U.S. Army Corps
of Engineers
Seattle District

Green/Duwamish River Basin Ecosystem Restoration Study

King County, Washington

Final Feasibility Report

October 2000

Executive Summary

The purpose of this study is to investigate ecosystem restoration opportunities in the Green/Duwamish River basin and recommend an alternative for implementation. The Green/Duwamish River basin has experienced significant degradation of its habitats, water quality and ecosystem functions and processes. To date, 97% of the estuary has been dredged or filled, 70% of the watershed (and flows) has been diverted out of the basin, and about 90% of the floodplain is no longer connected to the river. The Green/Duwamish River Basin is still an important producer of fish and wildlife resources, but plant and animal populations continue to decline and two species of fish have been listed as threatened and endangered species: chinook salmon (endangered) and bull trout (threatened). Without action, many of the fish and wildlife resources of the basin will continue to decline, likely to the point of extinction. Although numerous environmental problems exist in the basin, significant opportunities to restore fish and wildlife habitat and ecosystem functions and processes still remain. This ecosystem restoration plan seeks to: 1) enhance the physical nature of existing degraded habitats; 2) improve existing ecosystem functions and processes, 3) address limiting factors to fish and wildlife production, and 4) restore habitats for anadromous fish.

Restoration features at sixty-seven projects were developed and evaluated to determine the most cost effective and beneficial plan to recommend for restoration of the basin ecosystem. The recommended plan would implement a combination of 45 project-specific and programmatic restoration measures throughout the basin. This recommended National Ecosystem Restoration Plan was selected based upon cost effectiveness and incremental cost evaluation of alternative's costs and environmental outputs. The recommended NER Plan restores aquatic and terrestrial ecosystem continuity and connectivity and addresses all limiting habitat factors for threatened and endangered salmonids within the basin.

The estimated cost for the recommended plan is $115,879,400 (October 2000 price level), including preconstruction engineering and design (PED), lands, easements, rights-of-way, relocations, and disposal (LERRD), supervisory and administrative costs (S&A), construction management, and monitoring. The recommended National Ecosystem Restoration Plan restores over 1900 acres of habitat throughout the basin. The federal share is $75,321,610 and the non-federal sponsor share is $40,557,790 (cash share is $3,447,415 and LEERD value is estimated at $37,110,375). All costs presented in this report are in October 2000 price level. The Plan was formulated consistent with planning guidance in Corps Engineering Regulation 1105-2-100, applicable federal laws, and executive orders. The Plan addresses requirements of environmental protection statutes regarding actions taken to comply with the Fish and Wildlife Coordination Act, the Endangered Species Act, and the National Historic Preservation Act. The requirements of Section 404(r) of Public Law 92-500, as amended, have been met. For this project the monitoring costs exceed the Corps recommended 1% guidance. This report presents the case for this level of monitoring effort.

The sponsor, King County, has requested that congress give them the authority for in kind credit during the Preconstruction Engineering and Design and the Construction phase of this project.

Plan formulation and review included coordination and participation from King County, Cities of Tukwila, Kent, Auburn, Seattle, Tacoma and Renton, U.S. Fish & Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Washington Department of Fish and Wildlife (WDFW), Washington Department of Ecology (WDOE), U.S. Environmental Protection Agency (USEPA), Trout Unlimited, Green/Duwamish Watershed Alliance, Friends of the Green River, and Rainier Chapter of the Audubon Society.

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1. INTRODUCTION

This report is a feasibility level report for an Ecosystem Restoration Study in the Green/Duwamish River basin in King County, Washington. This study is cost-shared between the U.S. Army Corps of Engineers, Seattle District (Corps) and King County (County). A reconnaissance report was completed in 1997, at federal expense. That report demonstrated that there was a federal interest in conducting a feasibility study of ecosystem restoration alternatives.

1.1 Study Authority

Section 306, of the Water Resources Development Act (WRDA) of 1990 authorized the Secretary of the Army to include environmental protection as one of the primary missions of the U.S. Army Corps of Engineers. King County requested the Corps to initiate a planning study for ecosystem restoration in 1994. Congress initially authorized this study in the Energy and Water Development Appropriations Act of 1996 with an appropriation of $300,000 for a reconnaissance study as part of a General Investigation Study under Section 209 of Public Law (PL) 87-874, Puget Sound and Adjacent Waters. After completion of the reconnaissance phase in 1997, a Feasibility Cost Sharing Agreement and Project Study Plan were negotiated and agreed upon by the Corps and the County. The feasibility phase began in 1998.

The Corps has been involved in several flood control projects in the Green/Duwamish River basin. Howard Hanson Dam (HHD) was constructed in 1963 with the primary purposes of flood control and low flow augmentation during the summer months. The Corps maintains a navigation channel in the Duwamish River that is 5 miles in length. The Corps also has built several levees along the middle Green River from river miles (RM) 12.6 to 16.9 in Tukwila and from (RM) 24.3 to 25 in Kent. King County also has many levees along the middle Green River which are part of the PL 84-99 program.

1.2 Study Purpose and Scope

1.2.1 Project Need

The Green/Duwamish River watershed has one of the most highly altered hydrological ecosystems in the Puget Sound basin. To date, 97% of the Green/Duwamish River estuary wetlands have been dredged or filled, 70% of the historic flows from its former watershed have been diverted out of the basin, and about 90% of the floodplain is disconnected from the river (Fuerstenberg, et al, 1997). The Green/Duwamish River is still an important producer of fish and wildlife resources; however, many of the anadromous fish

in the watershed are now from hatchery production. The populations of native fish and wildlife continue to decline and the watershed is becoming increasingly urbanized. It is not likely that the ecosystem can ever be restored to a pristine condition, but important opportunities still exist to restore ecosystem functions and processes that will create and maintain natural habitats over time. Two anadromous salmon species have already been listed as threatened or endangered under the Endangered Species Act in Puget Sound and western Washington: chinook salmon and bull trout. It is expected that at least one other anadromous salmon species will be listed in the near future (coho salmon). Without restorative action, many of the fish and wildlife resources of the Green/Duwamish River basin will continue to decline, likely to the point of extinction.

1.2.2 Study Goals

The purpose of this feasibility study is to examine the restoration opportunities in the Green/Duwamish River ecosystem, determine the feasibility of restoring degraded ecosystem structures, functions and processes, evaluate potential projects using incremental cost analysis, and develop feasibility level designs and cost estimates for selected projects.

The ecosystem restoration goals of this study are to: 1) enhance the physical nature of existing degraded habitat; 2) improve existing ecosystem functions and processes; and, 3) address limiting factors to fish and wildlife production, and 4) restore degraded habitats for anadromous fish..

1.2.3 Specific Objectives

Specific elements of habitat degradation and limiting factors to fish and wildlife production have been evaluated by King County (Fuerstenberg, et al., 1996) and the U.S. Forest Service (1996) and can be classified as ten major resource problems within the basin (Table 1-1). As indicated in the Table, this study addresses nine of these resource problems.

Table 1-1. Resource Problems

Resource Problems	Issues Addressed in this Study
Lack of habitat in the Lower Green/Duwamish estuary	X
Changes in sediment loads and transport	X
Changes in flows	
Loss of channel complexity and in-channel structure	X
Water quality degradation	X
Barriers to fish passage	X
Floodplain disconnection	X
Habitat fragmentation	X
Degradation of wetlands and rare species habitats	X
Changes in forest structure and composition	X

1.3 Study Area

The Green River originates in the Cascade Range south of Stampede Pass at an elevation of about 4500 feet (ft) and flows northwest 90.5 miles to Elliott Bay in Puget Sound. The highest elevation in the basin is at 5750 ft on Blowout Mountain. The Green River becomes the Duwamish River at RM 11 where the historic Black River joins the Green River. The entire watershed is within King County, Washington. This study addresses the entire watershed from the headwaters to Elliott Bay. Since a major goal of this study is to restore ecosystem level functions and processes to the basin, effort has been made to ensure the entire watershed is evaluated.

1.4 Study Area Characteristics

1.4.1 Climate

The climate in the basin is a mid-latitude, west coast marine type characterized by cool wet winters and mild summers. The average rainfall in the basin ranges from 39 to approximately 100 inches annually. The urbanized lower elevation part of the basin receives the lower precipitation increasing up to the higher precipitation (rain and snow) near Stampede Pass. Approximately 75% of the precipitation falls between the months of October and April. The Cascades and the foothill portion of the basin are frequently subject to warm tropical rainstorms during the winter that cause rain-on-snow events. The

highest peak flows in the Green occur during rain-on-snow events. Over one third of the upper basin (above HHD) is within the rain-on-snow zone (USFS, 1996). The summer months from July through September are typically characterized by minimal, if any, precipitation; causing flows in the river to drop to minimums and water temperatures to increase.

1.4.2 Topography

The topography in the basin is quite varied. The upper basin is mountainous with steep terrain and narrow valleys; elevations range from 1000 to nearly 6000 ft. The upper basin has a drainage of 221 square miles, entirely within in the Cascade Range. Howard Hanson Dam is constructed at an elevation of approximately 1000 ft. Downstream of HHD, the river has a relatively steep gradient with boulders and cascades. Approximately five miles downstream of HHD, the river enters the 13-mile long Green River Gorge. The Green River has cut down through the erodable sandstone and mudstone and formed the gorge. The canyon walls are very high and nearly vertical, confining the river to a narrow, high velocity channel. Downstream of the gorge, the river flows through a moderate gradient valley where extensive braiding and channel movement used to occur, and landslides are still common. Most of the remaining side channels on the river occur in this middle basin. Downstream of Auburn (approximate elevation 330 ft), the river valley flattens out significantly and widens. The river flows sluggishly (less than 1% gradient) through the lower Green River valley confined almost entirely by levees, until it enters the zone of tidal influence at approximately RM 11.

1.4.3 Water Resources

Historically, the Cedar, Black, and White Rivers were all tributaries to the Green/Duwamish River (see plate 1-2). The White River (headwaters on Mt. Rainier) joined the Green/Duwamish River at Auburn through a channel called the Stuck River. The negligible elevation difference between the Green/Duwamish River and the Puyallup River basin near Auburn caused the White River to periodically flip back and forth between the two systems. After a large flood in 1906, King County, Pierce County and the Corps permanently diverted the White River into the Puyallup to reduce flooding in the Green/Duwamish valley. The Cedar River flowed into the Black River (which drained Lake Washington) near the south end of Lake Washington and the Black River flowed for about one mile joining the Green River to form the Duwamish River at Tukwila. At the time of the construction of the Hiram Chittenden Locks connecting Lake Washington to Puget Sound, the Cedar River was diverted into the Lake Washington basin and the Black River dried up due to the loss of the Cedar and the lowering of Lake Washington. The Black River now only contains minimal flow from localized surface runoff.

In 1913, the City of Tacoma completed a water diversion dam on the Green River near the town of Palmer. This diversion has a maximum capacity of 113 cfs. In 1962, the Corps built Howard Hanson Dam four miles upstream of the Tacoma diversion dam. The authorized purposes of HHD are to provide flood control and low flow augmentation. The maximum peak flow that now occurs is 12,000 cfs as measured at Auburn (approximately a 10-year flow). Minimum flows with the dam in place are now 110 cfs as measured at the Palmer gage (only fall below 150 cfs once in six years, below 100 cfs once in nine years). Prior to the dam, minimum flows were as low as 59 cfs and maximum flows were approximately 28,000 cfs. The Corps is currently in the preconstruction engineering and design phase of an additional water storage project to provide the City of Tacoma more water than they currently withdraw (113 cfs) and additional low flow augmentation. If this project is constructed, an additional 32,000 acre feet (ac-ft) of water will be stored by the dam, 22,400 ac-ft for water supply and 9,600 ac-ft for low flow augmentation. There are many additional water withdrawals downstream of the Tacoma diversion dam for agricultural and domestic uses. These legal withdrawals are approximately 13,500 ac-ft per year and occur primarily during the low flow period (Washington Dept. of Ecology water rights database cited in USACOE, 1997). A comparable amount of groundwater in the floodplain is also withdrawn. The volume of illegal withdrawals is unknown at this time.

The majority of the Green River and its tributaries are classified by the Washington State Department of Ecology as Class A waters (excellent). Class A waters support beneficial uses such as water supply, stock watering, fish and wildlife habitat and recreation. Generally, water quality in the basin mirrors the trend of urbanization along the river's course. Development is greatest in the lower half of the watershed and water quality is degraded. The Duwamish River (below RM 11) is designated as Class B (good) waters because of industrial contaminants. The Duwamish River has been listed on the state's 303(d) list of impaired waterways for over 35 industrial pollutants in the sediment and temperature, pH, dissolved oxygen (DO), ammonia and one industrial organic pollutant in water. The Green River has been listed for temperature, DO, fecal coliform and mercury in water.

1.4.4 Biological Resources

Historically, the Green/Duwamish River basin was heavily forested with evergreen coniferous trees and an understory of various shrubs, ferns and herbs. In the lower valley, patches of emergent wetland vegetation were interspersed with forested riparian (alder, willow, cottonwood) and swamp (cedar, spruce) patches. The Duwamish River meandered through an extensive estuarine zone with freshwater marsh transitioning into brackish and salt marsh with extensive mudflats. Fish species that were historically present in the basin included chinook, coho, sockeye, pink and chum salmon, steelhead and sea-run cutthroat trout, Dolly Varden and bull trout, resident rainbow and cutthroat trout, and about a dozen other resident fish (USFS, 1996; Chapman, 1981). Fish in the estuary included surf smelt, Pacific

herring, shiner perch, striped sea perch, pile perch, Pacific staghorn sculpin, starry flounder, white sturgeon and numerous other species. The estuary, marshy floodplain and forested basin would have been utilized by many species of migratory and resident waterfowl, songbirds, and raptors; large and small mammals, amphibians and reptiles.

Currently, the upper Green/Duwamish River basin has been extensively logged. Only about 10% of the old growth forest remains. The dominant coniferous species is Douglas fir of less than 100 years in age (primary species replanted on timberlands). Much of the formerly evergreen coniferous forest is also dominated by deciduous species such as big leaf maple and red alder. The middle Green/Duwamish River basin is primarily rural residential with agricultural lands, and commercial timber uses in the foothills. All forested areas are primarily deciduous (except timberlands) species such as big leaf maple and red alder. The lower Green/Duwamish River basin is highly urbanized along most of the river corridor, particularly in the lower 12 miles. Extensive levees line the river protecting residential, commercial and industrial properties adjacent to the river. Approximately 98% of the former estuarine wetlands and mudflats have been either dredged or filled in for industrial purposes (Blomberg, et al, 1988).

The Tacoma diversion dam blocks all access for anadromous salmon upstream of the dam, so has cut off more than 110 miles of river and stream habitat. The City of Tacoma traps adult steelhead and hauls them to the upper basin and the Washington Department of Fish & Wildlife (WDFW) and the Muckleshoot Indian Tribe (MIT) also plant juvenile coho and chinook in the upper basin. Three fish hatcheries are located in the basin, the Green River Hatchery and the Palmer Hatchery, operated by the WDFW and the Keta Creek Hatchery, operated by the MIT. Plants of salmon species have occurred from many other basins as well. A fourth hatchery is proposed as part of the future City of Tacoma water withdrawals. The existing status of most of the salmon species in the basin is that they are declining, and mixed between wild and hatchery production (SASSI, 1992). Currently four major species of anadromous salmon utilize the Green/Duwamish River downstream of the Tacoma diversion dam: chinook, coho and chum salmon and steelhead trout. Small numbers of sockeye and pink salmon and sea-run cutthroat are periodically observed. Bull trout or Dolly Varden have not been observed in recent years.

The middle Green/Duwamish River has moderately good habitat available for salmon species with some natural side channels and the only unleveed sections of the river. Resident fish in the estuary are subjected to a variety of chemical pollutants and have high rates of lesions and other diseases. Anadromous salmon do not spend a lot of time in the estuary because there is very little habitat available for them. Puget Sound chinook salmon and western Washington bull trout are currently listed as threatened species under the Endangered Species Act.

1.4.5 Socio-Economic Resources

The Green/Duwamish River valley was among the first areas of Puget Sound to be extensively settled by European-American immigrants. The vast valley provided abundant land for agriculture. Growth has continued unabated since the mid 1800s. The Green/Duwamish River basin now includes the cities of Enumclaw, Auburn, Kent, Renton, Tukwila, Sea-Tac, Burien, Black Diamond, Seattle and the Muckleshoot Indian Reservation. The larger population centers, along with the industrial, commercial, and residential land uses, are concentrated in the lower basin. Agriculture is still a major land use in the middle Green River basin. Timber harvesting is the major land use in the upper basin. The middle Green River is used extensively for recreational purposes, particularly the Green River Gorge. Several state and county parks are located upstream of Auburn where fishing, floating, canoeing, kayaking and hiking are popular activities. A bike trail system has been constructed along the top of the extensive levee system in the lower portion of the basin.

2. EXISTING PROJECTS, PRIOR STUDIES, AND REPORTS

2.1 Howard Hanson Dam

Howard Hanson Dam was completed in 1963 at RM 64.5 on the Green River. The primary purposes of the dam are flood control and low flow augmentation in the summer. Two secondary uses are authorized but have not been utilized, to date: irrigation and water supply. The typical maximum storage is 25,400 acre feet of water, which is used to provide a steady minimum flow of water throughout the summer months. In the winter, the reservoir is drained to provide a flood pocket for flood control purposes. Construction of the dam has eliminated coarse sediment and large woody debris (LWD) movement from the upper basin to the middle basin, reducing the volume of spawning gravels and habitat forming LWD in the lower river. A Section 1135 project has been approved to store an additional 5,000 ac-ft of water in the reservoir for additional low flow augmentation in the lower river. A feasibility report/EIS has been completed for an additional water supply project to provide more storage for water supply purposes.

2.2 Lower Green River Flood Control Section 205

The Corps constructed improvements to an existing private levee system in the City of Tukwila in 1990. The project included increasing the height of the existing levees for 3.5 miles.

2.3 Horseshoe Bend Section 205

The Corps constructed levee improvements along about 2/3 mile of the Green River near the City of Kent in 1996. This project raised and widened the levee to provide more flood control and stability. The project will be maintained by the Green River Flood Control Zone District.

2.4 Non-Federal Levees

Many miles (>30 miles) of non-federal levees exist along both banks of the Green/Duwamish River. These levees are variously owned and maintained by King County, City of Auburn, City of Kent, City of Tukwila, and private landowners. Many of these levees are in the federal PL 84-99 program.

2.5 Prior Corps Studies and Reports

2.5.1 Green-Duwamish River Basin General Investigation Ecosystem Restoration Reconnaissance Study Report, 1997.

The Reconnaissance report for this study evaluated the potential for ecosystem restoration in the Green-Duwamish River basin. The study evaluated over fifty potential restoration projects throughout the basin that would address a variety of the limiting factors to fish and wildlife production. The majority of those projects warranted further investigation in the feasibility phase and a few of the projects were pulled out of the general investigation study for quicker implementation under the Section 1135 authority. The estimated cost for implementation of the selected projects was $126 million.

2.5.2 Turning Basin Section 1135 Environmental Restoration Report, 1998.

Under Section 1135 of WRDA 1986, a fish and wildlife habitat restoration project was approved for implementation in the lower Duwamish River. King County is the local sponsor for this project, and the Seattle City Light owns the property utility. This project included removing a large quantity of fill material that had been placed in the former mudflats or marshes of the Duwamish estuary in order to develop the land for industrial purposes. After fill was removed, the lowered portion of the property is now an intertidal mudflat with emergent salt marsh habitat. Additionally, a small tributary to the Duwamish River (Hamm Creek) was "daylighted" out of a culvert and flows through the property. The property has been revegetated with native trees, shrubs and emergent species.

2.5.3 Howard Hanson Dam Section 1135 Fish and Wildlife Restoration Project Final Project Modification Report/Environmental Assessment.

Under Section 1135, a fish and wildlife habitat restoration was approved for implementation at HHD. The City of Tacoma Public Utilities is the sponsor for this project and the Corps owns the property. This project included providing additional water storage (5,000 ac-ft) for low flow augmentation below HHD during drought years (1 out of 5 years on average), an adaptive refill/storage regime to reduce effects on downstream smolt migration and steelhead spawning, and physical habitat improvements in the reservoir. This project is being recommended for construction.

2.5.4 Howard Hanson Dam Additional Water Storage Project Feasibility Report and Environmental Impact Statement, 1999.

This study evaluated alternatives for providing additional storage of water in the reservoir for water supply purposes for the City of Tacoma. The recommended alternative is a two-phased project that will store an additional 20,000 ac-ft of water for water supply in Phase 1 and in Phase 2 will store 2,400 acre-ft for water supply and 9,600 ac-ft for low flow augmentation. Mitigation will be required for this additional storage volume and will include features such as fish passage facilities at HHD, habitat restoration upstream and downstream of the reservoir. This project will likely be implemented beginning in 2001.

2.5.5 Seaboard Lumber Project Section 22 Aquatic Habitat Restoration Analysis, 1995.

This project evaluated the existing condition of a former industrial project on the Duwamish River and developed habitat restoration recommendations for the Muckleshoot Indian Tribe. The recommended option was to remove fill to bring the project down to intertidal elevations and create a diversity of intertidal habitats including high salt marsh, low salt marsh and mudflat.

3. BASELINE CONDITIONS

3.1 Existing Conditions

3.1.1 Geology and Soils

Surface soils have developed from the weathering of primarily glacial and volcanic materials. The three regions of the basin have distinctly different soils and soil forming processes. The upper Green River basin ranges from 1000 to nearly 6000 feet in elevation, which is generally lower in elevation than other watersheds that begin in the Cascade Mountains. Alpine glaciation has not been present in recent history. Recent volcanic activity from Mt. Rainier depoprojectd ash and pumice in many areas of the upper watershed. The bedrock materials are also generally volcanic in origin, and composed of basalts and andeprojects mixed with tuffs and breccias (USSCS, 1992). Soils are generally formed from the weathering of volcanic materials mixed with some older continental glacial deposits and colluvium. Organic material is sparse and decomposes slowly at the higher elevations. Slopes in the upper basin can be quite steep. The potential for erosion hazard is high, and numerous landslides and mass wasting events have occurred, particularly after timber harvest and logging road construction. Many locations of bedrock outcrop also exist. Along the floodplain of the Green River and its tributaries, the soils are largely formed from alluvium. Soils can be quite deep in some locations.

The middle Green River basin has a geologic history of weathering, alluvial deposition, landslides, seismic events, mudflows from Mt. Rainier, and historic continental glaciation. Soils in the floodplain are predominantly composed of alluvium, except in the Green River Gorge. Upstream of Auburn, the floodplain soils are typically gravelly and sandy, whereas, downstream of Auburn there is a high percentage of silts and finer materials washed down from the Osceola mudflow soils. Much of the river below HHD is currently lacking in spawning gravels. The middle Green River area is subject to landslides from the steep banks in and near the Gorge. A recurring landslide exists just downstream of Flaming Geyser State Park at RM 43, which continues to erode from an unstable ravine near the top of the 360-foot high valley wall. This landslide has contributed significant amounts of fine sediment to the River during every rainstorm in the last couple of years. The landslide has likely been moving for several hundred years and will continue to erode for perhaps several hundred more years. Other smaller landslides have occurred wherever high valley walls exist immediately adjacent to the River. Many of these landslides contribute a mix of fine and coarse materials to the river and promote natural sediment recruitment processes.

The lower Green/Duwamish River was once subject to tidal inundation nearly up to Auburn. The Osceola mudflow filled in much of this lower valley with several hundred feet of mud (Kruckeberg, 1991). The soils of this lower valley are poorly studied because there has been extensive urban and industrial development along the river for many years. It is expected that most of the soils were alluvial in nature with significant quantities of organic material from the floodplain swampland and marshlands. Fill material from other sources has been placed in most of the floodplain. The sediments in the estuary are contaminated with heavy metals, petroleum products and other organic materials.

3.1.2 Hydrology

The Green/Duwamish River is fed by runoff from rainfall, groundwater inflows, and snowmelt from the upper watershed. The flow regime is similar to other west slope Cascade fed rivers with a high peak from winter storms and a second lower peak from snowmelt runoff. Almost all large floods in the basin are caused by warm tropical storms with high rainfall causing significant snowmelt in the mountains (rain on snow events). These storms typically occur between the months of October through March.

Howard Hanson Dam provides flood protection up to the 100-year event (estimated to be approximately 28,000 cfs without the dam), and since 1963, there has not been more than a slight exceedance of the 12,000 cfs maximum as measured in Auburn. The primary difference between different recurrence interval floods, with the dam, is the duration of peak flows; the greater the flood event, the longer the duration of peak flows. Some localized flooding still occurs in unleveed portions of the basins, or from runoff behind the levees during flood events. The effect of the dam has been to limit overbank flooding downstream, preventing the formation of new natural side channels and other aquatic habitats. Additionally, the longer duration of moderately high flows (>8000 cfs) more effectively transports sediments through the river system, further contributing to the gravel starved condition of the river below the dam.

The dam is operated to store floodwaters during the winter, and the reservoir is typically drawn down to the minimum elevation (1070 ft) by November 1 each year. Normal river flows then pass through the outlet tunnel in the dam's left abutment; but when flood stage is reached, discharge from the dam is reduced and water is impounded in the reservoir. As the flood flows decline, discharge from the dam is held steady (up to 12,000 cfs as measured at Auburn) to draft the reservoir. The highest pool elevation that has been reached during a flood was 1183 ft, in 1996. To date, it has not been necessary to use the spillway above the tainter gates at elevation 1206 ft (maximum flood storage at elevation 1206 ft is 106,000 ac-ft). Spring refill operations occur from the middle of April through early July. The reservoir is raised from 1070 ft to about 1141 ft (25,400 ac-ft of storage) in order to augment summer flows for fisheries conservation. The additional water storage project proposes to store an additional 22,400 ac-ft to

provide additional water during the summer months for Tacoma's water supply facilities, and an additional 9,600 ac-ft for low flow augmentation. Additionally, fish passage facilities would be added to the dam for upstream and downstream passage of anadromous fish.

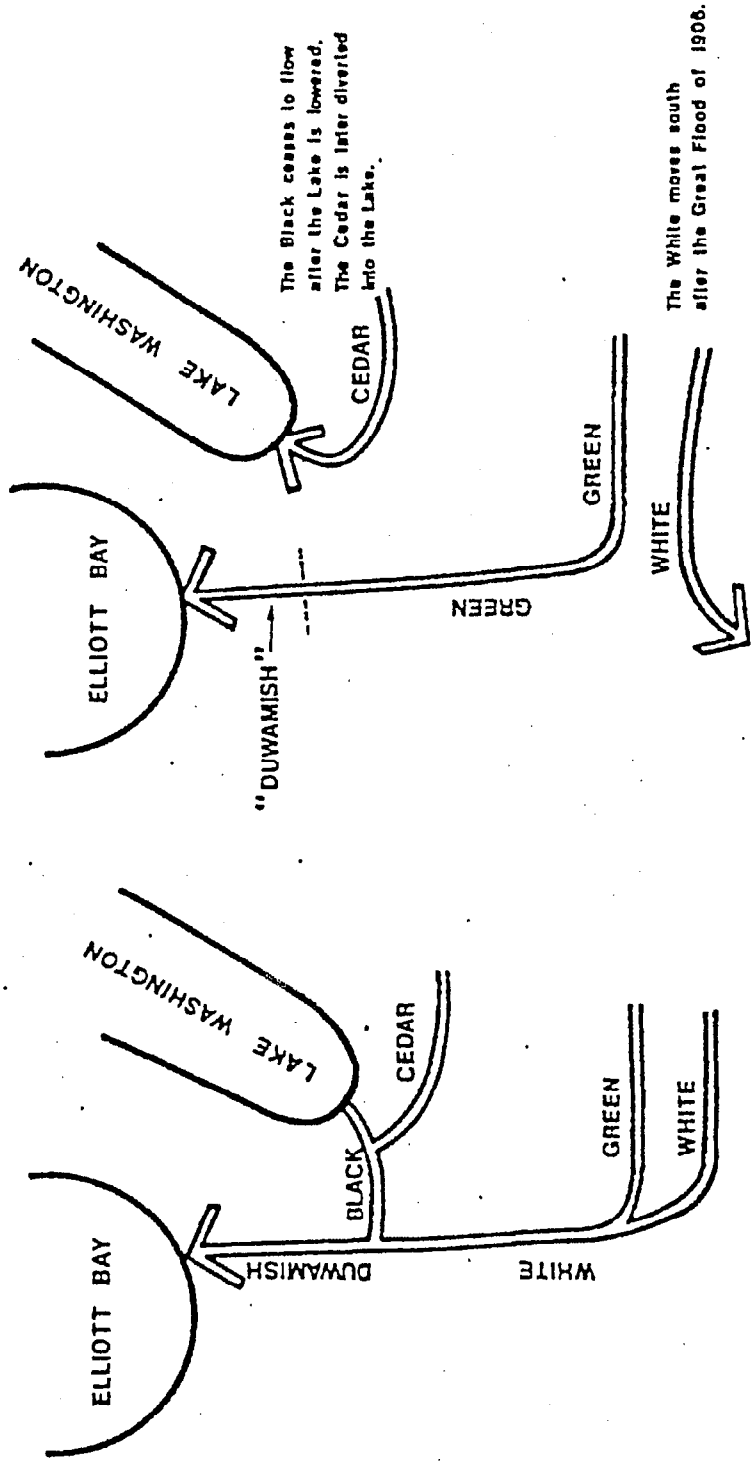
Three major tributaries feed into the Green River below HHD: Newaukum Creek near Black Diamond, Big Soos Creek upstream of Auburn, and Mill Creek/Mullen Slough near Kent. All of these tributaries experience increased peak flows in winter and decreased low flows in summer as a result of development and the spread of impervious surfaces.

3.1.3 Fluvial Geomorphology

Fluvial geomorphology is defined as the study of the interaction between river flows and processes and the physical structures and habitats that are created as a result of those processes. The types of physical structures and habitats created vary depending on the climate, topography and geologic setting of the watershed. The primary processes that shape the river geomorphology are river flow regime and flooding, sediment sources and transport, and riparian zone succession and large woody debris (LWD) recruitment. In the Green River, the river flow regime and flood cycles have been drastically altered. Approximately 70 percent of the watershed has been diverted away from the river, significantly reducing flows and HHD has constrained flood flows to below the 10-year recurrence level (12,000 cfs as measured at Auburn). Sediment sources have been reduced by the construction of levees and revetments and sediment transport has been altered by HHD and confinement of the river into one channel. The riparian zone has been significantly reduced in size by development and the removal of coniferous trees. LWD has been actively removed from the channel for many years and the recruitment of new wood is severely reduced because of the lack of large riparian trees and flood flows into the riparian zone and floodplain. Figure 3-1 shows the dramatic change in the shape and length of the Green/Duwamish River from 1898 to 1996. There are very few side channels or other off-channel habitats in the river and they are concentrated in the unconfined Metzler/O'Grady reach (RM 36.9-40.6) and the Auburn Narrows reach (RM 32.5-33.5) where the only active channel braiding is occurring.

Currently, HHD blocks about 90% of the coarse sediment load from the watershed (Perkins, 1999). Formerly, this sediment depoprojectd in the middle Green River valley below HHD (RM 60-64) and from below the Green River Gorge down to Auburn (RMs 30-45). Downstream of Auburn, the sediment load transported by the White River formerly provided significant sediment deposition downstream of Auburn. Overall, sediment deposition caused extensive braiding of the river and side channel and off-channel formation as well as providing extensive spawning grounds for salmon species. The loss of gravel-sized sediment has reduced deposition in a downstream direction from the dam, and results in armoring of the bed (scour of gravel sized particles so only cobble and larger materials remain). This armoring can be

Figure 3-1
Changes from 1898 to 1996



Configuration of the Duwamish drainage prior to 1900 and after 1916.

observed between HHD and the Tacoma Diversion Dam (RMs 60-64), but is less obvious downstream of the Gorge (below RM 45) (Perkins, 1999). It is expected, however, that armoring will appear further downstream over time without significant coarse sediment input below HHD.

3.1.4 Environmental Resources

3.1.4.1 Vegetation

Historically, the Green/Duwamish River basin was heavily forested with coniferous trees including cedar, western hemlock, Sitka spruce, Douglas fir, silver fir, mountain hemlock, and western white pine. This coniferous forest extended from the headwaters down to Puget Sound. In the floodplain, coniferous forest was replaced by deciduous shrubs and trees and emergent marsh vegetation in disturbed areas. Other localized events such as fire, avalanches and windthrow periodically downed the conifers, which were replaced by early seral species such as ferns and herbs, succeeded by red alder, big leaf maple and willows.

Currently, most of the original coniferous forest has been removed from the watershed. In the upper basin and foothill portions of the middle basin, the land is managed primarily for timber production and is dominated by Douglas fir of less than 100 years in age. Agriculture and rural residential uses dominate the floodplain areas of the middle basin, while urban and industrial uses dominate the entire lower basin. The riparian zone is limited in the lower and middle basins except between RMs 34 to 64. Typical dominant species include black cottonwood, red alder, willows and big leaf maple with an understory of salmonberry and snowberry. Occasional young cedars, hemlocks or Douglas fir are present.

3.1.4.2 Fish and Aquatic Habitat

More than 30 species of fish have been documented within the Green/Duwamish River basin. This includes potentially eight species of anadromous salmon: chinook, coho, chum and sockeye salmon, rainbow/steelhead and cutthroat trout, and potentially bull trout and Dolly Varden. Pink salmon were historically present, but have not been observed for many years. Anadromous fish cannot access the basin above the Tacoma diversion dam at RM 60, but use the rest of the river basin extensively. Water quality conditions can be harmful to all the anadromous fish species since temperatures regularly exceed 68° F, which is the highest tolerable temperature for most Pacific salmon species. Additionally, the lack of aquatic habitat (side channels, sloughs, instream cover, etc.) reduces the rearing capacity of the river and production of salmon species. Fast water habitats (riffle, run and glide) make up 82% of all mainstem habitat types (Fuerstenberg, et al, 1997). Juvenile salmon prefer to rear in slower velocities areas (pools

and under cover of LWD) where they do not need to expend tremendous amounts of energy to remain in place. The populations of anadromous fish have declined considerably over the last 50 years; see Table 3-1 below for a comparison of escapement numbers from the 1930s to the 1990s.

Table 3-1 Comparative Escapements to the Green River

Species	1938 to 1942	1987 to 1991
Chinook	55,197	10,300
Chum	12,750	3,000*
Coho	36,741	12,500
Pink	1,000	0
Steelhead	4,400	1,600**

Note: Recent hatchery returns have been larger, which is not reflected in this data, however, wild fish are still declining.
** This value includes fish passed above the Keta Creek hatchery and other naturally spawning fish in the mainstem.*
*** This value is for winter steelhead and is the simple average of returns in those years.*

3.1.4.3 Wildlife

The upper basin is primarily forested and managed for timber production, with many areas adjacent to the reservoir closed to public access. This provides good habitat for many large mammals such as elk, mountain goat, black-tailed deer, mule deer, black bear, and cougar. The number of clearcuts and other open areas favors herbivore populations. The large number of herbivores has resulted in a significant cougar population, possibly one of the highest densities in the U.S. Black bears are also common. Other mammals include beaver, mink, muskrat, weasels, raccoon, snowshoe hare, pika, and various voles and mice. Cascade frogs and red-legged frogs also occur in the upper basin. A number of waterfowl use the reservoir, including loons, which may nest near the reservoir. A variety of raptors and passerine birds also use the upper basin.

The middle and lower Green/Duwamish basin is increasingly urbanized in the downstream direction. However, the lakes, riparian zone and tributary streams provide habitat for small mammals such as foxes, skunks, weasels, squirrels and coyotes. Floodplain and wetland habitats support red-legged and Pacific tree frogs, salamanders, and toads. Waterfowl, including wood ducks can be found in many areas. The estuary is utilized by a number of waterfowl and shorebirds in spite of the loss of most of the habitat.

3.1.4.4 Threatened and Endangered Species

Several threatened and endangered species occur or may occur in the Green/Duwamish basin.

Bald Eagle. The bald eagle is listed as threatened in Washington. Bald eagles utilize lakes, rivers and marshes west of the Cascades as wintering grounds, and can be resident in many areas of western Washington. Preferred wintering projects typically have an expanse of large trees within 1 to 2 miles of foraging habitat. On the Skagit River, wintering areas are often large groves of 50-year-old cottonwoods adjacent to the River. The limiting features of bald eagle breeding habitat are suitable nest projects, perch trees and available prey. Bald eagles have been projectd year-round at HHD. The bald eagle is primarily a winter resident in the basin, and has been observed foraging at many projects along the river. Prey resources include waterfowl and spawning anadromous fish.

Northern Spotted Owl. The northern spotted owl is listed as threatened throughout its range on the West Coast. Some of the U.S. Forest Service lands in the upper watershed are designated as Critical Habitat and are part of the 120,000 acre Critical Habitat Unit (CHU) #WA-34. Preferred habitat is large blocks of multi-layered or old growth coniferous forests with standing snags or broken top trees for nesting. Very little old growth forest remains in the Green/Duwamish River basin; however, 35 known spotted owl activity centers exist on Forest Service lands in the upper basin, and 14 of those pairs have produced at least one young (USFS, 1996). No spotted owls are likely to occur downstream of HHD.

Marbled Murrelet. The marbled murrelet is listed as threatened in Washington. Some of the U.S. Forest Service lands in the upper watershed are designated as Critical Habitat and are part of the CHU #WA-11. Murrelets inhabit nearshore marine waters and nest in mature and old growth forested areas. Murrelets prefer large lateral branches (>4 inches diameter) with moss or lichen covering to place their nests on. Very little old growth forest remains in the Green/Duwamish River basin, and no marbled murrelets have been detected. However, the old growth stands that are managed for critical habitat may become utilized in the future. No marbled murrelets are likely to utilize the middle and lower Green River basins, but the estuarine habitat could be suitable.

Gray Wolf. The gray wolf is listed as an endangered species in Washington. Wolves use a variety of habitats, but prefer areas away from human disturbance with abundant prey resources. The upper watershed has an abundance of herbivores, which could be an excellent prey resource. The high density of logging roads and off-road vehicle recreation in the basin likely limits the suitability for wolves. There has been on class 2 (reliable but unconfirmed) gray wolf sighting within the upper basin, and several other sightings near the basin (USFS, 1996). No wolves are likely to occur downstream of HHD.

Grizzly Bear. The grizzly bear is listed as a threatened species in Washington. Grizzly bears utilize a variety of habitats, but prefer large tracts of land with minimal human disturbance. No sightings of grizzly bears or tracks have been reported in the Green/Duwamish River basin, but the North Cascades Grizzly Bear Recovery Zone has been designated north of I-90 adjacent to the northeast side of the upper basin. Habitat conditions are likely not suitable for grizzly bear due to the high road density and off-road vehicle recreation in the basin. No grizzly bears are likely to occur downstream of HHD.

Canada Lynx. The Canada lynx is proposed for listing as a threatened species in Washington. The lynx typically inhabits northern boreal forest near the Cascade crest and on the east side of the Cascades. Lynx require habitats with permanent winter snow since their primary prey source is snowshoe hare. Lynx also are highly disturbed by human intrusions such as roads. There are no reported sightings of lynx in the Green/Duwamish River basin. The highest elevation areas of the upper basin may be suitable habitat. No lynx are likely to occur below elevation 2,800 feet.

Spotted Frog. The spotted frog is listed as a candidate species in Washington. The species is known to occur in several locations east of the Cascades, but has been eliminated from most of its former range west of the Cascades (Corkran & Thoms, 1996). It is believed that non-native predator species such as the bullfrog and bass have depleted these populations. Spotted frogs are found near springs, ponds, lakes or slow-moving streams. The only sightings in western Washington in the past 23 years have been in Thurston County. Suitable habitat exists in the Green/Duwamish River basin, but it is unlikely that spotted frogs occur in the basin.

Chinook Salmon. Puget Sound stocks of chinook salmon are listed as a threatened species. The species occurs in the Green/Duwamish River basin from the mouth up to the Tacoma diversion dam. The status of the Green River stock is mixed between hatchery and natural production, but is declining. Key habitat requirements include adequate stream flow, high quality gravel for spawning, low temperatures, side channels and estuarine habitat for rearing. The lack of side channels and estuarine habitat is a significant issue for chinook salmon production.

Bull Trout. Western Washington bull trout are listed as a threatened species. Until recently, bull trout and Dolly Varden were considered to be the same species, so there is limited data on bull trout distribution. All native char identified south of the Nooksack basin in Puget Sound have been determined to be bull trout (F. Goetz, pers. comm.). Historically, bull trout were found in abundance in the middle Green River basin (Grette & Salo, 1986), but have not been observed since 1964. High stream temperatures generally preclude bull trout use. Native char have been observed in the estuary in 1994. It is not known if these are strays from the White River, which does support an anadromous run of bull trout, or if they represent a population in the Green/Duwamish River.

Coho Salmon. The Puget Sound/Straight of Georgia Evolutionarily Significant Unit (ESU) of coho salmon is a candidate species for listing under the Endangered Species Act. Coho salmon occur in the Green/Duwamish River basin from the mouth up to the Tacoma diversion dam. The status of the Green River stock is mixed between hatchery and natural production, but is declining. Key habitat requirements include adequate stream flow, high quality gravel for spawning, low temperatures, and side channels, pools and wetlands for rearing and winter refuge. The lack of side channels, pools and wetlands is a significant issue for coho salmon production.

Sea-run Cutthroat Trout. The Puget Sound ESU of sea-run cutthroat trout is a candidate species for listing under the Endangered Species Act. Sea-run cutthroat trout are suspected to be present in nearly every western Washington watershed, but very limited information is available. Many stocks are believed to return only to estuarine areas for spawning (Leider, 1997). Key habitat requirements include adequate stream flow, high quality gravel for spawning, side channels and pools for rearing, estuarine side channels and tributaries for spawning. The lack of these habitats is a significant issue for cutthroat trout production.

3.1.5 Human Environment

3.1.5.1 Population

The central Puget Sound region has had enormous population growth from the 1970s onward. In 1994, the population in the Green/Duwamish River basin was estimated at 900,000. The cities of Renton, Kent and Auburn are still rapidly growing, as are several smaller towns and the unincorporated areas of King County.

3.1.5.2 Land Use

The larger population centers such as Seattle, along with the industrial, commercial and residential land uses are concentrated in the lower 30 miles of the basin. A few parcels of agricultural land and parks and trails exist along the lower river. Agriculture is still a major land use in the middle Green River basin, but is rapidly being converted to hobby farms and country estates. Timber production is the dominant land use in the foothills of the middle Green River basin and in the upper basin. Shoreline development is extensive along the middle and lower Green/Duwamish River. Much of the banks are leveed to protect residential and commercial development in the floodplain. Along the Duwamish River, most of the banks and floodplain are completely developed for industrial purposes.

3.1.5.3 Socio-Economics

The majority of jobs in King County are in the manufacturing, wholesale and retail trade, financial services, and government sectors (USBEA, 1995). This data is somewhat inappropriate for the Green/Duwamish basin area since there is still a large rural agricultural, timber harvest and mining component in the basin. The robust economy of the greater Seattle metropolitan area keeps unemployment levels very low. However, in formerly timber or mining dependent communities unemployment levels may be higher. The average per capita personal income in King County in 1997 was $33,000. The median value of owner occupied dwellings in 1999 in King County was $230,000. The value of homes in cities in the Green/Duwamish River valley is generally below the median value.

3.1.5.4 Recreation

The Green/Duwamish River basin has many opportunities for recreation and is used quite heavily. Considerable use is made of the middle Green River for river rafting, kayaking, canoeing and floating. The Green River Gorge is a particular attraction for white-water enthusiasts. Several large parks exist in the middle Green River area such as Flaming Geyser State Park and Kanasket-Palmer State Park. King County has acquired several properties such as Metzler-O'Grady Park for additional public recreation and habitat restoration purposes. In the lower valley, numerous golf courses and parks exist in the floodplain of the river. The Green River Trail and Interurban Trail follow the river on top of levees. The upper basin is not accessible upstream of the Tacoma diversion dam, except via Forest Service roads from Stampede Pass.

Many of the tributaries to the Green/Duwamish River have parks along the water such as Big Soos Creek Park, Lake Meridian Park, Mill Creek Canyon Park, Isaac Evans Park, Kent Riverfront Park and Earlington Park. These parks are primarily utilized by local residents for fishing and walking.

3.1.5.5 Cultural Resources

The earliest evidence of human settlement of the Green/Duwamish basin dates back to the end of the last glaciation, almost 13,000 years ago. Some campprojects and stone tool manufacturing projects exist on beaches and river terraces in the Puget Sound region. Several cultural resource projects dating from approximately 2,500 years ago are present including campprojects, resource procurement projects (fishing, etc.), and village projects.

More recently, the Green/Duwamish basin was utilized by several bands of the southern coast Salish known variously as the Skopamish, Sko-pabsch, Skopeamish, Niskap, Neccope, Nescope and Nooscope (Hollenbeck, 1987). These bands were the precursors to the modern day Duwamish, Suquamish and Muckleshoot Indian Tribes. Permanent winter villages were established along the main rivers and tributaries including the Green, White, Stuck and Puyallup Rivers (Hollenbeck, 1987). The bands living closest to the estuary and Puget Sound primarily utilized marine fish and shellfish, bands further upstream relied on salmon, berries, and roots, whereas inland groups relied primarily on hunting and root gathering. Trading was common between the bands in the Green/Duwamish basin and externally with groups from other watersheds.

The Muckleshoot Indian Tribe currently resides primarily on a reservation near the former confluence of the White and Green Rivers. The Muckleshoot Tribe is a federally recognized tribe and has co-management authority with the Washington Department of Fish & Wildlife (WDFW) regarding game fish and wildlife resources within their usual and accustomed fishing areas (Lake Washington basin, Green/Duwamish basin and upper Puyallup/White River basin).

The Suquamish Indian Tribe currently resides primarily on the west side of Elliott Bay on the Kitsap Peninsula (Port Madison Indian Reservation). The Suquamish Tribe is a federally recognized tribe and has co-management authority with WDFW regarding game fish and wildlife resources within their usual and accustomed fishing areas (Duwamish estuary, Elliott Bay, Shilshole Bay).

The Duwamish Tribe is not federally recognized at this time as the descendants are considered to be part of either the Muckleshoot or Suquamish Tribes. The tribe has petitioned the government to be recognized, but has not yet received recognition. Even with recognition, the Duwamish Tribe would still not be eligible to harvest the fishery resources without further adjudication.

Since the Green/Duwamish River valley was highly desirable for agricultural uses by the early settlers, there are several structures in the area listed on the Historic Register. The Northern Pacific Railroad (now Burlington Northern) line through Stampede Pass and along the Green River was the first transcontinental railroad to enter western Washington.

3.2 Future Without-Project Conditions

If this ecosystem restoration plan is not implemented, there will still be fish and wildlife habitat restoration actions undertaken in the Green/Duwamish basin. However, the primary difference will be that these actions will be undertaken in an uncoordinated project-specific approach by local jurisdictions or other groups, as funding is available. It is expected that King County, on their own, would undertake a

number of habitat restoration actions designed to benefit chinook salmon as a result of ESA requirements. Additionally, the number of restoration projects undertaken would likely be reduced because of the lack of funds without federal involvement. It is likely that restoration actions would be undertaken over a much longer time scale as well, due to the limited funding and staffing resources at local jurisdictions. This could jeopardize the recovery of the anadromous salmon resources, including the threatened chinook salmon and bull trout, in the basin because there is currently a lack of suitable habitat for fish and the longer the time period before habitat is restored, the more likely that the fish populations will decline beyond the point of viability. This project is designed to provide habitat linkages and corridors for wildlife species as well, which may not occur with project-specific local jurisdiction restoration actions.

In short, while some restoration will continue with or without this project, the opportunity to restore broad-scale ecosystem functions and processes to recreate aquatic and terrestrial habitat will have been delayed or lost. It is unlikely that any future actions will consider ecosystem functions and requirements for a multi-species assemblage of plants, fish and wildlife. This will continue the trend, to date, of focusing on single species requirements and causing unforeseen adverse effects on other species, leading to continued listings of more and more species under the Endangered Species Act; rather than preserving an ecosystem that supports a multitude of species.

4. PLAN FORMULATION

4.1 Problem Identification

A number of studies were undertaken in the 1970s through the 1990s, which described the existing condition of the Green/Duwamish River basin. These studies included an analysis of the loss of estuarine habitat in the Duwamish River (Blomberg, et al, 1988); historic and current production of anadromous salmon in the Green River (Chapman, 1981; Grette & Salo, 1986); geomorphology of the Green River (Dunne & Dietrich, 1978); and a watershed analysis of the upper Green River basin (USFS, 1996). These studies all identified that the Green/Duwamish River basin had suffered serious declines in the quantity and quality of fish and wildlife habitat as a result of the loss of ecosystem functions and processes and the trends suggest continuing decline without restorative action.

King County requested that the Corps initiate an ecosystem restoration study in 1995. The generalized problem in the watershed is the loss of ecosystem functions and processes that create and maintain aquatic and riparian habitats over time. At the time of initiating this ecosystem restoration study, a separate Natural Resources Damage Assessment (NRDA) group for Elliott Bay and the Duwamish waterway were evaluating actions to mitigate for loss of habitat and contamination from industrial pollutants. As an off-shoot of that group, a Watershed Restoration Group (WRG) composed of representatives from the Corps, King County, Cities of Tukwila, Kent, Auburn, Seattle, Tacoma and Renton, U.S. Fish & Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Washington Department of Fish and Wildlife (WDFW), Washington Department of Ecology (WDOE), U.S. Environmental Protection Agency (USEPA), Trout Unlimited, Green/Duwamish Watershed Alliance, Friends of the Green River, and Rainier Chapter of the Audubon Society was formed to guide restoration planning for this study and other concurrent regional restoration efforts.

4.2 Problems and Opportunities

The primary reasons for the loss of ecosystem functions and processes is the regulation of flows by HHD and the disconnection from the floodplain and channelization of the river downstream of the dam by levees, revetments and other urban development. For the purposes of this study, it is assumed that the early historic actions such as diverting the White River and the Cedar River out of the basin are irreparable and that the analysis of the Green/Duwamish River basin should proceed using the existing watershed as the study area.

The ecosystem restoration goals of this study are to: 1) improve existing ecosystem functions and processes; 2) enhance the physical nature of existing degraded habitat; 3) address limiting factors to fish and wildlife production, and 4) restore degraded habitats for anadromous fish.

Specific elements of habitat degradation and limiting factors to fish and wildlife production have been evaluated by King County (Fuerstenberg, et al., 1996) and the U.S. Forest Service (1996) and can be classified as ten major resource problems within the basin (see Table 4-1). This study addresses nine of these resource problems as indicated in the Table.

Table 4-1 Resource Problems in the Green-Duwamish Basin

Resource Problems	Issues Addressed in this Study
Lack of habitat in the Lower Green/Duwamish estuary	X
Changes in sediment loads and transport	X
Changes in flows	
Loss of channel complexity and in-channel structure	X
Water quality degradation	X
Barriers to fish passage	X
Floodplain disconnection	X
Habitat fragmentation	X
Degradation of wetlands and rare species habitats	X
Changes in forest structure and composition	X

4.3 Significance of Environmental Resources and Degradation

The environmental resources that have been degraded are aquatic and terrestrial habitats of the Green/Duwamish River basin. These habitats formerly supported nine species of anadromous salmon; chinook, coho, chum, pink and sockeye salmon, rainbow/steelhead and cutthroat trout, and potentially bull trout and Dolly Varden. Pink and sockeye salmon may stray into the Green/Duwamish basin, but the system is currently unable to sustain runs. Two other species have been listed as threatened under the ESA, chinook salmon and bull trout, and coho salmon and sea-run cutthroat are candidate species for listing. The degradation that has occurred has eliminated 98% of the estuarine habitat that formerly existed, which is used by anadromous salmon species to acclimate between freshwater and saltwater. Chinook salmon, which use estuaries extensively, have been particularly affected as a result, although all species have reduced growth and survival as a result of no available habitat for rearing in the estuary. The channelization of the middle and lower Green River has eliminated rearing and spawning habitat for salmon species, as well. The migration corridor is now lethal to fish during the summer as a result of high temperatures and low dissolved oxygen and no holding or rearing pools are present in these reaches

of the river. The loss of habitat forming processes as a result of the control of flows at Howard Hanson Dam and the loss of exchange between the river and its floodplain has resulted in the loss of prime spawning and rearing habitats for most species of salmon in the basin.

Another five species of wildlife are listed under the ESA and occur or may occur in the Green/Duwamish River basin; bald eagle, gray wolf, grizzly bear, marbled murrelet, and northern spotted owl. Canada lynx are proposed for listing and the Oregon spotted frog is a candidate species. The habitat fragmentation resulting from timber harvest and urban development has pushed these species, which require large areas of relatively undisturbed habitat, to the brink of extinction. All of these species would benefit from improvements in forest structure and composition and the reconnection of habitats via riparian corridors.

Additionally, the Green/Duwamish River basin is part of the usual and accustomed fishing grounds for the federally recognized Muckleshoot and Suquamish Indian Tribes. It is a federal responsibility to ensure that resources necessary for the continuation of native cultures are maintained.

4.4 Scoping of Study Area

For the purposes of this study, the study area is the entire Green/Duwamish River basin from the headwaters near Stampede Pass to the mouth of Duwamish River inclucing Elliott Bay. Since the primary authority of the Corps is water resources development, the potential area for specific projects will generally be within the 500-year floodplain (pre-dam) of the Green/Duwamish River and its tributaries. This entire study area is within King County, however many reaches of the river are within the jurisdiction of cities. The cities of Kent, Auburn, Tukwila and Renton have expressed willingness to fund specific projects within their jurisdictions.

4.5 Formulation of Alternatives

Three major approaches to restoration were evaluated to determine the restoration approach to be used in this study and are evaluated in the attached programmatic EIS: 1) No Action; 2) Multi-Species Approach; and 3) Single Species Approach (chinook salmon). The No Action alternative would not implement this ecosystem restoration plan and restoration would continue to be implemented by local jurisdictions on a project-specific scale, as funding is available. The Multi-Species Approach would conduct ecosystem restoration planning to benefit multiple species of fish and wildlife. The Single Species Approach would conduct ecosystem restoration planning to benefit the listed threatened chinook salmon and implement projects regardless of their effects on other species. Within both the Multi-Species Approach and the Single Species Approach, the types of projects that could be implemented range from restoring ecosystem

functions and processes to engineering solutions such as hatcheries and spawning channels. Through coordination with the sponsor, stakeholders in the watershed and the EIS process, it was determined that a multi-species approach that uses a mix of ecosystem level and project specific habitat restoration projects and programmatic measures will not only provide significant benefits to listed species, but restore and protect the ecosystem processes that support a multitude of species to avoid further listings.

4.6 Environmental Quality Evaluation Methodology

In the study, twelve general types of restoration measures were developed to address the ten major resource problems in the basin. Prototype designs were developed for these twelve types of restoration measures, and then input from the Watershed Restoration Group was solicited on potential locations in the basin to implement such measures. A model was developed to measure the ecosystem benefits of a multi-project restoration plan (Klimas, 1996). This model was used during the reconnaissance phase to show with-project improvements on a river reach scale. Results of the model were useful in focusing plan formulation efforts during the feasibility phase and for evaluating the contribution of specific projects to ecosystem-wide environmental benefits. For detailed evaluation of benefits provided by each project-specific project, the individual projects and programmatic measures were screened and scored by the WRG using a rating system based on factors including its ability to provide benefits at an ecosystem scale and effectiveness at addressing limiting factors to the production of fish and wildlife. This rating system produced an environmental quality score for each project. Table 4-2 presents the rating criteria.

Table 4-2. Environmental Quality Evaluation Criteria

Limiting Factors:	*How effective is the project at addressing one or more of the following limiting factors?*
	1. Barriers to Fish Passage - Culverts, dams, and hatcheries have isolated stream reaches
	2. Reduction in Channel Forming Flows - Managing high flows cannot regenerate river habitat, resulting in loss of side channels and floodplain connections.
	3. Loss of Channel Diversity in Lower River- Levee and infrastructure have eliminated habitat
	4. Loss of Estuarine Habitat - Dredging/filling for navigation and development has dramatically reduced the size of the estuary
	5. Loss of Floodplain Habitat - Development and changes in flows have reduced the connections between the river and tributaries and their floodplains
	6. Reduction in Large Woody Debris - Log jams historically provided important pool habitat and cover, but are now uncommon
	7. Loss of Sediment Sources - Gravel trapped behind HHD and the construction of levees in the floodplain reduce spawning habitat and leads to channel downcutting
	8. Increase in Water Temperature - Summer temperatures are stressful to fish
Scale:	Project Size - How large is the project?
	Effect - How far-reaching is the project's effect?
Feasibility:	Technical - Does a reasonable technique exist and is it widely accepted?
	Political - Is the proposal socially and politically acceptable and likely to be wide supported?
Wildlife:	Habitat - Does the project benefit wildlife?

Each proposed restoration alternative was scored by the expert panel (representatives of the WRG) in each of the above criteria. For the criterion of limiting factors, those factors (of the eight identified) applicable to each project were identified and a score ranging from zero to five was selected for each alternative project. A score of zero corresponds to "addresses no identified limiting factors" and a score of 5 corresponds to "addresses all identified limiting factors". For all other criteria, a score ranging from one to three was provided. Because the criteria of Limiting Factors and Scale Effect were determined to be the most important, they were weighted more heavily (doubled) than the other criteria in deriving the project quality score for each alternative.

The resultant Environmental Quality Scores for all alternatives were then normalized to an index value between 0 and 1 and multiplied by the habitat area benefited by the project to derive "eco-units" for use in cost effectiveness and incremental cost analyses and comparison of alternative project outputs. These eco-units account for the quality and quantity of habitats supporting ecosystem function and salmon recovery. This approach is similar in structure to the common habitat suitability index models (such as

the US Fish and Wildlife Service's Habitat Evaluation Procedures) but did not focus on a single species and was determined by the study team and sponsors to be more appropriate for this broadly focused ecosystem restoration study.

4.7 Description of Generic Restoration Measures and Types of Benefits

The following section describes the types of project-specific restoration measures (projects) that have been proposed. In addition to the project-specific restoration measures, four programmatic restoration measures have been proposed and are also described.

4.7.1 Culvert Modification

Many of the tributaries entering the Green/Duwamish River pass through culverts placed in levees, roads, or other developed property adjacent to the river. Many of these culverts are perched above the river level or have impassable tide gates, preventing fish passage, or are undersized and frequently clog up with sediment and/or debris, preventing fish passage and exacerbating flooding. Design criteria utilized for culvert sizing included: 1) the culverts must be able to pass the 100 year flow for the tributary; 2) tide gates must still be able to prevent high flows in the Green River from flooding behind levees or other facilities; and, 3) culvert inverts must allow fish passage for all anadromous salmon species during all flow conditions, except when tide gates are closed during flooding. Replacement of culverts will allow fish access to many miles of streams that are currently not accessible, and in most cases have good existing habitat.

4.7.2 Restoration of Estuarine/Tidally Influenced Marsh Habitat

Only 3 percent of the original tidally influenced marsh habitat that existed prior to 1898 still exists. This project type will restore marsh habitat by excavating fill from the floodplain, reconnecting up wetlands behind levees to tidal action and plantings of native emergent marsh vegetation and fringing riparian vegetation such as willows and shore pine. Design criteria utilized for estuarine habitat design included: 1) the majority of the project must be within the intertidal zone for the specific location along the river; and 2) a diversity of intertidal habitats should be restored as feasible at the project including mudflats, low salt marsh, high salt marsh and freshwater intertidal swamp/marsh. Restoration of estuarine marsh habitats will provide rearing opportunities for salmon species, which currently have essentially no estuarine rearing habitat. Chinook salmon, in particular, will benefit because ocean-type chinook, which are the dominant life-history type in the Green River, rear for up to several months in estuaries. Other salmon species will benefit from the increased rearing opportunities and cover provided by the marsh

vegetation. Additionally, many birds and waterfowl utilize estuarine marsh habitat for perching, foraging and nesting.

4.7.3 Side Channel Modification/Restoration

Since the Green/Duwamish River can no longer naturally create side channels due to the reduced sediment load, reduced peak flows and channel confinement, this project type will create side channels or sloughs, and reconnect existing side channels and sloughs which have been cut off from the river. All of the projects will include other habitat features such as LWD, and revegetation of the riparian zone and floodplain with native trees and shrubs, particularly conifers. Design criteria utilized for side channel modification/restoration included: 1) the inlet and outlet elevations of side channels and slough must be connected to the river during all but low flows; 2) side channels and sloughs should have a diversity of habitat including LWD, overhanging vegetation, riffles and pools as feasible; 3) side channels and sloughs behind levees will be presumed to have an indefinite lifetime with local sponsor maintenance; and 4) side channels and slough unprotected by levees may last fewer than 10 years, but will provide important habitat in the interim until the river changes course and creates new habitats. Side channels provide important rearing and winter refuge habitat for most salmon species as well as habitat for amphibians, reptiles and waterfowl.

4.7.4 Levee Removal

Removing levees allows the river to naturally create habitats such as side channels and floodplain wetlands when it is no longer constrained by non-erodable materials (riprap, etc.). In locations where there would not be any adverse effects from flooding, levees can be removed entirely. This project type will also include revegetation of the floodplain with native trees and shrubs, particularly conifers. Design criteria utilized for levee removal included: 1) levees are only to be removed if there will be no increased flooding elevation or frequency to adjacent private property (or with landowner's permission); and, 2) removal of levees may require additional bank protection further back from the river to protect roads or other facilities. Unconstrained river reaches provide better spawning and rearing habitat opportunities because of reduced bed scour and increased input of LWD from the riparian zone.

4.7.5 Levee Setback

Setting back levees allows the river a greater floodplain area to meander and create habitats. In locations where there is vacant floodplain habitat behind a levee, but a need to still protect structures further back, a

levee can be set back as far as possible while still providing flood or erosion protection. This project type will also include revegetation of the floodplain with native trees and shrubs, particularly conifers. Design criteria for levee setback were the same as for levee removal. Levee setback projects will have smaller, but similar benefits to salmon spawning and rearing habitats by reducing bed scour and providing a source for LWD input to the river system.

4.7.6 Wetland Creation/Restoration

The levees and other channelization measures on the river prevent floodplain inundation and have disconnected wetland habitats from the river. In some cases wetlands have been filled in or highly degraded due to activities such as agriculture or urban development. This project type would reconnect the river to a floodplain area with an existing or former wetland habitat and enhance the wetland for use by fish and wildlife by creating a diversity of wetland types such as open water, emergent marsh, scrub/shrub or forested. LWD would also be placed in many of these wetlands. Design criteria for wetland creation/restoration included: 1) maximize wetland diversity by varying the topography of the project to allow differing levels of inundation; and, 2) create upland refuge habitat within the wetland for amphibian use. Wetlands provide flood storage, sediment control, nutrient uptake, groundwater recharge and habitat values for fish, waterfowl, amphibians, reptiles and other wildlife.

4.7.7 Levee/Bank Bioengineering (Project Specific and Programmatic)

In the lower Green/Duwamish River approximately 80% of the river is contained within levees or armored banks to protect the extensive urban and industrial development in the floodplain. This project-specific and programmatic project type would bioengineer these levees and banks by placing LWD into the structures and providing bank revegetation. The Corps will work with King County programmatically in the entire lower river area to install LWD and revegetate whenever the levees or banks would be undergoing routine maintenance. All of these projects are in the lower middle Green River basin between Auburn and Tukwila. Design criteria for bioengineering included: 1) bioengineering features must still provide effective erosion control to prevent damage to existing facilities; 2) bioengineering features must not raise the 100 year flood surface elevation; and 3) bioengineering features must not be overtly dangerous to recreational boaters. These projects will provide some rearing and winter refuge habitat for salmon juveniles in a long reach of the river without side channels and other low velocity habitats. Without winter refuge habitat, juvenile fish are often washed out into the estuary and Puget Sound when they are not ready to smolt, and hence, die.

4.7.8 Tributary Restoration

Many of the tributaries that flow into the Green/Duwamish River have poor connections to the river that discourage fish passage, and are in need of other types of restoration such as gradient reduction, sediment control, and riparian revegetation. These projects will include features such as new meandered channels, placement of spawning gravels, removal of noxious weeds, revegetation of the riparian zone and floodplain with native trees and shrubs, and the placement of LWD. Tributaries to the main river system provide spawning and rearing habitat for salmon species such as coho and chum salmon and steelhead and cutthroat trout. The lower reaches of tributaries can also provide excellent refuge or rearing habitat for all salmon species.

4.7.9 Gravel Nourishment

The sediment load has been severely reduced as a result of the construction of HHD and existing spawning gravels are frequently scoured out due to channel confinement with levees and other structures. This programmatic project type will place spawning sized gravels into the Green/Duwamish River in areas upstream of reaches that are lacking in spawning gravels. The two primary locations would be in the upper Green River basin between HHD and the Tacoma diversion dam and downstream of the Green River Gorge in the middle Green River basin. The lack of appropriate spawning substrate in the river is becoming a major limiting factor to wild salmon production.

4.7.10 Large Woody Debris Placement

The lack of large trees in the riparian zone and the lack of high peak flows have dramatically reduced the supply of large woody debris in the Green/Duwamish River. LWD creates channel diversity causing localized scour and pool formation and the retention of gravel in bars and riffles. This programmatic project measure type will create engineered logjams into the river in several locations between Highway 18 and Palmer, all within the middle Green River basin. Areas with LWD are extensively utilized for adult spawning and cover by juvenile salmon.

4.7.11 Volunteer Revegetation

The lack of riparian and floodplain vegetation has resulted in a lack of LWD recruitment to the river system and also caused a lack of shading and cover for the river increasing water temperatures and decreasing the habitat value for fish species. This programmatic project type will provide funds to purchase plants for a number of volunteer planting projects along the entire river system. Several project-specific projects would be implemented during each year of construction. The Corps will work with King County to develop a final list of projects for this programmatic restoration measure.

4.8 Feasibility Screening

During feasibility, the list of projects was expanded and ranked a second time by the expert panel. Several of the projects initially identified during the reconnaissance phase were eliminated from further consideration because of the identification of limited benefits or no demonstrated feasibility of actually constructing the project. Three of the twelve general types of restoration measures were dropped from the plan, either because the restoration measure could not be accomplished under the authority and timeframe of this study or it was not politically acceptable to the local sponsor(s). Those three types are acquisition/preservation, flow modification, and low flow augmentation. Under the HHD Additional Water Storage Project, low flow augmentation is one of the primary objectives.

Also during the second screening phase, one of the twelve general project types was converted into a programmatic measure type (gravel replenishment) and three other programmatic measures were added: LWD placement, volunteer revegetation, and mainstem levee bioengineering (maintenance). The result was a total of nine generic project types and four programmatic types with a total of 75 projects or programatic musures for evaluation. After this initial screening by the WRG, a total of 67 projects are considered to be feasible for implementation.

In the remainder of this document when we refer to projects and programmatic measures together we will use the turn **projects** for simplicity.

King County was interested that several of the 67 projects identified by the WRG be implemented on a "fast-track" to ensure that the County Council would continue to support this study. During 1999, two fast-track projects were implemented: an intertidal wetland and reconnection of a tributary (Puget Creek) in the Duwamish River; and the reconnection of a side channel in the middle Green River (Porter Levee Side Channel). These projects were easily implementable under the Section 1135 program because they were less than $300,000 federal, which meant they qualified for the one-step planning and design phase

and the property was already owned by King County or another public agency. One other project has been identified for fast-track implementation, the placement of LWD in an existing slough at Metzler/O'Grady Park.

After implementing these fast-track projects and further investigation that identified real estate constraints at several other projects, the list of projects was further screened down to 49 projects for detailed evaluation.

4.9 Array of Alternatives for Detailed Evaluation

A total of 49 individual or programmatic projects were evaluated to determine their feasibility for implementation under this ecosystem restoration study. At each project appropriate combinations of the general restoration measures were selected. Detailed specifications of the specific measures proposed for each project are included in the Engineering Design Appendix. Table 4-3 presents the projects considered. The location of each project is indicated on Figures 2 through 4. During the project evaluation phase of the feasibility study, two projects (in addition to those identified in Section 4.8) were pulled from further consideration for fast-track implementation through other programs. These two projects are projects "I" (Boundary Creek Culvert) and "AU" (Maywood Creek Culvert) in Table 4.3. Projects "I" and "AU" are not included in further documentation in this report. This resulted in 47 alternative projects for comparison of costs and benefits.

4.10 Environmental Benefits and Costs of Alternatives

This section provides cost estimates and environmental output estimates associated with implementation of restoration measures for each of the 47 projects. The preliminary cost estimates account for preconstruction engineering and design (PED), real estate requirements (lands, easements, rights-of-way, relocations, and disposal (LERRD)), supervisory and administrative (S&A) support, construction, construction management, project monitoring costs, and operation and maintenance (O&M) costs. Table 4.4 presents the line item cost estimates for each project. All cost estimates presented in this feasibility report are in October 2000 price level. Present values for future O&M and monitoring expenditures are calculated using the current federal interest rate for water resources projects of 6.875%.

Table 4-3. Projects Evaluated in Feasibility Study

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ID	Site Name	Location	Site Type
A	NE Auburn Creek	Tributary	Culvert Modification
B	Mainstem Green River LWD	Middle Green	Programmatic LWD
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation
D	Sweeney Creek Culvert	Upper Tributary	Culvert Modification
E	Newaukum Creek	Tributary	Tributary Restoration
F	Turley Side Channel	Middle Green	Side Channel Modification
G	Hamakami Levee	Middle Green	Wetland Habitat
H	Sunday Creek	Upper Tributary	Tributary Restoration
I	Boundary Creek Culvert ☆	Upper Tributary	Culvert Modification
J	Porter Levee Setback	Middle Green	Levee Setback
K	Kaetch Side Channel	Middle Green	Side Channel Modification
L	North East Creek Culvert	Upper Tributary	Culvert Modification
M	Green River Park	Lower Green	Side Channel Modification
N	Gale Creek Culvert	Upper Tributary	Culvert Modification
O	Mullen Slough	Lower Green	Side Channel Modification
P	Olson Creek	Tributary	Tributary Restoration
Q	Flaming Geyser Landslide	Middle Green	Flaming Geyser Landslide
R	Lones Levee Removal	Middle Green	Levee Removal
S	Codiga Farms	Estuary	Estuary Marsh Habitat
T	Horsehead Bend	Lower Green	Side Channel Modification
U	Schuler Brothers Reach	Tributary	Tributary Restoration
V	Upper Springbrook Reach	Tributary	Tributary Restoration
W	Duwamish Site 1	Estuary	Estuary Marsh Habitat
X	Lake Meridian Outlet	Tributary	Tributary Restoration
Y	Gilliam Creek	Lower Green	Culvert Modification
Z	Big Spring Creek	Tributary	Wetland Habitat
AA	Upper Green River Side Channels	Upper Green	Side Channel Modification
AB	May Creek Culvert	Upper Tributary	Culvert Modification
AC	Ray Creek	Middle Green	Side Channel Modification
AD	Riverton Creek	Estuary	Tributary Restoration
AE	Meridian Valley Creek	Tributary	Tributary Restoration
AF	Flaming Geyser Side Channel	Middle Green	Side Channel Modification
AG	Green River Gravel Replenishment	Middle Green	Gravel Nourishment
AH	Goedeke North Reach	Tributary	Tributary Restoration
AI	Wetland 5K Reach	Tributary	Tributary Restoration
AJ	Riverside Estates Side Channel	Middle Green	Side Channel Modification
AK	Gold Creek Culvert	Upper Tributary	Culvert Modification
AL	Burns Creek	Tributary	Tributary Restoration
AM	Garrison Creek	Tributary	Tributary Restoration
AN	Prentice Nursery Reach	Lower Green	Side Channel Modification
AO	Mill Creek East	Tributary	Tributary Restoration
AP	Brunner Slough	Middle Green	Side Channel Modification
AQ	Olsen Creek Culvert	Upper Tributary	Culvert Modification
R	Black River Marsh	Estuary	Estuary Marsh Habitat
AS	Elliott Bay Nearshore ☆	Estuary	Estuary Habitat
AT	Merlino Reach	Tributary	Tributary Restoration
AU	Maywood Creek Culvert	Upper Tributary	Culvert Modification
AV	Lower Springbrook Reach	Tributary	Tributary Restoration
AW	Mainstem Maintenance	Lower Green	Levee/Bank Bioengineering

Table 4-4. Cost Breakdown for Alternatives

	Site Name	Construction	LERRD	PED	Const. Mgmt.	S&A	Monitoring	O&M	TOTAL COST
A	NE Auburn Creek	$ 648,000	$ 102,875	$ 61,847	$ 77,298	$ 5,000	$ 68,086	$ 53,465	$ 1,016,571
B	Mainstem Green River LWD	$ 1,069,000	$ 622,188	$ 102,029	$ 127,518	$ 111,250	$ 228,962	$ 224,789	$ 2,485,736
C	Volunteer Revegetation	$ 2,440,000	$ -	$ 232,882	$ 291,060	$ -	$ 228,962	$ 74,930	$ 3,267,834
D	Sweeney Creek Culvert	$ 127,000	$ 29,500	$ 12,121	$ 15,149	$ 5,000	$ 17,548	$ 37,465	$ 243,784
E	Newaukum Creek	$ 3,848,000	$ 3,306,250	$ 367,267	$ 459,016	$ 183,750	$ 274,754	$ 179,832	$ 8,618,869
F	Turley Side Channel	$ 172,000	$ 136,250	$ 16,416	$ 20,517	$ 5,000	$ 34,043	$ 14,986	$ 399,212
G	Hamakami Levee	$ 575,000	$ 37,500	$ 54,880	$ 68,590	$ 5,000	$ 184,937	$ 22,479	$ 948,386
H	Sunday Creek	$ 2,492,000	$ 46,625	$ 237,845	$ 297,263	$ 6,250	$ 151,279	$ 52,451	$ 3,283,713
J	Porter Levee Setback	$ 862,000	$ 305,000	$ 82,272	$ 102,825	$ 3,750	$ 189,098	$ 7,493	$ 1,552,439
K	Kaetch Side Channel	$ 236,000	$ 90,000	$ 22,525	$ 28,152	$ 5,000	$ 34,043	$ 18,732	$ 434,452
L	North East Creek Culvert	$ 197,000	$ 32,250	$ 18,802	$ 23,500	$ 5,000	$ 35,097	$ 14,986	$ 326,635
M	Green River Park	$ 299,000	$ 139,750	$ 28,538	$ 35,667	$ 3,750	$ 184,937	$ 14,986	$ 706,627
N	Gale Creek Culvert	$ 253,000	$ 34,500	$ 24,147	$ 30,180	$ 5,000	$ 34,043	$ -	$ 380,870
O	Mullen Slough	$ 726,000	$ 937,500	$ 69,292	$ 86,602	$ 16,250	$ 126,065	$ 41,211	$ 2,002,921
P	Olson Creek	$ 95,000	$ 51,250	$ 9,067	$ 11,332	$ 5,000	$ 17,021	$ 14,986	$ 203,657
Q	Flaming Geyser Landslide	$ 3,360,000	$ 167,500	$ 320,690	$ 400,804	$ 5,000	$ 296,640	$ 149,860	$ 4,700,494
R	Lones Levee Removal	$ 2,578,000	$ 366,250	$ 246,053	$ 307,522	$ 7,500	$ 226,918	$ 29,972	$ 3,762,215
S	Codiga Farms	$ 1,084,000	$ 165,000	$ 103,461	$ 129,307	$ 5,000	$ 226,918	$ 29,972	$ 1,743,657
T	Horsehead Bend	$ 535,000	$ 180,000	$ 51,062	$ 63,819	$ 5,000	$ 184,937	$ 26,225	$ 1,046,043
U	Schuler Brothers Reach	$ 2,281,000	$ 997,500	$ 217,707	$ 272,094	$ 13,750	$ 226,918	$ 26,225	$ 4,035,193
V	Upper Springbrook Reach	$ 143,000	$ 27,500	$ 13,648	$ 17,058	$ 3,750	$ 27,887	$ 86,169	$ 319,012
W	Duwamish Site 1	$ 559,000	$ 1,183,750	$ 53,353	$ 66,681	$ 5,000	$ 226,918	$ 26,225	$ 2,120,928
X	Lake Meridian Outlet	$ 742,000	$ 164,875	$ 70,819	$ 88,511	$ 5,000	$ 85,107	$ 26,225	$ 1,182,538
Y	Gilliam Creek	$ 557,000	$ 70,000	$ 53,162	$ 66,443	$ 3,750	$ 68,086	$ 101,155	$ 919,596
Z	Big Spring Creek	$ 986,000	$ 144,063	$ 94,107	$ 117,617	$ 13,750	$ 176,492	$ 18,732	$ 1,550,761
ZA	Upper Green River Side Channels	$ 599,000	$ 317,875	$ 57,171	$ 71,453	$ 23,750	$ 189,098	$ 37,465	$ 1,295,812
ZB	May Creek Culvert	$ 236,000	$ 49,125	$ 22,525	$ 28,152	$ 6,250	$ 128,596	$ 7,493	$ 478,141
ZC	Ray Creek	$ 1,984,000	$ 467,500	$ 189,360	$ 236,665	$ 10,000	$ 167,207	$ 33,718	$ 3,088,451
ZD	Riverton Creek	$ 257,000	$ 513,750	$ 24,529	$ 30,657	$ 8,750	$ 68,086	$ 44,958	$ 947,729
ZE	Meridian Valley Creek	$ 292,000	$ 142,500	$ 27,869	$ 34,832	$ 6,250	$ 51,064	$ 26,225	$ 580,741
ZF	Flaming Geyser Side Channel	$ 582,000	$ 332,500	$ 55,548	$ 69,425	$ 5,000	$ 126,065	$ 18,732	$ 1,189,271
ZG	Green River Gravel Replenishment	$ 6,004,000	$ 548,750	$ 573,043	$ 716,199	$ 31,250	$ 457,924	$ 1,123,947	$ 9,455,112
ZH	Goedeke North Reach	$ 5,772,000	$ 811,250	$ 550,900	$ 688,524	$ 3,750	$ 176,492	$ -	$ 8,002,916
ZI	Wetland 5K Reach	$ 1,303,000	$ 981,250	$ 124,363	$ 155,431	$ 10,000	$ 226,918	$ -	$ 2,800,962
ZJ	Riverside Estates Side Channel	$ 446,000	$ 143,750	$ 42,568	$ 53,202	$ 10,000	$ 51,064	$ 19,746	$ 766,330
ZK	Gold Creek Culvert	$ 160,000	$ 18,375	$ 15,271	$ 19,086	$ 3,750	$ 17,548	$ 29,972	$ 264,002
ZL	Burns Creek	$ 373,000	$ 666,750	$ 35,600	$ 44,494	$ 21,250	$ 51,064	$ 68,451	$ 1,260,609
ZM	Garrison Creek	$ 805,000	$ 596,250	$ 76,832	$ 96,026	$ 28,750	$ 77,326	$ 60,958	$ 1,741,141
ZN	Prentice Nursery Reach	$ 336,000	$ 75,000	$ 32,069	$ 40,080	$ 8,750	$ 126,065	$ 29,972	$ 647,937
ZO	Mill Creek East	$ 2,867,000	$ 4,277,500	$ 273,636	$ 341,996	$ 52,500	$ 279,601	$ 202,310	$ 8,294,544
ZP	Brunner Slough	$ 1,045,000	$ 88,750	$ 99,738	$ 124,655	$ 10,000	$ 189,098	$ 18,732	$ 1,575,974
ZQ	Olsen Creek Culvert	$ 138,000	$ 18,375	$ 13,171	$ 16,462	$ 3,750	$ 17,548	$ 30,986	$ 238,292
ZR	Black River Marsh	$ 40,000	$ 121,250	$ 3,818	$ 4,771	$ 12,500	$ 17,021	$ 22,479	$ 221,840
ZS	Elliott Bay Nearshore	$ 328,000	$ 12,500	$ 31,305	$ 39,126	$ 3,750	$ 151,279	$ -	$ 565,960
ZT	Merlino Reach	$ 2,222,000	$ 4,795,000	$ 212,075	$ 265,056	$ 20,000	$ 252,131	$ 37,465	$ 7,803,727
ZV	Lower Springbrook Reach	$ 3,355,000	$ 4,022,500	$ 320,213	$ 400,208	$ 51,250	$ 279,601	$ 82,423	$ 8,511,194
ZW	Mainstem Maintenance	$ 1,492,000	$ 8,808,750	$ 142,402	$ 177,976	$ 23,750	$ 258,767	$ 187,324	$ 11,090,969
	ALL SITES TOTALS:	**$ 57,500,000**	**$ 37,147,125**	**$ 5,488,000**	**$ 6,859,000**	**$ 787,500**	**$ 6,915,260**	**$ 3,376,910**	**$ 118,073,794**

All costs estimates are in October 2000 cost level.

Present values for future O&M and Monitoring expenditures are calculated using current federal interest rate of 6.875%.

Output estimates are measured in eco-units (described in Section 4.6), which provide quality- and quantity-based estimates of environmental benefits. Table 4-5 summarizes the cost and output estimates for restoration at each of the 47 projects (affected acres of habitat are also listed).

Table 4-5. Cost and Output of Restoration at Each Project

	Site Name	Location	Site Type	TOTAL COST	Affected Acreage	Env. Quality Index	Outputs (Eco-Units)
A	NE Auburn Creek	Tributary	Culvert Modification	$ 1,016,571	107.0	0.61	64.98
B	Mainstem Green River LWD	Middle Green	Programmatic LWD	$ 2,485,736	130.4	0.86	111.77
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation	$ 3,267,834	200.0	0.54	107.14
D	Sweeney Creek Culvert	Upper Tributary	Culvert Modification	$ 243,784	7.1	0.75	5.34
E	Newaukum Creek	Tributary	Tributary Restoration	$ 8,618,869	224.0	0.86	192.00
F	Turley Side Channel	Middle Green	Side Channel Modification	$ 399,212	14.2	0.93	13.18
G	Hamakami Levee	Middle Green	Wetland Habitat	$ 948,386	17.3	0.93	16.07
H	Sunday Creek	Upper Tributary	Tributary Restoration	$ 3,283,713	70.3	0.89	62.72
J	Porter Levee Setback	Middle Green	Levee Setback	$ 1,552,439	32.8	0.93	30.46
K	Kaetch Side Channel	Middle Green	Side Channel Modification	$ 434,452	7.7	0.93	7.19
L	North East Creek Culvert	Upper Tributary	Culvert Modification	$ 326,635	4.8	0.77	3.71
M	Green River Park	Lower Green	Side Channel Modification	$ 706,627	5.3	0.79	4.13
N	Gale Creek Culvert	Upper Tributary	Culvert Modification	$ 380,870	5.7	0.82	4.71
O	Mullen Slough	Lower Green	Side Channel Modification	$ 2,002,921	91.9	0.86	78.73
P	Olson Creek	Tributary	Tributary Restoration	$ 203,657	7.5	0.71	5.36
Q	Flaming Geyser Landslide	Middle Green	Flaming Geyser Landslide	$ 4,700,494	60.0	0.86	51.43
R	Lones Levee Removal	Middle Green	Levee Removal	$ 3,762,215	42.5	0.93	39.43
S	Codiga Farms	Estuary	Estuary Marsh Habitat	$ 1,743,657	18.0	0.86	15.43
T	Horsehead Bend	Lower Green	Side Channel Modification	$ 1,046,043	14.1	0.75	10.55
U	Schuler Brothers Reach	Tributary	Tributary Restoration	$ 4,035,193	90.7	0.66	59.90
V	Upper Springbrook Reach	Tributary	Tributary Restoration	$ 319,012	2.9	0.64	1.85
W	Duwamish Site 1	Estuary	Estuary Marsh Habitat	$ 2,120,928	22.0	0.79	17.29
X	Lake Meridian Outlet	Tributary	Tributary Restoration	$ 1,182,538	9.9	0.82	8.15
Y	Gilliam Creek	Lower Green	Culvert Modification	$ 919,596	6.7	0.71	4.76
Z	Big Spring Creek	Tributary	Wetland Habitat	$ 1,550,761	14.9	0.89	13.30
ZA	Upper Green River Side Channels	Upper Green	Side Channel Modification	$ 1,295,812	12.5	0.68	8.49
ZB	May Creek Culvert	Upper Tributary	Culvert Modification	$ 478,141	6.5	0.77	4.99
ZC	Ray Creek	Middle Green	Side Channel Modification	$ 3,088,451	29.3	0.61	17.80
ZD	Riverton Creek	Estuary	Tributary Restoration	$ 947,729	6.0	0.89	5.36
ZE	Meridian Valley Creek	Tributary	Tributary Restoration	$ 580,741	3.1	0.89	2.79
ZF	Flaming Geyser Side Channel	Middle Green	Side Channel Modification	$ 1,189,271	25.2	0.89	22.48
ZG	Green River Gravel Replenishment	Middle Green	Gravel Nourishment	$ 9,455,112	79.0	0.79	62.07
ZH	Goedeke North Reach	Tributary	Tributary Restoration	$ 8,002,916	50.1	0.73	36.68
ZI	Wetland 5K Reach	Tributary	Tributary Restoration	$ 2,800,962	41.9	0.75	31.43
ZJ	Riverside Estates Side Channel	Middle Green	Side Channel Modification	$ 766,330	11.4	0.75	8.55
ZK	Gold Creek Culvert	Upper Tributary	Culvert Modification	$ 264,002	0.9	0.79	0.72
ZL	Burns Creek	Tributary	Tributary Restoration	$ 1,260,609	24.3	0.54	13.00
ZM	Garrison Creek	Tributary	Tributary Restoration	$ 1,741,141	19.8	0.75	14.84
ZN	Prentice Nursery Reach	Lower Green	Side Channel Modification	$ 647,937	25.0	0.68	16.96
ZO	Mill Creek East	Tributary	Tributary Restoration	$ 8,294,544	74.2	0.71	52.99
ZP	Brunner Slough	Middle Green	Side Channel Modification	$ 1,575,974	16.1	0.82	13.23
ZQ	Olsen Creek Culvert	Upper Tributary	Culvert Modification	$ 238,292	0.5	0.71	0.36
ZR	Black River Marsh	Estuary	Estuary Marsh Habitat	$ 221,840	4.9	0.82	3.99
ZS	Elliott Bay Nearshore	Estuary	Estuary Habitat	$ 565,960	5.0	0.68	3.39
ZT	Merlino Reach	Tributary	Tributary Restoration	$ 7,803,727	65.2	0.75	48.92
ZV	Lower Springbrook Reach	Tributary	Tributary Restoration	$ 8,511,194	55.2	0.64	35.45
ZW	Mainstem Maintenance	Lower Green	Levee/Bank Bioengineering	$ 11,090,969	140.3	0.86	120.26
	ALL SITES TOTALS:			**$ 118,073,794**	**1903.9**		**1,454.32**

All costs estimates are in October 2000 cost level.

Present values for future O&M and Monitoring components of total cost were calculated using current federal interest rate of 6.875%.

4.11 Cost Effectiveness and Incremental Cost Analysis

The cost and output information presented in the previous two sections is the input for cost effectiveness and incremental cost analyses to evaluate the relative effectiveness and efficiency of the different alternatives at producing environmental outputs. To conduct the analyses, the procedures identified in the Corps procedures manual for conducting cost effectiveness and incremental cost analyses (IWR Report #95-R-1, USACE, May 1995) were followed. These steps include: 1) display costs and outputs of alternatives, 2) identify combinable alternatives, 3) derive combinations and calculate costs and outputs, 4) identify cost effective plans, 5) calculate and display most efficient alternatives through incremental cost analysis. The results of the steps are summarized below.

Step 1) Display Costs and Outputs of Alternatives: Table 4-6 provides a display of the costs and outputs associated with each project. The projects are sorted by the output they each provide.

Step 2) Identify Combinable Alternatives: Because each alternative under consideration is an individual independent project, all alternatives are combinable with all others. None of the projects are dependent on any other project being implemented for feasibility.

Step 3) Derive Combinations and Calculate Costs and Outputs: Because of the large number of combinable projects (47), the derivation of all possible combinations was impossible. The number of possible combinations was calculated to be 3.88e+78.

Step 4) Identify Cost Effective Plans: Again, because of the large number of combinable projects (47), it was determined that the identification of the set of cost-effective plans was not feasible for this study. Instead, the analysis proceeded directly to incremental cost analysis to identify the most efficient plans at producing increasing levels of environmental outputs (see Step 5, below).

Step 5) Calculate and Display Most Efficient Alternatives through Incremental Cost Analysis: Incremental cost analysis was conducted to identify those cost-effective solutions that are the most efficient at producing environmental outputs. These most-efficient plans are referred to as "best-buys". They provide the greatest increase in eco-units for the least increase in cost per eco-unit. The analysis resulted in the identification of 48 best-buy plans (including the no-action plan). Table 4-7 provides the 48 restoration alternatives, with the values for their total costs and outputs, ordered by increasing incremental cost per unit. Table 4-8 displays the incremental cost analysis of the 48 most efficient combinations of the restoration alternatives (alternatives are added in order of sequentially increasing incremental cost per unit).

Table 4-6. Ecosystem Restoration Alternatives (sorted by output)

	Site Name	Location	Site Type	TOTAL COST	OUTPUT (Eco-Units)
E	Newaukum Creek	Tributary	Tributary Restoration	$ 8,618,869	192.00
ZW	Mainstem Maintenance	Lower Green	Levee/Bank Bioengineering	$ 11,090,969	120.26
B	Mainstem Green River LWD	Middle Green	Programmatic LWD	$ 2,485,736	111.77
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation	$ 3,267,834	107.14
O	Mullen Slough	Lower Green	Side Channel Modification	$ 2,002,921	78.73
A	NE Auburn Creek	Tributary	Culvert Modification	$ 1,016,571	64.98
H	Sunday Creek	Upper Tributary	Tributary Restoration	$ 3,283,713	62.72
ZG	Green River Gravel Replenishment	Middle Green	Gravel Nourishment	$ 9,455,112	62.07
U	Schuler Brothers Reach	Tributary	Tributary Restoration	$ 4,035,193	59.90
ZO	Mill Creek East	Tributary	Tributary Restoration	$ 8,294,544	52.99
Q	Flaming Geyser Landslide	Middle Green	Flaming Geyser Landslide	$ 4,700,494	51.43
ZT	Merlino Reach	Tributary	Tributary Restoration	$ 7,803,727	48.92
R	Lones Levee Removal	Middle Green	Levee Removal	$ 3,762,215	39.43
ZH	Goedeke North Reach	Tributary	Tributary Restoration	$ 8,002,916	36.68
ZV	Lower Springbrook Reach	Tributary	Tributary Restoration	$ 8,511,194	35.45
ZI	Wetland 5K Reach	Tributary	Tributary Restoration	$ 2,800,962	31.43
J	Porter Levee Setback	Middle Green	Levee Setback	$ 1,552,439	30.46
ZF	Flaming Geyser Side Channel	Middle Green	Side Channel Modification	$ 1,189,271	22.48
ZC	Ray Creek	Middle Green	Side Channel Modification	$ 3,088,451	17.80
W	Duwamish Site 1	Estuary	Estuary Marsh Habitat	$ 2,120,928	17.29
ZN	Prentice Nursery Reach	Lower Green	Side Channel Modification	$ 647,937	16.96
G	Hamakami Levee	Middle Green	Wetland Habitat	$ 948,386	16.07
S	Codiga Farms	Estuary	Estuary Marsh Habitat	$ 1,743,657	15.43
ZM	Garrison Creek	Tributary	Tributary Restoration	$ 1,741,141	14.84
Z	Big Spring Creek	Tributary	Wetland Habitat	$ 1,550,761	13.30
ZP	Brunner Slough	Middle Green	Side Channel Modification	$ 1,575,974	13.23
F	Turley Side Channel	Middle Green	Side Channel Modification	$ 399,212	13.18
ZL	Burns Creek	Tributary	Tributary Restoration	$ 1,260,609	13.00
T	Horsehead Bend	Lower Green	Side Channel Modification	$ 1,046,043	10.55
ZJ	Riverside Estates Side Channel	Middle Green	Side Channel Modification	$ 766,330	8.55
ZA	Upper Green River Side Channels	Upper Green	Side Channel Modification	$ 1,295,812	8.49
X	Lake Meridian Outlet	Tributary	Tributary Restoration	$ 1,182,538	8.15
K	Kaetch Side Channel	Middle Green	Side Channel Modification	$ 434,452	7.19
P	Olson Creek	Tributary	Tributary Restoration	$ 203,657	5.36
ZD	Riverton Creek	Estuary	Tributary Restoration	$ 947,729	5.36
D	Sweeney Creek Culvert	Upper Tributary	Culvert Modification	$ 243,784	5.34
ZB	May Creek Culvert	Upper Tributary	Culvert Modification	$ 478,141	4.99
Y	Gilliam Creek	Lower Green	Culvert Modification	$ 919,596	4.76
N	Gale Creek Culvert	Upper Tributary	Culvert Modification	$ 380,870	4.71
M	Green River Park	Lower Green	Side Channel Modification	$ 706,627	4.13
ZR	Black River Marsh	Estuary	Estuary Marsh Habitat	$ 221,840	3.99
L	North East Creek Culvert	Upper Tributary	Culvert Modification	$ 326,635	3.71
ZS	Elliott Bay Nearshore	Estuary	Estuary Habitat	$ 565,960	3.39
ZE	Meridian Valley Creek	Tributary	Tributary Restoration	$ 580,741	2.79
V	Upper Springbrook Reach	Tributary	Tributary Restoration	$ 319,012	1.85
ZK	Gold Creek Culvert	Upper Tributary	Culvert Modification	$ 264,002	0.72
ZQ	Olsen Creek Culvert	Upper Tributary	Culvert Modification	$ 238,292	0.36

All cost estimates are in October 2000 price level.

Present values for future O&M and Monitoring components of total cost were calculated using current federal interest rate of 6.875%.

Table 4-7. Ecosystem Restoration Alternatives (Sorted by Inc. Cost)

All cost estimates are in October 2000 price level.

Present values for future O&M and Monitoring components of total cost were calculated using current federal interest rate of 6.875%.

	Site Name	Location	Site Type	TOTAL COST	OUTPUT (Eco-Units)	Inc. Cost per Unit
A	NE Auburn Creek	Tributary	Culvert Modification	$ 1,016,571	64.98	$ 15,644
B	Mainstem Green River LWD	Middle Green	Programmatic LWD	$ 2,485,736	111.77	$ 22,239
O	Mullen Slough	Lower Green	Side Channel Modification	$ 2,002,921	78.73	$ 25,441
F	Turley Side Channel	Middle Green	Side Channel Modification	$ 399,212	13.18	$ 30,297
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation	$ 3,267,834	107.14	$ 30,500
P	Olson Creek	Tributary	Tributary Restoration	$ 203,657	5.36	$ 38,016
ZN	Prentice Nursery Reach	Lower Green	Side Channel Modification	$ 647,937	16.96	$ 38,194
E	Newaukum Creek	Tributary	Tributary Restoration	$ 8,618,869	192.00	$ 44,890
D	Sweeney Creek Culvert	Upper Tributary	Culvert Modification	$ 243,784	5.34	$ 45,652
J	Porter Levee Setback	Middle Green	Levee Setback	$ 1,552,439	30.46	$ 50,971
H	Sunday Creek	Upper Tributary	Tributary Restoration	$ 3,283,713	62.72	$ 52,352
ZF	Flaming Geyser Side Channel	Middle Green	Side Channel Modification	$ 1,189,271	22.48	$ 52,898
ZR	Black River Marsh	Estuary	Estuary Marsh Habitat	$ 221,840	3.99	$ 55,569
G	Hamakami Levee	Middle Green	Wetland Habitat	$ 948,386	16.07	$ 59,003
K	Kaetch Side Channel	Middle Green	Side Channel Modification	$ 434,452	7.19	$ 60,448
U	Schuler Brothers Reach	Tributary	Tributary Restoration	$ 4,035,193	59.90	$ 67,365
N	Gale Creek Culvert	Upper Tributary	Culvert Modification	$ 380,870	4.71	$ 80,919
L	North East Creek Culvert	Upper Tributary	Culvert Modification	$ 326,635	3.71	$ 88,071
ZI	Wetland 5K Reach	Tributary	Tributary Restoration	$ 2,800,962	31.43	$ 89,132
ZJ	Riverside Estates Side Channel	Middle Green	Side Channel Modification	$ 766,330	8.55	$ 89,629
Q	Flaming Geyser Landslide	Middle Green	Flaming Geyser Landslide	$ 4,700,494	51.43	$ 91,398
ZW	Mainstem Maintenance	Lower Green	Levee/Bank Bioengineering	$ 11,090,969	120.26	$ 92,227
R	Lones Levee Removal	Middle Green	Levee Removal	$ 3,762,215	39.43	$ 95,422
ZB	May Creek Culvert	Upper Tributary	Culvert Modification	$ 478,141	4.99	$ 95,799
ZL	Burns Creek	Tributary	Tributary Restoration	$ 1,260,609	13.00	$ 96,957
T	Horsehead Bend	Lower Green	Side Channel Modification	$ 1,046,043	10.55	$ 99,198
S	Codiga Farms	Estuary	Estuary Marsh Habitat	$ 1,743,657	15.43	$ 113,015
Z	Big Spring Creek	Tributary	Wetland Habitat	$ 1,550,761	13.30	$ 116,567
ZM	Garrison Creek	Tributary	Tributary Restoration	$ 1,741,141	14.84	$ 117,367
ZP	Brunner Slough	Middle Green	Side Channel Modification	$ 1,575,974	13.23	$ 119,166
W	Duwamish Site 1	Estuary	Estuary Marsh Habitat	$ 2,120,928	17.29	$ 122,698
X	Lake Meridian Outlet	Tributary	Tributary Restoration	$ 1,182,538	8.15	$ 145,122
ZG	Green River Gravel Replenishment	Middle Green	Gravel Nourishment	$ 9,455,112	62.07	$ 152,326
ZA	Upper Green River Side Channels	Upper Green	Side Channel Modification	$ 1,295,812	8.49	$ 152,647
ZO	Mill Creek East	Tributary	Tributary Restoration	$ 8,294,544	52.99	$ 156,522
ZT	Merlino Reach	Tributary	Tributary Restoration	$ 7,803,727	48.92	$ 159,536
ZS	Elliott Bay Nearshore	Estuary	Estuary Habitat	$ 565,960	3.39	$ 166,809
M	Green River Park	Lower Green	Side Channel Modification	$ 706,627	4.13	$ 171,304
V	Upper Springbrook Reach	Tributary	Tributary Restoration	$ 319,012	1.85	$ 172,306
ZC	Ray Creek	Middle Green	Side Channel Modification	$ 3,088,451	17.80	$ 173,554
ZD	Riverton Creek	Estuary	Tributary Restoration	$ 947,729	5.36	$ 176,909
Y	Gilliam Creek	Lower Green	Culvert Modification	$ 919,596	4.76	$ 193,019
ZE	Meridian Valley Creek	Tributary	Tributary Restoration	$ 580,741	2.79	$ 207,805
ZH	Goedeke North Reach	Tributary	Tributary Restoration	$ 8,002,916	36.68	$ 218,180
ZV	Lower Springbrook Reach	Tributary	Tributary Restoration	$ 8,511,194	35.45	$ 240,066
ZK	Gold Creek Culvert	Upper Tributary	Culvert Modification	$ 264,002	0.72	$ 365,220
ZQ	Olsen Creek Culvert	Upper Tributary	Culvert Modification	$ 238,292	0.36	$ 654,135
	ALL SITES TOTALS:			**$ 118,073,794**	**1,454.32**	

Table 4-8 Incremental Cost Analysis

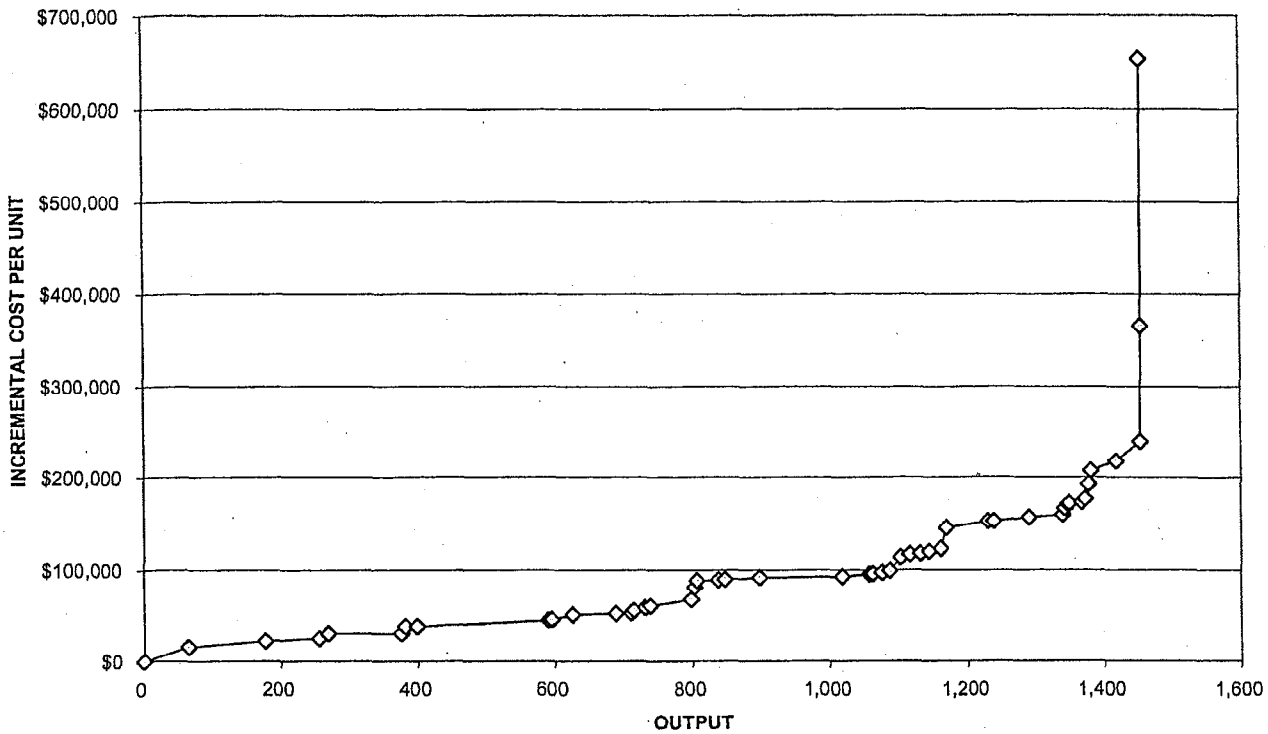
	Plan	Total Cost	Total Output	Change in Cost	Change in Output	Inc. Cost per Unit
1	No Action	$ -	0	$ -	0	$ -
2	A	$1,016,571	64.98	$ 1,016,571	64.98	$ 15,644
3	A+B	$3,502,306	176.75	$ 2,485,736	111.77	$ 22,239
4	A+B+O	$5,505,228	255.48	$ 2,002,921	78.73	$ 25,441
5	A+B+O+F	$5,904,440	268.66	$ 399,212	13.18	$ 30,297
6	A+B+O+F+C	$9,172,274	375.80	$ 3,267,834	107.14	$ 30,500
7	A+B+O+F+C+P	$9,375,931	381.16	$ 203,657	5.36	$ 38,016
8	A+B+O+F+C+P+AN	$10,023,868	398.12	$ 647,937	16.96	$ 38,194
9	A+B+O+F+C+P+AN+E	$18,642,736	590.12	$ 8,618,869	192.00	$ 44,890
10	A+B+O+F+C+P+AN+E+D	$18,886,520	595.46	$ 243,784	5.34	$ 45,652
11	A+B+O+F+C+P+AN+E+D+J	$20,438,959	625.92	$ 1,552,439	30.46	$ 50,971
12	A+B+O+F+C+P+AN+E+D+J+H	$23,722,672	688.64	$ 3,283,713	62.72	$ 52,352
13	A+B+O+F+C+P+AN+E+D+J+H+AF	$24,911,943	711.13	$ 1,189,271	22.48	$ 52,898
14	A+B+O+F+C+P+AN+E+D+J+H+AF+AR	$25,133,782	715.12	$ 221,840	3.99	$ 55,569
15	A+B+O+F+C+P+AN+E+D+J+H+AF+AR+G	$26,082,168	731.19	$ 948,386	16.07	$ 59,003
16	A+B+O+F+C+P+AN+E+D+J+H+AF+AR+G+K	$26,516,620	738.38	$ 434,452	7.19	$ 60,448
17	A+B+O+F+C+P+AN+E+D+J+H+AF+AR+G+K+U	$30,551,813	798.28	$ 4,035,193	59.90	$ 67,365
18	A+B+O+F+C+P+AN+E+D+J+H+AF+AR+G+K+U+N	$30,932,683	802.99	$ 380,870	4.71	$ 80,919
19	A+B+O+F+C+P+AN+E+D+J+H+AF+AR+G+K+U+N+L	$31,259,317	806.69	$ 326,635	3.71	$ 88,071
20	A+B+O+F+C+P+AN+E+D+J+H+AF+AR+G+K+U+N+L+AI	$34,060,279	838.12	$ 2,800,962	31.43	$ 89,132
21	A+B+O+F+C+P+AN+E+D+J+H+AF+AR+G+K+U+N+L+AI+AJ	$34,826,609	846.67	$ 766,330	8.55	$ 89,629
22	A+B+O+F+C+P+AN+E+D+J+H+AF+AR+G+K+U+N+L+AI+AJ+Q	$39,527,103	898.10	$ 4,700,494	51.43	$ 91,398
23	A+B+O+F+C+P+AN+E+D+J+H+AF+AR+G+K+U+N+L+AI+AJ+Q+AW	$50,618,072	1018.36	$ 11,090,969	120.26	$ 92,227
24	A+B+O+F+C+P+AN+E+D+J+H+AF+AR+G+K+U+N+L+AI+AJ+Q+AW+R	$54,380,287	1057.78	$ 3,762,215	39.43	$ 95,422
25	A+B+O+F+C+P+AN+E+D+J+H+AF+AR+G+K+U+N+L+AI+AJ+Q+AW+R+AB	$54,858,428	1062.77	$ 478,141	4.99	$ 95,799
26	...+R+AL	$56,119,037	1075.78	$ 1,260,609	13.00	$ 96,957
27	...+R+AL+T	$57,165,080	1086.32	$ 1,046,043	10.55	$ 99,198
28	...+R+AL+T+S	$58,908,738	1101.75	$ 1,743,657	15.43	$ 113,015
29	...+R+AL+T+S+Z	$60,459,498	1115.05	$ 1,550,761	13.30	$ 116,567
30	...+R+AL+T+S+Z+AM	$62,200,640	1129.89	$ 1,741,141	14.84	$ 117,367
31	...+R+AL+T+S+Z+AM+AP	$63,776,614	1143.11	$ 1,575,974	13.23	$ 119,166
32	...+R+AL+T+S+Z+AM+AP+W	$65,897,541	1160.40	$ 2,120,928	17.29	$ 122,698
33	...+R+AL+T+S+Z+AM+AP+W+X	$67,080,079	1168.55	$ 1,182,538	8.15	$ 145,122
34	...+R+AL+T+S+Z+AM+AP+W+X+AG	$76,535,191	1230.62	$ 9,455,112	62.07	$ 152,326
35	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA	$77,831,003	1239.11	$ 1,295,812	8.49	$ 152,647
36	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO	$86,125,547	1292.10	$ 8,294,544	52.99	$ 156,522
37	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT	$93,929,273	1341.01	$ 7,803,727	48.92	$ 159,536
38	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT+AS	$94,495,233	1344.41	$ 565,960	3.39	$ 166,809
39	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT+AS+M	$95,201,861	1348.53	$ 706,627	4.13	$ 171,304
40	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT+AS+M+V	$95,520,873	1350.38	$ 319,012	1.85	$ 172,306
41	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT+AS+M+V+AC	$98,609,324	1368.18	$ 3,088,451	17.80	$ 173,554
42	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT+AS+M+V+AC+AD	$99,557,053	1373.54	$ 947,729	5.36	$ 176,909
43	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT+AS+M+V+AC+AD+Y	$100,476,649	1378.30	$ 919,596	4.76	$ 193,019
44	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT+AS+M+V+AC+AD+Y+AE	$101,057,390	1381.10	$ 580,741	2.79	$ 207,805
45	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT+AS+M+V+AC+AD+Y+AE+AH	$109,060,306	1417.78	$ 8,002,916	36.68	$ 218,180
46	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT+AS+M+V+AC+AD+Y+AE+AH+AV	$117,571,500	1453.23	$ 8,511,194	35.45	$ 240,066
47	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT+AS+M+V+AC+AD+Y+AE+AH+AV+AK	$117,835,502	1453.95	$ 264,002	0.72	$ 365,220
48	...+R+AL+T+S+Z+AM+AP+W+X+AG+AA+AO+AT+AS+M+V+AC+AD+Y+AE+AH+AV+AK+AQ	$118,073,794	1454.32	$ 238,292	0.36	$ 654,135

All cost estimates are in October 2000 price level.

