the authority of the COE project manager. Therefore, early discussions with the COE are essential to understand what actions would be permissible/permittable under the COE's jurisdiction for all alternatives.

All of the alternatives would also replace, add, or modify outfalls to Puget Sound. By themselves, these modifications would comply with COE Nationwide Permit 7. However, combined with other project elements (see above), these components would be included in the overall permit for the project (Individual Permit). All of the alternatives would also require the following permits.

<u>Local</u>

- Shoreline
- City of Edmonds Critical Areas Ordinance (Title 23). Clearing and Grading (Chapter 19)
- SEPA Compliance

<u>State</u>

- NPDES Construction Stormwater General Permit
- DOE Section 401 Water Quality Certification
- Hydraulic Project Approval (from Washington State Department of Fish and Wildlife)
- Section 106 National Historic Preservation Act Compliance

<u>Federal</u>

- COE Section 404, Section 10 Permits
- ESA Compliance

In terms of restoration benefits, several components of the proposed alternatives have significant ecological restoration benefits.

Re-establishing the channel of Shellabarger Creek and Willow Creek within Edmonds Marsh will enhance riparian habitats, improve fish access, and increase the habitat

diversity by creating a range of water depths, downed wood, and species diversity by replacing a cattail area with a riparian shrub and tree plantings. The features will enhance habitat conditions for salmonids, primarily for juvenile fish rearing.

Regrading the marsh (Alternatives 1 and 2) by the removal of accumulated sediment to reestablish grades that will be inundated by salt water during high tides will dramatically increase the area of salt marsh within Edmonds Marsh. Salt marshes are highly critical for salmonid rearing, particularly for Chinook, a key target species for the marsh. Salt marsh habitat has been significantly reduced throughout Puget Sound, compared to historical conditions, resulting in limitations in the area's ability to support salmonid populations. This has been a key factor in the decline of many species, especially Chinook, which are heavily dependent on salt marshes for juvenile rearing. As such, the habitat benefits of expanding the salt marsh, although already significant within the local context, would improve regional habitat conditions, and support the recovery of protected salmonids.

Daylighting Willow Creek from the lower end of Edmonds Marsh to Puget Sound would provide significantly improved fish access to the marsh. Currently fish must navigate the 1600-feet of culvert to reach the marsh. Re-establishing a surface water connection to the marsh will significantly reduce the barriers to fish accessing the site, as well as adding a vegetated riparian corridor to the marsh outlet.

The following paragraphs provide some of the key findings associated with each alternative.

Alternative 1: This alternative includes the re-establishment of the Shellabarger Creek and Willow Creek channels and the regrading of the marsh. Habitat conditions will be significantly improved. However, fish access to the area will still be impaired by the maintenance of the existing marsh outlet (a very long culvert).

Alternative 2: This alternative includes all three restoration components described above: the re-establishment of the Shellabarger Creek and Willow Creek channels, the regrading of the marsh, and the daylighting of the Willow Creek outlet. Habitat conditions and fish access to the site will be significantly improved. As such, this alternative provides the highest level of habitat restoration among the alternatives.

Alternative 3: This alternative includes the re-establishment of the Shellabarger Creek and Willow Creek channels and the daylighting of Willow Creek. Habitat conditions will be improved and fish access to the site will be significantly improved. However, there will be only minor increases in salt marsh habitat (along the Willow Creek outlet channel), representing only about 5 percent of the salt marsh increases associated with Alternative 2. As such salt marsh functions, including Chinook rearing, would only be modestly improved.

Alternative 4: This alternative only includes the re-establishment of the Shellabarger Creek channel. Although it will improve habitat conditions within the Creek, this alternative lacks the expansion of the salt marsh and fish access enhancements. As such, this alternative provides the lowest level of habitat improvements.

Constructability

All alternatives are considered constructible using generally accepted construction methods. Some of the constructability challenges are listed below.

All alternatives have to account for the potential to encounter contaminated soils during excavation. This is a typical consideration in a formerly industrial area such as the Edmonds waterfront. Monitoring for contaminants during construction would be recommended. The elements that involve Daylighting Willow Creek (Alternative 2 and 3) and the large excavation within the marsh (Alternatives 1 and 2) have the greatest risk of encountering contaminated material.

The large marsh pump station and fish screen in Alternative 3 requires a fairly significant footprint, which would ideally be kept to a minimum to reduce impacts to the Port of Edmonds. The pump stations of Alternative 1 and 4 have a similar issue but to a lesser extent since they do not include the fish screen.

The Dayton Street Corridor west of SR 104 has a very high number of utilities. For example in terms of sewer system alone, there is the main 36-inch outfall from the treatment plant, two smaller gravity lines and one force main. Designing the alignment for the Alternative 4 force main would be challenging, but likely doable as it is a force main and can vary its depth.

The proposed water quality improvements (in all alternatives) would require construction of two vaults that would require tight space requirements to maintain vehicular access for ferry traffic (or possibly work at night).

Maintenance

Common to all alternatives are the water quality facility for the ferry queuing lanes and the Shellabarger Creek sediment pond. These would involve annual maintenance. It is assumed that WSDOT would maintain the water quality facility and that the City would maintain the sediment pond Access agreements could be required by WSDOT.

Alternative 1 would include the Dayton Street pump station that would require significant maintenance. Measures to keep cattails from returning to the excavated portions of the marsh could also be a concern. Alternative 2 would include the tide gate which would likely require annual maintenance. Alternative 3 is considered to have the highest maintenance demands due to the large pump station and fish screen. In particular, the fish screen could be prone to plugging and require frequent maintenance. Even with an automated cleaning system, it would likely have high maintenance needs.

In summary, Alternative 2 is considered to have the least increase in maintenance demands. Alternative 3 would result in the highest maintenance requirements. Alternatives 1 and 4 would similar to each other and less than Alternative 3.

Utility Conflict Potential

The research to potential utility conflicts was preliminary and limited to City utilities including water, sewer and storm. In general, potential utility conflicts are not

anticipated to be a significant risk to any of the alternatives or significantly increase their costs. The alternatives with the pump stations and new force mains have the ability to vary the depth of force mains to avoid conflicts. Alternatives 2 and 3 with the Willow Creek Daylighting will need to relocate a watermain, but this a pretty insignificant cost element. Alternative 4 would likely have the most significant utility conflict challenges associated with the 1,100-feet of 30-inch force main along Dayton Street due to the number of other utilities using this corridor.

Compatibility with other Site Uses

While many of the alternative elements appear to be generally compatible with existing uses, several areas of potential conflicts exist.

For Alternative 1, the Dayton Street pump station would increase noise in the area around the intersection of Dayton Street and Admiral Way.

For Alternatives 2 and 3, the Willow Creek Daylighting from the BNSF bridges to the Sound will need to co-exist within the City Park property. This section of creek is probably of greatest concern. An alignment through the park would need to address potential loss of parking spaces and park landscapes.

Also for Alternative 3, the large pump station facility could be located in areas within the Port of Edmonds property requiring an easement. While the pump station could be located in vaults to allow for continued site use for parking, the fish screen would likely need to be constructed in an open channel to allow for easier maintenance access and this would require the loss of some existing parking. It would also ideally be location to not impact one of the Port of Edmonds parking lot driveway access adjacent to where the fish screen would be located.

The sediment pond, included in all of the alternatives, would be within existing wetland areas. Typically it is undesirable to locate stormwater facilities in wetlands. However, given that this would result in benefits to the downstream marsh and that its permitting would be included with other project elements that result in an overall environmental benefit, locating the facility in a wetland appears reasonable.

Future Compatibility with Sea Level Rise

To provide some perspective on sea level rise and the future compatibility with alternatives, some information gathering about sea level rise projections was completed and summarized below.

One projection of sea level rise from the “Sea Level Rise in the Coastal Waters of Washington State” (January 2008, Climate Impacts Group and Ecology), is presented in the Table 2-5 below.

Table 2-5:
Low Medium and High Sea Level Rise Projections
(Source: January 2008, Climate Impacts Group and Ecology)

SLR Estimate	2050	2100
Low	3”	6”
Medium	6”	13”
High	22”	50”

A second recent study conducted analyses on the increases in coastal storm surges. According to Sea Level Rise Impacts on Storm Surges along US Coasts (March 2012, Climate Central/NOAA), substantial changes are projected in the frequency of what are now considered extreme water levels from storm surges. That is, according to the study, it projects that by 2050, the current 100-year maximum storm surge could be experienced 2 times per year.

For the marsh system, both the sea level rise and increase storm surges will impact the potential for flooding. The increased frequency of extreme tides would result in an increase in the occasions when high tides are coincident with heavy storms.

It is noted that Snohomish County is currently completing the Snohomish County Coastal Study which will be producing projected 100-year elevations that include storm surge based on sophisticated modeling. A draft of the result are expected sometime within late 2013 or 2014. This information, when available, should be consulted with respect to the alternative analysis and modeling assumptions. This study, however, will not include estimates of sea level rise.

In general, should sea level rise fall in the high estimates, it would have drastic affects to much of the near shore development, so that the Dayton Street and marsh vicinity would not be the only problem area. Nevertheless, when comparing alternatives Alternative 3 and 4 are probably most compatible with future sea level rise. This is because pumping could just be over a longer period but it would be able to keep water levels about the same as modeled in this study. However, it should also be noted that if the surge level generally exceeds the elevation of the BNSF railroad (about 13 to 14-feet NGVD), most of the developed area around the intersection, Harbor Square, Salish Crossing property would become inundated in any case.

It should also be noted that Alternative 2 does not preclude that a future pump station could be added and use the existing 48-inch outfall piping. Thus it is not considered entirely incompatible.

Other Considerations

See Table 2-6 for a listing of other considerations for each of the alternatives. Probably one of the biggest considerations not covered in other criteria is the ability to successfully obtain project funding from grants, loans, or stakeholder participation.

Daylighting Willow Creek (Alternatives 2 and 3) has been of interest for a number of years and has potential for grant funding. As previously mentioned, the Willow Creek Daylighting Project is currently on the Water Resource Inventory Area (WIRA) 8

three-year habitat work schedule (I.D. M3223) and is listed as a Tier 1 project. Tier 1 designation includes the highest quality remaining habitat, and the greatest Chinook use (S&W, 2013).

The water quality treatment facility (in all alternatives) for the ferry queuing lanes may also be a candidate project for both grant funding (Ecology Water Quality Retrofit Grants) and stakeholder participation (WSDOT).

Summary and Recommendations

Table 2-6 includes a summary of the alternative evaluation. City staff reviewed the alternative evaluation and identified a preliminary recommended alternative. The preliminary recommended alternative consisted of Alternative 2 with some modifications (described below). This preliminary recommended alternative was then presented to City Council on May 28, 2013 and to the public at a project open house discussion on June 20th, 2013. Meeting presentation materials from both meetings are included in Appendix E. Appendix E also contains a sign-up sheet listing meeting attendees for the open house discussion as well as questions that were asked and answered during the meeting. Based on input from the City Council and public meeting, City staff concluded that the preliminary recommended Alternative 2 be adopted as the final recommended alternative with modifications described in the next section.

Table 2-6:
Alternative Evaluation Summary

Alt.	Description	Hydraulic Performance (assessment of effectiveness in reducing flood hazard)	Costs	Environmental Implications	Constructability Issues	Maintenance Considerations	Utility Conflict Considerations	Compatibility of Site Uses	Future Compatibility with Sea Level Rise (SLR)	Other Considerations (advantages or disadvantageous)
1	Dayton Street Pump Station and Shellabarger Creek Restoration with Edmonds Marsh Expansion	Solves Flooding for 100-year event.	6,236,000	Habitat conditions will be significantly improved. However, fish access to the area will still be impaired by the maintenance of the existing marsh outlet (a very long culvert).	Some potential for contaminated material (marsh expansion).	Some increase in maintenance needs with Dayton pump station, Shellabarger Creek sediment pond, and water quality facility (ferry queuing)	Utility conflicts are not considered a major factor.	Some compatibility issues with pump station on Port of Edmonds property.	Does not significantly lower water levels in marsh so as tides increase, flood protection decreases. However, this is not inconsistent with SLR because a pump station could be added to marsh in future.	
2	Alternative 1 Improvements Plus Daylighting Willow Creek	Solves Flooding for 100-year event. More reduction in marsh water levels than Alternative 1.	11,980,000	Habitat conditions and fish access to the site will be significantly improved. As such, this alternative provides the highest level of habitat restoration among the alternatives.	Greatest potential for contaminated material because includes both Willow Creek daylighting and marsh expansion.	Same as Alternative 1 plus new tide gate and Willow Creek channel outfall.	Utility conflicts are not considered a major factor.	More compatibility issues than Alternative 1 due to Willow Creek daylighting through either the Marina Beach Park or the Off-Leash Dog Park.	This alternative does a good job of lower water levels in marsh to better than Alternative 1. It is also not inconsistent with SLR because a pump station could be added at the existing 48-inch Willow Creek outfall in the future.	Much community support for daylighting Willow Creek. The environmental benefits of the creek may make it easier to permit other alternative elements. Probably highest potential for grant/loan funding.
3	Willow Creek Daylighting and Edmonds Marsh Pump Station	Solves Flooding for 100-year event. Most significant reduction in marsh water levels. (which is needed to lower water levels at Dayton/SR 104 Intersection).	10,573,000	Habitat conditions will be improved and fish access to the site will be significantly improved. However, there will be only minor increases in salt marsh habitat (along the Willow Creek outlet channel).	Some potential for contaminated material (Willow Creek daylighting). Construction of fish Screen and marsh Pump station in small footprint will be challenging. This would reflect a large fish screen that is uncommon construction.	Highest level of new maintenance needs from large pump station and fish screen. Fish screen would likely require frequent inspections during flood events.	Utility conflicts are not considered a major factor.	Has the greatest impact to existing uses: ▪ Willow Creek daylighting through Marina Beach Park or the Off-Leash Dog Park. ▪ Large pump station and large fish screen in Port of Edmonds property resulting in loss of parking	This alternative is the most compatible since it includes the large pump station directly draining the marsh.	
4	Large Dayton Street Pump Station with Minor marsh Modifications	Solves Flooding for 100-year event.	4,413,000	Minor improvement from re-establishing Willow and Shellbarger Creek, but this alternative lacks the expansion of the salt marsh and fish access enhancements. As such, this alternative provides the lowest level of habitat improvements.	Least potential for encountering contaminated material. The corridor for the 30-inch force main along Dayton Street to outfall is highly congested with other utilities and will be challenging.	Roughly same as Alternative 1 or slightly higher since the pump station would be larger.	Most challenging in terms of dealing with potential utility conflicts for the 30 -inch force main between SR 104 and Sound due to the highly congested corridor with other utilities.	Some compatibility issues with pump station on Port of Edmonds property.	Nearly same as Alternative 1.	

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Recommended Alternative

The recommended alternative includes Alternative 2 with modifications as follows;

- Removal of the element "cattail removal and excavation of southeast portion of the marsh"
- Added element of "Willow Creek 48-inch CMP pipe rehabilitation"
- Added element of "Clean and/or lower Shellabarger Creek culvert crossing of SR 104"
- Added element of "Harbor Square pipe outfall modifications"
- Added element of "Raise WSDOT Overflow (or seal the MH lid)"

The following paragraphs describe these modifications.

The large marsh excavation of Alternative 2 had a high cost and did not result in significant flood reduction benefit based on the modeling efforts. It was initially envisioned that a significant marsh excavation would add flood storage to the system that would help lower water levels. However, during the flood simulation of the 100-year event only a modest reduction in flood levels was observed. Further investigation revealed that most of the added storage would be in the elevation range of 6 to 8-feet. During the 100-year simulation, the marsh fills up to elevation 8-feet, using all of the added storage, prior to the time that the peak of the storm enters the marsh. As a result, when the peak volume is in the system, the additional storage is used and not able to attenuate the peak.

The Willow Creek 48-inch CMP pipe rehabilitation was added to the recommended alternative. This 600 foot pipe segment between the tide gate and the intake vault is reported to be in poor condition. Lining the pipe would improve its hydraulic performance by reducing the roughness which modeling efforts show help lower marsh water levels. In addition, the lining would ensure the pipe's long-term structural integrity for future use. Future uses maybe using the pipe as a secondary outlet if Willow Creek is daylighted, or using the pipe as a pumped outlet to mitigate for sea level. It is also noted that this project is included in the City's Storm and Surface Water Management Comprehensive Plan (Project #2B).

Cleaning and/or lowering the SR 104 Shellabarger Creek culvert was added to the recommended alternative. While this culvert is not a hydraulic restriction, it increases water levels on the east side of SR 104 due to its high elevation in relation to the grade of the highway. It is also a potential plugging concern due to the internal posts that line the culverts (See Figure A-3). Given its current condition, it will likely need replacement at some point. Replacing it at a lower depth would help to reduce water levels. Replacing it at a lower depth could also help to reduce both the extent and height of the berms/walls on the eastside of SR 104. Cleaning out the culvert entirely (without leaving a foot depth for fish passage) would also be a benefit and the City could investigate this option. This element could also include maintenance/excavation of channel downstream of the culvert (and removal of associated cattails) that has built up with sediment. That is, prior to the implementation of the full channel restoration,

the City could perform channel maintenance to partially restore the channel downstream of culvert and provide positive drainage on an interim basis prior to the future channel relocation and restoration project.

The Harbor Square pipe outfall modifications were added to the recommended alternative because it became apparent that the outflow from the two existing outfalls is severely affected by sediment accumulation around the outfalls. This element of work would include maintenance to remove sediment as well as adding flap gates (or Tideflex valves) to the outlets. Flap gates would prevent flow going into Harbor Square during extreme marsh water levels.

The raising or sealing the WSDOT overflow manhole will be included in the recommended alternative if monitoring shows that the overflow volume is large and contributes to increased water levels in the marsh. During large storms, flows exceed the capacity of the WSDOT system and overflow into the marsh. Although current modeling shows the overflows have a small impact on upstream marsh levels, monitoring of the system may reveal a larger impact. Since the inclusion of this element is based on monitoring data and effort is relatively inexpensive, a cost estimate was not prepared. If the item is implemented, WSDOT approval is required.

Implementation of Recommended Alternative

Implementing the full recommended alternative will likely take many years based on the additional data that needs to be collected, the processes for securing funding, property and permit approvals. As such, this section of the report includes both a discussion of phased implementation as well as recommendations for further studies and data collection.

For the purpose of this report, the recommended alternative is proposed to be implemented in three phases:

- Early action (approximately within one to two years)
- Short term (approximately with two to three years)
- Long term (approximately three to ten years)

The time periods are estimates because of the several unkowns about future funding. The elements of the recommended alternative are listed in Table 2-7 by implementation category. This table also shows the cost for each element.

In addition to the early action projects shown on Table 2-7, it is recommended that the City collect additional data/analysis that will be helpful for future design and implementation of the recommended alternative. These recommendations are summarized below.

- Maintain the existing gages installed as a part of the Willow Creek Daylighting study. In addition, gauging should be added to the WSDOT pipe system where it overflows to the marsh in order to better assess the volumes of overflows. The information could be used to perform further hydraulic model validation and refinements upon obtaining data for a few large events. Consideration should also be given to a flow gage in the outlet pipe system that measures depth and

velocity. While the current water level gages are very helpful, they do not provide actual flow rate data.

- Research the anticipated ownership of the Unocal site to better understand the availability of the site for Willow Creek Daylighting.
- Conduct topographic survey of the entire marsh area. The current data available included a combination of topographic survey and cross sections. A complete topographic survey could be used to more accurately quantify available storage volumes in the marsh.
- Consider conducting some sediment sampling in the marsh and along the proposed Willow Creek daylighting alignment to assess the assumption that one-half of the excavation will require special disposal. According to the Willow Creek Daylighting study, most contamination within the existing Willow Creek has been removed, however Ecology may require further sampling of the creek as part of a Compliance Monitoring Plan for the Unocal site.

Table 2-7:
Recommended Alternative Implementation and Cost Estimate Summary

	Element Description	Cost
Early Action	(1-2 years)	
	Clean/Lower Shellabarger Creek/SR 104 Culvert (and maintenance of outlet channel) (1)	$132,000
	Remove 36"/22" Culverts and Embankment	122,000
	Harbor Square Pipe Outfall Modifications	44,000
	Willow Creek 48-inch Pipe Rehabilitation	518,000
Short Term	(2 – 3 years)	
	Dayton Street Pump Station	1,173,000
	Raise or Seal WSDOT Overflow Manhole	(2)
	Isolating Marsh System from Dayton	135,000
	Divert Salish Crossing to Dayton Street System	73,000
	Divert Harbor Square Overflows to Dayton Pump Station	112,000
Long Term	(3 - 10 years)	
	Ferry Queuing Area Water Quality Treatment	442,000
	Restore Shellabarger and Willow Creek to Marsh	421,000
	Shellabarger Creek Sediment Pond	323,000
	Daylight Channel Construction	5,032,000
	Self-Regulating Tide Gate and Structure	567,000
	Existing 48-inch Willow Creek Outlet Pipe Modifications (weir for marsh overflow)	55,000
Total		$9,149,000

Notes:

(1) Cost includes only culvert and channel clearing for early action activities. Replacing the culvert at a lower elevation would likely be in later years and at WSDOT expense.

(2) Cost not included at this time. See report text.

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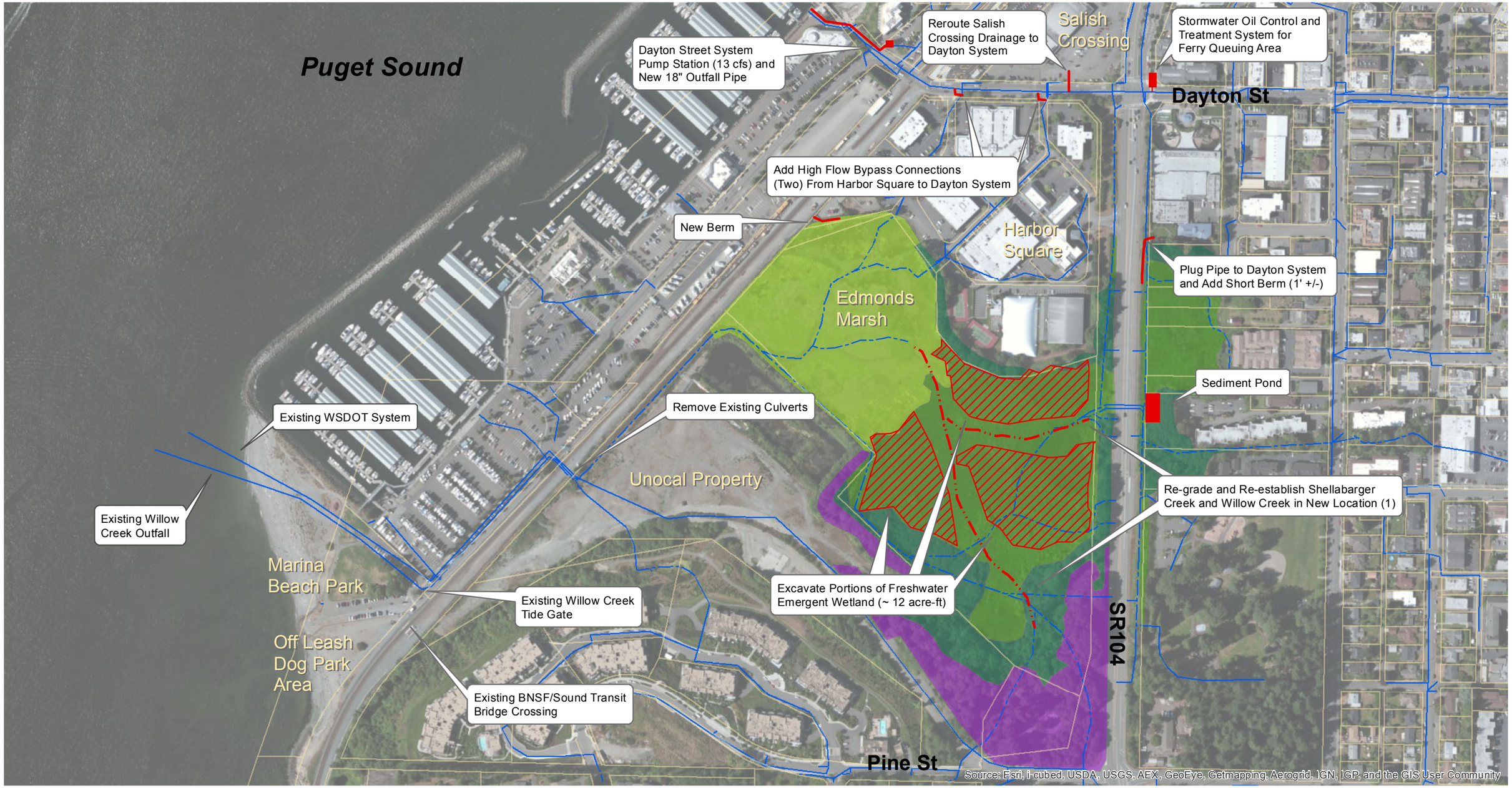

N

Feet

0 162.5 325

Legend

- Forested Upland
- Forested Wetland
- Freshwater Emergent
- Mudflat and Salt Marsh
- Parcels
- Existing Storm Drain
- Existing Channel
- Proposed Storm Drain/Berm
- Proposed Channel
- Proposed Water Quality or Conveyance Facility

Note: (1) As proposed under separate Willow Creek Daylighting Study, Shannon and Wilson, 2013.
(2) Marsh wetland designations are approximate and taken from Shannon and Wilson, 2013.

