U.S. Army Corps
of Engineers
Seattle District

Mapes Creek Restoration Project
Section 1135
Seattle, WA

DRAFT Integrated Detailed Project Report and Environmental Assessment
April 2011

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Seattle, WA

Draft Integrated Detailed Project Report and Environmental Assessment

April 2011

Responsible Agencies: The agencies responsible for the proposed work are the US Army Corps of Engineers, Seattle District (Corps) and City of Seattle.

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Executive Summary

Introduction

The Mapes Creek Integrated Detailed Project Report (DPR) and Environmental Assessment is submitted under Section 1135 the Water Resources Development Act of 1986 (Public Law 104-303), as amended, via the USACE Continuing Authorities Program. Mapes Creek, a tributary to Lake Washington, is located in southeast Seattle, King County, Washington. Seattle Public Utilities is the non-federal sponsor for the project.

Purpose, Need, & Objectives

Mapes Creek is currently piped for 3,200 feet at its downstream extent and discharges 20 feet offshore into Lake Washington. Environmental quality has been adversely impacted by the construction and operation of the authorized Lake Washington Ship Canal Project (LWSC). The purpose of this study is to evaluate restoration opportunities related to Mapes Creek, including its discharge into Lake Washington, and to recommend a plan to improve environmental quality. The discharge location, 3 miles north of the mouth of the Cedar River, is a critical location for migrating juvenile salmonids.

The goal of the Mapes Creek restoration project is to improve the function of the Lake Washington shoreline ecosystem, in particular as it relates to habitat for juvenile salmonids and other wildlife. There are opportunities to: increase shallow water shoreline habitat for refuge and rearing of migrating juvenile salmon; and also to increase adjacent aquatic habitat for birds, amphibians and other wildlife in Lake Washington. The project objectives include:

- Improve water conveyance pathways
- Improve rearing and migration habitats for salmonids
- Improve water quality for parameters determined to be critical to fish survival and migration, particularly temperature and dissolved oxygen
- Restore, where possible, the natural complexity of the aquatic and riparian ecosystems.
- Reduce predation and loss of habitat caused by competing non-native introduced species of fish and vegetation
- Restore rearing and migration habitats for salmonids
- Reduce fish passage barriers

Restoration measures related to the use of Mapes Creek flows were considered to meet these objectives. Potential restoration measures included daylighting the stream, creation of a stream channel through a public park, wetland creation and shoreline improvements.

Recommendation

The restoration measures were developed and evaluated in different combinations to meet project objectives. Based on the evaluation, the recommended plan includes the daylighting of Mapes Creek at Be'er Sheva Park, channel restoration through the park, and restoration of the shoreline at the mouth of Mapes Creek. Specific features of the recommended plan, from upstream to downstream, include:

- Diversion structure
- Diversion pipe
- Energy dissipater
- Channel restoration
- Shoreline restoration

The diversion structure would allow Mapes Creek flows to be separated from the combined sewer overflow system under South Henderson Street currently conveying the downstream portion of the creek to Lake Washington. Newly diverted flows would then enter the diversion pipe, which conveys the creek underground to Be'er Sheva Park. The creek would then be daylighted at the park, where the energy dissipater transitions flows to a newly restored stream channel through the park into Lake Washington at the shoreline. Restoration of the Lake Washington shoreline at and adjacent to the new mouth of Mapes Creek completes the recommended restoration plan.

Environmental Effects

Based on the Environmental Assessment, the Mapes Creek Restoration project is not expected to result in significant adverse environmental impacts. It is anticipated that the recommended plan would result in long-term, cumulative benefits to the amount and functional value of restored habitat, improvements in the overall watershed condition, and would ultimately increase the ability of the watershed to support critical life history stages of native fish and wildlife populations. Implementation of the recommended plan would have temporary affects on air quality, noise, and traffic resulting from construction. Temporary closures of the park during construction may also be required to ensure public safety. The following bullets summarize the environmental benefits of the recommended plan. The recommended plan will:

- Improve channel complexity and connectivity through a natural streambed and confluence with Lake Washington;
- Protect water quality in the new stream channel for salmonid, and other wildlife species by removing stormwater and infrequent combined sewer overflows from Mapes Creek;
- Improve vegetation through removal of invasive species, plantings, and placement of in-stream habitat structures to provide foraging, nesting, and cover for a variety of species;
- Increase adjacent aquatic habitats that support birds, amphibians, and other wildlife associated with Lake Washington and Be'er Sheva Park;
- Increase shallow water shoreline habitat for the refuge and rearing of listed migrating juvenile salmonids and increase off-channel habitat available via the daylighted creek;
- Improve the aesthetics of the project area by replacing a maintained lawnscape with a natural meandering stream and native habitat type; a pedestrian footbridge over the stream will maintain access through the park and provide controlled access to the restoration features;

Cost

Construction costs were developed for the management measures in the Cost Opinion for the Mapes Creek Stream Restoration (35%) Design Analysis Report (May 2009) at the 35% design level. These costs were updated to 2010 level for the current evaluation. The cost of the recommended plan was estimated based on total construction cost and annual operation and maintenance cost. Construction costs include construction supervision/administration, sales tax,

and contingency. The cost of design and implementation is estimated at $2,150,795 including contingency and supervision & administration. Lands and relocations value has been estimated at $103,400. Average annual operation and maintenance costs for the channel and pipe are estimated at $6,740.

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1. INTRODUCTION

1.1 Authority

This Integrated Detailed Project Report and Environmental Assessment is submitted under Section 1135 the Water Resources Development Act of 1986 (Public Law 104-303), as amended. Section 1135 projects are part of a larger Continuing Authorities Program (CAP) under which the Assistant Secretary of the Army, Civil Works, acting through the Chief of Engineers, is authorized to plan, design, and implement certain types of water resources projects without additional project-specific authorization. The Section 1135 authority allows the United States Army Corps of Engineers (Corps) to carry out projects for improving the quality of the environment when it is determined that such modifications are feasible, consistent with the authorized project purpose, and will improve the quality of the environment in the public interest. Projects under this authority can include modifications to the structures and operations of water resources projects constructed by the Corps or restoration projects can be at locations where a Corps project has contributed to degradation of the environment. Construction costs of approved Section 1135 Projects are cost shared at a rate of 75% federal and 25% non-Federal. The federal study and implementation cost limit for any one Section 1135 CAP project is $5,000,000. Operation and maintenance costs are 100 percent the responsibility of the project sponsor.

On March 20, 2003, Seattle Public Utilities submitted a letter to Seattle District Corps requesting federal assistance in restoring fish and wildlife habitat on lower Mapes Creek, located in the City of Seattle, King County, Washington.

1.2 Purpose and Need

The purpose of this study is to evaluate restoration opportunities related to Mapes Creek, including its discharge into Lake Washington, and to recommend a plan to improve environmental quality. Environmental quality has been adversely impacted by the construction and operation of the authorized Lake Washington Ship Canal Project (LWSC). The need for this project is to restore degraded ecosystem function and habitat.

Mapes Creek, an urban tributary to Lake Washington, is currently piped for a total distance of 3,200 feet, portions of which convey storm drainage as well as combined sewer overflow from infrequent storm events. The pipe discharges 20 feet offshore into Lake Washington. The discharge location, 3 miles north of the mouth of the Cedar River, is a critical location for migrating juvenile salmonids.

The goal of the Mapes Creek restoration project is to improve the function of the Lake Washington shoreline ecosystem, in particular as it relates to habitat for juvenile salmonids and other wildlife. Restoration opportunities exist to: 1) Increase shallow water shoreline habitat for refuge and rearing of migrating juvenile salmon; 2) Increase adjacent aquatic habitat for birds, amphibians and other wildlife in Lake Washington. The study will consider opportunities related to the use of Mapes Creek flows and daylighting the stream channel through a public park to meet the project goal and objectives. The goal of Mapes Creek project is complimentary to the Watershed Resource Inventory Area 8 (WRIA8) regional salmon recovery strategy for Puget Sound Chinook.

1.3 Project Location and Background

The Mapes Creek watershed is located in southeast Seattle between the southwestern shoreline of Lake Washington and the Duwamish River (Figure 1). Mapes Creek enters Lake Washington approximately 3 miles north of the mouth of the Cedar River in the Puget Sound Region of northwest Washington State.

This project represents an opportunity to restore a strategic location for Chinook salmon due to Mapes Creek's location along the salmon migration route between Puget Sound and the Cedar River. The Cedar River is a high-priority core production area for the Puget Sound Chinook salmon, a species listed as endangered under the Endangered Species Act (ESA). Because of this proximity to a vital salmon migration route, Mapes Creek has the potential to be a high-impact habitat restoration site.

Figure 2 provides a map of Mapes Creek watershed. The Mapes Creek catchment comprises approximately 92.2 acres (SvR design, 2002). Mapes Creek flows are conveyed through an underground pipe for the lower 3,200 feet of the creek. For approximately 1,100 feet of this distance, the flows are conveyed through an 84-inch stormwater drainage pipe that also carries combined sewer overflows (CSO) during infrequent overflow events. At the downstream end of the pipe, Mapes Creek water discharges into Lake Washington 20 feet offshore. It is unknown when the lower portion of the creek was put underground. The downstream terminus of the piped creek currently passes through Be'er Sheva Park, a City of Seattle park, along the Lake Washington shoreline. The park named to honor Beer Sheva Israel, one of Seattle's sister cities, consists of grassed areas, picnic tables and benches, a children's play area, restrooms parking area, and a hand boat launch. Be'er Sheva Park is located in a predominantly residential neighborhood, in close proximity to Rainier Beach High School.

1.3.1 Watershed Description

The Mapes Creek watershed is characterized by increasing levels of urbanization as it flows downstream. The Mapes Creek watercourse is approximately 1.25 miles in length. The Mapes Creek drainage area is shown in Figure 2. Figure 3 provides a more detailed view of the Mapes Creek stream reaches. The headwaters of Mapes Creek include riverine wetlands and intermittent streams fed by groundwater springs. The upper part of the watershed is relatively undeveloped, with the exception of Kubota Gardens. Upper forks of the creek (Reaches 7a & 7b, Figure 3) are buffered by large riparian areas consisting of mostly deciduous trees (Washington Trout 2002). Downstream of the East and West forks confluence, the creek flows into the Kubota Gardens where an additional fork joins from the east. The water is used in an ornamental display garden to create artificial pools, channels, and ponds (Reach 6, Figure 3). The creek then flows through the remainder of Kubota Gardens in a channel devoid of significant riparian cover (Reach 5, Figure 3). The next segment of the creek consists of a series of large, shallow, sediment pools created by four concrete dams or weirs (Reach 4, Figure 3). In each of these sediment pools, there is a decrease in flow and the channel broadens to the width of the concrete weirs (Washington Trout 2002). Downstream of the weirs, the creek flows through a culvert that spans Renton Avenue, and then enters a steep-sided ravine for approximately 250 feet (Reach 3, Figure 3). The creek then flows under Roxbury Street through another culvert and into another ravine (Reach 2, Figure 3). At the downstream end of this reach, Mapes Creek

enters the Sturtevant/Rainier culvert and is piped underground until it flows into Lake Washington (Reach 1, Figure 3).

In 2004, the Corps measured discharge rates on six occasions during the spring salmon rearing period (January through March), during which the average discharge rate was 0.82 cfs. Two-year flood flows are estimated at 6 cfs and 100-year event discharges are estimated to be 22 cfs. Additional hydrologic information is presented in section 2.3. The portion of Mapes Creek that is the subject of the current investigation is shown in Figure 4, and includes the lower 1,500 feet of the creek.

1.3.2 Watershed Impacts

In 1916, the Hiram M. Chittenden Locks were constructed to allow vessel passage between the Puget Sound and lakes Union and Washington and manage the level of Lake Washington. Construction of the locks resulted in the lowering of Lake Washington by 8 feet. Figure 5 illustrates the historic Lake Washington shoreline in the vicinity of Be'er Sheva Park as mapped by the U.S. Coast and Geodetic Survey in 1902. As a result of the lowering, the mouths of many tributary creeks were altered and the quantity of wetland habitat was reduced throughout the basin.

Since its lowering, Lake Washington has been managed under a reverse hydrologic regime, maintaining a low water level in the winter and high in the summer, fluctuating up to 2 feet seasonally. Maintaining a stable lake elevation has eliminated seasonal flooding, but is thought to inhibit natural shoreline and wetland vegetation because the water is highest during the growing seasons, rather than in the dormant season, reducing shoreline cover, and possibly favoring invasive species of vegetation.

Historically, Mapes Creek was a small watershed whose confluence with Lake Washington at Be'er Sheva Park was part of a complex near-shore freshwater environment. Management of lake level to only two feet of variation also spurred significant development of the Lake Washington shoreline. When the shoreline of Lake Washington became highly developed for both residential and commercial activities, it caused severe habitat loss over time, including the piping and offshore discharge of Mapes Creek.

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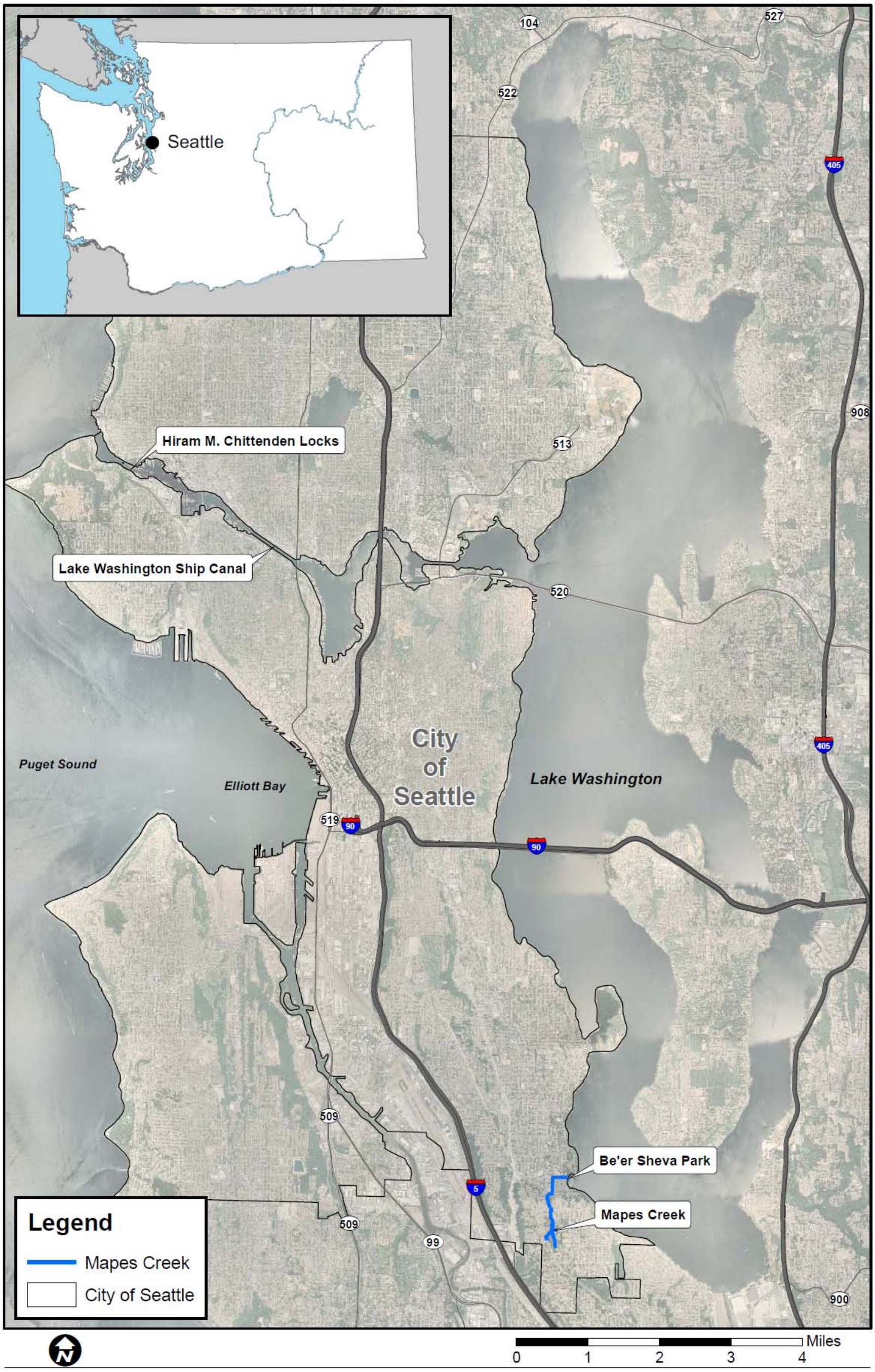

Figure 1: Vicinity Map

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Figure 2. Mapes Creek Drainage Basin

Source: SvR Design Company. 2002. Mapes Creek Sediment Source Investigation, Technical Memorandum.

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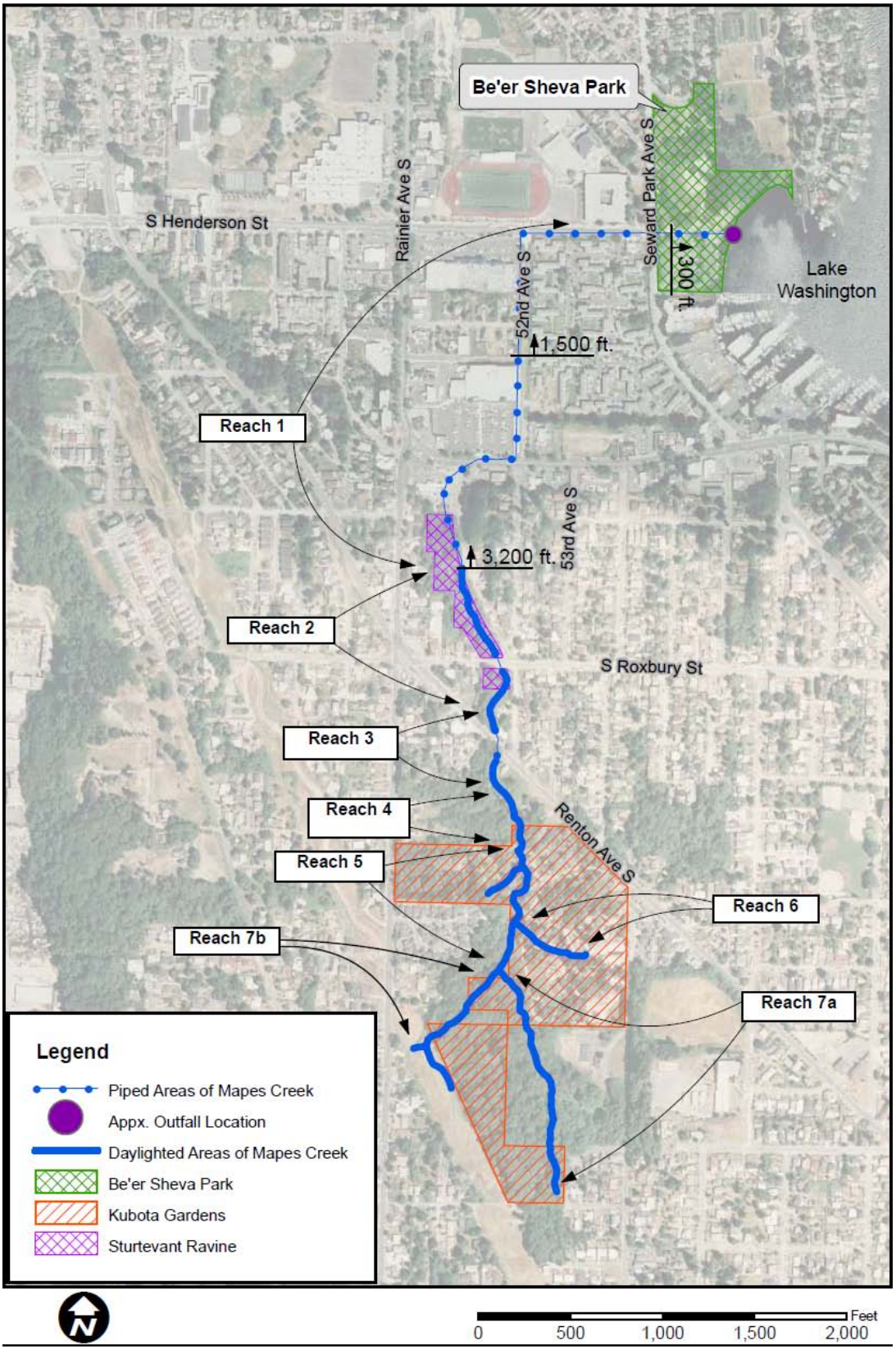

Figure 3: Mapes Creek Stream Reaches

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Figure 4: Lower Mapes Creek Study Area

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Figure 5: Historic Lake Washington Shoreline

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1.4 Existing Projects and Related Studies

This section provides a summary of existing Corps projects and non-federal studies related to the study area.

1.4.1 Lake Washington Ship Canal Water Conservation & Ecosystem Restoration General Investigation Study, Section 216 (2006)

The Lake Washington Ship Canal General Investigation was initiated in 1992 with the City of Seattle and King County to examine water conservation and ecosystem restoration for fish passage at the Hiram Chittenden Locks and habitat restoration. Phase 1 emphasized the habitat restoration opportunities in the eastern portion of Lake Washington basin. Phase 2 emphasized modifications to the operations of the Locks and habitat restoration opportunities in the western portion of the basin. The general investigation study was terminated by the non-federal sponsor in 2006. Mapes Creek was originally included in this study as a potential restoration area. Day-lighting and other in-channel restoration of Mapes Creek at Be'er Sheva Park was identified as the most appropriate restoration measure for the creek. The Mapes Creek project was classified as part of the Lake Washington Tributaries sub-basin. With the Corps and City already involved in a feasibility study for Mapes Creek through the 1135 program, Mapes Creek was removed from further formulation under the GI.

1.4.2 Lake Washington Ship Canal Project (1916)

The Hiram Chittenden Locks and the 8-mile-long Lake Washington Ship Canal provide a navigation link between Puget Sound and lakes Union and Washington. The authorized project purpose is navigation. The Locks control the elevation of Lake Washington and provide the navigable connection between the differing elevations of salt and fresh waters. A fish ladder was installed when the Locks were constructed and the ladder was later reconstructed in the 1970's. The locks, spillway, saltwater drain, and fish ladder control outflow of the Lake Washington drainage basin to Puget Sound. The fish ladder and locks enable adult anadromous fish passage from salt to fresh water. A moveable saltwater barrier, located in the large lock, reduces saltwater intrusion into Lake Washington during lock operations. The saltwater drain, located near the upstream end of the large lock, returns much of the saltwater to Puget Sound via the original spillway outlet located adjacent to the small lock and through the fish ladder. One surface collection flume (smolt flume) was first installed experimentally in 1995; four smolt slides currently operate from April to September each year to facilitate juvenile salmon downstream passage into the estuary.

1.4.3 Salmonid Habitat Limiting Factors Report for the Lake Washington Basin (WRIA 8) (2001)

The purpose of this report is to provide a current "snapshot in time" of the existing salmonid species and habitat conditions that limit natural production of salmonids in Lake Washington and the independent drainages to Puget Sound from Elliott Bay, north, to approximately the King County – Snohomish County line. *(John Kerwin, Washington Conservation Commission, Olympia, Washington, September 2001)*

1.4.4 Seattle's Urban Blueprint for Habitat Protection and Restoration (2003)

This report describes the City of Seattle's approach to applying scientific methodology to assess actions the City might consider to protect and restore Chinook habitat along its urban shorelines.

It also contains an overview of the aquatic environments of Seattle. *(City of Seattle's Salmon Team, December 2003)*

1.4.5 Lake Washington/Cedar/Sammamish Watershed (WRIA8) Near Term Action Agenda (NTAA) for Salmon Habitat Conservation (2002)

This report contains recommendations to help restore and protect habitat for Chinook salmon in the WRIA8 region. Mapes Creek was recommended as a high-priority restoration action. *(WRIA8 Steering Committee, August 2002)*

1.4.6 Sammamish/Washington Analysis and Modeling Program (SWAMP): Lake Washington Existing Conditions Report (2003)

This report summarizes water quality conditions and trends in Lake Washington from 1990-2001. It describes how Lake Washington has responded over time to watershed activities, lake nutrient inputs, ecological interactions, and annual seasonal variability. *(Tetra Tech, Inc. and Parametrix, submitted to King Co DNR, February 2003.)*

1.4.7 Mapes Creek Feasibility Study (2002)

The City of Seattle commissioned a feasibility study to consider the feasibility of three Alternatives for routing Mapes Creek to the restoration site in Be'er Sheva Park under the Corps' 1135 program. The feasibility study included hydrologic analysis of the upstream watershed to calculate the 25-year design flow and preliminary planning-level estimates of construction cost for each of the Alternative routes. The study also recommended further study of two alignments through the 52nd Avenue South Walkway and South Henderson Street. *(SvR Design, 2002)*

1.4.8 Sediment Source Investigation (2002)

As part of the initial feasibility study, Pentec Environmental completed a sediment source investigation for Mapes Creek. This memorandum summarized watershed conditions and evaluated general sediment composition, quantity, and transport. Field investigations indicated that the sediment supply in the Mapes Creek watershed is primarily composed of silt and clay materials, and that coarse materials would not be delivered to the mouth of Mapes Creek. The memorandum concluded that delta formation and long-term maintenance are not feasible under the current Mapes Creek watershed sediment regime. *(Pentec Environmental, 2002)*

1.4.9 Geotech Memorandum (2006)

The Corps conducted a field investigation of geotechnical conditions of the project site in July 2006 and summarizes their findings in a memorandum with accompanying field notes. *(USACE, 2006)*

1.4.10 Synthesis of Salmon Research and Monitoring: Investigations Conducted in the Western Lake Washington Basin (2008)

This synthesis summarizes recent research studies and findings on natural and hatchery-origin Chinook, sockeye, and coho salmon and steelhead trout in the western Lake Washington watershed. It includes studies conducted by the Lake Washington Basin Ecosystem Restoration General Investigation Study and identifies management strategies and recommended actions to increase understanding and improve conditions for salmon in the watershed. This report focuses

on the shop canal area specifically. *(Seattle Public Utilities and U.S. Army Corps of Engineers, 31 December 2008)*

1.5 Future without Project Conditions

Under the future without project condition, Mapes Creek will remain piped, limiting suitable habitat for migrating juvenile salmonid throughout the basin. Water will continue to be discharged offshore and no surface water will be available for fish and wildlife usage within the park. The limiting factors identified by the WRIA 8 steering committee (2002) will remain problematic. Specifically, hydrology and flows will remain altered and natural processes, as seen in running water systems, will be present only in the upper Mapes Creek watershed. Water quality will most likely be maintained, or will become slightly degraded as urbanization, population increase, and global climate change continue to escalate. Mapes Creek flows would continue to be combined with the CSO in the lower watershed. Without this project, channel complexity and connectivity will continue to function poorly, as there is an obvious break in the continuity of the Mapes Creek stream system. Riparian areas in the lower watershed would remain non-existent due to a lack of surface water near the lake shoreline. Upper watershed riparian areas would likely remain largely intact, or may become slightly degraded, as non-native species continue to invade, and urbanization continues to encroach on the area. Finally, fish passage and access will remain limited, and shallow water habitat will continue to be scarce along the Lake Washington shoreline. Even with restoration, sedimentation processes will remain altered because sediment from the lower watershed, which would still flow through a subsurface pipe, would not be able to mobilize and deposit to form natural shoreline features (i.e., delta or convergence pool). Fish passage to the upper watershed is not expected even with restoration, due to the piping of the stream to the park; fish will remain limited to the daylighted portion of the creek within Be' er Sheva Park. Without restoration, the Lake Washington shoreline ecosystem, in particular as it relates to habitat for juvenile salmonids and other wildlife, will continue to be a limiting factor. The value and functions of the adjacent wetland may decrease as non-native species flourish in the study area then migrate to take over areas newly regained by native species at the adjacent wetland. These native species provide better habitat for fish and wildlife, more effective treatment of stormwater, and better control of flooding.

1.6 Expected Success

The proposed restoration project would restore natural processes and functions that will benefit salmonid species, specifically by providing rearing habitat for juvenile Chinook salmon. It is anticipated that the recommended plan would result in long-term benefits to the amount and functional value of restored habitat, improvements in the overall watershed condition, and would ultimately increase the ability of the watershed to support critical life history stages of native fish and wildlife populations. The following bullets summarize benefits of the recommended plan. The recommended plan will:

- Improve channel complexity and connectivity through a natural streambed and confluence with Lake Washington;
- Protect water quality in the new stream channel for salmonid, aquatic, and wildlife species by removing stormwater and infrequent combined sewer overflows from Mapes Creek;

- Improve vegetation through removal of invasive species, plantings, and placement of in-stream habitat structures to provide foraging, nesting, and cover for a variety of species;
- Increase adjacent aquatic habitats that support birds, amphibians, and other wildlife in associated with Lake Washington and Be'er Sheva Park;
- Increase shallow water shoreline habitat for the refugia and rearing of listed migrating juvenile salmonids and increase off-channel habitat available via the daylighted creek;
- Improve the aesthetics of the project area by replacing a maintained lawn with a natural meandering stream and native habitat type; a pedestrian footbridge over the stream will maintain access across the park and provide controlled access to the stream.

2. AFFECTED ENVIRONMENT

2.1 Resource Problems and Existing Conditions

The Near Term Action Agenda (NTAA) for Salmon Habitat Conservation (WRIA 8, 2002) identified factors of decline for the entire Lake Washington/Cedar/Sammamish Watershed. These factors were identified as limiting the survival and viability of salmon populations in the watershed. The factors identified for the tributaries of Lake Washington largely coincide with the current resource problems in the Mapes Creek system. Specifically, these factors include:

- altered hydrology/flows;
- poor water quality;
- loss of channel complexity/connectivity;
- increased sedimentation/altered sediment transport processes;
- riparian/floodplain area; and
- fish access/passage barriers.

An additional resource problem, wetland biological function, was identified as the seventh factor of decline for the project area. The restoration planning and design for Mapes Creek considered restoration measures to address each of these limiting factors to varying degrees. Table 1 identifies resource problems in the watershed and their significance as they relate to ecosystem function under existing conditions.

Table 1: Ecosystem Problems and Environmental Significance

Ecosystem Problems	Environmental Significance
Altered hydrology/flow	Restricts and reduces migration of Chinook (ESA listed species) and other salmonids throughout the system, resulting in reduced populations.
Increased sedimentation and altered sediment transport processes	Lack of native riparian vegetation causes bank instability and erosion, which can cover or erode away salmonid habitat substrate materials leading to decreased spawning success. Increased turbidity from suspended sediment can increase mortality; altered sediment transport processes affect delta formation, decreasing shallow water habitat refuge areas.
Poor water quality	Elevated water temperatures and reduced oxygen levels can cause migration barriers to adults and smolts and reduce the reproductive health and survival of adult salmon for juvenile rearing. Adult Chinook (ESA listed species) and sockeye salmon are the primary species and age group likely to be adversely affected by elevated water temperatures. Lake Washington is also on the 303d list for fecal coliform.
Non-native species	Numerous non-native fish species are present that prey upon or compete with native salmonids. Non-native plant species take over riparian zones and wetlands and reduce cover and foraging suitability for native fish and wildlife species.
Degradation of riparian conditions	Degraded riparian zones have several direct effects on the spawning, rearing and migration habitats of salmonids. These habitats are vital for physiological transition and migration of juveniles, including, feeding, and refuge.

Ecosystem Problems	Environmental Significance
Loss of channel complexity and connectivity	Loss of channel complexity and reduction of side channel and off-channel habitats negatively impacts salmon spawning, rearing and refuge and can inhibit survival success. This habitat provides feeding, refuge, and spawning areas for ESA listed species. Loss of this habitat increases competition for remaining habitat and increases vulnerability of juveniles to predation.
Fish access and passage barriers	Barriers affect migration of Chinook (ESA listed species) and other salmonids throughout the system. This includes both adults seeking to migrate to spawning areas, and smolts making transition and migrating downstream. This results in reduced populations of ESA listed species.
Wetland Biological Function	Loss of wetland habitat has eliminated their ecosystem benefits. These include improvement of water quality, natural flow regime, and structures and functions that provide habitat for fish and wildlife.

2.2 Geology and Soils

A field survey of bed conditions was performed by Pentec Environmental in October 2002. The full length of the existing channel, from the headwaters to where the creek enters the CSO, was surveyed. Rough sediment samples were observed, but laboratory samples were not taken. Watershed material was reported to comprise mainly fine substrate, particularly sand and clay. Results of recent sediment monitoring in the Mapes Creek watershed conducted by the Corps found particle size to be dominated by sand (see Section 2.3). Pathways of sediment delivery to downstream areas include sheetwash, stormflow, and erosion of the streambed and banks, as opposed to mass wasting processes (e.g., landslides, debris flows, or creep).

Soil and geological studies of the park area have been documented by the Seattle Geological Mapping Project at the University of Washington. There are approximately 24 samples listed from Be'er Sheva Park and the immediate surroundings. Dominant soils include silts, peats, sands, gravels, and mixes of all types.

Foundation exploration borings and test pits in the general area of the pipe alignment provide sufficient subsurface details for the proposed dedicated pipe construction. In addition to the available information, the proposed stream channel and pool subsurface conditions must be defined with an additional set of backhoe test pits. It is anticipated that this additional exploration program will require four to five test pits along the proposed channel alignment in Be'er Sheva Park.

2.3 Sedimentation

A number of factors reduce the sediment transport in Mapes Creek. First, flow constraints, such as concrete weirs upstream of the input pipe, cause a loss of hydraulic energy, resulting in deposition of the suspended load in the stream. Large sediment pools developed on the upstream end of the weirs store much of the system's silt and organic sediment (Washington Trout 2002). A low gradient also causes sediment suspended in the stream flow to settle out. These processes do not currently affect the sediment deposition within the project area, because all flow is currently piped into Lake Washington. Under natural conditions, sediment transport would occur within the stream, depositing substrate that would ideally line the channel bed.

Sediment transport is an important stream function at the outlet of Mapes Creek. Sediment inflows into the piped section of flow were measured during 2004. A sediment trap was installed

approximately 50 feet upstream of the pipe inlet to collect sediment. The sediment was collected on four occasions between February and March 2004. The collected sediment was analyzed for grain size distribution and the results are shown in Table 2. Mapes Creek sediment consists mostly of sands, with some fines and small gravel. All samples were fairly consistent. No major rain events occurred in this time period, therefore, a determination of the sediments that are transported during a rain event was not possible.

Table 2: Mapes Creek Sediment Trap Grain Size Results

Sample Date	% Gravel	% Sand	% Fine
2/3/2004	12	71	17
2/11/2004	11	80	9
2/27/2004	9	66	25
3/31/2004	8	72	20
Average	10	72	18
Minimum	8	66	9
Maximum	12	80	25

Note: Gravel = 2 mm to 4 mm, Sand = 0.0625 mm to 2 mm, Fines = 0.0625 and smaller

Sediment grab samples were also collected at five locations: the inlet pipe, the Be'er Sheva shoreline, the Be'er Sheva shoreline 20 and 40 feet into the lake, and the shoreline near the wetland. These grab samples were collected with a hand trowel to characterize the grain size. The Be'er Sheva shoreline is armored with cobbles within 20 feet of the shoreline. Forty feet away from the Be'er Sheva shoreline and near the wetland shoreline, the substrate is mostly sand. The results of the grab samples are shown in Table 3.

Table 3: Grab Sample Sediment Grain Size Results

Sample Location	% Cobble	% Gravel	% Sand	% Fine
Mapes Creek at inlet pipe	5	9	81	5
Lake Washington at Be'er Sheva shoreline	97	0.5	2	0.1
Lake Washington at Be'er Sheva 20' from shoreline	99	0.05	0.6	0.2
Lake Washington at Be'er Sheva 40' from shoreline	0.5	0.5	94	5
Lake Washington at wetland shoreline	9	0.2	88	3

Note: Cobble > 4 mm, Gravel = 2 mm to 4 mm, Sand = 0.0625 mm to 2 mm, Fines = 0.0625 and smaller

The sediment that currently makes up the bottom substrate in the shallow lake area of Be'er Sheva Park may be undesirable for salmon. Chinook salmon surveys have been conducted along the park shoreline, and though other preferred conditions are present (i.e., low gradient, shallow water, overhanging vegetation), there are few salmon utilizing the area. This is presumably due to the presence of mud/silt bottoms substrate, as opposed to the preferred sand/gravel (Tabor et al., 2006).

2.4 Hydrology and Hydraulics

The Lake Washington shoreline and Lake Washington tributaries have been significantly altered, most dramatically as a result of the construction and operation of the Hiram Chittenden Locks (Locks) and the Lake Washington Ship Canal. The lowering of the lake affected all tributaries in

the basin through changes in gradient and alterations in mouth configurations. The lake lowering also exposed 5.4 square kilometers of previously shallow water habitat on Lake Washington, reduced the lake's surface area 7 percent, decreased the shoreline length by about 12.8 percent and significantly reduced the number of wetlands in the basin.

The Corps regulates the water level in Lake Washington within a range of about 2 feet through operation of the Locks (Figure 6). Historic fluctuations in lake level were significantly greater than what now occur. The lake is currently at its highest elevation during the summer months from about April through October, and at its lowest level in the winter, from October through April. Maintaining a stable lake elevation has eliminated seasonal flooding, but has also resulted in a lake whose hydrologic regime is the reverse of what naturally occurs in the Pacific Northwest. Under natural conditions, the lake would be at its highest levels during winter months and at its lowest during summer months.

This reversal of lake elevations is thought to inhibit natural shoreline and wetland vegetation because the water is highest during the growing season, rather than in the dormant season. This may have reduced shoreline cover, although the effects of shoreline development have also greatly reduced shoreline vegetation. The stable elevation variance of only 2 feet may also contribute to increased milfoil habitat in the lake.

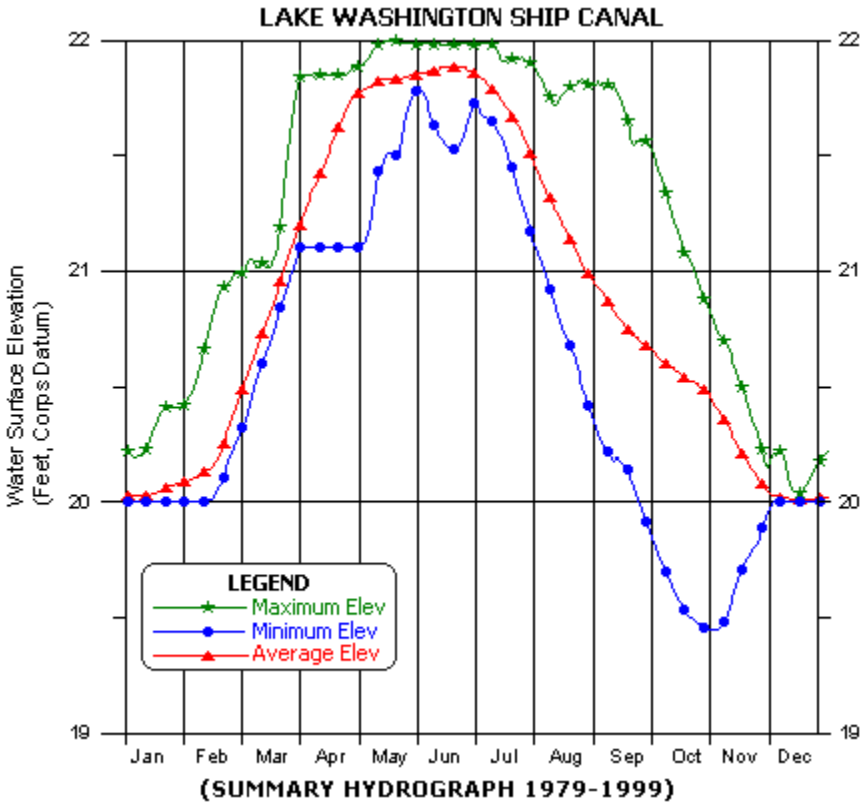

Figure 6: Water Surface Elevations at Lake Washington Ship Canal. Subtract 3.25 feet from Corps Datum to obtain Elevation Relative to NAVD88 Datum (Corps, 2008)

2.4.1 Affected Watershed

The headwaters of Mapes Creek are dominated by wetland seeps; the upper reaches are associated with an intact riparian corridor. The upstream bankfull width is similar to the wetted width, indicating that the headwater flow regime is relatively stable.

Numerous natural conditions and processes in the project area were degraded as a result of altered hydrology at Mapes Creek following construction of the Locks and implementation of the lake-level management regime. Changes in gradients and alternation of the tributary mouth configuration reduced fish access and rearing area. Reversal of the hydrologic regime and extensive shoreline development has inhibited shoreline vegetation and reduced vegetative cover along the littoral edge of the lake. The wetland that now occupies the northeastern portion of the project site does provide some cover and retention of high flows; however, invasive plant species prevent full functionality.

Upstream urban activities have also played a role in remodeling the hydrology of the project area. Though the upper watershed is relatively undeveloped, the Kubota Gardens, situated near the headwaters of Mapes Creek, utilize creek water for display purposes. The complex of pools and waterfalls within the park led to the disruption of natural flow patterns. However, the area lacks the degree of impervious cover employed by surrounding residential areas, making high flows and stormwater events less of an issue than many urban streams.

Mapes Creek Discharge

Much of the discharge within the watershed is collected by storm drains. The flow available to the Be'er Sheva project site enters a piped section at the downstream end of Reach 2 as depicted in Figure 3.

There are limited flow data available for Mapes Creek, which historically has had no flow gauging. As a result, the Corps calculated average daily flow rates for Mapes Creek by comparing the nearby long-term streamflow statistics at Mercer Creek to the available Spring 2004 daily average streamflow measurements for Mapes Creek.

The Mercer Creek gauge (USGS Gauge Number 12120000) had a period of record from 1955 to 2005. The Mercer Creek watershed encompasses 12 square miles at the gauge site, and has a similar geographic location (just across Lake Washington) from Mapes Creek. The ratio of daily average streamflow between Mapes Creek and Mercer Creek in spring 2004 was 1 cfs to 48 cfs. This ratio between was applied to the Mercer Creek hydrology to estimate summary statistics for Mapes Creek. Table 4 presents the results below:

Table 4: Mapes Creek Hydrologic Summary Statistics

	Discharge (cfs)
Peak Flows	
2-Year Frequency	6
10-Year Frequency	13
50-Year Frequency	17
100-Year Frequency	22
Average Daily Flows	
February Daily Average	0.7
March Daily Average	0.6
April Daily Average	0.6
May Daily Average	0.5
February-May Average	0.6

The average discharge for the critical period between February and May is 0.6 cfs. (More specifically, the estimated monthly average discharge during critical salmonid rearing time is estimated to be 0.7 cfs in February, 0.6 cfs in March, 0.6 cfs in April, and 0.5 cfs in May.)

The analysis does not bracket the flow estimates with a confidence interval. But two sources of flow data available at the time the 35 percent preliminary design can be used to help validate the estimate.

First, the Corps measured flow on six occasions between January and March of 2004, at a site approximately 15 feet upstream of the inlet pipe to Mapes Creek (Table 5). The average measured flow rate during this period was 0.82 cfs.

Table 5: Mapes Creek Instantaneous Discharge Measurements 15 feet Upstream of Inlet, Spring 2004.

Date	Discharge, cfs
1/9/2004	0.8
1/30/2004	1.6
2/13/2004	0.7
2/20/2004	0.7
2/27/2004	0.4
3/31/04	0.7
Average Discharge	**0.82**

Second, the Corps installed a continuous flow meter at the pipe inlet and logged flow data for the months of January to March and June to December 2004. Figure 7 illustrates the continuous flow and precipitation data collected in 2004. The peak flow during this time period was 2.5 cfs. Unfortunately there was a period of no data from late March to early June.

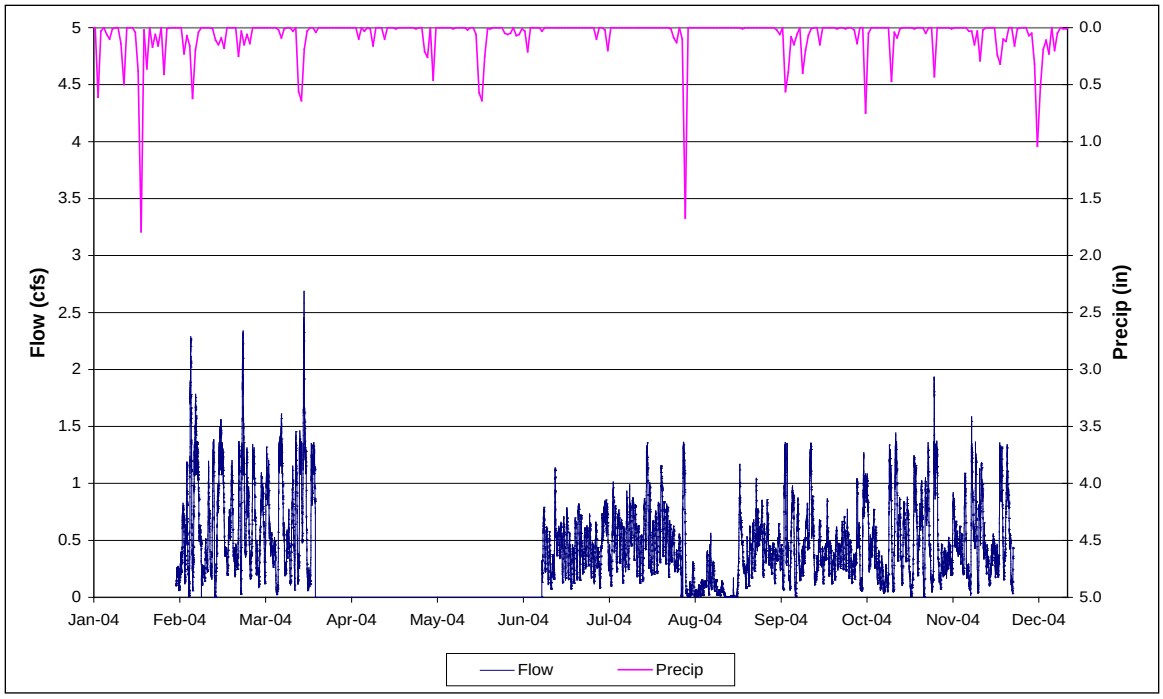

Figure 7: Mapes Creek Continuous Flow Data and Precipitation data (2004).

It appears that spring 2004 was a dry year compared to historic averages. Springtime monthly precipitation in 2004 was approximately 50 percent of the historic average precipitation at SeaTac airport from January-May (1971-2000). This indicates that our design flow rate may under-estimates actual spring time flow at the site. Figure 8 compares monthly precipitation at SeaTac airport in 2004 to the historic average 1971-2000.

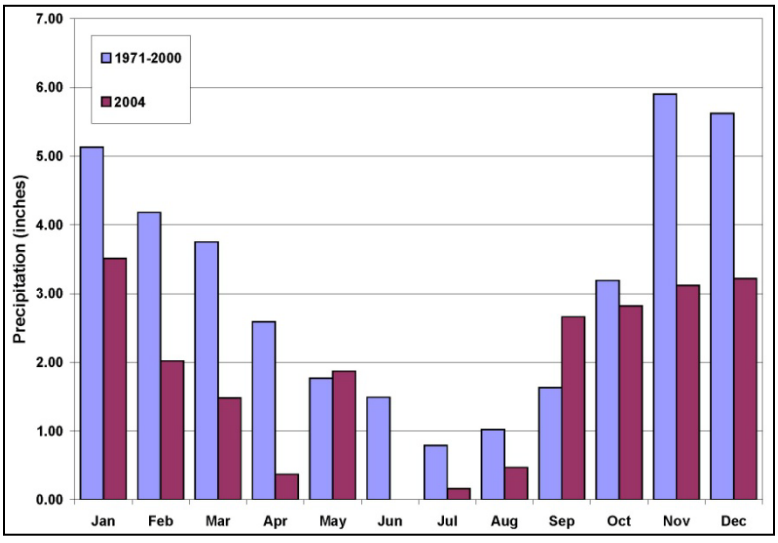

Figure 8: Comparison of 2004 and Historic (1971-2000) Monthly Precipitation Data at SeaTac Airport

Finally, Seattle Public Utilities installed a flow meter on Mapes Creek storm drain in summer 2008. There were not enough data available at the time to incorporate as part of the preliminary 35 percent design, but this data (up to two additional springtime periods, if the meter remains active and has functioned properly) will be useful to further validate the proposed design flow during final project design.

Channel Complexity/Connectivity

The channel complexity and connectivity of Mapes Creek is significantly disrupted, as evidenced by the last 3,200 feet currently piped underground. There is no creek mouth, as Mapes flows are directed offshore, and there is no connectivity between the upper and lower watershed. Some upstream channel complexity exists, although most of it is created by unnatural process such as weirs or constructed pools. Additionally, there is a culvert that transports Mapes Creek under Renton Avenue. Some unimpeded shallow water habitat exists at the park site, with a gradual, rocky slope lining the lakes edge, and fine sediment comprising the shallow edge floor. Natural wood, which has been shown to provide refuge for small salmonids, is largely absent at the site due to lack of surrounding large trees. Shoreline habitat connectivity is disrupted along the southern section of the site.

Be'er Sheva Park Topography

Mapes Creek currently enters Lake Washington via a storm drainage pipe/combined sewer overflow pipe that runs under Be'er Sheva Park. Preliminary topography and bathymetry data were gathered to analyze possible open channel stream Alternatives. Figure 9 shows a plan view of Be'er Sheva Park elevations obtained by the Corps and Seattle University in 2004. A shallow shoreline extends about 150 feet into the lake, north of the discharge pipe. The average slope of the shoreline is 3%.

2.5 Water Quality

Water quality has been identified as a limiting factor for Lake Washington tributaries and Lake Washington in general. The limited studies performed on Mapes Creek, however, suggest this tributary has good quality water with little impairment. However, the relatively high water quality of Mapes Creek water is compromised when it is combined with storm drainage and occasional combined sewer overflows.

Water quality within the Lake Washington Basin has had a long history of monitoring. Currently, Lake Washington is included on the Department of Ecology 303(d) list (Category 5) of water quality impairments for Fecal *Coliform*, PCB, 2,3,7,8-TCDD, 4,4'-DDD, 4,4'-DDE, total chlordane, total phosphorus, and sediment bioassay (Ecology 2008). A full list of water quality impairments for Lake Washington by category is available in Table 6.

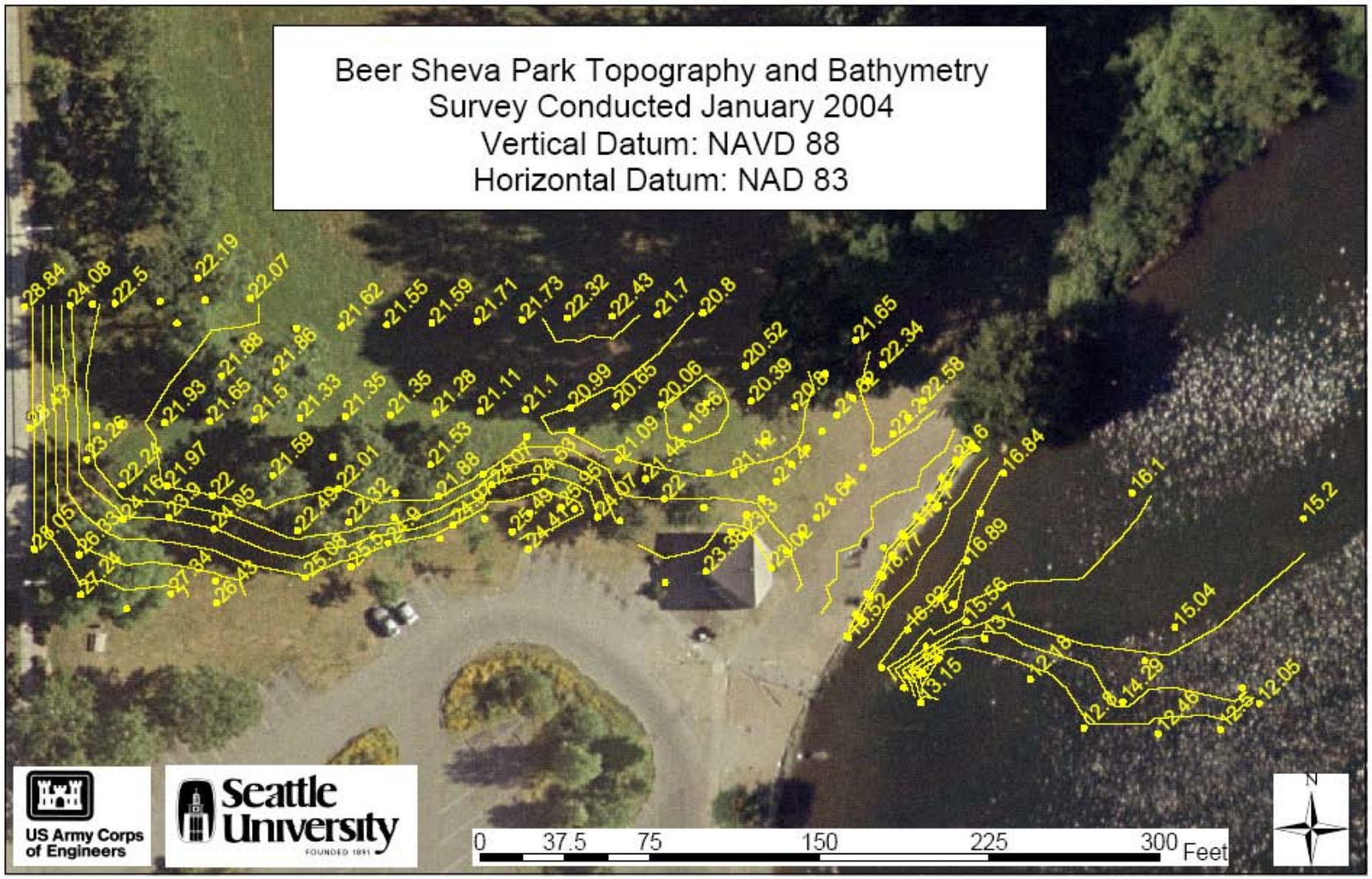

Figure 9: Be'er Sheva Park Topography and Bathymetry

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Table 6: Water Quality Assessment of Lake Washington Impairments by Category (Ecology 2008); only Categories 2, 4, and 5 Indicate Impairments and are included [a]

Impairment Category a	Parameter
5	Fecal Coliform
5	PCB
5	2,3,7,8-TCDD
5	4,4'-DDE
5	PCB
5	Total Chlordane
5	Total Phosphorus
5	Sediment Bioassay
4C	Invasive Exotic Species
2	Ammonia-N
2	PCB
2	Mercury
2	Lead
2	2,3,7,8-TCDD TEQ
2	Sediment Bioassay

a Category 2 - Waters of concern; Category 4 - Polluted waters that do not require a TMDL (Category 4a - has a TMDL; Category 4b - has a pollution control program; Category 4c - is impaired by a non-pollutant (low water flow, stream channelization, and dams)); Category 5 - Polluted waters that require a TMDL

Water temperatures in the lake are often higher than what is ideal for native fish species, with surface littoral zone waters experiencing the highest peak values. Water temperatures monitored during 2009 at frequent intervals at the Lake Washington Buoy located north of Mercer Island, averaged 57.8 degrees (F) in the first meter of water, and 48.5 degrees (F) below one meter in depth (King County 2009). Table 7 lists the upper thermal tolerance (maximum weekly temperature) for salmonids.

Table 7: Upper Thermal Tolerance (Maximum Weekly Temperature) for Salmonids

Species	Upper Thermal Tolerance
Chum Salmon	19.8 ºC (67.6 ºF)
Pink Salmon	21.0 ºC (69.8 ºF)
Cutthroat Trout	23.3 ºC (73.9 ºF)
Chinook Salmon	24.0 ºC (75.2 ºF)
Rainbow Trout	24.0 ºC (75.2 ºF)

Source: Eaton and Scheller (1996)

King County also operated a surface water sampling site; station 4903, adjacent to Henderson Street and within the project vicinity, which collected various types of water quality data. The most current available data from station 4903 is from 2008 and the sampling frequency was twice per-month (King County 2008). Data at this site was collected at a depth of one meter, approximately 50 feet offshore. Results are included in Table 8.