Present values for future O&M and Monitoring components of total cost were calculated using current federal interest rate of 6.875%.

The data in Table 4-8 is displayed graphically in Figure 4-1. The figures displays the sharp increase in incremental cost that are accompanied by small increases in output for plans providing more output than Plan 46 in Table 4-8. Plans 2 through 46 show relatively smaller increases in incremental cost for increases in output, while plans 47 through 48 have a large increase in incremental cost for relatively small increases in output.

FIGURE 4.1
GREEN-DUWAMISH RESTORATION - INCREMENTAL COST ANALYSIS



4.12 Selected Plan

Based upon the cost effectiveness and incremental cost analyses, Plan 46 in Table 4-8 has been selected as the National Ecosystem Restoration Plan. The plan would implement 45 of the project specific and programmatic alternatives. The plan would significantly restore ecosystem level functions and processes. It would provide significant ecosystem benefits by addressing the majority of limiting resource problems in the basin, providing restored habitats where needed to address all riverine life stages of endangered salmon. Furthermore, the plan would provide a very significant increase in habitat connectivity from the estuary all the way to the upper watershed. Table 4-9 provides a summary of the features in the selected plan sorted by watershed location.

Table 4-9. Selected Restoration Projects (sorted by location)

	Site Name	Location	Site Type	TOTAL COST	OUTPUT (Eco-Units)	Inc. Cost per Unit
ZR	Black River Marsh	Duwamish Estuary	Estuary Marsh Habitat	$ 221,840	3.99	$ 55,569
S	Codiga Farms	Duwamish Estuary	Estuary Marsh Habitat	$ 1,743,657	15.43	$ 113,015
W	Duwamish Site 1	Duwamish Estuary	Estuary Marsh Habitat	$ 2,120,928	17.29	$ 122,698
ZS	Elliott Bay Nearshore	Duwamish Estuary	Estuary Habitat	$ 565,960	3.39	$ 166,809
ZD	Riverton Creek	Duwamish Estuary Tributary	Tributary Restoration	$ 947,729	5.36	$ 176,909
ZW	Mainstem Maintenance	Lower Green Mainstem	Levee/Bank Bioengineering	$ 11,090,969	120.26	$ 92,227
T	Horsehead Bend	Lower Green Mainstem	Side Channel Modification	$ 1,046,043	10.55	$ 99,198
M	Green River Park	Lower Green Mainstem	Side Channel Modification	$ 706,627	4.13	$ 171,304
A	NE Auburn Creek	Lower Green Tributary	Culvert Modification	$ 1,016,571	64.98	$ 15,644
O	Mullen Slough	Lower Green Tributary	Side Channel Modification	$ 2,002,921	78.73	$ 25,441
P	Olson Creek	Lower Green Tributary	Tributary Restoration	$ 203,657	5.36	$ 38,016
ZN	Prentice Nursery Reach	Lower Green Tributary	Side Channel Modification	$ 647,937	16.96	$ 38,194
U	Schuler Brothers Reach	Lower Green Tributary	Tributary Restoration	$ 4,035,193	59.90	$ 67,365
ZI	Wetland 5K Reach	Lower Green Tributary	Tributary Restoration	$ 2,800,962	31.43	$ 89,132
ZM	Garrison Creek	Lower Green Tributary	Tributary Restoration	$ 1,741,141	14.84	$ 117,367
ZO	Mill Creek East	Lower Green Tributary	Tributary Restoration	$ 8,294,544	52.99	$ 156,522
ZT	Merlino Reach	Lower Green Tributary	Tributary Restoration	$ 7,803,727	48.92	$ 159,536
V	Upper Springbrook Reach	Lower Green Tributary	Tributary Restoration	$ 319,012	1.85	$ 172,306
Y	Gilliam Creek	Lower Green Tributary	Culvert Modification	$ 919,596	4.76	$ 193,019
ZH	Goedeke North Reach	Lower Green Tributary	Tributary Restoration	$ 8,002,916	36.68	$ 218,180
ZV	Lower Springbrook Reach	Lower Green Tributary	Tributary Restoration	$ 8,511,194	35.45	$ 240,066
B	Mainstem Green River LWD	Middle Green Mainstem	Programmatic LWD	$ 2,485,736	111.77	$ 22,239
F	Turley Side Channel	Middle Green Mainstem	Side Channel Modification	$ 399,212	13.18	$ 30,297
J	Porter Levee Setback	Middle Green Mainstem	Levee Setback	$ 1,552,439	30.46	$ 50,971
ZF	Flaming Geyser Side Channel	Middle Green Mainstem	Side Channel Modification	$ 1,189,271	22.48	$ 52,898
G	Hamakami Levee	Middle Green Mainstem	Wetland Habitat	$ 948,386	16.07	$ 59,003
K	Kaetch Side Channel	Middle Green Mainstem	Side Channel Modification	$ 434,452	7.19	$ 60,448
ZJ	Riverside Estates Side Channel	Middle Green Mainstem	Side Channel Modification	$ 766,330	8.55	$ 89,629
Q	Flaming Geyser Landslide	Middle Green Mainstem	Flaming Geyser Landslide	$ 4,700,494	51.43	$ 91,398
R	Lones Levee Removal	Middle Green Mainstem	Levee Removal	$ 3,762,215	39.43	$ 95,422
ZP	Brunner Slough	Middle Green Mainstem	Side Channel Modification	$ 1,575,974	13.23	$ 119,166
ZG	Green River Gravel Replenishment	Middle Green Mainstem	Gravel Nourishment	$ 9,455,112	62.07	$ 152,326
E	Newaukum Creek	Middle Green Tributary	Tributary Restoration	$ 8,618,869	192.00	$ 44,890
ZL	Burns Creek	Middle Green Tributary	Tributary Restoration	$ 1,260,609	13.00	$ 96,957
Z	Big Spring Creek	Middle Green Tributary	Wetland Habitat	$ 1,550,761	13.30	$ 116,567
X	Lake Meridian Outlet	Middle Green Tributary	Tributary Restoration	$ 1,182,538	8.15	$ 145,122
ZC	Ray Creek	Middle Green Tributary	Side Channel Modification	$ 3,088,451	17.80	$ 173,554
ZE	Meridian Valley Creek	Middle Green Tributary	Tributary Restoration	$ 580,741	2.79	$ 207,805
ZA	Upper Green River Side Channels	Upper Green Mainstem	Side Channel Modification	$ 1,295,812	8.49	$ 152,647
D	Sweeney Creek Culvert	Upper Green Tributary	Culvert Modification	$ 243,784	5.34	$ 45,652
H	Sunday Creek	Upper Green Tributary	Tributary Restoration	$ 3,283,713	62.72	$ 52,352
N	Gale Creek Culvert	Upper Green Tributary	Culvert Modification	$ 380,870	4.71	$ 80,919
L	North East Creek Culvert	Upper Green Tributary	Culvert Modification	$ 326,635	3.71	$ 88,071
ZB	May Creek Culvert	Upper Green Tributary	Culvert Modification	$ 478,141	4.99	$ 95,799
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation	$ 3,267,834	107.14	$ 30,500

**Costs are in October 2000 price level.*

Selected Projects in Duwamish Estuary Zone: As noted in the report, 98% of estuarine habitat has been lost in the basin. This habitat is vital to the survival of salmon, providing the transitional zone where the fish adjust for the change from freshwater to saltwater. The selected plan includes four estuary restoration projects and one estuarine tributary habitat restoration project. Based on the significance of this habitat for survival of salmonids in the system, the environmental benefit provided by all 5 estuary restoration projects were determined to be worth their incremental cost.

Selected Projects in Lower Green River: Development in the Lower Green River Watershed has resulted in a dramatic loss in watershed function and productivity. The selected plan includes 3 restoration projects on the Green River Mainstem. Existing development including flood control constrains the opportunities for restoration along the Lower Green River mainstem. Because of the scarcity of refugia and rearing habitats in the basin the environmental benefit provided by both Lower Green River side channel projects was determined to be worth their incremental cost. In addition, because of the scarcity of quality riparian habitats and the resultant effects on water temperature and in-channel habitat quality, the Mainstem Maintenance project was determined to be worth its incremental cost.

Thirteen tributary restoration projects in the lower Green River Watershed were selected for recommendation (see Table 4-9). The environmental benefit provided by each project was determined to be worth its incremental cost. The projects address identified watershed resource problems, including loss of channel complexity and in-channel structure, water quality degradation, barriers to fish passage, floodplain disconnection, and changes in riparian habitat. The projects include culvert modifications, side channel modifications, and tributary restoration.

Selected Projects in Middle Green River: Agricultural and transportation development in the Middle Green River Watershed has resulted in dramatic habitat degradation and diminished ecosystem functions and processes. Eleven projects were selected for recommendation along the middle Green River mainstem (see Table 4-9). The restoration of in-channel, refugia, and rearing habitats through the reach are required by migrating salmonids. The environmental benefit of each of the eleven middle Green River mainstem restoration projects was determined to be worth its incremental cost. The projects include the reintroduction of large woody debris, levee setbacks, levee removal, side channel modifications, wetland restoration, and sedimentation management.

Six tributary restoration projects in the middle Green River Watershed were selected for recommendation (see Table 4-9). The environmental benefit provided by each project was determined to be worth its incremental cost. The projects address identified watershed resource problems (see Table 4-1), including *loss of channel complexity and in-channel structure, water quality degradation, barriers to fish passage, floodplain disconnection*, and *changes in forest structure and composition* (riparian). The projects include culvert modifications, side channel modifications, wetland habitat restoration, and tributary restoration.

Selected Projects in Upper Green River: One project was selected on the upper Green River mainstem. This side channel restoration project was determined to be worth its incremental cost. Five tributary restoration projects were selected in the upper Green River Watershed. The output provided by each project was determined to be worth it's incremental cost. One of the projects is tributary habitat

restoration and four are culvert modifications. The projects address the identified resource problems (see Table 4-1) of *barriers to fish passage* and *habitat fragmentation*.

5. DESCRIPTION OF SELECTED PLAN

The recommended National Ecosystem Restoration (NER) Plan includes 45 individual projects representing all nine restoration measures plus all four programmatic restoration measures to place LWD and gravel in the middle Green River, provide bioengineering modifications to mainstem levees and implement volunteer revegetation projects. The total estimated cost for this plan is $127,929,400 (present value is $117,571,500) to restore and provide access to 1903 acres of aquatic and riparian/floodplain habitat, providing an additional 1,453 ecounits of project output. This cost estimate includes all costs (PED, LERRDs, S&A, Construction Mgmt., Construction, Monitoring, and OMRR&R.) Present value was calculated using current 6.875% federal interest rate and a 50-year period of analysis. All engineering cost estimates were developed in October 2000 price level. Real Estate estimates are in current prices. Table 5-1 provides a summary of the selected projects, including location, project type, total project cost, present value of total project cost, output (eco-units), and affected acreage.

The primary significance of this ecosystem restoration plan is that it will restore habitats and migratory corridors of particular importance to both wildlife species and almost every life history stage of the salmon species, including federally listed endangered species. Dramatic historical reductions in these vital habitats and corridors have produced the major limiting factors for these species within the basin. The only salmon life history stage not addressed by this plan is ocean rearing. The value of restoration is greatly diminished when there are no corridors to connect restored projects to each other, even if localized benefits can be achieved. This is particularly true for fish species. It is important to provide frequent restored habitats and improved migration corridors to facilitate upstream and downstream migration, rather than the stressful conditions that currently exist for vast stretches of the river between small restoration projects. For the salmon species it is also very important to restore all of the types of habitats utilized by various life history stages, particularly habitats that limit production. Otherwise, improved production from one type of habitat is almost completely negated by the limited capacity of the habitat required for the next life history stage (i.e. improved spawning habitat doesn't guarantee increased production of smolts if rearing habitat is severely limited).

The overall effect of the NER plan is best shown in the basin map showing the locations of all the projects as they are distributed around most of the entire watershed (see Figures Two through Four) and address nine of the ten major resource problems in the watershed. All of the proposed projects are described in further detail in the Programmatic EIS for the study (published under separate cover).

Table 5-1 Selected Projects Summary

	Site Name	Location	Type	Total Project Cost*	Project Cost (Present Value)**	Output (Eco-Units)	Affected Area (Acres)
A	NE Auburn Creek	Tributary	Culvert Modification	$ 1,400,745	$ 1,016,571	64.98	107.0
B	Mainstem Green River LWD	Middle Green	Programmatic LWD	$ 3,083,180	$ 2,485,736	111.77	130.4
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation	$ 3,516,672	$ 3,267,834	107.14	200.0
D	Sweeney Creek Culvert	Upper Tributary	Culvert Modification	$ 333,913	$ 243,784	5.34	7.1
E	Newaukum Creek	Tributary	Tributary Restoration	$ 9,128,587	$ 8,618,869	192.00	224.0
F	Turley Side Channel	Middle Green	Side Channel Modification	$ 440,376	$ 399,212	13.18	14.2
G	Hamakami Levee	Middle Green	Wetland Habitat	$ 1,026,613	$ 948,386	16.07	17.3
H	Sunday Creek	Upper Tributary	Tributary Restoration	$ 3,437,771	$ 3,283,713	62.72	70.3
J	Porter Levee Setback	Middle Green	Levee Setback	$ 1,606,812	$ 1,552,439	30.46	32.8
K	Kaetch Side Channel	Middle Green	Side Channel Modification	$ 484,440	$ 434,452	7.19	7.7
L	North East Creek Culvert	Upper Tributary	Culvert Modification	$ 366,772	$ 326,635	3.71	4.8
M	Green River Park	Lower Green	Side Channel Modification	$ 767,039	$ 706,627	4.13	5.3
N	Gale Creek Culvert	Upper Tributary	Culvert Modification	$ 387,110	$ 380,870	4.71	5.7
O	Mullen Slough	Lower Green	Side Channel Modification	$ 2,123,956	$ 2,002,921	78.73	91.9
P	Olson Creek	Tributary	Tributary Restoration	$ 241,756	$ 203,657	5.36	7.5
Q	Flaming Geyser Landslide	Middle Green	Flaming Geyser Landslide	$ 5,117,753	$ 4,700,494	51.43	60.0
R	Lones Levee Removal	Middle Green	Levee Removal	$ 3,878,209	$ 3,762,215	39.43	42.5
S	Codiga Farms	Estuary	Estuary Marsh Habitat	$ 1,857,980	$ 1,743,657	15.43	18.0
T	Horsehead Bend	Lower Green	Side Channel Modification	$ 1,132,979	$ 1,046,043	10.55	14.1
U	Schuler Brothers Reach	Tributary	Tributary Restoration	$ 4,142,102	$ 4,035,193	59.90	90.7
V	Upper Springbrook Reach	Tributary	Tributary Restoration	$ 532,616	$ 319,012	1.85	2.9
W	Duwamish Site 1	Estuary	Estuary Marsh Habitat	$ 2,225,910	$ 2,120,928	17.29	22.0
X	Lake Meridian Outlet	Tributary	Tributary Restoration	$ 1,259,535	$ 1,182,538	8.15	9.9
Y	Gilliam Creek	Lower Green	Culvert Modification	$ 1,168,478	$ 919,596	4.76	6.7
Z	Big Spring Creek	Tributary	Wetland Habitat	$ 1,629,140	$ 1,550,761	13.30	14.9
ZA	Upper Green River Side Channels	Upper Green	Side Channel Modification	$ 1,419,919	$ 1,295,812	8.49	12.5
ZB	May Creek Culvert	Upper Tributary	Culvert Modification	$ 517,315	$ 478,141	4.99	6.5
ZC	Ray Creek	Middle Green	Side Channel Modification	$ 3,227,245	$ 3,088,451	17.80	29.3
ZD	Riverton Creek	Estuary	Tributary Restoration	$ 1,064,973	$ 947,729	5.36	6.0
ZE	Meridian Valley Creek	Tributary	Tributary Restoration	$ 651,278	$ 580,741	2.79	3.1
ZF	Flaming Geyser Side Channel	Middle Green	Side Channel Modification	$ 1,257,624	$ 1,189,271	22.48	25.2
ZG	Green River Gravel Replenishment	Middle Green	Gravel Nourishment	$ 12,229,958	$ 9,455,112	62.07	79.0
ZH	Goedeke North Reach	Tributary	Tributary Restoration	$ 8,042,881	$ 8,002,916	36.68	50.1
ZI	Wetland 5K Reach	Tributary	Tributary Restoration	$ 2,845,501	$ 2,800,962	31.43	41.9
ZJ	Riverside Estates Side Channel	Middle Green	Side Channel Modification	$ 1,068,519	$ 766,330	8.55	11.4
ZL	Burns Creek	Tributary	Tributary Restoration	$ 1,676,512	$ 1,260,609	13.00	24.3
ZM	Garrison Creek	Tributary	Tributary Restoration	$ 2,153,759	$ 1,741,141	14.84	19.8
ZN	Prentice Nursery Reach	Lower Green	Side Channel Modification	$ 742,275	$ 647,937	16.96	25.0
ZO	Mill Creek East	Tributary	Tributary Restoration	$ 8,850,839	$ 8,294,544	52.99	74.2
ZP	Brunner Slough	Middle Green	Side Channel Modification	$ 1,656,812	$ 1,575,974	13.23	16.1
ZR	Black River Marsh	Estuary	Estuary Marsh Habitat	$ 277,384	$ 221,840	3.99	4.9
ZS	Elliott Bay Nearshore	Estuary	Estuary Habitat	$ 595,049	$ 565,960	3.39	5.0
ZT	Merlino Reach	Tributary	Tributary Restoration	$ 7,941,617	$ 7,803,727	48.92	65.2
ZV	Lower Springbrook Reach	Tributary	Tributary Restoration	$ 8,787,924	$ 8,511,194	35.45	55.2
ZW	Mainstem Maintenance	Lower Green	Levee/Bank Bioengineering	$ 11,631,547	$ 11,090,969	120.26	140.3
	ALL SITES TOTALS:			**$ 127,929,375**	**$ 117,571,500**	**1,453.23**	**1,902.5**

All costs are presented in October 2000 price levels

** Actual value in October 2000 price level (includes PED, LERRDs, S&A, Construction Mgmt., Construction, Monitoring, and O&M.*

***Future expenditures are discounted to year 2000 level using FY00 federal interest rate of 6.875% for water resources studies.*

5.1 Monitoring

5.1.1 Monitoring Plan

The role of project monitoring in environmental restoration activities is to guide the maintenance or modification of the project to realize intended project benefits and to collect information useful for further restoration efforts. Monitoring serves to ensure the ultimate success of the project and overall project and provide meaningful data to help in the design of future restoration projects (USACE, 1996 Planning and Evaluating Restoration of Aquatic Habitats.)

Corps policy states that post-construction monitoring should be designed to evaluate whether or not environmental measures are working as planned following their construction (USACE Policy Digest, *Chapter 19 Environmental Restoration and Protection*, 30 July 1999). Monitoring programs are guided by a monitoring plan. A monitoring plan will be completed and approved by the technical committee for this overall project prior to construction of the first projects, currently scheduled in 2002. This section outlines the approach that the monitoring plan will incorporate.

Monitoring is planned to occur on a project specific level as well as a river reach level and ecosystem (basin) level. Monitoring will be tied to the specific restoration goals of each specific project. Monitoring plans may be developed for single projects or for groups of projects.

Because there is much emphasis on restoring riverine processes where possible, geomorphic evaluation may be part of the monitoring plan. In such cases, analysis of sediment distribution, river cross-sections, flow depths and aerial photos will be used to evaluate how successful the projects have been.

The monitoring plan for each project or group of projects will address:

1) Specific Goals and Objectives

Goals and objectives for each project will be specified in measurable terms for evaluating project success.

2) Performance Criteria

Performance criteria will be specified and actions (if any) required for different performance ratings. The criteria will be based on program and project objectives.

3) Monitoring Methods

Monitoring and sampling methods will be specified in the monitoring plan. Specific methods under under consideration include:

- Estuarine Habitat Assessment Protocol (Simenstad et. al. 1991) for evaluation of restoration project that occur in the estuary (such as the Port Susan and South Pass projects)
- Standard methods for assessing in-stream fish use such as seining or electroshocking
- Percent cover of vegetation and species
- Assessment of biotic integrity for invertebrate analysis (Karr 1981)
- Physical data such as water quality to focus on dissolved oxygen, temperature and sedimentation and be consistent with the "Standard Methods for Evaluating Water and Wastewater"
- Birds and other wildlife presence/absence and perhaps some behavior and productivity at selected projects

4) Reporting Requirements

The monitoring plan will specify a schedule and medium for reporting the findings of the monitoring program. The Corps will maintain a database on the results of the monitoring program and issue a report every two years after monitoring has been initiated.

6) Feedback Mechanisms

The monitoring plan will identify trigger points to activate adaptive management that are passed upon the Goals and Objectives (Item 1, above) and Performance Criteria (Item 2, above). Project success, as determined by performance criteria, may result in either:

- No Action
- Adaptive management (physical actions to move the program or project towards the desired objectives)
- Modification of project goals and objectives

5.1.2 Monitoring Cost Estimate and Schedule

Monitoring costs were estimated for each project based upon experience with ecosystem restoration projects in the Seattle District. Individual projects will typically be monitored over a five-year period, although in only either two or three of the five years. The longest monitoring period is for ten years (for alternative AW, Mainstem Maintenance) although monitoring occurs in only three of those ten years. For developing the feasibility cost estimate, monitoring costs and timing schedules were developed for each project. Table 5-2 displays the monitoring cost and timing information for each recommended project. The column "Monitoring Years" indicates the years following project construction in which monitoring is scheduled to be conducted. The Table shows the annual cost that is incurred in each of three monitoring years for each project. The Table also shows the total monitoring cost for each project and the present value of that cost. Per Corps policy, monitoring cost is apportioned at 65% federal, 35% non-federal sponsor cost for the 10 year duration of project construction. Any monitoring after the construction period will be a 100% sponsor cost.

Monitoring is an important component to any restoration program. Monitoring serves to ensure the ultimate success of the project and provide meaningful data to help in the design of future restoration projects (Planning and Evaluating Restoration of Aquatic Habitats USACE, 1996.). Restoration activities for the Green/Duwamish GI are large in scale (an entire river basin) and over a long duration (construction is expected to take ten years). The duration and costs of monitoring that are outlined in the feasibility report in a few instances exceed the current guidance. Typical recommendations for monitoring costs are 1% of the construction budget and the duration should not exceed more than five years. On few of the projects there is a recommendation to relax some of this guidance.

As previously stated, this restoration is unique in terms of size, and length of construction. What is also unique are some of the restoration methods that are intended to help restore the habitat forming processes in the river basin. In the feasibility report, Table 5-2 displays monitoring costs and what years monitoring would take place. Out of a total of forty-five projects, eight of these suggest monitoring take place one time after the five-year period. All eight of these projects are of large scale and propose to physically change the hydrology in the reach of the river where they are located. All of these projects employ relatively new restoration techniques where information is limited on their effectiveness or there is no information on how the project would change current sediment deposition, erosion rates or local

changes in flooding. It is important to document for a number of reasons these changes. Some of these changes will probably occur after the five year recommended monitoring time frame and some of these projects will take a few years to stabilize as well, so it would seem prudent to obtain later year monitoring results.

In regards to the cost of monitoring, this project exceed the recommended 1% guidance. When evaluating the types of projects that are proposed and the associated monitoring a deliberate effort was made to avoid doing research or projects that were too experimental. There was also a realization that habitat restoration is burgeoning science and all the answers are not yet available. At the same time, there is also an expectation from both reviewing agencies and the public that if this restoration initiative goes forward that monitoring of the projects will be able to provide some answers on effectiveness, impacts to endangered species and long term stability of the projects. In this regards, the need for additional monitoring costs come from the need to provide specific information on physical changes (i.e. changes to river morphology, sedimentation patterns etc.) to the environment and also to demonstrate improved biological productivity (fish use, increases in rearing and refuge habitat etc.).

Examples of the need for additional physical data beyond the typical needs is demonstrated by:

- Many of the projects are located along the mainstem of the river. The project areas experience wide ranges in both tidal inundation and river flow. This makes for a difficulty in estimating changes at the outlet channels, tributaries and sloughs even with detailed hydraulic and geomorphological studies. It is necessary to dedicate some monitoring money to physically survey these elevations to make sure that they were done correctly and determine if they need to be modified. This is also a highly erosive environment due to the same hydraulic features and there is a need to physically monitor channel morphology over time to insure stability or that the project is performing as designed.

- There are a few projects that include the placement of wood or gravel into the river system over large areas. While this type of restoration has occurred occasionally in other places there are few examples of this occurring at such a large scale in recently de-glaciated rivers. These projects have been designed to take an adaptive management approach. That is, they start at a small scale are monitored, and the effects are evaluated to determine what is the best

way to proceed. This type of approach is dependent on good monitoring information over several years.

From a biological standpoint, the increased monitoring costs above the recommended 1% are needed to provide information on a few issues that are particular to this restoration program. They include:

- One of the stated objectives of the project is to provide off-channel rearing and feeding habitat for juvenile salmonids and other fish species. There is little or no existing information documenting fish occurrence, density, residency and timing in many of the environments in this river. It would provide invaluable information for future similar projects. It will also be instrumental in evaluating the success of these projects and design of future projects.

- Some of the species of fish that will be utilizing the project projects have a threatened status under the Endangered Species Act. Additional coordination and documentation (permits, additional Biological Assessments) are required to accomplish fish sampling.

- Standardized monitoring protocols will be used for monitoring the project. This is so the information obtained will be consistent with other studies and can provide meaningful results. It may cost more to implement these procedures, but by following such procedures the information become useful to a larger audience and to future projects. This approach seems to be consistent with the conclusion expressed in National Review of Non-Corps Environmental Restoration Projects (IWR report 95-R-12, 1995).

During the monitoring of the restoration program every effort will be made to achieve cost savings. This may occur from a variety of sources such as contracting methods, obtaining volunteers to acquire some of the data and similar endeavors. Perhaps the best chance at cost saving will come from close coordination with the Howard Hansen Project. Every opportunity will be made to incorporate the relevant aspects of that sampling plan with this one.

Table 5-2. Monitoring Cost Summary

		ANNUAL MONITORING COST	TOTAL MONITORING COST	PRESENT VALUE MONITORING	MONITORING YEARS
A	NE Auburn Creek	$ 40,000	$ 80,000	$ 68,085.72	2,5
B	Mainstem Green River LWD	$ 100,000	$ 300,000	$ 228,962.02	2,5,9
C	Volunteer Revegetation	$ 100,000	$ 300,000	$ 228,962.02	2,5,9
D	Sweeney Creek Culvert	$ 10,000	$ 20,000	$ 17,548.38	2,4
E	Newaukum Creek	$ 120,000	$ 360,000	$ 274,754.43	2,5,9
F	Turley Side Channel	$ 20,000	$ 40,000	$ 34,042.86	2,5
G	Hamakami Levee	$ 70,000	$ 210,000	$ 184,936.75	1,3,5
H	Sunday Creek	$ 60,000	$ 180,000	$ 151,278.51	2,4,5
J	Porter Levee Setback	$ 75,000	$ 225,000	$ 189,098.14	2,4,5
K	Kaetch Side Channel	$ 20,000	$ 40,000	$ 34,042.86	2,5
L	North East Creek Culvert	$ 20,000	$ 40,000	$ 35,096.76	2,4
M	Green River Park	$ 70,000	$ 210,000	$ 184,936.75	1,3,5
N	Gale Creek Culvert	$ 20,000	$ 40,000	$ 34,042.86	2,5
O	Mullen Slough	$ 50,000	$ 150,000	$ 126,065.43	2,4,5
P	Olson Creek	$ 10,000	$ 20,000	$ 17,021.43	2,5
Q	Flaming Geyser Landslide	$ 120,000	$ 360,000	$ 296,640.41	2,4,6
R	Lones Levee Removal	$ 90,000	$ 270,000	$ 226,917.77	2,4,5
S	Codiga Farms	$ 90,000	$ 270,000	$ 226,917.77	2,4,5
T	Horsehead Bend	$ 70,000	$ 210,000	$ 184,936.75	1,3,5
U	Schuler Brothers Reach	$ 90,000	$ 270,000	$ 226,917.77	2,4,5
V	Upper Springbrook Reach	$ 20,000	$ 40,000	$ 27,886.74	5,8
W	Duwamish Site 1	$ 90,000	$ 270,000	$ 226,917.77	2,4,5
X	Lake Meridian Outlet	$ 50,000	$ 100,000	$ 85,107.15	2,5
Y	Gilliam Creek	$ 40,000	$ 80,000	$ 68,085.72	2,5
Z	Big Spring Creek	$ 70,000	$ 210,000	$ 176,491.60	2,4,5
AA	Upper Green River Side Channels	$ 75,000	$ 225,000	$ 189,098.14	2,4,5
AB	May Creek Culvert	$ 75,000	$ 150,000	$ 127,660.73	2,5
AC	Ray Creek	$ 75,000	$ 225,000	$ 167,207.31	3,5,9
AD	Riverton Creek	$ 40,000	$ 80,000	$ 68,085.72	2,5
AE	Meridian Valley Creek	$ 30,000	$ 60,000	$ 51,064.29	2,5
AF	Flaming Geyser Side Channel	$ 50,000	$ 150,000	$ 126,065.43	2,4,5
AG	Green River Gravel Replenishment	$ 200,000	$ 600,000	$ 457,924.05	2,5,9
AH	Goedeke North Reach	$ 70,000	$ 210,000	$ 176,491.60	2,4,5
AI	Wetland 5K Reach	$ 90,000	$ 270,000	$ 226,917.77	2,4,5
AJ	Riverside Estates Side Channel	$ 30,000	$ 60,000	$ 51,064.29	2,5
AL	Burns Creek	$ 30,000	$ 60,000	$ 51,064.29	2,5
AM	Garrison Creek	$ 50,000	$ 100,000	$ 77,325.75	3,7
AN	Prentice Nursery Reach	$ 50,000	$ 150,000	$ 126,065.43	2,4,5
AO	Mill Creek East	$ 120,000	$ 360,000	$ 279,601.12	2,5,8
AP	Brunner Slough	$ 75,000	$ 225,000	$ 189,098.14	2,4,5
AR	Black River Marsh	$ 10,000	$ 20,000	$ 17,021.43	2,5
AS	Elliott Bay Nearshore	$ 60,000	$ 180,000	$ 151,278.51	2,4,5
AT	Merlino Reach	$ 100,000	$ 300,000	$ 252,130.85	2,4,5
AV	Lower Springbrook Reach	$ 120,000	$ 360,000	$ 279,601.12	2,5,8
AW	Mainstem Maintenance	$ 120,000	$ 360,000	$ 258,766.89	2,7,10
			$ 8,440,000	$ 6,879,227.24	

**Cost estimate in October 2000 price level.*

Present value calculations use current 9,875% federalinterest rate.

5.2 Operation and Maintenance

King County, as the local sponsor, will have the requirement to operate and maintain all of the proposed project specific and programmatic restoration measures. The County intends to sign inter-local agreements with several of the cities within the watershed for some of these other entities to be responsible for operation and maintenance of the projects in their jurisdictions. However, ultimately, it will be the responsibility of the County to ensure the projects are appropriately maintained. It is the intent of the design of these projects to minimize the potential maintenance requirements as much as possible. And, the primary goal of this ecosystem restoration plan is to recreate natural ecosystem processes that change and create habitats over time. It is not expected that all of the projects will remain in their constructed form over the life of the project.

Expected maintenance activities include elements such as: .

- All vegetation plantings will require initial watering and other maintenance such as removing noxious weeds in order to ensure appropriate survival of the plantings.
- Large Woody Debris projects will require some maintenance such as wood replacement in cases of extensive lost woody debris to ensure that project objectives are fulfilled
- Side channels and sloughs may experience sediment deposition or erosion depending on the level of flows that occur.
- Bioengineered levees and banks will likely require periodic replacement of rock plantings or LWD.
- Culverts and tide gates will need to be periodically cleaned of debris.
- Fences required for elimination of livestock access to plated areas will require periodic survey for and replacement of damage

The total estimated cost for operation and maintenance, which the local sponsor will be responsible for over the life of the project is $12,050,000. The present value of this cost (annual expenditures brought back to year 2000 values using the current Federal interest rate for water resources projects, 6.875%) is $3,315,950 which has an average annual equivalent value of $236,483 for 50 years. Details associated with the annual maintenance and one-time replacement costs associated with the recommended projects are provided in Table 5-3.

Table 5-3. Operation, Maintenance, and Replacement Costs

	Project Name	Vegetation Mgmt.	LWD Maint.	Sediment Mgmt.	Structural Maint.	Fence Maint.	Total Annual Maint.	Total Replacement Cost (year 25)	Total Annual O&M&R	Total O&M&R Over 50-yr Project Life
A	NE Auburn Creek	2,000.00	500.00	500.00	500.00		3,500.00	5,000.00	8,500	425,000.00
B	Mainstem Green River LWD	5,000.00	10,000.00	-			15,000.00	-	15,000	750,000.00
C	Volunteer Revegetation	5,000.00					5,000.00		5,000	250,000.00
D	Sweeney Creek Culvert	500.00	500.00	500.00	1,000.00		2,500.00		2,500	125,000.00
E	Newaukum Creek	5,000.00	1,000.00	1,000.00		5,000.00	12,000.00		12,000	600,000.00
F	Turley Side Channel	500.00	500.00				1,000.00		1,000	50,000.00
G	Hamakami Levee	500.00		1,000.00			1,500.00		1,500	75,000.00
H	Sunday Creek	2,500.00	1,000.00				3,500.00		3,500	175,000.00
J	Porter Levee Setback	500.00					500.00		500	25,000.00
K	Kaetch Side Channel	250.00	250.00	500.00		250.00	1,250.00		1,250	62,500.00
L	North East Creek Culvert			500.00	500.00		1,000.00		1,000	50,000.00
M	Green River Park			500.00	500.00		1,000.00		1,000	50,000.00
N	Gale Creek Culvert						-		-	-
O	Mullen Slough	2,000.00	500.00	250.00			2,750.00		2,750	137,500.00
P	Olson Creek	500.00	250.00	250.00			1,000.00		1,000	50,000.00
Q	Flaming Geyser Landslide				10,000.00		10,000.00		10,000	500,000.00
R	Lones Levee Removal	500.00		500.00	1,000.00		2,000.00		2,000	100,000.00
S	Codiga Farms	500.00	500.00	1,000.00			2,000.00		2,000	100,000.00
T	Horsehead Bend	500.00	250.00	1,000.00			1,750.00		1,750	87,500.00
U	Schuler Brothers Reach	1,000.00	250.00	500.00			1,750.00		1,750	87,500.00
V	Upper Springbrook Reach	500.00	250.00	5,000.00			5,750.00		5,750	287,500.00
W	Duwamish Site 1	500.00	250.00	1,000.00			1,750.00		1,750	87,500.00
X	Lake Meridian Outlet	500.00	250.00	1,000.00			1,750.00		1,750	87,500.00
Y	Gilliam Creek	500.00	250.00	1,000.00	5,000.00		6,750.00		6,750	337,500.00
Z	Big Spring Creek	500.00	250.00	500.00			1,250.00		1,250	62,500.00
AA	Upper Green River Side Channels		2,500.00				2,500.00		2,500	125,000.00
AB	May Creek Culvert	500.00					500.00		500	25,000.00
AC	Ray Creek	500.00	500.00	500.00		750.00	2,250.00		2,250	112,500.00
AD	Riverton Creek	250.00	250.00	1,500.00	1,000.00		3,000.00		3,000	150,000.00
AE	Meridian Valley Creek	500.00	250.00	1,000.00			1,750.00		1,750	87,500.00
AF	Flaming Geyser Side Channel	500.00	250.00	500.00			1,250.00		1,250	62,500.00
AG	Green River Gravel Replenishment			75,000.00			75,000.00		75,000	3,750,000.00
AH	Goedeke North Reach						-		-	-
AI	Wetland 5K Reach						-		-	-
AJ	Riverside Estates Side Channel	250.00	250.00	250.00	500.00		1,250.00	5,000.00	6,250	312,500.00
AL	Burns Creek	500.00	500.00	2,000.00	1,000.00	500.00	4,500.00	5,000.00	9,500	475,000.00
AM	Garrison Creek	500.00	500.00	2,000.00	1,000.00		4,000.00	5,000.00	9,000	450,000.00
AN	Prentice Nursery Reach	500.00	500.00	1,000.00			2,000.00		2,000	100,000.00
AO	Mill Creek East	5,000.00	2,500.00	5,000.00	1,000.00		13,500.00		13,500	675,000.00
AP	Brunner Slough	250.00	500.00	500.00			1,250.00		1,250	62,500.00
AR	Black River Marsh	500.00	500.00	500.00			1,500.00		1,500	75,000.00
AS	Elliott Bay Nearshore						-		-	-
AT	Merlino Reach	500.00	500.00	1,000.00		500.00	2,500.00		2,500	125,000.00
AV	Lower Springbrook Reach	1,500.00	1,500.00	2,500.00			5,500.00		5,500	275,000.00
AW	Mainstem Maintenance	5,000.00	5,000.00		2,500.00		12,500.00		12,500	625,000.00
	ALL SITES TOTALS:	**$ 46,000**	**$ 32,750**	**$ 109,750**	**$ 25,500**	**$ 7,000**	**$ 221,000**	**$ 20,000**	**$ 241,000**	**$ 12,050,000**

Values displayed are actual values in October 2000 price level (not converted to present value).

5.3 Real Estate

The footprints of the 47 proposed ecosystem restoration projects would require approximately 1,325 acres of land. The Real Estate Plan (REP) (see Appendix C) specifies real estate requirements for each project. Following execution of the Project Cooperation Agreement (PCA), the Non Federal Sponsor (NFS) will generally require approximately 4 to 48 months to complete its real estate activities, and certify the lands available to the Corps before advertising for project construction. Project specific time requirement estimates are provided in the REP. Following authorization for entry, the NFS will provide the District Real Estate Division with all supporting lands, easements, and rights-of-way credit documentation.

See Appendix C - Real Estate Plan for additional real estate information. The REP includes maps of the project area, ownership information, estates, and acreage. The REP also provides an assessment of the NFS's real estate acquisition capability and the Certification of Lands and Attorney's Certificate.

Table 5-4 provides a summary of the real estate baseline cost estimate (in present dollars) for land value, NFS's administration costs, and Federal review and assistance costs (S&A) required to implement the recommended plan. Discussion of construction sequencing is provided in Section 6.4 of this report and summarized in Table 6.1. Also see the Construction Phase Summary in the REP (Appendix C) for a breakdown of the currently proposed construction schedule.

Table 5-4 Real Estate Baseline Cost Estimate

SITE NAME	TOTAL ACRES	LAND VALUES	NON-FEDERAL SPONSOR'S ADMINISTRATIVE COSTS	FEDERAL GOV'T REVIEW & ASSISTANCE COSTS	TOTAL LAND COSTS PER SITE
NE Auburn Creek	11.64	$ 68,300	$ 14,000	$ 4,000	$ 86,300
Middle Green River Large Woody Debris	41.25	$ 147,750	$ 350,000	$ 89,000	$ 586,750
Volunteer Revegetation (NO REAL ESTATE)					
Sweeney Creek*	0.30	$ 16,600	$ 7,000	$ 4,000	$ 27,600
Newaukum Creek	224.00	$ 1,806,000	$ 839,000	$ 147,000	$ 2,792,000
Turley Levee Setback	12.94	$ 95,000	$ 14,000	$ 4,000	$ 113,000
Hamakami Levee Modification	3.20	$ 16,000	$ 14,000	$ 4,000	$ 34,000
Sunday Creek Riparian Plantings*	70.25	$ 23,300	$ 14,000	$ 5,000	$ 42,300
Porter Levee Setback	31.64	$ 237,000	$ 7,000	$ 3,000	$ 247,000
Keach Levee Pond	5.28	$ 58,000	$ 14,000	$ 4,000	$ 76,000
Northeast Creek*	1.00	$ 18,800	$ 7,000	$ 4,000	$ 29,800
Green River Park	3.56	$ 104,800	$ 7,000	$ 3,000	$ 114,800
Gale Creek*	0.63	$ 20,600	$ 7,000	$ 4,000	$ 31,600
Mullen Slough Reach	91.85	$ 684,000	$ 66,000	$ 13,000	$ 763,000
Olson Creek	7.50	$ 27,000	$ 14,000	$ 4,000	$ 45,000
Flaming Geyser Slide	10.15	$ 127,000	$ 7,000	$ 4,000	$ 138,000
Lones Levee Setback	30.45	$ 273,000	$ 20,000	$ 6,000	$ 299,000
Codiga Farms	3.40	$ 118,000	$ 14,000	$ 4,000	$ 136,000
Horsehead Bend Side Channel	14.06	$ 130,000	$ 14,000	$ 4,000	$ 148,000
Mill Creek, Schuler Brothers Reach	90.66	$ 745,000	$ 53,000	$ 11,000	$ 809,000
Upper Springbrook Creek	2.13	$ 15,000	$ 7,000	$ 3,000	$ 25,000
Site 1, Duwamish	2.82	$ 933,000	$ 14,000	$ 4,000	$ 951,000
Lake Meridian Outlet Relocation	8.80	$ 117,900	$ 14,000	$ 4,000	$ 135,900
Gilliam Creek	4.40	$ 49,000	$ 7,000	$ 3,000	$ 59,000
Big Spring Creek	14.90	$ 68,250	$ 47,000	$ 11,000	$ 126,250
Upper Green River Side Channel Enhancement*	12.51	$ 174,300	$ 80,000	$ 19,000	$ 273,300
May Creek*	6.50	$ 25,300	$ 14,000	$ 5,000	$ 44,300
Ray Creek Trib Corridor	29.31	$ 341,000	$ 33,000	$ 8,000	$ 382,000
Riverton Side Channel	3.48	$ 391,000	$ 20,000	$ 7,000	$ 418,000
Meridian Valley Creek	2.23	$ 94,000	$ 20,000	$ 5,000	$ 119,000
Flaming Geyser Side Channel	25.18	$ 252,000	$ 14,000	$ 4,000	$ 270,000
Middle Green River Gravel Replacement	78.82	$ 353,000	$ 86,000	$ 25,000	$ 464,000
Mill Creek, Goedeke Reach	15.47	$ 642,000	$ 7,000	$ 3,000	$ 652,000
Mill Creek, Wetland 5K Reach	41.90	$ 752,000	$ 33,000	$ 8,000	$ 793,000
Riverside Estates Side Channel	11.40	$ 82,000	$ 33,000	$ 8,000	$ 123,000
Burns Creek Restoration	24.27	$ 440,400	$ 93,000	$ 17,000	$ 550,400
Garrison Creek (1)	19.78	$ 358,000	$ 119,000	$ 23,000	$ 500,000
Prentice Nursery	4.86	$ 33,000	$ 27,000	$ 7,000	$ 67,000
Mill Creek East	74.19	$ 3,263,000	$ 159,000	$ 42,000	$ 3,464,000
Brunner Slough	16.10	$ 38,000	$ 33,000	$ 8,000	$ 79,000
Black River Marsh	4.86	$ 57,000	$ 40,000	$ 10,000	$ 107,000
Elliot Bay Nearshore	5.70	$ 3,000	$ 7,000	$ 3,000	$ 13,000
Mill Creek, Merlino Reach	65.22	$ 3,750,000	$ 86,000	$ 16,000	$ 3,852,000
Lower Springbrook Creek	55.15	$ 3,020,000	$ 198,000	$ 41,000	$ 3,259,000
Mainstem Maintenance (Auburn to Elliot Bay)	140.30	$ 6,967,000	$ 80,000	$ 19,000	$ 7,066,000
SUBTOTAL	**1,324.04**	**$ 26,935,300.00**	**$ 2,753,000.00**	**$ 624,000.00**	**$ 30,312,300.00**
25% Contingency		$ 6,733,825	$ 688,250	$ 156,000	$ 7,578,075
GRAND TOTAL		**$ 33,669,125**	**$ 3,441,250**	**$ 780,000**	**$ 37,890,375**

**Real estate costs associated with an access road in the upper watershed are divided evenly across these six projects.*

Cost displayed are in October 2000 price level.

5.4 Transportation/Access

Impacts on transportation will occur as a result of construction activities. Construction of the proposed projects will be phased over several years, which will minimize the impact each year, but extend the period of potential effects over a longer time. Primarily, the effect will be from truck traffic either hauling materials off-project or bringing in materials such as LWD. Temporary access roads will be needed at many of the projects. During the preconstruction engineering and design phase, access requirements and traffic effects will be determined for each project and the effects will be minimized. Eight of the recommended projects located in the upper watershed will require an access road (projects identified in Table 5.2).

5.5 Recreation

The Green/Duwamish River basin is heavily utilized for recreation. During the preconstruction engineering and design phase, projects should be designed to allow educational and interpretive activities, or other passive recreation that will not compromise the functioning of the individual projects. The nature and scope of the ecosystem restoration plan will implement significant habitat restoration projects throughout the basin, providing increased opportunities for public access and passive recreation in many locations where access is currently limited. Additionally, since an expected effect of this plan will be to increase fish and wildlife populations, opportunities for fishing will likely be increased.

During construction, there could be temporary restrictions on recreation, particularly on the projects that are in existing parks or other recreation areas. The only potential long-term negative effect on recreation exists with the placement of LWD in the river. Recreational boaters have expressed a concern about boater safety relative to LWD, primarily with "floaters" that are not actively controlling their descent down the river and may not have experience with varying conditions. During the preconstruction engineering and design phase, each project that will have LWD in the river will be reviewed to ensure the wood is placed in such a way to reduce the potential danger to boaters. Signage along the river may be necessary to warn boaters of upcoming projects with wood. The design and location of the LWD projects will be coordinated with the Boater Safety Council

5.6 Aesthetics

In general, this ecosystem restoration plan will restore the Green/Duwamish River and its riparian zone and floodplain to a more natural condition. This will include revegetating many areas along the river and removing or minimizing human built structures such as levees. This will tend to reduce broad views of

the river in some locations where there is currently no riparian vegetation, but should create a more aesthetically pleasing riparian zone with a mix of native trees and shrubs. During construction, there will be temporary effects on aesthetics with ground clearing, excavation work and other such activities. All construction work will be done in a manner to minimize removal of existing native vegetation, particularly trees to avoid effects on aesthetic and biological resources. All of the specific project locations will be revegetated as quickly as possible after construction work is complete.

5.7 Cultural and Historic Resources

The Corps will prepare a Programmatic Agreement (PA) with the Washington State Office of Archaeology and Historic Preservation for this ecosystem restoration plan, that will guide the design and construction activities to ensure the Corps will be in compliance with Section 106 of the National Historic Preservation Act (NHPA). Prior to final design and construction, each project will be field checked by a qualified archaeologist to determine if any cultural or historic resources are on the project or will be affected. The ecosystem restoration plan is designed to recreate ecosystem level functions and processes that will lead to changes in the river channel location and morphology. This will be restoring a natural process that existed prior to the turn of the century, but may affect more recent historic projects or structures. The PA will address issues of how to minimize and mitigate for potential effects on cultural and historic resources. We believe that the cost of cultural resource inventory/mitigation will remain below the 1% level. If the initial field check and investigation finds a significant cultural resource at the proposed restoration project then the plan for restoration would be modified to minimize or eliminate the impact on cultural resources or if necessary the proposed restoration project would be moved to avoid the impact.

5.8 Cumulative Effects of the Proposed Plan

In general, this ecosystem restoration plan is designed to have beneficial cumulative effects on the greater Green/Duwamish River ecosystem for fish and wildlife, and to reverse some of the habitat degradation that has occurred in the past. Adverse cumulative effects, which have occurred in the basin, which this plan seeks to remedy, include:

- Trapping of sediment by Howard Hanson Dam
- Loss/lack of LWD recruitment to the River
- Loss/lack of estuarine habitat

- Loss of channel diversity in the lower River from levees and other structures
- Disconnection between the River and its floodplain
- Loss/lack of side channel habitat

This plan is also designed to positively interact with other programs or plans for habitat restoration in the basin, including the King County Regional Needs Assessment, the Mill Creek Special Area Management Plan (SAMP), and the Water Resource Inventory Area (WRIA 9) Planning Process for Chinook Salmon Recovery. In fact, this ecosystem restoration plan is a major component of the WRIA 9 Recovery Plan.

The construction process will be phased over several years to avoid significant cumulative temporary construction impacts and appropriate best management practices will be employed to minimize temporary impacts, particularly to water quality.

Indirect impacts could occur in localized situations, particularly as the river is allowed to naturally form and change aquatic habitats. In certain situations, an existing side channel or slough may become disconnected from the river or be taken over as the main channel of the river. This process is considered to be beneficial since naturally formed habitats are more robust and effective over time than human created habitats, but may be viewed initially by some to be a loss of habitat. Additionally, while the ecosystem restoration plan will provide beneficial effects for native fish and wildlife species, it may come at the expense of habitat which currently is utilized by non-native or generalist fish and wildlife species (i.e. anadromous salmon species may increase in population while cutthroat trout which do well in human modified streams may decline to a lower population level). The removal or setback of levees may make certain properties less attractive for development. During the preconstruction engineering and design phase, it will be important to consider potential indirect and cumulative effects of each project-specific or programmatic meausure.

5.9 Project Performance

The expected project life is 50 years. In reality, it is expected that many of the projects will be viable over an indefinite time period, particularly the revegetated riparian zone and floodplain areas. The primary goal of the ecosystem restoration plan is to restore ecosystem functions and processes, which will indefinitely create and reform natural riverine and stream habitats. This will likely mean that some channels constructed under this plan will be naturally reformed or disconnected unless artificially maintained by the local sponsor(s) or protected by levees. We consider this loss to be acceptable, since the created channels are in many cases designed to be a temporary measure until the ecosystem processes have time to create their own habitats. The projects will be monitored for up to ten years following construction to determine the level of functioning for the projects and if maintenance may be required.

The primary area of the basin where maintenance is likely to be required is in the lower River and estuary where extensive development is adjacent to the River and flood control must be maintained. The addition of gravel to the river system or more frequent meandering of the river may cause some increased deposition of sediment in the navigation channel, which may require an incremental increase in maintenance of the channel.

5.10 Coordination With Other Regional Restoration Initiatives

King County is a leading player in all of the other regional restoration initiatives occurring in the Puget Sound region including the Regional Needs Assessment (for flood control, water quality and habitat restoration), the WRIA 9 Planning Process, and the Tri-County ESA Response. The Corps has also been involved in all of these restoration initiatives. The WRG used to guide this restoration plan includes many of the major players in the regional restoration initiatives as well. The local sponsor(s) intend to include this ecosystem restoration plan as a major component of the WRIA 9 Recovery Plan which will address land use plans and regulations, facilities maintenance activities, water supply and instream flows, water quality, and habitat restoration and preservation.

The Howard Hanson Dam Additional Water Storage Project will be a major future Corps' project in the Green/Duwamish River basin. This study has been fully coordinated with that project and is designed to function with or without implementation of that project. The ecosystem benefits that could be realized with changes in the flow regime at the dam will be implemented as part of the Additional Water Storage Project.

6. PLAN IMPLEMENTATION

This chapter summarizes cost-sharing requirements and procedures necessary to implement the environmental restoration features of the selected plan.

6.1 Selected Plan

The selected plan is Plan 46 (see Table 4-8), which includes the implementation of 45 project-specific and programmatic restoration measures throughout the Green/Duwamish River basin. This plan will provide significant ecosystem benefits by addressing all limiting factors in the basin and providing a high level of spatial connectivity for migratory species (including federally listed threatened and endangered anadromous fish species) and ecosystem integrity. The selected plan is described in Chapter 5.

6.2 Division of Responsibilities for Implementing the Selected Plan

The WRDA of 1986 (PL 99-662) and various administrative policies have established the basis for the division of Federal and non-federal responsibilities in the construction, operation and maintenance of Federal water resources projects accomplished under the authority of the Corps. This is discussed in detail below. Sections 6.3 and 6.4 specify federal and non federal responsibilities during the preconstruction engineering and design phase (PED) and construction phase.

6.2.1 Federal Responsibilities

The Federal government is responsible for conducting and completing the PED (detailed plans and specifications), advertising and administering the construction contracts after authorization and receipt of federal and non-federal funds, and managing the construction phase. The Federal Government is responsible for supervisory and administrative support for the non-federal sponsor's LERRD activities. The Federal Government is responsible for project monitoring during the construction phase. The Federal Government will provide 65% of the cost sharing for these phases.

6.2.2 Non-Federal Responsibilities

The non-federal sponsor is responsible for acquiring all real estate interests required to implement the project-specific and programmatic restoration meausers. The non-federal sponsor is not required to provide this real estate until after the PCA is executed. The non-federal sponsor will provide 35% of the

cost sharing for the preconstruction engineering and design phase, construction, construction management, federal supervisory and administrative costs, and project monitoring. The non-federal sponsor will receive credit for in-kind work completed after the PCA is executed for all expenses to acquire sufficient real estate interest in the project locations. The non-federal sponsor is responsible for obtaining all non-federal permits and authorizations for the construction work. The non-federal sponsor is responsible for all future operation and maintenance of the project-specific and programmatic restoration measures as deemed appropriate and necessary by the Corps and the County.

6.3 Preconstruction Engineering and Design Phase

This phase of project development encompasses all planning and engineering necessary for project construction, and may commence after release of the Division Engineer's Public Notice on a favorable preauthorization study. These studies are required to review the earlier study data, obtain current data, evaluate any changed conditions, establish the most suitable plan for accomplishment of the improvement and establish the basic design of the project features in final detail. Preconstruction planning and engineering studies for projects authorized for construction will be programmed as "continuing" activities.

The results of preconstruction planning and engineering studies are presented in reports identified as "design memorandums." Preparation of design memorandums, and plans and specifications will be cost shared in accordance with the cost sharing required for project construction. Under Corps policy, the non-Federal sponsor should provide 25% of the cost of PED during this phase. Adjustments, if necessary, shall be made after initiation of the construction phase. Current engineering guidance respecting document preparation and approvals should be consulted. (ER 1110-2-1150) 9-2.

The non-Federal sponsor has requested that Congress give them the authority for in kind credit during the PED and construction phase of this project.

Negotiation of a Preconstruction Engineering and Design (PED) Agreement may begin after Division approval of the feasibility report and issuance on the Division Engineers public notice. After receiving Division approval of the project and an allocation of funds for the PED phase, the Seattle District will commence work in PED. If the non-federal sponsor has received congressional authority to perform in kind work during PED, the PED Agreement must be clear on the scope of the local sponsor's in-kind effort, up to a limit of 35%.

6.4 Construction Phase

6.4.1 Project Cooperation Agreement

Prior to the initiation of construction, the non-Federal sponsor and the government will enter into a binding agreement in the form of a Project Cooperation Agreement (PCA) as required by Section 221 of the Flood Control Act of 1970 (Public Law 91-611), as amended, and by Section 101(e) {Harbors} and Section 103(j) {Flood Control and Other Projects} of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662), as amended. The non-Federal sponsor has requested that congress provide authorization for it to receive in-kind credit for work performed during the construction phase. If the local sponsor receives congressional authority, and wants credit for in kind effort during construction, it must be specified in the PCA Agreement with the understanding that the sponsor's in kind contribution will only be credited toward their cash contribution and not their LERRD requirement.

If desired, separate PCA's may be developed for separate projects or groups of projects included in the recommended plan. Each PCA must describe, among other things, all of the requirements and responsibilities relating to construction of each project including items of local cooperation required from the non-Federal sponsor. Local cooperation includes that the sponsor's cost share apportionment for the recommended NER plan.

In addition, a non-Federal sponsor must also provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas required for the project (collectively referred to as LERRD requirements; see Section 101(a) and (e), Section 103(a) and (j) of P.L. 99-662). The value of the required LERRD provided by the non-Federal sponsor will be credited against the non-Federal sponsor's percentage share of the costs of construction. The portion of the non-Federal sponsor's required share of costs that remains after LERRD credit is afforded must be paid to the Government in cash, or if authorized by congress, in in kind credit. If construction of the project will be completed within one fiscal year, the in kind credit (if authorized) or lump sum cash payment must be available prior to solicitation of the first construction contract. If construction of the project will not be completed within one fiscal year, the non-Federal sponsor must provide in kind credit (if authorized) and/or cash payments each fiscal year in proportion to the Government's estimated financial obligations for construction in each fiscal year. (ER 1165-2-131; Chapter 12, ER 405-1-12).

The PCA for a project will be negotiated between representatives of the district and the non-Federal sponsor. Once the project is authorized for construction, the budget/appropriations process drives the

PCA process. Current policy dictates that PCAs will not be executed until: (1) the project document has been approved by HQUSACE; (2) the project is budgeted as a new construction start or construction funds are added by Congress, apportioned by OMB, and their allocation approved by ASA(CW); (3) documentation of compliance with the National Environmental Policy Act (NEPA) and other associated environmental laws and statutes in the PCA checklist has been furnished; and (4) the draft PCA has been reviewed and approved by ASA(CW).

All Civil Works projects are managed, planned, and executed under the Life Cycle Project Management System (LCPM) (ER 5-1-11). Consistent with ER 5-1-11, the forecast final cost estimate to be entered into PCAs for all specifically authorized new starts is based on the most current cost estimate prepared in accordance with the Micro-Computer Aided Cost Estimating System (M-CACES) in the Code of Accounts format.

Under the terms of the PCA, when the Government determines that the entire project, or functional portion thereof, is complete, the Government will provide written notice to the non-Federal sponsor of such determination and furnish an Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) Manual to the non-Federal sponsor. The non-Federal sponsor is then responsible for the OMRR&R of the project, or functional portion. After completion and notice to the non-Federal sponsor, authority is considered to expire for expenditure of Federal funds for construction of additional improvements on the project or for maintenance thereof.

6.4.2 Project Construction

Construction is intended to occur over a period of ten years (2002 –2012). A total of 45 project-specific and programmatic restoration measures will be constructed. The non-federal sponsor must provide all of their cost-sharing funds and real estate and documentation of in kind (if authorized by Congress) at the beginning of construction (prior to award of construction contracts) unless they specifically request a change to the PCA to allow provision of funds in a phased manner similar to the construction schedule.

For construction sequencing, it would make most biological sense to construct projects that will provide habitat which is currently most limited, first, such as the estuarine projects. Then, move on to projects which will affect the entire basin, such as improving migratory corridors that are used by fish and wildlife in all parts of the basin (culvert replacements in the lower watershed, levee setbacks, bioengineering of levees and riparian revegetation); and then finally, constructing projects which will provide more localized benefits or are not as limited in the basin (such as culvert replacement in the upper watershed). In reality, a combination of biological criteria and real estate feasibility has been used to develop the following construction sequence. Projects on land which is already owned by King County or its other

partners (such as Cities of Auburn, Kent and Tukwila) will be constructed first, followed by projects which only require easements, followed by projects which will require the acquisition of real estate in fee. Within each type of ownership situation, the projects which will provide the most limited or critical habitat will be constructed first, followed by projects which will provide ecosystem benefits, followed by projects which will primarily have localized benefits. The proposed construction sequencing schedule is presented in Table 6.1. See the Real Estate Plan (Appendix C) for further details on construction sequencing. Phase 1 is for construction staring in years 2002-5, Phase 2 for 2006-8, and Phase 3 for 2009-2010. All construction is scheduled for completion by the end of 2012.

Table 6-1. Construction Sequencing

Phase	Project Name	Begin Construction	End Construction
I	Codiga Farms	2002	2004
I	Flaming Geyser Land Slide	2002	2009
I	Gilliam Creek	2002	2006
I	Middle Green Gravel Replacement Projects S1, S2, C1 & C2	2002	2012
I	Duwamish Project 1	2004	2008
I	Elliot Bay Nearshore	2004	2006
I	Green River Park	2004	2006
I	Hamakami Levee Breach	2004	2006
I	Mainstem Maintenance – Russell Road Upper Setback Restoration	2004	2006
I	Middle Green Large Woody Debris (LWD) Projects BAJ19, 20 & MAJ6; BAJ25, BAJ28; BAJ29 & 30	2004	2006
I	Prentice Nursery	2004	2006
I	Turley Levee Setback	2004	2006
I	Flaming Geyser Side Channel	2005	2012
I	Horsehead Bend Side Channel	2005	2010
I	Lones Levee Setback	2005	2007
I	Mainstem Maintenance Russell Road Lower Setback & Restoration	2005	2007
I	Middle Green LWD Projects BAJ33-36 MJ11-MJ13	2005	2007
I	Mullen Slough Reach	2005	2008

I	Riverside Estates Side Channel	2005	2008
I	Riverton Side Channel	2005	2008
II	Mainstem Maintenance Boeing Setback and Restoration	2006	2008
II	Burns Creek	2006	2010
II	Lake Meridian Outlet	2006	2009
II	Meridian Valley Creek	2006	2008
II	Middle Green Large Woody Debris Projects BAJ 6, BAJ7 & BAJ8; BAJ9; BAJ12, BAJ13 &BAJ14	2006	2008
II	Mill Creek East	2006	2012
II	Mill Creek, Schuler Brothers Reach	2006	2010
II	Porter Levee Setback	2006	2010
II	Brunner Slough	2007	2011
II	Mainstem Maintenance Carrot Patch Setback and Restoration	2007	2009
II	Garrison Creek	2007	2012
II	Keach Levee	2007	2012
II	Middle Green Large Woody Debris Projects BAJ23, BAJ24 MJ8, MJ9; BAJ31, BAJ32, & MJ10	2007	2010
II	Mill Creek, Merlino Reach	2007	2010
II	NE Auburn Creek	2007	2012
II	Olson Creek	2007	2012
II	Upper Springbrook	2007	2010
II	Black River Marsh	2008	2012
II	Mainstem Maintenance Fenster Setback and Restoration	2008	2010
II	Middle Green Large Woody Debris Projects MJ1 & BAJ3	2008	2010
II	Mill Creek, Wetland 5K Reach	2008	2009
III	Newaukum Creek	2008	2012
III	Upper Green Side Channel Enhancement	2008	2012
III	Gale Creek	2009	2010
III	Gold Creek	2009	2011
III	Lower Springbrook Creek	2009	2012
III	May Creek	2009	2010
III	Maywood Creek	2009	2010
III	Middle Green Large Woody Debris Projects	2009	2011

	BAJ10, BAJ11; BAJ26 & BAJ27		
III	Mill Creek, Geodeke Reach	2009	2012
III	Northeast Creek	2009	2010
III	Olsen Creek	2009	2011
III	Ray Creek Tributary	2009	2012
III	Russell Road Lowest Setback and Restoration	2009	2011
III	Sweeney Creek	2009	2010
III	Sunday Creek Riparian Plantings	2009	2012
III	TPU Roads	2009	2012
III	Big Spring Creek	2010	2012

6.5 Monitoring

Monitoring will be conducted for up to a ten year period following completion of construction, although monitoring is scheduled to occur in no more than three years per project within that ten year period. Because the construction phase will take place over several years, the monitoring will be phased to follow construction. The monitoring costs are included as part of the construction costs and will be cost shared. If Authorized the non-federal sponsor wishes to include monitoring work as part of their in-kind services to receive credit against the total cost-sharing burden. During the PED phase, a detailed monitoring plan will be developed and responsibilities will be shared between the Corps and the non-federal sponsor. If the non-federal sponsor wishes to conduct monitoring beyond the designated time period for each project, they may do so at their own expense. See Section 5.1 for further discussion of project monitoring. Table 5.1 includes the scheduled years for monitoring for each project. The county requests that cost shared monitoring be conducted up to 5 years after construction of the final projects and that the county will take over any monitoring after that period. The has been the standard practice on other restoration projects that Seattle District has constructed with the county as local sponsor.

6.6 Operation and Maintenance

The non-federal sponsor(s) is responsible for all future operation and maintenance activities and costs unless a Corps design error or negligence during construction causes a problem. An Operation and Maintenance Manual will be developed during construction and provided to the County for implementation. Because the science of ecosystem restoration is relatively new, unanticipated issues could arise after construction. One reason for constructing these projects over a 10-year period, is to be able to adaptively manage these restoration projects. Typically, there is not an easy mechanism for the Corps to come back and revise a project once construction is complete, even though the ecosystem restoration guidance clearly emphasizes adaptive management. If unforeseen problems arise on some of the first constructed projects, it will allow time for revision of the final projects, as well as some rectification of problems at the earlier projects. The Corps and the County will work together to adaptively manage this ecosystem restoration plan. At the completion of construction the Corps will turn the project over to the county and after that point the O&M will be the county's responsibility. The estimated total cost of O&M is $12,050,000. See Section 5.2 for further discussion of operation and maintenance.

6.7 Cost Allocation

Cost allocation is the practice of allocating the separable costs of a project to the project purpose that they serve. For this project, all costs have been allocated to the purpose of National Ecosystem Restoration (NER).

6.8 Cost Apportionment

Cost sharing for construction of this project will be in keeping with current Corps of Engineers policy whereby for environmental restoration projects, the non-federal share will be 35 percent of the project implementation costs (PED, construction, construction management, federal supervision and administration, and monitoring). The non-federal sponsor will provide 100 percent of the necessary lands, easements, rights-of-way, relocations and disposal areas (LERRDs), and conduct all future operation, maintenance, repair, rehabilitation and replacement (OMRR&R) activities. If the LERRD value exceeds the 35 percent share required from the non-federal sponsor, the sponsor will be reimbursed for the value of the LERRD that exceeds the 35 percent share. If this situation is estimated prior to executing the PCA, no additional credit will be given to the sponsor for in-kind services.

Table 6-2 provides a summary of the estimated cost apportionment between the federal and non-federal interests for the recommended plan. The table shows the total implementation cost of the recommended project as $115,879,400, of which $75,321,610 is federal cost and $40,557,790 is non-federal cost. The non-federal cost includes the sponsor's LERRD value of $37,110,375. Adding the non-federal noel OMRR&R cost of $12,050,000 brings the total project life-cycle cost to $127,929,400.

Table 6-2. Green-Duwamish Basin Cost Apportionment

COST APPORTIONMENT

	Federal	Non-Federal	Total
ECOSYSTEM RESTORATION*	$ 75,321,610	$ 40,557,790	$ 115,879,400
LERRD**		$ 37,110,375	$ 37,110,375
CASH CONTRIBUTION	$ 75,321,610	$ 3,447,415	$ 78,769,025

**October 2000 price level (rounded) - Ecosystem Restoration is project cost less OMRR&R.*
*** LERRD is total land cost less Federal Government supervision and administration*

6.9 Completed, Current and Future Work Eligible for Credit

The non-federal sponsor has completed a significant amount of in-kind highly technical services during the feasibility phase which they were given credit for in the Feasibility Cost-Sharing Agreement (FCSA). The non-federal sponsor has requested authority from congress to perform additional in-kind services for credit during the PED and construction phase. Future in-king services may be limited due to the fact that the sponsor's LERRD value may exceed their 35% cost share obligation (see Table 6.2). If authorized by Congress the non-Federal sponsor will be allowed to receive in-kind credit during these phases, as long as the combination of their in kind work and there LERRD value does not exceed 35% of the overall construction cost.

6.10 Institutional Requirements

The items that the local sponsor will need to require are as follows:

Provide 35 percent of the separable project costs allocated to environmental restoration as further specified below:

- Enter into an agreement that provides, prior to execution of a project cooperation agreement for the project, 25 percent of design costs and/or in kind (if authorized);

- Provide, during construction, any additional funds needed to cover the non-federal share of design costs and/or in kind (if authorized);

- Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

- Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

- Provide, during construction, any additional costs and/or in kind (if authorized) as necessary to make its total contribution equal to 35 percent of the separable project costs allocated to environmental restoration.

For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Government, in accordance with applicable Federal and State laws and any specific directions prescribed by the Government.

Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project, including mitigation features without cost to the Government, in a manner compatible with the project authorized

purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

Hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) which might reduce the ecosystem restoration, hinder its operation and maintenance, or interfere with its proper function, such as any new development on project lands or the addition of facilities which would degrade the benefits of the project.

Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

Comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

Provide 35 percent of that portion of total cultural resource preservation mitigation and data recovery costs attributable to environmental restoration that are in excess of one percent of the total amount authorized to be appropriated for environmental restoration.

Not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

6.11 Environmental Requirements

There are many federal, state, tribal and local laws, regulations and treaties that may be applicable to certain features of this ecosystem restoration plan. Developed along with this Feasibility Report is a Programmatic Environmental Impact Statement and Restoration Plan (EIS/RP) and attached to this report is a Fish and Wildlife Coordination Act Report that programmatically satisfy NEPA requirements when a Record of Decision (ROD) is signed. Environmental Assessments (EA) will be tiered from the EIS and prepared during the PED phase for specific projects or groups of projects. Seattle District personnel have

discussed the different process and sequencing for this study relative to Section 7 consultation with the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) (Services). Both agencies expressed support for the restoration effort. Both agencies also expressed concern over how the Corps would be able to assure future compliance with ESA on this project given the fact that most projects won't be constructed for several years, and designs could change in the interim. These concerns were verbally expressed by FWS to Seattle District personnel upon their receipt of the programmatic biological assessment (PBA). At that time, Seattle District's ESA Coordinator, discussed with the FWS representative a potential solution to this dilemma that would allay his concerns with ESA compliance. This is simply to hold annual meetings to address projects scheduled to be constructed in the following year, and assure their consistency with the PBA. Seattle Districts ESA Coordinator reviprojectd these issues with representatives of the FWS and of the NMFS. Both expressed support for the project and are comfortable with ESA compliance provided we regularly consult on future projects prior to their construction. The formal process for doing this still needs to be defined, and Seattle District will be working with the Services in the near future to develop the process. Seattle District has been involved in numerous restoration projects and has had very little problem in successfully working with the FWS and the NMFS on implementation of these projects.

Some of the projects being investigated will require the completion of a 404(b)(1) analysis under the Clean Water Act prior to construction. In all cases where a 404(b)(1) is needed, it will be fully developed on a project-specific basis prior to construction. The applicability of Nationwide Permit No. 27 for satisfying requirements of Section 404(b)(1) for the majority of the projects being investigated was coordinated with the Office of Counsel and Regulatory Branch and they could see no reason why the Nationwide permit could not be used. There are a few projects that are of large enough scale or associated impacts with the restoration activities may make the use of this Nationwide somewhat tenuous. Those projects that do not seem suitable for the Nationwide permit are: Meridian Valley Creek, Lake Meridian Outlet Relocation, Middle Green River Large Woody Debris Placement, Middle Green River Gravel Replacement, Flaming Geyser Landslide, Upper Green River Side Channel Enhancement and Upper Green River Gravel Replacement. It appears at the present time, a total of seven projects or programmatic measures do not meet the criteria for the Nationwide permit. Prior to any of these projects going to construction, if they do not qualify for a Nationwide permit, a project specific 404(b)(1) analysis will be completed as well as other pertinent regulatory requirements. At this point in time, the remaining projects seem to qualify for Nationwide permit #27. The Corps is in coordination with the State Department of Ecology to obtain Section 401 state water quality certification. Certification is usually done during PED (about 90% design level) when necessary information is developed. The Corps has requested a letter of support from the Department of Ecology. Table 6-3 below shows that status and responsibility for compliance with the applicable laws, regulations and treaties.

Table 6-3. Status of Compliance with Environmental Laws/Regulations/Treaties

Law/Regulation/Treaty	Status of Compliance	Responsibility
National Environmental Policy Act (NEPA)	Will be complete after programmatic EIS is approved	Corps
Endangered Species Act	Consultation on-going	Corps
National Historic Preservation Act	Consultation on-going	Corps
Clean Water Act	A 404(b)(1) analysis will be prepared in PED and NPDES construction permits will be obtained	Corps
Clean Air Act	In compliance	Corps
Coastal Zone Management Act	Will be in compliance through maximum consistency	Corps
Fish and Wildlife Coordination Act	In compliance	Corps
Marine Mammal Protection Act	In compliance	Corps
Migratory Bird Treaty Act	In compliance	Corps
Executive Order 12898, Environmental Justice	In compliance	Corps
Executive Order 11990, Protection of Wetlands	In compliance	Corps
Executive Order 11988, Floodplain Management	In compliance	Corps
Indian Treaty Rights	Will be in compliance through public review process	Corps
State Environmental Policy Act	King County will adopt Final EIS	King County
Shoreline Management Act	King County will obtain required permits	King County
Washington Hydraulic Code	King County will obtain required permits	King County
Water Quality Certification	Corps will obtain required permits	Corps/King County
Growth Management Act	In compliance	King County
Model Toxics Control Act	King County will obtain any necessary approvals	King County
State Aquatic Lands Management Laws	Consultation on-going	Corps/King County
King County Regulations	King County will obtain all required permits	King County
City Regulations and Ordinances	King County will obtain all required permits	King County

6.12 Sponsorship Agreements

The non-federal sponsor (King County) has provided a letter of intent acknowledging sponsorship requirements of the Green/Duwamish Ecosystem Restoration Project. Prior to the award of construction contracts, the sponsor will be required to execute the Project Cooperation Agreement and provide required funds. King County may enter into inter-local agreements with various cities in the watershed for those entities to become sub-sponsors on project-specific projects. However, King County will retain the ultimate responsibility as the non-federal sponsor for all future OMRR&R.

6.13 Sponsor's Financial Plan and Capability Assessment

King County is one of 39 counties in the State of Washington. The County was created in 1853. The County is a government entity with powers of eminent domain and the ability to levy property and sales taxes within the County. The Washington State Auditor annually conducts financial and legal compliance audits. King County operates under a Home Rule Charter adopted by a vote of the citizens of King County in 1967, amended through the charter review process effective 1969. Independently elected administrative officials include the County Executive, the Prosecuting Attorney, the Sheriff, the Auditor, the Clerk, the Treasurer, and the Assessor who are elected at-large. A nine-member council, elected by district, constitutes the legislative body. Elected officials serve four-year terms, council member elections are staggered. For 2000, approximately 24% of the County's total revenues are expected to come from taxes. For the County's General Fund, about 58% of its revenues will come from taxes; one-third of the revenues will come from property tax. A letter from the County discussion their financial capability for this recommended plan is included at the rear of this chapter.

The 1999 tax revenues of the County totaled $818,000,000. The financial position of the County is such that bonds issued in 1998 and 1999 received Aa1 ratings from Moody's investment Services and AA+ ratings from Standard and Poor's Corporation on both revenue and general obligation bonds. These ratings are considered excellent among Counties. Based on 1999 assessed values the county could provide significantly more than the local financial requirements for this project in any given year by a vote of the County Council, without a public vote. Table 6-4 shows funding requirements by fiscal year to implement the recommended National Ecosystem Restoration Plan.

Table 6-4. Implementation Cost Sharing through Construction Phase

	IMPLEMENTATION COSTS		
Year (FY)	**Federal**	**Non Federal**	**Total**
2002	$ 4,000,000	$ 2,000,000	$ 6,000,000
2003	$ 6,000,000	3,000,000	$ 9,000,000
2004	$ 6,500,000	3,500,000	$ 10,000,000
2005	$ 8,000,000	4,000,000	$ 12,000,000
2006	$ 10,000,000	5,500,000	$ 15,500,000
2007	$ 10,500,000	6,000,000	$ 16,500,000
2008	$ 9,322,000	5,000,000	$ 14,322,000
2009	$ 8,000,000	4,000,000	$ 12,000,000
2010	$ 6,000,000	3,557,000	$ 9,557,000
2011	$ 3,500,000	2,000,000	$ 5,500,000
2012	$ 3,500,000	2,000,000	$ 5,500,000
Total	**$ 75,322,000**	**$ 40,557,000**	**$ 115,879,000**

All costs are in October 2000 price level.

In accordance with ER 1005-2-100, paragraph 6-184.b, a preliminary financing plan and statement of financial capability has been prepared by the local sponsor. The District has reviewed the plan and assess the sponsor's understanding of the budgetary issues related to financing the proposed project. The District has verified that the local sponsor has the capability to fund their portion of implementation responsibilities. Table 6-4 provides schedule for implementation cost apportionment between the Federal Government and non-Federal sponsor. The statement of financial capability is included at the end of this chapter.

King County
Sponsor's Statement of Financial Capability
Duwamish/Green National Ecosystem Restoration Project

As local sponsor for the Duwamish/Green Ecosystem Restoration Project, King County is financially capable of providing the necessary local share for project implementation utilizing a variety of funding sources and partnership arrangements. Any commitment to move forward with implementation of this project is contingent upon County budgetary decisions and upon successful negotiation of individual project-related construction agreements between the County and the United States Army Corps of Engineers (Corps) prior to project design and construction.

King County's assessment of its financial capability is based on the U.S. Army Corps of Engineers' estimated project cost of $149,648,000, and the estimated local share of approximately $52,377,000 or 35 percent of the total project cost. The Corps further estimates that approximately $3,015,000 of this local share will be provided in cash, with the remainder provided as land rights, easements, utility relocation and engineering services. The Corps has based these estimated project shares on its most recent fully funded cost estimate, assuming a project implementation period of ten years.

It is anticipated that engineering and construction agreements will be prepared and agreed to between King County and the Corps of Engineers in such a way as to be most beneficial to King County within the legal authority of the Corps of Engineers. King County also intends to work cooperatively with co-sponsors such as Seattle, Tacoma, and the suburban cities in the watershed--including Tukwila, Kent, Auburn, and Renton--as well as the Muckleshoot Indian Tribe in the funding and implementation of this project. King County understands that any maintenance required after the construction period will be the responsibility of the local sponsor and/or their co-sponsors.

It is King County's desire to implement these projects in the most cost-effective way. To that end, King County will seek salmon recovery and other grants to assist in providing the local match to the project as well as funding from the co-sponsors mentioned above. Other constraints, such as limitations on land acquisition, may also limit the County's ability to implement some projects, depending on willingness of landowners and availability of property acquisition funding.

<u>Sources of Funds</u>

King County's funding for implementation of this project is likely to come from a variety of existing sources, and will be subject to budgetary approval by the King County Council. These potential funding sources include the King County Surface Water Management Fee, King Conservation District assessment, Conservation Futures fund, and other funding sources as appropriate. King County will also seek grants from the Washington State Salmon Recovery Funding Board and other sources to provide the local share for these projects, as well as funding and in-kind services support from Seattle, Tacoma, and the suburban cities in the watershed--including Tukwila, Kent, Auburn, and Renton--as well as the Muckleshoot Indian Tribe and

other potential partners. The County also remains committed to working with these regional partners to evaluate the potential for creating a new revenue source dedicated to regional habitat funding which could be used for property acquisition for Ecosystem Restoration Program projects and/or local share for design and construction activities.

Nancy Hansen

Nancy Hansen, Manager
King County Water and Land Resources Division

7. SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS

7.1 Non-Federal Sponsor Views and Preferences

The non-federal sponsor, King County, has provided a strong partnership with the Corps over the past four years. The County contributed fifty percent of the feasibility study costs. In-kind products such as real estate and project design were complex tasks, which were performed professionally. The sponsor has indicated their willingness to continue their support during the implementation phase of this project. Two projects that were spun out of this study for early implementation under Section 1135 have been completed with sponsor support (Puget Creek and Porter Levee Side Channel).

Issues that the non-federal sponsor would like to have addressed further by the Corps prior to signing a Project Cooperation Agreement include:

- The County would like to perform work in-kind during the PED and construction phases and has requested the authority to do so from Congress.
- The County would like the Corps to provide for adaptive management during the 10-year construction period to ensure the restoration measures work effectively.
- The County desires to be able to enter into separate PCAs for suites of projects in other jurisdictions.

7.2 Study Management and Outreach

The project managers from the Corps and King County developed an Executive Committee early in the study to help direct and make major decisions dealing with the feasibility phase of the project. The project managers were also active members of the WRIA 9 steering committee, which provided extensive opportunities for agency and public involvement in the restoration planning process. As discussed earlier, a Watershed Restoration Group (WRG) composed of agency biologists and other technical disciplines were formed to guide the planning process and screen individual restoration projects.

A series of landowner workshops and field trips were conducted throughout the basin with general support being given by the landowners whose land would be effected by the proposed project.

Additional public involvement has been gained during the EIS process. A Notice of Intent to prepare an EIS was published in the Federal Register on December 23, 1998. A scoping meeting was held on January 16, 1999 and 31 people attended. One June 30, 2000 a Notice of Availability (NOA) for the Draft Programmatic EIS was published in Volume 65, Number 127 of the Federal Register. This initiated the forty five-day review and comment period for the Draft PEIS. The Draft document was distributed to over 225 citizens, State and Federal agencies, Native American Tribes and libraries. The Draft PEIS was also available through King County's web project (http://dnr.metrokc.gov/wrias/9/GDRPdeis.htm). In addition, a public meeting to solicit input on the document was held on July 27, 2000
Thirteen comment letters were received during the 45-day comment period to accompany the single comment obtained during the public meeting. Most comments were favorable and supported the preferred alternative.
The public was involved as well during the implementation of the Porter Levee Side Channel 1135 Project. A volunteer planting event was organized following the completion of construction at the project in October 1999. A great deal of positive feedback has been received from interested parties regarding the Porter Levee project.

7.3 Study and Review Teams

The study team was a multi-disciplinary group that consisted of several functional elements within the Corps and at the County, and included study and project managers, planners, civil engineers, hydrologists and hydraulic engineers, environmental specialists, biologists, cost estimators, real estate specialists, economists, materials and geotechnical specialists. Table 7-1 below lists the members of the study and review teams.

Table 7-1. Study and Review Team Members

Study Team			*Review Team*		
Name	**Grade**	**Discipline**	**Name**	**Grade**	**Discipline**
N. Gilbrough	GS-12	Project Manager	H. Gibbons	Tetra Tech	Environmental Enginner
P. Cagney	GS-12	Environmental Coordinator	M. Martz	Tetra Tech	Biologist
M. Kaiser	GS-12	Geotechnical	M. Callasarre	Tetra Tech	Geotechnical
J. Lencioni	GS-13	Hydraulic Engineer	H. Fehlman	Tetra Tech	Hydraulic Engineer
Pat Naher	GS-11	Civil Design	K. Price	Tetra Tech	Civil Design/Cost
J. Mendenhall	GS-12	Economics	M. Gorecki	Tetra Tech	Economics
S. Pierce	GS-12	Cost Estimator	A.E. Hamilton	GS-12	Real Estate
W. Gentry	GS-12	Real Estate			

C. Loper	King Co.	County Project Manager	
B. King	HDR	Civil Design	
Sue Perkins	N/A.	Geomorphologist	
Faith Roland	King Co.	County Real Estate	
Wendy Kara	King Co.	County Civil Design	

7.4 Review Milestones and Independent Technical Review

Review of all products is being conducted by members of the study and technical review teams, King County staff, and by Corps' contractors including Jones & Stokes, HDR Engineering, and Tetra Tech, Inc. During the course of the Feasibility phase study, there has been on-going, independent technical review of the major report products as they have become available. These include:

- Project Designs
- Incremental Cost Analysis
- Hydrology and Hydraulics
- Environmental Analysis
- Real Estate Plan

The independent reviews have been completed, responded to, and backchecked prior to release of this report for public and agency review. The review has been documented in a review documentation report and a certification of technical and legal review, which are on file with the Corps of Engineers project manager.

8. CONCLUSION AND RECOMMENDATION

8.1 Conclusion

Sixty-seven site-specific and programmatic restoration measures were identified for study by the interagency Watershed Restoration Group which was formed to guide restoration planning for this study. The recommended National Ecosystem Restoration (NER) Plan would implement a total of 45 sites and programmatic restoration measures . This plan was selected based upon evaluation of the economic costs and environmental benefits of each alternative. Chapter 5 of this report fully describes the combination of measures that make up the recommended plan. The plan addresses the major limiting factors for Federally listed endangered anadromous fish in the basin. Based on the incremental cost and cost effectiveness analyses performed, the NER Plan will provide significant benefits in a cost effective manner, restoring critical habitats, spatial connectivity, and fish passage throughout the basin.

8.2 Recommendation

I recommend that the plan described herein for environmental restoration purposes be authorized for implementation as a Federal project. The implementation cost of the project is currently estimated at $115,879,400. The Federal share is currently estimated at $75,321,610 and the non-federal share is $40,557,790 ($3,447,415 cash requirement and $37,110,375 LERRD value). (These costs are in October 2000 price level).

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

for Colonel Ralph H. Graves
U.S. Army Corps of Engineers
District Engineer

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Table 1-1. Resource Problems

Resource Problems	Issues Addressed in this Study
Lack of habitat in the Lower Green/Duwamish estuary	X
Changes in sediment loads and transport	X
Changes in flows	
Loss of channel complexity and in-channel structure	X
Water quality degradation	X
Barriers to fish passage	X
Floodplain disconnection	X
Habitat fragmentation	X
Degradation of wetlands and rare species habitats	X
Changes in forest structure and composition	X

1.3 Study Area

The Green River originates in the Cascade Range south of Stampede Pass at an elevation of about 4500 feet (ft) and flows northwest 90.5 miles to Elliott Bay in Puget Sound. The highest elevation in the basin is at 5750 ft on Blowout Mountain. The Green River becomes the Duwamish River at RM 11 where the historic Black River joins the Green River. The entire watershed is within King County, Washington. This study addresses the entire watershed from the headwaters to Elliott Bay. Since a major goal of this study is to restore ecosystem level functions and processes to the basin, effort has been made to ensure the entire watershed is evaluated.

1.4 Study Area Characteristics

1.4.1 Climate

The climate in the basin is a mid-latitude, west coast marine type characterized by cool wet winters and mild summers. The average rainfall in the basin ranges from 39 to approximately 100 inches annually. The urbanized lower elevation part of the basin receives the lower precipitation increasing up to the higher precipitation (rain and snow) near Stampede Pass. Approximately 75% of the precipitation falls between the months of October and April. The Cascades and the foothill portion of the basin are frequently subject to warm tropical rainstorms during the winter that cause rain-on-snow events. The

and under cover of LWD) where they do not need to expend tremendous amounts of energy to remain in place. The populations of anadromous fish have declined considerably over the last 50 years; see Table 3-1 below for a comparison of escapement numbers from the 1930s to the 1990s.

Table 3-1 Comparative Escapements to the Green River

Species	1938 to 1942	1987 to 1991
Chinook	55,197	10,300
Chum	12,750	3,000*
Coho	36,741	12,500
Pink	1,000	0
Steelhead	4,400	1,600**

Note: Recent hatchery returns have been larger, which is not reflected in this data, however, wild fish are still declining.
** This value includes fish passed above the Keta Creek hatchery and other naturally spawning fish in the mainstem.*
*** This value is for winter steelhead and is the simple average of returns in those years.*

3.1.4.3 Wildlife

The upper basin is primarily forested and managed for timber production, with many areas adjacent to the reservoir closed to public access. This provides good habitat for many large mammals such as elk, mountain goat, black-tailed deer, mule deer, black bear, and cougar. The number of clearcuts and other open areas favors herbivore populations. The large number of herbivores has resulted in a significant cougar population, possibly one of the highest densities in the U.S. Black bears are also common. Other mammals include beaver, mink, muskrat, weasels, raccoon, snowshoe hare, pika, and various voles and mice. Cascade frogs and red-legged frogs also occur in the upper basin. A number of waterfowl use the reservoir, including loons, which may nest near the reservoir. A variety of raptors and passerine birds also use the upper basin.

The middle and lower Green/Duwamish basin is increasingly urbanized in the downstream direction. However, the lakes, riparian zone and tributary streams provide habitat for small mammals such as foxes, skunks, weasels, squirrels and coyotes. Floodplain and wetland habitats support red-legged and Pacific tree frogs, salamanders, and toads. Waterfowl, including wood ducks can be found in many areas. The estuary is utilized by a number of waterfowl and shorebirds in spite of the loss of most of the habitat.

The ecosystem restoration goals of this study are to: 1) improve existing ecosystem functions and processes; 2) enhance the physical nature of existing degraded habitat; 3) address limiting factors to fish and wildlife production, and 4) restore degraded habitats for anadromous fish.

Specific elements of habitat degradation and limiting factors to fish and wildlife production have been evaluated by King County (Fuerstenberg, et al., 1996) and the U.S. Forest Service (1996) and can be classified as ten major resource problems within the basin (see Table 4-1). This study addresses nine of these resource problems as indicated in the Table.

Table 4-1 Resource Problems in the Green-Duwamish Basin

Resource Problems	Issues Addressed in this Study
Lack of habitat in the Lower Green/Duwamish estuary	X
Changes in sediment loads and transport	X
Changes in flows	
Loss of channel complexity and in-channel structure	X
Water quality degradation	X
Barriers to fish passage	X
Floodplain disconnection	X
Habitat fragmentation	X
Degradation of wetlands and rare species habitats	X
Changes in forest structure and composition	X

4.3 Significance of Environmental Resources and Degradation

The environmental resources that have been degraded are aquatic and terrestrial habitats of the Green/Duwamish River basin. These habitats formerly supported nine species of anadromous salmon; chinook, coho, chum, pink and sockeye salmon, rainbow/steelhead and cutthroat trout, and potentially bull trout and Dolly Varden. Pink and sockeye salmon may stray into the Green/Duwamish basin, but the system is currently unable to sustain runs. Two other species have been listed as threatened under the ESA, chinook salmon and bull trout, and coho salmon and sea-run cutthroat are candidate species for listing. The degradation that has occurred has eliminated 98% of the estuarine habitat that formerly existed, which is used by anadromous salmon species to acclimate between freshwater and saltwater. Chinook salmon, which use estuaries extensively, have been particularly affected as a result, although all species have reduced growth and survival as a result of no available habitat for rearing in the estuary. The channelization of the middle and lower Green River has eliminated rearing and spawning habitat for salmon species, as well. The migration corridor is now lethal to fish during the summer as a result of high temperatures and low dissolved oxygen and no holding or rearing pools are present in these reaches

Table 4-2. Environmental Quality Evaluation Criteria

Limiting Factors:	*How effective is the project at addressing one or more of the following limiting factors?*
	1. Barriers to Fish Passage - Culverts, dams, and hatcheries have isolated stream reaches
	2. Reduction in Channel Forming Flows - Managing high flows cannot regenerate river habitat, resulting in loss of side channels and floodplain connections.
	3. Loss of Channel Diversity in Lower River- Levee and infrastructure have eliminated habitat
	4. Loss of Estuarine Habitat - Dredging/filling for navigation and development has dramatically reduced the size of the estuary
	5. Loss of Floodplain Habitat - Development and changes in flows have reduced the connections between the river and tributaries and their floodplains
	6. Reduction in Large Woody Debris - Log jams historically provided important pool habitat and cover, but are now uncommon
	7. Loss of Sediment Sources - Gravel trapped behind HHD and the construction of levees in the floodplain reduce spawning habitat and leads to channel downcutting
	8. Increase in Water Temperature - Summer temperatures are stressful to fish
Scale:	Project Size - How large is the project?
	Effect - How far-reaching is the project's effect?
Feasibility:	Technical - Does a reasonable technique exist and is it widely accepted?
	Political - Is the proposal socially and politically acceptable and likely to be wide supported?
Wildlife:	Habitat - Does the project benefit wildlife?

Each proposed restoration alternative was scored by the expert panel (representatives of the WRG) in each of the above criteria. For the criterion of limiting factors, those factors (of the eight identified) applicable to each project were identified and a score ranging from zero to five was selected for each alternative project. A score of zero corresponds to "addresses no identified limiting factors" and a score of 5 corresponds to "addresses all identified limiting factors". For all other criteria, a score ranging from one to three was provided. Because the criteria of Limiting Factors and Scale Effect were determined to be the most important, they were weighted more heavily (doubled) than the other criteria in deriving the project quality score for each alternative.

The resultant Environmental Quality Scores for all alternatives were then normalized to an index value between 0 and 1 and multiplied by the habitat area benefited by the project to derive "eco-units" for use in cost effectiveness and incremental cost analyses and comparison of alternative project outputs. These eco-units account for the quality and quantity of habitats supporting ecosystem function and salmon recovery. This approach is similar in structure to the common habitat suitability index models (such as

Table 4-3. Projects Evaluated in Feasibility Study

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ID	Site Name	Location	Site Type
A	NE Auburn Creek	Tributary	Culvert Modification
B	Mainstem Green River LWD	Middle Green	Programmatic LWD
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation
D	Sweeney Creek Culvert	Upper Tributary	Culvert Modification
E	Newaukum Creek	Tributary	Tributary Restoration
F	Turley Side Channel	Middle Green	Side Channel Modification
G	Hamakami Levee	Middle Green	Wetland Habitat
H	Sunday Creek	Upper Tributary	Tributary Restoration
I	Boundary Creek Culvert ☆	Upper Tributary	Culvert Modification
J	Porter Levee Setback	Middle Green	Levee Setback
K	Kaetch Side Channel	Middle Green	Side Channel Modification
L	North East Creek Culvert	Upper Tributary	Culvert Modification
M	Green River Park	Lower Green	Side Channel Modification
N	Gale Creek Culvert	Upper Tributary	Culvert Modification
O	Mullen Slough	Lower Green	Side Channel Modification
P	Olson Creek	Tributary	Tributary Restoration
Q	Flaming Geyser Landslide	Middle Green	Flaming Geyser Landslide
R	Lones Levee Removal	Middle Green	Levee Removal
S	Codiga Farms	Estuary	Estuary Marsh Habitat
T	Horsehead Bend	Lower Green	Side Channel Modification
U	Schuler Brothers Reach	Tributary	Tributary Restoration
V	Upper Springbrook Reach	Tributary	Tributary Restoration
W	Duwamish Site 1	Estuary	Estuary Marsh Habitat
X	Lake Meridian Outlet	Tributary	Tributary Restoration
Y	Gilliam Creek	Lower Green	Culvert Modification
Z	Big Spring Creek	Tributary	Wetland Habitat
AA	Upper Green River Side Channels	Upper Green	Side Channel Modification
AB	May Creek Culvert	Upper Tributary	Culvert Modification
AC	Ray Creek	Middle Green	Side Channel Modification
AD	Riverton Creek	Estuary	Tributary Restoration
AE	Meridian Valley Creek	Tributary	Tributary Restoration
AF	Flaming Geyser Side Channel	Middle Green	Side Channel Modification
AG	Green River Gravel Replenishment	Middle Green	Gravel Nourishment
AH	Goedeke North Reach	Tributary	Tributary Restoration
AI	Wetland 5K Reach	Tributary	Tributary Restoration
AJ	Riverside Estates Side Channel	Middle Green	Side Channel Modification
AK	Gold Creek Culvert	Upper Tributary	Culvert Modification
AL	Burns Creek	Tributary	Tributary Restoration
AM	Garrison Creek	Tributary	Tributary Restoration
AN	Prentice Nursery Reach	Lower Green	Side Channel Modification
AO	Mill Creek East	Tributary	Tributary Restoration
AP	Brunner Slough	Middle Green	Side Channel Modification
AQ	Olsen Creek Culvert	Upper Tributary	Culvert Modification
R	Black River Marsh	Estuary	Estuary Marsh Habitat
AS	Elliott Bay Nearshore ☆	Estuary	Estuary Habitat
AT	Merlino Reach	Tributary	Tributary Restoration
AU	Maywood Creek Culvert	Upper Tributary	Culvert Modification
AV	Lower Springbrook Reach	Tributary	Tributary Restoration
AW	Mainstem Maintenance	Lower Green	Levee/Bank Bioengineering

Table 4-4. Cost Breakdown for Alternatives

	Site Name	Construction	LERRD	PED	Const. Mgmt.	S&A	Monitoring	O&M	TOTAL COST
A	NE Auburn Creek	$ 648,000	$ 102,875	$ 61,847	$ 77,298	$ 5,000	$ 68,086	$ 53,465	$ 1,016,571
B	Mainstem Green River LWD	$ 1,069,000	$ 622,188	$ 102,029	$ 127,518	$ 111,250	$ 228,962	$ 224,789	$ 2,485,736
C	Volunteer Revegetation	$ 2,440,000	$ -	$ 232,882	$ 291,060	$ -	$ 228,962	$ 74,930	$ 3,267,834
D	Sweeney Creek Culvert	$ 127,000	$ 29,500	$ 12,121	$ 15,149	$ 5,000	$ 17,548	$ 37,465	$ 243,784
E	Newaukum Creek	$ 3,848,000	$ 3,306,250	$ 367,267	$ 459,016	$ 183,750	$ 274,754	$ 179,832	$ 8,618,869
F	Turley Side Channel	$ 172,000	$ 136,250	$ 16,416	$ 20,517	$ 5,000	$ 34,043	$ 14,986	$ 399,212
G	Hamakami Levee	$ 575,000	$ 37,500	$ 54,880	$ 68,590	$ 5,000	$ 184,937	$ 22,479	$ 948,386
H	Sunday Creek	$ 2,492,000	$ 46,625	$ 237,845	$ 297,263	$ 6,250	$ 151,279	$ 52,451	$ 3,283,713
J	Porter Levee Setback	$ 862,000	$ 305,000	$ 82,272	$ 102,825	$ 3,750	$ 189,098	$ 7,493	$ 1,552,439
K	Kaetch Side Channel	$ 236,000	$ 90,000	$ 22,525	$ 28,152	$ 5,000	$ 34,043	$ 18,732	$ 434,452
L	North East Creek Culvert	$ 197,000	$ 32,250	$ 18,802	$ 23,500	$ 5,000	$ 35,097	$ 14,986	$ 326,635
M	Green River Park	$ 299,000	$ 139,750	$ 28,538	$ 35,667	$ 3,750	$ 184,937	$ 14,986	$ 706,627
N	Gale Creek Culvert	$ 253,000	$ 34,500	$ 24,147	$ 30,180	$ 5,000	$ 34,043	$ -	$ 380,870
O	Mullen Slough	$ 726,000	$ 937,500	$ 69,292	$ 86,602	$ 16,250	$ 126,065	$ 41,211	$ 2,002,921
P	Olson Creek	$ 95,000	$ 51,250	$ 9,067	$ 11,332	$ 5,000	$ 17,021	$ 14,986	$ 203,657
Q	Flaming Geyser Landslide	$ 3,360,000	$ 167,500	$ 320,690	$ 400,804	$ 5,000	$ 296,640	$ 149,860	$ 4,700,494
R	Lones Levee Removal	$ 2,578,000	$ 366,250	$ 246,053	$ 307,522	$ 7,500	$ 226,918	$ 29,972	$ 3,762,215
S	Codiga Farms	$ 1,084,000	$ 165,000	$ 103,461	$ 129,307	$ 5,000	$ 226,918	$ 29,972	$ 1,743,657
T	Horsehead Bend	$ 535,000	$ 180,000	$ 51,062	$ 63,819	$ 5,000	$ 184,937	$ 26,225	$ 1,046,043
U	Schuler Brothers Reach	$ 2,281,000	$ 997,500	$ 217,707	$ 272,094	$ 13,750	$ 226,918	$ 26,225	$ 4,035,193
V	Upper Springbrook Reach	$ 143,000	$ 27,500	$ 13,648	$ 17,058	$ 3,750	$ 27,887	$ 86,169	$ 319,012
W	Duwamish Site 1	$ 559,000	$ 1,183,750	$ 53,353	$ 66,681	$ 5,000	$ 226,918	$ 26,225	$ 2,120,928
X	Lake Meridian Outlet	$ 742,000	$ 164,875	$ 70,819	$ 88,511	$ 5,000	$ 85,107	$ 26,225	$ 1,182,538
Y	Gilliam Creek	$ 557,000	$ 70,000	$ 53,162	$ 66,443	$ 3,750	$ 68,086	$ 101,155	$ 919,596
Z	Big Spring Creek	$ 986,000	$ 144,063	$ 94,107	$ 117,617	$ 13,750	$ 176,492	$ 18,732	$ 1,550,761
ZA	Upper Green River Side Channels	$ 599,000	$ 317,875	$ 57,171	$ 71,453	$ 23,750	$ 189,098	$ 37,465	$ 1,295,812
ZB	May Creek Culvert	$ 236,000	$ 49,125	$ 22,525	$ 28,152	$ 6,250	$ 128,596	$ 7,493	$ 478,141
ZC	Ray Creek	$ 1,984,000	$ 467,500	$ 189,360	$ 236,665	$ 10,000	$ 167,207	$ 33,718	$ 3,088,451
ZD	Riverton Creek	$ 257,000	$ 513,750	$ 24,529	$ 30,657	$ 8,750	$ 68,086	$ 44,958	$ 947,729
ZE	Meridian Valley Creek	$ 292,000	$ 142,500	$ 27,869	$ 34,832	$ 6,250	$ 51,064	$ 26,225	$ 580,741
ZF	Flaming Geyser Side Channel	$ 582,000	$ 332,500	$ 55,548	$ 69,425	$ 5,000	$ 126,065	$ 18,732	$ 1,189,271
ZG	Green River Gravel Replenishment	$ 6,004,000	$ 548,750	$ 573,043	$ 716,199	$ 31,250	$ 457,924	$ 1,123,947	$ 9,455,112
ZH	Goedeke North Reach	$ 5,772,000	$ 811,250	$ 550,900	$ 688,524	$ 3,750	$ 176,492	$ -	$ 8,002,916
ZI	Wetland 5K Reach	$ 1,303,000	$ 981,250	$ 124,363	$ 155,431	$ 10,000	$ 226,918	$ -	$ 2,800,962
ZJ	Riverside Estates Side Channel	$ 446,000	$ 143,750	$ 42,568	$ 53,202	$ 10,000	$ 51,064	$ 19,746	$ 766,330
ZK	Gold Creek Culvert	$ 160,000	$ 18,375	$ 15,271	$ 19,086	$ 3,750	$ 17,548	$ 29,972	$ 264,002
ZL	Burns Creek	$ 373,000	$ 666,750	$ 35,600	$ 44,494	$ 21,250	$ 51,064	$ 68,451	$ 1,260,609
ZM	Garrison Creek	$ 805,000	$ 596,250	$ 76,832	$ 96,026	$ 28,750	$ 77,326	$ 60,958	$ 1,741,141
ZN	Prentice Nursery Reach	$ 336,000	$ 75,000	$ 32,069	$ 40,080	$ 8,750	$ 126,065	$ 29,972	$ 647,937
ZO	Mill Creek East	$ 2,867,000	$ 4,277,500	$ 273,636	$ 341,996	$ 52,500	$ 279,601	$ 202,310	$ 8,294,544
ZP	Brunner Slough	$ 1,045,000	$ 88,750	$ 99,738	$ 124,655	$ 10,000	$ 189,098	$ 18,732	$ 1,575,974
ZQ	Olsen Creek Culvert	$ 138,000	$ 18,375	$ 13,171	$ 16,462	$ 3,750	$ 17,548	$ 30,986	$ 238,292
ZR	Black River Marsh	$ 40,000	$ 121,250	$ 3,818	$ 4,771	$ 12,500	$ 17,021	$ 22,479	$ 221,840
ZS	Elliott Bay Nearshore	$ 328,000	$ 12,500	$ 31,305	$ 39,126	$ 3,750	$ 151,279	$ -	$ 565,960
ZT	Merlino Reach	$ 2,222,000	$ 4,795,000	$ 212,075	$ 265,056	$ 20,000	$ 252,131	$ 37,465	$ 7,803,727
ZV	Lower Springbrook Reach	$ 3,355,000	$ 4,022,500	$ 320,213	$ 400,208	$ 51,250	$ 279,601	$ 82,423	$ 8,511,194
ZW	Mainstem Maintenance	$ 1,492,000	$ 8,808,750	$ 142,402	$ 177,976	$ 23,750	$ 258,767	$ 187,324	$ 11,090,969
	ALL SITES TOTALS:	**$ 57,500,000**	**$ 37,147,125**	**$ 5,488,000**	**$ 6,859,000**	**$ 787,500**	**$ 6,915,260**	**$ 3,376,910**	**$ 118,073,794**

All costs estimates are in October 2000 cost level.

Present values for future O&M and Monitoring expenditures are calculated using current federal interest rate of 6.875%.

Output estimates are measured in eco-units (described in Section 4.6), which provide quality- and quantity-based estimates of environmental benefits. Table 4-5 summarizes the cost and output estimates for restoration at each of the 47 projects (affected acres of habitat are also listed).

Table 4-5. Cost and Output of Restoration at Each Project

	Site Name	Location	Site Type	TOTAL COST	Affected Acreage	Env. Quality Index	Outputs (Eco-Units)
A	NE Auburn Creek	Tributary	Culvert Modification	$ 1,016,571	107.0	0.61	64.98
B	Mainstem Green River LWD	Middle Green	Programmatic LWD	$ 2,485,736	130.4	0.86	111.77
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation	$ 3,267,834	200.0	0.54	107.14
D	Sweeney Creek Culvert	Upper Tributary	Culvert Modification	$ 243,784	7.1	0.75	5.34
E	Newaukum Creek	Tributary	Tributary Restoration	$ 8,618,869	224.0	0.86	192.00
F	Turley Side Channel	Middle Green	Side Channel Modification	$ 399,212	14.2	0.93	13.18
G	Hamakami Levee	Middle Green	Wetland Habitat	$ 948,386	17.3	0.93	16.07
H	Sunday Creek	Upper Tributary	Tributary Restoration	$ 3,283,713	70.3	0.89	62.72
J	Porter Levee Setback	Middle Green	Levee Setback	$ 1,552,439	32.8	0.93	30.46
K	Kaetch Side Channel	Middle Green	Side Channel Modification	$ 434,452	7.7	0.93	7.19
L	North East Creek Culvert	Upper Tributary	Culvert Modification	$ 326,635	4.8	0.77	3.71
M	Green River Park	Lower Green	Side Channel Modification	$ 706,627	5.3	0.79	4.13
N	Gale Creek Culvert	Upper Tributary	Culvert Modification	$ 380,870	5.7	0.82	4.71
O	Mullen Slough	Lower Green	Side Channel Modification	$ 2,002,921	91.9	0.86	78.73
P	Olson Creek	Tributary	Tributary Restoration	$ 203,657	7.5	0.71	5.36
Q	Flaming Geyser Landslide	Middle Green	Flaming Geyser Landslide	$ 4,700,494	60.0	0.86	51.43
R	Lones Levee Removal	Middle Green	Levee Removal	$ 3,762,215	42.5	0.93	39.43
S	Codiga Farms	Estuary	Estuary Marsh Habitat	$ 1,743,657	18.0	0.86	15.43
T	Horsehead Bend	Lower Green	Side Channel Modification	$ 1,046,043	14.1	0.75	10.55
U	Schuler Brothers Reach	Tributary	Tributary Restoration	$ 4,035,193	90.7	0.66	59.90
V	Upper Springbrook Reach	Tributary	Tributary Restoration	$ 319,012	2.9	0.64	1.85
W	Duwamish Site 1	Estuary	Estuary Marsh Habitat	$ 2,120,928	22.0	0.79	17.29
X	Lake Meridian Outlet	Tributary	Tributary Restoration	$ 1,182,538	9.9	0.82	8.15
Y	Gilliam Creek	Lower Green	Culvert Modification	$ 919,596	6.7	0.71	4.76
Z	Big Spring Creek	Tributary	Wetland Habitat	$ 1,550,761	14.9	0.89	13.30
ZA	Upper Green River Side Channels	Upper Green	Side Channel Modification	$ 1,295,812	12.5	0.68	8.49
ZB	May Creek Culvert	Upper Tributary	Culvert Modification	$ 478,141	6.5	0.77	4.99
ZC	Ray Creek	Middle Green	Side Channel Modification	$ 3,088,451	29.3	0.61	17.80
ZD	Riverton Creek	Estuary	Tributary Restoration	$ 947,729	6.0	0.89	5.36
ZE	Meridian Valley Creek	Tributary	Tributary Restoration	$ 580,741	3.1	0.89	2.79
ZF	Flaming Geyser Side Channel	Middle Green	Side Channel Modification	$ 1,189,271	25.2	0.89	22.48
ZG	Green River Gravel Replenishment	Middle Green	Gravel Nourishment	$ 9,455,112	79.0	0.79	62.07
ZH	Goedeke North Reach	Tributary	Tributary Restoration	$ 8,002,916	50.1	0.73	36.68
ZI	Wetland 5K Reach	Tributary	Tributary Restoration	$ 2,800,962	41.9	0.75	31.43
ZJ	Riverside Estates Side Channel	Middle Green	Side Channel Modification	$ 766,330	11.4	0.75	8.55
ZK	Gold Creek Culvert	Upper Tributary	Culvert Modification	$ 264,002	0.9	0.79	0.72
ZL	Burns Creek	Tributary	Tributary Restoration	$ 1,260,609	24.3	0.54	13.00
ZM	Garrison Creek	Tributary	Tributary Restoration	$ 1,741,141	19.8	0.75	14.84
ZN	Prentice Nursery Reach	Lower Green	Side Channel Modification	$ 647,937	25.0	0.68	16.96
ZO	Mill Creek East	Tributary	Tributary Restoration	$ 8,294,544	74.2	0.71	52.99
ZP	Brunner Slough	Middle Green	Side Channel Modification	$ 1,575,974	16.1	0.82	13.23
ZQ	Olsen Creek Culvert	Upper Tributary	Culvert Modification	$ 238,292	0.5	0.71	0.36
ZR	Black River Marsh	Estuary	Estuary Marsh Habitat	$ 221,840	4.9	0.82	3.99
ZS	Elliott Bay Nearshore	Estuary	Estuary Habitat	$ 565,960	5.0	0.68	3.39
ZT	Merlino Reach	Tributary	Tributary Restoration	$ 7,803,727	65.2	0.75	48.92
ZV	Lower Springbrook Reach	Tributary	Tributary Restoration	$ 8,511,194	55.2	0.64	35.45
ZW	Mainstem Maintenance	Lower Green	Levee/Bank Bioengineering	$ 11,090,969	140.3	0.86	120.26
	ALL SITES TOTALS:			**$ 118,073,794**	**1903.9**		**1,454.32**

All costs estimates are in October 2000 cost level.