Figure 2-1.
Alternative 1

SAIC
From Science to Solutions

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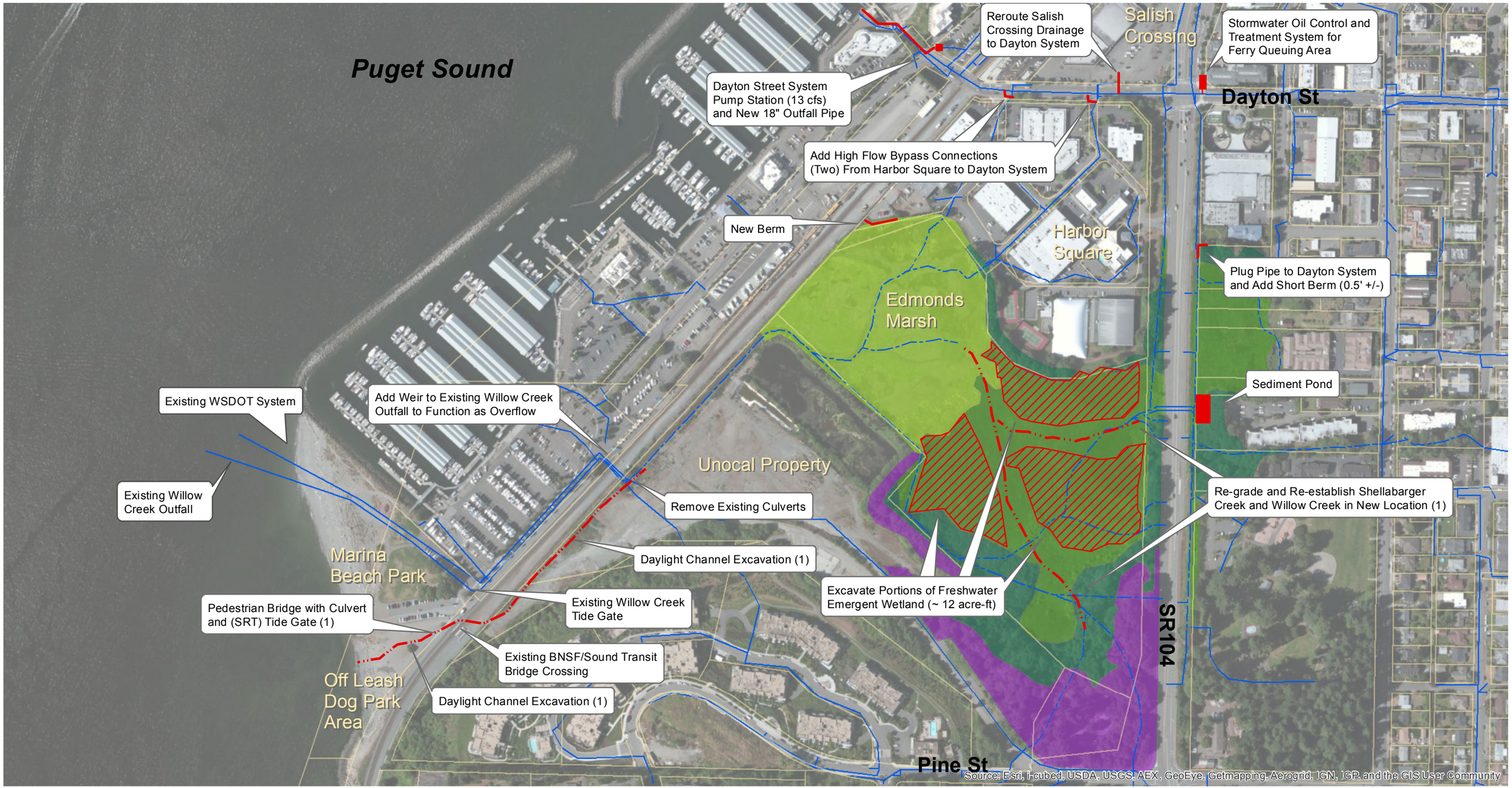

N

Feet

0 162.5 325

Legend

- Forested Upland
- Forested Wetland
- Freshwater Emergent
- Mudflat and Salt Marsh
- Parcels
- Existing Storm Drain
- Existing Channel
- Proposed Storm Drain/Berm
- Proposed Channel
- Proposed Water Quality or Conveyance Facility

Note: (1) As proposed under separate Willow Creek Daylighting Study, Shannon and Wilson, 2013.
(2) Marsh wetland designations are approximate and taken from Shannon and Wilson, 2013.

Figure 2-2.
Alternative 2

SAIC
From Science to Solutions

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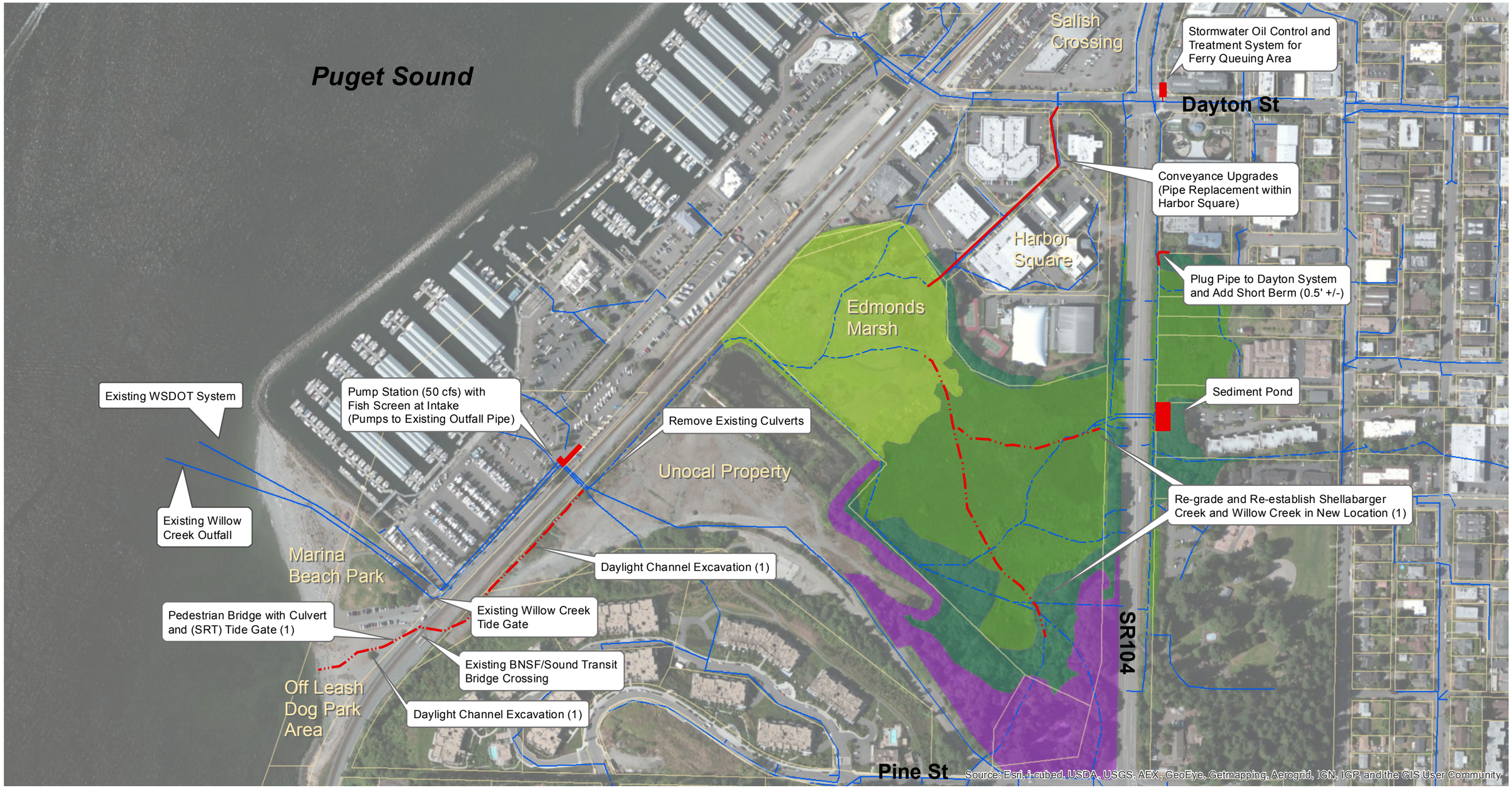

N

Feet

0 162.5 325

Legend

- Forested Upland
- Forested Wetland
- Freshwater Emergent
- Mudflat and Salt Marsh
- Parcels
- Existing Storm Drain
- Existing Channel
- Proposed Storm Drain/Berm
- Proposed Channel
- Proposed Water Quality or Conveyance Facility

Note: (1) As proposed under separate Willow Creek Daylighting Study, Shannon and Wilson, 2013.
(2) Marsh wetland designations are approximate and taken from Shannon and Wilson, 2013.

Figure 2-3.
Alternative 3

SAIC
From Science to Solutions

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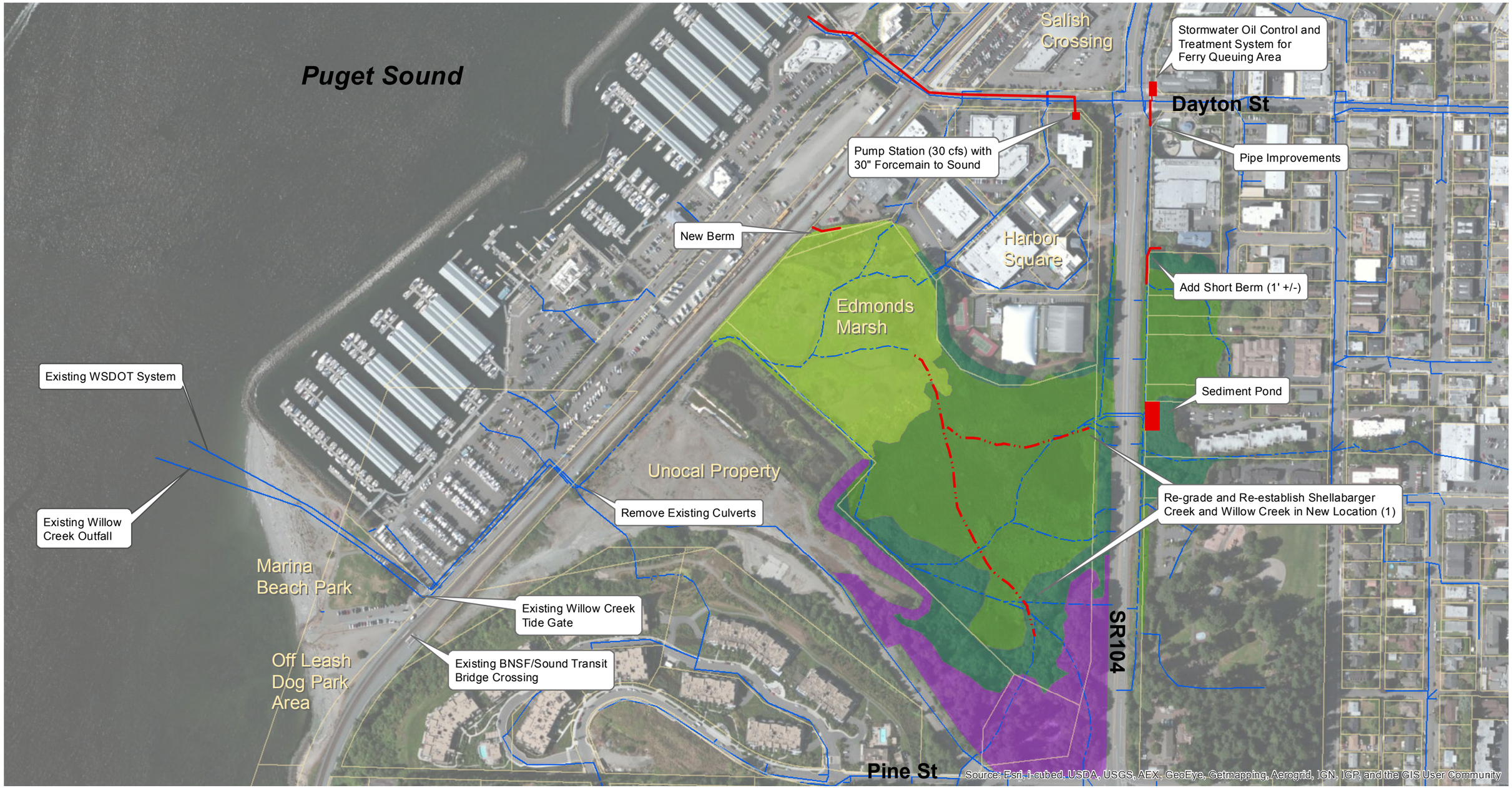

N

Feet

0 162.5 325

Legend

- Forested Upland
- Forested Wetland
- Freshwater Emergent
- Mudflat and Salt Marsh
- Parcels
- Existing Storm Drain
- Existing Channel
- Proposed Storm Drain/Berm
- Proposed Channel
- Proposed Water Quality or Conveyance Facility

Note: (1) As proposed under separate Willow Creek Daylighting Study, Shannon and Wilson, 2013.
(2) Marsh wetland designations are approximate and taken from Shannon and Wilson, 2013.

Figure 2-4.
Alternative 4

SAIC
From Science to Solutions

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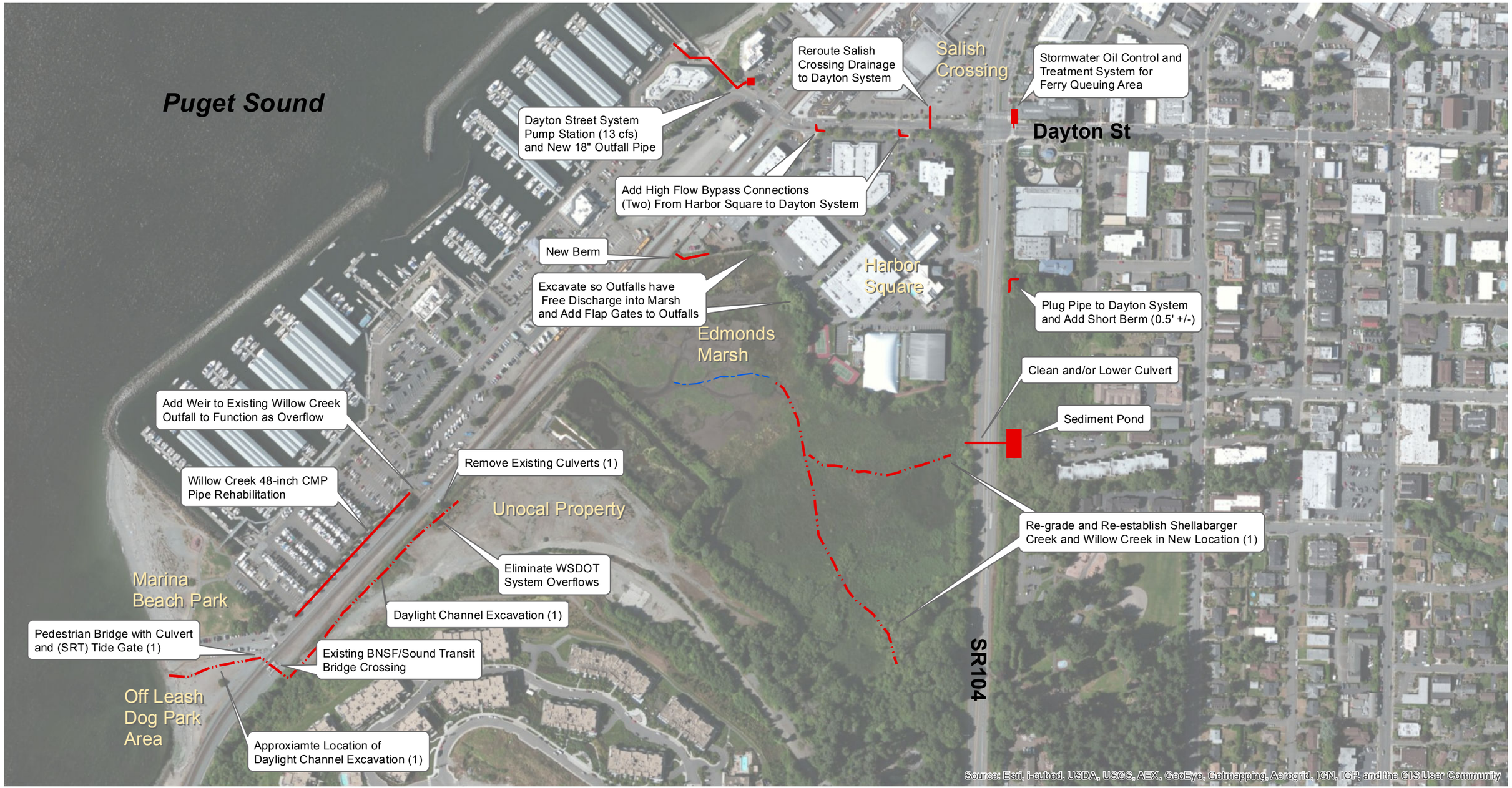

N

Feet

0 162.5 325

Legend

- Forested Upland (2)
- Forested Wetland
- Freshwater Emergent
- Mudflat and Salt Marsh
- Parcels
- Existing Storm Drain
- Existing Channel
- Proposed Storm Drain/Berm
- Proposed Channel
- Proposed Water Quality or Conveyance Facility

Notes: (1) As proposed under separate Willow Creek Daylighting Study, Shannon and Wilson, 2013.
(2) Marsh wetland designations are approximate and taken from Shannon and Wilson, 2013.

Figure 2-5.
Recommended Alternative

SAIC
From Science to Solutions

P:\ECI\1798-SEA\001772 Edmonds WA, City of\2651211002 Dayton St SR104 Alternatives Study\Data Analytical\GIS | 7-18-2013

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Appendix A
HYDROLOGIC / HYDRAULIC ANALYSIS

Appendix A
HYDROLOGIC / HYDRAULIC ANALYSIS

Introduction

An HSPF model was developed to generate a long term time series of runoff tributary to both the SR 104/Dayton Street drainage system and the Edmonds Marsh. Major tributary systems include Shellabarger Creek, Willow Creek and portions of urban drainage systems north of Dayton Street. The time series of runoff from the different systems was developed to route flows through an unsteady state hydraulic model, XP-SWMM to examine historical coincidence of high tides, high rainfall events and flooding, and to examine the performance of alternative solutions to flooding problems within the study area. The advantage to using long-term hydrology with unsteady state hydraulic modeling is that it can inherently account for the interaction of tidally influenced flood events by using historical tides along with historical precipitation.

This appendix describes the analysis under two major parts, HSPF Hydrologic Model Development and XP-SWMM Hydraulic Model Development.

HSPF Hydrologic Model Development

The Hydrologic Simulation Program - FORTRAN (HSPF) is a continuous hydrologic model for watersheds that produces a long-term time history of runoff based upon historical precipitation and runoff from different soil types and land uses. HSPF routes flow downstream through stream reaches (defined as FTABLEs that include relationships between stage, storage and discharge) that accounts for attenuation from system storage but does not account for the effects of dynamic routing such as tidal impacts on the Edmonds Marsh and Dayton Street systems. The following paragraphs describe the model development.

Some of the model parameters for the Edmonds HSPF model were taken from a model developed for a nearby basin, Scriber Creek by Snohomish County. The Scriber Creek HPSF model was developed by Snohomish County as part of the Drainage Needs Report (2000), and later updated by SAIC for the City of Lynnwood. These assumptions include the various parameters controlling infiltration, soil water storage, overland flow and groundwater. Unique to the model created for this study are the basins contributing flow to Edmonds Marsh, the basin characteristics and the stage-storage relationship of the conveyance within the basins.

Basin Delineations and Model Schematic

The area contributing runoff to the Edmonds Marsh and Dayton Street systems was divided into sixteen subbasins using GIS maps showing aerial photographs, contours and the City of Edmond surface drainage system. Field visits and as-built information

were also used. Figure A-1 shows the HSPF subbasins as well the City's storm drainage system.

Another basin, the Edmonds Way basin, was added to the model because it was determined that it could overflow into the Edmonds Marsh.

Figure A-2 shows the network schematic of the subbasins and conveyance reaches (RCHRES) within the HSPF model. Subbasin areas are shown on the network schematic and in Table A-1. It is important to note that the HSPF model routes the flow from subbasin 140 to subbasin 400. However, during actual high flows, runoff from Subbasin 140 will travel north to Subbasin 120. This change in flow direction is included in the hydraulic component of the analysis, but is not reflected in the HSPF model.

Precipitation/Evaporation

Precipitation data used in the hydrology model was obtained from the Alderwood rain gauge located approximately 5.5 miles northeast of the intersection of Dayton St/SR 104. The Alderwood rain gauge is located at the Alderwood Water District offices and is owned and operated by Snohomish County. The Alderwood gauge has 15 minute recorded data from November 20, 1987 to present. The dataset was extended with nearby stations by Snohomish County in its Drainage Needs Report (DNR) effort to provide a composite record for the station which extended the record back to October 1, 1948. The precipitation record used in this analysis is 15-minute data from October 1, 1980 to December 31, 2012. Extensions of the record for this precipitation station since the 2002 DNR study were obtained directly from Snohomish County Public Works staff.

The City of Edmonds has daily rain gage data from 2000 to the present. A comparison between the rain gage at the Edmonds Wastewater Treatment Plant (Edmonds WWTP) and the Alderwood station shows that on average the Alderwood rain gage is 27 percent higher than Edmonds WWTP station for annual totals of precipitation (correcting for days of missing data). The percent annual difference between the two stations was 51 percent to 14 percent with the Edmonds station always being lower. Although the difference between two stations is relatively high, the decision was made to use the Alderwood precipitation as-is, i.e. not scaled down. There are four reasons for this decision:

1. The Edmonds rain gage data had several days when data was not recorded (excluding zero precipitation days) which indicates that the measuring equipment may not read data accurately,
2. The Edmonds WWTP is located at the downstream end of the basin, while many of subbasins modeled are at higher elevations similar to the Alderwood station,
3. The higher elevation modeled subbasins and the Alderwood station are in the same isopluvial curve for the mean annual precipitation 2-year, 10-year and 100-year 24 hour storms (Appendix III-A, Snohomish County Drainage Manual, 2010), and

4. Comparison of individual storms within the period showed that for some individual storms the 24-hr precipitation was at times very similar. For example, for the 2007 storm, the largest storm on record, the precipitation totals from the two stations were nearly identical.

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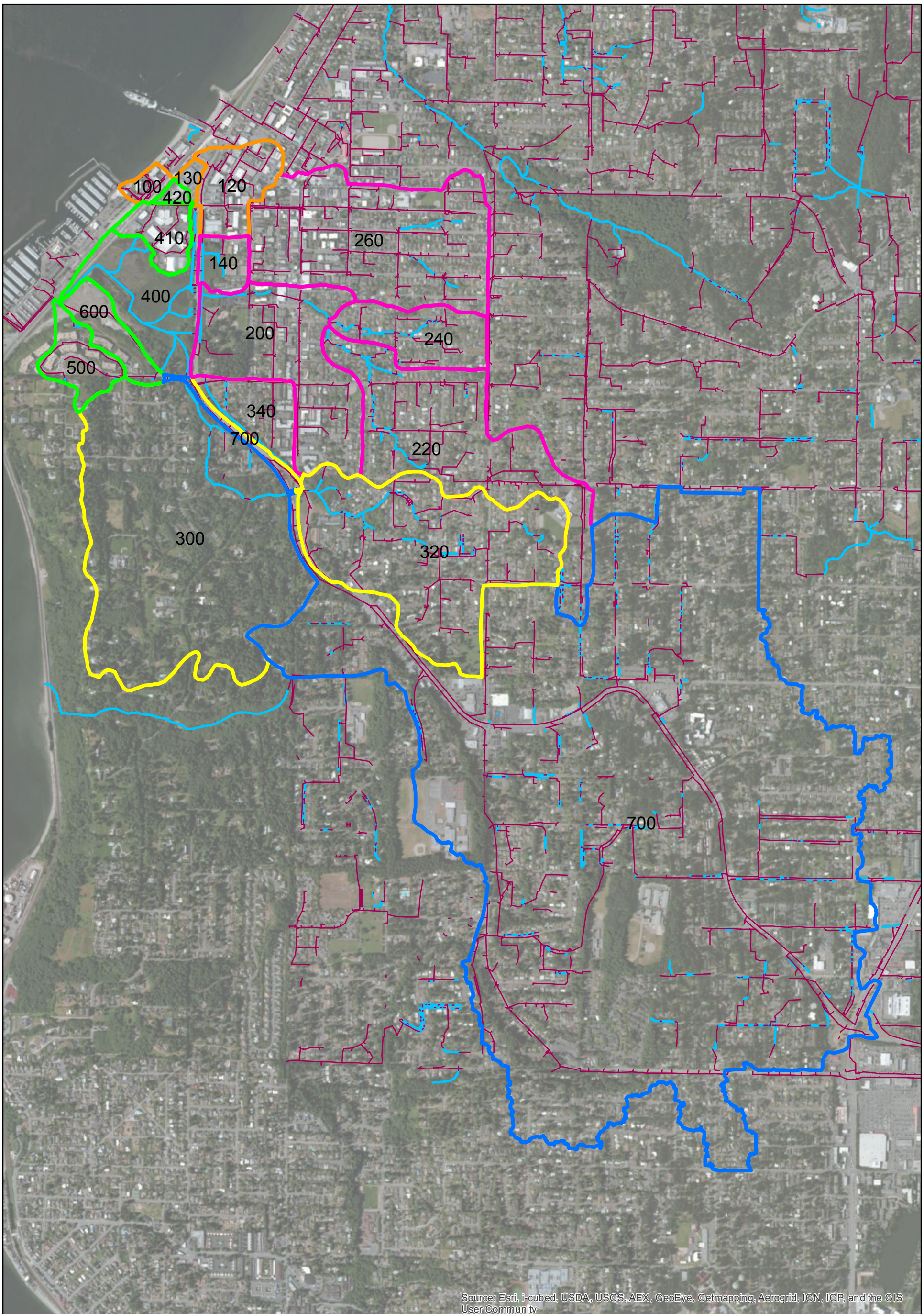


N

0 625 1,250 2,500 Feet

Legend

- Dayton Street
- Shellabarger Creek
- Willow Creek
- Edmonds Marsh
- WSDOT/Edmonds Way
- Stormwater System
- Streams and Ditches

Figure A-1.
HSPF Basins

City of Edmonds
Dayton St and SR 104
Storm Drainage Alternatives Study

R:\Seattle\001772 Edmonds WA, City of\2651211002 Dayton St SR104 Alternatives Study

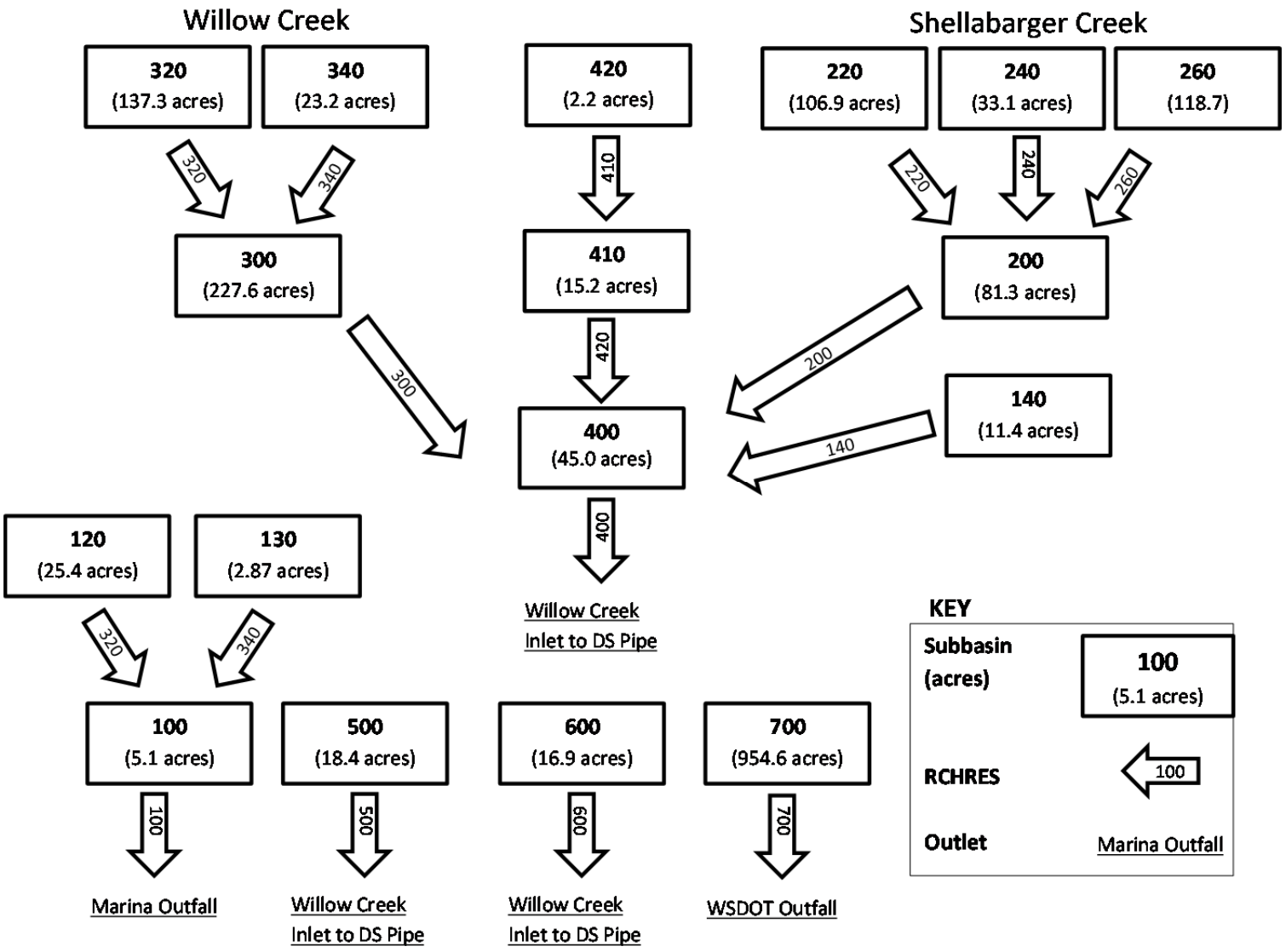


Figure A-2. HSPF Model Schematic

The evaporation data used in the model is the same data set used in the DNR effort. As discussed in DNR documentation, the evaporation data input to the HSPF model is in the form of pan evaporation data. The nearest Class A pan is located in Puyallup at the Washington State University Experimental Field Station. Puyallup is approximately 40 miles south of the Edmonds, but because evaporation does not vary greatly in the Puget Sound lowland watersheds, the distance from the study area is not significant. The Puyallup station was used for pan evaporation data in this study. The period of record was October 1948 to September 2001. Record extensions for this evaporation since the 2000 DNR study were obtained directly from Snohomish County Public Works staff.