Table 8: Lake Washington 2008 Water Quality Data, Collected at Station 4903

Parameters	Mean	Units
Ammonia Nitrogen	0.01	mg/L
Chlorophyll a	4.55	ug/L
Chlorophyll a MDL	0.56	ug/L
Escherichia coli	12.42	CFU/100ml
Fecal Coliform	16.50	CFU/100ml
Nitrite + Nitrate Nitrogen	0.10	mg/L
Nitrite + Nitrate Nitrogen MDL	0.02	mg/L
Orthophosphate Phosphorus	0.00	mg/L
Orthophosphate Phosphorus MDL	0.00	mg/L
Total Nitrogen	0.27	mg/L
Total Nitrogen MDL	0.05	mg/L
Total Phosphorus	0.01	mg/L
Total Phosphorus MDL	0.01	mg/L
Conductivity, Field	97.53	umhoms/cm
Conductivity, Field MDL	0.50	umhoms/cm
Dissolved Oxygen, Field	10.80	mg/L
Dissolved Oxygen, Field MDL	0.50	mg/L
Sample Temperature, Field	13.68	Degree Celsius
pH, Field	8.22	pH

Source: King County 2008

Past monitoring of the reach of Mapes Creek located upstream of where it becomes piped, has shown water quality to be relatively good; temperature, pH, dissolved oxygen, and conductivity values all fall within the acceptable range for salmonids (Seattle University 2004). Monitoring was conducted on six occasions between January and May 2004 by Seattle University using a YSI 56 Multi-Probe System. Measured parameters all fell within the range of acceptable for Chinook bearing streams (Table 9). Although increased levels of fertilizer compounds could move into the creek from upstream display gardens, the relatively protected nature of Mapes Creek Watershed (within parkland and residential areas) is most likely responsible for the high water quality relative to other urban creek systems. Mapes Creek does not appear to have any specifically identified water quality issues.

Table 9: Mapes Creek Water Quality Data Summary

Parameters	Mean	Units
Dissolved Oxygen	11	mg/L
Temperature	9	Degree Celsius
pH	7.5	pH
Conductivity	0.2	mS/cm

Source: Seattle University 2004

2.6 Vegetation and Wetlands

Various benefits are known to be associated with native vegetation and functioning wetland areas, including the improvement of water quality, natural flow regime, and structures and functions that provide habitat for fish and wildlife. Wetlands reduce contaminants and pollutants in water transported from upland areas by absorbing these compounds and reducing them into less harmful forms. They store water from high flow events to reduce flooding and store stormwater before releasing it into nearby streams or water bodies. Wetlands also support abundant fish and wildlife, as a result of their many processes and characteristics that are suitable for a broad range of species. Native vegetation maintains the delicate natural balance of the habitat type native to the project area.

2.6.1 Vegetation

The vegetation in the project area is a combination of maintained lawn and ornamental trees; very few native species are present. Most trees are located in the upland urban park and include ornamental species such as, black locust (*Robinia pseudoacacia*), redbud (*Cercis* sp.), quaking aspen (*Populus tremuloides*), an ornamental variety of cottonwood (*Populus* sp.), pendant silver linden (*Tilia petiolaris*), and weeping willow (*Salix babylonica*) (Figure 10). A gravel beach with limited vegetation dominates the water's edge of Lake Washington. In this area, non-native invasive species such as Himalayan blackberry (*Rubus armeniacus*), bachelor's button (*Centaurea cyanus*), Queen Anne's lace (*Daucus carota*), common dandelion (*Taraxacum officinale*), morning glory (*Convolvulus* sp.), reed canarygrass (*Phalaris arundinacea*) and tree of heaven (*Ailanthus altissima*) are common. Also present in this area are native species such as common rush (*Juncus effusus*), smallflowered woodrush (*Luzula parviflora*), and northern bugleweed (*Lycopus uniflorus*). The aquatic habitat in the project area has been reported to host the highly invasive Eurasian water milfoil (*Myriophyllum spicatum*) (King County 2010a).

Figure 10: Upland vegetation in the park (left) and along the lake shore (right).

Native vegetation communities are not present in the project area due to the lack of native plant species being present, high densities of non-native invasive species dominating the upland area, and the highly maintained condition of the upland park. In addition, the reach of Mapes Creek that once flowed in the vicinity of the project area has been completely altered from natural state. Functioning riparian habitat is completely absent downstream of the input pipe, where it has

been replaced by impervious pavement, urban structures, and urban park vegetation. Although the vegetation in the project area is highly altered from its natural state, patches of semi-native habitat can still be found in the surrounding areas.

2.6.2 Wetlands

Along the northern boundary of Be'er Sheva Park is a marsh and scrub/shrub wetland, which is currently fenced off to limit pedestrian access and maintain wetland function. This wetland is shown as "AW" on Figure 11. The wetland is comprised of a variety of native species such as Cottonwood, Willow, Douglas Spirea, spiked rush, small fruited bulrush, and non-native species, including Himalayan Blackberry, holly, ivy, Yellow Flag iris, and reed canary grass. These non-native species prevent natural succession of native plants, thus altering habitats for fish and wildlife species. Water input into the wetland ponds before connecting to the lake providing pool habitat for fish and wildlife and stormwater detention functions. Near the lake, native vegetation is dense and provides good shade and structure for wildlife usage. However, non-native blackberries and ivy dominate the more upland area of the wetland, along the fence that borders Be'er Sheva Park, and are currently choking out native species. There is a strong possibility that non-native species are encroaching on and threatening the stands of native vegetation that are present along the shoreline. Although this wetland is fenced and no connection to the project area has been established, the presence of marsh and scrub/shrub wetland habitat marginally increases habitat quality in the project area.

Directly bordering the Be'er Sheva Park wetland to the east is a restored wetland owned by Seattle Parks and Recreation (directly east of "AW" of Figure 11). This half-acre site was restored during the summer of 2004 by Sound Transit as mitigation for expansion of I-405. Native tree, shrub and herbaceous species were planted throughout the site, and a depression was excavated to hold water for detention and habitat creation purposes. Large woody debris was installed along the shoreline to provide habitat for migrating salmonids. Maintenance and monitoring of this site is ongoing.

Seward Park, located approximately three miles north of the project area, has extensive native vegetation and wetland habitat. Lakeridge Park, located approximately two miles southeast of the project area, also hosts semi-native habitat. Connectivity between the project area and neighboring parks is limited but still occurs along the shoreline of Lake Washington. West and upstream of the project area, Mapes Creek Ravine is also home to semi-native habitat and retains some important riparian features.

Figure 11. Approximate Wetland Locations

2.7 Aquatic Biota

2.7.1 Aquatic Invertebrates

Benthic invertebrate communities in Lake Washington have been affected by changes in the physical and chemical nature of the substrate, diminished water quality, presence of non-native species, and changes to the shoreline. Although water quality has been improved, the installation of overwater structures such as docks and piers has increased shading and segmented the lake shoreline and near shore areas, reducing populations of benthic invertebrates (a common prey item of juvenile salmonids) (Warner and Fresh 1999; Kahler et al. 2000; Koehler 2002). Currently, benthic invertebrates typical of gravelly littoral zones and stream mouths of Lake Washington include isopods, leeches, stoneflies, mayflies, and caddisflies. Occasionally copepods and benthic cladocerans are present (Armbrust, et. al, 2009). Chiromid larve (common midges) are more typical of finer substrates. However, data regarding the benthic communities at or near the project site is lacking.

In 2002, the King County Water and Land Resources Division (WLRD) began conducting a baseline study to assess whether resident benthic macroinvertebrate communities can be used to assess environmental conditions in King County watercourses, and thereby provide a practical tool for monitoring changes in aquatic ecosystem health (King Co. 2005). The focus of this report is the use of the Benthic Index of Biotic Integrity (B-IBI). Two years of data were summarized and the results of this study show that all of the watercourses in the West Lake Washington basin had “poor” or very poor” B-IBI scores. In addition, it was found that B-IBI increases as the amount of forest and scrub/shrub in a watershed increases, and decreases with the amount of developed land (i.e., bare ground/asphalt, bare rock/concrete, and high, medium, and low-intensity development) (King Co. 2005). As the percent of Effective Impervious Area

(EIA) in a watershed increases, its B-IBI score decreases. Due to the high-intensity of development and high EIA in the project area B-IBI scores are predicted to be low.

2.7.2 Fish and Fish Habitat

Native Fish Species

Native salmonids, which are important keystone species of the greater ecosystem, still inhabit Lake Washington despite the degraded aquatic habitat. Juvenile Chinook salmon (*Oncorhynchus tshawytscha*) have been observed as intermittently occupying shallow water habitat in close proximity to shoreline vegetation and near the boat ramp located in the parking lot to the south of the grassy area where the stream will be daylighted (Tabor et al., 2004). Other salmonids present in Lake Washington include cutthroat trout (*O. clarkii*), rainbow trout and steelhead (*O. mykiss*), sockeye salmon (*O. nerka*), and coho salmon (*Oncorhynchus kisutch*).

Various life history stages of Chinook use the lake at different time periods throughout the year. There are two different life history strategies present in natural populations of outgoing migrants within Lake Washington. The first group consists of Chinook fry that enter the lake as early as January, after which time they rear for a number of months before migrating to Puget Sound. These individuals use littoral habitats along the lake shore for rearing, and are most often observed in areas near creek mouths and areas with little development. The other outmigration strategy is to rear for a time in riverine conditions, then use the Lake between mid-May and late July, mainly as a migration corridor (Kerwin 2001).

Restoration of freshwater input to the lake and enhancement of shoreline habitat would benefit both life history stages of Chinook, as well as Coho salmon (*O. kisutch*). Other native fish species are found in the waters of the project area. Two common species are longfin smelt (*Spirinchus thaleichthys*) and northern pikeminnow (*Ptychocheilus oregonensis*).

The upper reaches of Mapes Creek are home to just a few fish species. In a survey conducted by Washington Trout in 2002, only two species were observed. Threespine stickleback (*Gasterosteus aculeatus*), and Japanese Koi (*Cyprinus carpio*) were observed in the pond system within the Kubota Gardens, and one other stickleback was observed in the large sediment pool in Reach 2 (Figure 3).

Non-Native Fish Species

Numerous non-native animal species prevent healthy ecological functions within the project area. The introduction of large, non-native fish species such as smallmouth bass (*Micropterus dolomieu*) and largemouth bass (*Micropterus salmoides*) have disrupted the natural food web of the lake. These predators feed on juvenile salmon, reducing their survival rates. Other introduced fish species include yellow perch (*Perca flavescens*), common carp (*Cyprinus carpio*), tench (*Tinca tinca*), pumpkinseed sunfish (*Lepomis gibbosus*), black bullhead (*Ameiurus melas*), and bluegill (*Lepomis macrochirus*) (City of Seattle 2010). Many of these species are either predators of native salmonids or directly compete with them, limiting the population potential of the native species. It is difficult for an ecosystem to maintain healthy processes in the face of invasive species, as they have not evolved sympatrically with native species and are adept at disrupting the natural balance of an area.

Fish Passage/Access

Lower Mapes Creek has been entirely piped; eliminating riparian and wetland habitat that formerly existed in the vicinity of the project area. All corresponding aquatic habitat has also been eliminated, preventing the project area from supporting aquatic species that were present in the past.

Current fish access in the project area is limited to shoreline habitat characterized by soft substrate and a limited amount of vegetative cover. The boat ramp at the south end of the park causes shoreline obstruction and cover for larger predatory fishes. A dock is situated adjacent to the boat ramp, also serving as a structure that may perpetuate the presence of large fish and non-native species. It has been shown that juvenile salmonids typically avoid overhead structures such as piers and docks (Tabor et al, 2004). No passage is afforded to fish in the current state, as a pipe separates the lake from upper reaches of the system. It is unlikely, with the degree of urbanization and infrastructure present in the lower watershed, that passage could be restored. However access to shallow water shoreline habitat for refuge and rearing of migrating juvenile salmon could be addressed.

Multiple studies have shown that juvenile Chinook show a preference for shallow, natural shoreline habitat, which is often characterized by stream inputs and a lack of shoreline obstructions. Juvenile Chinook avoid retained shorelines and over-water structures because they prefer shallow water with a gradual slope, and evidence suggests that piscivores such as non-indigenous smallmouth bass prefer habitat surrounding dock piers. Corps field observations confirmed these habitat preferences at a reference site on Johns Creek, finding that juvenile Chinook salmon preferred smaller pools with depth of approximately 1.0 foot, flowing at approximately 1.0 ft/sec. Deeper pools were not utilized as much, possibly due to predator species.

In general, higher densities of juvenile Chinook in Lake Washington have been observed near stream deltas than along shorelines without streams nearby (Tabor et al., 2004). This preference is presumed to be a function of the increased area of shallow water habitat, which large predatory fishes are unable to inhabit. To form these deltas, sand and sediment are transported down the tributary and deposited beyond the shoreline to produce a shallower offshore gradient than typical shoreline habitat. Juveniles may also congregate around stream deltas because of the increased availability of terrestrial food sources being conveyed downstream, especially during high flow events (Tabor et al., 2006). The offshore area of Be'er Sheva Park has some of the desired characteristics for shoreline deltaic habitat area, with a shallow 300-ft-wide shoreline extending approximately 150 feet into the lake at a 3% grade. However, the Pentec sediment investigation (Pentec, 2002) concluded that the fine-grained nature of Mapes Creek sediment would not be amenable to forming a stable delta in the lake. As a result, shoreline delta restoration was not proposed as part of Mapes Creek restoration during project development.

While the project does not propose an attempt to restore a persistent stream delta formation at Mapes Creek, the restoration may help capitalize on the existing shoreline characteristics and increase Chinook salmon survival.

2.8 Wildlife

Despite the elimination of some habitats from the project area and the degradation of others, wildlife species are still present. The upland park supports various bird species such as migrant and nesting passerines, raptors such as sharp-shinned hawk (*Accipiter striatus*) and Cooper's hawk (*Accipiter cooperii*), and waterfowl such as Canada goose (*Branta canadensis*) and various ducks. Waterfowl and shorebirds frequent the shoreline of the lake where they forage, loaf, and in some cases, nest. Bald eagles (*Haliaeetus leucocephalus*) are known to winter and nest in the Lake Washington Watershed Basin in areas of undeveloped shoreline where large trees suitable for nesting or perching are present. Very limited habitat that would support bald eagles is present in the project area. Urban-adapted mammals such as raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), eastern grey squirrel (*Sciurus carolinensis*), and native and non-native rats (*Ratus sp.*) and mice also use the area. Reptiles and amphibians are apparently rare in the project area due to the lack of supporting habitat features.

2.9 Threatened and Endangered Species

Table 10 lists the three species of special interest with the potential to occur in the project area. The only species of special concern listed by the United States Fish and Wildlife Service (USFWS) that may occur in the project area is bull trout (*Salvelinus confluentus*) (USFWS 2007). Two species of special concern have been listed by National Oceanic and Atmospheric Administration–National Marine Fisheries Service (NOAA-NMFS) as potentially occurring in the project area; Chinook salmon (Puget Sound ESU) and steelhead (*Oncorhynchus mykiss*) (Puget Sound DPS) (NOAA-NMFS 2009). All three species are currently listed as threatened and two species, bull trout and Chinook salmon, have designated critical habitat in the project area. In addition, Washington Department of Fish and Wildlife (WDFW) have listed all three of these species on their Priority Habitat and Species (PHS) List (WDFW 2008a) as having habitat in the proposed project area. These three species, along with other salmonids, have been declining for over a century in the western United States mainly as a result of the degradation and reduction of habitat (Sedell and Froggatt 1984; Gregory and Bisson 1997).

Table 10: Wildlife species of special interest that could potentially occur in the project area.

Common name (*Scientific Name*)	**Federal Status**	**State Status**	**Designated Critical Habitat**
Bull trout (*Salvelinus confluentus*)	Threatened[1]	Candidate[3]	70 FR 56211 56311
Chinook salmon (*Oncorhynchus tshawytscha*); Puget Sound ESU	Threatened[2]	Candidate[3]	70 FR 52630 52858
Steelhead (*Oncorhynchus mykiss*); Puget Sound DPS	Threatened[2]	None[3]	None

Source: 1 USFWS 2007 2 NOAA-NMFS 2009 3 WDFW 2008

Other species of special concern are listed as occurring in King County but have no supporting habitat features in the project area, making their presences highly unlikely. These species are; Canada lynx (*Lynx canadensis*), gray wolf (*Canis lupus*), grizzly bear (*Ursus arctos = U. a. horribilis*), marbled murrelet (*Brachyramphus marmoratus*), and northern spotted owl (*Strix occidentalis caurina*) (USFWS 2007).

2.9.1 Bull Trout

Bull trout were designated as threatened under the ESA on November 1, 1999 (64 FR 58909 58933) (USFWS 1999a); critical habitat was designated September 9, 2005 (70 FR 56211 56311) (USFWS 2005).

Neither spawning activity nor juvenile rearing of bull trout has been observed in Lake Washington. The potential for spawning or rearing in Lake Washington is thought to be very low as the majority of accessible habitat does not have a proper thermal regime (USFWS 2004). Although bull trout occurrence is low in Lake Washington, adult and sub-adult bull trout do enter the lake. They are regularly observed at the Ballard Locks, and they are known to utilize the south end of Lake Washington and the lower Cedar River and have been observed in Issaquah Creek (Berge et al 2000; Goetz et al. 2004). Within the lake they would likely occur in areas with higher prey concentration including shoreline and offshore areas, which may include areas near creek mouths during selected times of the year (F. Goetz, personal communication).

2.9.2 Chinook Salmon

Chinook salmon were designated as threatened under the ESA on 2 August, 1999 (64 FR 41835 41839) (USFWS 1999b); critical habitat was designated 2 September, 2005 (70 FR 52487 52627) (NOAA 2005).

Lake Washington hosts three generally recognized Chinook stocks as determined based on their distinct spawning distributions; Cedar Chinook, Issaquah Chinook, and North Lake Washington Tributaries Chinook (WDFW 2010a); however, genetic analysis has shown no difference between Issaquah Chinook and North Lake Washington Tributaries Chinook (Marshall 2000; Young and Shaklee 2000) causing them to sometimes be described as sub-populations within the Sammamish River Chinook population (LW/C/SW 2005). All of these populations are fall runs with adults returning to the Lake Washington Watershed primarily between June and September to spawn (WDFW 2010a; PSIT-WDFW 2010).

Cedar Chinook are a native stock with wild production. Most spawning takes place in the mainstem Cedar River, upstream of river mile 5.0, although some spawning also occurs in Taylor Creek, and spawning may occur in Rock Creek when flows are adequate (WDFW 2010a; PSIT-WDFW 2010). Spawning generally occurs from mid-September to early November (WDFW 2010a; PSIT-WDFW 2010). Juveniles, after emerging from the gravel, migrate into the south end of Lake Washington either as fry or fingerlings between February and June (LW/C/SW 2005). While in the lake, the juveniles rear and migrate north along the shoreline in shallow habitats with gentle gradient and small substrates (Tabor and Piaskowski, 2002; Tabor et al., 2006). They also utilize small creek mouths (Tabor et al. 2006). Once they become larger (by May or June), most juveniles move offshore and prepare to exit Lake Washington through the Ship Canal and Hiram M. Chittenden Locks (LW/C/SW 2005). Chinook smolts typically enter saltwater between May and July (DeVries, 2001; 2002). They then spend time rearing in the marine near shore environment in and around Elliott Bay and other areas of Puget Sound before migrating to the open ocean (LW/C/SW 2005).

The Issaquah population spawns in tributaries to Lake Sammamish, including the Issaquah Creek system and Lewis and Laughing Jacobs Creeks (LW/C/SW 2005; WDFW 2010a; PSIT-WDFW 2010). This population also contains the Issaquah hatchery and population propagation occurs

through both natural and artificial spawning between September and November (LW/C/SW 2005). Migration behavior and timing of naturally spawned juveniles have not been investigated in great detail, however, limited information indicates that they migrate into Lake Sammamish as either fry or fingerlings, similar to behavior seen in the North Lake Washington and Cedar populations (Seiler et al. 2003). Juveniles rear as they migrate towards Lake Washington and typically enter that lake at a large size, moving quickly into offshore areas (LW/C/SW 2005). While in Lake Sammamish, juvenile Chinook likely use shallow areas with gentle slopes, similar to fish in Lake Washington (LW/C/SW 2005). As with other Lake Washington Watershed smolts, those from the Issaquah population pass through the Ship Canal and Locks to reach Puget Sound during May, June and July, and then rear in Puget Sound before reaching the ocean (LW/C/SW 2005).

The North Lake Washington population spawns in the tributaries to northern Lake Washington and the Sammamish River between September and November (LW/C/SW 2005; WDFW 2010a). This includes Bear, Little Bear, North, Swamp and Kelsey creeks. Similar to migration behavior seen in the Cedar River, juveniles migrate into the Sammamish River or Lake Washington either as fry or fingerlings between February and June (LW/C/SW 2005; WDFW 2010a). Juveniles rear as they migrate towards Lake Washington and typically enter the lake at a larger size than their fry migrant counterparts from the Cedar River. While a small portion of the North Lake Washington juveniles use near shore areas in Lake Washington, most fish are believed to move into offshore areas quickly (LW/C/SW 2005). North Lake Washington Chinook smolts pass through the Ship Canal and Locks to reach Puget Sound during May, June and July (DeVries, 2001; 2002). As with other Chinook smolts from the Lake Washington Watershed, they rear in marine near shore areas of Puget Sound before heading to the ocean (LW/C/SW 2005).

Of the three Chinook populations found in Lake Washington, the Issaquah Chinook and North Lake Washington Tributaries Chinook are considered healthy stocks while Cedar Chinook is considered depressed (WDFW 2010a). Abundance trends show the Cedar River population to be in steep decline. Reduced abundance is primarily driven by habitat degradation and the loss of life history diversity, among other factors that all salmonids face upon entering Puget Sound (e.g., ocean conditions, harvest, etc.) (LW/C/SW 2005). Adult Chinook habitat use in the Cedar River system is concentrated in the mainstem river below Landsburg Dam, with limited use of larger tributaries. The area above Landsburg Dam was not accessible to spawners until the fall of 2003 when fish access structures were installed (LW/C/SW 2005).

2.9.3 Puget Sound Steelhead

The Puget Sound DPS of steelhead was designated as threatened on September 25, 2008 (50 FR 55451 55455) (NOAA 2008); critical habitat has been proposed for this species and is currently under review (64 FR 5740 5754) (NOAA 1999).

Steelhead can be divided into two different ecotypes based on the state of maturity at the time of river entry and the duration of spawning migration (Burgner, et al., 1992; WDFW 2008b); summer steelhead and winter steelhead. Winter runs spawn closer to the ocean, and require less travel time (Burgner, et al., 1992; WDFW 2008b). The population found in Lake Washington is exclusively winter run steelhead (WDFW 2008b, 2010b, 2010d).

Steelhead generally prefer fast water in small to large mainstem rivers, and medium to large tributaries (NOAA, 1999; WDFW, 2008b). In streams with steep gradient and large substrate, they spawn between these steep areas, where the water is flatter and the substrate is small enough for them to dig their redds (NOAA 1999; WDFW 2008b). The steeper areas make excellent rearing habitat for the juveniles. Spawning takes place throughout the Lake Washington Basin including the Sammamish River and its tributaries, Issaquah Creek, Coal Creek, May Creek, the lower Cedar River (although very few redds have been observed in recent years, Burton, pers. comm., 2011)), and several smaller Lake Washington tributaries (WDFW 2008b, 2010b, 2010d). A limited hatchery program utilizing the native winter steelhead stock was initiated in 1997 as a supplemental program to assist in recovery of winter steelhead populations in the north Lake Washington tributaries (WDFW 2008b, 2010b, 2010d). Typical steelhead use of Lake Washington is as a migration corridor through deeper water, not the along the shoreline (Longenbaugh, NMFS, pers. comm.).

2.10 Cultural Resources

A cultural resources assessment was performed by a professional archaeologist in order to determine if a potential exists to cause effects to Historic Properties if they should exist within the project area. A search of the archaeological and historic site records at the Washington State Department of Archaeology and Historic Preservation (DAHP) indicated that no properties listed in the National Register of Historic Places (NRHP) or the Washington State Historic Site Register are recorded in the project area. Historic aerial photos and General Land Office (GLO) survey maps were reviewed in order to identify any potential areas where cultural resources could be present. These maps show that prior to the construction of the Hiram M. Chittendam Locks and the lowering of the water level in Lake Washington in 1917, the project APE was inundated.

2.11 Land Use

Land use in the vicinity of Be'er Sheva Park is primarily mixed residential, with both single-family dwellings and multi-unit apartments adjacent to the park. Rainier Beach High School is located immediately west of the park. Further west along Henderson Street, there is a small retail development containing a grocer, convenience stores, and a variety of small shops. The park land is designated vacant residential by the City of Seattle.

2.12 Air Quality and Noise

In general, air quality in the Puget Sound region is considered to be good. However, areas where pollutants originate include urban areas where there is a high density of cars, residences, and industry. Sources of these pollutants include car and truck exhaust and smoke from outdoor burning and wood stoves (WDOE, 2009). For 2008, the Puget Sound Clean Air Agency (2009) reported that the number of days air quality was considered to be "good" 78% in King County, the number days that air quality was "moderate" 21%, and days where the air quality was considered "unhealthy for sensitive groups" occurred 1% of the time, likely during times of stable weather when there is an absence of wind. Ozone is a standard that is exceeded in Puget Sound on hot, sunny days with little or no wind during the summer (Puget Sound Clean Air Agency 2009).

The project site is situated in a residential neighborhood, bordered by commercial development and a high school. Elevated noise is produced from automobile and bus traffic and additional boat traffic in the summer months.

2.13 Transportation and Utilities

Henderson Street, between 52nd avenue and Seward Park Avenue, is an undivided one-lane road. 52nd Avenue Walkway is an unimproved right-of-way used as a pedestrian connection between Henderson Street and Rainier Avenue. Additionally, several Seattle Metro bus lines make stops along Henderson and Rainier Avenue within a three block radius of Be'er Sheva Park. A moderate amount of traffic flows on streets surrounding the project site. Rainier Avenue experiences heavy usage, while Henderson and Seward Park Avenue experience moderate usage.

The existing 3,200-foot pipeline containing Mapes Creek flows north along 52nd Avenue walkway and is routed east at Henderson Street, discharging offshore into Lake Washington. The first 700 feet of pipe convey creek flows only before entering a short section of 24-inch storm drain. Flows continue into a 30-inch storm drain along 52nd Avenue S Walkway, flowing north for 1,400 feet. At Henderson Street, the flow is conveyed to an 84-inch combined sewer overflow pipeline and travels the remaining 1,100 feet to the outlet in Lake Washington. Additionally, there are many overhead utilities (e.g., power and telecommunication) and underground storm, sewer and water lines present along Henderson Avenue. Cross-utilities were identified using record drawings, notes from field topographic surveys, and a ground-penetrating radar survey in August 2010. Table 11 summarizes the utilities that might be affected by the project.

Table 11: Summary of Utility Crossings

Utility	Station	Invert Elevation	Diameter	Ownership	Construction Note
	(ft)	(ft NAVD88)	(in)		
DIVERSION PIPELINE (52ND AVE WALKWAY - S HENDERSON STREET)					
Storm Drain	00+47.00	21.49	18	SPU	(No Issue)
Storm Drain	00+67.00	23.34	30	SPU	(No Issue)
Storm Drain	03+15.00	20.82	18	SPU	(No Issue)
Power Line(s) - Street Lights	06+55.00	28.33	n/a	Seattle City Light	Protect In Place/Temporary Re-Locate
Storm Drain	07+25.00	18.91	18	SPU	(No Issue)
Storm Drain	11+64.00	17.43	24	SPU	(No Issue)
Sanitary Sewer	12+24.00	17.22	18	SPU	(No Issue)
Sanitary Sewer (Force Main)	12+46.00	21.46	20	King County Metro	Protect In Place
Sanitary Sewer (Force Main)	12+50.00	21.36	20	King County Metro	Protect In Place
Sanitary Sewer (Force Main)	12+70.00	22.33	14	King County Metro (Abandoned)	Remove
Sanitary Sewer (Force Main)	12+73.00	22.33	14	King County Metro (Abandoned)	Remove
Sanitary Sewer	12+92.00	14.19	42	King County Metro	(No Issue)
Water	12+97.00	22.33	8	SPU	Re-Locate
Storm Drain	13+69.00	23.09	8	SPU	Re-Locate
Storm Drain	13+75.00	17.59	18	SPU	(No Issue)
Storm Drain	13+91.00	15.26	30	SPU	(No Issue)
Natural Gas	n/a	n/a	n/a	PSE (?)	Protect In Place/Temporary Re-Locate
Water	14+13.00	22.40	8	SPU	Re-Locate
Storm Drain	14+24.00	22.40	8	SPU	Re-Locate
Power Line - Traffic Signal	14+26.00	27.00	n/a	SDOT	Protect In Place/Temporary Re-Locate
Power Line - Traffic Signal	14+27.00	27.00	n/a	SDOT	Protect In Place/Temporary Re-Locate
Power Line - Street Lights	14+28.00	27.00	n/a	Seattle City Light	Protect In Place/Temporary Re-Locate
Storm Drain	14+87.50	13.10	30	SPU	(No Issue)
Combined Sewer Outfall	15+15.88	13.16	84	SPU or King County Metro	Protect In Place
STREAM CHANNEL THROUGH BE'ER SHEVA PARK					
Sanitary Sewer	01+85.00	n/a	n/a	Seattle Parks and Recreation	Protect In Place/Temporary Re-Locate
Power	03+10.00	n/a	n/a	Seattle Parks and Recreation	Re-Locate

2.14 Recreation

A strong community exists in the residential neighborhood surrounding the park, with a moderate contingent of people using the park for recreational purposes. Residents use grassy areas and paths for walking dogs, and children often utilize the playground facilities. Two sets of restrooms within the park boundary are also used by people in the vicinity. Due to the close proximity of the park to Rainier Beach High School, students use the park for recreational purposes. During periods of favorable weather, the boat ramp is highly utilized by people launching small motorized and non-motorized watercraft.

2.15 Hazardous, Toxic and Radioactive Wastes

A preliminary (Level 1) assessment (PA) of hazardous, toxic and radioactive wastes (HTRW) was conducted for the Mapes Creek restoration project area. The project alternatives pose low risk of identifying hazardous materials. Appendix A provides a copy of the HTRW assessment.

2.16 Aesthetics

The project site currently is a maintained park setting in a highly urbanized environment. The park is landscaped with mowed lawn with patches of trees and shrubs. The park includes the shoreline of Lake Washington and provides views of a marina and naturally vegetated areas.

3. REFERENCE SITE CHARACTERIZATION AND DESIGN GUIDANCE

The following sections describe reference sites that were chosen based on their similarity and applicability to Mapes Creek in order to inform the development of design criteria for use in formulation of potential Mapes Creek restoration measures and alternatives.

Criteria for potential reference sites included: beneficial juvenile Chinook habitat, proximity to natural habitat, site use by Chinook, topography, slope, sediment characteristics, maintenance requirements, and public access. The unique water level fluctuation in Lake Washington was also taken into consideration; the lake is two feet higher in the summer than the winter.

Several potential reference sites were examined. Based on the above listed criteria, two creeks were selected, Johns Creek and Kennydale Creek. Specifically, fish abundance was observed to be higher along the shoreline near the mouths of these creeks than along Lake Washington shoreline without natural stream-mouth input (Tabor et al. 2004; Tabor et al. 2006). These creeks also provided features of interest that may benefit fish habitat: pools, riffles, overhanging vegetation, woody debris, sediment type, temperature, and sediment delta. In addition, both creeks are located on Lake Washington and are therefore subject to the same water level change as Mapes Creek. These creeks are also within close proximity to the Cedar River, the natal river of the salmon present at Mapes Creek.

Measurements of the physical features were collected at the two sites and the results are discussed below. Seward Park, located 2.5 miles north of the Mapes Creek project area was also considered for development of design criteria and is discussed in this section. Specifically monitoring results of a recent restoration project which included gravel nourishment are considered. The objective of the gravel nourishment project was to enhance the shoreline for salmonid habitat. The City of Seattle has continued to monitor this site for fish presence and shoreline erosion.

Relevant design guidance from other sources such as literature was used as needed to supplement the reference site information. This enables the development of comprehensive design criteria.

3.1 Johns Creek

Johns Creek is located in Gene Coulon Park near Renton on the southeast shore of Lake Washington, east of the Cedar River confluence. Surveys conducted on juvenile Chinook salmon presence in Lake Washington showed that the lower stream reaches and area encompassed by the confluence of Johns Creek contained higher numbers of fish than all Lake Washington tributary mouths combined (Tabor et al. 2006). Field investigations of this reference site were conducted on January 16 and January 21, 2004. Surveys consisted of detailing the topographic characteristics of the creek and pool, collecting and analyzing sediment samples, and measuring the water quality. Figure 12 illustrates a site map for Johns Creek and identifies sample collection locations.

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Figure 12: Johns Creek Site Map and Data Collection Locations

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3.1.1 Fish Habitat

Juvenile Chinook were observed to extensively inhabit the lower reaches of Johns Creek during the spring season (Tabor *et al.,* 2006). The gently sloped, meandering creek is composed of a series of pool types including glide, scour, and convergence. These pools provide increasing gradients regarding velocity and depth, which are desirable to juvenile Chinook as they grow. Dense riparian vegetation (i.e., pine, Himalayan blackberry, yellow iris, cat tails, and purple loosestrife) overhangs both sides of the creek, providing shade and habitat for prey resources. Along some reaches, the banks of the creek are undercut approximately one foot, providing additional shade and protection. Additional off-channel habitats were also present. Fish were also observed underneath an eight foot wide pedestrian footbridge that spans the Creek (Tabor 2004). Juvenile Chinooks' strong preference for Johns Creek may also be attributed to the creek's close geographic proximity to their natal Cedar River.

The characteristics listed above provide beneficial reference characteristics; however, portions of Johns Creek contain undesirable habitat. The depth of the convergence pool varies from 0.5 to 2.5 feet. As the pool deepens by the rising lake level, preferred habitat for salmonid competitors and predators is created. These convergence pools are also heavily bordered by large riprap creating unnatural stream boundaries. In addition, a developed sediment delta is not present at the mouth of Johns Creek. Higher fish abundance has been documented at such sediment deltas in other tributaries.

3.1.2 Stream Discharge

A discharge of 2.4 cfs was measured near the mouth of Johns Creek on January 16, 2004. This discharge was approximately three times larger than the measured discharge at Mapes Creek. The Johns Creek watershed area is approximately 2.14 square miles, 15 times larger than the Mapes Creek watershed.

3.1.3 Stream and Pool Bathymetric Characteristics

The stream profile and cross sections were surveyed for 875 feet of stream length from the mouth of the stream at the Lake Washington shoreline. The stream was modeled in HEC-RAS in order to determine typical flow depths and velocities. The average stream velocity for a discharge of 2.35 cfs was 1.1 fps. The channel slope was 0.5%.

A convergence pool exists at the convergence of Johns Creek with Lake Washington. The pool is approximately 50 feet wide and 200 feet long. Depths vary from 0.5 ft in the winter to 2.5 feet in the summer.

3.1.4 Sediment Analysis

Sediment samples in the channel and convergence pool were collected and analyzed for grain size distribution. The channel bed consisted of nearly 100% gravel/cobble with armored sides. The convergence pool sediment grain size distribution was 74% gravel/cobble, 26% sands, and 0% fines.

3.1.5 Water Quality

Water quality measurements for Johns Creek were obtained on January 21, 2004 (Seattle University 2004). The values are shown in Table 12.

Table 12: Johns Creek Water Quality

Station	Temperature (°C)	Conductivity (mS/cm)	DO (mg/L)	pH
800 feet upstream of pool	9.60	0.188	9.43	7.21
Convergence Pool	9.25	0.189	8.52	6.45

3.1.6 Pool Velocity Investigation and Site Visit

On March 9, 2007 Corps personnel met with Roger Tabor of the U.S. Fish and Wildlife Service at Johns Creek to assess flow and depth conditions as a reference for the Mapes Creek design. Roger Tabor has been assessing salmonid use at Johns Creek for several years and was along to point out areas where salmonids have been observed. In past years Roger has noted up to 500 juvenile Chinook using the creek. Depth and velocity measurement were taken in pools that are known to attract juvenile fish. The average measurements for the best pools were 1.0 feet deep with a velocity of 1.0 fps. It was also observed that the best pools were along boulder banks with significant vegetative cover. It was suggested that a pool-riffle stream morphology should be used to develop the pools.

3.2 Kennydale Creek

Kennydale Creek is also located in Gene Coulon Park near Renton on the southeast shore of Lake Washington, just north of Johns Creek. Fish use was observed in the sediment delta along the shoreline of Kennydale Creek; however, the stream channel was steep and impassable by juvenile salmonids (Tabor et al. 2006). Field investigations of this site were conducted on January 14 and 21, 2004. Surveys consisted of detailing the topographic characteristics of the creek, collecting and analyzing sediment samples, and measuring the water quality. The Kennydale Creek site map and data collection locations are found in Figure 13.

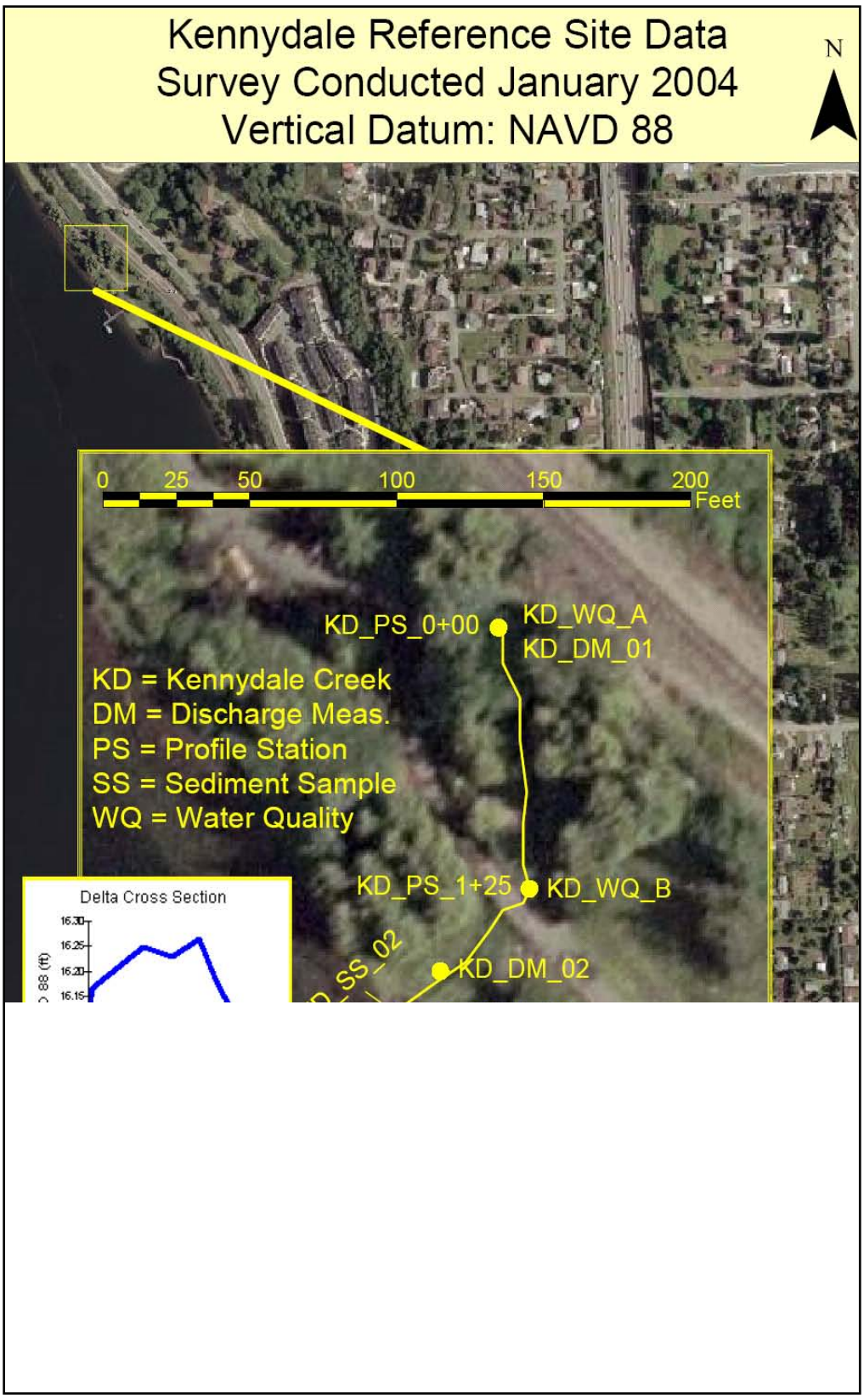

Figure 13: Kennydale Creek Site Map and Data Collection Locations

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3.2.1 Fish Habitat

During the Tabor (2006) study, juvenile fish were observed on the sediment delta at the mouth of Kennydale Creek, but not in the upper reaches due to an impassable blockage of large woody debris. After this study was complete, the blockage was removed and upstream reaches were modified. Fish may now access Kennydale Creek from the shore up to 20 meters; however, no further surveys have been performed to document this outcome. Overhanging vegetation (i.e., pine, morning glory, cat tails, and reed canary grass) and woody debris provide beneficial shade and refuge from predators. The naturally maintained sediment delta provides beneficial shallow water habitat and foraging opportunities.

Kennydale Creek contains several habitat characteristics that restrict fish access and limit the creeks functionality as a salmonid rearing habitat. Upstream of the first 20 meters, a severe stream slope and large boulders completely restrict upstream access. Minimal pooling, glide or convergence, exists. In addition, a narrow bankfull width (i.e., approximately less than 10 feet) provides limited area for salmonid passage. Under the Washington State interim water typing system, stream segments having a defined channel 20 feet or greater within the bankfull width are presumed to support larger fish populations.

3.2.2 Stream Discharge

The average discharge of Kennydale Creek on January 14, 2004 was 0.74 cfs; a flow comparable to Mapes Creek. The discharge was measured by timing the fill rate of a 5 gallon bucket at the exit of the upstream culvert. The Kennydale Creek watershed area is approximately 0.69 square miles, which is about five times larger than the Mapes Creek watershed.

3.2.3 Stream and Sediment Delta Bathymetric Characteristics

The stream was surveyed from Lake Washington to a culvert located 190 feet upstream from the lake. Thalweg elevations of the stream channel were taken every 10 feet. The survey extended 30 feet into Lake Washington to include the sediment delta. Three transects were surveyed with elevations measured every one foot. The channel slope was determined to be 4.3%. The sediment delta extended approximately 20 feet from the shoreline at a slope of 10%. The delta was approximately 20 feet wide and had a maximum water depth of 1.5 feet.

3.2.4 Sediment Analysis

Kennydale stream discharge is similar to Mapes Creek, but the channel slope and sediment discharge is much greater. Sand and gravel have deposited in the entire channel from the culvert to Lake Washington. Deposited sediments have even filled in the span of a small pedestrian bridge located approximately 100 feet upstream from Lake Washington. Three sediment samples were taken from the sediment delta and analyzed for grain size distribution. The Kennydale delta sediments were predominantly sand, with some gravel. The percent sand for each site was 68%, 64%, and 98%, respectively. The sediment analysis results for Kennydale Creek are shown in Table 13. The third sample was taken the furthest from the shoreline (approximately 20 feet) and contained very little gravel. The sand and gravel being transported in Mapes Creek is similar in size (predominately sand 0.0625 to 2 mm diameter) to the Kennydale delta sediments. The results of the laboratory analyses differ from the field observations reported by Pentec (2002) (see Section 2.2).

Table 13: Kennydale Creek Delta Sediment Grain Size

Sample Location	% Gravel	% Sand	% Fine
10' from shoreline	32	68	0
15' from shoreline	35	64	1
20' from shoreline	1	98	1

Note: Gravel = 2 mm to 4 mm, Sand = 0.0625 mm to 2 mm, Fines = 0.0625 and smaller

3.2.5 Water Quality

Water quality measurements at Kennydale Creek were obtained on January 21, 2004 (Seattle University, 2004). The values for two stream channel locations are shown in Table 14.

Table 14: Kennydale Creek Water Quality

Station	Temperature (°C)	Conductivity (mS/cm)	DO (mg/L)	pH
KD_WQ_A	7.59	0.134	11.43	7.02
KD_WQ_B	7.58	0.132	11.51	7.42

3.3 Seward Park

Seward Park is located about 2.5 miles north of Be'er Sheva, on the west shore of Lake Washington. The Corps and the City of Seattle conducted a restoration project that involved nourishing the shoreline with gravel/cobble (USACE 2001). In 2001, 1,400 cubic yards of sand and gravel were placed on 1,000 feet of shoreline. The project was identified to provide information regarding juvenile salmonid preferences for the characterization of substrate nourishment, grain size, and erosion rates on the southwestern shoreline of Lake Washington.

Substrate scour monitoring at Seward Park beach was subsequently conducted by the City of Seattle from October 2003 through February 2005 (City of Seattle 2006). Most of the sediment movement occurred at the water line and at one foot above the water line (with respect to the winter low lake level). Accretion on the order of 2 to 10 cm was measured in the fall and spring while the lake was at maximum elevation. Scour patterns as the lake elevation was drawn down in the summer to fall months varied with substrate size. The accumulated sediments moved back down to the starting depth in locations with smaller gravel (0.5 to 5.0 cm diameter). At the coarse gravel/cobble location (2.5 to 15 cm diameter), the sediment accumulated at a higher elevation than the smaller gravel before moving back down to the shoreline location. Tabor (2006) concluded that there was no increased use of this restoration site by juvenile Chinook salmon but saw a slight preference for the smaller gravel substrate over the larger gravel/cobble substrate.

3.4 Summary of Conclusions from Reference Site Data

The Johns Creek and Kennydale Creek reference sites were chosen to obtain design guidance regarding fish habitat, stream discharge, bathymetric characteristics, sediment, and water quality. Similar to Mapes Creek, these sites are close to the Cedar River discharge into Lake Washington and are subject to the reverse hydrology of the lake levels. Data from Johns Creek showed

characteristics of beneficial fish habitat including riparian vegetation, woody debris, a gently sloping channel, and pools of varying function. In addition, gravel/cobble substrate comprised the majority of the creek bed. The temperature and pH data met Washington State Department of Ecology's (Ecology) standards for core salmonid habitat (the designation of Lake Washington); however, dissolved oxygen was below the minimum criterion.

The pool at the mouth of Johns Creek changes depth with the rising levels of Lake Washington. Lake Washington is rising during the targeted time period (Feb-May) from approximately 16.9 feet to 18.9 feet (NAVD 88), a change of 24 inches. The pool is characterized as a glide/scour pool in late winter/early spring. With the rising lake elevation in late spring/early summer, the pool becomes a convergence pool as deep as 1 meter. During the late portion of the targeted time period for migratory juvenile Chinook (April/May) Johns Creek convergence pool provides less desirable habitat for juvenile Chinook.

The Johns Creek site visit with the US Fish and Wildlife Service provided valuable information for stream channel design. Smaller pools with vegetative cover in a pool-riffle system provide the best habitat based on recent fish surveys. During low flows, the average depth and velocity for the Johns Creek pools were 1.0 feet and 1.0 fps respectively.

Data from Kennydale Creek showed characteristics beneficial for juvenile salmonid foraging along the shoreline, including a 20 foot long shallow water sediment delta comprised of sand and gravel substrate. Juvenile fish have been observed to gather along the sediment delta but may have been due to the blockage of creek habitat. Temperature, pH, and dissolved oxygen data met Ecology's water quality standards for core salmonid habitat. The Kennydale Creek stream channel was not accessible to fish during the surveys, but the stream channel morphology was not found to be desirable habitat for juvenile salmonids.

The Seward Park data showed a slight preference for smaller substrate at the nourishment sites but no overall increase in fish presence post construction (Tabor 2006). Other sites with finer grained substrate at Seward Park, however; reportedly had higher fish presence.

3.5 Design Criteria

Design criteria for the project site at Be'er Sheva Park and Mapes Creek were deduced from the beneficial characteristics of the reference sites and from beneficial habitat characteristics described in current literature. In accordance with the project objectives, Mapes Creek restoration actions are intended to benefit juvenile Chinook during their outmigration from the Cedar River in the months of February to May. These design criteria are applied to the appropriate measures described below.

3.5.1 Riparian Vegetation

Overhanging, riparian vegetation, woody debris, and an absence of shoreline armoring were beneficial characteristics of both reference sites and in the literature and should be incorporated into the Mapes Creek design. The stream channel banks will be bordered with emergent and woody plantings to create a riparian corridor along the stream. Native vegetation, such as hazelnut, elderberry, and red-osier dogwood, would be planted on either side of the channel to provide overhanging vegetation for fish and to prevent pedestrian access. Patches of conifers would also be utilized. Large and small woody debris would be placed in and along the channel

to provide shade, cover, and channel complexity. Mapes Creek design will incorporate a minimum of 30 foot native riparian buffer from stream channel and shoreline, where practicable.

3.5.2 Stream Channel

Johns Creek is 875 feet long with a 0.5% slope. The proposed daylighted Mapes Creek stream channel is approximately 375 feet long and would meander through the park with a slope of 0.0081 ft/ft. Stream discharges averaging less than 1.0 cfs during the critical time period of February through May are expected based on discharges measured at Sturtevant Park. These discharges are similar to those observed at Kennydale Creek.

3.5.3 Pool Morphology

Johns Creek was characterized by a series of glide, scour, and convergence pools that supported a high concentration of juvenile Chinook. However, the deeper portions of these pools were not utilized by juvenile Chinook, possibly due to the increased concentration of predator species. Therefore, a design incorporating a series of shallower and faster flowing pools was incorporated into this project's measures. The downstream half of the channel will become inundated with a less desirable convergence pool, but inundation will occur at the tail end of the migration period. An advantage of the inundation is that stream diversity will be provided. Tabor et al found that slower, shallower pools contained higher counts of Chinook in early development, while slightly faster, deeper scour pools were favored later in development (Tabor 2006). Boulders will be placed to create stream meanders and develop a series of pools.

3.5.4 Substrate Size

The channel substrate at Johns Creek was 100% gravel/cobble with heavily armored sides. The pool at Johns Creek was 74% gravel and 26% sand. The substrate at Mapes Creek at Sturtevant Park was found to be about 81% sand at the inlet pipe and about 70% in the stream channel sediment traps. The Seward Park data showed a slight preference for smaller substrate at the nourishment sites but no overall increase in fish presence post construction (Tabor 2006). However, other sites with finer grained substrate than Seward Park reportedly had higher fish presence.

Based on Johns Creek reference site, the design criteria for channel substrate on the new daylighted channel bed design would include 6-inch deep clean sand/gravel substrate placed throughout the channel, with a mix of 35% gravel and 65% sand. This is based on the gradation of mobile sediment trapped at the pipe inlet. The bed is designed to be slightly mobile and replaced with incoming sediment. The mobile bed will keep the substrate clean and prevent silt deposition, which was seen in areas of Johns Creek. Below the 6-inch bed material will be an armor layer consisting of 3 to 6-inch gravel. The outside bends of the meandering channel will incorporate wood debris and boulder walls to create scour and glide pools.

3.5.5 Channel Lining

Pit investigations during the summer, when the lake elevation was 18.9-feet NAVD88, showed that the channel likely does not need to be lined. Similar investigation should be made during low lake elevations in the winter to verify this conclusion. If lining is required, a 6-inch clay layer below the gravel armoring is recommended.

3.5.6 Shoreline Delta

The shallow sediment delta at the shoreline of Kennydale Creek was found to extend about 20 feet into the lake and about 20 feet wide. The slope was about 10%, with substrate predominately sand (65% to 98%) with some gravel.

Offshore of the potential Mapes Creek surface stream channel, desired characteristics are already present; a shallow shoreline extending about 150 feet into the lake and 300 feet wide, 3% slope with 90% sands beyond the armored shoreline within 20 feet of the park. Additionally, sediment collected from the upper Mapes Creek channel has been measured as 80% sands.

At Mapes Creek, a sediment delta may not be naturally maintained due to the quantity and quality of substrate inputs that result from the upstream hydraulic constraints, settling pools, and low gradient. In addition, sediment transport processes may present the risk of maintenance issues and eventual blockage of fish passage to the open channel. For these reasons a sediment delta will not be considered as a potential restoration measure at this time.

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4. PLAN FORMULATION

The goal of the Mapes Creek restoration project is to improve the function of the Lake Washington shoreline ecosystem, in particular as it relates to habitat for juvenile salmonids and other wildlife. Opportunities include: 1) Increase shallow water shoreline habitat for refuge and rearing of migrating juvenile salmon; 2) Increase adjacent aquatic habitat for birds, amphibians and other wildlife in Lake Washington.

4.1 Methodology

The plan formulation methodology for the Mapes Creek project includes identification of restoration objectives and constraints, development of measures to address restoration needs, evaluation of measures against the baseline condition, and comparison of measures against one another and in various combinations. Based on this evaluation and comparison of measures against expected realization of the planning objectives, a recommended plan is identified. A cost-effectiveness analysis and incremental cost analysis (CEA/ICA) is one of the primary tools the Corps uses to help inform decision making for arriving at a recommended plan. Chapter 4 presents each of these planning steps and the findings from the evaluation.

4.2 Project Area Problems, Objectives and Measures

The Mapes Creek study is informed by existing data gathered for lake-wide restoration efforts in the Lake Washington Basin and the Lake Washington Tributaries system. Mapes Creek problems and objectives are meant to compliment those restoration efforts. Measures were formulated to address basin-wide as well as creek-specific problems and objectives.

The goal of the Mapes Creek Section 1135 restoration project is to improve the function of the Lake Washington shoreline ecosystem, in particular as it relates to habitat for juvenile salmonid and other wildlife. The Mapes Creek ecosystem problems and objectives are presented in Table 15. Table 15 also displays the restoration measures associated with the problems and objective that have been documented to date.

Table 15: Mapes Creek Potential Restoration Measures

Problems	Objectives	Measures
Altered Hydrology and Flow	Improve water conveyance pathways	Improve Mapes Creek surface flows
Altered Sediment Transport Processes	Improve rearing and migration habitats for salmonids	Improve sediment transport processes thru surface flows
Poor Water Quality	Improve water quality for parameters determined to be critical to fish survival and migration, particularly temperature, salinity and dissolved oxygen	Provide cool, fresh water source Restore wetland habitat and function
Degradation of Riparian Conditions	Restore, where possible, the natural complexity of the aquatic and riparian ecosystems Reduce predation and loss of habitat caused by competing non-native introduced species of fish and vegetation	Restore riparian corridor to lake shoreline Extend riparian corridor into restored wetland area Restore wetland habitat and function

Problems	Objectives	Measures
Loss of Channel Complexity and Connectivity	Restore, where possible, the natural complexity of the aquatic and riparian ecosystems Restore rearing and migration habitats for salmonids	Restore lake shoreline habitat complexity Restore surface channel connection of Mapes Creek to Lake Washington Restore wetland habitat and function
Fish Access and Passage Barriers	Reduce fish passage barriers	Improve fish access to lower Mapes Creek

4.3 Project Criteria and Constraints

The potential restoration measures listed above were evaluated against a series of site-specific criteria. The following criteria and constraints were used to limit the scope of potential restoration measures:

- Available Real Estate for project proposal
- Existing development and infrastructure
- Low Stream Discharges (<1cfs)
- Lake Elevation/Fluctuation (Reverse Hydrology)

The following criteria and constraints were used to identify considerations to be taken into account for each restoration measure:

- Public Support
- SPU and Parks Maintenance
- Park Current Function
- Preliminary Benefits

The following design goals were to identify favorable design features and to screen measures:

- Create a system that maximizes to the extent practicable, habitat suitable for juvenile Chinook salmon;
- Utilize City of Seattle standard design plans to the extent practicable;
- Create a sustainable system that will function with minimal maintenance or human intervention; and
- Preserve and/or recycle existing infrastructure if possible

The results of the preliminary screening of restoration measures are contained within Table 16 below. The table also notes additional data needs that may be required to confirm the ultimate feasibility of each measure.