Present values for future O&M and Monitoring components of total cost were calculated using current federal interest rate of 6.875%.

Table 4-6. Ecosystem Restoration Alternatives (sorted by output)

	Site Name	Location	Site Type	TOTAL COST	OUTPUT (Eco-Units)
E	Newaukum Creek	Tributary	Tributary Restoration	$ 8,618,869	192.00
ZW	Mainstem Maintenance	Lower Green	Levee/Bank Bioengineering	$ 11,090,969	120.26
B	Mainstem Green River LWD	Middle Green	Programmatic LWD	$ 2,485,736	111.77
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation	$ 3,267,834	107.14
O	Mullen Slough	Lower Green	Side Channel Modification	$ 2,002,921	78.73
A	NE Auburn Creek	Tributary	Culvert Modification	$ 1,016,571	64.98
H	Sunday Creek	Upper Tributary	Tributary Restoration	$ 3,283,713	62.72
ZG	Green River Gravel Replenishment	Middle Green	Gravel Nourishment	$ 9,455,112	62.07
U	Schuler Brothers Reach	Tributary	Tributary Restoration	$ 4,035,193	59.90
ZO	Mill Creek East	Tributary	Tributary Restoration	$ 8,294,544	52.99
Q	Flaming Geyser Landslide	Middle Green	Flaming Geyser Landslide	$ 4,700,494	51.43
ZT	Merlino Reach	Tributary	Tributary Restoration	$ 7,803,727	48.92
R	Lones Levee Removal	Middle Green	Levee Removal	$ 3,762,215	39.43
ZH	Goedeke North Reach	Tributary	Tributary Restoration	$ 8,002,916	36.68
ZV	Lower Springbrook Reach	Tributary	Tributary Restoration	$ 8,511,194	35.45
ZI	Wetland 5K Reach	Tributary	Tributary Restoration	$ 2,800,962	31.43
J	Porter Levee Setback	Middle Green	Levee Setback	$ 1,552,439	30.46
ZF	Flaming Geyser Side Channel	Middle Green	Side Channel Modification	$ 1,189,271	22.48
ZC	Ray Creek	Middle Green	Side Channel Modification	$ 3,088,451	17.80
W	Duwamish Site 1	Estuary	Estuary Marsh Habitat	$ 2,120,928	17.29
ZN	Prentice Nursery Reach	Lower Green	Side Channel Modification	$ 647,937	16.96
G	Hamakami Levee	Middle Green	Wetland Habitat	$ 948,386	16.07
S	Codiga Farms	Estuary	Estuary Marsh Habitat	$ 1,743,657	15.43
ZM	Garrison Creek	Tributary	Tributary Restoration	$ 1,741,141	14.84
Z	Big Spring Creek	Tributary	Wetland Habitat	$ 1,550,761	13.30
ZP	Brunner Slough	Middle Green	Side Channel Modification	$ 1,575,974	13.23
F	Turley Side Channel	Middle Green	Side Channel Modification	$ 399,212	13.18
ZL	Burns Creek	Tributary	Tributary Restoration	$ 1,260,609	13.00
T	Horsehead Bend	Lower Green	Side Channel Modification	$ 1,046,043	10.55
ZJ	Riverside Estates Side Channel	Middle Green	Side Channel Modification	$ 766,330	8.55
ZA	Upper Green River Side Channels	Upper Green	Side Channel Modification	$ 1,295,812	8.49
X	Lake Meridian Outlet	Tributary	Tributary Restoration	$ 1,182,538	8.15
K	Kaetch Side Channel	Middle Green	Side Channel Modification	$ 434,452	7.19
P	Olson Creek	Tributary	Tributary Restoration	$ 203,657	5.36
ZD	Riverton Creek	Estuary	Tributary Restoration	$ 947,729	5.36
D	Sweeney Creek Culvert	Upper Tributary	Culvert Modification	$ 243,784	5.34
ZB	May Creek Culvert	Upper Tributary	Culvert Modification	$ 478,141	4.99
Y	Gilliam Creek	Lower Green	Culvert Modification	$ 919,596	4.76
N	Gale Creek Culvert	Upper Tributary	Culvert Modification	$ 380,870	4.71
M	Green River Park	Lower Green	Side Channel Modification	$ 706,627	4.13
ZR	Black River Marsh	Estuary	Estuary Marsh Habitat	$ 221,840	3.99
L	North East Creek Culvert	Upper Tributary	Culvert Modification	$ 326,635	3.71
ZS	Elliott Bay Nearshore	Estuary	Estuary Habitat	$ 565,960	3.39
ZE	Meridian Valley Creek	Tributary	Tributary Restoration	$ 580,741	2.79
V	Upper Springbrook Reach	Tributary	Tributary Restoration	$ 319,012	1.85
ZK	Gold Creek Culvert	Upper Tributary	Culvert Modification	$ 264,002	0.72
ZQ	Olsen Creek Culvert	Upper Tributary	Culvert Modification	$ 238,292	0.36

All cost estimates are in October 2000 price level.

Present values for future O&M and Monitoring components of total cost were calculated using current federal interest rate of 6.875%.

Table 4-7. Ecosystem Restoration Alternatives (Sorted by Inc. Cost)

All cost estimates are in October 2000 price level.

Present values for future O&M and Monitoring components of total cost were calculated using current federal interest rate of 6.875%.

	Site Name	Location	Site Type	TOTAL COST	OUTPUT (Eco-Units)	Inc. Cost per Unit
A	NE Auburn Creek	Tributary	Culvert Modification	$ 1,016,571	64.98	$ 15,644
B	Mainstem Green River LWD	Middle Green	Programmatic LWD	$ 2,485,736	111.77	$ 22,239
O	Mullen Slough	Lower Green	Side Channel Modification	$ 2,002,921	78.73	$ 25,441
F	Turley Side Channel	Middle Green	Side Channel Modification	$ 399,212	13.18	$ 30,297
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation	$ 3,267,834	107.14	$ 30,500
P	Olson Creek	Tributary	Tributary Restoration	$ 203,657	5.36	$ 38,016
ZN	Prentice Nursery Reach	Lower Green	Side Channel Modification	$ 647,937	16.96	$ 38,194
E	Newaukum Creek	Tributary	Tributary Restoration	$ 8,618,869	192.00	$ 44,890
D	Sweeney Creek Culvert	Upper Tributary	Culvert Modification	$ 243,784	5.34	$ 45,652
J	Porter Levee Setback	Middle Green	Levee Setback	$ 1,552,439	30.46	$ 50,971
H	Sunday Creek	Upper Tributary	Tributary Restoration	$ 3,283,713	62.72	$ 52,352
ZF	Flaming Geyser Side Channel	Middle Green	Side Channel Modification	$ 1,189,271	22.48	$ 52,898
ZR	Black River Marsh	Estuary	Estuary Marsh Habitat	$ 221,840	3.99	$ 55,569
G	Hamakami Levee	Middle Green	Wetland Habitat	$ 948,386	16.07	$ 59,003
K	Kaetch Side Channel	Middle Green	Side Channel Modification	$ 434,452	7.19	$ 60,448
U	Schuler Brothers Reach	Tributary	Tributary Restoration	$ 4,035,193	59.90	$ 67,365
N	Gale Creek Culvert	Upper Tributary	Culvert Modification	$ 380,870	4.71	$ 80,919
L	North East Creek Culvert	Upper Tributary	Culvert Modification	$ 326,635	3.71	$ 88,071
ZI	Wetland 5K Reach	Tributary	Tributary Restoration	$ 2,800,962	31.43	$ 89,132
ZJ	Riverside Estates Side Channel	Middle Green	Side Channel Modification	$ 766,330	8.55	$ 89,629
Q	Flaming Geyser Landslide	Middle Green	Flaming Geyser Landslide	$ 4,700,494	51.43	$ 91,398
ZW	Mainstem Maintenance	Lower Green	Levee/Bank Bioengineering	$ 11,090,969	120.26	$ 92,227
R	Lones Levee Removal	Middle Green	Levee Removal	$ 3,762,215	39.43	$ 95,422
ZB	May Creek Culvert	Upper Tributary	Culvert Modification	$ 478,141	4.99	$ 95,799
ZL	Burns Creek	Tributary	Tributary Restoration	$ 1,260,609	13.00	$ 96,957
T	Horsehead Bend	Lower Green	Side Channel Modification	$ 1,046,043	10.55	$ 99,198
S	Codiga Farms	Estuary	Estuary Marsh Habitat	$ 1,743,657	15.43	$ 113,015
Z	Big Spring Creek	Tributary	Wetland Habitat	$ 1,550,761	13.30	$ 116,567
ZM	Garrison Creek	Tributary	Tributary Restoration	$ 1,741,141	14.84	$ 117,367
ZP	Brunner Slough	Middle Green	Side Channel Modification	$ 1,575,974	13.23	$ 119,166
W	Duwamish Site 1	Estuary	Estuary Marsh Habitat	$ 2,120,928	17.29	$ 122,698
X	Lake Meridian Outlet	Tributary	Tributary Restoration	$ 1,182,538	8.15	$ 145,122
ZG	Green River Gravel Replenishment	Middle Green	Gravel Nourishment	$ 9,455,112	62.07	$ 152,326
ZA	Upper Green River Side Channels	Upper Green	Side Channel Modification	$ 1,295,812	8.49	$ 152,647
ZO	Mill Creek East	Tributary	Tributary Restoration	$ 8,294,544	52.99	$ 156,522
ZT	Merlino Reach	Tributary	Tributary Restoration	$ 7,803,727	48.92	$ 159,536
ZS	Elliott Bay Nearshore	Estuary	Estuary Habitat	$ 565,960	3.39	$ 166,809
M	Green River Park	Lower Green	Side Channel Modification	$ 706,627	4.13	$ 171,304
V	Upper Springbrook Reach	Tributary	Tributary Restoration	$ 319,012	1.85	$ 172,306
ZC	Ray Creek	Middle Green	Side Channel Modification	$ 3,088,451	17.80	$ 173,554
ZD	Riverton Creek	Estuary	Tributary Restoration	$ 947,729	5.36	$ 176,909
Y	Gilliam Creek	Lower Green	Culvert Modification	$ 919,596	4.76	$ 193,019
ZE	Meridian Valley Creek	Tributary	Tributary Restoration	$ 580,741	2.79	$ 207,805
ZH	Goedeke North Reach	Tributary	Tributary Restoration	$ 8,002,916	36.68	$ 218,180
ZV	Lower Springbrook Reach	Tributary	Tributary Restoration	$ 8,511,194	35.45	$ 240,066
ZK	Gold Creek Culvert	Upper Tributary	Culvert Modification	$ 264,002	0.72	$ 365,220
ZQ	Olsen Creek Culvert	Upper Tributary	Culvert Modification	$ 238,292	0.36	$ 654,135
	ALL SITES TOTALS:			**$ 118,073,794**	**1,454.32**	

Table 4-9. Selected Restoration Projects (sorted by location)

	Site Name	Location	Site Type	TOTAL COST	OUTPUT (Eco-Units)	Inc. Cost per Unit
ZR	Black River Marsh	Duwamish Estuary	Estuary Marsh Habitat	$ 221,840	3.99	$ 55,569
S	Codiga Farms	Duwamish Estuary	Estuary Marsh Habitat	$ 1,743,657	15.43	$ 113,015
W	Duwamish Site 1	Duwamish Estuary	Estuary Marsh Habitat	$ 2,120,928	17.29	$ 122,698
ZS	Elliott Bay Nearshore	Duwamish Estuary	Estuary Habitat	$ 565,960	3.39	$ 166,809
ZD	Riverton Creek	Duwamish Estuary Tributary	Tributary Restoration	$ 947,729	5.36	$ 176,909
ZW	Mainstem Maintenance	Lower Green Mainstem	Levee/Bank Bioengineering	$ 11,090,969	120.26	$ 92,227
T	Horsehead Bend	Lower Green Mainstem	Side Channel Modification	$ 1,046,043	10.55	$ 99,198
M	Green River Park	Lower Green Mainstem	Side Channel Modification	$ 706,627	4.13	$ 171,304
A	NE Auburn Creek	Lower Green Tributary	Culvert Modification	$ 1,016,571	64.98	$ 15,644
O	Mullen Slough	Lower Green Tributary	Side Channel Modification	$ 2,002,921	78.73	$ 25,441
P	Olson Creek	Lower Green Tributary	Tributary Restoration	$ 203,657	5.36	$ 38,016
ZN	Prentice Nursery Reach	Lower Green Tributary	Side Channel Modification	$ 647,937	16.96	$ 38,194
U	Schuler Brothers Reach	Lower Green Tributary	Tributary Restoration	$ 4,035,193	59.90	$ 67,365
ZI	Wetland 5K Reach	Lower Green Tributary	Tributary Restoration	$ 2,800,962	31.43	$ 89,132
ZM	Garrison Creek	Lower Green Tributary	Tributary Restoration	$ 1,741,141	14.84	$ 117,367
ZO	Mill Creek East	Lower Green Tributary	Tributary Restoration	$ 8,294,544	52.99	$ 156,522
ZT	Merlino Reach	Lower Green Tributary	Tributary Restoration	$ 7,803,727	48.92	$ 159,536
V	Upper Springbrook Reach	Lower Green Tributary	Tributary Restoration	$ 319,012	1.85	$ 172,306
Y	Gilliam Creek	Lower Green Tributary	Culvert Modification	$ 919,596	4.76	$ 193,019
ZH	Goedeke North Reach	Lower Green Tributary	Tributary Restoration	$ 8,002,916	36.68	$ 218,180
ZV	Lower Springbrook Reach	Lower Green Tributary	Tributary Restoration	$ 8,511,194	35.45	$ 240,066
B	Mainstem Green River LWD	Middle Green Mainstem	Programmatic LWD	$ 2,485,736	111.77	$ 22,239
F	Turley Side Channel	Middle Green Mainstem	Side Channel Modification	$ 399,212	13.18	$ 30,297
J	Porter Levee Setback	Middle Green Mainstem	Levee Setback	$ 1,552,439	30.46	$ 50,971
ZF	Flaming Geyser Side Channel	Middle Green Mainstem	Side Channel Modification	$ 1,189,271	22.48	$ 52,898
G	Hamakami Levee	Middle Green Mainstem	Wetland Habitat	$ 948,386	16.07	$ 59,003
K	Kaetch Side Channel	Middle Green Mainstem	Side Channel Modification	$ 434,452	7.19	$ 60,448
ZJ	Riverside Estates Side Channel	Middle Green Mainstem	Side Channel Modification	$ 766,330	8.55	$ 89,629
Q	Flaming Geyser Landslide	Middle Green Mainstem	Flaming Geyser Landslide	$ 4,700,494	51.43	$ 91,398
R	Lones Levee Removal	Middle Green Mainstem	Levee Removal	$ 3,762,215	39.43	$ 95,422
ZP	Brunner Slough	Middle Green Mainstem	Side Channel Modification	$ 1,575,974	13.23	$ 119,166
ZG	Green River Gravel Replenishment	Middle Green Mainstem	Gravel Nourishment	$ 9,455,112	62.07	$ 152,326
E	Newaukum Creek	Middle Green Tributary	Tributary Restoration	$ 8,618,869	192.00	$ 44,890
ZL	Burns Creek	Middle Green Tributary	Tributary Restoration	$ 1,260,609	13.00	$ 96,957
Z	Big Spring Creek	Middle Green Tributary	Wetland Habitat	$ 1,550,761	13.30	$ 116,567
X	Lake Meridian Outlet	Middle Green Tributary	Tributary Restoration	$ 1,182,538	8.15	$ 145,122
ZC	Ray Creek	Middle Green Tributary	Side Channel Modification	$ 3,088,451	17.80	$ 173,554
ZE	Meridian Valley Creek	Middle Green Tributary	Tributary Restoration	$ 580,741	2.79	$ 207,805
ZA	Upper Green River Side Channels	Upper Green Mainstem	Side Channel Modification	$ 1,295,812	8.49	$ 152,647
D	Sweeney Creek Culvert	Upper Green Tributary	Culvert Modification	$ 243,784	5.34	$ 45,652
H	Sunday Creek	Upper Green Tributary	Tributary Restoration	$ 3,283,713	62.72	$ 52,352
N	Gale Creek Culvert	Upper Green Tributary	Culvert Modification	$ 380,870	4.71	$ 80,919
L	North East Creek Culvert	Upper Green Tributary	Culvert Modification	$ 326,635	3.71	$ 88,071
ZB	May Creek Culvert	Upper Green Tributary	Culvert Modification	$ 478,141	4.99	$ 95,799
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation	$ 3,267,834	107.14	$ 30,500

**Costs are in October 2000 price level.*

Selected Projects in Duwamish Estuary Zone: As noted in the report, 98% of estuarine habitat has been lost in the basin. This habitat is vital to the survival of salmon, providing the transitional zone where the fish adjust for the change from freshwater to saltwater. The selected plan includes four estuary restoration projects and one estuarine tributary habitat restoration project. Based on the significance of this habitat for survival of salmonids in the system, the environmental benefit provided by all 5 estuary restoration projects were determined to be worth their incremental cost.

Table 5-1 Selected Projects Summary

	Site Name	Location	Type	Total Project Cost*	Project Cost (Present Value)**	Output (Eco-Units)	Affected Area (Acres)
A	NE Auburn Creek	Tributary	Culvert Modification	$ 1,400,745	$ 1,016,571	64.98	107.0
B	Mainstem Green River LWD	Middle Green	Programmatic LWD	$ 3,083,180	$ 2,485,736	111.77	130.4
C	Volunteer Revegetation	Watershed-wide	Volunteer Revegetation	$ 3,516,672	$ 3,267,834	107.14	200.0
D	Sweeney Creek Culvert	Upper Tributary	Culvert Modification	$ 333,913	$ 243,784	5.34	7.1
E	Newaukum Creek	Tributary	Tributary Restoration	$ 9,128,587	$ 8,618,869	192.00	224.0
F	Turley Side Channel	Middle Green	Side Channel Modification	$ 440,376	$ 399,212	13.18	14.2
G	Hamakami Levee	Middle Green	Wetland Habitat	$ 1,026,613	$ 948,386	16.07	17.3
H	Sunday Creek	Upper Tributary	Tributary Restoration	$ 3,437,771	$ 3,283,713	62.72	70.3
J	Porter Levee Setback	Middle Green	Levee Setback	$ 1,606,812	$ 1,552,439	30.46	32.8
K	Kaetch Side Channel	Middle Green	Side Channel Modification	$ 484,440	$ 434,452	7.19	7.7
L	North East Creek Culvert	Upper Tributary	Culvert Modification	$ 366,772	$ 326,635	3.71	4.8
M	Green River Park	Lower Green	Side Channel Modification	$ 767,039	$ 706,627	4.13	5.3
N	Gale Creek Culvert	Upper Tributary	Culvert Modification	$ 387,110	$ 380,870	4.71	5.7
O	Mullen Slough	Lower Green	Side Channel Modification	$ 2,123,956	$ 2,002,921	78.73	91.9
P	Olson Creek	Tributary	Tributary Restoration	$ 241,756	$ 203,657	5.36	7.5
Q	Flaming Geyser Landslide	Middle Green	Flaming Geyser Landslide	$ 5,117,753	$ 4,700,494	51.43	60.0
R	Lones Levee Removal	Middle Green	Levee Removal	$ 3,878,209	$ 3,762,215	39.43	42.5
S	Codiga Farms	Estuary	Estuary Marsh Habitat	$ 1,857,980	$ 1,743,657	15.43	18.0
T	Horsehead Bend	Lower Green	Side Channel Modification	$ 1,132,979	$ 1,046,043	10.55	14.1
U	Schuler Brothers Reach	Tributary	Tributary Restoration	$ 4,142,102	$ 4,035,193	59.90	90.7
V	Upper Springbrook Reach	Tributary	Tributary Restoration	$ 532,616	$ 319,012	1.85	2.9
W	Duwamish Site 1	Estuary	Estuary Marsh Habitat	$ 2,225,910	$ 2,120,928	17.29	22.0
X	Lake Meridian Outlet	Tributary	Tributary Restoration	$ 1,259,535	$ 1,182,538	8.15	9.9
Y	Gilliam Creek	Lower Green	Culvert Modification	$ 1,168,478	$ 919,596	4.76	6.7
Z	Big Spring Creek	Tributary	Wetland Habitat	$ 1,629,140	$ 1,550,761	13.30	14.9
ZA	Upper Green River Side Channels	Upper Green	Side Channel Modification	$ 1,419,919	$ 1,295,812	8.49	12.5
ZB	May Creek Culvert	Upper Tributary	Culvert Modification	$ 517,315	$ 478,141	4.99	6.5
ZC	Ray Creek	Middle Green	Side Channel Modification	$ 3,227,245	$ 3,088,451	17.80	29.3
ZD	Riverton Creek	Estuary	Tributary Restoration	$ 1,064,973	$ 947,729	5.36	6.0
ZE	Meridian Valley Creek	Tributary	Tributary Restoration	$ 651,278	$ 580,741	2.79	3.1
ZF	Flaming Geyser Side Channel	Middle Green	Side Channel Modification	$ 1,257,624	$ 1,189,271	22.48	25.2
ZG	Green River Gravel Replenishment	Middle Green	Gravel Nourishment	$ 12,229,958	$ 9,455,112	62.07	79.0
ZH	Goedeke North Reach	Tributary	Tributary Restoration	$ 8,042,881	$ 8,002,916	36.68	50.1
ZI	Wetland 5K Reach	Tributary	Tributary Restoration	$ 2,845,501	$ 2,800,962	31.43	41.9
ZJ	Riverside Estates Side Channel	Middle Green	Side Channel Modification	$ 1,068,519	$ 766,330	8.55	11.4
ZL	Burns Creek	Tributary	Tributary Restoration	$ 1,676,512	$ 1,260,609	13.00	24.3
ZM	Garrison Creek	Tributary	Tributary Restoration	$ 2,153,759	$ 1,741,141	14.84	19.8
ZN	Prentice Nursery Reach	Lower Green	Side Channel Modification	$ 742,275	$ 647,937	16.96	25.0
ZO	Mill Creek East	Tributary	Tributary Restoration	$ 8,850,839	$ 8,294,544	52.99	74.2
ZP	Brunner Slough	Middle Green	Side Channel Modification	$ 1,656,812	$ 1,575,974	13.23	16.1
ZR	Black River Marsh	Estuary	Estuary Marsh Habitat	$ 277,384	$ 221,840	3.99	4.9
ZS	Elliott Bay Nearshore	Estuary	Estuary Habitat	$ 595,049	$ 565,960	3.39	5.0
ZT	Merlino Reach	Tributary	Tributary Restoration	$ 7,941,617	$ 7,803,727	48.92	65.2
ZV	Lower Springbrook Reach	Tributary	Tributary Restoration	$ 8,787,924	$ 8,511,194	35.45	55.2
ZW	Mainstem Maintenance	Lower Green	Levee/Bank Bioengineering	$ 11,631,547	$ 11,090,969	120.26	140.3
	ALL SITES TOTALS:			**$ 127,929,375**	**$ 117,571,500**	**1,453.23**	**1,902.5**

All costs are presented in October 2000 price levels

** Actual value in October 2000 price level (includes PED, LERRDs, S&A, Construction Mgmt., Construction, Monitoring, and O&M.*

***Future expenditures are discounted to year 2000 level using FY00 federal interest rate of 6.875% for water resources studies.*

Table 5-2. Monitoring Cost Summary

		ANNUAL MONITORING COST	TOTAL MONITORING COST	PRESENT VALUE MONITORING	MONITORING YEARS
A	NE Auburn Creek	$ 40,000	$ 80,000	$ 68,085.72	2,5
B	Mainstem Green River LWD	$ 100,000	$ 300,000	$ 228,962.02	2,5,9
C	Volunteer Revegetation	$ 100,000	$ 300,000	$ 228,962.02	2,5,9
D	Sweeney Creek Culvert	$ 10,000	$ 20,000	$ 17,548.38	2,4
E	Newaukum Creek	$ 120,000	$ 360,000	$ 274,754.43	2,5,9
F	Turley Side Channel	$ 20,000	$ 40,000	$ 34,042.86	2,5
G	Hamakami Levee	$ 70,000	$ 210,000	$ 184,936.75	1,3,5
H	Sunday Creek	$ 60,000	$ 180,000	$ 151,278.51	2,4,5
J	Porter Levee Setback	$ 75,000	$ 225,000	$ 189,098.14	2,4,5
K	Kaetch Side Channel	$ 20,000	$ 40,000	$ 34,042.86	2,5
L	North East Creek Culvert	$ 20,000	$ 40,000	$ 35,096.76	2,4
M	Green River Park	$ 70,000	$ 210,000	$ 184,936.75	1,3,5
N	Gale Creek Culvert	$ 20,000	$ 40,000	$ 34,042.86	2,5
O	Mullen Slough	$ 50,000	$ 150,000	$ 126,065.43	2,4,5
P	Olson Creek	$ 10,000	$ 20,000	$ 17,021.43	2,5
Q	Flaming Geyser Landslide	$ 120,000	$ 360,000	$ 296,640.41	2,4,6
R	Lones Levee Removal	$ 90,000	$ 270,000	$ 226,917.77	2,4,5
S	Codiga Farms	$ 90,000	$ 270,000	$ 226,917.77	2,4,5
T	Horsehead Bend	$ 70,000	$ 210,000	$ 184,936.75	1,3,5
U	Schuler Brothers Reach	$ 90,000	$ 270,000	$ 226,917.77	2,4,5
V	Upper Springbrook Reach	$ 20,000	$ 40,000	$ 27,886.74	5,8
W	Duwamish Site 1	$ 90,000	$ 270,000	$ 226,917.77	2,4,5
X	Lake Meridian Outlet	$ 50,000	$ 100,000	$ 85,107.15	2,5
Y	Gilliam Creek	$ 40,000	$ 80,000	$ 68,085.72	2,5
Z	Big Spring Creek	$ 70,000	$ 210,000	$ 176,491.60	2,4,5
AA	Upper Green River Side Channels	$ 75,000	$ 225,000	$ 189,098.14	2,4,5
AB	May Creek Culvert	$ 75,000	$ 150,000	$ 127,660.73	2,5
AC	Ray Creek	$ 75,000	$ 225,000	$ 167,207.31	3,5,9
AD	Riverton Creek	$ 40,000	$ 80,000	$ 68,085.72	2,5
AE	Meridian Valley Creek	$ 30,000	$ 60,000	$ 51,064.29	2,5
AF	Flaming Geyser Side Channel	$ 50,000	$ 150,000	$ 126,065.43	2,4,5
AG	Green River Gravel Replenishment	$ 200,000	$ 600,000	$ 457,924.05	2,5,9
AH	Goedeke North Reach	$ 70,000	$ 210,000	$ 176,491.60	2,4,5
AI	Wetland 5K Reach	$ 90,000	$ 270,000	$ 226,917.77	2,4,5
AJ	Riverside Estates Side Channel	$ 30,000	$ 60,000	$ 51,064.29	2,5
AL	Burns Creek	$ 30,000	$ 60,000	$ 51,064.29	2,5
AM	Garrison Creek	$ 50,000	$ 100,000	$ 77,325.75	3,7
AN	Prentice Nursery Reach	$ 50,000	$ 150,000	$ 126,065.43	2,4,5
AO	Mill Creek East	$ 120,000	$ 360,000	$ 279,601.12	2,5,8
AP	Brunner Slough	$ 75,000	$ 225,000	$ 189,098.14	2,4,5
AR	Black River Marsh	$ 10,000	$ 20,000	$ 17,021.43	2,5
AS	Elliott Bay Nearshore	$ 60,000	$ 180,000	$ 151,278.51	2,4,5
AT	Merlino Reach	$ 100,000	$ 300,000	$ 252,130.85	2,4,5
AV	Lower Springbrook Reach	$ 120,000	$ 360,000	$ 279,601.12	2,5,8
AW	Mainstem Maintenance	$ 120,000	$ 360,000	$ 258,766.89	2,7,10
			$ 8,440,000	$ 6,879,227.24	

**Cost estimate in October 2000 price level.*

Present value calculations use current 9,875% federalinterest rate.

Table 5-3. Operation, Maintenance, and Replacement Costs

	Project Name	Vegetation Mgmt.	LWD Maint.	Sediment Mgmt.	Structural Maint.	Fence Maint.	Total Annual Maint.	Total Replacement Cost (year 25)	Total Annual O&M&R	Total O&M&R Over 50-yr Project Life
A	NE Auburn Creek	2,000.00	500.00	500.00	500.00		3,500.00	5,000.00	8,500	425,000.00
B	Mainstem Green River LWD	5,000.00	10,000.00	-			15,000.00	-	15,000	750,000.00
C	Volunteer Revegetation	5,000.00					5,000.00		5,000	250,000.00
D	Sweeney Creek Culvert	500.00	500.00	500.00	1,000.00		2,500.00		2,500	125,000.00
E	Newaukum Creek	5,000.00	1,000.00	1,000.00		5,000.00	12,000.00		12,000	600,000.00
F	Turley Side Channel	500.00	500.00				1,000.00		1,000	50,000.00
G	Hamakami Levee	500.00		1,000.00			1,500.00		1,500	75,000.00
H	Sunday Creek	2,500.00	1,000.00				3,500.00		3,500	175,000.00
J	Porter Levee Setback	500.00					500.00		500	25,000.00
K	Kaetch Side Channel	250.00	250.00	500.00		250.00	1,250.00		1,250	62,500.00
L	North East Creek Culvert			500.00	500.00		1,000.00		1,000	50,000.00
M	Green River Park			500.00	500.00		1,000.00		1,000	50,000.00
N	Gale Creek Culvert						-		-	-
O	Mullen Slough	2,000.00	500.00	250.00			2,750.00		2,750	137,500.00
P	Olson Creek	500.00	250.00	250.00			1,000.00		1,000	50,000.00
Q	Flaming Geyser Landslide				10,000.00		10,000.00		10,000	500,000.00
R	Lones Levee Removal	500.00		500.00	1,000.00		2,000.00		2,000	100,000.00
S	Codiga Farms	500.00	500.00	1,000.00			2,000.00		2,000	100,000.00
T	Horsehead Bend	500.00	250.00	1,000.00			1,750.00		1,750	87,500.00
U	Schuler Brothers Reach	1,000.00	250.00	500.00			1,750.00		1,750	87,500.00
V	Upper Springbrook Reach	500.00	250.00	5,000.00			5,750.00		5,750	287,500.00
W	Duwamish Site 1	500.00	250.00	1,000.00			1,750.00		1,750	87,500.00
X	Lake Meridian Outlet	500.00	250.00	1,000.00			1,750.00		1,750	87,500.00
Y	Gilliam Creek	500.00	250.00	1,000.00	5,000.00		6,750.00		6,750	337,500.00
Z	Big Spring Creek	500.00	250.00	500.00			1,250.00		1,250	62,500.00
AA	Upper Green River Side Channels		2,500.00				2,500.00		2,500	125,000.00
AB	May Creek Culvert	500.00					500.00		500	25,000.00
AC	Ray Creek	500.00	500.00	500.00		750.00	2,250.00		2,250	112,500.00
AD	Riverton Creek	250.00	250.00	1,500.00	1,000.00		3,000.00		3,000	150,000.00
AE	Meridian Valley Creek	500.00	250.00	1,000.00			1,750.00		1,750	87,500.00
AF	Flaming Geyser Side Channel	500.00	250.00	500.00			1,250.00		1,250	62,500.00
AG	Green River Gravel Replenishment			75,000.00			75,000.00		75,000	3,750,000.00
AH	Goedeke North Reach						-		-	-
AI	Wetland 5K Reach						-		-	-
AJ	Riverside Estates Side Channel	250.00	250.00	250.00	500.00		1,250.00	5,000.00	6,250	312,500.00
AL	Burns Creek	500.00	500.00	2,000.00	1,000.00	500.00	4,500.00	5,000.00	9,500	475,000.00
AM	Garrison Creek	500.00	500.00	2,000.00	1,000.00		4,000.00	5,000.00	9,000	450,000.00
AN	Prentice Nursery Reach	500.00	500.00	1,000.00			2,000.00		2,000	100,000.00
AO	Mill Creek East	5,000.00	2,500.00	5,000.00	1,000.00		13,500.00		13,500	675,000.00
AP	Brunner Slough	250.00	500.00	500.00			1,250.00		1,250	62,500.00
AR	Black River Marsh	500.00	500.00	500.00			1,500.00		1,500	75,000.00
AS	Elliott Bay Nearshore						-		-	-
AT	Merlino Reach	500.00	500.00	1,000.00		500.00	2,500.00		2,500	125,000.00
AV	Lower Springbrook Reach	1,500.00	1,500.00	2,500.00			5,500.00		5,500	275,000.00
AW	Mainstem Maintenance	5,000.00	5,000.00		2,500.00		12,500.00		12,500	625,000.00
	ALL SITES TOTALS:	**$ 46,000**	**$ 32,750**	**$ 109,750**	**$ 25,500**	**$ 7,000**	**$ 221,000**	**$ 20,000**	**$ 241,000**	**$ 12,050,000**

Values displayed are actual values in October 2000 price level (not converted to present value).

Table 5-4 Real Estate Baseline Cost Estimate

SITE NAME	TOTAL ACRES	LAND VALUES	NON-FEDERAL SPONSOR'S ADMINISTRATIVE COSTS	FEDERAL GOV'T REVIEW & ASSISTANCE COSTS	TOTAL LAND COSTS PER SITE
NE Auburn Creek	11.64	$ 68,300	$ 14,000	$ 4,000	$ 86,300
Middle Green River Large Woody Debris	41.25	$ 147,750	$ 350,000	$ 89,000	$ 586,750
Volunteer Revegetation (NO REAL ESTATE)					
Sweeney Creek*	0.30	$ 16,600	$ 7,000	$ 4,000	$ 27,600
Newaukum Creek	224.00	$ 1,806,000	$ 839,000	$ 147,000	$ 2,792,000
Turley Levee Setback	12.94	$ 95,000	$ 14,000	$ 4,000	$ 113,000
Hamakami Levee Modification	3.20	$ 16,000	$ 14,000	$ 4,000	$ 34,000
Sunday Creek Riparian Plantings*	70.25	$ 23,300	$ 14,000	$ 5,000	$ 42,300
Porter Levee Setback	31.64	$ 237,000	$ 7,000	$ 3,000	$ 247,000
Keach Levee Pond	5.28	$ 58,000	$ 14,000	$ 4,000	$ 76,000
Northeast Creek*	1.00	$ 18,800	$ 7,000	$ 4,000	$ 29,800
Green River Park	3.56	$ 104,800	$ 7,000	$ 3,000	$ 114,800
Gale Creek*	0.63	$ 20,600	$ 7,000	$ 4,000	$ 31,600
Mullen Slough Reach	91.85	$ 684,000	$ 66,000	$ 13,000	$ 763,000
Olson Creek	7.50	$ 27,000	$ 14,000	$ 4,000	$ 45,000
Flaming Geyser Slide	10.15	$ 127,000	$ 7,000	$ 4,000	$ 138,000
Lones Levee Setback	30.45	$ 273,000	$ 20,000	$ 6,000	$ 299,000
Codiga Farms	3.40	$ 118,000	$ 14,000	$ 4,000	$ 136,000
Horsehead Bend Side Channel	14.06	$ 130,000	$ 14,000	$ 4,000	$ 148,000
Mill Creek, Schuler Brothers Reach	90.66	$ 745,000	$ 53,000	$ 11,000	$ 809,000
Upper Springbrook Creek	2.13	$ 15,000	$ 7,000	$ 3,000	$ 25,000
Site 1, Duwamish	2.82	$ 933,000	$ 14,000	$ 4,000	$ 951,000
Lake Meridian Outlet Relocation	8.80	$ 117,900	$ 14,000	$ 4,000	$ 135,900
Gilliam Creek	4.40	$ 49,000	$ 7,000	$ 3,000	$ 59,000
Big Spring Creek	14.90	$ 68,250	$ 47,000	$ 11,000	$ 126,250
Upper Green River Side Channel Enhancement*	12.51	$ 174,300	$ 80,000	$ 19,000	$ 273,300
May Creek*	6.50	$ 25,300	$ 14,000	$ 5,000	$ 44,300
Ray Creek Trib Corridor	29.31	$ 341,000	$ 33,000	$ 8,000	$ 382,000
Riverton Side Channel	3.48	$ 391,000	$ 20,000	$ 7,000	$ 418,000
Meridian Valley Creek	2.23	$ 94,000	$ 20,000	$ 5,000	$ 119,000
Flaming Geyser Side Channel	25.18	$ 252,000	$ 14,000	$ 4,000	$ 270,000
Middle Green River Gravel Replacement	78.82	$ 353,000	$ 86,000	$ 25,000	$ 464,000
Mill Creek, Goedeke Reach	15.47	$ 642,000	$ 7,000	$ 3,000	$ 652,000
Mill Creek, Wetland 5K Reach	41.90	$ 752,000	$ 33,000	$ 8,000	$ 793,000
Riverside Estates Side Channel	11.40	$ 82,000	$ 33,000	$ 8,000	$ 123,000
Burns Creek Restoration	24.27	$ 440,400	$ 93,000	$ 17,000	$ 550,400
Garrison Creek (1)	19.78	$ 358,000	$ 119,000	$ 23,000	$ 500,000
Prentice Nursery	4.86	$ 33,000	$ 27,000	$ 7,000	$ 67,000
Mill Creek East	74.19	$ 3,263,000	$ 159,000	$ 42,000	$ 3,464,000
Brunner Slough	16.10	$ 38,000	$ 33,000	$ 8,000	$ 79,000
Black River Marsh	4.86	$ 57,000	$ 40,000	$ 10,000	$ 107,000
Elliot Bay Nearshore	5.70	$ 3,000	$ 7,000	$ 3,000	$ 13,000
Mill Creek, Merlino Reach	65.22	$ 3,750,000	$ 86,000	$ 16,000	$ 3,852,000
Lower Springbrook Creek	55.15	$ 3,020,000	$ 198,000	$ 41,000	$ 3,259,000
Mainstem Maintenance (Auburn to Elliot Bay)	140.30	$ 6,967,000	$ 80,000	$ 19,000	$ 7,066,000
SUBTOTAL	**1,324.04**	**$ 26,935,300.00**	**$ 2,753,000.00**	**$ 624,000.00**	**$ 30,312,300.00**
25% Contingency		$ 6,733,825	$ 688,250	$ 156,000	$ 7,578,075
GRAND TOTAL		**$ 33,669,125**	**$ 3,441,250**	**$ 780,000**	**$ 37,890,375**

**Real estate costs associated with an access road in the upper watershed are divided evenly across these six projects.*

Cost displayed are in October 2000 price level.

partners (such as Cities of Auburn, Kent and Tukwila) will be constructed first, followed by projects which only require easements, followed by projects which will require the acquisition of real estate in fee. Within each type of ownership situation, the projects which will provide the most limited or critical habitat will be constructed first, followed by projects which will provide ecosystem benefits, followed by projects which will primarily have localized benefits. The proposed construction sequencing schedule is presented in Table 6.1. See the Real Estate Plan (Appendix C) for further details on construction sequencing. Phase 1 is for construction staring in years 2002-5, Phase 2 for 2006-8, and Phase 3 for 2009-2010. All construction is scheduled for completion by the end of 2012.

Table 6-1. Construction Sequencing

Phase	Project Name	Begin Construction	End Construction
I	Codiga Farms	2002	2004
I	Flaming Geyser Land Slide	2002	2009
I	Gilliam Creek	2002	2006
I	Middle Green Gravel Replacement Projects S1, S2, C1 & C2	2002	2012
I	Duwamish Project 1	2004	2008
I	Elliot Bay Nearshore	2004	2006
I	Green River Park	2004	2006
I	Hamakami Levee Breach	2004	2006
I	Mainstem Maintenance – Russell Road Upper Setback Restoration	2004	2006
I	Middle Green Large Woody Debris (LWD) Projects BAJ19, 20 & MAJ6; BAJ25, BAJ28; BAJ29 & 30	2004	2006
I	Prentice Nursery	2004	2006
I	Turley Levee Setback	2004	2006
I	Flaming Geyser Side Channel	2005	2012
I	Horsehead Bend Side Channel	2005	2010
I	Lones Levee Setback	2005	2007
I	Mainstem Maintenance Russell Road Lower Setback & Restoration	2005	2007
I	Middle Green LWD Projects BAJ33-36 MJ11-MJ13	2005	2007
I	Mullen Slough Reach	2005	2008

I	Riverside Estates Side Channel	2005	2008
I	Riverton Side Channel	2005	2008
II	Mainstem Maintenance Boeing Setback and Restoration	2006	2008
II	Burns Creek	2006	2010
II	Lake Meridian Outlet	2006	2009
II	Meridian Valley Creek	2006	2008
II	Middle Green Large Woody Debris Projects BAJ 6, BAJ7 & BAJ8; BAJ9; BAJ12, BAJ13 &BAJ14	2006	2008
II	Mill Creek East	2006	2012
II	Mill Creek, Schuler Brothers Reach	2006	2010
II	Porter Levee Setback	2006	2010
II	Brunner Slough	2007	2011
II	Mainstem Maintenance Carrot Patch Setback and Restoration	2007	2009
II	Garrison Creek	2007	2012
II	Keach Levee	2007	2012
II	Middle Green Large Woody Debris Projects BAJ23, BAJ24 MJ8, MJ9; BAJ31, BAJ32, & MJ10	2007	2010
II	Mill Creek, Merlino Reach	2007	2010
II	NE Auburn Creek	2007	2012
II	Olson Creek	2007	2012
II	Upper Springbrook	2007	2010
II	Black River Marsh	2008	2012
II	Mainstem Maintenance Fenster Setback and Restoration	2008	2010
II	Middle Green Large Woody Debris Projects MJ1 & BAJ3	2008	2010
II	Mill Creek, Wetland 5K Reach	2008	2009
III	Newaukum Creek	2008	2012
III	Upper Green Side Channel Enhancement	2008	2012
III	Gale Creek	2009	2010
III	Gold Creek	2009	2011
III	Lower Springbrook Creek	2009	2012
III	May Creek	2009	2010
III	Maywood Creek	2009	2010
III	Middle Green Large Woody Debris Projects	2009	2011

	BAJ10, BAJ11; BAJ26 & BAJ27		
III	Mill Creek, Geodeke Reach	2009	2012
III	Northeast Creek	2009	2010
III	Olsen Creek	2009	2011
III	Ray Creek Tributary	2009	2012
III	Russell Road Lowest Setback and Restoration	2009	2011
III	Sweeney Creek	2009	2010
III	Sunday Creek Riparian Plantings	2009	2012
III	TPU Roads	2009	2012
III	Big Spring Creek	2010	2012

6.5 Monitoring

Monitoring will be conducted for up to a ten year period following completion of construction, although monitoring is scheduled to occur in no more than three years per project within that ten year period. Because the construction phase will take place over several years, the monitoring will be phased to follow construction. The monitoring costs are included as part of the construction costs and will be cost shared. If Authorized the non-federal sponsor wishes to include monitoring work as part of their in-kind services to receive credit against the total cost-sharing burden. During the PED phase, a detailed monitoring plan will be developed and responsibilities will be shared between the Corps and the non-federal sponsor. If the non-federal sponsor wishes to conduct monitoring beyond the designated time period for each project, they may do so at their own expense. See Section 5.1 for further discussion of project monitoring. Table 5.1 includes the scheduled years for monitoring for each project. The county requests that cost shared monitoring be conducted up to 5 years after construction of the final projects and that the county will take over any monitoring after that period. The has been the standard practice on other restoration projects that Seattle District has constructed with the county as local sponsor.

Table 6-2 provides a summary of the estimated cost apportionment between the federal and non-federal interests for the recommended plan. The table shows the total implementation cost of the recommended project as $115,879,400, of which $75,321,610 is federal cost and $40,557,790 is non-federal cost. The non-federal cost includes the sponsor's LERRD value of $37,110,375. Adding the non-federal noel OMRR&R cost of $12,050,000 brings the total project life-cycle cost to $127,929,400.

Table 6-2. Green-Duwamish Basin Cost Apportionment

COST APPORTIONMENT

	Federal	Non-Federal	Total
ECOSYSTEM RESTORATION*	$ 75,321,610	$ 40,557,790	$ 115,879,400
LERRD**		$ 37,110,375	$ 37,110,375
CASH CONTRIBUTION	$ 75,321,610	$ 3,447,415	$ 78,769,025

**October 2000 price level (rounded) - Ecosystem Restoration is project cost less OMRR&R.*
*** LERRD is total land cost less Federal Government supervision and administration*

6.9 Completed, Current and Future Work Eligible for Credit

The non-federal sponsor has completed a significant amount of in-kind highly technical services during the feasibility phase which they were given credit for in the Feasibility Cost-Sharing Agreement (FCSA). The non-federal sponsor has requested authority from congress to perform additional in-kind services for credit during the PED and construction phase. Future in-king services may be limited due to the fact that the sponsor's LERRD value may exceed their 35% cost share obligation (see Table 6.2). If authorized by Congress the non-Federal sponsor will be allowed to receive in-kind credit during these phases, as long as the combination of their in kind work and there LERRD value does not exceed 35% of the overall construction cost.

6.10 Institutional Requirements

The items that the local sponsor will need to require are as follows:

Table 6-3. Status of Compliance with Environmental Laws/Regulations/Treaties

Law/Regulation/Treaty	Status of Compliance	Responsibility
National Environmental Policy Act (NEPA)	Will be complete after programmatic EIS is approved	Corps
Endangered Species Act	Consultation on-going	Corps
National Historic Preservation Act	Consultation on-going	Corps
Clean Water Act	A 404(b)(1) analysis will be prepared in PED and NPDES construction permits will be obtained	Corps
Clean Air Act	In compliance	Corps
Coastal Zone Management Act	Will be in compliance through maximum consistency	Corps
Fish and Wildlife Coordination Act	In compliance	Corps
Marine Mammal Protection Act	In compliance	Corps
Migratory Bird Treaty Act	In compliance	Corps
Executive Order 12898, Environmental Justice	In compliance	Corps
Executive Order 11990, Protection of Wetlands	In compliance	Corps
Executive Order 11988, Floodplain Management	In compliance	Corps
Indian Treaty Rights	Will be in compliance through public review process	Corps
State Environmental Policy Act	King County will adopt Final EIS	King County
Shoreline Management Act	King County will obtain required permits	King County
Washington Hydraulic Code	King County will obtain required permits	King County
Water Quality Certification	Corps will obtain required permits	Corps/King County
Growth Management Act	In compliance	King County
Model Toxics Control Act	King County will obtain any necessary approvals	King County
State Aquatic Lands Management Laws	Consultation on-going	Corps/King County
King County Regulations	King County will obtain all required permits	King County
City Regulations and Ordinances	King County will obtain all required permits	King County

Table 6-4. Implementation Cost Sharing through Construction Phase

	IMPLEMENTATION COSTS		
Year (FY)	**Federal**	**Non Federal**	**Total**
2002	$ 4,000,000	$ 2,000,000	$ 6,000,000
2003	$ 6,000,000	3,000,000	$ 9,000,000
2004	$ 6,500,000	3,500,000	$ 10,000,000
2005	$ 8,000,000	4,000,000	$ 12,000,000
2006	$ 10,000,000	5,500,000	$ 15,500,000
2007	$ 10,500,000	6,000,000	$ 16,500,000
2008	$ 9,322,000	5,000,000	$ 14,322,000
2009	$ 8,000,000	4,000,000	$ 12,000,000
2010	$ 6,000,000	3,557,000	$ 9,557,000
2011	$ 3,500,000	2,000,000	$ 5,500,000
2012	$ 3,500,000	2,000,000	$ 5,500,000
Total	**$ 75,322,000**	**$ 40,557,000**	**$ 115,879,000**

All costs are in October 2000 price level.

In accordance with ER 1005-2-100, paragraph 6-184.b, a preliminary financing plan and statement of financial capability has been prepared by the local sponsor. The District has reviewed the plan and assess the sponsor's understanding of the budgetary issues related to financing the proposed project. The District has verified that the local sponsor has the capability to fund their portion of implementation responsibilities. Table 6-4 provides schedule for implementation cost apportionment between the Federal Government and non-Federal sponsor. The statement of financial capability is included at the end of this chapter.

Additional public involvement has been gained during the EIS process. A Notice of Intent to prepare an EIS was published in the Federal Register on December 23, 1998. A scoping meeting was held on January 16, 1999 and 31 people attended. One June 30, 2000 a Notice of Availability (NOA) for the Draft Programmatic EIS was published in Volume 65, Number 127 of the Federal Register. This initiated the forty five-day review and comment period for the Draft PEIS. The Draft document was distributed to over 225 citizens, State and Federal agencies, Native American Tribes and libraries. The Draft PEIS was also available through King County's web project (http://dnr.metrokc.gov/wrias/9/GDRPdeis.htm). In addition, a public meeting to solicit input on the document was held on July 27, 2000
Thirteen comment letters were received during the 45-day comment period to accompany the single comment obtained during the public meeting. Most comments were favorable and supported the preferred alternative.
The public was involved as well during the implementation of the Porter Levee Side Channel 1135 Project. A volunteer planting event was organized following the completion of construction at the project in October 1999. A great deal of positive feedback has been received from interested parties regarding the Porter Levee project.

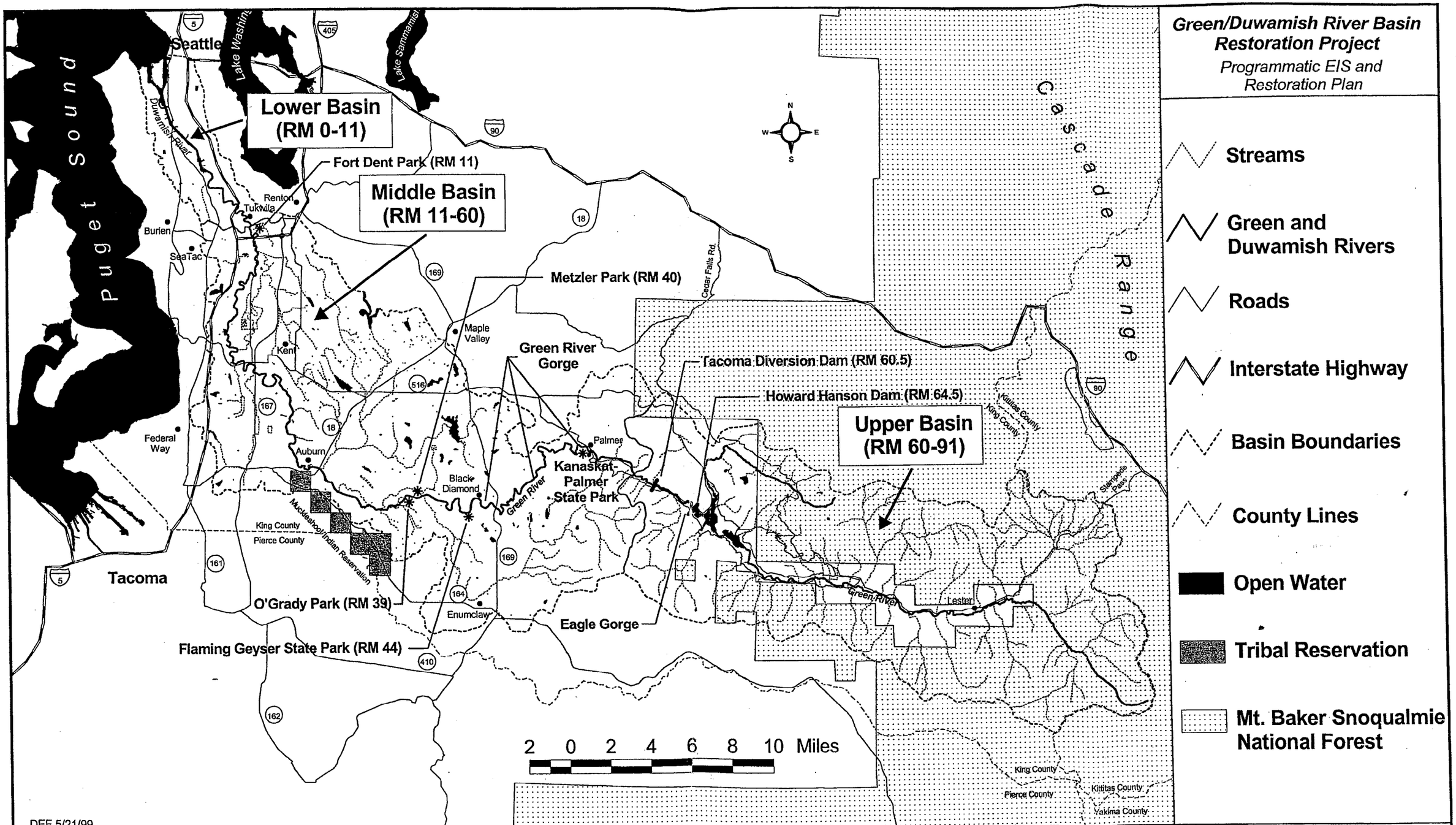
7.3 Study and Review Teams

The study team was a multi-disciplinary group that consisted of several functional elements within the Corps and at the County, and included study and project managers, planners, civil engineers, hydrologists and hydraulic engineers, environmental specialists, biologists, cost estimators, real estate specialists, economists, materials and geotechnical specialists. Table 7-1 below lists the members of the study and review teams.

Table 7-1. Study and Review Team Members

Study Team			*Review Team*		
Name	**Grade**	**Discipline**	**Name**	**Grade**	**Discipline**
N. Gilbrough	GS-12	Project Manager	H. Gibbons	Tetra Tech	Environmental Enginner
P. Cagney	GS-12	Environmental Coordinator	M. Martz	Tetra Tech	Biologist
M. Kaiser	GS-12	Geotechnical	M. Callasarre	Tetra Tech	Geotechnical
J. Lencioni	GS-13	Hydraulic Engineer	H. Fehlman	Tetra Tech	Hydraulic Engineer
Pat Naher	GS-11	Civil Design	K. Price	Tetra Tech	Civil Design/Cost
J. Mendenhall	GS-12	Economics	M. Gorecki	Tetra Tech	Economics
S. Pierce	GS-12	Cost Estimator	A.E. Hamilton	GS-12	Real Estate
W. Gentry	GS-12	Real Estate			

C. Loper	King Co.	County Project Manager	
B. King	HDR	Civil Design	
Sue Perkins	N/A.	Geomorphologist	
Faith Roland	King Co.	County Real Estate	
Wendy Kara	King Co.	County Civil Design	



U.S. Army
Corps of Engineers
Seattle District

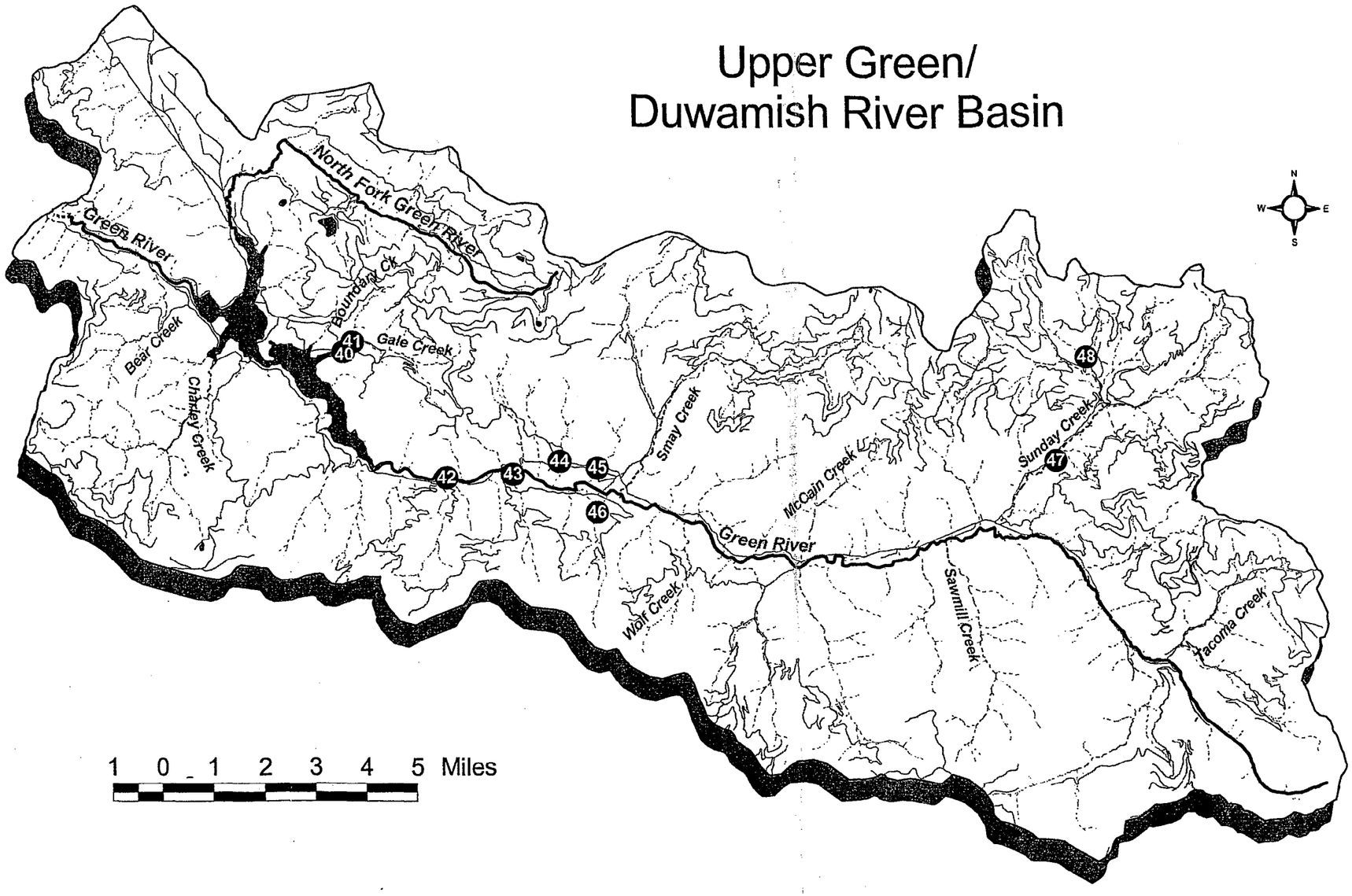
Hydrography from WDFW Streamnet database; Roads from U.S. Census Bureau (TIGER), King County, and U.S. Army Corps of Engineers

Figure 1

Major Features Green/Duwamish Basin

Green/Duwamish River Basin Restoration Project

Programmatic EIS and Restoration Plan



40 Gale Creek
41 Boundary Creek
42 Sweeney Creek
43 Olsen Creek
44 May Creek
45 Maywood Creek
46 Gold Creek
47 Sunday Creek Riparian Plantings
48 Northeast Creek

DFF 10/20/00

U.S. Army
Corps of Engineers
Seattle District

Hydrography from King County (1998);
City Limits and Roads from Washington Department of Transportation (1999)

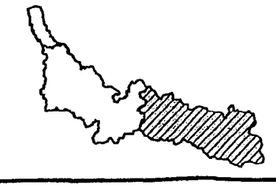
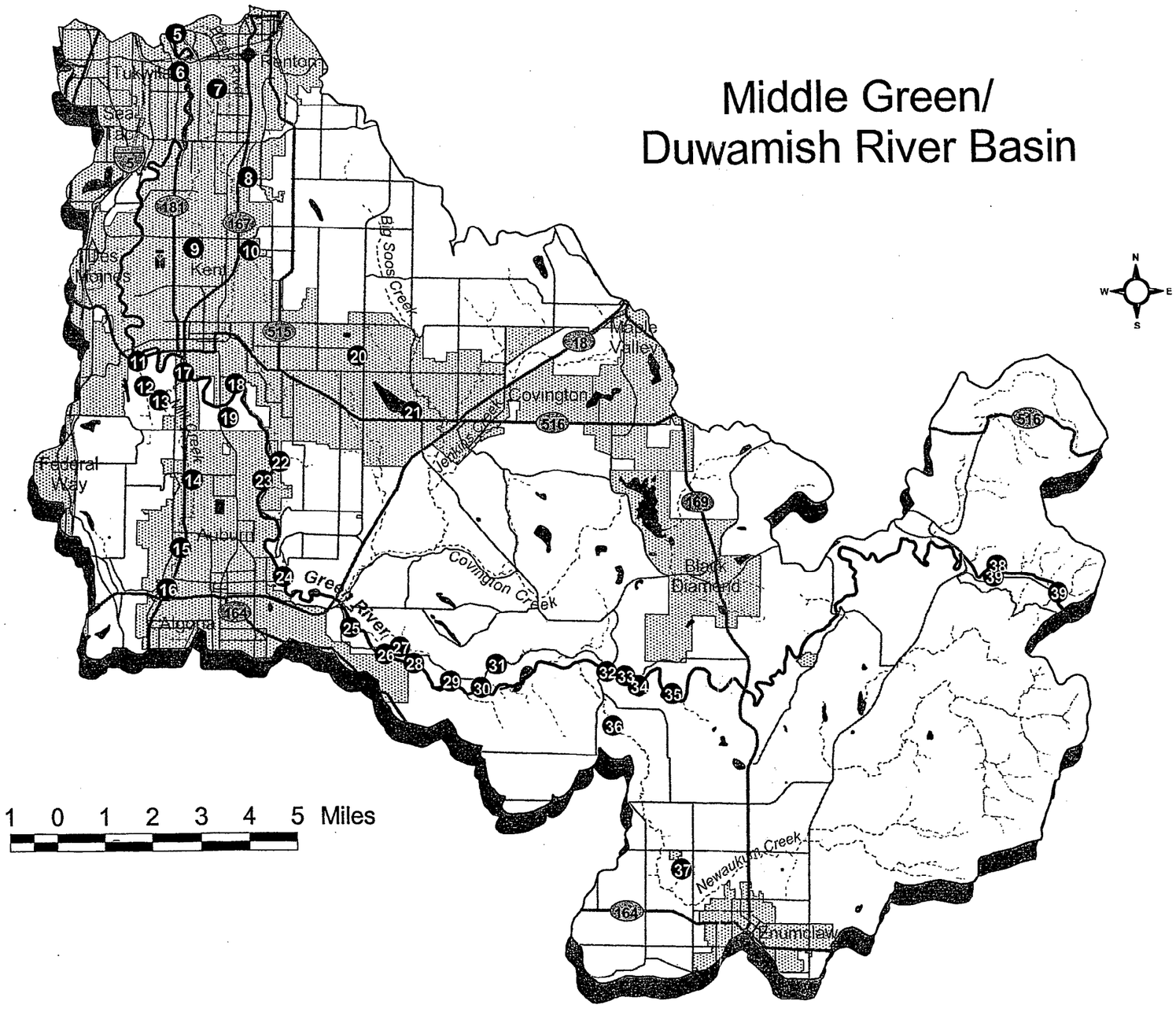


Figure 2

Upper Basin Restoration Sites



Green/Duwamish River Basin Restoration Project

Programmatic EIS and Restoration Plan

5 Black River Marsh
6 Gilliam Creek
7 Lower Springbrook Creek
8 Upper Springbrook Creek
9 Mill Creek East
10 Garrison Creek (1)
11 Mullen Slough, Prentice Nursery Reach
12 Mullen Slough Reach
13 Mill Creek, Schuler Brothers Reach
14 Mill Creek, Merlino Reach
15 Mill Creek, Wetland 5K Reach
16 Mill Creek, Goedeke Reach
17 Green River Park
18 Horsehead Bend Side Channel
19 NE Auburn Creek
20 Meridian Valley Creek
21 Lake Meridian Outlet Relocation
22 Olson Creek
23 Riverside Estates Side Channel
24 Mainstem Maintenance (Auburn to Elliott Bay)
25 Porter Levee Setback
26 Kaech Levee Pond
27 Ray Creek Trib Corridor
28 Hamakami Levee Modification
29 Turley Levee Setback
30 Loans Levee Setback
31 Burns Creek Restoration
32 Middle Green River Large Woody Debris
33 Middle Green River Gravel Replacement
34 Flaming Geyser Landslide
35 Flaming Geyser Side Channel
36 Newaukum Creek
37 Big Spring Creek
38 Brunner Slough
39 Upper Green River Side Channel Enhancement

U.S. Army
Corps of Engineers
Seattle District

Hydrography from King County (1998);
City Limits and Roads from Washington Department of Transportation (1999)

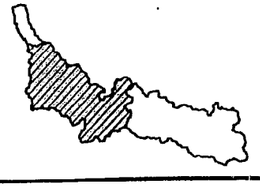
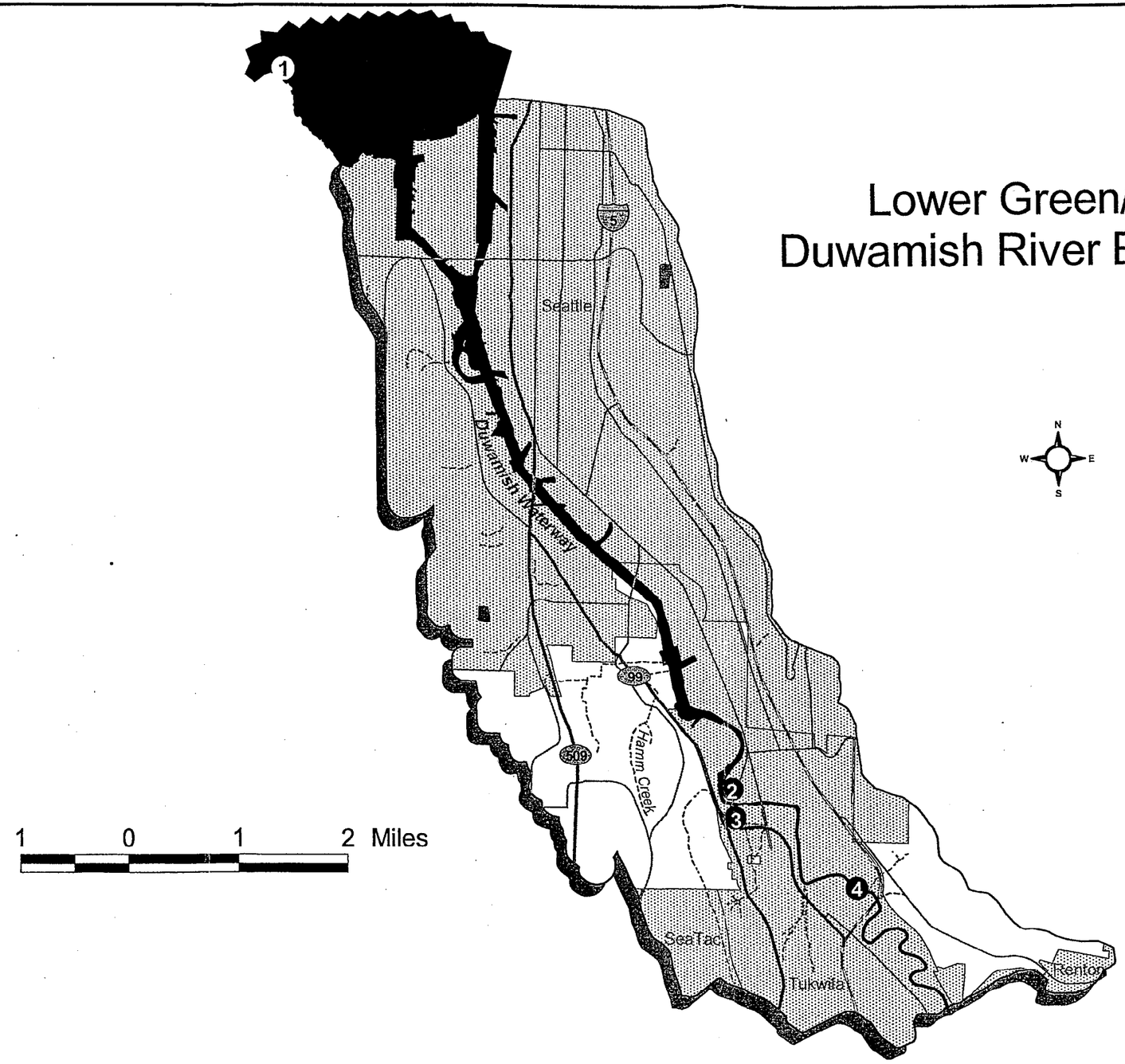


Figure 3
Middle Basin Restoration Sites

Green/Duwamish River Basin Restoration Project

Programmatic EIS and Restoration Plan



① Elliott Bay Nearshore

❷ Site 1, Duwamish

❸ Riverton Side Channel

❹ Codiga Farms

DFF 11/20/99

U.S. Army
Corps of Engineers
Seattle District

Hydrography from King County (1998);
City Limits and Roads from Washington Department of Transportation (1999)

Figure 4

Lower Basin Restoration Sites

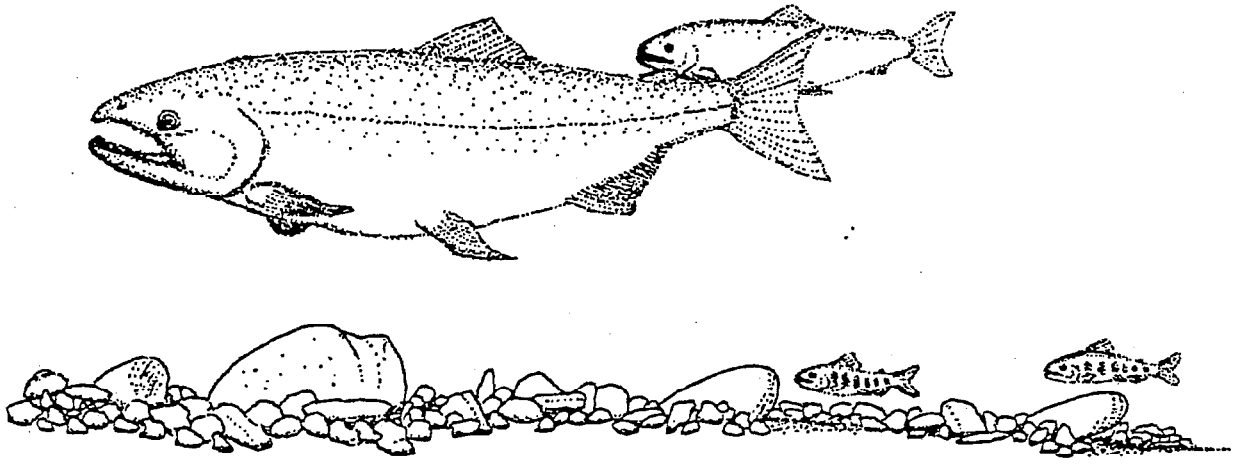
APPENDIX A

U.S. FISH AND WILDLIFE SERVICE

COORDINATION ACT REPORT

Green/Duwamish River Basin Restoration Program

FISH AND WILDLIFE COORDINATION ACT REPORT



U.S. Fish and Wildlife Service
Western Washington Office

September 2000

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U.S. Fish and Wildlife Service

Fish and Wildlife Coordination Act Report

GREEN/DUWAMISH RIVER BASIN RESTORATION PROGRAM

Prepared for
U.S. Army Corps of Engineers
Seattle District

Prepared by
Gwill Ging, Biologist
Western Washington Office
Lacey, Washington

September 2000

INTRODUCTION

This Coordination Act Report (CAR) presents the U.S. Fish and Wildlife Service's (USFWS) conclusions on the effects of the proposed Green/Duwamish Basin Restoration Project. This report is based on the project description and the related information provided in the Corps of Engineers' (Corps) reconnaissance report, 35 percent design and cost estimate reports, the Jones and Stokes' report, "Restoration Plan - Green/Duwamish River Basin Restoration Program," and on site visits to the projects on August 30, 1999 and on February 7-8, 2000. This CAR is being provided under the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended: 16 U.S.C. 661, et seq.) and fulfills Section 2(b) of this Act.

The U.S. Fish and Wildlife Service (Service) strongly supports the restoration of the Green/Duwamish River Basin ecosystem. We believe many species of fish and wildlife, including the federally listed bald eagle, bull trout and chinook salmon, would significantly benefit from the implementation of the proposed actions.

PROJECT LOCATION AND SETTING

The Green/Duwamish River Basin covers an area totaling 483 square miles and extends from its highest point (5,750 feet mean sea level) at Blowout Mountain near Stampede Pass in the Cascade Range to sea level at Elliott Bay in Central Puget Sound. The Green/Duwamish River is about 90 miles long and flows generally in a northwestern direction toward its mouth at Seattle. Fifty project elements are included in the proposed action and are located from the headwaters to the estuary. See figure 1.

The topography and character of the Green/Duwamish River Basin varies dramatically between its headwaters and mouth. The upper watershed is undeveloped and managed almost entirely for timber production. The terrain is generally steep and forested, timbered mainly by conifers except along the river and stream channels where deciduous and mixed forest stands dominate. Few manmade structures confine or restrict the river channels in the upper basin. In the middle basin below the Green River Gorge (River Mile 47) where a noticeable break in the terrain occurs, the Green River reaches the gentle slope of the valley floor. Much of the original forest land has been converted to farmland, and levees increasingly confine the river channel. Most of the lower basin has been highly altered by the clearing of the original forest lands and the filling of freshwater and estuarine wetlands and intertidal flats, and now consists largely of industrial and residential development. The river channel is highly restricted along both banks by levees or rock revetment, and is periodically dredged between its mouth and River Mile 5.5 for navigation.

PROJECT PURPOSE

The project purpose is to restore ecological processes that are directly associated with, or directly dependent on, the hydrologic regime of the watershed that has been affected by dredging and filling, construction of flood control levees, and operation of Howard Hanson Dam and Reservoir. Problems that have been identified include the following:

- Lack of habitat in the lower Green/Duwamish Estuary,
- Changes in sediment loads and transport,
- Changes in streamflows,
- Loss of channel complexity and in-channel structure,
- Water quality degradation,
- Barriers to fish passage,
- Floodplain disconnection,

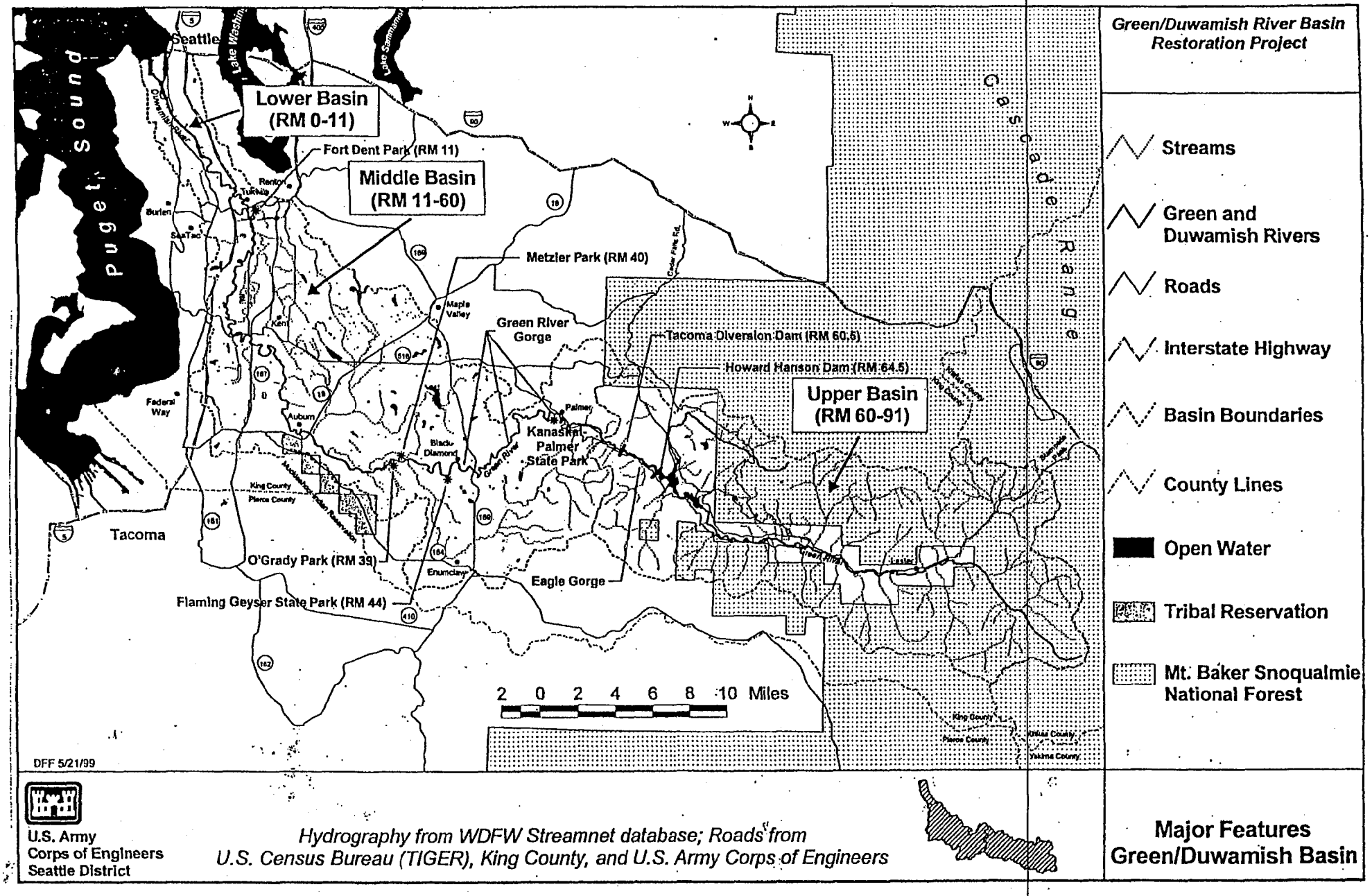

Figure 1. Project Location (Adapted from Corps of Engineers)

- Habitat fragmentation,
- Degradation of wetlands and rare species habitats,
- Changes in forest structure and composition.

PROJECT AUTHORITY AND SCOPE

The Green/Duwamish Ecosystem Restoration Study is authorized under the 1962 Flood Control Act (Section 209, Puget Sound and Adjacent Waters) and the General Investigation and Water Resources Development Act of 1990.

PROJECT DESCRIPTION

The Corps of Engineers (federal sponsor) and King County (local sponsor) have proposed 49 site specific projects and 1 programmatic restoration project for implementation over a ten year period. Individual project elements involve one or more of the following restoration measures: (1) riparian enhancements; (2) channel relocation and reconstruction to restore channel diversity and habitat complexity and/or creation of dendrites to increase off-channel rearing habitat; (3) large woody debris and boulder additions to increase channel diversity and in-channel complexity; (4) gravel additions to offset the trapping of gravel in Howard Hanson Dam and the reduction in gravel recruitment caused by channel confinement; and the control of fine sediment inputs from landslides; (5) floodplain reconnection with the river; (6) fish passage improvements; and (7) estuarine habitat restoration. A brief description of all fifty project proposals is included in appendix A. More detailed information can be found in the project site write up and plans, prepared by Jones and Stokes, Inc. Table 1 is a matrix of the specific project elements and their respective proposed restoration measures. The locations of the restoration proposals are shown in figures 2 through 4.

RESTORATION ELEMENTS

Riparian Enhancements

Many areas along the bank of the Green River and its tributaries lack trees and shrubs and are dominated by undesirable invasive and non-native species such as Himalayan blackberry, Scotch broom, Japanese knotweed, English ivy, and reed canary grass. As a consequence, the stream channel is poorly shaded, lacks the normal inputs of terrestrial insects and detritus to the aquatic system, and has limited complexity.

The removal of undesirable species would be undertaken, as needed, prior to replanting the proposed restoration sites with native tree and shrub species such as red alder, big-leaf maple, Sitka spruce, western red cedar, red osier dogwood, vine maple, Oregon grape, and sword fern. Twenty eight of the fifty project proposals include riparian enhancements.

Channel Relocation and Reconstruction

A significant number of tributaries to the Green River have been channelized and relocated to facilitate urban development, agriculture and water conveyance. As a consequence, instream habitat has been adversely impacted by the reduction in channel length, isolation from its floodplain and wetlands, scouring caused by the increase in both channel gradient and peak discharges, and the loss of diversity and complexity by the removal of large woody debris and streambank vegetation.

The proposed restoration elements include the relocation of channelized streambeds back to their

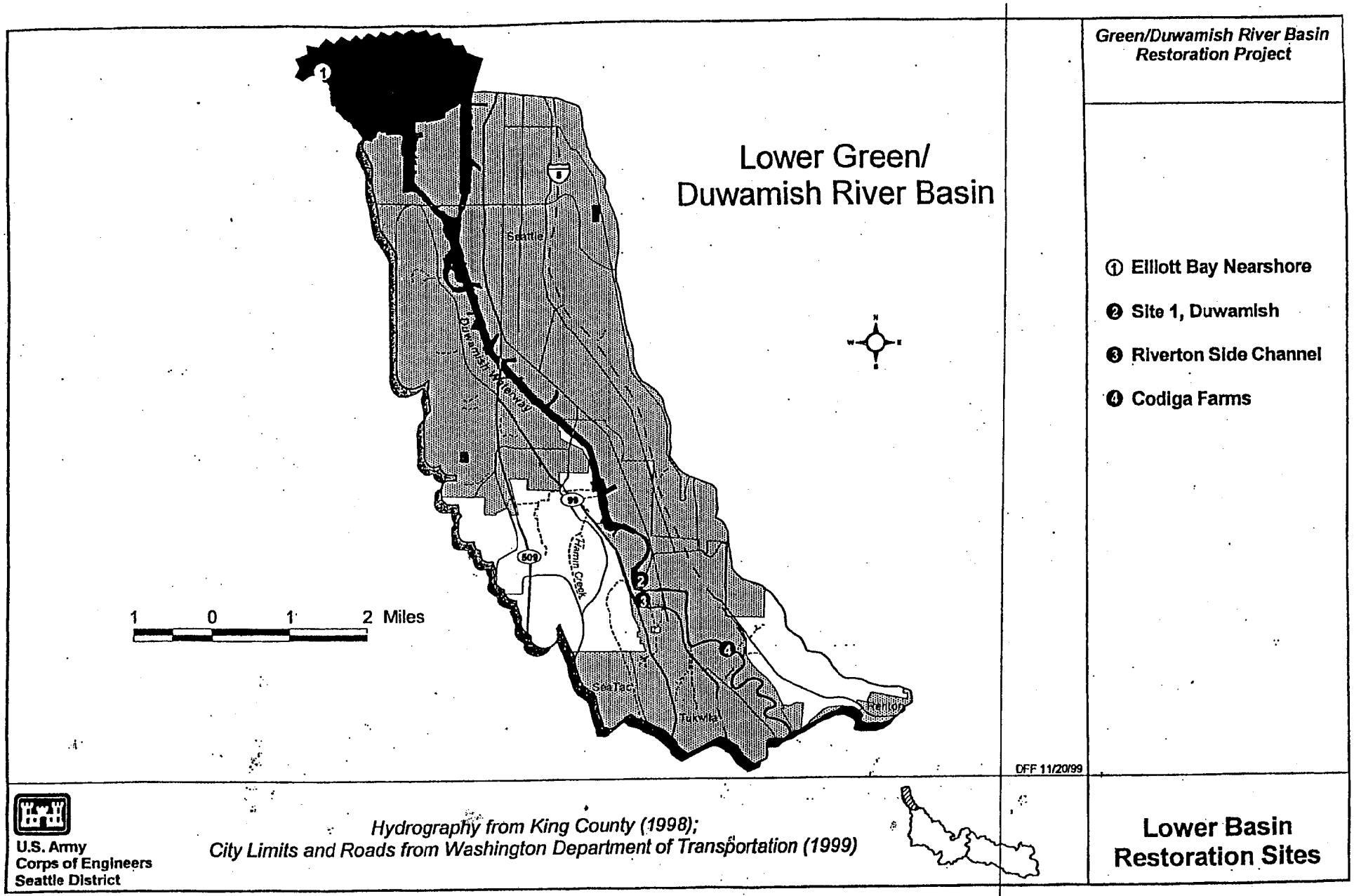

Figure 2. Lower Basin Restoration Sites (Adapted from Corps of Engineers)

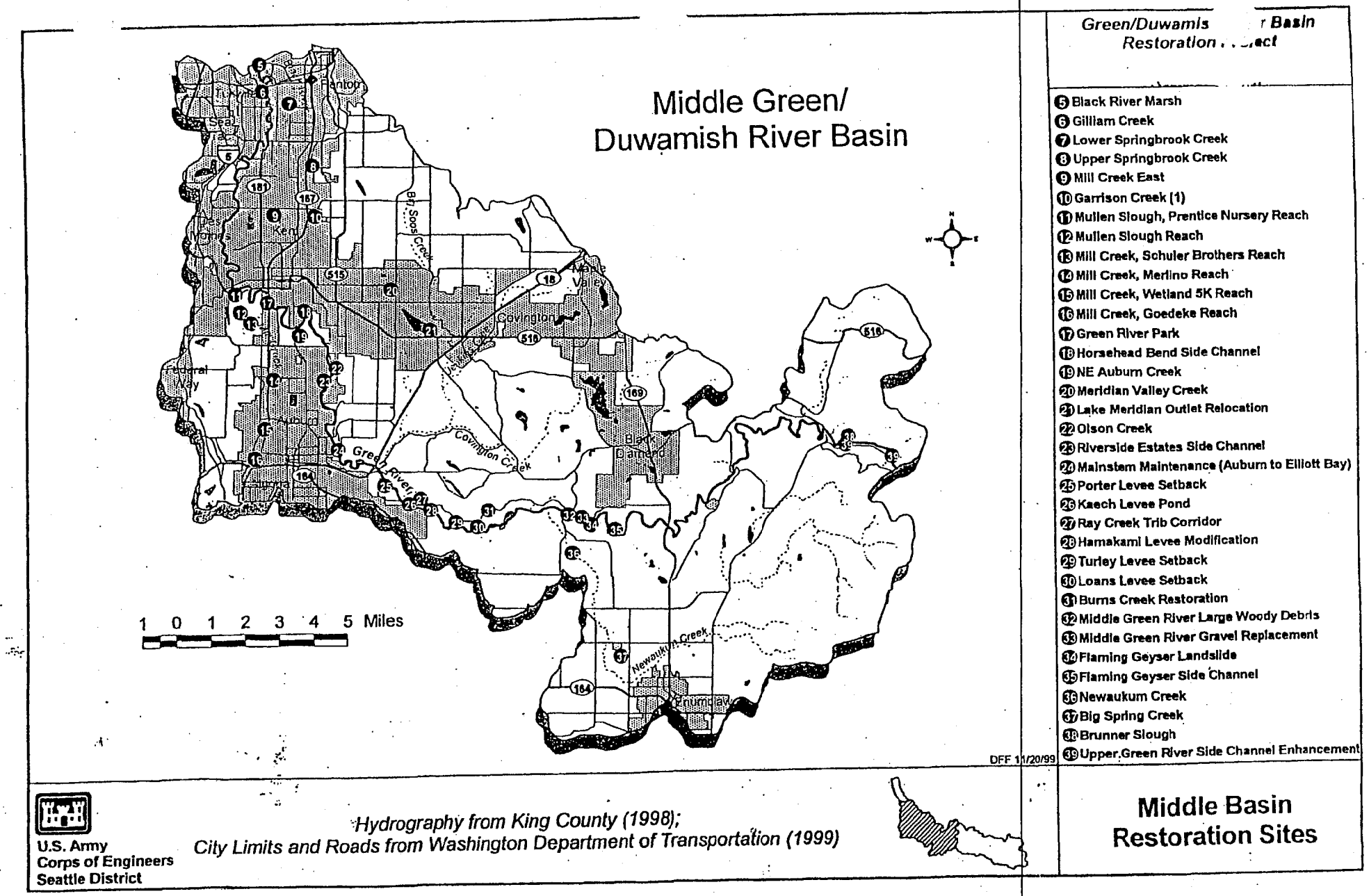

Figure 3. Middle Basin Restoration Sites (Adapted from Corps of Engineers)

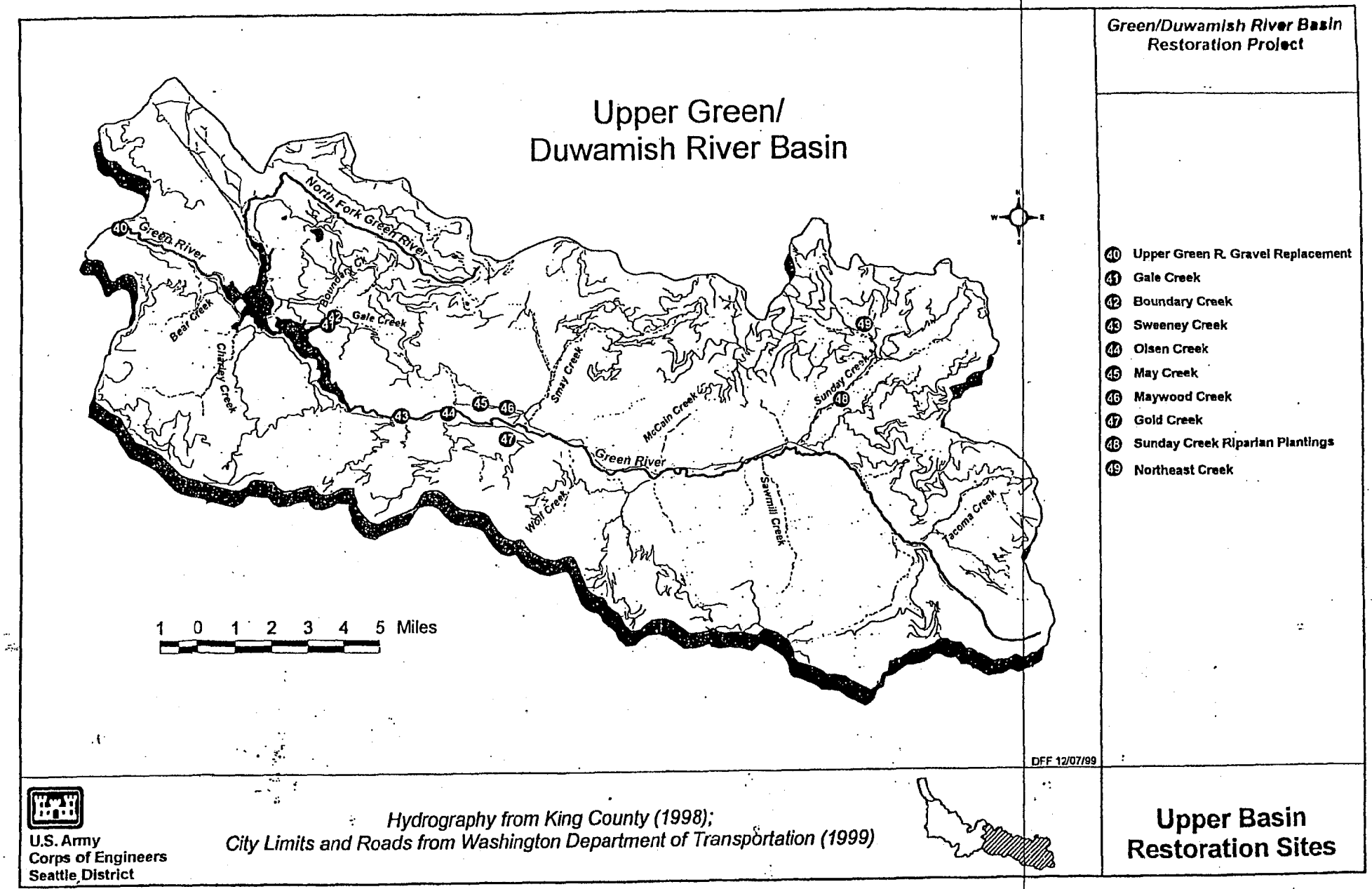

Figure 4. Upper Basin Restoration Sites (Adapted from Corps of Engineers)

Table 1. Matrix of Specific Projects and Their Respective Restoration Measures.

Project Elements	Restoration Measures						
	riparian[1]	channel[2]	lwd[3]	gravel[4]	flood plain[5]	passage[6]	estuarine[7]
1. Elliott Bay Nearshore							X
2. Site 1, Duwamish							X
3. Riverton Side Channel	X	X	X	X			
4. Codiga Farms	X	X	X				
5. Black River Marsh	X		X				
6. Gilliam Creek		X	X	X		X	
7. Lower Springbrook Creek	X	X	X				
8. Upper Springbrook Creek	X	X	X	X			
9. Mill Creek East	X		X				
10. Garrison Creek	X	X	X			X	
11. Mullen Sl., Prentice Nursery	X	X	X				
12. Mullen Slough Reach	X	X	X				
13. Mill Cr., Schuler Brothers Reach	X	X					
14. Mill Cr., Merlino Reach	X	X	X				
15. Mill Cr., Wetland 5K Reach	X	X	X				
16. Mill Cr., Goedeke Reach	X	X	X				
17. Green River Park	X	X					
18. Horsehead Bend Side Channel	X						
19. NE Auburn Creek	X		X			X	
20. Meridian Valley Creek	X	X	X				
21. Lake Meridian Outlet Relocation	X	X	X				
22. Olson Creek	X		X				
23. Riverside Estates Side Channel			X			X	
24. Mainstem Maintenance					X		
25. Porter Levee Setback		X			X		

[1] Riparian enhancements
[2] Channel relocation and reconstruction
[3] Large woody debris additions and construction of engineered log jams
[4] Gravel additions and sediment control
[5] Flood plain reconnection
[6] Fish passage improvements
[7] Estuarine habitat creation

Table 1 (Cont.). Matrix of Specific Projects and Their Respective Restoration Measures.							
Project Elements	Restoration Measures						
	riparian[8]	channel[9]	lwd[1]	gravel[1]	flood plain[12]	passage[1]	estuarine[1]
26. Kaech Levee Pond	X	X	X				
27. Ray Creek Tributary Corridor	X						
28. Hamikami Levee		X	X		X		
29. Turley Levee Setback			X		X		
30. Loans Levee Setback					X		
31. Burns Creek Restoration	X					X	
32. Middle Green River LWD			X				
33. Middle Green R. Gravel				X			
34. Flaming Geyser Landslide				X			
35. Flaming Geyser Side Channel	X	X	X				
36. Newaukum Creek	X	X	X				
37. Big Spring Creek	X	X					
38. Brunner Slough		X				X	
39. Upper Green R. Side Channel			X	X			
40. Upper Green R Gravel				X			
41. Gale Creek				X		X	
42. Boundary Creek				X		X	
43. Sweeney Creek			X			X	
44. Olson Creek			X			X	
45. May Creek			X	X		X	
46. Maywood Creek	X		X	X		X	
47. Gold Creek			X			X	
48. Sunday Creek	X		X	X		X	
49. Northeast Creek			X	X		X	
50. Programmatic Elements	X		X	X			

[8] Riparian enhancements
[9] Channel relocation and reconstruction
[10] Large woody debris additions and construction of engineered log jams
[11] Gravel additions and sediment control
[12] Flood plain reconnection
[13] Fish passage improvements
[14] Estuarine habitat creation

former alignment, the reconstruction of degraded channels to increase sinuosity, complexity and diversity. The construction of small sloughs (i.e., dendrites) to provide additional off-channel rearing habitat is also proposed. There are 20 proposed actions that involve dendrite construction, channel relocation and/or reconstruction.

Large Woody Debris and Boulder Additions

Many of the tributaries and main channel of the Green River are lacking in large woody debris, which has caused a reduction in channel complexity and instream habitat diversity and value. To address this issue, additions of large woody debris, the construction of engineered log jams, as described by Abbey (1996), and to a lesser extent, the placement of boulders, are included in thirty two of the proposed actions.

Gravel Additions and Fine Sediment Control

The construction of Howard Hanson Dam at RM 64.5 and levees at various locations downstream have interrupted the supply of gravel to the middle and lower river. As a result of the diminished sediment supply, the channel bed is becoming increasingly armored and the floodplain is becoming more isolated from the river because of its perched condition. The addition of gravel at multiple locations in the middle river is intended to replenish degraded spawning habitats and to reduce or prevent further channel downcutting and armoring. Gravel additions are also proposed in tributaries to the Green River for the purpose of increasing habitat diversity to stream segments that have been impacted by excessive inputs of sand and silt. Excessive amounts of fine sediment (silt, clay and sand) also impact salmonid spawning habitat and the production of aquatic insects that serve as an important prey resource to juvenile salmon, trout and char. A number of options for reducing the input of fine sediment from landslides are proposed, including stabilizing active landslides, rerouting the live channel away from the toe of the slide, mechanically removing sediments from the face of the slide, or combination of these elements. Thirteen of the proposed actions involve the addition of gravel or measures to reduce the input of sand and silt.

Floodplain Reconnection

Levees and training dikes limit the migration of the Green River as well as limit the hydrologic connection between the river and its floodplain. The removal or breeching of levees and dikes are proposed at five locations to improve the habitat value of the floodplain for fish and wildlife, and to restore the fluvial processes.

Fish Passage Improvements

The ability of fish to use a number of Green River tributaries and side channels is impaired or precluded by dikes, levees, perched culverts, and tide gates. Proposed fish passage improvements include breaching levees and dikes to permit access to former side channels and backwaters, replacing culverts at stream crossings with bridges or bottomless culverts, and replacing tide gates with those that are designed to allow fish passage. Fifteen projects include a fish passage improvement element.

Estuarine Habitat Restoration

More than 95 percent of the Duwamish estuary has been lost as a result of industrial, residential, navigation and other urban developments. The estuary is an very important transition zone for anadromous fish as they adjust to the increasingly saline waters on their migration to the marine

environment. Two estuarine restoration projects have been included and involve the removal of fill to create intertidal channels, mudflats, and emergent marsh habitats, or the addition of structure to increase the complexity of subtidal habitat.

BIOLOGICAL RESOURCES

All of the proposed actions are located within or adjacent to the Green and Duwamish Rivers or their tributaries. Consequently, this report will focus on the fish, wildlife and botanical resources that are expected to occur within the project's direct influence. The description of the resources within the project impact zone, however, will be more general in detail because the project schedule allowed for only a very limited amount of time to conduct our review of the project sites. As a consequence, the discussion on the effect of the proposed action on fish, wildlife, and botanical resources will be more general and qualitative, and in some cases will be based on the assumption that these resources occur within the proposed project sites, rather than on actual observations. Additional information on the Green/Duwamish River Basin's biological resources can be found in the Corps' reconnaissance report.

VEGETATION AND WILDLIFE

Lower Green River and Duwamish Estuary (River Mile 0 to11)

Most of the lower Green River is located on the valley bottom and has been heavily affected by urbanization, agriculture, flood control levees, and the development of Port and navigation facilities. Only a few acres of the former estuarine mudflat and salt marsh complex still remain. Representative vegetation includes saltgrass, seaside arrowgrass, Lyngby's sedge, pickleweed, and eelgrass. Bird species that use the Duwamish estuary include the double-crested cormorant, great blue heron, western grebe, Canada goose, mallard, white-winged scoter, bufflehead, common merganser, red-tailed hawk, herring gull, killdeer, crow and song sparrow. Mammal species include the raccoon, river otter and deer mouse.

Historically, expansive freshwater wetlands existed along the lower Green River, but now most of the wetlands have been converted to industrial and residential properties and agricultural fields. Occasionally, small patches of red alder, black cottonwood, big-leaf maple and willow occur along the river bank, which is typically confined between flood control levees. More commonly, Himalayan blackberry and various grass species are the dominate vegetation on the channel bank. Representative wildlife includes the great blue heron, Canada goose, mallard, common merganser, red-tailed hawk, violet green swallow, song sparrow, coyote, raccoon, river otter and deer mouse.

Middle Green River (River Mile 11 to 60)

This river zone occurs between 200 feet and 1000 feet in elevation, and is located entirely within the western hemlock vegetation zone. Western hemlock, western red cedar, and Douglas fir are the dominate tree species, with understory vegetation including vine maple, salal, Oregon grape and sword fern. The riparian forest is dominated by big-leaf maple, black cottonwood, red alder and western red cedar. Understory vegetation includes salmonberry, snowberry, and sword fern. Representative wildlife includes the bald eagle, Cooper's hawk, great blue heron, northern flicker, willow flycatcher, rufous sided towhee, winter wren, ruby crowned kinglet, song sparrow, black-tailed deer, raccoon, river otter, beaver, and red legged frog.

Although residential development, hobby farms, agriculture and bank stabilization have encroached on the riparian forests along the middle green river, significant blocks of riparian forests still remain.

Upper Green River

Most of the upper Green River Basin lies within the western hemlock vegetation zone, although intensive timber harvest during the last 50 years has converted much of this area to young stands of Douglas fir and western hemlock. Development, with the exception of the Howard Hanson Dam and Reservoir, the railroad and access roads, has had little impact on the riparian forest of the upper basin. Steep terrain and frequent channel migration probably limit the establishment and size of the riparian forest upstream of Howard Hanson Dam. The riparian forest is dominated by red alder, black cottonwood and willow, and also includes such understory species as salmonberry and sword fern. Representative wildlife includes the black bear, mountain lion, elk, raccoon, red-tailed hawk, raven, willow flycatcher, and red-legged frog.

FISHERY RESOURCES

At least 47 species of fish are known to use the Green/Duwamish River, based on the fish surveys conducted by Masuda, et al. (1968), Meyer et al. (1980), USFS (1996), Warner and Fritz (1995), Wunderlich and Toal (1992). They include anadromous, freshwater, estuarine and marine species. See appendix D for the list of fish species known or expected to occur in the Green/Duwamish River Basin and Estuary.

Anadromous fish species known or expected to occur in the system include chinook salmon, coho salmon, chum salmon, pink salmon, steelhead and sea-run cutthroat trout and sea-run char. Naturally spawning populations returning to the Green/Duwamish system have all declined dramatically in response to the loss of habitat and/or overfishing. Major losses of habitat occurred with the filling of the Duwamish Estuary, channelization, levee construction, timber harvest, and the construction of the Tacoma Diversion Dam. Presently, significant numbers of chinook, coho and chum salmon and steelhead trout are released from State and Tribal hatcheries.

Fall chinook salmon are managed for natural production, with an escapement goal of 5,800 fish. Spawner escapement has averaged about 7,600 fish and has ranged between 5,000 and 10,500 fish (Warner et al. 1995). Significant numbers of hatchery fish are released annually from the WDFW Green River Hatchery (3.2 million young-of-the-year and 300,000 yearlings) and the Tribe's Keta Creek Hatchery (up to 2 million young-of-the-year). The hatchery component is believed to equal or exceed the naturally produced component of the total run (Hage, personal communication). In recent years, between 500,000 and 1.8 million chinook salmon have been planted annually upstream of HHD (Hickey 1996). Spring chinook salmon occur now in only very low numbers.

Green River coho salmon are essentially managed as a hatchery stock, even though there is a natural escapement goal of 8,700 fish. As a consequence of the higher harvest rate, the natural escapement goal is rarely met. The run size has ranged between 3,000 and 23,000 fish and is maintained primarily through hatchery releases (Warner et al. 1995). The Tribe's Keta Creek Hatchery produces about 600,000 yearling and up to 2 million young-of-the-year coho, annually. About 500,000 yearlings are also produced at the WDFW Green River Hatchery.

Green River chum salmon runs are supported by both natural and hatchery production. The combined run size has averaged a few thousand fish, which is markedly smaller than the run size

of over 11,000 estimated by Williams et al. (1975) from the mid-70's, or the 12,750 annual escapement estimate for the 1938 to 1942 period estimated by Fuerstenberg et al. (1996). In the last few years, however, chum salmon escapement surveys conducted by the Muckleshoot Indian Tribe have placed the run at over 10,000 fish, annually. A minimum of 500,000 chum salmon fry are release annually from the Keta Creek Hatchery.

Pink salmon historically used the system but have dropped to such low numbers that they are now functionally extinct from an ecological perspective. Pink salmon have not returned in large numbers since the 1930's (Warner et al. 1995).

The Green River supports both a summer and winter run of steelhead. The winter population is larger and is composed of both a hatchery and a wild stock. About 220,000 hatchery smolts, originally derived from Chambers Creek stock, are released annually from the WDFW's Palmer Hatchery. In addition, up to 90,000 smolts are produced at the Tribe's Keta Creek Hatchery. In recent years, between 55,000 and 84,000 steelhead have been planted upstream of HHD (Hickey 1996). The wild run is considered healthy, and because of its different spawning timing, does not interbreed with the hatchery stock to a significant degree. The escapement goal for the wild run is 2,000 fish. Between 1975 and 1985, the total run size of wild and hatchery stocks, combined, averaged 11,000 annually (Grette and Salo 1986). Between 1988 and 1996, the total run size declined to an average of about 4,700 fish (Cropp 1996). The summer run originated from plants of Skamania steelhead smolts beginning in 1965, and is maintained by the annual release of about 80,000 hatchery smolts. The summer run catch (sport and tribal) has ranged from a low of 396 in 1991 to a high of 3,461 in 1981 (Cropp 1996).

Information is very limited on abundance and distribution of sea-run cutthroat trout, Dolly Varden and bull trout. Historically, the Green River is believed to have supported large numbers of each of these species (Grette and Salo 1986) but now supports remnant populations at best.

The use of the Duwamish-Green River systems by marine and estuarine fish species occurs primarily within the lower 10 miles, although some species like starry flounder that have a tolerance for freshwater, may use habitats upstream of the saltwater wedge. The saltwater wedge can extend upstream to rivermile 10 during low runoff and high tides (Santos and Stoner 1972 in Corps 1995). More than twenty estuarine and marine species occur in the lower river, including surf smelt, Pacific herring, pile perch, Pacific tomcod, and starry flounder.