Subbasin Characteristics

Using GIS analysis tools and GIS shapefiles for soil, slope and vegetation, each subbasin is described by a unique combination of soil, slope and land cover. Table A-1 lists the subbasins and their areas with the unique soil, slope and land cover combination.

Soil information was obtained from USDA/NRCS soil maps and further classified for use within the HSPF model platform in accordance with Table 3.1 in the 2010 Snohomish County Drainage Manual (SCDM). The soil maps were obtained from the City of Edmonds in GIS format. Slope information was obtained from LiDAR data from the Puget Sound LiDAR Consortium using GIS analysis. Land covers (types of vegetation and impervious surfaces) were obtained from both City of Edmonds Zoning GIS and USDS/NRSC vegetation aerial maps.

The impervious area with each subbasin was calculated with the use of the City's zoning GIS data and aerial photos, impervious area estimates (Table 3.2 in SCDM) and effective impervious fraction guidelines (Table 3.2.2.E, King County Surface Water Design Manual, 2009). The impervious area estimates and the effective fractions in the design manual were used as guidelines, but for some land use types these values were modified based on specific information in the study area such as areas of known connectivity to the drainage system (decreases effective fraction from design manual tables), typical landscaping practices (decreases impervious fraction from design manual tables), and larger than typical homes (increases impervious fraction). Table A-2 shows the impervious fraction, effective impervious fraction, and the resulting effective impervious as applied to the study area. Where there has been a change in fractions given in the drainage design manual, the reason has been noted in the table comments.

Table A-1:
HSPF Basin PERLND, IMPLND and Total Areas

Basin ID	Till Forest Flat	Till Forest Mod	Till Forest Steep	Till Grass Flat	Till Grass Mod	Till Grass Steep	Outwash Forest	Outwash Grass	Saturated Forest	Saturated Grass	Effective Imper-vious	Total
100	0.14	0.13	0.09	0.34	0.14	0.09	-	-	-	-	4.22	5.15
120	1.43	0.59	0.32	2.03	1.20	0.45	-	-	-	-	19.77	25.45
130	-	-	-	0.13	0.02	-	-	-	-	-	2.72	2.87
140	0.38	0.29	0.08	0.86	1.03	0.34	-	0.29	0.23	0.81	7.08	11.39
200	0.44	0.48	0.15	4.79	4.91	1.95	7.89	24.13	0.00	0.27	36.32	81.33
220	0.09	0.19	0.13	23.28	21.58	12.76	0.30	12.68	0.27	0.67	34.95	106.89
240	-	-	-	3.63	7.90	5.35	-	3.70	-	-	12.51	33.10
260	0.83	0.29	0.14	11.55	18.96	11.24	-	8.18	-	0.22	67.24	118.66
300	25.33	28.60	14.16	25.40	28.90	14.65	31.87	41.42	0.98	0.98	15.30	227.59
320	0.13	0.23	0.07	13.77	12.49	7.99	2.44	46.08	0.08	1.03	53.03	137.34
340	0.00	0.02	-	0.00	0.02	-	0.21	11.50	-	-	11.41	23.18
400	2.21	1.52	1.42	3.27	1.66	1.42	0.63	0.63	13.83	13.94	24.38	64.91
410	-	-	-	0.67	0.08	-	-	-	-	0.01	14.48	15.24
420	-	-	-	0.10	0.01	-	-	-	-	-	2.11	2.22
500	0.79	0.75	1.05	1.43	1.85	2.54	-	-	-	-	10.04	18.45
600	3.11	1.13	1.03	3.38	1.67	1.76	0.06	0.06	-	-	4.70	16.91
700	-	-	-	243.09	180.25	120.00	-	73.59	-	0.48	337.23	954.64
Total	34.87	34.22	18.63	336.82	282.57	180.55	43.41	222.26	15.39	18.40	638.22	1825.36

Table A-2:
Impervious and Effective Impervious Fractions for Study Area Zoning Types

Edmonds Zoning (except where noted)	Description	Impervious Fraction	Effective Impervious Fraction	Resultant Effective Impervious	Resultant Pasture Fraction	Resultant Wood Fraction	Comments
BD1, BD2, BD3, BD4, BD5, BC, BP, CG, CW	Business, Commercial	0.95	1	0.95	0.05	0	Impervious Fraction reduced from 1 to 0.95 for Edmonds based on Edmonds typical commercial area landscaping
RM-1.5, RM-2.4, RM-3, MP1	Multi Family	0.75	1	0.75	0.25	0	Impervious Fraction calculated from GIS analysis of sample MF parcels
RS-6	Single Family (6,000 sq.ft. lot)	0.42	0.9	0.378	0.622	0	Impervious Fraction based on 4.0 DU/GA, Effective Fraction based on typical Edmonds connectivity
RS-8	Single Family (6,000 sq.ft. lot)	0.34	0.9	0.306	0.694	0	Impervious Fraction based on 3.0 DU/GA, Effective Fraction based on typical Edmonds connectivity
RS-10	Single Family (6,000 sq.ft. lot)	0.3	0.9	0.27	0.73	0	Impervious Fraction based on 2.5 DU/GA, Effective Fraction based on typical Edmonds connectivity
RS-MP	Single Family – Master Plan	0.3	0.9	0.27	0.73	0	Impervious Fraction based on 2.5 DU/GA, Effective Fraction based connectivity to drainage system.
0.5DU (Town of Woodway zoning)	Woodway Residential (0.5 Dwelling Unit/ Gross Acre)	0.09	0.4	0.036	0.48	0.48	Impervious fraction based on larger than typical home size.
0.6DU (Town of Woodway zoning)	Woodway Residential (0.6 Dwelling Unit/ Gross Acre)	0.12	0.66	0.08	0.46	0.46	Impervious fraction based on larger than typical home size. Effective fraction based on connectivity to drainage system.
0.8DU (Town of Woodway Zoning)	Woodway Residential (0.8 Dwelling Unit/ Gross Acre)	0.14	0.66	0.09	0.45	0.45	Impervious fraction based on larger than typical home size. Effective fraction based on connectivity to drainage system.
P	Public Use	0	0	0	0.5	0.5	No changes from Design Manual
MP2	Master Plan – Mixed Use	0	0	0	0.5	0.5	No changes from Design Manual
OS	Open Space	0	0	0	0.5	0.5	No changes from Design Manual

Runoff Routing (FTABLE Development)

The storage contained in conveyance systems is estimated by a hydraulic function table (FTABLE). The FTABLEs define the depth-area-volume-flow relationships used for routing runoff through the stream or pipe reaches represented in the HSPF model. The FTABLEs developed for the Edmonds HSPF model are based on normal depth (Manning's equation) and represent a single stream or ditch in each basin rather than the actual network of streams, ditches, culverts and pipes. This simplified approach is reasonable for this study because the subbasins upstream of the marsh area are generally moderately steep to steep and do not provide significant storage volume. The significant storage volume occurs in the lower portions of the system in the area of the marsh which is modeled using the dynamic hydraulic model.

HSPF Model Results

Peak flow analyses were performed for each of the HSPF subbasins. The annual peak flows were developed for each year of record simulated and were plotted using an Extreme Value Type I scale. Table A-3 shows the peak flow rate for various return intervals. It is important to note that these HSPF peak flow predictions do not account for backwater affects from system hydraulics and tidal conditions and therefore overstate the peak flows in the lower system that is modeled with the hydraulic model. The peaks are shown here to demonstrate relative impact of the subbasin within the study area. Peak flows and water levels from the hydraulic model do account for these affects and are used for system analysis.

It is also noted that the analysis of the Edmonds Way basin was simplified because it was outside the original study area. The simplifications are that the entire basin is treated as one large subbasin (as opposed to breaking it into several smaller basins) and the FTABLE storage was simply estimated using the storage of the Edmonds Way trunk storm drain.

Table A-3:
Peak Flow Predictions for 2-, 10-, 25- and 100-Year Return Intervals, cfs

HSPF Reach	Location	2-yr peak flow, cfs[1]	10-yr peak flow, cfs[1]	25-yr peak flow, cfs[1]	100-yr peak flow, cfs[1]
100	Dayton Street and Railroad Ave	6.7	10.3	12.2	14.9
120	Dayton Street and SR 104	5.9	9.2	10.8	13.4
130	Xx St and XX St	0.7	1.0	1.2	1.4
140	East of SR 104 between Dayton Street and Pine St	2.2	3.4	4.0	4.9
200	Shellabarger Creek at inlet to SR 104 culvert crossing	31.9	47.7	55.8	67.9
220	3rd Ave between Walnut St and Howell Way	7.7	11.6	13.7	16.9
240	East end of Homeland Dr	4.5	7.4	8.9	11.1
260	East end of Homeland Dr	14.5	22.2	26.1	31.8
300	Willow Creek crossing of Pine St (near Willow Creek Hatchery)	20.8	32.7	38.9	48.5
320	Willow Creek crossing of Edmonds Way near 5th Ave S	13.8	21.4	25.3	31.2
340	Edmonds Way and Pine St	3.3	5.4	6.4	8.0
400	Willow Creek at outlet from Edmonds Marsh	39.1	50.3	55.1	61.7
410	Dayton Street and	3.3	4.9	5.8	7.1
420	Dayton Street and	0.5	0.8	0.9	1.1
500	Near Willow Creek inlet to Outlet pipe system	2.7	4.4	5.2	6.5
600	Willow Creek tributary basin adjacent to Edmonds Marsh	1.2	2.0	2.4	3.1
700	WSDOT & Edmonds Way	148.6	233.2	275.1	336.8

(1) These peak flow predictions are based on a frequency analysis of runoff with simplified FTABLEs and do not account for backwater/tidal effects and therefore likely overstate actual flows, particularly in the areas modeled with the hydraulic model. Refer to the Hydraulic model results.

XP SWMM Hydraulic Model Development

Model Extents and Data Sources

The hydraulics of the Dayton Street /Edmonds Marsh system were modeled using XP-SWMM (SWMM). The SWMM model extents include the Dayton Street System from the intersection of SR 104 to Puget Sound and the Edmonds Marsh system from the east side of SR 104 where Shellabarger Creek enters the wetland, through the marsh to Puget Sound. The two systems are connected via pipes and channels on both the east and west sides of SR 104. Figure 1-4 in the main body of the report presents the extent of the model.

Several data sources were used:

Existing Data

- As-built drawings of the drainage system along Dayton Street (SR 104 to Railroad Avenue)
- As-built drawings of the Willow Creek outfall extension (2004)
- Prior surveys along Dayton Street and SR 104 (by the City)
- Edmonds Antique Mall Boundary & Topographic Survey (2009 Pace)
- Dayton Street/SR 104 Storm Drainage Replacement Project (1991)
- Shellabarger Creek SR 104 culvert crossing (prior to cleaning)(DHA)
- Storm and Sewer Improvements Railroad Ave & Dayton Street Topographic Survey (sheet 1 of 3).
- A 2008 survey by WSDOT throughout the salt water portions of marsh. This survey includes multiple spot elevations throughout the marsh and was validated as described below.
- A 2008 survey of the Willow Creek outlet channel from the downstream end of the marsh to the pipe outlet system (CH2M Hill)

Supplemental Survey

A 2012 survey by Perteet was conducted as part of this project in order to both collect new data and validate prior 2008 WSDOT survey within the marsh. The 2008 survey of the marsh included a topographic survey of the salt water portions of the marsh. Rather than re-surveying this area, three cross sections were surveyed across the saltwater portions of marsh in order to compare and validate the 2008 survey. The 2008 survey (and multiple other prior surveys were in the MLLW (Mean Lower Level Water) datum which is 2.25-feet lower than NAVD88 (the City's current elevation datum). As a result, the 2008 elevations were converted to NAVD88. The elevations in the 2008 and 2012 surveys matched well which allowed the more extensive 2008 topography survey of the saltwater portion of the marsh to be used to develop cross sections for the SWMM model.

In addition to these cross sections, the supplemental survey included additional cross section in the marsh (beyond the saltwater portion) as well as ditch cross sections along SR 104, rim and invert elevations at the intersection of Dayton Street and SR 104, and culvert and pipe information downstream of the marsh.

The survey also picked up known observed high water marks where this information was available.

Drainage System Description

The drainage system in the study area consists of the Dayton Street System and the Edmonds Marsh system. These systems are generally described in the main report, but are described below in more detail with respect to the hydraulic modeling effort.

The Dayton Street System

The Dayton Street system consists of approximately 1280-feet of 24-inch and 30-inch concrete storm drains between the intersection of Dayton Street and SR 104, and the Dayton Street outfall north of the Edmonds Marina. The outfall has a tide flex gate which prevents high tides from entering the system. The transition from 24-inch pipes to 30-inch pipes occurs at a manhole near the intersection of Dayton Street and Railroad Ave. At this manhole (referred to as "swirl concentrator type water quality treatment facility" in Section 1) the invert elevation of the outlet 30-inch pipe is 5.3-feet above the invert elevation of the incoming 24-inch pipe. This creates a high point in the system which has the potential to contribute to the flooding during extreme events. In addition, because a portion of the incoming storm drain is continuously under water, it may be subject to sediment accumulation if not regularly maintained.

Along the east side of SR 104 there is a 24-inch diameter pipe system that extends south from the intersection along the west side of the City's wastewater treatment. This system extends to a low-lying wetland that also extends south to Shellabarger Creek. At the southeast corner of the intersection, this 24-inch diameter pipe system is joined by a system extending from the north and draining the ferry queuing area. At this point, an 8-inch diameter pipe connects it to the Dayton Street system. The southeast corner of the intersection is the general low point in the area and is often the sign of flooding.

The ditch and culvert system on the west side of SR 104 south of the intersection is also included in the model. This system flows south to the marsh. While not much area is tributary to this system, it can serve as an overflow path when the intersection is flooded.

An additional goal of the modeling effort that was specifically requested by the City was to determine how the WSDOT ferry queuing area east of SR 104 and north of Dayton Street connects to the City's drainage system. A field visit with City staff along with a review of City GIS files and WSDOT drainage plans revealed that that this area connects to the 24-inch storm drain in the Dayton Street system via an 8-inch direct connection as shown in Figure A-6. The east side of the ferry queuing area includes a series of 8-inch underdrains that connect to a 12-inch storm system that extends south along the west side of the ferry queuing area. The 12-inch pipe transitions to an 18-inch x 11-inch arch pipe where it enters Dayton Street. It extends south, crossing above the east-west running 24-inch system in Dayton Street to connect to a catchbasin at the southeast corner of the Dayton St/SR 104 intersection. This catchbasin has a pipe connection from the south that receives overflow from Shellabarger Creek. The catch basin also has a short 8-inch connection to another catch basin a few-feet away. This catchbasin includes an 8-inch outlet that extends north to connect directly to the 24-inch Dayton Street system.

Edmonds Marsh

The Edmonds Marsh drainage system receives runoff from Shellabarger Creek (crossing SR 104) from the east and Willow Creek from the south and locally adjacent areas. The dual arch culverts that cross SR 104 have approximately 1.3 to 2-feet of sediment built up at the inlet and outlet. In addition, sediment accumulation and extensive cattail growth has filled in the former creek alignment downstream of the culvert, such that the creek now flows in a southerly direction along the west side of SR 104 then extends west to join with Willow Creek.

Willow Creek flows into the marsh after crossing under Pine Street near the Willow Creek Salmon Hatchery. It flows north and west joining Shellabarger Creek and then flows in a clearly defined channel that extends west along the south side of the marsh. This channel continues west and then south approximately 0.5 miles along the railroad to turn west and crosses the railroad in dual 42-inch diameter culverts. These culverts discharge to a short section of open channel on the west side of the railroad where the creek enters a 600-foot-long 48-inch diameter pipe extending south to a stormwater vault south of the Edmonds marina. The pipe in the vault is equipped with a 48-inch tide (flap) gate which is controlled by a manually operated pulley system. During the wet season from November to mid-March, the tide gate is closed to prevent seawater from entering the system during high tides and exacerbating high water levels in the winter. The tide gate is opened during the drier part of the year, mid-March through October. The weight and size of the tide gate is likely causing some headloss at the pipe outlet. Approximately 1000-feet of 48-inch pipe comprises the remainder of the Willow Creek outfall system from the tide gate to the Sound.

In addition to the tide gate, there are two smaller gates attached to culverts that can affect the marsh outflows. These two parallel culverts are located just upstream of the dual 42-inch diameter railroad culverts (See Nodes 29 and 30 on Figure 1-5). The two culverts include a 36-inch CMP culvert and a 22-inch diameter steel culvert, both placed within a short berm crossing Willow Creek. The height of the berm allows it to be overtopped during significant events. The purpose of these culverts and gates is not specifically known, however, anecdotal information from the City suggests that Unocal may have installed these gates in order to provide a method of cutting off flow in case there was a spill within the Unocal property. One of the gates is partially closed and the other is fully closed.

Model Setup and Key Assumptions

In SWMM, a node represents a manhole, connection point between pipes or channels, a location for water enter or leaving the system, or an outfall. A SWMM link represents a pipe or channel (it can also represent a pump). The SWMM model includes all of the drainage systems described in the section above. The marsh is modeled through links and nodes and the large amount of flood storage is represented by wide cross sections (rather than a storage unit). Elevations at flow line nodes with no survey data were interpolated based the 2008 survey.

The Manning's roughness coefficients for the model cross sections were determined based on photos taken from the site visit and aerials for areas that could not be accessed (such the creek channel downstream of the marsh on BNSF property). The following coefficients were used:

- 0.07 for the channel on the east side of SR 104 due to the heavy vegetation and brushes. The overbank towards the east being even more vegetated was assigned a roughness of 0.1 while the SR 104 overbank was assigned a roughness of 0.016 for asphalt.
- 0.07 for the channel on the west side of SR 104 south of the Harbor Square driveway culvert and 0.045 north of the culvert due to a less vegetative growth. The overbank towards the west was assigned a roughness of 0.05 while the SR 104 overbank was assigned a roughness of 0.016.
- 0.3 for the portion of the marsh with heavy cattail growth and sediment buildup and where no clear flow path is defined. This rather high value is based on a technical note TN SD-CP-2.2 (May 1994) by the US COE.
- 0.05 for the channel through the marsh downstream of the Willow Creek inflow point. A lower roughness coefficient was used since the aerial shows a clearly defined flowpath with less vegetative cover. The overbank north of this channel was assigned a coefficient of 0.07 and the left overbank along the embankment to the Unocal stormwater detention pond was assigned a coefficient of 0.06.
- 0.04 for the channel downstream of the marsh southeast of the railroad and 0.045 along the overbank.

Tidal data at both the Dayton Street and Willow Creek outfalls was downloaded from NOAA's historic database at the Puget Sound station 9447130 located in Seattle. The datum for these elevations is NAVD88. The NOAA tides generally indicate a 0.4 ft lower tide in Edmonds than in Seattle. However, as a part of the Willow Creek Daylighting project, a gage was installed in the Port of Edmonds Marina. A comparison of gaged Edmonds and Seattle tides showed the high tides being closer to the gaged Seattle tide than the 0.4 ft reduction. As a result, the Seattle gaged tidal data was used in the analysis. Additionally, no modification to the model or the tidal elevation was applied to account for the larger density of seawater due to salinity. It is believed that this factor does not have a noticeable impact upon the modeled water elevations.

Overflow links were used to simulate runoff on the surface above the rim elevations of the catch basins. The cross section for these links was virtually flat with a roughness coefficient of asphalt (roadway surface). Overflow links were added to the model between open grate catch basins on the Dayton Street system as well as between the SR 104 ditches and the Dayton/SR 104 intersection. In order to simulate the "bathtub-like" flooding at the intersection of Dayton Street and SR 104, all open grate catch basins were connected using overflow links so that the model equalizes the ponding elevation.

The effect of sediment build up in the arch culverts crossing SR 104 was accounted for by using the sediment top elevation as in the invert elevation for the culvert. Then the remaining open area along with the span (width) of the 47-inch x 71-inch arch culverts were used to pick new culvert dimensions. The total area and dimensions of these culverts reflect the area and approximate dimensions of the culverts with sediment. Hence, a 33-inch x 49-inch and a 38-inch x 57-inch culvert were used in SWMM instead of the actual dimensions. It was also noted that these culverts have an unusual internal support system using timber beams and posts. Figure A-3 includes a photo taken from one of the culverts outlets. It is likely these were installed to provide structural support due to differential settlement across the road. The roughness coefficient for the culverts was 0.035 in order to account to the sediment along the streambed and timber support system.

Figure A-3. Shellabarger Creek - SR 104 Culvert

Another key element of the model set up was the use of additional pipe length to simulate the head loss at the tide gate located at the outlet of the 600-ft 48-inch diameter Willow Creek outfall pipe. Literature review regarding head loss due to tide (flap) gates suggests that the gates have a relatively minor effect on the discharge capacity of pipes. However, manufacturers also acknowledge that heavy-duty flap gates or flap gates with significant weight may have a more pronounced effect on the discharge capacity. A head loss of 0.8-feet was hence estimated during the peak of the storm, which is equivalent to 179-feet of additional pipe length using the Hazen-Williams equation. Similarly, a head loss of 0.1-feet was estimated for the tide flex gate valve at the Dayton Street outfall, which amounts to 33-feet of equivalent pipe length.

As previously discussed in the main body of the report, a pump with a capacity of about 0.5 cfs was installed in the parking lot of the shopping plaza northwest of the intersection of Dayton Street and Admiral Way. It is engaged only during high tides and heavy rains. Due to the low pumping rate, this pump was not included in the model.

Fifteen-minute flow data from the delineated subbasins was computed using HSPF (see hydrology section above) for numerous historical high precipitation and high tide events. The flows are entered into the hydraulic model at select nodes (See Figure 1-5):

- Subbasin 140 inflows were inserted at node 40, the inlet to the SR 104 arch culverts.

- Subbasin 200 inflows were inserted at node 24 where Shellabarger Creek enters the ditch along the east side of SR 104.
- Subbasin 300 inflows were inserted at node 51 where Willow Creek drains into the marsh.
- Subbasin 120 inflows were distributed among nodes 14, 79 and 81 near the intersection of Dayton Street and SR 104.
- Subbasin 100 inflows were distributed along nodes 7 and 10 along Dayton St.
- Subbasin 500 inflows were inserted at node 31, upstream of the railroad culvert crossing and downstream of the marsh. WSDOT overflows were also inserted at this node where applicable.
- Subbasins 400, 410 and 420 inflows were distributed among multiple nodes between the SR 104 culvert outlet (node 23) and downstream end of the marsh (node 59).
- Subbasin 600 was split in half between the marsh (nodes 51 and 26) and the downstream end of the channel southeast of the railroad (node 29).
- Subbasin 700 inflows were inserted in the WSDOT system which was modeled generally from near upstream of the manhole that can overflow into Willow Creek to its outfall. An orifice overflow link was added at Node 31. This orifice was meant to model the overflows from the top of the WSDOT manhole. It is noted that during initial modeling, the WSDOT pipe system was not included in the model. However, it was deemed important to get an understanding of how much the overflows from this system affect flooding at the intersection. System pipe sizes and invert elevations were obtained from the 1991 Edmonds Way basin study (RW Beck, 1991).