Table 16: Presentation of Management Measures

	Measure	Function	Description
M1	Wetland Restoration	Improve existing habitat and access in adjacent wetland	Remove invasive species, replant with native wetland vegetation; remove sediment blocking fish access
M2	Shoreline	Improve existing shoreline habitat	Plant 30' buffer of native riparian vegetation along existing shoreline
M3	Large Wetland Creation	Provide interior wetland habitat	Excavate and plant native wetland vegetation within the interior area of Be'er Sheva Park.
M4	Stream Channel Creation	Shoreline Excavation and stream input	Excavate stream channel thru Park totaling 400 lf and plant a native riparian 30' buffer.
M5	Stream Channel with Small Wetland Creation	Provide stream channel and wetland habitat in park.	Excavate stream channel thru park, with adjacent off-channel wetland connecting north in the park.
M6	Stream Channel Pipe	Transfer Mapes Flow to dedicated pipe and daylight in park.	Place a dedicated pipe to separate Mapes Creek flow from CSO, connecting to Rainier Beach Safeway dedicated pipe. New pipe will surface at SW corner of Park.

4.4 Description of Measures

The following paragraphs describe each measure in more detail. Descriptions of each measure have been supplemented using the 35 Percent Design Analysis Report where applicable. Figure 14 provides a plan view of the project site. Figures 15, 16 and 17 show several different measures and configurations for the site.

4.4.1 Measure 1 – Wetland Restoration

In this measure, the adjacent wetland would be improved in function and quality. The location of the adjacent wetland (AW) is indicated on Figure 14, and is located in the eastern portion of Be’er Sheva Park . Non-native vegetation would be removed and native vegetation would be replanted throughout the 0.84-acre wetland. Measure 1 would remove material at the wetland outlet, allowing lake connectivity throughout the low-water periods (November through March). Additionally, this measure would provide general debris and trash removal from the shallow water and wetland areas. Since this feasibility study began, a significant portion of this measure was completed as mitigation for an unrelated project. For this reason and because it is a separate wetland area not affected by, or causing impact to, the other measures being considered, this measure was screened from further consideration.

4.4.2 Measure 2 – Shoreline Improvement

Native vegetation would be planted along the existing shoreline (30 foot buffer) and in the adjacent, fenced wetland (this wetland is not included in this study). This alternative would improve approximately 272 linear feet (8,171 square feet) of shoreline habitat (red hatched area in Figure 15, 16 and 17). While a minor feature relative to other measures, this measure can be combined with any other and further refines and improves the restoration effort at relatively low

cost. Design efforts aim to create a diversity of habitat for juvenile Chinook and other species by providing a combination of protective cover and open areas on the shoreline. Specific features would likely include wood debris structures that mimic natural tree falls and shoreline plantings to enhance the insect and detrital input to the system.

4.4.3 Measure 3 – Large Wetland Creation

This measure focuses on increasing the effective shoreline area by creating natural wetland function in the park interior, which would depend on lake water to maintain wetland condition (without additional water from Mapes Creek). The interior area of Be'er Sheva would be re-graded to allow the hydrologic regime to mimic those of the adjacent wetlands. While the slope would be mild, some fencing would be implemented to discourage foot traffic in the wetland. Currently, heavy winter and spring precipitation pools in the center of the park inundating the grass field while not providing any wetland habitat. This alternative would restore the natural hydrologic function. Additional wetland vegetation would be planted in and around this affected area to facilitate retention and filtration of the water. This action would create approximately 0.64 acres of wetland habitat in the interior of the park. The wetland will be designed primarily as a pocket refuge or shallow water marsh rearing area for target fish species. See Figure 15 for a plan view of this measure.

4.4.4 Measure 4 – Stream Channel Creation

Measure 4 requires implementation of Measure 6, which would deliver water from Sturtevant Park to a new, dedicated pipe and terminates at the southwest corner of Be’er Sheva Park. Figure 14 illustrates the approximate alignment of the proposed channel through the Park. Figure 15 provides a more detailed view of the alignment with elevations..The creek would then flow in an open, meandering channel from this discharge point to the shore of Lake Washington based on the design criteria described in Section 3.5. The 375-foot-long creek would maintain an average slope of 0.0081 ft/ft to provide stream discharge averaging less than 1.0 cfs with velocities of approximately 1.0 ft/sec during the months of February to May, a time critical to local juvenile salmonids. A low-flow pilot channel will be used in conjunction with a larger trapezoidal channel. The lake elevation will steadily increase during critical months. The mouth of the creek will be inundated by the lake with depths of about 2 feet. Figure 18 and Figure 19 illustrate the water surface and flow velocity profiles of the channel during periods of high and low lake elevation.

The channel banks will be bordered with emergent and woody plantings to create a 30-foot riparian corridor on each side of the stream. Native vegetation such as hazelnut, elderberry, and red-osier dogwood would be planted on either side of the channel to provide overhanging vegetation and to prevent pedestrian access. Large and small woody debris would be placed in and along the channel to provide shade, cover, and complexity. A pedestrian bridge (i.e., boardwalk piles or arched structure) would be placed across the channel to provide shade cover for fish and maintain access from the parking lot to the interior of Be’er Sheva Park. This controlled access would protect habitat features. This measure would create approximately 0.55 acres of creek and riparian habitat.

4.4.5 Measure 5 – Stream Channel and Small Wetland Creation

Measure 5 requires implementation of Measure 6, which would deliver water from Sturtevant Park to a new, dedicated pipe and terminate at the southwest corner of Be’er Sheva Park. This

measure is intended to enhance the habitat created by the stream channel measure through creation of an additional 500 square feet of adjacent wetland (Figure 17).

The stream channel design is identical to the channel described in Measure 4 based on design criteria from Section 3.5. The creek would flow in an open, meandering channel from this discharge point to the shore of Lake Washington. The daylighted Mapes Creek stream channel is approximately 375 feet long and would meander through the park with a slope of 0.0081. Stream discharges averaging less than 1.0 cfs during the critical time period from February through May are expected based on discharges measured at Sturtevant Park.

The channel banks would then be bordered with emergent and woody plantings to create a riparian corridor along the stream. Native vegetation, such as hazelnut, elderberry, and red-osier dogwood, would be planted on either side of the channel to provide overhanging vegetation for the fish and to prevent pedestrian access. Patches of conifers will also be planted. Large and small woody debris would be placed in and along the channel to provide shade, cover, and channel complexity. A pedestrian bridge (i.e., boardwalk piles or arched structure) would be placed across the channel to provide shade cover for fish and maintain access from the parking lot to the interior of Be'er Sheva Park. This controlled access would also help protect habitat features. This measure would create approximately 0.55 acres of creek and riparian habitat.

Next, the interior area of Be'er Sheva would be re-graded to allow the hydrologic regime to mimic those of the adjacent wetlands. While heavy winter and spring precipitation currently pools in the center of the park, the inundated field of grass does not provide any wetland habitat. This alternative would help restore natural hydrologic function with nearly 2 feet of inundation in the summertime and 1 to 1.5 feet during the spring. Additional wetland vegetation would be planted in and around this affected area to facilitate retention and filtration of the water. This action would create wetland habitat in the interior of the park.

The adjacent wetland habitat will enhance the biologic functions of Measure 4 by effectively extending the riparian border. Thus, this area will provide additional shade, woody material, nutrients, organic and inorganic debris, terrestrial insects, and habitat for riparian-associated wildlife such as invertebrates, waterfowl, amphibians, birds, and mammals. This habitat may be used for feeding, reproduction, or refuge. Specific benefits to the creek channel include improved water quality through the retention of sediment and pollutants from overland flow and during flood events, storage and release of nutrients into and out of the aquatic environment, retention of water during storm events providing longer-term base flow contributions, and increased stabilization of stream banks. These exchanges and complexity would also be of benefit to the wetland portion of the combined stream-wetland system, when compared to a wetland-only type alternative (Measure 3).

4.4.6 Measure 6 – Stream Channel Pipe

Measure 6 is required for the implementation of Measures 4 or 5, and cannot be implemented without either Measure 4 or Measure 5. For the purposes of the cost-effectiveness and incremental cost analysis (CE/ICA), Measure 6 is not considered individually, but rather as an integral component of Measures 4 and 5. The costs and benefits ascribed to Measures 4 and 5 for the purposes of the CE/ICA assume implementation of Measure 6.

This measure provides a new dedicated underground pipe to convey upstream Mapes Creek surface flows to a new discharge point in Be'er Sheva Park, at the upstream end of the Stream Channel (Measure 4 or 5). The new pipe would separate Mapes Creek flows from the combined sewer line to which it is currently piped. The pipe will begin at the point at which Mapes Creek flows join the CSO pipe - the "Safeway manhole" at the south terminus of the 52nd Avenue Walkway. The new pipe is 1,555 feet in length and would run north on 52nd Ave Walkway, east under S Henderson Street, cross Seward Park Ave and discharge at the southwest corner of Be'er Sheva Park. The proposed pipe diameter is 24 inches with a 0.3% slope. The precise alignment of the new pipe must avoid many existing underground utilities. A number of alternative alignments have been proposed and are detailed in the 35 Percent Design Analysis Report. The report recommends a more detailed utility survey be completed prior to further design.

Other features related to the pipe include a diversion structure at the upstream end of the pipe and an energy dissipater system built into the downstream end of the pipe. The proposed diversion structure would replace the existing manhole with an 84-inch diameter structure designed to accommodate 25-year design flow of 50cfs, directing 10cfs toward Mapes Creek and overflowing remaining flows to the storm drain.

The energy dissipater will effectively dissipate flow energy before it enters the surface channel in the park. During the 35% design phase, the proposed energy dissipater was changed from a standard exterior riprap apron to an enlarged pipe terminus filled with concrete-grouted riprap. This modified design is preferred primarily for aesthetic reasons.

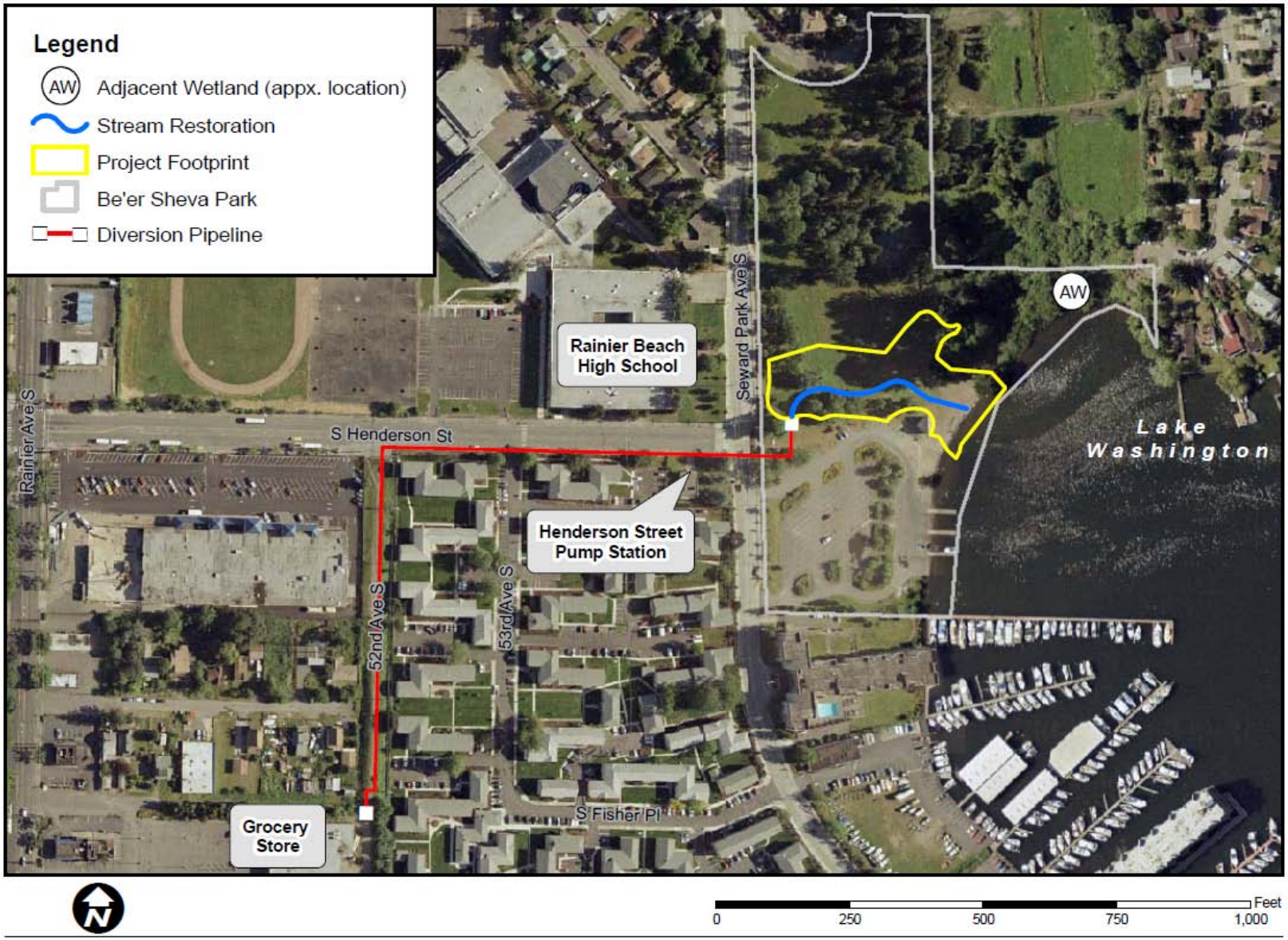

Figure 14: Management Measures

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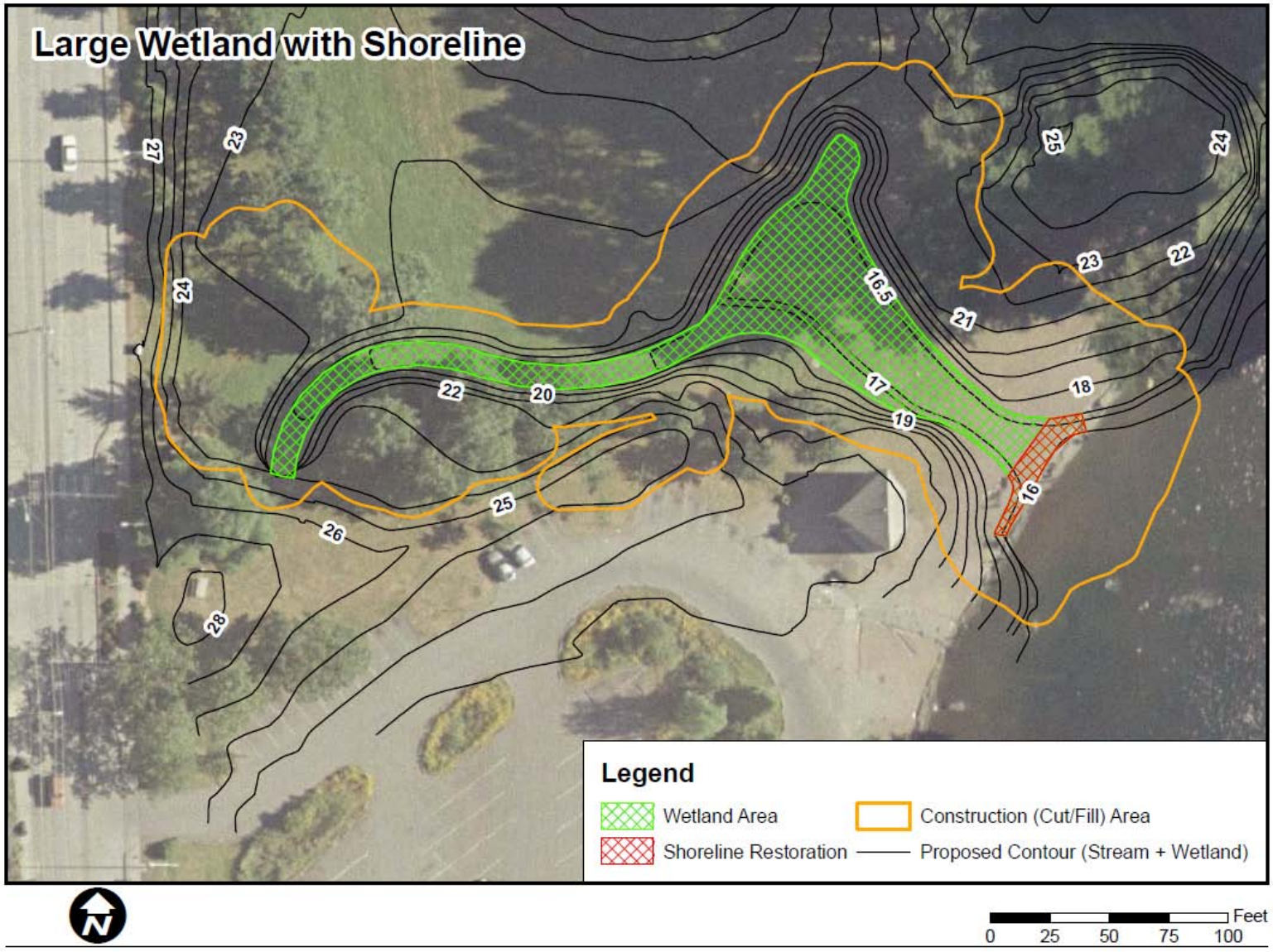

Figure 15. Mapes Creek Stream Channel Alignment (M3 - Large Wetland)

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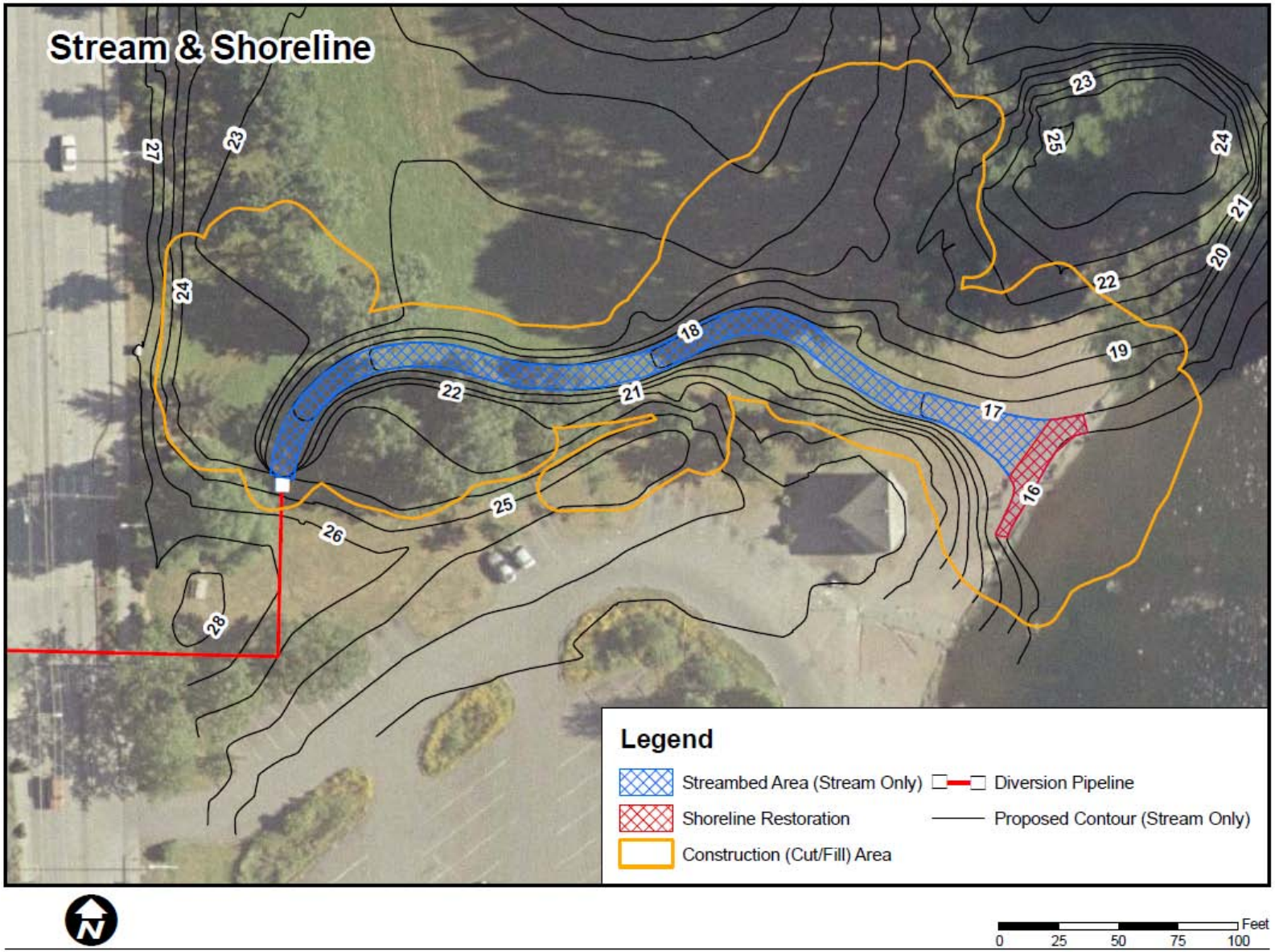

Figure 16: Mapes Creek Stream Channel Alignment (M4 - Creek Only)

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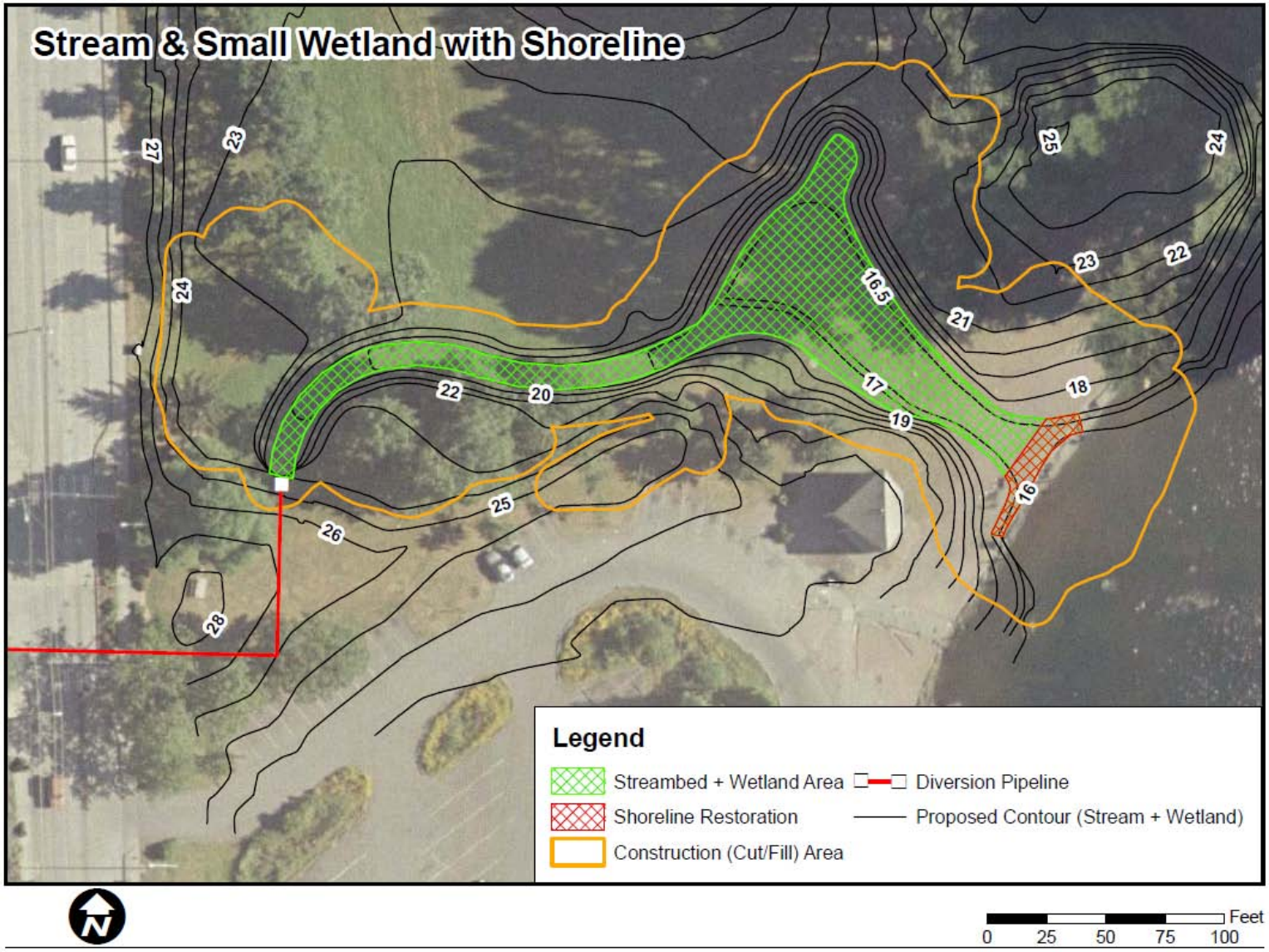

Figure 17: Mapes Creek Stream Channel Alignment (M5 - Stream & Wetland)

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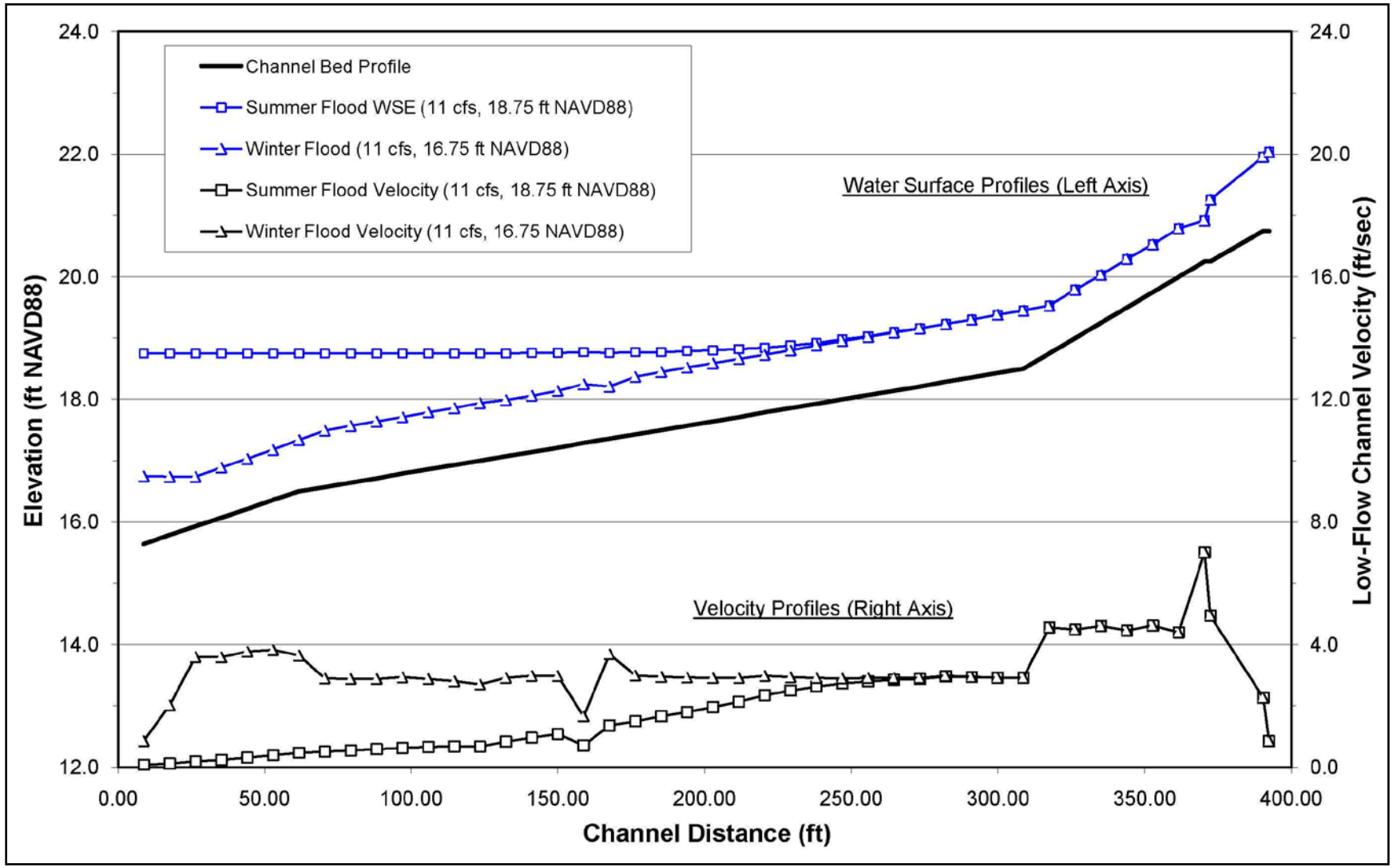

Figure 18: Calculated Water Surface and Velocity Profiles for Maximum Flood Flow (11 cfs)
Under Low (16.75 ft) and High (18.75 ft) Lake Washington Boundary Condition, Mapes Creek Restoration, Seattle WA

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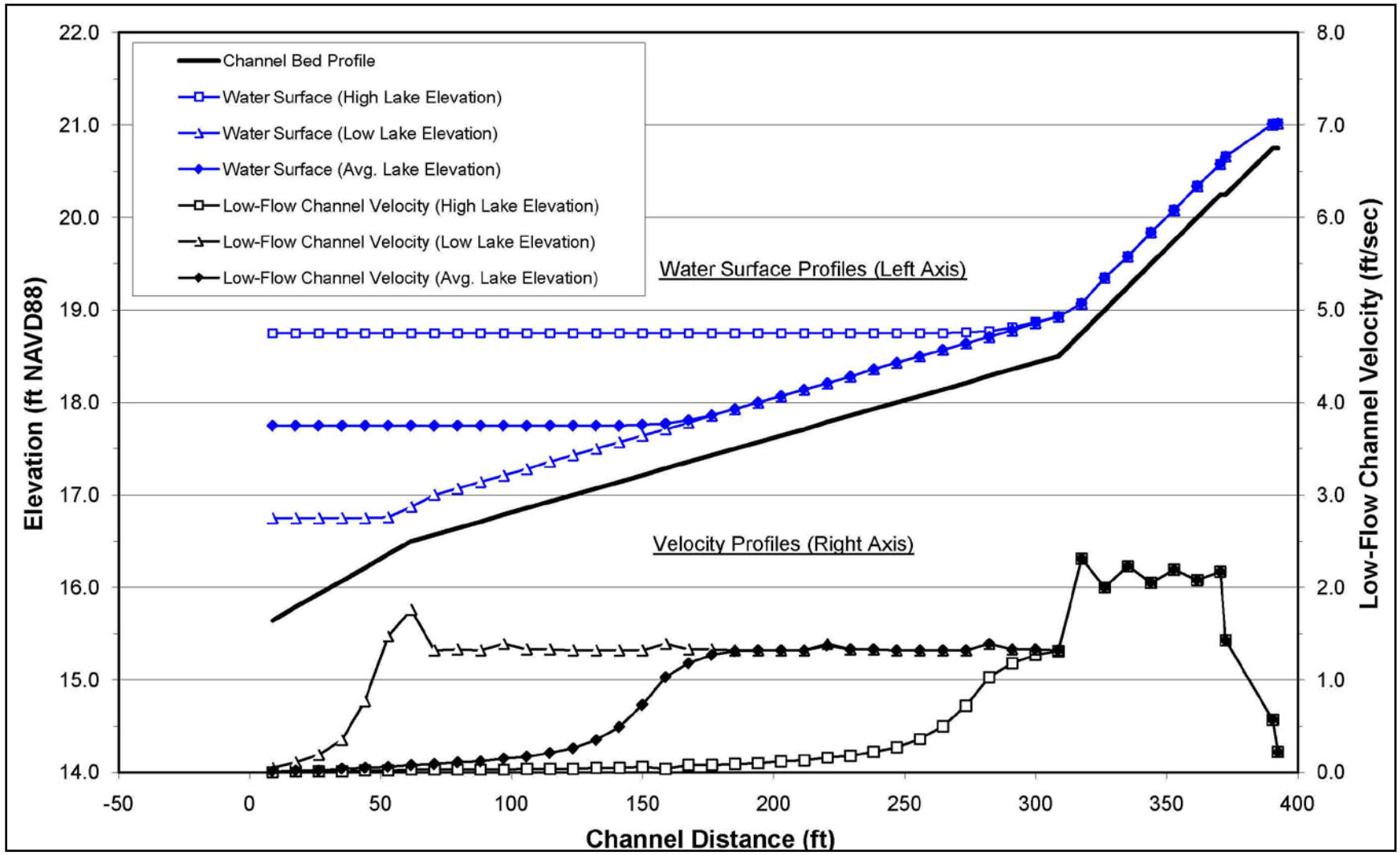

Figure 19: Calculated Water Surface Profile for Spring Rearing Season Typical Flow 0.6 cfs (February-May)
Under Low (16.75 ft), Average (17.75 ft), and High (18.75 ft) Lake Washington Boundary Condition, Mapes Creek Restoration, Seattle WA

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4.5 Habitat Benefit and Cost Analysis of Restoration Measures

4.5.1 Measure Cost Estimates

Construction costs were developed for several of the management measures in the Cost Opinion for the Mapes Creek Stream Restoration (35 Percent) Design Analysis Report (May 2009) at the 35% design level. These costs were used to calculate present value and average annual first costs over the lifetime of the project (50 years) for each of the measures, as shown in Table 17.

Table 17: Measure Construction Costs

Cost Line Items (PV)	Measure 2 Shoreline	Measure 3 Large Wetland	Measure 4 Stream Channel	Measure 5 Stream Channel with Small Wetland	Measure 6[1] Stream Channel Pipe
Base Project Costs					
Labor and Materials	$126,000	$222,000	$210,000	$256,000	$416,000
Site Prep / Demolition	$66,000	$38,000	$73,200	$76,200	$12,700
Site Survey	$10,100	$10,100	$10,100	$10,100	$10,100
Mobilization (8%)	$16,000	$21,000	$23,300	$27,400	$35,500
Constr. Supervisory/Admin.	$26,000	$35,000	$38,000	$44,300	$56,900
Sales Tax	$21,000	$28,000	$30,000	$35,100	$45,000
Contingency	$66,000	$89,000	$96,100	$112,000	$142,000
Subtotal	$331,000	$443,000	$481,000	$561,000	$720,000
Average Annual Cost	$16,400	$21,900	$23,800	$27,800	$35,700

Measure 6 costs are shown in the above table as a separate line item, however for the CEA/ICA these costs are combined with those identified for M5 and M4. This is because neither Measure 4 nor Measure 5 can be implemented without Measure 6, and Measure 6 would not be implemented without either Measure 4 or Measure 5.

Operation and Maintenance

Operation and maintenance costs (O&M) costs were estimated for each measure by Corps staff with input from Seattle Public Utilities and Seattle Parks and Recreation staff. Table 18 provides average annual O&M costs by measure.

Table 18: Measure O&M Costs

(Average annual costs calculated using FY11 Federal Interest Rate of 4.125%)

Measure	O&M Features	Interval (yrs)	Cost per event	Avg Ann ($)
M2 Shoreline	none	n/a		$0
M3 Large Wetland	none	n/a		$0
M4 Stream Channel	Channel	5-yr	$2,000	$356
	Park Access	5-yr	$800	
M5 Stream Channel w/ Small Wetland	Channel	5-yr	$2,000	$356
	Park Access	5-yr	$800	
M6[1] Stream Channel Pipe	Diversion Structure	5-yr	$5,269	$6,384
	Diversion Pipe	1-yr	$5,269	
	Energy Dissipater	5-yr	$1,000	

Measure 6 costs are shown in the above table as a separate line item, however for the CEA/ICA these costs are combined with those identified for M5 and M4.This is because neither Measure 4 nor Measure 5 can be implemented without Measure 6, and Measure 6 would not be implemented without either Measure 4 or Measure 5.

Real Estate Values

Real estate values were developed for each measure for use in the evaluation of measures. An average value per acre of $1.75M was used and is based on assessed values for the relevant parcels. Table 19 is based on assessed value and does not reflect navigational servitude or values for real estate crediting. Figure 20 shows the affected parcels. Table 20 presents the results.

Table 19: Measure Real Estate Values

Measure	$ per Acre	Acres	Total Value
M2	$1,750,000	0.08	$140,000
M3[1]	$1,750,000	1.26	$2,205,000
M4	$1,750,000	1.10	$1,925,000
M5	$1,750,000	1.26	$2,205,000
M6	$1,750,000	0.01	$17,500

Acres shown for M3 and M5 are the same because the footprint of the large wetland was assumed to be the same as the footprint of the small wetland/stream channel.

For purposes of the CE/ICA (Section 4.7 below) Measure 6 is not analyzed separately. Measure 6 costs are included in costs for Measure 3 & 4. This is because neither Measure 4 nor Measure 5 can be implemented without Measure 6, and Measure 6 cannot be implemented without either Measure 4 or Measure 5.

Table 20 summarizes these costs and presents the total annual cost for each measure. Note that interest during construction is not included because the construction period is anticipated to be less than one year. Finally Table 20.5 presents the combined costs Measure 4 and 5 which both require Measure 6. These costs are integral to the Cost-Effectiveness and Incremental Cost Analysis presented in Section 4.7.

Table 20: Summary of Measure Costs

Measure	Construction Cost	Real Estate Value	Total Construction Cost	Annual Cost (50 years, 4.125%)	Annual O&M Costs	Total Annual Cost ($)
M2	$331,000	$140,000	$471,000	$22,397	$0	$22,397
M3	$443,000	$2,205,000	$2,648,000	$125,915	$0	$125,915
M4	$481,000	$1,925,000	$2,406,000	$114,408	$356	$114,764
M5	$561,000	$2,205,000	$2,766,000	$131,526	$356	$131,882
M6	$720,000	$17,500	$737,500	$35,069	$6,384	$41,453

For purposes of the CE/ICA (Section 4.7 below) Measure 6 is not analyzed separately. Measure 6 costs are included in costs for Measure 3 & 4. This is because neither Measure 4 nor Measure 5 can be implemented without Measure 6, and Measure 6 cannot be implemented without either Measure 4 or Measure 5.

Table 20.5: Summary of Measure Costs with M6 Costs Combined with M4 & M5 Costs

Measure	Construction Cost	Real Estate Value	Total Construction Cost	Annual Cost (50 years, 4.125%)	Annual O&M Costs	Total Annual Cost ($)
M2	$331,000	$140,000	$471,000	$22,397	$0	$22,397
M3	$443,000	$2,205,000	$2,648,000	$125,915	$0	$125,915
M4+M6	$1,201,000	$1,942,500	$3,143,500	$149,477	$6,740	$156,217
M5+M6	$1,281,000	$2,222,500	$3,503,500	$166,595	$6,740	$173,335

For purposes of the CE/ICA (Section 4.7 below) Measure 6 is not analyzed separately. Measure 6 costs are combined here with costs for Measure 3 & 4 for use in running the CE/ICA. This is because neither Measure 4 nor Measure 5 can be implemented without Measure 6, and Measure 6 cannot be implemented without either Measure 4 or Measure 5.

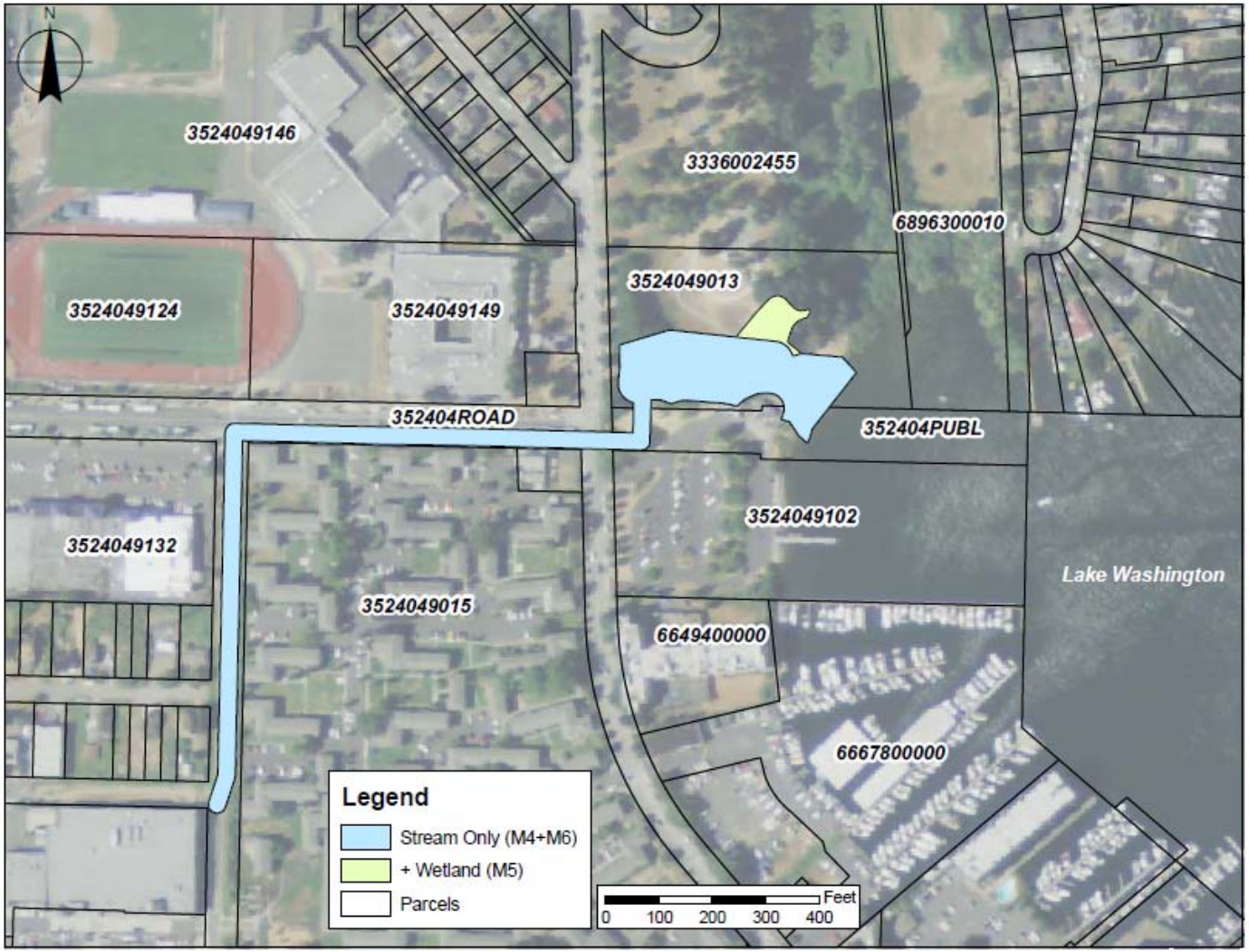

Figure 20: Affected Parcel Map

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4.6 Habitat Benefits Analysis of Restoration Measures

4.6.1 Methodology

Having estimated the cost of each measure, a Habitat Benefit Analysis was conducted to measure the beneficial output of each measure.

Habitat benefits, or outputs, resulting from implementation of the alternatives were quantified using qualitative descriptions of the factors of decline that were identified for the Lake Washington Basin, specifically, the factors of decline for the Lake Washington shoreline and its tributaries (WRIA 8, 2002). This system and the associated incremental cost analysis (Section 4.7) are the decision making tools used to help identify a recommended plan. Habitat benefits or outputs, are based on a measure's potential to improve the factors of decline: 1) wetland hydrology; 2) stream hydrology 3) water quality; 4) channel complexity/connectivity; 5) sedimentation and sediment transport processes; 6) riparian and floodplain areas; 7) fish access and passage; and 8) wetland biological function.

A matrix was developed to score the measures according to how they would impact the factors (parameters) of decline. Matrix scores were assigned by Corps technical staff using best professional judgment. The rationale for the scores was based on the Lake Washington Limiting Factors. For each measure, an individual parameter is assigned a value between 0.0 and 10.0. A score of 0.0 indicates that the factor is not functioning and a score of 10.0 indicates the parameter is beneficially functioning to its maximum extent.

The individual raw scores are then multiplied by a percentage representing the average degree to which a given benefit parameter is expected to accrue over time. Percentages were assigned to each benefit parameter for each five-year period from year zero through year fifty (the period of analysis). The average percentage was used to adjust the raw scores to account for variable accrual of benefits over time.

After time had been factored into the raw scores, the resulting time-weighted scores were further weighted according to the significance of the benefit parameter to the primary project opportunities. The identified opportunities include: 1) increase shallow water shoreline habitat for refuge and rearing of migrating juvenile salmon; 2) increase adjacent aquatic habitat for birds, amphibians and other wildlife in Lake Washington. All time- and significance-weighted scores are then summed to produce a total score for each measure.

The score for a given measure would be calculated as follows:

$$\sum_{j=1}^{N} X_j T_j W_j$$

Where…

X_j = raw score for parameter *j;*
T_j = time factor for parameter *j*;
W_j = weighting factor for parameter *j;* and
N = total number of parameters evaluated.

Table 21 summarizes each of the parameters, and the relative scoring system that was used to evaluate ecosystem conditions.

In order to accurately compare each measure, baseline values were assigned to quantify the existing ecological functions at the project site. For the purposes of this analysis, those baseline conditions represent the output of the No Action Alternative because it is assumed that the existing conditions will continue into the future if no project is implemented. The baseline values are not always 0.0, as some of the factors are partially functioning in the current system. Net ecosystem benefits are then calculated by subtracting the scores for the baseline condition from those for the expected future with-project condition.

Table 21: Physical Parameter Scoring Criteria Definitions

Score	Description
	Wetland Hydrology
0	No wetland hydrologic function
5	Degraded wetland hydrologic function due to artificial structures, sedimentation or urbanization.
10	Natural wetland hydrologic function demonstrated by water retention and recharge of the groundwater supply.
	Stream Hydrology
0	No natural stream flows.
5	Degraded stream flows (volume and/or timing) due to artificial structures or urbanization.
10	Natural stream flows demonstrated by uncontrolled freshwater confluence with the lake, natural storm hydrology and recharge of the groundwater supply.
	Water Quality
0	Severe degradation of water quality parameters such as temperature, HC, Fecal Coliform, turbidity, pesticides, DO, and metals. These parameters are regulated by Ecology and have been found to impact fish mortality. (WAC 173-201A-200; Fish and Wildlife Service, 1995 *in* Smith, 2005).
5	Degraded water quality due to urbanization resulting in tolerable but not ideal conditions.
10	Non-degraded water quality function, resulting in ideal fish habitat.
	Channel Complexity/Connectivity
0	Restricted, simplistic channel path and design. No off-channel or in-channel habitat present.
5	Degraded channel design. Presence of off-channel or in-channel habitat, but access is restricted.
10	Natural channel design parameters including geometry, channel alignment, sinuosity, channel length and slope, channel cross section, riffle and pool spacing, and channel stability (WDFW et al., 2003). Off channel habitats present.
	Sediment Transport Processes
0	No natural channel or channel features (i.e., pools or riffles) forming due to a lack of sediment transport processes or extreme sediment depositions forming barriers in channel.
5	Degraded sediment transport processes due to artificial structures or disruptive features (i.e., constructed pools).
10	Natural sediment transport processes evident by the deposition of gravel and substrate along the channel bed. Natural channel formations provide appropriate sedimentation locations.
	Riparian and Floodplain Areas
0	Riparian zone or other appropriate native buffer is non-existent or is dominated impervious surfaces.
5	Riparian zone or other appropriate native buffer averages less than 10 feet and is interspersed with non-native species.
10	Riparian zone or other appropriate native buffer averages greater than 10 feet and is not composed of non-native species. The zone provides ideal habitat function and structure.
	Fish Access and Passage
0	No access to habitat areas.
5	Restricted access to habitat areas due to high velocities, low flows, sediment blockage, etc.
10	Uninhibited access to in-channel and off-channel habitat.
	Wetland Biological Function
0	Wetland area is fully degraded due to minimal hydric soils, obligate species and presence of water
5	Wetland area is partially functioning and degraded due to some hydric soils, obligate native species and presence of water
10	Wetland area is fully functioning due to abundance of hydric soils, obligate native species and presence of water, as seen by improved water quality through filtration and beneficial shoreline or near shoreline habitat for fish and wildlife.

4.6.2 Summary of Analysis

A summary of the *raw scores* of the habitat benefit analysis is presented in Table 22. Table 23 shows the percentage of benefit accrual assumed per factor over the period of analysis. Table 24 presents the weighting factors for each parameter, and Table 25 shows a summary of the habitat benefit scores by measure with the time and factor significance weightings incorporated. The weighted-habitat-benefit-over-time scores for each parameter were generated by multiplying:

a) The raw score for that parameter (Table 23)
b) The average expected percentage of habitat benefits over time (Table 24), and by
c) The weighting factor (Table 25).

The resulting scores adjusted to account for time and weighting factor were then summed to get a total score for each measure (Table 26).

The results of this analysis show that no-action, received the lowest score. Measure 5, Stream Channel with Small Wetland Creation, received the highest score, indicating that this design would restore the most function to the area on an individual measure basis. In order to develop alternative plans, combinations of measures are evaluated using a Cost-Effectiveness and Incremental Cost Analysis as detailed in the following section.

Table 22: Habitat Benefit Analysis Matrix

Benefit Scoring (not weighted)	Wetland Hydrology	Stream Hydrology	Water Quality	Channel Complexity/ Connectivity	Sedimentation/ Sediment Transport	Riparian/ Floodplain Areas	Fish Access Passage	Wetland Biological Function
No Action	1	0	3	0	0	0	0	0
M2 - Shoreline	1	0	3	2	1	6	2	0
M3 – Large Wetland Creation	6	0	4	0	1	5	2	5
M4 – Stream Channel	1	6	4	6	3	6	6	0
M5 – Stream Channel w/ Small Wetland	6	6	6.5	6	4	6	6	5

Table 23: Expected Percentage of Habitat Benefits Over Time

	Y0 (Post Construction)	Y5	Y 10	Y15	Y20	Y25	Y30	Y35	Y40	Y45	Y50	Average
Wetland Hydrology	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	95%
Stream Hydrology	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Water Quality	10%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	92%
Channel Complexity/ Connectivity	90%	95%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
Sediment Transport Processes	100%	80%	50%	100%	80%	50%	100%	80%	50%	100%	80%	79%
Riparian and Floodplain Areas	20%	50%	90%	100%	100%	100%	100%	100%	100%	100%	100%	87%
Fish Access and Passage	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Wetland Biological Function	20%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	93%

Table 24: Habitat Benefit Weighting Factors

Weight	Function
0.6	Wetland Hydrology
0.8	Stream Hydrology
0.7	Water Quality
0.9	Channel Complexity/Connectivity
0.5	Sedimentation/Sediment Transport
0.9	Riparian/Floodplain Areas
1.0	Fish Access Passage
0.6	Wetland Biological Function

Table 25: Weighted Habitat Benefit Over Time Analysis Matrix

Benefit Scoring (weighted)	Wetland Hydrology	Stream Hydrology	Water Quality	Channel Complexity/ Connectivity	Sedimenta -tion/ Sediment Transport	Riparian/ Floodplain Areas	Fish Access Passage	Wetland Biological Function	Total Points (weighted)
No Action	.57	0	1.93	0	0	0	0	0	2.50
M2 - Shoreline	.57	0	1.93	1.78	0.40	4.70	2.00	0	11.38
M3 – Large Wetland Creation	3.42	0	2.58	0	0.40	3.92	2.00	2.79	15.10
M4 – Stream Channel	.57	4.80	2.58	5.35	1.19	4.70	6.00	0	25.18
M5 – Stream Channel w/ Small Wetland	3.42	4.80	4.19	5.35	1.58	4.70	6.00	2.79	32.82

The weighted-habitat-benefit-over-time scores for each parameter were generated by multiplying:

a) the raw score for that parameter (Table 23)
b) the average expected percentage of habitat benefits over time (Table 24), and by
c) the weighting factor (Table 25).

The resulting scores adjusted to account for time and weighting factor were then summed to get a total score for each measure.

4.7 Economic Evaluation of Project Alternatives: Cost-Effectiveness and Incremental Cost Analysis

A cost-effectiveness and incremental cost analysis was conducted to evaluate the relative effectiveness and efficiency of restoration alternatives at addressing environmental objectives of the project. The analyses provide a framework for comparing the differences in output across alternatives and the associated changes in cost. The analysis was conducted in the following steps:

- Tabulate average annual cost and average annual environmental outputs of each restoration measure
- Identify any measures whose implementation is dependent upon implementation of others
- Identify any measures that are not combinable with others
- Identify all potential combination of measures (alternative plans)
- Calculate cost and output estimates for each alternative plan
- Identify any measures that provide the same output at greater cost than other combinations (non cost-effective plans)
- Identify any measures that provide less output at the same or greater cost as other combinations (non cost-effective plans)
- Evaluate changes in incremental costs and benefits for remaining combinations
- Identify most efficient set of remaining combinations ("best-buys")
- Display changes in incremental cost relative to benefit for best-buy combinations
- Interpret results to inform selection of a preferred plan

The analyses use the FY11 federal discount rate of 4.125% and a period of analysis of 50 years for discounting and amortization of costs. Costs are presented in 2010 price levels.

Measure M1 (Wetland Restoration) involved restoration of an area on an adjacent parcel unaffected by, and having no impact on, the other measures being considered. The Wetland Restoration measure has been removed from the analysis, as it has been substantially implemented since formulation began, as mitigation for an unrelated project.

Measure M4 (Stream Channel) and Measure M5 (Stream Channel with Small Wetland) both require implementation of Measure M6 (Stream Channel Pipe), which cannot be implemented without either M4 or M6. Consequently, Measure 6 was not analyzed as a separate measure; instead, it was analyzed as an integral component on M4 and of M5. Benefits ascribed to M4 & M5 assume implementation of the pipe, and costs ascribed to those measures include pipe costs.

Each restoration measure was given an identification code letter for use in entering the data into IWR-PLAN, the Corps software program developed for conducting the analyses. Table 26 displays the identifier codes for each site. These codes are used to reference the measures in the discussion that follows.

Table 26: CE/ICA Solution Codes

Solution Code	Measure	Management Measure Name
A	M2	Shoreline Improvement
B	M3	Large Wetland Creation
C	M4	Stream Channel Creation
D	M5	Stream Channel with Small Wetland Creation

Notes:

M1 - Wetland Restoration has been removed from the analysis, as it has been substantially implemented since formulation began, as mitigation for an unrelated project.

M6 – Stream Channel Pipe was analyzed as an integral component of M4 and of M5.

4.7.1 Step 1: Defining Measure Cost and Output

Measure costs were presented in Section 4.5. The estimation of total measure ecosystem outputs is discussed in Section 4.6 and presented in Table 25. For the CE/ICA analysis, net habitat outputs are calculated by subtracting total no action output from the total output of each measure.

Table 27 provides a table summarizing the total construction cost and average annual cost (AAC) of each measure. Note that for the purposes of the economic analysis, the costs presented earlier (Table 20) for Measure 6 are included in the costs presented here for Measures 4 and 5, as they cannot be implemented without Measure 6, and Measure 6 cannot be implemented without one of those two measures. Table 20.5 presents the combined costs for Measures 4 and 6 and Measures 5 and 6. Table 28 presents the average annual O&M costs associated with each measure.

Table 27: Measures Total Construction* Costs and Average Annual Costs

Solution Code	Measure	Management Measure Name	Total Construction Cost ($)	Total Construction Cost (AAC) ($)
No Action	-	No Action	$0	$0
A	M2	Shoreline Improvement	$471,000	$22,397
B	M3	Large Wetland Creation	$2,648,000	$125,915
C	M4	Stream Channel Creation	$3,143,500	$149,477
D	M5	Stream Channel with Small Wetland Creation	$3,503,500	$166,595

1. *Includes real estate values.*

2. AAC calculated using FY2011 federal interest rate (4.125%)

Table 28: Measure Estimated Annual Operations and Maintenance (O&M) Costs

Solution Code	Measure	Management Measure Name	O&M
No Action	-	No Action	$0
A	M2	Shoreline Improvement	$0
B	M3	Large Wetland Creation	$0
C	M4	Stream Channel Creation	$6,740
D	M5	Stream Channel with Small Wetland Creation	$6,740

Table 29 presents calculation of net output per measure versus the No Action alternative over the 50 year period of analysis for each of the management measures. The Net Output for each measure is equal to its Total Output minus the Total Output for the No Action.