The Green River and its tributaries upstream of HHD support resident populations of rainbow trout, cutthroat trout, mountain whitefish, and several species of sculpins. Brook trout are also known to occur in Page Mill Pond and Page Mill Creek. Since 1982, hatchery chinook and coho salmon, and steelhead trout juveniles have been frequently planted upstream of Howard Hanson Dam. Wild or naturally produced adult steelhead, numbering between 20 and 133, have been collected at the fish trap at Tacoma's diversion dam since 1992, and released upstream of Howard Hanson Dam.

FEDERALLY LISTED SPECIES

The federally listed species that are known to or may occur within the vicinity of the proposed projects include the gray wolf, bald eagle, marbled murrelet, northern spotted owl, bull trout, and chinook salmon. The Corps is preparing a biological assessment that discusses the occurrence of listed species, their use of the project area and the expected effect of the project on them.

WITHOUT THE PROJECT CONDITIONS

In the absence of the proposed project, the Duwamish and Green Rivers, tributaries, associated riparian forests and floodplains would not benefit from the improvements being proposed under the Corps of Engineers' Water Resources Development Act authority. Although other habitat restoration efforts are being pursued by the Corps and other entities at the present (through other authorities and actions), and will likely continue into the future, it is unlikely that an alternative funding source would be found to implement the large number and broad scope of projects being proposed under this authority. Furthermore, additional urbanization and development could preclude the implementation of a number of the restoration proposals even if an alternative funding source was available in the future.

Without the project, 6 acres of estuarine and subtidal habitats would not be created , restored or enhanced and therefore, there would be no increase in the amount of foraging habitat for juvenile salmon and steelhead while they acclimate to the increasing salinity of the marine environment. Nor would a wide variety of estuarine and marine fish and wildlife have the opportunity to utilize the highly productive intertidal habitat.

In the absence of gravel additions to the Green River, channel armoring will continue to progress downstream, resulting in the further loss of anadromous fish spawning habitat. Degraded spawning habitat would not be replenished with new gravels. The downcutting of the Green River into its channel would also continue, leaving its floodplain in an increasingly perched conditions and less available to support its functions and values, e.g., cycling of nutrients, maintenance of associated wetlands, etc.

Several creek segments that presently resemble a roadside ditch or lack a defined channel will continue to offer little value to fish and wildlife, mainly because they provide little channel complexity or habitat diversity.

Riparian plantings and/or the acquisition of riparian buffers at 28 locations, totaling more than 360 acres along the streambank would not occur, leaving many tributaries with unshaded banks, lower detrital and insect production, higher summertime water temperatures, and little opportunity for the future recruitment of large woody debris to provide channel complexity and habitat diversity. Many of the proposed project sites would continue to support non-native vegetation (e.g., Scotch broom, reed canary grass, Himalayan blackberry, and Japanese knotweed) that provide little value to fish and wildlife species.

Tributary and mainstem instream habitats would not be enhanced by the placement of large woody debris or the construction of engineered log jams. The current lack of large trees, especially conifers, within the riparian zone indicates that the natural recruitment of sufficient large woody debris to the channel to restore channel complexity and diversity is not possible. Therefore, in the absence of large woody debris supplementation, habitat diversity and value will continue to decline.

At five locations, the Green River would remain isolated from its floodplain by dikes and levees, precluding the formation of new side channels and backwater areas which are important rearing habitats for salmon and steelhead.

Tributary and side channel habitat at fourteen locations would continue to be inaccessible to fish due to poorly designed culverts, water control structures and training dikes.

WITH THE PROJECT CONDITIONS

Implementation of the proposed project would result in improvements in habitat and river processes that were just described as not being implemented in the "without the project" discussion. Specifically, the implementation of the project would result in the following: (1) eight acres of estuarine restoration in the Duwamish River and two acres of subtidal enhancement in Elliott Bay; (2) the revegetation of stream banks and/or the acquisition of riparian buffers at twenty eight sites, totaling more than 365 acres; (3) the reconnection of the floodplain at five locations in the middle Green River, (4) improvements to channel complexity and diversity at thirty seven sites, totaling over 160 acres; (5) the rehabilitation of spawning habitat and restoration of sediment transport processes; and (6) passage improvements at fourteen tributaries.

DISCUSSION

The implementation of all fifty habitat restoration proposals represents an important step toward reducing the adverse effects of development along the Green/Duwamish River corridor, and restoring habitat for salmon, steelhead, other fish species and wildlife. The restoration measures proposed under the Corps' Water Resources Development Act authority are not sufficient alone to reverse the loss of habitat and the interruption to the natural riverine processes, but are a critical component of the larger restoration efforts being undertaken in the basin. Other restoration actions in planning or underway include the Howard Hanson Additional Water Storage Project, the draft Tacoma Water Habitat Conservation Plan (HCP), Department of Natural Resources HCP, Muckleshoot/Tacoma Public Utilities Settlement Agreement for Pipeline 5, and several projects funded under the Corps' Section 1135 authority.

The fifty proposed projects address to varying degrees most of the limiting factors that were identified during the Green/Duwamish River Basin General Investigation, and listed earlier in this report. Of the limiting factors, we believe the proposed actions will have the greatest effect on removing barriers to fish passage, improving channel complexity and in-channel structure, addressing sediment loads and transport problems, and to a lesser extent, on restoring habitat in the lower Green/Duwamish Estuary, reconnecting the mainstem with its floodplain, and reducing habitat fragmentation.

Essentially all of the proposed actions would beneficially affect habitats and resources of special concern to the USFWS, including riparian forests, the estuary, anadromous fish, and federally listed species.

Riparian Forest

The Service strongly supports protection and restoration of riparian forests, as well as their associated wetlands, because of the high value of this habitat to many species of fish and wildlife, the important processes and functions they provide, and because only a small amount of this habitat still remains in the Green/Duwamish River Basin. Riparian forests provide important breeding and foraging habitat, as well as a migration corridor for many species of wildlife.

The riparian zone functions both as a producer and a temporary trap for the recycling of nutrients. The decomposition of forest litter produced onsite and the trapping of leaves, detritus and other organic material from upstream sources during floods makes the riparian zone highly productive and of great importance to wildlife. As a consequence of losing much of the riparian forests within the basin to agricultural and industrial development, and the separation from the river by levees, significantly less nutrients are produced, intercepted from upstream sources, and made

available in usable forms for both the terrestrial and aquatic food chains.

The riparian zone also benefits fish and other aquatic resources by reducing fluctuation in water temperature through solar shading, by providing a refuge from high water velocities during flood events, by increasing flows during the summer low flow period through the gradual release of flood waters that have percolated into the floodplain, and by its contribution of large woody debris. Besides the structural value of large woody debris as fish and wildlife habitat, it is also an important component in channel formation and the maintenance of channel complexity and diversity. Presently, large woody debris occurs in such low abundance in the Green/Duwamish system that it has little effect on the channel formation processes (Fuerstenberg et. al. 1996). The construction of levees and the removal of much of the riparian forests within the basin has greatly impaired all of the above processes and values.

Green/Duwamish Estuary

Severe losses of estuarine wetlands and intertidal habitats have occurred due to the development of industrial and urban areas and port facilities. Presently, less than 3 percent (100 acres of the pre-settlement estimate of 3950 acres) of the tidally influenced flats, marsh and swamp remain (Blomberg et al. 1987). The value of estuarine habitat to fish and wildlife is well documented in the literature, so the following discussion will focus on our main reason for supporting restoration efforts in the Duwamish River estuary. Estuarine wetlands and their associated intertidal zone provide crucial habitat for outmigrating juvenile anadromous fish while they physiologically adapt to the higher salinity of the marine environment. During this acclimation period, these habitats provide rich foraging areas and a refuge from predators occurring in the deeper water of the channel.

Anadromous Fish

Historically, the Green/Duwamish River supported significant runs of chinook, coho, chum and pink salmon, and steelhead trout, as well as Dolly Varden and/or bull trout and sea-run cutthroat trout. Populations of all of these species have declined dramatically in response to habitat loss or degradation, and over-fishing. Salmon and steelhead escapements to the Green River declined by 60 percent or more between the 1938 to 1942 and 1987 to 1991 periods (Fuerstenberg et al. 1996).

Besides their importance to the commercial and recreational fisheries, anadromous fish provide a portion of the food requirement of a variety of wildlife and have a significant role in the recycling of nutrients in the ecosystem. Cedarholm et al. (1989) determined that at least 22 species of wildlife, including black bear, mink, river otter, and bald eagle, feed on salmon carcasses. Bilby et al. (1996) found that coho salmon carcasses provided a significant percentage of the nitrogen in riparian vegetation adjacent to salmon-bearing streams, and significant percentages of both carbon and nitrogen in the streams' aquatic macroinvertebrates.

The proposed projects would provide major benefits to anadromous fish by improving spawning and rearing habitats, as well as addressing factors that impact their migration, e.g., barriers and a lack of channel complexity and instream structure.

Federally Listed Species

Habitat loss within the basin has caused significant impacts to a number of federally listed species including chinook salmon, bull trout, bald eagle, marbled murrelet, northern spotted owl, and gray wolf. Of these, chinook salmon, bull trout, bald eagle, marbled murrelet are species

that would benefit the most from the proposed project. Chinook salmon and bull trout would benefit from the improvements in habitat and restored fluvial processes previously discussed in this report. Bald eagles would benefit from improvements to their prey resources, e.g., salmon and waterfowl, and in the long term from the additional perching and nest trees that result from the riparian enhancements. Marbled murrelets are likely to benefit from the improvements in estuarine productivity that increase forage fish abundance, e.g., herring and sandlance.

Although the proposed projects are expected to benefit federally listed species in the long term, project construction could adversely affect some of these species, e.g., chinook salmon, bull trout, and bald eagle in the short term, depending on the timing and construction methods used. The Corps will be addressing the potential impact of the proposed actions on listed species in their programmatic biological evaluation. It is our expectation that the Corps will meet with the USFWS and NMFS to discuss the final design refinements for of each of the proposed projects. Based on these details, we would determine if the projects still fall within the scope of the programmatic biological assessment and coverage under our Section 7 consultation.

Other Issues and Concerns

Although we support the restoration objectives of the proposed project, it is necessary to mention that important details (i.e., hydrology, elevations, alignment, effect on adjacent lands, etc.) on many of the 50 specific projects have yet to be developed and will not be available until the advanced engineering and design phase. Consequently, we can only provide our conditional support for the proposed project and its individual restoration elements at this time. We may be unable to maintain our support for a few of the proposals because of unacceptable natural resource tradeoffs or risks that may come to light during the design phase. For example, the goal of optimizing fish use in a Middle Green River side channel may conflict with our wetland protection objectives if significant dredging is involved, e.g., Brunner Slough. Other concerns include the potential effect of ground water tapping on adjacent wetlands, the placement of gravel or large woody debris in side channels that may increase the sediment transport rate in the mainstem channel, etc. We believe that most of the potential conflicts can be reduced by our continued participation during the final design phase.

The prioritization and implementation of the individual projects should be updated to address important changes in project design, location, feasibility or other assumptions that may occur as the project details are refined. For example, re-prioritization would be desirable to address changes in project cost, expected effectiveness, and risk from competing uses that may jeopardize the opportunity for implementation at a later date. In addition, flexibility should be added to allow for the addition of new projects to replace those on the current list that cannot be implemented because of landownership, feasibility or for other reasons.

We also have some current reservations about some of the proposals that involve restoring some of the very highly degraded sites (e.g., Gilliam Creek) because of concerns about high cost, risk, limited biological return, and reliance on improved future conditions in the upper watershed. Favorable information on water quality and on measures or zoning to protect the upper watershed would help reduce our concern about the cost effectiveness of these projects. In addition, we recognize that there are intangible benefits from public education and awareness.

We strongly support the inclusion of monitoring (both compliance and effectiveness) and adaptive management as essential components of the project. Habitat restoration, unlike the construction of roads or dams, should be viewed as a dynamic process. The desired habitat, along with its biological community, rarely occurs at the time of project construction but develops over time in response to physical, hydrologic and biological interactions.

Consequently, the need for project maintenance or modifications should be expected and included as part of the project design. We believe the success of the project can be greatly improved by developing a detailed monitoring plan and using the monitoring results to adaptively manage both the normal maintenance of the sites and the implementation of remedial actions. This approach is recommended by the Corps (1996) in its report, "Planning and evaluating restoration of aquatic habitats from and ecological perspective." In that document the Corps states, "Successful restoration of ecosystems is uncertain, and management of the restored system requires a continuous source of information. A monitoring program reduces uncertainty and forms the cornerstone of the assessment of the progress of the system." With regard to the role of adaptive management, the Corps states, " In a restoration project, the active adaptive method may provide the most meaningful information for making decisions that will ensure the ultimate success of the project and provide meaningful data that will help in the design of future projects."

CONCLUSIONS

We believe the proposed project would benefit many species of fish and wildlife, including a number of federally listed species, and would begin to address a number of the ecological processes that have been impacted by development in and along the floodplain.. Although the proposed project by itself cannot be expected to reverse the adverse effects of development, we consider it the main component of the larger effort to restore anadromous fish and other natural resources within the Green/Duwamish River Basin.

We strongly support the approach of the proposed restoration project, and give our conditional support on the individual restoration proposals and programmatic elements, pending the satisfactory resolution of any remaining fish and wildlife resource issues during the final design phase. It is our expectation and understanding that we will have further opportunities to review and comment on the detailed plans as they are developed.

RECOMMENDATIONS

1. The project sponsors should follow through with their commitment to develop and include as a part of the project a detailed monitoring plan that clearly identifies the objectives and goals to achieve for each of the individual restoration projects and the use of adaptive management in the maintenance and implementation of corrective actions. This plan should contain both compliance and effectiveness monitoring elements for the purpose of verifying that each of the projects was constructed as designed and that the biological goals are being achieved. In addition, the monitoring plan should define the adaptive management approach that would be followed, including time lines, measurable goals, etc. We would like to participate in the development of the monitoring and adaptive management plan.

2. The project sponsors should provide a commitment to monitor the projects for a minimum of ten years, with the provision to adjust the monitoring period to reflect the degree of project uncertainty. The actual monitoring period for some project elements could be shortened if the goal is being met and the project site has reached a level of stability, i.e., dynamic equilibrium, that indicates the goal will continue to be met. For example, the fish passage improvement projects would likely require less than ten years of monitoring. For some other projects, however, the monitoring period should be longer than ten years because of the higher level of uncertainty and the more dynamic site conditions. Examples of projects that are likely to require more than ten years to determine their long term effectiveness include gravel and large woody debris augmentations and the construction of engineered log jams.

3. The prioritization of the pending projects should be updated annually to reflect new or updated information, including the effectiveness monitoring results, additional risks to the project site from competing land use interests, changes in upper watershed influences, design constraints or necessary modifications due to landownership, hydrology, soils, hazardous waste, and updated cost estimates. In addition, a mechanism should be included to allow for the replacement of project elements that are dropped because of landownership, feasibility or other reasons.

4. Annual meetings should be held during the ten year project implementation period to facilitate discussions on the monitoring results and on the projects that are scheduled for construction within the next 12 months. These meetings would be useful in updating the project reviewers on the project changes and refinements that have occurred.

5. Threatened and endangered species issues for specific project proposals should be addressed in time to avoid delays in project construction.

6. The USFWS should be funded in the next project phase so that we can continue to participate in the review of the updated project plans and to help resolve any remaining fish and wildlife issues on a timely basis.

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Appendix A. Common and scientific names for the plant species mentioned in this report that occurring within the vicinity of the proposed project.

Common Name	Scientific Name
Big-leaf maple	*Acer macrophyllum*
Black cottonwood	*Populus trichocarpa*
Douglas fir	*Pseudotsuga menziesii*
Eelgrass	*Zostera marina*
English ivy	*Hedera helix*
Himalayan blackberry	*Rubus discolor*
Japanese knotweed	*Polygonum cuspidatum*
Lyngby's sedge	*Carex lyngbyei*
Oregon grape	*Berberis nervosa*
Pickleweed	*Salicornia virginica*
Red Alder	*Alnus rubra*
Red-osier dogwood	*Cornus stolonifera*
Reed canary grass	*Phalaris arundinacea*
Salmonberry	*Rubus spectabilis*
Saltgrass	*Distichlis spicata*
Scotch broom	*Cytisus scoparius*
Seaside arrowgrass	*Triglochin maritimum*
Sitka spruce	*Picea sitchensis*
Snowberry	*Symphoricarpus albis*
Sword fern	*Polystichum munitum*
Thimbleberry	*Rubus parviflorus*
Vine maple	*Acer circinatum*
Western hemlock	*Tsuga heterophylla*
Western red cedar	*Thuja plicata*
Willow	*Salix* sp.

Appendix B. Common and scientific names of reptiles and amphibians mentioned in this report that are known or expected to occur within the vicinity of the proposed project.

Common Name	Scientific Name
Common garter snake	*Thamnophis sirtalis*
Ensatina	*Ensatina eschscholtzii*
Northern alligator lizard	*Elgaria coerulea*
Pacific chorus frog	*Pseudacris regilla*
Red-legged frog	*Rana aurora*

Appendix C. Common and scientific names of bird species mentioned in this report that are known or expected to occur within the vicinity of the proposed project.

Common Name	Scientific Name
American crow	*Corvus brachynchos*
Bald eagle	*Haliaeetus leucocephalus*
Black-capped chickadee	*Parus atricapillus*
Bufflehead	*Bucephala albeola*
Canada goose	*Branta canadensis*
Common merganser	*Mergus merganser*
Cooper's hawk	*Accipiter cooperii*
Double-crested cormorant	*Phalacrocorax auritus*
Great blue heron	*Ardea herodias*
Herring gull	*Larus argentatus*
Killdeer	*Charadrius vociferus*
Mallard	*Anas platyrhynchos*
Marbled murrelet	*Brachyramphus marmoratus marmoratus*
Northern flicker	*Colaptes auratus*
Osprey	*Pandion haliaetus*
Pileated woodpecker	*Dryocopus pileatus*
Common raven	*Corvus corax*
Rufous-sided towhee	*Pipilo erythropthalmus*
Red-tailed hawk	*Buteo jamaicensis*
Ruby-crowned kinglet	*Regulus calendula*
Song sparrow	*Melospiza melodia*
Violet-green swallow	*Tachycineta thalassina*
Western grebe	*Aechmophorus occidentalis*
White-winged scoter	*Melanitta fusca*
Willow flycatcher	*Empidonax traillii*
Winter wren	*Troglodytes troglodytes*

Appendix D. Common and scientific names of fish species mentioned in this report that are known or expected to occur in the Green/ Duwamish River

Common Name	Scientific Name	Common Name	Scientific Name
Chum salmon	*Oncorhynchus keta*	Northern sculpin	*Icelinus borealis*
Coho salmon	*O. kisutch*	Sharpnose sculpin	*Clinocottus acuticeps*
Chinook salmon	*O. tshawytscha*	Surf smelt	*Hypomesus pretiousus*
Pink salmon	*O. gorbuscha*	Pacific herring	*Clupea harengus pallasi*
Sockeye salmon	*O. nerka*	Shiner perch	*Cymatogaster aggregata*
Steelhead trout	*O. mykiss*	Striped seaperch	*Embiotoca lateralis*
Cutthroat trout	*O. clarki*	Pile perch	*Rhacochilus vacca*
Dolly Varden	*Salvelinus malma*	Longfin smelt	*Spirinchus thaleichthys*
Bull trout	*S. confluentus*	Threespine stickleback	*Gasterosteus aculeatus*
Brook trout	*S. fontinalis*	Pacific snake blenny	*Lumpenus sagitta*
Mountain whitefish	*Prosopium williamsoni*	Crescent gunnel	*Pholis laeta*
Largescale sucker	*Catastomus macrocheilus*	Saddleback gunnel	*P. ornata*
Longnose sucker	*Catastomus catastomus*	Penpoint gunnel	*Apodichthys flavidus*
Pacific lamprey	*Lampetra tridentata*	Bay goby	*Lepidogobius lepidus*
Western brook lamprey	*Lampetra richardsoni*	Bay pipefish	*Syngnathus griseolineatus*
River lamprey	*Lampetra ayresi*	Walleye pollock	*Theragra chalcogrammus*
Longnose dace	*Rhinichthys cataractae*	Pacific tomcod	*Microgadus proximus*
Speckled dace	*R. osculus*	Starry flounder	*Platichthys stellatus*
Northern squawfish	*Ptychocheilus oregonensis*	English sole	*Parophrys vetulus*
Prickly sculpin	*Cottus asper*	Butter sole	*Isopsetta isolepis*
Torrent sculpin	*Cottus rhotheus*	Hybrid sole	*Inopsetts ischyra*
Riffle sculpin	*Cottus gulosus*	Sand sole	*Psettichthys*
Pacific staghorn sculpin	*Leptocottus armatus*	Pacific sandlance	*Ammodytes hexapterus*
Buffalo sculpin	*Enophrys bison*		

Appendix E. Common and scientific names of mammal species mentioned in this report that are known or expected to occur within the vicinity of the proposed project.

Common Name	**Scientific Name**
Beaver	*Castor canadensis*
Black bear	*Ursus americanus*
Black-tailed deer	*Odocoileus hemionus*
Deer mouse	*Peromyscus maniculatus*
Mountain lion	*Felis concolor*
Raccoon	*Procyon lotor*
River otter	*Lutra canadensis*
Roosevelt elk	*Cervus canadensis roosevelti*

Appendix F. Description of the Individual Restoration Projects

Elliott Bay Nearshore. The purpose of this project is to provide additional primary productivity in the nearshore area and to provide a more complex environment for juvenile rockfish and salmonids in the nearshore subtidal zone. The project involves the placement of angular rock (18 inches in diameter) along the minus thirty foot contour and shell hash and pea gravel at the minus two foot contour.

Site 1, Duwamish. The goal of the project is to improve intertidal and wetland habitat for juvenile salmonids. The project would entail excavating fill and native soils to a depth of 2 feet MLLW at the inlet to 12 feet at the upper edge of the marsh to create off-channel, emergent marsh and intertidal habitats. The project would also include adding riparian and emergent vegetation and LWD to create higher quality intertidal habitat.

Riverton Side Channel. The goal of this project is to provide summer rearing, winter rearing, and flood refuge habitat for juvenile salmonids in a newly constructed side-channel to the Green River. A backwater slough would be constructed to provide winter rearing and flood refuge habitat. Construction will include establishment of LWD and spawning gravel in the new channel. Loss of existing wood will be minimized. Excavated material would be removed from the site. The existing tide gate would be replaced with a passable gate. Invasive plants will be removed and replanted with native trees and shrubs.

Codiga Fams. The purpose of this project is to provide off- channel refugia for juvenile salmonids when flows in the Green River mainstem are high. The project would create off-channel habitat through excavation of a backwater channel. Riparian and wetland plantings would be included. Unwanted vegetation would be removed prior to planting. Pool habitat would be created through excavation and LWD placement. LWD would be placed in front of excavated pools to add stream shade and structure. Large rocks would be placed to break up the flow within the backwater channel.

Black River Marsh. The project goal is to create salmonid rearing and storm refuge habitat. The restoration activities include riparian and wetland plantings, and LWD placement. The riparian buffer would be planted from the railroad bridge to the confluence with the Green River. Wetland species would be planted to 12-foot elevation.

Gilliam Creek. The goal is to provide fish passage, improve coho and cutthroat rearing habitat, and enhance spawning habitat. The project would improve fish passage by adding a tunnel to the existing culvert under the levee. The existing gate would be replaced with a passable Waterman gate. Rearing habitat would be improved by pulling back the north bank as far as space (I-405 right-of-way) permits. LWD wads would be placed. Sinuosity may be added if settling velocities permit. Spawning habitat would be improved by adding one to three gravel pads in the potential spawning reach.

Lower Springbrook Creek. The project goal is to create rearing and storm refuge habitat for salmonids. The project includes two-stage rechanneling, riparian planting, LWD placement, and dendrite and hummock construction. The reach between SW 16th Street and SW 23rd Street would be rechanneled, as would the west side of the reach between SW 34th and SW 40th. Riparian plantings would take place within a 60-foot buffer on the east side and a 30-foot buffer on the west side of the channel. Unwanted vegetation would be removed prior to planting. Pool habitat would be created through excavation and LWD placement. Dendrites would be created and excavated material used to form hummocks to provide increased riparian topography.

Upper Springbrook Creek. The project goal is to create spawning, rearing and storm refuge habitat for salmonids. The project includes meandering the channel, placement of spawning gravel, sediment trap installation, placement of LWD, and riparian planting. The stream would be shifted to the north and gently meandered, maintaining one-stage stream configuration. Spawning gravel would be placed in the streambed. A sediment trap would be installed at the north end of the reach on one side of the channel, with riparian plantings on the opposite side. A 100-foot corridor of riparian plantings would occur along existing and proposed channels. Approximately five pools with LWD would be placed.

Mill Creek East. The purpose of the project is to create spawning, rearing and refuge habitat. The project involves the excavation of excess sediments and the construction of a new low flow channel. Riparian vegetation would be planted after removing non-native, invasive plant species.. Plantings would include a combination of native shrubs, conifers, and deciduous trees. LWD would be placed within the stream channel to provide in-stream cover and habitat complexity.

Garrison Creek. The project goals are to create spawning, rearing and refuge habitat, and to control sediment from the landslide. The proposed action includes the removal of excess sediments and the construction of a new low flow channel. In addition, the existing culvert would be replaced with a three-sided box culvert to allow fish passage. Riparian vegetation would be planted after removing non-native, invasive plant species. Plantings would take place within the landslide area to minimize sediment delivery. Plantings would include a combination of native shrubs, conifers, and deciduous trees. LWD would be placed within the stream channel to provide instream cover and habitat complexity.

Mullen Slough, Prentice Nursery Reach. The goal is to create salmonid rearing and storm refuge habitat. The proposed action would fill the channel from its confluence with the Green River to about 500 feet upstream, creating a steady 2 percent gradient. The channel would be cleared of debris and blackberry bushes and the riparian zone would be planted with trees and shrubs to provide shade and bank stability. LWD would be placed in front of excavated pools to add stream shade and structure. Two dendrites would be constructed as additional refuge habitat. They would be 4 feet in width at the main channel and meander along the natural slope, narrowing gradually and ending at ground elevation. Hummocks would be formed with cut material from the dendrite construction.

Mullen Slough Reach. The project goal is to create salmonid rearing and storm refuge habitat. The project actions include channel meandering, LWD placement, and riparian plantings. The channel would be gently meandered from 277th Street to the beginning of the tree canopy. LWD pools would be created approximately every 50 feet. Riparian vegetation would be planted from 277th Street to the beginning of the tree canopy. Removal of reed canary grass, blackberry, and purple loosestrife would occur within a 100-foot buffer of the channel prior to planting. Plantings would include a combination of native shrubs, conifers, and deciduous trees.

Mill Creek, Schuler Brothers Reach. The project goals are to create salmonid rearing and storm refuge habitat and to increase the high flow capacity of the channel reach. The project includes channelization, riparian planting, and dendrite construction. A two-stage rechanneling would create a meandering narrow segment bypassing the existing pond just south of South 277th Street. A two-stage channel would be created in the remainder of the reach to provide additional conveyance during high flows. Existing channel meandering would be left as is. Riparian vegetation would be planted (and unwanted vegetation removed) along existing and proposed channels. LWD pools would be created. Dendrites would be created and the excavated material would be used to form hummocks to provide increased riparian topography.

Mill Creek, Merlino Reach. The goal is to create salmonid rearing and storm refuge habitat. The project would include deepening, widening, and meandering of the channel, riparian planting, woody debris pool placement, and creation of dendrites and hummocks. A one-stage channel would be constructed south of 37th Street NW and a two-stage channel north of 37th Street NW. The existing stream would be deepened, widened, and meandered. Riparian planting of trees and shrubs would occur adjacent to any newly constructed channel. Unwanted vegetation would be removed prior to planting. Pools would be excavated and LWD placed every 50 feet. Dendrites would be constructed and excavated material used to create hummocks within the riparian buffer.

Mill Creek, Wetland 5K Reach. The project goal is to create salmonid rearing and storm refuge habitat. A straight, shallow stream channel and a lack of riparian vegetation hinder the Wetland 5K Reach from functioning effectively as rearing habitat and storm refuge. The channel would be gently meandered, maintaining a one-stage stream configuration. The riparian buffer would be planted according to the King County Flood Control Plan. Pool habitat would be created through excavation and LWD placement. Dendrites would be created and excavated material used to form hummocks to provide increased riparian topography.

Mill Creek, Goedeke Reach. The project purpose is to create rearing and storm refuge habitat and eliminate fish stranding in the north end pond. The existing channel is straight and shallow and lacks riparian vegetation. A disconnected pond at the north end of the site is a likely location for fish stranding. The project would widen the existing 5- to 6-foot channel to 8 to 10 feet. The channel would be deepened and meandered. The pond would be deepened to the water table (about 3 feet). A narrow connection would be excavated while minimizing riparian destruction. An additional 2-acre rearing and storm refuge pond would be constructed. Riparian plantings would take place within a 200-foot buffer of an 800-foot-long corridor and along the newly constructed channel. Unwanted vegetation would be removed prior to planting. Pool habitat would be created through excavation and LWD placement. Dendrites would be created and excavated material used to form hummocks to provide increased riparian topography.

Green River Park. The goal is to create off-channel high-flow refugia from the Green River mainstem. The project would create off-channel habitat through excavation of an off-channel slough. The bottom of the slough would be set at mean winter flow elevation. The slough would connect to the mainstem with a wide mouth to avoid sedimentation and make it easy for fish to find during high flows. LWD would be placed in the channel. Riparian areas would be planted.

Horsehead Bend Side Channel. The goal is to provide winter rearing and flood refuge habitat for salmonids. A channel would be excavated in the narrow peninsula on the south side of Horsehead Bend (on the inside of the bend). The channel, which would connect with the river on the downstream end, but not the upstream end, would be a backwater slough providing winter rearing and flood refuge habitat. A specific location for the channel has not been determined.

NE Auburn Creek. The goal is to provide adult and juvenile passage, winter refugia, and summer rearing habitat in NE Auburn Creek. A large tide gate currently blocks passage for fish into Auburn Creek at its confluence with the Green River. The creek currently has approximately 2,000 feet of cottonwood riparian canopy upstream from the tide gate. Beyond this, the creek turns into a ditch with little or no riparian vegetation other than blackberry. The project would remove the existing tide gate and install a passable culvert to allow fish passage into the creek. LWD would be added to the existing channel and riparian vegetation would be rehabilitated where it is currently lacking.

Meridian Valley Creek. The goal is to provide fish passage, improve instream habitat, and to provide a hydraulic connection between Soos Creek and existing wetlands. The project would

improve fish passage by abandoning the flume and constructing a new channel from SE 256th Street to Soos Creek. LWD would be placed and riparian vegetation would be planted.

Lake Meridian Outlet Relocation. The project goal is to improve instream habitat and anadromous fish passage between Soos Creek and Lake Meridian. The project would construct a channel between Soos Creek and Lake Meridian. Construction would minimize the loss of existing wood and add LWD to the constructed channel. Excavated material would be removed from the site. Vegetation would be planted along the newly constructed channel.

Olson Creek. The project goal is to provide summer rearing habitat for salmonids by enhancing tributary habitat. The proposed project would restore 1,500 feet of tributary channel habitat by excavating excessive quantities of material from the channel. The project would remove excess gravel load, install LWD, plant the riparian zone, and create a two-stage channel for low flow transport. Riparian plantings would take place within a 50-foot buffer on both sides of the channel. Unwanted vegetation would be removed prior to planting. LWD would be added to the existing channel. Coir fabric (similar to jute) would prevent erosion of the disturbed soil.

Riverside Estates Side Channel. The project purpose is to provide summer rearing habitat and winter refugia. The proposed project would re-establish off-channel habitat through construction of a side channel slough. The channel would be excavated to groundwater elevation at summer low flow. The existing tide gate would be replaced with a passable gate. Construction will include establishment of LWD in the new channel. Loss of existing wood will be minimized. Excavated material will be removed from the site. The proposed action will not increase flood elevations.

Mainstem Maintenance. The project goals are to restore the natural meandering process of the river and to create salmonid rearing and refuge habitat. The proposed action involves setting back a levee to the edge of its former meander bend, removing an access road that crosses the meander bend, and excavating a downstream connection to the river. This would allow the river to reoccupy the meander bend. New bends would also develop downstream in response to flow deflection in the first bend.

Porter Levee Setback. The goal of this project is to reconnect the river with about 45 acres of its flood plain. The project involves the removal of an existing training levee to provide more room for the river to meander, the placement of large woody debris and the planting of native riparian vegetation. To protect adjacent lands, a new 1,800 foot-long levee would be constructed along the toe of the Green River Valley Road, and a smaller 200-foot long levee would be constructed toward the upstream end of the property.

Kaech Levee Pond. The goal is to provide salmonid rearing and storm refuge habitat by improving access to Kaech Pond. The project involves excavating a channel between the Green River and Kaech Pond, deepening the pond, and adding LWD. Riparian plantings would take place within a 50-foot buffer. Unwanted vegetation would be removed prior to planting.

Ray Creek Trib Corridor. The project goals include the restoration and protection of the riparian zone and the creation of spawning, rearing and storm refuge habitat. The project would include easements and fencing boundaries. Riparian plantings would take place within a 100-foot buffer width on both sides of the channel. Invasive vegetation would be removed and replaced with native riparian vegetation. The project would remove excess fine sediment where necessary.

Hamikami Levee Modification. The project involves improving winter habitat by increasing the amount, duration, and quality of water in the old channel. There are two methods under

consideration. The first approach involves the excavation of the existing outlet at the downstream end of the levee. This would cause backwater flooding of the old channel and provide winter refuge from floods, but there would be no flow through of surface water, except during floods. Periodic maintenance dredging would be needed to remove sediment that would deposit at the channel outlet. LWD could be placed to help keep the channel outlet open. The second approach expands on the first approach by also creating a breach in the levee further upstream. This would allow flow through the channel (as opposed to backwater flooding) during ordinary winter flows. The breach should be created 450 feet upstream of the levee.

Turley Levee Setback. The project goal is to provide additional side-channel habitat. Turley Levee is the middle of a series of three discontinuous training levees built in the early 1960s to prevent the Green River from migrating north into farmland. The levee was built at the river's edge and a forested strip of lowland exists behind the levee that was previously occupied by side channels. Three alternatives are under consideration. The first approach involves improving fish access to the old channel behind the levee by excavating the outlet, installing LWD at the outlet to promote scour and keep it open, and possibly replace the twin 30-inch culverts with a bridge. The second approach expands on the first approach by removing elevated portions of the levee down to the grade of the floodplain behind it. This would increase flows in the channel during floods, but probably not during ordinary winter flows. The existing riprap on the levee toe would continue to prevent northward channel migration, if maintained and repaired following flood damage. The third option expands on option two and includes the removal of the riprap that armors the levee down to the ordinary high water elevation and construct a setback revetment along the forest edge. If riprap were removed just along the downstream section, about 800 feet of revetment would be needed to prevent erosion of adjoining farmland to the west. If riprap were removed from the entire levee, an additional 900 feet of revetment would need to be constructed to protect farmland and barns to the north. This latter alternative would widen the functional meander belt by about 400 feet.

Loans Levee Setback. The goals are to restore the natural meandering process of the river and to create increased side-channel habitat. The Loans Levee is a training levee built in 1960 to prevent the Green River from migrating north into farmland. The levee has gradually dampened channel migration activity for about half a mile downstream, resulting in a straighter channel with no recent formation of side channels. Two project alternatives are being considered. The first option would set back the levee to the edge (or near the edge) of the former meander bend, remove the access road that crosses the meander bend, and excavate a downstream connection to the river. This would allow the river to reoccupy the meander bend. The second option involves leaving the levee in place, but increasing winter flows in the former meander bend behind it by deepening the high flow connection to Burns Creek at the upstream end, removing the access road that crosses the meander bend, and excavating a downstream connection to the river.

Burns Creek Restoration. The goal of this project is to provide fish passage and improve instream habitat primarily by controlling the amount of sediment coming from Bell Ravine. The project includes planting the landslide area to reduce the delivery of sediments and the removal of channel constrictions (bridge replacements) to reduce deposition.

Middle Green River LWD. The goal is to improve fish habitat by increasing the number and depth of pools. The project involves the placement and anchoring of LWD in the stream channel.

Middle Green River Gravel Replacement. The project goal is to improve spawning habitat. The project involves the placement of 4,000 cubic yards of spawning gravel into the stream channel.

Flaming Geyser Landslide. The goal is to reduce the amount of fine sediment entering the river and protecting downstream spawning habitat. The project involves moving the river away from the sediment fan by constructing a new channel and a levee to prevent the river from returning to its former channel.

Flaming Geysers Side Channel. The goal is to provide summer and winter rearing and flood refuge habitat. The project would construct approximately 2,100 feet of new side channel between an existing side channel and the Green River. The proposed new channel would start at the existing side channel about 200 feet from its downstream end. It would be excavated in a dry swale for 1,300 feet, then follow a small, seasonably dry channel that drains a wetland. Options being considered are (1) to split flow between the new constructed channel and the downstream end of the existing channel, or (2) divert all flow from the existing channel into the new channel, thus reducing flow in (and possibly dewatering) about 200 feet of the existing channel.

Newaukum Creek. The project goal is to create wetland habitat for rearing and refuge for juvenile salmonids, and to improve habitat complexity in Newaukum Creek. The project includes adding LWD to the existing channel, planting the riparian zone and adjacent wetlands, and fencing off the creek from livestock.

Big Spring Creek. The goal of the project is to create wetland habitat to provide rearing and refuge for juvenile salmonids. The project would construct approximately 3,700 feet of new stream channel and include approximately 2,700 feet easement, buffer planting and fencing. The reach at 244th Avenue SE would be rechanneled. Riparian plantings would take place within a 100-foot buffer width on both sides of the channel. Invasive vegetation would be removed and replaced with native riparian vegetation.

Brunner Slough. The project goal is to improve salmonid habitat in Brunner Slough. Salmon habitat could be improved by increasing the flow of water through the slough, particularly during the summer rearing season. This would be accomplished by excavating the slough to below the water table. Excavation would occur in the portion of the slough where gravel could be encountered. The wetland in the downstream portion of the slough may also need to be excavated in order to achieve continuous flow through the slough to the river. Frequent maintenance may be needed to remove sediment deposits near the outlet of the slough and keep water moving through year-round.

Upper Green River Side Channel Enhancement. The goal is to provide spawning, summer and winter rearing, and flood refuge habitat. The side channel would be enhanced by addition of LWD and spawning gravel, and by the creation of pool habitat though excavation and LWD placement.

Upper Green River Gravel Replacement. The project goal is to enhance spawning habitat. The project involves the addition of 4,000 cubic yards of spawning gravel into the stream channel.

Gale Creek. The goal is to restore fish passage to the upper reaches of Gale Creek and Boundary Creek and to improve habitat upstream of the culvert. The project would replace the culvert with a 40-foot span bridge located next to the existing culvert. The creek will be re-routed through the bridge with the natural channel gradient maintained. Spawning gravel will be placed upstream of the site.

Boundary Creek. The goal is to restore fish passage to the upper reaches of Boundary Creek and to improve habitat upstream of the culvert. The project would replace the high water diversion

culvert with a bottomless arch of larger size (16-foot span and 8-foot rise). Spawning gravel will be placed for 100 feet upstream of the site.

Sweeney Creek. The goal is to restore fish passage to the upper reaches of Sweeney Creek and to improve habitat upstream of the culvert. The project would replace the existing culverts with a 30-foot span bridge. In order to minimize creek channel re-routing, the bridge would be placed over the existing 48-inch culvert. LWD would be placed in the channel for 100 feet upstream of the culvert.

Olson Creek. The goal is to provide fish passage into the upstream reaches of Olsen Creek and improve habitat upstream of the culvert. The existing culvert would be replaced with a bottomless arch culvert of a larger size. LWD and spawning gravel would be placed in the upstream reach for 100 feet upstream of the culvert.

May Creek. The goal is to provide fish passage into the upstream reaches of May Creek and improve habitat upstream of the culvert. The existing culvert would be replaced with a bottomless arch culvert of a larger size. Riparian plantings would occur within the approximately 700-foot-wide Bonneville Power Administration corridor, 650 feet upstream of the culvert. LWD and spawning gravel would be placed in the upstream reach for 100 feet upstream of the culvert.

Maywood Creek. The goal is to provide fish passage into the upstream reaches of Maywood Creek and improve habitat upstream of the culvert. The existing culvert would be replaced with a bottomless culvert adjacent to the existing culvert. The creek channel would be re-routed through the new culvert with the natural channel gradient maintained. The upstream riparian corridor would be vegetated to provide shading. LWD and spawning gravel would be placed in the upstream reach.

Gold Creek. The goal is to provide fish passage to the upstream reaches of Gold Creek. A perched culvert would be removed and replaced with a bottomless culvert with an 18-foot span and a 9-foot rise. LWD will be placed every 25 feet for 100 feet upstream of the culvert.

Sunday Creek Riparian Planting. The project goal is to re-establish riparian vegetation along the stream corridor to enhance salmonid habitat Riparian plantings would take place within a 100-foot buffer width on both sides of the channel. Invasive vegetation would be removed and replaced with native riparian vegetation.

North East Creek. The goal is to provide fish passage to upstream habitat and to improve habitat for coho, steelhead, and cutthroat trout. The project would replace the culvert with a bridge at a location to the west of the existing culvert and divert the stream by meandering a bypass channel to the confluence with Snow Creek. LWD and spawning gravel would be placed upstream of the existing culvert.

Programmatic Elements. The goals are to improve habitat for fish and wildlife in and/or near the stream channel and to restore the natural processes and functions of streams and riparian corridors. The proposed elements include the addition of gravel and LWD, and plantings within the riparian zone and would be implemented as part of the renovation or repair of existing levees.

APPENDIX G

Agency Responses to the Draft Coordination Act Report

APPENDIX B

LETTERS FROM LOCAL CONSTITUENTS

KENT
WASHINGTON

PUBLIC WORKS
Don E. Wickstrom, P.E.
Director of Public Works

Phone: 253-856-5500
Fax: 253-856-6500

220 Fourth Ave. S.
Kent, WA 98032-5895

August 14, 2000

Mr. Patrick Cagney
Environmental Resources Section
U.S. Army Corps of Engineers
4735 East Marginal Way S.
P.O. Box 3755
Seattle, Washington 98124-3755

RE: Draft Programmatic EIS Green/Duwamish River Basin Restoration Program

Dear Mr. Cagney :

The Draft Programmatic Environmental Impact Statement and Draft Restoration Plan, Green/Duwamish River Basin Restoration Program, June,2000 has been reviewed. The City of Kent supports the preferred alternative. The City of Kent is pleased with the high quality of effort and professionalism that the Corps staff has displayed throughout this project. The Green/Duwamish Ecosytem Restoration Program is vital to the regional efforts to restore and manage this great natural resource. The City of Kent is committed to support this effort. Please contact me at (253) 856-5548 if your have any questions.

Sincerely,

William S. Wolinski,P.E., Manger
Environmental Engineering Section

Cc: Don E. Wickstrom
Gary Gill

MP2045

TOTAL P.02

OFFICE OF THE MAYOR
Charles A. Booth, Mayor

CITY ADMINISTRATION
25 West Main, Auburn, WA 98001
(253) 931-3041 Fax: (253) 288-3132

September 18, 2000

Colonel Ralph Graves, Commander
US Army Corps of Engineers
Seattle District
PO Box 3755
Seattle WA 98124-2255

RE: Green/Duwamish River Basin Restoration Study EIS

Dear Colonel Graves:

The City technical staff have completed the review of the Green River Eco-system Restoration Study EIS. At this time no technical comments that would improve the document were noted. The study, in the opinion of staff, accurately portrays the situation in the field for those portions of the study located within the city. I have followed the study as a member of the Green/Duwamish WRIA 9 Steering Committee and am familiar with the work that has been accomplished to date.

The Steering Committee was established by the King County Executive to formulate a basin wide response to the listing of the Puget Sound Chinook. The committee membership represents the major stakeholders in the basin and all meetings are open to the public and have been well attended. The committee has provided an excellent forum for obtaining public review and comment regarding the Corps' study. Corps staff have done an excellent job of informing and involving the local interests, including property owners, that may be affected by proposed work. The study and the recommendations have received a high level of acceptance and support from the committee. The City of Auburn would like to compliment the District for a job well done, and we look forward to working with the Corps and other jurisdictions within the basin to implement recommended improvements.

Please continue to keep us informed regarding your progress, and let us know if there is any assistance the City can provide to facilitate your work towards implementation of study recommendations.

Sincerely,

Charles A. Booth

Charles A. Booth
Mayor

c:\mayor\letter\00-Colonel Graves-915.doc

City of Tukwila

Steven M. Mullet, Mayor

Department of Public Works

James F. Morrow, P.E., Director

September 22, 2000

Mr. Noel Gilbrough/Planning Branch
US Army Engineer District, Seattle
PO Box 3755
Seattle, WA 98234-3755

Dear Noel:

With the completion of the Draft Green/Duwamish Ecosystem Restoration Study, the City of Tukwila would like to express our thanks and appreciation to the Army Corps for your outstanding efforts in this process. We are aware of the many challenges that you faced to bring this multi-project, multi-jurisdictional effort to this point.

We look forward to working with you and your staff on the next phase and the eventual construction of these vital habitat projects.

Sincerely,

Ryan Larson

Ryan D. Larson, P.E.
Senior Engineer

6300 Southcenter Boulevard, Suite #100 • Tukwila, Washington 98188 • Phone: 206-433-0179 • Fax: 206-431-3665

CITY OF RENTON

Mayor
Jesse Tanner

September 27, 2000

Colonel Ralph Graves, Commander
U.S. Army Corps of Engineers
Seattle District
PO Box 3755
Seattle, WA 98124-3755

SUBJECT: LOCAL SUPPORT FOR THE ECOSYSTEM RESTORATION STUDY

Dear Commander Graves:

This letter is sent to you in appreciation for the Corps' efforts to successfully complete the Feasibility Phase of the Green/Duwamish River Basin Ecosystem Restoration Study (ERS). As one of the lead agencies responsible for the Green/Duwamish Feasibility Report, the Corps has been very responsive in addressing the needs of the local sponsors. Specifically, coordination by the Corps with the representative cities, local property owners and businesses, and the Muckleshoot Indian Tribe has resulted in identification of habitat restoration projects that, when completed, will greatly improve the region's fisheries resources. The Corps has made every effort to listen and be responsive to all the local stakeholders and to incorporate recommended improvements to many of the projects.

With the Feasibility Phase of the study almost complete, the City of Renton looks forward to working with the Corps on the Planning, Engineering and Design Phase. I'm confident the successful and productive partnership that exists between the City of Renton and the Corps will continue as projects move into the construction phase of the ERS.

For any further assistance regarding this matter, please contact Ron Straka, Utility Supervisor, at 425-430-7248.

Sincerely,

Jesse Tanner

Jesse Tanner
Mayor

00-118/RS:mp

cc: Jay Covington
Gregg Zimmerman
Ron Straka
Allen Quynn

1055 South Grady Way - Renton, Washington 98055 - (425)430-6500 / FAX(425)430-6523

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MUCKLESHOOT INDIAN TRIBE

39015 172nd Avenue S.E. • Auburn, Washington 98092-9763
Phone: (253) 939-3311 • Fax: (253) 939-5311

21 September 2000

Col. Ralph Graves, District Engineer
US Army Corps of Engineers
4735 East Marginal Way S
P.O. Box 3755
Seattle, WA 98124-3755

RE: GREEN/DUWAMISH RIVER BASIN RESTORATION PROGRAM

Dear Col. Graves:

The US Army Corps of Engineers is proposing to embark upon an ambitious plan to restore ecosystem function and structure in the Green/Duwamish River basin. The outcome of this plan will be a measurable increase in both the quality and quantity of fish and wildlife habitat in the Green/Duwamish Basin. The Muckleshoot Indian Tribe Fisheries Department supports the Corps' efforts to implement the restoration projects described in the Green/Duwamish Basin Restoration Program. Implementation of these projects will be a major step in the actions required to restore salmon habitat in the Green/Duwamish River.

The Fisheries Department for the past several years has participated in the on-going development of the restoration program. Though the Tribe was not a financial contributor to the Ecosystem Restoration Study, the Tribe has been involved in the program by other means. This involvement included staff participation in project selection and ranking, participation in many meetings throughout the reconnaissance and feasibility phases, and the opportunity for early review of conceptual designs. The involvement of the Fisheries Department in this process is illustrated by the inclusion in the restoration program of several restoration projects proposed by Fisheries Department.

We hope to be involved in all other future aspects of the Restoration Program and look forward to an early finalization of project designs during the Planning, Engineering, and Design phase, so that these projects can be implemented throughout the Green/Duwamish Basin.

Comments from the Tribe's Cultural program are being sent in a separate letter.

If you have any questions regarding this please feel free to contact me at (253) 939-3311.

Sincerely,

Isabel Tinoco
Director
Muckleshoot Fisheries Department

FISHERIES DEPARTMENT
Area Code (360)
394-5248
Fax 598-4666

THE SUQUAMISH TRIBE
P.O. Box 498 Suquamish, Washington 98392

October 5, 2000

US Army Engineer District, Seattle
ATTN: Noel Gilbrough/ Planning Branch
PO Box 3755
Seattle, WA 98124-3755

Dear Mr. Gilbrough,

Thank you for providing the Draft Feasibility Report for the Green Duwamish River Ecosystem Restoration Study to the Suquamish Tribe. The Green Duwamish River Ecosystem includes resources the Tribe reserved the right to with the Treaty of Point Elliott. The marine portions, up to the Spokane Street Bridge are squarely within usual and accustomed fishing area of the Suquamish Tribe. The resources present within these waters, including migratory species, are economically and culturally important to the Tribe. The Tribe has been fishing in Elliott Bay since before record, and has been co-managing fisheries within Elliott Bay and the Duwamish since 1976.

The Tribe looks forward to working with the US Army Corps of Engineers in finalizing and implementing this plan. Specifically, the Tribe requests to be included in the Programmatic Agreement proposed for cultural and historic resources. This is referenced on page 5-12. The Tribe appreciates coordination on natural resource management as well. The Tribe supports only those projects that improve ecological conditions.

Thank you for your consideration of these comments. I can be reached at 360-394-5249 or by e-mail at pmeyers@suquamish.nsn.us.

Sincerely,

Phyllis S. Meyers
Environmental Program Manager
Suquamish Fisheries Department

CC Rob Purser, Fisheries Director

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Western Washington Office
510 Desmond Drive SE, Suite 102
Lacey, Washington 98503
Phone: (360) 753-9440 Fax: (360) 753-9008

SEP 13 2000

Colonel Ralph H. Graves, District Engineer
U.S. Army Corps of Engineers, Seattle District
PO Box 3755
Seattle, Washington 98124-3755

Attn: Mr. Patrick Cagney, Environmental Resources Section

Re: Fish and Wildlife Coordination Act report for the Stillaguamish River Basin Restoration Program, Snohomish County, Washington

Dear Colonel Graves:

Enclosed are four copies of our Fish and Wildlife Coordination Act report on the Stillaguamish River Basin Restoration Program. It is being provided under the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661, *et seq.*) and fulfills Section 2(b) of this Act.

We strongly support the Corps of Engineers' approach for restoring fish and wildlife habitat within the Stillaguamish River Basin, and believe the proposed actions have the potential to result in significant long-term benefits to many species of fish and wildlife, including federally listed species. As described in the report, there are a few outstanding issues that remain to be worked out during the advanced engineering and design phase of the project. We look forward to working with you and your staff.

Copies of our report are being provided concurrently to the appropriate resource agencies and Stillaguamish Indian Tribe.

Sincerely,

Lynn P. Childers

for Gary A. Jackson, Manager
Western Washington Office

State of Washington
DEPARTMENT OF FISH AND WILDLIFE

Mailing Address: 600 Capitol Way N • Olympia, WA 98501-1091 • (360) 902-2200, TDD (360) 902-2207
Main Office Location: Natural Resources Building • 1111 Washington Street SE • Olympia, WA

May 12, 2000

U.S. FISH & WILDLIFE SERVICE
WESTERN WA OFFICE
MAY 23 2000
LACEY, WA
RECEIVED

Mr. Gerry Jackson, Manager
United States Department of the Interior
Fish and Wildlife Service
510 Desmond Drive Southeast, Suite 102
Lacey, Washington 98503

Dear Mr. Jackson:

Thank you for providing a copy of your draft Fish and Wildlife Coordination Act report on the proposed program for our review and comment.

The Washington Department of Fish and Wildlife (WDFW) also strongly supports the approach of the proposed restoration project. We do, however, have a stronger confidence that unresolved questions about design details of some of these projects will be resolved prior to their construction. These details must be worked out and approved to satisfy the requirements for obtaining the necessary Hydraulic Project Approvals (HPA) from WDFW.

The Department also agrees with your statement on page 16 that the compliance and effectiveness monitoring plans for these projects need to be very detailed and very thorough. The HPA process should help in this regard as well.

Your staff has done an excellent analysis of the restoration program.

Sincerely,

Jeff P. Koenings, Ph.D.
Director

JPK:TM:cf

APPENDIX C

REAL ESTATE PLAN

Green/Duwamish River Basin
Ecosystem Restoration Study
King County, Washington

REAL ESTATE PLAN

October 21, 2000

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1.0 INTRODUCTION

1.1. Real Estate Plan Purpose

The Real Estate Plan is presented in support of Green/Duwamish River Basin Ecosystem Restoration Study and describes the real estate required to evaluate 47 sites and programmatic measures within the Green River Basin.. The purpose of the real estate plan is to: 1) identify the lands, easements and rights-of-way and disposal areas (LERD) necessary to support construction, operation and maintenance of the project sites contained in the ecosystem feasibility report; 2) to outline the costs and real estate considerations associated with project implementation; and 3) to assess the Non-Federal Sponsor's (NFS) capability for LERD acquisition. For purposes of this plan, King County, Washington is the Non-Federal Sponsor.

Separate Preliminary Restoration Reports are also being developed for the Codiga Farms Site and Sweeney Creek Site. Once these sites are approved for implementation under the Corps' Continuing Authority Program, they will be removed from the general investigation implementation process.

1.2 General Project Description

The Green/Duwamish River Basin Ecosystem Restoration Study was initially authorized by Congress in 1995 as a General Investigation Study under Section 209 of Public Law (PL) 87-874, Puget Sound and Adjacent Waters. Following completion of the reconnaissance phase in 1997, a Feasibility Cost Charge Agreement and Study Plan was negotiated and agreed upon by the Corps and King County. The feasibility phase began in 1998. As part of the cost-sharing agreement, the County agreed to prepare the real estate drawings and perform the real estate appraisal work products as part of their work-in-kind contributions.

1.3 Specific Feasibility Study Objectives:

The objective of the feasibility study is restoration of fish and wildlife habitat that was lost as a result of human activities throughout the watershed. The overall goal of the project is to restore diverse and sustainable riverine and stream habitats within the study area. The project focuses on restoring estuarine, salmon spawning, juvenile rearing and over wintering habitats and rehabilitation tributaries.

1.4 Reconnaissance Report

The reconnaissance report for the proposed federally assisted ecosystem restoration project was approved March 1997. The reconnaissance report contained over fifty potential site-specific restoration projects throughout the basin.

2.0 PROJECT LOCATION

There are 47 specific site or programmatic measure locations situated from the south Seattle industrial area through Renton, Kent, and Auburn, following the Green and Duwamish Rivers through the Green River Valley. Within these locations there is a total of 103 individual sites with the following programmatic measures having multiple sites.

- Mainstem Maintenance has 6 separate sites.
- Middle Green Large Woody Debris has 48 individual sites.
- Middle Green River Gravel Replacement has 4 separate individual sites.
- Upper Green River side Channel Enhancement has 2 individual sites.

All 103 individual project sites are being addressed in the Real Estate Plan (REP). See Figure 2,3 and 4 of the main report for project site locations.

3.0 GENERAL PROJECT DESCRIPTION

The Green/Duwamish River Basin Ecosystem Restoration Project involves approximately 1,464.64 acres of land and approximately 273 ownerships for initial construction of all 47-restoration projects discussed in this plan. See Section 5 of this plan for a real estate description by project. The implementation of these 47 sites will address most of the limiting factors to fish and wildlife production in the basin. The project sites will be constructed in the estuary to address the lack of estuarine habitat, in the lower river to address the loss of channel diversity and increased water temperature, the tributaries to address barriers to fish passage, the middle river to address the loss of floodplain habitat and increased water temperatures, and programmatically to address the reduction of large woody (LWD) debris, sedimentation sources and lack of riparian habitat. Detailed site descriptions are available in the Engineering Appendix.

4.0 ACCESS TO PROJECT SITES

Access to the project sites is generally by existing public access unless otherwise noted. The sites listed below are located within the City of Tacoma Public Utilities municipal watershed, (hereinafter referred to as the Tacoma Public Utilities (TPU) area). The County will need to obtain a non-exclusive right of access over and across the existing access roads to each site listed below unless otherwise noted in the site description. See Sheets 1 and 2 in Exhibit A of the report for the approximate location of the sites and access to the sites. The road area includes approximately 103.76 acres with an estimated value of $77,800.

Project Sites located within TPU watershed area:

Gale Creek
Sweeney Creek
Olsen Creek
May Creek
Maywood Creek
Gold Creek
Northeast Creek

5.0 DESCRIPTION OF LANDS, EASEMENTS AND RIGHTS OF WAY (LER) BY SITE

5.1 Big Spring Creek

Big Spring Creek is located within the Newaukum Creek basin on the northern boundary of the Enumclaw plateau northwest of Enumclaw. Big Spring Creek is part of a depositional area created by the Osceola Mudflow originating from a past eruption of Mt. Rainier. The existing remnant of plateau wetland complexes today is highly disturbed pastures heavily grazed by livestock. The total wetland area has also been reduced in size through agricultural modification that has included filling, ditches, and draining. The project restoration goals are to restore salmonid habitat complexity and process-based ecological functions by recreating a diverse riparian corridor along Big Spring Creek, addressing wetland attenuation and wetland native plant diversity on the Enumclaw plateau.

The Big Spring Creek site consists of a total of 14.90 acres. See Exhibit A of this plan for the project site footprint. For construction, operation and maintenance of this site, the NFS will need to acquire approximately 14.90 acres of land in fee with an estimated value of $68,250. The majority of the land in this area is zoned agriculture. There are approximately 7 private ownerships within the project site. This site involves stream relocation with 100 feet of new creek bed. The NFS will need to acquire lands for the new creek bed and buffer areas along the creek. Access to the site is from existing public roads. All staging will take place within the project footprint. The disposal material will be taken to the Seattle Tacoma-Airport third runway construction site and a commercial site. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

5.2 Black River Mash

The location of this site is in the city of Renton, just down river from the Black River Pumping Plant in Fort Dent. This project is at the confluence of the Green River and the Black River. The project restoration goals are to provide primary productivity/nutrient export to the surrounding system and allow juvenile salmon and trout access at higher tide for fish refuge and feeding. The goal of the riparian planing is to provide habitat connectivity and a buffer from local disturbance. Water quality benefits should also be realized once the vegetation has matured in the form of shading (to help keep in-stream temperatures down) and filtration of runoff from adjacent land uses.

The Black River Marsh site currently involves a total of 4.86 acres. The NFS currently owns 0.18 of an acre and will need to acquire an additional 4.68 acres for construction, operation and maintenance of this site. See Exhibit A of this plan for the project site footprint and the Table below for a summary of property interest and land values by estate. The land zoning in the proposed project area is a mix of industrial, commercial and low density residential. There are 6 ownerships within the project footprint that consists of a mix of public, private and NFS land holdings. This site involves creating 50-foot buffers on both sides of the river. The NFS plans on acquiring 4.53 acres environmental easement and 0.15 acres for 2 permanent access easements to the project

site. All staging will take place within the project footprint. The disposal material will be taken to the Seattle Tacoma-Airport third runway construction site. Acquisition of a disposal site is not necessary. For LER crediting purposes the lands already owned by the NFS will be based on federal appraisal principles for determining fair market value. The requirement for a formal crediting appraisal will most likely be waived because of the size of the NFS's parcel.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	0.18	Nominal
Environmental Easement	4.53	$54,000
Permanent Access Easement	0.15	$ 5,000
TOTALS	**4.86**	**$59,000**

5.3 Brunner Slough

The Brunner Slough Site is located in unincorporated King County at about river mile 58 on the Green River up stream of Kanasket and Palmer. In this reach the river is confined by a levee and bank stabilization projects, and significant development. The project site is adjacent to urban and industrial development. The goal of this project is to provide off-channel winter and summer rearing habitat for a variety of salmon and trout (Chinook, Coho, chum, steelhead and char). There is also some potential for chum spawning in the restored slough.

This Brunner Slough site currently involves a total of 16.10 acres. The NFS needs to acquire 15.10 acres in fee from 5 private property owners and a 1-acre staging area for construction, operation and maintenance of this site. See Exhibit A of this plan for the project site footprint and the table below for a summary of property interest and land values by estate. Access to the site is from an existing pubic road - SE Hudson Street. Disposal of material is on site and within the project footprint. The land in the project area is rural residential construction site. See Table 17A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	15.10	$30,500
Temporary Work Area Easements (5 years)	1.00	$ 7,500
TOTALS	**16.10**	**$38,000**

5.4 Burns Creek

Burns Creek joins the Green River on the right-bank at rive mile 38, at the upstream end of the Lones Levee. Burns Creek is approximately 2.1 miles long and flows along the north side of Southeast Green Valley Road, roughly parallel to the Green River. The project restoration goals are to enhance salmonid habitat in Burns Creek and reduce property damage associated with flooding and channel aggradation.

This Burn Creek site currently involves a total of 24.27 acres, and approximately 14 private ownerships. The NFS needs to acquire 22.00 acres permanent environmental easement, 1.27 acres permanent access easement for construction, operation and maintenance of this site. A 1-acre temporary staging area is needed during the period of construction. See Exhibit A of this plan for the project site footprint and the table below for a summary of property interest and land values by estate. Disposal material will go to a commercial site. The land in the project area is zoned as rural residential and agricultural. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Permanent Environmental Easement	22.00	$435,000
Permanent Access Road Easement	1.27	$ 1,600
Temporary Work Area Easements (5 years)	1.00	$3,800
TOTALS	**24.27**	**$440,400**

5.5 Codiga Farms

The Codiga Farms site is located in the city of Tukwila near 50th Place South and South 130th Place. Currently a farm and a pea patch occupy the site. The purpose of the project is to restore tidal hydrology to the Codiga Farm site. The goal of the project is to restore tidal hydrology to the site in the form of a slough. The slough will provide rearing and feeding habitat for juvenile fish. Also a fringing estuarine marsh will be planted at the site providing primary productivity and nutrient export.

The Codiga Farms site currently involves a total of 3.4 acres of land. See Exhibit A of this plan for the project site footprint. The NFS will need to acquire 3.4 acres environmental easement for construction, operation and maintenance of this site. The environmental easement for this parcel has an estimate value of $118,000. The land in this area is zoned low density residential. There appears to be two public owners within the project footprint – City of Tukwila and State of Washington, Department of Natural Resources. Temporary staging will take place within the project footprint. Existing public access to the site is available. The disposal material will be taken to the Seattle-

Tacoma Airport third runway construction site. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

5.6 Duwamish Site 1

Duwamish Site 1 is located on the east bank of the Duwamish River just north of South 112th Street in the city of Tukwila, Washington. Historically, the lower Duwamish River was the setting of an expansive estuary with a complex mix of habitat types, including tide flats and intertidal wetlands, as well as various channel forms such as large meanders, braided channels, and numerous tributary streams. The primary goal of the project is to restore important estuarine habitat within the lower Duwamish River, with the intent of enhancing salmonid habitat within the Green-Duwamsih River system as a whole. This will be accomplished by regrading the majority of the subject property to elevations that would be subject to regular tidal influence and inundation and connecting the area to the river via an inlet channel.

Duwamish Site 1 site currently involves a total of 2.82 acres of land owned by one private ownership. See Exhibit A of this plan for the project site footprint. The NFS will need to acquire 2.82 acres of environmental easement for construction, operation and maintenance of this site. The environmental easement for this parcel has an estimate value of $993,000. The land in this area is zoned manufacturing. Temporary staging will take place within the project footprint. Existing public access to the site is available from South 112th Street. Approximately 90% of disposal material will be taken to the Seattle-Tacoma Airport third runway construction site and the remaining 10% will be taken to a hazardous material confinement site. See the following table for a summary of property interest and land values by estate. See Table 17.A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

5.7 Elliot Bay Nearshore

The Elliot Bay Nearshore site involves all submerged lands in navigable waters. Washington State, Department of Natural Resources owns the submerged lands. See Exhibit A of this plan for the project site footprint. All construction, operation and maintenance of this site will be in water. Temporary staging will be at contractor's yard and will be provided by the contractor. The estimated value of the 5.7 acres of submerged land is $3,000. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

5.8 Flaming Geyser Side Channel

The location of the Flaming Geyer Side Channel is on a gravel terrace just downstream of an existing wall based side channel within the Green River floodplain. The primary goal of the project is to construct additional side channel habitat within the Green River system in order to allow natural ecosystem processes to be re-established in the side channel riparian corridor. Project goals include creating a natural environment to enhance salmonid rearing within the side channel and create refuge wetland habitat.

The Flaming Geyser Side Channel site currently involves a total of 25.18 acres of land. See Exhibit A of this plan for the project site footprint. The NFS will need to acquire 25 acres of environmental easement and 0.18 of an acre permanent access easement for construction, operation and maintenance of this site. The land in this area is zoned rural-residential, although a state park occupies all of the land. Washington State Parks owns the land within the project. Temporary staging will take place within the project footprint. Disposal material will go to a commercial site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	25.00	$250,800
Permanent Access Easement	0.18	$ 1,200
TOTALS	**25.18**	**$252,000**

5.9 Flaming Geyser Slide

The Flaming Geyser Slide site is located on the south side of the Green River at approximately River Mile 43 just downstream of Flaming Geyser Park. The basic goal of this project is to eliminate a large source of fine sediment from this reach of the river. There is also an additional goal of improving the success of downstream spawning and juvenile habitat.

The NFS owns the 10.15 acres of land need for construction, operation, maintenance and access to this site. See Exhibit A of this plan for the project site footprint. The land in this area is zoned as rural residential, although much of the land appears to be encumbered by steep slopes and riverbanks. Temporary staging will take place within the project footprint. Excess disposal material will be taken to the Seattle-Tacoma Airport third runway construction site. See the following table for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site. For LER crediting purposes the lands already owned by the NFS will be based on federal appraisal principles for determining fair market value.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	10.00	$126,000
Permanent Access Easement	0.15	$ 1,000
TOTALS	**10.15**	**$127,000**

5.10 Gale Creek

The Gale Creek site is a perched culvert located on Road 5530 at milepost 11.5. Gale Creek is a tributary to the Green River. The culvert is approximately 3,100 feet upstream of the confluence with the Green River. The project restoration goals are to eliminate the perched culvert conditions and allow fish passage into the upstream reaches of Gale Creek and Boundary Creek.

The Gale Creek Culvert site currently involves a total of 0.63 of an acre of land located in the City of Tacoma watershed that is closed to the public and has controlled access. See Exhibit A of this plan for the project site footprint. Land zone in this area is forest with the existing use as forest. This site is on lands owned by the City of Tacoma. The NFS will need to acquire 0.33 of an acre permanent environmental easement for culvert rehabilitation, operation and maintenance, and .30 acres for a temporary work area easement to temporarily relocate the road during the construction period. while the culvert is being rehabilitated. See Exhibit A of this plan for the project site footprint. The culvert lies beneath an existing access road that is jointly used by property owners in the watershed. The NFS will need to acquire a non-exclusive right over and across the existing road in the TPU watershed. See paragraph 4.0 of this report for further discussions on roads within the TPU area. A disposal site is not necessary. Material will be reused on site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	0.33	$ 300
Temporary Work Area Easement (18 months)	0.30	$4,000
TOTALS	**0.63**	**$4,300**

5.11 Garrison Creek

The Garrison Creek project encompasses four project sites. The project sites are located in the city of Kent and are named the South 218th wetland site, Southeast 216 Street slide stabilization/drainage control site, Middle Fork sediment removal/channel restoration site, ad the 167th culvert replacement site. The primary goals of this project are to restore and enhance salmonid habitat within Garrison Creek using natural habitat elements and ecosystem-based processes. This will be accomplished by restoring a more natural stream channel that provides riparian functions for fish habitat in low-flow and high-flow regimes, re-establishing reliable fish access to the upper reaches of the Middle Fork, and rehabilitating the existing channel to provide rearing and refuge habitat for salmonid species.

The Garrison Creek site currently involves a total of 19.78 acres of land. See Exhibit A of this plan for the project site footprint. The NFS will need to acquire 2.09 acres in fee; 16.80 acres environmental easement; and 0.89 of an acre permanent access easement for construction, operation and maintenance of this site. The land in this area is zoned primarily single-family residential. There are 18 ownerships within the project footprint that consists of a mix of public and private land holdings. Temporary staging will take place within the project footprint. A commercial disposal site will be used. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	2.09	$ 77,000
Environmental Easement	16.80	$261,500
Permanent Access Easement	0.89	$ 19,500
TOTALS	**19.78**	**$358,000**

5.12 Gilliam Creek

The Gilliam Creek project site is located in the city of Tukwila, Washington, at the confluence of the Gilliam Creek and the Green River at River Mile 12.5. The confluence of the Gilliam and Green Rivers can be found east of the I-405 ad I-5 interchange, near south Center Mall's north entrance. The site extends approximately 2000 feet upstream along Gilliam Creek. The project restoration goal is to eliminate present fish barriers and improve approximately 2000 feet of Gilliam Creek to provide for enhanced winter rearing and spawning salmonid habitat while maintaining the current level of flood protection to the regional area.

The Gilliam Creek site currently involves a total of 4.4 acres of land owned by the City of Tukwila. See Exhibit A of this plan for the project site footprint. The NFS will need to acquire 4.2 acres of environmental easement for construction, operation and maintenance of this site. An additional 0.20-acre temporary work area is needed during the construction period. The land in this area is zoned primarily commercial. A commercial disposal site will be used. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	4.20	$48,400
Temporary Work Area Easement (18 months)	0.20	$ 600
TOTALS	**4.4**	**$49,000**

5.13 Gold Creek

The Gold Creek site is a perched 84-inch, 80-foot long corrugated metal pipe located under road 3703 at milepost 24.75 and lies next to a concrete culvert of 54-inch diameter. The existing stream channel width is approximately 10 to 14 feet wide. Gold Creek is a tributary to the Green River. The project restoration goal is to eliminate the perched culvert conditions to allow for fish passage in the upstream reaches of Gold Creek. The habitat upstream of the culvert would be improved with the addition of large woody debris for approximately 100 feet.

The Gold Creek Culvert Projects site currently involves a total of 0.57 of an acre of land located in the City of Tacoma watershed that is closed to the public and has controlled access. See Exhibit A of this plan for the project site footprint. Land zone in this area is forest with the existing use as forest. This site is on lands owned by the City of Tacoma. The NFS will need to acquire 0.27 of an acre permanent environmental easement for culvert rehabilitation, operation and maintenance; and 0.30 acres for temporary road relocation while the culvert is being rehabilitated. See Exhibit A of this plan for the project site footprint. The culvert lies beneath an existing access road that is jointly used by property owners in the watershed. The NFS will need to acquire a non-exclusive right over and across the existing road. See paragraph 4.0 of this report for further discussions on roads within the TPU area. A separate disposal site is not necessary. Material will be reused on site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	0.27	$ 200
Temporary Work Area Easements (1 year)	0.30	$7,500$
TOTALS	**0.57**	**$7,700**

5.14 Green River Park

This project site is located within the Green River Park in the city of Kent, Washington, at the end of Hawley Road near River Mile 23.7. The site extends approximately 600 feet due east from the riverbank. The project restoration goals are to provide summer rearing habitat at the mouth and establish a backwater winter channel refuge for fish during high/flood flows in the mainstem of the Green River.

The Green River Park site currently involves a total of 3.56 acres of land owned by two public owners. See Exhibit A of this plan for the project site footprint. The NFS will need to acquire 2.44 acres environmental easement, and 0.12 of an acre for a permanent access road easement for construction, operation and maintenance of this site. An additional 1-acre temporary work area easement is needed during the period of construction. The land in this area is zoned as manufacturing and agriculture. The disposal material will be taken to the Seattle-Tacoma Airport third runway construction site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	2.44	$ 89,000
Permanent Access Easement	0.12	$ 2,600
Temporary Work Area Easements (3 years)	1.0	$ 13,200
TOTALS	**3.56**	**$104,800**

5.15 Hamikami Levee Breach

The Hamikami Levee Breach is in the vicinity of an existing training levee at approximately River Mile 36. The proposed site is adjacent to existing croplands and a forested wetland that is landward of the training level. The primary goal of the project is to connect an existing forested wetland to the river to allow it to be used for fish habitat, and creating a natural environment to enhance salmonid rearing within the forested wetland created refuge wetland habitat.

The Hamikami Levee Breach site currently involves a total of 3.20 acres of land owned by one public and one private owner. See Exhibit A of this plan for the project site footprint. The NFS will need to acquire 1.4 acres environmental easement and 1.8 acres for a permanent access for construction, operation and maintenance of this site. The land in this area is primarily agricultural. Temporary staging will take place within the project footprint. Disposal of material will be on site. See the table below for a summary of

property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	1.40	$ 9,000
Permanent Access Easements	1.80	$ 7,000
TOTALS	**3.20**	**$16,000**

5.16 Horsehead Bend Side Channel

The Horsehead Bend side Channel site, name for a sharp meander on the Green River is located at River Mile 26. The site is located within the city of Kent, Washington, east of Central Avenue South and west of the intersection of 94th Place South and Green River Road. The project restoration goal is to provide a summer rearing area and to establish a refuge for fish during high flows in the mainstem of the Green River. This project will especially benefit Coho, emergent Chinook fry, and fingerling rearing.

The Horsehead Bend Side Channel site currently involves a total of 14.06 acres of land owned by the NFS and the city of Kent. See Exhibit A of this plan for the project site footprint. The NFS currently owns 11.90 acres and will need to acquire an additional 2.16 acres permanent access easement for construction, operation and maintenance of this site. The land in this area is zoned agriculture. Temporary staging will take place within the project footprint. The disposal material will be taken to the Seattle-Tacoma Airport third runway construction site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	11.90	$116,500
Permanent Access Easement	2.16	$ 13,500
TOTALS	**14.06**	**$130,000**

5.17 Keach Levee Pond

This location of this site is on a gravel terrace just upstream of Nealy Bridge on the right-bank of the river. The primary goal of this project is to construct additional side channel habitat within the Green River system in order to allow natural ecosystem processes to be re-established in the side channel riparian corridor. Project goals also include creating as natural environmental as possible to enhance salmonid rearing within the side channel and create refuge wetland habitat.

The Keach Levee Pond site currently involves a total of 5.30 acres of land owned by the NFS and one private owner. See Exhibit A of this plan for the project site footprint. The NFS currently owns 2.4 acres and will need to acquire an additional 2.2 acres environmental easement; and 0.7 of an acre permanent access easement for construction, operation and maintenance of this site. The land in this area is zoned agricultural. Temporary staging will take place within the project footprint. The disposal material will be taken to the Seattle-Tacoma Airport third runway construction site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site. LER crediting purposes the lands already owned by the NFS will be based on federal appraisal principles for determining fair market value.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	2.40	$30,000
Environmental Easement	2.20	$22,000
Permanent Access Easement	0.70	$ 6,000
TOTALS	**5.30**	**$58,000**

5.18 Lake Meridian Outlet

The Lake Meridian Outlet site is located in the city of Kent, Washington, and includes the reach of Meridian Valley Creek from the concrete box culvert under SE 246th Street, through an approximate 100-foot long, rectangular, concrete flume near the confluence of Soos Creek.

The Lake Meridian Outlet Site consists of 8.80 acres of land. For construction, operation and maintenance of this site, King County will need to acquire approximately 8.80 acres of land from the city of Kent and Puget Sound Energy. See Exhibit A of this plan for the project site footprint. The land in this area is zoned medium density single-family residential. The NFS will need to acquire approximately 0.51 acres of streambed in fee;

8.19 acres environmental easement over parklands and 0.1 of an acre permanent access easement for construction, operation and maintenance of the site. All staging will take place within the project footprint. The disposal material will be taken to the Seattle Tacoma-Airport third runway construction site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	0.51	$ 5,100
Environmental Easement	8.19	$108,700
Permanent Access Easement	0.10	$ 4,100
TOTALS	**8.80**	**$117,900**

5.19 Lones Levee

The Lones Levee project site located approximately 1,000 feet south of the 17200 block of Southeast Green Valley Road and on the right bank of the Green River at about River Mile 38. The basic project goal of this site is to restore natural channel-migration processes that are consistent with present-day flow regimes attributable to the Green River.

The Lones Levee Site consists of 30.45 acres of land. For construction, operation and maintenance of this site, the NFS will need to acquire approximately 30.45 acres of land. See Exhibit A of this plan for the project site footprint. The land in this area is zoned agricultural. There are approximately 3 private ownerships within the project site. The NFS's plan is to acquire 27.4 acres in fee; 2.5 acres environmental easement; and 0.55 of an acre permanent access easement for construction, operation and maintenance of this site. All staging will take place within the project footprint. The disposal of material will be on site or taken to the Seattle Tacoma-Airport third runway construction site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	27.40	$256,000
Environmental Easement	2.50	$ 15,000
Permanent Access Easement	0.55	$ 2,000
TOTALS	**30.45**	**$273,000**

5.20 Lower Springbrook Creek

The Springbrook Creek water supply watershed is located east of SR 167 and south of the city of Renton. The creek flows north and west across SR 167 to the Black River Pump Station. Portions of the Springbrook Creek are located within the city of Renton including the Lower Springbrook site. This reach of Springbrook extends from SR 167 to upstream of the Black River Pump Station forebay. The project restoration site goal is to create a natural habitat for rearing and storm refuge.

The Lower Springbrook Creek site currently involves a total of 55.15 acres of land located in the cities of Kent and Renton, Washington. See Exhibit A of this plan for the project site footprint. The NFS currently owns approximately 8.07 acres and will need to acquire an additional 46.85 acres of environmental easement for construction, operation and maintenance of this site. An additional 0.23 of an acre for a temporary work area easement is needed during the period of construction. The land in this area is primarily industrial and commercial, with a few single-family residential. There are approximately 30 ownerships within the project footprint that consists of a mix of public, private and NFS land holdings. Access to the site is from existing public roads. A commercial disposal site will be used for all disposal material. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	8.07	$ 880,000
Environmental Easements	46.85	$2,085,000
Temporary Work Area Easement (11 years)	0.23	$ 55,000
TOTALS	**55.15**	**$3,020,000**

5.21 Mainstem Maintenance

Mainstem Maintenance currently consists of six sites that generally follow along the cities of Tukwila, Kent and Auburn's Green River corridor. The primary goal of mainstem maintenance is to work with the NFS and Local Dike Improvement Districts for a 10-year period to implement more fish friendly bioengineer solutions to the annual maintenance problems on the Green River. It also includes opportunities to implement measures that will provide bank and levee protection as well as provide much needed fish habitat.

The six sites currently identified along the Green River Corridor involve a total of 140.30 acres with an estimated value of $6,967,000. See Exhibit A of this plan for the project footprints of the six sites identified below.

Boeing Setback and Restoration
Carrot Patch Setback and Restoration
Fenster Setback and Restoration
Russell Road Upper Setback Restoration
Russell Road Lower Setback and Restoration
Russell Road Lowest Setback Restoration

The zoning for the sites within the city of Kent's Green River corridor consists of industrial and residential sites either owned by the City of Kent, Boeing, or Rockwall Industries. The Fenster Setback Site located along the Green River in the Auburn area consists of residential and agricultural lands owned by the city of Auburn or private owners. For construction, operation and maintenance of all six sites, the NFS will need to acquire 76.40 acres in fee, and an additional 63.90 acres environmental easement. See the tables below for a summary of property values and estates by site. Temporary staging will take place within the project footprint for each site. Material will be disposed of on site or will be taken to the Seattle-Tacoma Airport third runway construction site. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for the mainstem maintenance sites.

Boeing Setback and Restoration

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	10.50	$1,264,000
Environmental Easement	11.90	$353,000
TOTALS	**22.40**	**$1,617,000**

Carrot Patch Setback and Restoration

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	43.90	$3,225,000
Environmental Easement	2.00	$ 130,000
TOTALS	**45.90**	**$3,355,000**

Fenster Setback and Restoration

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	21.70	$440,200
Environmental Easement	14.40	$147,800
TOTALS	**36.10**	**$588,000**

Russell Road Upper Setback Restoration

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement **Site Total**	14.80	$738,000

Russell Road Lower Setback and Restoration

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement **Site Total**	10.50	$340,000

Russell Road Lowest Setback Restoration

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	0.30	$ 13,000
Environmental Easement	10.30	$316,000
TOTALS	**10.60**	**$329,000**

Summary of Mainstem Maintenance
Property Interest and Land Values by Estate.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	76.00	$4,942,200
Environmental Easement	63.90	$2,024,800
TOTALS	**140.30**	**$6,967,000**

5.22 May Creek

The May Creek Culvert Replacement project involves a culvert perched over May Creek under Road 5530. May Creek is a tributary to the Green River. The culvert is approximately 3,100 feet upstream of the confluence with the Green River. The project restoration goals are to allow for fish passage into the upstream reach of May Creek, and upstream enhancement by adding large woody debris, spawning gravel and plantings in the riparian corridor.

The May Creek site currently involves a total of 6.50 of an acre of land located in the City of Tacoma watershed that is closed to the public and has controlled access. See Exhibit A of this plan for the project site footprint. Land zone in this area is forest with the existing use as forest. This site is on lands owned by the City of Tacoma Public Utilities and Burlington Northern Railroad. The NFS will need to acquire 6.20 acres permanent environmental easement for culvert rehabilitation, operation and maintenance, and .30 acres for a temporary work area easement to temporarily relocate the road during the construction period. See Exhibit A of this plan for the project site footprint. The culvert lies beneath an existing access road that is jointly used by property owners in the watershed. The NFS will need to acquire a non-exclusive right over and across the existing road in the TPU watershed. See paragraph 4.0 of this report for further discussions on roads within the TPU area. A disposal site is not necessary. Material will be reused on site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	6.20	$5,000
Temporary Work Area Easements (18 months)	0.30	$4,000
TOTALS	**6.50**	**$9,000**

5.23 Maywood Creek

The Maywood Creek Culvert Replacement project involves a culvert perched over Maywood Creek under Road 5530 at milepost 19.5. May Creek is a tributary to the Green River. The culvert is approximately 2,000 feet upstream of the confluence with the Green River. The project restoration goals are to allow for fish passage into the upstream reach of Maywood Creek, and upstream enhancement by adding large woody debris, spawning gravel and plantings in the riparian corridor.

The Maywood Creek Culvert site currently involves a total of 35.94 acres of land located in the City of Tacoma watershed that is closed to the public and has controlled access. See Exhibit A of this plan for the project site footprint. Land zone in this area is forest with the existing use as forest. This site is on lands owned by four owners that include the City of Tacoma, Tacoma Public Utilities, Burlington Northern Santa Fe Railroad, and a private party. For construction, operation and maintenance, the NFS County will need to acquire 34.00 acres permanent environmental easement, and 1.94 acres for a temporary work area easement to temporarily relocate the road during the construction period. The culvert lies beneath an existing access road that is jointly used by property owners in the watershed. The NFS will need to acquire a non-exclusive right over and across the existing road in the TPU watershed. See paragraph 4.0 of this report for further discussions on roads within the TPU area. A disposal site is not necessary. Material will be reused on site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	34.00	$26,000
Temporary Work Area Easement (1 year)	1.94	$ 4,000
TOTALS	**35.94**	**$30,000**

5.24 Meridian Valley Creek

The Meridian Creek Project site is located in the City of Kent, Washington, and includes the reach of Meridian Valley Creek from the concrete box culvert under SE 256th Street, through an approximate 1000-foot long, rectangular, concrete flume near the confluence of Soos Creek. The project restoration goal is to provide passage with habitat enhancement from Soos Creek to Meridian Valley Creek upstream of SE 256th Street. An ancillary benefit of the project is that it will provide a hydraulic connection between Soos Creek and the existing wetlands.

The Meridian Valley Creek site currently involves a total of 2.23 acres of land. The NFS currently owned 0.13 acres in fee, and will need to acquire an additional 2.10 acres

environmental easement from one private and one public owner for construction, operation and maintenance of this site. See Exhibit A of this plan for the project site footprint. The land in this area is single-family residential. Temporary staging will take place within the project footprint. Existing public access is available. The disposal material will be taken to the Seattle Tacoma-Airport third runway construction site. For LER crediting purposes the lands already owned by the NFS will be based on federal appraisal principles for determining fair market value. The requirement for a formal crediting appraisal will most likely be waived because of the size of the NFS's parcel. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	0.13	$ 2,700
Environmental Easement	2.10	$91,300
TOTALS	**2.23**	**$94,000**

5.25 Middle Green River Gravel Replenishment

This project includes work along a substantial length of the Green River, starting at the City of Tacoma water supply intake at approximately River Mile 61, and extending downstream to the vicinity of Flaming Geyser State Park. The goal of this project is to stop further fisheries degradation and to restore areas currently degraded as a result of the bedload blockage at the Howard Hanson Reservoir.

The Middle Green River Gravel Replacement project currently involves four sites and a total of 78.82 acres. See Exhibit A of this plan for the project site footprint for the four sites identified as Gravel Replenishment Sites S-1, S-2, C-1 and C-2. There are approximately 9 owners for a mix of public and private owners, including state owned submerged lands. For construction, operation and maintenance of these sites, the NFS will need to acquire approximately 69.80 acres environmental easement for the State owned submerged lands; 3.45 acres for permanent access; 5.50 acres for a 10-year temporary work area easement; and 0.07 acres temporary air right easements for a estimated value of $354,000. The temporary air right easements are intended to allow for a cable and bucket operation across the river. The air rights easements will occur in a 10-year timeframe, and will reportedly be approximately 150 feet in height. A ten-year temporary air rights easement seems the most suitable for gravel placement in the riverbed, and monitoring the effectiveness of this method of placement. Following the initial 10-year period, a more suitable method for placing gravels may be available. During the10-year period approximately 250,000 cubic yards of gravel will be placed in the river to make up for the gravel held back by the dam since 1961. The four gravel placement sites will be used to make up the gravel deficit over a 10-year period; then the sites will be abandoned at the end of 10 years. Also, a ten-year temporary easement reduces the damages to the upland owners that a permanent taking would cause. See the

table below for a summary of property interest and land values by site and estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

SITE NUMBER	ENVIRO EASMT SUB-MERGED LANDS ACS	EST FMV ENVIRO ESMT	PERM ACCESS ESMT ACS	EST FMV PERM ACCESS	TEMP WORK AREA ESMT (10 YRS) ACS	EST FMS TEMP WORK AREAS	TEMP AIR RIGHTS ESMT (10 YRS) ACS	EST FMV AIR RIGHTS ESMT
S-1	19.00	$92,000	1.46	$15,000	2.25	$42,600	0.04	$400
S-2	16.80	$81,000	0.90	$ 2,200	1.25	$25,000	0.03	$300
C-1	21.00	$63,000	0.28	$ 500	1.00	$13,000	--	--
C-2	13.00	$ 3,000	0.81	$ 2,000	1.00	$13,000	--	--
TOTALS	69.80	$239,000	3.45	$19,700	5.50	$93,600	0.07	$700

Grand Totals 78.82 Acres, Est. FMV $353,000

5.26 Mainstem Green River Large Woody Debris (LWD)

The Mainstem Green River LWD project sites are located within the mainstem Green River between the city of Auburn and city of Tacoma pipeline withdrawal (River Mile 32 to 61). The primary project goal is to restore natural ecosystem processes of LWD recruitment, transportation, and structure in the mainstem Green River. Restoring this ecosystem process will accomplish additional project goals of rehabilitating instream salmon spawning, rearing, and migration habitat while reducing the need for ongoing habitat maintenance. Restoring ecosystem processes will also rehabilitate habitat for non-salmonid aquatic organisms, and non-aquatic organisms that use the Green River for some component of their life history.

The NFS will need approximately 39.87 acres of land for construction, operation and maintenance of 46 sites. The NFS currently owns approximately 7.74 acres and will need to acquire the remaining 32.13 acres from a mix of public and private owners. The LWD project site involves approximately 55 owners. The size of LWD sites is approximately .46 acres per site. There are two distinct classifications of land use types, characterized as either residential or agricultural in nature. The estimated value for these sites is $142,770. See Exhibit A of this plan for the project footprints, and the below table (providing estates and land values) for a list of the LWD sites being addressed in this section of the report. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

Middle Green River Large Woody Debris

SITE NUMBER	FEE ACS	FEE FMV	ENVIRO ESMT ACS	ENVIRO ESMT FMV	PERM ACCESS ESMT	PERM ACESS ESMT FMV
BAJ3 to MJ3	--	--	2.30	$ 6,900	2.07	$ 4,200
BAJ6 to BAJ8	--	--	1.38	$ 4,200	1.11	$ 2,200
BA J9	--	--	0.46	$1,400	0.21	$ 420
BAJ10 – BAJ 11	--	--	0.92	$2,800	0.72	$1,500
BAJ12-BAJ14	--	--	1.38	$4,200	1.20	$2,400
BAJ15-BAJ18 and MAJ5	--	--	2.30	$7,600	1.40	$2,800
BAJ 19, BAJ 20 & MAJ 6	0.23	$1,500	0.69	$2,100	1.00	$2,000
BAJ21, BAJ22 & MJ7	0.23	$1,400	1.15	$3,500	2.63	$ 5,300
BAJ23 and 24, and MJ8 and MJ9	0.46	$5,750	1.38	$4,100	1.82	$24,800
BAJ25	0.46	$1,400	--	--	0.15	$ 300
BAJ26 to BAJ27	--	--	0.92	$2,800	0.58	$ 1,200
BAJ28	--	--	0.46	$1,400	0.21	$ 400
BAJ29 & BAJ 30	--	--	0.92	$2,800	0.05	$ 100
BAJ31, BAJ32 and MJ10	0.23	$1,400	1.05	$3,200	1.03	$ 2,100
BAJ33 to BAJ36 and MJ11 to MJ13	--	--	3.22	$9,700	4.85	$ 9,700
MJ1	--	--	0.46	$7,600	0.24	$ 7,600
TOTALS	**1.61**	**$11,450**	**18.99**	**$64,300**	**19.27**	**$67,020**

Grand Totals 39.87 Acres, Est. FMV $142,770

5.27 Mill Creek East

The Mill Creek East project encompasses four sites recommended by city of Kent, Washington. The project sites are located within the city of Kent, and are named Memorial Park, State Route (SR) 167, 76th Avenue South, and South 212th sites. Memorial Park site is located north of James Street and West of Jason Avenue/88th Avenue. The SR 167 site is adjacent to SR 167, west of East Valley Highway/84th Avenue, south and north of Novac Lane. The 76th Avenue South site is located between 76th Avenue South and 72nd Avenue South. The South 212th site is located north of South 212th Street and west of 77th Avenue South.

For construction, operation and maintenance of this site the NFS will need to acquire approximately 47.59 acres of land in fee, and 26.60 acres of environmental easement for a total of 74.19 acres. See Exhibit A of this plan for the project site footprint. The majority of the land in this area is zoned as industrial and general commercial. There are approximately 24 private and public owners within the project footprint. Access to the site is from existing public roads. All staging will take place within the project footprint. The disposal material will be taken to a commercial site. See the following table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	47.59	$1,875,000
Environmental Easement	26.60	$1,388,000
TOTALS	**74.19**	**$3,263,000**

5.28 Mill Creek, Geodeke Reach

The proposed Mill Creek, Geodeke Reach site is located at the south end of Mill Creek on the west side of SR 167 just downstream of Peasley Canyon. The site begins just upstream of a box culvert through which Mill Creek flows under Highway 18 and ends at Main Street. The project restoration goal at the Geodeke reach is to create a natural habitat for rearing and storm refuge.

The Mill Creek, Geodeke Reach consists of approximately 15.47 acres. For construction, operation and maintenance of this site, the NFS will need to acquire approximately 15.47 acres of environmental easement from the city of Auburn with an estimated land value of $642,000. See Exhibit A of this plan for the project site footprint. The character of land in this area is zoned industrial although much of the land appears to be encumbered by wetlands. Access to the site is from existing public roads. All staging will take place

within the project footprint. The disposal material will be taken to a commercial site. See Table17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

5.29 Mill Creek Merlino Reach

The proposed Merlino Reach of Mill Creek site links the Wetland 5k Reach and the Schuler Brothers Reach and includes portion of Mill Creek located at SR 167 to the south edge of the Schuler property. The project restoration goal at this site is to create natural habitat for rearing and storm refuge.

For construction, operation and maintenance of this site, thew NFS will need to acquire approximately 65 acres environmental easement; and 0.22 of an acre for permanent access to the site, for a total of 65.22 acres. See Exhibit A of this plan for the project site footprint. The land in this area is zoned manufacturing. There are 13 owners within the project footprint that consists of a mix of public, and private owners. Temporary staging will take place within the project footprint. All disposal material will be taken to a commercial disposal site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	65.00	$3,677,000
Permanent Access Easements	0.22	$ 73,000
TOTALS	**65.22**	**$3,750,000**

5.30 Mill Creek Schuler Brothers Reach

The Mill Creek Schuler Brothers Reach site upstream boundary begins where Mill Creek crosses from east to the west side of SR 167. It meanders north through the Schuler Brothers property and crosses S. 277th Street. North of 277th Street, Mill Creek crosses from the east to the west side of the West Valley Highway, meanders north, and crosses back over the West Valley Highway. The final crossing is the downstream boundary of the Schuler Brothers Reach. South 277th Street divides the reach into two sub-reaches along which the district habitat improvements are proposed. The project restoration goal at the Schuler Brothers Reach is to create a natural habitat for rearing and storm refuge while increasing the reach's high flow hydraulic capacity.

For construction, operation, and maintenance of Mill Creek Schuler Brothers Reach site, the NFS will need to acquire approximately 89 acres environmental easement and 1.66 acres for two permanent access easements to the site, for a total of 90.66 acres of land.

See Exhibit A of this plan for the project site footprint. The land in this area is zoned for agricultural uses. There are 8 private owner within the proposed project footprint. Temporary staging will take place within the project footprint. All disposal material will be taken to a commercial disposal site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	89.00	$738,800
Permanent Access Easement	1.66	$ 6,200
TOTALS	**90.66**	**$745,000**

5.31 Mill Creek Wetland 5K Reach

The Mill Creek Wetland 5K Reach includes the reach of Mill Creek just north of the Geodeke reach on the west side of SR 167. It extends from the Main Street to the crossing of Mill Creek with SR 167. The project restoration goal at this site is to create a natural habitat for rearing and storm refuge.

The Mill Creek Wetland 5K Reach site currently involves a total of 41.9 acres of land. For construction, operation and maintenance of this site, the NFS will need to acquire 41.40 acres of environmental easement and .50 of an acre permanent access to the site. See Exhibit A of this plan for the project site footprint. The land in this area is zoned industrial. There are 5 private owners within the project footprint. Temporary staging will take place within the project footprint. All disposal material will be taken to a commercial disposal site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	41.40	$722,000
Permanent Access Easement	0.50	$ 30,000
TOTALS	**41.90**	**$752,000**

5.32 Mullen Slough Reach

The Mullen Slough Reach site originates at S. 277th Street and flows north into the Green river. It is located west of Mill Creek and SR 167. The Mullen Slough reach extends for the north border of the Prentice Nursery at S. 277th Street. The project restoration goal at this site is to create a natural habitat for rearing and storm refuge. Restoration along Mullen Slough will include channel meandering, large woody debris placement, and riparian plantings.

The Mullen Slough Reach site currently involves a total of 91.85 acres of land. For construction, operation, maintenance of the site, the NFS will need to acquire approximately 90.00 acres environmental easement and 1.85 acres for two permanent access easements. See Exhibit A of this plan for the project site footprint. The land in this area is zoned low to medium density, single-family residential. There are 10 owners within the project footprint that consists of a mix of public and private land holdings. Temporary staging will take place within the project footprint. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	90.00	$677,000
Permanent Access Easement	1.85	$ 7,000
TOTALS	**91.85**	**$684,000**

5.33 NE Auburn Creek

The NE Auburn Creek site is a Green River tributary located north of SE 277th Street in the city of Auburn, Washington. The project site begins at the confluence of NE Auburn Creek and the Green River at about River Mile 25.9. The project site extends upstream through a series of ditches and culverts for approximately 3,300 feet to the culvert crossing SE of 277th Street.

The NE Auburn Creek site currently involves a total of 11.64 acres. For construction, operation and maintenance of this site the NFS will need to acquire approximately 10.64 acres of environmental easement and a 1-acre temporary work area easement. . Access to the site is from existing public roads. The disposal material will be taken to the Seattle Tacoma-Airport third runway construction site. See Exhibit A of this plan for the project site footprint. The lands in this area are zoned agriculture. There is one private owner and one public owner within the project footprint. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	10.64	$63,300
Temporary Work Area Easements 5-years	1.0	$ 4,500
TOTALS	**11.64**	**$68,300**

5.34 <u>Newaukum Creek</u>

The Newaukum Creek site is one of the two major tributaries flowing into the middle reach of the Green River and is located in southeast King County, east of Auburn, Washington. The mainstem of Newaukum Creek watershed is14.3 river miles long, and can be divided into three distinct sections: 1) the upper headwater 5-mile section; 2) the middle 6-mile section that meanders through plateau farmland near Enumclaw, Washington; and 3) the lower 3-mile section that descends through a steep-walled ravine from the plateau to the Green River at river mile 40. The project goal is to restore process-based ecological functions that include addressing wetland attenuation and wetland native plant diversity on the Enumclaw plateau. This includes reclaiming wetland areas for additional flow attenuation and planting wetlands with native plants to increase functions/values of wetland and stream connections. A secondary goal is to provide additional key LWD pieces within the mid-lower sections of Newaukum Creek channel to promote formation of instream habitat complexity. LWD should form new logjams that will create additional pools, side channels, and juvenile salmonid refuge.

The Newaukum Creek site currently involves a total of 222.0 acres of land located in the cities of Kent and Renton, Washington. See Exhibit A of this plan for the project site footprint. The NFS currently owns 2.10 acres of land, and will need to acquire 219.00 acres in environmental easements for construction, operation, and maintenance of this site. There is existing public access to the site. Temporary staging will take place within the project footprint. A commercial disposal site will be used for debris and unusable materials. The land in this area is zoned, rural residential or agricultural. There are approximately 127 owners within the project footprint that consists of a mix of public, private and NFS land holdings. For LER crediting purposes the lands already owned by the NFS will be based on federal appraisal principles for determining fair market value. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	2.10	$ 12,000
Environmental Easement	219.9	$1,794,000
TOTALS	**222.0**	**$1,806,000**

5.35 Northeast Creek

The Northeast Creek site is a perched culvert approximately 225 feet upstream of the confluence with Snow Creek. The existing 48-foot long pipe arch culvert is perched approximately 15 to 17 feet above the downstream pool and precludes upstream fish passage to roughly 2 miles of habitat. The existing stream channel width is approximately 10 to 15 feet wide. The project restoration goal is to eliminate the perched culvert conditions and open upstream habitat access to Coho, Steelhead, and Cutthroat adults, as well as, certain juveniles. Upstream habitat improvements would include placement of large woody debris and spawning gravel in the creek.

The Northeast Creek Culvert Projects site currently involves 1.00 acre of land with an estimated value of $2,500. The one-acre site is located in the City of Tacoma watershed that is closed to the public and has controlled access. See Exhibit A of this plan for the project site footprint. Land zone in this area is forest with the existing use as forest. This site is on lands owned by Burlington Northern Railroad, Inc. The NFS will need to acquire a 1-acres environmental easement for creating and diverting the stream upstream of the existing culvert and constructing the bridge roughly 50 feet west of the existing culvert. Material dredged for the new channel will be sidecast and later placed in the old channel bed after the existing stream is diverted to the new creek channel. All staging will take place within the existing project footprint. See Exhibit A of this plan for the project site footprint. The NFS will need to acquire a non-exclusive right over and across the existing road to access this site. See paragraph 4.0 of this report for further discussions on roads within the TPU area. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

5.36 Olson Creek

Olson Creek is a tributary to the Green River located partially within the city of Auburn, Washington. The proposed project site includes the reach from the confluence with the Green River ad extends approximately 1500 feet upstream. The project restoration goal is to improve access to the tributary from the Green River, enhance the tributary habitat, restore ecological integrity, and to provide summer and winter rearing habitat for salmonid species.

The Olson Creek site currently involves a total of 7.5 acres of land. See Exhibit A of this plan for the project site footprint. For construction, operation and maintenance of this site, the NFS will need to acquire 7.5 acres of environmental easement with and estimated land value of $26,000. Land zoning in this area is residential, single family. There is one public and one private owner within the project footprint. Existing public access is available to the site from Green River Road South. Temporary staging will take place within the project footprint. A commercial disposal site will be used for all material not reused on site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

5.37 Olsen Creek Culvert Project

The Olsen Creek Culvert project site involves a perched 72-inch CMP culvert located on Road 3703 at milepost 23.5. The existing stream channel width is approximately 8 to 12 feet wide. Olsen Creek is a tributary to the Green River and the culvert is located approximately 250 feet upstream of the confluence with the Green River. The confluence is upstream of the Corps of Engineers' Howard Hanson Dam on Tacoma Public Utilities property. Upstream of the culvert there is no woody debris. There are a few large boulders directly at the culvert mouth. The stream is flat and undefined. Quality habitat exists about 800-1000 feet upstream of the culvert. The project restoration goal is to ensure fish passage and enhance fish habitat with additional stream structures, refine existing habitat and provide a link to further habitat upstream.

The Olsen Creek Culvert Project site currently involves a total of 0.57 of an acre of land located in the City of Tacoma watershed that is closed to the public and has controlled access. See Exhibit A of this plan for the project site footprint. Land zone in this area is forest with the existing use as forest. This site is on lands owned by the City of Tacoma. The NFS will need to acquire 0.27 of an acre permanent environmental easement for culvert rehabilitation, operation and maintenance, and 0.30 acres for a temporary work area easement to temporarily relocate the road during the construction period. The culvert lies beneath an existing access road that is jointly used by property owners in the watershed. The NFS will need to acquire a non-exclusive right over and across the existing road in the TPU watershed. See paragraph 4.0 of this report for further discussions on roads within the TPU area. A disposal site is not necessary. Material will be reused on site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs for this site.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	0.27	$ 200
Temporary Work Area Easement (2-years)	0.30	$7,500
TOTALS	**0.57**	**$7,700**

5.38 Porter Levee Setback

The Porter Levee Setback site is located one mile upstream of the crossing of Highway 18 and the Green River. It is on the right bank of the river near the slaughterhouse. Much of the historic flood plain for this portion of the Green River has been lost to conversion to agriculture. Levees have been placed along the river to keep the river in its

current position. There are very few places where the river is allowed to spill over its banks and re-charge the adjacent flood plain. The levee construction has also limited the Rivers ability to meander and make new channels. The result of both of these actions means less spawning habitat in the mainstream, a loss of flood storage capacity and limiting nutrient export from the adjacent terrestrial system.

The proposed restoration goals for this site (mainstream of the river) is the removal of an existing training levee, and hydrologically connecting approximately 45 acres of flood plain. This would give the river the opportunity to move or meander across the former flood plain, increasing channel length in a highly productive Chinook spawning area as well as the opportunity to create additional off-channel habitat. Nutrient export, increase in base flow and some flood storage capacity would be additional benefits of the project.

The Porter Levee Setback site currently involves a total of 35.22 acres of land. See Exhibit A of this plan for the project site footprint. The NFS is the sole owner of the lands needed for construction, operation and maintenance of this site. The NFS will not receive credit for 3.58 acres of the 35.22 acres necessary for this project since it was previously provided for the Porter Creek Sec 1135 Project. The remaining 31.64 creditable acres fee interest will be credited to the NFS for the Duwamish-Green Project. The estimated fair market value of the 31.64 acres is $237,000. A majority of the land is zoned agricultural. Access to the site is from SE Green Valley Road. The disposal material will be taken to the Seattle Tacoma-Airport third runway construction site. For LER crediting purposes the lands already owned by the NFS will be based on federal appraisal principles for determining fair market value. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

5.39 Prentice Nursery

The Pretence Nursery Site begins at the Green River and extends upstream approximately 500 feet to include the Nursery. Highway 516 crosses Mullen Slough within the site. The project restoration goal for this site is to create a natural habitat for rearing ad storm refuge.

The Prentice Nursery site currently involves a total of 4.86 acres of land with an estimated fair market value of $33,000. See Exhibit A of this plan for the project site footprint. King County will need to acquire 4.86 acres of environmental easement for construction, operation and maintenance of this site. The land in this area is zoned for agricultural uses and a portion is zoned for multi-family. There are 3 ownerships within the project footprint that consists of one private and two public land holdings. Existing public access will be used. Temporary staging will take place within the project footprint. A commercial disposal site will be used. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

5.40 Ray Creek

The Ray Creek site is a former side channel now occupied by a wall-based tributary located within the Green River floodplain. Ray Creek joins the Green River at Rivermile

34.2, immediately downstream of the Nealy Bridge. The 2.3-mile long stream originates within a former Green River side channel that formed along the right bank. The primary project restoration goal for this site is to restore and protect a native coniferous plant community within the riparian buffer and allow natural ecosystem processes to be reestablished in the stream riparian corridor. Project goals also include creating a natural environment to enhance salmonid rearing within the stream, reduce sediment impacts from cattle, and, and create additional connected refuge wetland habitat.

The Ray Creek Corridor site currently involves a total of 29.31 acres of land. The NFS currently owns approximately 0.65 acres, and will need to acquire an additional 27.40 acres environmental easement; and 1.26 acres for two permanent accesses for construction, operation and maintenance of this site. See Exhibit A of this plan for the project site footprint. The land in this area is zoned agricultural. There are 5 approximately 5 owners within the project footprint that consists of private owners and NFS land holdings. Temporary staging will take place within the project footprint. A commercial disposal site will be used. For LER crediting purposes the lands already owned by the NFS will be based on federal appraisal principles for determining fair market value. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	.65	$ 8,000
Environmental Easement	27.4	$264,000
Permanent Access Easements	1.26	$ 8,000
TOTALS	**29.31**	**$281,000**

5.41 Riverside Estates Side Channel

Riverside Estates Side Channel is named after the existing residential development located near 37th Street NE in the city of Auburn, Washington. The site is located at River Mile (RM) 28.8, behind Reddington Levee that currently provides flood protection. The proposed project includes the reach from an existing flap-gated culvert in the levee approximately 1,500 feet upstream. The project purpose is to re-establish the side channel habitat to provide summer rearing habitat, and winter refugia while maintaining the existing level of flood protection to the local region.

The Riverside Estates Side Channel site involves a total of 11.40 acres of land. See Exhibit A of this plan for the project site footprint. The NFS currently owns 0.80 of an acre, and will need to acquire an additional 8.35 acres of environmental easement, and 2.25 acres permanent easement for construction, operation and maintenance of this site. The land in this area is zoned primarily single-family residential. There are

5 owners within the project footprint that consists of a mix of public, private and NFS land holdings. A 0.09 of an acre temporary staging area is needed for the construction period. All disposal material will go to a commercial site. For LER crediting purposes the lands already owned by the NFS will be based on federal appraisal principles for determining fair market value. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	0.80	$6,000
Environmental Easement	8.35	$54,000
Permanent Access Easement	2.25	$22,000
TOTALS	**11.40**	**$82,000**

5.42 Riverton Side Channel

This project site is located in the city of Tukwila, immediately north and east of the intersection of State Route (SR) 99 and SR 599. Riverton Creek has been heavily impacted both directly re relocation and channelization, as well as indirectly by increased flows and sedimentation resulting from urban development. The primary goal of the project is to restore and enhance salmonid habitat within Riverton Creek and improve its connection to the Duwamish River, using natural processes and habitat elements to facilitate upstream migration and to provide juvenile off-channel rearing.