Model Validation and Observed High Water Marks

In order to provide some validation of model results, a review of historical observed high water marks and a comparison with simulated model results were performed. Identifying historical observed high water marks included review of flooding records, discussions with maintenance staff, and obtaining input from Washington State Department of Ferries. In general, there were limited historical events having clearly accurate known elevations of flooding. These included the following:

- December 3, 2007 Flood. Two records of high water marks were obtained which matched well with each other. These included anecdotal reports of flooding just above the finish floor of the ferry toll booths (which were subsequently surveyed), and surveyed elevation collected by Reid Middleton in the vicinity of the Harbor Square buildings (documented in an 11/12/09 memorandum to the City of Edmonds).
- December 12, 2010 Flood. A photograph taken during the storm was used to get an approximate high water mark. It was noted that following this storm event, the City determined that some pipe plugging may have affected the system response. This storm was still used for validation, recognizing that there is

some uncertainty about the system performance and the time the photo was taken.

- November 19, 2012 Flood. As a part of the Willow Creek Daylighting Project, three gages had been installed at various locations in the project vicinity. These locations are shown on Figure 1-5. One of the locations is on Shellabarger Creek on the east side of SR 104, one is in the west portion of the marsh, and one in the Edmonds Marina. In addition, SAIC staff took field measurements of flooding depth during this flood.

Table A-4 provides the validation results.

Table A-4:
SWMM Model Validation Runs

Storm Date	Observed High Water Mark	Maximum High Tide (NAVD88)	Simulated Elevation in the Marsh	Simulated Flooding at OHWM Location	Low point at Intersection	Simulated Depth of Flooding at Intersection
12/3/2007	12.43[1]/12.4[2]	11.34	11.93	12.26	10.1	2.16
12/12/2010[3]	10.54[4]	10.52	9.66	11.26	10.1	1.16
11/19/2012	11.5[5]	11.21	10	11.42	10.1	1.32
11/19/2012	11.85[6]	11.21	10	11.95	10.1	1.32
11/19/2012	10.39[7]	11.21	10	10	10.1	1.32

(1) Based on data collected by Reid Middleton (11/12/09) in vicinity of Harbor Square Buildings
(2) Based on reported standing water in WSDOT ferry tollbooth (inches above floor); floor surveyed at 12.2
(3) Note there may have been partial blockages in Dayton System that could have affected flows
(4) Observed high water from Dayton Roadway Shoulder, photograph and survey by Perteet 2012
(5) Based on field measurement by SAIC staff on Dayton Street south of Salish Crossing
(6) Gaged flow with data logger (LTC#3) near the SR 104 culvert inlet
(7) Gaged flow with data logger (LTC#2) on the west side of the marsh

Based on the validation simulations, the model appeared to simulate reasonably the system response. Since the November 2012 had an the most reliable data regarding observed flooding and included continual water level recording, it was used as the basis for model validation efforts. Note that as part of these efforts, 0.5 ft of elevation was added to the bottom of the cross sections through a portion of the eastern part of the marsh. Without this modification, the simulation results tended to under-simulate marsh water levels. The reasoning behind adding the 0.5-feet was to account for some of the reduced available storage from the very dense cattails throughout the eastern side of the marsh and there was some uncertainty in the bottom elevations in the northeastern portion of the marsh because of the limited cross sections obtained in this area. Once the bottom elevation was raised, the system response improved.

Figure A-4 shows a time series of the elevations modeled and measured during the November 2012 event. While there are some differences between the marsh water levels (0.4 ft at the peak), the maximum water level at the Shellabarger Creek

entrance to the SR 104 culvert was very close (within 0.1 ft). In addition, the simulation response through the overall storm event shows a good representation of the gaged data. While some improvements in the system response could be made, it would be difficult without more gaged data of storm events. For the purposes of this study, it was concluded that the model reflects a valid representation of the system and can be used for evaluating alternatives.

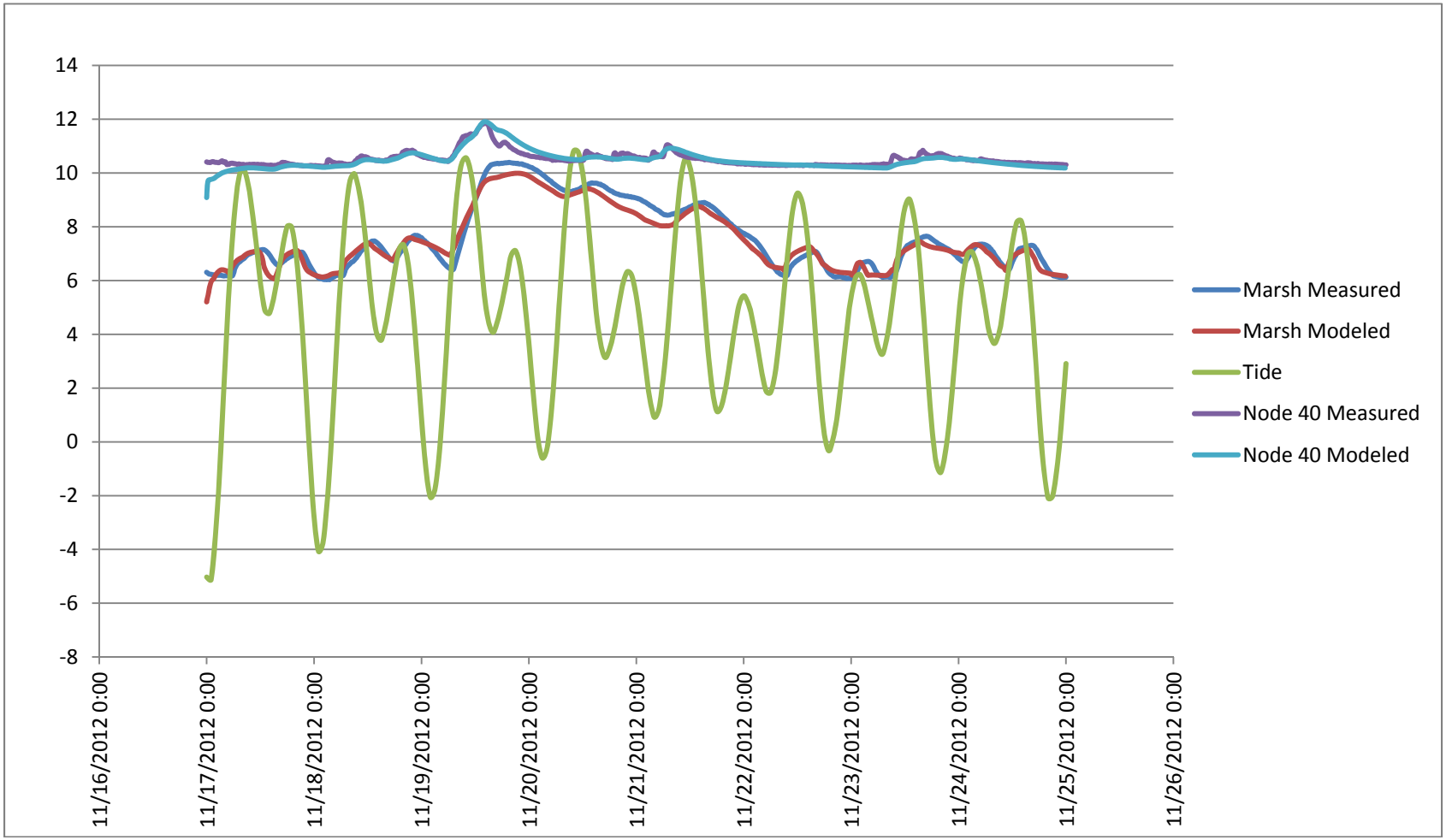


Figure A-4. Model Validation with the November 2012 Storm

Frequency Analysis

Upon concluding that the model simulations were validated by historical observations, the SWMM model was then used to simulate 30 years of flows in order to conduct a frequency analysis of water levels in the marsh. While the SWMM model can run very long simulations, it does not have the capacity to run 30 years of complex data including multiple inflow points and varying downstream tidal elevations. . This is because internal tables for holding tidal data have limits to the extent of input data. As such, individual simulations were run for the largest storms occurring within each hydrologic year (October 1 to September 30) for the 30 year period from 1982 to 2011 to obtain annual predicted maximum elevations.

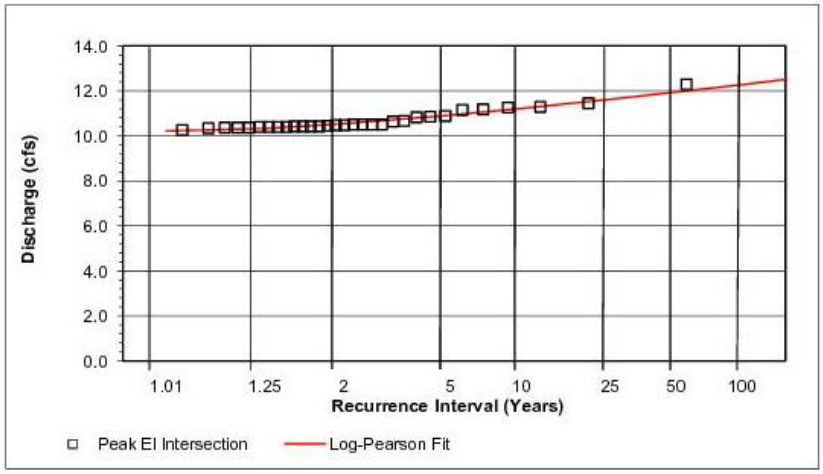
The simulated storm period for each year was selected by reviewing flow data (HSPF runoff) in tandem with tidal data to select the period in which there were both high runoff rates and high tides. Most often, the selection of the worst storm for each year was very evident. In some cases, however, there was some uncertainty which particular storm period was the worst for the year. For example, a given year might have one high runoff event with a moderate tide level and another event with a lower runoff rate but a higher tide. In such a case, the period of the simulation was extended to cover both events.

Maximum water surface elevations were extracted at three locations within the model:

- Node 60. Representing the marsh west of SR 104. It is noted that the simulated water level in this node is often the same as several other nodes in the marsh (72, 26, 61, 60, 70 and 59).
- Node 40. Representing Shellabarger Creek east of SR 104
- Node15. Representing the intersection of Dayton Street and SR 104

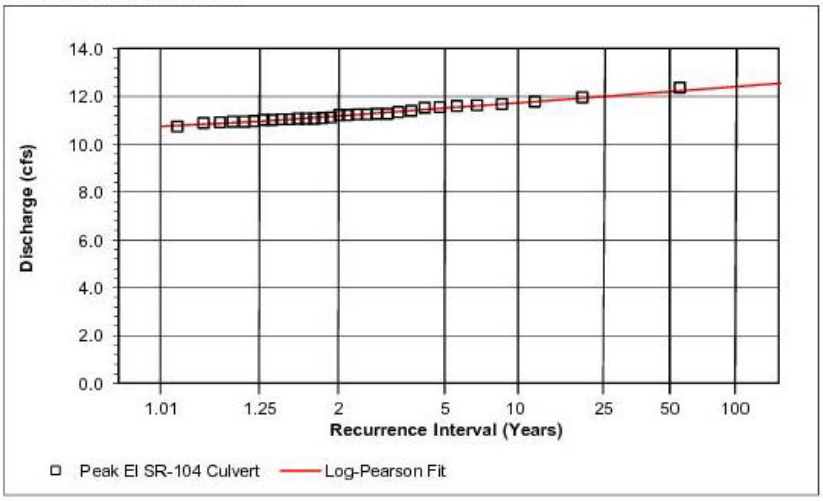
The results are presented in Table A-5. This table also includes the high tide during each flooding event and its time of occurrence for comparison with the time of maximum water surfaces at other locations. Using the elevations in Table A-5, frequency analysis was performed for each the three locations. The frequency analysis was done using the log-Pearson Type III probability distribution best-fit line through the yearly simulated water levels. The log-Pearson Type III distribution is a statistical technique used in hydrologic studies for fitting a best-fit curve through a series of yearly peak data (e.g. elevations or flows) to predict the design flood for a site. Typically, it is desirable to have a long record (e.g., 30-year record of peak elevations) to be used as the input data for a high level of confidence in the analysis results. The probabilities of floods of various magnitudes can be extracted from the Log-Pearson Type III best-fit curve. Additionally, this curve enables the extrapolation of the values for events with return periods beyond the observed flood events. The frequency analysis results and the predicted 2-year, 10-year, 25-year and 100-year elevations at the three study points are shown in Figure A-4.

Peak EI Intersection



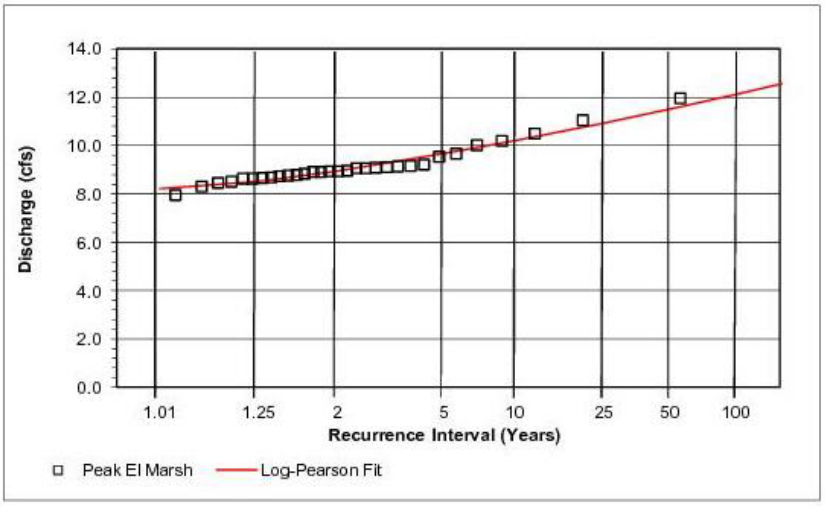
2-YR	10.53
10-YR	11.21
25-YR	11.62
100-YR	12.27

Peak EI SR-104 Culvert



2-YR	11.19
10-YR	11.73
25-YR	12.00
100-YR	12.40

Peak EI Marsh



2-YR	8.95
10-YR	10.20
25-YR	10.93
100-YR	12.11

Figure A-5. SWMM Frequency Plots

Table A-5:
SWMM Model Results

HY	Hide Tide*	Time of High Tide	Max WSE at Inter-section	Time of Max at Intersection	Max WSE at SR 104 culvert	Max WSE in Marsh	Time of Max in Marsh	Gate Open?
2012	10.96	11/19/2012 10:00 AM	11.42	11/19/2012 2:15 PM	11.95	10.00	11/19/2012 9:30 PM	No
2011	10.35	12/12/2010 10:00 AM	11.26	12/12/2010 12:15 PM	11.68	9.66	12/12/2010 2:45 PM	No
2010	9.27	5/28/2010 7:00 PM	10.38	5/28/2010 3:00 PM	11.21	8.77	5/28/2010 10:00 PM	Yes
2009	9.78	11/12/2008 3:00 PM	10.48	11/12/2008 3:00 PM	11.25	8.71	11/12/2008 5:00 PM	No
2008	11.34	12/3/2007 1:00 PM	12.26	12/3/2007 3:00 PM	12.35	11.93	12/3/2007 3:00 PM	No
2007	8.42	12/15/2006 3:00 AM	10.66	12/15/2006 6:15 PM	11.53	9.11	12/15/2006 6:00 AM	No
2006	11.42	1/30/2006 6:00 AM	11.17	1/30/2006 7:30 AM	11.38	10.19	1/30/2006 5:45 PM	No
2005	9.21	11/2/2004 9:00 AM	10.45	11/2/2004 10:00 AM	11.26	8.94	11/2/2004 1:00 PM	No
2004	9.85	10/20/2003 3:00 PM	10.87	10/20/2003 5:00 PM	11.60	9.12	10/20/2003 8:00 PM	No
2003	11.24	1/2/2003 6:00 AM	10.42	1/2/2003 7:00 AM	11.05	8.68	1/2/2003 5:15 PM	No
2002	10.96	1/7/2002 11:00 AM	10.49	1/7/2002 12:15 PM	11.35	9.15	1/7/2002 2:30 PM	No
2001	9.81	8/22/2001 8:00 PM	10.35	8/22/2001 8:00 PM	11.03	8.62	8/22/2001 10:00 PM	Yes
2000	9.63	11/12/1999 8:00 AM	10.33	11/12/1999 10:00 AM	10.93	8.50	11/12/1999 6:00 PM	No
1999	10.76	12/1/1998 2:00 PM	10.41	12/1/1998 3:00 PM	11.09	8.64	12/1/1998 6:00 PM	No
1998	9.23	1/23/1998 12:00 PM	10.40	1/23/1998 1:30 PM	11.20	8.91	1/23/1998 5:30 PM	No
1997	11.66	1/1//1997 10:00 AM	11.14	1/1/1997 12:30 AM	11.63	11.04	1/1/1997 12:30 AM	No
1996	10.08	4/23/1996 11:00 PM	10.82	4/23/1996 4:00 PM	11.51	9.52	4/24/1996 1:30 AM	No
1995	11.04	12/20/1994 7:00 AM	10.47	12/20/1994 8:00 AM	11.11	9.07	12/20/1994 10:30 AM	No
1994	10.72	12/13/1993 6:00 AM	10.34	12/13/1993 7:00 AM	11.03	8.93	12/13/1993 9:00 AM	No
1993	8.96	8/23/1993 10:00 PM	10.37	8/23/1993 10:30 PM	11.06	8.45	8/24/1993 12:00 AM	Yes
1992	10.01	1/31/1992 4:00 AM	10.35	1/31/1992 5:00 AM	10.88	8.81	1/31/1992 3:00 PM	No
1991	11.05	12/4/1990 7:00 AM	10.84	12/4/1990 9:00 AM	11.23	9.05	12/4/1990 6:15 PM	No
1990	9.57	1/9/1990 2:00 PM	10.37	1/9/1990 2:30 PM	11.02	8.89	1/9/1990 5:15 PM	No
1989	10.00	1/9/1989 7:00 PM	10.25	1/9/1989 8:00 PM	10.74	7.94	1/9/1989 10:30 PM	No
1988	11.02	12/6/1987 7:00 AM	10.50	12/6/1987 9:00 AM	11.06	9.21	12/6/1987 6:30 AM	No
1987	11.86	2/1/1987 7:00 AM	10.62	2/1/1987 9:00 AM	10.92	8.75	2/1/1987 7:00 AM	No
1986	10.30	1/18/1986 10:00 AM	11.24	1/19/1986 1:00 AM	11.77	10.48	1/19/1986 1:00 AM	No
1985	10.36	12/14/1984 10:00 AM	10.48	12/14/1984 3:00 PM	11.24	8.30	12/14/1984 10:15 PM	No
1984	10.19	11/20/1983 5:00 AM	10.38	11/20/1983 6:30 AM	11.02	9.05	11/20/1983 5:30 AM	No
1983	11.16	12/3/1982 7:00 AM	10.41	12/3/1982 8:30 AM	10.90	8.90	12/3/1982 7:00 PM	No
1982	11.08	12/5/1981 11:00 AM	10.40	12/5/1981 12:30 PM	10.95	8.62	12/5/1981 2:30 PM	No

[1]Nearest high tide to time of max at intersection

Some of the conclusions that can be drawn from these results and a review of the modeling are as follows:

- The intersection floods frequently. The frequency analysis shows the intersection floods annually. In addition, the simulations indicate some ponding occurred in all of the 30 years and it is likely that it occurred multiple times in any given year (the results only show the worst flooding of the year).
- The marsh west of SR 104 is simulated to have a 2-year water level less than the intersection low point (10.1) while east of SR 104; Shellabarger Creek is higher than the intersection low point indicating the creek overflows towards the intersection. The conclusion that can be drawn from this is that if the Shellabarger SR 104 culvert was cleaned and/or upsized and the channel downstream of the culvert was restored to allow free flow west of the culvert it would reduce the overflows from Shellabarger Creek that extend north to the intersection that exacerbates flooding.
- Marsh flooding is not necessarily always coincident with extreme high tides. Only three of the top seven floods (in terms of elevations in the marsh) coincide with high tides in excess of 10-feet. The others occur at lesser high tides. Storm events having significant runoff volume can result in the severe flooding without high tides.
- The WSDOT pipe system overflows into the marsh. That is not the main driver of flooding at the intersection but this occurrence causes some loss of storage in the marsh and loss of capacity in the piped outfall system at high flows, which impacts the hydraulics of the Dayton Street system. In fact, there were no overflows in approximately half of the years modeled for the frequency analysis. Peak overflows amounted to 14.2 cfs during the 25-year event and 19.7 cfs during the 100-year event.

Selection of Design Event

The design event is created by taking a historical runoff event that produces a maximum flood level that is closest to the flood level predicted by the frequency analysis. When there is a significant difference with the closest flood level, the simulated runoff is factored up or down as required until the simulated water surface elevation matches the predicted elevation by the frequency analysis. Table A-6 presents the selected design events.

Table A-6:
Design Events

Design Event	Date	Maximum Simulated WSE (NAVD88)	Water Surface Elevation Predicted by Frequency Analysis (NAVD88)	Factor Needed to Apply to Flows
25-year	1-1-97	11.04	10.93	No correction[1]
100-year	12-3-07	11.93	12.11	1.05

(1) No correction factor was applied because the values were very close.

Modeling of Alternatives

The existing condition XPSMM model was modified and used to size the alternatives elements and to evaluate the effectiveness of alternatives. Both the 25-year and 100-year events were used for the analysis. Alternative modeling was done incrementally. That is, individual elements of each alternative listed in Section 2 were added to the XPSWMM model in a stepwise manner. Once a model included all the alternative elements, it was used to report the results and evaluate the alternative.

The Alternative 1 model (Dayton Street Pump Station and Shellabarger Creek Restoration with Edmonds Marsh Expansion) was built in six steps:

- Alternative 1.1: This model run consisted of isolating the marsh system from the Dayton Street system by removing the links between them in order to simulate the plugging/removal of the system on SR 104.
- Alternative 1.2: This model was built by starting from the Alternative 1.1 model. Flows from the south half of the Salish Crossing were diverted to Dayton Street and high flows from Harbor Square were also diverted to Dayton Street (when the water level within Harbor Square reached elevation 9). An overflow weir simulated the diversion from Harbor Square to Dayton Street. This step is only meant to precede the addition of a pump station and take advantage of the added capacity along Dayton Street.
- Alternative 1.3: This model was built by starting from the Alternative 1.2 model. A pump station was added at Node 10 with a force main to Puget Sound. The pump station capacity was determined such that the force main is no larger than 18-inches in diameter and such that the freeboard at the low point of the intersection of Dayton Street and SR 104 is at least one foot during the 25-year event and at least 0.5 ft during the 100-year event. A 13 cfs pump satisfies those parameters.
- Alternative 1.4: This model was built by starting from the Alternative 1.3 model. The cross sections and the links in the south portion of the marsh at the downstream end of the SR 104 culvert were updated by adding the restored Shellabarger and Willow Creek channel as designed by Shannon and Wilson (triangular section with 2:1 side slopes). The restored channel results in a

positive grade from the downstream face of the SR 104 culvert to the confluence point of Shellabarger Creek and Willow Creek.

- Alternative 1.5: This model was built by starting from the Alternative 1.4 model. The cross sections and the links in the south portion of the marsh at the downstream end of the SR 104 culvert were updated by adding the excavated areas as shown on Figure 2-1 and as described in Section 2. The Manning's roughness coefficient was reduced to 0.05 in the areas where cattail removal and excavation took place. The added storage was hence simulated in the cross sections.
- Alternative 1.6: This model was built by starting from the Alternative 1.5 model. The 36-inch culvert, 22-inch culvert and embankment downstream of the marsh were removed from this model. This model represents Alternative 1 as a whole since all the elements of this Alternative have been included.

The Alternative 2 model (Alternative 1 Improvements plus Daylighting Willow Creek) was built by starting from the Alternative 1.6 model. The daylighted Willow Creek alignment as shown on Figure 2-2 was added to the model. The geometry of the daylighted was obtained from a Civil 3D surface by Shannon and Wilson (Trapezoidal section with 14 bottom width and 2:1 side slopes). The Manning's roughness coefficient for the daylighted channel was assumed to be 0.04. The dimensions of the BNSF/Sound Transit railroad box culvert crossing were obtained from as-built drawings. The tide-gate was simulated at this stage by adding a 48-inch culvert at the downstream end of the railroad box culvert with a flap gate (i.e. downstream flows only). Two additional alternative model scenarios were done. The first, referred to as "2A" reflects Alternative 2 with the exception that the Willow Creek tide gate is not included. Removing the tide gate improves fish passage but lessens the flood protection. Additional analysis including running multiple storms would be necessary to understand fully the effects of not including the tide gate. The other model scenario referred to as 2.1 reflects the recommended alternative, Alternative 2.1, includes the lining of the existing 48-inch Willow Creek outfall (to reduce roughness and improve conveyance), the removal of WSDOT overflows and the exclusion of the marsh excavation element due to its limited benefit. It also includes the tide gate in operation.

The Alternative 3 model (Daylighting Willow Creek and Edmonds Marsh Pump Station Without Significant Marsh Expansion) was built in four steps:

- Alternative 3.1: This model was built by starting from the existing conditions model and adding the daylighted Willow Creek alignment as described above for Alternative 2 (with a tide gate simulated by a 48" culvert with downstream flows only).
- Alternative 3.2: This model was built by starting from the Alternative 3.1 model. A pump station was added near Node 33 to pump high flows into the existing 48-inch Willow Creek outfall. The pump engages when the water level upstream of the outfall reaches Elevation 9 and the pump capacity was 30 cfs.

- Alternative 3.3: This model was built by starting from the Alternative 3.2 model and adding the restored Shellabarger and Willow Creek channels through the marsh as described in Alternative 1.4.
- Alternative 3.4: This model was built by starting from the Alternative 3.3 model and isolating Shellabarger Creek east of SR 104 from the Dayton Street system by removing the links between them in order to simulate the plugging/removal of the system on SR 104. Additionally, a 30-inch pipe system was added from Dayton to the marsh (through Harbor Square) to allow Dayton to overflow to the marsh at high flows (above Elevation 8.5). The pump station was also upsized to 50 cfs to improve conveyance and handle the excess flows from Dayton. The Alternative 3.4 model thus represents the model for Alternative 3 as a whole since all the elements have been included.