Table 29: Management Measure Net Ecosystem Output

Solution Code	Measure	Management Measure Name	Total Output (HU)	Net Output (HU)
No Action	-	No Action	2.50	0
A	M2	Shoreline Improvement	11.38	8.88
B	M3	Large Wetland Creation	15.10	12.59
C	M4	Stream Channel Creation	25.18	22.67
D	M5	Stream Channel with Small Wetland Creation	32.82	30.32

Table 30 summarizes the ecosystem output (HU) and the total annual cost of each measure, including O&M.

Table 30: Management Measure Estimated Costs and Outputs

Solution Code	Management Measure Name	Output (HU's)	Total Annual Cost
No Action	No Action	0	$0
A	Shoreline Improvement	8.88	$22,397
B	Large Wetland Creation	12.59	$125,915
C	Stream Channel Creation	22.67	$156,217
D	Stream Channel with Small Wetland Creation	30.32	$173,335

4.7.2 Step 2 and 3: Combinability and Dependency

Identification of the combinability and dependency relationships between measures were completed through discussion with the PDT to understand the specific implementation requirements as well as consequences of implementation for each measure.

Table 31: Measure Relationships

Management Measure	Solution Code	Not Combinable With	Dependent On
No Action		None	None
M2- Shoreline	A	None	None
M3- Large Wetland Creation (no pipe and stream)	B	C, D	None
M4- Stream Channel (includes pipe and stream)	C	B, D	None
M5- Stream, Small Wetland (includes pipe and stream)	D	B, C	None

Measure 3 is combinable with all other measures. Measures 3, 4, and 5 would all be implemented on the same or overlapping footprints, so could be combined with each other. Table 31 summarizes the relationships that were defined.

4.7.3 Steps 4 and 5: All Possible Alternative Plans

Having defined the cost and benefits of all measures, as well as the relationship between measures, the software was used to generate a list of all possible combinations of measures. Each combination is referred to as an alternative plan. Given the number of measures and the relationships defined previously, eight possible plans were generated. The software reports the measures included in each plan, the annual cost of the plan, and the plan's total output. Table 32 presents the results.

Table 32: All Possible Plans

Alternative Plan	Average Annual Cost ($1,000's)	Net Output (HUs)	Cost-Effective
No Action Plan	$0	0	Yes (Best Buy)
Shoreline	$22.40	8.88	Yes (Best Buy)
Large Wetland Creation	$125.92	12.59	Yes
Large Wetland Creation & Shoreline	$148.31	21.47	Yes
Stream Channel (Includes pipe)	$156.22	22.67	Yes
Stream Channel with Small Wetland (Includes pipe)	$173.33	30.32	Yes
Stream Channel (Includes pipe) & Shoreline	$178.61	31.55	Yes
Stream Channel with Small Wetland (Includes pipe) & Shoreline	$195.73	39.20	Yes (Best Buy)

4.7.4 Steps 6 and 7: Identification of Cost-Effective Plans

In addition to generating all possible combinations and calculating their respective costs and outputs, IWR Plan Suite performs a cost-effectiveness analysis, completing the following two steps:

Identify any measures that provide the same output at greater cost than other combinations and screen from further analysis

Identify any measures that provide less output at the same or greater cost as other combinations and screen from further analysis

This cost-effectiveness screening resulted in identification of the array of combinations that are referred to as the "Cost-Effective Set". If considering only the cost and output estimates, there is no rational reason to implement a non-cost-effective combination. Figure 21 identifies the cost-effective plans.

4.7.5 Steps 8 to 10: Incremental Cost Analysis

Following the identification of cost-effective combinations, IWR Plan Suite conducts an incremental cost analysis on the cost-effective set of management measure combinations. This incremental cost analysis compares the rate of increase in cost and the rate of increase in output between the cost-effective plans providing the least output to all other cost-effective plans

producing more output. The next identified plan is the one that provides the greatest increase in output for the least increase in cost. This plan is identified as a "best buy" plan. This best buy is then compared to all remaining cost-effective plans in a reiteration of the same analytical process to identify the "next best buy." This process is repeated until no plans remain. The result is an array of "best-buy" plans that based on the cost and benefit numbers entered, are the most efficient at producing the desired environmental outputs. Figure 21 identifies the best buy plans.

4.7.6 Step 11: Interpreting Results

Figure 21 presents the results of the cost-effectiveness and incremental cost analysis graphically. A plot is presented of all possible plan relating annual cost and annual output. Plans are differentiated according to whether they are best-buy, cost-effective, or non-cost-effective plans.

After design progressed and more detail became available on costs and benefits for the measures considered, CE/ICA was performed with 35% design information. The array of alternatives did not change with regards to cost-effectiveness or "best-buy" status.

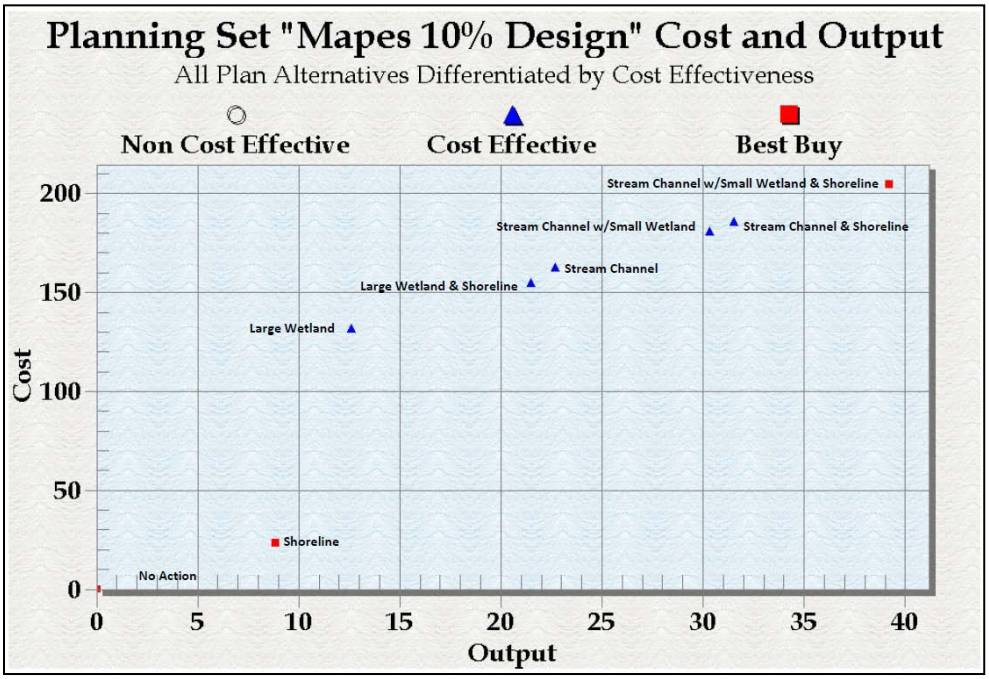

Figure 21: All Possible Plans Differentiated by Effectiveness

Table 33 presents the tabulated results of the CE/ICA, showing for each plan the overall average annual cost, the overall net outputs, the cost per unit of net output, the incremental cost (the difference between the cost of a plan and the next lower plan), the incremental output (the difference between the outputs of a plan and the next lower plan) and the cost per unit of incremental output.

Table 33: Tabulated Results of CE/ICA

Alternative Plan	Average Annual Cost ($1,000's)	Net Output (HUs)	Average $/HU	Incremental Cost ($1,000's)	Incremental Output (HUs)	Incremental $/ HU ($1,000's)
No Action Plan	$0	0				
Shoreline	$22.40	8.88	2.52	$22.40	8.88	2.52
Large Wetland Creation	$125.92	12.59	10.00	$103.52	3.71	27.90
Large Wetland Creation & Shoreline	$148.31	21.47	6.91	$22.39	8.88	2.52
Stream Channel (Includes pipe)	$156.22	22.67	6.89	$7.91	1.20	6.59
Stream Channel with Small Wetland (Includes pipe)	$173.33	30.32	5.72	$17.11	7.65	2.24
Stream Channel (Includes pipe) & Shoreline	$178.61	31.55	5.66	$5.28	1.23	4.29
Stream Channel with Small Wetland (Includes pipe) & Shoreline	$195.73	39.20	4.99	$17.12	7.65	2.24

4.8 Summary of CE/ICA Results

The CE/ICA tabulated each possible combination of measures to form alternative plans given the combinability and dependency relationships defined in Section 4.7.2. Each of these potential plans is summarized below, including the constituent plan features and type. Due to the small number of measures and their relationships, a total of 8 possible plans (including no action) are detailed below.

No Action: The No Action Alternative will not implement any restoration measures. This alternative establishes a baseline against which all other alternatives will be evaluated. Costs and habitat output for the No Action are zero. The No Action Alternative is always identified by IWR Plan Suite as a "best buy" alternative. The outputs presented for each measure are the net values calculated by subtracting the output value of the no action alternative.

Shoreline Only: This alternative would implement the Shoreline Improvement Measure by itself. Because of its relatively low cost and positive benefits, this alternative is cost-effective and a "best-buy".

Large Wetland: This alternative would entail creation of a wetland at the project site. It is cost-effective, and the least expensive of the cost-effective plans that generate more than ten units of ecosystem output. The average costs per unit of output are greater for the Large Wetland Alternative than for any other alternative.

Large Wetland and Shoreline: This alternative would implement the Shoreline Improvement Measure and the Large Wetland Measure. This alternative is cost-effective. This plan has the second highest averagel cost per unit of output of all the plans considered. Addition of the Shoreline Improvement Measure provides additional benefits at a low incremental cost.

Stream Channel: This alternative would implement the Stream Channel Measure, including the diversion pipe, successfully connecting Mapes Creek to Lake Washington. This alternative is cost-effective. It has the third highest average cost per unit of output of all the plans considered.

Stream Channel with Small Wetland: This alternative would implement just the Stream Channel with Small Wetland Measure. It is a cost-effective plan with costs and benefits higher than those for the Stream Channel Alternative. The incremental cost per unit of output achieved by adding the small wetland is relatively low.

Stream Channel & Shoreline Improvement: This alternative includes the Stream Channel Measure (including the diversion pipe) and the Shoreline Improvement Measure. The incremental cost per unit of output achieved by adding the Shoreline Improvement Measure, while higher than that for adding the Small Wetland Measure, is still relatively low..

Stream Channel with Small Wetland & Shoreline Improvement: This alternative is a combination of all the measures considered. This alternative produces the greatest number of HUs and is the most expensive plan. As a result IWR Plan identifies it as a Best Buy Plan by default. As when added to the Stream Channel Alternative, adding the Small Wetland Measure to the Stream Channel with Shoreline Improvement Alternative provides additional benefits at a low incremental cost.

4.9 Selection and Justification of the Recommended Alternative

For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost effective and justified to achieve the desired level of output. This plan shall be identified as the National Ecosystem Restoration (NER) Plan. For this study, the NER plan is also the Recommended Alternative.

In selecting the NER plan the project team must consider the results of the cost effectiveness and incremental cost analysis, comparing the successive levels of output and their cost and determining which levels are worth their added cost

Using the CE/ICA results, best-buy plans are often identified as the alternatives from which a preferred plan will be chosen. At Mapes Creek the alternatives identified by the CE/ICA as best-buy plans were the No-Action Plan, Shoreline Only Plan (Solution A/Measure 2), and the Stream Channel with Small Wetland and Shoreline Plan (Solutions D & A/Measures 2 & 5). The No-Action plan and the Stream Channel with Small Wetland and Shoreline Plan both appear as best-buy plans by default as a function of how IWR Plan-Suite works. In order to better encompass the range of plans available, all cost-effective plans were considered for selection as the NER plan. The following is a summary of the rationale for selecting the NER Plan.

No Action Plan
The no action plan was not selected as the NER because there were no benefits associated with the plan.

Shoreline
Although the Shoreline plan was identified as a Best Buy, it was not selected as the NER because it did not reasonably maximize ecosystem restoration benefits compared to costs.

Large Wetland Creation
The Large Wetland Creation plan had the highest average cost per unit of output of all the plans considered. The wetland would obscure clear sight lines into the park, making it more difficult to protect public safety, maintain security and deter illicit activity. In addition, previous projects have already addressed wetland restoration near the project site in a less trafficked area of the park (see discussion, Section 2.6.2). Finally, there is concern about the sustainability of the plan with respect to sediment management in the wetland area. The wetland may collect sediment and require maintenance over time. Maintenance costs could be further impacted by invasive species management needs. Large Wetland Creation was not selected as the NER.

Large Wetland Creation and Shoreline
While addition of the Shoreline Measure brought down the overall cost per HU considerably as compared to just implementing the Large Wetland Measure, this plan still had the second highest overall cost per unit of output of all the plans considered. The wetland would obscure clear sight lines into the park, making it more difficult to protect public safety, maintain security and deter illicit activity. In addition, previous projects have already addressed wetland restoration near the project site in a less trafficked area of the park (see discussion, Section 2.6.2). Finally, there is concern about the sustainability of the plan with respect to sediment management in the wetland area. The wetland may collect sediment and require maintenance over time. Maintenance costs could be further impacted by invasive species management needs. Large Wetland Creation and Shoreline was not selected as the NER.

Stream Channel (includes pipe)
The Stream Channel Alternative has the third highest average cost per unit of all the plans considered. However, this alternative is the first to include the stream channel which is fundamental to creating the stream mouth/delta habitat that juvenile salmon in Lake Washington utilize, and that has been dramatically reduced since urbanization. The level of net outputs was considerably less than other cost-effective plans. This plan was not selected as the NER.

Stream Channel with Small Wetland (includes pipe)
Adding the small wetland to the Stream Channel plan does lower the average cost per habitat unit, but not to the degree that other plans do. The small wetland would obscure clear sight lines into the park, making it more difficult to protect public safety, maintain security and deter illicit activity. In addition, previous projects have already addressed wetland restoration near the project site in a less trafficked area of the park (see discussion, Section 2.6.2). Finally, there is concern about the sustainability of the plan with respect to sediment management in the small wetland area. The small wetland may collect sediment and require maintenance over time. Maintenance costs could be further impacted by invasive species management needs. This plan was not selected as the NER.

Stream Channel (includes pipe) and Shoreline
The Stream Channel and Shoreline Alternative reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the federal objective; it was selected as the NER Plan

and the Recommended Alternative. This plan is a cost-effective plan that achieves project objectives by taking advantage of opportunities to: 1) increase shallow water shoreline habitat for refuge and rearing of migrating juvenile salmon; 2) increase adjacent aquatic habitat for birds, amphibians and other wildlife in Lake Washington. The Stream Channel with Shoreline Plan is designed to minimize in-stream deposition and pass sediment to the lake where it may improve juvenile Chinook salmon habitat. Large wood and native vegetation along the shoreline would further benefit salmon habitat. It would have minimal operations and maintenance costs. It would leave lawn space available for continued multiple recreational use and it would not impact public safety.

Stream Channel with Small Wetland & Shoreline Improvement

This plan, while having a favorable incremental cost to incremental output ratio and overall cost to output, was not selected as the NER plan. The small wetland would obscure clear sight lines into the park, making it more difficult to protect public safety, maintain security and deter illicit activity. Second, previous projects have already addressed wetland restoration near the project site in a less trafficked area of the park (see discussion, Section 2.6.2). Third, there is concern about the sustainability of the plan with respect to sediment management in the small wetland area. The small wetland may collect sediment and require maintenance over time. Maintenance costs could be further impacted by invasive species management needs.

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5. RECOMMENDED PLAN

5.1 Description of the Recommended Plan

The major elements of the proposed Mapes Creek project, from upstream to downstream, include:

- Diversion Structure (Measure 6 Sub-Component)
- Mapes Creek Diversion Pipe (Measure 6)
- Energy Dissipater (Measure 6 Sub-Component)
- Stream Channel (Measure 4)
- Shoreline Restoration (Measure 2)

Figure 23 shows the location of the major elements of the recommended plan.

5.1.1 Diversion Structure

Plan Set Reference: Plate C-301, C-501

The purpose of the diversion structure is to redirect Mapes Creek flow away from its current route through the municipal combined sewer system and toward the new surface stream channel in Be'er Sheva Park. The diversion structure will replace the existing Type 202-b manhole structure with a larger Type 203-b (84-inch) diameter structure. A 15-inch orifice plate combined with an overflow weir with a height of 1.33 feet will apportion the 25-year design flow of 50 cubic feet per second (cfs), directing approximately 10 cfs to the new Mapes Creek diversion pipe and overflow the remaining 40 cfs to the existing 30-inch storm drain. The overflow weir is designed to discharge 40 cfs over the overflow weir while maintaining a headwater at or below the soffit elevation of the diversion structure during the 25-year design event.

5.1.2 Diversion Pipe

Plan Set Reference: Plate C-301 through Plate C-304

The Mapes Creek diversion pipe will convey Mapes Creek north under the 52nd Avenue Walkway and east under South Henderson Street to Be'er Sheva Park. The 35% design analysis concluded that the South Henderson Street sidewalk alignment with flume as the most feasible alternative for conveying Mapes Creek to Be'er Sheva Park. The diversion pipe, approximately 1555 feet long, extends the separated drainage of Mapes Creek to Be'er Sheva Park, where the pipe will "daylight" to a restored surface channel. The 35% design proposes using ductile iron pipe (DIP) for the Mapes Creek diversion pipe. DIP construction is advantageous in the current situation, since it does not require as much soil cover as concrete pipe. The City of Seattle also prefers DIP from the standpoint of long-term maintenance and operation.

5.1.3 Energy Dissipater

Plan Set Reference: Plate C-304

The initial 35% design proposed a standard riprap or grouted riprap apron energy dissipater, which would have measured approximately 24 feet long and 30 feet wide at its maximum. The City of Seattle was disinclined toward this type of riprap apron because of the potential for

creating an attractive nuisance at the park and for aesthetic reasons. Therefore, the 35% design currently proposes over-sizing (to 48-inch diameter) the last segment of the Mapes Creek diversion pipe, creating a near-zero longitudinal slope where the lower half would be filled with concrete-grouted riprap. Based on hydraulic modeling (Appendix E, Section 2.4.1.3), this configuration will effectively dissipate flow energy before it enters the surface channel in the park.

5.1.4 Channel Restoration

Plan Set Reference: Plate C-301, C-501

The channel through Be'er Sheva Park will be approximately 370 feet long and overlay two components. The first component will be a low-flow or pilot channel 2 to 3 feet wide and 0.5-ft deep. It will be parabolic in shape and meander through a larger trapezoidal channel. This second channel will be approximately 8 to 10 feet wide and 3 feet deep. The side slope of the trapezoidal channel would vary between 3H:1V and 10H:1V, with the side slope at the pedestrian bridge possibly being 2H:1V (with appropriate reinforcement) to accommodate Americans with Disability Act (ADA) requirements. The overall longitudinal slope of the channel will be 0.0081 ft/ft (0.81 percent).

The low-flow channel will contain variable pool-riffle habitat. Rock, wood structures, and low-growing riparian plantings will be added to provide fish and wildlife habitat. Woody debris features will be placed primarily in the lower portion of the newly constructed channel (roughly 10-piece wood structures spaced every 20 feet). Upstream of the proposed pedestrian bridge, the stream is unfenced and woody debris on the upper reach will be minimized to lessen potential hazards to park patrons. Instead, rocks and boulders (20-30 small to medium sized boulders spaced roughly every 20 feet) will provide variations in the stream section and profile and help create habitat complexity. The daylighted channel likely will be constructed with excavators, bulldozers, and front loaders.

5.1.5 Stream Crossing and Access

Plan Set Reference: Plate C-101, C-501

The stream crossing will maintain access across the Park. The crossing will also provide a means of controlled access to protect habitat features. The proposed crossing will be a 24-foot long, 6-foot wide wooden pedestrian bridge placed in the middle of the daylighted reach. The pedestrian bridge installation would be similar to other City of Seattle park facilities in the vicinity and would meet ADA requirements. Figure 22 illustrates an example of a pedestrian bridge across Madrona Creek, located in a City of Seattle park about 6.5 miles north of the project site.

Concrete pilings will support the bridge, but will not be placed in the creek. Approach paths will consist of crushed rock with a 10 percent or less slope. Plate C-503 of the plan set in Appendix B provides conceptual details of the pedestrian bridge. The pedestrian bridge could be built on-site, or pre-assembled and delivered to the site for installation.

The bridge will require an adequate foundation to meet design performance specifications. The design concept calls for a simple footing wall on each side of the channel, protected with riprap

if necessary. Another alternative for construction of the foundation will be using a proprietary "diamond pin pile" foundation system, often used for boardwalks and in environmentally sensitive areas. Future design efforts should investigate and recommend an appropriate foundation system for the pedestrian bridge.

Figure 22. Example Pedestrian Bridge (Madrona Park, Seattle Washington).

5.1.6 Channel Substrate

Six inches of clean substrate will be placed throughout the channel reach, with a 35:65 sand/gravel ratio (3 inch minus gravel), with an underlying armor layer of 3 to 6-inch cobble. The bed is designed to be slightly mobile to prevent siltation. Boulders will be placed in the channel upstream of the pedestrian bridge to provide fish habitat.

5.1.7 Channel and Shoreline Habitat Features

Plan Set Reference: Plate C-503 and C-504

Woody debris features will be placed inside the proposed fence line along both the Lake Washington shoreline and the lower portion of the newly constructed channel (roughly 10-12 wood structures placed every 20 feet). Upstream of the proposed pedestrian bridge rocks, boulders (20-30 small to medium sized boulders spaced roughly every 20 feet), and variations in the stream section and profile will help create habitat complexity.

The design intent in the upper reach is that pools and riffles will create conditions suitable for juvenile salmonids. This avoids placing wood debris in this reach that may present an attractive nuisance to park patrons. In-stream habitat features and plantings will likely use excavators and hand labor for installation. A wheel-mounted crane might be used for installation of larger boulders and large wood debris structures.

5.1.8 Outlet Construction

Outlet construction and re-watering are the only major construction tasks that will be required to occur during the in-water work window ("fish window"). The construction of the channel outlet will require installation of a cofferdam or equivalent device to isolate the excavation of the outlet from waters of Lake Washington. Given the limited length and minimal water depths anticipated at the current project site, isolation of the construction site can be accomplished using approaches such as ecology block and plastic liner, tilt-up frames barriers, or inflatable water barriers (as opposed to a more traditional, heavier-duty sheet-pile cofferdam system).

The cofferdam structure will minimize impacts of turbidity, noise, and physical disturbance to the aquatic biota of Lake Washington. It is likely that some level of sump pumping and disposal of water will be necessary while working in these areas. The isolation structures will likely extend out from the existing bank line a minimum distance (to be determined) to allow room for excavation and installation of the creek outlet using heavy equipment. In addition to isolation structures, floating filter blankets (turbidity curtains) will help control turbidity during construction and re-watering. All of this outlet work will be performed after Lake Washington summertime high water levels.

Cofferdam installation, de-watering, outlet construction, re-watering, and cofferdam demobilization will require construction equipment such as a wheel-mounted crane.

5.1.9 Channel Re-watering

Channel re-watering, if not properly managed, has the potential to create significant turbidity upon removal of the isolation structures. Several BMPs will be implemented to minimize these impacts. Some examples include:

- Pre-washing, rinsing, and sump pump removal of turbid water from channel work areas;
- Stopping work when water quality standards are exceeded;
- Timing and sequencing of outlet/inlet isolation structure removal; and
- Removal and flow release rates of isolation structures.

Cofferdam installation, de-watering, outlet construction, re-watering, and cofferdam demobilization will require construction equipment such as a wheel-mounted crane.

5.1.10 Riparian Plantings

Through restoration of the *shoreline*, the 35% design strives to create a diversity of habitat for juvenile Chinook and other species by providing a combination of protective cover and open areas on the shoreline. Woody debris structures will mimic natural tree falls on the lake shore, and provide overhead cover via the dense rootballs and branches for aquatic species that favor shaded pockets of shallow water underneath tree trunks. By placing wood debris features inside the fence line, the design attempts to avoid creating a dangerous attractive nuisance for park patrons.

Riparian plantings will consist of conifers and native shrubs to meet restoration objectives and the need for clear sightlines to promote public safety in a City of Seattle park. The area planted will be a 20-30 foot buffer zone on each side of the creek, totally roughly 0.17 acres. The planting will be managed to ensure at least 80% survival and to control encroachment of invasive

species. Further refinement of native riparian plantings will occur in subsequent levels of design. Below is a list of native plants that will likely be planted:

- Trees: Sitka spruce, douglas fir, western red cedar, Oregon Ash
- Shrubs: Hazelnut, red osier dogwood, oceanspray, pacific ninebark, salmonberry, serviceberry, nootka rose, Indian plum, oceanspray, Oregon grape, vine maple, pacific willow, sitka willow
- Emergents: slough sedge, Baltic rush, hardstem bulrush

Rocks, boulders, and variations in the stream section and profile will help create habitat complexity upstream of the proposed pedestrian bridge. The design intent is that the pools and riffles in this reach will generate habitat conditions suitable to juvenile salmonids. The stream immediately downstream of the diversion pipe will have higher velocities and shallower flow depths than the main part of the creek. This will help discourage fish from migrating further upstream and into the diversion pipe. As proposed, the channel alignment should preserve almost all of existing trees in the park. These trees, mostly elms with trunk diameters between 12-18 inches, will enhance habitat by shading the channel and providing insect and detrital input to the food web.

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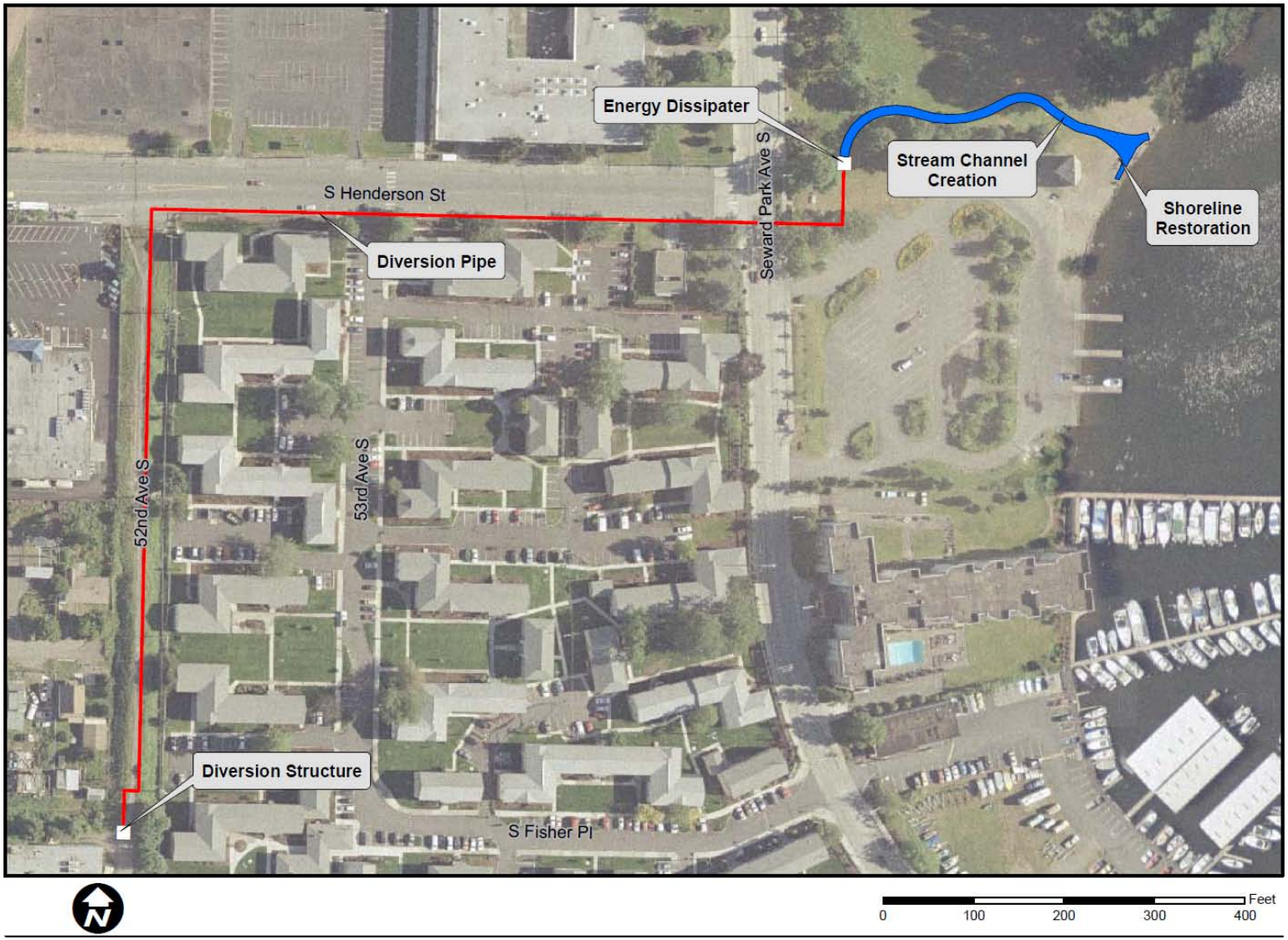

Figure 23: Features of the Recommended Plan

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5.2 Design and Construction, Phasing and Other Considerations

The following construction sequence was developed for the current project elements in the 35 Percent Design Analysis Report, May 2009. Construction sequence and methods will need to be revised as final design plans and specifications are developed. Design and construction considerations are noted and discussed within each sequence step.

5.2.1 Mobilization, Site Preparation, and Staging

Mobilization of equipment will likely be performed several times throughout the different phases of work on the Mapes Creek restoration project. Logical construction phases for the project might include:

- Installation of the diversion pipe under South Henderson Street;
- Installation of diversion structure and diversion pipe under the 52nd Street Walkway; and
- Channel construction in Be'er Sheva Park.

Equipment mobilization for the diversion structure and diversion pipe, as well as channel construction, would include excavators, bull dozers and front loaders. A wheel-mounted crane might be used for installation of pipe material. In-stream habitat features and landscaping and plantings will likely use excavators and hand labor for installation. A wheel-mounted crane might be used for installation of larger boulders or large wood debris structures. Other specialty mobilization activities could include sheet pile drivers or installation of water control devices for the construction of the Mapes Creek outlet and channel rewatering activities.

Construction staging and material stockpile (storage) locations should be located as near as possible to active construction sites. For instance, staging and storage location for activities along 52nd Avenue Walkway might be located within that right-of-way. Staging and storage areas for construction along South Henderson Street will require more careful consideration. The parking lot at Be'er Sheva Park can provide a relatively convenient staging and stockpile to construction for both South Henderson Street and Be'er Sheva Park phases of the construction. If needed, project planners might consider obtaining temporary construction easements to supplement the limited area available in the existing right-of-way.

5.2.2 Demolition and Clearing and Grubbing

Basic site preparation for the project will include clearing and grubbing out of vegetation in the construction area. The current design plans do not specify any tree removal; the Temporary Erosion and Sediment Control (TESC) plan will specify the preservation of existing trees and vegetation on the site. Construction site preparation will likely involve stripping and stockpiling of the existing topsoil in the park area for re-use during finish grading. Site preparation for the diversion pipe construction will involve demolition of existing pavement, curb, and gutter.

5.2.3 Temporary Erosion and Sediment Control (TESC)

Topsoil or excavated soils temporarily stored on the site and any material (streambed gravel or riprap) stockpiled on-site before placement would require the installation of stormwater runoff control and/or treatment best management practices (BMPs). These BMPs, specified in the TESC plan, may require additional space during construction. The TESC plan will also include

measures for stabilizing areas that have been cleared and grubbed during site preparation. BMP measure might include silt fence, straw wattles, or temporary erosion control mats.

5.2.4 Channel Excavation and Bank Stabilization

A majority of the Mapes Creek channel in Be'er Sheva Park can be "pre-excavated" prior to connecting with Lake Washington. This sequential construction will involve excavation along the proposed channel alignment channel in late spring and early summer, then connecting the creek to Lake Washington and rewatering the channel during the summer construction window.

Based on available topographic information and the preliminary design plans, the channel and/or wetland will not require more than approximately 5 feet of excavation, with side slopes generally no steeper than 3H:1V. Therefore, it should be possible to construct the channel and wetland without extensive shoring or stabilization measures beyond what is normally employed for post-construction soil stabilization (vegetation and temporary erosion control). Similarly, trenching activities for construction of the diversion pipe are not excessively deep, but may require some shoring based on actual excavation depths and site-specific conditions. It may be necessary to open up larger holes than typical to work around existing cross-utilities with tight clearances.

5.2.5 In-Stream Habitat Feature Installations

In-stream habitat features will comprise bed material substrate treatments and some large wood installations. The bed material treatment placement will likely be one of the last items to occur in the construction sequence and will be placed after all side channel construction activities have occurred. This will likely involve dumping from a loader or excavator and light compaction along the channel bottom width. The large wood installations will likely occur in tandem with the bank stabilization work, where the wood is installed and anchored as part of the foundation of the bank.

5.2.6 Park Fill Grading

The proposed design assumes that some of the excavated materials will be used on site for fill grading and landscaping purposes. Excess or unsuitable material will be disposed offsite at a commercial facility; acquisition of a disposal site is therefore not necessary for this project. The park fill grading will likely involve dozer earthwork, light compaction and fine grading over portions of the park on either bank of the channel restoration feature.

5.2.7 Stream Crossing & Access

The project proposes a small pedestrian bridge for maintaining access between the parking lot and restroom to the play area and other facilities in Be'er Sheva Park. The bridge will also be a means of providing controlled access to protect habitat features. The 35% design concept calls for a wooden pedestrian bridge approximately 24 feet long by 6 feet wide. The wooden bridge could be built on-site, or pre-assembled and delivered to the site for installation. The bridge will require an adequate foundation to meet designed performance specifications. The design concept calls for a simple footing wall on each side of the channel, protected with dumped riprap if necessary. Another alternative for construction of the foundation would be using a proprietary "diamond pin pile" foundation system, often used for boardwalks and in environmentally sensitive areas. Future design efforts should investigate and recommend an appropriate foundation system for the pedestrian bridge.

5.2.8 Outlet Construction

In-water work will be done during the designated fish window (July 16 – December 31), which will likely be *after* the summertime high. The outlet construction and re-watering are the only major construction task that will be required to occur during the fish window (described in further detail below). The construction of the channel outlet will require installation of water control, i.e. coffer dam devices to isolate the outlet areas from Lake Washington. It is likely that some level of sump pumping and disposal of water will be necessary while working in these areas, which should be addressed in the site TESC plan. The coffer structures will likely extend out from the existing bank line a minimum distance (to be determined) to allow room for excavation and installation of the creek outlet using heavy equipment. In addition to coffer structures, floating filter blankets might also help control turbidity during construction and re-watering. The Mapes Creek work will be performed below summertime Lake Washington high water and will need to be part of the permit application process.

5.2.9 Channel Re-Watering

Channel re-watering is identified as a separate activity because this will likely receive the most scrutiny by permit review agencies. This construction activity, if not properly managed, has the potential to create significant turbidity upon removal of the coffer and/or isolation structures. There are several strategies available for managing this task, which will be developed further during the final design process. Some examples include:

- Pre-washing, rinsing, and sump pump removal of turbid water from channel work areas;
- Timing and sequencing of outlet/inlet coffer structure removal; and
- Removal and flow release rates of coffer structures.

5.2.10 Landscape Planting

Landscape planting will occur at the end of the project, upon completion of major construction activities. A majority of the native riparian plantings will be done by hand, or with the assistance of a small backhoe for minor excavations and handling larger trees.

5.3 Construction Impacts

This section summarizes some of the construction impacts that might occur during the project. The construction of the proposed project will have significant effects on the neighborhood residents, patrons of Be'er Sheva Park, and the City of Seattle.

5.3.1 52nd Avenue Walkway

The 52nd Avenue Walkway will need to be closed during construction of that segment of the diversion pipeline. This temporary closure will require pedestrians to detour from the Walkway, which provides a useful link between neighborhood centers like Rainier Beach High School and the grocery store at Rainier Avenue South and South 52nd Avenue.

5.3.2 52nd Avenue Walkway Plaza

The north end of the 52nd Avenue Walkway at South Henderson Street features a small plaza area with a public art (a mosaic installation in the concrete sidewalk), along with sitting walls, landscaping, and specialty street lighting. The public art installation is meaningful to the neighborhood community. Construction of the Mapes Creek diversion pipeline must necessarily

pass under the 52nd Avenue Walkway plaza. Methods to mitigate negative effects to the plaza might include saw-cutting around and removing the mosaic panels during pipeline installation and replacing them after back-filling the utility trench. Alternately, it might be possible to "jack and bore" a segments of the diversion pipe to avoid disturbing the area, though this would increase the cost of construction.

5.3.3 Sidewalk Closures

The sidewalk along eastbound South Henderson Street will need to be closed during construction of that segment of the diversion pipeline.

5.3.4 Property Access

Installation of the diversion pipeline along South Henderson Street will disrupt access to the King County Metro South Henderson Street pump station and the apartment complex at Apartment Complex Driveway. Measures (e.g., steel plates) will need to be taken to ensure access to these facilities during the construction period.

5.3.5 Traffic Impacts

Though the proposed alignment along South Henderson Street is located underneath the sidewalk, it is most likely that construction of the diversion pipeline will require closure of the eastbound bicycle and traffic lanes of South Henderson Street. Partial or full road closures will also be necessary as the pipeline construction crosses the intersection of Seward Park Avenue South and South Henderson Street.

This traffic disruption will have temporary significant effects because both South Henderson Street and Seward Park Avenue South are arterial streets that serve as vital links to the local neighborhood. Small passenger vehicles, commercial traffic, and bicyclists use these streets heavily. In addition, the streets are a service corridor for public transit (including Metro Routes 7, 32, 36, and 48), and experience periodic high traffic volume (including autos, pedestrians, bicycles, and school buses) due to nearby Rainier Beach High School. Methods to mitigate negative traffic effects might include re-channeling traffic on South Henderson Street or employing flaggers or temporary traffic signals to manage traffic. Such alternatives will need to be detailed in the traffic control plan developed as part of final design.

5.3.6 Underground Utilities

The proposed diversion pipe alignment avoids almost all conflicts with major cross-utilities. The diversion pipe alignment proposes narrow clearance tolerances that may be less than typical utility installations, but still has some flexibility once it clears the force mains at the Metro pump station. The 35% design analysis found that it may be necessary to re-locate two 8-inch storm drain catch basin laterals and a water main at the southwest corner of the intersection of South Henderson Street and Seward Park Avenue South. Based on their actual field location and operational status, it may be necessary remove or relocate a pair of 14 inch force mains (noted as "abandoned" on record drawings) from the Henderson Street Pump Station. Because of tight clearances, the Mapes Creek diversion pipe will likely require measures (e.g., "geofoam" blocks or concrete encasement) to provide a buffer between the diversion pipe and the two 20-inch Henderson Street Pump Station force mains. There are also several utilities at Seward Park Avenue South (such as a water line, telecommunication lines, possibly a natural gas line, and power lines) that had not been surveyed as of the date of the preparation of the current design

analysis. As these utilities do not depend on gravity to function, their re-location is not necessarily a serious impediment to the project. It is recommended that a utility survey be completed to confirm the vertical location of all cross-utilities along the proposed alignment.

In Be'er Sheva Park, there is a sewer line and underground power line servicing the boat ramp and restroom located at the southeast corner of the project site. Because the sewer line is a service lateral, its size, location and elevation are not known with certainty; the situation is similar for the power line. The 35 percent design recommends that both the sewer and power services be relocated, attaching the utilities to the underside of the bridge to cross the stream restoration with as little disturbance as possible. Because the restroom is at a higher grade and sewer laterals are generally located several feet below grade, the design team anticipates that the sewer will continue to be operable as a gravity system, and no pumps will be required. A more detailed evaluation of the location and disposition of utilities within Be'er Sheva Park is recommended during the next phases of design.

5.3.7 Overhead Utilities and Street Lighting

The diversion pipe alignment is located in an urban street corridor with overhead power lines and street lighting. In addition, there are overhead lines along South Henderson Street, and turning south on Seward Park Avenue South, for electric bus service. While the proposed alignment avoids permanent relocation of overhead utilities, construction may require temporary shoring of poles or relocation of overhead utilities to facilitate construction activities.

5.3.8 Be'er Sheva Park

The proposed project will cause major disruption to the use of Be'er Sheva Park. The channel alignment bisects the park between the existing play area to the north and the parking lot and restroom to the south. It may be more convenient for construction and best for public safety to close the park entirely during construction.

Though they may be deep enough to not be impacted by channel construction, the 35% design recommends relocating sewer and power service to the existing park restroom. One alternative for this utility relocation would be to attach the utilities to the proposed pedestrian bridge. Construction staging and other activities may require closure of some areas of the parking lot on the south side of Be'er Sheva Park. It should not be necessary to close the boat launch facility located there.

5.3.9 35 Percent Design Improvement and Cost Saving Opportunities

This section discusses some of the potential opportunities to improve the current 35% design and/or reduce the cost of the project during future design phases.

Additional Flow Sources

Unfortunately, the opportunity for additional flow to the creek is not be feasible because current stormwater treatment technology is not capable of removing contaminants (in particular, heavy metals) to the extent necessary to prevent harm to salmonids.

Channel Lining

Preliminary flow monitoring data from the SPU in 2008 suggest that summertime flow rates can be extremely low, to the point of non-existent, during dry summer periods. Preliminary design analysis for the project had indicated that lining the restored Mapes Creek channel would not be necessary. The 35% design analysis also used this assumption. Future design phases of the project may want to consider the potential benefit of providing an impermeable liner underneath the gravel and cobble bed of the stream to help maintain surface flows and/or hydrophilic conditions during lower-flow periods. The additional water could be a benefit to the water quality and aesthetics of the project.

Sidewalk Flume and Cover

The 35% design proposes a 200-ft long U-channel or flume along South Henderson Street beginning at 52nd Avenue in order to meet utility clearance and cover requirements. The 35% design originally proposed that this flume be outfitted with an iron grate. Initial estimates indicated that this solution would be quite costly, at approximately $360 per linear foot (almost twice the cost of the rest of the diversion pipe), primarily due to the grate covering. In addition to the cost, the grate was not the most friendly solution for pedestrian or bicycles using the sidewalk.

Therefore, the design team replaced the originally proposed iron grate with pre-cast concrete lid system. The concrete lid concept design is based upon a lid from a pre-cast trench system used for industrial pipe and cable crossings. A concrete lid system will cost substantially less than iron grates, and is much friendlier to pedestrian and bicycle traffic. The concrete lids should feature pull points to facilitate removal for maintenance access to the flume. Future design phases will need to specify the appropriate traffic loading criteria (i.e., pedestrian, light vehicular, or heavy vehicular traffic).

Discussions with a pre-cast utility trench manufacturer (Trenwa, Inc. of metropolitan Cincinnati, OH) opened the possibility of constructing the flume using a pre-cast utility trench system. Larger sizes of the Trenwa-brand utility trench system feature partially open sides, which could be lined with shot-crete to create a cross-section similar to the dimensions of the proposed flume. Future design phases should explore the potential cost savings of using a hybrid cast-in-place/shot-crete alternative for flume construction.

52nd Avenue Walkway Riverwalk

One suggestion flowing from the 35% design process was to create a miniature “river walk” along the 52nd Avenue Walkway instead of an underground diversion pipe. This option would daylight a longer reach of Mapes Creek and provide an additional amenity to the community. The river walk alternative would involve cutting down the existing fill under the 52nd Avenue Walkway and re-building it with an embankment featuring modular concrete unit (e.g., Keystone™ brand block) retaining walls on each side. The additional width gained by steepening the sideslopes would provide enough room for a Mapes Creek surface channel alongside the sidewalk through the corridor. Such an alternative would require more design analysis, especially with respect to geotechnical concerns and public safety issues.

5.4 Plans and Specification Phase Considerations

Because of the project's vicinity to heavily trafficked roads, including municipal bus routes, the plans and specifications will require a well-developed traffic control plan. The traffic control plan will need to address both pedestrian and vehicular traffic throughout the project vicinity, including the 52nd Avenue Walkway, S Henderson Street, and within Be'er Sheva Park.

The State of Washington's National Pollution Discharge Elimination System (NPDES) Construction General Permit will require the implementation of temporary erosion and sediment control (TESC) measures and appropriate best management practices to manage stormwater and non-stormwater discharges on the project site. The plans and specifications will require a well-developed TESC plan, including measures for the care and diversion of water that will isolate construction activities from Lake Washington.

In addition to traffic control and TESC measures, the plans and specifications for the project should also include provisions for protection in place of the art installation at the end of the 52nd Avenue Walkway, as well as the removal, re-location or protection in place of necessary utility lines. Also, the ground-penetrating radar survey indicated significant root structures along the proposed S Henderson Street pipe alignment; the project landscape plan might need to consider specifying the replacement in kind of the ornamental shrubs along the alignment if their survival is threatened by project construction.

5.5 Operation and Maintenance Considerations

An Operation and Maintenance (O&M) Plan will be developed for the project in the next phase and prior to construction completion. The operation and maintenance of the project will require regular cleaning and maintenance of the diversion pipeline delivering stream water to the restoration site. Maintenance activities would typically include the flushing and vacuuming of sediment and debris from the underground conveyances. It is critical that these maintenance activities not discharge sediment or non-stream water to the stream restoration or Lake Washington downstream.

Operation and maintenance of the project will also require regular maintenance of the stream and shoreline restoration area. Maintenance activities would typically include manual clean up of litter, trash, and debris from the stream channel and shoreline. This litter clean-up could be integrated as part of regular park maintenance, or perhaps be implemented as a community volunteer activity.

Maintenance of the stream and shoreline restoration will also include replacement of non-successful vegetation, pruning of overly-precocious species, and removal of invasive plants. These activities would generally be limited to a specific maintenance and monitoring period after construction is complete.

The restoration may also require occasional or "spot" maintenance of project features such as bank slopes, large woody debris structures, fence lines, and pedestrian bridges to ensure public safety and integrity of the restoration project. The project has been designed so that velocities through the restoration site should avoid any significant sedimentation or scour. However, the

O&M plan should specify for seasonal and/or post-storm inspections so that minor adjustments to the channel or shoreline configuration can be made if necessary.

5.6 Habitat Monitoring Plan

A habitat monitoring plan is being developed by the Corps and the City and Seattle. This plan will include monitoring of abiotic and biotic elements, and identify specific performance targets and adaptive management actions to be implemented if those targets are not met. The plan will be finalized during the design phase. Adaptive management will be implemented by the non-federal sponsor, and will not be cost-shared. Cost shared monitoring will continue for no more than five years, and costs for the monitoring, estimated at $21,000, will not exceed 1% of the cost to design and implement the project restoration features.

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6. PLAN IMPLEMENTATION

6.1 Cost Sharing

The cost of design and implementation of the recommended plan is estimated at $2,150,795 including contingency and supervision & administration. Lands and relocations value has been estimated at $103,400. This cost reflects the recommended plan at the 35 percent feasibility design phase.

The Mapes Creek Ecosystem Restoration Project is a grandfathered CAP Section 1135 project. The non-federal sponsor will be responsible for funding 25% of the total project cost, which includes all associated Lands, Easements, Rights-of-way, Relocations and Disposal area (LERRD) costs. The LERRD costs are credited to the non-federal sponsor as part of the 25% contribution and the remaining contribution can be provided in cash or in-kind services.

Costs associated with operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) are not included in the MII cost estimate. The OMMRR&R costs were computed separately and described and documented in Section 4.5.1 of this report. OMRR&R costs are 100 percent funded by the non-federal sponsor.

Cost associated with post-project monitoring were not included as a separate line item in the MII cost estimate, but have been incorporated into the total project costs for the project. Monitoring costs shall not exceed 1% of the costs to design and implement the project restoration features.

Table 34 presents a summary of the fully funded total project implementation costs, which include costs incurred during the feasibility phase, construction costs, engineering and design costs, and supervisory and administration costs (including post construction monitoring), and all estimated LERRD costs.

Table 34: Estimated Total Project Cost of Preferred Alternative Plan

Civil Works Feature and Sub-Feature Description	**Spent through 2011 March 24**	**Estimated Cost** (Fully Funded)	**Contingency**	**Total**
Feasibility	$839,650	$1,008,000		$1,008,000
Feasibility Estimate Totals				**$1,008,000**
Planning, Engineering, and Design		$402,000		$402,000
Planning, Engineering, and Design Totals				**$402,000**
Construction Contract		$1,203,300	$320,100	$1,523,400
Construction Management		$161,200	$42,900	$204,100
Monitoring		$17,665	$3,630	$21,295
Construction Estimate Totals				**$1,748,795**
Lands, Relocations, Non-fed admin		$94,000	$9,400	$103,400

LERRD Estimate Totals				**$103,400**
Project Cost Totals		$2,886,165	$376,030	**$3,262,195**

6.2 Non-Federal Responsibilities

The City of Seattle, Public Utilities Department has been the non-federal sponsor for the project during the feasibility phase, and intends to continue in that capacity throughout the Design and Implementation phase and the life of the project. The non-federal sponsor is aware of its responsibilities as detailed below.

The non-federal sponsor ("NFS") is responsible for 25% of feasibility costs and 25% of design and implementation costs. The non-federal sponsor is responsible for 100% of OMRR&R. The non-federal sponsor is responsible for providing all lands, easements, rights-of-way, relocations, and disposal areas, the value of which will be applied towards their 25% of design and implementation costs. Table 35 outlines the various costs for these items as well as the different shares between the Corps and the non-federal sponsor.

There are no identified extraordinary institutional or legal issues that will impact implementation of the project.

Table 35: Cost Share Summary

	Total	Federal Share	Non-Federal Sponsor Share
Feasibility Costs [a]	**$1,008,000**	**$756,000**	**$252,000**
Implementation Costs			
Planning, Engineering, and Design	$402,000	$301,500	$100,500
Construction [b]	$1,748,795	$1,389,113	$359,682
Relocations [c]	$76,943		$76,943
Lands, Easements, and Rights-of-way, Non-fed LERR Admin [c]	$26,413		$26,413
Subtotal Implementation Costs	**$2,254,151**	**$1,690,613**	**$563,538**
Totals	**$3,262,151**	**$2,446,613**	**$815,538**

Notes:

a– Feasibility costs are initially paid for by the federal government; non-federal sponsor will pay 25% of those costs upon initiating the Design and Implementation phase, per the PPA.

b– Construction costs include PED and Construction Management

c– Lands, easements, rights-of-way and relocations are the responsibility of the non-federal sponsor; those costs are applied to the non-federal sponsor's 25% share of design and implementation costs.

6.3 Real Estate Requirements of Selected Plan

The proposed Section 1135 Mapes Creek Daylight and Stream Restoration Project will affect the three parcels (10.4 acres) that compose Be'er Sheva Park in the City of Seattle, King County, Washington (See Real Estate Plan Appendix, Exhibit A maps). All lands required for the project

are owned in fee by the City of Seattle, the Non-Federal Sponsor (NFS). The public road right-of-way covering S. Henderson Street and 52nd Avenue Walkway is controlled by the NFS as well. The total perpetual project footprint covers approximately 3.83 acres. Real property within Be'er Sheva park is subject to a deed covenant that restricts land use to public open space or a public recreational facility for park and bathing beach purposes only (Thurman v Hillman Investments, 1907).

Primary construction access to the project footprint will be via the main park entrance road, Seward Park Avenue, South. Approximately .43 acres of Temporary Work Area (TWA) for construction access and staging is required for construction staging in the parking lot adjacent to the south side of the Perpetual Project Footprint. The TWA will terminate when construction is completed or one year from the date the TWA is certified available for the project whichever comes first. A TWA is also required to provide a construction buffer along the 52nd Avenue South and S. Henderson Street. The easement will allow the construction crew (s) room to work along the right-of-way. The TWA will terminate when construction is completed since the City has a perpetual right to access the right-of-way as needed for maintenance/operations activities. The Mapes Creek Daylight and Stream Restoration Project is an attempt to restore environmental quality that has been degraded through the operation of Lake Washington Ship Canal. The influence on navigation though indirect is a sufficient connection to allow the exercise of navigational servitude. Only those lands lying above the navigational servitude elevation line will be creditable. 0.10 acres of the proposed perpetual project foot print area within the park lies above the navigational servitude line.

Excavated materials will be re-utilized within the proposed project footprint. Excavated materials that are not suitable for re-use will be transported to a commercial disposal facility. Therefore the need for a temporary disposal or re-handling site is not anticipated at this time. The NFS will need to certify all available Lands, Easements, and Rights-of-Way (LER) necessary for construction, operation and maintenance of the proposed project prior to the opening date for advertisement of the construction contract. In addition, the NFS will be responsible for ensuring the design and specifications for, and the performance of, the proposed utility and public facility relocations identified in the Real Estate Plan. The NFS will have approximately 180 days after certifying lands available for construction to provide the Seattle Real Estate Division with documentation required to support their claim for LERR credit. Please refer to the Real Estate Plan, for additional real estate information. Also see Exhibit A, LER maps; Exhibit B, NFS Acquisition Capability Assessment; Exhibit C draft Certification of Lands and Authorization for Entry, Exhibit D draft Attorney's Certificate and Exhibit E, draft Risk Analysis for Outstanding Third Party Interests.

The Baseline Cost Estimate for Real Estate (BCERE) presented below provides a breakdown of the estimated cost of project Lands, Easements, Rights-of-Way and Relocations (LERR), NFS administrative costs, and Federal review and assistance costs. The project lands were acquired by the NFS more than five years ago. Therefore, incidental acquisition costs incurred to acquire the project lands will not be creditable. However, costs associated with certifying the project lands available for the project may be creditable, including costs for title, crediting appraisal, recording fees and legal fees. Federal review and assistance costs include those costs associated

with providing the NFS with LER requirements, review of crediting appraisals, coordination meetings, review of right-of-way documents, legal support and LER crediting activities.

Table 36: Cost Estimate for Real Estate

Estate	Acres	Estimated Land Cost	NFS LERR Admin. Cost	NFS LERR Cost (Lands+Admin.)	Federal LERR cost
Fee Interest	2.22	$6,000			
Perpetual Pipeline Easement	0.50	$0			
Temp. Work Area Easement Pipeline	0.72	$0			
Temp. Work Area Park	0.39	$0			
Utility Relocations		$67000			
Subtotal	3.83	$73000	$17,000	$90,000	$9,000
10% Contingency		$7,300	$1,700	$9,000	$900
TOTAL (rnd up)	3.8	$81,000	$19,000	$99,000	$10,000

6.4 Final Design and Preparation of Bid Package

The recommended plan will require further design beyond 35% prior to construction. Preparation of the final design and bid package will occur following completion of this feasibility study. IT will include all the elements in the 35% design, but will be developed to fully support accurate bids. Sections 5.3.9 through 5.3.13 outline additional features to be considered during additional design phases.

6.5 Construction Phasing and Scheduling

Construction phasing will be determined by the final costs and cost sharing between USACE and thenon-federal sponsor. It is possible that some elements of the Project may need to be deferred to a future phase if available funding does not allow for full implementation of the Project as currently defined. At this time, it is assumed that the entire restoration project will be constructed during one construction season, and any elements included in a future phase will be upland park related features rather than restoration related features.

For the purposes of this report, it is assumed the Design and Implementation phase will proceed according to the following schedule based on a 6-month construction period:

Design Complete/Start Construction: March 2013
Construction Complete: September 2013

Basic site preparation for the project will include clearing and grubbing out of vegetation in the construction area. The current design plans do not specify any tree removal; the Temporary

Erosion and Sediment Control (TESC) plan will specify the preservation of existing trees and vegetation on the site. Construction site preparation will likely involve stripping and stockpiling of the existing topsoil in the park area for re-use during finish grading. Site preparation for the diversion pipe construction will involve demolition of existing pavement, curb, and gutter.

A majority of the Mapes Creek channel in Be'er Sheva Park can be "pre-excavated" prior to connecting with Lake Washington. This sequential construction will involve excavation along the proposed channel alignment in late spring and early summer, then connecting the creek to Lake Washington and rewatering the channel during the summer construction window.

In-stream habitat features will comprise bed material substrate treatments and some large wood installations. The bed material treatment placement will likely be one of the last items to occur in the construction sequence and will be placed after all side channel construction activities have occurred.

The project proposes a small pedestrian bridge for maintaining connectivity within the park and preventing park goers from entering the creek. Split rail fencing will also line the creek to prevent people from disturbing the creek.

The outlet construction and re-watering are the only major construction tasks that will be required to occur during the fish window. The construction of the channel outlet will require installation of water control, i.e. coffer dam devices to isolate the outlet areas from Lake Washington.