The Riverton Side Channel site currently involves a total of 3.48 acres of land. See Exhibit A of this plan for the project site footprint. The NFS will need to acquire 2.0 acres environmental easement, and 1.39 acres for permanent access road easement for construction, operation and maintenance of this site. The NFS will need to acquire an additionally 0.09 of an acre temporary staging area for the construction period for this site. The land in this area is zoned manufacturing. There are 3 ownerships within the project footprint that consists of a mix of public and private land holdings. A disposal site is necessary during construction period for this site. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement	2.00	$ 28,000
Permanent Access Easement	1.39	$362,200
Temporary Work Area Easements (4 years)	0.09	$ 800
TOTALS	**3.48**	**$391,000**

5.43 Sunday Creek Riparian Plantings

Sunday Creek is located in the Upper Green River Basin approximately 2.5 miles upstream of Lester, Washington. This site is located within the city of Tacoma Public Utilities municipal watershed, (TPU) area that is closed to the public and has controlled access. The project site begins near the Bonneville Power Administration (BPA) power lines crosses Sunday Creek, approximately 2.75 miles upstream of the Sunday Creek confluence. The project extends upstream for approximately 2.9 miles. The project restoration goal is to improve salmon habitat. This will be accomplished by decreasing stream temperatures by providing shade from the reestablishment of riparian vegetation along the project corridor.

The Sunday Creek Riparian Plantings site currently involves 70.25 acres with an estimated value of $7,000. Access to the site is from an existing access road owned mainly by TPU with a short segment or road crossing USFS lands. See paragraph 4.0 of this report for a discussion of the access roads in the TPU watershed. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs

5.44 Sweeney Creek

The Sweeney Creek site includes two perched culverts located on Road 3703 at milepost 21.8. The creek is a south tributary of the Green River and the culverts are approximately 200 feet upstream of the confluence with the Green River. The existing 60-inch diameter east culvert is perched 1.3 feet high and does not allow fish passage; the 48-inch diameter west culvert is perched 3.54 feet high. The existing steam channel width is approximately 10 to 14 feet wide. Presently, there is a 4 to 5 foot drop I the last 12 to 15 feet of the creek at the confluence with the Green River. The project restoration goal is to eliminate the perched culverts as well as the steep gradient in the last 15 feet of the creek to allow for fish passage into the upstream reach of Sweeney Creek. Upstream habitat improvements will include placement of large woody debris in the creek.

The Sweeney Creek-Culvert Projects site currently involves a total of 0.33 of an acre of land located in the City of Tacoma watershed that is closed to the public and has controlled access. See Exhibit A of this plan for the project footprint. Land zone in this area is forest with the existing use as forest. This site is on lands owned by the City of Tacoma. The NFS will need to acquire 0.33 of an acre permanent environmental

easement with an estimated fair market value of $300 for culvert rehabilitation, operation and maintenance. The NFS will need to acquire a non-exclusive right over and across the existing road in the TPU watershed. See paragraph 4.0 of this report for further discussions on roads within the TPU area Temporary staging will take place within the project footprint. A separate disposal site is not necessary. Material will be reused on site. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

5.45 Turley Levee

The Turley Levee site is located at River Mile 37 about 2 miles upstream of Nealey Bridge. The proposed project would include moving approximately 1300 feet of levee back approximately 500 feet. This will allow a significant amount of area to be open to the power of the river to flood and work on this new area and sculpted it into new fish habitat. The primary restoration goal of the project is to make additional area available to the river for it to construct additional side channel habitat within the Green River system in order to allow natural ecosystem processes to be re-established in the side channel riparian corridor. Project goals include creating as natural an environment as possible to enhance salmonid rearing within the area now open to the river and let the river create refuge wetland habitat.

The Turley Levee site currently involves a total of 12.94 acres of land owned by two private owners. See Exhibit A of this plan for the project site footprint. The NFS will need to acquire 12.40 acres in fee and 0.54 acres for permanent access easement for construction, operation and maintenance of this site. The land in this area is zoned agricultural. Temporary staging will take place within the project footprint. A commercial disposal site will be used. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Fee	12.4	$93,000
Permanent Access Easement	0.54	$2,000
TOTALS	**12.94**	**$95,000**

5.46 Upper Green River Side Channel Enhancement

The Upper Green River Side Channel sites include Sites 1 and 2. Site 1 is located on the Green River about Rivermile 60, approximately 4.5 miles downstream of the Howard Hanson Dam. Site 2 is located downstream of Site 1 at about Rivermile 58.5. The upper Green River is sediment-limited because the Howard Hanson Dam now traps sediment historically supplied by upstream processes, such as landslides and bedload transport.

Because natural recruitment of sediment in river reaches located immediately downstream of the dam is insufficient to compensate for lost sediment, the channel has begun to incise, the surface substrate has become imbedded and armored with boulders and cobbles, and there is an absence of gravels of suitable size for spawning salmon.

This restoration project has two primary goals: 1) restore natural ecosystem processes of sediment supply and transport to the side channels (and mainstem) at Sites 1 and 2; and 2) restore natural ecosystem processes of large woody debris (LWD) recruitment, transport, and structure in the side channels (and mainstem). Restoring these ecosystem processes will accomplish additional project goals of rehabilitating instream salmon spawning, rearing, and migration habitat while reducing the need for ongoing maintenance. Restoring ecosystem processes will also rehabilitate habitat for non-salmonid aquatic organisms, and non-aquatic organisms that use the Green River for some component of their life history.

The Upper Green River Side Channel Enhancement site currently consists of a total of 12.51 acres of land involving public and private ownerships. See Exhibit A of this plan for the project footprints for Sites 1 and 2. The NFS will need to acquire 11.27 acres of environmental easement; and 1.24 acres for permanent access easements for construction, operation and maintenance of this site. The land zoning in these areas consist primarily of rural residential and forest zoned sites. No disposal is required. See the table below for a summary of property interest and land values by estate. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

ESTATES	ACRES	ESTIMATED FAIR MARKET VALUE
Environmental Easement Sites 1 & 2	11.27	$145,000
Permanent Access Easement Sites 1 & 2	1.24	$ 13,000
TOTALS	**12.51**	**$158,000**

5.47 Upper Springbrook Creek

The Upper Springbrook Creek site upstream boundary begins where the creek crosses from the south to the north side of S. 55th Street. The Reach continues west along the north side of S. 55th Street until it reaches the SR 167 east R-O-W. The site is lacking in riparian vegetation, and native canary grass; and black berry shrubs leave the stream without shaded. The existing canopy also provides access for fish-eating birds. There is essentially no instream habitat such as woody debris. Further, certain reaches of the stream would benefit from two-stage channeling. Additionally, sediment from upstream runoff originating in the City of Renton's jurisdiction causes a channel maintenance problem and plugs the Washington Department of Transportation culvert under 405. The project restoration goal at the Upper Springbrook reach is to create a natural habitat for spawning, rearing, and storm refuge. Restoration along Upper Springbrook will include

adding channel spawning gravel, large woody debris, and riparian plantings. Also, an effective means of sediment removal with minimal disturbance to the creek is also a project goal.

The Upper Springbrook Creek site currently involves a total of 2.13 acres of land with an estimated fair market value of $15,000. This site involves one private owner. See Exhibit A of this plan for the project site footprint. The NFS will need to acquire 2.13 acres of environmental easement for construction, operation and maintenance of this site. Land zoning in this area is a combination of single-family residential and multi-family residential. Temporary staging will take place within the project footprint. Access to the site is available from S. 192nd Street. The disposal material will be taken to the Seattle-Tacoma Airport third runway construction site. See Table 17-A, Baseline LER Cost Estimate Summary for total estimated real estate costs.

6.0 ESTATES

6.1 General

This report is based on the requirement and assessment of fee value for the portions of land within a site that is already owned by the NFS, or where the NFS advises they reasonable believe they cannot successfully acquire a fee interest. The NFS has been advised that federal regulations prescribe fee interest for restoration type projects. The NFS is willing to obtain fee interest when and where possible; however, a majority of the sites where acquisition is necessary is based on perpetual environmental easement. See Section 7.3 for the easement estate developed for the Green/Duwamish River Basin project sites justification for approval through this decision document. The District will advise the NFS of the fee requirements again during the project implementation phase. Where fee acquisition may not be possible the District will instruct the NFS to use the approved environmental estate language. The NFS was provided with all the estates given below for review, and comment at this stage.

During the PED phase the District will reconsider the need for bank protection and/or permanent levee easements for the mainstem maintenance projects in place of the environmental easement currently proposed and valued for this plan. Listed below is a temporary disposal easement. The District will also reconsider the need for disposal sites beyond what is currently identified in this report during the PED phase. Finally, note that the underlining and strikethrough in the standard estates below show non-material deviations.

6.2 Standard Estates

The standard estates that follow are from ER 405-1-12, Chapter 5, Change 7 of 8 Feb 79.

1. **Fee:** The fee simple title to the land described in ~~Schedule~~ Exhibit A, subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

2. **Flood Protection Levee Easement:** A perpetual and assignable right and easement in the land described in ~~Schedule~~ Exhibit A ~~(Tracts Nos. ___, ___ and ___)~~ to construct, maintain, repair, operate, patrol, and replace a flood protection levee, including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads, and pipelines.

3. **Road Easement:** A perpetual and assignable easement and right-of-way in, on, over, and across the land described in ~~Schedule~~ Exhibit A for the location, construction, operation, maintenance, alteration, and replacement of (a) road(s) and appurtenances thereto; together with the right to trim, cut, fell, and remove therefrom all trees, underbrush, obstructions, and other vegetation, structures, or obstacles within the limits of the right-of-way; [1](reserving, however, to the owners, their heirs and assigns, the right to cross over or under the right-of-way as access to their adjoining land at the locations indicated in Schedule b);[2] subject, however, to existing easements for public roads and highways, public utilities, railroads, and pipelines.

4. **Temporary Work Area Easement:** A temporary easement and right-of-way in, on, over, and across the land described in ~~Schedule~~ Exhibit A, for a period not to exceed [see individual site requirements], beginning with date possession of the land is granted to ~~the United~~ States King County, Washington, for use by the United States, its representatives, agents, and contractors as a work area, including the right to deposit fill, dredge and waste material thereon, move, store, and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the Green/Duwamish River Basin Ecosystem Restoration Project, together with the right to trim, cut, fell, and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject however, to existing easements for public roads and highways, public utilities, railroads, and pipelines.

5. **Temporary Disposal Area Easement:** A temporary easement and right-of-way in, on, over, and across the land described in ~~Schedule~~ Exhibit ~~A (Tracts Nos. ___, ___, and ___)~~, for a period not to exceed _____, beginning with date possession of the land is granted to ~~the United~~ States King County, Washington, for use by the United States, its representatives, agents, and contractors as a temporary disposal area, including the right to deposit fill, spoil, and waste material thereon, move, store, and remove equipment and supplies, and erect and remove temporary structures on the land

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[1] Parenthetical clause may not apply to every road easement proposed for acquisition, and could be deleted as necessary.

[2] The parenthetical clause may be deleted, where necessary; however, the use of this reservation may substantially reduce the liability of the Government through reduction of severance damages and consideration of special benefits; therefore, its deletion should be fully justified. Also, access may be restricted to designated points.

and to perform any other work necessary and incident to the construction of the Green/Duwamish River Basin Ecosystem Restoration Project, together with the right to trim, cut, fell, and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject however, to existing easements for public roads and highways, public utilities, railroads, and pipelines.

6.3 Proposed Environmental Easement Estate

The following environmental easement estate is provided for review and approval for use in cases where the NFS is unable to obtain a fee interest for an environmental restoration project site. Some of the lands project site lands identified in this report fall on State Park or other public agency lands where the public agency may not be able to convey to the NFS a fee interest. Additionally, the NFS has many years of experience in land acquisition along the Green/Duwamish corridor, which include development rights on agricultural lands and acquiring lands for parks and open space. Also, based on input from landowners during workshops conducted in May 2000, a majority of the landowners expressed they will consider granting an environmental easement, but not fee. Some of the landowners have been on the land for 4 generations and are not interested in selling their land to anyone for any reason. The NFS is concerned that if they were to pursue the fee ownership policy it would turn the landowners from being in favor of the overall project to one of opposition, and would probably eliminate any opportunity for ecosystem restoration in much of the basin. The District and NFS are in agreement that the proposed environmental estate is sufficient and recommend it for implementation for the sites Green/Duwamish Environmental Restoration Project Sites.

Environmental Easement: A perpetual and assignable right and easement in, on, and across the lands of Grantor described in Exhibit A attached hereto to construct, operate, maintain, repair, alter, rehabilitate, remove, replace and monitor project features; plantings; and any other improvements within and adjacent to the stream or shore for grade control, channel, bank, and /or shore, and bank stabilization, fish and wildlife habitat improvements, and other environmental improvements, including the removal of structures or obstructions including levees; the placement of materials or structures in the bed, banks, or shorelines that influence stream velocity or channel form, the removal or placement of gravels, cobbles, and boulders, and other structures, or conveyances to recharge or maintain flow to existing wetlands; reserving, however, to the owners, their heirs and assigns, all other rights and privileges that may be used without interfering with or abridging the enumerated rights and easement hereby conveyed and acquired; all subject to existing easements for public roads and highways, public utilities, railroads and pipelines.

6.4 Proposed Shore Protection Easement:

The following shore protection easement estate is provided for review and approval for use in cases where a shore protection easement is determined to be the minimum interest required for mainstem maintenance. Past experience with King County is that their shore

protection easements generally need to be brought up to COE estate standards before implementing a shore protection type project. Also, as previously stated in Section 7.1 of this plan, the District will reconsider the need for bank protection during the PED phase. The District desires approval of this estate to have it as an available tool for future use for the mainstem maintenance sites, as necessary. The proposed shore protection easement presented is similar to the shore protection easement previously approved for the District's use (CERE-AP 2nd End of 4 March 1997) for the Lummi Shore Protection Section 103 Project.

Shore Protection Easement: A perpetual and assignable easement and right-of-way in, on, over, and across the land described in Exhibit "A" to construct, operate, maintain, patrol, repair, and replace shore protection works, and appurtenances thereto, including the right to borrow and/or deposit fill, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures or obstacles within the limits of the easement; reserving, however, to the grantor(s), (his) (her) (its) (their) (heirs), successors and assigns, all such rights and privileges as may be used without interfering with a abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

6.5 Temporary Air Rights for Middle Green Gravel Replenishment Sites S-1 and S-2.

The following air right easement estate is necessary to facilitate the construction of the Middle Green River Gravel Replenishment Sites S-1, and S-2. The Air Right easements are intended to allow for a cable and bucket operation across the river. The easements will also occur in a 10-year timeframe, and will reportedly be approximately 150 feet in height. The District is proposing use of the standard temporary work area easement as the base estate with modifications shown by strikethrough and underlined text. The temporary work area easement seems the most suitable to meet the proposed ten years of placement and monitoring. Following the ten-year period there may be a more suitable method for placing gravels in the riverbed. The ten-year period also reduces the damages to the upland owners resulting from a permanent taking. A perpetual environmental easement is proposed for placement of gravel in the riverbed from mean high water to mean high water.

Temporary Air Rights Easement: A temporary easement and right-of-way in, on, over, and across the land described in ~~Schedule~~ Exhibit A, for a period not to exceed ten-years beginning with date possession ~~of~~ the ~~land and~~ overhead air right are granted to ~~the United States~~ King County, Washington, for use by the United States, its representatives, agents, and contractors for overhead cable and bucket operation over the bed and shorelands of the Green River ~~including the right~~ to deposit gravels in the riverbed ~~a work area, to deposit fill, dredge and waste material thereon, move, store, and remove equipment and supplies, and erect and remove temporary structures on the land~~ and to perform any other work necessary and incident to the construction of the Green/Duwamish River Basin Ecosystem Restoration, Middle Green River Gravel Replenishment Project, together with the right to trim, cut, fell, and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within

the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject however, to existing easements for public roads and highways, public utilities, railroads, and pipelines.

7.0 NAVIGATIONAL SERVITUDE

Navigational servitude for the 47 project is not being exercised for this project. There are no project sites that include a nexus to previous Crops of Engineers Project where navigational servitude was exercised in aid to navigation.

8.0 PUBLIC LAW 91-646 AND ACQUISITION

The NFS has been advised of Public Law 91-646 as amended. The NFS has land acquisition experience and is fully capable of acquiring any lands necessary for the project. Exhibit B provides a detailed assessment of the NFS's real estate acquisition capability.

Before advertisement for construction for each site, the NFS will make all lands, other than USACE owned lands, necessary for the project available to the Federal Government by a Certification of Lands and Authorization for Entry and an Attorney's Certificate presented in Exhibit C. The NFS will provide the USACE, within 180 days after authorization of entry for construction, supporting LERRD credit documentation, including appraisals for crediting purposes for NFS lands made available for a project site.

9.0 RELOCATION ASSISTANCE BENEFITS

No relocation assistance benefits are anticipated to be required for the implementation of the project. There are no families or businesses that will temporarily or permanently be displaced.

10.0 ZONING

There are no zoning ordinances proposed in lieu of or to facilitate acquisition in connection with this project.

11.0 MINERAL INTERESTS

At this time the USACE is not aware of any outstanding mineral interests in the vicinity of the project that may affect implementation of the project.

12.0 HAZARDOUS AND TOXIC WASTES

The USACE will performed an investigation to identify the presence of hazardous and/or toxic wastes (HTRW) and level of HTRW during the PED phase. A tiered investigation and binary decision approach will be performed during PED.

To date it was determined there is a potential for hazardous wastes to enter the Green/Duwamish River, and consequent sediment contamination is of most concern in the lower river. Because there is a potential for encountering hazardous materials at restoration sites, particularly in the lower basin, the potential for hazardous waste will be evaluated on a project-by-project base. Land use practices at each restoration site will be examined to determine if there is a reason to believe that potential contamination exists. If a determination is made that there is contamination potential; then the proper sampling intensity will be conducted to determine the type and extent of contaminants. Where appropriate, soil testing will occur and all applicable policies and regulations will be followed. If testing indicates that there are contaminants at a site, the site will be cleaned up in compliance with pertinent regulations, policies and laws. If the contamination is too severe, the project will be abandoned.

Further investigation and clean up requirements will be in accordance with current policy, laws and the Project Cooperation Agreement.

The estimated fair market value of the lands for this report was valued based on the assumption the lands are not contaminated. Following future determination of the existence of CERCLA regulated materials the sites will be dropped. If materials not regulated by CERCLA are discovered, the land shall be appraised as it exists.

13.0 LANDOWNER'S VIEWS AND PUBLIC OPPOSITION

Landowners that have attended the public meetings and workshops held to date and have basically accepted all the proposed restoration projects. No public opposition has been noted to date.

14.0 Outstanding Third Party Interests

All property interest acquired in support of the proposed project must take priority over any third party interests such as: public roads and highways, public utilities, railroads, and pipelines. Any third party interests that could defeat or impair the NFS's title to the property or interfere with construction, operation and maintenance of the project must be cleared from the title or subordinated to the interest made being available for the project. As stated in paragraph 16.0 of the report, there are no utility or facility relocations anticipated at this time.

15.0 Risks Associated with Advanced Land Acquisition

The NFS was advised of the risks (summarized below) associated with advance land acquisition activities. The District supports the NFS's desire to move ahead with land acquisition activities in advanced of signing the Project Cooperation Agreement, and will provide the NFS with Federal review and assistance.

A summary of risks associated with advance land acquisition activities include, but is not limited to the following:

- Congress may not appropriate funds to construct the proposed project.

- The proposed project may otherwise not be funded, or approved for construction.

- A Project Cooperation Agreement (PCA) mutually agreeable to the NFS and the Government may not be executed and implemented.

- The NFS may incur liability and expense by virtue of its ownership of contaminated lands, or interests therein, whether such liability should arise out of local, state, or Federal laws or regulations including liability arising out of CERCLA, as amended.

- The NFS may acquire interests or estates that are later determined by the Government to be inappropriate, insufficient, or otherwise not required for the project.

- The NFS may initially acquire insufficient or excessive real property acreage which may result in additional negotiations and/or benefit payments under Public Law 91-646 as well as the payment of additional fair market value to affected landowners which could be avoided by delaying acquisition until after PCA execution and the Government's notice to commence acquisition and performance of their lands, easements, and rights-of-way activities.

- The NFS may incur costs or expenses in connection with its decision to acquire or perform their lands, easements and rights-of-way activities in advance of the signing of the PCA and the Government's notice to proceed which may not be creditable under the provisions of Public Law 99-662 or the PCA.

16.0 UTILITY and Facility Relocations

No utility and facility relocations are anticipated to be required.

17.0 COST ESTIMATE FOR LANDS EASEMENTS AD RIGHTS-OF-WAY

17.1 Baseline Cost Estimate

The baseline cost estimate presented in Table 17-A includes a breakdown of the estimated fair market value of project lands, the NFS's acquisition costs, and Federal review and assistance costs. NFS acquisition costs include incidental acquisition costs such as title, survey and appraisal, and negotiation costs; recording fees; and legal fees. Federal review and assistance costs include those costs associated with providing the NFS with LERRD requirements, review of acquisitions and crediting appraisals, coordination meetings, review of right-of way documents, legal support, and crediting activities. The total cost of LER acquisition is estimated to be approximately $37,961,000.

TABLE 17-A
Baseline LER Cost Estimate Summary

SITE NO.	SITE NAME	TOTAL ACRES	LAND VALUES	NON-FEDERAL SPONSOR'S ADMINISTRATIVE COSTS	FEDERAL GOV'T REVIEW & ASSISTANCE COSTS	TOTAL LAND COSTS PER SITE
1	Big Spring Creek	14.90	$ 68,250	$ 47,000	$ 11,000	$ 126,250
2	Black River Marsh	4.86	$ 57,000	$ 40,000	$ 10,000	$ 107,000
3	Brunner Slough	16.10	$ 38,000	$ 33,000	$ 8,000	$ 79,000
4	Burns Creek Restoration	24.27	$ 440,400	$ 93,000	$ 17,000	$ 550,400
5	Codiga Farms	3.40	$ 118,000	$ 14,000	$ 4,000	$ 136,000
6	Elliot Bay Nearshore	5.70	$ 3,000	$ 7,000	$ 3,000	$ 13,000
7	Flaming Geyser Side Channel	25.18	$ 252,000	$ 14,000	$ 4,000	$ 270,000
8	Flaming Geyser Slide	10.15	$ 127,000	$ 7,000	$ 4,000	$ 138,000
9	Gale Creek	0.63	$ 4,300	$ 7,000	$ 3,000	$ 14,300
10	Garrison Creek (1)	19.78	$ 358,000	$ 119,000	$ 23,000	$ 500,000
11	Gilliam Creek	4.40	$ 49,000	$ 7,000	$ 3,000	$ 59,000
12	Gold Creek	0.57	$ 7,700	$ 7,000	$ 3,000	$ 17,700
13	Green River Park	3.56	$ 104,800	$ 14,000	$ 4,000	$ 122,800
14	Hamakami Levee Modification	3.20	$ 16,000	$ 14,000	$ 4,000	$ 34,000
15	Horsehead Bend Side Channel	14.06	$ 130,000	$ 14,000	$ 4,000	$ 148,000
16	Keach Levee Pond	5.28	$ 58,000	$ 14,000	$ 4,000	$ 76,000
17	Lake Meridian Outlet Relocation	8.80	$ 117,900	$ 14,000	$ 4,000	$ 135,900
18	Lones Levee Setback	30.45	$ 273,000	$ 20,000	$ 6,000	$ 299,000
19	Lower Springbrook Creek	55.15	$ 3,020,000	$ 198,000	$ 41,000	$ 3,259,000
20	Mainstem Maintenance (Auburn to Elliot Bay)	140.30	$ 6,967,000	$ 80,000	$ 19,000	$ 7,066,000
21	May Creek	6.50	$ 9,000	$ 14,000	$ 4,000	$ 27,000
22	Maywood Creek	35.94	$ 30,000	$ 27,000	$ 7,000	$ 64,000
23	Meridian Valley Creek	2.23	$ 94,000	$ 20,000	$ 5,000	$ 119,000
24	Middle Green River Gravel Replacement	78.82	$ 353,000	$ 86,000	$ 25,000	$ 464,000
25	Middle Green River Large Woody Debris	41.25	$ 142,770	$ 359,000	$ 95,000	$ 596,770
26	Mill Creek East	74.19	$ 3,263,000	$ 159,000	$ 42,000	$ 3,464,000
27	Mill Creek, Goedeke Reach	15.47	$ 642,000	$ 7,000	$ 3,000	$ 652,000
28	Mill Creek, Merlino Reach	65.22	$ 3,750,000	$ 86,000	$ 16,000	$ 3,852,000
29	Mill Creek, Schuler Brothers Reach	90.66	$ 745,000	$ 53,000	$ 11,000	$ 809,000
30	Mill Creek, Wetland 5K Reach	41.90	$ 752,000	$ 33,000	$ 8,000	$ 793,000
31	Mullen Slough Reach	91.85	$ 684,000	$ 66,000	$ 13,000	$ 763,000
32	NE Auburn Creek	11.64	$ 68,300	$ 14,000	$ 4,000	$ 86,300
33	Newaukum Creek	224.00	$ 1,806,000	$ 839,000	$ 147,000	$ 2,792,000
34	Northeast Creek	1.00	$ 2,500	$ 7,000	$ 3,000	$ 12,500
35	Olsen Creek Culvert Project	0.30	$ 7,700	$ 7,000	$ 3,000	$ 17,700
36	Olson Creek	7.50	$ 26,000	$ 14,000	$ 4,000	$ 44,000
37	Porter Levee Setback	31.64	$ 237,000	$ 7,000	$ 3,000	$ 247,000
38	Prentice Nursery	4.86	$ 33,000	$ 27,000	$ 7,000	$ 67,000
39	Ray Creek Trib Corridor	29.31	$ 281,000	$ 33,000	$ 8,000	$ 322,000
40	Riverside Estates Side Channel	11.40	$ 82,000	$ 33,000	$ 8,000	$ 123,000
41	Riverton Side Channel	3.48	$ 391,000	$ 20,000	$ 7,000	$ 418,000
42	Road in TPU Watershed	103.76	$ 77,800	$ 20,000	$ 6,000	$ 103,800
43	Site 1, Duwamish	2.82	$ 933,000	$ 14,000	$ 4,000	$ 951,000
44	Sunday Creek Riparian Plantings	70.25	$ 7,000	$ 14,000	$ 4,000	$ 25,000
45	Sweeney Creek	0.33	$ 300	$ 7,000	$ 3,000	$ 10,300
46	Turley Levee Setback	12.94	$ 95,000	$ 14,000	$ 4,000	$ 113,000
47	Upper Green River Side Channel Enhancement	12.51	$ 158,000	$ 80,000	$ 18,000	$ 256,000
48	Upper Springbrook Creek	2.13	$ 15,000	$ 7,000	$ 3,000	$ 25,000
	SUBTOTAL	1464.64	$ 26,894,720	$ 2,830,000	$ 644,000	$ 30,368,720
	25% Contingency		$ 6,723,680	$ 707,500	$ 161,000	$ 7,592,180
	GRAND TOTAL	1464.64	$ 33,618,400	$ 3,537,500	$ 805,000	$ 37,960,900

17.2 LER Cost Estimate by Construction Phase

It is anticipated that the proposed project will be constructed in three phases spanning from 2003 to 2012. These construction phases are summarized in Table 17-B. Phase 1 construction starts are between 2003-2005 with some site construction continuing until 2012. Phase 2 construction starts are scheduled to occur between 2006-2008 with some site construction continuing until 2012. Phase 3 construction starts are between 2009 & 2010 with construction continuing until 2012. A cost estimate breakdown by construction phase is provided in Tables 17-C, 17-D and 17-E.

Construction Phases By Site
Table 17-B

Phase	Project Site Name	Construction Start	Construction End	NFS Acquisition & Certification Period
I	Codiga Farms	2003	2004	8 months
I	Flaming Geyser Land Slide	2003	2009	8 months
I	Gilliam Creek	2003	2006	6 months
I	Middle Green Gravel Replacement Sites S1, S2, C1 & C2	2003	2012	14 months
I	Duwamish Site 1	2004	2008	12 months
I	Elliot Bay Nearshore	2004	2006	12 months
I	Green River Park	2004	2006	8 months
I	Hamakami Levee Breach	2004	2006	8 months
I	Mainstem Maintenance – Russell Road Upper Setback Restoration	2004	2006	8 months
I	Middle Green Large Woody Debris (LWD) Sites BAJ19, 20 & MAJ6; BAJ25, BAJ28; BAJ29 & 30	2004	2006	12 months
I	Prentice Nursery	2004	2006	11 months
I	Turley Levee Setback	2004	2006	8 months
I	Flaming Geyser Side Channel	2005	2012	9 months
I	Horsehead Bend Side Channel	2005	2010	8 months

Table 17-B Continued

Phase	Project Site Name	Construction Start	Construction End	NFS Acquisition & Certification Period
I	Lones Levee Setback	2005	2007	11 months
I	Mainstem Maintenance Russell Road Lower Setback & Restoration	2005	2007	6 months
I	Middle Green LWD Sites BAJ33-36 MJ11-MJ13	2005	2007	8 months
I	Mullen Slough Reach	2005	2008	18 months
I	Riverside Estates Side Channel	2005	2008	8 months
I	Riverton Side Channel	2005	2008	11 months
II	Mainstem Maintenance Boeing Setback and Restoration	2006	2008	8 months
II	Burns Creek	2006	2010	24 months
II	Lake Meridian Outlet	2006	2009	8 months
II	Meridian Valley Creek	2006	2008	11 months
II	Middle Green Large Woody Debris Sites BAJ 6, BAJ7 & BAJ8; BAJ9; BAJ12, BAJ13 &BAJ14	2006	2008	24 months
II	Mill Creek East	2006	2012	
II	Mill Creek, Schuler Brothers Reach	2006	2010	14 months
II	Porter Levee Setback	2006	2010	NFS already owns the lands.
II	Brunner Slough	2007	2011	12 months

Table 17-B Continued

Phase	Project Site Name	Construction Start	Construction End	NFS Acquisition & Certification Period
II	Mainstem Maintenance Carrot Patch Setback and Restoration	2007	2009	8 months
II	Garrison Creek	2007	2012	30 months
II	Keach Levee	2007	2012	8 months
II	Middle Green Large Woody Debris Sites BAJ23, BAJ24 MJ8, MJ9; BAJ31, BAJ32, & MJ10	2007	2010	11 months
II	Mill Creek, Merlino Reach	2007	2010	24 months
II	NE Auburn Creek	2007	2012	12 months
II	Olson Creek	2007	2012	8 months
II	Upper Springbrook	2007	2010	12 months
II	Black River Marsh	2008	2012	12 months
II	Mainstem Maintenance Fenster Setback and Restoration	2008	2010	11 months
II	Middle Green Large Woody Debris Sites MJ1 & BAJ3 to MJ3	2008	2010	24 months
II	Mill Creek, Wetland 5K Reach	2008	2009	12 months
III	Newaukum Creek	2009	2012	5 years
III	Upper Green Side Channel Enhancement	2009	2012	24 months

Table 17-B Continued

Phase	Project Site Name	Construction Start	Construction End	NFS Acquisition & Certification Period
III	Gale Creek	2009	2010	11 months
III	Gold Creek	2009	2011	12 months
III	Lower Springbrook Creek	2009	2012	56 months
III	May Creek	2009	2010	12 months
III	Maywood Creek	2009	2010	12 months
III	Middle Green Large Woody Debris Sites BAJ10, BAJ11; BAJ26 & BAJ27	2009	2011	24 months
III	Mill Creek, Geodeke Reach	2009	2012	6 months
III	Northeast Creek	2009	2010	12 months
III	Olsen Creek	2009	2011	12 months
III	Ray Creek Tributary	2009	2012	12 months
III	Russell Road Lowest Setback and Restoration	2009	2011	8 months
III	Sweeney Creek	2009	2010	12 months
III	Sunday Creek Riparian Plantings	2009	2012	12 months
III	TPU Roads	2009	2012	12 months
III	Big Spring Creek	2010	2012	14 months

Table 17-C LER Cost Estimate for Phase I Construction (2003 – 2012)

Land Values	$4,753,000
NFS Administrative Costs	$ 450,000
Federal Review and Assistance Costs	$ 132,000
Subtotal	$5,335,000
25% Contingency	$1,334,000
Total Phase I	**$6,669,000**

Table 17-D LER Cost Estimate for Phase II Construction (2006 – 2012)

Land Values	$15,645,000
NFS Administrative Costs	$ 930,000
Federal Review and Assistance Costs	$ 215,000
Subtotal	$16,790,000
25% Contingency	$ 4,197,000
Total Phase II	**$20,987,000**

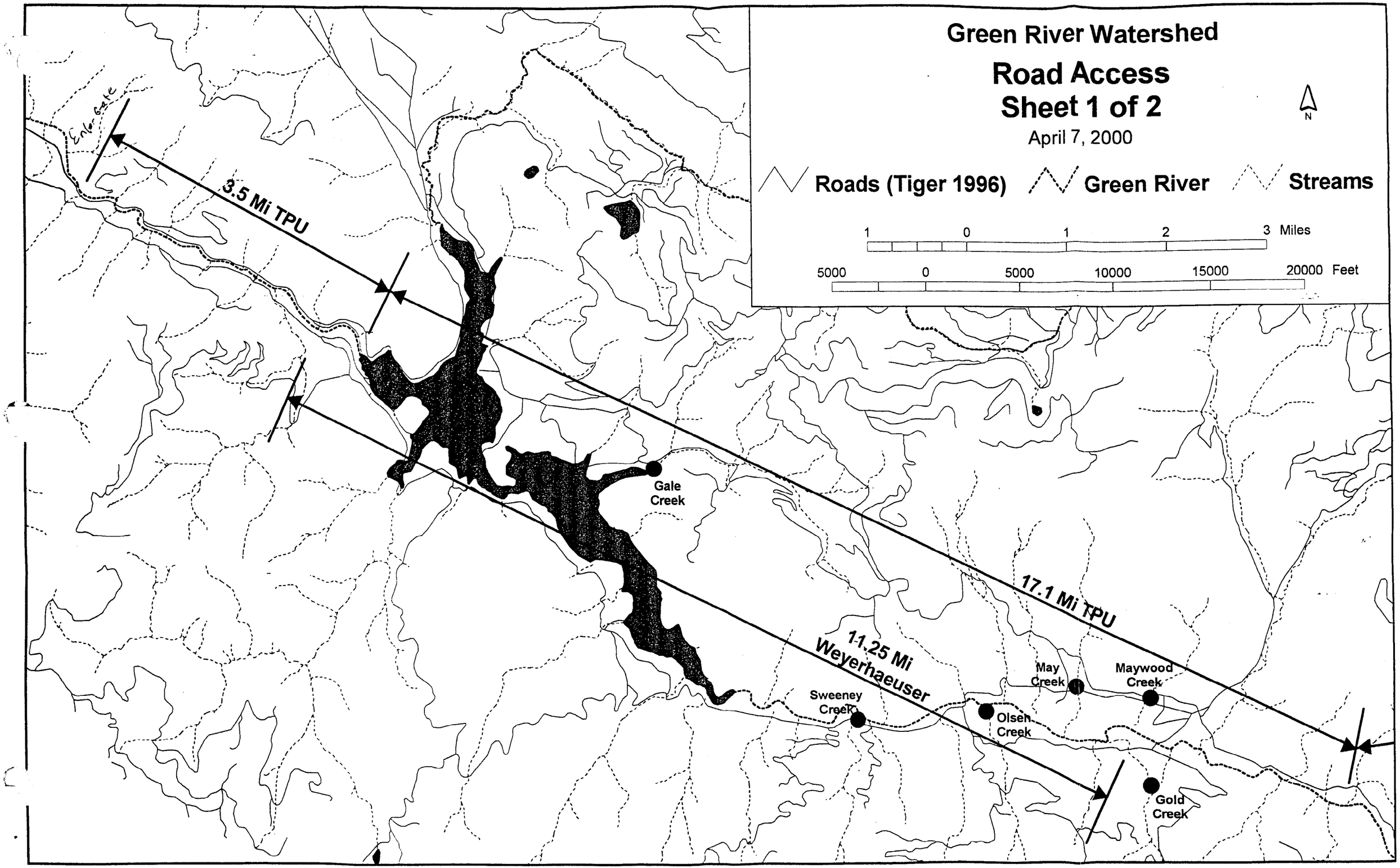
Table 17-E LER Cost Estimate for Phase III Construction (2009 – 2012)

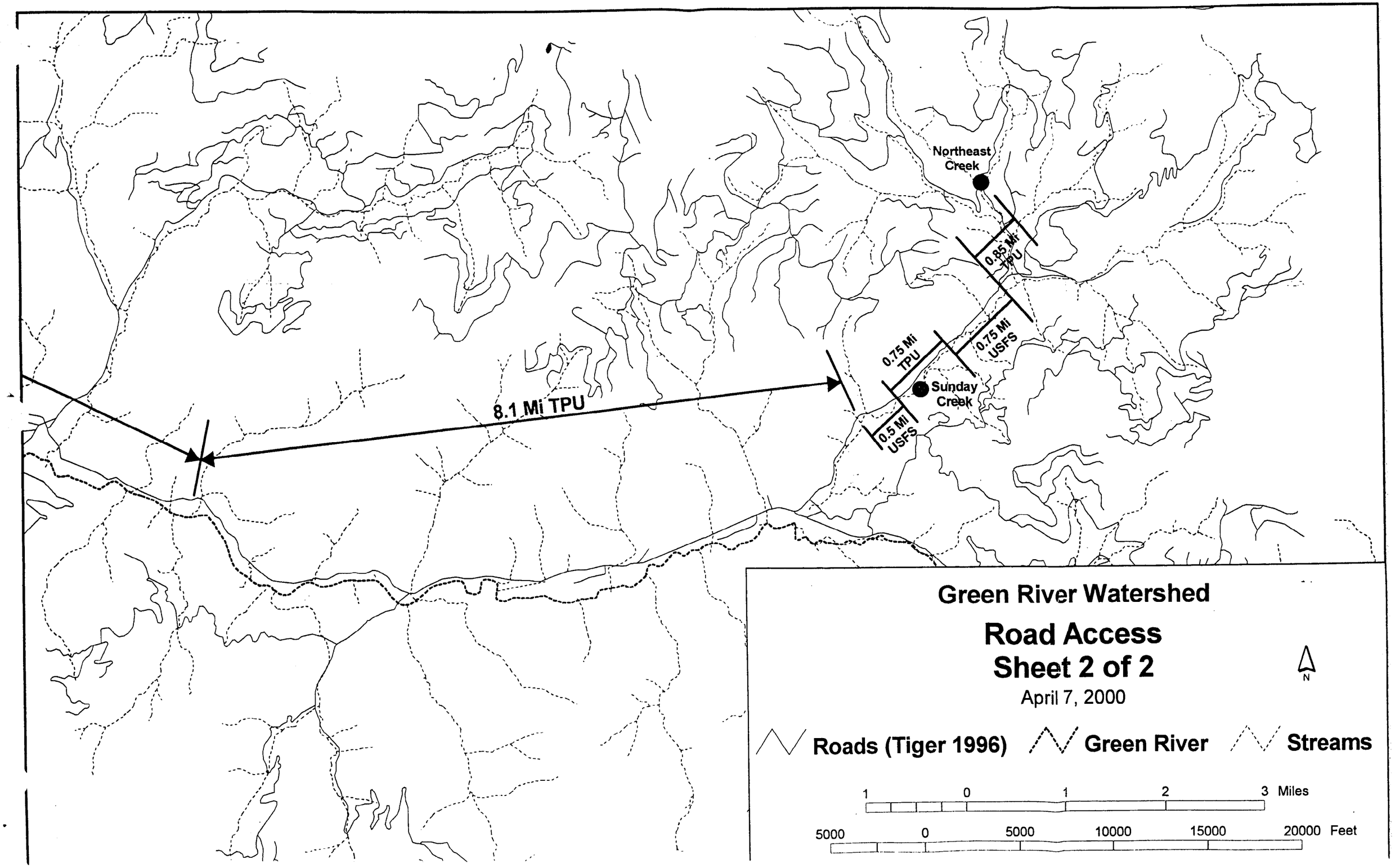
Land Values	$6,497,000
NFS Administrative Costs	$1,450,000
Federal Review and Assistance Costs	$ 297,000
Subtotal	$8,244,000
25% Contingency	$2,061,000
Total Phase III	**$10,305,000**

Exhibit A

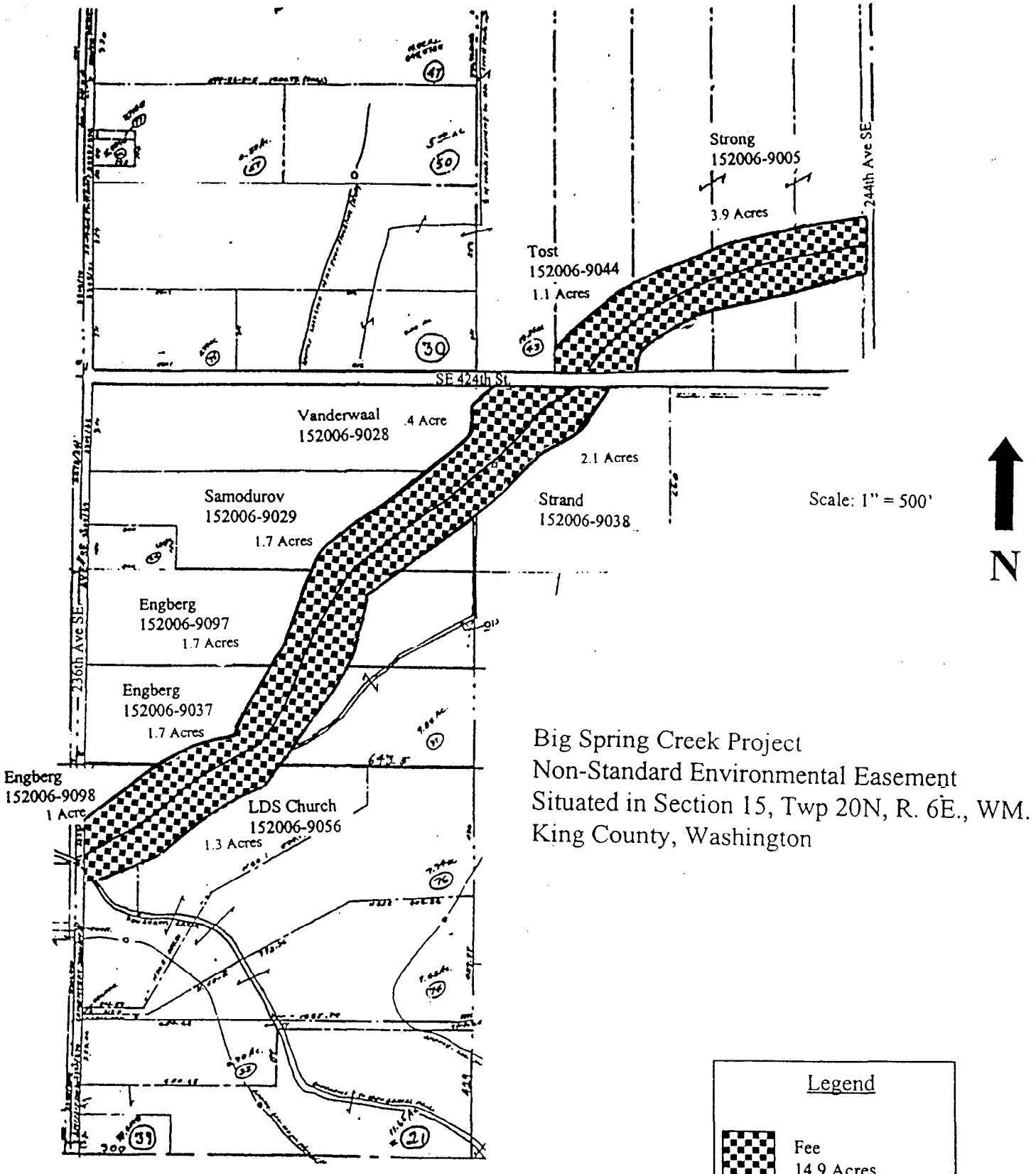
Real Estate Drawings

Prepared by
King County, Washington, Non-federal Sponsor


Green River Watershed
Road Access
Sheet 1 of 2
April 7, 2000
N
Roads (Tiger 1996)
Green River
Streams
1 0 1 2 3 Miles
5000 0 5000 10000 15000 20000 Feet
Enlr Gate
3.5 Mi TPU
Gale Creek
17.1 Mi TPU
11.25 Mi
Weyerhaeuser
Sweeney Creek
Olsen Creek
May Creek
Maywood Creek
Gold Creek


Northeast Creek
0.85 Mi TPU
0.75 Mi USFS
0.75 Mi TPU
Sunday Creek
0.5 Mi USFS
8.1 Mi TPU
Green River Watershed
Road Access
Sheet 2 of 2
April 7, 2000
N
Roads (Tiger 1996)
Green River
Streams
1 0 1 2 3 Miles
5000 0 5000 10000 15000 20000 Feet

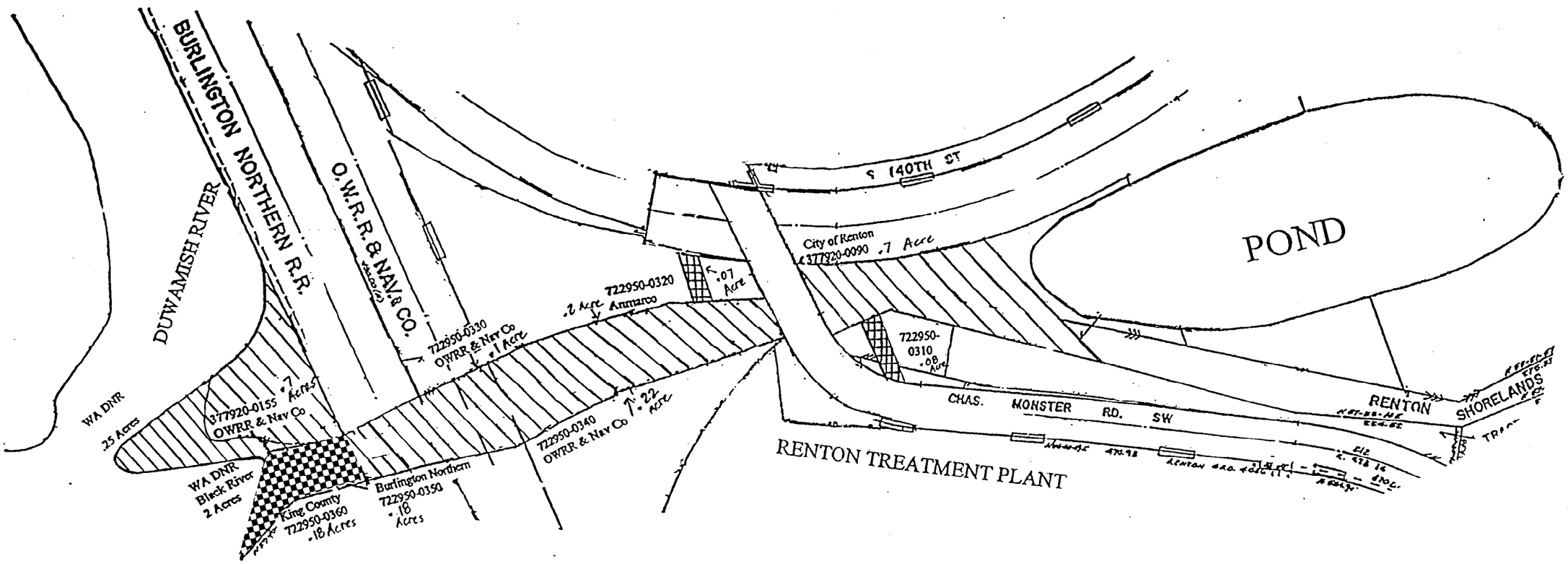
BIG SPRING CREEK



Big Spring Creek Project
Non-Standard Environmental Easement
Situated in Section 15, Twp 20N, R. 6E., WM.
King County, Washington

4/4/00

BLACK RIVER MARSH



Legend

Env. Easement
4.53 Acres

Permanent Access
Needed as Shown
From Monster Rd.: 32'x110' - .08 Acre
From S. 140th St.: 32'x100' - .07 Acre

Fee .18 Acre

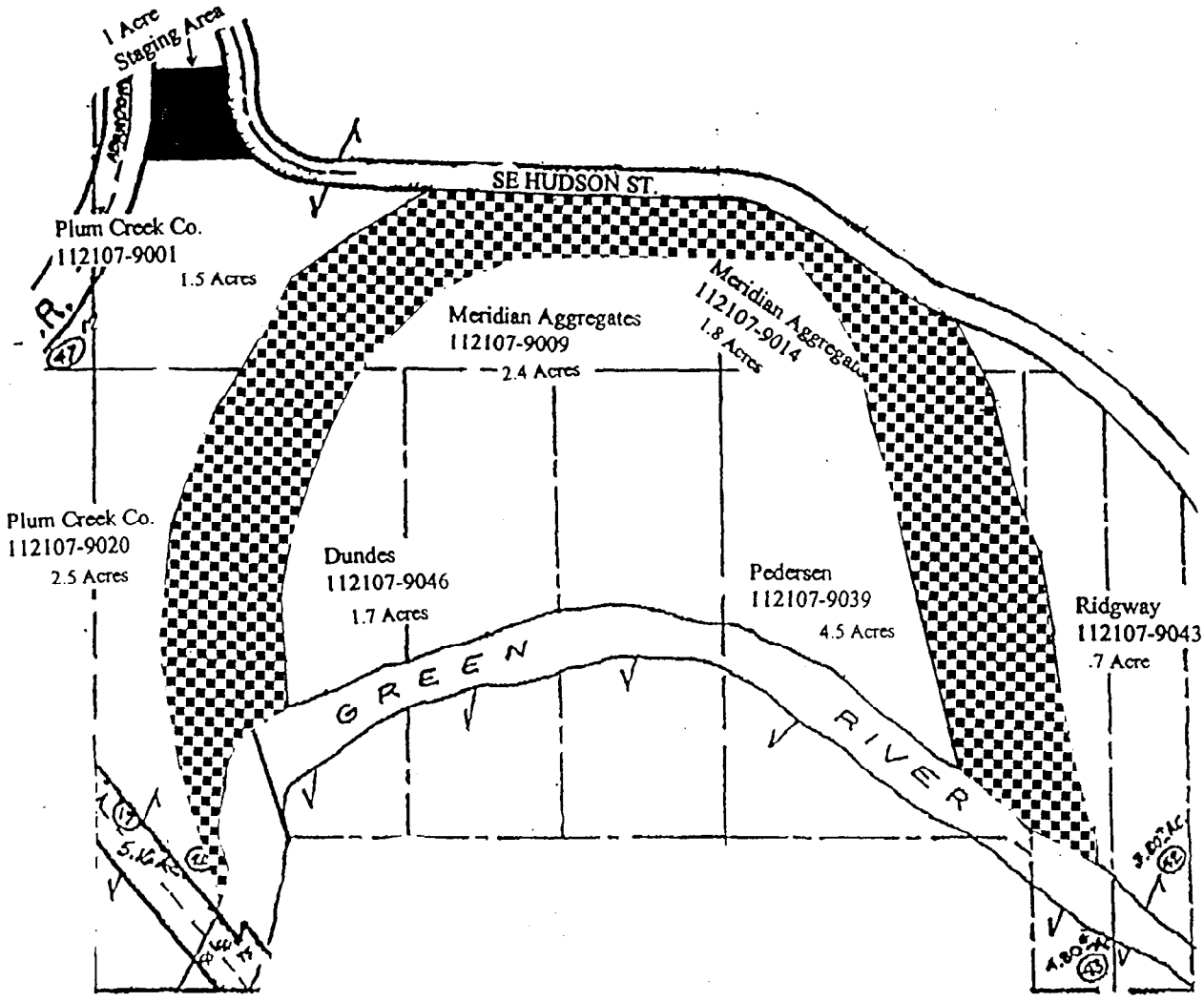
Scale: 1" = 255'

N

Black River Marsh Project
Non-Standard Environmental Easement
Fee interest on King County parcel
Situated in Section 14, T 23N., R 5E., WM.
King County, Washington

5/16/00

Brunner Slough



Legend

Fee
15.1 Acres

1 Acre Temporary Staging Area Needed as Shown
* Not to Scale

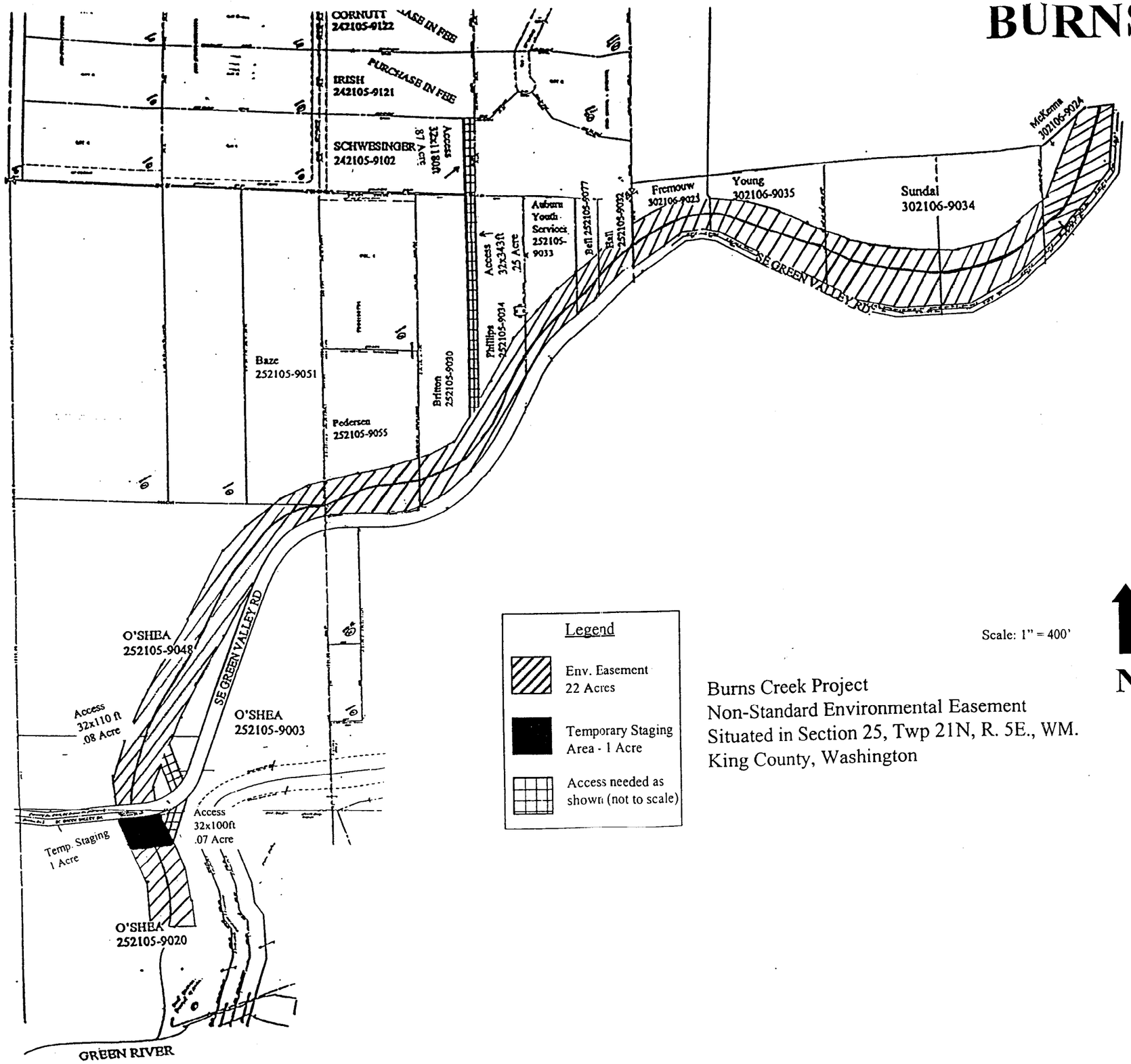
Scale: 1" = 400'

N

Brunner Slough Project
Fee interest to be acquired
Situated in Section 11, T 21N., R 7E., WM.
King County, Washington

4/4/00

BURNS CREEK



Legend

- Env. Easement 22 Acres
- Temporary Staging Area - 1 Acre
- Access needed as shown (not to scale)

Scale: 1" = 400'

N

Burns Creek Project
Non-Standard Environmental Easement
Situated in Section 25, Twp 21N, R. 5E., WM.
King County, Washington

ENVIRONMENTAL EASEMENT

O'Shea
252105-9020
1.9 Acres

O'Shea
252105-9003
1.13 Acres

O'Shea
252105-9048
4.5 Acres

Baze
252105-9051
.4 Acre

Pedersen
252105-9055
2.0 Acres

Britton
252105-9030
1 Acre

Phillips
252105-9034
.9 Acre

Auburn Youth Service
252105-9033
.8 Acre

Bell
252105-9077
.3 Acre

Hall
252105-9032
.5 Acre

Fremouw
302106-9023
1 Acre

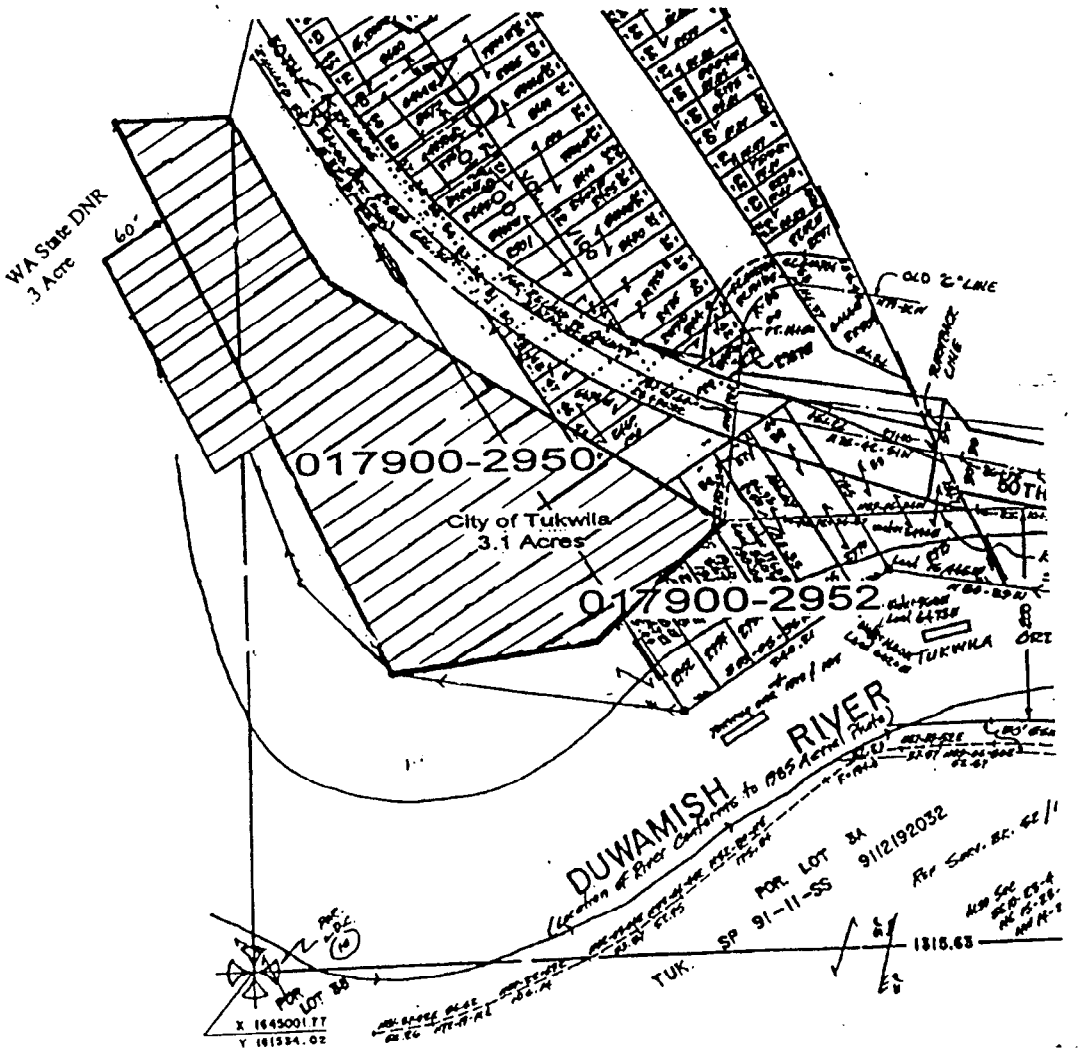
Young
302106-9035
2 Acres

Sundal
302106-9034
3.6 Acres

McKenna
302106-9024
1.9 Acres

3/27/00

CODIGA FARMS



Scale: 1" = 190'

N

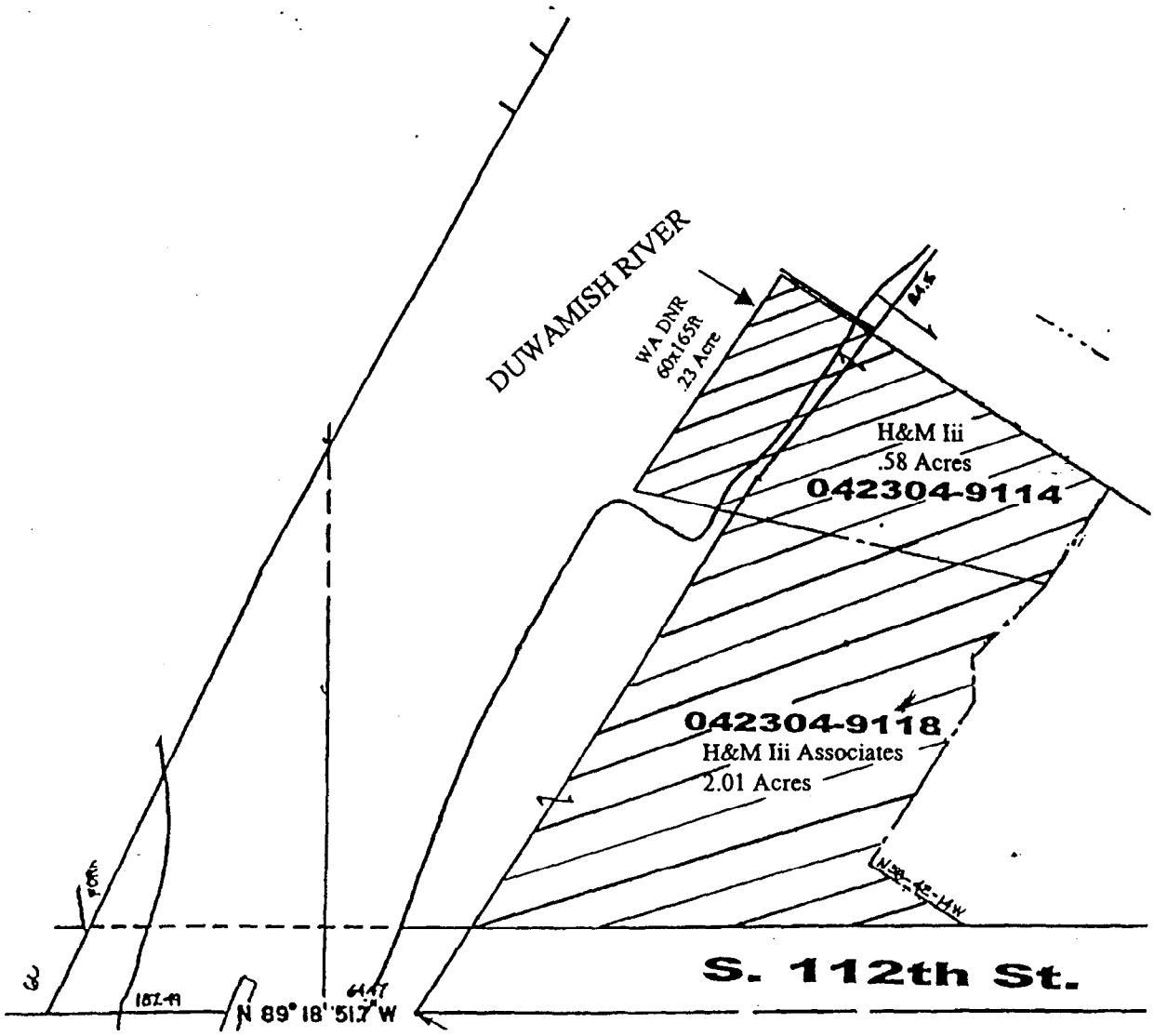
Legend

Env. Easement
3.4 Acres

Codia Farms Project
Situated in Section 11, Twp 23N, and R.4E. WM.
King County, Washington

4/4/00

DUWAMISH SITE 1



Scale: 1" = 125'

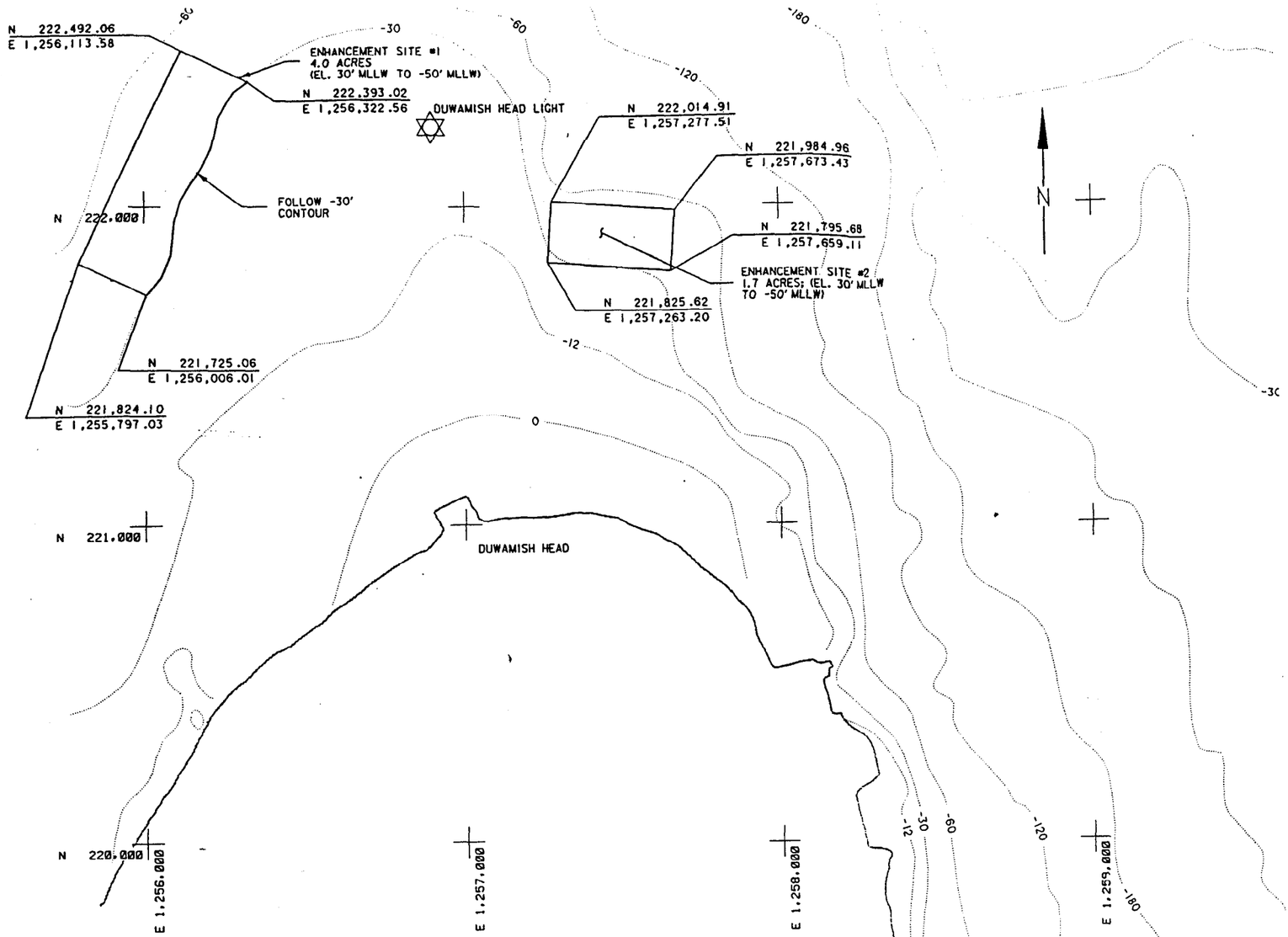
N

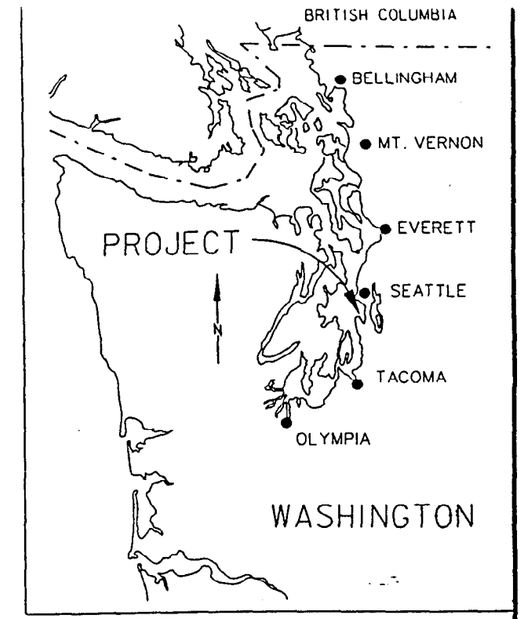
Legend

Env. Easement
2.82 Acres

Site 1 Duwamish Project
Situated in Section 4, Twp 23 N, R. 4E., WM.
King County, Washington.

4/4/00



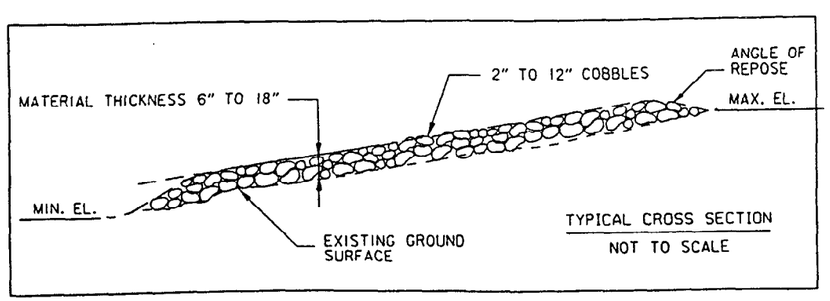


1" = 200' 200' 100' 0 200' 400'

HORIZONTAL CONTROL IS BASED ON NAD 83/91.
VERTICAL DATUM IS MLLW (NOS)

NOTES:

1. CONTRACTOR SHALL NOT PLACE MATERIAL ON EEL GRASS.



DATE AND TIME PLOTTED: 28-FEB-2000 16:50
DESIGN FILE: I:\designs\msgd\civ\msgdcs0e.dgn

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

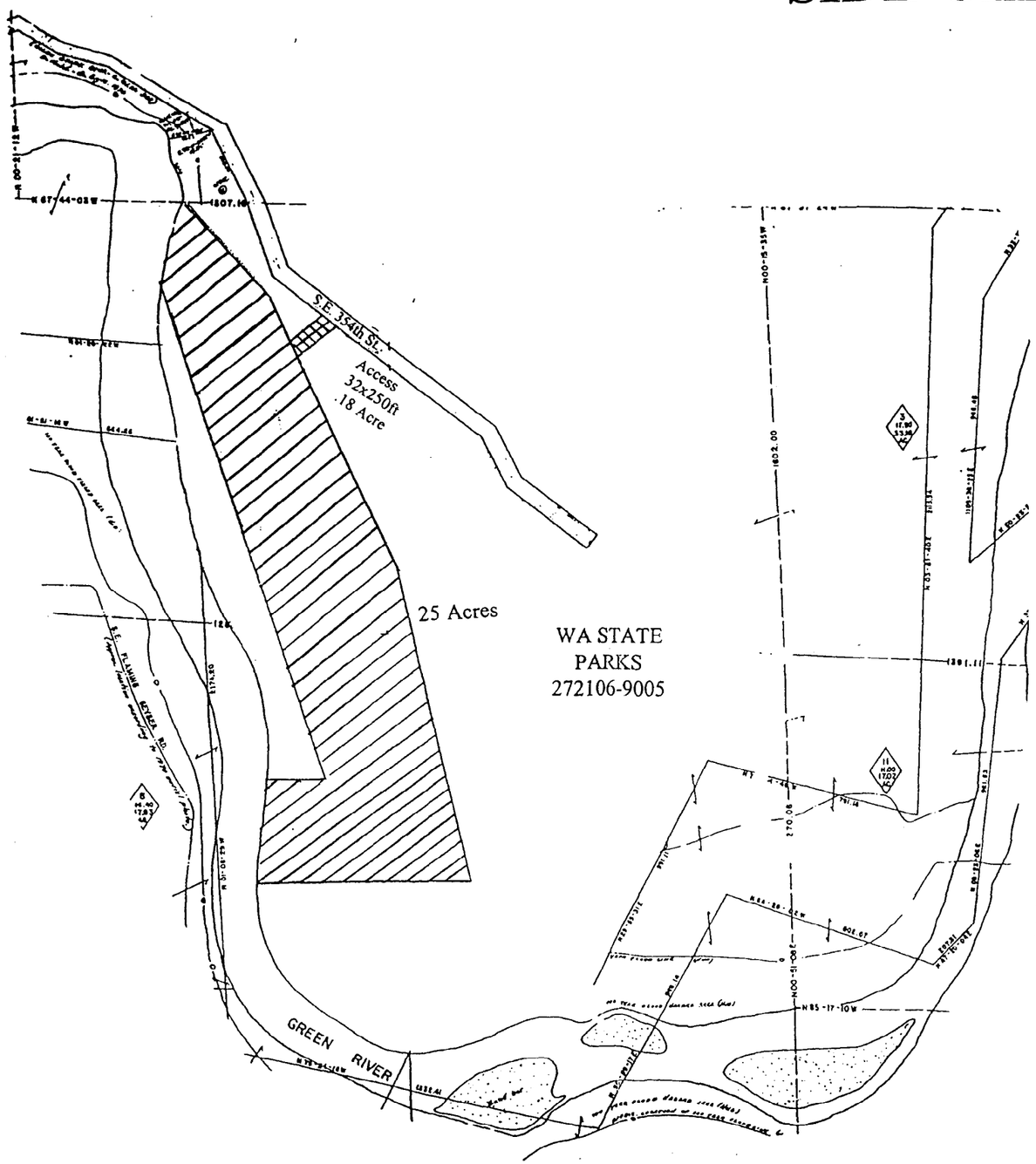
GREEN/DUWAMISH RIVER HABITAT RESTORATION

ELLIOT BAY NEARSHORE

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	99AUG15	C-5
DSGN. PWN		CHK. DAF	SHEET 6	

FLAMING GEYSER SIDE CHANNEL



Legend

Env. Easement
25 Acres

Permanent Access
needed as shown
.18 Acre
(not to scale)

Scale: 1" = 450'

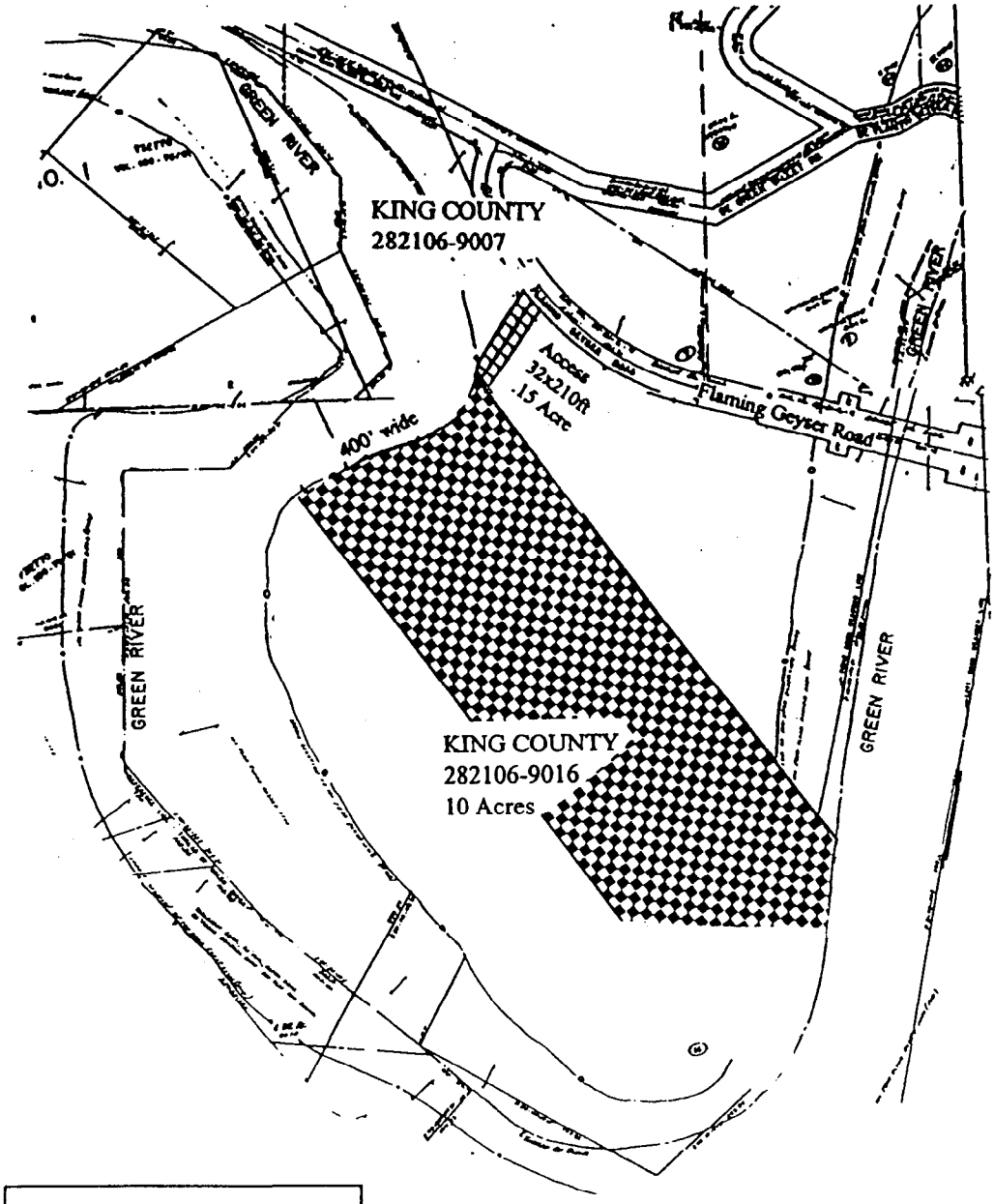
N

Flaming Geyser Side Channel Project
Non-Standard Environmental Easement
Situated in Section 27, Twp 21N, R. 6E., WM.
King County, Washington

3/27/00

MF

FLAMING GEYSER SLIDE



Legend

Fee Interest
10 Acres

Permanent Access needed as shown (not to scale)

Scale: 1" = 375'

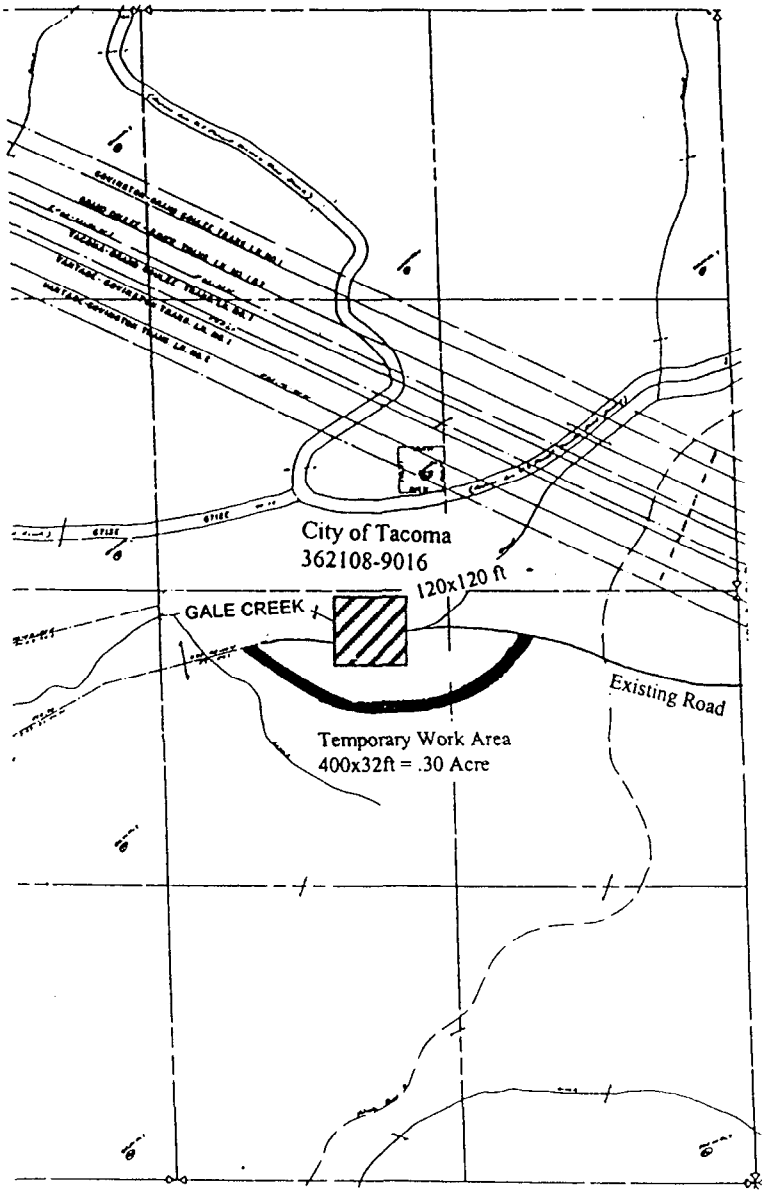
N

Flaming Geyser Side Channel Project
Fee interest owned by King County
Non-Standard Environmental Easement on DNR Parcel
Situated in Section 28, Twp 21N, R. 5E., WM.
King County, Washington

3/27/00

11B

GALE CREEK



Legend

120x120 ft Environmental Easement .33Acre

Temporary Work Area .30 Acre

Scale: 1" = 660'

N

Gale Creek Culvert Project
Non-Standard Environmental Easement
Situated in Section 8, Twp 20N, R. 09E., WM.
King County, Washington

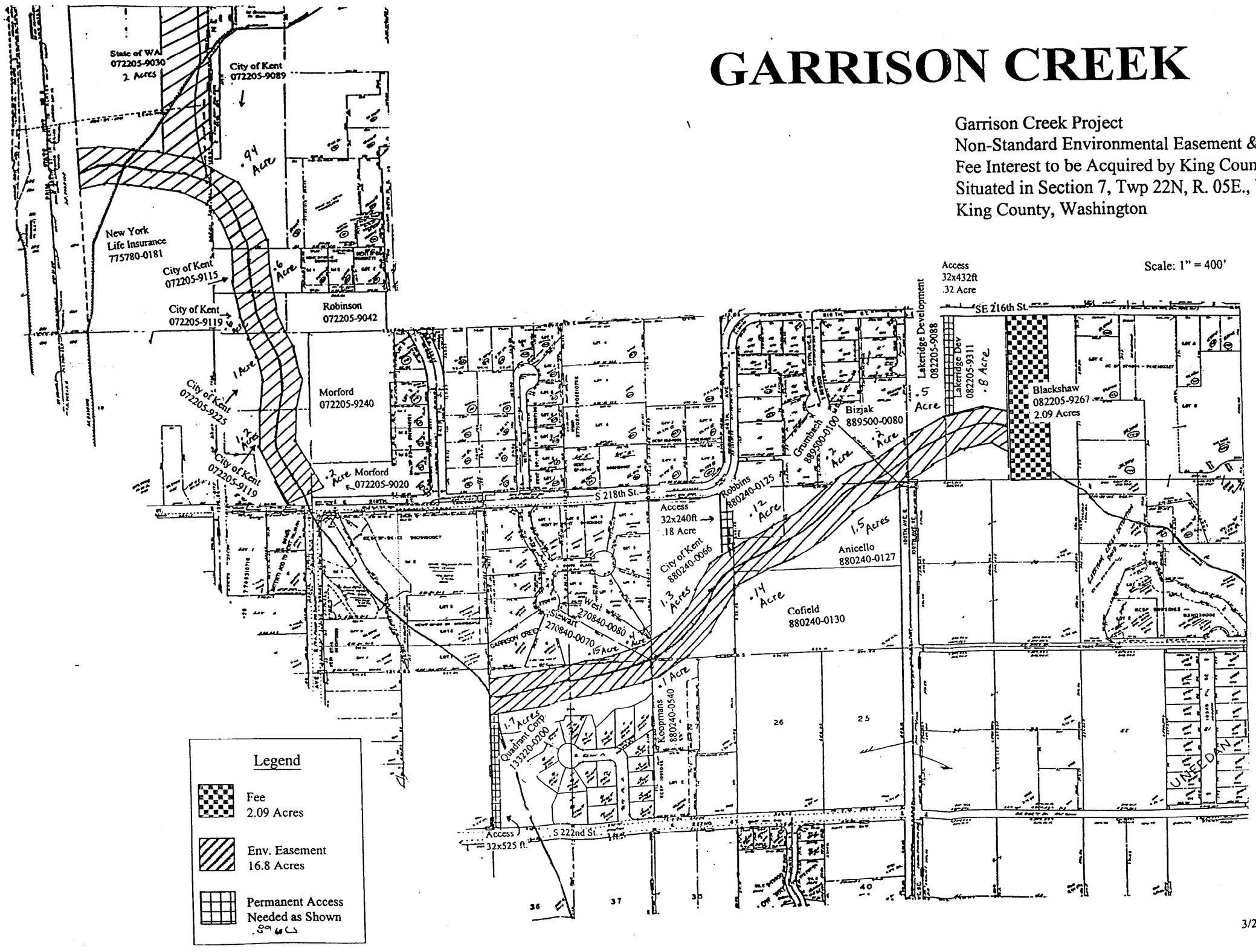
5/1/00

GARRISON CREEK

Garrison Creek Project
Non-Standard Environmental Easement &
Fee Interest to be Acquired by King County
Situated in Section 7, Twp 22N, R. 05E., WM.
King County, Washington

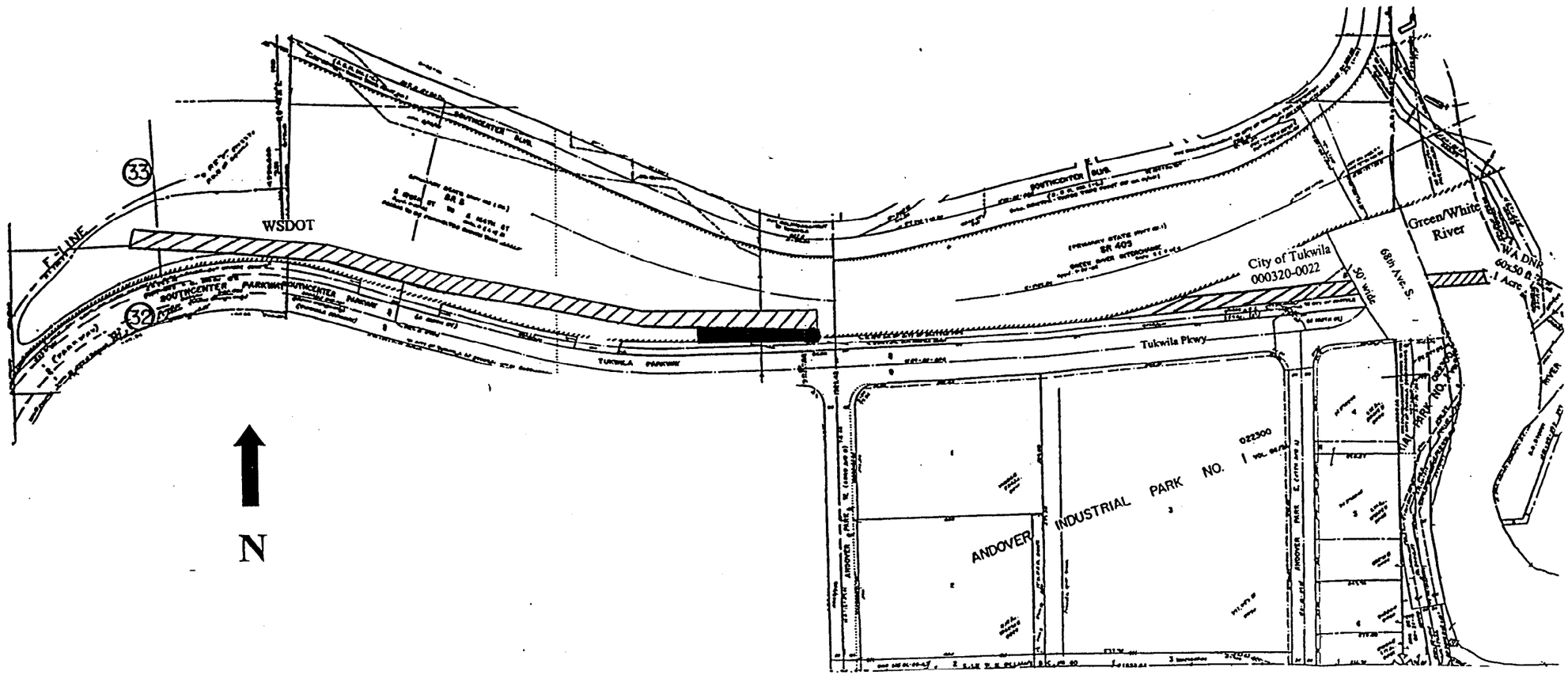
Scale: 1" = 400'

N



3/27/00

GILLIAM CREEK



Legend

Env. Easement
4.2 Acres

Temp Stage Area
.2 Acre

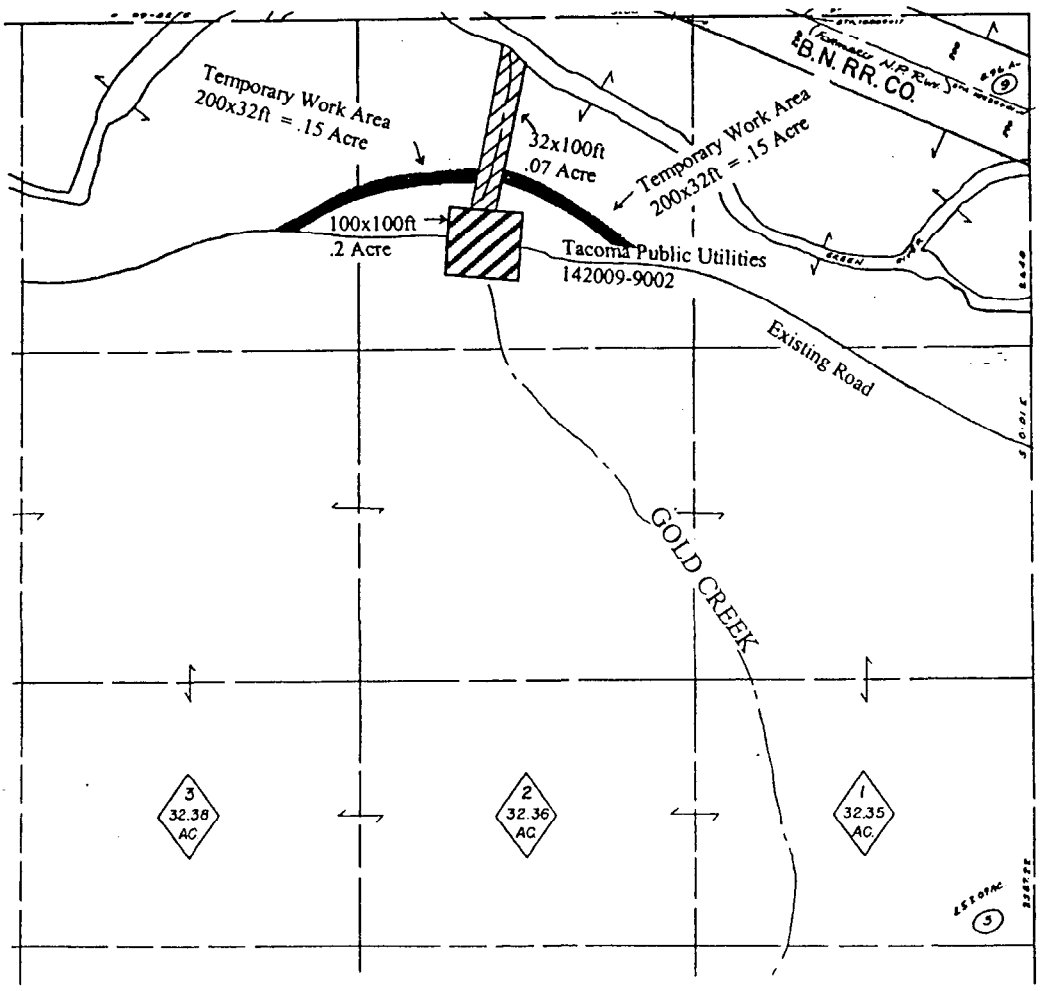
Gilliam Creek Project
Non-Standard Environmental Easements
Situated in Section 23, T 23N., R 4E., WM.
King County, Washington

**Temp Stage Area not to scale. Env. Easement width not to scale.
WA DNR not to scale.

3/29/00

14 F

GOLD CREEK



Scale: 1" = 650'

N

Legend

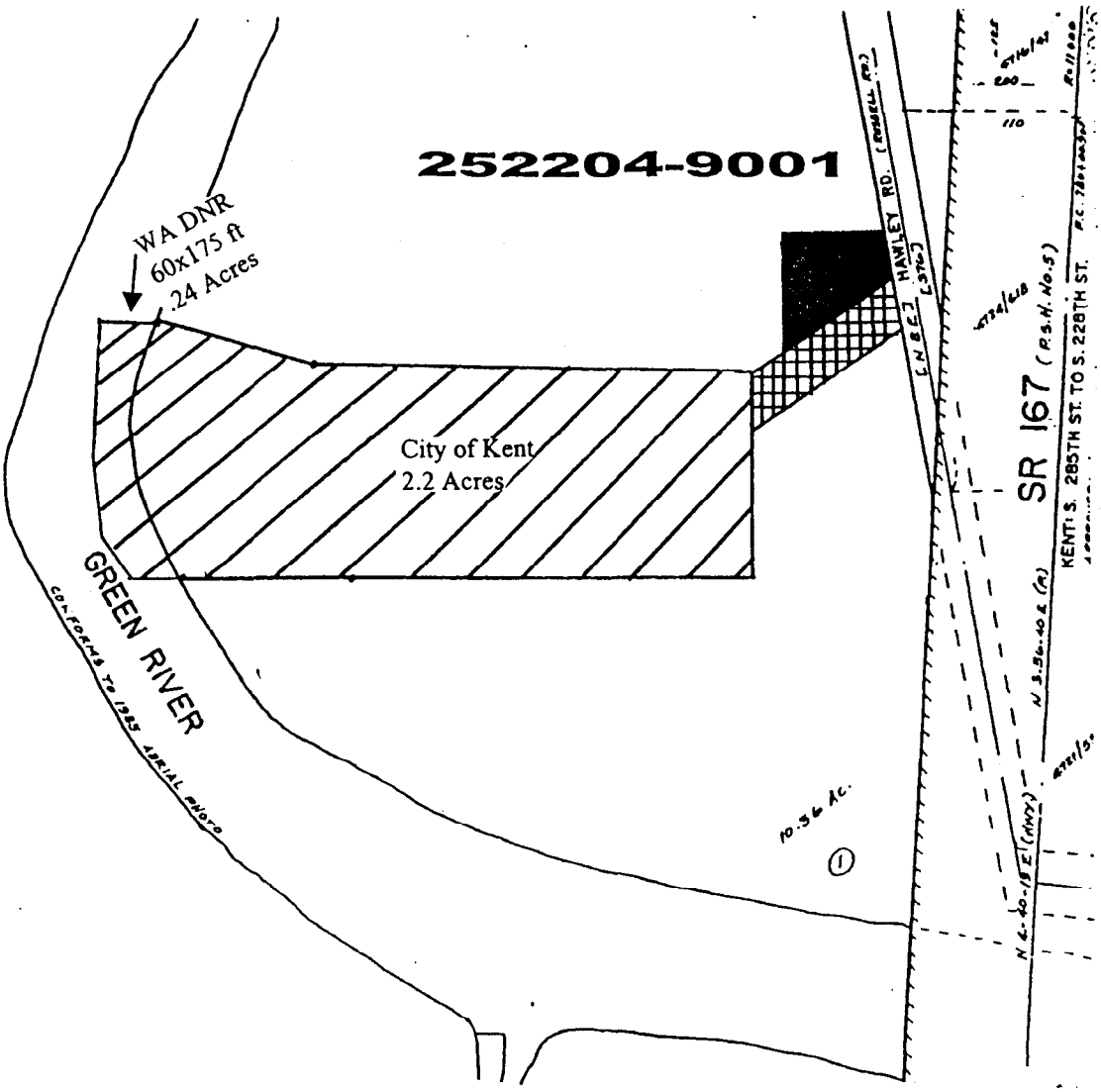
Environmental Easement .27 Acre

Temporary Work Area .30 Acre

Gold Creek Project
Non-Standard Environmental Easement
Situated in Section 14, Twp 20N, R. 09E., WM.
King County, Washington

5/1/00

GREEN RIVER PARK



Legend

- Env. Easement 2.44 Acres
- Permanent Access Needed as Shown .12 Acre
- Temp Stage Area Need 1 Acre in are shown

Scale: 1" = 160'

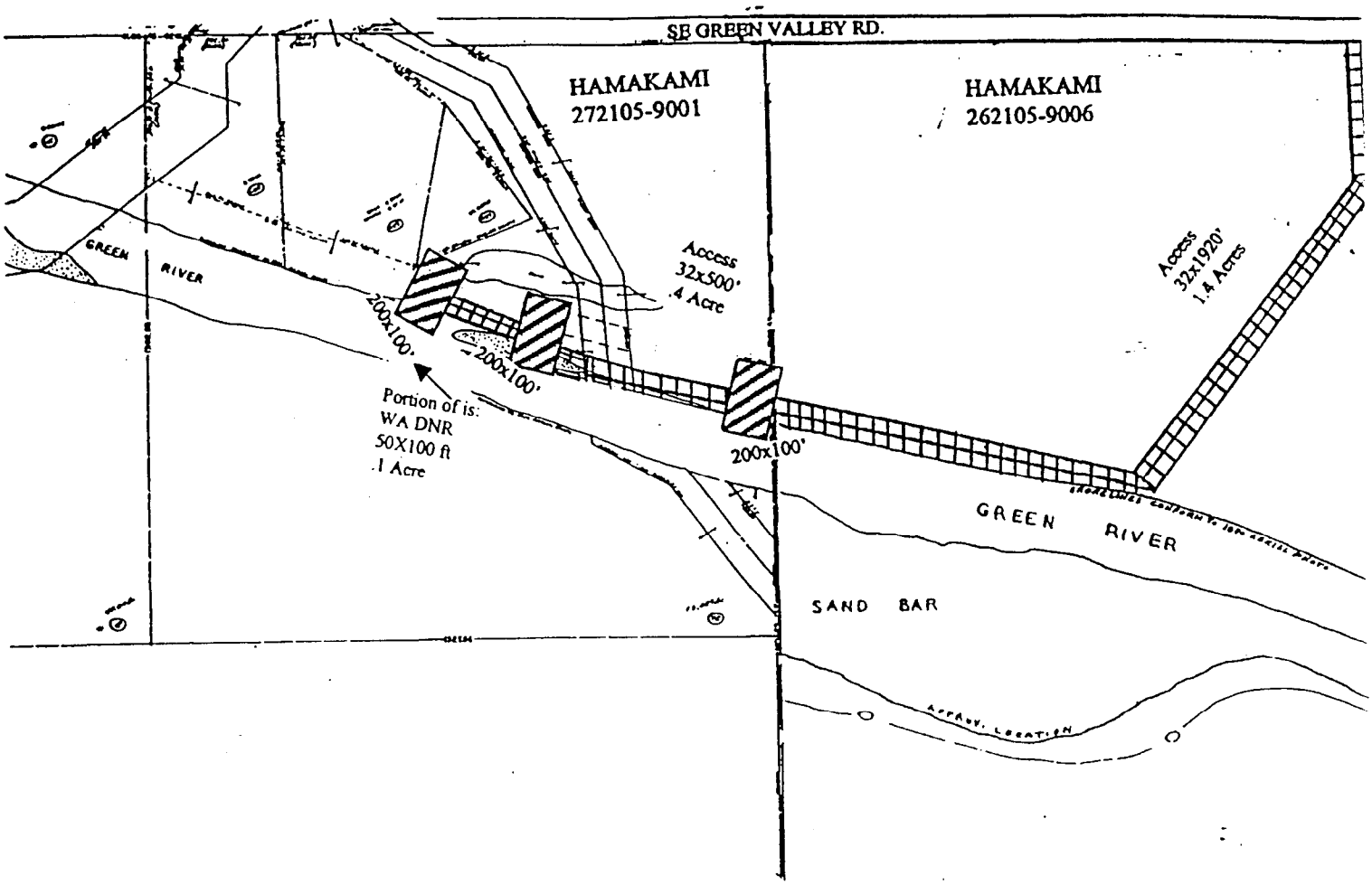
N

Green River Park Project
Proposed Non-Standard Environmental Easement
Situated in Section 25, Twp 22N, R. 4E., WM.
King County, Washington

**Temp Stage Area & Permanent Access are not to scale.

3/29/00

HAMAKAMI LEVEE



Legend

Env. Easement needed as shown Total 1.4 Acres

Access Easement needed as shown Total 1.8 Acres

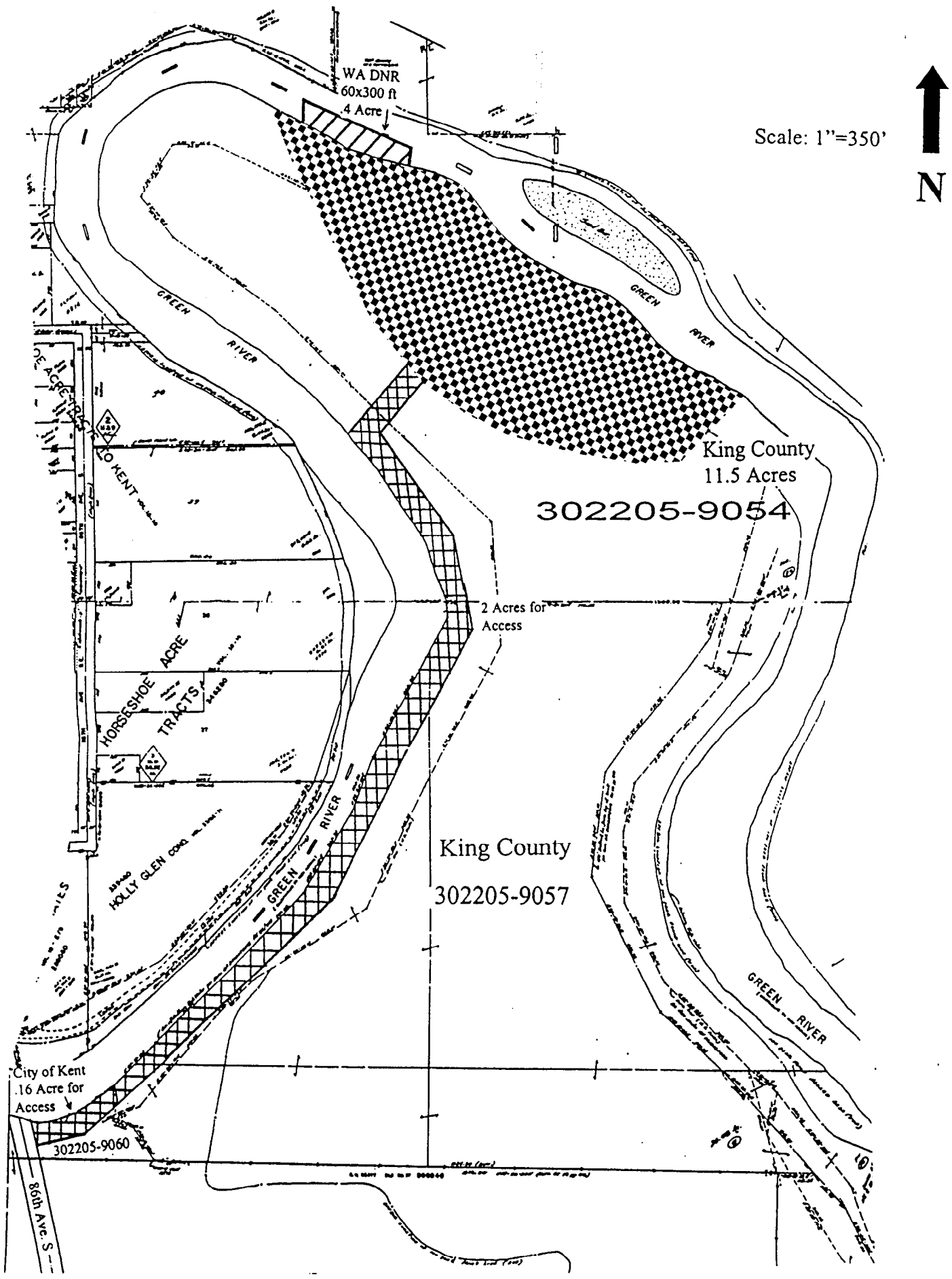
Scale: 1" = 350'

N

Hamakami Levee Project
Non-Standard Environmental Easement
Situated in Section 26, Twp 21N, R. 5E., WM.
King County, Washington

3/27/00

HORSEHEAD BEND & SIDE CHANNEL



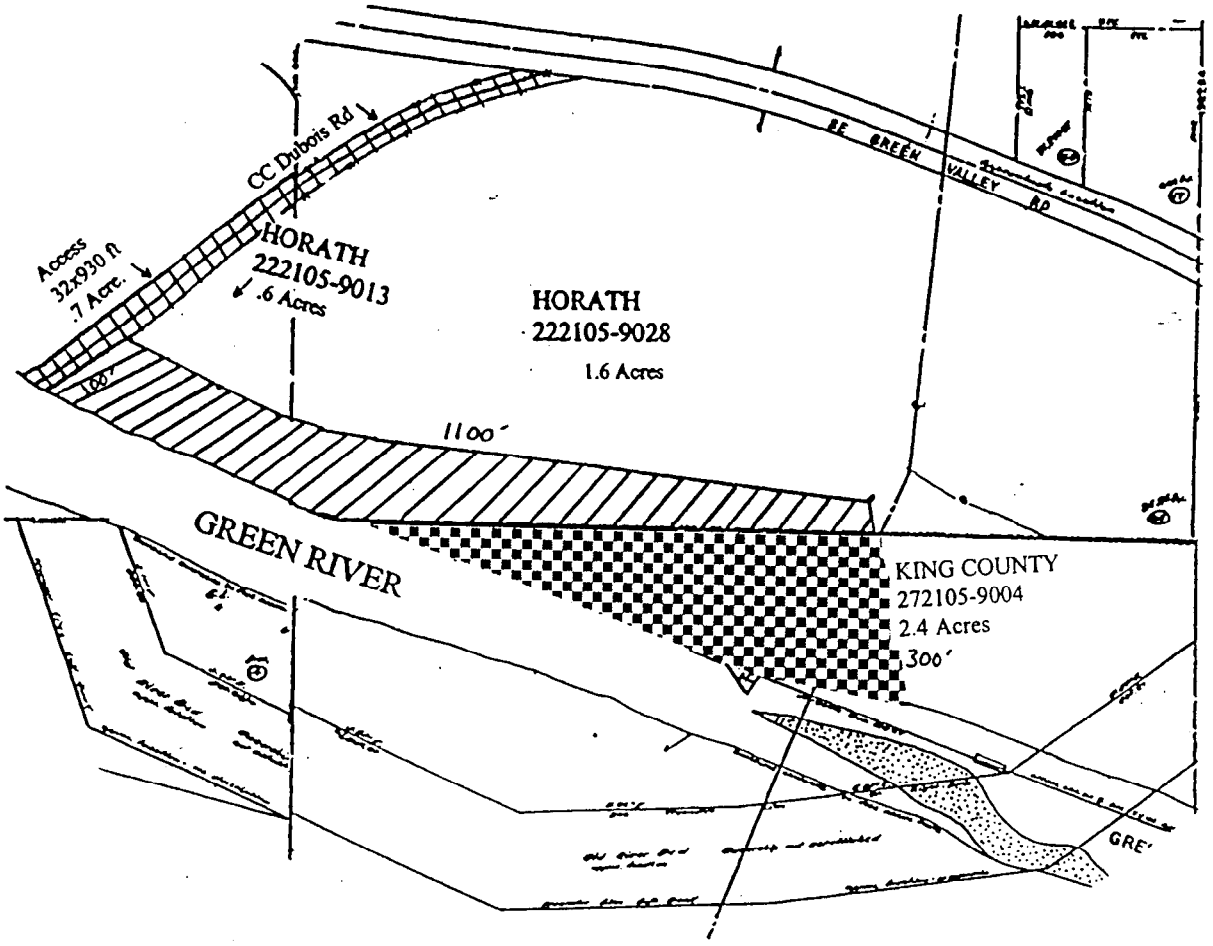
Legend

- Fee 11.90 Acres
- Permanent Access Needed from 86th Ave. S. (2.16 Acres)
- .40 Environmental Easement

Horsehead Bend Project
Fee Interest owned by King County
Situated in Section 30, Twp 22N, R. 5E., WM.
King County, Washington

4/13/00

KEACH LEVEE



Legend

- Fee 2.4 Acres
- Env. Easement 2.2 Acres
- Access Needed as Shown on CC Dubois Rd.