The Alternative 4 model (Large Dayton Street Pump Station with Minor Marsh Modifications) was built by adding a 30 cfs pump station at Node 13 near the intersection of Dayton Street and SR 104 with a 30-inch 1100-feet long force main system to Puget Sound. Overflows from Harbor square were directed to Dayton above Elevation 9.5. The restored Shellabarger and Willow Creek channels through the marsh were added to this model as described in Alternative 1.4 Additionally, the 24-inch system along the east side of SR 104 was directly connected to the Dayton system (Node 16 to Node 14) to allow overflows from Shellabarger Creek to more easily reach the pump station. The 36-inch culvert, 22-inch culvert and embankment downstream of the marsh were also removed from this model.

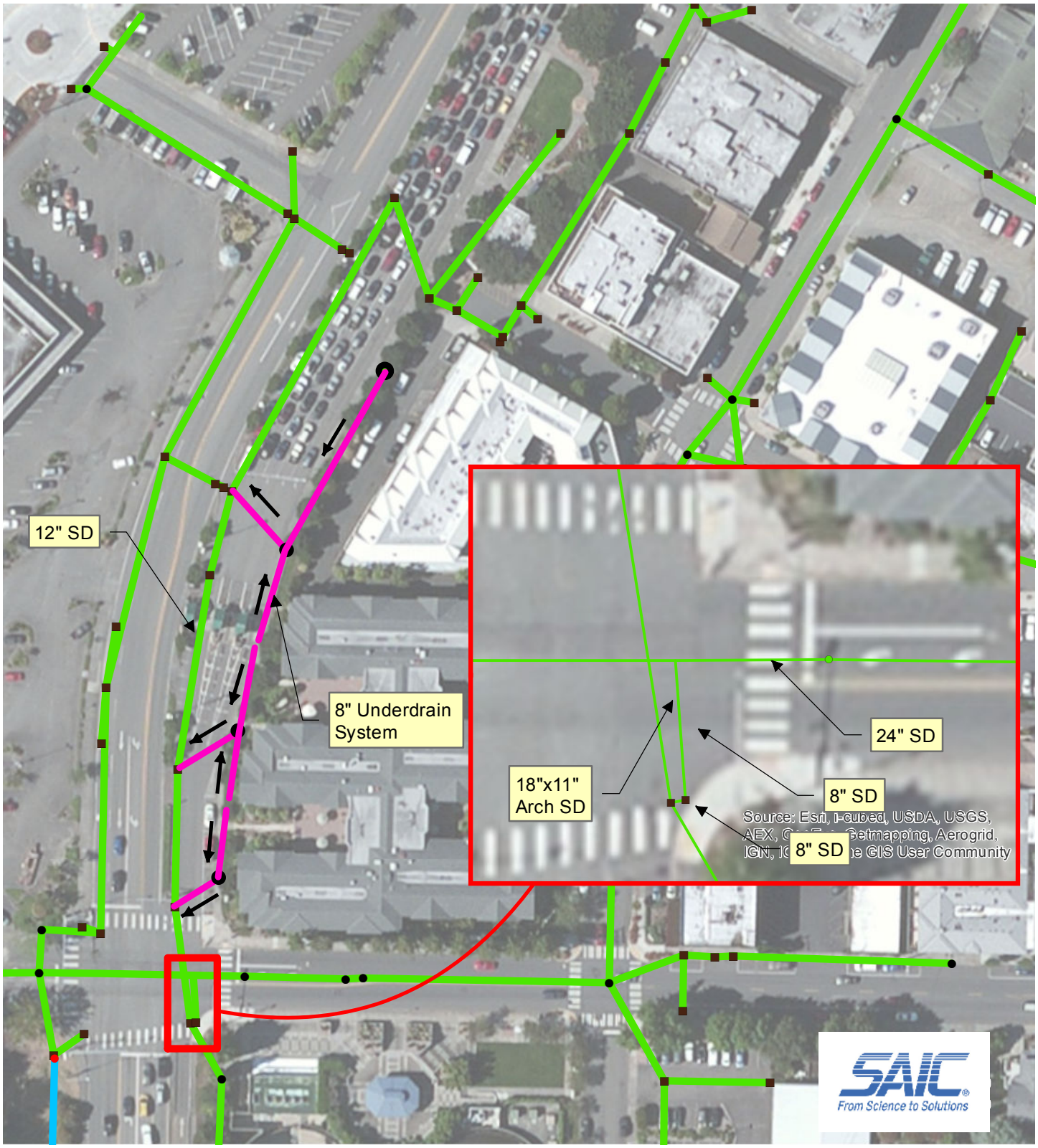
Table A-7 lists the detailed results of the different models gradually constructed for each Alternative.

Table A-7:
Alternative Modeling Results

Alternative	Description	25-Year Storm			100-Year Storm		
		Max WSE at Intersection	Max WSE in Marsh	Max WSE East of SR-104	Max WSE at Intersection	Max WSE in Marsh	Max WSE East of SR-104
-	Existing Conditions	11.14	11.04	11.63	12.32	12.14	12.41
1.1	Isolate Marsh System from Dayton by plugging the system on SR-104	10.88	11.4	11.93	11.5	12.21	12.96
1.2	1.1 + Divert high flows from Harbor Square and south half of Salish to Dayton St	10.89	11.32	11.89	11.75	12.2	12.95
1.3	1.2 + Add 13 cfs pump station to evacuate Dayton St system during high tides and high flows	9.1	11.31	11.89	9.32	12.19	12.95
1.4	1.3 + Restore Shellabarger Creek and Willow Creek to Marsh	9.1	11.31	11.39	9.32	12.51	12.65
1.5	1.4 + Remove Cattails and Excavate South Portion of Marsh	9.1	11.28	11.35	9.32	12.37	12.49
1.6	1.5 + Remove 36"/22" Culverts and Embankment downstream of the Marsh	9.1	10.15	10.98	9.32	12.08	12.14
1.6T1	1.6 + Existing 48-inch Willow Creek Outlet Pipe Modifications (Lining)	9.1	9.48	10.98	9.32	11.87	11.95
1.6T2	1.6 + No WSDOT Overflows	9.1	10.11	10.98	9.32	11.82	11.88
2	1.6 + Daylight Willow Creek to Existing BNSF Culvert and Construct New Outfall with a Self-Regulating Tide Gate	9.1	8.81	10.98	9.32	10.65	11.1
2A	Alternative 2 without tide gate	9.1	11.38	11.39	9.32	11.38	11.54
2.1	Alternative 2 with Existing 48-inch Willow Creek Outlet Pipe Modifications (Lining), Removing WSDOT Overflows and Not Including Marsh Excavation	9.1	8.92	11.1	9.32	10.43	11.26
3.1	Daylight Willow Creek to Existing BNSF Culvert and Construct New Outfall with a Self-Regulating Tide Gate	10.76	8.95	11.56	12.32	10.46	12.41
3.2	3.1 + 30 cfs pump station that uses existing outfall as discharge pipe	10.75	8	11.56	12.32	9.95	12.4
3.3	3.2 + Restore Shellabarger Creek and Willow Creek to Marsh	10.39	8.18	11.03	11.18	10.17	11.21
3.4	3.3 + Isolate Marsh System from Dayton + Pipe Improvements to Allow Dayton to Overflow to Marsh at High Flows (above El 8.5) + Upsize pump station to 50 cfs	9.21	8.23	11.15	9.86	9.84	11.31
4	Pump Station on Dayton (30 cfs), Restore Shellabarger Creek and Willow Creek to Marsh, Direct Overflows from Harbor Square and from Shellabarger Creek to Dayton (above El 9.5), Restore Shellabarger Creek and Willow Creek to Marsh and Remove 36"/22" Culverts and Embankment downstream of the Marsh .	9.1	10.48	10.64	9.29	11.77	11.89

Indicates final Alternative model run
Overall recommended Allternative run

Notes:
1. This table shows simlation results from various alternative runs as alternative elements were "added" to the Alternative. Note that these results, in particular the "benefit" from each alternative element, should be considered preliminary and approximate. This is because the elements are added to the modeling in sequence building off of other elements. If the order of elements were modified, the benefit from the individual elements would vary.
2. Each row corresponds to one model run. For example, 1.1 reflects Alternative 1 with modeling scenario 1 and 1.2 reflects Alternative 1 with modeling scenario 2.



N

Feet

0 50 100

Legend

STORM CB

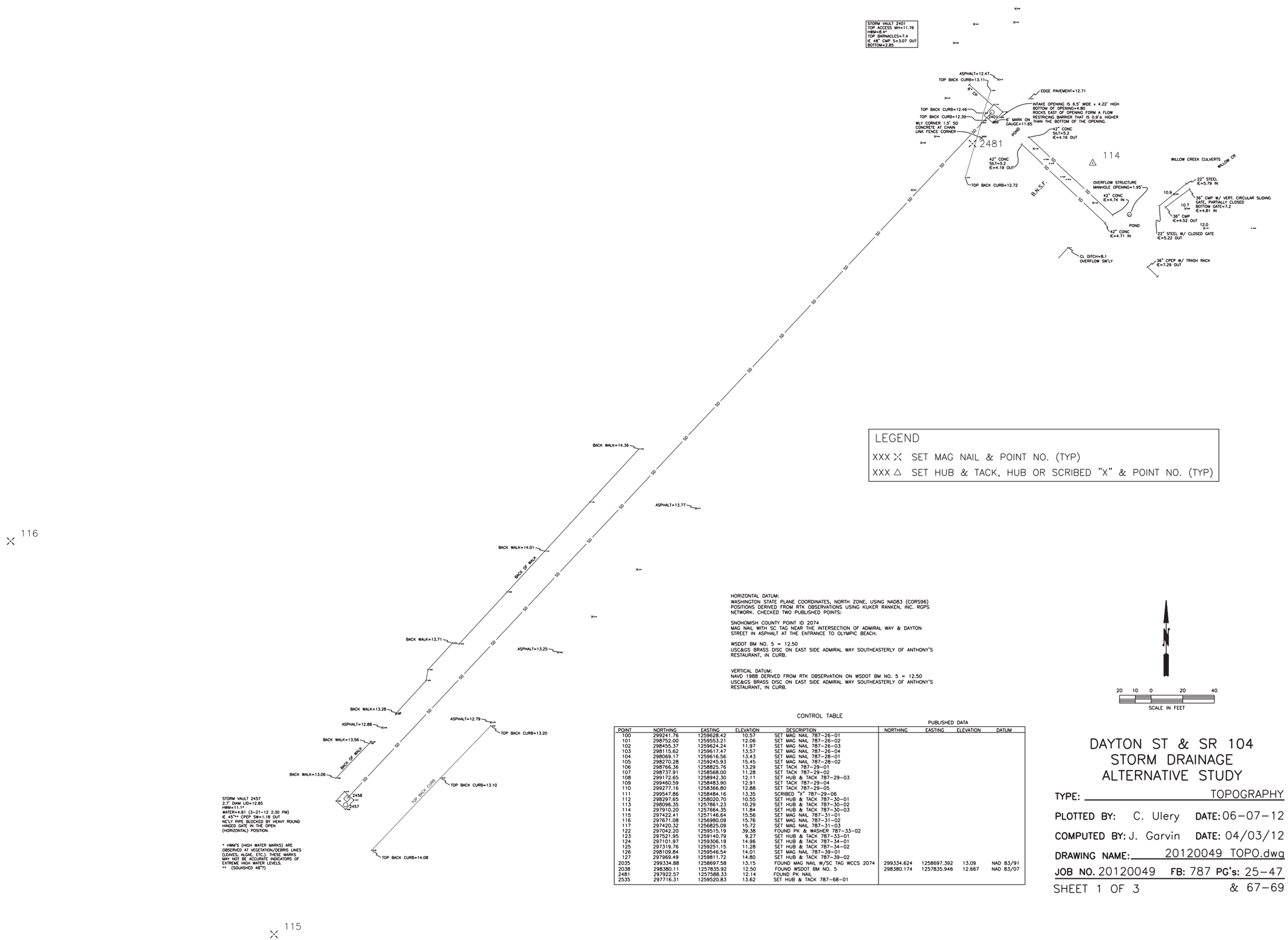
STORM LINE

STORM DITCH CREEK

Figure A-6
Ferry Queuing
Area Drainage

P:\ECI\1798-SEA\001772 Edmonds WA, City of\2651211002 Dayton St SR104 Alternatives Study\Data Analytical\GIS | 7-18-2013

Appendix B
FIELD SURVEY RESULTS



LEGEND

XXX ⨯ SET MAG NAIL & POINT NO. (TYP)

XXX △ SET HUB & TACK, HUB OR SCRIBED "X" & POINT NO. (TYP)

HORIZONTAL DATUM:
WASHINGTON STATE PLANE COORDINATES, NORTH ZONE, USING NAD83 (CORS96) POSITIONS DERIVED FROM RTK OBSERVATIONS USING KUKER RANKEN, INC. RGPS NETWORK. CHECKED TWO PUBLISHED POINTS:

SNOHOMISH COUNTY POINT ID 2074
MAG NAIL WITH SC TAG NEAR THE INTERSECTION OF ADMIRAL WAY & DAYTON STREET IN ASPHALT AT THE ENTRANCE TO OLYMPIC BEACH.

WSDOT BM NO. 5 = 12.50
USC&GS BRASS DISC ON EAST SIDE ADMIRAL WAY SOUTHEASTERLY OF ANTHONY'S RESTAURANT, IN CURB.

VERTICAL DATUM:
NAVD 1988 DERIVED FROM RTK OBSERVATION ON WSDOT BM NO. 5 = 12.50
USC&GS BRASS DISC ON EAST SIDE ADMIRAL WAY SOUTHEASTERLY OF ANTHONY'S RESTAURANT, IN CURB.

CONTROL TABLE

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION	PUBLISHED DATA NORTHING	EASTING	ELEVATION	DATUM
100	299241.76	1259628.42	10.57	SET MAG NAIL 787-26-01				
101	298752.00	1259553.21	12.06	SET MAG NAIL 787-26-02				
102	298455.37	1259624.24	11.97	SET MAG NAIL 787-26-03				
103	298115.62	1259617.47	13.57	SET MAG NAIL 787-26-04				
104	298069.17	1259616.56	13.43	SET MAG NAIL 787-28-01				
105	298270.28	1259245.93	15.45	SET MAG NAIL 787-28-02				
106	298766.36	1258825.76	13.29	SET TACK 787-29-01				
107	298737.91	1258568.00	11.28	SET TACK 787-29-02				
108	299172.65	1258942.30	12.11	SET HUB & TACK 787-29-03				
109	299460.59	1258483.90	12.91	SET TACK 787-29-04				
110	299277.16	1258366.80	12.88	SET TACK 787-29-05				
111	299547.86	1258484.16	13.35	SCRIBED "X" 787-29-06				
112	298297.65	1258020.70	10.55	SET HUB & TACK 787-30-01				
113	298096.35	1257861.23	10.29	SET HUB & TACK 787-30-02				
114	297910.20	1257664.35	11.84	SET HUB & TACK 787-30-03				
115	297422.41	1257146.64	15.56	SET MAG NAIL 787-31-01				
116	297671.08	1256980.09	15.76	SET MAG NAIL 787-31-02				
117	297420.32	1256825.09	15.72	SET MAG NAIL 787-31-03				
122	297042.20	1259515.19	39.38	FOUND PK & WASHER 787-33-02				
123	297521.95	1259140.79	9.27	SET HUB & TACK 787-33-01				
124	297101.97	1259306.19	14.96	SET HUB & TACK 787-34-01				
125	297319.76	1259251.15	11.28	SET HUB & TACK 787-34-02				
126	298109.84	1259546.54	14.01	SET MAG NAIL 787-39-01				
127	297969.49	1259811.72	14.80	SET HUB & TACK 787-39-02				
2035	299334.88	1258697.58	13.15	FOUND MAG NAIL W/SC TAG WCCS 2074	299334.624	1258697.392	13.09	NAD 83/91
2038	298380.11	1257835.92	12.50	FOUND WSDOT BM NO. 5	298380.174	1257835.946	12.667	NAD 83/07
2481	297922.57	1257588.33	12.14	FOUND PK NAIL				
2535	297716.31	1259520.83	13.62	SET HUB & TACK 787-68-01				

DAYTON ST & SR 104
STORM DRAINAGE
ALTERNATIVE STUDY

TYPE: TOPOGRAPHY

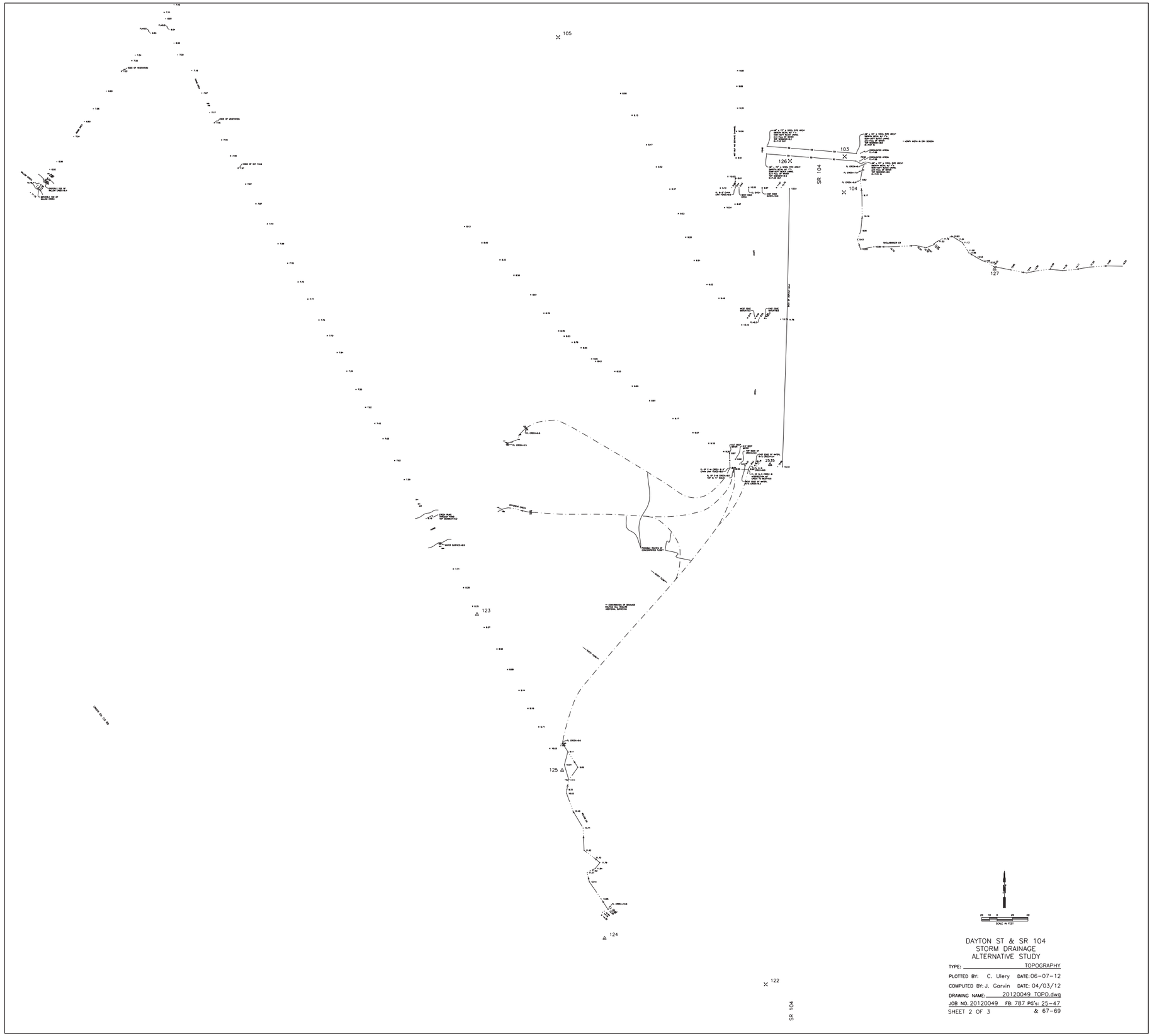
PLOTTED BY: C. Ulery DATE: 06-07-12

COMPUTED BY: J. Garvin DATE: 04/03/12

DRAWING NAME: 20120049 TOPO.dwg

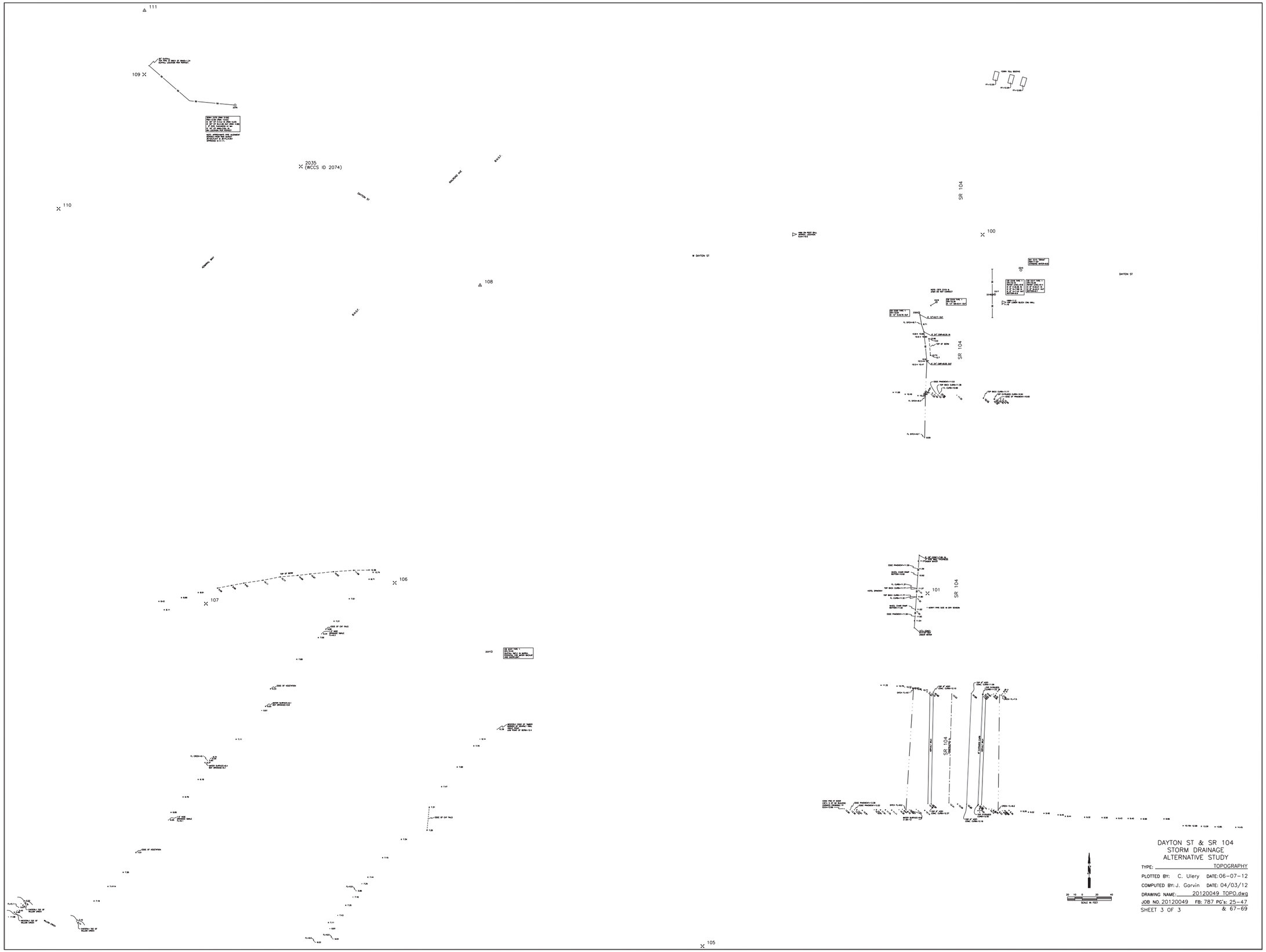
JOB NO. 20120049 FB: 787 PG's: 25-47

SHEET 1 OF 3 & 67-69



DAYTON ST & SR 104
STORM DRAINAGE
ALTERNATIVE STUDY

TYPE: TOPOGRAPHY
PLOTTED BY: C. Ulery DATE: 06-07-12
COMPUTED BY: J. Garvin DATE: 04/03/12
DRAWING NAME: 20120049 TOPO.dwg
JOB NO. 20120049 FB: 787 PG's: 25-47 & 67-69
SHEET 2 OF 3



DAYTON ST & SR 104
STORM DRAINAGE
ALTERNATIVE STUDY

TYPE: TOPOGRAPHY
PLOTTED BY: C. Ulery DATE: 06-07-12
COMPUTED BY: J. Garvin DATE: 04/03/12
DRAWING NAME: 20120049 TOPO.dwg
JOB NO. 20120049 FB: 787 PG's: 25-47 & 67-69
SHEET 3 OF 3

20 10 0 20 40
SCALE IN FEET

Appendix C
PRELIMINARY SCREENING OF ALTERNATIVES

Appendix C
PRELIMINARY SCREENING OF ALTERNATIVES

Following the modeling and assessment of the existing drainage system, the Consultant team completed a process of identifying potential solutions to reduce flood hazards and screening these down to a manageable set of solutions that could be evaluated in detail. That is, because detailed evaluation of alternatives involves signification effort in terms of modeling, cost estimating and evaluation of other factors, it was desirable to have the analysis be limited to a fewer number of potential alternative that appear the most favorable for implementation.

This began with the Consulting team and City staff working together to develop an initial draft list of alternatives that was presented to a broader audience. The preliminary alternatives were organized into near-term, medium-term, and long-term alternative solutions and shown on Table C-1. The table identified alternative components and associated pros and cons associated with the alternatives. This set of alternatives was then presented during a stakeholder meeting that included the following:

- City Staff (public works, planning, maintenance, stormwater)
- Washington Department of Transportation (WSDOT) (Roads)
- WSDOT Ferries
- Washington State Department of Fish and Wildlife
- Port of Edmonds
- Salish Crossing Property Representatives (one of the adjacent properties west of SR 104 and north of Dayton Street subject to recurrent flooding)

Burlington Northern Santa Fe was also invited to the meeting but did not attend. During the meeting, each set of alternatives was presented and input was received from the group. A summary of the meeting minutes is included at the end of Appendix C. From this discussion and input from the City, the draft preliminary list of alternatives was narrowed with input from City staff to a reduce set of alternatives shown on Table 2-1 in the main body of the report.