Landscape planting will occur at the end of the project, upon completion of major construction activities. A majority of the native riparian plantings will be done by hand, or with the assistance of a small backhoe for minor excavations and handling larger trees.

6.6 Monitoring

Monitoring required by the Corps is intended to provide information useful for determining whether the desired ecosystem benefits have been achieved, and if not, what adaptive management may be needed to attain those benefits. In addition, the sponsor may provide discretionary monitoring not required for the purpose described above but that supports the weight of evidence for decision making about project performance. A monitoring plan in preparation by the Corps and the non-federal sponsor will lay out details on the monitoring considered necessary to identify project success. Corps policy allows up to 1% of total construction costs for performance monitoring over a period of up to 5 years. Monitoring costs are currently estimated at $21,000. A detailed monitoring plan to include monitoring protocols and triggers for specific adaptive management action will be prepared during the design phase. Adaptive management costs will be paid for solely by the non-federal sponsor.

6.7 Operation and Maintenance

Operation and maintenance is solely the responsibility of the non-federal sponsor and is not cost-shared. The primary operation and maintenance activities for the restoration are briefly described in Section 5.5. They include stream, pipe and shoreline maintenance as well as ensuring the

establishment of riparian and other native vegetation. The estimated annual O&M cost for the stream channel and pipe is $6,931, a present value of $139,802. Seattle Parks and Recreation has estimated landscape maintenance costs for the recommended alternative (including ongoing bridge maintenance; graffiti removal; weeding, pruning, mulching, watering, water cost, litter control, plant replacement and associated materials; equipment; labor and dump fees) at $21,000 per year.

6.8 Hazardous, Toxic and Radioactive Waste (HTRW)

A Phase I Assessment was completed in July 2010 (Appendix A). The Phase I Assessment revealed evidence of recognized environmental conditions in connection with two sites listed on the Confirmed and Suspected Contaminated Sites and two sites listed on the Leaking Underground Storage Tanks List. These four sites are within 1000 feet of the subject site. However, based on topography, surface flows are unlikely to move towards the project area. Therefore contamination from these sites is unlikely to reach the project area. With these exceptions, the subject property appears relatively fit and contains no conditions that would present a significant adverse impact on the use of this property as indicated by the Mapes Creek Restoration Project. Historical documents searched and site reconnaissance reveal no evidence of the presence of hazardous substances on the project property. See Appendix A for more details.

7. ENVIRONMENTAL EFFECTS OF THE PREFERRED ALTERNATIVE

The Stream Channel with Shoreline Improvement Plan (Measures 2, 4, and 6 of section 4.4) is the Preferred Alternative and therefore recommended for implementation (described as the recommended plan in section 5).The Preferred Alternative is a cost-effective plan and will address the primary project opportunities, which are: 1) increase shallow water shoreline habitat for refuge and rearing of migrating juvenile salmon; 2) increase adjacent aquatic habitat for birds, amphibians and other wildlife in Lake Washington. The Stream Channel with Shoreline Improvement Plan is designed to minimize in-stream deposition and pass sediment to the lake where it may improve juvenile salmonid and wildlife habitat. Large wood and native vegetation along the shoreline would further enhance salmon habitat. It would have minimal operations and maintenance costs. It would leave lawn space available for continued multiple recreational use and it would not impact public safety.

The major elements of the Preferred Alternative from upstream to downstream, include:

- Diversion Structure (Measure 6 Sub-Component)
- Mapes Creek Diversion Pipe (Measure 6)
- Energy Dissipater (Measure 6 Sub-Component)
- Stream Channel (Measure 4)
- Shoreline Restoration (Measure 2)

Figure 23 (page 101) shows the location of the major elements of the Preferred Alternative . Section 5 provides a detailed description of the proposed project. The following discussion evaluates the environmental effects of the Preferred Alternative/Recommended Plan. In addition to the Preferred Alternative, the following alternatives were evaluated for environmental effects: No Action and Stream Only (measures 4 and 6 of section 4.4).

7.1 Geology and Soils

7.1.1 No Action

Under the No Action Alternative, no impacts to existing geology and soils would occur.

7.1.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

The stream channel and shoreline improvement would not have significant impacts on the geology or soil at the project site. Final design plans will attempt to balance (use of excavated materials on site) the amount of cut and fill at the project site. Construction excavation spoils or unsuitable materials will be removed from the project site and disposed of at a commercial facility. Acquisition of a disposal site is therefore not necessary for this project. Also, measures will be implemented to control erosion both duringF and after construction. These measures will be described in a Stormwater Pollution Prevention Plan (SWPPP) and will be in compliance with the Washington Department of Ecology's Construction Stormwater General Permit (NPDES permit) and City of Seattle requirements.

7.1.3 Stream Channel Only

Impacts to geology and soils would be the same as those described for the stream channel and shoreline improvement alternative.

7.2 Sedimentation

7.2.1 No Action

Under the No Action Alternative, sedimentation would not increase. Currently the sediment continuity on the Mapes Creek watershed is disrupted at several locations, including the ponds at Kubota Gardens and the culvert entrance at Sturtevant Ravine. The lower 3,200 feet of the stream is piped underground. Sediment that does enter the drainage system either remains in the pipeline or is directed to the combined sewer system (CSS) and removed by the municipal sanitary sewer treatment process.

7.2.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

The stream channel and shoreline improvement would allow the creek to flow above the surface in a natural stream bed, and connecting the creek through a natural confluence with Lake Washington will improve the channel complexity and connectivity. Daylighting Mapes Creek will also restore some natural geomorphic processes in the lower 300 feet of the stream. This would improve sedimentation conditions in the watershed. Instead of being directed to the CSS, the project's diversion structure at the 52nd Avenue Walkway will direct sediment bed load toward the restored channel at Be'er Sheva Park, where it can be dispersed more naturally.

7.2.3 Stream Channel Only

Impacts to sedimentation would be similar to those described for the stream channel and shoreline improvement alternative.

7.3 Hydrology and Hydraulics

7.3.1 No Action

Under the No Action Alternative, no impacts to existing hydrology and hydraulics would occur.

7.3.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

The preferred alternative would improve the altered hydrologic conditions of Mapes Creek by separating the creek from the combined sewer system (CSS). Instead of being directed through the CSS, flows from Mapes Creek would enter Lake Washington via a diversion pipeline and a restored surface channel in Be'er Sheva Park. All flows in Mapes Creek below approximately 5 cfs would be directed to the new stream channel. Site constraints in the diversion pipeline limit the flow to the new creek to a maximum of approximately 11 cfs.

7.3.3 Stream Channel Only

Impacts to hydrology and hydraulic would be similar to those described for the stream channel and shoreline improvement since Mapes Creek flows would still be routed away for the stormwater system and daylighted at the Lake Washington shoreline.

7.4 Water Quality

7.4.1 No Action

Under the No Action Alternative, water quality conditions would not change.

7.4.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

There will be temporary impacts to water quality, mainly turbidity, during construction of the outlet and diversion of flow into the new channel. These impacts will be minimized by isolating construction activities from adjacent receiving waters using cofferdam structures, and implementation of construction stormwater best management practices (BMPs) to the maximum extent practicable. These BMPs will include surface stabilization and other erosion control measures, silt fence and other sediment control measures, and a thorough housekeeping and source-control program to prevent the generation or release of potential stormwater pollutants. Water quality monitoring will take place to make sure state standards are met. If the standards are exceeded then construction will be halted until the standards can be met. Improvement to temperature may result from the increased planting along the shoreline.

7.4.3 Stream Channel Only

Impacts to water quality would be similar to those described for the stream channel and shoreline improvement. However, there may be no changes in temperature as there would be no riparian plantings along the shoreline.

7.5 Vegetation and Wetlands

7.5.1 No Action

Under the No Action Alternative, vegetation would remain as is, with patches of invasive and horticultural species growing in the managed park landscape.

7.5.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

Under the Preferred Alternative, all mature trees will be protected to the extent possible. Any trees that would be taken down due to construction would be used to create instream habitat structure. Additional native riparian trees and shrubs will be planted along the riparian area of the stream. Invasive species will be removed from the project area. The riparian plantings would increase the habitat value of the site by creating additional opportunities for foraging, nesting, cover, and refuge for a wide variety of species.

7.5.3 Stream Channel Only

Impacts to vegetation and wetlands would be similar to those described for the stream channel and shoreline improvement, although the benefits resulting from plantings would be slightly less due to lack of plantings along the shoreline.

7.6 Aquatic Biota and Fish

7.6.1 No Action

Under the No Action Alternative, aquatic biota would remain unchanged and fish communities would continue to experience a lack of habitat in Mapes Creek.

7.6.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

Under the Preferred Alternative, shallow water shoreline habitat will be created to provide refugia and rearing habitat for migrating juvenile salmon. In addition, the lower 370 feet of Mapes Creek will be day-lighted to provide habitat for salmonids, and other native fish and aquatic species.

During construction, cofferdams will isolate the construction area from adjacent receiving waters in order to protect aquatic species and fish. In addition, construction stormwater best management practices (BMPs) will be implemented to the maximum extent practicable in order to preserve local water quality, especially with respect to turbidity effects. These BMPs will include surface stabilization and other erosion control measures, silt fence and other sediment control measures, and a thorough housekeeping and source-control program to prevent the generation or release of potential stormwater pollutants.

Most of the project will be constructed "in the dry," but additional precautions will be made for construction activities along the shoreline and the final connection of the restored creek mouth to Lake Washington. Measures such as turbidity curtains will be used during construction activities along the lake shore and the "re-watering" of the stream channel. All work below the ordinary high water line will take place only during the in water work window ("fish window"), designated by the Washington Department of Fish and Wildlife (WDFW), to minimize possible harm to local fish species.

7.6.3 Stream Channel Only

Impacts due to construction would be similar to those described for the stream channel and shoreline improvement alternative. Long-term benefits to aquatic biota would be slightly less due to a lack of habitat features along the shoreline including riparian plantings and woody debris.

7.7 Wildlife

7.7.1 No Action

No changes to wildlife use would occur in the area under the No Action Alternative.

7.7.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

Due to the heavily managed nature of the project area and extensive visitor use, little wildlife habitat is found within the project area. Although there will be temporary negetive impacts to wildlife during construction of the Preferred Alternative due to the presence of heavy machinery and the associated noise and potential elevated levels of turbidity, short-term negative impacts are expected to be minimal and the long-term impacts will be beneficial. Possible short-term impacts include displacement from foraging areas, disruption of normal feeding and dispersal patterns, and increased stress due to noise and human presence. Short-term effects from possible increases in turbidity may occur and are discussed in the fisheries section. The Preferred Alternative will increase adjacent aquatic habitats that support birds, amphibians, and other wildlife associated with Lake Washington and Be'er Sheva Park.

7.7.3 Stream Channel Only

Construction impacts on wildlife would be similar to those described for the stream channel and shoreline improvement alternative. Long-term benefits to wildlife, including birds and small

mammal that may forage all the Lake Washington shoreline, would be slightly less due to a lack of habitat features along the shoreline including riparian plantings and woody debris. However, benefits resulting from the stream would provide habitat and foraging opportunities.

7.8 Threatened and Endangered Species

7.8.1 No Action

The degraded condition of Mapes Creek and its influence on Lake Washington would continue to influence downstream conditions for protected species.

7.8.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

The Preferred Alternative would increase the amount of shallow water shoreline and off-channel habitat for the refugia and rearing of listed migrating juvenile salmonids (mainly Chinook salmon).

A Section 7 consultation was performed with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) for this project. A determination of "may affect, but not likely to adversely affect" was made for Puget Sound Chinook, Puget Sound bull trout, and Puget Sound steelhead. Concurrence with this determination was received from NMFS on October 4, 2010, and USFWS on October 10, 2010.

Although there may be temporary impacts (such as water quality and noise impacts) to listed salmonids during construction, cofferdams will isolate the construction area from adjacent receiving waters in order to protect aquatic species and fish. In addition, construction stormwater best management practices (BMPs) will be implemented to the maximum extent practicable in order to preserve local water quality, especially with respect to turbidity effects. These BMPs will include surface stabilization and other erosion control measures, silt fence and other sediment control measures, and a thorough housekeeping and source-control program to prevent the generation or release of potential stormwater pollutants.

Most of the project will be constructed "in the dry," but additional precautions will be made for construction activities along the shoreline and the final connection of the restored creek mouth to Lake Washington. Measures such as turbidity curtains will be used during construction activities along the lake shore and the "re-watering" of the stream channel. All work below the ordinary high water line will take place only during the in water work window ("fish window"), designated by the Washington Department of Fish and Wildlife (WDFW), to minimize possible harm to endangered fish species.

7.8.3 Stream Channel Only

Temporary impacts to listed species would be the same as the described for the stream channel and shoreline improvement alternative. The same BMPs would be implemented to minimize the impacts. Long-term benefits to ESA listed salmonids would also be similar, although to a lesser extent due to the lack of habitat features such as riparian plantings and woody debris along the shoreline.

7.9 Cultural Resources

7.9.1 No Action

No disturbance to any possible cultural and historic resources would occur under the No Action Alternative.

7.9.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

The Corps has determined that the project has no potential to cause effects to Historic Properties under the NHPA, as the area was created in modern times and there are no historic structures adjacent to the undertaking, or within immediate view sheds that are eligible for the National Register. This determination completes the NHPA process.

7.9.3 Stream Channel Only

Impacts to cultural resources would be the same as those described for the stream channel and shoreline improvement alternative.

7.10 Land Use

7.10.1 No Action

There would be no changes to land use at the site under the No Action Alternative.

7.10.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

There would be no changes to the land use that the site under the Preferred Alternative. Be'er Sheva Park will maintain its recreational uses and benefits. A fence will restrict access to the shoreline and lower portion of the restored channel, and gravel paths and bridge will manage pedestrian access in the park.

7.10.3 Stream Channel Only

There would be no land use changes at the site under this alternative. It would still be designated as a city park.

7.11 Recreation

7.11.1 No Action

Under the No Action Alternative, no changes in recreation would occur on site.

7.11.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

The Preferred Alternative will change pedestrian use patterns in Be'er Sheva Park, primarily because the channel alignment bisects the park between the existing play area to the north and the parking lot and restroom to the south. However, the project proposes a pedestrian footbridge over the creek in order to maintain access on both sides of the channel. Because low-lying areas of the park are often unusable during the rainy season due to poor drainage, the project would affect recreational opportunities like picnicking only during the summer dry season. The project would preserve most of the shade trees in the park, and would replace in kind the benches at the viewing areas looking out on Lake Washington.

The park may be partially or entirely closed during construction in consideration of public safety. Closure of a portion of the parking on the south side of Be'er Sheva Park may be required.

However, it should not be necessary to close the boat launch facility. Mitigation for temporary impacts might include temporary portable restrooms near the play area of the park.

7.11.3 Stream Channel Only

Impacts to recreation would be similar to those described for the stream channel and shoreline improvement alternative.

7.12 Air Quality and Noise

7.12.1 No Action

No changes to air quality or noise levels would occur under the No Action Alternative.

7.12.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

Air Quality

Construction vehicles may temporarily increase air emissions in the immediate project vicinity. Air quality emissions should not exceed EPA's *de minimis* threshold levels (100 tons/year for carbon monoxide and 50 tons/year for ozone) for non-attainment areas, however there have been no standards set for green house gas emissions (CO_2 in the case of this project) in Washington State. See below for specific details on air pollutants..

For every gallon of diesel fuel burned, 22 pounds of CO_2 are produced, and every gallon of gasoline produces 19.4 pounds of CO_2 (USEPA, 2008). Based on the amount of equipment needed for construction, including but not limited to a vibratory roller, compactors, front end loaders, cranes, and excavators, operating varying hours an estimated 118 tons of CO_2 would be emitted using a construction emissions spreadsheet model for non-road equipment (SMAQMD, 2008). Also calculated for non-road construction equipment are carbon monoxide (CO), reactive organic gases (ROGs) (which are ozone precursors), nitrogen oxides (NOx), particulate matter (PM), and sulfur oxides (SOx). In addition, emissions were calculated for loaded dump trucks and water trucks, as well as personal vehicles. Table 37 outlines assumed emissions based on USEPA (2008) and SMAQMD (2008). The CO_2 emissions listed below may seem insignificant compared to the giga-tons emitted per year globally (Raupach et. al., 2007). Nevertheless, diesel fuel consumption by heavy machinery required for construction, material delivery and haul-off, and gasoline consumption for travel to the sites for all Corps projects, including this project, are a part of world-wide cumulative contributions to change in climate by way of increases in greenhouse gas emission. However, the plantings at the site should aid in the absorption of CO_2 over time.

Table 37: Estimated emissions of air pollutants and greenhouse gasses from operation of vehicles and construction equipment for Mapes Creek Restoration.

	Carbon Monoxide	Reactive Organic Gases	Carbon Dioxide	Nitrogen Oxides	Particulate Matter	Sulfur Oxides
	CO	ROG	CO2	NOx	PM	SOx
Source	**(tons)**	**(tons)**	**(tons)**	**(tons)**	**(tons)**	**(tons)**
Non-road emissions [1]	0.2	0.1	118	1.2	0.0	0.0
Truck emissions [2]	Tbd	Tbd	90.21	Tbd	Tbd	Tbd
Personal vehicle emissions [3]	Tbd	Tbd	5.28	Tbd	Tbd	Tbd

Notes: (1) Construction equipment; based on spreadsheet model from SMAQMD (2008); assumes both 50 and 500-hp diesel engines working 10 hrs per day, modeling data; (2) Assumes 5 mpg diesel, traveling 45,200 miles; modeling data not available for pollutants other than CO_2; (3) Assumes 20 mpg gasoline, 5 vehicles for 120 days of construction, 20 miles round trip; data not available for pollutants other than CO_2

Noise

The City of Seattle's Noise Ordinance Subchapter 3 section 25.08.425 defines the exterior sound level limits for "sounds created by construction and maintenance equipment" based on measurement from the nearest real property line or 50 feet from the equipment, whichever is greater. The following limits are established for noise levels allowable during approved daytime operating hours (City of Seattle, 2009). Noise level given in the A-type decibel log scale "dB(A)".

- 25 dB(A) for equipment on constructions sites including equipments such as: tractors, dozers, drills/augers, loaders, cranes, trucks, compactors/compressors, etc.
- 20 dB(A) for portable powered equipment used in temporary locationsin support of construction activities or maintenance, such as: chainsaws, log chippers, lawn and garden equipment, and other powered hand tools.
- 15 dB(A) for powered equipment used in temporary or period maintenance such as lawnmowers, snow removal equipment, and other hand tools.
- Impact equipment such as pile drivers, jackhammers, blasting tools, or other tools creating impulse/impact sound may exceed the above limits temporarily, so long as sound level does not exceed the following equivalent sound levels (Leq):
    - Leq 90bB(A) continuously
    - Leq 93 dB(A) for 30 minutes
    - Leq 96 dB(A) for 15 minutes
    - Leq 99 dB(A) for 7.5 minutes

Construction vehicles and equipment may temporarily increase noise in the immediate project vicinity. Construction will be restricted to daytime hours as designated in City of Seattle

municipal code to minimize this disturbance. Some example sources and magnitude of noise arising from construction is summarizes in the following table from the FHWA Construction Noise Handbook.

Table 38: Example Equipment Noise Levels

Equipment Description[1]	Impact Device?	Spec. 721.560 L_{max} @ 50 feet (dBA, slow)
All Other Equipment > 5 HP	No	85
Auger Drill Rig	No	85
Chain Saw	No	85
Compactor (ground)	No	80
Compressor (air)	No	80
Concrete Mixer Truck	No	85
Concrete Pump Truck	No	82
Concrete Saw	No	90
Crane	No	85
Dozer	No	85
Dump Truck	No	84
Excavator	No	85
Flat Bed Truck	No	84
Front End Loader	No	80
Grader	No	85
Impact Pile Driver	Yes	95
Jackhammer	Yes	85
Paver	No	85
Pickup Truck	No	55
Pneumatic Tools	No	85
Sand Blasting (single nozzle)	No	85
Tractor	No	84
Vacuum Excavator (Vac-Truck)	No	85
Vibrating Hopper	No	85
Vibratory Concrete Mixer	No	80
Vibratory Pile Driver	No	95
1 – List of equipment truncated for example purposes. Full list available at source below. *Source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm*		

The preliminary project design calls for use of excavators, bull dozers, front loaders, a wheel-mounted crane, sheet pile driver, and sump pump system. Based on the type and duration of construction activities proposed, temporarily elevated levels of noise are not expected to be an issue for most of the evaluated area. The land uses adjacent to the construction zones (pipe alignment and within Be'er Sheva Park) are largely composed of residential developments, small frontage retail/commercial businesses, and small shopping centers. Two potential sensitive receptors were identified within close proximity to the construction zones and were evaluated further.

First, Rainier Beach High School is located directly west of Be'er Sheva Park. Specifically, a large campus building is located on the corner of S Henderson St and Seward Park Ave S. Due to its location, this building would likely be affected by construction within Be'er Sheva Park as well as construction related to installation of the diversion pipe on S Henderson St. In both cases, the school building is approximately 50 yards from the construction zone, likely resulting

in elevated exterior noise levels. Interior noise levels will be mitigated by distance and by implementing reasonable measures such as closing windows and doors of the building.

Second, and further from a construction zone, is the Rainier Beach Public Library, a branch of the City of Seattle Library. Located at the intersection of Rainier Ave S and S Fisher Pl, the library is approximately 230 yards from the nearest construction zone. Due to its location, the library would be affected only by construction related to installation of the diversion pipe at the corner of S Fisher Pl and the 52nd Ave Walkway. Because less heavy machinery will be required at this location than at the park, it is unlikely that noise levels would increase to the same level as experienced by the high school. Reasonable abatement measures such a closing library doors and windows are expected to reduce noise levels to negligible levels.

Based on this preliminary analysis, noise associated with the use of heavy machinery may cause minor disturbance to local residences and businesses, but these will not be significant. The identified sensitive receptor likely to be most affected is Rainier Beach High School. These impacts would be temporary, highly localized, within City regulations, and would not result in impacts after construction is complete.

7.12.3 Stream Channel Only

Impacts to air quality and noise would be similar to those described for the stream channel and shoreline improvement. Since the shoreline improvement is not a very large component of the plan, the construction duration and equipment needed would be similar.

7.13 Transportation

7.13.1 No Action

No changes to transportation would occur under this alternative.

7.13.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

The Preferred Alternative would require the temporary closure of roads and sidewalks at and adjacent to the project site during construction resulting in temporary impacts to traffic. Detours and access limitations would need to be implemented during the construction period.

The 52nd Avenue Walkway and plaza will need to be closed temporarily during construction of the diversion pipeline. This closure will require pedestrians to detour from the walkway, which provides a useful link between neighborhood centers like Rainier Beach High School and the grocery store at Rainier Avenue South and South 52nd Avenue.

The construction of the diversion pipeline along South Henderson Street will temporarily close the eastbound sidewalk and disrupt access to the King County Metro South Henderson Street pump station and the apartment complex at Apartment Complex Driveway during construction. Measures will be taken to ensure access to these facilities during the construction period. Closure of the eastbound bicycle and traffic lanes on South Henderson Street may also be required.

During the construction of the pipeline as it crosses the intersection of Seward Park Avenue South and South Henderson Road, partial or full road closures will be necessary. This traffic

disruption will have significant effects because both South Henderson Street and Seward Park Avenue South are arterial streets that serve as vital links to the local neighborhood. The streets are a service corridor for public transit including Metro bus Routes 7, 32, 36, and 48 and experience periodic high traffic volume including autos, pedestrians, bicycles, and school buses. Methods to mitigate negative traffic effects might include re-channeling traffic on South Henderson Street or employing flaggers or temporary traffic signals to manage traffic. Such Alternatives will be detailed in a traffic control plan meeting City of Seattle Department of Transportation (SDOT) standards.

Post-construction, the project is not anticipated to significantly increase vehicular, bicycle, or pedestrian traffic to the park.

7.13.3 Stream Channel Only

Impacts to transportation would be the same as those described for the stream channel and shoreline improvement since the diversion pipe is required for this alternative as well.

7.14 Aesthetics

7.14.1 No Action

Under the No Action Alternative, no changes to aesthetics are expected to occur.

7.14.2 Stream Channel and Shoreline Improvement (Preferred Alternative)

Under the Preferred Alternative, the aesthetics of the project area would improve because the project would provide a more natural and native habitat type. The project would replace a maintained lawn-scape with a natural meandering stream. The project will also install a small pedestrian footbridge over the stream that will maintain access between the parking lot and Be'er Sheva Park.

7.14.3 Stream Channel Only

Impacts to aesthetics would be similar to those described for the stream channel and shoreline alternative. Long-term benefits would be slightly less due to a lack of riparian plantings along the shoreline.

7.15 Unavoidable Adverse Effects

Unavoidable adverse effects of the proposed project include:

1) Temporary increases in turbidity during construction, which will be minimized by isolating the in-water work with a cofferdam (or equivalent), water quality monitoring, and working within the designated in-water work window ("fish window").
2) Temporary noise disturbances to wildlife, homeowners, and institutions in the vicinity due to operating heavy equipment during excavation and construction of the restoration site. Most wildlife is anticipated to avoid the area while work is in progress. To mitigate impacts, work would be conducted only during daylight hours and in accordance with local noise ordinances.

3) Temporary disruption of local traffic in the project vicinity during construction. Proper signage, flagmen, and detour routes would be utilized to move vehicular and pedestrian traffic through the area as quickly and safely as possible.
4) Potential mortality of vegetation, including larger riparian trees and under-story shrubs within the project site. There will be extensive native plantings on site that would far exceed any loss of ornamental species currently in the park.

Given the temporary, localized, and minor nature of these effects, the Corps has determined that the proposed restoration project would not result in significant adverse environmental impacts.

7.16 Cumulative Impacts

Cumulative impacts result from the "individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). As such they include the impacts of this restoration project considered in conjunction with current and future projects constructed or planned within the Mapes Creek watershed.

Additional restoration projects in the Mapes Creek area, including those listed in Section 1.4 of this Environmental Assessment, are ongoing in the Mapes Creek watershed and Lake Washington basin. All of these efforts would result in long-term, cumulative benefits to the amount and functional value of restored habitat, improvements in the overall watershed condition, and would ultimately increase the ability of the watershed to support critical life history stages of native fish and wildlife populations.

Other less beneficial activities in the watershed include ongoing urbanization and development which perpetuate the degraded condition of the Mapes Creek watershed. The negative effects due to the construction of the Mapes Creek Restoration project would add to the cumulative negative effects of the development activities in the watershed. However, the negative effects associated with this project are temporary and concentrated. More significantly, the long-term beneficial effects generated by the project compensate for these short-term negative effects. Thus, the proposed restoration project would have beneficial cumulative effects within the watershed.

8. COORDINATION AND COMPLIANCE

8.1 Public and Agency Coordination

Development and design of this project has been coordinated with involvement by the following agencies and entities:

- State of Washington Department of Fish and Wildlife
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- Washington Department of Ecology
- Washington State Historic Preservation Office
- City of Seattle
- King County, Washington

8.2 Environmental Compliance

8.2.1 National Environmental Policy Act

This Draft Detailed Project Report and Environmental Assessment (EA), prepared March 2011, is intended to achieve NEPA compliance for the proposed project. As required by NEPA, this EA describes existing environmental conditions at the project site, the proposed action and alternatives, potential environmental impacts of the proposed project, and measures to minimize environmental impacts.

The draft version of this feasibility study and environmental assessment was released for public review and comment on April 29, 2011 and comments will be accepted through May 28, 2011. A draft Finding of No Significant Impact (FONSI) can also be found in Appendix G1.

8.2.2 Endangered Species Act

The Endangered Species Act (ESA) of 1973, as amended, declares that all federal agencies "…utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to section 4 of this Act.". Section 7 of the ESA requires federal agencies to ensure that any agency action (any action authorized, funded, or carried out by the agency) is not likely to jeopardize the continued existence of any threatened, endangered, or proposed species. Agencies are further required to develop and carry out conservation programs for these species.

In accordance with Section 7(a)(2) of the Endangered Species act of 1973, as amended, federally funded, constructed, permitted, or licensed projects must identify and evaluate any threatened and endangered species, and their critical habitat, that may be affected by an action proposed by that agency. A determination of "may affect, but not likely to adversely affect" biological assessment (Appendix G2) was made for Puget Sound Chinook, Puget Sound bull trout, and Puget Sound steelhead. The Corps received electronic concurrence with the determinations made in the Biological Assessment on October 5, 2010 (USFWS) and on October 4, 2010 (NOAA). Copies of these emails can be found in Appendix G.

8.2.3 Clean Water Act

Section 404 of the Clean Water Act authorized a permit program for the disposal of dredged or fill material into waters of the United States, and defined conditions which must be met by federal projects before they may make such discharges. The Corps retains primary responsibility for this permit program. The USACE does not issue itself a permit under the program it administers, but rather demonstrates compliance with the substantive requirements of the Act through preparation of a 404(b)(1) evaluation.

The Corps has prepared a 404(b)(1) evaluation to document findings regarding this project pursuant to Section 404 of the Act as well as Section 10 of the Rivers and Harbors Act of 1899. Preliminarily, the Corps believes that this project is analogous to the conditions of Nationwide Permit 27, Aquatic Habitat Restoration. The Corps has prepared a decision document to demonstrate the rationale for coverage under the NWP; this evaluation is provided in Appendix G3 of this document.

Section 401 of the Act requires federal agencies to comply with EPA, state, or tribal water quality standards. EPA has delegated implementation of Section 401 to the Washington Department of Ecology. This work requires a WQC from the Washington Department of Ecology for compliance with Section 401 of the Clean Water Act for work below the Ordinary High Water (OHW) line. On December 1, 2010 the Corps received a 401 certification under the conditions of a Nationwide Permit 27 from the Washington Department of Ecology (Appendix G4). The Corps will abide by the conditions of the water quality certification to ensure compliance with Washington water quality standards.

Section 402 of the Act requires a National Pollutant Discharge Elimination System (NPDES) permit and the associated implementing regulations for General Permit for Discharges from large and small construction activities for construction disturbance over one acre. This permit will be obtained by the construction contractor closer to construction of the project.

8.2.4 Coastal Zone Management Act

The Coastal Zone Management Act of 1972 as amended (15 CFR 923) requires federal agencies to carry out their activities in a manner consistent with the maximum extent practicable, and with the enforceable policies of the approved Washington Coastal Zone Management Program. The proposed action would create a stream where there currently is not one, thus moving the shoreline. However, this project would not cause substantial adverse effects to shore resources or the environment. After review of the City of Seattle Shoreline Master Plan, the Corps believes this proposal is consistent to the maximum extent practicable (see Appendix G for Coastal Zone Consistency Determination). On December 1, 2010 Coastal Zone Consistency Determination concurrence was received from the Washington Department of Ecology under the conditions of a Nationwide Permit 27, aquatic restoration See appendix G for the Coastal Zone Consistency Determination.

The City of Seattle, the local project sponsor, will apply for and receive a shoreline conditional use permit and a hydraulic project approval for the proposed project prior to construction.

8.2.5 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 U.S.C. 661) requires that wildlife conservation receive equal consideration and be coordinated with other features of water resource development projects. This goal is accomplished through Corps funding of a US Fish and Wildlife Service (USFWS) evaluation of the likely impacts of proposed actions, which provide the basis for recommendations for avoiding or minimizing such impacts. Coordination with USFWS has been ongoing throughout the study process. An email was received from USFWS on August 30, 2010 stating the following; "Given the location (Lake Washington) and the fact that this is a fairly small restoration project in an urban setting, we don't have any issues or concerns with the alternatives that you are considering or the project as a whole. So, we are declining to provide a formal planning aid or report for this project." A copy of this email can be found in Appendix G.

8.2.6 National Historic Preservation Act

The National Historic Preservation Act (16 U.S.C. 470) requires that the effects of proposed federal undertakings on sites, buildings structures, or objects included or eligible for the National Register of Historic Places must be identified and evaluated. The Mapes Creek project is a federal undertaking of the type which has no potential to cause effects to historic properties, as the area was created in modern times and there are no historic structures adjacent to the undertaking, or within immediate view sheds that are eligible for the National Register. This determination completes the NHPA process.

8.2.7 Magnuson-Stevens Fishery Conservation and Management Act

The evaluation of project impacts to essential fish habitat (EFH) occurred as part of the Section 7 consultations with NOAA Fisheries described in Section 7.2.2 above. NOAA Fisheries determined that conservation measures included as part of the proposed action are adequate to avoid, minimize, or otherwise offset potential adverse effects to EFH (see Appendix G).

8.2.8 Bald and Golden Eagle Protection Act (BGEPA) (16 U.S.C. 668-668d)

The Bald and Golden Eagle Protection Act (BGEPA) prohibits the taking, possession or commerce of bald and golden eagles, except under certain circumstances. Amendments in 1972 added penalties for violations of the act or related regulations.

Although there are known bald eagle sighting along the shoreline adjacent to the project site, no take of either bald or golden eagles is likely during project construction. A survey of nests will be done prior to the start of construction, and if a nest or juveniles are observed during construction, appropriate measures would be taken to ensure no harassment occurs. Therefore, no adverse effects to eagles are anticipated.

8.2.9 Wild and Scenic Rivers Act (16 U.S.C. 1271-1287)

No portions of Mapes Creek have been designated as a Wild and Scenic River so this Act is not applicable to the proposed work.

8.2.10 Executive Order 12898, Environmental Justice

Executive Order 12898 directs every federal agency to identify and address disproportionately high and adverse human health or environmental effects of agency programs and activities on minority and low-income populations.

The project would only temporarily affect noise, park access, traffic, and air quality during construction, and should enhance aesthetics after construction is complete. The project does not involve the siting of a facility that would discharge pollutants or contaminants, so no human health effects would occur. Therefore the proposed action is in compliance with this order.

8.2.11 Executive Order 11990, Protection of Wetlands, May 24, 1977

No impacts to wetlands are anticipated from the construction of this project.

8.2.12 Executive Order 11988, Floodplain Management, 24 May 1977

Executive Order 11988 requires federal agencies to avoid, to the extent possible, the long and short-term adverse impacts associated with the occupancy of the floodplain, and to avoid direct and indirect support of floodplain development where there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains."

The proposed action would not create a change that would affect occupancy of the floodplain.

9. CONCLUSION AND RECOMMENDATION

Through use of a habitat benefit evaluation and a cost-effectiveness and incremental cost analysis, this study developed and evaluated measures and combinations of measures that increase shoreline refuge habitat for migrating juvenile salmonids. The study concludes that the alternative that would best realize the project objectives, and in turn address the ecosystem restoration need in the project area, would include diversion of Mapes Creek to a restored surface channel at Be'er Sheva Park and shoreline restoration at the mouth of the creek on Lake Washington. It is anticipated that this recommended plan would result in long-term, cumulative benefits to the amount and functional value of restored habitat, improvements in the overall watershed condition, and would ultimately increase the ability of the watershed to support critical life history stages of native fish and wildlife populations. The recommended plan is acceptable in terms of applicable laws, regulations and public policy. The plan is also acceptable to the City of Seattle. The plan is complete, effective, and efficient.

In addition, based on this Environmental Assessment and on coordination with federal agencies, Native American Tribes, and State agencies, the Mapes Creek Restoration project is not expected to result in significant adverse environmental impacts. The Mapes Creek Restoration project is not considered a major federal action having a significant impact on the human environment. Therefore, the preparation of an environmental impact statement is not required. Appendix G documents the Finding of No Significant Impact (FONSI).

Anthony O. Wright
Colonel, Corps of Engineers
District Engineer

Date

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Appendix A Phase I Environmental Site Assessment

Contents

EXECUTIVE SUMMARY

United States Army Corps of Engineers (USACE) performed a Phase I Environmental Site Assessment (ESA) of the Mapes Creek Restoration area located on the southwestern side of Lake Washington in Seattle, Washington. The Phase I ESA of this property was performed in conformance with the scope and limitations of ASTM Standard Practice E 1527-00. The purpose of this study was to identify any recognized environmental conditions on the subject property and/or within a reasonable search zone around the subject property. Sites located within one mile of the subject property that were found to have the potential for adverse impacts on the Mapes Creek Restoration Area were listed. Of those sites, only the ones within 1000 feet of the nearest boundary of the subject property were considered as recognized environmental conditions.

This phase I ESA did reveal the presence of recognized environmental conditions in connection with the subject property.

Sites found to have the potential for adverse environmental impacts to the subject property:

- Four sites reporting confirmed and/or suspected contamination within one mile of the subject property
- Nine sites containing leaking underground storage tanks within one mile of the subject property
- 248 records of regulated underground storage tanks, only one of which was found to be within the subject property
- 12 facilities in the vicinity of the subject property are regulated by the Environmental Protection Agency (EPA); all are listed as “compliant”

Of these sites:

- Two sites listed on the Confirmed and Suspected Contaminated Sites List are considered recognized environmental conditions
- Two sites listed on the Leaking Underground Storage Tanks List are considered recognized environmental conditions

There are three wells of interest listed in the well log found on the State of Washington’s Department of Ecology website. The wells, classified as “Resource Protection Wells,” are located at the intersection of Seward Park Ave S and Henderson, which is directly in the construction corridor of the Mapes Creek diversion pipe. These wells are not considered a recognized environmental condition, but the proposed construction could have an impact on the wells. Similarly, it is important to document the regulated underground storage tank found on the subject property. It is not considered a recognized environmental condition, but the proposed construction could have an impact on the tank.

1 INTRODUCTION

The Mapes Creek Restoration area (subject property) is located along the walkway of 52nd Ave S and along S Henderson St, in Be'er Sheva Park, on the southwestern side of Lake Washington, Seattle, Washington. The subject property is an urban area in the southeast portion of Seattle. The restoration project will construct a new diversion pipeline, to separate the underground flow of Mapes Creek from the combined sewer overflow (CSO), and daylight the creek into a new meander channel which will enter Lake Washington. Currently, the shoreline of Lake Washington is highly developed with both residential and commercial activities. The new diversion pipe and restoration site is an urban setting, occupied by homes, Seattle school district high school, stores, shops, recreation areas, etc. A records review and site reconnaissance were performed for this Environmental Site Assessment (ESA) in order to identify and call out any recognized environmental conditions present on the subject property and/or within a reasonable search zone around the subject property.

This ESA was performed consistent with the American Society for Testing and Materials (ASTM) Practice E 1527-00 *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.* This report presents the information generated by the assessment as well as conclusions and recommendations.

1.1 Purpose

The purpose of the Phase I ESA was to evaluate past and present activities on or near the subject property, evaluate historical use of the site, and identify evidence of recognized environmental conditions in connection with the subject property. The information was used to draw reasonable conclusions regarding the presence of recognized environmental conditions at the site. ASTM Standard Practice E 1527-00 defines a recognized environmental condition as *the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, ground water, or surface water of the property.*

1.2 Scope of Work

The Phase I ESA consisted of the following tasks:

- Regulatory agency document review
- Historical records review
- Review of site characteristics
- Site reconnaissance
- Preparation of this report

2 SITE DESCRIPTION

2.1 Property Identification

The 52nd Avenue Walkway is owned by Seattle Department of Transportation (SDOT). The legal description of this property, according to Seattle Parks and Recreation, is *Rainier Beach: 52nd Avenue South right-of-way between Rainier Avenue South and South Henderson Street*.

The strip of South Henderson Street included in the subject property is identified as 5246 South Henderson Street, east across the Seward Park Avenue South and South Henderson Street intersection to the boundary of Be'er Sheva Park.

The section of the subject property located in Be'er Sheva Park is identified as "Be'er Sheva Park".

2.2 Setting

The subject property (Figure 2-1) is an urban area in the southeast part of Seattle. It lies on the southwest shore of Lake Washington and extends through Be'er Sheva Park, away from the shore, up S Henderson Street to the 52nd Ave walkway. It makes a right angle turn from S Henderson St and runs along the walkway for approximately 800 feet. The lower stream channel of Mapes Creek is currently underground and joins a combined sewer overflow (CSO) pipe that runs along the 52nd Ave walkway. The CSO pipe continues underground through Be'er Sheva Park before discharging into Lake Washington. The subject property consists of the property that the proposed Mapes Creek diversion pipe runs through, starting at the point where the Mapes Creek underground flow joins the CSO and continues along the path of the diversion pipe, through the restoration area at the shoreline of Lake Washington (Figure 2-2). Photographs were taken at nine points along the subject property. Figure 2-3 is a map of where photographs were taken and Attachment 1 is the actual photos.

Rainier Beach High School is north of the subject property, and South Shore Middle School is west of the property. A Rite Aid, Safeway Market and plaza, and residential homes along S Director Street and S Fisher Place are located nearby. There are residential homes on the south side of Rainier Ave which is located south of the property. East of the 52nd Ave walkway is another residential area which extends until reaching Seward Park Ave S. Be'er Sheva Park begins on the east side of Seward Park Ave S and extends to the shore of Lake Washington.

2.3 Review of Topographical Map

The subject property is mainly flat with a general slope east toward Lake Washington. The highest elevation in the vicinity of the subject property appears to be about 60 feet, and occurs southwest of the subject property. According to the topographic map (Figures 2-4 and 2-5), the surface water appears to flow generally southeast toward Lake Washington.

2.4 Review of Hydrogeology-Groundwater

There was not enough data in the well log to map groundwater movement; in many cases, the static water level was not recorded.

2.4 Current Uses of the Subject Property and Adjoining Properties

The subject property and surrounding areas are currently used for residential, commercial and recreation. Be'er Sheva Park is used for walking, relaxing, boat launching, and play. The urban residential area is home to many people who utilize the high school and its athletic fields, streets, walkways, nearby shopping plazas and public transportation.

3 RECORDS REVIEW

3.1 Standard Environmental Record Sources

The Washington State Department of Ecology website was used to find records for:

- Well logs (Appendix 4)
- Regulated underground storage tanks
- Leaking underground storage tanks
- Confirmed and suspected contaminated sites

The well log was searched by zooming in on the provided map until it showed only the subject property, then the wells were identified and the report was viewed and analyzed. The Regulated and Leaking Underground Storage Tanks lists as well as the Confirmed and Suspected Contaminated Sites list were searched by zip code (98118). The results were analyzed for sites within one mile of the subject property. This report only contains the results of the well logs search; it does not contain the complete results of any other database search.

The United States Environmental Protection Agency (USEPA) Envirofacts website was used to find information on all the nearby facilities that are required to report activity to a state or federal system. A multisystem search was performed in order to retrieve information about:

- Hazardous waste (including the Biennial Report)
- Toxic and air releases
- Superfund sites
- Water discharge permits

This search was performed by zip code 98118. The search results were tagged on a map which was used to zoom in on the subject property and narrow down the results to only significant sites. Facility information and a map of its location were included in the search results.

3.2 Physical Setting Sources

The physical setting of the subject property and surrounding area was observed using Google Maps and Google Earth Pro as well as a site reconnaissance conducted on July 21, 2010.

3.4 Historical Use of the Subject Property and Adjoining Properties

The subject property includes a Seattle city park, so the Seattle Parks and Recreation website was used to find historical information on Be'er Sheva Park and the surrounding neighborhood. Historical photos

of the area were searched for and viewed using the University of Washington library website. No historical photographs of the subject property itself were found, but there were some photos of the surrounding neighborhood, which were used to make generalized, educated conclusions about the historical uses of the area surrounding the subject property. Much of Seattle park history was documented by an engineer, Donald N. Sherwood (1916-1981), who worked for Parks for 22 years from 1955 to 1977. The Seattle Parks and Recreation's *Sherwood History Files* contains the information documented by Sherwood including an engineer's sketch (Figure 3-1) of Be'er Sheva Park (formerly known as Atlantic City Park) along with an overview of the park's history.

The subject property and adjoining properties were historically developed as a residential neighborhood which was annexed to the city of Seattle in 1907. As documented by Sherwood, the pioneer town of Rainier Beach was once the terminus of a trolley car from Washington Street in Seattle, whose route created Rainier Avenue. Regional growth was spurred by these trolley cars. The Park Department operated a boathouse on the shore of what is now called Be'er Sheva Park until 1917 when the level of Lake Washington dropped by nine feet due to the opening of the Lake Washington Ship Canal. The land consequently dried out; in 1917 tennis courts were built, and a picnic stove and play apparatus were built by 1924. Before the lake was lowered, water covered all the land where Rainier Beach High School and its athletic fields are located today. The trolley service ended in 1937 and the tracks down Rainier Ave S were removed. In 1948, the low area north of Henderson Street was filled in and graded and developed into an informal ball field. Rainier Beach Junior-Senior High School was completed in 1960.

As described on the Seattle Parks Department website, the park has been a centerpiece of this neighborhood since the property was acquired in 1905 and plans were drawn up showing lots for sale and an area labeled "park," which was beautified and improved by adding a bath house, pier and boat house. Land has since been added to the park and development has taken place around it.

Information on the Rainier Valley Historical Society website suggests that logging seems to have been the most dominant industry in the Rainier Beach area from the late 1800s to the mid 1900s. Rail cars and waterways were the main forms of transportation of timber into and out of the mills.

4 SITE RECONAISSANCE

4.1 Methodology

The subject property was visited on July 21, 2010 in order to visually identify possible sources or evidence of hazardous materials contamination, and to view the use of the land and the surrounding areas. Upon arrival at the subject property, I parked in a lot in Be'er Sheva Park facing the playground and proceeded to walk up to S Henderson St. I walked the property, along the path of the proposed Mapes Creek diversion pipe noting visual observations, basic topography and the proximity of the subject property to the nearby buildings and roads. When I reached the Safeway plaza where the diversion pipe is to be separated from the combined sewage overflow pipe, I noted the stores in the plaza and retraced my steps back to Be'er Sheva Park. I continued to walk along the path of the subject property until I reached the shoreline of the lake, the terminus of the subject property.

I visited the site one more time on July 23, 2010 to take photographs. Nine photos were taken, and the location and orientation of the photos were recorded on an aerial map of the site (Figure 2-3).

4.2 General Site Setting

The setting was a busy urban area surrounded by people walking along the streets and the 52nd Ave walkway, utilizing the shopping plazas, park, playground, and boat docks. High school students were walking around the high school and using the track and fields. The roads were busy with cars and light rail busses.

4.3 Exterior Observations

The following observations were made during the site reconnaissance:

- There is a regulated underground storage tank that appears to be directly in the path of the proposed Mapes Creek diversion pipe
- The subject property is in very close proximity to a high school with a running track and sports fields, a gated housing community, and two shopping plazas
- The walkway appeared to have a steep slope on either side of it which extended down on the South side to meet the fenced in yard of the housing community and on the North side to meet vacant land which lies behind the two shopping plazas
- There appeared to be no factories or large-scale industries
- No evidence of hazardous materials was noticed

4.4 Field Inspection Report

Since the subject property consists of land being used as a walkway, a road, and a city park, there are no buildings on the property except for one bath house in Be'er Sheva Park (which can be seen on the right side of Photo 9 in Attachment 1). This building only contains a men's and a women's restroom.

5 INTERVIEWS

No interviews were conducted since this subject property is not owned by any one person, and it was not found necessary to interview government officials.

6 FINDINGS AND CONCLUSIONS

6.1 Findings Based on Records Review

There are several sites that have the potential for adverse environmental impacts to the subject property. Any of these sites within 1000 feet of the nearest subject property boundary are considered recognized environmental conditions.

- Four sites reporting confirmed and/or suspected contamination within one mile of the subject property
- Nine sites containing leaking underground storage tanks within one mile of the subject property
- One regulated underground storage tank was found within the subject property
- 12 facilities in the vicinity of the subject property are regulated by the EPA; all are listed as "compliant"

There are three wells of interest listed in the well log, classified as "Resource Protection Wells," which are located at the intersection of Seward Park Ave S and Henderson, in the construction footprint of the Mapes Creek diversion pipe. These wells are not considered a recognized environmental condition, but the proposed construction could have an impact on the wells. Similarly, the one regulated underground storage tank on the subject property is not considered a recognized environmental condition, but the proposed construction could have an impact on the tank.

There are four sites within one mile of the subject property that are listed on the Confirmed and Suspected Contaminated Sites List:

1. Fisher Property, 9420 Rainier Ave S, Seattle, WA 98118
    - Lat: 47.52014 / Long: -122.26441
2. Low Rate Hauling & Yard Clean Up, 7020 44th Ave S, Seattle, WA 98118
    - Lat: 47.53444 / Long: -122.26944
3. Stone Property 55th Av, 8433 55th Ave S, Seattle, WA 98118
    - Lat: 47.52785 / Long: -122.26446
4. Vinson Brothers Corp, 9245 Rainier Ave S, Seattle, WA 98118
    - Lat: 47.51991 / Long: -122.26941

Figure 6-1 shows the location of each of these sites with respect to the subject property. The Vinson Brothers Corp and Fisher Property are less than 1000 feet from the subject property and should be considered recognized environmental conditions.

When measuring the location of each of these four sites to the nearest subject boundary, the shortest straight line distance was found to be approximately 700 feet (Vinson Brothers Corp site). This site is southwest of the subject property boundary, and considering the topography of the immediate area, surface flows are unlikely to move northeast to the subject property. Although this site has been considered a recognized environmental condition, contamination from this site is probably unlikely. The Fisher Property site lies approximately 900 feet southeast of the subject property boundary. Surface flows are unlikely to move northwest toward the subject property, so contamination from this site is unlikely. The other two listed sites are greater than 1000 feet from the subject property.

The nine sites containing leaking underground storage tanks within one mile of the subject property are:

1. 7-Eleven 2307-17381P, 9436 Rainier Ave S, Seattle, WA 98118
    - Lat: 47.52033 / Long: -122.26308
2. ASAP Auto Repair, 9480 Rainier Ave S, Seattle, WA 98118

    - Lat: 47.52003 / Long: -122.2655
3. Rainier Beach Automotive, 9479 Rainier Ave S, Seattle, WA 98118-5565
    - Lat: 47.52003 / Long: -122.26357
4. Rainier Beach Playfield, 8825 Rainier Ave S, Seattle, WA 98118
    - Lat: 47.52441 / Long: -122.2742
5. Rose St Auto Repair, 8335 Rainier Ave S, Seattle, WA 98118-4652
    - Lat: 47.52894 / Long: -122.27019
6. Rossoe Energy Systems, Inc., 9367 Rainier Ave S, Seattle, WA 98118-5567
    - Lat: 47.51967 / Long: -122.26728
7. Sea & Shore Pile Driving Co, 9250 Martin Luther King Way So, Seattle, WA 98118-5315
    - Lat: 47.52043 / Long: -122.28145
8. Seattle City Parks Kubota Garden, 9817 55th Ave S, Seattle, WA 98118
    - Lat: 47.51327 / Long: -122.2663
9. South Shore Texaco, 9001 Renton Ave S, Seattle, WA 98118-5018
    - Lat: 47.52322 / Long: -122.27789

Figure 6-2 shows the location of each of these sites with respect to the subject property. The Rossoe Energy Systems and ASAP Auto Repair sites are less than 1000 feet from the nearest subject property boundary and are both considered recognized environmental conditions. The shortest straight line distance was approximately 500 feet (the Rossoe Energy Systems site) to the nearest boundary of the subject property. This site is 500 feet due south from the subject property boundary. Considering the topography of the immediate area, surface flows are unlikely to move north toward the subject property. The ASAP Auto Repair site is approximately 700 feet southeast of the subject property boundary. Surface flows are unlikely to move northwest toward the subject property. Contamination from these sites is probably unlikely to reach the subject property.

One regulated underground storage tank (UST) was found on the subject property:

- WTD Henderson Pump Station, 5327 S Henderson St., Seattle, WA 98118
    - Lat: 47.52314 / Long: -122.26795

When plotting the location of this UST, I found out that the longitude/latitude coordinates do not pinpoint the same location as the address. Figure 6-3 shows both locations with respect to the subject property. If the UST is actually located at 47.52314, -122.26795, then it is not on the subject property; it is on an adjoining property. The Regulated Underground Storage Tank list displays three USTs at this location. One is listed as *removed*, one is listed as *closure in progress* and one is listed as *operational.* All three were/are used for diesel fuel storage. The operational tank has a capacity of 1,101 to 2,000 gallons. This UST is not a recognized environmental condition, but if it is located at the address above, then it appears to be directly in the path of the proposed diversion pipe.

The 12 facilities that are regulated by the EPA are:

- Duwamish RIV Abandone, Director St Foot of Seattle, WA 98118
- Rainier Beach Cleaners, 9432 Rainier Ave, Seattle, WA 98118

- Rite Aid 5217, 9000 Rainier Ave, Seattle, WA 98118
- Rossoe Energy Systems Inc, 9367 Rainier Ave S, Seattle, WA 98118
- Seattle City Parks Aqua Marina, 9520 Rainier Ave, Seattle, WA 98118
- Seattle City Rainier Beach Play, 8802 Rainier Ave S, Seattle, WA 98118
- Seattle City Used Oil Collect Rainier Av, 9416 Rainier Ave S, Seattle, WA 98118
- Seattle School District 1 Rainier Beach HS, 8815 Seward Park Ave S, Seattle, WA 98118
- Seattle School District 1 S Shore Middle, 8825 Rainier Ave S, Seattle, WA 98118
- Southland Store 17381, 9436 Rainier Ave, Seattle, WA 98118
- Vinson Brothers Corp, 9245 Rainier Ave S, Seattle, WA 98118
- Washington 1 Hour Cleaners, 9180 Rainier Ave S, Seattle, WA 98118

According to the available compliance report, all are compliant. It is concluded that none of these sites are considered recognized environmental conditions.

The historical documents search revealed no evidence of the presence of hazardous substances on this property.

6.2 Findings Based on Site Reconnaissance

The site reconnaissance revealed no visual evidence of hazardous substances on this property. The site reconnaissance did reinforce the concern for the location of the regulated underground storage tank with respect to the location of the proposed path of the diversion pipe.

6.3 Determination of the Environmental Condition of the Property

The subject property is considered a *Type 1* area; as described by the American Society for Testing and Materials (ASTM) Practice D 5746-98 (2002) *Standard Classification of Environmental Condition of Property Area Types for Defense Base Closure and Realignment Facilities*, this is a property where no release or disposal of hazardous substances or petroleum products or their derivatives has occurred, including no migration of these substances from adjacent properties.

6.4 Conclusions

The Phase I ESA has revealed evidence of recognized environmental conditions in connection with the subject property as follows:

- Two sites listed on the Confirmed and Suspected Contaminated Sites List are considered recognized environmental conditions
    - Fisher Property, 9420 Rainier Ave S, Seattle, WA 98118
      Lat: 47.52014 / Long: -122.26441
    - Vinson Brothers Corp, 9245 Rainier Ave S, Seattle, WA 98118
      Lat: 47.51991 / Long: -122.26941
- Two sites listed on the Leaking Underground Storage Tanks List are considered recognized environmental conditions
    - Rossoe Energy Systems, Inc., 9367 Rainier Ave S, Seattle, WA 98118-5567
      Lat: 47.51967 / Long: -122.26728

- ASAP Auto Repair, 9480 Rainier Ave S, Seattle, WA 98118
  Lat: 47.52003 / Long: -122.2655

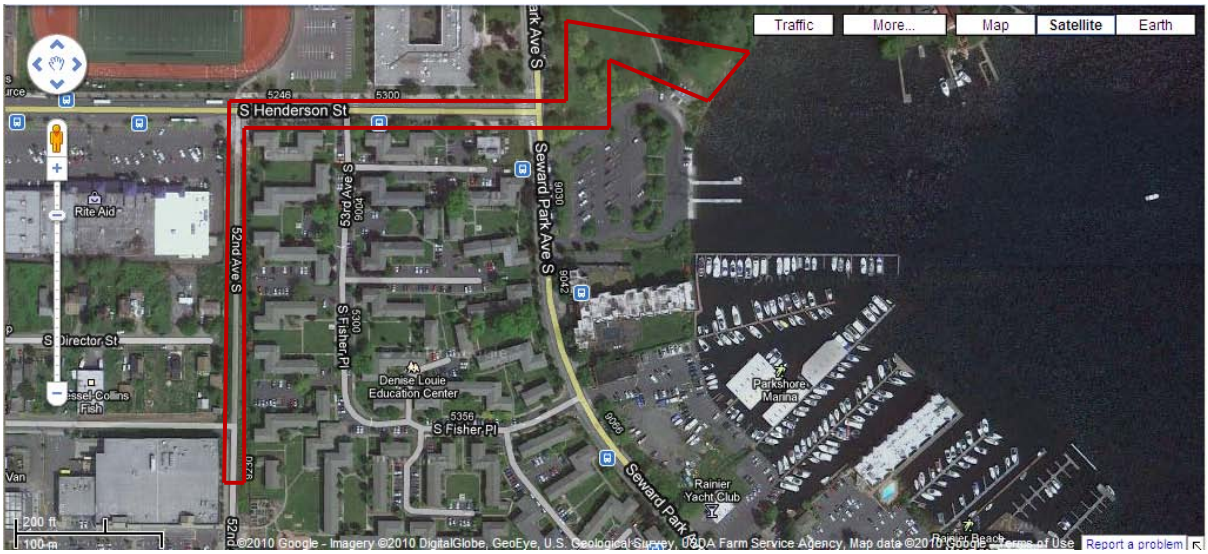
With these exceptions, the subject property appears relatively fit and contains no conditions that would present a significant adverse impact on the use of this property as indicated by the Mapes Creek Restoration Project.