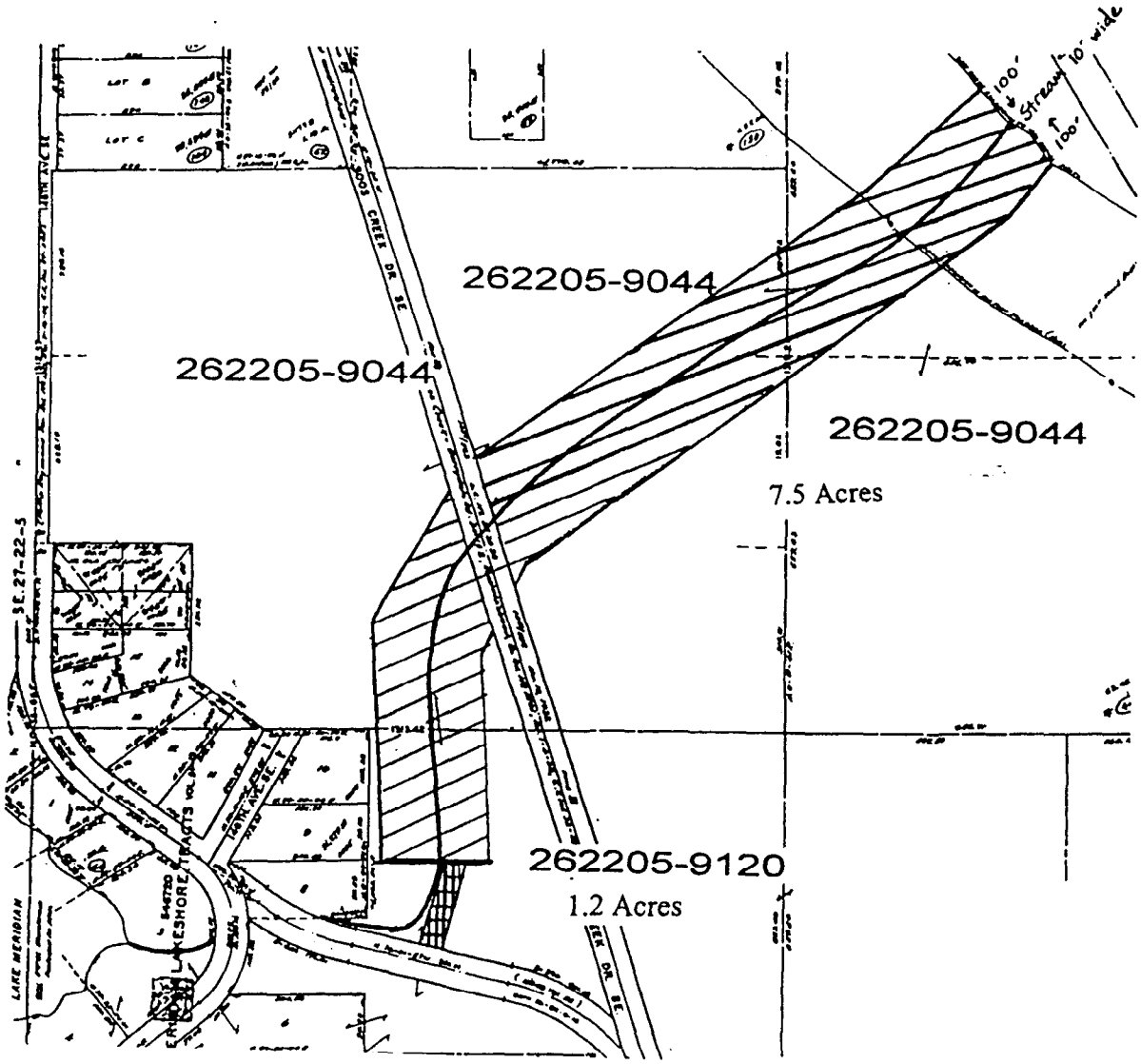
Scale: 1" = 260'

N

Keach Levee Project
Non-Standard Environmental Easement &
Fee interest in King County
Situated in Section 22, Twp 21N, R. 5E., WM.
King County, Washington

3/27/00

LAKE MERIDIAN OUTLET



Scale: 1"=340"

N

Fee
.51 Acres (stream)
(2,200 X 10')

Env. Easement
8.19 Acres

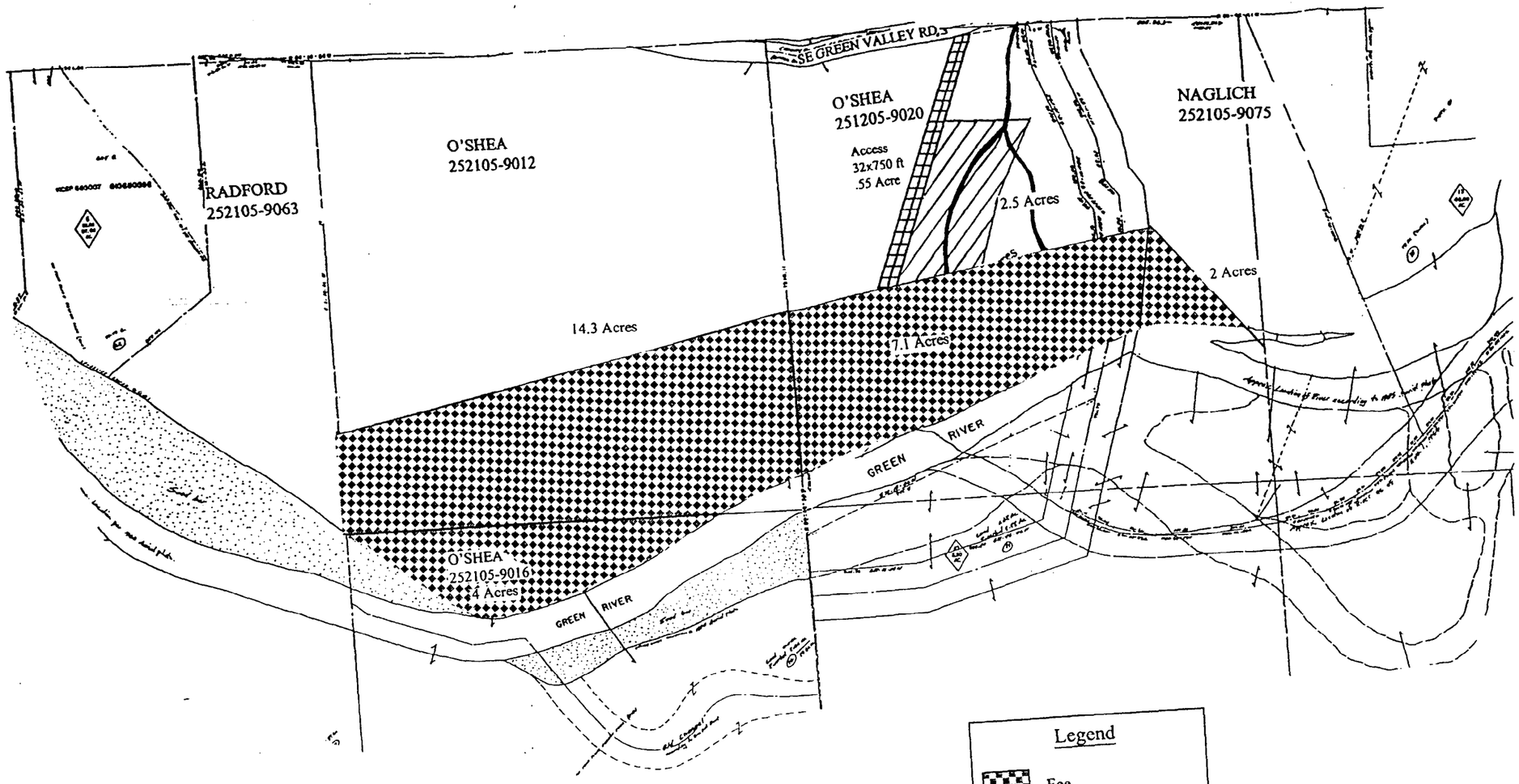
Permanent Access
Needed as shown
32' X 160' (.1 Acre)*

Lake Meridian Outlet Project
Non-Standard Environmental Easement
Situated in Section 26, Twp 22N, R. 5E., WM.
King County, Washington

*Access Easement is not to scale

3/29/00

LONES LEVEE



Legend

- Fee 27.4 Acres
- Env. Easement 2.5 Acres
- Permanent Access needed as shown

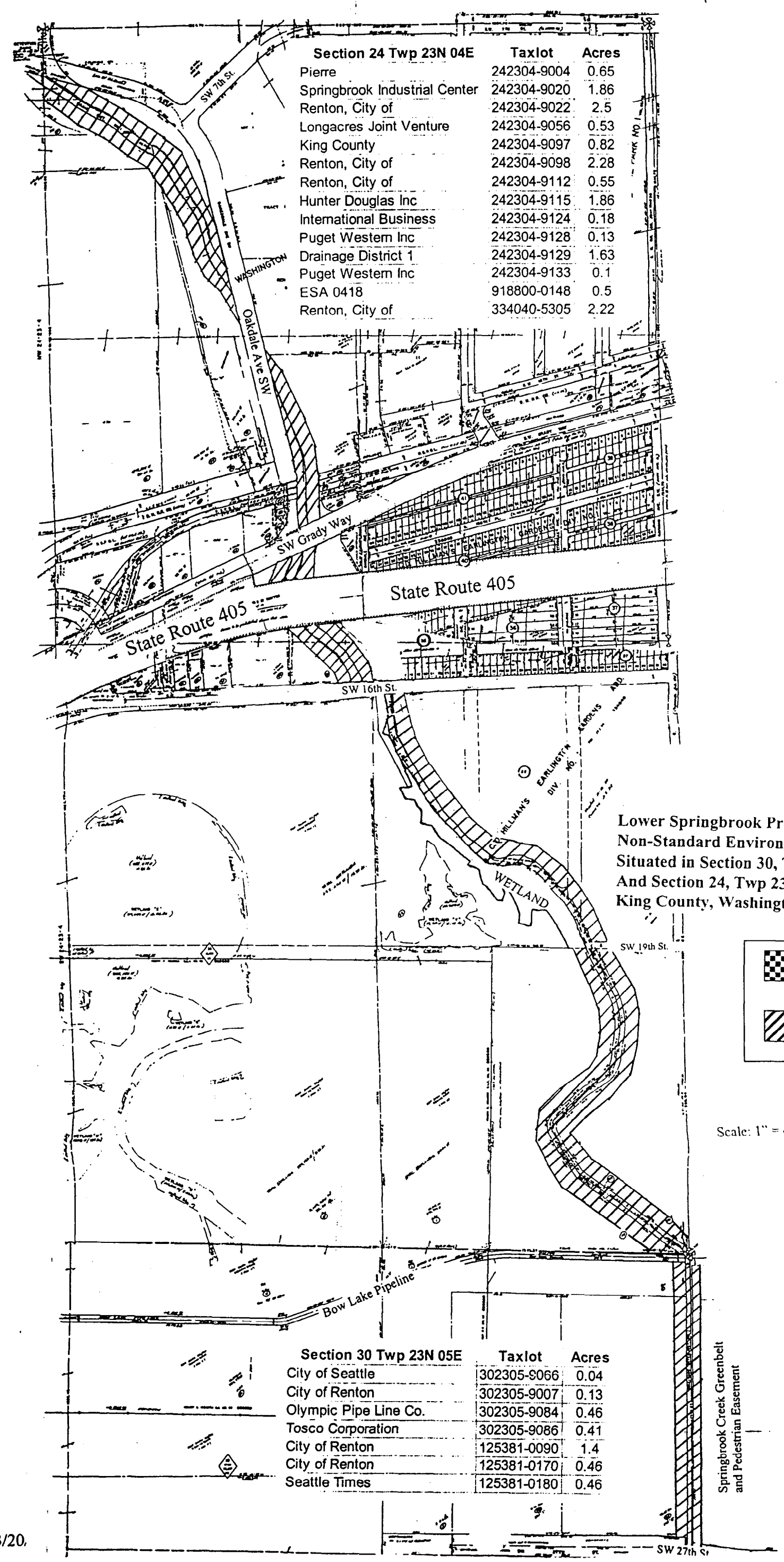
Scale: 1" = 120'

N

Lones Levee Project
Fee Interest to be acquired by King County
Non-Standard Environmental Easement
Situated in Section 25, Twp 21N, R. 5E., WM.
King County, Washington

3/27/00

LOWER SPRINGBROOK



Section 24 Twp 23N 04E	Taxlot	Acres
Pierre	242304-9004	0.65
Springbrook Industrial Center	242304-9020	1.86
Renton, City of	242304-9022	2.5
Longacres Joint Venture	242304-9056	0.53
King County	242304-9097	0.82
Renton, City of	242304-9098	2.28
Renton, City of	242304-9112	0.55
Hunter Douglas Inc	242304-9115	1.86
International Business	242304-9124	0.18
Puget Western Inc	242304-9128	0.13
Drainage District 1	242304-9129	1.63
Puget Western Inc	242304-9133	0.1
ESA 0418	918800-0148	0.5
Renton, City of	334040-5305	2.22

Lower Springbrook Project
Non-Standard Environmental Easement
Situated in Section 30, Twp 23N, R. 5E., WM.
And Section 24, Twp 23N, 4E., WM.
King County, Washington

Section 30 Twp 23N 05E	Taxlot	Acres
City of Seattle	302305-9066	0.04
City of Renton	302305-9007	0.13
Olympic Pipe Line Co.	302305-9084	0.46
Tosco Corporation	302305-9086	0.41
City of Renton	125381-0090	1.4
City of Renton	125381-0170	0.46
Seattle Times	125381-0180	0.46

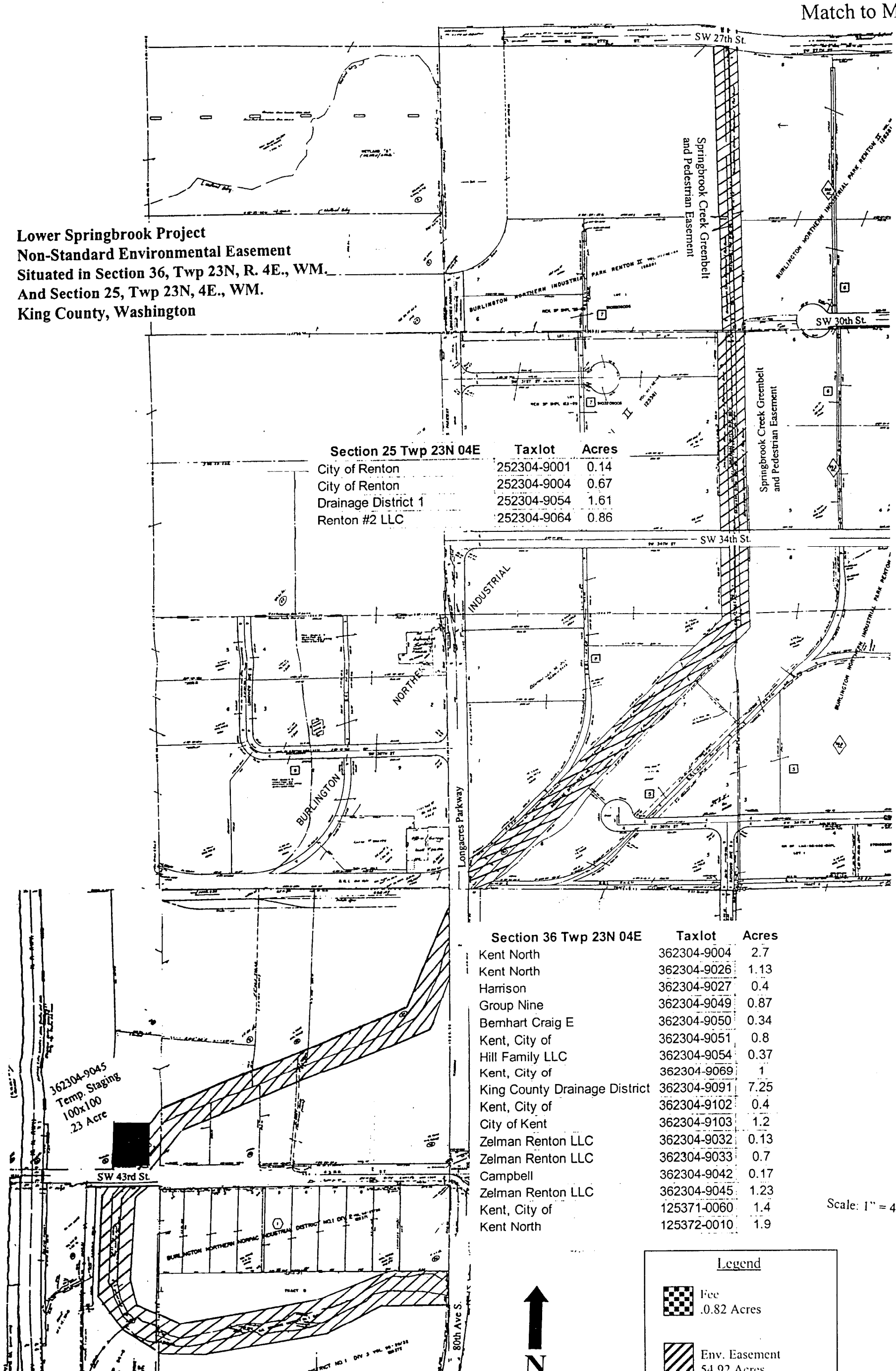
Match to M- ?

3/20,

LOWER SPRINGBROOK

Match to Map 1

Lower Springbrook Project
Non-Standard Environmental Easement
Situated in Section 36, Twp 23N, R. 4E., WM.
And Section 25, Twp 23N, 4E., WM.
King County, Washington



Section 25 Twp 23N 04E	Taxlot	Acres
City of Renton	252304-9001	0.14
City of Renton	252304-9004	0.67
Drainage District 1	252304-9054	1.61
Renton #2 LLC	252304-9064	0.86

Section 36 Twp 23N 04E	Taxlot	Acres
Kent North	362304-9004	2.7
Kent North	362304-9026	1.13
Harrison	362304-9027	0.4
Group Nine	362304-9049	0.87
Bernhart Craig E	362304-9050	0.34
Kent, City of	362304-9051	0.8
Hill Family LLC	362304-9054	0.37
Kent, City of	362304-9069	1
King County Drainage District	362304-9091	7.25
Kent, City of	362304-9102	0.4
City of Kent	362304-9103	1.2
Zelman Renton LLC	362304-9032	0.13
Zelman Renton LLC	362304-9033	0.7
Campbell	362304-9042	0.17
Zelman Renton LLC	362304-9045	1.23
Kent, City of	125371-0060	1.4
Kent North	125372-0010	1.9

Scale: 1" = 480'

Legend

- Fee .0.82 Acres
- Env. Easement 54.92 Acres
- Temporary Staging Area 100x 100ft .23 Acre

Match to Map 3

3/20/00

LOWER SPRINGBROOK

Match to Map 2

Lower Springbrook Project
Non-Standard Environmental Easement
Situated in Section 06, Twp 23N, R. 5E., WM.
And Section 31, Twp 23N, 5E., WM.
King County, Washington

80th Ave S.

S 188th St.

S 192nd St.

84th Ave. S

State Route 167

Section 31 Twp 23N 05E	Taxlot	Acres
Brekke Properties	312305-9018	0.27
Cho-Wong-Lian	312305-9059	0.29
Kent, City of	312305-9165	0.66

Section 6 Twp 23N 05E	Taxlot	Acres
Metal Form Acq. Group	062205-9003	0.26
Batavia Holdings	062205-9005	1
Scarsella Family LLC	062205-9048	2.3
Scarsella Family LLC	062205-9060	0.17
Burke Robert	062205-9131	0.35
Burke Robert	062205-9087	0.65
Master Halco, Inc.	062205-9107	0.5
Metal Form Acq. Group	062205-9110	0.5
Tri-State Construction	062205-9125	0.93
Renton, City of	062205-9128	1

Env. Easement
54.92 Acres

Scale: 1" = 480'

N

MAINSTEM MAINTENANCE SITES

BOEING SETBACK AND RESTORATION SITE

CARROTT PATCH SETBACK AND RESTORATION

FENSTER SETBACK AND RESTORATION

RUSSELL ROAD UPPER SETBACK AD RESTORATION

RUSSELL ROAD LOWEST SETBACK AND RESTORATION

RUSSELL ROAD LOWER SETBACK AND RESTORATION

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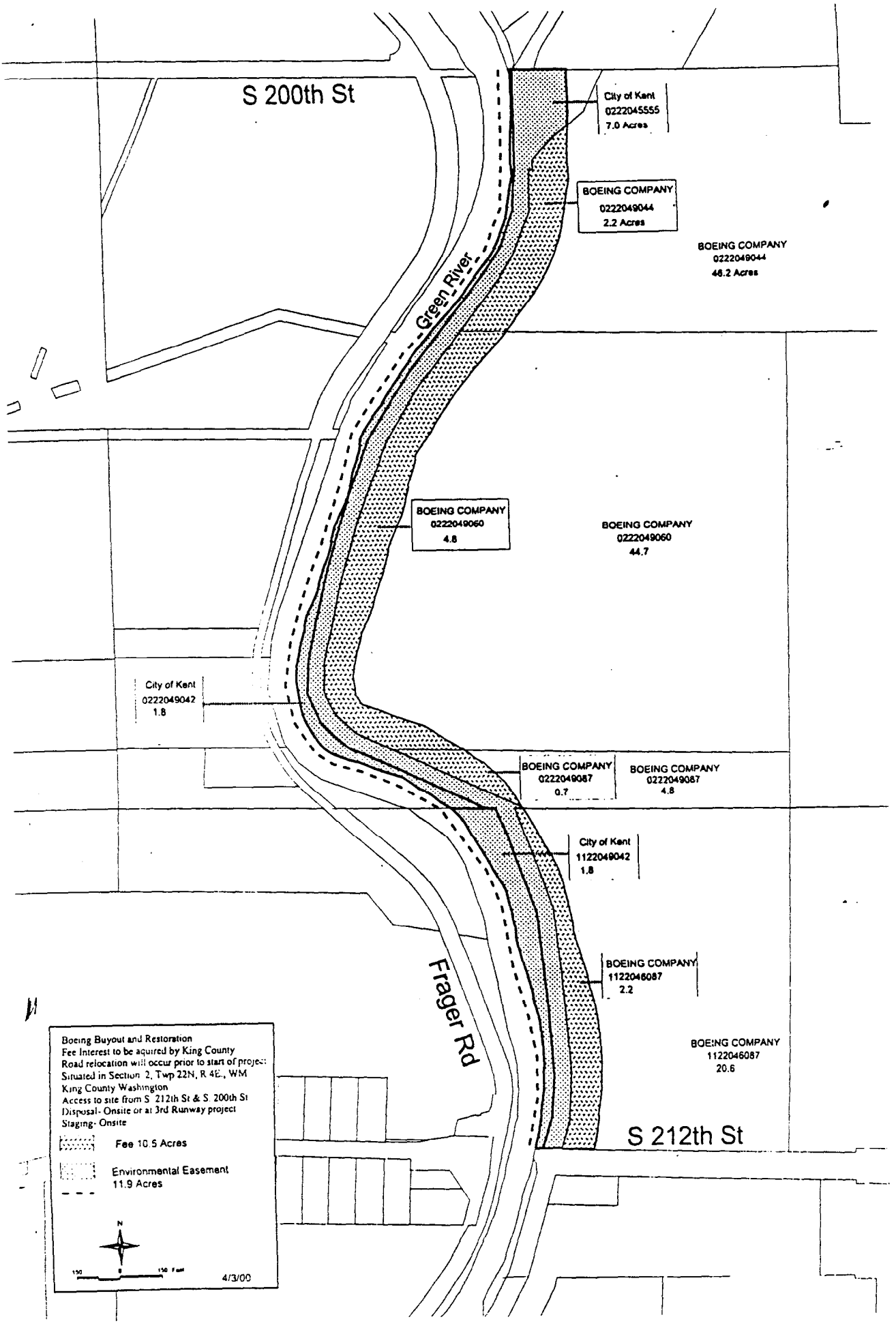
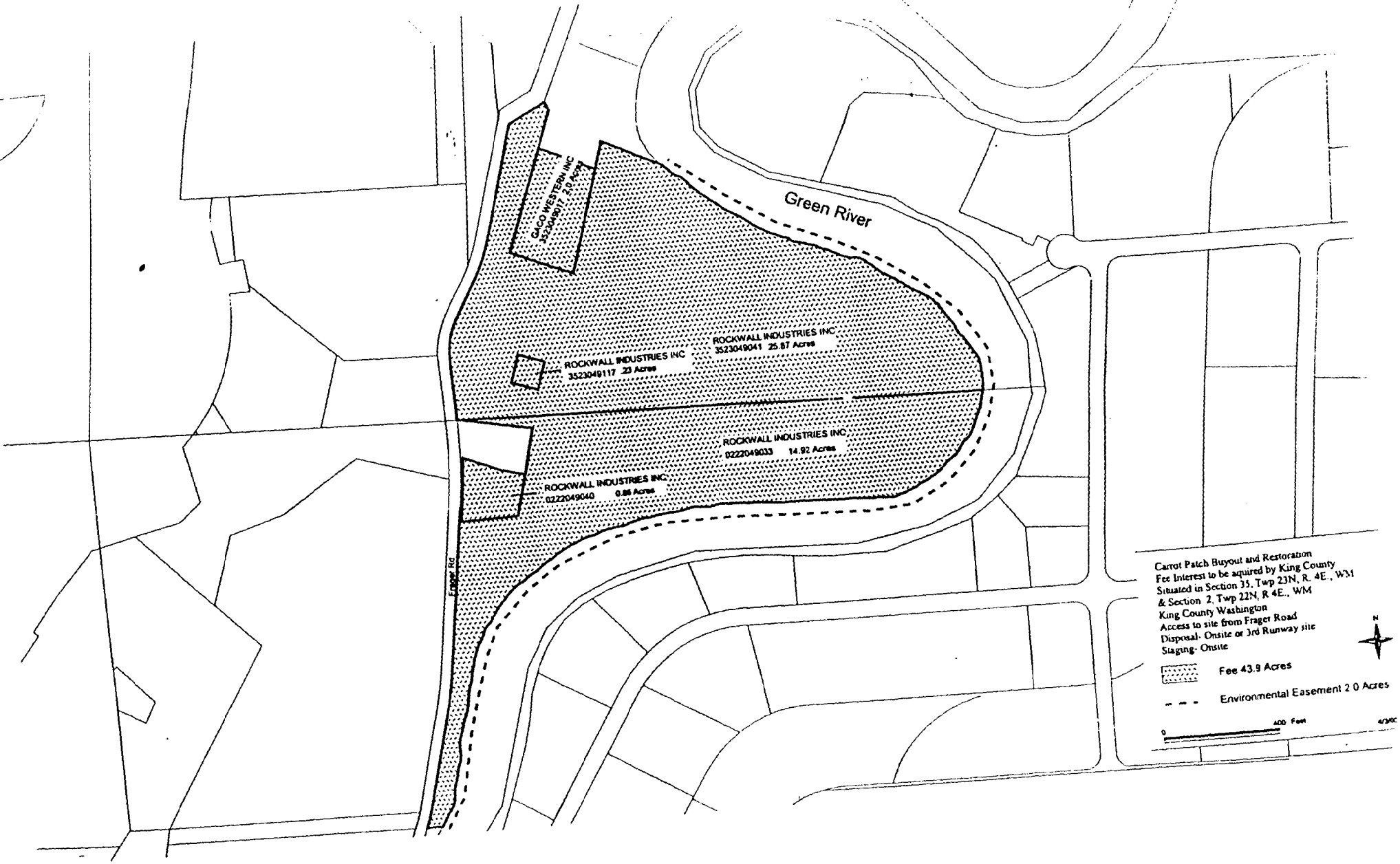
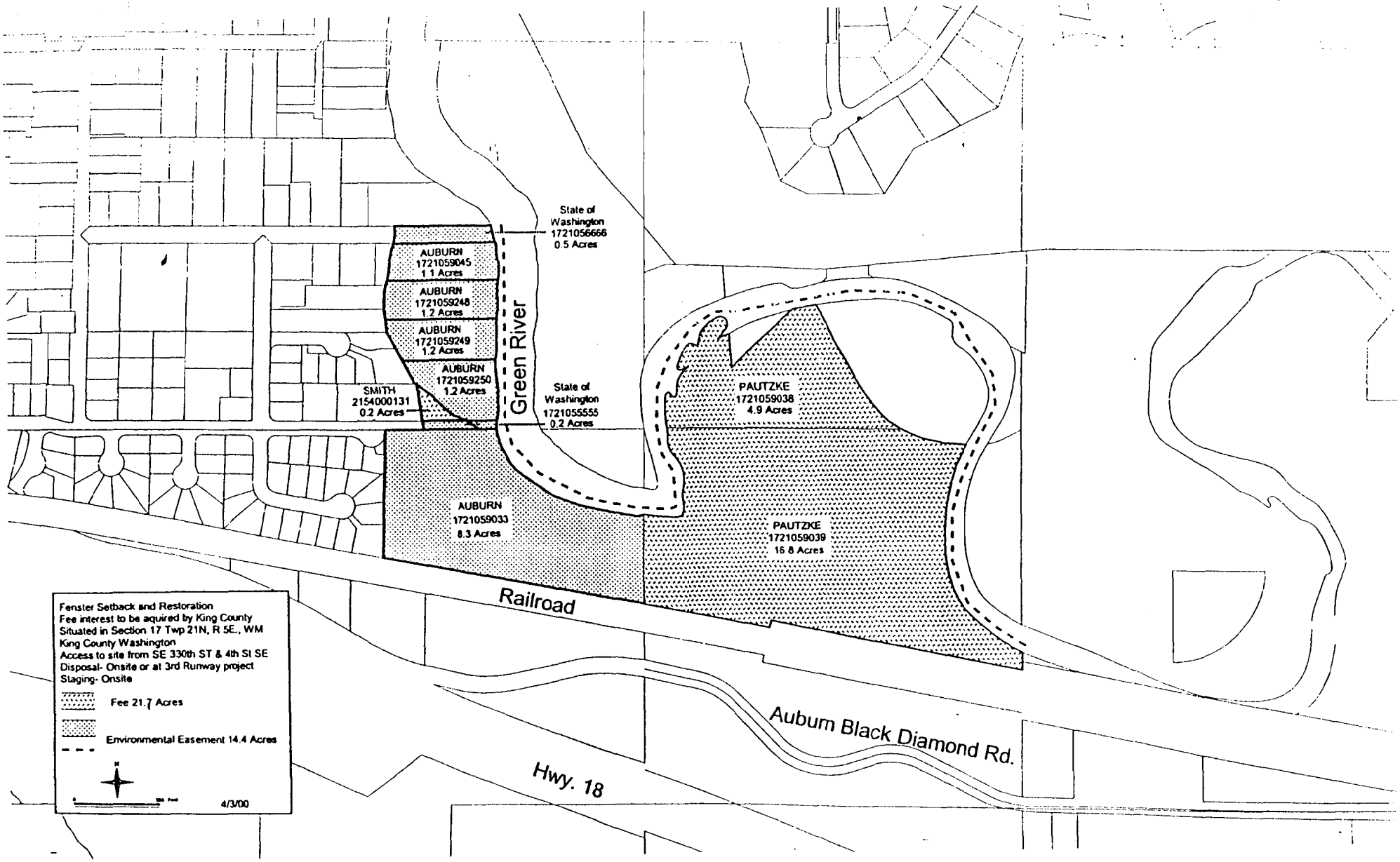
Boeing Setback and Restoration



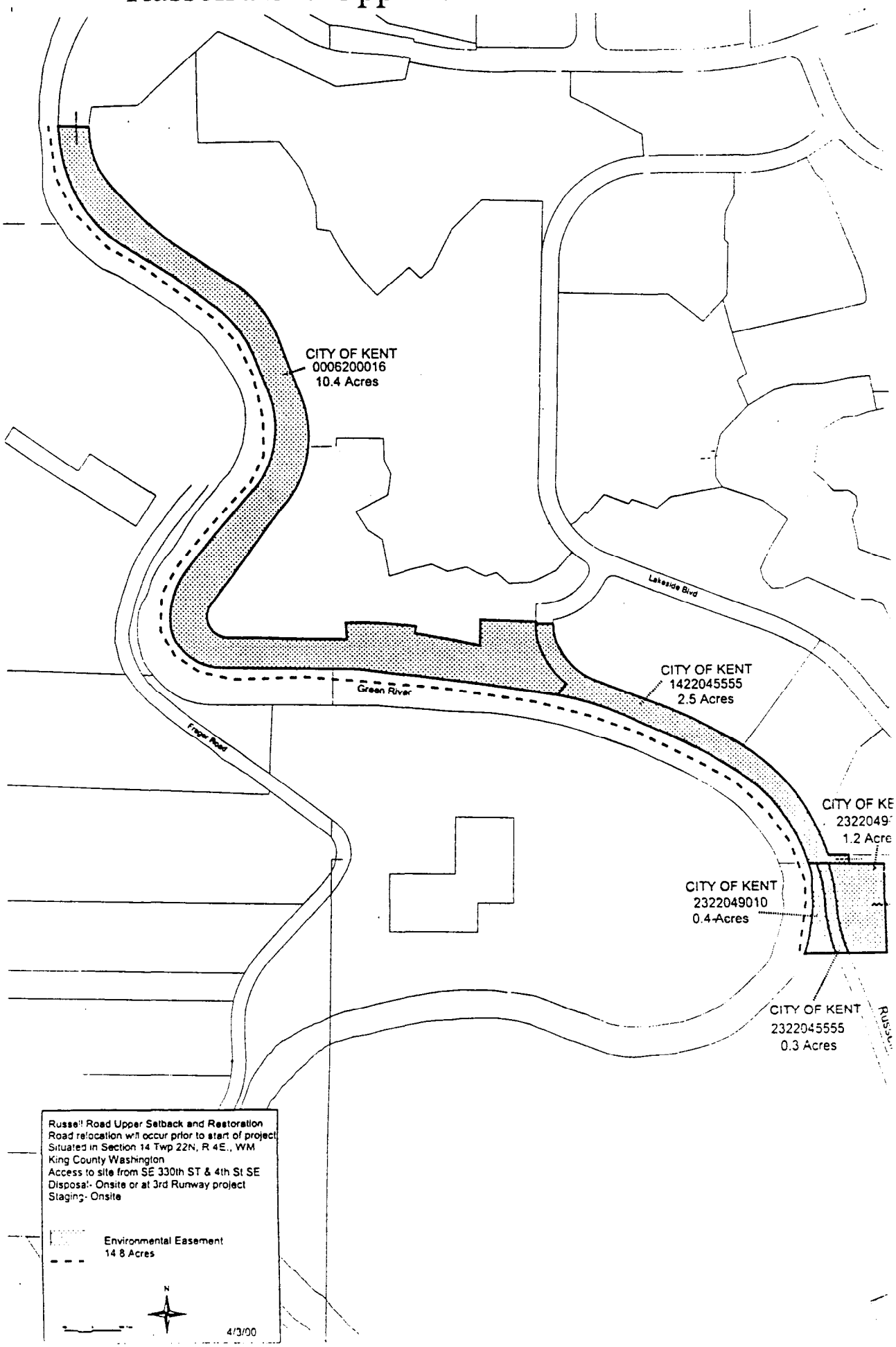
Carrot Patch



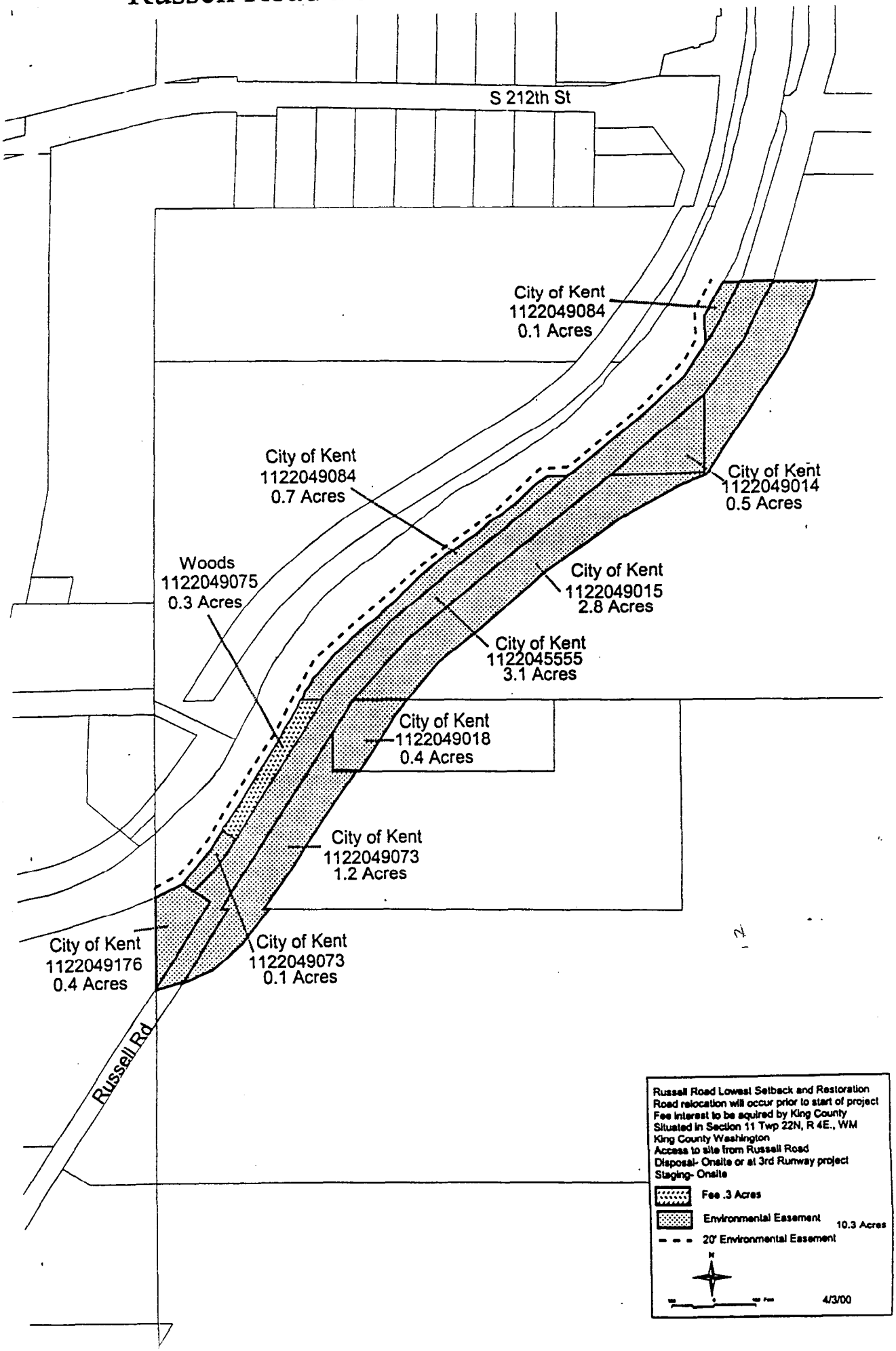
Fenster Setback a Restoration



Russell Road Upper Setback and Restoration

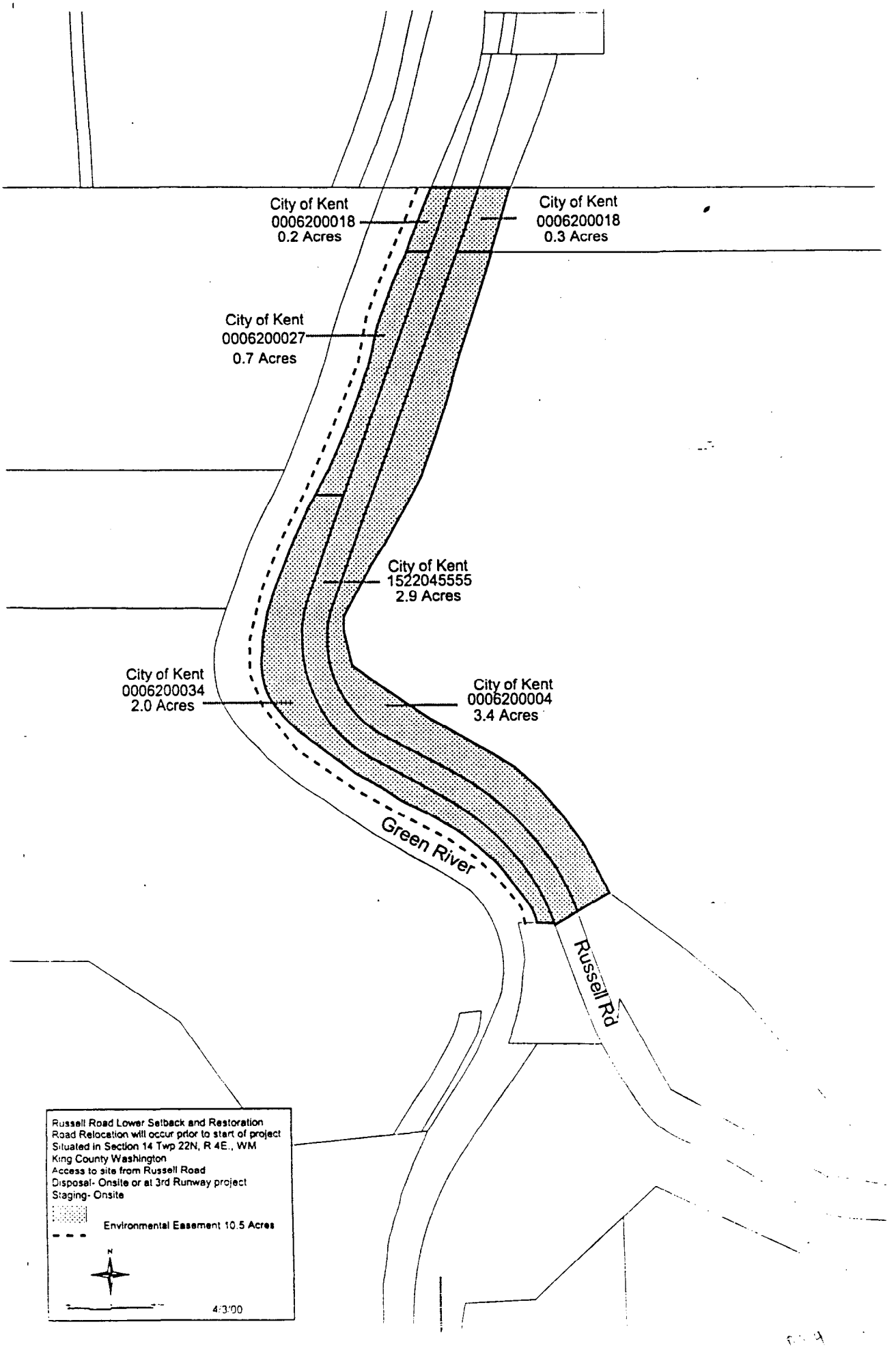


Russell Road Lowest Setback and Restoration



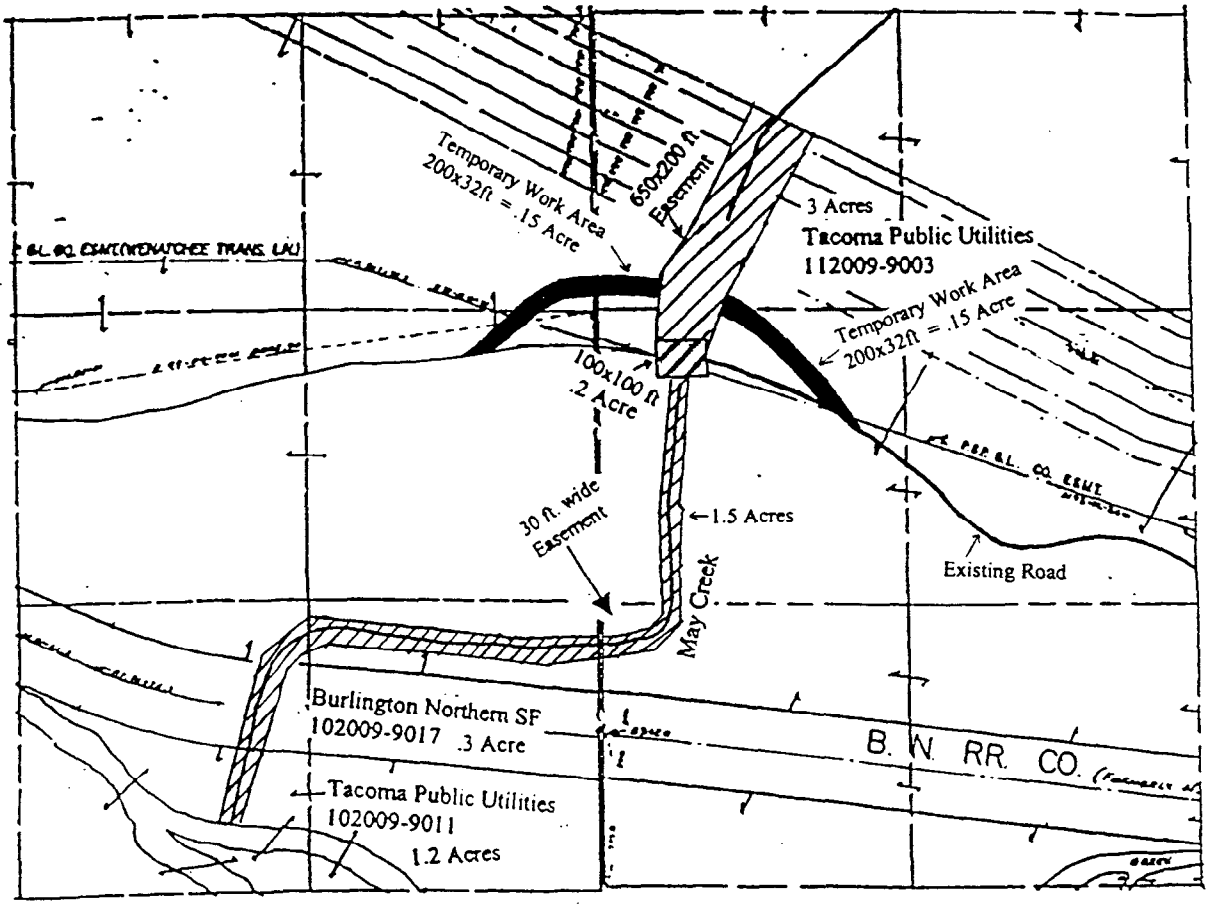
26 F

Russell Road Lower Setback and Restoration



26 B

MAY CREEK



Scale: 1" = 660'

N

Legend

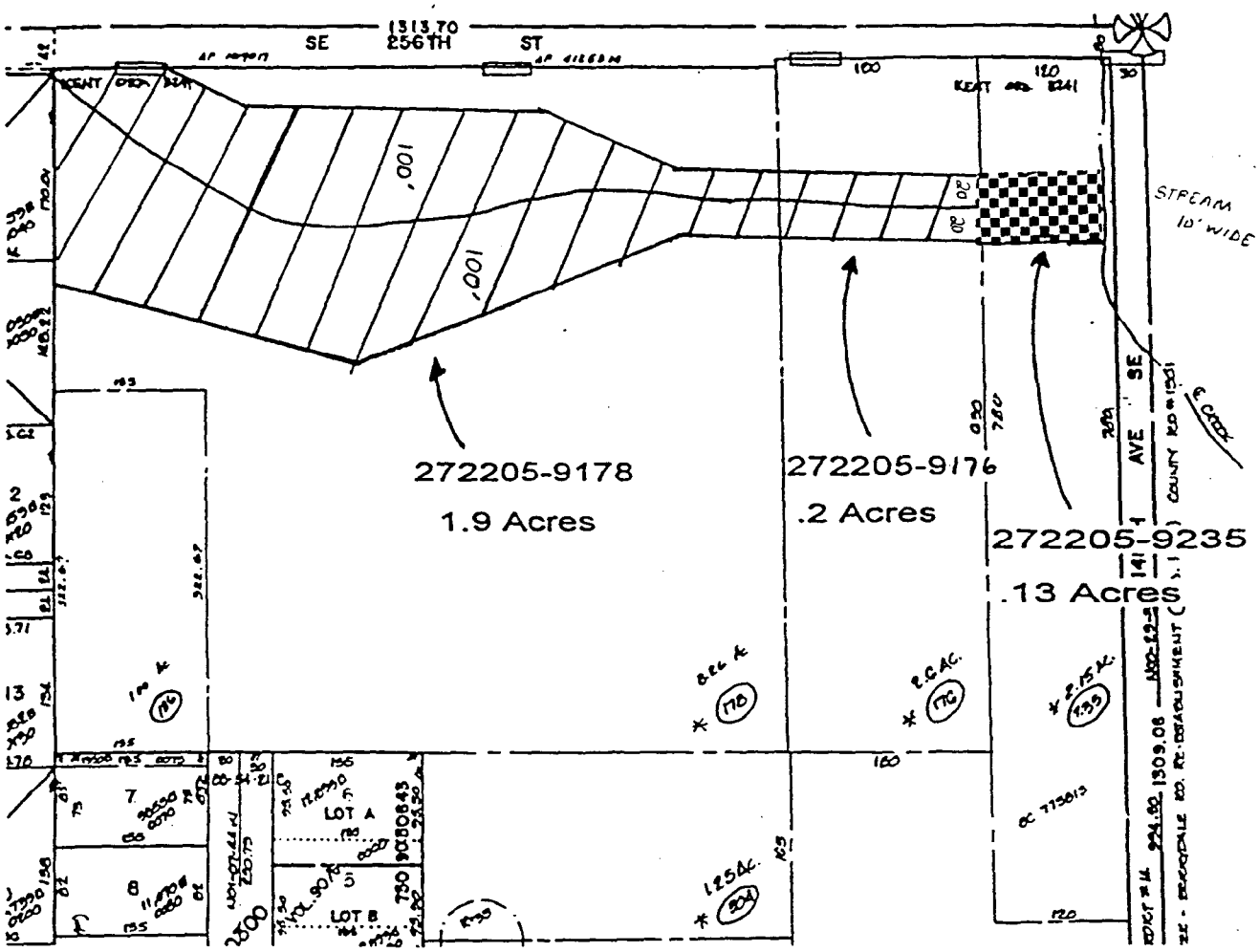
Env. Easement
6.2 Acres

Temporary Work
Area .30 Acre

May Creek Culvert Project
Non-Standard Environmental Easement
Situated in Section 11, Twp 20N, R. 09E., WM.
King County, Washington

5/1/00

MERIDIAN VALLEY CREEK PROJECT



Scale: 1"=160'

N

Fee
.13 Acres

Env. Easement
2.10 Acres

Meridian Valley Creek Project
Non-Standard Environmental Easement
Situated in Section 27, Twp 22N, R. 5E., WM.
King County, Washington

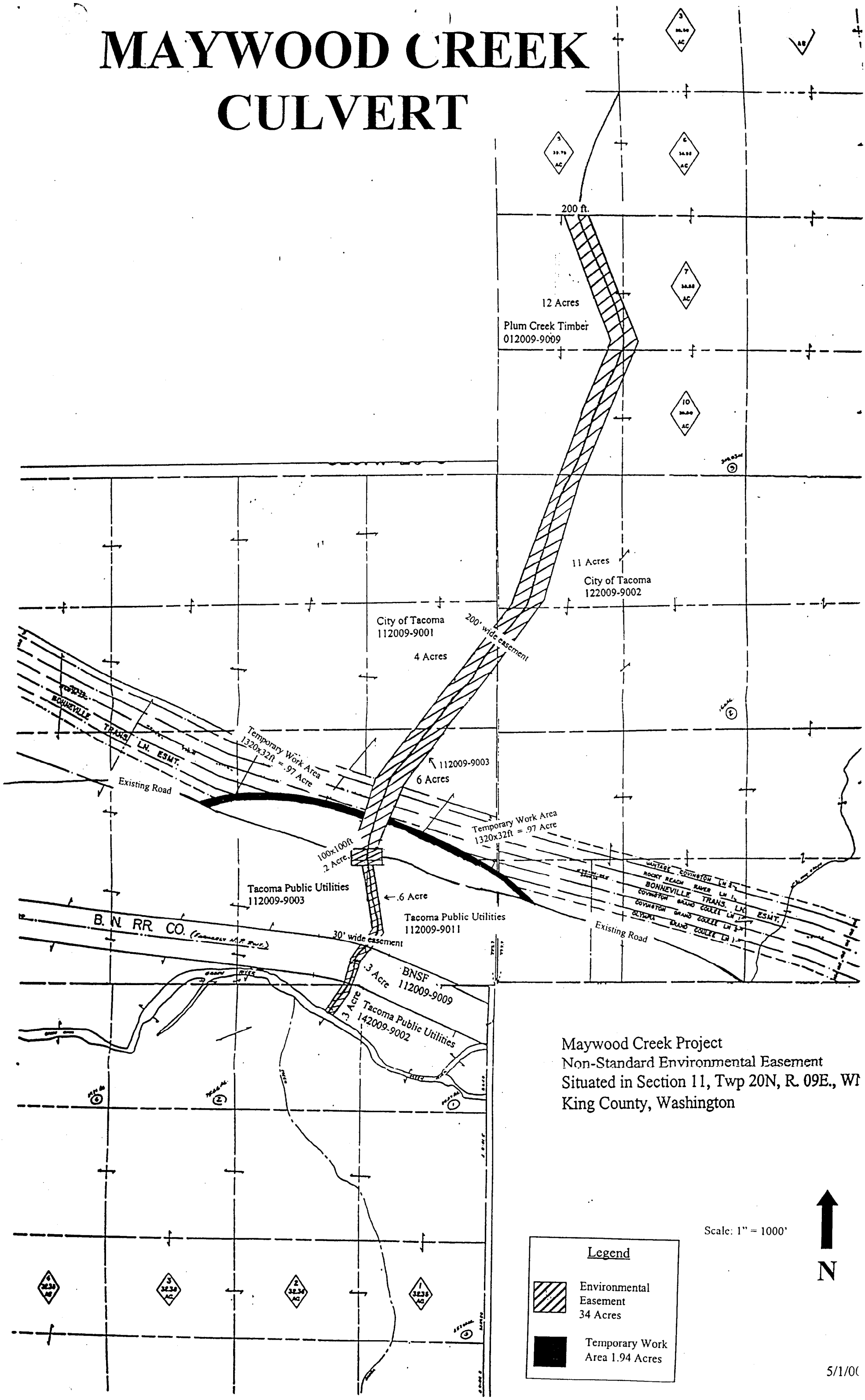
3/29/00

27B

MIDDLE GREEN RIVER
GRAVEL REPLENISHMENT SITES

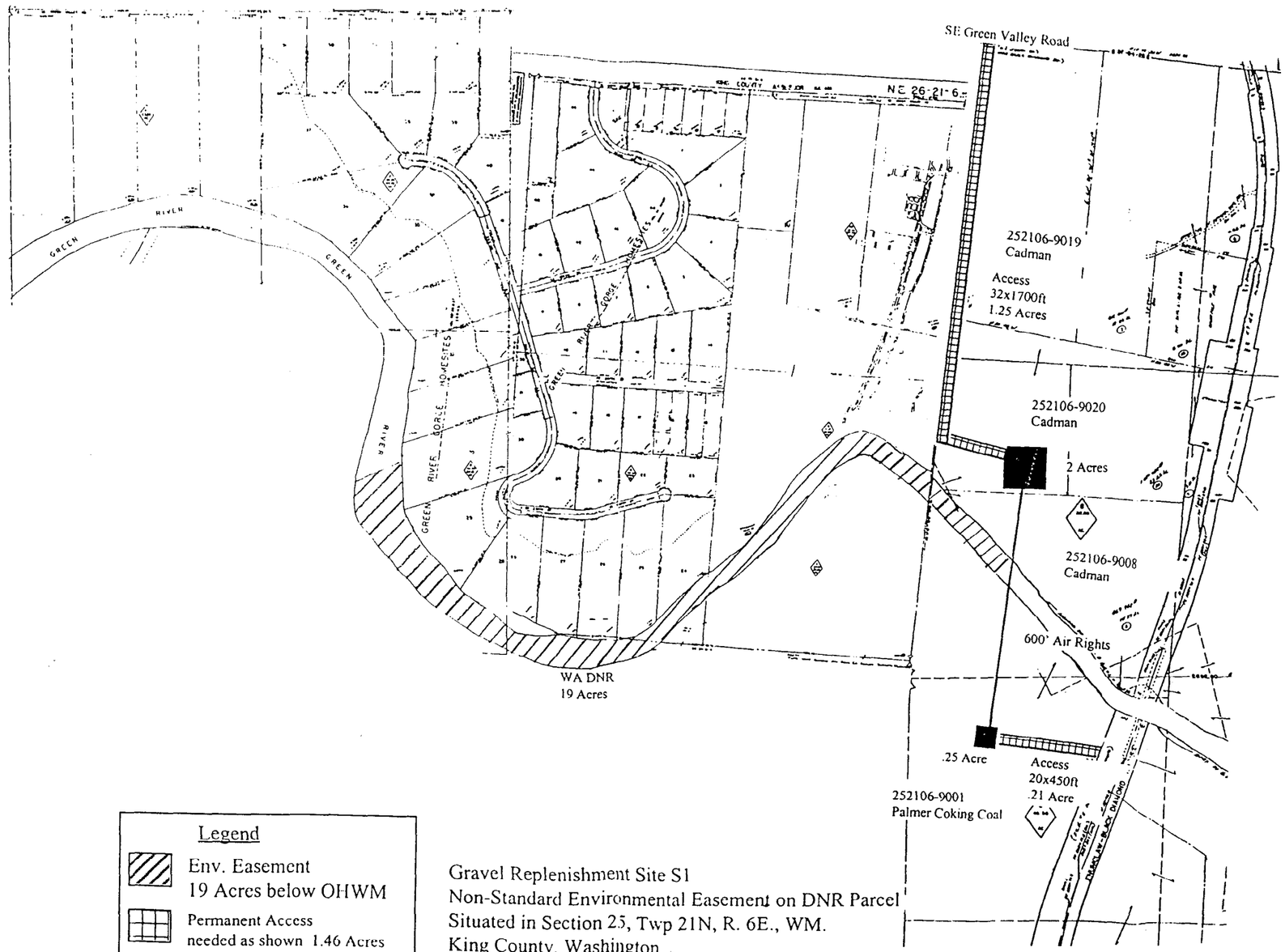
Sites S-1
S-2
C-1
C-2

MAYWOOD CREEK CULVERT



Gravel Replenishment

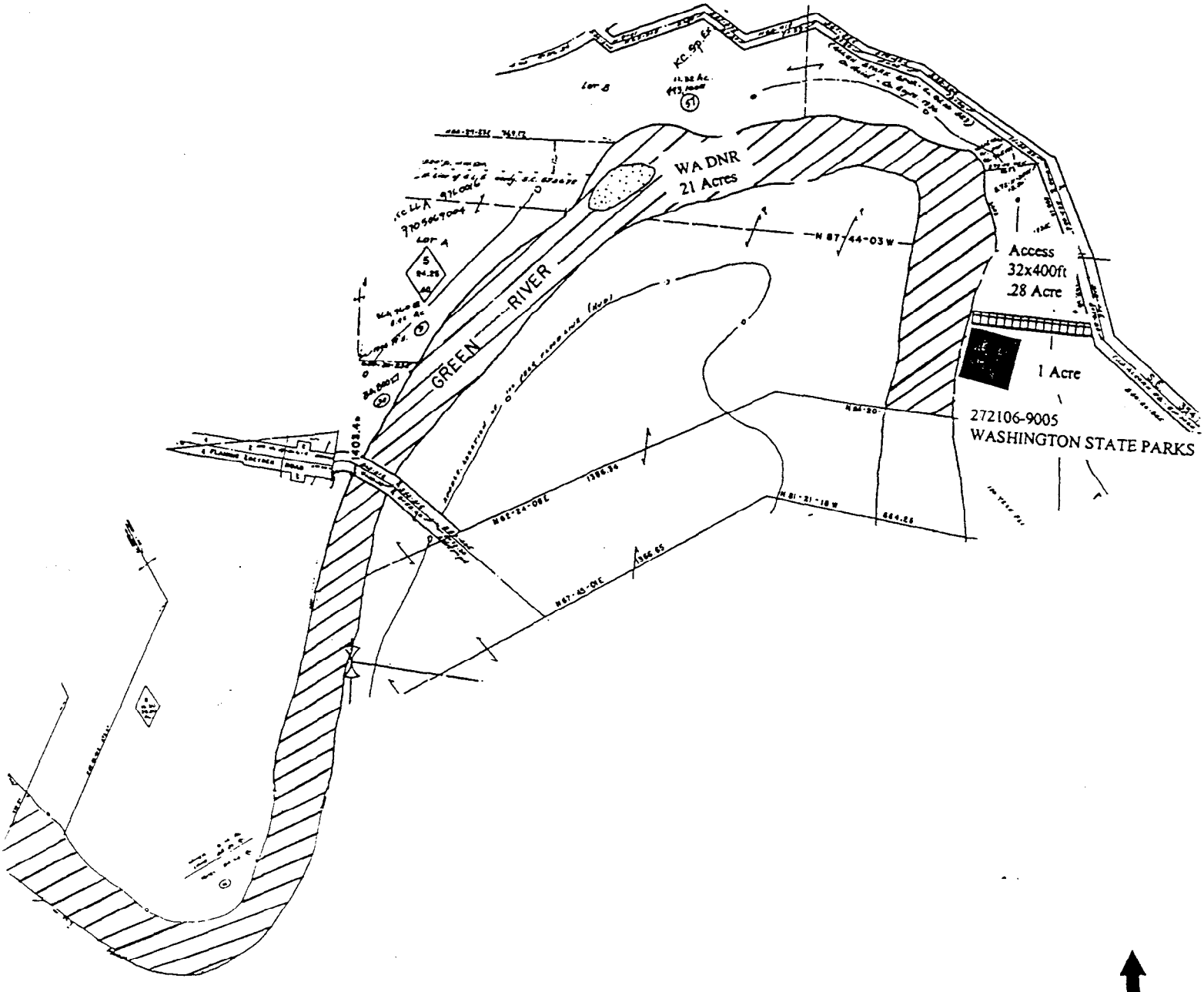
Site S1



5/15/00

Gravel Replenishment

Site C1



Scale: 1" = 430'

N

Legend

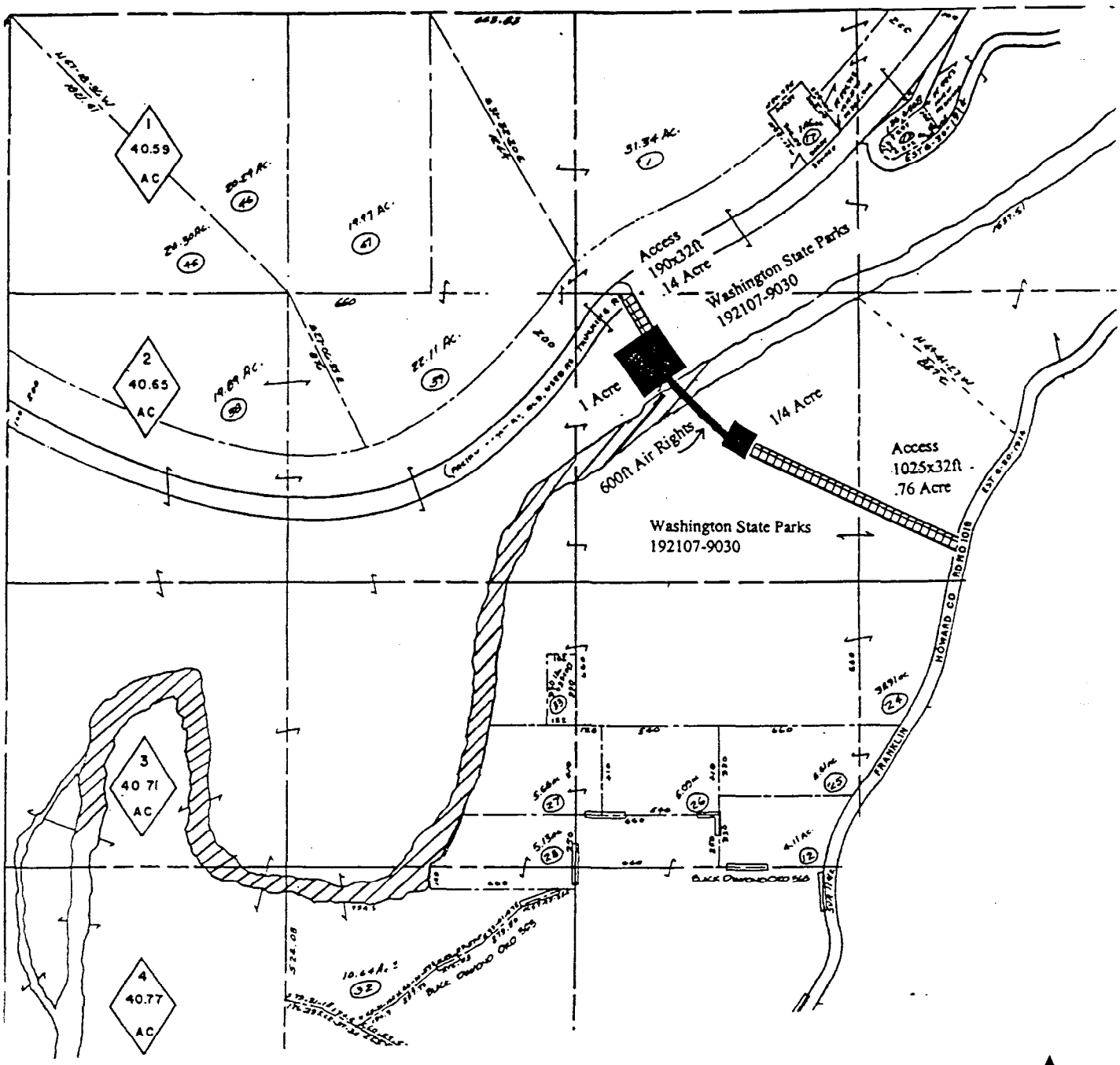
- Env. Easement 21 Acres below OHWM
- Permanent Access needed as shown .28 Acre
- 1 Acre - 10 year Temporary Construction Easement

Gravel Replenishment Site C1
Non-Standard Environmental Easement on DNR Parcel
Situated in Section 27, Twp 21N, R. 6E., WM.
King County, Washington

5/15/00

308

Gravel Replenishment Site 2



Legend

Env. Easement
16.8 Acres below OHWM

Permanent Access
needed as shown .90 Acre

10 year temporary construction
easement 1.25 Acres

Scale: 1" = 680'

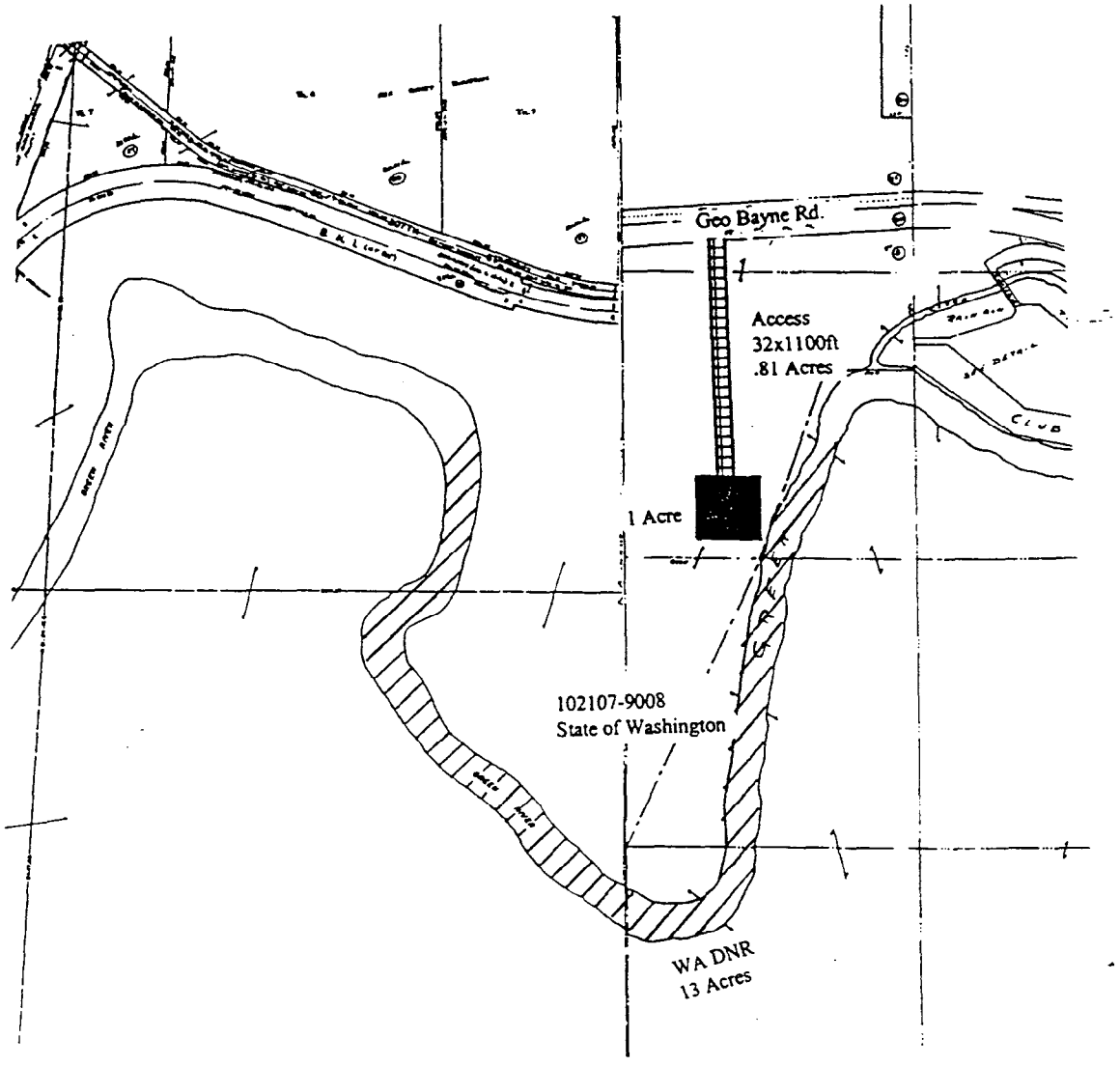
N

Gravel Replenishment Site 2
Non-Standard Environmental Easement on DNR Parcel
and 10-year Temporary Construction Easement
Situated in Section 19, Twp 21N, R. 7E., WM.
King County, Washington

5/10/00

Gravel Replenishment

Site C2



Scale: 1" = 600'

N

Legend

- Env. Easement 13 Acres below OHWM
- Permanent Access needed as shown .81 Acres
- 1 Acre - 10 year Temporary Construction Easement

Gravel Replenishment Site C2
Non-Standard Environmental Easement on DNR Parcel
Situated in Section 10, Twp 21N, R. 7E., WM.
King County, Washington

5/15/00

31B

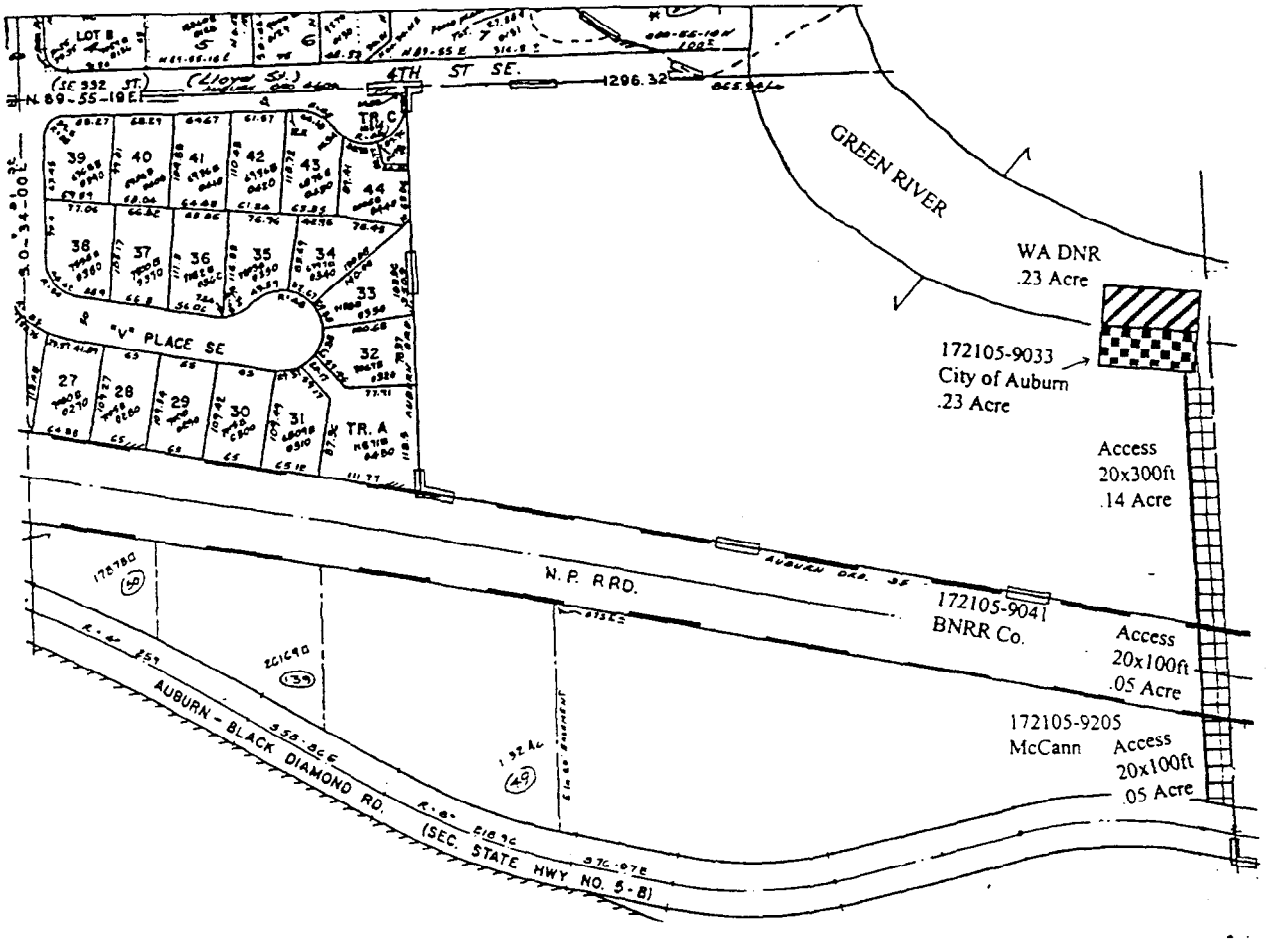
MIDDLE GREEN LARGE WOODY DEBRIS SITES

SITES BAJ3 to MJ3
BAJ6 to BAJ8
BAJ9
BAJ10, & BAJ11
BAJ12 – BAJ14
BAJ15 – BAJ18, & MAJ5
BAJ 19, BAJ-20, & MAJ6
BAJ21, BAJ22 & MJ7
BAJ23 & 24 and MJ8 and MJ9
BAJ 25
BAJ 26 to BAJ27
BAJ 28
BAJ 29 & 30
BAJ 31, 32 & MJ10
BAJ 33 to 36, & MJ11, and MJ13
MJ1

32F

LOG JAM SITES

MJ1



Legend

Env. Easement
.23 Acres below OHWM

Fee Interest
.23 Acres

Permanent Access
needed as shown
.24 Acres

Scale: 1" = 215'

N

Log Jam Sites MJ1
Fee interest & Non-Standard Environmental
Easement on DNR Parcel
Situated in Section 17, Twp 21N, R. 5E., WM.
King County, Washington

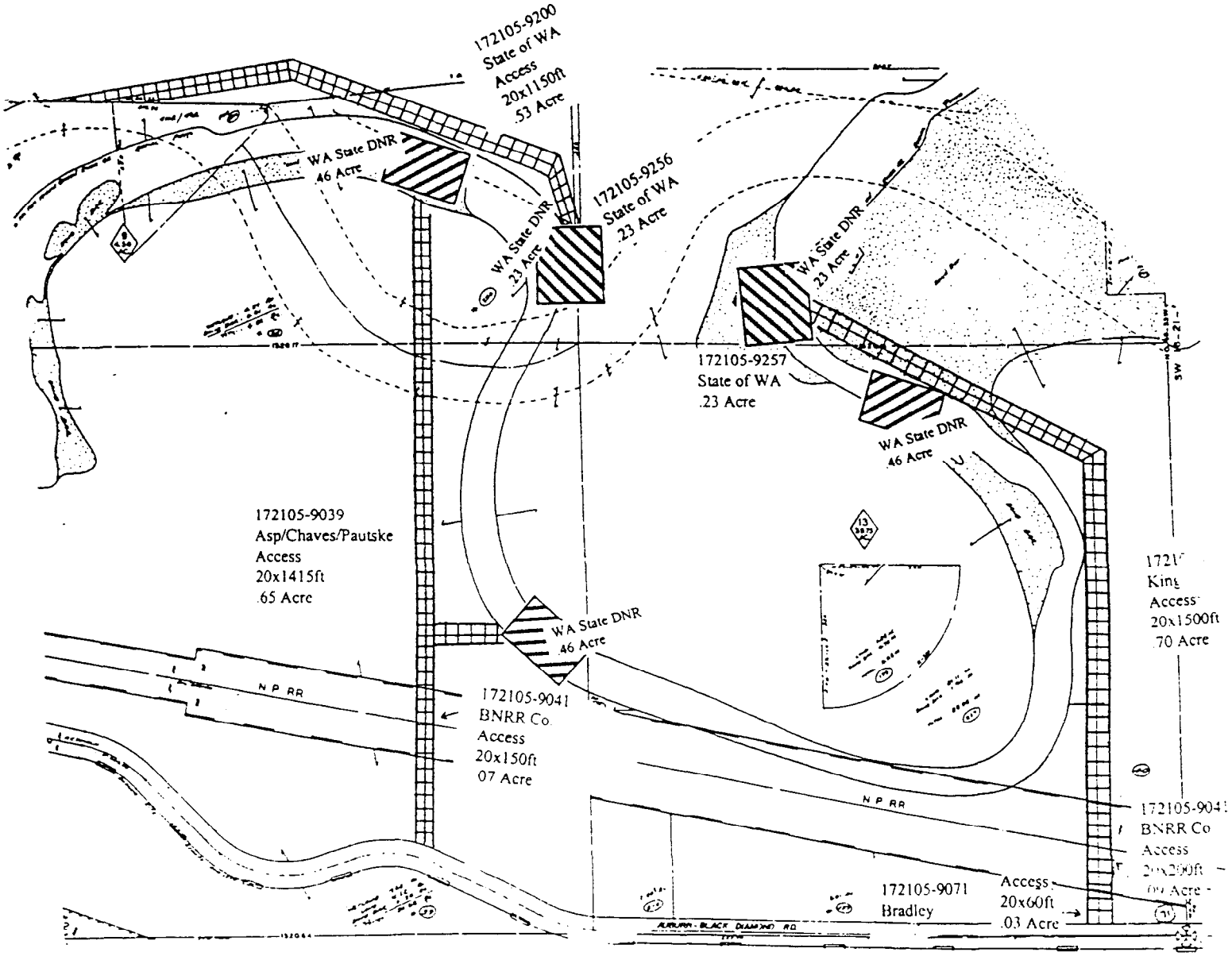
Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland.

4/17/00

328

LOG JAM SITES

BAJ 3 TO MJ 3



Legend

Env. Easement
2.30 Acres below OHWM

Permanent Access
needed as shown
2.07 Acres

Scale: 1" 330'

N

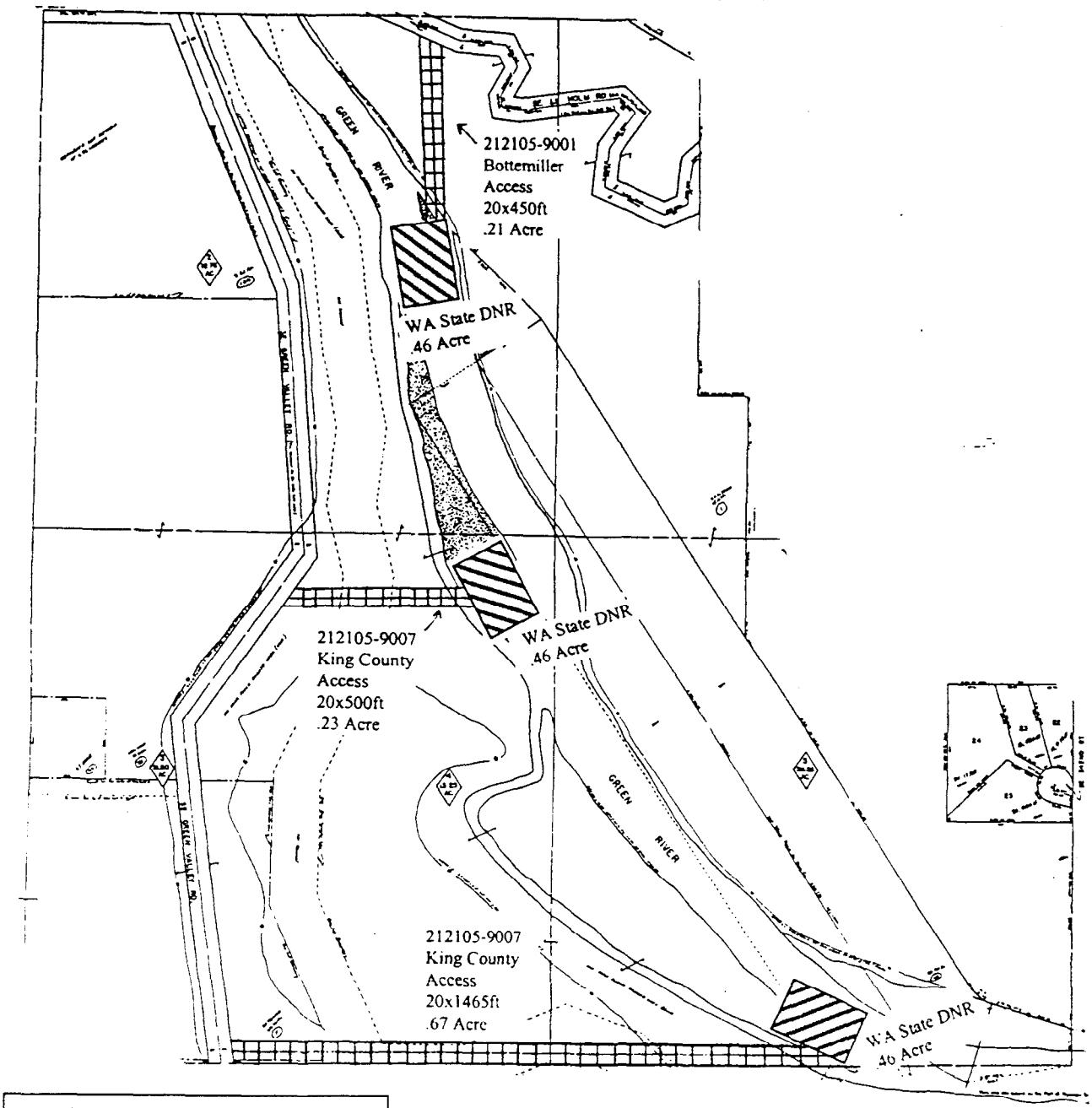
Log Jam Sites MJ1
Fee interest & Non-Standard Environmental
Easement on DNR Parcel
Situated in Section 17, Twp 21N, R. 5E., WM.
King County, Washington

Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

4/17/00

LOG JAM SITES

BAJ6 TO BAJ8



Legend

Env. Easement
.92 Acres below OHWM
38

Permanent Access
needed as shown
1.11 Acres

Scale: 1" = 330'

N

Log Jam Sites BAJ6 to BAJ8
Fee interest & Non-Standard Environmental
Easement on DNR Parcel
Situated in Section 21, Twp 21N, R. 5E., WM.
King County, Washington

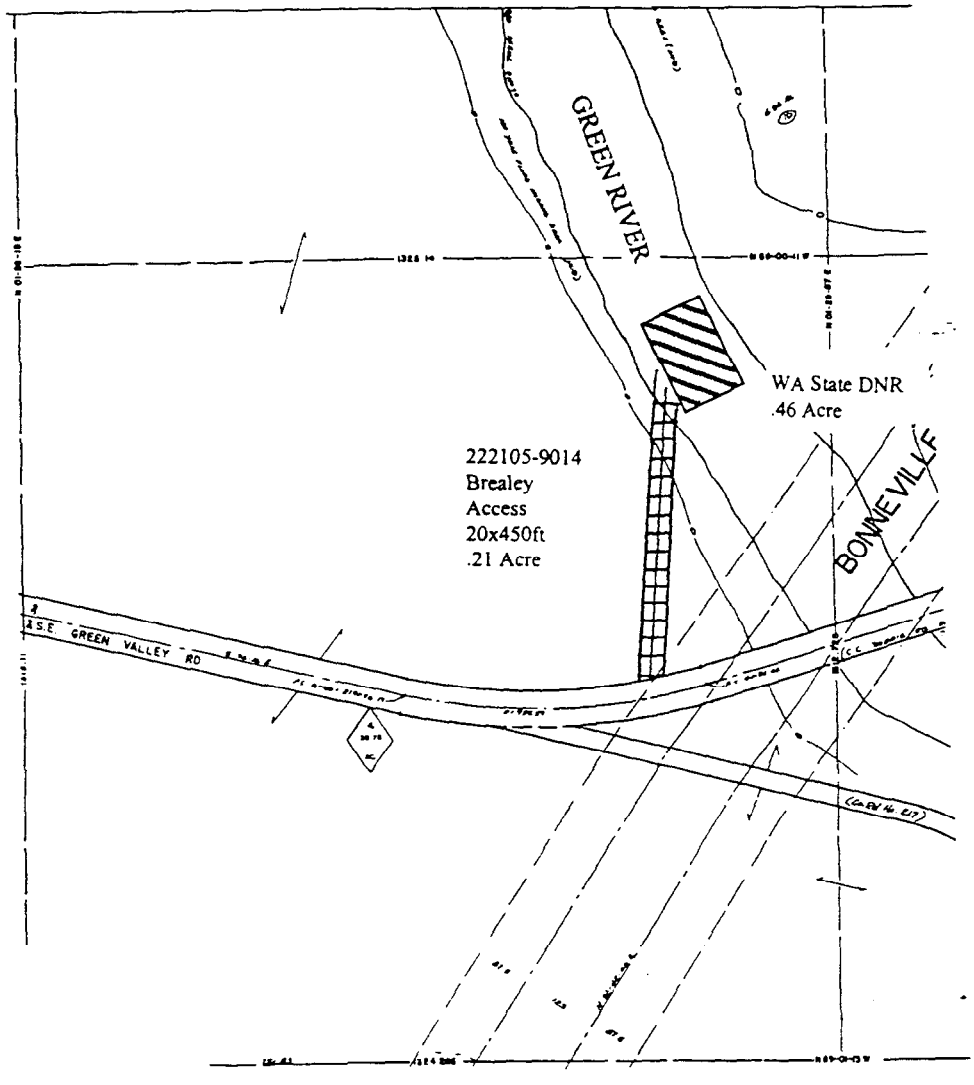
Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

4/17/00

33

LOG JAM SITES

BAJ9



Legend

Env. Easement
.46 Acre below OHWM

Permanent Access
needed as shown
.21 Acre

Scale: 1" = 310'

N

Log Jam Sites BAJ9
Non-Standard Environmental
Easement on DNR Parcel
Situated in Section 22, Twp 21N, R. 5E., WM.
King County, Washington

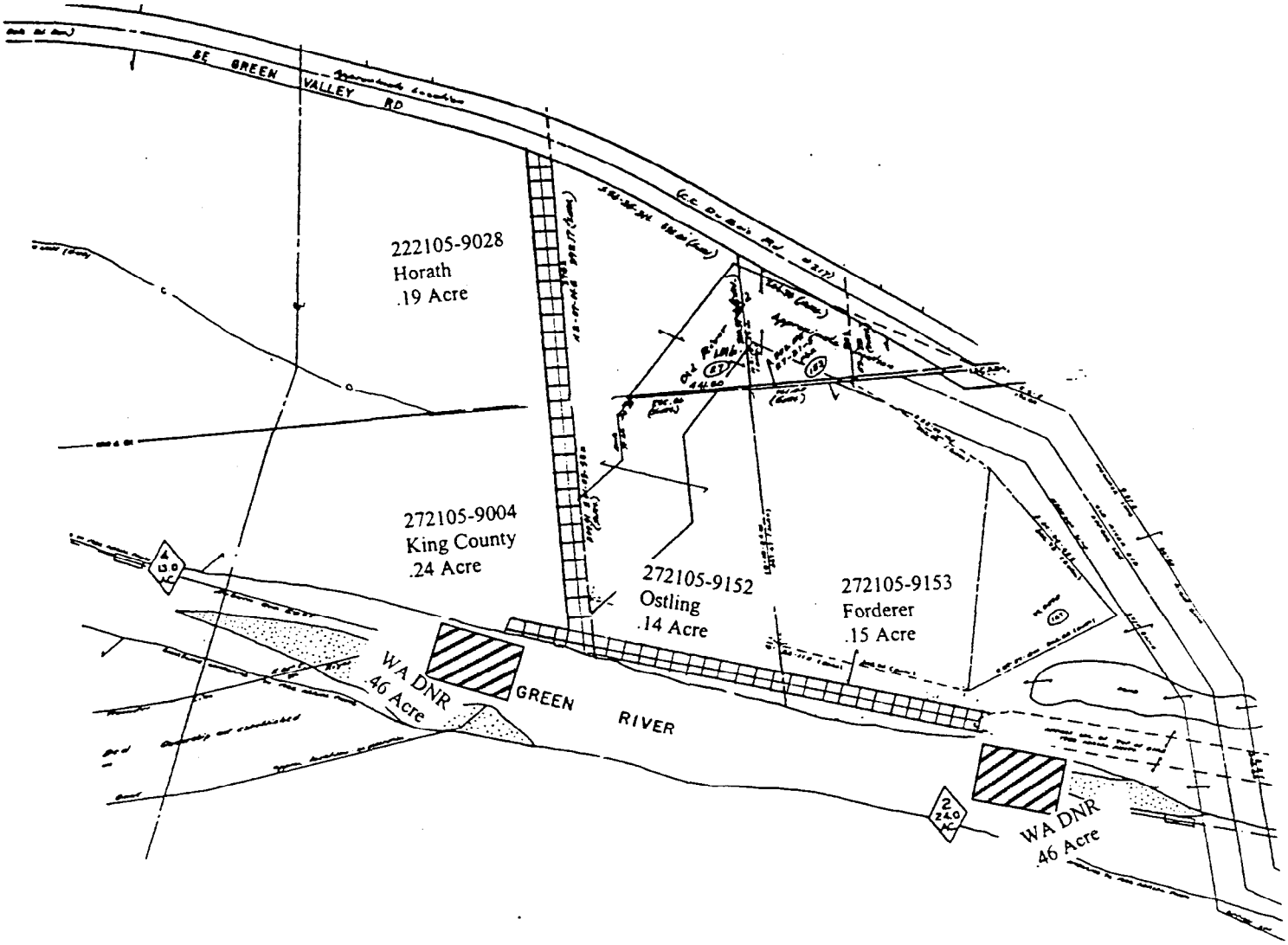
Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

4/17/00

34F

LOG JAM SITES

BAJ 10 & BAJ 11



Legend

Env. Easement
.92 Acre below OHWM

Permanent Access
needed as shown
.72 Acre

Scale: 1" = 270'

N

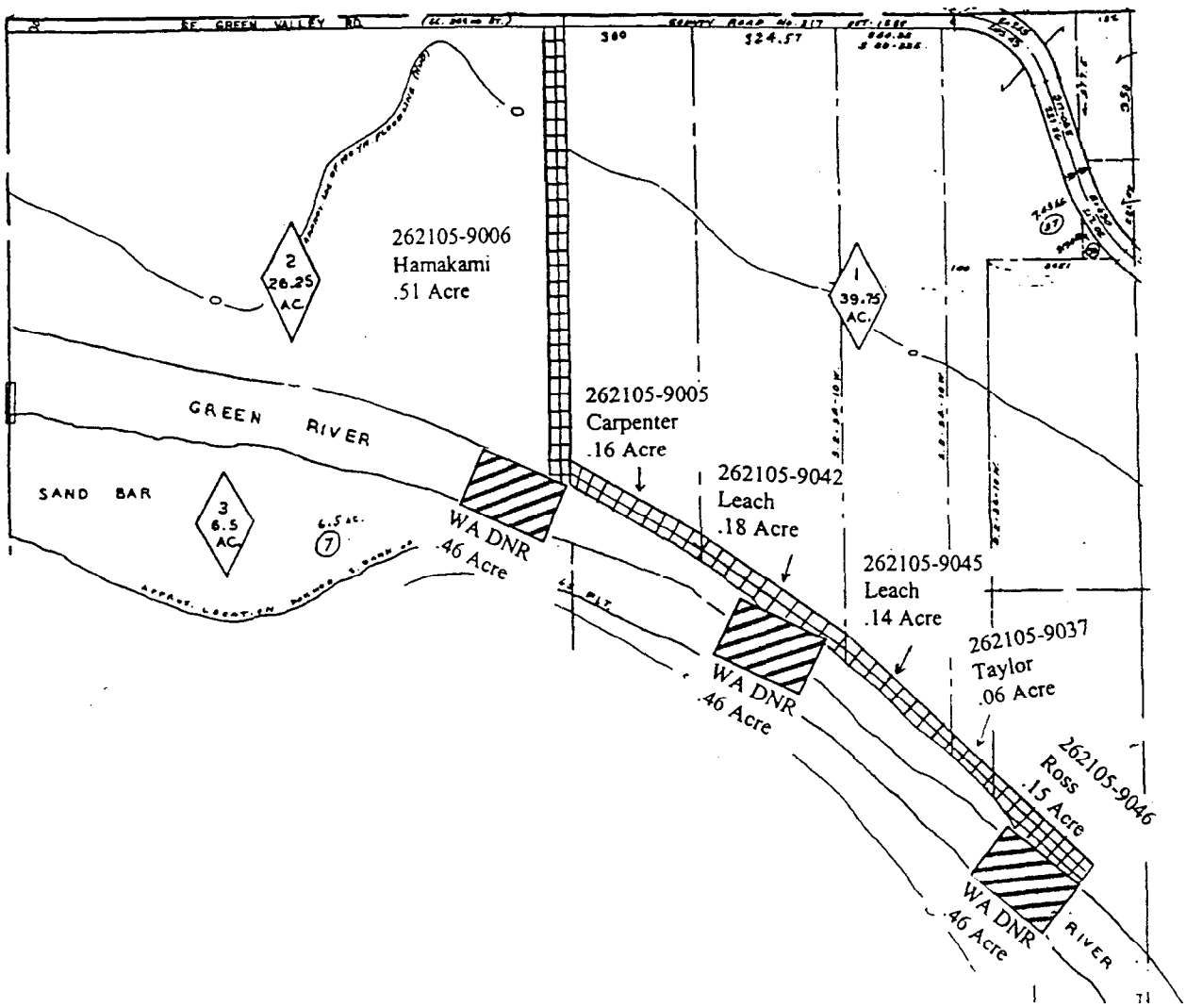
Log Jam Sites BAJ10 & BAJ11
Non-Standard Environmental
Easement on DNR Parcel
Situated in Section 27, Twp 21N, R. 5E., WM.
King County, Washington

Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

4/24/00

LOG JAM SITES

BAJ 12 through BAJ 14



Legend

Env. Easement
1.38 Acre below OHWM

Permanent Access
needed as shown
1.2 Acres

Scale: 1" = 400'

N

Log Jam Sites BAJ12 through BAJ14
Non-Standard Environmental
Easement on DNR Parcel
Situated in Section 26, Twp 21N, R. 5E., WM.
King County, Washington

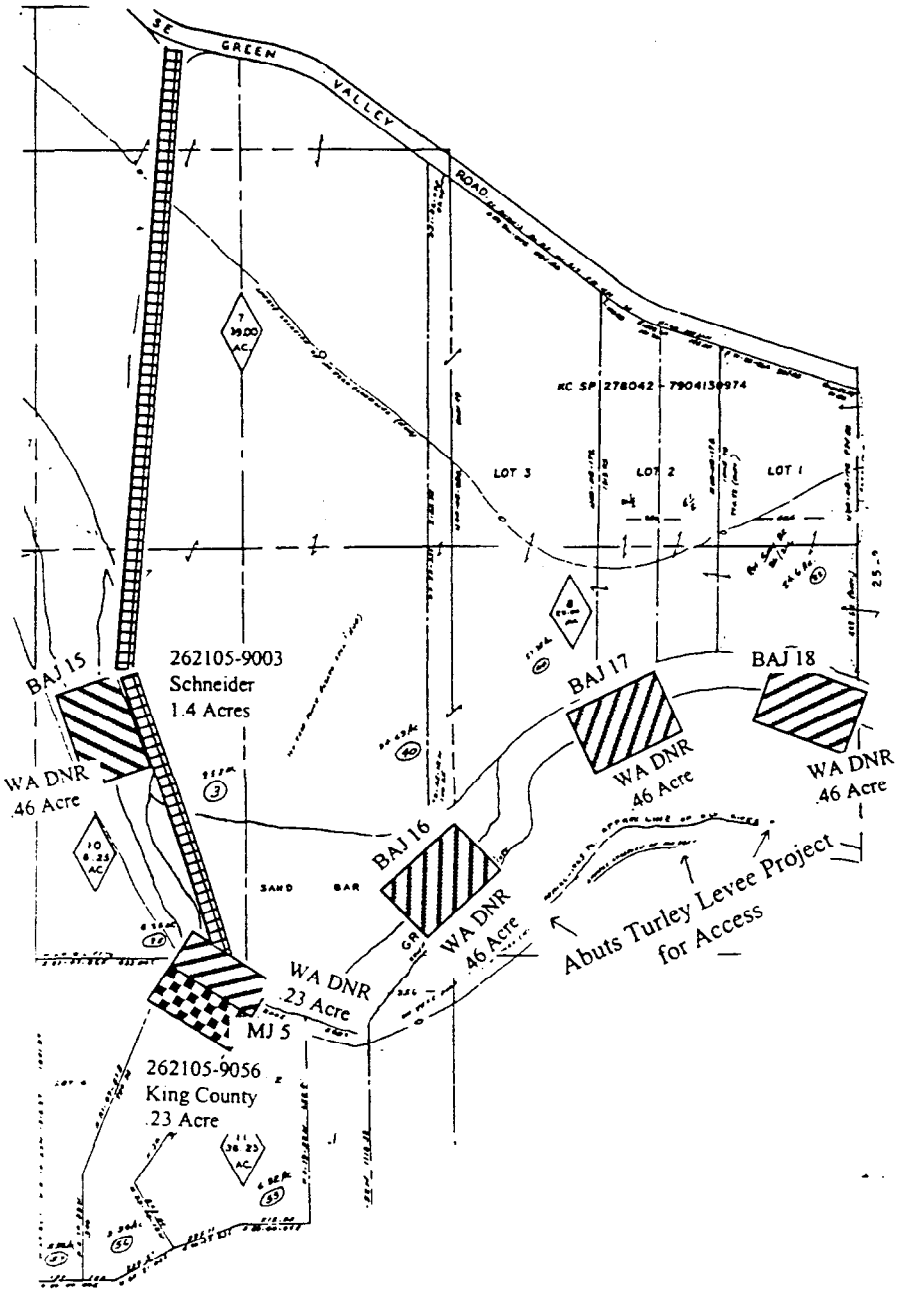
Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

4/24/00

35 F

LOG JAM SITES

BAJ 15 through BAJ 18 & MAJ 5



Legend

Env. Easement
2.07 Acres below OHWM

Permanent Access
needed as shown
1.4 Acres

Fee interest .23 Acre

Scale: 1" = 480'

N

Log Jam Sites BAJ15 through BAJ18 & MJ5
Non-Standard Environmental Easement on DNR Parcel
Fee Interest on King County Parcel
Situated in Section 26, Twp 21N, R. 5E., WM.
King County, Washington

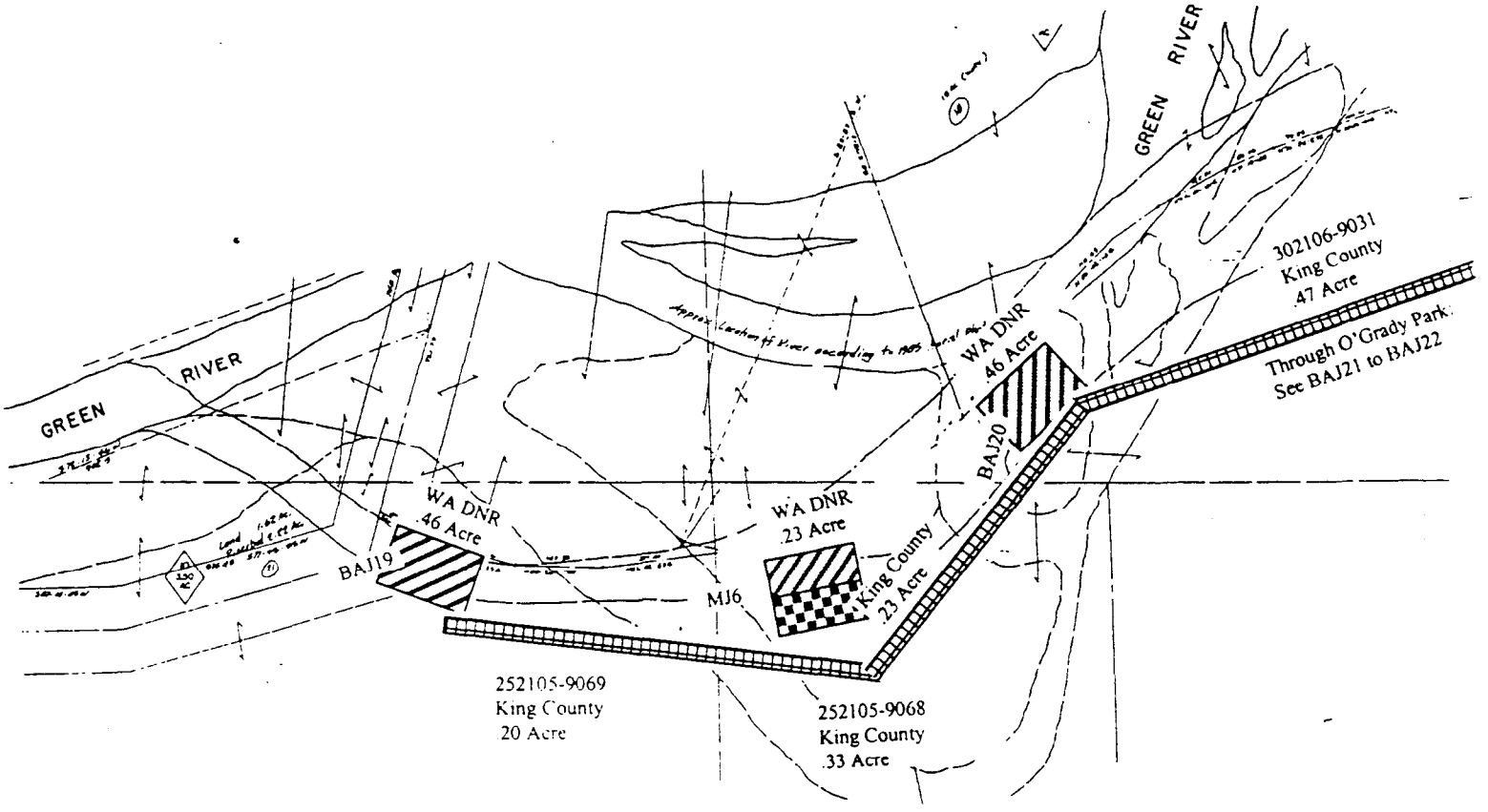
Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

4/24/00

35B

LOG JAM SITES

BAJ 19 & BAJ 20 and MAJ 6



Legend

Env. Easement
1.15 Acres below OHWM

Permanent Access
needed as shown
1.0 Acres

Fee interest .23 Acre

Scale: 1" = 300'