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Table C-1:
City of Edmonds
Initial List (Draft) of Alternatives for Screening – December 6, 2012

Alternative	Preliminary Description	Comments – Pro	Comments - Con
Short Term			
Maintenance of Shellabarger Creek/SR 104 Culvert	Remove sediment from culvert. If possible, include limited channel excavation downstream of culvert to improve hydraulics.	▪ Relatively minor permitting. ▪ Reduces overflows directed towards intersection.	
Add Monitoring Equipment to WSDOT Overflow	Add gage to assess and quantify overflows into marsh	▪ Be able to better assess frequency and duration of overflows. ▪ No permitting required, only coordination with WSDOT.	
Raise WSDOT Overflow (or Seal MH)	Raise or seal manhole at overflow location to prevent overflows into Willow Creek	▪ Could be phased improvement if monitoring determines that overflows are significant ▪ Low Cost ▪ Very simple permitting. Primarily requires WSDOT buyoff.	▪ Preliminary modeling indicates overflows may not have much impact on upstream marsh levels
Medium Term			
Isolate Dayton Street System from Marsh System	Use berming and/or plugging pipe System on east side of SR 104 to prevent/reduce Shellabarger Creek flows from extending north to Dayton System.	▪ Reduces flow to Dayton Street system (which is not designed to handle flows from Shellabarger Creek) ▪ By forcing flow into Shellabarger Creek, helps keep velocities higher and reduce deposition ▪ Low cost ▪ Straightforward permitting (may affect some ditch wetlands)	
Expand Dayton Street pump station system (Beach Place Pump Station)	Add pump capacity for Dayton System. This alternative would likely need to be combined with isolating the marsh system from Dayton Street system (alternative above) (otherwise pumps would need to be large). For longer term, would also need to add berming to isolate marsh from Harbor Square for the significant events.	▪ Likely straight forward permitting ▪ Low cost	▪ Most of benefit wouldn't be achieved until marsh system is isolated from Dayton system
Divert drainage from Salish Crossing	Divert some of the drainage from Salish Crossing to Dayton system. May only be effective if the Dayton street pump station is expanded.	▪ Reduces flood volume to marsh system ▪ Minimal permitting ▪ Low cost	
Divert upstream drainage from Dayton system	Divert some of the ferry lane and roadway areas to the north away from the Dayton Street system.	▪ Reduce flood volume to Dayton system ▪ Minimal permitting ▪ Low cost	▪ Need to assess impact to system receiving diverted flows
Replace Shellabarger Creek SR 104 Culvert	Replace Culvert with larger (fish passage) culvert.	▪ Additional modeling needed to evaluate benefit of upsizing culvert. ▪ Could integrate sump in replacement culvert to help trap sediments.	

Table C-1:
City of Edmonds
Initial List (Draft) of Alternatives for Screening – December 6, 2012

Alternative	Preliminary Description	Comments – Pro	Comments - Con
Long Term			
Restore Shellabarger Creek Channel downstream of SR 104	Excavate and restore Shellabarger Creek channel and possibly increase grades from SR 104 to Willow Creek. Restore creek planting.	▪ Eliminates current backwater effect on Shellabarger Creek crossing of SR 104 ▪ Restores stream channel ▪ Reduced sediment deposition in SR 104 culvert	▪ Significant permitting. Goal would be to attempt to re-establish original conditions, grades and restore Shellabarger Creek channel. ▪ Best if coordinated with Daylight Willow Creek, and Expand Marsh Flood Storage Volume actions for long-term sediment management.
Daylighting Creek (similar to former People for Puget Sound Plan)	Daylight creek to existing BNSF culvert and construct new channel outfall. Would likely require a manual/automated tide gate to function during combination of high tides and storm events	▪ Increases marsh diversity ▪ Improves fish and wildlife habitat ▪ Increases salt marsh area	▪ Will need to assess impacts to dog park. ▪ Likely needs tide gate to prevent loss of flood storage during storm events. ▪ May involve significant permitting, but assisted by preliminary work already completed and that the goal is restoration.
Expand Marsh Flood Storage Volume	Remove accumulated sediment from easterly portion of marsh and restore/expand brackish marsh area.	▪ Adds significant flood storage ▪ Expands salt water marsh area to increase habitat diversity. ▪ Expanded brackish habitat would reduce cattail area.	▪ Significant permitting. Goal would be to attempt to re-establish original conditions, grades and restore Shellabarger Creek channel. ▪ Best if coordinated with Daylight Willow Creek, and restore Shellabarger Creek actions for long-term sediment management.
Daylighting Creek (Similar to People for Puget Sound Plan) plus marsh pumping system	Daylight creek along east side of BNSF to existing BNSF bridge already constructed and construct new channel outfall downstream of BNSF bridge. Would likely require a manual/automated tide gate to function during combination of high tides and storm events. Add pump to keep marsh levels from flooding. Could use existing gravity outfall for discharge.	▪ Increases marsh diversity ▪ Improves fish habitat ▪ Increases salt marsh area	▪ May involve significant permitting, but assisted by preliminary work already completed and that the goal is restoration. ▪ Will need to assess impacts to dog park.
Raise intersection and Dayton Street	Raise road and intersection. This would also require isolation between marsh system and Dayton System. If wanted to also prevent flooding of adjacent private properties, would need added pumping for Dayton Street system	▪ Would need to assess impacts on private properties. ▪ No environmental permitting. ▪ Long-term, structural solution	▪ Costly ▪ Impacts to adjacent properties (access, flooding) ▪ Challenges may make this alternative not feasible.

STAKEHOLDER MEETING SUMMARY
City of Edmonds
Dayton Street and SR 104 Storm Drainage Alternatives Study
12-6-12 (1:30 – 3 pm)

Meeting Attendees:

- Phil Williams, City of Edmonds
- Stephen Clifton, City of Edmonds
- Jerry Shuster, City of Edmonds
- Mike DeLilla, City of Edmonds
- Tod Moles, City of Edmonds
- Kernen Lien, City of Edmonds
- Bob McCesney, Port of Edmonds
- Erik Hansen, WSDOT
- Jamie Bails, WDFW
- Josh Wozniak, Herrera
- Lindsey Echelbarger, Salish Crossing, LLC
- Tom Castor, WS Ferries
- Mike Giseburt, SAIC
- Joe Farah, SAIC

(Also see attached Sign-up Sheet)

The following paragraphs summarize the meeting discussion:

- Phil Williams and Jerry Shuster provided introductions and brief purpose for the meeting
- Mike Giseburt provided some history of flooding and purpose of the Study;
  - Determine major causes of flooding
  - Identify best alternatives to reduce flood hazards
- Joe Farah went into more depth at describing his recent account of the flooding that occurred on November 19th and showed several photographs.
- Mike went over the desired meeting outcomes (objectives); generally to;
  - Introduce Project to Parties affected by flooding
  - Summarize Initial Study Findings
  - Present Some Initial Ideas for Alternative Improvements
  - Solicit Input From Group So That We Can Focus on Those Alternatives Most Promising For Detailed Evaluation
- Mike and Jerry provided a description of the existing drainage systems that are the focus of the study.

- Jerry provided a discussion of the former "People for Puget Sound" project to daylight Willow Creek
- Mike provided a brief overview of the hydrologic/hydraulic modeling analysis and results and described the major causes of flooding. Mike then provided a discussion of the approach to the alternative analysis process.
- Mike touched on some of the recent sea level rise study information and noted that this would be one of the considerations when comparing alternatives.
- The remainder of the meeting focused on a discussion of the preliminary alternatives being considered to reduce flooding. A list of the alternatives was passed around and the alternatives were organized by short term, medium term, and long term solutions. Short term solutions were those that were smaller in scale and could be implemented with relative ease. Long term alternatives were generally those that were larger, more complex, involving significant permitting and/or stakeholder agreement which would take longer to implement. The preliminary list of alternatives was intended to reflect the full range of alternatives that could be implemented, and the goal was to focus in on those alternatives thought to be more promising. The following comments were noted.
  - Monitoring the WSDOT overflows was generally thought to be a good idea.
  - Raising the Rim (or sealing) of the WSDOT manhole would need to consider the effects on the upstream system. That is, would not want to create a new problem or move the problem upstream.
  - Regarding replacement of the Shellabarger Creek culvert crossing of SR 104, it was noted that creek takes a sharp turn to the north in order to enter the culvert. If replacing the culvert, consideration should be give to improving the alignment. It was also noted that this could be equipped with a downstream sump to help trap sediments at an acceptable location for maintenance. If it was elected that sediments be removed from the culvert as a short term solution, Jamie Bails indicated permitting could be obtained. It was also noted that the SR-104 culvert is probably towards the end of its service life and replacement could become more of a necessity.
  - Isolating the marsh drainage and keeping it separate from the Dayton Street drainage was thought to be a good alternative. It was noted that this should be coordinated with improvements to the Shellabarger Creek Culvert crossing of SR 104 (so it does not create a problem somewhere else). It was recommended that the reduction in flooding along Dayton St resulting from such isolation be further assessed so that the incremental impacts of such a solution are determined when combined with other solutions.
  - Re-establishing Shellabarger Creek between SR 104 and Willow Creek also was a favorable alternative, including combining this with large excavation to create more storage volume. The reestablishment of the Creek was noticeably an element of consensus among all attendees. As such, it was suggested that it might be considered as a short term rather than a long term alternative.

- In general, excavating the marsh to create additional flood storage was considered favorable. Jamie noted that any dredging in the wetland will have a length permitting process and will need to involve Ecology and the possibly the USACE. In addition, the permitting process will need to highlight the habitat restoration aspects of such improvements. SAIC would also need to assess how much excavation is needed to achieve certain reductions in flooding.
- Regarding pumping of the Dayton System, the City should consider the location does not have to be where the existing pump station is. We can choose the best location that makes sense. The existing location is not the best considering noise. The City does own some extra right-of-way near the intersection of Dayton/SR 104, but there are some potential utility conflicts with one of the WWTP systems.
- It was noted that the WS Ferry's plan to sell the former Union Oil clean-up site just south of the marsh.
- Raising the roads was not feasible.
- Harbor Square is currently considering redevelopment. Such redevelopment plans should be coordinated with the approach to the flooding mitigation project.

SAIC

COMP. _____ CHK. _____ REV. _____
DATE _____ DATE _____ DATE _____

PROJECT _____
FILE NO. _____
PAGE _____ OF _____ PAGES

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City of Edmonds

Dayton Street SR104 Storm Drain Alternative Study

NATIONAL SECURITY • ENERGY & ENVIRONMENT • HEALTH • CYBERSECURITY

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Background and Purpose of Study

November 2012

December 2007

- **Significant History of Flooding (minor flooding during small events, and major flooding during significant events)**
- **Study Purpose**
  - **Define major causes of flooding**
  - **Identify best alternatives to reduce flooding**

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Meeting Outcomes (Objectives)

- Introduce Project to Parties affected by flooding (Stakeholders)
- Summarize Initial Study Findings
- Present Some Initial Ideas for Alternative Improvements
- Solicit Input From Group So That We Can Focus on Those Alternatives Most Promising For Detailed Evaluation

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Existing Drainage System

- Tributary Basins

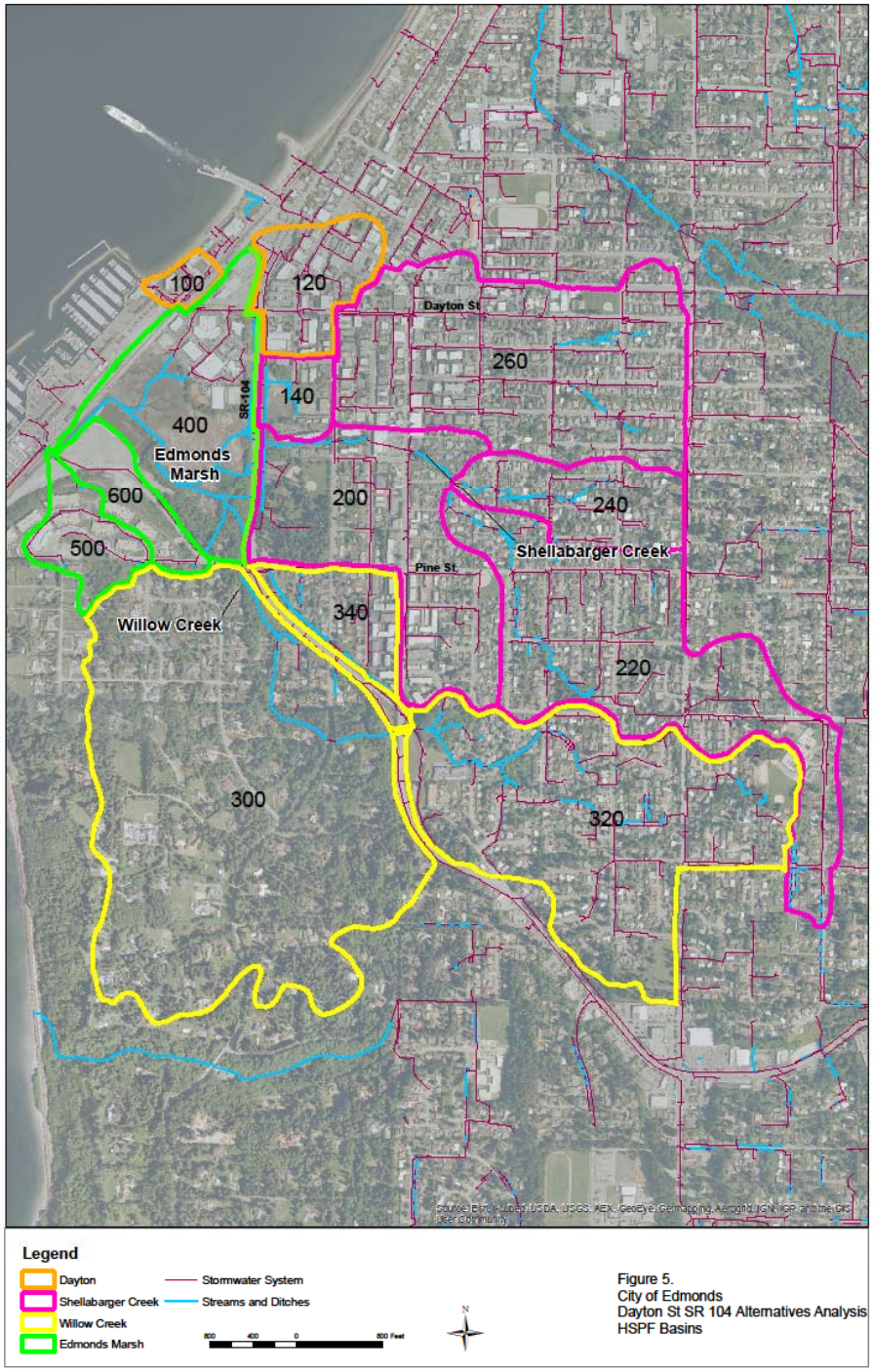

Figure 5.
City of Edmonds
Dayton St SR 104 Alternatives Analysis
HSPF Basins

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Existing Drainage System – Dayton Street and Marsh

1"=325' 325 0 325 650
Scale Feet

Creek/Ditch

Pipe/Culvert

Figure 1
Project Area

SAIC.
SAIC Energy, Environment & Infrastructure, LL

Other Relevant Projects

1"=325' 325 0 325 650
Scale Feet

Creek/Ditch

Pipe/Culvert

Figure 1
Project Area

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Hydrologic / Hydraulic Analysis

Methods

- Continuous hydrologic modeling
- Hydraulic modeling that takes into account history of flows and tides
- Simulate annual maximum water levels in marsh to establish flood frequencies

Findings/Causes of Flooding

- Tides have major impact, but flooding can also occur during non-extreme tides, particularly with high volume events.
- Shellabarger Creek overflows to north towards Dayton system (which was not designed to handle this flow).
- Significant sediment build-up both in and downstream of SR 104/Shellabarger Creek crossing affects hydraulics
- Dayton System would flood even if Shellabarger Creek overflows were removed.
- Intersection floods at less then 2-year event (often multiple times per year)
- Predicted 100-year elevation is 13.1 (2-3 feet depth)

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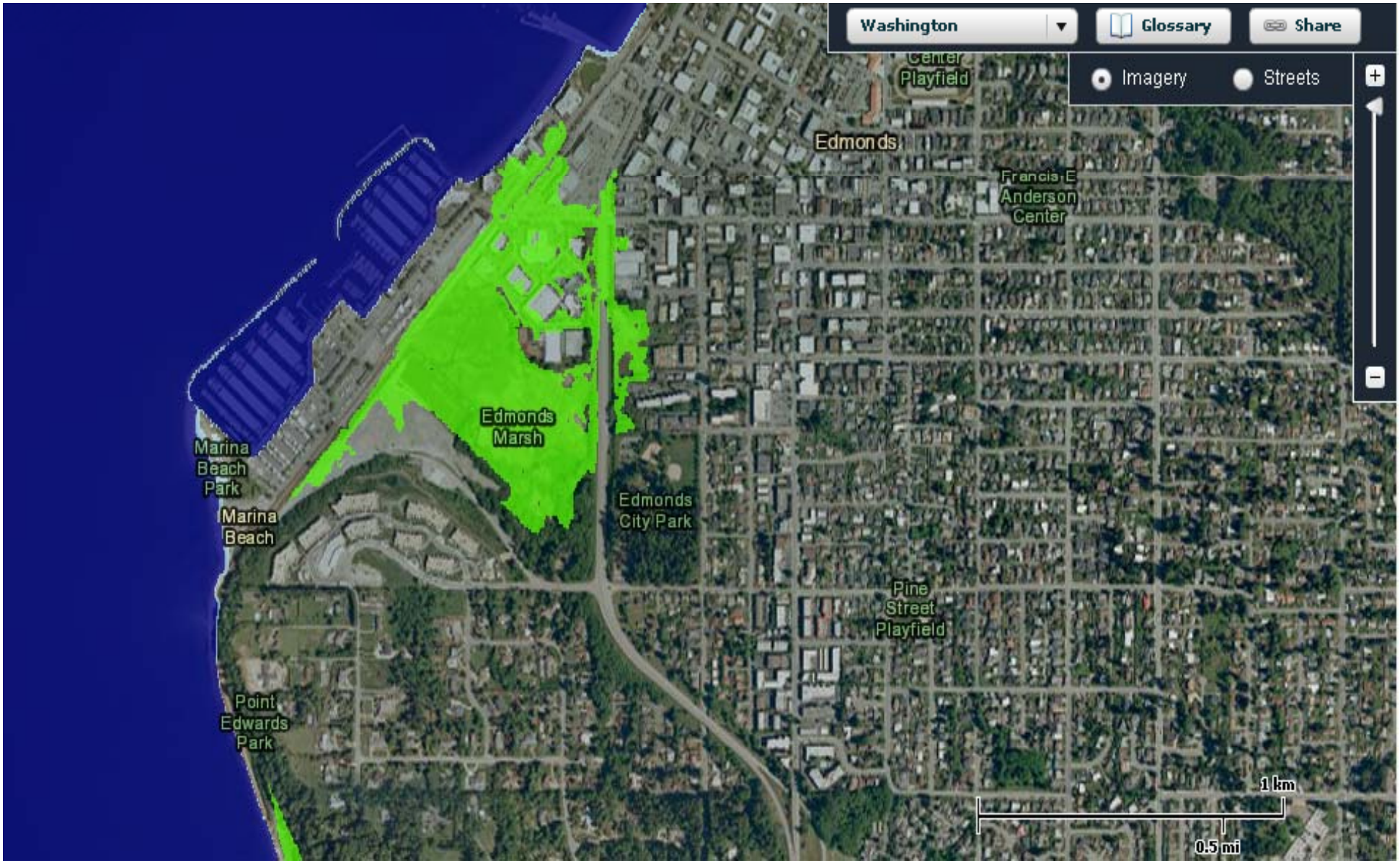
Approximate 100-year Inundation Area

(+/- 0.5 feet)



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Approach to Alternative Analysis

- Alternative Screening (Preliminary list of full range of options)
- Stakeholder Meeting (Solicit Your Input)
- Council Meeting (Keep Edmonds Council Informed) - January 2013
- Public Meeting (Solicit Public Input)
- Select Most Favorable Alternatives for Detailed Evaluation/Comparison (conduct H/H modeling, assess performance, benefits, cost, environmental impacts, sea level rise, etc.)
- Complete a Draft & Final Report

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Sea Level Rise - Considerations

- **FEMA is Completing Coastal Zone Flood Mapping Effort**
  (Preliminary flood mapping in Dec. 2013)
- **Sea Level Rise Projections (Climates Impacts Group and Ecology, 2008)**

SLR Estimate	2050	2100
Low	3”	6”
Medium	6”	13”
High	22”	50”

- **Sea Level Rise Impacts on Storm Surges along US Coasts: (March 2012, Climate Central/NOAA) Projects substantial changes in the frequency of what are now considered extreme water levels from storm surges. That is, it projects by 2050, the 100-year maximum storm surge could be experienced 2 x year.**

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Review Preliminary List of Alternatives (Short Term, Medium Term, Long Term) – Refer to Handout

1"=325' 325 0 325 650
Scale Feet

Creek/Ditch

Pipe/Culvert

Figure 1
Project Area

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SAIC Energy, Environment & Infrastructure, LL

Appendix D
COST ESTIMATES

Cost Estimate Index

Alternative	Element Description	Element Reference (See bottom of page)
1	Dayton Street Pump Station and Shellabarger Creek Restoration with Edmonds Marsh Expansion	
	Isolating Marsh System from Dayton	Alt1.1
	Dayton Street Pump Station	Alt1.2
	Shellabarger Creek Sediment Pond	Alt1.3
	Divert Salish Crossing to Dayton St System	Alt1.4
	Restore Shellabarger and Willow Creek to Marsh (1)	Alt1.5
	Remove Cattails and Excavate South Portion of Marsh	Alt1.6
	Divert Harbor Square Overflows to Dayton Pump Station	Alt1.7
	Ferry Queing Area Water Quality Treatment	Alt1.8
	Remove 36"/22" Culverts and Embankment	Alt1.9
2	Alternative 1 Improvements Plus Daylighting Willow Creek	
	Isolating Marsh System from Dayton	Alt2.4
	Dayton Street Pump Station	Alt1.2
	Shellabarger Creek Sediment Pond	Alt1.3
	Divert Salish Crossing to Dayton St System	Alt1.4
	Restore Shellabarger and Willow Creek to Marsh	Alt1.5
	Remove Cattails and Excavate South Portion of Marsh	Alt1.6
	Divert Harbor Square Overflows to Dayton Pump Station	Alt1.7
	Ferry Queing Area Water Quality Treatment	Alt1.8
	Remove 36"/22" Culverts and Embankment	Alt1.9
	Daylight Channel Construction (1)	Alt2.1
	Self-Regulating Tide Gate and Structure (1)	Alt2.2
	Existing 48-inch Willow Creek Outlet Pipe Modifcations	Alt2.3
3	Willow Creek Daylighting and Edmonds Marsh Pump Station	
	Isolating Marsh System from Dayton	Alt3.3
	Shellabarger Creek Sediment Pond	Alt1.3
	Restore Shellabarger and Willow Creek to Marsh	Alt1.5
	Ferry Queing Area Water Quality Treatment	Alt1.8
	Daylight Channel Construction (1)	Alt2.1
	Self-Regulating Tide Gate and Structure (1)	Alt2.2
	Edmonds Marsh Pump Station	Alt3.1
	Pipe Improvements Between Dayton and Marsh	Alt3.2
4	Large Dayton Street Pump Station with Minor Marsh Modifications	
	Dayton Street/SR 104 Pump Station	Alt4.1
	Shellabarger Creek Sediment Pond	Alt1.3
	Restore Shellabarger and Willow Creek to Marsh (1)	Alt1.5
	Ferry Queing Area Water Quality Treatment	Alt1.8
	Berming Marsh at Harbor Square and SR104	Alt4.2
	Remove 36"/22" Culverts and Embankment	Alt1.9
	Pipe Improvements At Intersection of Dayton St and SR104	Alt4.3
Recommended	Alternative 2 with Modifications	
	Clean/Lower Shellabarger Creek/SR104 Culvert (and maintenance of outlet channel)	Alt2M.1
	Remove 36"/22" Culverts and Embankment	Alt1.9
	Harbor Square Pipe Outfall Modification	Alt2M.3
	Willow Creek 48-inch Pipe Rehabilitation	Alt2M.2
	Raise or Seal WSDOT Overflow Manhole	NA
	Dayton Street Pump Station	Alt1.2
	Ferry Queuing Area Water Quality Treatment	Alt1.8
	Restore Shellabarger and Willow Creek to Marsh	Alt1.5
	Shellabarger Creek Sediment Pond	Alt1.3
	Isolating Marsh System from Dayton	Alt2.4
	Divert Salish Crossing to Dayton St System	Alt1.4
	Divert Harbor Square Overflows to Dayton Pump Station	Alt1.7
	Daylight Channel Construction (1)	Alt2.1
	Self-Regulating Tide Gate and Structure (1)	Alt2.2
	Existing 48-inch Willow Creek Outlet Pipe Modifcations	Alt2.3