APPENDIX I: References

- American Society for Testing and Materials (ASTM) Practice E 1527-00 *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process*
- American Society for Testing and Materials (ASTM) Practice D 5746-98 (2002) *Standard Classification of Environmental Condition of Property Area Types for Defense Base Closure and Realignment Facilities*
- State of Washington Department of Ecology
    - http://www.ecy.wa.gov/
        - Well Logs: http://apps.ecy.wa.gov/welllog/
        - Regulated and Leaking Underground Storage Tanks and Confirmed and Suspected Contaminated Sites lists: https://fortress.wa.gov/ecy/tcpwebreporting/reports.aspx
- USEPA Envirofacts Multisystem Search
    - http://www.epa.gov/enviro/facts/multisystem.html
- Historical Documents
    - Park history: http://www.seattle.gov/parks/park_detail.asp?ID=440
    - Engineer's sketch and historical overview: http://www.seattle.gov/parks/history/AtlanticCity.pdf
    - Rainier Valley Historical Society: http://rainiervalleyhistory.org/
    - Photographs: http://content.lib.washington.edu/imls/kcsnapshots/rainier-valley.html
- Maps
    - Google Maps: http://maps.google.com/
    - Google Earth Pro 2010
    - Topographic-bathymetric 7.5x15 minute series map of Seattle South, Washington: http://topomaps.usgs.gov
- Property Identification
    - Seattle Parks and Recreation web site, *Mapes Creek 52nd Avenue Walkway Pro Parks Project Information:* http://www.seattle.gov/parks/proparks/projects/mapesCreek.htm#overview

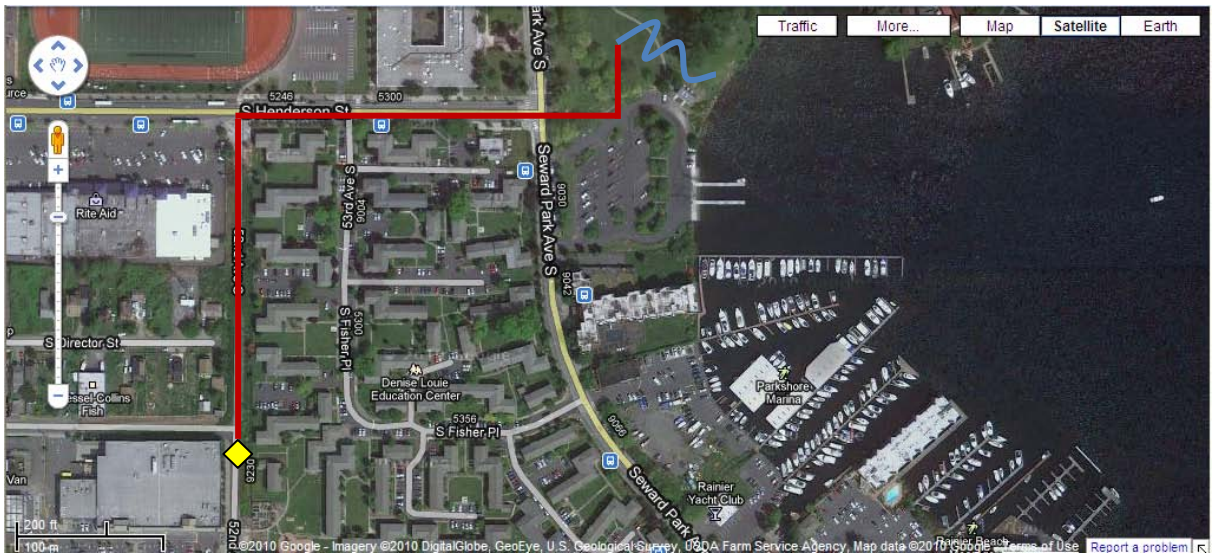
APPENDIX 2: Figures

Figure 2-1: Visual Description of the Subject Property



KEY: Subject Property Boundary

Figure 2-2: Map of Mapes Creek Diversion Pipe and Delta Restoration Area



LEGEND:

Path of Proposed Diversion Pipe

Path of Proposed Delta Restoration

Location Where Mapes Creek Underground Flow Currently Combines with Storm Sewer Flow

Figure 2-3: Reference Map of Photographs of the Subject Property

LEGEND:
⇨ Points Toward the Direction the Camera Was Facing While The Photograph Was
References the Photo Number; See Appendix 1

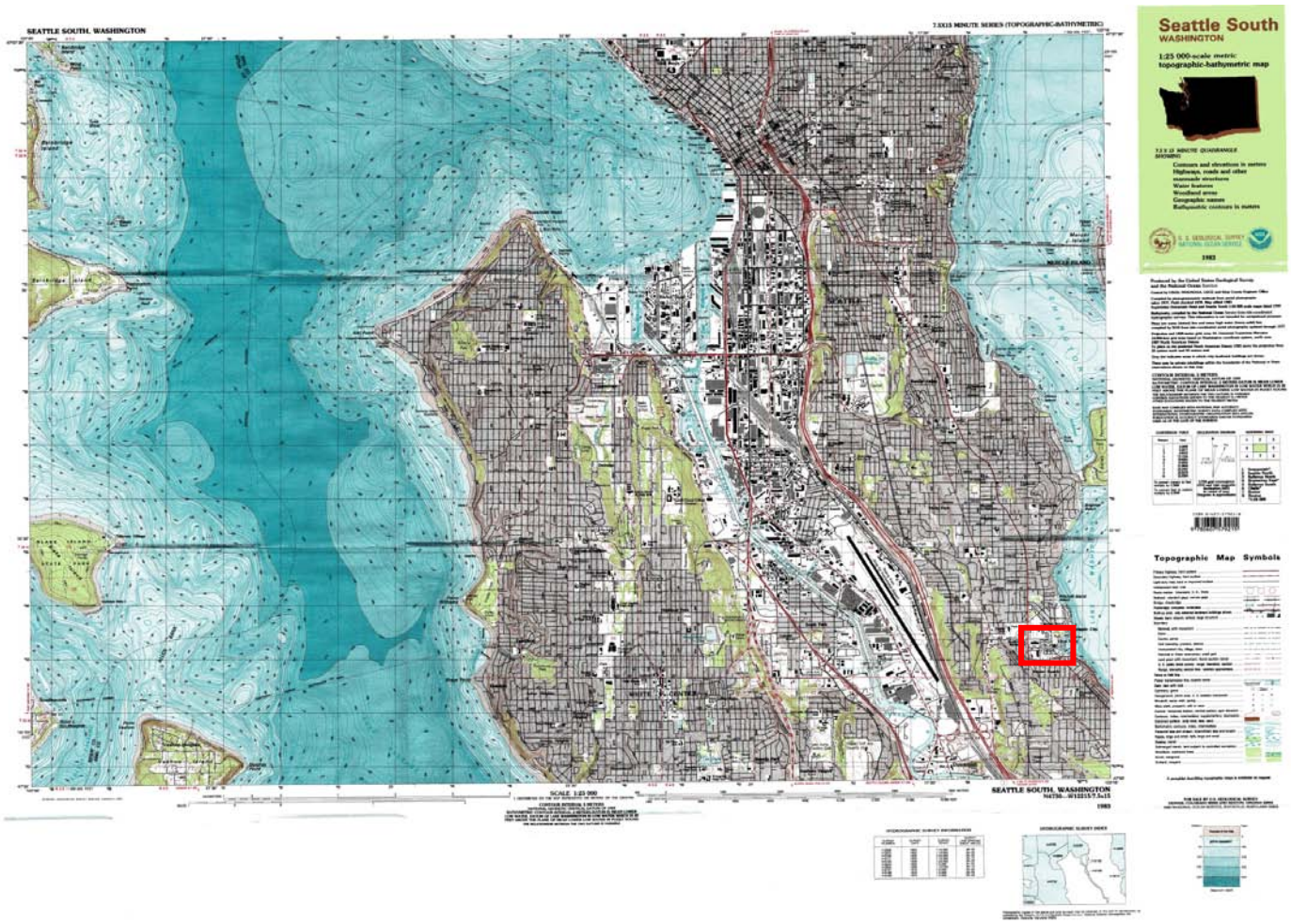


Figure 2-4: Topographic Map of the Subject Property and the Surrounding Area (Topographic-bathymetric 7.5x15 minute series map of Seattle South, Washington)

The subject property lies within the red box.

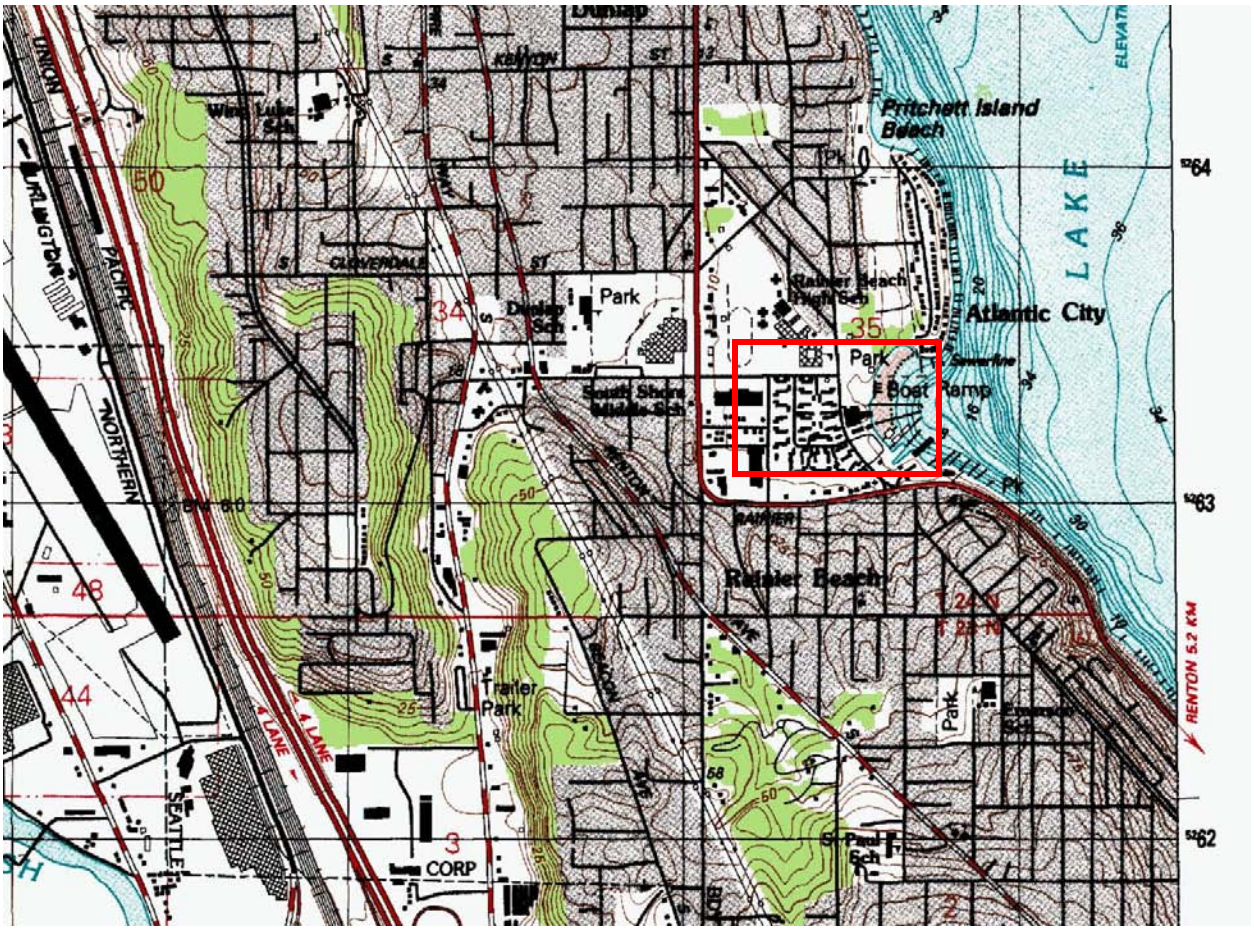


Figure 2-5: Topographic Map of the Subject Property and the Surrounding Area
(Zoomed in topographic-bathymetric 7.5x15 minute series map of Seattle South, Washington)

The subject property lies within the red box.

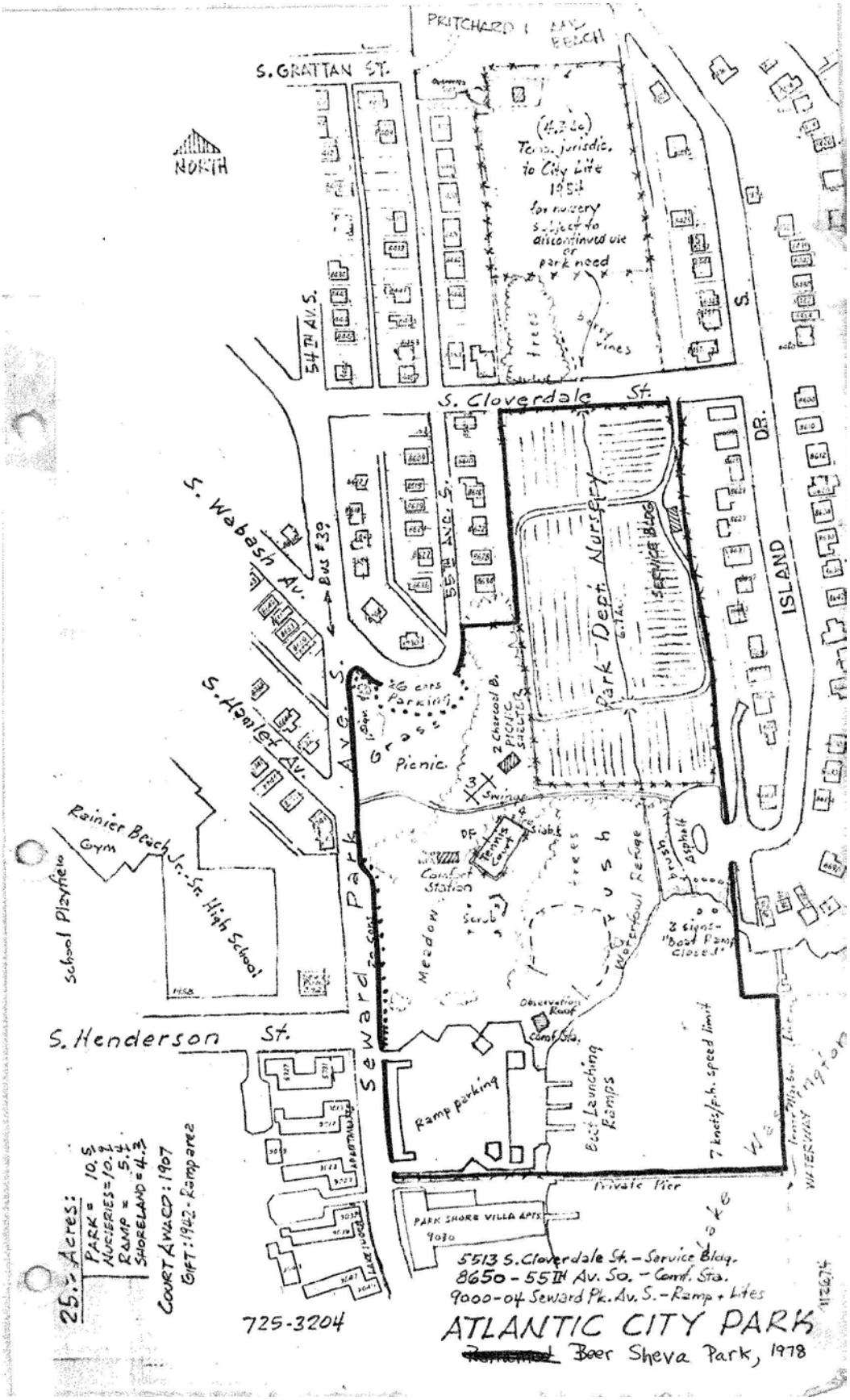


Figure 3-1: An Engineer's Sketch of Be'er Sheva Park, formerly known as Atlantic City Park

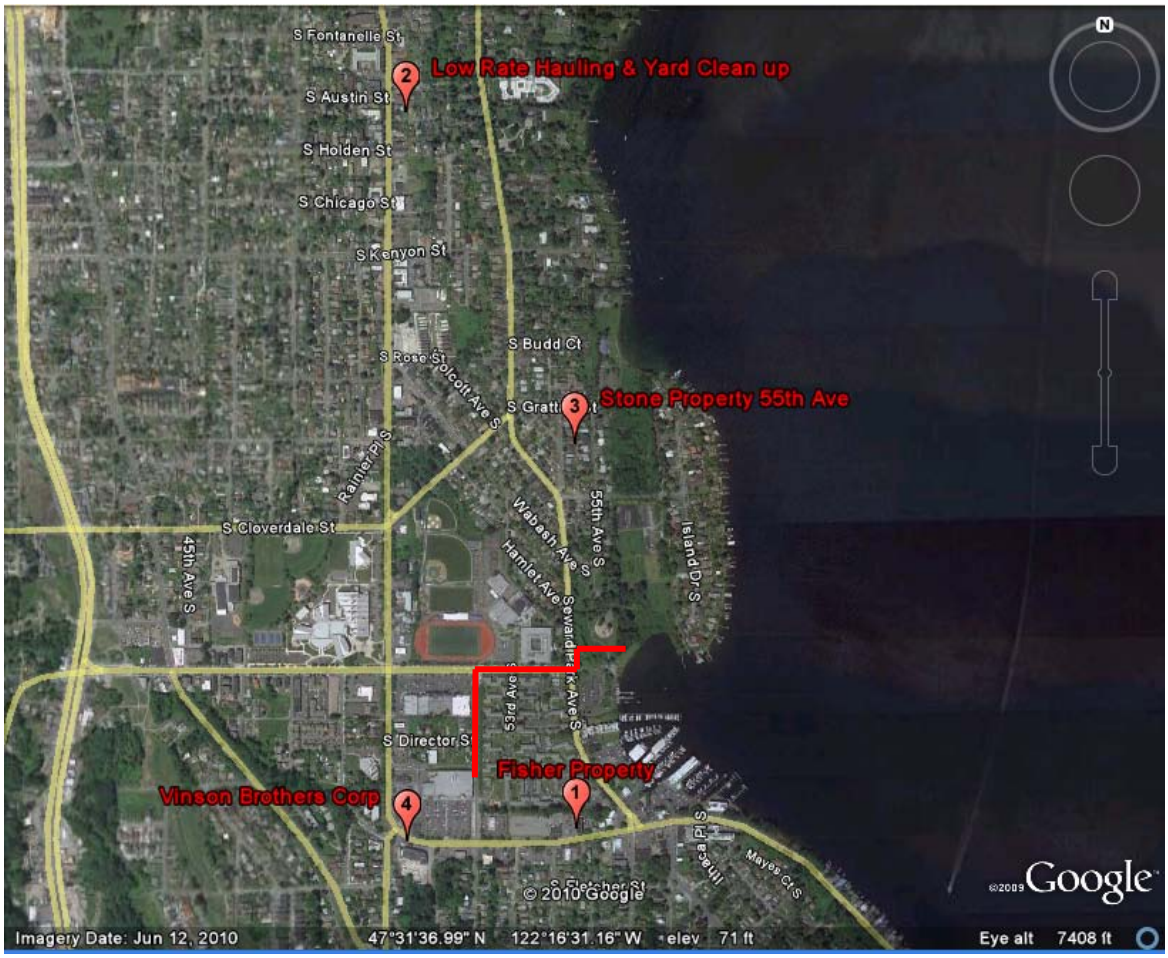


Figure 6-1: Location of the four sites on the Confirmed and Suspected Contamination List within one mile of the subject property.

The red line represents the subject property.

Google Earth Pro was used to generate this image.

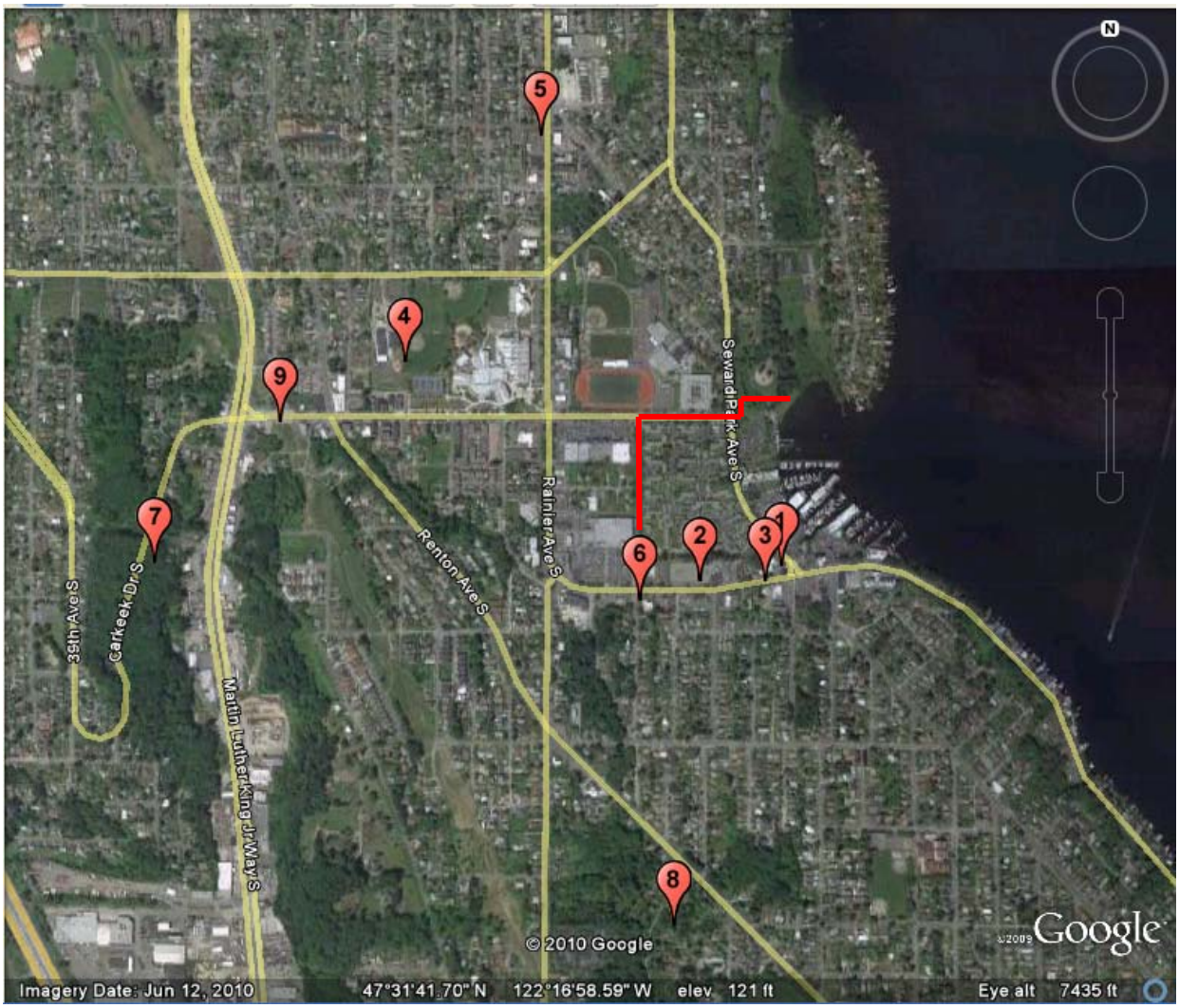


Figure 6-2: Location of the nine sites on the Leaking Underground Storage Tanks List within one mile of the subject property.

The red line represents the subject property.

Google Earth Pro was used to generate this image.

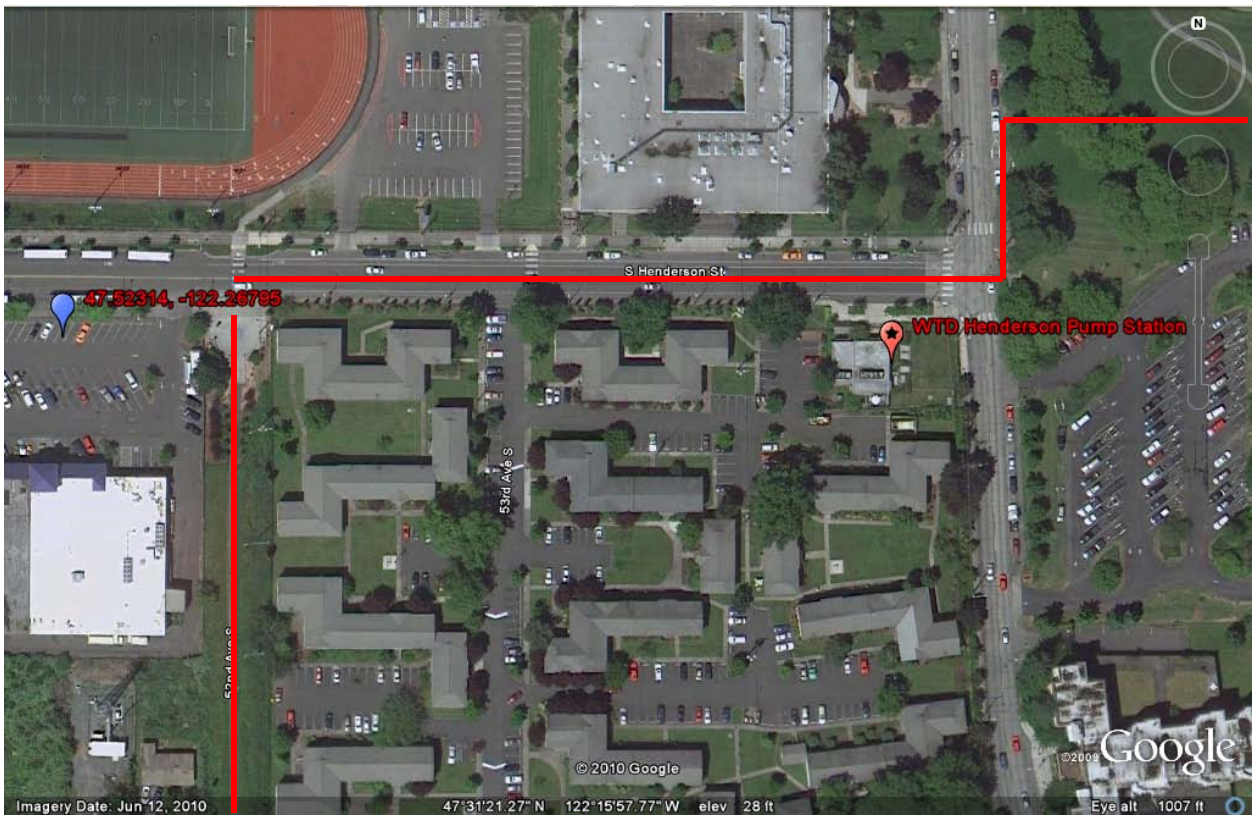


Figure 6-3: Two Possible Locations of the Underground Storage Tank

WTD Henderson Pump Station (right hand side of image) is located at the address 5327 S Henderson St.

The coordinates 47.52314, -122.26795 (left hand side of image) pinpoint a location that is not directly in the construction footprint.

The subject property is represented by the red line.

APPENDIX 3: Photographs #1-9 of the Subject Property (Referenced in Figure 2-3)

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

These photographs were taken during a site reconnaissance on Friday 23 July 2010.

APPENDIX 4: Well Log

1. **ENECO TECH** - { view PDF | view TIFF }
   Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
   County: KING, Well Address: 8824 RAINIER AVE S, SEATTLE
   Well Log ID: 318857, Well Tag ID: (blank) , Notice of Intent Number: R058650
   Well Diameter: (blank) , Well Depth: 8 (feet)
   Well Type: Resource Protection, Well Completion Date: 9/11/2001, Well Log Received Date: 10/1

2. **ENECO TECH** - { view PDF | view TIFF }
   Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
   County: KING, Well Address: 8824 RAINIER AVE S, SEATTLE
   Well Log ID: 318858, Well Tag ID: (blank) , Notice of Intent Number: S014526
   Well Diameter: (blank) , Well Depth: 12 (feet)
   Well Type: Resource Protection, Well Completion Date: 9/11/2001, Well Log Received Date: 10/1

3. **ENECO TECH** - { view PDF | view TIFF }
   Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
   County: KING, Well Address: 8824 RAINIER AVE S, SEATTLE
   Well Log ID: 318859, Well Tag ID: (blank) , Notice of Intent Number: S014526
   Well Diameter: (blank) , Well Depth: 12 (feet)
   Well Type: Resource Protection, Well Completion Date: 9/11/2001, Well Log Received Date: 10/1

4. **ENECO TECH** - { view PDF | view TIFF }
   Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
   County: KING, Well Address: 8824 RAINIER AVE S, SEATTLE
   Well Log ID: 318860, Well Tag ID: (blank) , Notice of Intent Number: S014526
   Well Diameter: (blank) , Well Depth: 11 (feet)
   Well Type: Resource Protection, Well Completion Date: 9/11/2001, Well Log Received Date: 10/1

5. **ENECO TECH** - { view PDF | view TIFF }
   Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
   County: KING, Well Address: 8824 RAINIER AVE S, SEATTLE
   Well Log ID: 318861, Well Tag ID: (blank) , Notice of Intent Number: S014526
   Well Diameter: (blank) , Well Depth: 11 (feet)
   Well Type: Resource Protection, Well Completion Date: 9/11/2001, Well Log Received Date: 10/1

6. **ENECO TECH** - { view PDF | view TIFF }
   Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
   County: KING, Well Address: 8824 RAINIER AVE S, SEATTLE
   Well Log ID: 318862, Well Tag ID: (blank) , Notice of Intent Number: S014526
   Well Diameter: (blank) , Well Depth: 11 (feet)
   Well Type: Resource Protection, Well Completion Date: 9/11/2001, Well Log Received Date: 10/1

7. **ENECO TECH** - { view PDF | view TIFF }

Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
County: KING, Well Address: 8824 RAINIER AVE S, SEATTLE
Well Log ID: 318863, Well Tag ID: (blank) , Notice of Intent Number: S014526
Well Diameter: (blank) , Well Depth: 11 (feet)
Well Type: Resource Protection, Well Completion Date: 9/11/2001, Well Log Received Date: 10/1

8. **ENECO TECH** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
County: KING, Well Address: 8824 RAINIER AVE S, SEATTLE
Well Log ID: 322481, Well Tag ID: (blank) , Notice of Intent Number: S014526
Well Diameter: (blank) , Well Depth: 12 (feet)
Well Type: Resource Protection, Well Completion Date: 9/11/2001, Well Log Received Date: 10/1

9. **HENDERSON C S O** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
County: KING, Well Address: SEWARD PARK AVE S AND HENDERSON
Well Log ID: 110692, Well Tag ID: ACJ181, Notice of Intent Number: R039285
Well Diameter: 9 (inches), Well Depth: (blank)
Well Type: Resource Protection, Well Completion Date: 9/21/1998, Well Log Received Date: 10/2

10. **HENDERSON C S O** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
County: KING, Well Address: SEWARD PARK AVE S AND HENDERSON
Well Log ID: 110693, Well Tag ID: ACJ182, Notice of Intent Number: R039285
Well Diameter: 9 (inches), Well Depth: (blank)
Well Type: Resource Protection, Well Completion Date: 9/21/1998, Well Log Received Date: 10/2

11. **HENDERSON CSO** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
County: KING, Well Address: (blank)
Well Log ID: 300696, Well Tag ID: ACJ183, Notice of Intent Number: (blank)
Well Diameter: 9 (inches), Well Depth: (blank)
Well Type: Resource Protection, Well Completion Date: (blank) , Well Log Received Date: (blank)

12. **LIVING COLOR BEAUTY SUPPLY | KANE ENVIRONMENTAL** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: 7129304820
County: KING, Well Address: 9416 RAINIER AVE S, SEATTLE 98118
Well Log ID: 545784, Well Tag ID: APJ104, Notice of Intent Number: R073661
Well Diameter: 2.5 (inches), Well Depth: 24 (feet)
Well Type: Resource Protection, Well Completion Date: 6/9/2008, Well Log Received Date: 6/23/

13. **LIVING COLOR BEAUTY SUPPLY | KANE ENVIRONMENTAL** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: 7129304820
County: KING, Well Address: 9416 RAINIER AVE S, SEATTLE 98118
Well Log ID: 545785, Well Tag ID: APJ105, Notice of Intent Number: R073661
Well Diameter: 2.5 (inches), Well Depth: 24 (feet)

Well Type: Resource Protection, Well Completion Date: 6/9/2008, Well Log Received Date: 6/23/

14. **LIVING COLOR BEAUTY SUPPLY | KANE ENVIRONMENTAL** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: 7129304820
County: KING, Well Address: 9416 RAINIER AVE S, SEATTLE 98118
Well Log ID: 545786, Well Tag ID: APJ106, Notice of Intent Number: R073661
Well Diameter: 2.5 (inches), Well Depth: 24 (feet)
Well Type: Resource Protection, Well Completion Date: 6/9/2008, Well Log Received Date: 6/23/

15. **LIVING COLOR BEAUTY SUPPLY | KANE ENVIRONMENTAL** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: 7129304820
County: KING, Well Address: 9416 RAINIER AVE S, SEATTLE
Well Log ID: 546500, Well Tag ID: (blank) , Notice of Intent Number: S026920
Well Diameter: 1 (inches), Well Depth: 5 (feet)
Well Type: Resource Protection, Well Completion Date: 6/9/2008, Well Log Received Date: 6/23/

16. **LIVING COLOR BEAUTY SUPPLY | KANE ENVIRONMENTAL** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: 7129304820
County: KING, Well Address: 9416 RAINIER AVE S, SEATTLE
Well Log ID: 546501, Well Tag ID: (blank) , Notice of Intent Number: A134954
Well Diameter: 1 (inches), Well Depth: 5 (feet)
Well Type: Decommissioned, Well Completion Date: 6/9/2008, Well Log Received Date: 6/23/200

17. **Living Color Beauty Supply | Kane Environmental** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: 7129304820
County: KING, Well Address: 9416 Rainier Avenue, Seattle 98118
Well Log ID: 616376, Well Tag ID: APJ074, Notice of Intent Number: RE03908
Well Diameter: 2.5 (inches), Well Depth: 16 (feet)
Well Type: Resource Protection, Well Completion Date: 10/21/2009, Well Log Received Date: 11/

18. **Living Color Beauty Supply | Kane Environmental** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: 7129304820
County: KING, Well Address: 9416 Rainier Avenue, Seattle 98118
Well Log ID: 616378, Well Tag ID: APJ075, Notice of Intent Number: RE03908
Well Diameter: 2.5 (inches), Well Depth: 16 (feet)
Well Type: Resource Protection, Well Completion Date: 10/21/2009, Well Log Received Date: 11/

19. **Living Color Beauty Supply | Kane Environmental** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: 7129304820
County: KING, Well Address: 9416 Rainier Avenue, Seattle 98118
Well Log ID: 616380, Well Tag ID: APJ076, Notice of Intent Number: RE03908
Well Diameter: 2.5 (inches), Well Depth: 16 (feet)
Well Type: Resource Protection, Well Completion Date: 10/21/2009, Well Log Received Date: 11/

20. **Living Color Beauty Supply | Kane Environmental** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: 7129304820
County: KING, Well Address: 9416 Rainier Avenue, Seattle 98118

Well Log ID: 616382, Well Tag ID: BBK376, Notice of Intent Number: RE03908
Well Diameter: 2.5 (inches), Well Depth: 16 (feet)
Well Type: Resource Protection, Well Completion Date: 10/21/2009, Well Log Received Date: 11/

---

21. **Living Color Beauty Supply | Kane Environmental** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: 7129304820
County: KING, Well Address: 9416 Rainier Avenue, Seattle 98118
Well Log ID: 616384, Well Tag ID: (blank) , Notice of Intent Number: AE07418
Well Diameter: (blank) , Well Depth: (blank)
Well Type: Decommissioned, Well Completion Date: 10/21/2009, Well Log Received Date: 11/2/

22. **STOCKMARKET FOODS** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
County: KING, Well Address: 9000 RAINIER AVE S SEATTLE
Well Log ID: 327381, Well Tag ID: (blank) , Notice of Intent Number: R005707
Well Diameter: (blank) , Well Depth: 28 (feet)
Well Type: Resource Protection, Well Completion Date: 2/5/1997, Well Log Received Date: 2/23/

23. **STOCKMARKET FOODS** - { view PDF | view TIFF }
Public Land Survey: NW, SW, S-35, T-24-N, R-04-E, Tax Parcel Number: (blank)
County: KING, Well Address: 9000 RAINIER AVE S SEATTLE
Well Log ID: 327382, Well Tag ID: (blank) , Notice of Intent Number: R005707
Well Diameter: (blank) , Well Depth: 28 (feet)
Well Type: Resource Protection, Well Completion Date: 2/5/1997, Well Log Received Date: 2/23/

Well Log Data Export

Data Dictionary

The table below lists the data field names, descriptions, and examples of each data item that makes up the well log data extract file.

Column Name	Description	Example
well_log_id	WELL LOG ID. A sequential number generated by the system to track a well log record.	100564
well_tag_nr	WELL TAG NUMBER. The number issued by the Department of Ecology that is stamped on a metal tag that is attached to the actual well.	AAA-000
project_tag_nr	PROJECT TAG NUMBER – The number issued by the property owner or consulting firm to track the well. This number is NOT affiliated with Ecology's tag number in any way.	MW-001
nit_id_nr	NOTICE OF INTENT ID NUMBER. A sequential number issued by the Department of Ecology to track the Notice of Intent to Construct or Decommission a Well.	W072515
well_depth_qt	WELL DEPTH. Depth of the well in feet.	55
well_diameter_qt	WELL DIAMETER. Diameter of the casing of the well in inches.	6
well_owner_nm	WELL OWNER NAME. The name of the original property owner who had the well drilled.	John Smith
township_nr	TOWNSHIP. The identifier describing which Township the well falls within. Based on the Washington State Public Land Survey (PLS).	05

range_nr	RANGE. The identifier describing the Range location of the well. (PLS)	15
range_dir_cd	RANGE DIRECTION. The direction code describing further which range the well falls within. Washington State is divided into two halves – 'West' and 'East'. (PLS)	E
section_nr	SECTION. The identifier describing which Section the well falls within. (PLS)	06
qtr_section_cd	QUARTER SECTION (1/4). The identifier describing which Quarter section the well falls within. (PLS)	NW
qtr_qtr_section_cd	QUARTER-QUARTER SECTION (1/4-1/4). The identifier describing which Quarter-Quarter section the well falls within. (PLS)	SW
well_comp_dt	WELL COMPLETION DATE. Date the well was drilled.	1/1/1997
county_nm	COUNTY NAME. County name where the well is located.	King
well_type_cd	WELL TYPE. Code which indicates the well type. See appendix for code descriptions.	W
driller_nr	DRILLER LICENSE NUMBER. License number of the well driller.	2327
well_log_recv_dt	WELL LOG RECEIVAL DATE. Date the Department of Ecology received the well log form.	1/6/1997
tax_parcel_nr	TAX PERCEL IDENTIFIER. County Assessor code of the parcel where the well was drilled.	232019130050

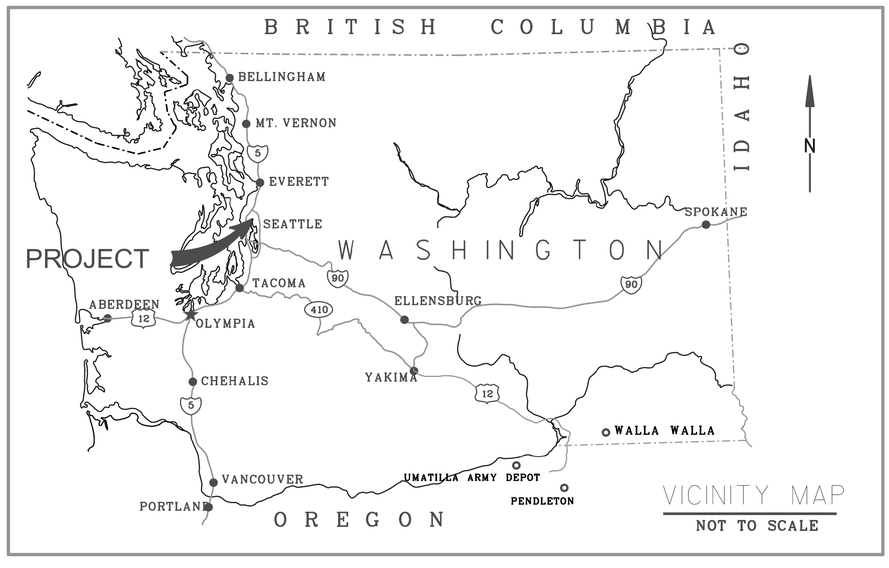
Appendix B Design Drawings

PRELIMINARY - NOT FOR CONSTRUCTION

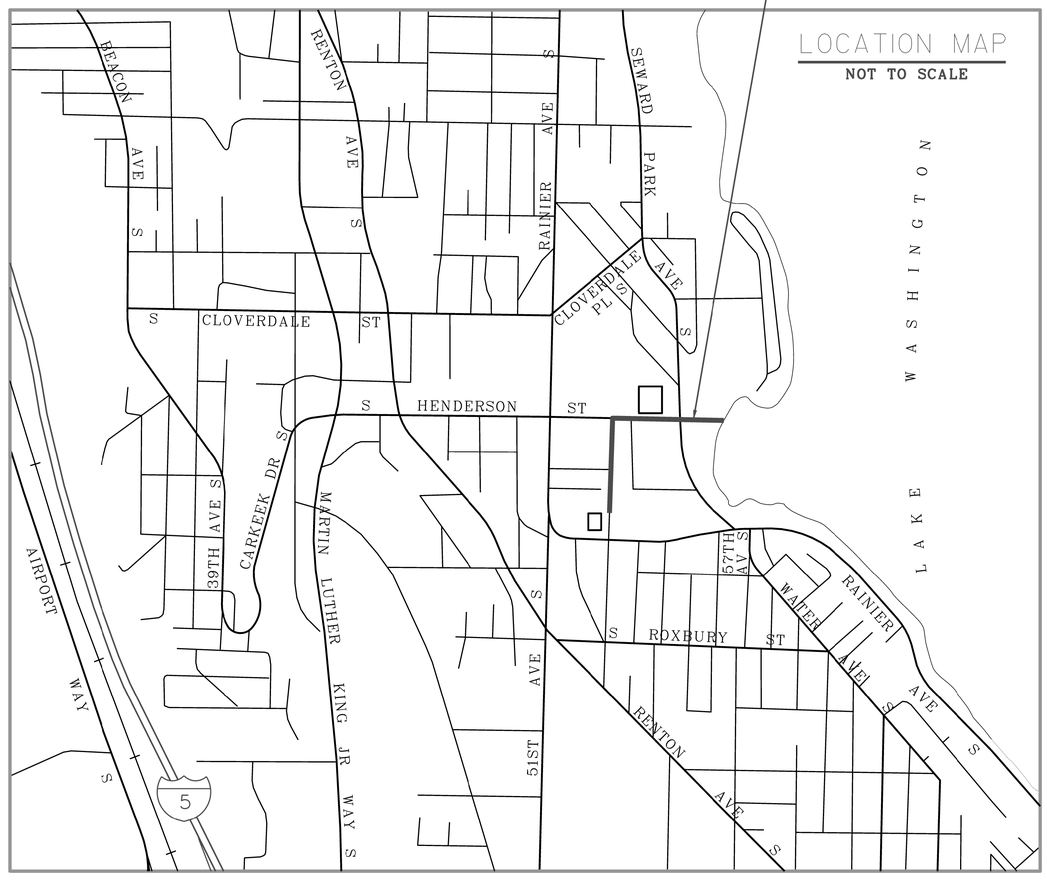
US Army Corps
of Engineers
Seattle District

MAPES CREEK RESTORATION PROJECT

SEATTLE, WA



35% DESIGN SUBMITTAL
FY 2009



SAFETY PAYS

PLAN NORTH

US Army Corps
of Engineers
Seattle District

File •
Invitation •
Date

Recommended by
DATE:
CHIEF, DESIGN BRANCH
Approved by
DATE:
ACTG CH, ENG AND CONST DIV
DATE:

Submitted by
DESIGN MANAGER
Reviewed by
CH, TECH ENG AND REVIEW SEC
DATE:

U.S.ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON
Prepared by
TETRA TECH
SEATTLE, WASHINGTON
A/E FIRM NAME
DATE:

MAPES CREEK
RESTORATION PROJECT
TITLE SHEET AND
VICINITY MAP
SEATTLE
WA

Plate
number:
G-001
Sheet 1 of 14

PRELIMINARY - NOT FOR CONSTRUCTION

SURVEY

THEOR./ EXIST.	FOUND/ PROP.	DESCRIPTION (ABBR)
△	△	ANGLE POINT
⊕	⊕	BENCH MARK
◉	◉	REBAR/IRON PIPE
⊗	⊗	MONUMENT (IN CASE)
⊙	⊙	MONUMENT (SURFACE)
× ELEV	× ELEV	SPOT ELEVATION

N

TRUE NORTH

SCALE

200' 100' 0 200' 400'

FEET

SH-DATUM

USGS 1982

LINETYPES

- EXISTING CONTOUR (PRIMARY)
- EXISTING CONTOUR (SECONDARY)
- PROPOSED CONTOUR (PRIMARY)
- PROPOSED CONTOUR (SECONDARY)
- EXISTING GROUND
- PROPOSED GROUND
- GRADING LIMITS

CONCRETE SIDEWALK

DRAFTING

SYMBOL	DESCRIPTION (ABBR)
1 T2 CT	DETAIL CALLOUT ON PLAN SHEET
	SECTION CALLOUT ON PLAN SHEET

DETAIL CALLOUT

DESCRIPTION

DETAIL NUMBER

DETAIL

SCALE:

XX

SHEET WHERE DETAIL IS REFERENCED

SECTION/ELEVATION CALLOUT

DESCRIPTION

SECTION DESIGNATION (ALPHABETIC)

SECTION

SCALE:

XX

SHEET WHERE SECTION IS CUT

90 DEGREE ANGLE

ABBREVIATIONS

CU. FT	CUBIC FEET/FOOT
E	EAST
ELEV	ELEVATION
EXIST	EXISTING
FIG	FIGURE
FT	FEET/FOOT
IN	INCH/INCHES
LF	LINEAL FEET/FOOT
M1	
MIN	MINIMUM
MISC	MISCELLANEOUS
N	NORTH
NTS	NOT TO SCALE
R	RADIUS OF CURVE
REQD	REQUIRED
SE	SPOT EL
SECT	SECTION
SF	SQUARE FEET/FOOT
SPEC.	SPECIFICATION
STA	STATION
STD	STANDARD
TEMP	TEMPORARY
TYP	TYPICAL
VAR	VARIES

GENERAL NOTES:

1. VERTICAL CONTROL BASED ON NAVD88.

2. HORIZONTAL CONTROL BASED ON THE WASHINGTON STATE PLANE COORDINATE SYSTEM, NAD83.

3. THE HORIZONTAL AND VERTICAL LOCATIONS OF EXISTING UTILITIES ARE APPROXIMATE. THE CONTRACTOR SHALL VERIFY THE EXACT LOCATION OF ALL UTILITIES PRIOR TO EXCAVATION TO AVOID DAMAGE AND DISTURBANCE. THE CONTRACTOR IS RESPONSIBLE FOR PROTECTING AND PRESERVING THE INTEGRITY OF ALL EXISTING UTILITIES DURING CONSTRUCTION.

DRAWING INDEX

SHEET NO.	PLATE NO.	TITLE
		GENERAL
1	G-001	TITLE SHEET AND VICINITY MAP
2	G-002	SYMBOLS, ABBREVIATIONS & GENERAL NOTES
3	G-003	SITE LAYOUT
		CIVIL
4	C-101	SITE PLAN
5	C-102	SITE PLAN
6	C-103	SITE PLAN
7	C-104	SITE PLAN
8	C-105	SITE PLAN
9	C-106	SITE PLAN
10	C-107	LOG DETAILS
11	C-108	TYPICAL CHANNEL DETAIL
12	C-109	BRIDGE DETAILS
12	C-110	UNDER SIDEWALK "FLUME" DETAILS
12	C-111	DIVERSION STRUCTURE DETAILS

US Army Corps of Engineers
Seattle District

Symbol	Description	Date	Appr.	Symbol	Description
		/ /			

Designed by: M. Schulte
Drawn by: Bolton/F. Pasha
Checked by: J. Lynch
Date: MAY 25 2009
File: SEE EC-TB-RI
Rev:

U.S.ARMY ENGINEER DISTRICT,SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

Prepared by: TETRA TECH SEATTLE, WASHINGTON

MAPES CREEK
RESTORATION PROJECT
SEATTLE

SYMBOLS, ABBREVIATIONS, AND GENERAL NOTES

WA

Plate number: G-002

Sheet 2 of 14

DESIGN FILE: MCRPG-002SYM.DGN

DATE AND TIME PLOTTED: 5/28/2009 4:53:56 PM

PRELIMINARY - NOT FOR CONSTRUCTION

SEWARD PARK AVENUE SO.

C-105, ATLANTIC CITY/
C-106 BE'ER SHEVA PARK

C-103

C-104

C-102

C-101

S. HENDERSON ST.

52ND AVENUNE WALKWAY

LAKE WASHINGTON

RAINIER BEACH HIGH SCHOOL

SEWARD PARK AVENUE S.

LAKE WASHINGTON SHORELANDS

PARK SHORE VILLA CONDO
(T-VILLA CONDO, VOL. 3/50-64)
AMENDED VOL. 17/55-69)

LENHART & LINDSAY'S
RAINIER BEACH TRACTS
(VOL. 13/71)

1" = 60' 60' 30' 0 60' 120'

N

PLAN NORTH

US Army Corps of Engineers
Seattle District

Symbol	Description	Date	Appr.	Symbol	Description
		/ /			

Designed by: M. Schulte
Drawn by: Bolton/F. Pasha
Checked by: J. Lynch
Date: MAY 25 2009
File: SEE EC-TB-RI
Rev:

U.S.ARMY ENGINEER DISTRICT,SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

Prepared by: TETRA TECH
SEATTLE, WASHINGTON

MAPES CREEK
RESTORATION PROJECT

SITE LAYOUT

SEATTLE WA

Plate number:
G-003
Sheet 3 of 14

DESIGN FILE: MCRPG-103001.DGN
DATE AND TIME PLOTTED: 5/28/2009 5:04:17 PM

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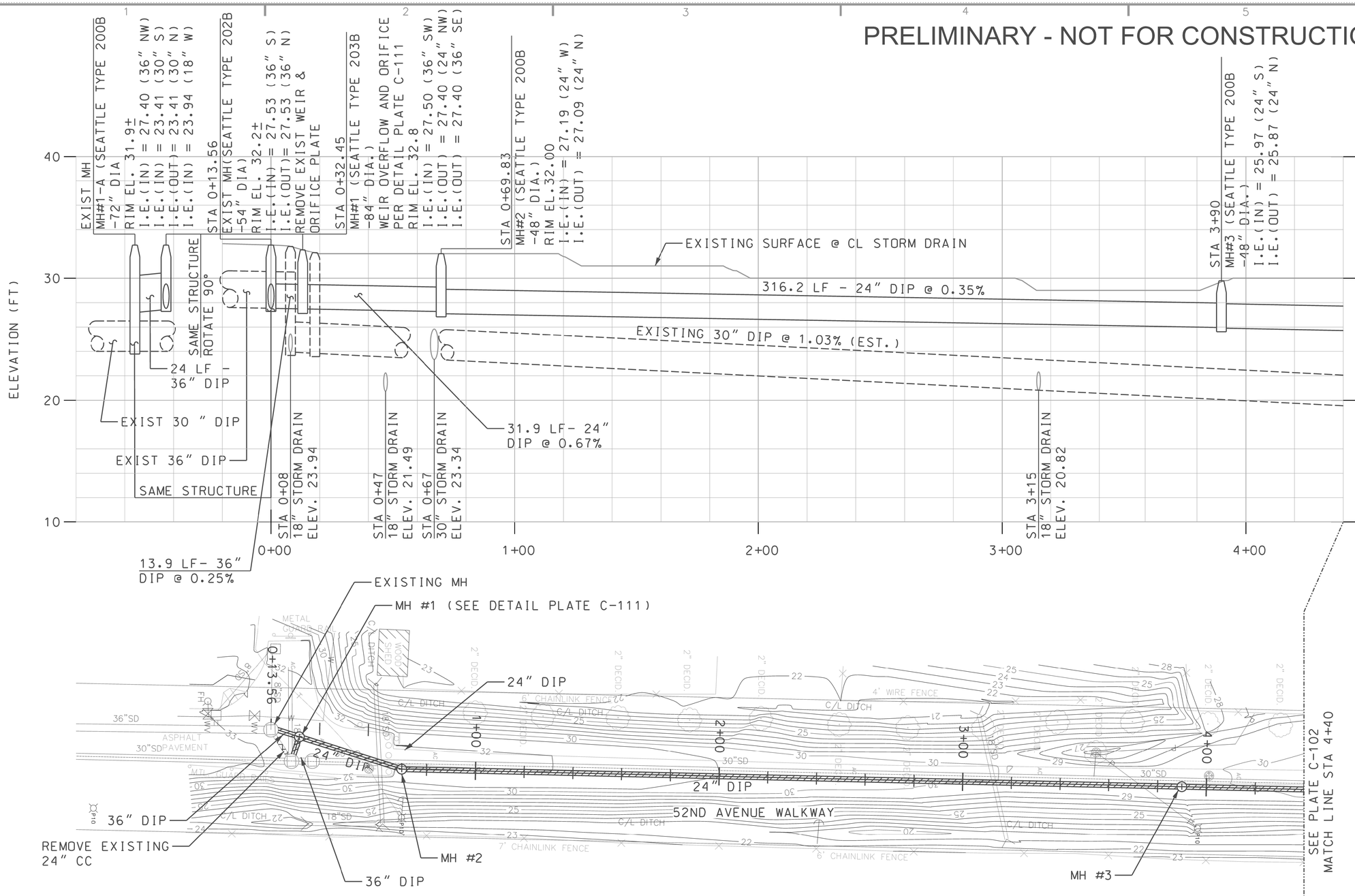


1" = 20' 20' 10' 0 20' 40'

N

PLAN NORTH

US Army Corps of Engineers
Seattle District

Symbol	Description	Date	Appr.	Symbol	Description
		/ /			

Designed by: M. Schulte
Drawn by: Bolton/F. Pasha
Checked by: J. Lynch
Date: MAY 25 2009
File*: SEE EC-TB-RI
Rev.