N

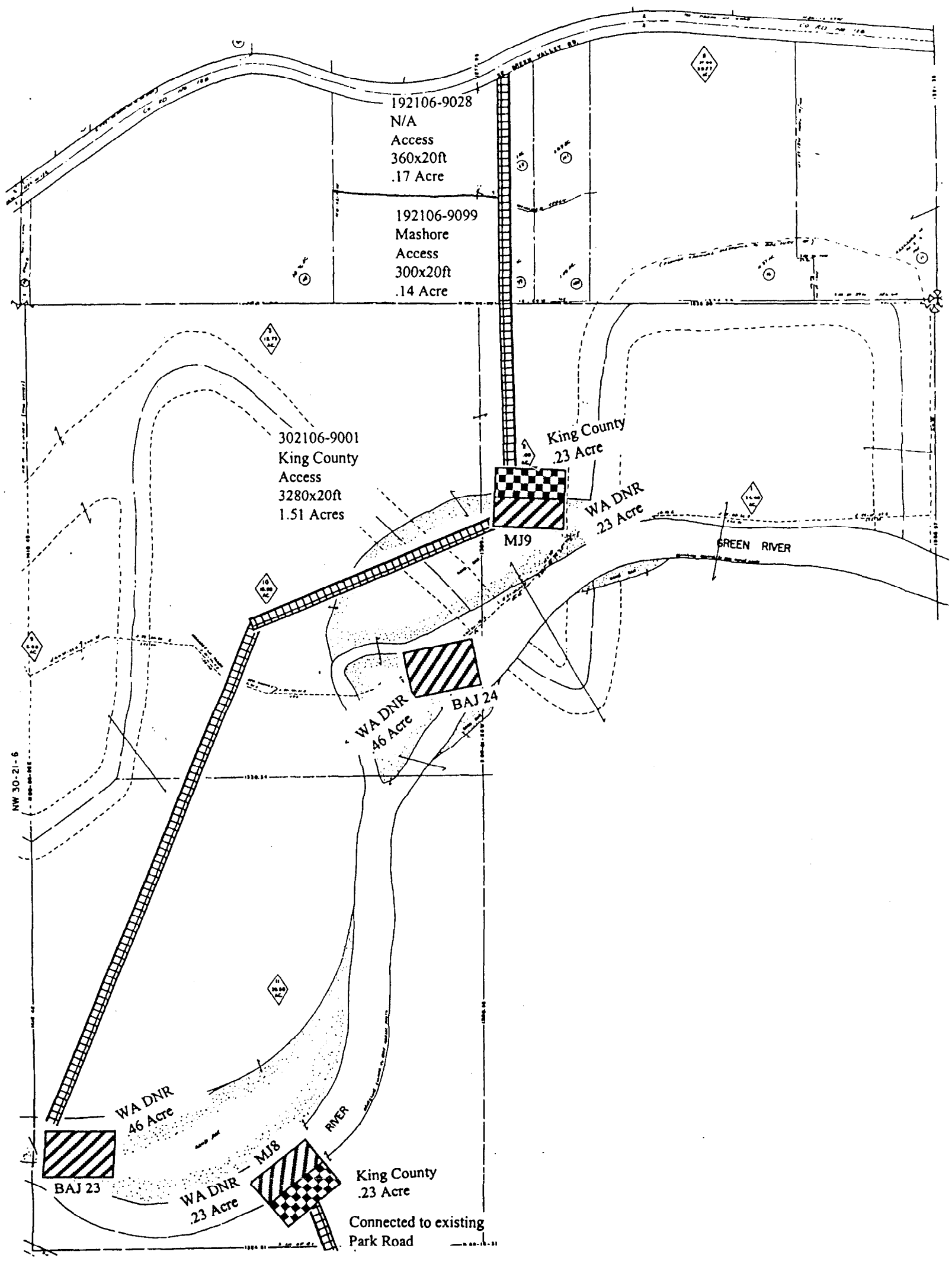
Log Jam Sites BAJ19 & BAJ20 and MJ6
Non-Standard Environmental Easement on DNR Parcel
Fee Interest on King County Parcel
Situated in Section 26, Twp 21N, R. 5E., WM.
King County, Washington

Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

4/24/00

Log Jam Sites

BAJ 23 & 24 and MJ 8 & 9



Scale: 1" = 410'

N

Legend

- Env. Easement 1.38 Acres below OHWM
- Permanent Access needed as shown 1.82 Acres
- Fee interest .46 Acre

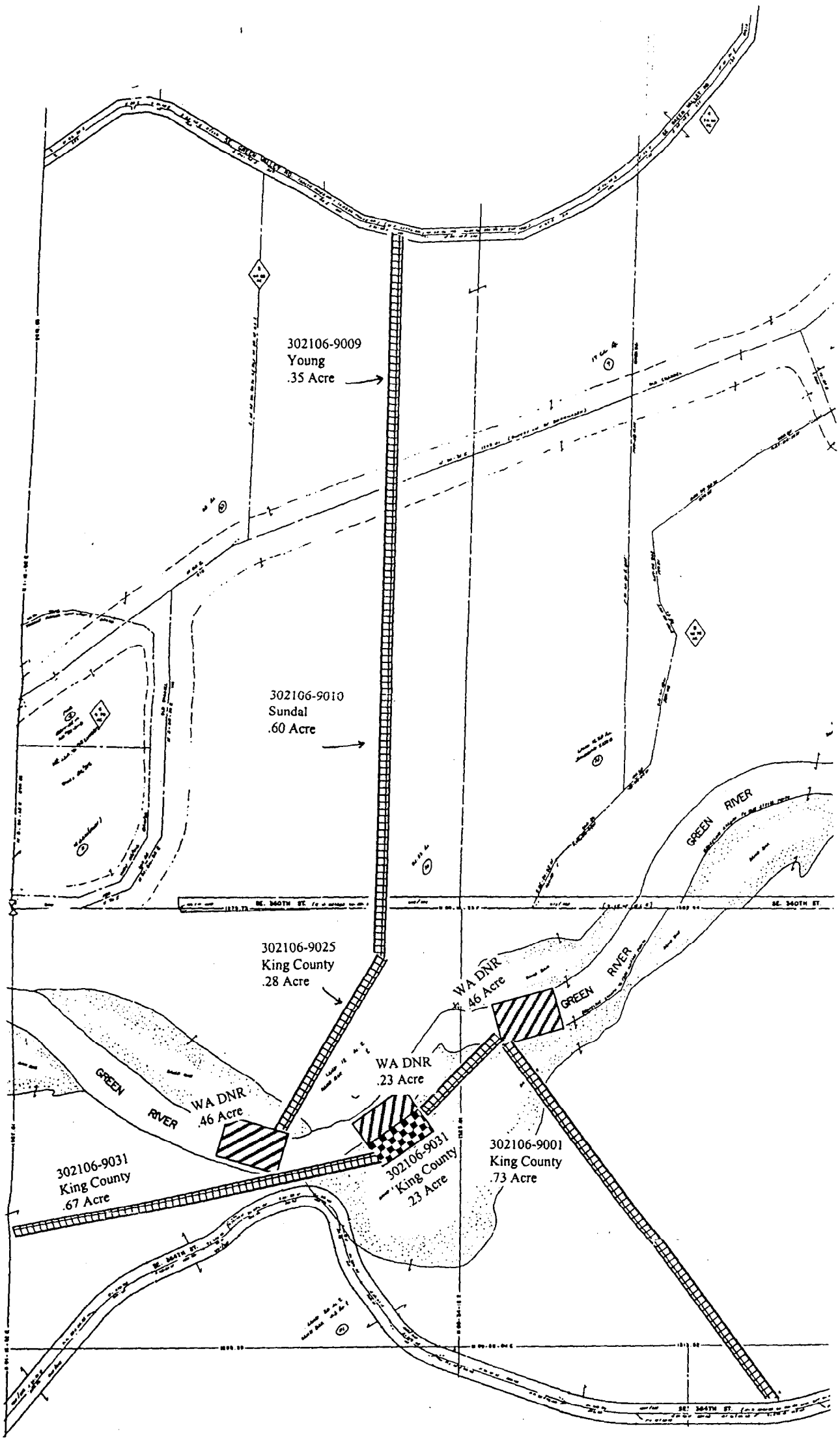
Log Jam Sites BAJ 23&24 and MJ 8&9
Non-Standard Environmental Easement on DNR Parcel
and Fee interest on King County Parcel
Situated in Section 30, Twp 21N, R. 6E., WM.
King County, Washington

Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

5/10/00

LOG JAM SITES

BAJ 21 & BAJ 22 and MJ7



Legend

- Env. Easement 1.15 Acres below OHWM
- Permanent Access needed as shown 2.63 Acres
- Fee interest .23 Acre

Scale: 1" = 440'

N

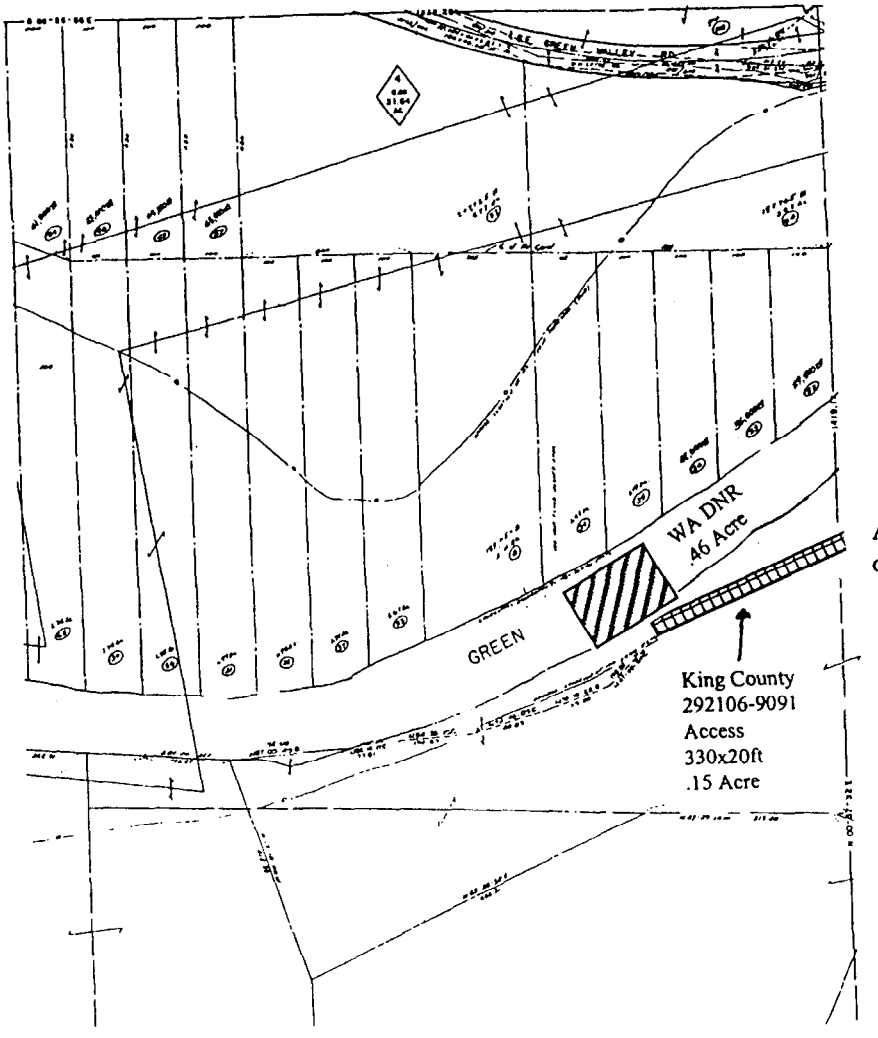
Log Jam Sites BAJ21 & BAJ22 and MJ7
Non-Standard Environmental Easement on DNR Parcel
Fee Interest on King County Parcel
Situated in Section 30, Twp 21N, R. 6E., WM.
King County, Washington

Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

4/24/

Log Jam Sites

BAJ 25



Access route continues on Map BAJ 26 & 27

Scale: 1" = 375'

N

Legend

Env. Easement
.46 Acres below OHWM

Permanent Access
needed as shown .15 Acre

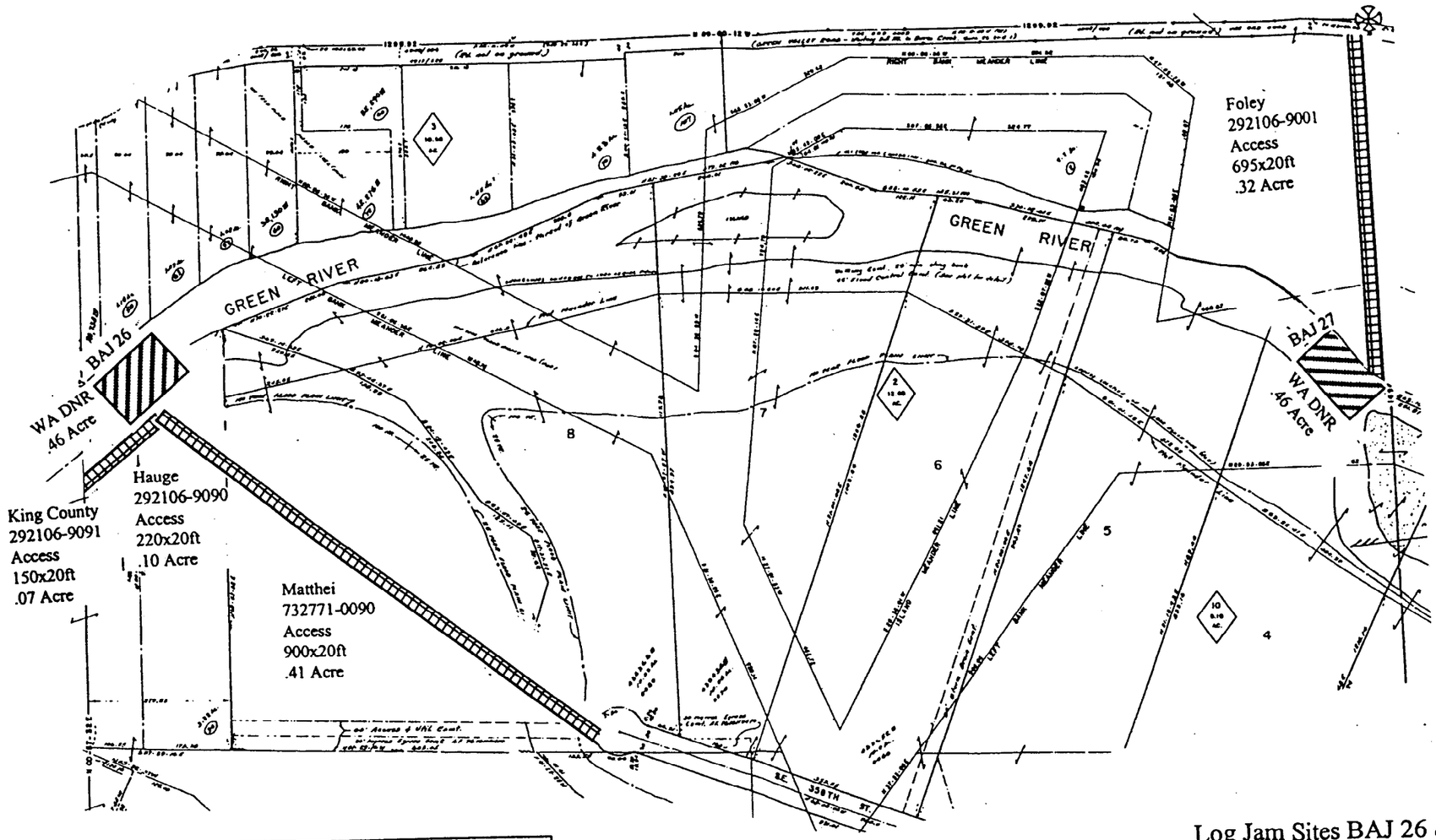
Log Jam Sites BAJ 25
Non-Standard Environmental Easement on DNR Parcel
Situated in Section 29, Twp 21N, R. 6E., WM.
King County, Washington

Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

5/10/00

Log Jam Sites

BAJ 26 & BAJ 27



Scale: 1" = 350'

N

Legend

Env. Easement
.92 Acres below OHWM

Permanent Access
needed as shown .90 Acre

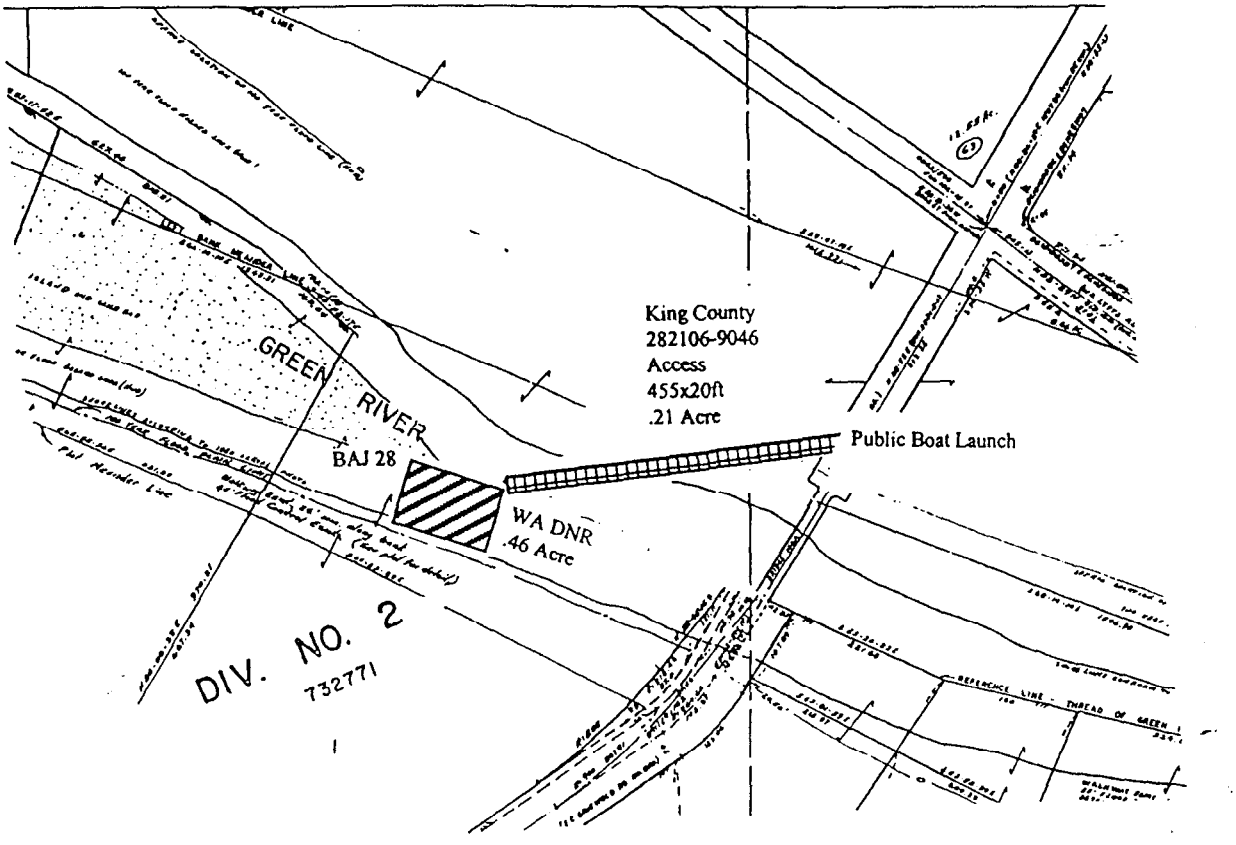
Log Jam Sites BAJ 26 & 27
Non-Standard Environmental Easement on DNR Parcel
Situated in Section 29, Twp 21N, R. 6E., WM.
King County, Washington

Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in wat

5/10/0

Log Jam Sites

BAJ 28



Scale: 1" = 270'

N

Legend

Env. Easement
.46 Acres below OHWM

Permanent Access
Needed as shown .21 Acre

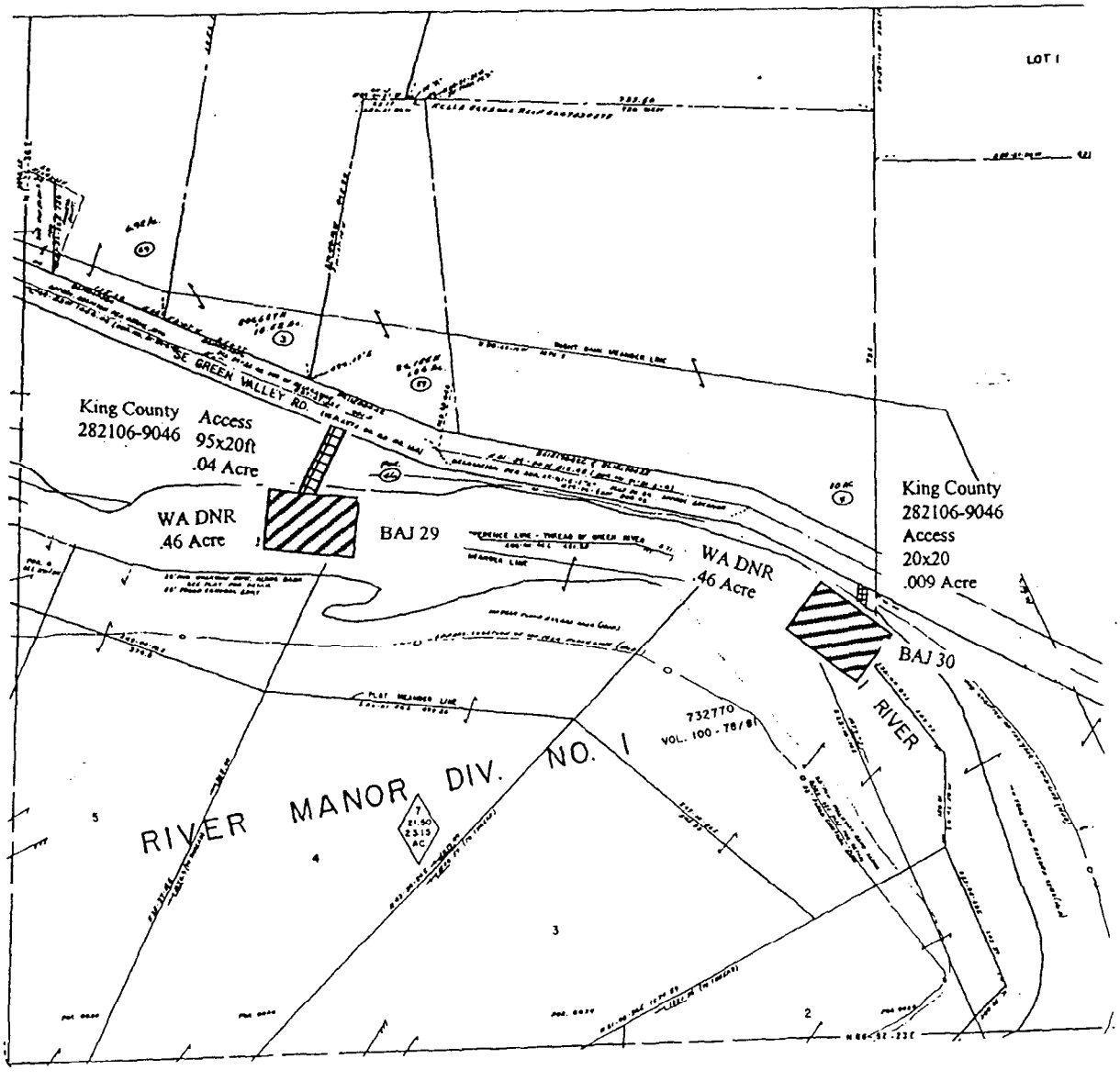
Log Jam Sites BAJ 28
Non-Standard Environmental Easement on DNR Parcel
Situated in Section 28, Twp 21N, R. 6E., WM.
King County, Washington

Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

5/10/00

Log Jam Sites

BAJ 29 & BAJ 30



Scale: 1" = 285'

N

Legend

Env. Easement
.92 Acres below OHWM

Permanent Access
needed as shown .049 Acre
.05

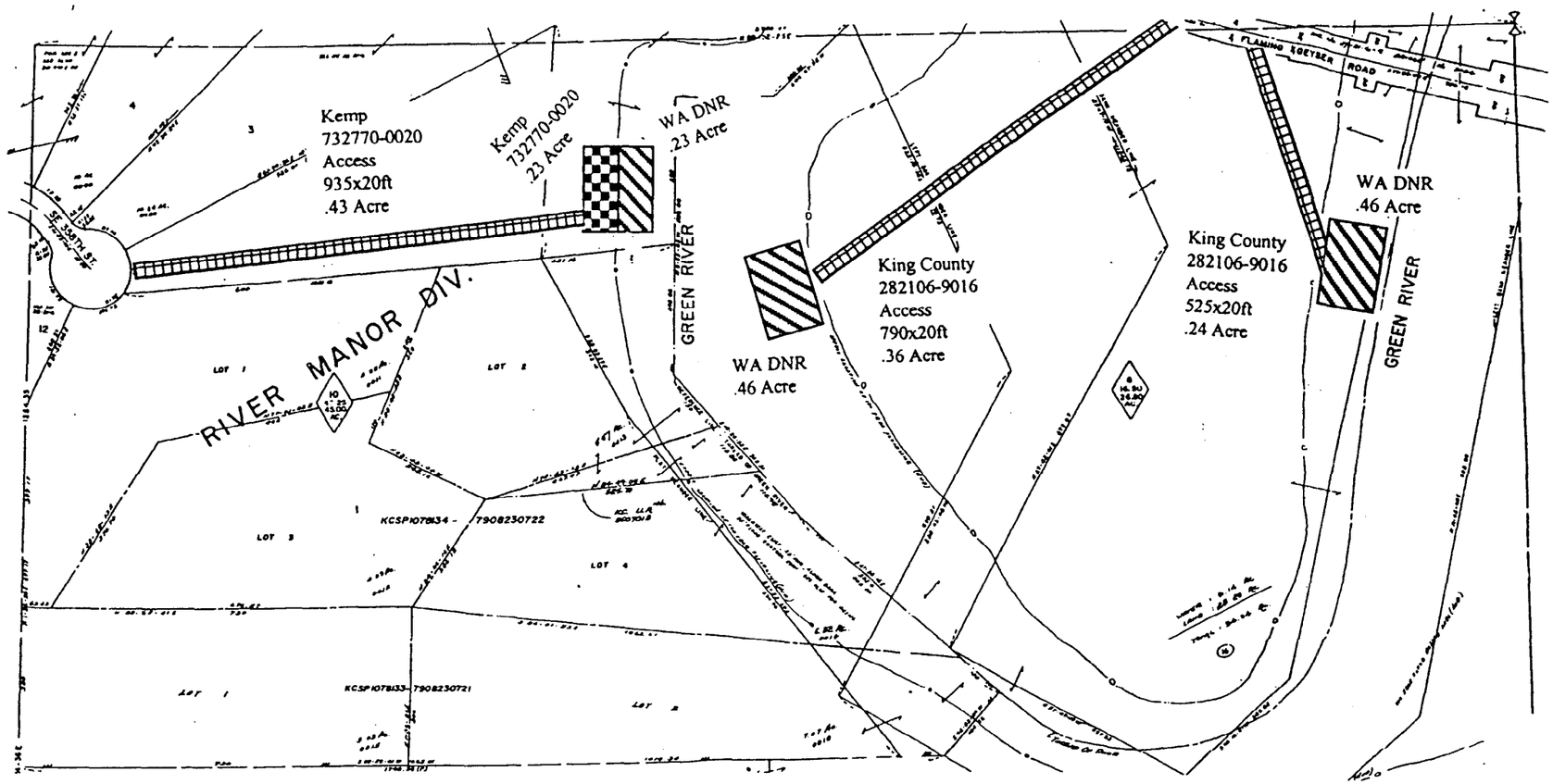
Log Jam Sites BAJ 29 & 30
Non-Standard Environmental Easement on DNR Parcel
Situated in Section 28, Twp 21N, R. 6E., WM.
King County, Washington

Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in water.

5/10/00

Log Jam Sites

BAJ 31 & 32 and MJ 10



Scale: 1" = 325'

N

Legend

- Env. Easement 1.15 Acres below OHWM
- Permanent Access needed as shown 1.03 Acres
- Fee .23 Acre

Log Jam Sites BAJ 31 & 32 and MJ 10
Non-Standard Environmental Easement on DNR Parcel
Situated in Section 28, Twp 21N, R. 6E., WM.
King County, Washington

Note: All Jam footprints are 100x200 feet, Meander Jams (MJ) are 50% in-river and 50% upland and Bar Apex Jams (BAJ) are 100% in wat

5/10/(

42F

MILL CREEK EAST

MILL CREEK EAST		
Manheim Auto Auctions	012204-9118	1 Acre
Manheim Auto Auctions	122204-9009	2.3 Acres
Barnier JR	122204-9018	FEE
Barnier JR	122204-9019	FEE
Puget Sound Energy/Elec	122204-9030	.4 Acre
OWRR & Nav Co.	122204-9031	.4 Acre
Puget Sound Energy/Elec	122204-9072	1 Acre
Fix Leon David	122204-9083	.5 Acre
Drainage Dist 1	122204-9086	1 Acre
Maneim Auto Auctions	122204-9103	.6 Acre
Manheim Auto Auctions	122204-9104	.5 Acre
Fiorito Enterprises Inc	122204-9110	.3 Acre
Barnier JR	122204-9127	FEE
Barnier JR	122204-9128	FEE
Kent, City of	122204-9130	FEE
Kent, City of	132204-9015	.5 Acre
Jabow Inc	132204-9052	1.2 Acres
Miles Sand & Gravel Co	132204-9059	.3 Acre
Carpinito Michael A	132204-9091	.3 Acre
Mcmonigle Davie R or Nancy	132204-9095	.3 Acre
Carpinito Michael A	132204-9096	.6 Acre
Jabow Inc	132204-9105	1.2 Acres
Chang Gyely, AKA Chang Gary	132204-9131	.5 Acre
Holman Distribution Center	132204-9170	1 Acre
Fisher Properties Inc	132204-9211	3 Acres
Corporation of the Catholic Achdiocese	132204-9221	FEE
Valley Freeway/228th Street LLC	132204-9341	.8 Acre
Little Gary	182205-9023	FEE
Chandler's Bay I Apartment	182205-9363	1.8 Acre
Manheim Services Corporation	631440-0021	1 Acre
Clark Family LLC	775980-0130	1.3 Acres
Spp Real Estate Inc	775980-0150	3.5 Acres
Fiorito Enterprises Inc.	775980-0170	.3 Acre
Stuart Properties	886700-0106	.6 Acre
Zep Manufacturing Company	886700-0116	.4 Acre

Scale: 1" = 400'

N

Legend

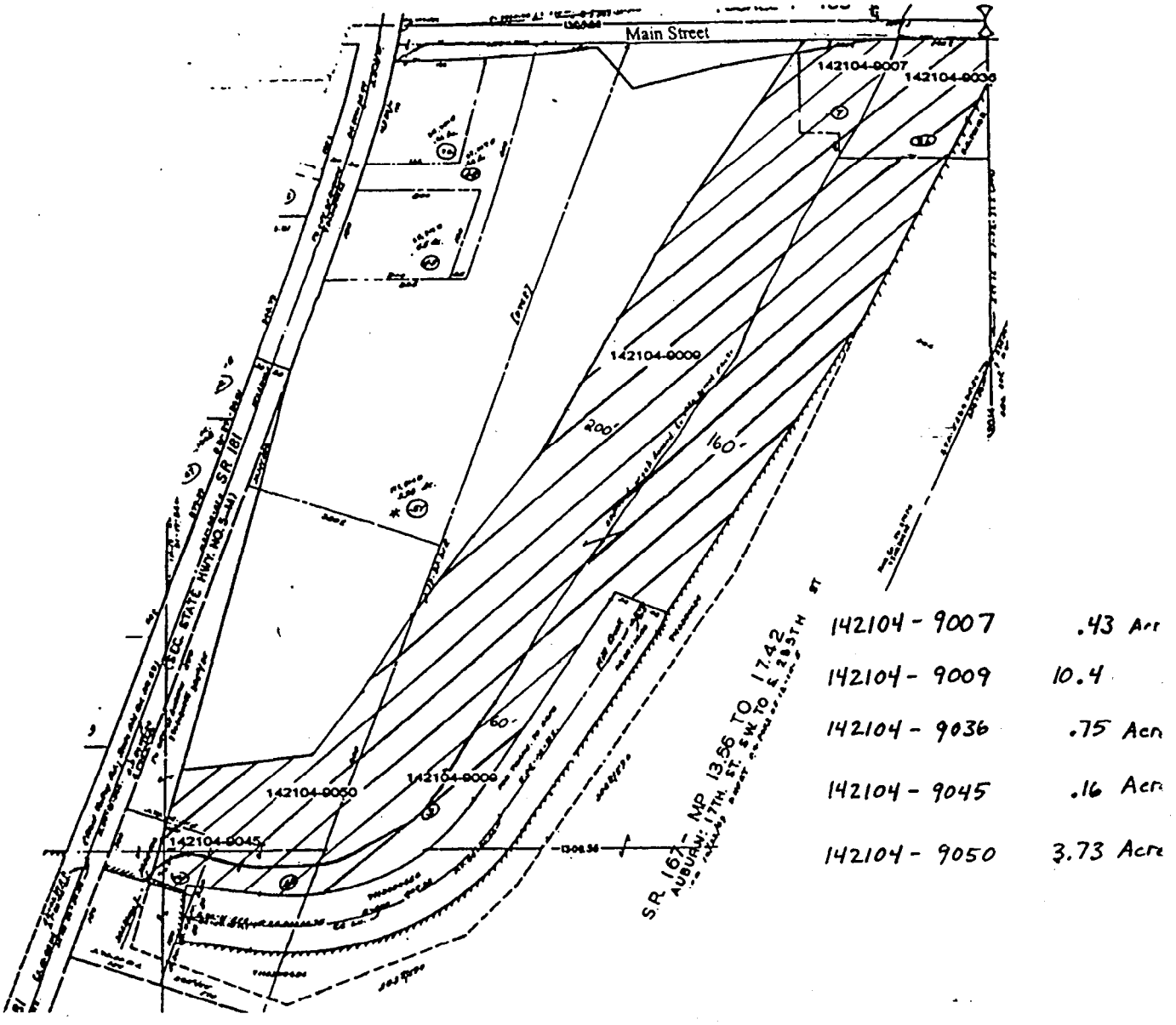
Env. Easement 26.6 Acres

Fee 47.59 Acres

Mill Creek East Project
Non-Standard Environmental Easement and Interest in Fee
Situated in Section 12, Twp 22N, R. 4E., WM.
King County, Washington

3/2/00

MILL CREEK, GEODEKE REACH



Scale: 1"= 320'

N

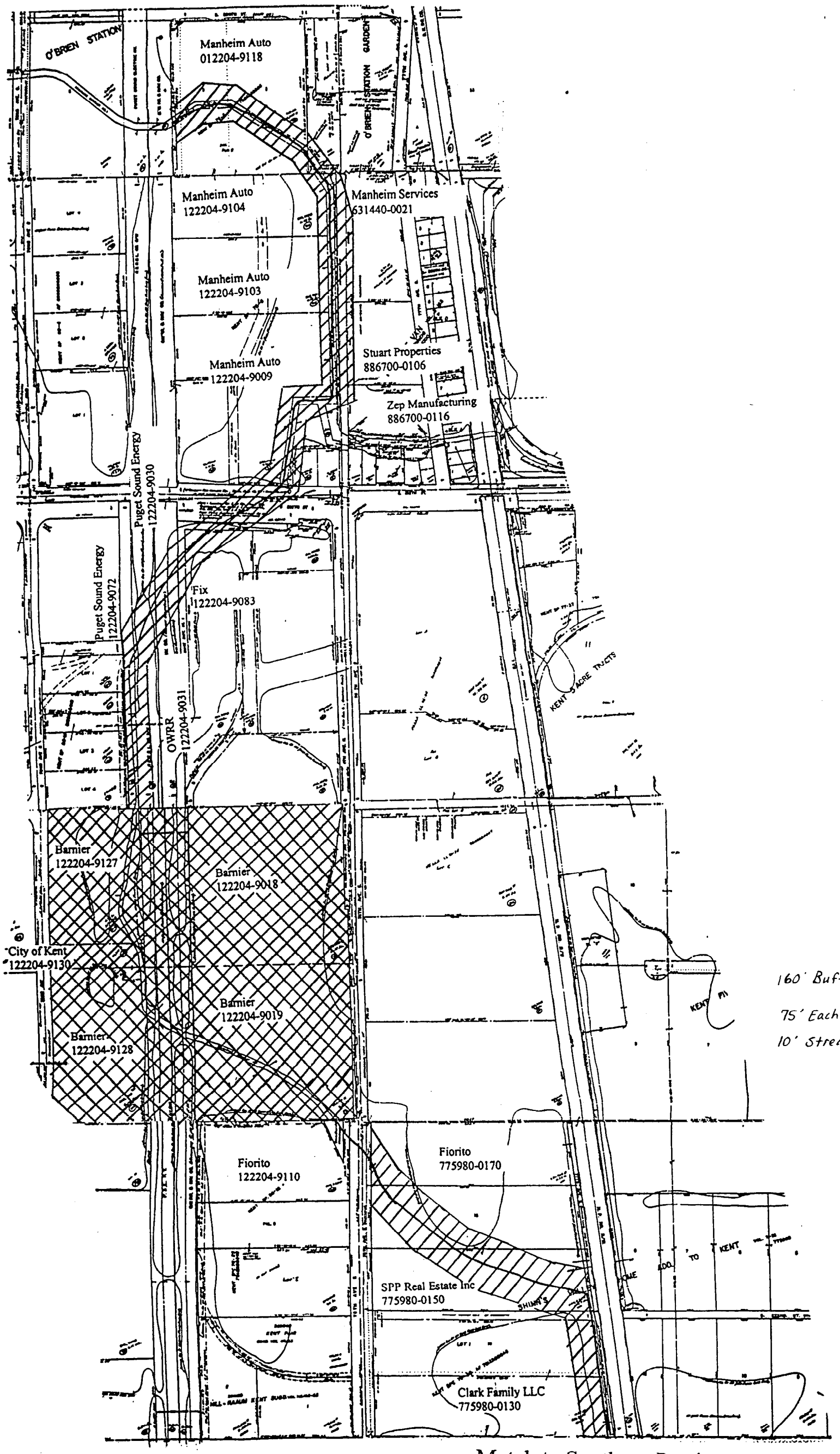
Legend

Env. Easement
15.47 Acres

Mill Creek, Geodeke Reach Project
Non-Standard Environmental Easements
Situated in Section 14, T 21N., R 4E., WM.
King County, Washington

3/29/00

MILL CREEK EAST
(Northern Portion)

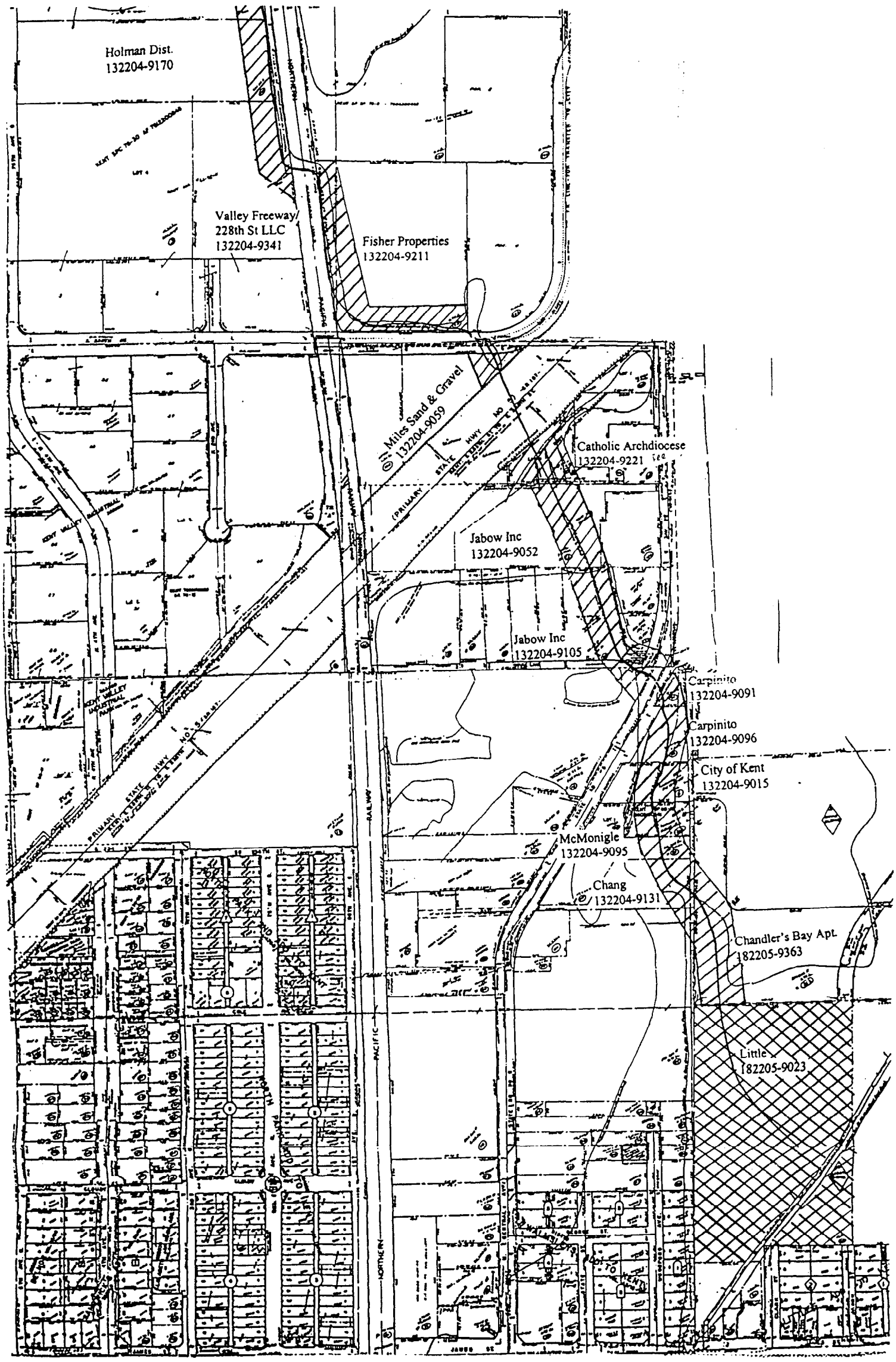


- Match to Southern Portion -

43

MILL CREEK EAST
(Southern Portion)

- Match to Northern Portion -



MILL CREEK, MERLINO REACH

N

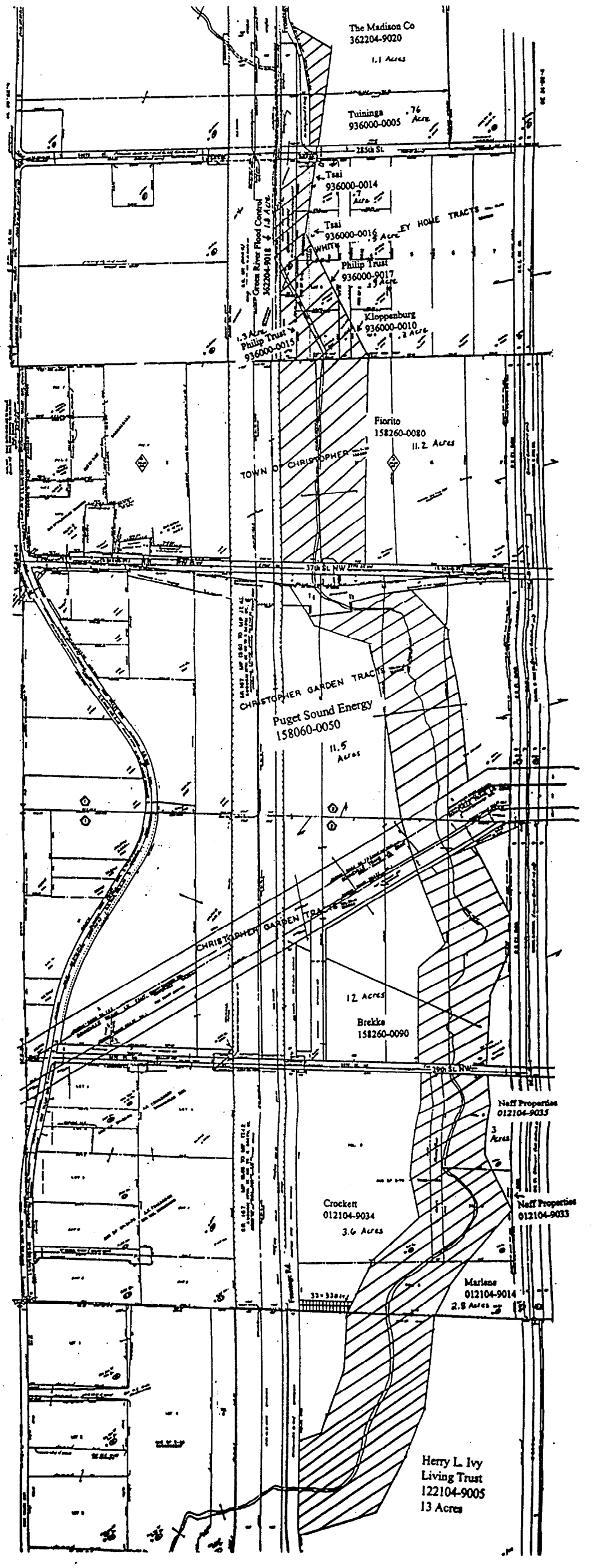
Mill Creek Merlino Reach Project
Non-Standard Environmental Easements
Situated in Section 36, T 22N., R 4E., WM.
King County, Washington

*200' Buffer with 20' Stream
*Access not shown to scale.

Scale: 1" = 740'

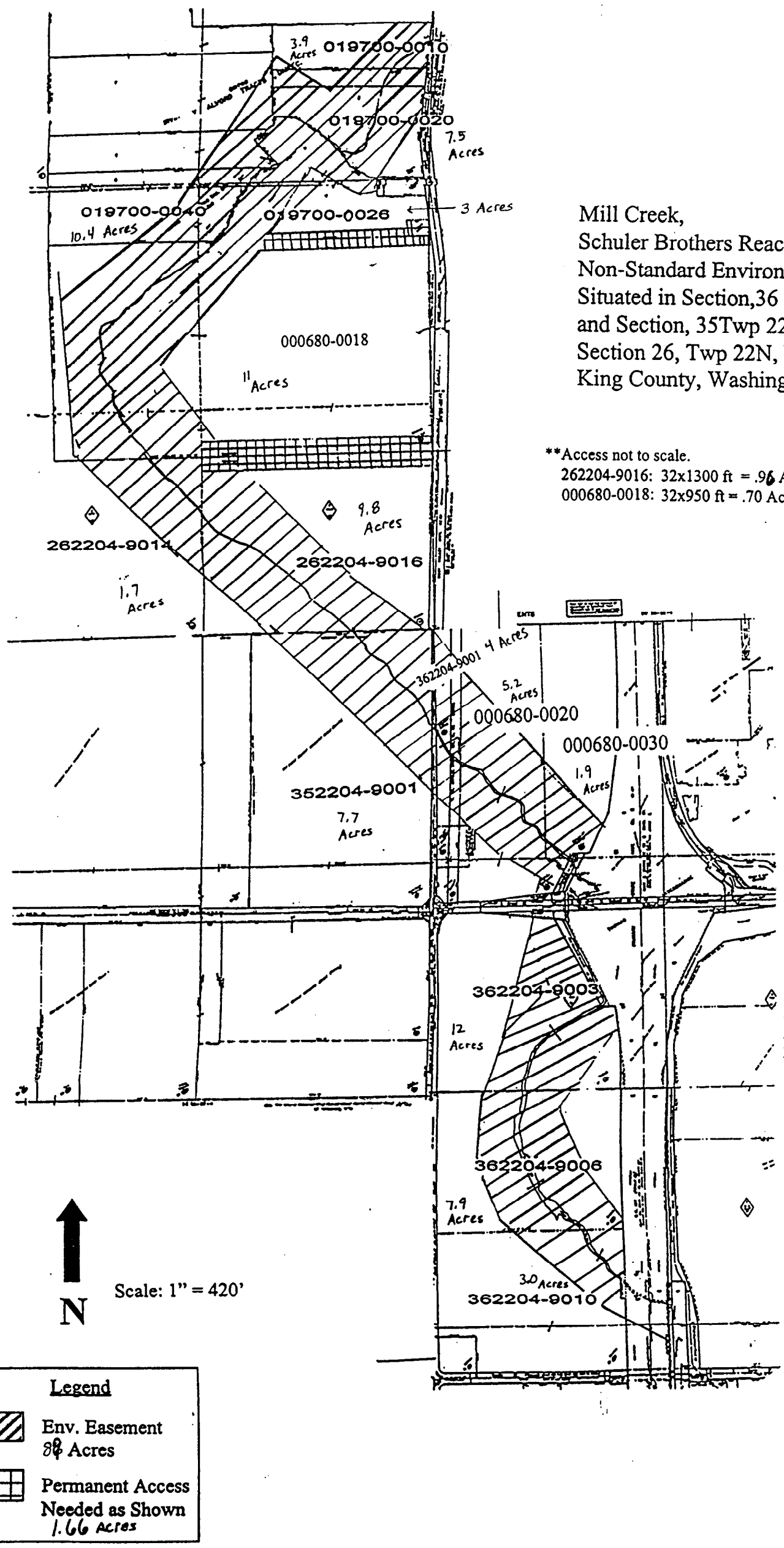
Legend

- Env. Easement 65 Acres
- Permanent Access Needed as Shown 32x300 ft .22 Acre



4/4/00

MILL CREEK,
SCHULER BROTHERS REACH



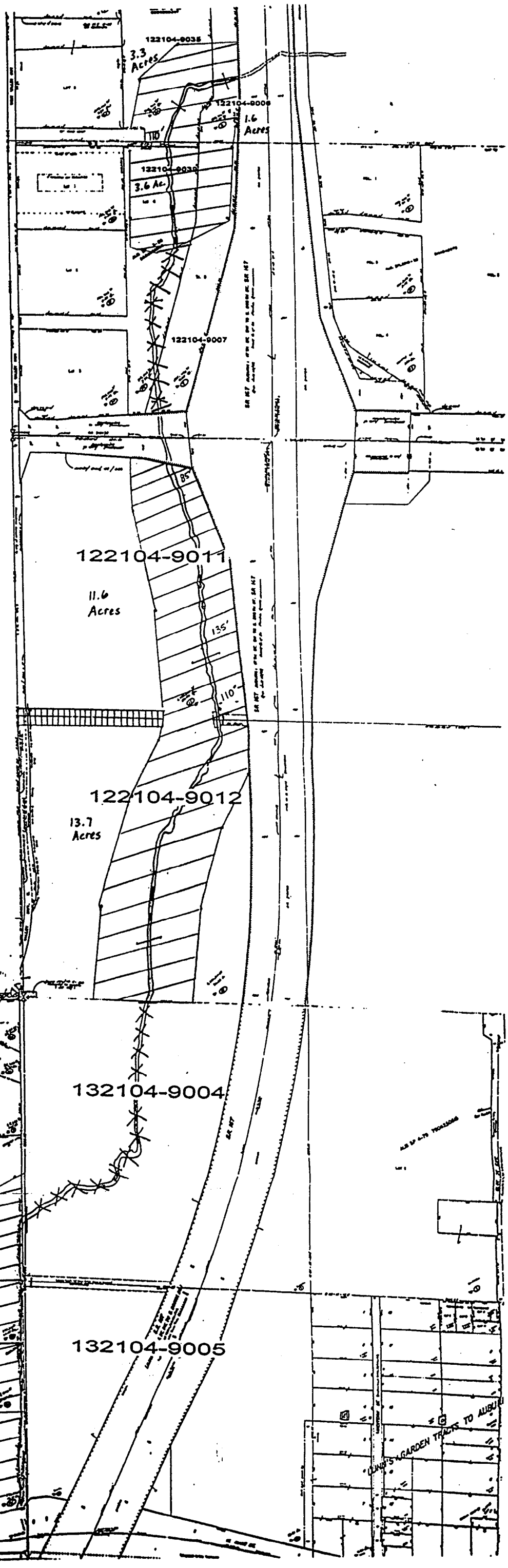
Mill Creek,
Schuler Brothers Reach Project
Non-Standard Environmental Easements
Situated in Section,36 Twp 25N, R. 4E.,
and Section, 35Twp 22N, R. 4E., and
Section 26, Twp 22N, R. 4E, WM.
King County, Washington

**Access not to scale.
262204-9016: 32x1300 ft = .96 Acre
000680-0018: 32x950 ft = .70 Acre

000680-0018:	Carpinito
000680-0020:	Carpinito
000680-0030:	Bauer
019700-0010:	Patoc
019700-0020:	Toyoshima
019700-0026:	Kim
019700-0040:	Buhler
262204-9014:	Smith Bros Farm
262204-9016:	Smith Bros Farm
352204-9001:	Smith Bros Farm
362204-9001:	Carpinito
362204-9003:	Schuler
362204-9006:	Schuler
362204-9010:	Schuler

3/29/00

MILL CREEK, WETLAND 5K



N

Scale: 1" = 420'

Legend

Env. Easement
~~43.2~~ 41.4 Acres

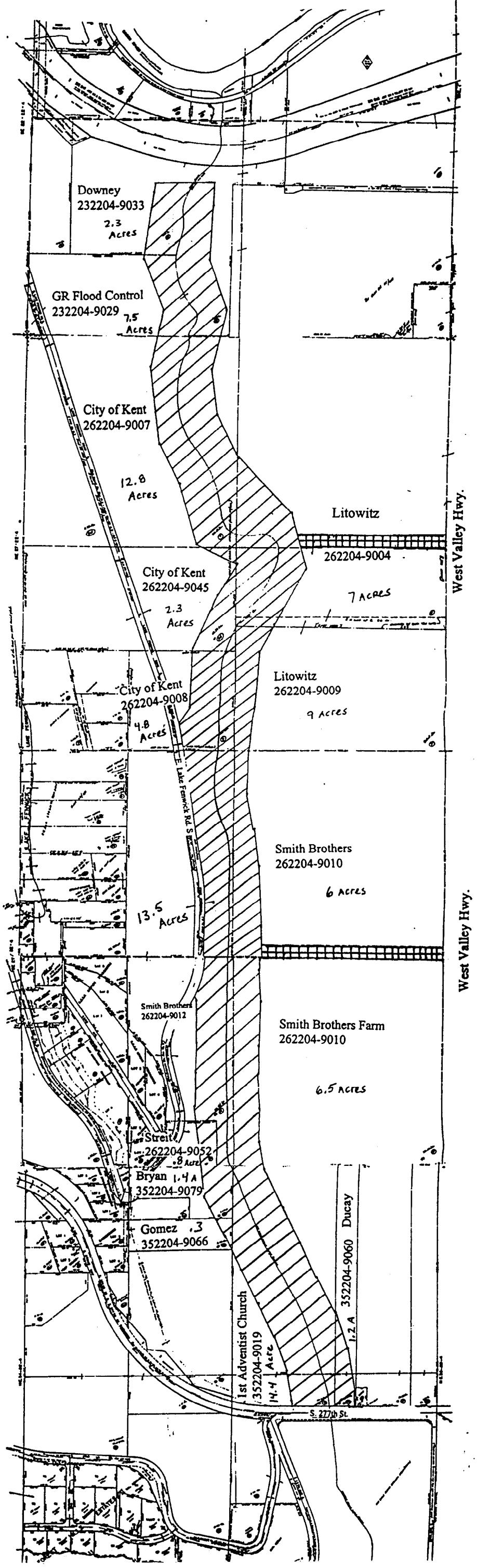
Permanent Access Needed as Shown 32x660 ft = .5 Acre

Mill Creek, Wetland 5K Project
Non-Standard Environmental Easements
Situated in Section 14, Twp 21N, R. 4E.,
and Section 12, Twp 21N, R. 4E., WM.
King County, Washington

**Access not to scale.

3/29/00

MULLEN SLOUGH



N

Scale: 1" = 780'

Mullen Slough Reach Project
Non-Standard Environmental Easements
Situated in Section 26, T 22N., R 4E., and
Section 35, T 22N, R 4E, WM.
King County, Washington

*Access not to scale.

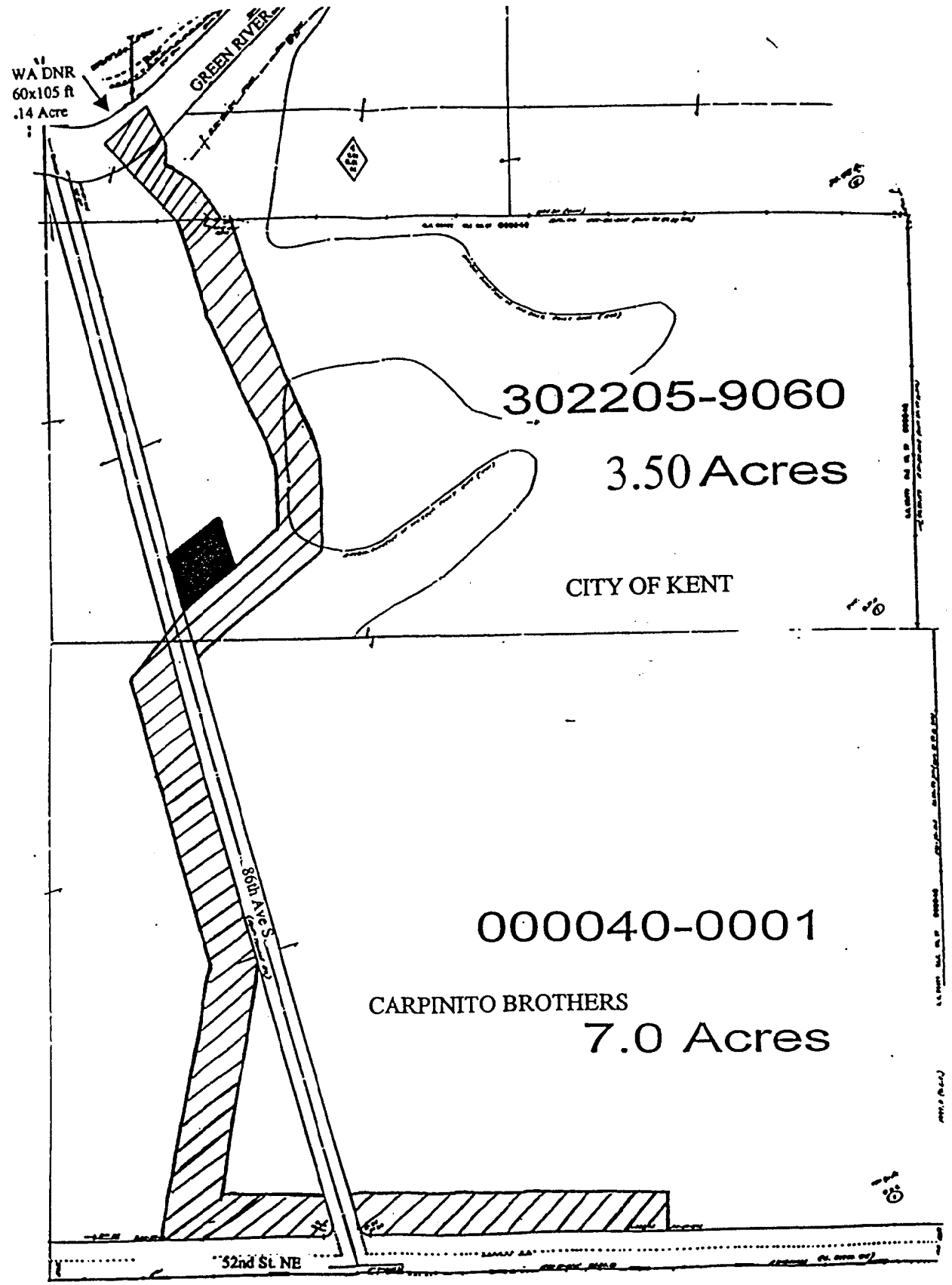
Legend

Env. Easement
90 Acres

Permanent Access
Needed as Shown
32x1170 ft = .85 Acre
32x1350 ft = 1 Acre

3/29/00

NE AUBURN CREEK



Legend

- Env. Easement 10.64 Acres
- Temp Stage Area 1 Acre needed as Shown

NE Auburn Creek Project
Non-Standard Environmental Easement
Situated in Section 31, Twp 22N, R. 5E.,
and Section 30, Twp 22N., R.5E WM.
King County, Washington
**Temp Stage Area not to scale.

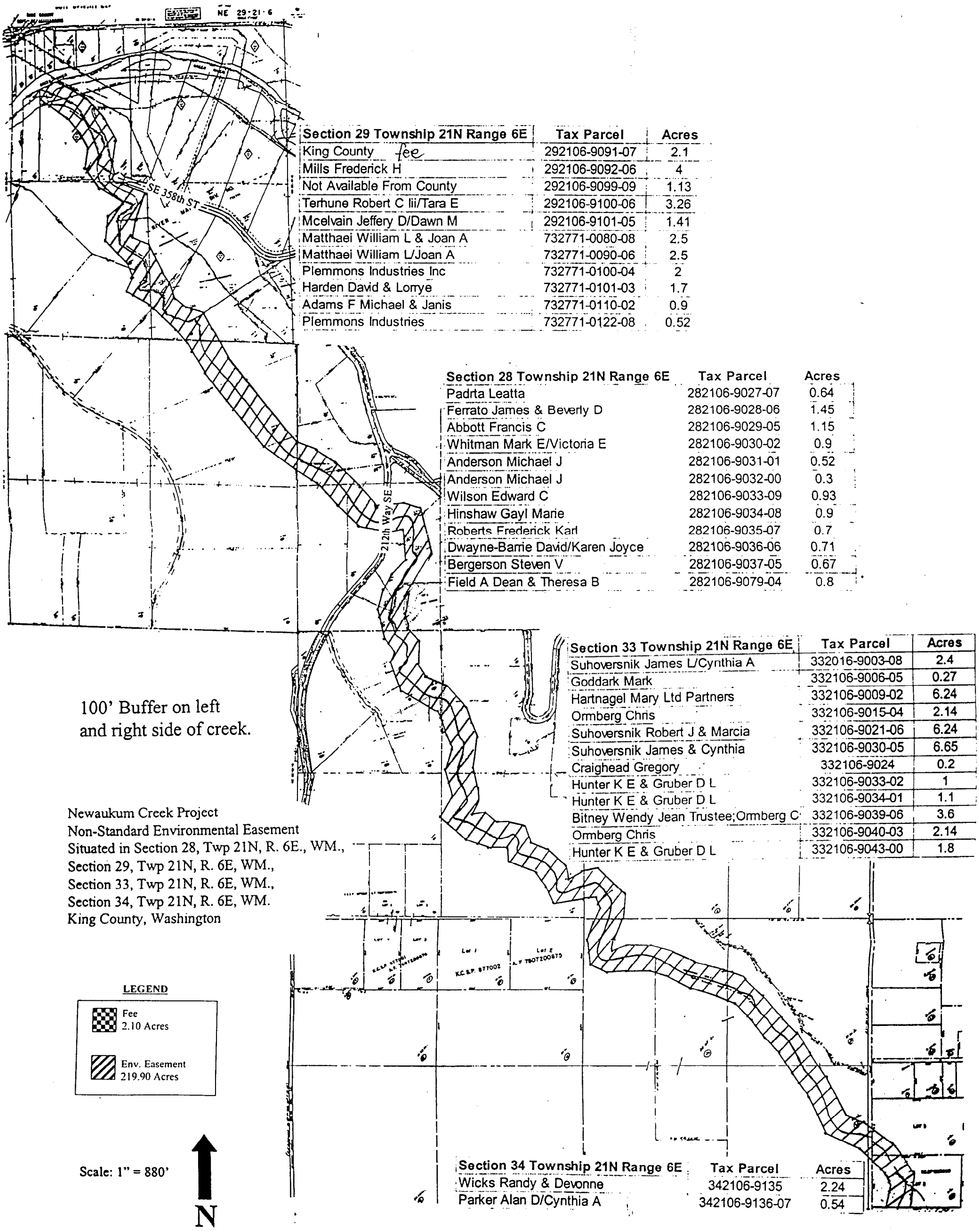
Scale: 1"= 400'

N

3/29/00

NEWAUKUM CREEK

Map 1 of 4



Section 29 Township 21N Range 6E	Tax Parcel	Acres
King County fee	292106-9091-07	2.1
Mills Frederick H	292106-9092-06	4
Not Available From County	292106-9099-09	1.13
Terhune Robert C Iii/Tara E	292106-9100-06	3.26
Mcelvain Jeffery D/Dawn M	292106-9101-05	1.41
Matthaei William L & Joan A	732771-0080-08	2.5
Matthaei William L/Joan A	732771-0090-06	2.5
Plemmons Industries Inc	732771-0100-04	2
Harden David & Lorrye	732771-0101-03	1.7
Adams F Michael & Janis	732771-0110-02	0.9
Plemmons Industries	732771-0122-08	0.52

Section 28 Township 21N Range 6E	Tax Parcel	Acres
Padrta Leatta	282106-9027-07	0.64
Ferrato James & Beverly D	282106-9028-06	1.45
Abbott Francis C	282106-9029-05	1.15
Whitman Mark E/Victoria E	282106-9030-02	0.9
Anderson Michael J	282106-9031-01	0.52
Anderson Michael J	282106-9032-00	0.3
Wilson Edward C	282106-9033-09	0.93
Hinshaw Gayl Marie	282106-9034-08	0.9
Roberts Frederick Karl	282106-9035-07	0.7
Dwayne-Barrie David/Karen Joyce	282106-9036-06	0.71
Bergerson Steven V	282106-9037-05	0.67
Field A Dean & Theresa B	282106-9079-04	0.8

Section 33 Township 21N Range 6E	Tax Parcel	Acres
Suhoversnik James L/Cynthia A	332016-9003-08	2.4
Goddark Mark	332106-9006-05	0.27
Hartnagel Mary Ltd Partners	332106-9009-02	6.24
Ormberg Chris	332106-9015-04	2.14
Suhoversnik Robert J & Marcia	332106-9021-06	6.24
Suhoversnik James & Cynthia	332106-9030-05	6.65
Craighead Gregory	332106-9024	0.2
Hunter K E & Gruber D L	332106-9033-02	1
Hunter K E & Gruber D L	332106-9034-01	1.1
Bitney Wendy Jean Trustee;Ormberg C	332106-9039-06	3.6
Ormberg Chris	332106-9040-03	2.14
Hunter K E & Gruber D L	332106-9043-00	1.8

100' Buffer on left and right side of creek.

Newaukum Creek Project
Non-Standard Environmental Easement
Situated in Section 28, Twp 21N, R. 6E., WM.,
Section 29, Twp 21N, R. 6E, WM.,
Section 33, Twp 21N, R. 6E, WM.,
Section 34, Twp 21N, R. 6E, WM.
King County, Washington

LEGEND

Fee
2.10 Acres

Env. Easement
219.90 Acres

Scale: 1" = 880'

N

Section 34 Township 21N Range 6E	Tax Parcel	Acres
Wicks Randy & Devonne	342106-9135	2.24
Parker Alan D/Cynthia A	342106-9136-07	0.54

Match to Map 2

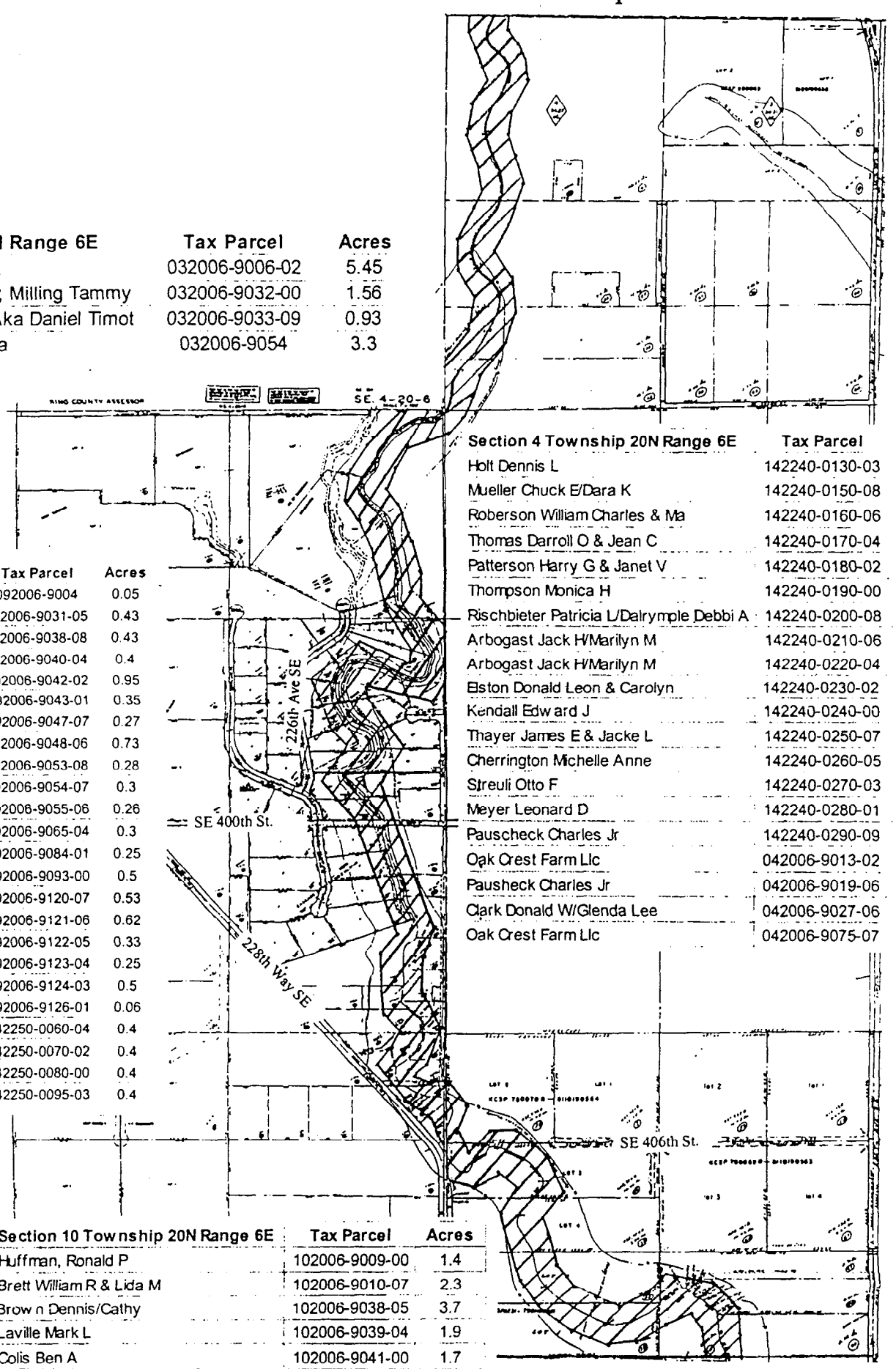
3/20/00

NEWAUKUM CREEK

Map 2 of 4

Match to Map 1

Section 3 Township 20N Range 6E	Tax Parcel	Acres
Murray Brian E/Barbara R	032006-9006-02	5.45
Fackrell Joseph R/Julia A; Milling Tammy	032006-9032-00	1.56
Flood Reva J D/Daniel T/Aka Daniel Timot	032006-9033-09	0.93
Walthers Douglas & Debra	032006-9054	3.3



Section 4 Township 20N Range 6E	Tax Parcel	Acres
Holt Dennis L	142240-0130-03	0.5
Mueller Chuck E/Dara K	142240-0150-08	1
Roberson William Charles & Ma	142240-0160-06	0.38
Thomas Darroll O & Jean C	142240-0170-04	0.3
Patterson Harry G & Janet V	142240-0180-02	0.37
Thompson Monica H	142240-0190-00	0.35
Rischbieter Patricia L/Dalrymple Debbi A	142240-0200-08	0.48
Arbogast Jack H/Marilyn M	142240-0210-06	0.26
Arbogast Jack H/Marilyn M	142240-0220-04	0.44
Elston Donald Leon & Carolyn	142240-0230-02	0.32
Kendall Edward J	142240-0240-00	0.25
Thayer James E & Jacke L	142240-0250-07	0.4
Cherrington Michelle Anne	142240-0260-05	0.27
Streuli Otto F	142240-0270-03	0.68
Meyer Leonard D	142240-0280-01	1
Pauscheck Charles Jr	142240-0290-09	1.2
Oak Crest Farm Llc	042006-9013-02	1.8
Pausheck Charles Jr	042006-9019-06	3.15
Clark Donald W/Glenda Lee	042006-9027-06	0.4
Oak Crest Farm Llc	042006-9075-07	1.35

Section 9 Township 20N Range 6E	Tax Parcel	Acres
Buckner Family LP	092006-9004	0.05
Riley W James	092006-9031-05	0.43
All American Homes Inc	092006-9038-08	0.43
Bartenetti Frank P	092006-9040-04	0.4
Ducken Jeffery W	092006-9042-02	0.95
Norman Lyle E/Betty J	092006-9043-01	0.35
Bartenetti Frank P	092006-9047-07	0.27
Uhde Janet A	092006-9048-06	0.73
Pickering Howard J/Nancy L	092006-9053-08	0.28
Riederer Dwight E/Carmen M	092006-9054-07	0.3
Mcfatridge Jerry T;Padilla Karen L	092006-9055-06	0.26
Jacobson J E	092006-9065-04	0.3
Pope Scott L	092006-9084-01	0.25
Adams Sam J./Michele K	092006-9093-00	0.5
Dodge Aaron Lee/Sandra Jonelle	092006-9120-07	0.53
All American Homes	092006-9121-06	0.62
All American Homes	092006-9122-05	0.33
All American Homes	092006-9123-04	0.25
Bartenetti Frank P	092006-9124-03	0.5
Mcfatridge Jerry T/Padilla Karen L	092006-9126-01	0.06
Buckendahl Carol D	142250-0060-04	0.4
Walczak Stella	142250-0070-02	0.4
De Santo William D;Halmold Kathy Jo	142250-0080-00	0.4
De Santo William D;Halmold Kathy Jo	142250-0095-03	0.4

Section 10 Township 20N Range 6E	Tax Parcel	Acres
Huffman, Ronald P	102006-9009-00	1.4
Brett William R & Lida M	102006-9010-07	2.3
Brown Dennis/Cathy	102006-9038-05	3.7
Laville Mark L	102006-9039-04	1.9
Colis Ben A	102006-9041-00	1.7
Glazier Catherine	102006-9042-09	1.8
Fitzpatrick John A	102006-9043-08	0.6
Willner Andrew N & Nancy C	102006-9047-04	0.53
Ashley House Therapeutic Foste	102006-9050-08	0.63
Tuohy Craig D/Marilyn M	102006-9053-05	1.6
Walker Donald W	102006-9054-04	1.9
Riederer Dwight/Carmen M	102006-9055-03	0.9
Petersen Robert A;Dewilde Linda M	102006-9056-02	3

Match to Map 3

LEGEND

- Fee 2.10 Acres
- Env. Easement 219.90 Acres

Newaukum Creek Project
Non-Standard Environmental Easement
Situated in Section 3, Twp 20N, R. 6E., WM.,
Section 4, Twp 20N, R. 6E, WM.,
Section 33, Twp 20N, R. 6E, WM.,
Section 10, Twp 20N, R. 6E, WM.
Section 9, Twp 20N, R. 6E, WM.
King County, Washington

Scale: 1" = 880'

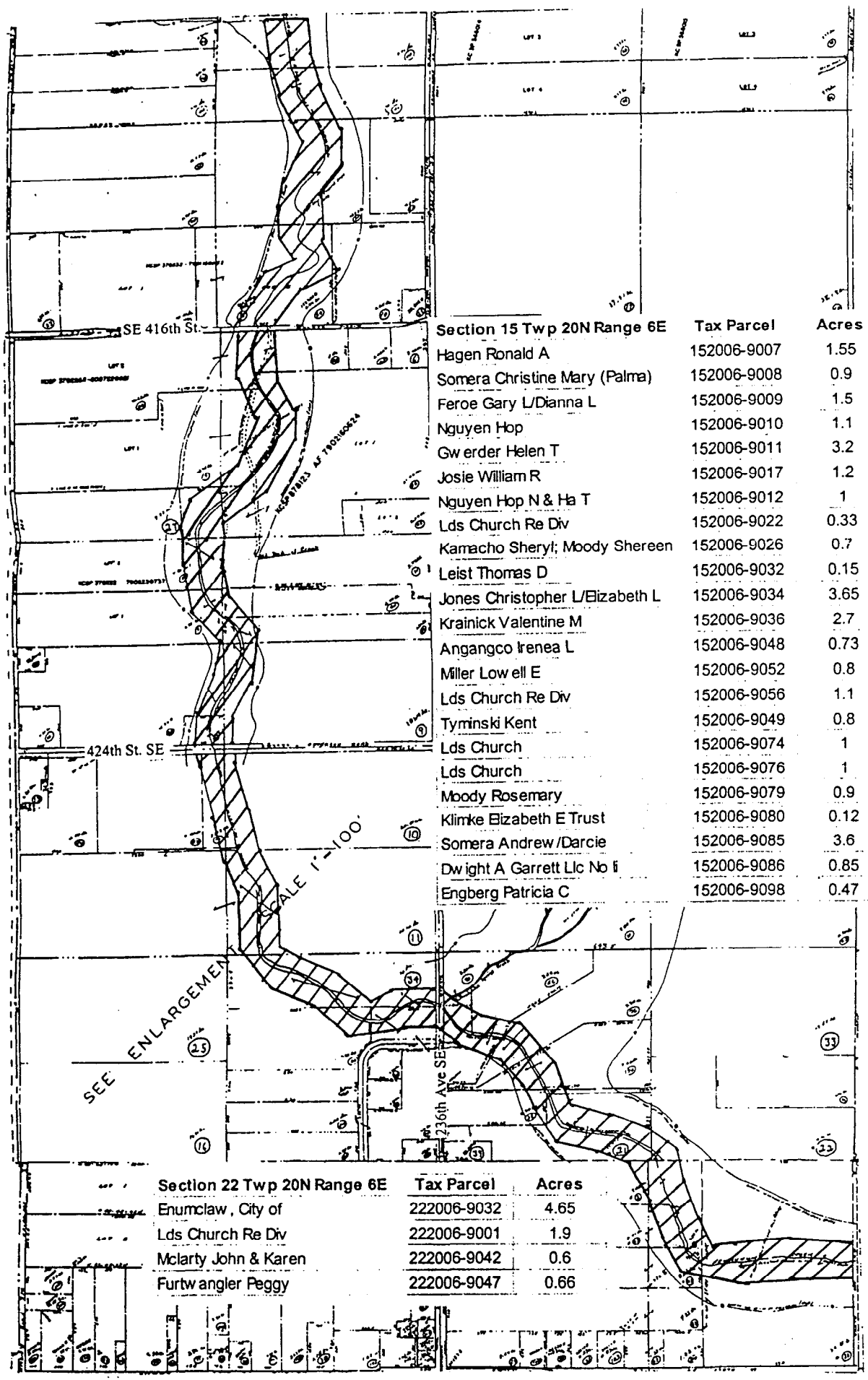
N

NEWAUKUM CREEK

Map 3 of 4

Match to Map 2

100' Buffer on left and right side of creek.



Section 15 Twp 20N Range 6E	Tax Parcel	Acres
Hagen Ronald A	152006-9007	1.55
Somera Christine Mary (Palma)	152006-9008	0.9
Feroe Gary L/Dianna L	152006-9009	1.5
Nguyen Hop	152006-9010	1.1
Gw erder Helen T	152006-9011	3.2
Josie William R	152006-9017	1.2
Nguyen Hop N & Ha T	152006-9012	1
Lds Church Re Div	152006-9022	0.33
Kamacho Sheryl; Moody Shereen	152006-9026	0.7
Leist Thomas D	152006-9032	0.15
Jones Christopher L/Elizabeth L	152006-9034	3.65
Krainick Valentine M	152006-9036	2.7
Angangco Irenea L	152006-9048	0.73
Miller Low ell E	152006-9052	0.8
Lds Church Re Div	152006-9056	1.1
Tyminski Kent	152006-9049	0.8
Lds Church	152006-9074	1
Lds Church	152006-9076	1
Moody Rosemary	152006-9079	0.9
Klimke Elizabeth E Trust	152006-9080	0.12
Somera Andrew /Darcie	152006-9085	3.6
Dw ight A Garrett Llc No li	152006-9086	0.85
Engberg Patricia C	152006-9098	0.47

Section 22 Twp 20N Range 6E	Tax Parcel	Acres
Enumclaw , City of	222006-9032	4.65
Lds Church Re Div	222006-9001	1.9
Mclarty John & Karen	222006-9042	0.6
Furtw angler Peggy	222006-9047	0.66

Match to Map 4

LEGEND

- Fee 2.10 Acres
- Env. Easement 219.90 Acres

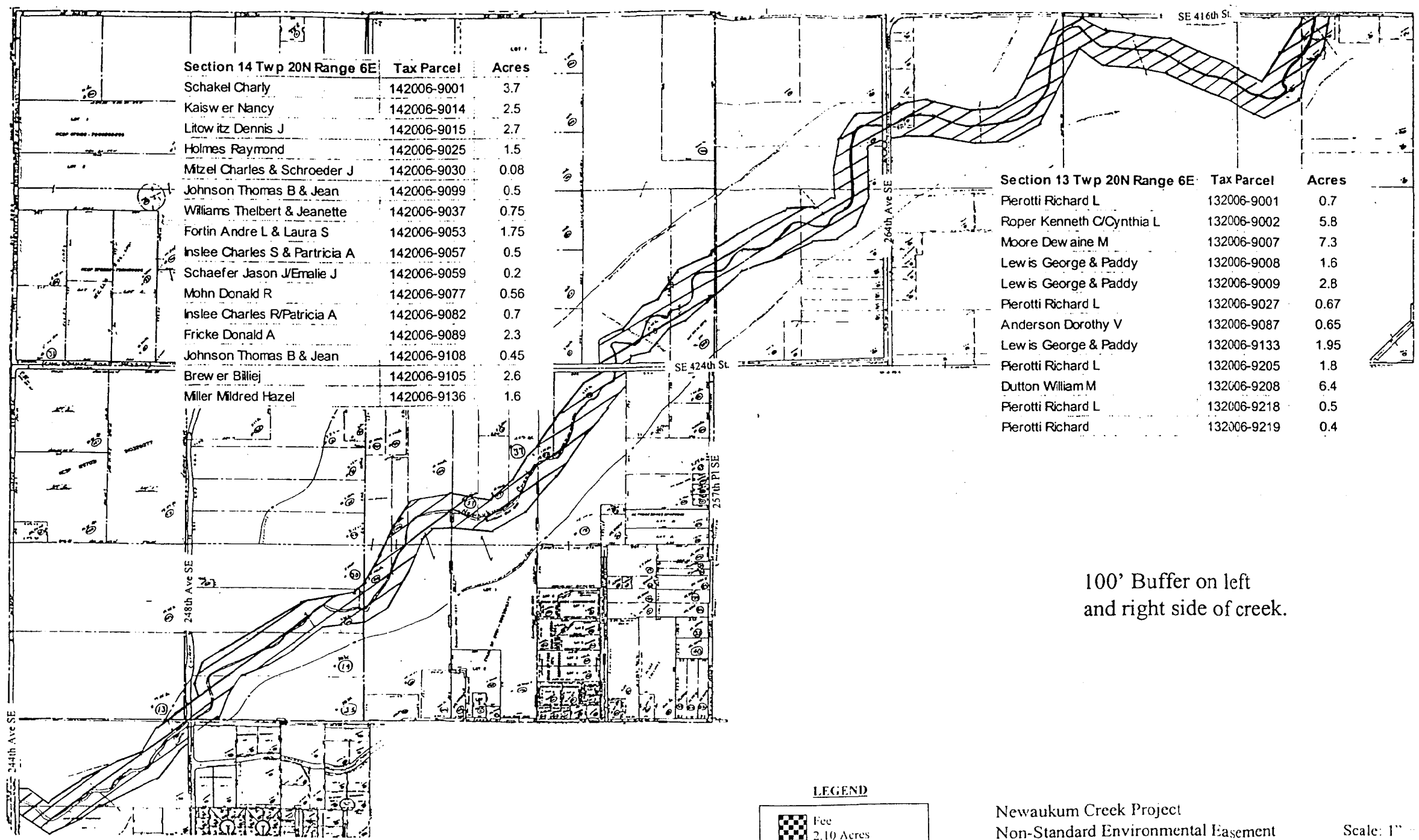
Newaukum Creek Project
Non-Standard Environmental Easement
Situated in Section 15, Twp 20N, R. 6E., WM.
And Section 23, Twp 20N, R. 6E, WM.
King County, Washington

Scale: 1" = 880'

N

NEWAUKUM CREEK

Map 4 of 4



Section 14 Twp 20N Range 6E	Tax Parcel	Acres
Schakel Charly	142006-9001	3.7
Kaiswer Nancy	142006-9014	2.5
Litowitz Dennis J	142006-9015	2.7
Holmes Raymond	142006-9025	1.5
Mitzel Charles & Schroeder J	142006-9030	0.08
Johnson Thomas B & Jean	142006-9099	0.5
Williams Thelbert & Jeanette	142006-9037	0.75
Fortin Andre L & Laura S	142006-9053	1.75
Inslee Charles S & Partricia A	142006-9057	0.5
Schaefer Jason J/Emalie J	142006-9059	0.2
Mohn Donald R	142006-9077	0.56
Inslee Charles R/Patricia A	142006-9082	0.7
Fricke Donald A	142006-9089	2.3
Johnson Thomas B & Jean	142006-9108	0.45
Brewer Billiej	142006-9105	2.6
Miller Mildred Hazel	142006-9136	1.6

Section 13 Twp 20N Range 6E	Tax Parcel	Acres
Pierotti Richard L	132006-9001	0.7
Roper Kenneth C/Cynthia L	132006-9002	5.8
Moore Dewaine M	132006-9007	7.3
Lewis George & Paddy	132006-9008	1.6
Lewis George & Paddy	132006-9009	2.8
Pierotti Richard L	132006-9027	0.67
Anderson Dorothy V	132006-9087	0.65
Lewis George & Paddy	132006-9133	1.95
Pierotti Richard L	132006-9205	1.8
Dutton William M	132006-9208	6.4
Pierotti Richard L	132006-9218	0.5
Pierotti Richard	132006-9219	0.4

100' Buffer on left
and right side of creek.

Match to
Map 3

Section 23 Twp 20N Range 6E	Tax Parcel	Acres
Rosatto Associates	232006-9012	4.2
Dunning William H	232006-9013	1.75

LEGEND

- Fee 2.10 Acres
- Env. Easement 219.90 Acres

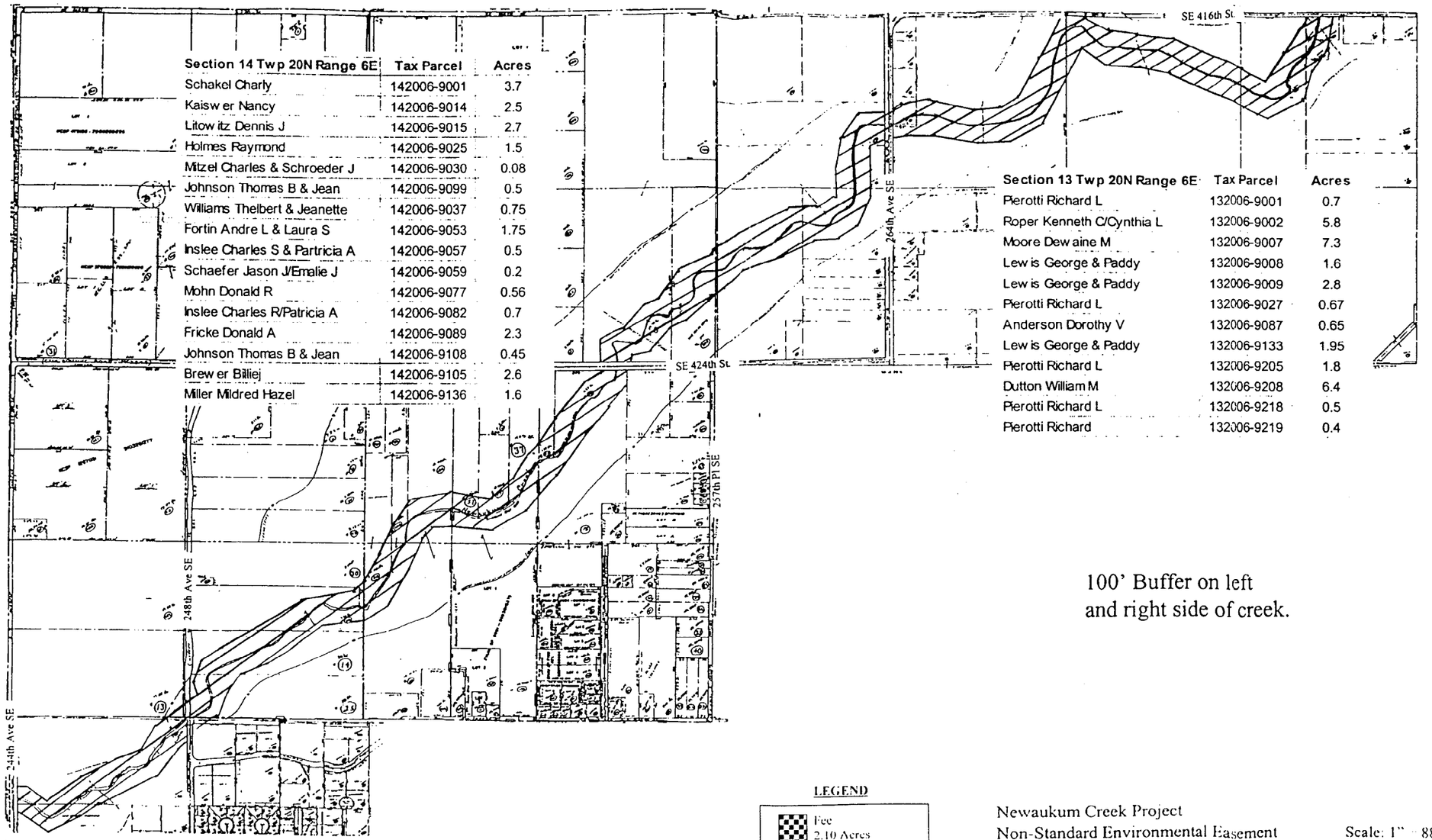
Newaukum Creek Project
Non-Standard Environmental Easement
Situated in Section 13, Twp 20N, R. 6E., WM.
And Section 14, Twp 20N, R. 6E, WM.
King County, Washington

Scale: 1" = 880'

N

NEWAUKUM CREEK

Map 4 of 4



Section 14 Twp 20N Range 6E	Tax Parcel	Acres
Schakel Charly	142006-9001	3.7
Kaisw er Nancy	142006-9014	2.5
Litow itz Dennis J	142006-9015	2.7
Holmes Raymond	142006-9025	1.5
Mitzel Charles & Schroeder J	142006-9030	0.08
Johnson Thomas B & Jean	142006-9099	0.5
Williams Thelbert & Jeanette	142006-9037	0.75
Fortin Andre L & Laura S	142006-9053	1.75
Inslee Charles S & Partricia A	142006-9057	0.5
Schaefer Jason J/Emalie J	142006-9059	0.2
Mohn Donald R	142006-9077	0.56
Inslee Charles R/Patricia A	142006-9082	0.7
Fricke Donald A	142006-9089	2.3
Johnson Thomas B & Jean	142006-9108	0.45
Brew er Billiej	142006-9105	2.6
Miller Mildred Hazel	142006-9136	1.6

Section 13 Twp 20N Range 6E	Tax Parcel	Acres
Pierotti Richard L	132006-9001	0.7
Roper Kenneth C/Cynthia L	132006-9002	5.8
Moore Dew aine M	132006-9007	7.3
Lew is George & Paddy	132006-9008	1.6
Lew is George & Paddy	132006-9009	2.8
Pierotti Richard L	132006-9027	0.67
Anderson Dorothy V	132006-9087	0.65
Lew is George & Paddy	132006-9133	1.95
Pierotti Richard L	132006-9205	1.8
Dutton William M	132006-9208	6.4
Pierotti Richard L	132006-9218	0.5
Pierotti Richard	132006-9219	0.4

100' Buffer on left
and right side of creek.

Match to
Map 3

Section 23 Twp 20N Range 6E	Tax Parcel	Acres
Rosatto Associates	232006-9012	4.2
Dunning William H	232006-9013	1.75

LEGEND

- Fee 2.10 Acres
- Env. Easement 219.90 Acres

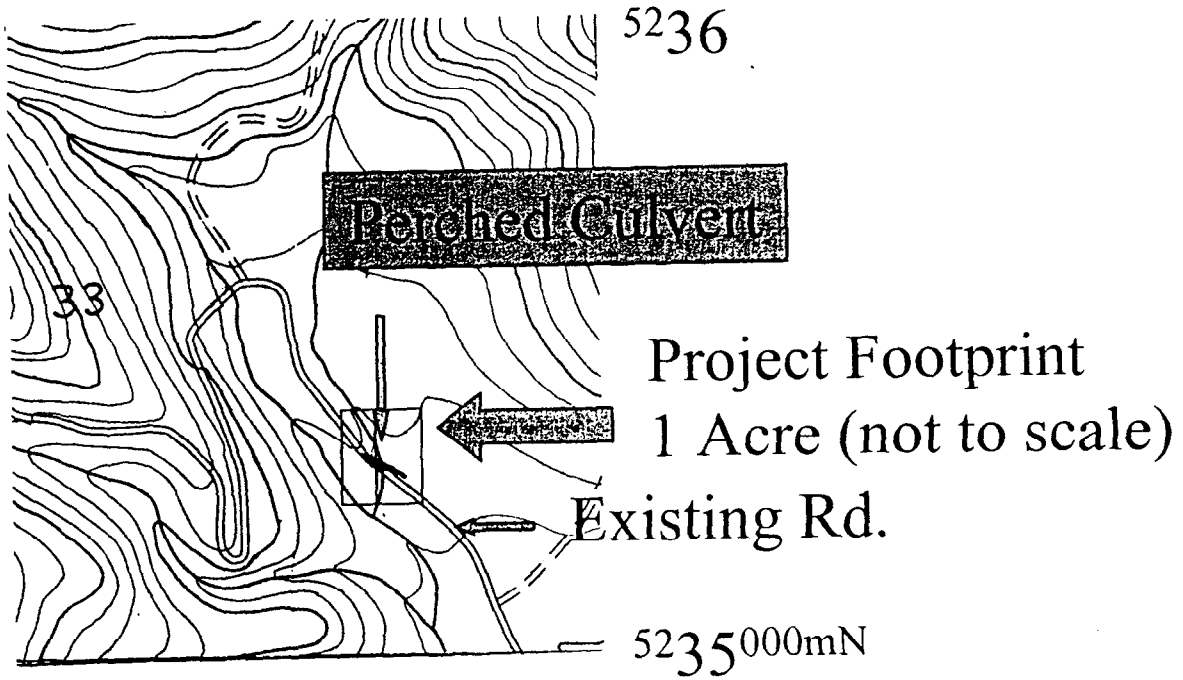
Newaukum Creek Project
Non-Standard Environmental Easement
Situated in Section 13, Twp 20N, R. 6E., WM.
And Section 14, Twp 20N, R. 6E, WM.
King County, Washington

Scale: 1" = 880'

N

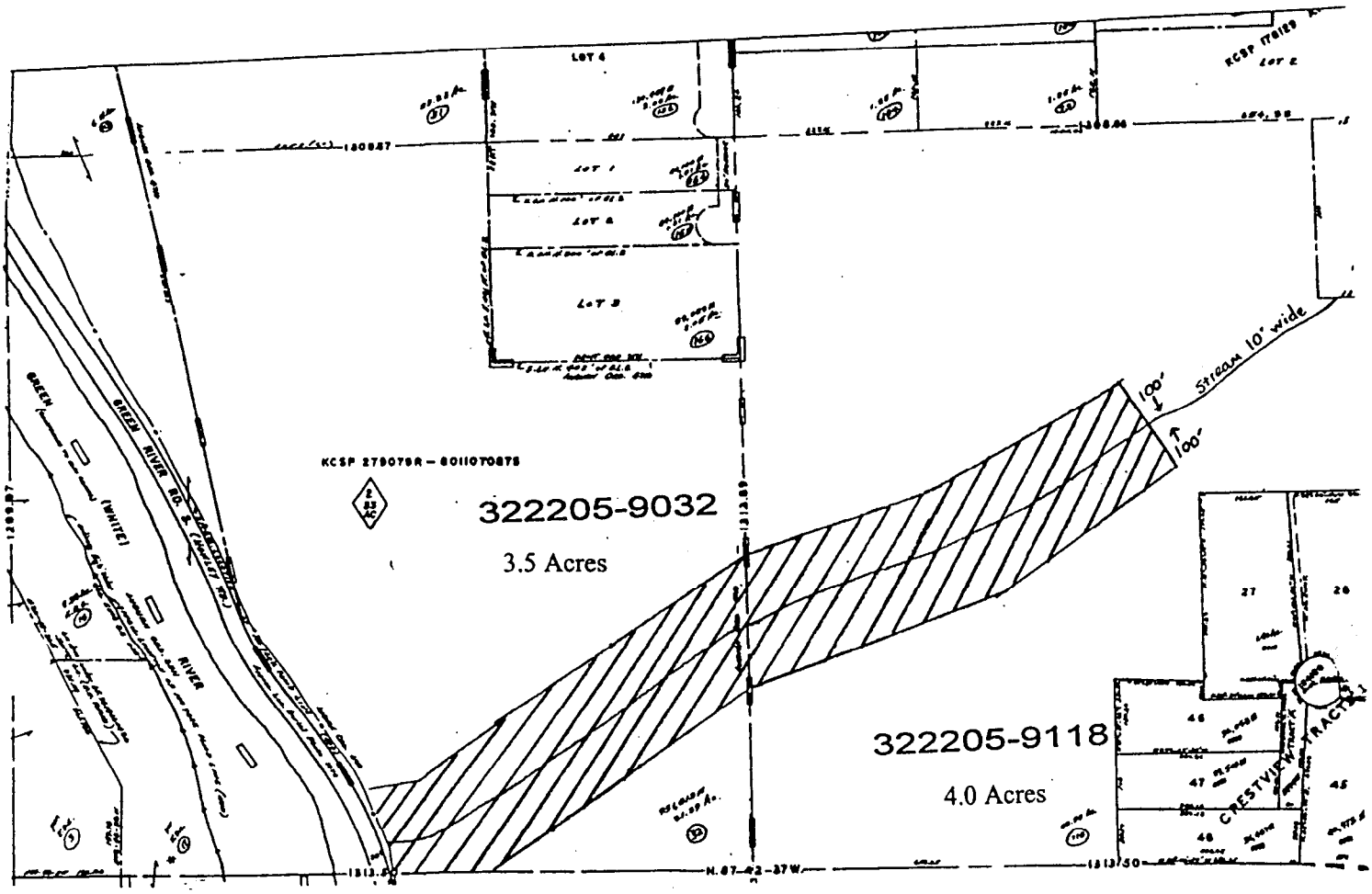
North East Creek
Perched Culvert Site

N
T:21N
R:11E



1:11.77,000

OLSON CREEK



Scale: 1" = 340'

N

Legend

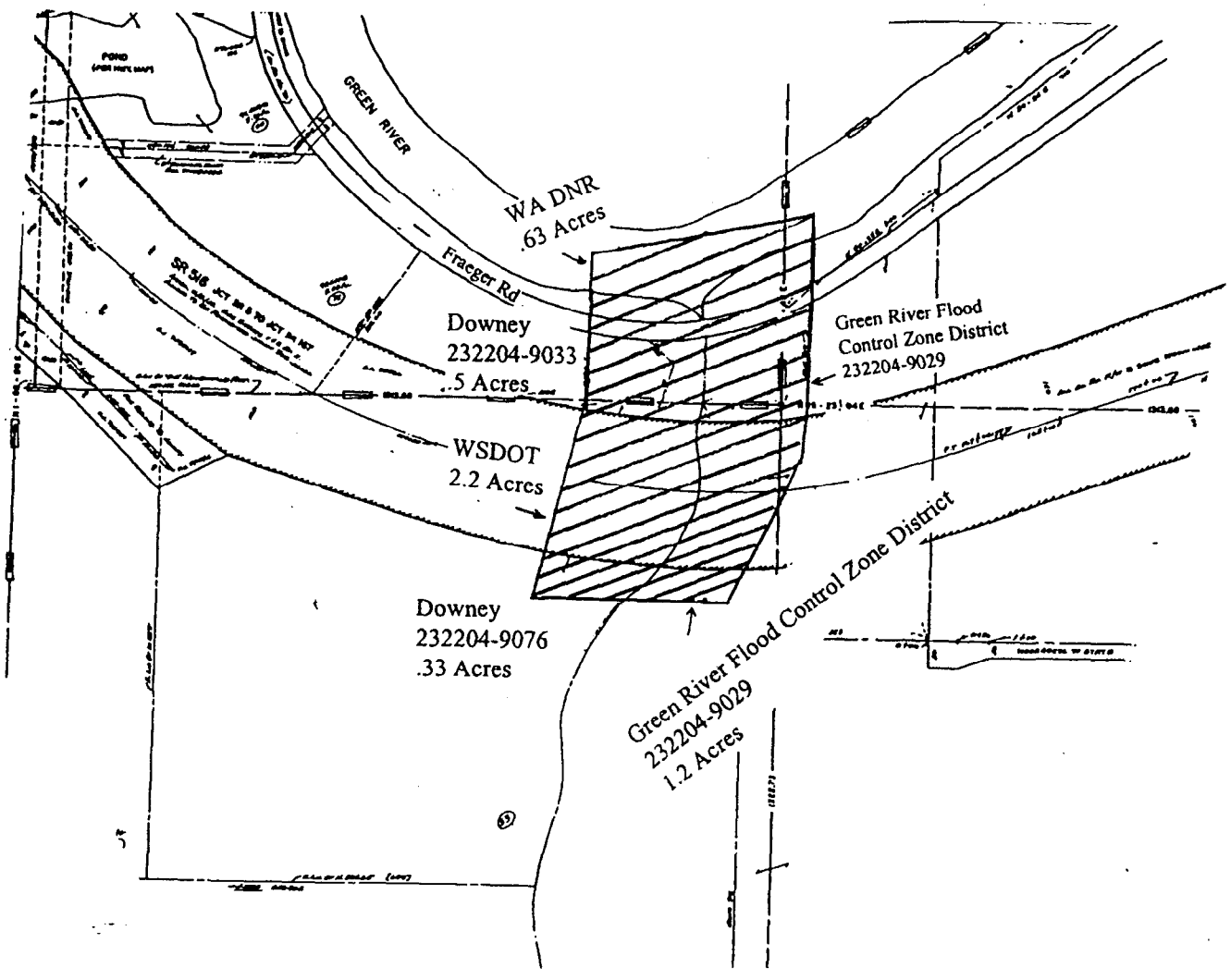
Env. Easement
7.5 Acres

Olson Creek Project
Non-Standard Environmental Easements
Situated in Section 32, T 22N., R 5E., WM.
King County, Washington

3/29/00

55A

PRENTICE NURSERY



Scale: 1" = 365'

N

Legend

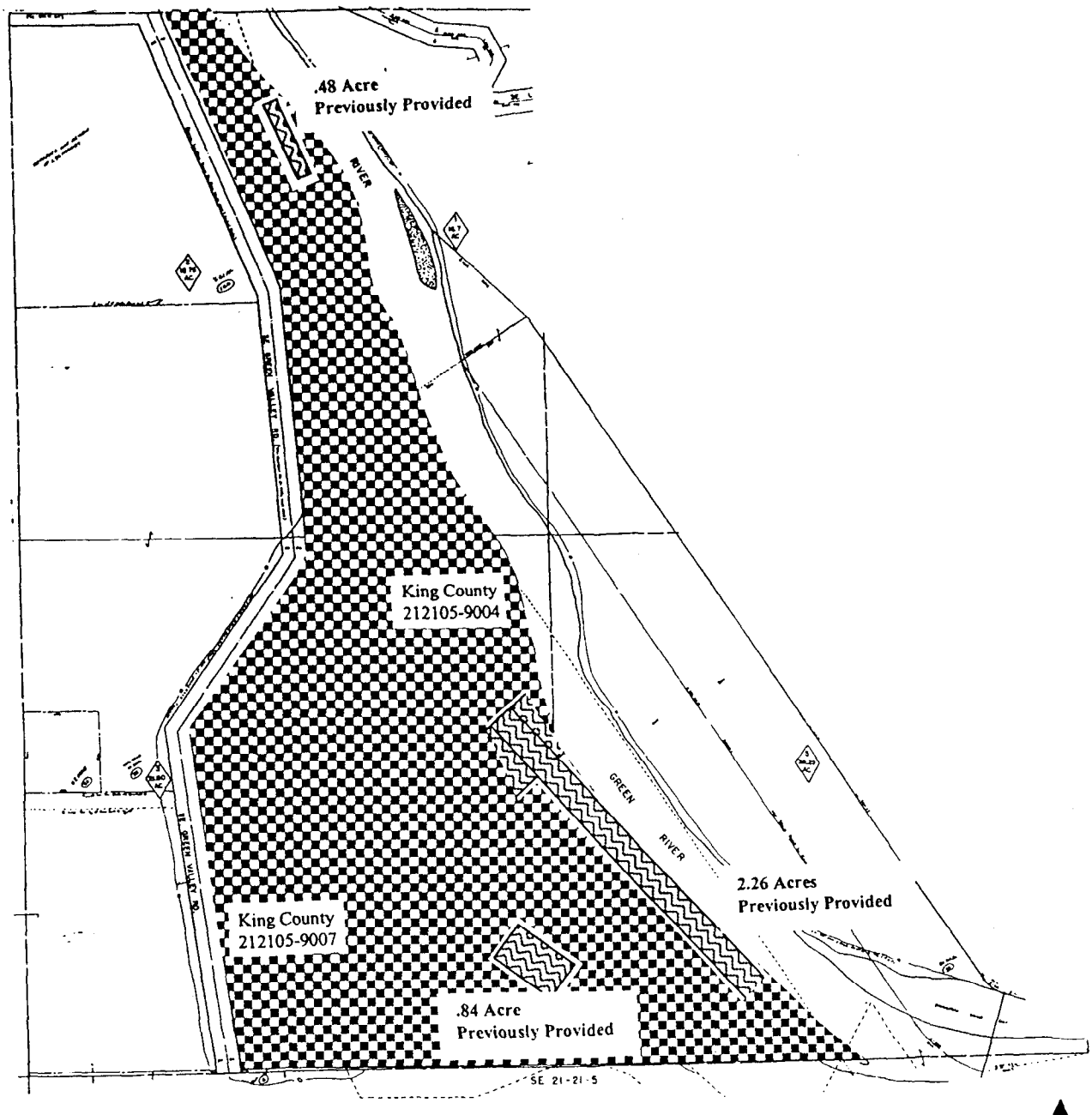
Env. Easement
~~4.3~~ Acres
4.86

Prentice Nursery Project
Non-Standard Environmental Easements
Situated in Section 23, T 22N., R 4E., and
King County, Washington

3/29/00

55B

Porter Levee



Scale: 1" = 410'

N

Legend

3.58 Acres Previously Provided NFS Lands

Fee 31.64 Acre

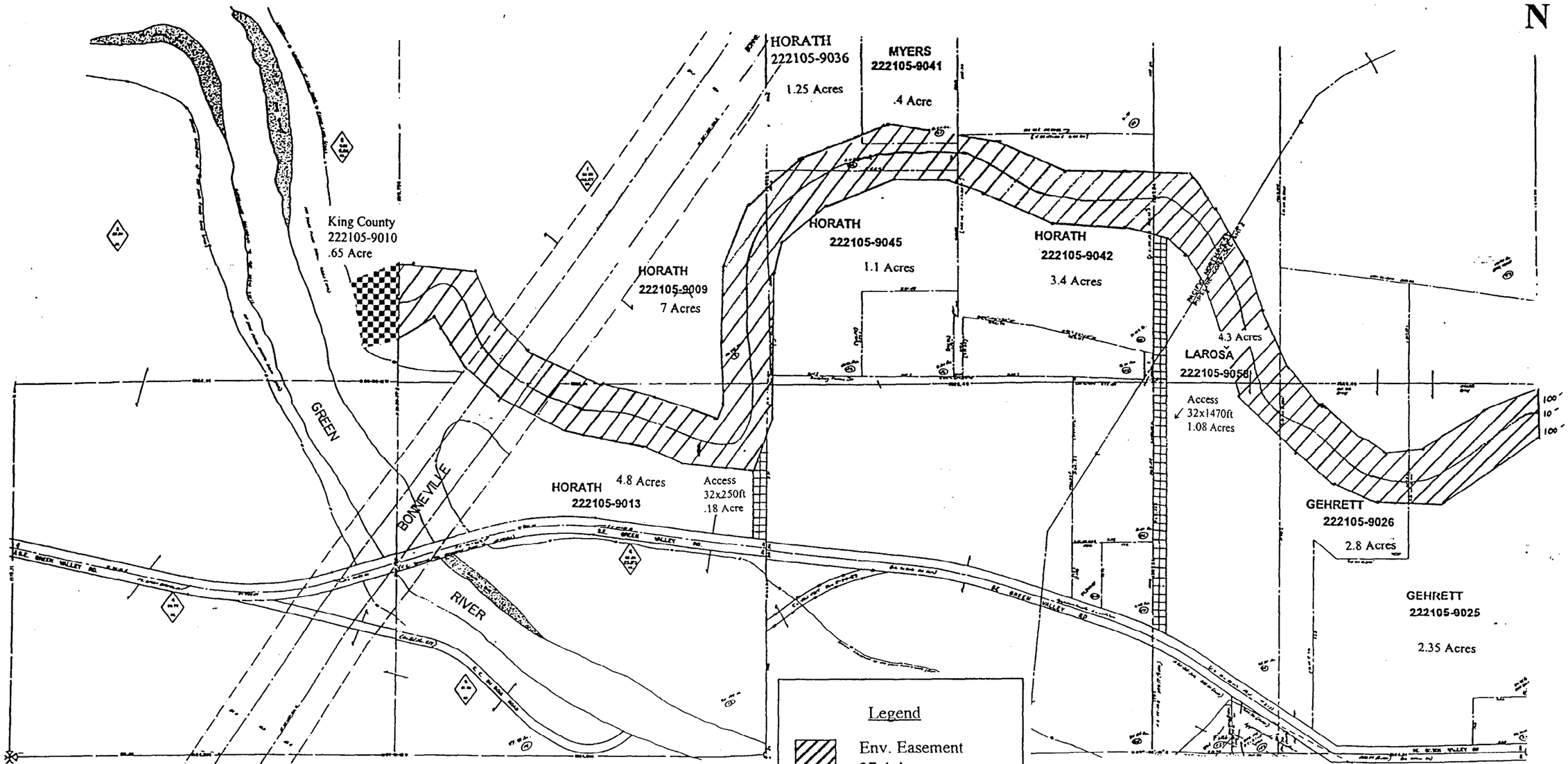
Porter Levee
Fee interest on King County parcel
Situated in Section 21, Twp 21N, R. 5E., WM.
King County, Washington