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 1**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Isolating Marsh System from Dayton**				
	Modification to East Side of SR104 South of Dayton				
	Plug Existing Pipe	1	LS	$ 1,000	$ 1,000
	Berm Across East Side of Roadway Shoulder	1	LS	$ 5,000	$ 5,000
	Roadside/Landscape Restoration	1	LS	$ 500	$ 500
	Temporary Cofferdam (bypass)	1	LS	$ 1,000	$ 1,000
	Short Concrete Curb with footing for floodwall (approx. 1 ft)	150	LF	$ 80	$ 12,000
	Miscellaneous Construction Items (small incidentals)	1	LS	$ 2,000	$ 2,000
	Berm on West Side of Harbor Square	150	LF	$ 80	$ 12,000
	Clearing and Grubbing	0.1	AC	$ 4,000	$ 358
	Fill Material	170	CY	$ 25	$ 4,250
	Short Concrete Curb with footing for floodwall (approx. 2 ft)	150	LF	$ 100	$ 15,000
	Roadside/Landscape Restoration	1	LS	$ 5,000	$ 5,000
	Mitigation	0	AC	$ 15,000	$ 3,000
				Subtotal	$ 61,108
	Miscellaneous Construction Items (small incidentals)	10%			$ 6,111
	Tempoary Erosion & Sediment Control	10%			$ 6,111
	Traffic Control	0	LS		$ -
				Subtotal	$ 73,330
	Mobilization	10%			$ 7,333
				Subtotal	$ 81,000
	Contingency	30%			$ 24,300
				Subtotal	$ 105,300
	State Sales Tax	9.50%			$ 10,004
				Total Estimated Construction Cost (Rounded)	$ 115,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 23,000
	Permitting	10%			$ 11,500
	Construction Engineering and Administration	15%			$ 17,250
				Total Estimated Project Cost (Rounded)	**$ 167,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 1**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Dayton Street Pump Station**				
	Traffic Control	1	LS	$ 10,000	$ 10,000
	Excavation	200	CY	$ 35	$ 7,000
	Shoring	800	SF	$ 25	$ 20,000
	Dewatering	1	LS	$ 10,000	$ 10,000
	Pump Vault	1	LS	$ 25,000	$ 25,000
	Pump Vault Hatches	2	EA	$ 2,500	$ 5,000
	Foundation Preparation	1	LS	$ 5,000	$ 5,000
	6.5 cfs submersible pumps	2	EA	$ 40,000	$ 80,000
	Variable Frequency Drive	2	EA	$ 12,000	$ 24,000
	Pump Contols & MCC	1	LS	$ 40,000	$ 40,000
	Pump Controls - Panel and PLC	1	LS	$ 20,000	$ 20,000
	Pump Controls - Cable Conduit, Instrumentation	1	LS	$ 25,000	$ 25,000
	Pump Controls - Commissioning	1	LS	$ 30,000	$ 30,000
	Check Valve Vault	1	LS	$ 10,000	$ 10,000
	Swing Check Valve - 12"	2	EA	$ 14,000	$ 28,000
	Eccentric Plug Valve - 12"	2	EA	$ 6,000	$ 12,000
	Power Service	1	LS	$ 25,000	$ 25,000
	Storm Drain - 30"	20	LF	$ 150	$ 3,000
	Manholes	2	EA	$ 6,000	$ 12,000
	Force Main - 18"	170	LF	$ 150	$ 25,500
	New 18-inch Outfalll through Seawall	1	LS	$ 10,000	$ 10,000
	Pavement Removal	320	SY	$ 15	$ 4,800
	Pavement Restoration	320	SY	$ 25	$ 8,000
	Utility Relocations	1	LS	$ 10,000	$ 10,000
				Subtotal	$ 449,300
	Miscellaneous Construction Items (small incidentals)	10%			$ 44,930
	Tempoary Erosion & Sediment Control	5%			$ 22,465
				Subtotal	$ 516,695
	Mobilization	10%			$ 51,670
				Subtotal	$ 568,000
	Contingency	30%			$ 170,400
				Subtotal	$ 738,400
	State Sales Tax	9.50%			$ 70,148
				Total Estimated Construction Cost (Rounded)	$ 809,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 161,800
	Permitting	10%			$ 80,900
	Construction Engineering and Administration	15%			$ 121,350
				Total Estimated Project Cost (Rounded)	**$ 1,173,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Land Acquisition unit costs are for Administrative Costs only.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 1**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Shellabarger Creek Sediment Pond**				
	Access	1	LS	$ 1,000	$ 1,000
	Access Restoration	1	LS	$ 1,000	$ 1,000
	Temporary Stream Bypass	1	LS	$ 5,000	$ 5,000
	Clearing and Grubbing	0.2	AC	$ 4,000	$ 716
	Excavation (assume 40 x 100 x 6)	900	CY	$ 20	$ 18,000
	Haul and Disposal Excavated Mat'l	450	CY	$ 10	$ 4,500
	Haul and Disposal Excavated Mat'l (50% contaminated)	450	CY	$ 95	$ 42,750
	Construction Geotextile (for pond bottom strength)	444	SY	$ 4	$ 1,778
	CSBC (for pond bottom)	150	TN	$ 30	$ 4,500
	Permanent Maintenance Access Road	1	LS	$ 2,000	$ 2,000
	Roadside/Landscape Restoration	1	LS	$ 10,000	$ 10,000
				Subtotal	$ 91,244
	Miscellaneous Construction Items (small incidentals)	10%			$ 9,124
	Tempoary Erosion & Sediment Control	10%			$ 9,124
				Subtotal	$ 109,493
	Mobilization	10%			$ 10,949
				Subtotal	$ 120,000
	Contingency	30%			$ 36,000
				Subtotal	$ 156,000
	State Sales Tax	9.50%			$ 14,820
				Total Estimated Construction Cost (Rounded)	$ 171,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 34,200
	Permitting	10%			$ 17,100
	Construction Engineering and Administration	15%			$ 25,650
	Land Cost [4]	0.25	AC	$ 300,000	$ 75,000
				Total Estimated Project Cost (Rounded)	**$ 323,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Land Cost assuming assessed land value divided by entire parcel (no discount for wetland).

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 1**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Divert Salish Crossing to Dayton St System**				
	Storm Drain - 18"	30	LF	$ 80	$ 2,400
	Catch Basins	1	EA	$ 1,500	$ 1,500
	Manholes	1	EA	$ 6,000	$ 6,000
	Connection to Existing	1	EA	$ 500	$ 500
	Pavement Removal	30	SY	$ 15	$ 450
	Pavement Restoration	30	SY	$ 25	$ 750
	Utility Relocations	1	LS	$ 10,000	$ 10,000
	Dewatering	1	LS	$ 5,000	$ 5,000
				Subtotal	$ 26,600
	Miscellaneous Construction Items (small incidentals)	10%			$ 2,660
	Tempoary Erosion & Sediment Control	10%			$ 2,660
				Subtotal	$ 31,920
	Mobilization	10%			$ 3,192
				Subtotal	$ 35,000
	Contingency	30%			$ 10,500
				Subtotal	$ 45,500
	State Sales Tax	9.50%			$ 4,323
				Total Estimated Construction Cost (Rounded)	$ 50,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 10,000
	Permitting	10%			$ 5,000
	Construction Engineering and Administration	15%			$ 7,500
				Total Estimated Project Cost (Rounded)	**$ 73,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 1**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Restore Shellabarger and Willow Creek to Marsh[4]**				
	Clear and Grubbing (remove cattails)	1	AC	$ 3,500	$ 4,900
	Channel Excavation/Dredging	970	CY	$ 50	$ 48,500
	Haul and Disposal Excavated Mat'l	485	CY	$ 10	$ 4,850
	Haul and Disposal Excavated Mat'l (50% contaminated)	485	CY	$ 95	$ 46,075
	Stream Habitat Restoration (Habitat Features)	1	LS	$ 25,000	$ 25,000
	Revegetation	1	LS	$ 25,000	$ 25,000
				Subtotal	$ 154,325
	Miscellaneous Construction Items (small incidentals)	10%			$ 15,433
	Tempoary Erosion & Sediment Control	10%			$ 15,433
				Subtotal	$ 185,190
	Mobilization	10%			$ 18,519
				Subtotal	$ 204,000
	Contingency	30%			$ 61,200
				Subtotal	$ 265,200
	State Sales Tax	9.50%			$ 25,194
				Total Estimated Construction Cost (Rounded)	$ 290,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 58,000
	Permitting	10%			$ 29,000
	Construction Engineering and Administration	15%			$ 43,500
				Total Estimated Project Cost (Rounded)	**$ 421,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Cost Estimate taken from Willow Creek Daylighting Study (capital cost only) (Draft, S&W, 2013). Does not include Tide Gate.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 1**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Remove Cattails and Excavate South Portion of Marsh**				
	Clear and Grubbing (remove cattails)	9	AC	$ 3,500	$ 31,500
	Channel Excavation/Dredging	11,293	CY	$ 15	$ 169,400
	Haul and Disposal Excavated Mat'l	5,647	CY	$ 10	$ 56,467
	Haul and Disposal Excavated Mat'l (50% contaminated)	5,647	CY	$ 95	$ 536,433
	Stream Habitat Restoration (Habitat Features)	1	LS	$ 225,000	$ 225,000
	Revegetation	1	LS	$ 225,000	$ 225,000
	Control of Water/diversion/cofferdams	1	LS	$ 50,000	$ 50,000
				Subtotal	$ 1,293,800
	Miscellaneous Construction Items (small incidentals)	10%			$ 129,380
	Tempoary Erosion & Sediment Control	10%			$ 129,380
				Subtotal	$ 1,552,560
	Mobilization	10%			$ 155,256
				Subtotal	$ 1,708,000
	Contingency	30%			$ 512,400
				Subtotal	$ 2,220,400
	State Sales Tax	9.50%			$ 210,938
				Total Estimated Construction Cost (Rounded)	$ 2,431,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 486,200
	Permitting	10%			$ 243,100
	Construction Engineering and Administration	15%			$ 364,650
				Total Estimated Project Cost (Rounded)	**$ 3,525,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 1**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Divert Harbor Square Overflows to Dayton Pump Station**				
	Storm Drain - 18"	60	LF	$ 80	$ 4,800
	Catch Basins	2	EA	$ 1,500	$ 3,000
	Manholes	2	EA	$ 6,000	$ 12,000
	Connection to Existing	2	EA	$ 500	$ 1,000
	Pavement Removal	50	SY	$ 15	$ 750
	Pavement Restoration	50	SY	$ 25	$ 1,250
	Utility Relocations	1	LS	$ 10,000	$ 10,000
	Dewatering	1	LS	$ 8,000	$ 8,000
				Subtotal	$ 40,800
	Miscellaneous Construction Items (small incidentals)	10%			$ 4,080
	Tempoary Erosion & Sediment Control	10%			$ 4,080
				Subtotal	$ 48,960
	Mobilization	10%			$ 4,896
				Subtotal	$ 54,000
	Contingency	30%			$ 16,200
				Subtotal	$ 70,200
	State Sales Tax	9.50%			$ 6,669
				Total Estimated Construction Cost (Rounded)	$ 77,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 15,400
	Permitting	10%			$ 7,700
	Construction Engineering and Administration	15%			$ 11,550
				Total Estimated Project Cost (Rounded)	**$ 112,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 1**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Ferry Queing Area Water Quality Treatment**				
	Traffic Control	1	LS	$ 20,000	$ 20,000
	Excavation	150	CY	$ 35	$ 5,250
	Shoring	900	SF	$ 25	$ 22,500
	Dewatering	1	LS	$ 10,000	$ 10,000
	Coellescing Plate Vault	1	LS	$ 30,000	$ 30,000
	Vault Hatches	2	EA	$ 2,500	$ 5,000
	Contech StormFilter Vault	1	LS	$ 30,000	$ 30,000
	Foundaiton Preparation	1	LS	$ 5,000	$ 5,000
	Divering upstream drainage around WQ Facility, 12" SD	120	LF	$ 45	$ 5,400
	Storm Drain - 12"	20	LF	$ 45	$ 900
	Manholes	2	EA	$ 6,000	$ 12,000
	Pavement Removal	320	SY	$ 15	$ 4,800
	Pavement Restoration	320	SY	$ 25	$ 8,000
	Utility Relocations	1	LS	$ 10,000	$ 10,000
				Subtotal	$ 168,850
	Miscellaneous Construction Items (small incidentals)	10%			$ 16,885
	Tempoary Erosion & Sediment Control	5%			$ 8,443
				Subtotal	$ 194,178
	Mobilization	10%			$ 19,418
				Subtotal	$ 214,000
	Contingency	30%			$ 64,200
				Subtotal	$ 278,200
	State Sales Tax	9.50%			$ 26,429
				Total Estimated Construction Cost (Rounded)	$ 305,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 61,000
	Permitting	10%			$ 30,500
	Construction Engineering and Administration	15%			$ 45,750
				Total Estimated Project Cost (Rounded)	**$ 442,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Land Acquisition unit costs are for Administrative Costs only.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 1 - Remove 36"/22" Culverts and Embankment**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Remove 36"/22" Culverts and Embankment**				
	Clear and Grubbing	1	LS	$ 2,000	$ 2,000
	Channel Excavation	170	CY	$ 20	$ 3,400
	Haul and Disposal Excavated Mat'l	85	CY	$ 10	$ 850
	Haul and Disposal Excavated Mat'l (50% contaminated)	85	CY	$ 95	$ 8,075
	Remove 36"/22" and Gates	1	LS	$ 5,000	$ 5,000
	Stream Habitat Restoration (Habitat Features)	1	LS	$ 5,000	$ 5,000
	Revegetation	1	LS	$ 10,000	$ 10,000
	Control of Water/diversion/cofferdams	1	LS	$ 10,000	$ 10,000
				Subtotal	$ 44,325
	Miscellaneous Construction Items (small incidentals)	10%			$ 4,433
	Tempoary Erosion & Sediment Control	10%			$ 4,433
				Subtotal	$ 53,190
	Mobilization	10%			$ 5,319
				Subtotal	$ 59,000
	Contingency	30%			$ 17,700
				Subtotal	$ 76,700
	State Sales Tax	9.50%			$ 7,287
				Total Estimated Construction Cost (Rounded)	$ 84,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 16,800
	Permitting	10%			$ 8,400
	Construction Engineering and Administration	15%			$ 12,600
				Total Estimated Project Cost (Rounded)	**$ 122,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 2**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Daylight Channel Construction**				
	Daylight Channel Section above BNSF Bridge (Cost from S&W, 2				$ 1,306,600
	Beach Outfalll Construction(Downstream BNSF Bridge (Cost from S&W, 2013)[4]				$ 910,000
				Subtotal	$ 2,216,600
	Miscellaneous Construction Items (small incidentals)	0%			$ -
	Tempoary Erosion & Sediment Control	0%			$ -
				Subtotal	$ 2,216,600
	Mobilization	10%			$ 221,660
				Subtotal	$ 2,438,000
	Contingency	30%			$ 731,400
				Subtotal	$ 3,169,400
	State Sales Tax	9.50%			$ 301,093
				Total Estimated Construction Cost (Rounded)	$ 3,470,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 694,000
	Permitting	10%			$ 347,000
	Construction Engineering and Administration	15%			$ 520,500
				Total Estimated Project Cost (Rounded)	**$ 5,032,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Cost Estimate taken from Willow Creek Daylighting Study (capital cost only) (Draft, S&W, 2013). Does not include Tide Gate.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 2**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Daylight Channel Construction**				
	Self-Regulating Tide Gate (Cost from S&W, 2013)[4]				$ 250,000
				Subtotal	$ 250,000
	Miscellaneous Construction Items (small incidentals)	0%			$ -
	Tempoary Erosion & Sediment Control	0%			$ -
				Subtotal	$ 250,000
	Mobilization	10%			$ 25,000
				Subtotal	$ 275,000
	Contingency	30%			$ 82,500
				Subtotal	$ 357,500
	State Sales Tax	9.50%			$ 33,963
				Total Estimated Construction Cost (Rounded)	$ 391,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 78,200
	Permitting	10%			$ 39,100
	Construction Engineering and Administration	15%			$ 58,650
				Total Estimated Project Cost (Rounded)	**$ 567,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Cost Estimate taken from Willow Creek Daylighting Study (capital cost only) (Draft, S&W, 2013). Does not include Tide Gate.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 1**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Existing 48-inch Willow Creek Outlet Pipe Modifcations**				
	Traffic Control	1	LS	$ 1,000	$ 1,000
	Excavation	10	CY	$ 35	$ 350
	Dewatering/Control of Water	1	LS	$ 10,000	$ 10,000
	Concrete Weir (with adjustable plate)	1	LS	$ 10,000	$ 10,000
				Subtotal	$ 21,350
	Miscellaneous Construction Items (small incidentals)	10%			$ 2,135
	Tempoary Erosion & Sediment Control	5%			$ 1,068
				Subtotal	$ 24,553
	Mobilization	10%			$ 2,455
				Subtotal	$ 27,000
	Contingency	30%			$ 8,100
				Subtotal	$ 35,100
	State Sales Tax	9.50%			$ 3,335
				Total Estimated Construction Cost (Rounded)	$ 38,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 7,600
	Permitting	10%			$ 3,800
	Construction Engineering and Administration	15%			$ 5,700
				Total Estimated Project Cost (Rounded)	**$ 55,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Land Acquisition unit costs are for Administrative Costs only.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 2 - Isolating Marsh System from Dayton**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Isolating Marsh System from Dayton**				
	Modification to East Side of SR104 South of Daytong				
	Plug Existing Pipe	1	LS	$ 1,000	$ 1,000
	Berm Across East Side of Roadway Shoulder	1	LS	$ 5,000	$ 5,000
	Roadside/Landscape Restoration	1	LS	$ 500	$ 500
	Temporary Cofferdam (byass)	1	LS	$ 1,000	$ 1,000
	Short Concrete Curb with footing for floodwall (approx. 0.5 ft)	50	LF	$ 60	$ 3,000
	Miscellaneous Construction Items (small incidentals)	1	LS	$ 2,000	$ 2,000
	Berm on West Side of Harbor Square	150	LF	$ 80	$ 12,000
	Clearing and Grubbing	0.1	AC	$ 4,000	$ 358
	Fill Material	170	CY	$ 25	$ 4,250
	Short Concrete Curb with footing for floodwall (approx. 1 ft)	150	LF	$ 80	$ 12,000
	Roadside/Landscape Restoration	1	LS	$ 5,000	$ 5,000
	Mitigation	0	AC	$ 15,000	$ 3,000
				Subtotal	$ 49,108
	Miscellaneous Construction Items (small incidentals)	10%			$ 4,911
	Tempoary Erosion & Sediment Control	10%			$ 4,911
	Traffic Control	0	LS		$ -
				Subtotal	$ 58,930
	Mobilization	10%			$ 5,893
				Subtotal	$ 65,000
	Contingency	30%			$ 19,500
				Subtotal	$ 84,500
	State Sales Tax	9.50%			$ 8,028
				Total Estimated Construction Cost (Rounded)	$ 93,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 18,600
	Permitting	10%			$ 9,300
	Construction Engineering and Administration	15%			$ 13,950
				Total Estimated Project Cost (Rounded)	**$ 135,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 3**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Edmonds Marsh Pump Station**				
	Traffic Control	1	LS	$ 10,000	$ 10,000
	Excavation	1900	CY	$ 35	$ 66,500
	Shoring	5000	SF	$ 25	$ 125,000
	Dewatering	1	LS	$ 100,000	$ 100,000
	Pump Vault	1	LS	$ 72,000	$ 72,000
	Pump Vault Hatches	3	EA	$ 4,000	$ 12,000
	Foundation Preparation	1	LS	$ 10,000	$ 10,000
	25 cfs submersible pumps	2	EA	$ 70,000	$ 140,000
	Pump Contols & MCC	1	LS	$ 40,000	$ 40,000
	Pump Controls - Panel and PLC	1	LS	$ 20,000	$ 20,000
	Pump Controls - Cable Conduit, Instrumentation	1	LS	$ 25,000	$ 25,000
	Pump Controls - Commissioning	1	LS	$ 40,000	$ 40,000
	Check Valve Vault	1	LS	$ 25,000	$ 25,000
	Swing Check Valve - 24"	2	EA	$ 30,000	$ 60,000
	Eccentric Plug Valve - 24"	2	EA	$ 20,000	$ 40,000
	Power Service	1	LS	$ 25,000	$ 25,000
	Emergency Generator	1	LS	$ 50,000	$ 50,000
	Storm Drain - 48"	20	LF	$ 200	$ 4,000
	Manholes	2	EA	$ 15,000	$ 30,000
	Fish Screen Intake Structure (conc)	1	LS	$ 230,000	$ 230,000
	Fisc Screen (140' x 4')	1	LS	$ 140,000	$ 140,000
	Pavement Removal	500	SY	$ 15	$ 7,500
	Pavement Restoration	500	SY	$ 25	$ 12,500
	Utility Relocations	1	LS	$ 10,000	$ 10,000
	Fencing	250	LF	$ 30	$ 7,500
				Subtotal	$ 1,302,000
	Miscellaneous Construction Items (small incidentals)	20%			$ 260,400
	Tempoary Erosion & Sediment Control	5%			$ 65,100
				Subtotal	$ 1,627,500
	Mobilization	10%			$ 162,750
				Subtotal	$ 1,790,000
	Contingency	30%			$ 537,000
				Subtotal	$ 2,327,000
	State Sales Tax	9.50%			$ 221,065
				Total Estimated Construction Cost (Rounded)	$ 2,548,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 509,600
	Permitting	10%			$ 254,800
	Construction Engineering and Administration	15%			$ 382,200
				Total Estimated Project Cost (Rounded)	**$ 3,695,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Land Acquisition unit costs are for Administrative Costs only.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 3 - Pipe Improvements Between Dayton and Marsh**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Pipe Improvements Between Dayton and Marsh**				
	Traffic Control	1	LS	$ 10,000	$ 10,000
	Dewatering	1	LS	$ 20,000	$ 20,000
	Storm Drain - 30"	730	LF	$ 140	$ 102,200
	Manholes	5	EA	$ 6,000	$ 30,000
	Flap Gate at Outlet	1	LS	$ 5,000	$ 5,000
	Pavement Removal	650	SY	$ 15	$ 9,750
	Pavement Restoration	650	SY	$ 25	$ 16,250
	Utility Relocations	1	LS	$ 10,000	$ 10,000
				Subtotal	$ 203,200
	Miscellaneous Construction Items (small incidentals)	20%			$ 40,640
	Tempoary Erosion & Sediment Control	5%			$ 10,160
				Subtotal	$ 254,000
	Mobilization	10%			$ 25,400
				Subtotal	$ 279,000
	Contingency	30%			$ 83,700
				Subtotal	$ 362,700
	State Sales Tax	9.50%			$ 34,457
				Total Estimated Construction Cost (Rounded)	$ 397,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 79,400
	Permitting	10%			$ 39,700
	Construction Engineering and Administration	15%			$ 59,550
				Total Estimated Project Cost (Rounded)	**$ 576,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Land Acquisition unit costs are for Administrative Costs only.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 3 - Isolating Marsh System from Dayton**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Isolating Marsh System from Dayton**				
	Modification to East Side of SR104 South of Dayton				
	Plug Existing Pipe	1	LS	$ 1,000	$ 1,000
	Berm Across East Side of Roadway Shoulder	1	LS	$ 5,000	$ 5,000
	Roadside/Landscape Restoration	1	LS	$ 500	$ 500
	Temporary Cofferdam (byass)	1	LS	$ 1,000	$ 1,000
	Short Concrete Curb with footing for floodwall (approx. 1 ft)	150	LF	$ 80	$ 12,000
	Miscellaneous Construction Items (small incidentals)	1	LS	$ 2,000	$ 2,000
	Berm on West Side of Harbor Square	0	LF	$ 80	$ -
	Clearing and Grubbing	0.1	AC	$ 4,000	$ 358
	Fill Material	170	CY	$ 25	$ 4,250
	Short Concrete Curb with footing for floodwall (approx. 2 ft)	0	LF	$ 100	$ -
	Roadside/Landscape Restoration	1	LS	$ 5,000	$ 5,000
	Mitigation	0	AC	$ 15,000	$ 3,000
				Subtotal	$ 34,108
	Miscellaneous Construction Items (small incidentals)	10%			$ 3,411
	Tempoary Erosion & Sediment Control	10%			$ 3,411
	Traffic Control	0	LS		$ -
				Subtotal	$ 40,930
	Mobilization	10%			$ 4,093
				Subtotal	$ 45,000
	Contingency	30%			$ 13,500
				Subtotal	$ 58,500
	State Sales Tax	9.50%			$ 5,558
				Total Estimated Construction Cost (Rounded)	$ 64,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 12,800
	Permitting	10%			$ 6,400
	Construction Engineering and Administration	15%			$ 9,600
				Total Estimated Project Cost (Rounded)	**$ 93,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 3**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Dayton St/SR104 Pump Station**				
	Traffic Control	1	LS	$ 40,000	$ 40,000
	Excavation	400	CY	$ 35	$ 14,000
	Shoring	1400	SF	$ 25	$ 35,000
	Dewatering	1	LS	$ 25,000	$ 25,000
	Pump Vault	1	LS	$ 35,000	$ 35,000
	Pump Vault Hatches	2	EA	$ 4,000	$ 8,000
	Foundation Preparation	1	LS	$ 8,000	$ 8,000
	10 cfs submersible pumps	3	EA	$ 50,000	$ 150,000
	Pump Contols & MCC	1	LS	$ 40,000	$ 40,000
	Pump Controls - Panel and PLC	1	LS	$ 20,000	$ 20,000
	Pump Controls - Cable Conduit, Instrumentation	1	LS	$ 25,000	$ 25,000
	Pump Controls - Commissioning	1	LS	$ 30,000	$ 30,000
	Check Valve Vault	1	LS	$ 20,000	$ 20,000
	Swing Check Valve - 16"	3	EA	$ 20,000	$ 60,000
	Eccentric Plug Valve - 16"	3	EA	$ 12,000	$ 36,000
	Power Service	1	LS	$ 25,000	$ 25,000
	Emergency Generator (portable)	1	LS	$ 50,000	$ 50,000
	Storm Drain - 30"	20	LF	$ 140	$ 2,800
	Manholes	2	EA	$ 8,000	$ 16,000
	Force Main - 30"	1,100	LF	$ 200	$ 220,000
	Borring and Jacking Carrier Pipe under RR	100	LF	$ 400	$ 40,000
	Boring and Jacking Pits	2	EA	$ 10,000	$ 20,000
	Air Release Valve	2	ea	$ 3,000	$ 6,000
	New 30-inch Outfalll through Seawall	1	LS	$ 15,000	$ 15,000
	Pavement Removal	2,400	SY	$ 15	$ 36,000
	Pavement Restoration (assume 1/2 street)	140	TN	$ 160	$ 22,400
	Special Sidewalk Restoration (near outfall)	200	SY	$ 40	$ 8,000
	Utility Relocations	1	LS	$ 30,000	$ 30,000
				Subtotal	$ 1,037,200
	Miscellaneous Construction Items (small incidentals)	20%			$ 207,440
	Tempoary Erosion & Sediment Control	5%			$ 51,860
				Subtotal	$ 1,296,500
	Mobilization	10%			$ 129,650
				Subtotal	$ 1,426,000
	Contingency	30%			$ 427,800
				Subtotal	$ 1,853,800
	State Sales Tax	9.50%			$ 176,111
				Total Estimated Construction Cost (Rounded)	$ 2,030,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 406,000
	Permitting	10%			$ 203,000
	Construction Engineering and Administration	15%			$ 304,500
				Total Estimated Project Cost (Rounded)	**$ 2,944,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Land Acquisition unit costs are for Administrative Costs only.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 4 - Berming Marsh at Harbor Square and SR104**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Berming Marsh at Harbor Square and SR104**				
	Modification to East Side of SR104 South of Daytong				
	Berm Across East Side of Roadway Shoulder	1	LS	$ 5,000	$ 5,000
	Roadside/Landscape Restoration	1	LS	$ 500	$ 500
	Short Concrete Curb with footing for floodwall (approx. 1 ft)	150	LF	$ 80	$ 12,000
	Miscellaneous Construction Items (small incidentals)	1	LS	$ 2,000	$ 2,000
	Berm on West Side of Harbor Square	150	LF	$ 80	$ 12,000
	Clearing and Grubbing	0.1	AC	$ 4,000	$ 358
	Fill Material	170	CY	$ 25	$ 4,250
	Short Concrete Curb with footing for floodwall (approx. 2 ft)	150	LF	$ 100	$ 15,000
	Roadside/Landscape Restoration	1	LS	$ 5,000	$ 5,000
	Mitigation	0	AC	$ 15,000	$ 3,000
				Subtotal	$ 59,108
	Miscellaneous Construction Items (small incidentals)	10%			$ 5,911
	Tempoary Erosion & Sediment Control	10%			$ 5,911
	Traffic Control	0	LS		$ -
				Subtotal	$ 70,930
	Mobilization	10%			$ 7,093
				Subtotal	$ 78,000
	Contingency	30%			$ 23,400
				Subtotal	$ 101,400
	State Sales Tax	9.50%			$ 9,633
				Total Estimated Construction Cost (Rounded)	$ 111,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 22,200
	Permitting	10%			$ 11,100
	Construction Engineering and Administration	15%			$ 16,650
				Total Estimated Project Cost (Rounded)	**$ 161,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/jf**
Client:	**City of Edmonds**		
Description	**Alternative 3 - Pipe Improvements at Dayton St/SR 104 Intersection**	**DATE:**	**4/15/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Pipe Improvements At Intersection of Dayton St and SR104**				
	Traffic Control	1	LS	$ 10,000	$ 10,000
	Dewatering	1	LS	$ 10,000	$ 10,000
	Storm Drain - 30"	730	LF	$ 30	$ 21,900
	Manholes	2	EA	$ 6,000	$ 12,000
	Pavement Removal	30	SY	$ 15	$ 450
	Pavement Restoration	30	SY	$ 25	$ 750
	Utility Relocations	1	LS	$ 10,000	$ 10,000
				Subtotal	$ 65,100
	Miscellaneous Construction Items (small incidentals)	20%			$ 13,020
	Tempoary Erosion & Sediment Control	5%			$ 3,255
				Subtotal	$ 81,375
	Mobilization	10%			$ 8,138
				Subtotal	$ 90,000
	Contingency	30%			$ 27,000
				Subtotal	$ 117,000
	State Sales Tax	9.50%			$ 11,115
				Total Estimated Construction Cost (Rounded)	$ 128,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 25,600
	Permitting	10%			$ 12,800
	Construction Engineering and Administration	15%			$ 19,200
				Total Estimated Project Cost (Rounded)	**$ 186,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Land Acquisition unit costs are for Administrative Costs only.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/ma**
Client:	**City of Edmonds**		
Description	**Alternative 2 (modified)**	**DATE:**	**7/18/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Clean SR 104 Culvert and Shellabarger Creek Maintenance[4]**				
	Clear and Grubbing (remove cattails)	0.1	AC	$ 10,000	$ 1,000
	Channel Excavation/Dredging, assumes (2'x10'x200')[5]	148	CY	$ 200	$ 29,600
	Haul and Disposal Excavated Mat'l	74	CY	$ 10	$ 740
	Haul and Disposal Excavated Mat'l (50% contaminated)	74	CY	$ 95	$ 7,030
	Stream Diversion	1	LS	$ 5,000	$ 5,000
	Revegetation	1	LS	$ 5,000	$ 5,000
				Subtotal	$ 48,370
	Miscellaneous Construction Items (small incidentals)	10%			$ 4,837
	Tempoary Erosion & Sediment Control	10%			$ 4,837
				Subtotal	$ 58,044
	Mobilization	10%			$ 5,804
				Subtotal	$ 64,000
	Contingency	30%			$ 19,200
				Subtotal	$ 83,200
	State Sales Tax	9.50%			$ 7,904
				Total Estimated Construction Cost (Rounded)	$ 91,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 18,200
	Permitting	10%			$ 9,100
	Construction Engineering and Administration	15%			$ 13,650
				Total Estimated Project Cost (Rounded)	**$ 132,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Cost Estimate based on culvert maintenance and downstream channel maintenance.
5. Assume hand work.