U.S.ARMY ENGINEER DISTRICT,SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON
Prepared by: TETRA TECH SEATTLE, WASHINGTON

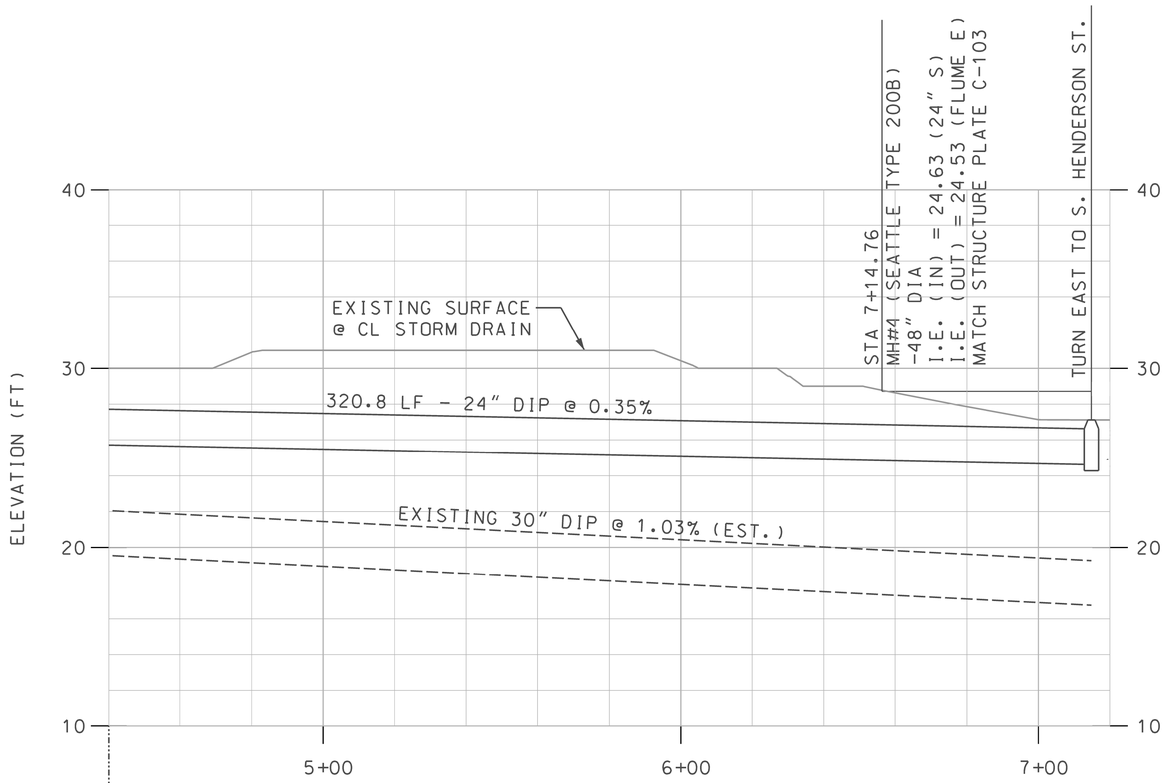
MAPES CREEK
RESTORATION PROJECT
SITE PLAN
SEATTLE WA

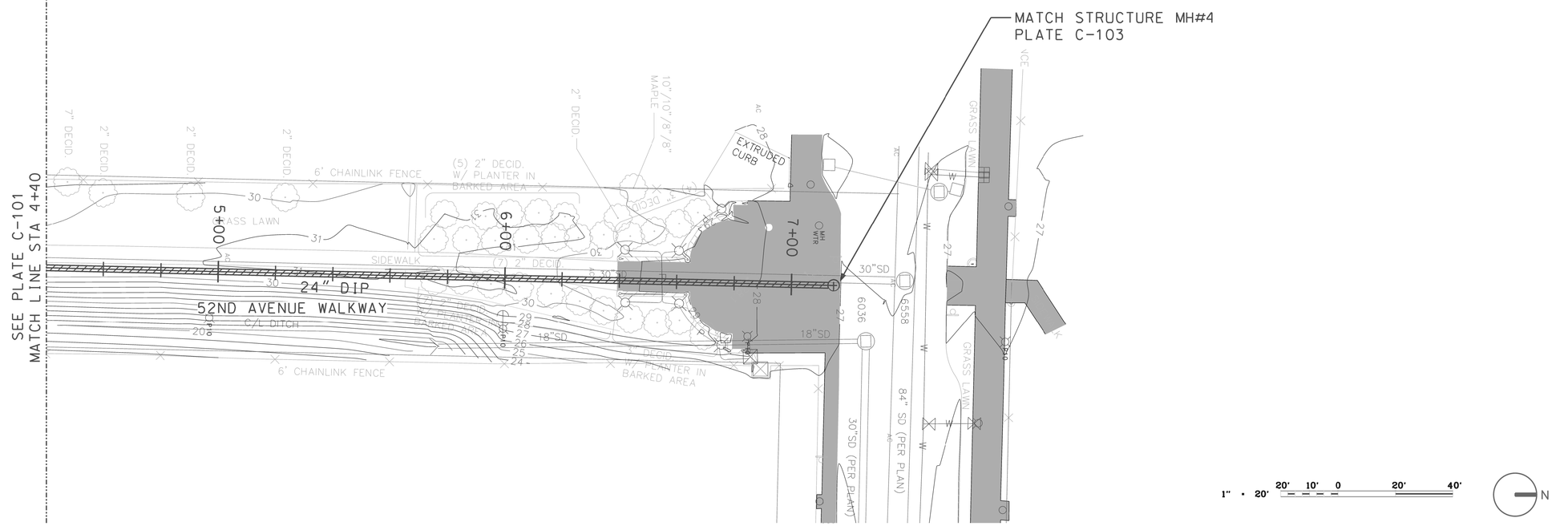
Plate number:
C-101
Sheet 4 of 14

DESIGN FILE*: MCRPC-101C01-052709.DGN

DATE AND TIME PLOTTED*: 6/1/2009 4:14:08 PM

PRELIMINARY - NOT FOR CONSTRUCTION





US Army Corps of Engineers
Seattle District

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U.S.ARMY ENGINEER DISTRICT,SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

Prepared by: TETRA TECH
SEATTLE, WASHINGTON

MAPES CREEK
RESTORATION PROJECT
SITE PLAN
SEATTLE WA

Plate number:
C-102
Sheet 5 of 14

DESIGN FILE: MCRPC-102C01.DGN
DATE AND TIME PLOTTED: 5/29/2009 9:24:56 AM

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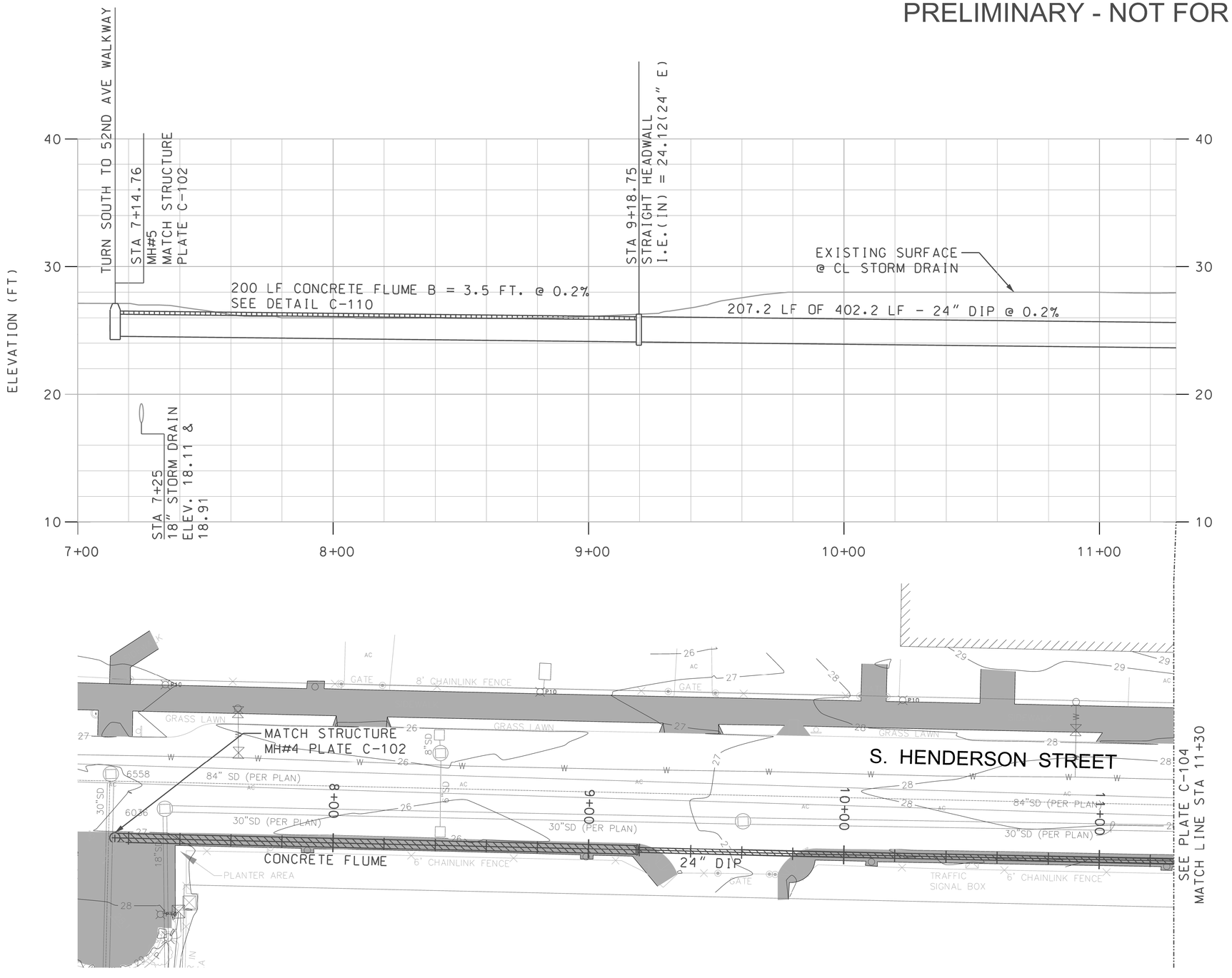

1" = 20' 20' 10' 0 20' 40'

N

PLAN NORTH

US Army Corps of Engineers
Seattle District

Symbol	Description	Date	Appr.	Symbol	Description
		/ /			

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SEATTLE, WASHINGTON

Prepared by: TETRA TECH
SEATTLE, WASHINGTON

MAPES CREEK
RESTORATION PROJECT

SITE PLAN

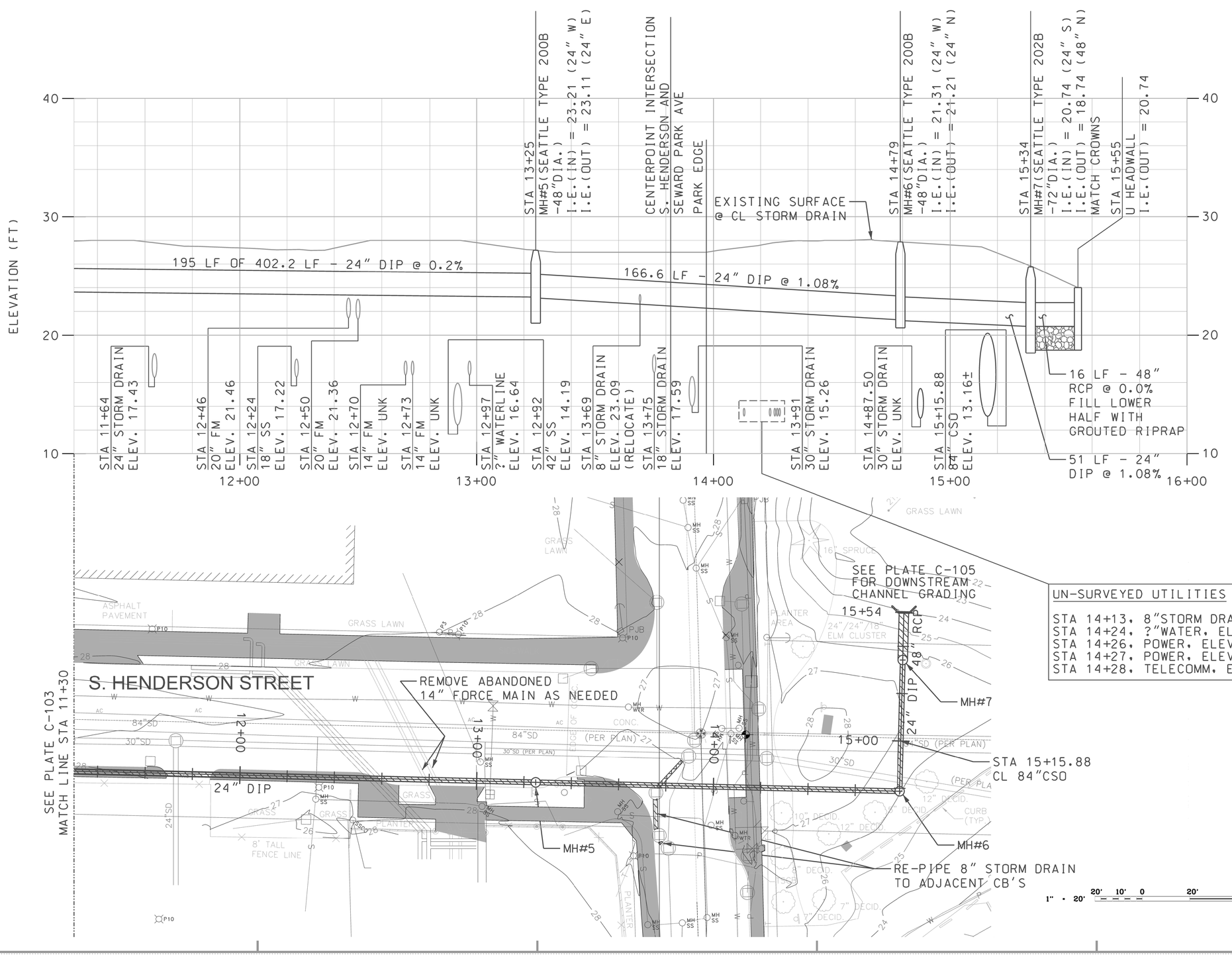
SEATTLE WA

Plate number:
C-103
Sheet 6 of 14

DESIGN FILE: MCRPC-103C01.DGN

DATE AND TIME PLOTTED: 5/29/2009 9:26:25 AM

PRELIMINARY - NOT FOR CONSTRUCTION



UN-SURVEYED UTILITIES

STA 14+13, 8"STORM DRAIN, ELEV. UNK
STA 14+24, ?"WATER, ELEV. UNK
STA 14+26, POWER, ELEV. UNK
STA 14+27, POWER, ELEV. UNK
STA 14+28, TELECOMM, ELEV. UNK

1" = 20' 20' 10' 0 20' 40'

N

PLAN NORTH

US Army Corps of Engineers
Seattle District

Symbol	Description	Date	Appr.	Symbol	Description
		/ /			

Designed by: M. Schulte
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Date: MAY 25 2009
File: SEE EC-TB-RI
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MAPES CREEK
RESTORATION PROJECT
SITE PLAN
SEATTLE WA

Plate number: C-104
Sheet 7 of 14

DESIGN FILE: MCRPC-104C01.DGN

DATE AND TIME PLOTTED: 5/28/2009 5:39:56 PM

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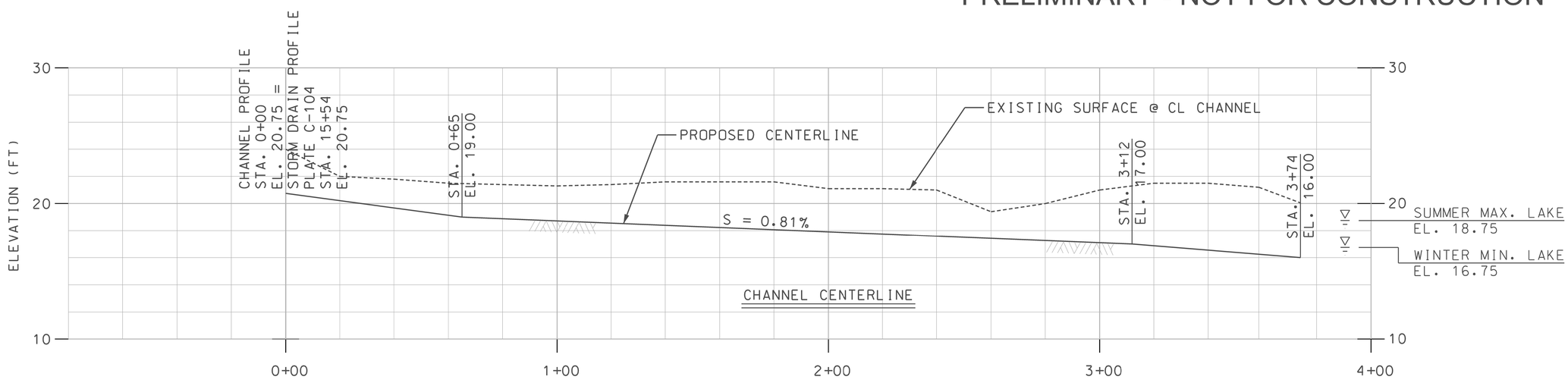

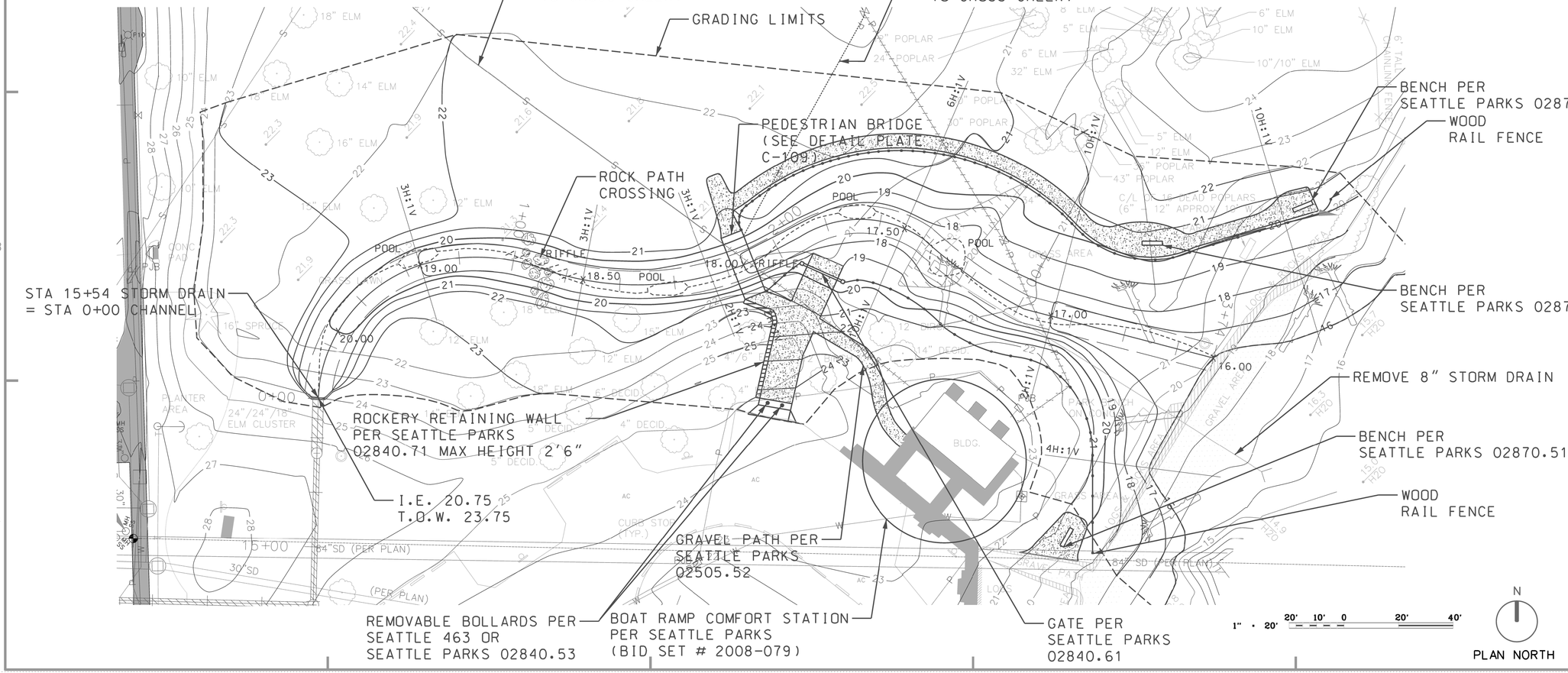

US Army Corps of Engineers
Seattle District

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		/ /			

Designed by: M. Schulte
Drawn by: Bolton/F. Posho
Checked by: J. Lynch
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File: SEE EC-TB-RI
Rev.

U.S.ARMY ENGINEER DISTRICT,SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

Prepared by: TETRA TECH
SEATTLE, WASHINGTON

MAPES CREEK
RESTORATION PROJECT
SITE PLAN
SEATTLE WA

Plate number:
C-105
Sheet 8 of 14

DESIGN FILE: MCRPC-105C01-050709.DGN
DATE AND TIME PLOTTED: 6/1/2009 4:09:04 PM

PRELIMINARY - NOT FOR CONSTRUCTION

PEDESTRIAN BRIDGE (SEE DETAIL PLATE C-109)

RELOCATE SEWER LINE (ATTACH TO PED BRIDGE TO CROSS CREEK)

GRADING LIMITS

RELOCATE POWER LINE (ATTACH TO PED BRIDGE TO CROSS CREEK)

BENCH PER SEATTLE PARKS 02870.51

WOOD RAIL FENCE

ROCK PATH CROSSING

STA 15+54 STORM DRAIN = STA 0+00 CHANNEL

ROCKERY RETAINING WALL PER SEATTLE PARKS 02840.71 MAX HEIGHT 2'6"

I.E. 20.75
T.O.W. 23.75

GRAVEL PATH PER SEATTLE PARKS 02505.52

REMOVABLE BOLLARDS PER SEATTLE 463 OR SEATTLE PARKS 02840.53

BOAT RAMP COMFORT STATION PER SEATTLE PARKS (BID SET # 2008-079)

GATE PER SEATTLE PARKS 02840.61

1" = 20'

PLAN NORTH

US Army Corps of Engineers
Seattle District

Symbol	Description	Date	Appr.	Symbol	Description
		/ /			

Designed by: M. Schulte
Drawn by: Bolton/F. Posha
Checked by: J. Lynch
Date: MAY 25 2009
File: SEE EC-TB-RI
Rev.

U.S.ARMY ENGINEER DISTRICT,SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

Prepared by: TETRA TECH
SEATTLE, WASHINGTON

MAPES CREEK
RESTORATION PROJECT
SITE PLAN
(WETLAND OVERLAY)
SEATTLE WA

Plate number: C-106
Sheet 9 of 14

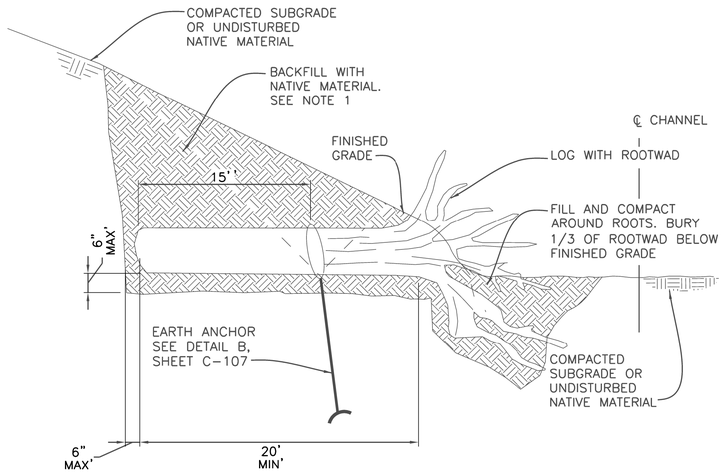
DESIGN FILE: MCRPC-106C01 - 050809.DGN

DATE AND TIME PLOTTED: 6/1/2009 4:16:23 PM

PRELIMINARY - NOT FOR CONSTRUCTION

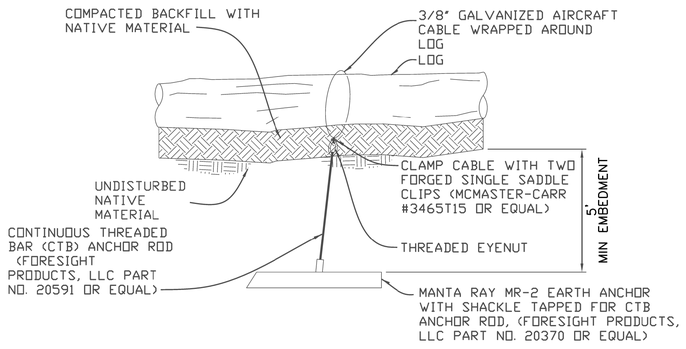
GENERAL NOTES:

1. NATIVE BACKFILL MATERIAL TO BE COMPACTED TO 90% OF MAXIMUM DRY DENSITY. REFER TO SPECIFICATION FOR MORE INFORMATION.



LOG WITH ROOT WAD (A / 107)

NOT TO SCALE



EARTH ANCHOR DETAIL (B / 107)

NOT TO SCALE

US Army Corps of Engineers
Seattle District

Symbol	Description	Date	Appr.	Symbol	Description
		/ /			

Designed by: M. Schulte
Drawn by: Bolton/F. Pasho
Checked by: J. Lynch
Date: MAY 25 2009
File: SEE EC-TB-RI
Rev.

U.S.ARMY ENGINEER DISTRICT,SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

Prepared by: TETRA TECH SEATTLE, WASHINGTON

MAPES CREEK
RESTORATION PROJECT

LOG DETAILS

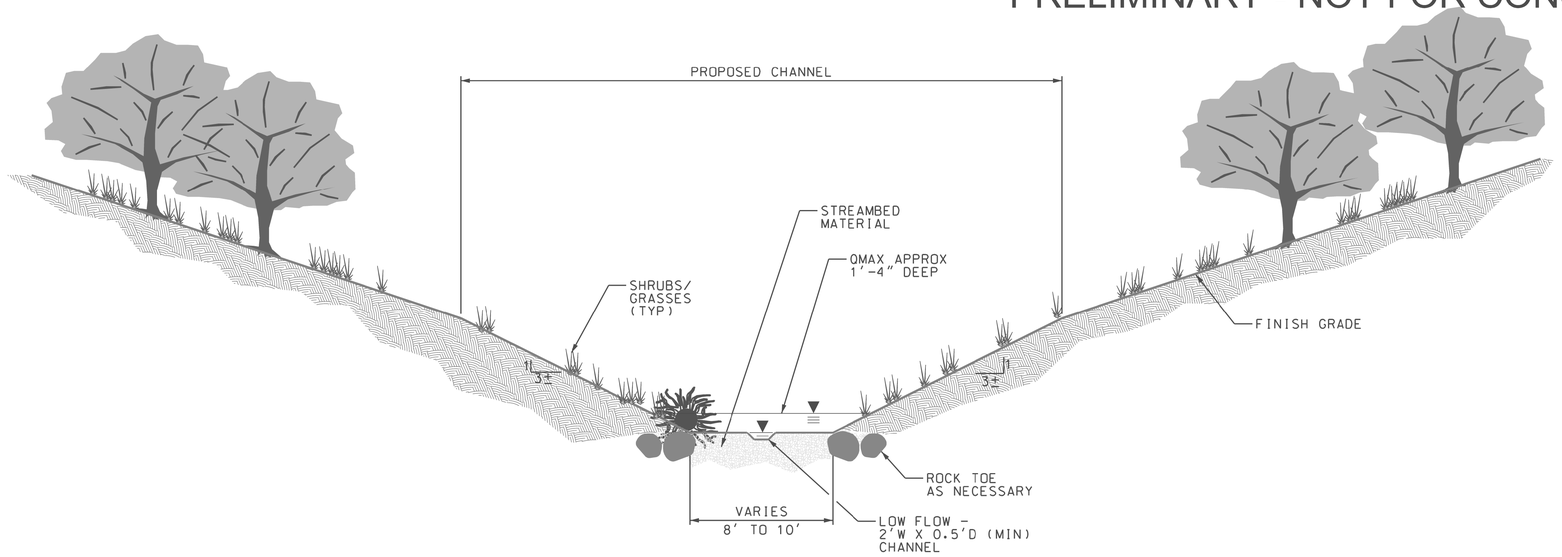
SEATTLE WA

Plate number:
C-107
Sheet 10 of 14

DESIGN FILE: MCRPC-107C01.DGN

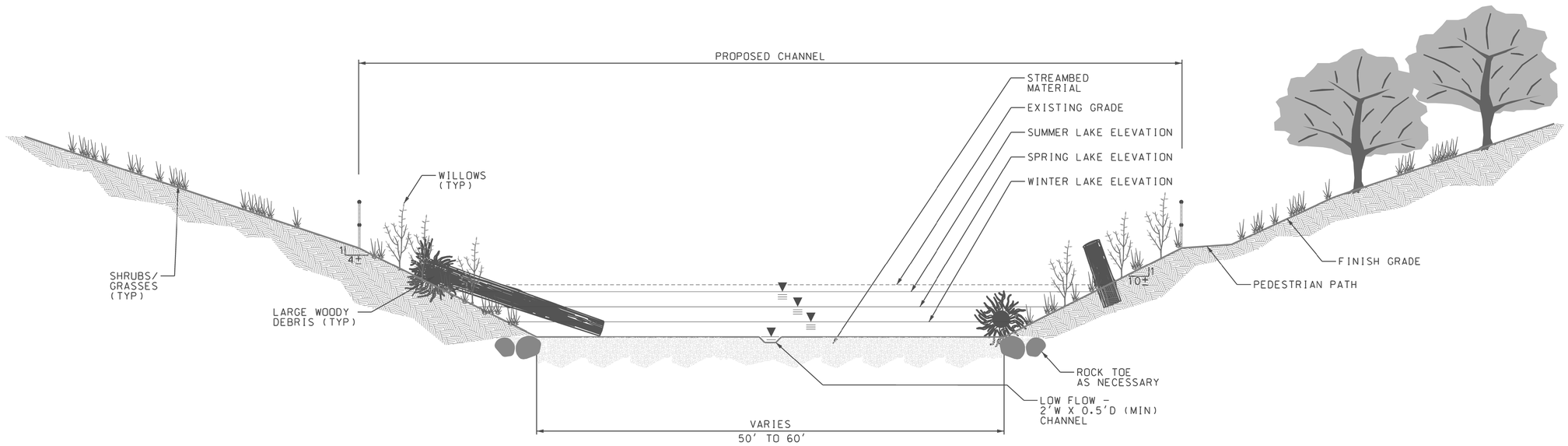
DATE AND TIME PLOTTED: 5/29/2009 8:34:13 AM

PRELIMINARY - NOT FOR CONSTRUCTION



UPSTREAM CHANNEL DETAIL (CONCEPT) — A / 106

NOT TO SCALE



CHANNEL MOUTH DETAIL (CONCEPT) — B / 106

NOT TO SCALE

US Army Corps of Engineers
Seattle District

Symbol	Description	Date	Appr.	Symbol	Description
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Designed by: M. Schulte
Drawn by: Bolton/F. Posho
Checked by: J. Lynch
Date: MAY 25 2009
File: SEE EC-TB-RI
Rev.

U.S.ARMY ENGINEER DISTRICT,SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

Prepared by: TETRA TECH
SEATTLE, WASHINGTON

MAPES CREEK
RESTORATION PROJECT
SEATTLE WA

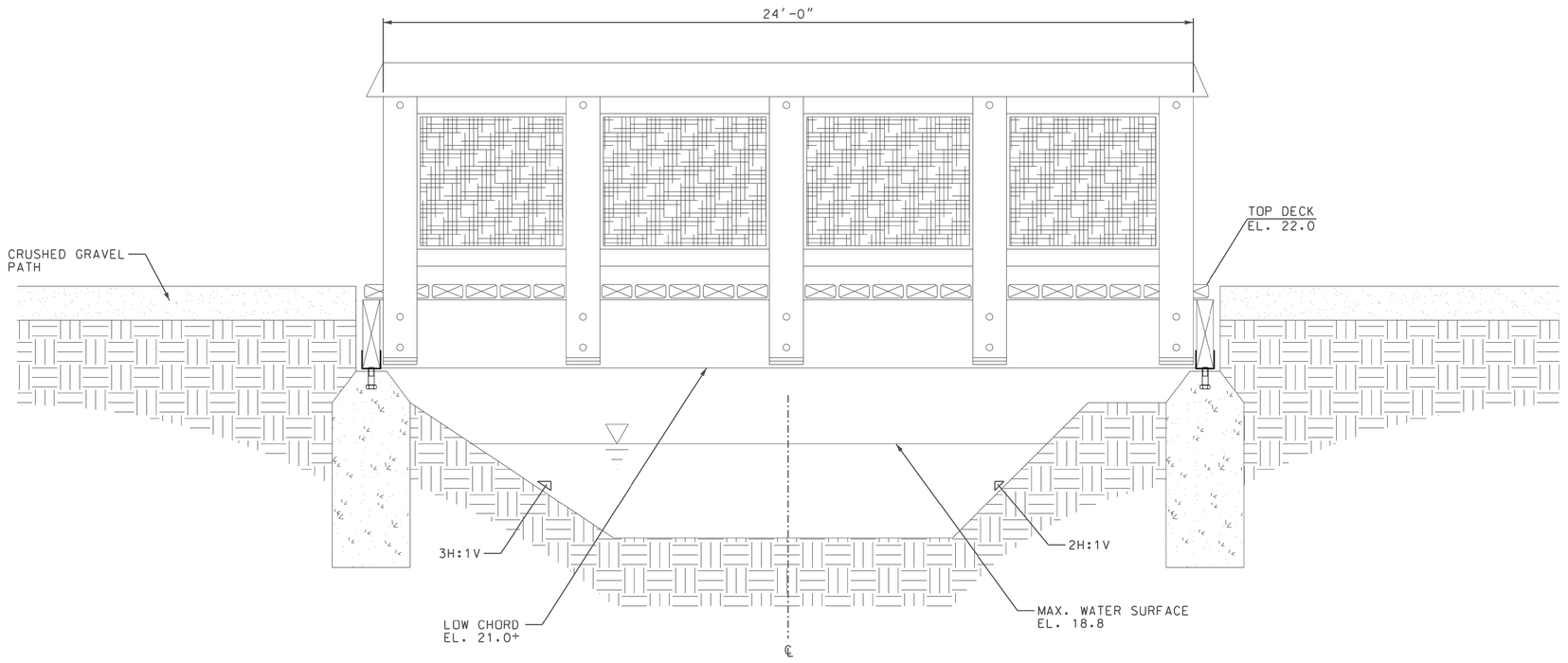
TYPICAL CHANNEL DETAIL

Plate number:
C-108
Sheet 11 of 14

DESIGN FILE: MCRPC-108C01-051209.DGN

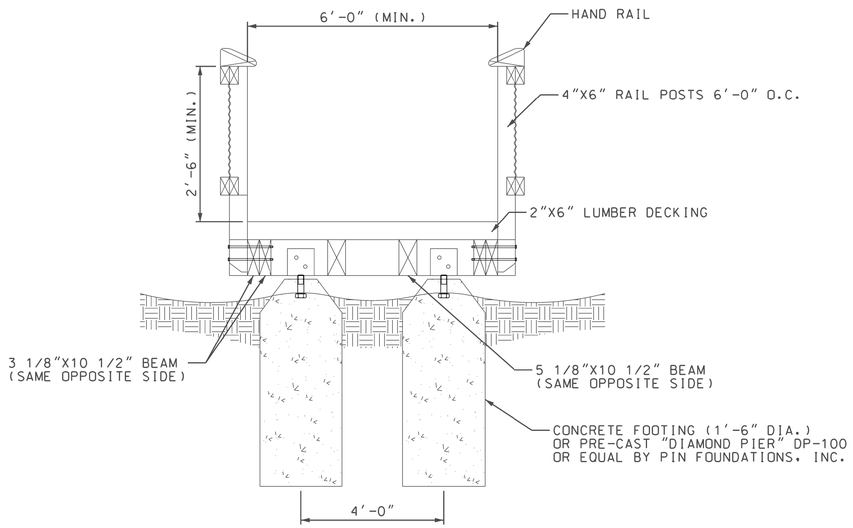
DATE AND TIME PLOTTED: 5/29/2009 8:37:32 AM

PRELIMINARY - NOT FOR CONSTRUCTION



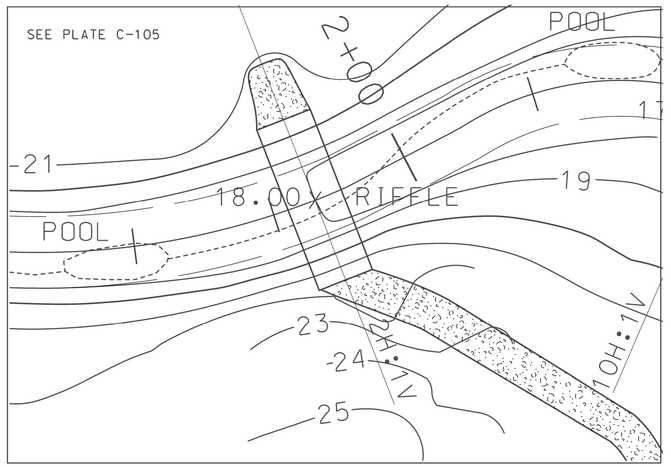
BRIDGE ELEVATION (CONCEPT) — A 109

NOT TO SCALE



BRIDGE CROSS-SECTION (CONCEPT) — B 109

NOT TO SCALE



PLAN — C 109

NOT TO SCALE

US Army Corps of Engineers
Seattle District

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Designed by: M. Schulte
Drawn by: Bolton/F. Pasha
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U.S.ARMY ENGINEER DISTRICT,SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

Prepared by: TETRA TECH
SEATTLE, WASHINGTON

MAPES CREEK
RESTORATION PROJECT
BRIDGE DETAILS
SEATTLE WA

Plate number:
C-109
Sheet 12 of 14

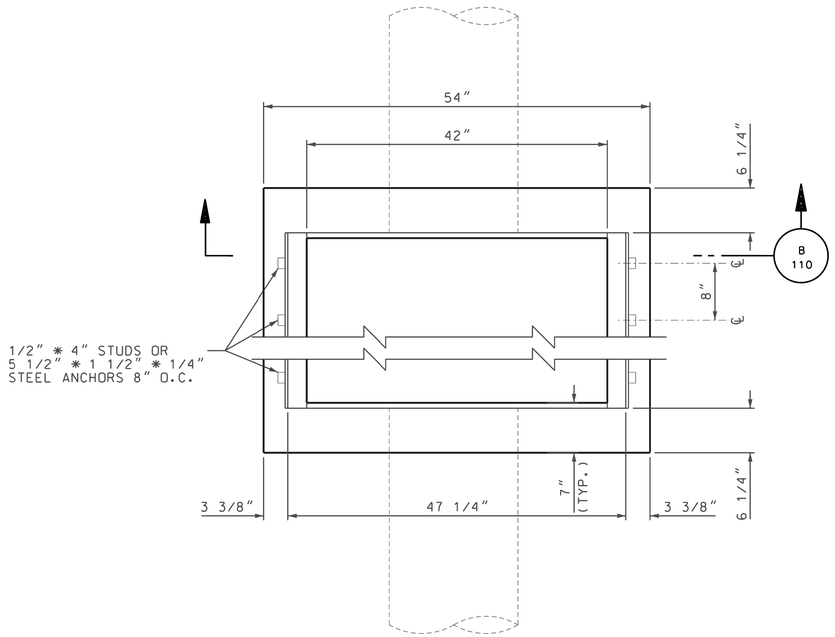
DESIGN FILE: MCRPC-109C01.DGN

DATE AND TIME PLOTTED: 5/29/2009 8:40:41 AM

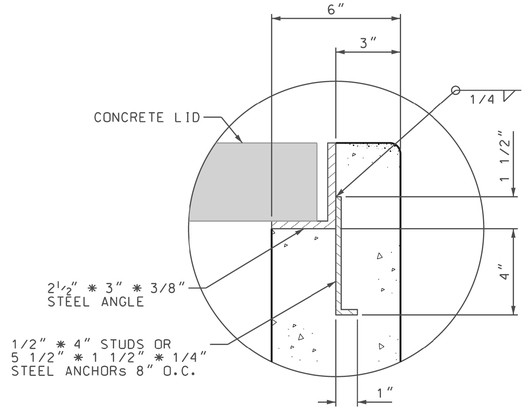
PRELIMINARY - NOT FOR CONSTRUCTION

NOTES

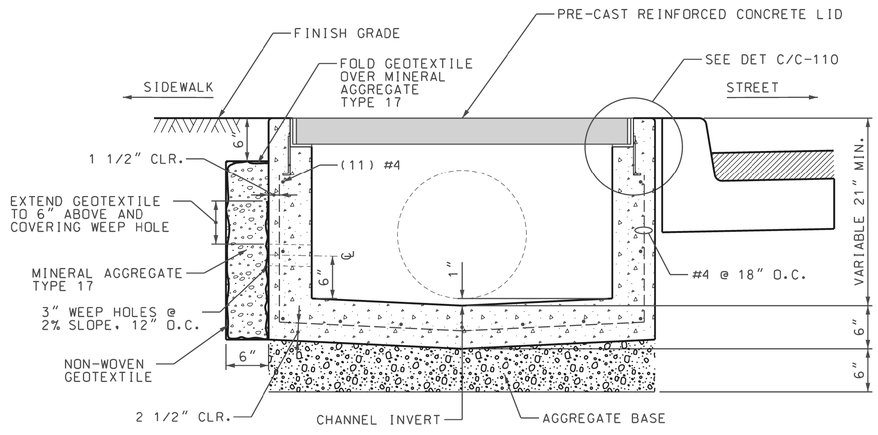
1. THE STEEL ANGLES SHALL BE SET SO THAT EACH BEARING BAR OF PREFABRICATED GRATE SHALL HAVE FULL BEARING ON BOTH ENDS. THE FINISHED TOP OF CONCRETE SHALL BE EVEN WITH THE GRATE SURFACE.
2. ALL EXPOSED CONCRETE SHALL BE FINISHED WITH A 1/2" RADIUS
3. THE GRADE LINE OF THE TOP INSIDE OF ANY PIPE SHALL ENTER NO LOWER THAN THE GRADE LINE OF TOP INSIDE OF THE OUTLET PIPE.



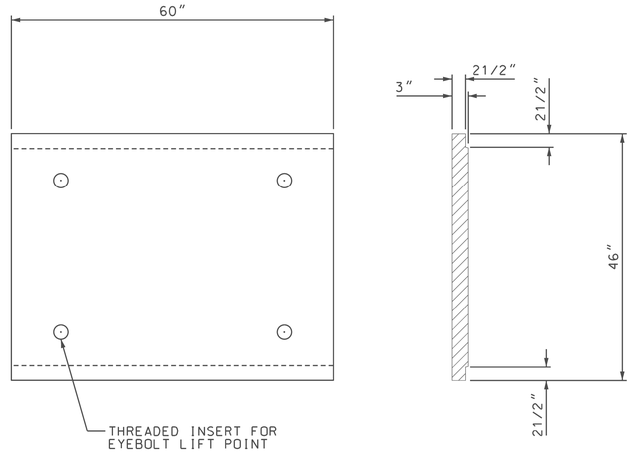
UNDER SIDEWALK "FLUME" TOP VIEW — A 110



UNDER SIDEWALK "FLUME" DETAIL — C 110



UNDER SIDEWALK "FLUME" SIDE VIEW — B 110



PRE-CAST REINFORCED CONCRETE LID DETAIL DETAIL — D 110

US Army Corps of Engineers
Seattle District

Symbol	Description	Date	Appr.	Symbol	Description
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Drawn by: Bolton/F. Pasho
Checked by: J. Lynch
Date: MAY 25 2009
File: SEE EC-TB-RI
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U.S.ARMY ENGINEER DISTRICT,SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

Prepared by: TETRA TECH
SEATTLE, WASHINGTON

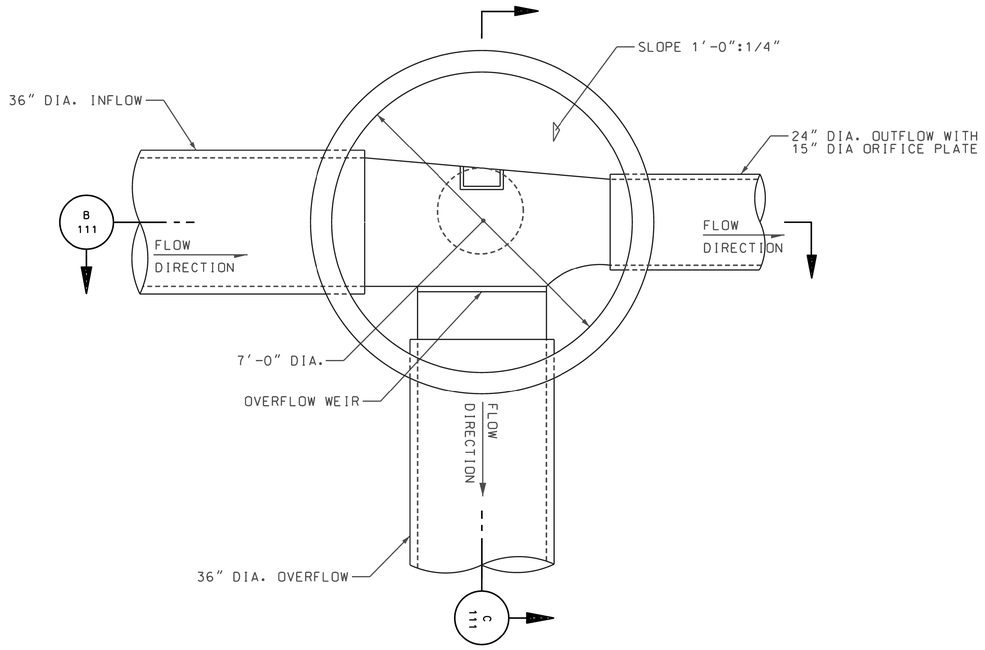
MAPES CREEK
RESTORATION PROJECT
SEATTLE WA

UNDER SIDEWALK "FLUME" DETAILS

Plate number: C-110
Sheet 13 of 14

DESIGN FILE: MCRPC-110C01-051109.DGN
DATE AND TIME PLOTTED: 5/29/2009 9:29:32 AM

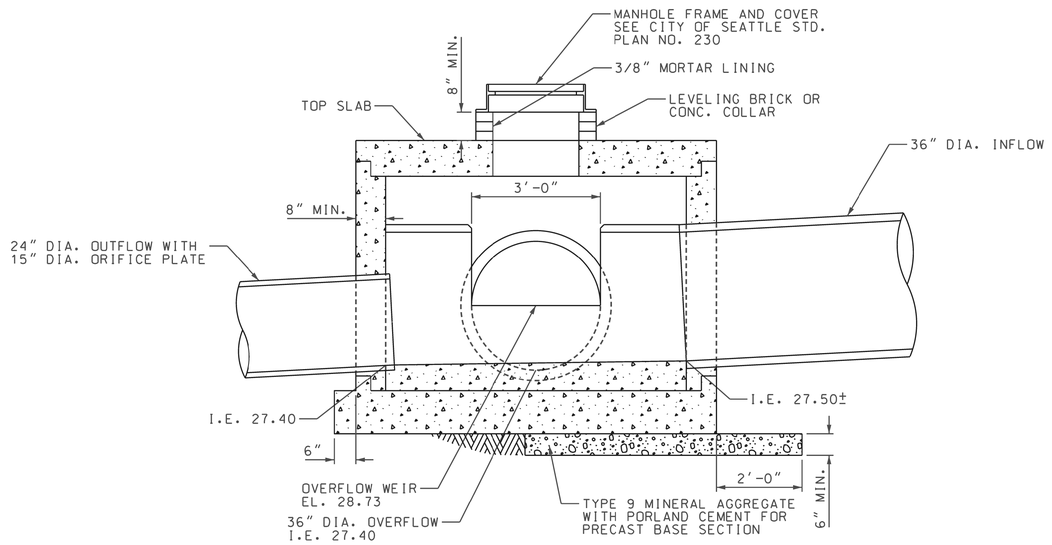
PRELIMINARY - NOT FOR CONSTRUCTION



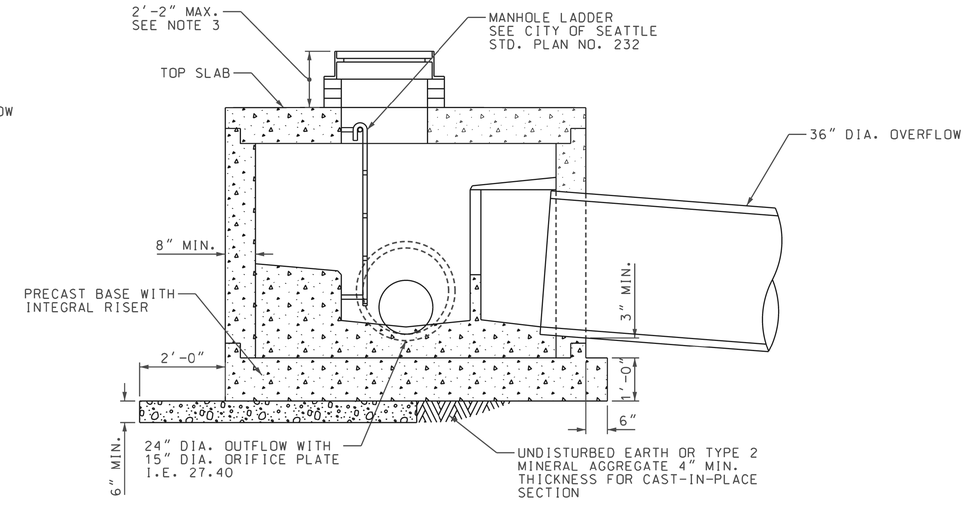
PLAN VIEW MH#1 (STA 0+32.45)
(TOP REMOVED)
A
C-101111

NOTES

1. MANHOLE DESIGNATES A MANHOLE TOP SLAB WITH A 2'-0" DIA. ACCESS.
2. MAX. DIMENSION FROM OUTSIDE MANHOLE WALL TO THE FIRST PIPE FLEX JOINT. THE GREATER OF 1/2 INSIDE PIPE DIAMETER OR 1'-0".
3. TOTAL HEIGHT OF FRAME EXTENSIONS, MANHOLE FRAME AND COVER, AND LEVELING BRICKS SHALL NOT EXCEED 2'-2".
4. MAX. HOLE SIZE IS EQUAL TO THE OUTSIDE DIAMETER OF THE PIPE PLUS THE MANHOLE WALL THICKNESS. MIN. DISTANCE BETWEEN HOLES IS 1'-0".
5. PRECAST MANHOLE COMPONENTS SHALL CONFORM TO ASTM C 478. JOINTS BETWEEN PRECAST COMPONENTS SHALL BE RUBBER GASKETED CONFORMING TO ASTM C 443.



SECTION
B
111



SECTION
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111

US Army Corps of Engineers
Seattle District

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Designed by: M. Schulte
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Checked by: J. Lynch
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U.S.ARMY ENGINEER DISTRICT,SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

Prepared by: TETRA TECH
SEATTLE, WASHINGTON

MAPES CREEK
RESTORATION PROJECT

DIVERSION STRUCTURE DETAILS

WA
SEATTLE

Plate number:
C-111
Sheet 14 of 14

DESIGN FILE: MCRPC-111C01.DGN
DATE AND TIME PLOTTED: 5/29/2009 8:46:11 AM

Appendix C Preliminary Geotechnical Investigation

For a copy of this document please contact:
Melissa Leslie 206-764-6587 or
Melissa.L.Leslie@usace.army.mil

Appendix D Hydrology and Hydraulics

For a copy of this document please contact:
Melissa Leslie 206-764-6587 or
Melissa.L.Leslie@usace.army.mil

Appendix E 35 Percent Design Analysis Report

This document is not available for public comment

Appendix F Sponsor Letters and Letters of Project Support

For a copy of this document please contact:
Melissa Leslie 206-764-6587 or
Melissa.L.Leslie@usace.army.mil

Appendix G Environmental Compliance

Appendix G1 Draft Finding of No Significant Impact

CENWS-PM-PL-ER April 25, 2011

DRAFT FINDING OF NO SIGNIFICANT IMPACT
and
404 (b) (1) DETERMINATION

MAPES CREEK RESTORATION

1. Background.

a. Purpose.

Mapes Creek, an urban tributary to Lake Washington, is currently piped for a total distance of 3,200 feet, portions of which convey storm drainage as well as combined sewer overflow from infrequent storm events. The pipe discharges 20 feet offshore into Lake Washington. The discharge location, 3 miles north of the mouth of the Cedar River, is a critical location for migrating juvenile salmonids.

The goal of the Mapes Creek restoration project is to improve the function of the Lake Washington shoreline ecosystem, in particular as it relates to habitat for juvenile salmonids and other wildlife. Restoration opportunities exist to: 1) Increase shallow water shoreline habitat for refuge and rearing of migrating juvenile salmon; 2) Increase adjacent aquatic habitat for birds, amphibians and other wildlife in Lake Washington. The project will daylight the stream channel through a public park to meet the project goal and objectives. The goal of Mapes Creek project is complimentary to the Watershed Resource Inventory Area 8 (WRIA8) regional salmon recovery strategy for Puget Sound

b. Authority.

Section 1135 the Water Resources Development Act of 1986 (Public Law 104-303), as amended. Section 1135 projects are part of a larger Continuing Authorities Program (CAP) under which the Assistant Secretary of the Army, Civil Works, acting through the Chief of Engineers, is authorized to plan, design, and implement certain types of water resources projects without additional project-specific authorization. The Section 1135 authority allows the Corps to carry out projects for improving the quality of the environment when it is determined that such modifications are feasible, consistent with the authorized project purpose, and will improve the quality of the environment in the public interest. Projects under this authority can include modifications to the structures and operations of water resources projects constructed by the Corps or restoration projects can be at locations where a Corps project has contributed to degradation of the environment.

2. Proposed Action.

The proposed action would divert the flow of Mapes Creek away from its current route through a combined sewer over flow (via an approximately 1500 foot long diversion) to Be’er Sheva Park where it would be daylighted for approximately 370 feet. This daylighted portion would empty into Lake Washington creating a natural stream mouth along the shoreline. Riparian plantings

and large woody debris would be incorporated as habitat features along the daylighted channel and Lake Washington shoreline. The primary goal of this project is to create critical shallow water habitat for juvenile salmon migrating along the Lake Washington shoreline, as well as wildlife. This shallow water habitat will function as refuge from predators and as a foraging area.

3. Summary of Impacts and Compliance. Unavoidable adverse effects associated with this project are expected to include minor temporary increases in lake turbidity during the connection of the creek with Lake Washington, temporary noise and increased traffic during construction of the diversion pipe, a temporary reduction in aesthetic value during construction, and disturbance to park users in Be er' Sheva Park during construction of the daylighted channel. However, the project will result in a net gain in aquatic habitat function and value by creating a stream mouth along the Lake Washington shoreline. This gain will provide much needed shallow water habitat for juvenile salmonids and other native fish that will function as refuge from predators and forage and rearing opportunities. In addition to fish, the daylighted stream and its associated riparian plantings will provide habitat for a variety of other aquatic wildlife including birds, amphibians, and mammals.

The Corps finds this projects is "not likely to adversely affect" federally listed species under the Endangered Species Act. Concurrence with this determination has been received from both the National Marine Fisheries Service and the United States Fish and Wildlife Service. This project complies with Section 404 of the Clean Water Act. The Corps has prepared a 404(b)(1) Analysis, included as an attachment to the draft EA (Appendix G). The project received a 401 water quality certification from the Washington Department of Ecology on December 1, 2010. The Corps has determined that the project has no potential to cause effects to historic properties, as the area was created in modern times and there are no historic structures adjacent to the undertaking, or within immediate view sheds that are eligible for the National Register. Negative impacts to water quality, aesthetics, traffic flow and noise will generally be highly localized and short in duration.

Avoidance measures and reduction of impacts will take the form of on-site biological and archeological monitoring, the implementation of best management practices (BMPs) during construction, and scheduling to avoid potential impacts to fish and wildlife species.

4. Finding.

Based on the attached environmental documentation, coordination, and analysis conducted by the Corps environmental staff, I have determined that this project, given the long term net gain in habitat value and function, will not result in significant adverse environmental impacts. The proposed action is not a major federal action significantly affecting the quality of the human environment, and therefore does not require preparation of an environmental impact statement.

_____ _____

Date

Anthony O. Wright
Colonel, Corps of Engineers
District Engineer

Appendix G2 ESA Concurrence

NMFS

Electronic Approval for Use of the 2008 Fish Passage and Restoration Programmatic

The National Marine Fisheries Service (NMFS) has reviewed the Specific Project Information Form (SPIF) and Memorandum for the Services, received September 8, 2010, for the proposed restoration of 370 feet of Mapes Creek at Be'er Sheva Park, in King County, WA (HUC 1711001203, Lake Washington). This restoration project fits under the categories "2a. Placement of Woody Material, 2b Placement of Live Stakes, 2f Placement of Boulders, and 4 Channel Habitat Restoration and Reconnection" of the 2008 Washington State Fish Passage and Habitat Enhancement/Restoration Programmatic (FPRP). NMFS' tracking number for this project is 2010/04423. The US Army Corps of Engineers' (COE) tracking number is PL-10-09. The COE has determined that the proposed action "may affect, but is not likely to adversely affect" Puget Sound Chinook (*Oncorhynchus tshawytscha)* and Puget Sound steelhead (*O. mykiss*) and designated critical habitat. NMFS concurs with this determination via this electronic format, as per approval criteria set forth in the programmatic consultation, NMFS Tracking No. 2008-03600 (informal).

Mapes Creek currently flows through underground pipes into the municipal combined sewer system. The proposed project would redirect 10 cubic feet per second (cfs) of Mapes Creek toward a new 370 feet long surface stream. To redirect these 10 cfs of flow, a new diversion structure and pipe northeast of the grocery store at Rainier Ave South and 52nd Ave South would be installed. The new surface Stream would flow though Be'er Sheva Park and empty into Lake Washington. The 370 feet of new stream channel would contain pool and riffle habitat with rock and wood habitat structures. The riparian area would be planted with native vegetation. One pedestrian bridge and a rock path in a shallow area in the more upstream section would allow for people to cross the stream. Since the stream would be constructed in a public park, a maintenance driveway would also be necessary.

The outlet construction and re-watering are the only major construction tasks that will have water contact and thus be performed during the fish window, July 16 through December 31. A large amount of excavation will be required to match up the grade for the stream with the bed elevation of Lake Washington. To reduce the turbidity from this excavation, a worksite isolation structure like a cofferdam will be installed prior to excavation. In addition to an isolation structure, floating filter blankets will help control turbidity during outlet construction and re-watering. The low summer water levels and nearshore conditions will most likely allow for seining out juvenile salmon from the to be isolated area. (pers com. COE, 9-92-2010) Should during later design phases fish rescue appear to be likely, please re-initiate. For your re-initiation NMFS would need the area you plan to isolate and from with you propose fish rescue and the area you propose to protect with filter blankets. NMFS would be able to again issue electronic

concurrence for that formal re-consultation under the FPRP within 30 days after all necessary information is received.

The action area includes the to be constructed stream channel and riparian area and the to be isolated workarea in Lake Washington plus the area protected by filter blankets. At this design stage ,35 percent, the applicant is not able to provide the exact size of this area.

Essential Fish Habitat (EFH) for coho and Chinook salmon has been designated in the action area. The proposed project may adversely affect EFH; the to be isolated area in Lake Washington plus the area subject to greatly increased turbidity.

EFH Conservation Recommendations: Because the conservation measures that the COE included as part of the proposed action to address ESA concerns are also adequate to avoid, minimize, or otherwise offset potential adverse impacts to the EFH of the species listed above, conservation recommendations pursuant to MSA (section 305(b)(4)(A)) are not necessary. Since NMFS is not providing conservation recommendations at this time, no 30-day response from the COE is required (MSA section 305(b)(4)(B)).

The proposed project would result in restoration benefits to listed salmon and EFH. The proposed partial day lighting of Mapes Creek would increase the available rearing habitat for Chinook, coho, and steelhead.

The COE has met their obligations under Section 7 of the Endangered Species Act and EFH and no further consultation on this action is required.

Sincerely,

Stephanie Ehinger

USFWS (email)

Chemine and Maryann,

The U.S. Fish and Wildlife Service (Service) has reviewed the Specific Project Information Form (SPIF), dated August 13, 2010, the Memorandum for the Services (MFS), and additional information provided for the proposed creation of a surface stream channel at Be'er Sheva Park. The project is located in Mapes Creek, a tributary to Lake Washington, at 8650 55th Avenue South, Seattle, King County, Washington (T24N, R4E, Section 35). The SPIF and MFS requesting approval of the project under the Programmatic were received in our office on September 8, 2010.

As per the criteria set forth in the programmatic consultation, the Service is responding via this electronic format to give approval to cover the proposed action under the Fish Passage/Habitat Restoration Programmatic (FWS Ref.# 13410-2008-F-0209). The U.S. Army Corps of Engineers (Corps) made the determination that the proposed action "may affect, but is not likely to adversely affect" bull trout (Salvelinus confluentus) and bull trout critical habitat.

The applicant is proposing to conduct activities that fall under two Sections outlined in the Programmatic:

2. Installation of Instream Structures and 4. Side Channel/Off-Channel Habitat Restoration and Reconnection

The Corps proposes to restore approximately 370 linear feet of Mapes Creek by constructing a surface stream channel with pool and riffle complexes, adding woody debris and boulders, and planting native vegetation. Mapes Creek is currently a piped municipal system that drains into a 30-inch storm drain, which then converges with a combined sewer and stormwater overflow which flows into Lake Washington. Ten cubic feet of flow would be diverted from the Mapes Creek storm drain to a new pipe that would be installed upstream from the 52nd Avenue walkway and divert flow to the newly created stream channel. The diversion pipe will only carry flows from Mapes Creek and will not be used to carry stormwater runoff or combined sewer overflow. Small and large woody debris will be installed throughout the new channel based on recommendations provided by the Corps, Muckleshoot Tribe, and the City of Seattle. The riparian area of the new channel would be planted with native vegetation. The work area will be isolated using a cofferdam or other means, and Best Management Practices would be implemented to prevent sedimentation in Mapes Creek and/or Lake Washington. Work is anticipated to take six months and would be performed during the approved inwater work window (July 16 to December 31). The outflow of the created channel will direct flows naturally into Lake Washington, will provide fish access, and will provide areas of foraging and refuge for fish.

The proposed project meets all of the requirements outlined in the Fish Passage/Habitat Restoration Programmatic. The Service does not anticipate bull trout to currently use Mapes Creek because of the degraded condition of the stream and very low occurrence of bull trout in Lake Washington. In the extremely unlikely event that a bull trout should be captured or injured during construction, the Service will apply the incidental take to the quota that is authorized under the Programmatic.

The Corps has met their obligations under Section 7 of the Endangered Species Act and no further consultation on this action is required.

The TAILS tracing number for this project is 13410-2010-I-0549. If you have any questions, please contact Lindsy Wright (360) 753-6037 or Martha Jensen (360) 753-9000 out of this office.

_____

Martha Jensen
Branch Manager,
Division of Consultation and Technical Assistance Washington Fish and Wildlife Office 510 Desmond Dr SE Lacey, WA 98503
tel: (360) 753-9000/ fax: (360) 753-9008 martha_l_jensen@fws.gov

Appendix G3 404(b)1 Analysis

Clean Water Act Section 404(b)(1) Analysis

Mapes Creek Ecosystem Restoration
Channel Creation
Kent, King County, Washington

Clean Water Act

Prepared by:

U.S. Army Corps of Engineers
Seattle District
Environmental Resources Section

April 2010

US Army Corps of Engineers ®
Seattle District

1.0 Introduction

The purpose of this document is to record the U.S. Army Corps of Engineers (USACE) Clean Water Act Section 404 compliance evaluation of a plan to divert the flow of Mapes Creek away from its current route through a combined sewer over flow to Be'er Sheva Park where it would be daylighted for approximately 370 feet. This daylighted portion would empty into Lake Washington creating a natural stream mouth along the shoreline. The primary goal of this project is to create shallow water habitat for juvenile salmon migrating along the Lake Washington shoreline. This shallow water habitat will function as refuge from predators and as a foraging area.

2.0 Project Background

The Mapes Creek project site is located in southeast Seattle, Washington, east of the intersection of Rainier Avenue South and South Henderson Street. Neighborhood landmarks include Rainier Beach High School, the Henderson Street King County Metro sewer pump station, and the 52nd Avenue South Walkway. Be'er Sheva Park is located on the shore of Lake Washington near the intersection of South Henderson Street and Seward Park Avenue South.

Mapes Creek is a small stream tributary to Lake Washington, with its confluence located on the southwestern shoreline approximately 3 miles north of the mouth of the Cedar River. The Mapes Creek catchment comprises approximately 92.2 acres. The headwaters of Mapes Creek include riverine wetlands and intermittent streams fed by groundwater springs. The upper part of the watershed is relatively undeveloped, with the exception of the Kubota Gardens. The Kubota Gardens use Mapes Creek as a water supply for ornamental pools, channels, and ponds. Mapes Creek enters the municipal storm drainage system through a culvert at Sturtevant Ravine, and eventually is routed to an 84-inch combined sewer overflow (CSO) pipe under Henderson Street and discharges into Lake Washington roughly 30 feet offshore.

The 370 linear feet of day-lighted stream will be constructed in Be'er Sheva Park, located on the Lake Washington shoreline. Be' er Sheva Park is currently owned by the City of Seattle. The diversion structure will be constructed northeast of the grocery store at Rainier Ave S and 52nd Ave S. The diversion pipe will run north underneath the 52nd Ave S walkway before it makes a 90 degree turn to the east running under S. Henderson St toward Be' er Sheva Park.

3.0 Project Need

Populations of native fish in the Pacific Northwest, particularly anadromous salmonids, are declining at a rapid rate, largely due to habitat loss. Three salmon species, Puget Sound Chinook (*O. tshawytscha*), Puget Sound steelhead (*O. mykiss)* and Puget Sound/Coastal bull trout (*Salvelinus confluentus*) have been listed as threatened or endangered under the Endangered

Species Act (ESA), and a third species, coho *(O. kisutch)*, is considered a Species of Concern under the ESA.

Mapes Creek has been significantly altered since the Hiram M. Chittenden Locks were built in 1916 and consequently, Lake Washington was lowered 8 feet. As a result, the mouths of many tributary creeks were altered and the amount of wetland habitat was reduced throughout the entire basin. Since the lowering, Lake Washington has been managed under a reverse hydrologic regime, maintaining a low water level in the winter and high levels in the summer, fluctuating up to 2.5' seasonally. Currently, the shoreline of Lake Washington is highly developed for both residential and commercial activities, which has caused severe habitat loss over time, including the piping and offshore discharge of Mapes Creek. Without restorative actions throughout the basin, many of the fish and wildlife resources of the Lake Washington/Cedar River system would continue to decline.

Day-lighting Mapes Creek and creating a natural stream mouth along the Lake Washington shoreline would provide much needed shallow water habitat for juvenile salmonids migrating along the shoreline.

4.0 Project Purpose

The project purpose is to create shallow water habitat for juvenile salmonids migrating along the Lake Washington Shoreline. This habitat would function as refuge from both native and non-native predatory fish that occupy the lake, and as a foraging area. The project would include native plantings and LWD, both of which are integral to the development of salmonid and other wildlife habitat.

5.0 PROPOSED ACTION AND ALTERNATIVES

Alternatives considered under NEPA must include the proposed action (preferred alternative), and the no-action alternative. Other reasonable alternatives that meet the project purpose and need must also be considered in detail.

Three alternatives were considered for this project: 1) The No Action Alternative, 2) Diversion Pipe and Day-lighted Creek Alternative, and 3) Diversion Pipe and Daylighted Creek with Wetland Overlay.

The No Action Alternative was eliminated because it did not meet the project objectives. Alternative three, Diversion Pipe and Daylighted Creek with Wetland Overlay, was eliminated due to concerns the local sponsor had with maintenance costs associated with the wetland and additional park land required to construct it. The preferred alternative, Diversion Pipe and Day-lighted Creek Alternative, was selected because it meets the goal of providing shallow water habitat for juvenile salmonids while balancing the use of the area as a public park.

6.0 POTENTIALLY ADVERSE EFFECTS (INDIVIDUALLY OR CUMULATIVELY) ON THE AQUATIC ENVIRONMENT

a. Effects on Physical, Chemical, or Biological Characteristics of the Aquatic Ecosystem

Short term impacts from temporary increases in turbidity may result from activities associated with constructing the outlet of the channel. The largest impact may occur during the connection of the new channel with Lake Washington, which may cause a pulse of sedimentation as the new channel is watered and adjusts to the new flow. In addition, there is a risk of a chemical spill (fuel, oil, or other machinery fluids) into the water whenever construction occurs near a water body. Best management practices would be implemented during construction to ensure the chances of this occurrence are minimized.

In the long term, the construction of the channel would provide important shallow water refuge for juvenile salmonids from predatory fish, as well as forage and rearing habitat. Increased native overhanging vegetation and the introduction of LWD into the channel would provide additional high quality habitat to a variety of fish species. It is anticipated that juvenile salmonids and other fish would utilize this new habitat primarily during the spring outmigration along the Lake Washington shoreline. Access to the site by the public could cause an increase in fishing and overall disturbance to adult and juvenile salmon, however educational signage (put up to encourage conservation), dense riparian planting, and fencing should limit access to the channel

b. Effects on Recreational, Aesthetic, Historical, and Economic Values

The installation of the channel and pedestrian bridge may result in increased interest in the site and therefore recreational use, including fishing, might increase.

The visual quality of Lake Washington consists mostly of private residences and marinas with piers along the majority of the shoreline. Greenspace and natural areas along Lake Washington are quite scarce. Creating a natural stream channel and planting native vegetation along the newly created channel would greatly improve the visual and aesthetic appeal of the site.

During excavation and construction of the site, the aesthetic quality of the general area could be reduced due to the noise and air emissions generated by the construction equipment, which may disturb recreational users of the Be' er Sheva Park. However, these impacts would be temporary and highly localized, and are not expected to result in significant impacts.

A cultural resources assessment was performed by a professional archaeologist in order to determine if a potential exists to cause effects to Historic Properties if they should exist within the project area. A search of the archaeological and historic site records at the Washington State Department of Archaeology and Historic Preservation (DAHP) indicated that no properties listed in the National Register of Historic Places (NRHP) or the Washington State Historic Site Register are recorded in the project area. Historic aerial photos and General Land Office (GLO) survey maps were reviewed in order to identify any potential areas where cultural resources could be present.

These maps show that prior to the construction of the Hiram M. Chittendam Locks and the lowering of the water level in Lake Washington in 1917, the project APE was inundated. The Corps has determined that the project has No Potential to cause effects to Historic Properties under the NHPA, as the area was created in modern times and there are no historic structures adjacent to the undertaking, or within immediate view sheds that are eligible for the National Register. This determination completes the NHPA process.

c. Findings

There would be no significant adverse impacts to aquatic ecosystem functions and values. It is expected that aquatic ecosystem functions and values would increase by construction of the channel and planting its corridor with native vegetation.

7.0 ALL APPROPRIATE AND PRACTICABLE MEASURES TO MINIMIZE POTENTIAL HARM TO THE AQUATIC ECOSYSTEM

a. Impact Avoidance Measures

Potential impacts to aquatic animals and fish would be avoided by constructing the internal portion of the channel prior to opening the outlet of the channel to Lake Washington, as well as performing all in-water work within the designated fish window (July 16-December 31) as well as during fall/winter low lake levels.

b. Impact Minimization Measures

USACE would take all practicable steps during construction of the project to minimize impacts to aquatic resources during in-water construction. Contingencies would be in place if any of the water quality protection measures fail to achieve their intended function. USACE

would observe all construction windows to ensure that impacts to migratory fish would be avoided or minimized. The minimization measures would be as follows:

- Best management practices (BMPs), such as stormwater runoff prevention, will be used to ensure that no unnecessary damage to the environment occurs
- Although the majority of the work will be done in the dry, the construction of the channel outlet will require installation of water control, i.e. cofferdam device or equivalent, to isolate the outlet areas from Lake Washington. It is likely that some level of sump pumping and disposal of water will be necessary while working in these areas. In addition to isolation structures, floating filter blankets will help control turbidity during construction and re-watering.
- During channel watering the following will take place:
  -Pre-washing, rinsing, and sump pump removal of turbid water from channel work areas;
  -Halting work when water quality standards are exceeded
  -Timing and sequencing of outlet/inlet isolation structure removal; and
  -Removal and flow release rates of isolation structures.
- All of the outlet work will be performed during fall/winter Lake Washington low water levels.
- Work will occur only during the WDFW established fish window (July 16-December 31).
- Turbidity monitoring will occur during in-water work, if turbidity levels exceed water quality standards construction will cease until those standards can be met.
- A Corps biologist will periodically check on construction progress to ensure BMPs are in place and environmental impacts are properly avoided and minimized
- Temporary impacts will be limited to staging and access areas.
- Coir fabric will also be installed along the banks of the new channel below the imported channel sediment and extend upland as necessary. Long-term stabilization will be established by riparian planting.

c. Compensatory Mitigation Measures

Due to the absence of wetlands on this project, compensatory mitigation measures are not applicable.

d. Findings

Given the temporary, localized, necessary, and minor nature of these effects, the Corps has determined that the proposed restoration project would not result in significant adverse environmental impacts.

8.0 OTHER FACTORS IN THE PUBLIC INTEREST

a. Fish and Wildlife

USACE has coordinated construction activities with the Muckleshoot tribe, and state and

federal resource agencies to ensure that only minimal impacts to fish and wildlife resources would occur. The in-water portions of project construction would take place during the designated fish window, established by Washington Department of Fish and Wildlife (WFDW), to avoid impacts to fish. A Corps biologist would check for perched bald eagles before construction begins to avoid and minimize disturbance due to large machinery. Work may be delayed if it appears that there would be a disturbance to eagles. U.S. Fish and Wildlife Service declined the issuance of a planning aid letter or a coordination act report "due to fact that it is a fairly small restoration project in an urban setting, and therefore don't have any issues or concerns with the alternatives considered or the project as a whole." National Marine Fisheries Service and U.S. Fish and Wildlife Service concur that the proposed project "may affect, not likely to adversely affect" federally listed species and critical habitat located in the project area.

b. Water Quality

The Corps concludes that this project would not violate state water quality standards and meets the condition of a Nationwide Permit 27, Aquatic Habitat Restoration. A Section 401 water quality certification from the Washington Department of Ecology, under the conditions of a Nationwide Permit 27, is currently being persued.

c. Historical and Cultural Resources

A search of the archaeological and historic site records at the Washington State Department of Archaeology and Historic Preservation (DAHP) indicated that no properties listed in the National Register of Historic Places (NRHP) or the Washington State historic site register are recorded within the project area. Historic aerial photos and General Land Office (GLO) survey maps were reviewed in order to identify any potential areas where cultural resources could be present.

These maps show that prior to the construction of the Hiram M. Chittendam Locks and the lowering of the water level in Lake Washington in 1917, the project APE was inundated. The Corps has determined that the project has No Potential to cause effects to Historic Properties under the NHPA, as the area was created in modern times and there are no historic structures adjacent to the undertaking, or within immediate view sheds that are eligible for the National Register. This determination completes the NHPA process.

e. Environmental Benefits

The project would restore significant ecosystem function and structure that has been degraded within Lake Washington by increasing shallow habitat for juvenile salmonids and other fish and riparian habitat for other wildlife. The addition of native riparian plants along the channel and shoreline would provide shading and cover leading to localized cooler temperatures, and increase primary production in the form of insect and leave drop. Woody debris would create pools and cover that provide refuge for juvenile salmonids from avian predators. Riparian vegetation will create habitat for birds, amphibians, and small mammals.

9.0 CONCLUSIONS

USACE finds that this project is within the public's interest, complies with the substantive elements of Section 404 of the Clean Water Act and the Rivers and Harbors Act, and meets the criteria of Nationwide Permit 27: Aquatic Habitat Restoration, Establishment, and Enhancement Activities.

Attachment A

Clean Water Act 404(b)(1) Evaluation [40 CFR §230]
Permit Application Evaluation [33 CFR §320.4]

404(b)(1) Evaluation [40 CFR §230]

Potential Impacts on Physical and Chemical Characteristics [Subpart C]:

1. **Substrate [230.20]**
   The placement of the sand gravel mixture (fish mix) would be suitable for benthic invertebrate colonization that will provide juvenile salmonids with a forage base is expected to lead to an overall improvement in ecosystem function along this stretch of the Lake Washington shoreline.
2. **Suspended particulates/turbidity [230.21]**
   Construction of the outlet and watering of the channel may cause short-term increases in turbidity. These increases are attributable to the excavation of the channel outlet, placement of rock, LWD and other materials, and watering and stabilization of the new channel. Heavy equipment needed to perform in-water work would be staged in upland areas and would not enter Lake Washington. All in-water work would be conducted during the prescribed work windows and during low Lake Washington water levels to minimize water quality impacts. The project would use BMPs to ensure state water quality standards are maintained during construction. Daily water quality monitoring would be conducted during in-water work to ensure compliance with these standards. Should monitoring indicate that state water quality maximum standards for turbidity are exceeded; work would be halted and modified such that standards are met.
3. **Water [230.22]**
   The project is not expected to add any nutrients to the water that could affect the clarity, color, odor, or aesthetic value of the water, or that could reduce the suitability of Lake Washington for aquatic organisms or recreation. While the groundwater table elevation may vary with season and lake levels, it is anticipated that the channel would receive groundwater flow for the majority of the year since water pools in the location where the proposed channel will be constructed. As groundwater is of a lower temperature than that of surface water, it can be expected that temperatures within the proposed channel, as well as those in Lake Washington, may exhibit minor reductions in temperature due to the project. The cooler water temperatures in the immediate vicinity of the side channel may increase dissolved oxygen in this area resulting in improved water quality.

   Coniferous large woody debris, which is resistant to breakdown (and therefore has low biochemical oxygen demand), would be placed to enhance fish habitat.

4. **Current patterns and water circulation [230.23]**
   The hydraulic effects of the project on the portion of the Lake Washington shoreline parallel to the channel were simulated using the Corps' HEC-RAS River Analysis System computer model. The hydraulic analysis comprised four scenarios combining flow rates from Mapes Creek and water surface elevation on Lake Washington. These scenarios represented spring salmon rearing, winter flush, summer flood, and winter flood conditions. With higher lake levels, summer levels being the highest, less of the stream is influenced by upstream flow. No significant change in current patterns and water circulation within Lake Washington is expected to result from the project.

   It is expected there would be some hyporheic flow of groundwater into the channel. The designed elevation of the channel bottom is below the groundwater table. Paired with the highly permeable soils on site, this seems to indicate that some hyporheic flow would be available to supplement the surface flow in the channel. This input has not been quantified, however.
5. **Normal water fluctuations [230.24].**
   Water fluctuations in the channel would be affected by flow upstream, to the limit of 11 cfs, and by water levels in Lake Washington, which is controlled by the Hiram M. Chittenden Locks.
6. **Salinity gradients [230.25]**
   Not applicable, there is no salt intrusion in Lake Washington or its tributaries.

Potential Impacts on Biological Characteristics of the Aquatic Ecosystem [Subpart D]:

1. **Threatened and endangered species [230.30]**
   In September 2010, USACE submitted a SPIF (Specific Project Information Form) under Section 7 ESA Programmatic Biological Assessment for Fish Passage and Restoration projects in Washington State to the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). Concurrence with the Corps' determinations of **may affect, but not likely to adversely affect** for species that are federally listed as well as their critical habitat was received from USFWS on October 5, 2010, and from NMFS on October 4, 2010.
2. **Fish, crustaceans, mollusks and other aquatic organisms in the food web [230.31]**
   There may be temporary impacts to aquatic organisms during construction and connection of the channel due to turbidity or if the lakebed is disturbed during outlet construction and watering of the new channel. However, aquatic habitat quality conditions are expected to improve greatly following construction. Streambed sand and gravel would line the channel, providing rearing habitat and better substrate for the production of aquatic insects and other benthic organisms. Planting the stream banks and shoreline with native vegetation would provide shading that functions as a thermal refuge during warm summer days as well as providing a source of organic input for the food chain and insect drop as a direct source of food.

3. **Other wildlife [230.32]**
   Birds and other wildlife may be temporarily displaced during construction due to noise and presence of construction vehicles. Because these impacts would only occur during the period of construction, and the great majority of existing trees would be retained, they are expected to be inconsequential and temporary. Planting native trees and shrubs along the stream and shoreline would increase the extent and species diversity on the site and create additional opportunities for foraging, nesting, cover, and refuge for a wide variety of species.

Potential Impacts on Special Aquatic Sites [Subpart E]:

1. **Sanctuaries and refuges [230.40]**
   Not applicable. This portion of Lake Washington is not designated by local, state or federal regulations to be managed principally for the preservation and use of fish and wildlife resources.
2. **Wetlands [230.41]**
   Not applicable. There are no wetlands present.
3. **Mud flats [230.42]**
   Not applicable. There are no mudflats present.
4. **Vegetated shallows [230.43]**
   Not applicable because there are no vegetated shallows present.
5. **Coral reefs [230.44**]
   Not applicable.
6. **Riffle and pool complexes [230.45]**
   Not applicable because there are no riffle/pools present.

Potential Effects on Human Use Characteristics [Subpart F]:

1. **Municipal and private water supplies [230.50]**
   The project would not impact water supply or other public utilities.
2. **Recreational and commercial fisheries [230.51]**
   There are no known commercial fisheries at or near the project area. Recreational and tribal harvest does occur in Lake Washington during sockeye years, if numbers are deemed to be sufficient. The sockeye recreational and tribal harvest is typically in mid to late July. It is not likely that the in-water work would occur during this harvest, since the lake levels would be too high. In addition, the project is expected to provide shallow water habitat for juvenile salmonids migrating along the lake Washington shoreline, thus improving fishing opportunities for sport and tribal fisherman in the long term. The Corps will coordinate with the Muckleshoot Tribe prior to construction to ensure that construction activities are coordinated with the tribe and impacts to tribal fishing are avoided and minimized.
3. **Water-related recreation [230.53]**
   The installation of the channel and bridge may result in increased interest in the site, and therefore, recreational use, including fishing, might increase. However, dense riparian plantings and fencing downstream of the bridge, where the majority of fish will be rearing, should discourage access.

4. **Aesthetics [230.53]**
   Creating a day-lighted creek and planting native vegetation along the newly created channel would greatly improve the visual and aesthetic appeal of the site.

   During excavation and construction of the site, the aesthetic quality of the general area could be reduced due to the noise and air emissions generated by the construction equipment, which may disturb recreational users of Be'er Sheva Park. However, these impacts would be temporary and highly localized.

5. **Parks, national and historic monuments, national seashores, wilderness areas, research sites and similar preserves [230.54]**
   No such structures or areas are designated in the project area.

Evaluation and Testing [Subpart G]:

1. **General evaluation of dredged or fill material [230.60]**
   All imported material would be free from contamination.
2. **Chemical, biological, and physical evaluation and testing [230.61]**
   Water quality sampling would be conducted according to the protocol approved by the Washington Department of Ecology for the following parameters: turbidity, dissolved oxygen, and pH. Construction could be halted if deemed necessary under the water quality sampling plan in compliance with the Section 401 Water Quality Certification.

Actions to Minimize Adverse Effects [Subpart H]:

1. **Actions concerning the location of the discharge [230.70]**
   Discharge would be at channel bottom below the ordinary high-water mark. It would utilize methods that minimize the likelihood of turbidity increases in Lake Washington during the activity and comply with all permit protocols and restrictions.
2. **Actions concerning the material to be discharged [230.71]**
   Material to be placed in the project area consists of a layer of a sand/gravel within the new channel, rounded riprap at the bridge abutments, and boulders placed to provide fish habitat.
3. **Actions controlling the material after discharge [230.72]**
   Material to be added to the site includes streambed sand/gravel, rounded riprap, and boulders. There may be a pulse of sedimentation following diversion of the stream into the new channel resulting in short term turbidity increases as the streambed adjusts to the new flow. Localized shifting of sediments may continue sporadically as the new stream adjusts.
4. **Actions affecting the method of dispersion [230.73]**
   See above.
5. **Actions related to technology [230.74]**
   No technologies would be used to construct this site.

6. **Actions affecting plant and animal populations [230.75]**
   USACE has coordinated construction activities with local Native American Tribes and state and Federal resource agencies to ensure that minimal impacts to fishery and wildlife resources would occur. The in-water portions of project construction would take place during the designated fish window and during lower Lake Washington water levels to avoid impacts to fish. Providing rearing gravel and sand, increasing shallow water habitat, and planting the banks with native vegetation, is expected to lead in an increase in habitat value for aquatic biota. A Corps biologist would check for perched bald eagles before construction begins to avoid and minimize disturbance due to large machinery. Work would be delayed if it appears that there would be a disturbance to eagles. If necessary, fish rescue would take place during the installation of the isolation devices to be used during inlet/outlet construction and watering of the channel.

7. **Actions affecting human use [230.76]**
   The project will occur in a City of Seattle Park. A public playground, restroom, and boat lauch are present in the project area. The restoration projects will likely be utilized by humans for passive recreation.
8. **Other actions [230.77]**
   Best management practices would be used to ensure that impacts are minimized during construction.

General Policies for Evaluating Permit Applications [33 CFR §320.4]

1. **Public Interest Review [320.4(a)]**
   USACE finds this ecosystem restoration action to be in compliance with the 404(b)(1) guidelines and not contrary to public interest.
2. **Effects on wetlands [320.4(b)]**
   Not applicable as there are no wetlands present on the site.
3. **Fish and wildlife [320.4(c)]**
   USACE consulted extensively with state and federal resource agencies, tribes and other interested members of the public on this action.
4. **Water quality [320.4(d)]**
   The Corps concluded that this project would not violate state water quality standards and is seeking a Section 401 water quality certification from the Washington Department of Ecology under the conditions of a Nationwide Permit 27, Aquatic Habitat Restoration. The Corps will comply with all conditions set forth in the Certification.
5. **Historic, cultural, scenic, and recreational values [320.4(e)]**
   The Corps has determined that the project has No Potential to cause effects to Historic Properties under the NHPA, as the area was created in modern times and there are no historic structures adjacent to the undertaking, or within immediate view sheds that are eligible for the National Register. This determination completes the NHPA process.

   The park will continue to be utilized for recreational purposes. The restoration portion of the park will likely be used by way of passive recreation, and should add to the scenic value of the park.

6. **Effects on limits of the Territorial Sea [320.4(f)]**
   Not applicable, since the project would not occur in coastal waters.
7. **Consideration of property ownership [320.4(g)]**
   Be'er Sheva Park is currently owned by the City of Seattle Parks Department. Federal involvement in ecosystem restoration is supported in law and Executive Order.
8. **Activities affecting coastal zones [320.4(h)]**
   The Corps has determined this project to be analogous to Nationwide Permit 27 (NWP 27), "Restoration". Under NWP 27, if an individual Section 401 certification is not triggered, the coastal zone consistency determination is considered to be consistent. An analysis of the coastal zone consistency determination for Mapes Creek has been completed.
9. **Activities in marine sanctuaries [320.4(i)]**
   Not applicable, since the area is not a marine sanctuary.
10. **Other federal, state, or local requirements [320.4(j)]**
    Concurrence with the Corps' determinations of **may affect, but not likely to adversely affect** for species that are federally listed as well as their critical habitat was received from USFWS on October 5, 2010, and from NMFS on October 4, 2010. The Corps received is seeking a Section 401 water quality certification from the Washington Department of Ecology under the conditions of a Nationwide Permit 27. The local sponsor, the City of Kent, would obtain all locally necessary permits including a Hydraulic Approval Permit with the Washington Department of Fish and Wildlife.
11. **Safety of impoundment structures [320.(k)]**
    Not applicable, since an impoundment structure is not being built.
12. **Water supply and conservation [320.4(m)]**
    No impacts to water supply are anticipated.
13. **Energy conservation and development [320.4(n)]**
    Not applicable.
14. **Navigation [320.4(o)]**
    This project should not interfere with navigation on Lake Washington as it will occur along the shoreline and all in-water work will be isolated.
15. **Environmental benefits [320.4(p)]**
    The project would create shallow water habitat and foraging area for juvenile salmonids migrating along the Lake Washington shorline. It would also include native plantings and LWD, both of which are integral to the development of salmonid and other wildlife habitat.
16. **Economics [320.4(q)]**
    No impacts to economics are anticipated.
17. **Mitigation [320.4(r)]**
    No mitigation is required on this project as there would be no impact to wetlands.

Appendix G4 Water Quality Certification

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Avenue SE • Bellevue, Washington 98008-5452 • (425) 649-7000

December 1, 2010

United States Army Corps of Engineers
Attn: Chemine Jackels
PO Box 3755
Seattle, WA 98124

RE: U.S. Army Corps of Engineers Reference #PL-10-09
Mapes Creek Stream Restoration Project, Seattle, King County, Washington

Dear Ms. Jackels:

Ecology has determined that the above project meets the requirements for Washington State 401 Water Quality Certification and Coastal Zone Management Act Consistency under NWP #27. Therefore, an individual 401 certification will not be required for this project.

Any changes to your project that would impact water quality should be submitted in writing to Ecology before work begins for additional review.

This letter does not exempt you from other requirements of federal, state, and local agencies.

Please contact me if you have any questions regarding this letter at (425) 649-7129 or e-mail rpad461@ecy.wa.gov.

Sincerely,

Rebekah R. Padgett
Federal Permit Manager
Shorelands and Environmental Assistance Program

e-cc: Larry Fisher, Washington Department of Fish and Wildlife
Karen Walter, Muckleshoot Indian Tribe

Appendix G5 Coastal Zone Consistency Determination

COASTAL ZONE MANAGEMENT ACT CONSISTANCY DETERMINATION

Mapes Creek Diversion and Channel Daylighting April, 2010

This restoration and rehabilitation of Mapes Creek is an activity undertaken by a Federal agency. The following constitutes a federal consistency determination with the enforceable provisions of the Washington Coastal Zone Management Program.

1. Introduction: The proposed Federal action applicable to this consistency determination is the diversion and channel daylighting of a section of Mapes Creek in mowed lawn area in Be er' Sheve Park, as described in the Environmental Assessment. This determination of consistency with the Washington Coastal Zone Management Act is based on review of applicable sections of the City of Seattle Shoreline Master Program. The determination of consistency is further confirmed through analogy to the provisions of the regional conditions under Nationwide Permit 27 pursuant to the Corps of Engineers' Clean Water Act Sec. 404 permitting program. The regional conditions under NWP 27 provide that the State of Washington has predetermined its concurrence that the diversion and channel daylighting project meeting NWP 27 parameters is consistent with the State's coastal management program as long as individual review under CWA Section 401 is not triggered. The consequent State predetermination of concurrence with a conclusion of consistency provides extrinsic validation for the Corps' analysis that follows.

2. State Of Washington Shoreline Management Program. Primary responsibility for implementation of the State of Washington Shoreline Management Act of 1971 has been assigned to local governments. The applicable local government office responsible for King County is the King County Department of Development and Environmental Services.

3. Description of the City of Seattle Plan. According to Seattle Municipal Code (SMC) 23.60, Mapes Creek is classified by the City and State as Shorelines of the State, and is zoned as Conservancy Recreation (code 23.60.360). The following environmentally critical areas occur in the parcel of land the project is located in (code 25.09): liquefaction zone, peat-settlement prone areas, wetlands, riparian corridor, and shoreline habitat buffers. The liquefaction zone code applies to structures/buildings therefore Mapes Creek will not be evaluated for consistency with this critical area code. The following outlines pertinent sections of the city of Seattle's program. The Corps of Engineers consistency determination is indicated in bold italics.

Chapter 23.60 Shoreline District
A. To be permitted in the Shoreline District, a use must be permitted in both the shoreline environment and the underlying land use zone in which it is located.

Consistent- the project type, ecosystem restoration, is a permitted use in the conservancy recreational zone.

B. Unless otherwise stated in this chapter all principal uses on waterfront lots shall be water-dependent, water-related or non-water-dependent with public access.

Consistent- the purpose of this project is to create a stream mouth along the Lake Washington shoreline and is therefore water-dependent.

C. Principal uses are permitted in the respective shoreline environments in accordance with the lists of permitted and prohibited uses in the respective environments and subject to all applicable development standards. If a use is not identified in this chapter and is permitted in the underlying zone, it may be authorized as a conditional use by the Director in specific cases upon approval by the Department of Ecology when the criteria contained in Section *23.60.034* are satisfied.

Consistent- the primary purpose of this project is ecosystem restoration which is permitted as a use in the conservancy recreation zone.

All uses and developments shall be subject to the following general development standards:

A. The location, design, construction and management of all shoreline developments and uses shall protect the quality and quantity of surface and ground water on and adjacent to the lot and shall adhere to the guidelines, policies, standards and regulations of applicable water quality management programs and regulatory agencies. Best management practices such as paving and berming of drum storage areas, fugitive dust controls and other good housekeeping measures to prevent contamination of land or water shall be required.

Consistent- the project is not expected to impact ground water quality or quantity. Best management practices will be implemented during construction to adhere to water quality standards including silt fencing, straw wattles, a coffer dam, temporary erosion control mats, and settling ponds for pumping turbid water.

D. The release of oil, chemicals or other hazardous materials onto or into the water shall be prohibited. Equipment for the transportation, storage, handling or application of such materials shall be maintained in a safe and leak proof condition. If there is evidence of leakage, the further use of such equipment shall be suspended until the deficiency has been satisfactorily corrected.

Consistent- construction equipment will be inspected for leaks daily, fuel clean-up kits will be kept on site, drive train will not operate in the water, and biodegradable hydraulic fluid will be used.

E. All shoreline developments and uses shall minimize any increases in surface runoff, and control, treat and release surface water runoff so that receiving water quality and shore properties and features are not adversely affected. Control measures may include, but are not limited to, dikes, catch basins or settling ponds, interceptor drains and planted buffers.

Consistent- *the completed project will not increase surface runoff*; *best management practices will be implemented during construction to adhere to water quality standards including silt*

fencing, straw wattles, a coffer dam, temporary erosion control mats, and settling ponds for pumping turbid water. In addition, Storm water Pollution Prevention Plan will be developed prior to construction.

F. All shoreline developments and uses shall utilize permeable surfacing where practicable to minimize surface water accumulation and runoff.

Consistent- no impervious surfaces will be constructed as a part of this project.

G. All shoreline developments and uses shall control erosion during project construction and operation.

Consistent-silt fencing, temporary erosion control mats will be used and great care will be given to only disturb areas required for project construction. All disturbed areas will be planted with native vegetation, and the appropriate locations will be hydroseeded.

H. All shoreline developments and uses shall be located, designed, constructed and managed to avoid disturbance, minimize adverse impacts and protect fish and wildlife habitat conservation areas including, but not limited to, spawning, nesting, rearing and habitat areas, commercial and recreational shellfish areas, kelp and eel grass beds, and migratory routes. Where avoidance of adverse impacts is not practicable, project mitigation measures relating the type, quantity and extent of mitigation to the protection of species and habitat functions may be approved by the Director in consultation with state resource management agencies and federally recognized tribes.

Consistent- the purpose of this project is to restore a stream mouth thus creating shallow water and riparian habitat for aquatic species including fish, birds, amphibians, and small mammals. Disturbances to wildlife may occur during construction, but they will be temporary and the overall effect to wildlife will be beneficial. Work windows issued by WDFW will be adhered to minimize impacts to wildlife.

I. All shoreline developments and uses shall be located, designed, constructed and managed to minimize interference with or adverse impacts to beneficial natural shoreline processes such as water circulation, littoral drift, sand movement, erosion and accretion.

Consistent- the project will daylight creek and create a natural stream mouth along the Lake Washington shoreline and therefore improve natural shoreline processes

J. All shoreline developments and uses shall be located, designed, constructed and managed in a manner that minimizes adverse impacts to surrounding land and water uses and is compatible with the affected area.

Consistent- the current landuse is recreation, and a habitat restoration project can be used for passive recreation. A small pedestrian bridge will cross the creek allowing for its enjoyment. The new creek mouth along the Lake Washington shoreline should not interfere with water uses.

K. Land clearing, grading, filling and alteration of natural drainage features and landforms shall be limited to the minimum necessary for development. Surfaces cleared of vegetation and not to be developed shall be replanted. Surface drainage systems or substantial earth modifications shall be professionally designed to prevent maintenance problems or adverse impacts on shoreline features.

Consistent- grading of the park will be limited to the amount necessary to create a creek that will maintain a surface connection with Lake Washington and maintain sufficient depth and flows for juvenile salmonids. Only invasive vegetation will be removed from the site, and native vegetation will be planted along the shoreline and riparian zone of the newly daylighted creek.

L. All shoreline development shall be located, constructed and operated so as not to be a hazard to public health and safety.

Consistent- the creation of the creek through the park will not pose a hazard to public safety. A maximum of 11 cfs will enter the creek and a pedestrian bridge will provide safe access across. Fencing will limit access to the lower half of the creek, further reducing potential hazards to the public.

M. All development activities shall be located and designed to minimize or prevent the need for shoreline defense and stabilization measures and flood protection works such as bulkheads, other bank stabilization, landfills, levees, dikes, groins, jetties or substantial site regrades.

Consistent- no shoreline defense structures will be necessary for this project.

N. All debris, overburden and other waste materials from construction shall be disposed of in such a way as to prevent their entry by erosion from drainage, high water or other means into any water body.

Consistent- all excavated material that is necessary for construction of the stream will be disposed of at on off-site upland location.

SMC 23.60.360 Uses permitted outright in the CR Environment.

The following uses shall be permitted outright in the Conservancy Recreation Environment as either principal or accessory uses:

A. Shoreline recreation uses except auto-trailered boat launching ramps; and

B. Aquaculture.

Consistent- the project is habitat restoration and can be utilized for passive recreation.

E. Dredging necessary for water-dependent uses, installation of utility lines or creation of wildlife or fisheries habitat as mitigation or enhancement; and

Consistent- the project will create wildlife and fisheries habitat.

F. The following types of landfill:

2. Landfill for the creation of wildlife or fisheries habitat as mitigation or enhancement

Consistent- a sand/gravel substrate will be placed in the newly daylighted creek to serve as fish habitat.

The following uses shall be prohibited as principal uses in the CR Environment:

A. Residential uses except those permitted by Section *23.60.365* A;

B. Commercial uses except those specifically permitted by Section *23.60.365* C;

C. Utility uses except utility lines;

D. Manufacturing uses;

E. High-impact uses;

F. Institutional uses except community clubs meeting the criteria of Section *23.60.365* C;

G. Public facilities not authorized pursuant to Section *23.60.370*;

H. Parks and open space uses except shoreline recreation uses permitted by Section *23.60.360* A;

I. Agricultural uses except aquaculture;

Consistent- none of the above are primary uses of the project (see exception in H., project will be used as passive recreation).

A. All developments in the CR Environment shall be located and designed to minimize adverse impacts to natural areas of biological or geological significance and to enhance the enjoyment by the public of those natural areas.

Consistent- the purpose of this project is to restore a stream mouth thus creating shallow water and riparian habitat for aquatic species including fish, birds, amphibians, and small mammals. The public can enjoy this newly created natural area through passive recreation.

B. Development in critical natural areas shall be minimized. Critical areas include: Salt or fresh water marshes, swamps, bogs, eel grass areas, kelp beds, streams, fish spawning areas and other habitats.

Consistent- the project will create a natural stream corridor and mouth in an area that is currently a mowed lawn. No critical natural areas will be degraded.

A. Public Property. Public access meeting the criteria of Section *23.60.160* shall be provided and maintained on all publicly owned and publicly controlled waterfront property whether leased to private lessees or not, except where the property is submerged land which does not abut dry land.

Consistent- the property is currently a City of Seattle Park and therefore has public access. Public access will still be maintained after the construction of the stream channel. A small pedestrian bridge will allow for crossing the stream and benches will provide public enjoyment of the site.

Chapter 25.09 Regulations for Environmentally Critical Areas

The following general development standards apply to development on parcels containing environmentally critical areas or their buffers, except as specifically provided in this chapter:

A. Any required non-disturbance area shall be legibly shown and described on the site plan, and a covenant shall be required as set out in Section *25.09.335*.

Consistent- there are no non-disturbance areas on the site.

B. The project shall avoid adverse impacts from development on environmentally critical areas and buffers, and the Director shall restrict developmental coverage and construction activity areas to the most environmentally suitable, naturally stable, and least sensitive portion of the site in order to protect the ecological functions and values of wetlands and fish and wildlife habitat areas, prevent erosion from development on steep slope areas, and protect the public health, safety and welfare in landslide-prone, liquefaction-prone, and flood-prone areas. Grading activities and impervious surfaces that may impact environmentally critical areas or buffers shall be kept to a minimum and limited to areas approved by the Director.

Consistent- the site is currently a mowed lawn in a public park. The purpose of this project is to restore a section of stream and its mouth thus creating shallow water and riparian habitat for aquatic species including fish, birds, amphibians, and small mammals. No structures will be built that would be impacted by liquefaction, landslides, erosion, or floods. The only grading that will take place will be what is necessary to maintain a surface connection between Lake Washington and the stream, and water depths and flow suitable for juvenile salmonids.

D. All buffers and designated non-disturbance areas shall be fenced with a highly visible and durable protective barrier during construction to prevent access and to protect environmentally critical areas.

Consistent- no buffers are located in the project area, as the site is a mowed lawn in a public park.

E. All site clearing on the lot that may impact environmentally critical areas or buffers shall be carried out in stages just prior to construction, and cleared areas shall be kept to the minimum for construction. Revegetation shall occur after the particular phase of construction is completed. When required by the Director, a tree and revegetation plan shall establish a staged vegetation removal and replacement program that keeps the amount of exposed soil during and after construction to a minimum. In drier months, temporary surface irrigation or temporary installation of intermediate plantings may be required until weather or seasonal conditions permit installation of the permanent plantings.

Consistent-the current project location is a mowed lawn in a public park. Site clearing will be limited to the minimum area required for construction. Only invasive vegetation will be removed from the site, and native vegetation will be planted along the shoreline and riparian zone of the newly daylighted creek.

G. All grading in environmentally critical areas shall be completed or stabilized by October 31st of each year unless the applicant demonstrates to the satisfaction of the Director based on approved technical analysis that no environmental harm or safety problems would result from grading between October 31st and April 1st. This provision does not apply to grading in liquefaction-prone areas and abandoned landfills environmentally critical areas unless the parcel contains another environmentally critical area.

Consistent- grading will take place during the dry season. If grading is necessary during the wet season than BMPs will be implemented to control runoff. The initial connection of the creek will occur during the designated fish window (July 16th-December 31st), likely in the fall when the lake levels are lower. In addition, a Stormwater Pollution Prevention Plan will be developed prior to construction.

H. Best management practices shall be used for all construction activity on parcels with or adjacent to environmentally critical areas or buffers to prevent sediment and other pollutants from entering the riparian corridor watercourses or other fish and wildlife habitat conservation areas on or off the property. Best management practices include, but are not limited to, installation of siltation barriers, diversion measures, slope drains, and structural, vegetative stabilization techniques and other methods prescribed in Chapters 22.800 through 22.808, the Stormwater Code.

Consistent- Best management practices will be implemented during construction to adhere to water quality standards including silt fencing, straw wattles, a coffer dam, temporary erosion control mats, and settling ponds for pumping turbid water. The shoreline and riparian corridor will be planted with native vegetation following construction of the stream.

I. The Director may require an erosion control plan and a tree and revegetation plan when erosion potential is severe. The erosion control plan shall be consistent with best management

practices, and best management practices shall be followed in implementing it. The tree and revegetation plan shall be prepared by a qualified professional with landscaping, plant ecology and botany education and experience. All revegetation shall consist of native vegetation.

Consistent- Best management practices will be implemented during construction to adhere to water quality standards including silt fencing, straw wattles, a coffer dam, temporary erosion control mats, and settling ponds for pumping turbid water. The shoreline and riparian corridor will be planted with native vegetation following construction of the stream.

J. The site, including developmental coverage and construction activity areas, shall be managed in a manner sufficient to control stormwater and prevent erosion during construction, and shall be revegetated to promote stormwater control and prevent erosion after construction, consistent with Chapters 22.800 through 22.808, the Stormwater Code.

Consistent- A Stormwater Pollution Prevention Plan will be developed and a NPDES permit will be obtained prior to construction. Only invasive vegetation will be removed from the site, and native vegetation will be planted along the shoreline and riparian zone of the newly daylighted creek

L. Pesticides and fertilizers shall not be applied within (50) feet of a riparian corridor watercourse, wetland or shoreline except as allowed by the Director for the following circumstances and when allowed pesticide applications will be done by a licensed applicator:

> 2. A county, state, or federal agency with jurisdiction directs their use for control of a state listed noxious weed or plant pests covered by the Washington State Department of Agriculture plant pest program, and when non-chemical alternatives have been evaluated

Consistent- pesticides and fertilizers will be avoided. In some cases approved pesticides may be applied to aggressive invasive plant species if it is determined that physical removal will not be sufficient.

N. The Director may require additional construction practices and methods and requirements, including, but not limited to best management practices as outlined in federal, state and Seattle manuals, and limitations on construction equipment permitted on the site, to protect environmentally critical areas and buffers on and off the property.

Consistent- Best management practices will be implemented during construction to adhere to water quality standards including silt fencing, straw wattles, a coffer dam, temporary erosion control mats, and settling ponds for pumping turbid water. In addition, a Stormwater Pollution Prevention Plan will be developed prior to construction.

A. The general development standards set out in Section *25.09.060* do not apply to peat settlement-prone areas.

B. A geotechnical study detailing the location of the annual high static groundwater level is required for development in peat settlement-prone areas that involve excavation more than thirty (30) inches below the existing grade.

Consistent- the annual high static groundwater is known and is not expected to be impacted by the project. No structure will be built on site, and therefore there are vulnerabilities to groundwater levels.

C. No development shall occur within a peat settlement-prone area below the annual high static groundwater level except to the minimum extent the Director deems necessary to allow the following:

5. Aquatic habitat restoration;

Consistent- the project is aquatic habitat restoration.

D. Groundwater collection systems are prohibited in peat settlement-prone area unless otherwise required by law.

Consistent- no groundwater collection systems are proposed as a part of this project.

E. Development in a Category I peat settlement-prone area shall not increase the total impervious surface on the site unless the Director approves using an infiltration facility or soil amendments that offset the lost infiltration function. The Director may waive this requirement to the extent offsetting the lost infiltration function would adversely affect a landslide-prone area or steep slope area.

Consistent- there will be no increases in impervious surfaces resulting from this project.

F. For construction activity in a peat settlement-prone area, the Director may require additional construction practices, methods, and restrictions that limit temporary groundwater de-watering.

Consistent- the project should not result in temporary groundwater de-watering.

G. In a peat settlement-prone area, land-disturbing activities with the potential to modify the groundwater regime are limited to the minimum reasonably necessary for development. Surface drainage systems or substantial earth modifications shall be professionally designed to prevent maintenance problems and adverse impacts to off-site parcels.

Consistent- the construction of the new stream should not modify the groundwater regime since the groundwater is close to the surface as indicated by the pooling of water in the low point of the park (where the daylighted stream will be located).

A. Wetlands are rated according to the Washington State Wetland Rating System for Western Washington (Ecology Publication #04-06-25). Illegal grading, filling, draining, or other development will not result in a change to that wetland's rating. Wetlands constructed for mitigation or replacement purposes are subject to the provisions of this chapter.

Consistent- although the parcel the project is located in has mapped wetlands and the project is within 100 feet of wetlands along the Lake Washington shoreline, the project itself does not overlap with wetlands. The project location is in a mowed grassy area in a Seattle Park.

B. Impacts to Wetlands.

1. Development, including but not limited to grading, filling, or draining, is prohibited within or over:

Consistent- although the parcel the project is located in has mapped wetlands and the project is within 100 feet of wetlands along the Lake Washington shoreline, the project itself does not overlap with wetlands. Therefore there will be no grading, filling, or draining in wetlands. .

4. Removal of, clearing, or any action detrimental to habitat, trees or vegetation in wetlands is prohibited, except as provided Section *25.09.320*.

Consistent- although the parcel the project is located in has mapped wetlands and the project is within 100 feet of wetlands along the Lake Washington shoreline, the project itself does not overlap with wetlands. Therefore there will be no grading, filling, or draining in wetlands.

C. Wetland Buffers and Mitigation.

2. Development is prohibited in wetland buffers, except as approved by the Director under subsection 25.09.160.D.

Consistent- although the project is a parcel zoned as a wetland buffer area, the project itself is currently in grassy mowed area. No wetland buffers will be affected. The stream restoration will include native plantings that will provide much more function as a wetland buffer than what is currently there.

4. Buffer Vegetation.

a. Removal of, clearing, or any action detrimental to habitat, trees or vegetation in the wetland buffer is prohibited, except as provided in subsection D and Section *25.09.320*.

Consistent- Only invasive vegetation will be removed from the site, and native vegetation will be planted along the shoreline and riparian zone of the newly daylighted creek.

b. Invasive plants and noxious weeds may be removed by hand. No machines or chemical removal shall be permitted without the Director's approval.

Consistent- Only invasive vegetation will be removed from the site, and will be done by hand.

D. Buffer Averaging and Buffer Reductions

2. Buffer Reductions.

Consistent- the project will not result in any buffer reductions.

E. Avoidance and Mitigation Standards

1. The standards for wetland mitigation shall be applied in following order of priority:

a. avoid the impact to the extent practicable by not taking all or part of an action;

b. keep the impact to a minimum by limiting the degree or magnitude of the action and its implementation, and by taking affirmative actions to mitigate the impact over time; and

c. mitigate unavoidable impacts to the designated uses of a wetland by replacement, enhancement, or other approved compensation methods.

Consistent- this project avoids impacts to wetlands and therefore no mitigation is necessary.

A. 1. Removing, clearing, or any action detrimental to habitat, vegetation or trees is prohibited, except as provided below, within the following areas: landslide-prone critical areas, (including steep slopes), steep slope buffers, riparian corridors, shoreline habitat, shoreline habitat buffers, wetlands, and wetland buffers.

Consistent- Only invasive vegetation will be removed from the site, and native vegetation will be planted along the shoreline and riparian zone of the newly daylighted creek.

2. Tree-topping is prohibited.

Consistent- no tree topping will result from the project.

3. The vegetation and tree removal and revegetation activities listed in subsections 3a -- d are allowed. The application submittal requirements and general development standards in Sections *25.09.330* and *25.09.060* do not apply to actions under subsections 3a, b(1), c(2)(a) or d, provided that no other development is carried out for which a permit is required.

c. Restoring or improving vegetation and trees, including removing non-native vegetation or invasive plants and noxious weeds by hand, to promote maintenance or creation of a naturally functioning condition that prevents erosion, protects water quality, or provides diverse habitat

Consistent- Only non-native vegetation will be removed from the site, and will be done by hand. The native vegetation will be planted along the shoreline and riparian zone of the newly daylighted creek is a part of the project purpose to provide habitat to aquatic species.

Based on the above evaluation, it is determined that the proposed rehabilitation activities comply with the policies, general conditions, and activities as specified in the King County Shoreline Master Program. The proposed action is considered to be consistent to the maximum extent practicable with the State of Washington Shoreline Management Program and policies and standards of the King County Shoreline Master Program.

Appendix G6 Fish Wildlife Coordination Act Compliance

Chemine
I talked to both Karen and Jim about this project. Given the location (Lake Washington) and the fact that this is a fairly small restoration project in an urban setting, we don't have any issues or concerns with the alternatives that you are considering or the project as a whole. So, we are declining to provide a formal planning aid or report for this project. I hope this reply will suffice with regards to meeting your obligations under the Fish and Wildlife Coordination Act.

_____

Martha Jensen
Branch Manager,
Division of Consultation and Technical Assistance Washington Fish and Wildlife Office 510 Desmond Dr SE Lacey, WA 98503
tel: (360) 753-9000/ fax: (360) 753-9008 martha_l_jensen@fws.gov

Jackels, Chemine R NWS" <Chemine.R.Jackels@usace.army.mil>

08/30/2010 02:05 PM To
<Martha_L_Jensen@fws.gov>
cc
Subject
RE: Draft Upper Springbrook Creek EA

Hi Martha/Karen-

I would like to set up a site visit for Mapes Creek with agency staff including USFWS, WDOE, WDFW, and the Muckleshoot Tribe. Is Karen the official USFWS staff member assigned to the project?

Thanks,
Chemine

Appendix H Corps Cost Opinion

This document is not available for public comment

Appendix I Real Estate

This document is not available for public comment

Appendix J Public Comments with Corps and Seattle Public Utilities Reponses

To be included after public comment period closes, when the Environmental Assessment is finalized.