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/ma**
Client:	**City of Edmonds**		
Description	**Alternative 2 (modified)**	**DATE:**	**7/18/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Willow Creek 48-inch Pipe Rehabilitation(5)**				
	Traffic Control	1	LS	$ 1,000	$ 1,000
	Excavation	10	CY	$ 35	$ 350
	Dewatering/Control of Water	1	LS	$ 20,000	$ 20,000
	Pipe Rehabilitation	600	LF	$ 295	$ 177,000
				Subtotal	$ 198,350
	Miscellaneous Construction Items (small incidentals)	10%			$ 19,835
	Tempoary Erosion & Sediment Control	5%			$ 9,918
				Subtotal	$ 228,103
	Mobilization	10%			$ 22,810
				Subtotal	$ 251,000
	Contingency	30%			$ 75,300
				Subtotal	$ 326,300
	State Sales Tax	9.50%			$ 30,999
				Total Estimated Construction Cost (Rounded)	$ 357,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 71,400
	Permitting	10%			$ 35,700
	Construction Engineering and Administration	15%			$ 53,550
				Total Estimated Project Cost (Rounded)	**$ 518,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Land Acquisition unit costs are for Administrative Costs only.
5. Cost generally taken from 2010 City of Edmonds Comprehensive Drainage Plan

PLANNING LEVEL COST OPINION

SAIC

PROJECT:	**Dayton Street/SR 104 Storm Drain Alternatives Study**	**BY:**	**msg/ma**
Client:	**City of Edmonds**		
Description	**Alternative 2 (modified)**	**DATE:**	**7/26/2013**

	BID ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	CONSTRUCTION COSTS				
Element:	**Harbor Square Pipe Outfall Modifications**				
	Traffic Control	1	LS	$ 1,000	$ 1,000
	Excavation	6	CY	$ 50	$ 300
	Dewatering/Control of Water	1	LS	$ 5,000	$ 5,000
	Haul and Disposal Excavated Mat'l	3	CY	$ 10	$ 30
	Haul and Disposal Excavated Mat'l (50% contaminated)	3	CY	$ 95	$ 285
	Flap Gate	2	EA	$ 5,000	$ 10,000
				Subtotal	$ 16,615
	Miscellaneous Construction Items (small incidentals)	10%			$ 1,661.50
	Tempoary Erosion & Sediment Control	5%			$ 830.75
				Subtotal	$ 19,107
	Mobilization	10%			$ 1,910.73
				Subtotal	$ 21,000
	Contingency	30%			$ 6,300
				Subtotal	$ 27,300
	State Sales Tax	9.50%			$ 2,594
				Total Estimated Construction Cost (Rounded)	$ 30,000
	INDIRECT COSTS				
	Surveying and Design	20%			$ 6,000
	Permitting	10%			$ 3,000
	Construction Engineering and Administration	15%			$ 4,500
				Total Estimated Project Cost (Rounded)	**$ 44,000**

Notes:

1. The above cost opinion is in 2013 dollars and does not include future escalation, financing, or O&M costs.
2. The construction items and quantities are based upon conceptual solution types and should be considered conceptual. See Report text.
3. SD costs include trenching, bedding, pipe and backfill.
4. Land Acquisition unit costs are for Administrative Costs only.

Appendix E
CITY COUNCIL AND PUBLIC OPEN HOUSE MEETINGS

Briefing on the Status of the Dayton Street & SR104 Drainage Alternatives Study.

May 28, 2013

Jerry Shuster, P.E., Stormwater Engineering Program Manager

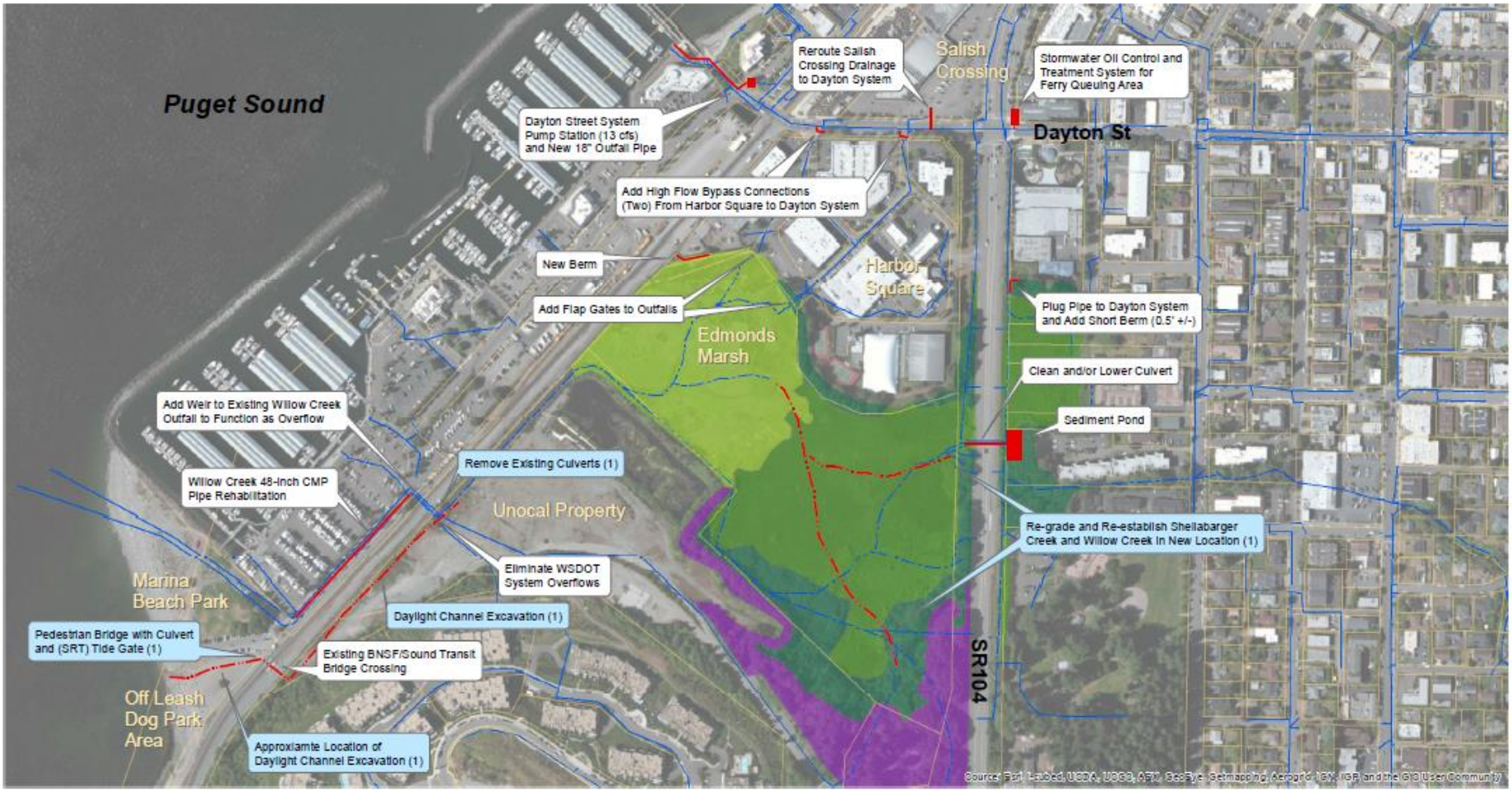
Why does the intersection flood?

1. The inability of Shellabarger Creek to entirely flow under SR104 into Edmonds Marsh and the inability of getting the flow out of the Marsh into Puget Sound in timely manner.
2. The elevation of the Dayton St. stormwater line at the intersection of SR104 is lower than the water level in Puget Sound during much of the tidal cycle.

Dayton St. Storm line outfall into Puget Sound
DAYTON
ADMIRAL
EDMONDS
2ND
ALDER
3RD
Shellabarger Creek culverts under SR 104
12 CMP
18 CMP
24 CONCRETE
15 CMP
8 CMP
12 CONCRETE
18 CONCRETE
8 CONCRETE
24 CMP
36 CONCRETE
12 PVC
48 CMP

What is the Recommended Alternate to Reduce the Flooding?

- Isolate the two main drainage systems
  - Dayton St System
  - Willow Creek/Shellabarger Creek/Edmonds Marsh system
- Improve Conveyance to Puget Sound for both systems



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Feet

0 162.5 325

Legend

- Forested Upland (2)
- Forested Wetland
- Freshwater Emergent
- Mudflat and Salt Marsh
- Parcels
- Existing Storm Drain
- Existing Channel
- Proposed Storm Drain/Berm
- Proposed Channel
- Proposed Water Quality or Conveyance Facility

Notes: (1) As proposed under separate Willow Creek Daylighting Study, Shannon and Wilson, 2013.
(2) Marsh wetland designations are approximate and taken from Shannon and Wilson, 2013.

Recommended Alternative

SAIC From Science to Solutions

R:\Seattle\001772 Edmonds WA, City of\2651211002 Dayton St SR104 Alternatives Study\Data Analytical\GIS | 5-20-2013

What are the Estimated Planning Level Costs?

Item	Estimated Cost
Isolate the two main drainage systems (incl. sediment pond)	$ 458,000
Improve Conveyance	
Dayton St System	
Pump Station	$ 1,173,000
Connect Salish Crossing flow and Harbor Square Overflow	$ 185,000
WQ Treatment for Ferry Holding Lanes	$ 442,000
Edmonds Marsh System	
Willow Creek Daylighting (incl. channel restoration)	$ 5,450,000
Harbor Square flap gates and berm	$ 200,000
Rehab existing pipe/outlet improvements	$ 400,000
Self-regulating tidegate (TBD)	$ 567,000
Estimated Total	$ 8,875,000

What are the next steps?

- Public Open House in late spring/early summer 2013 to present the recommended alternatives and get input.
- Work with stakeholders to develop plan to implement preferred alternatives.
- Move projects into CIP for design and implementation.

Questions?

AM-5789 **8.**

City Council Meeting

Meeting Date:	05/28/2013		
Time:	20 Minutes		
Submitted For:	Jerry Shuster	**Submitted By:**	Megan Luttrell
Department:	Engineering		
Review Committee:		**Committee Action:**	
Type:	Information		

Information

Subject Title

Briefing on the Recommended Alternative – Dayton Street & SR104 Drainage Study

Recommendation

For information only.

Previous Council Action

On January 15, 2013, the Council was updated on this project. The briefing included the reason the intersection floods and a discussion of the next steps.

Narrative

The intersection of Dayton St. and SR104 frequently floods. Flooding was particularly evident on November 19, 2012 when 2.26 inches of precipitation fell in a 24-hr period. The intersection and immediate vicinity is an economic and transportation focal point for the City, Port of Edmonds, Washing Department of Transportation, Washington State Ferries, Sound Transit and private commercial property owners.

Briefly, the primary causes of the flooding at the intersection during moderate to large storm events are:

- The inability of Shellabarger Creek to entirely flow under SR104 into Edmonds Marsh. The flow, instead, travels north along the eastern ditch line of SR104 overwhelming the storm system at the Dayton St. intersection. The culverts under SR104 that are supposed to carry the Shellabarger Creek flow into the marsh are partially silted restricting their capacity. More importantly, the Marsh has silted in over the years such that the flow has "no place to go."
- The elevation of the Dayton St. stormwater line at the intersection of SR104 is lower than the water level in Puget Sound during much of the tidal cycle; this means the water cannot flow on its own into Puget Sound when the tide is up. Even if the Shellabarger Creek flow was removed from the Dayton St. storm system, the intersection would still flood in larger storms.

The recommended alternative:

1. Isolate the two main drainage systems:

- Prevent Shellabarger Creek from flowing north the intersection by:
  o Cleaning/lowering/replacing the culverts under SR 104

o Plugging the existing 24-inch pipe that extends along the east side of SR 104 along with some berming near the inlet of this pipe.
o Incorporate an in-line sediment trap on Shellabarger Creek upstream of the SR 104 culvert crossing.

2. Improve conveyance to Puget Sound.

- Dayton Street System
  o Install large pump station east in City/Port owned Beach Place parking lot to move peak flows out of the Dayton stormwater main line into Puget Sound.
  o Connect south part of Salish Crossing site (that currently drains though Harbor Square and into the Marsh) and overflow from the Harbor Square system into this pump station.
  o Add water quality treatment from runoff from ferry holding lanes.

- Edmonds Marsh System
  o Re-establish Shellabarger Creek and Willow Creek channels in the Marsh and daylight Willow Creek.
  o Add low berm between Marsh and southwest part of Harbor Square
  o Add flap gates to Harbor Square discharge pipes to Marsh to prevent backflow (storm system owned by the City).
  o Rehab existing 48-inch Willow Creek outfall pipe and other improvements to serve as an emergency overflow for the Marsh.

A public meeting will be held in late spring or early summer to present the detailed analysis of alternatives and get input. Staff will continue to work with the Stakeholders and the consultant to develop a plan to implement the most effective alternative solutions. The study is expected to be completed in the 3nd quarter of 2013.

Fiscal Impact:

The following are planning level cost opinion for this recommended alternative (includes entire Willow Creek Daylighting Project):

Item	**Estimated Cost**
Isolate the two main drainage systems (incl. sediment pond)	$458,000
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Rehab existing pipe/outlet improvements	$400,000
Self-regulating tidegate (TBD)	$567,000
Estimated Total	**$8,970,000**

Attachments

Recommended Alternative

Form Review

Inbox	Reviewed By	Date
Engineering	Robert English	05/23/2013 11:49 AM
Public Works	Phil Williams	05/23/2013 01:58 PM
City Clerk	Sandy Chase	05/23/2013 02:00 PM
Mayor	Dave Earling	05/23/2013 02:46 PM
Finalize for Agenda	Sandy Chase	05/23/2013 02:50 PM
Form Started By: Megan Luttrell		Started On: 05/23/2013 09:58 AM
Final Approval Date: 05/23/2013		

Public Open House
Dayton Street & SR104 Drainage Alternatives Study

June 20, 2013

Jerry Shuster, P.E.

Stormwater Engineering Program Manager

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

SAIC

OUTLINE

- Why does the intersection flood?
- What are the components Recommended Alternative to reduce the frequency of flooding?
- How much will it cost?

Why does the intersection flood?

1. The inability of Shellabarger Creek to entirely flow under SR104 into Edmonds Marsh and the inability of getting the flow out of the Marsh into Puget Sound in timely manner.
2. The elevation of the Dayton St. stormwater line at the intersection of SR104 is lower than the water level in Puget Sound during much of the tidal cycle.

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What is the Recommended Alternate to Reduce the Flooding?

- Separate the two main drainage systems
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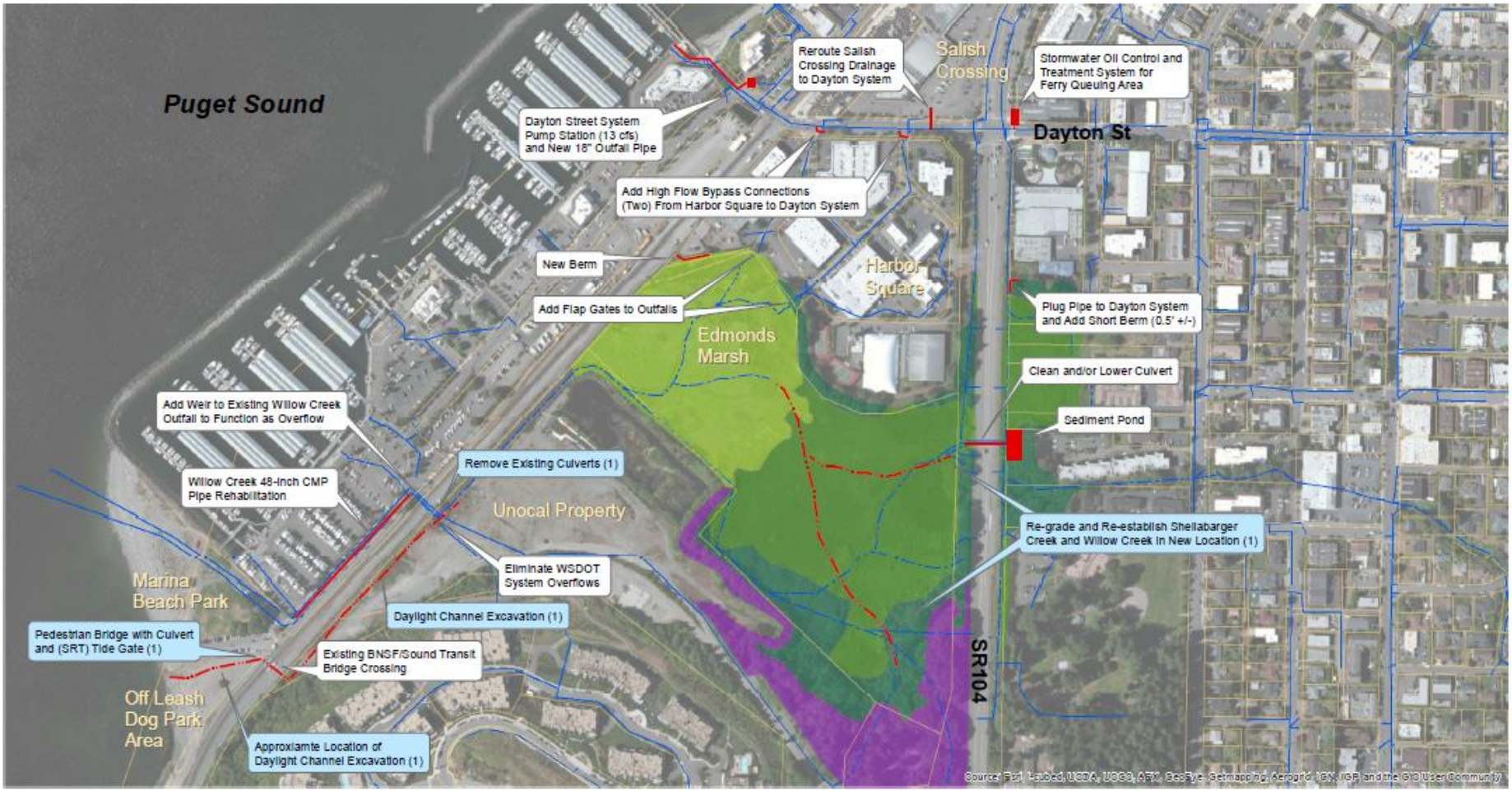
- Improve Conveyance to Puget Sound for both systems



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- Freshwater Emergent
- Mudflat and Salt Marsh
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Notes: (1) As proposed under separate Willow Creek Daylighting Study, Shannon and Wilson, 2013.
(2) Marsh wetland designations are approximate and taken from Shannon and Wilson, 2013.

Recommended Alternative

SAIC From Science to Solutions

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Cat Tails Overgrown Shellabarger Creek Channel in Marsh

Willow Creek – Open Channel Portion

Willow Creek – Entrance to Piped Portion

What are the Estimated Planning Level Costs?

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What are the next steps?

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Questions?

CITY OF EDMONDS

Dayton St. & SR 104 Drainage Alternatives

Public Open House

June 20, 2013, 6:30pm

SIGN IN SHEET

	NAME	PHONE	E-MAIL ADDRESS
1	Franklin Bischel	425-512-5624	fandshel@comcast.net
2	Sherla Belcher	425 673-5892	Belcher363@comcast.net
3	DEE PIEPHO	425-775-3123	deepiepho@yahoo.com
4	Steve Hatzenbeler	425.697.4159	hatz@riseup.net
5	DAVID CUNE		DRC@SHANWIL.COM
6	Shirley Oczkewicz	425-582-2267	Socz@comcast.net
7	Glenn Sharp	360-633-5381	glennmsharp@yahoo.com
8	MIKE GISEBURT	206.695-4607	mike.s.giseburt@SAIC.com
9	Keeley O'Connell	360-220-5544	
10			
11			
12			

Shuster, Jerry

From: Shirley Oczkewicz <socz@comcast.net>
Sent: Tuesday, June 18, 2013 3:40 PM
To: Shuster, Jerry; Cawrse, Michael
Subject: our marsh/coal trains

Mr. Shuster and Mr. Cawrse,

I watched on the internet your presentation to the City Council about daylighting Willow Creek, and wish to call this video to your attention. I'm wondering just how 'clean' is the marsh, and how can it be more protected from coal hazards as your plans proceed.

Also, positioning the day lighted creek in the area of the dog and public parks would hopefully dispel any remaining thoughts of moving the ferry to that area.

Please reply and thank you,

Shirley Oczkewicz

Worried about coal trains? Or maybe you are not yet sure what is up...either way, watch this short video of how **existing** coal trains are polluting the Columbia River. Also, a documentary is airing on KCTS at 7:30 PM on 6/19.

http://www.youtube.com/watch?v=kHIcaGLvI_Q&feature=youtu.be

Dayton Street & SR 104 Drainage Alternative Study

Summary of Questions Asked and Answered During June 20, 2013 Public Open House

- Will you be discharging untreated stormwater in the Marsh, and Puget Sound?
- Utilizing the Marsh as a filter to clean up stormwater, and proposing the use of the Marsh for salmon rearing, seem to be counterproductive – can you explain how both can be accomplished?
- Would it be better to not plug the pipe that conveys Shellabarger Creek overflows to Dayton, as an overflow option during storm flows?
- Will completing this project indicate that the ferry terminal will be permanently located in its' present location?
- Who owns the Marsh?
- What other agencies are involved in this project?
- Will increased train traffic, including trains to the proposed coal processing facility, affect the project?
- What are the alternative proposals to the recommended alternative?
- For the pump station near Boat Street, what will it be housed in?

CITY OF EDMONDS

DAYTON STREET & SR104 DRAINAGE ALTERNATIVES

Public Open House – June 20, 2013

In the space provided below or in an e-mail, please provide your comments on the presentation and your thoughts on the Recommended Alternative to address the flooding problem at the intersection of Dayton Street & SR 104.

Plans for mitigation of the water at 104 + Dayton are seem excellent to me. perhaps the pumping station on dayton is the place to start.

Well researched it seems.

(use space on the back, if necessary)

YOUR NAME: Sheila Belcher

ADDRESS: 200 JAMES ST. #303 EDMONDS, WA 98020

DAYTIME PHONE/E-MAIL 425 673 5892

PLEASE MAIL FORM TO:

Jerry Shuster, P.E.
City of Edmonds-Engineering Division
121 5th Ave N.
Edmonds WA, 98020

OR

E-MAIL THE INFORMATION TO:

Jerry.Shuster@edmondswa.gov or

Michael.Cawrse@edmondswa.gov