5/12/00

RAY CREEK

Scale: 1" = 400'

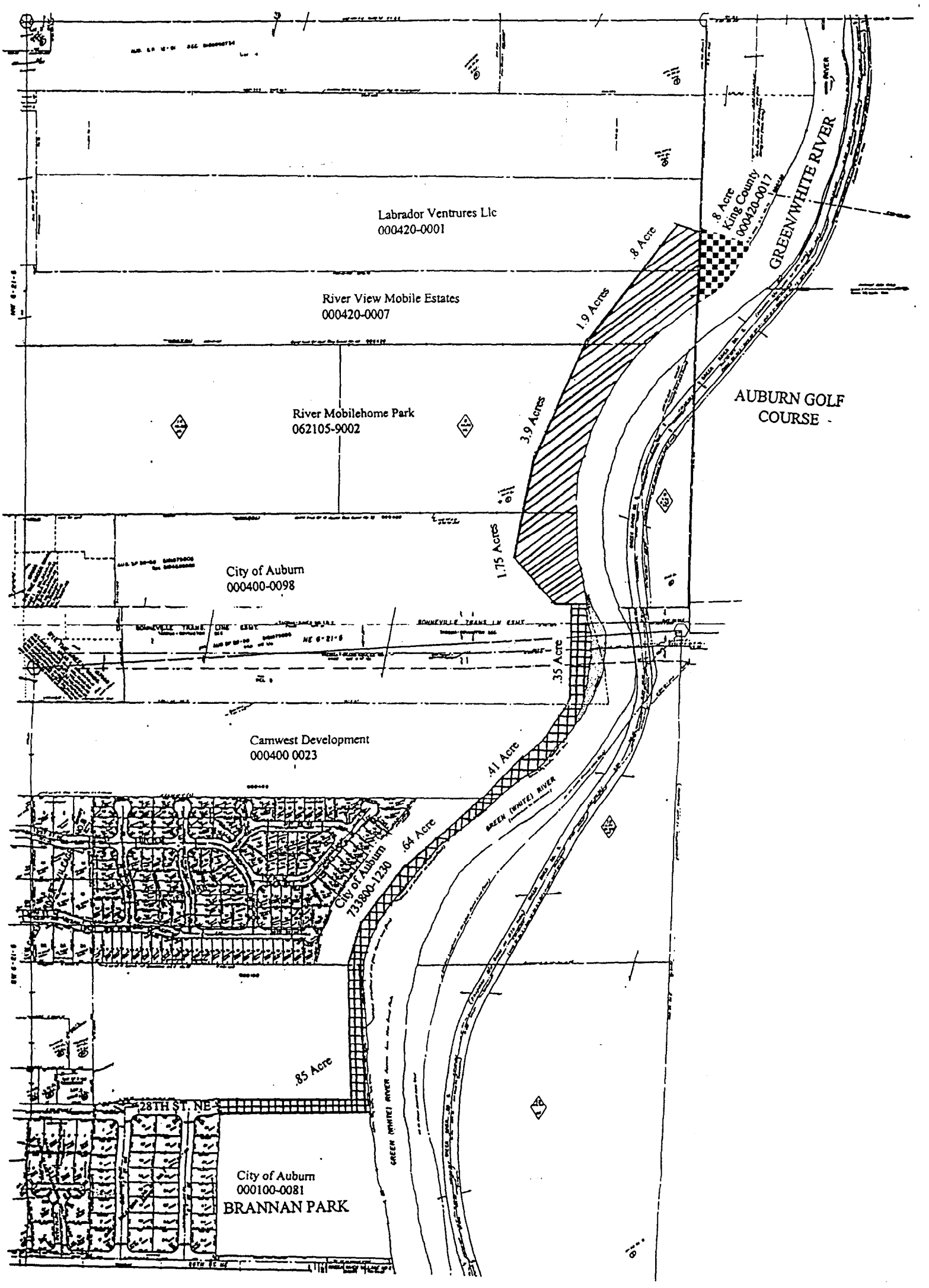
N



Ray Creek Project
Non-Standard Environmental Easement
and Fee Interest in King County
Situated in Section 21, Twp 22N, R. 5E., WM.
King County, Washington

4/19/00

RIVERSIDE ESTATES



Legend

- Fee .8 Acre
- Env. Easement 8.35 Acres
- Permanent Access Needed as Shown 32' wide 2.25 Acres

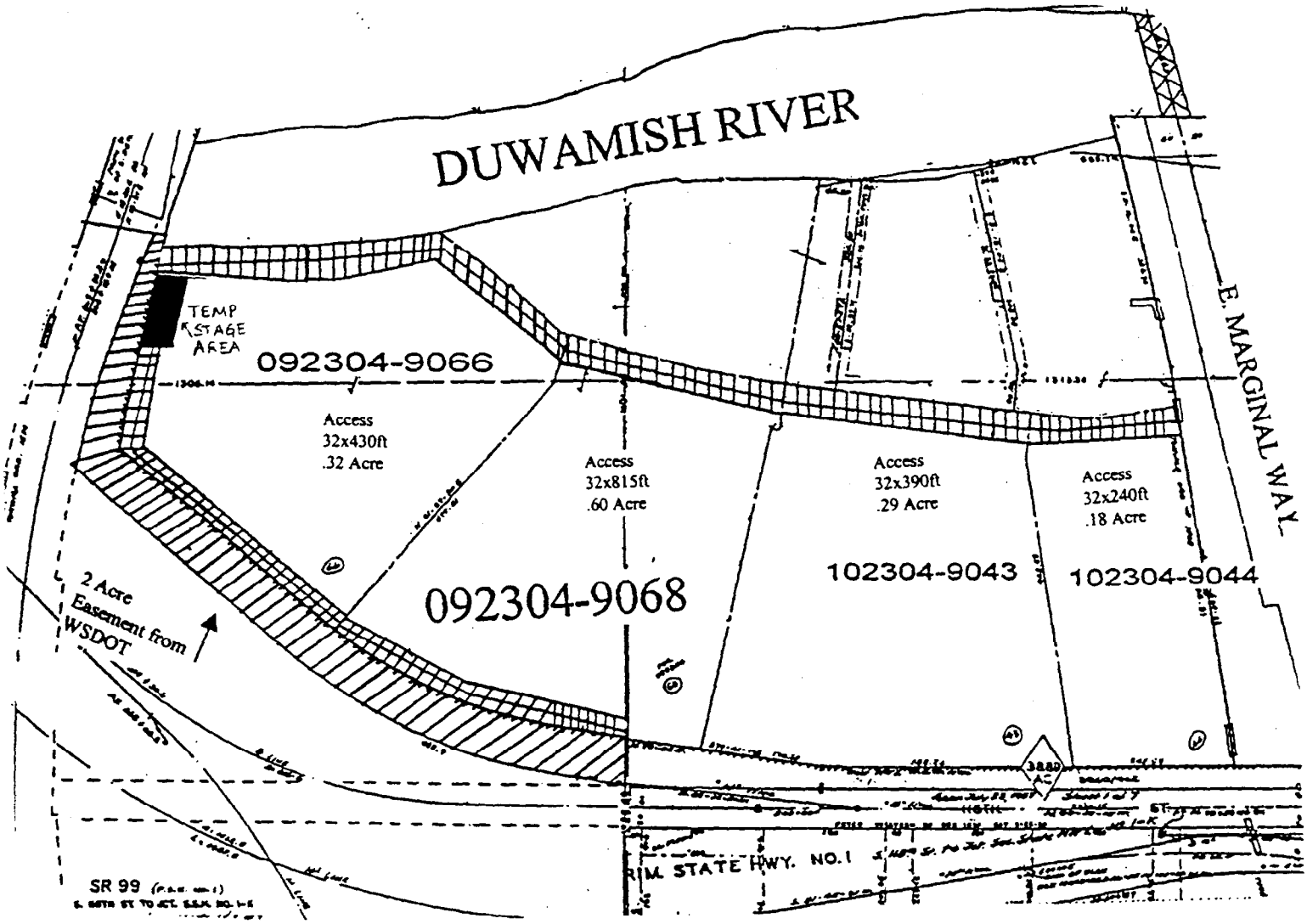
Scale: 1" = 400'

N

Riverside Estates Project
Non-Standard Environmental Easement &
Fee Interest in King County
Situated in Section 6, Twp 21N, R. 5E., WM.
King County, Washington

3/27/00

RIVERTON SIDE CHANNEL



Legend

- Env. Easement 2 Acres
- Permanent Access Needed as Shown 1.39 Acres Total
- Temp Stage Area 25x150ft = .09 Acre

Scale: 1" = 240'

N

Riverton Side Channel Project
Non-Standard Environmental Easement
Situated in Section 09, Twp 23N, R. 4E., WM.
And Section 10, Twp 23N, R.4E., WM
King County, Washington

**Temp Stage Area and Permanent Access are not to scale.

3/29/00

N

R11E

Sunday Creek
Project Footprint

Beginning of Project
2.75 miles from confluence

Stream Length: 15,300ft

100 ft

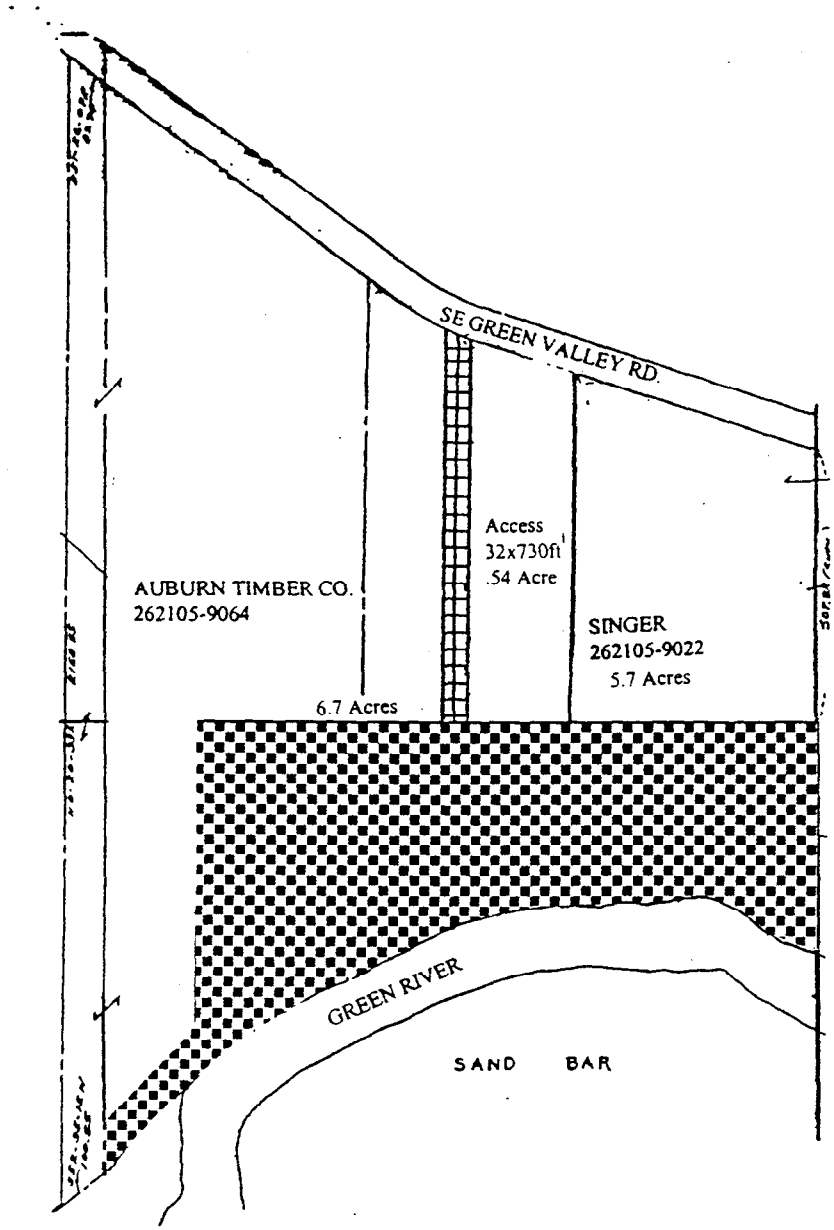
100 ft

Culvert
Site

T21N
T20N

Riparian Area Plantings
70.25 Acres, Environmental Easement
100ft buffer zone, each side of creek

TURLEY LEVEE



Scale: 1" = 300'

N

Legend

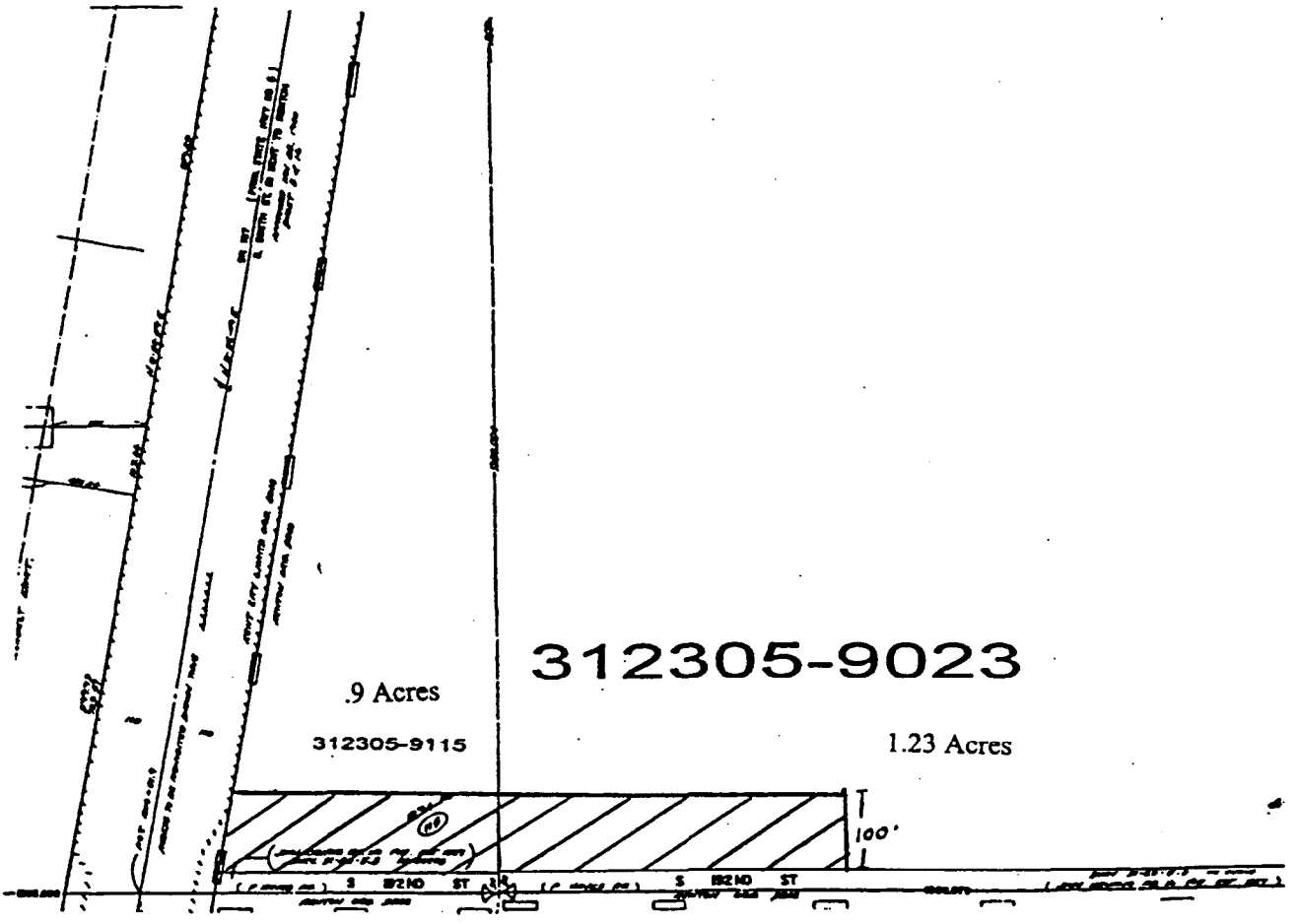
Fee Interest
12.4 Acres

Permanent Access
Needed as Shown
.54 Acre

Turley Levee Project
Fee interest to be acquired by King County
Situated in Section 26, Twp 21N, R. 5E., WM.
King County, Washington

4/19/00

UPPER SPRINGBROOK



Scale: 1" = 350'

N

Legend

Env. Easement
2.13 Acres

Upper Springbrook Project
Non-Standard Environmental Easements
Situated in Section 31, Twp 23N, R. 5E.,
and Section 6, Twp 22N., R.5E WM.
King County, Washington

3/29/00

6DF

UPPER GREEN RIVER

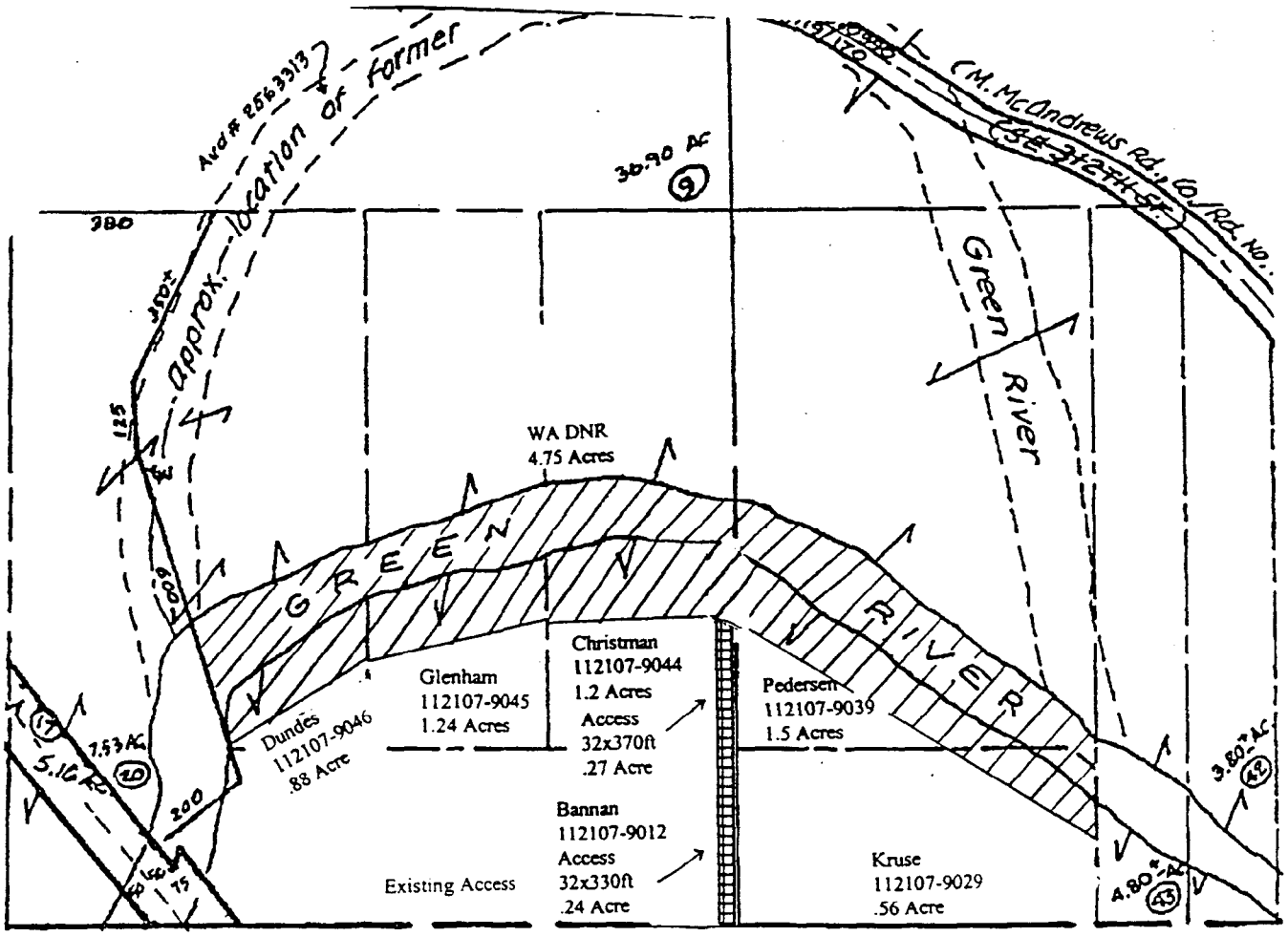
SIDE CHANNEL ENHANCEMENT

SITES 1 & 2

608

Side Channel Enhancement

Site 1



Scale: 1" = 380'

N

Legend

Env. Easement
10.13 Acres below OHWM

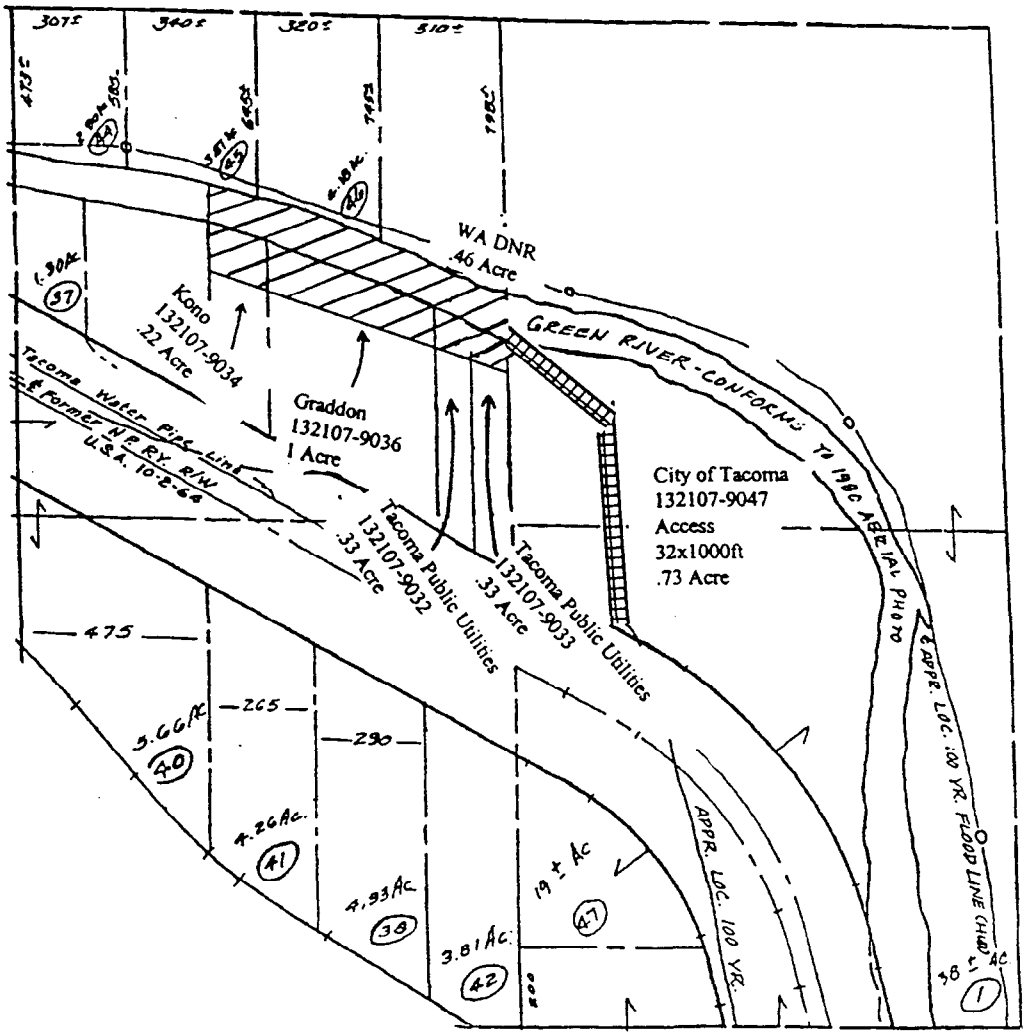
Permanent Access
needed as shown .51 Acres

Side Channel Enhancement Site 1
Non-Standard Environmental Easement
Situated in Section 11, Twp 21N, R. 7E., WM.
King County, Washington

5/16/00

Side Channel Enhancement

Site 2



Scale: 1" = 560'

N

Legend

Env. Easement
2.34 Acres below OHWM

Permanent Access
needed as shown .73 Acre

Side Channel Enhancement Site 2
Non-Standard Environmental Easement
Situated in Section 13, Twp 21N, R. 7E., WM.
King County, Washington

5/16/00

EXHIBIT B

Non-Federal Sponsor's Real Estate Acquisition
CAPABILITY ASSESSMENT

Exhibit B

GREEN/DUWAMISH RIVER BASIN

ECOSYSTEM RESTORATION PROJECTS

KING COUNTY, WASHINGTON

ASSESSMENT OF NON-FEDERAL SPONSOR'S

REAL ESTATE ACQUISITION CAPABILITY

I. **Legal Authority:**

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? **Yes.**

b. Does the sponsor have the power of eminent domain for this project? **Yes.**

c. Does the sponsor have "quick-take" authority for this project? **No. However, the County has other avenues available to them. For the County this is a willing seller only project and they do not have eminent domain authority, but could use a Possession and Use Agreement if it becomes necessary to have use of the property before settlement.**

d. Are any of the lands /interests in land required for the project located outside the sponsor's political boundary? **No.**

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? **Yes. State of Washington, Department of Natural Resources (DNR), and Washington State Parks.**

State of Washington (DNR) typically owns the submerged lands unless a court decision determines otherwise. Until further investigation of property ownerships during the implementation phase, the premise for the purposes of this assessment is that DNR owns the submerged lands at various project sites.

II. **Human Resource Requirements:**

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including Public Law 91-646, as amended? **No.**

b. If the answer to II.a. is "yes," has a reasonable plan been developed to provide such training? **N/A.**

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? **Yes.**

d. Are the sponsor's projected in-house staff level sufficient considering its other workload, if any, and the project schedule? **Yes.**

e. Can the sponsor obtain contractor support, if required, in a timely fashion? **Yes.**

f. Will the sponsor likely request USACE assistance in acquiring real estate? **No.**

III. **Other Project Variables:**

a. Will the sponsor's staff be located within reasonable proximity to the project site? **Yes.**

b. Has the sponsor approved the project/real estate schedule/milestones? **Yes, however, due to the number of project sites, the priority and proposed construction schedule could change during the PED phase.**

IV. **Overall Assessment:**

a. Has the sponsor performed satisfactorily on other USACE projects? **Yes, however; the District has experienced delays in the NFS being able to certify on schedule. Historically, the NFS, has been slow to acquire and certify the necessary interests or to adequately demonstrate they have the necessary interests in project lands which has lead to challenges in getting project implemented. The County's technical staff and COE technical staff will continue to closely work together to obviate project delays.**

b. With regard to this project, the sponsor is anticipated to be:

___ highly capable
X_ fully capable
___ moderately capable
___ marginally capable
___ insufficiently capable. (If sponsor is believed to be "insufficiently capable:, provide explanation).

V. **Coordination:**

a. Has this assessment been coordinated with the sponsor? **Yes.**

b. Does the sponsor concur with this assessment? **Yes.**

Prepared by:

_____
WANDA F. GENTRY
Realty Specialist

Reviewed and approved by:

_____
JOSEPH C. DUNCAN
Chief, Real Estate Division

EXHIBIT C

Certification of Lands

and

Attorney's Certificate

EXHIBIT C

DATE

Department of the Army
Seattle District, Corps of Engineers
ATTN:Real Estate Division
Post Office Box 3755
Seattle, Washington 98124-3755

RE Certification of Lands and Authorization for Entry for the Green/Duwamish River Basin Ecosystem Restoration Project [Insert Project Site Name]

Dear Sir:

By Project Cooperation Agreement dated the _____ day of _____ 200__, King County, Washington, assumed full responsibility to fulfill the requirements of non-federal cooperation as specified therein and in accordance with the Water Resources Development Act of 1986, as amended.

This is to certify that King County, Washington, has sufficient title and interest in the lands hereinafter shown on Exhibit A, attached, in order to enable King County, Washington to comply with the aforesaid requirements of non-federal cooperation.

Said lands and/or interest therein are owned or have been acquired by King County, Washington, and are to be used for the construction, maintenance and operation of the above referenced project and include but are not limited to the following specifically enumerated rights and uses, except as hereinafter noted:

1. Fee: The fee simple title to the land shown Exhibit A attached.

2. Environmental Easement: A perpetual and assignable right and easement in, on, and across the lands of Grantor described in Exhibit A attached hereto to construct, operate, maintain, repair, alter, rehabilitate, remove, replace and monitor project features; plantings; and any other improvements within and adjacent to the stream or shore for grade control, channel, bank, and /or shore, and bank stabilization, fish and wildlife habitat improvements, and other environmental improvements, including the removal of structures or obstructions including levees; the placement of materials or structures in the bed, banks, or shorelines that influence stream velocity or channel form, the removal or placement of gravels, cobbles, and boulders, and other structures, or conveyances to recharge or maintain flow to existing wetlands; reserving, however, to the owners, their heirs and assigns, all other rights and

privileges that may be used without interfering with or abridging the enumerated rights and easement hereby conveyed and acquired.

3. Flood Protection Levee Easement: A perpetual and assignable right and easement in the land described in Exhibit A to construct, maintain, repair, operate, patrol, and replace a flood protection levee, including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired.

4. Shore Protection Easement: A perpetual and assignable easement and right-of-way in, on, over, and across the land described in Exhibit "A" to construct, operate, maintain, patrol, repair, and replace shore protection works, and appurtenances thereto, including the right to borrow and/or deposit fill, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures or obstacles within the limits of the easement; reserving, however, to the grantor(s), (his) (her) (its) (their) (heirs), successors and assigns, all such rights and privileges as may be used without interfering with a abridging the rights and easement hereby acquired.

5. Road Easement: A perpetual and assignable easement and right-of-way in, on, over, and across the land described in Exhibit A for the location, construction, operation, maintenance, alteration, and replacement of (a) road(s) and appurtenances thereto; together with the right to trim, cut, fell, and remove therefrom all trees, underbrush, obstructions, and other vegetation, structures, or obstacles within the limits of the right-of-way.

6. Road and Permanent Crane Pad Easement: A perpetual and assignable easement and right-of-way in, on, over, and across the land described in Exhibit A for the location, construction, operation, maintenance, alteration, and replacement of permanent gravel pad site and (a) road(s) and appurtenances thereto; together with the right to trim, cut, fell, and remove therefrom all trees, underbrush, obstructions, and other vegetation, structures, or obstacles within the limits of the right-of-way.

7. Temporary Work Area Easement: A temporary easement and right-of-way in, on, over, and across the land described in Exhibit A, for a period not to exceed [see individual site requirements], beginning with date possession of the land is granted to King County, Washington, for use by the United States, its representatives, agents, and contractors as a work area, including the right to deposit fill, dredge and waste material thereon, move, store, and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the Green/Duwamish River Basin Ecosystem Restoration Project, together with the right to trim, cut, fell, and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering

with or abridging the rights and easement hereby acquired; subject however, to existing easements for public roads and highways, public utilities, railroads, and pipelines.

8. Temporary Disposal Area Easement: A temporary easement and right-of-way in, on, over, and across the land described in Exhibit~~,~~ for a period not to exceed (insert site specific requirements), beginning with date possession of the land is granted to King County, Washington, for use by the United States, its representatives, agents, and contractors as a temporary disposal area, including the right to deposit fill, spoil, and waste material thereon, move, store, and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the Green/Duwamish River Basin Ecosystem Restoration Project, together with the right to trim, cut, fell, and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject however, to existing easements for public roads and highways, public utilities, railroads, and pipelines.

9. Temporary Air Rights. A temporary easement and right-of-way in, on, over, and across the land described in Exhibit A, for a period not to exceed ten-years beginning with date possession of the land and overhead air right are granted to King County, Washington, for use by the United States, its representatives, agents, and contractors for overhead cable and bucket operation across the river including the right to deposit gravels in the riverbed, and to perform any other work necessary and incident to the construction of the Green/Duwamish River Basin Ecosystem Restoration Project, together with the right to trim, cut, fell, and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject however, to existing easements for public roads and highways, public utilities, railroads, and pipelines.

King County, Washington, does hereby grant to the United States of America, its representatives, agents and contractors, an irrevocable right, privilege and permission to enter upon the lands hereinbefore mentioned for the purpose of prosecuting the project.

King County, Washington, certifies to the United States of America that any lands acquired subsequent to the execution of the Project Cooperation Agreement that are necessary for this project have been accomplished in compliance with the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, (Public Law 91-646) as amended by Title IV of the Surface Transportation and

Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR, Part 24.

KING COUNTY, WASHINGTON

By: _____
Name:
Title:

DATE: _____

*****

ATTORNEY'S CERTIFICATE

I, _____, an attorney admitted to practice law in the State of Washington, certify that:

I am the attorney for King County, Washington.

I have examined the title to _____
_____
_____
_____
[Parcel #] of land identified by the U.S. Army Corps of Engineers as needed for the Green/Duwamish River Basin Ecosystem Restoration [Insert Project Site Name] Project and included in the Certification of Lands and Authorization For Entry document to which this Certificate is appended.

King County, Washington, is vested with sufficient title and interest in the described lands required by the United States of America to support the construction, operation, and maintenance of the Green/Duwamish River Basin Ecosystem Restoration [Insert Project Site Name] Project.

There are no outstanding third party interests of record that could defeat or impair the title and interests of King County, Washington, in and to the lands described, or interfere with construction, operation, and maintenance of the Project. Such interests include, but are not limited to, public roads and highways, public utilities, railroads, pipelines, other public and private rights of way, liens and judgments. To the extent such interests existed prior to acquisition of the described lands by King County, Washington, such interests have either been cleared or subordinated to the title and interests so acquired.

King County, Washington, has authority to grant the Certification of Lands and Authorization For Entry to which this Certificate is appended; that said Certification of Lands and authorization for entry is executed by the proper duly authorized authority; and that the authorization for entry is in sufficient form to grant the authorization therein stated.

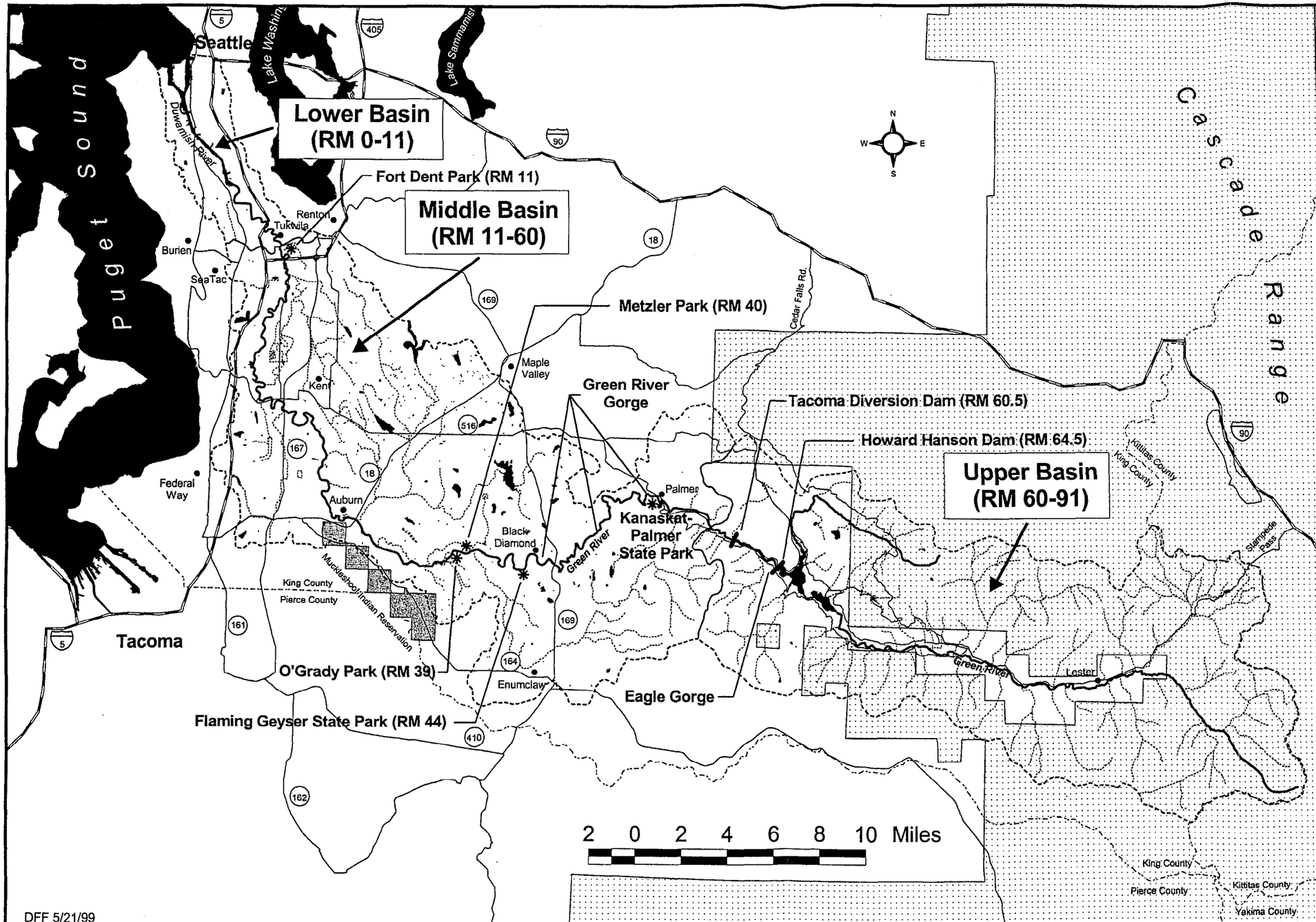
DATED AND SIGNED at _____, this ____ day of _____ 200__.

_____
(Signature)
Name:
Title:

APPENDIX D

ENGINEERING APPEDIX

SITE WRITE UP
AND
DESIGN SECTION



U.S. Army
Corps of Engineers
Seattle District

Hydrography from WDFW Streamnet database; Roads from U.S. Census Bureau (TIGER), King County, and U.S. Army Corps of Engineers

Figure 1

Major Features Green/Duwamish Basin

Green/Duwamish River Basin Restoration Project

Programmatic EIS and Restoration Plan

Upper Green/ Duwamish River Basin

North Fork Green River
Green River
Boundary Ck
Gale Creek
Bear Creek
Charley Creek
Smay Creek
McCain Creek
Sunday Creek
Green River
Wolf Creek
Sawmill Creek
Tacoma Creek

N W E S

1 0 1 2 3 4 5 Miles

40 Gale Creek
41 Boundary Creek
42 Sweeney Creek
43 Olsen Creek
44 May Creek
45 Maywood Creek
46 Gold Creek
47 Sunday Creek Riparian Plantings
48 Northeast Creek

DFF 10/20/00

U.S. Army
Corps of Engineers
Seattle District

Hydrography from King County (1998);
City Limits and Roads from Washington Department of Transportation (1999)

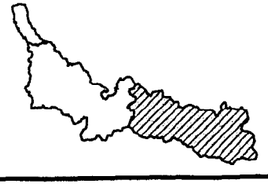
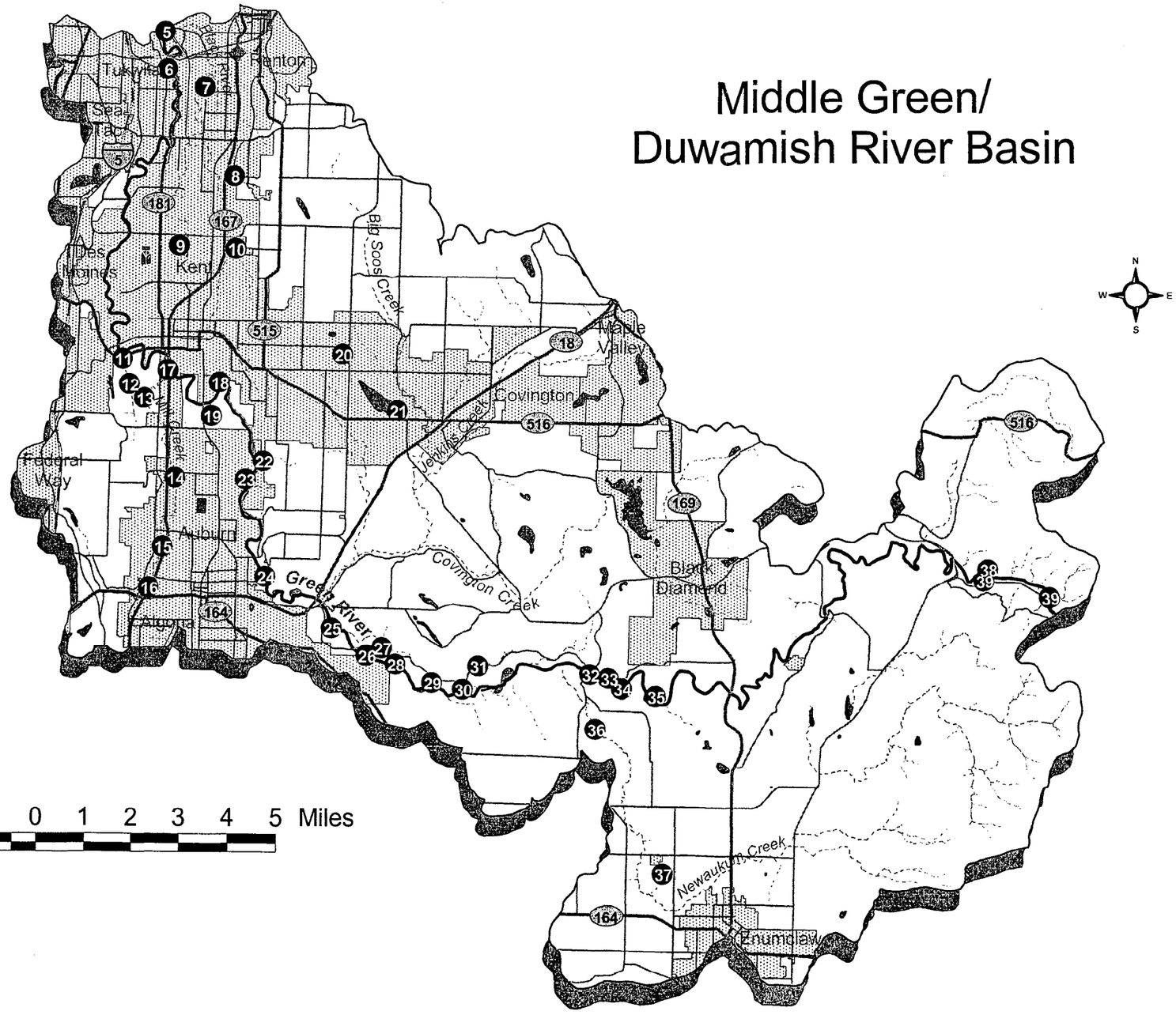


Figure 2
Upper Basin Restoration Sites



DFF 11/20/99

Green/Duwamish River Basin Restoration Project

Programmatic EIS and Restoration Plan

5 Black River Marsh
6 Gilliam Creek
7 Lower Springbrook Creek
8 Upper Springbrook Creek
9 Mill Creek East
10 Garrison Creek (1)
11 Mullen Slough, Prentice Nursery Reach
12 Mullen Slough Reach
13 Mill Creek, Schuler Brothers Reach
14 Mill Creek, Merlino Reach
15 Mill Creek, Wetland 5K Reach
16 Mill Creek, Goedeke Reach
17 Green River Park
18 Horsehead Bend Side Channel
19 NE Auburn Creek
20 Meridian Valley Creek
21 Lake Meridian Outlet Relocation
22 Olson Creek
23 Riverside Estates Side Channel
24 Mainstem Maintenance (Auburn to Elliott Bay)
25 Porter Levee Setback
26 Kaech Levee Pond
27 Ray Creek Trib Corridor
28 Hamakami Levee Modification
29 Turley Levee Setback
30 Loans Levee Setback
31 Burns Creek Restoration
32 Middle Green River Large Woody Debris
33 Middle Green River Gravel Replacement
34 Flaming Geyser Landslide
35 Flaming Geyser Side Channel
36 Newaukum Creek
37 Big Spring Creek
38 Brunner Slough
39 Upper Green River Side Channel Enhancement

U.S. Army
Corps of Engineers
Seattle District

Hydrography from King County (1998);
City Limits and Roads from Washington Department of Transportation (1999)

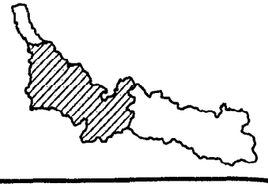
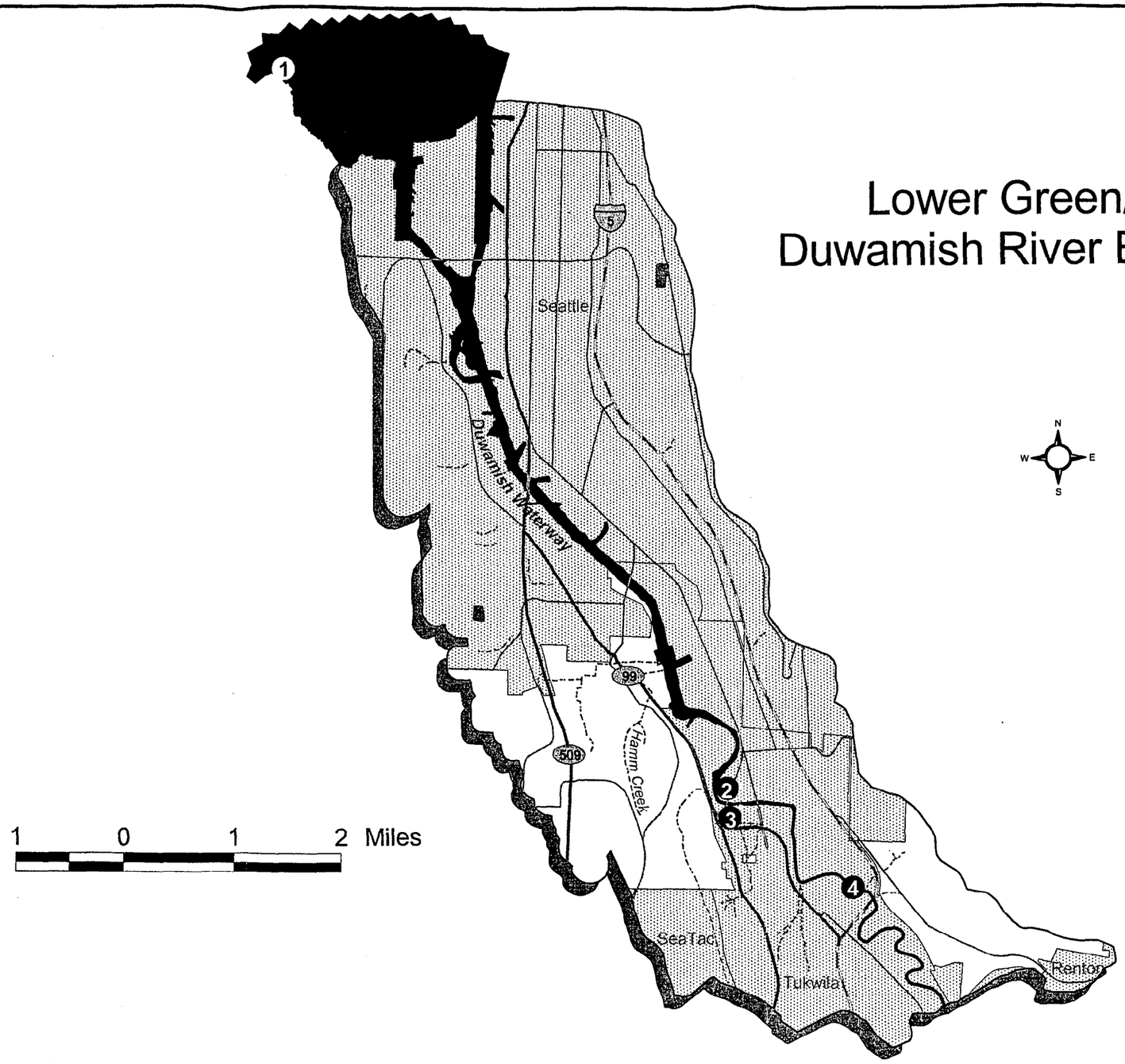


Figure 3
Middle Basin Restoration Sites

Green/Duwamish River Basin Restoration Project

Programmatic EIS and Restoration Plan



① **Elliott Bay Nearshore**

❷ **Site 1, Duwamish**

❸ **Riverton Side Channel**

❹ **Codiga Farms**

U.S. Army
Corps of Engineers
Seattle District

Hydrography from King County (1998);
City Limits and Roads from Washington Department of Transportation (1999)

Figure 4

Lower Basin Restoration Sites

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Elliot Bay Near-shore

Location
The site is located at the 30-ft. contour Northeast of Duwamish Head, Elliott Bay. There is also a near shore component that is at the –2 elevation just off Don Armeni Park. Reference site maps for longitude and latitude.

Site Constraints/Problems
Elliott Bay has been altered from its original state by the placements of large amounts of fill. Large expanses of the Bay have a uniform silty substrate with little complexity (such as rock or boulders) for attachment of macro algae. In some areas the nearshore is lacking in vegetation and provides little refuge for out-migrating salmon or juvenile rockfish. If more hard substrates were available for algae attachment this would improve the local habitat by providing both primary productivity and refuge.

Project Goals
The project goal is two-fold. The first is to provide additional primary productivity in the nearshore area. The second is to provide a hard substrate for macro algae attachment which would furnish a more complex nearshore environment that provides refuge for juvenile salmon and young rockfish.

Proposed Solutions
In 1998 a small pilot study was conducted in the Duwamish Head area. There were several purposes of the project. One was to evaluate different substrate types that could be placed in the intertidal area around Seacrest Park to provide refuge for small Dungeness Crab as well as provide for an increase in epibenthic productivity. The other purpose of the project was to place different types of rock (angular and smooth) by different placement techniques at about the forty foot contour. It was the placement of the rock that seemed to provide the most immediate benefit. Large macro algae attached within the first year. Divers that visually monitored the site told of how quick the plants become established and how a wide variety of marine organisms used the new site. A few different alternatives have been considered in the early pilot study. They included:

1. Enhancing the nearshore habitat by placing Christmas trees at the forty-foot contour.
2. Building reefs out of large rock and placing them at the same location.
3. Building reefs out of scrap metal and construction debris.
4. Using the information that was obtained in the pilot study to enhance the substrate by placing angular minus12"rock at the thirty-foot contour. The material would be spread along the floor by clamshell dredge using a global positioning system. The 12' material was selected as the largest size we could use and not effected the

minimum depth of 18", we have several demonstration sites we constructed and monitoring has shown us that this material is working very well.

Recommended Plan

Alternative one was eliminated because, although successful in other locations, Christmas trees provide only a temporary benefit since the break down quickly. Alternative two was dismissed because a large (tall) reef has the potential to snag fishing nets. Alternative three was dropped because there is a potential to release hazardous substances from construction debris (iron, zinc, alkaline byproducts etc.). Alternative 4 seems to be the most viable alternative and the pilot study has demonstrated that it can be implemented with minimal impacts to the aquatic environment. Some concerns have been expressed over deposition in the project area but old bottles found on the bottom have shown very little deposition in over fifty years.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix

Conclusions and Recommendations

The pilot study for this type of restoration was very successful (colonization of rock by macro algae within one year). Placement of the material is the key to a favorable project. Material (rock) that is free of fines (the material must be sieved at the borrow source) should be placed at the 30 to 35-ft contour. Experience from the pilot project has shown that the material should be placed by clam bucket. The bucket should be slightly swung parallel to the shoreline and the bucket slowly opened. The material to be used should be 18" minus (that is angular rock that is 18' in diameter or less). Piles of rock should be no more than 18" off of the bottom of the Bay to avoid any snagging of fishing nets. Divers should examine the site prior to placement. Buoys should be placed on the corners of the project site to facilitate the placement of rock. If any eelgrass is in the area, it should be avoided. That is, an eel grass survey should be conducted prior to placement. Any material should be placed waterward of eelgrass beds. For the nearshore site, avoidance of high energy areas is important. Early coordination with Department of Natural Resources (the landowner) and City of Seattle is essential.

SITE NO. 1A

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Volunteer Revegetation

Location
The location of the proposed project is throughout the entire Green River Basin. The project would provide plants to volunteer groups involved in replanting riparian habitat along the main stem Green River and its tributaries. Currently on many weekends throughout the year volunteer groups plant vegetation at numerous sites from the estuary to areas just below Howard Hanson dam. This alternative would also include volunteer plantings upstream of Howard Hanson dam and at numerous river and stream sites throughout the basin.

Site Constraints/Problems
There is a critical need throughout the basin for riparian plantings along the river and its tributaries. Riparian corridors provide essential watershed functions such as buffers, shade providers, filters, fish and wildlife habitat, and food sources.

The majority of the historical trees and vegetation have been destroyed through development and agricultural and timber practices throughout the basin. The majority of the streams in this basin have very little or no riparian habitat.

The fisheries resources of the existing river and stream systems include chinook and coho salmon (*Oncorhynchus kisutch*), and anadromous and resident cutthroat trout (*O. clarki clarki*) The pre-disturbed Lower Green River supported a much larger population of spawning and juvenile salmon -due to the annual scouring of the small wall tributaries and side channels before construction of the Howard Hanson Dam. Many side channel areas were cleared of most trees, destroying wetland connections, which provided deep rearing pools and critical habitat for salmonids. Also lacking in the Lower Green River is large wood that provided a significant amount of habitat prior to it being removed for agricultural practices and urban development. In summary, there is a critical need for more fish habitat in the Lower Green River to improve the survivability of downstream moving juveniles

Project Goals
The goal of this project is to significantly improve the fish and wildlife habitat in the Green River basin. This will be accomplished through collaboration with King County, the local public, and private resource agencies. These affiliates will be supplied with a significant quantity of plants for use in riparian planting projects throughout the basin annual over a 10 year period. This program will promote a significant increase in the acreage of riparian plantings placed annually.

Proposed Solutions

- Alternative No. 1 – No action to enhance the existing riparian system.

- Alternative No. 2 – Work with King County and other public and private agencies throughout the basin to provide plants for riparian habitat enhancement through out the basin.

Recommended Plan

Alternative No. 1 – No action was rejected since the need for additional riparian habitat in the Green River basin is critical to the future viability of fish and wildlife.

Alternative No. 2 – This is the recommended plan. This involves working with the County, the public and local districts throughout the basin to enhance the overall environmental heath of the Green River basin through a program of riparian plantings.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.

Conclusions and Recommendations

We recommend the implementation of a plan that would allow the Corps to work with the County and local agencies on the implementation of a comprehensive riparian planting program throughout the basin. In areas were new vegetation may effect stream and river flows it will be necessary to insure adequate h&h analysis has been done to assure that vegetation does not cause increased flooding and/or damage to privately owned lands.

SITE NO. 2

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Duwamish Site 1

Location
The project site lies on the east bank of the Duwamish River just north of South 112th Street in the City of Tukwila in the southeast quarter of Section 4, Township 23 North, Range 4 East.

Site Constraints/Problems
Historically, the lower Duwamish River was the setting of an expansive estuary with a complex mix of habitat types, including tide flats and intertidal wetlands, as well as various channel forms such as large meanders, braided channels, and numerous tributary streams. Within this diverse environment, juvenile salmonids had abundant opportunities to rest, feed, and acclimate to the brackish water before heading out to sea. Over time, the intertidal areas were filled, tributaries were piped and/or made inaccessible, and the Duwamish channel itself was dredged and straightened to facilitate Port development and industrial use of the adjacent land. What remains is a fairly uniform channel sorely lacking in habitat diversity, with very little off-channel habitat available for refuge and/or rearing for juvenile salmonids. The loss of this habitat all but eliminated the critical transitional environment between fresh and salt water, once found in the side channels and intertidal wetlands that are essential to the successful completion of a number of lifestage changes for several species of salmonids (*Onchorhyncus*). As a result, the outmigrating juvenile salmon must rear elsewhere in the system longer and/or leave the system weaker and more susceptible to mortality through a variety of causes.

Project Goals
The primary goal of this project is to restore important estuarine habitat within the lower Duwamish River, with the intent of enhancing salmonid habitat within the Green-Duwamish River system as a whole. This would be accomplished by regrading the majority of the subject property to elevations that would be subject to regular tidal influence and inundation and connecting that area to the river via an inlet channel. The resulting off-channel, intertidal marsh would provide critically important transitional habitat where juvenile salmonids have the opportunity to feed, rest, and undergo smoltification prior to heading out to the ocean.

Proposed Solutions
For the Duwamish Site 1 project, two options have been considered:

- Alternative No. 1 – No action: Under this alternative, the site would remain upland and would continue to provide marginal habitat for upland birds and small mammals, but would provide little benefit to the Duwamish directly.

- Alternative No. 2 – Restoration of estuarine, intertidal habitat along the Duwamish River by implementing the following restoration activities:

  - Excavate the fill and native soils on-site to create off-channel, emergent marsh and intertidal habitat. The elevations will vary from approximately +2 feet (MLLW) at the inlet to +12 feet (MLLW) at the upper edge of the estuarine marsh to obtain a diverse and productive intertidal environment. The rest of the site would also be graded at moderate slopes to match existing topography at the property edges.

  - Lower the elevation of the existing bank and cut an inlet/outlet channel to the river that will allow water to flow freely in and out of the system with the tides.

  - Create gradual sloped benches/terraces within the marsh that are suitable for planting of appropriate emergent vegetation.

  - Plant the intertidal wetland with emergent marsh vegetation appropriate to both the setting and elevation to stabilize the soils, provide food and cover for organisms at all trophic levels; add organic debris into the system, etc.

  - Place large woody debris where appropriate within the marsh and adjacent areas to add structure, cover, and complexity to the off-channel areas.

  - Plant the adjacent uplands with native trees and shrubs to provide cover, shade, and organic debris input into the system.

Recommended Plan
Alternative No. 1 was rejected since it provides no benefit to the Duwamish and fails to take advantage of one of the few remaining opportunities to do so. Given its central location and zoning, the site will undoubtedly be converted to industrial or commercial development, and the opportunity for meaningful restoration will be lost. In addition, it is likely that what little function is currently provided would be further degraded by site improvements to facilitate commercial or industrial use of the property in the future.

Alternative No. 2 was selected primarily because it provides a unique opportunity to restore important transitional habitat within the lower Duwamish. Although the exact configuration of the excavation can be determined during the final design phase, the concept of creating the off-channel habitat is very important. Historic losses in both the amount and type of habitats available in the lower Duwamish-Green River system have

relegated them to transportation corridors rather than the productive nurseries they once were. As a result, juvenile salmonids, including chinook, undoubtedly leave the system less fit than they could or should be, and as a result, suffer higher mortality. Given the limited opportunities available within this highly urbanized setting, the potential restoration value of this particular site is significant. Given the site's history and location, however, there is a potential for contaminated sediments to be present in the fill material. Prior to final cost estimates, the material should be evaluated to determine if additional disposal costs should be included.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix

Conclusions and Recommendations

Acquire the property and proceed with planning, design, and construction of Alternative No. 2. Unlike many other types of habitat restoration, the design of this project is extremely simple and relies on very predictable natural processes for success. Assuming that the site is graded appropriately, the daily tides will flow in and out of the site, creating the off-channel, intertidal habitat desired. Although the potential for success is high, the value of the site for other uses is also high; therefore, there is a need to acquire the site in a timely manner. Even if construction is not possible right away, the site should be secured for future habitat enhancement. Some hydaulic design and geotec work will be necessary on this site to insure its function under high flow conditions prior to construction. Also during the planning engineering and design (PED) phase we need to investigate other possible configurations that would include deepening the channel down to –2MLLW and the possibility of opening up another entrance to the river.

SITE NO. 3

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Riverton Creek

Location

The project is located in the City of Tukwila, immediately north and east of the intersection of State Route (SR) 99 and SR 599, in the northeast quarter of Section 9, Township 23 North, Range 4 East. The stream study reach extends from the Green River, upstream to where the stream crosses underneath SR 599.

Site Constraints/Problems

Riverton Creek has been heavily impacted both directly by relocation and channelization, as well as indirectly by increased flows and sedimentation resulting from urban development. Squeezed between the fill associated with adjacent commercial development and state highways, the subject reach has the appearance of a typical roadside ditch for much of the project length. The lower reach also has been separated from the Duwamish River by a set of culverts with flapgates, which severely restricts fish access and limits the influence of the tide on the existing stream. The resulting channel is narrow, lacks habitat complexity, floodplain connectivity and has very limited buffer vegetation.

Project Goals

The primary goal of this project is to restore and enhance salmonid habitat within Riverton Creek and improve its connection to the Duwamish River, using natural processes and habitat elements to facilitate upstream migration and to provide juvenile off-channel rearing. This would be accomplished by restoring a more natural tidal connection between the Duwamish River and Riverton Creek, re-establishing reliable fish access to Riverton Creek, and rehabilitating the existing channel to provide productive rearing and refuge habitat for salmonid species.

Proposed Solutions

For the Riverton project, three alternatives have been considered:

- Alternative No. 1 – No action: No modifications to the existing stream conditions. Instream habitat would remain poor and isolated from the river/tidal influences.

- Alternative No. 2 – Restore and enhance the existing channel by implementing the following restoration activities:

- Remove the existing floodgates and replace with a bridge to re-establish tidal influence and improve fish access to the system.
- Remove accumulated sediments and install suitable gravel substrate.
- Add large woody debris to increase habitat complexity and provide cover for juveniles.
- Remove invasive reedcanary grass and Himalayan blackberry and replant native trees and shrubs along the remaining buffer.

- Alternative No. 3 – Create a side channel connected to the Green River by implementing the following:
  - Excavate (widen and deepen) an existing ditch/swale along the east side of the existing commercial development and install suitable gravel substrate.
  - Replace two culverts, potentially with bridges, and set a new, lower channel invert.
  - Plant native trees and shrubs along the new side channel where there is sufficient space.

Recommended Plan

Alternative No. 1, no action, was rejected because it does not accomplish the goal of habitat restoration.

Alternative No. 2, enhancement of the existing stream channel, was selected because it provides a unique opportunity to restore valuable off-channel habitat and improve fish access and utilization of Riverton Creek with minimal effort.

As described above, this alternative will revegetate available buffer areas, improve habitat quality and complexity by adding large woody debris, removing accumulated sediment, and adding streambed gravel. A backwater (hydraulic) analysis showed that if the flapgates were removed, the current 100-year flow would come within approximately one foot of overtopping SR 599. The City of Tukwila has stated that this is an acceptable risk but addition h&h analysis will need to be done prior to construction.

Alternative No. 3, construction of a side channel, was rejected primarily because of difficulties involved with creating viable off-channel habitat within the space available. Based on available information, it appears that the area where the proposed channel would be located would need to be lowered by at least 5 feet to ensure tidal influence for any meaningful length. This would require replacing the existing culverts under the office park entrances with new culverts set to a lower elevation or with bridges. This would also require creating over-steepened side slopes and/or a very narrow channel. As the value of this type of feature is tied to the amount of area made available, this would

seem to create very little estuarine environment at a fairly high cost. A detailed hydraulic analysis would be needed to determine if replacing the culverts, potentially with bridges, would significantly affect upstream flooding.

Although the excavation of the existing ditch/swale to create a side channel may have merit, the high cost for a relatively small amount of habitat makes it more prudent to improve and enhance the existing stream channel and monitor the net benefits. If monitoring suggests additional potential, then the second connection can be pursued.

Based on the conditions within the basin as a whole, it is recommended that the restoration focus on the existing stream channel, where the potential for the most cost-effective restoration/enhancement can be performed. Once the tidal influence has been restored, and other habitat elements are in place, the results can be evaluated and used to predict the merits of the more extensive channel creation project outlined in Alternative No. 3.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix

Conclusions and Recommendations

Proceed with detailed planning and design to enhance the existing stream channel and monitor the results with the possibility of creating the additional side channel in the future as a second phase. One of the concerns with this project is that effective, long-term value of the restored lower reach is dependent upon effective sediment and stormwater controls implemented in the upper basin. Without adequate controls, it is likely that sediment deposition will continue to degrade the habitat in the lower reach. An h&h analysis, water quality study and sediment analysis is necessary prior to construction.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Codiga Farms

Location
The site is located in the City of Tukwila near 50th Place South and South 130th Place.

Site Constraints/Problems
Currently, the site is occupied by a farm and a pea patch. The purpose of the project is to restore tidal hydrology to the Codiga Farm site. Historically, this portion of the Duwamish had a broad and connected flood plain. Within the tidal portion of the flood plain existed estuarine marshes and sloughs. Starting in the 1860's levees were constructed at the marsh edges and these areas were converted to agricultural production such as hop fields. Sloughs in the area were also filled to make more farmable land. In many places farmland was then converted to housing or industry. In this particular location, a farm is still present. From a fish and wildlife standpoint, this conversion had harsh consequences. The levees and fill that was placed along the margins of the tidal portions of the River interrupted the flow and as a result, nutrient export from the marshes to the adjoining habitats such as mudflats was diminished. Intertidal sloughs that were once refuge areas for juvenile fish (salmon, sculpins, and sole) shorebirds (dunlin, sandpiper and yellowlegs) and waterfowl (pintail, and baldpate) was lost. The continuity of the large interspersed habitats of the estuary became fragmented. This project offers an opportunity to restore some of the former estuary. Perhaps even more significant is the location of the site. Codiga farms is in the brackish to fresh water tidal area making it a prime area where juvenile salmon change their physiology from a freshwater to salt tolerant.

Project Goals
The goal of the project is to restore tidal hydrology to the site in the form of a slough. This slough would then provide rearing and feeding habitat for juvenile fish. In addition, a fringing estuarine marsh will also be planted at the site providing primary productivity and nutrient export. A third objective, unique to this site would be educational benefits to the public. Through the use of interpretive signage and observation area, information of estuarine and riverine ecology could be disseminated.

Proposed Solutions
Several alternatives were considered for this project. They include:

- Alternative No.1-No Action: The city could maintain the existing farm and small pea patch. This would not achieve the goal of restoring historic hydrologic conditions.

- Alternative No 2- The site would be converted wholly to a park. A large picnic area could be built and the pea patch expanded. The farm could be turned into a

demonstration area for historic farming that once occurred throughout this portion of the valley.

- Alternative No 3- This alternative would restore much of the property to tidal influence. Two new channels would be excavated back into the property (total length about 800-ft. The outlet would be down river from the existing sand spit. The bottom elevation would be about +2 (MllW=0) allowing some water in the slough most of the time. One side of the pond would be at a slightly higher elevation allowing for some off-channel refuge at high water. Woody debris such as large stumps with root wads would be put in the new channel to provide cover. Adjacent to the channel would be an intertidal bench at the appropriate elevation to grow freshwater estuarine emergent plants such as sedges and rushes. Insects associated with this type of vegetation would provide prey resources for juvenile fish using the new channel. A fifty-foot riparian buffer would be planted on the uplands adjacent to the channel providing shade and shield against local disturbance. Finally, around the channel certain compatible park features would be included such as an observation platform with interpretive signing, maintain the existing pea patch, a hand boat launch a gravel parking area and small picnic pavilion with associated parking lot. On the upriver portion of the project on the bench of the Green a 300 ft. berm would be constructed for flood protection. This berm would be constructed on uplands and planted in vegetation upon completion of construction. The purpose of the berm is to keep the river in its channel and not allow it to move and destroy the tidal marshland and the rest of the park.

Recommended Plan

Alternative three is the preferred alternative. It provides a rare opportunity to gain some unique habitat types that have long been missing from this portion of the river. This project also has an opportunity to provide an education and low impact recreation benefit.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix

Conclusions and Recommendations

The alternative three provides the best chance of insuring habitat benefits while accommodating human needs. Since this area has been designated to be a park it is import to maintain some of the public amenities while also insuring the biological integrity of the restoration effort. With the park designation this project offers the opportunity to provide habitat benefits and public education while offering low impact human uses. There is currently a pea patch on site that needs to be retained. A hand boat launch, parking lot, picnic area and observation platform are features that should be included. We recommend that any new parking or walking areas be done in gravel instead of asphalt. One concern is the current and past use of the site. Soil testing should occur in the area that was farmed and compared to current regulatory standards prior to any work. There should be some analysis of the tidal elevations in the area to make sure the mouth is set at the correct elevation. Reference areas for emergent vegetation should

also be established. An h&h analysis of the effects of tidal fluctuations and flood flows on the project and the entrance conditions will be done prior to project construction

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Black River Marsh

Location
The site is located in the city of Renton, just down river from the Black River Pumping Plant in Fort Dent. This project is at the confluence of The Green River and the Black River.

Site Constraints/Problems
Estuarine habitat in the lower Green/Duwamish has greatly diminished over the last 100 years. Almost 99% of intertidal habitat has been lost to some kind of development. Especially rare are fresh water emergent marshes. Historically, there was a large marsh located at the confluence of the Black River and the Duwamish near the current Ft. Dent Park. Emergent marshes provide a number of benefits to fish and wildlife. They provide significant primary productivity, nutrient export, and food and refuge at high tides for juvenile salmon and trout. It is especially important to provide young fish an opportunities for refuge and feeding as they migrate downstream for ocean migration. In addition, there is also a need for a more established riparian area from the Black River pumping station to Ft. Dent. The newly planted riparian belt would provide shade to the Black River; it would also buffer the River from disturbance from adjacent uses (railroad, traffic etc.). Once the newly planted trees matured, they would provide food and refuge for a variety of birds, including passerines such as white crowned sparrows, chickadees, and kingfisher as well as great blue heron and red tailed hawks. Long, continuous strips of mature trees would also provide migration corridors for surrounding wildlife. The area around Ft. Dent has been fragmented over time by construction of a quarry, railroads, water treatment facility and roads. There is still remnant patches of rivereine habitat just upstream of the pumping plant and this riparian strip would offer some amount of connectivity between there and the confluence of the Black River.

Project Goals:
The objectives for the intertidal emergent marsh are to provide primary productivity/nutrient export to the surrounding system and to allow juvenile salmon and trout access at higher tides for fish refuge and feeding. The goal of the riparian planting is to provide habitat connectivity and a buffer from local disturbance. Also, water quality benefits such shading (to help keep instream temperatures down) and filtration of runoff from adjacent land uses should be realized once the vegetation has matured.

Proposed Solutions
A number of alternatives were considered for this project. There was an understanding that this area was lacking in opportunities for juvenile salmon and trout rearing habitat. The Black River and Springbrook creek still have viable populations of migratory fish. Also lacking down river from the plant was any significant riparian habitat. The question

was, with most of the immediate area already developed where were the opportunities to locate the needed habitat.

- Alternative one: Do nothing, maintain the status quo (the no action alternative). This alternative was rejected because it did not meet the project goals of providing habitat benefits to an area that needed them.

- Alternative two: Some consideration was given to constructing a channel from a pond located near the playing fields in Ft. Dent park to the Black River. This channel would have given access to juvenile fish to the pond for rearing and feeding. Wetland plants would have been added to the pond and a riparian buffer would have been planted next to the newly excavated channel. The alternative was reject because of site constraints. The channel to connect the pond and the river would have to have been fairly deep. There is little elevation difference between the pond and the river so the channel would have been flat causing concern for potential fish stranding at low tides. Finally, do to the limit space in the park, there was only a narrow strip to excavate the channel in. The sides slopes for the channel would almost be vertical. From a structural standpoint there would always be anxiety over the channel collapsing. In addition there would also not been much room to plant vegetation next to the newly constructed channel.

- Alternative three: This alternative proposes to remove about 200 cubic yards of fill from the left bankline of the Black River at the confluence with the Green just south of the railroad tracks. The final elevation would be about +10 (MllW=0). This small area would then be planted in sedges and or rushes. A few large stumps with root wads would be placed to provide cover. This alternative also proposes to create a 50-ft. wide riparian buffer along the banks of the Black River from the pumping plant to the confluence. Existing blackberries and other noxious weeds would be removed. Trees, such a cottonwood, fir, cedar, willow and alder would be planted. Scrubs, such as current, cascara, rose, snowberry and thimbleberry would also be planted.

Recommended Plan
Due to site and multiple landowners constraints, alternative three is recommended.

Cost Items and Quantities
Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix

Conclusions and Recommendations
Alternative three does seem like the best option although there is limited room to construct a very large project. Also, there will be ongoing disturbance from the railroad line that runs through the project area. Water quality in the Black River has also been a concern although upon maturation this project should provide some benefits in this arena. The opportunity to gain any estuarine marsh in this area regardless of the size should be seized upon. Prior to construction H&H and geotechnical studies should be conducted to determine effects of possible scour on the project entrance, railroad bridge, and

constructed marsh. This analysis should also include the effects of the LWD on existing structures and facilities.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Gilliam Creek

Location
The project site is located in the City of Tukwila, WA, at the confluence of Gilliam Creek and the Green River at River Mile (RM) 12.5. The confluence of the Gilliam and Green Rivers can be found east of the I-405 & I-5 interchange, near the South Center Mall's north entrance. The site extends approximately 2000 feet upstream along Gilliam Creek.

Site Constraints/Problems
Gilliam Creek drains approximately 1,900 acres (Perteet, 1994, KCM, 1986). Its upper basin, contained within the City of SeaTac, is subject to poor water quality, erosion of the stream banks, and siltation within the stream corridor (Parteet, 1994). Culverts in the vicinity of 42nd Avenue South and South 154th Street were determined undersized and would likely flood the roads in the 25-year storm events (KCM, 1986). The lower basin land use area is predominately commercial and high-density residential property whose storm drainage is routed to Gilliam Creek via a storm drainage system. The last 2000 feet of Gilliam Creek is a series of ditches and culverts. All runoff from the basin is discharged through a 108 inch flap-gated culvert which currently prohibits fish passage, into the Green River (KCM, 1986). At the Gilliam Creek Confluence, the Green River is constricted by levees on both sides and is tidally influenced.

The existing flapgate can become submerged during high flows in the Green River impeding drainage from Gilliam Creek which can result in local urban flooding (KCM, 1986). Due to increased urbanization within the basin, the tributary's ability to provide salmon habitat and spawning grounds has been reduced.

Project goals
The proposed project will eliminate present fish barriers and improve approximately 2000 feet of Gilliam Creek to provide for enhanced winter hearing and spawning salmonid habitat while maintaining the current level of flood protection to the regional area.
Project construction should be limited to the areas immediately surrounding Gilliam Creek and its confluence with the Green River while minimizing the impact to existing vegetation. Temporary erosion and sedimentation control measures should be integrated to prevent the transport of sediment into the Green River. Excavated material should be removed from the site. Gilliam Creek should be landscaped to include large woody debris (LWD), riparian vegetation, and stream gravel.

The entrance to Gilliam Creek must provide passage at all tide stages, meet Washington Department of Fish and Wildlife (WDFW) criteria, and should target salmonid requirements.

The primary concern is to maintain the current level of flood protection while providing for project goals. The intent of the project is to provide for fish passage during low flow conditions up to about 6000 cfs, which is well above the expected average winter flows. Fish passage above these flows would not to be provided.

This project must comply with King County's drainage manual to insure that current regulations pertaining to flooding and sediment issues are addressed. To ensure that current flood conditions are not exacerbated, enhanced channel conditions will need to be modeled. Advanced engineering design efforts will also need to address flood impacts presented by this project.

Proposed Solutions

Three sections of alternatives are proposed. Each section coincides with the purposes of the project: removal of fish barriers, habitat enhancement, and spawning grounds enhancement.

Removal of Fish Barriers:

- Alternative 1: No Action. No modifications to the existing flap-gated culvert. Fish passage and access to Gilliam Creek would remain unchanged.
- Alternative 2: Fish Ladder. Modify the existing entrance with a self-regulating tidegate (SRT) and the existing apron to provide a fish ladder.
- Alternative 3: Sub-channel. Add a sub-channel within the existing culvert and fit with a gate to provide protection from high flows.
- Alternative 4: New Culvert. Install a new culvert positioned to be accessible during low flow conditions whose entrance is controlled by a SRT.

Habitat Enhancement:

- Alternative 1: No Action. No modifications to the existing stream conditions. Habitat conditions would remain unchanged.
- Alternative 2: Increase Creek Diversity. Field place LWD and riparian vegetation to increase creek diversity.
- Alternative 3: Widen Creek. Increase the existing channel by pushing the north bank (I-405) to the I-405 Right-of-way. Field place LWD and riparian vegetation. Increase creek sinuosity if settling velocities permit. Provide additional flood storage.

Spawning Grounds Enhancement:

- Alternative 1: No Action. No modification to the existing stream spawning conditions. Conditions would remain unchanged.
- Alternative 2: Enhance the current conditions by the addition of gravel in selected location.

Recommended Plan

Removal of Fish Barriers:

Alternative 2 is the recommended alternative. Alternative 1, the No Action alternative, does not meet the purpose of the project and is not a viable option for this site. Alternatives 2, 3, and 4 meet the project purpose. Alternative 2, the fish ladder alternative calls for modifying the existing entrance with a SRT and the existing apron to provide a fish ladder. Additional budget concerns might include operation and maintenance costs. Alternative 3 requires construction of a sub-channel under the existing culvert. The complexity of construction eliminates this alternative. Alternative 4, the installation of a new culvert with a SRT would provide access at low flow conditions while maintaining the current level of flood protection to the local area. However, this alternative would prove expensive and possibly compromise flood protection during construction.

Habitat Enhancement:
Alternative 3 is the recommended alternative. Alternative 1, the No Action alternative does not meet the purpose of the project and is not a viable option for this site. Alternative 2 and 3 meet the project purpose, however Alternative 2 only increases the existing creek diversity and misses the opportunity to maximize habitat enhancement.

Spawning Grounds Enhancement:
Alternative 2 is the recommended alternative. Alternative 1, the No Action alternative does not meet the purpose of the project and is not a viable option for this site.

In summary, it is recommended that the existing flapgate be modified with a SRT and a fish ladder be installed (Removal of Fish Barriers: Alternative 2). Habitat enhancement should include widening the creek and provide for LWD and riparian vegetation (Habitat Enhancement: Alternative 3). The addition of gravel pads is recommended to improve spawning grounds (Spawning Grounds Enhancement: Alternative 2).

Water surface elevations and flows at this location will be needed for the 2, 25, 50 and 100-year events to insure fish passage and further design efforts. The effects of tidal fluctuations should also be considered.

The addition of a fish access will allow for fish passage low flow condition to Gilliam Creek. The existing flapgate will be replaced with a SRT. The proposed SRT is a float-actuated water control valve. The SRT will remain open during most flow conditions. Upon a preset flow elevation of the Green River, the SRT will close to ensure the existing level of flood protection is maintained. The SRT will reopen once the high flows have receded allowing fish access again. It will be necessary to address low flow, peak flood flow, and the maximum water velocities to properly set the SRT.

Access to the modified culvert will be provided by a fish ladder. Conceptual plans for the fishway require a minimum pool size of 6 foot (L) by 4 foot (W) per 1 foot drop. The fishway will have a turn pool so that the entrance to the fishway is downstream to avoid intruding into the Green River. Initial fishway drawings have been included. It will be necessary to assess hydraulic conditions for fishway design and the ability of the fish to bypass the SRT during low flow conditions.

The enhancement to the channel is estimated to be 2000 feet in length. Assuming the proposed channel will be trapezoidal in shape, have 3H:1V side slopes, and a 8-ft bottom width, a Manning's coefficient (n) of 0.045, the channel will be able to convey approximately 300 cfs at a depth of approximately 5 feet and provide for increased storage. The sinuosity of the lower section of the stream channel could be increased and held by rock anchors depending on stream velocities. Depending on available space, stream banks could be terraced to provide for depth during low flow conditions. For erosion and sedimentation control a coir fabric can be used until the bank is stabilized by vegetation. The use of root wads to provide further stability and habitat benefits should be field placed in the new channel at the toe of the slope every two stream widths on average at offsetting sides. Additional habitat enhancement consists of riparian vegetation to provide to instream structure and cover, and the enhancement of a small pond located near the western end of the project. The non-channel planting zone should extend from the channel edges through the construction areas. The Gilliam Plan, Profile, and Typical Section drawings reference woody debris and riparian plantings. It will be necessary to model basin hydrology and tributary hydraulics in advanced engineering design efforts.

Spawning gravel should be added to areas determined to be best suited to the needs of the salmonid. Pool bottoms should be lined with gravel. Successful creation of spawning grounds will depend somewhat on efforts to minimize sedimentation within the pools. Increased sedimentation concerns may be a long-term operation and maintenance consideration. Advanced engineering and design efforts to model the hydrology and hydraulics of the basin should address these issues.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. Quantities were calculated based on the information obtained during HDR's site visit and from topographical mapping provided by the Corps. Given the extent of the survey, hydrologic, and hydraulic information, at this time, a 15 percent contingency has been applied to the quantities. An additional 25 percent cost contingency will be added when the USACE prepares the cost estimate unless otherwise specified.

Conclusions and Recommendations

The Gilliam Creek project can meet the project purpose with the recommended tributary and habitat improvements. The following items should be considered in the advanced engineering and design phase:

1. A detailed field survey to identify local topography, culvert elevations, and ditch details.
2. A detailed hydrologic and hydraulic including a sediment analysis of the basin is recommended.
3. Criteria and design of fishway passage.

4. Sediment transport analysis from the upper basin to develop final designs that minimize deposition along spawning grounds in the lower basin.
5. Determine operation and maintenance costs associated with the fish ladder.
6. A h&h analysis of the Green River in the vicinity of the proposed fish ladder needs to be done to determine its effect on the River and its integrity under high flow and high sediment conditions.

Figures

Gilliam Creek Plan, Profile, and Typical Section
Self Regulating Tidegate Details
Fishway Details
1-Stage Channel Riverine Planting Scheme Detail
1-Stage Woody Debris Drawing

References

KCM, Inc., Gilliam Creek Basin Drainage Study, report to City of Tukwila, Public Works Department, June, 1986

Perteet Engineering, Inc., Design Memorandum for Gilliam Creek Detention and Water Quality Enhancements, report to the City of Tukwila, Department of Public Works, October, 1994

SITE NO. 7

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: **Lower Springbrook Reach**

Location

- The Springbrook Creek water supply watershed is located east of SR 167 and south of the City of Renton. The Creek flows north and west across SR 167 to the Black River Pump Station. Portions of Springbrook Creek are located within the City of Renton including the Lower Springbrook Site. This reach of Springbrook extends from SR 167 to upstream of the Black River Pump Station forebay. A portion of Upper Springbrook Creek is included in the reach because of its similar habitat. The City of Renton is planning channel modifications within this reach between SW 34th Street and SW 40th Street and between SW 16th Street and SW 23rd Street. These modifications have been incorporated in this report. Refer to Springbrook Creek location map, Figure No. 2.

Site Constraints/Problems

Based on discussion in the field, the Corps identified appropriate locations for minimum disturbance channels. Such channeling was defined as one-stage and is to have minimal impacts on the surrounding habitat. Otherwise, two-stage channeling was designated where re-channeling was specified. In either case, the proposed channel has a higher cross sectional area than that of the existing channel to help prevent a decrease in the channel's hydraulic capacity.

- Site constraints are described as follows in the City of Renton East Side Green River Watershed Project, Plan and Environmental Impact Statement, Volume I, September, 1997 (Renton ESGRWP) The site is lacking in riparian vegetation, and native canary grass and black berry shrubs leave the stream surface open to solar insulation. The existing canopy also provides access for fish-eating birds. There is essentially no instream habitat such as woody debris. Further, certain reaches of the stream would benefit from two-stage channeling.

Project Goals

- The goal at the Lower Springbrook reach is to create a natural habitat for rearing and storm refuge. Habitat improvements would include plantings in the riparian corridor and placement of large woody debris in the creek. Further, certain reaches of the stream would benefit from two-stage channeling. The City and the Natural Resource Conservation Service (NRCS) are implementing a project to increase the capacity of lower Springbrook Creek. The goal of this project will be to incorporate fish and wildlife habitat features into the City-NRCS project during and after construction. This will require continued coordination to ensure a good multi-purpose project.

Proposed Solutions

- Alternative No. 1 - No Action: No modifications to the existing stream conditions. Habitat conditions would remain marginal.
- Alternative No. 2 – Implement the following restoration activities:
  - Place LWD and plantings in a two-stage re-channeled reach between SW 16th Street and SW 23rd Street with minimal disturbance of the low flow channel. Place LWD and plantings in a single-stage re-channel on the west side of the reach between SW 34th Street and SW 40th Street with no disturbance of the low flow channel.
  - A 30-foot buffer will be planted and LWD placed between SW 23rd Street and SW27th Street.
  - Placement of large woody debris would introduce stream shade and structure. Small woody debris should also be placed in dendrites.
  - ~~Construction of dendrites would provide additional habitat. Dendrites should be~~ about 4 feet wide at the main channel and meander along the natural slope, narrowing gradually and ending at ground elevation. Dendrites should be created about every 1/4-mile along the main channel.
  - Hummocks can be formed with cut material from dendrite construction and re-channeling.

Recommended Plan

The no action alternative will not achieve the project goals and is not a viable option for this site. Alternative No. 2 is recommended to accomplish the project goals.

The conceptual design for the recommended plan is depicted in the Lower Springbrook Reach Site Plan, See the attached Figure

The two-stage channel configuration with riparian planting scheme can be found in the 2-Stage Channel Detail, Figure No. 13. Channel design dimensions were taken from the Renton ESGRWP. Plantings include a combination of shrubs, coniferous and deciduous trees to be planted in natural random clusters. Water fluctuation zone plants will further reduce water temperatures, increase dissolved oxygen levels, and bind the soil. Pacific willow and red alder, are to be staked in the water fluctuation zone along channel side slopes at a maximum ninety-degree angle. Quantity calculations for all 3 plant types in the water fluctuation zone (2 staking plants and slough sedge) were based upon a 3 row zone with one row of each type with plants 2-feet center to center and rows 1 to 2 feet apart and staggered. Each row, however, should be a random mix of the plant types. Refer to One Stage Channel Detail, Figure No. 12, for riparian plantings scheme along one-stage reaches.

Approximately 1300 feet of the riparian planting work would be on City owned lands and between SW 27th Street and SW 30th Street. The remaining 3200 feet of riparian plantings would be on private property and requiring the permission of the property owner. Any instream habitat improvement would require the permission of the KC drainage district no 1, which owns a 40-foot width of ROW along the creek.

A Woody Debris Pool Detail, Figure No. 14, depicts a typical pool with rootwads keyed into the channel side slopes. Pools bottoms, where possible, should be lined with gravel. Excavating moderate pools for placement of wood will prevent it from decreasing the hydraulic capacity of the channel. At the outlet of each pool, an 18- to 24-inch cedar log should be placed along the channel bottom and buried in the banks. The log will prevent down cutting at the constriction.

For construction quantity purposes, a woody debris pool with two pieces of debris was placed about every 50 feet. This is consistent with the placement of one piece of large woody debris every two stream widths for streams of about 12.5 feet wide.

Dendrites serve as storm refuge and offer additional habitat. Construction of hummocks reduces the amount of excavated material to be hauled off-site and provides varied riparian topography. Refer to the Dendrite and Hummock Detail, Figure No. 15, for typical cross sections.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable and are left blank. Quantities were calculated based on the information obtained HDR's site visit and from mapping. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied.

Conclusions and Recommendations

The Lower Springbrook Reach can be cost-effectively restored via the above proposed habitat improvements. As part of the final design, we recommend that a detailed site survey, geotechnical investigation, and hydrologic/hydraulic and sediment transport analyses be conducted. Also an analysis of local scour on LWD will be done.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: **Upper Springbrook Reach**

Location

- The upstream boundary of the Upper Springbrook Reach begins where the creek crosses from the south to the north side of S. 55th Street. The Reach continues west along the north side of S. 55th Street until it reaches the SR 167 east R-O-W. Refer to Springbrook Creek location map, Figure No. 2.

Site Constraints/Problems
Corps personnel to add environmental site constraints.

- The site is lacking in riparian vegetation, and native canary grass and black berry shrubs leave the stream unshaded. The existing canopy also provides access for fish-eating birds. There is essentially no instream habitat such as woody debris. Further, certain reaches of the stream would benefit from two-stage channeling.

- Sediment from upstream runoff originating in the City of Renton's jurisdiction causes a channel maintenance problem and plugs the Washington Department of Transportation culvert under 405.

Project Goals

- The goal at the Upper Springbrook reach is to create a natural habitat for spawning, rearing, and storm refuge. Restoration along Upper Springbrook will include adding channel spawning gravel, large woody debris, and riparian plantings.

- An effective means of sediment removal with minimal disturbance to the creek is also a project goal.

- Provide fish passage under South 55 Street.

Proposed Solutions

- Alternative No. 1 - No Action: No modifications to the existing stream conditions. Habitat conditions would remain marginal.
- Alternative No. 2 – Implement the following restoration activities:
  - Minimal stream disturbance conveyance is recommended; gently meander and maintain one stage stream configuration. The stream should be shifted to the north away from the street to accommodate meandering.
  - Spawning gravel placement is recommended.

- A sediment trap at the north end with an access road to one side for maintenance and numerous plantings on the other side is suggested.
- Placement of large woody debris will introduce stream shade and structure. About 5 such pools are recommended. A 100-foot corridor of riparian vegetation along the existing and proposed channels is recommended. Any reedcanary grass, blackberry, purple loose stribe, and other harmful weeds should be removed prior to planting.
- Hummocks can be formed with cut material from dendrite construction and re-channeling.
- Provide a fish frendly culvert under South 55th Street

Recommended Plan
The no action alternative will not achieve the project goals and is not a viable option for this site. Alternative No. 2 is recommended to accomplish the project goals.

The conceptual design for the recommended plan is depicted in the attached Upper Springbrook Reach Site Plan, Figure No. 10.

The proposed channel has a larger cross sectional area than that of the existing channel to offset any decrease in the channel hydraulic capacity.

One-stage channel configuration with riparian planting scheme can be found in the 1-Stage Channel Detail, Figure No. 12. Plantings include a combination of shrubs, coniferous and deciduous trees to be planted in natural random clusters. Water fluctuation zone plants will further reduce water temperatures, increase dissolved oxygen levels, and bind the soil. Pacific Willow and Alder, are to be staked in the water fluctuation zone along channel side slopes at a maximum ninety-degree angle. Quantity calculations for all 3 plant types in the water fluctuation zone (2 staking plants and slough sedge) were based upon a 3 row zone with one row of each type with plants 2-feet center to center and rows 1 to 2 feet apart and staggered. Each row, however, should be a random mix of the plant types.

A sediment trap, depicted in the Upper Springbrook Reach Drawing, is installed to provide easy access for operation and maintenance purposes. The design includes an access road to allow city staff to excavate and remove sediment with minimal disturbance to the downstream reach. The design also includes a bypass feature so that work can be conducted outside of the stream flow, minimizing water quality concerns and avoiding permitting issues. Detailed siting analysis for the proposed sediment trap will be performed prior to construction. Remove the existing sediment trap at SR 167 as it now is a fish blockage.

A Woody Debris Pool Detail, Figure No. 14, depicts a typical pool with rootwads keyed into the channel side slopes. Excavating moderate pools for placement of wood will prevent it from decreasing the hydraulic capacity of the channel. At the outlet of each pool, an 18- to 24-inch cedar log should be placed along the channel bottom and buried in the banks. The log will prevent down cutting at the constriction.

For construction quantity purposes, a woody debris pool with two pieces of debris was placed about every 50 feet. This is consistent with the placement of one piece of large woody debris every two stream widths for streams of about 12.5 feet wide. Gravel should be placed at tailouts and riffles to facilitate spawning.

Construction of a fish friendly Culvert under South 55th Street.

Cost Items and Quantities
Construction line items and quantities are listed in the MCASES construction cost estimate section in this appendix. Quantities were calculated based on the information obtained during HDR's site visit and from mapping. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied.

Cost Items and Quantities
Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.

Conclusions and Recommendations
The Upper Springbrook Reach can be cost-effectively restored via the above proposed habitat improvements. As part of Advanced Engineering and Design, we recommend that a detailed site survey and hydrologic/hydraulic analyses be conducted. A sediment transport analyses will be required for siting and sizing the proposed sediment basin. Also an h&h analysis will include local scour analysis of the proposed LWD and log grade controls to assess stability under a range of flow conditions.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Mill Creek East

Location
Mill Creek projects encompass four sites that have been recommended by the City of Kent. The project sites are located in the City and are named Memorial Park, State Route (SR) 167, 76th Avenue South and South 212th sites. The Memorial Park site is located north of James Street and west of Jason Avenue/88th Avenue South. The SR 167 site is adjacent to SR 167, west of East Valley Highway/84th Avenue, south and north of Novac Lane. The 76th Avenue South site is located between 76th Avenue South and 72nd Avenue South. The South 212th site is located north of South 212th Street and west of 77th Avenue South.

Site Constraints/Problems
Residential development in the upper reaches and industrial development in the lower Green River floodplain have heavily impacted Mill Creek. Impacts include relocation, channelization, increased flows, and sedimentation resulting from urban development in the headwaters. In places, it is squeezed between buildings, and alongside road fills and state highways. At most of the project locations, the creek reach has the appearance of a typical roadside ditch. The resulting channel has limited floodplain storage and limited shade and canopy trees in the buffer. The channel is narrow and lacks habitat complexity and floodplain connectivity.

Project Goals
The primary goal of this project is to restore and enhance salmonid habitat within Mill Creek using natural habitat elements and ecosystem-based processes. This would be accomplished by restoring a more natural stream channel that provides riparian functions for fish habitat in low-flow and high-flow regimes, re-establishing reliable fish access to upper reaches of the creek, and rehabilitating the existing channel to provide productive rearing and refuge habitat for salmonid species. In addition, a more sinuous stream alignment, side channels, high-flow benches, riparian planting, large woody debris (LWD), and constructed pool and riffle sections will be integrated to achieve the project goals.

Proposed Solutions
For the Mill Creek project, three alternatives were considered:

- Alternative No. 1 – No action: No modifications to the existing stream conditions. In-stream habitat would remain poor and isolated. This alternative would not achieve the goal(s) of restoring natural processes or rehabilitating the stream.

- Alternative No. 2 – Restore and enhance the existing channel by implementing the following restoration activities at the proposed locations:

  - Create a more sinuous stream alignment and improve fish access and passage to the system.

  - Utilize plantings to achieve a riparian canopy, habitat complexity, temperature moderation, nutrient input, and insect recruitment.

  - Remove accumulated sediments and install suitable-sized substrate.

  - Add LWD to increase habitat complexity and provide in-stream cover for juveniles.

  - Where feasible, purchase a 50-foot buffer/easement on each side of the stream and remove invasive plants and replant native trees and shrubs.

In general, the proposed restoration sites were selected based mainly on the degree of resource impairment, the potential for improvement, and the potential success of restoration. Stream reaches that have already been restored and/or are estimated to have existing good habitat were excluded from the site-selection process.

- Alternative No. 3, other sites considered by the City.

  - Daylighting of a 175-foot-long section of Mill Creek passing under the Bowen Scarff car dealership has been investigated.

  - Rehabilitation of Mill Creek through the Western Processing Superfund site was investigated.

Recommended Plan
Alternative No. 1, no action, was rejected because it does not accomplish the goal of habitat restoration using a process-based approach.

Alternative No. 2, enhancement of the existing stream channel, was selected because it provides an opportunity to restore valuable in-stream and off-channel habitat, re-introduces large components of the natural stream processes, and improves fish access and utilization of Mill Creek.

As described above, this alternative will also revegetate available buffer areas and increase habitat quality and complexity, add LWD, remove accumulated sediments, and replenish streambed gravel.

Based on the conditions within the basin as a whole, it is recommended that the restoration focus on the proposed locations where the potential for the most effective enhancement can be performed.

Alternative No. 3 – Other sites considered by the City but rejected include.

- Bowen Scarff car dealership site. The alternative was not pursued due to limited land availability for a new creek location and the cost for a sufficient easement.

- Western Processing Superfund site. It was decided that an ecosystem restoration project would be very complicated due to existing cleanup orders, legal issues, presence of contaminants, and inherent environmental constraints.

Many stream reaches in need of restoration were excluded due to the potential project cost and complexity. Additionally, the achieved benefits would not be as great as the proposed locations. Similarly, in some cases, existing development simply precludes effective habitat restoration. Examples of this include existing roads and buildings near streams and existing underground utilities.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.

Conclusions and Recommendations

Proceed with detailed planning and design to enhance the stream channel, as described in Alternative No. 2, and monitor the results. Design efforts should include hydrologic and hydraulic modeling to ensure that the addition of LWD does not exacerbate flooding. The long-term benefits, which are envisioned, are dependent upon effective stormwater and land-use controls implemented in the upper basin. Without adequate controls, it is likely that erosion, sediment deposition, and high temperatures will continue to degrade the habitat in the lower reach.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Garrison Creek

Location

The Garrison Creek project encompasses four project sites that have been recommended by the City of Kent. The project sites are located in the City and are named the South 218th wetland site, Southeast 216th Street slide stabilization/drainage control site, Middle Fork sediment removal/channel restoration site, and 167th culvert replacement site. The South 218th wetland site is located north and south of South 218th Street in the adjoining wetlands and forested wetlands. The Southeast 216th Street slide stabilization project site is located south of Southeast 216th Street and east of 100th Avenue Southeast. The Middle Fork sediment removal/channel restoration site is located in an area delineated by Southeast 216th Street on the north side, South 222nd Street on the south side, 94th Avenue South on the west side, and 100th Avenue Southeast on the east side, if extended. The State Route (SR) 167 site is adjacent to SR 167, under the northbound off-ramp to South 212th Street.

Site Constraints/Problems

Garrison Creek has been heavily impacted by a landslide located south of Southeast 216th Street and east of 100th Avenue Southeast, as well as by increased flows and sedimentation resulting from urban development. The landslide is contributing large amounts of sediment to the wetlands and has caused die-outs in the forested wetland complexes located downstream of South 218th Street. Additionally, a long reach of the Middle Fork of Garrison Creek, between the slide and the confluence, is silted with sediment and has lost habitat complexity for much of the project length. The creek has the appearance of a typical depositional reach full of fines not suitable for salmonid habitat. The channel has limited conveyance capacity, limited pool habitat, a shallow channel cross section, and little cover for fish. The low-flow channel has been filled with sediment, and there is very limited high-flow refuge/bench habitat.

Project Goals

The primary goal of this project is to restore and enhance salmonid habitat within Garrison Creek using natural habitat elements and ecosystem-based processes. This would be accomplished by restoring a more natural stream channel that provides riparian functions for fish habitat in low-flow and high-flow regimes, re-establishing reliable fish access to upper reaches of the Middle Fork, and rehabilitating the existing channel to provide productive rearing and refuge habitat for salmonid species. In addition, removal of sediment and re-establishment of a low-flow channel, more sinuous stream alignment, construction of side channels, high-flow benches, riparian habitat planting, large woody debris (LWD) placement, and construction of pool and riffle sections will be utilized to achieve the above-mentioned goals.

Proposed Solutions
For the Garrison Creek project, three alternatives have been considered:

- Alternative No. 1 – No action: No modifications to the existing stream conditions. In-stream habitat would remain poor and isolated. The sediment would remain in the channel, impeding fish access.

- Alternative No. 2 – Restore and enhance Garrison Creek by implementing the following restoration activities:

  - Create a more sinuous stream alignment and improve fish access to the system.

  - Use plantings to achieve a riparian tree canopy for habitat complexity, temperature control, nutrient source, and insect recruitment.

  - Remove accumulated sediments and install suitable gravel substrate.

  - Add LWD to increase habitat complexity and provide cover for juvenile salmonids.

  - Remove invasive plants such as Himalayan blackberry and replant with native trees and shrubs along the remaining buffer.

  - Stabilize the slide to reduce sediment loads to the Middle Fork of Garrison Creek.

- Alternative No. 3 – Additional sites considered by the City:

  - Restore and enhance the existing channel north of the SR 167/212th intersection, where lower Garrison goes north in a straight channel directly west of SR 167 and then takes two 90-degree turns before entering Springbrook Creek as a straight channel.

  - Restore and enhance the existing channel at the valley tributary to lower Garrison Creek that is heavily impacted by development.

Recommended Plan
Alternative No. 1, no action, was rejected because it does not accomplish the goal of habitat restoration.

Alternative No. 2, enhancement of the existing stream channel, was selected because it provides an opportunity to restore valuable in-stream and off-channel habitat as well as improve fish access and use of Garrison Creek.
As described above, this alternative will stabilize the slide, revegetate available buffer areas, increase habitat quality and complexity by adding LWD, removing accumulated sediment, creating pools and riffles, and adding streambed gravel in reaches where

needed. One possibility for stabilizing the slide might be to collect the runoff in a pipe and carry it to Garrison Creek. This is shown on Plan Sheet 7.

Based on the conditions within the basin as a whole, it is recommended that the restoration focus on the existing stream channel where the potential for the most effective restoration/enhancement can be performed.

Alternative No. 3, additional sites considered by the City but rejected.

Channel north of the SR 167/212th intersection. Lack of available land to work with would severely impact any proposed project here. This area could receive LWD and riparian planting, but placement in the creek meander would be difficult.

Valley tributary to lower Garrison Creek. The entire reach was not selected for any projects at this time mainly due to existing development adjacent to the creek. Without property acquisition/easement, significant improvements are unlikely for this 25-foot, buffer-rated stream. It is thought to be a good candidate for volunteer planting activities to control summer temperatures for water flowing into the main Garrison tributary.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.

Conclusions and Recommendations

Proceed with detailed planning and design to enhance the existing stream channel, as described in Alternative No. 2, and monitor the results with the possibility of creating additional project sites in the future. One of the concerns with this project is that the effective, long-term value of the restored lower reach is dependent upon effective sediment and stormwater controls implemented in the upper basin. Without the recommended Southeast 216th Street slide stabilization, it is likely that sediment deposition will continue to degrade the habitat in the lower reach. Options for stabilizing the slide should be further evaluated in the next phase of this project. The City of Kent should also continue to investigate ways to reduce flood flows in Garrison Creek. A complete h&h and sediment yield and transport analysis should be accomplished prior to project construction.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Prentice Nursery Reach

Location
The Prentice Nursery Site begins at the Green River and extends upstream approximately 500 feet to include the Nursery. Highway 516 crosses Mullen Slough within the site. Refer to Mill Creek and Mullen Slough Site location map, Figure No. 1.

- Site Constraints/Problems
  A steep channel slope prevents passage of juveniles for summer rearing during low flow.

Project Goals
The goal at the Prentice Nursery Site is to create a natural habitat for rearing and storm refuge.

Proposed Solutions
- Alternative No. 1 - No Action: No modifications to the existing stream conditions. Habitat conditions would remain marginal.
- Alternative No. 2 – Implement the following restoration activities:
- Clear channel of previously dumped garbage and junk. Remove blackberry plants.
- **Cut** channel from its confluence with the Green River upstream about 500 feet to create a 2% slope and place grade structures on the upstream end of this channel and in it to control the slope. Do not undercut the Highway 516 bridge pilings.
- Minimal stream disturbance is recommended; gently meander and maintain one stage stream configuration.
- Placement of large woody debris would introduce stream shade and structure. Small woody debris should also be placed in dendrites.
- Construction of dendrites would provide additional habitat. Dendrites should be about 4 feet wide at the main channel and meander along the natural slope, narrowing gradually and ending at ground elevation. Two dendrites should be created along the main channel.
- Hummocks can be formed with cut material from dendrite construction and re-channeling.
- Fill in riparian corridor with plantings where necessary.

Recommended Plan
The no action alternative will not achieve the project goals and is not a viable option for this site. Alternative No. 2 is recommended to accomplish the project goals.

The conceptual design for the recommended plan is depicted in the attached Prentice Nursery Reach Site Plan.

The proposed channel has a larger cross sectional area than that of the existing channel to offset any decrease in the channel hydraulic capacity caused by the addition of LWD and riparian plantings.

Clear channel of debris and blackberry bramble. There is a summer blockage in the lower 500 feet of the channel. Re-slope channel from its confluence with the Green River upstream about 500 feet to create a 2% slope. Do not undercut the Highway 516 bridge pilings.

One-stage channel configuration with riparian planting scheme can be found in the 1-Stage Channel Detail, Figure No. 12. Plantings include a combination of shrubs, coniferous and deciduous trees to be planted in natural random clusters to augment the existing riparian cover in this area. Water fluctuation zone plants will further reduce water temperatures, increase dissolved oxygen levels, and bind the soil. Pacific and Red Alder, are to be staked in the water fluctuation zone along channel side slopes at a maximum ninety-degree angle. Quantity calculations for all 3 plant types in the water fluctuation zone (2 staking plants and slough sedge) were based upon a 3 row zone with one row of each type with plants 2-feet center to center and rows 1 to 2 feet apart and staggered. Each row, however, should be a random mix of the plant types. Upland planting should be implemented only where vegetation is lacking.

A Woody Debris Pool Detail, Figure No. 14, depicts a typical pool with rootwads keyed into the channel side slopes. Excavating moderate pools for placement of wood will offset any decrease in the hydraulic capacity of the channel.

For construction quantity estimating purposes, a woody debris pool with two pieces of debris was placed about every 50 feet. This is consistent with the placement of one piece of large woody debris every two stream widths for streams of about 12.5 feet wide. Care needs to be taken to not disturb the existing riparian corridor cover.

Dendrites serve as storm refuge and offer additional habitat. Construction of hummocks reduces the amount of excavated material to be hauled off-site and provides varied riparian topography. Refer to the Dendrite and Hummock Detail, Figure No. 15, for typical cross sections

Cost Items and Quantities

Construction line items and quantities shown in the MCACES portion of the attached engineering appendix.

The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable and are left blank. Quantities were calculated based on the information obtained HDR's site visit and from mapping. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied.

Conclusions and Recommendations

The Prentice Nursery Reach can be cost-effectively restored via the above proposed habitat improvements. As part of the final design, we recommend that a detailed site survey, geotechnical investigation, and existing and proposed condition hydrologic/hydraulic and sediment analyses be conducted.

SITE NO. 12

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: **Mullen Slough** (Former Site 2)

Location

- Mullen Slough originates at S. 277th Street and flows north into the Green River. It is located west of Mill Creek and SR 167. The Mullen Slough reach extends from the north border of the Prentice Nursery to S. 277th Street. Refer to Mill Creek and Mullen Slough Site location map, Figure No. 1.

Site Constraints/Problems

- Garbage and junk, a blackberry canopy, and unplanted reaches within the site are the main detriments to fish habitat at the Mullen Slough Site. A lack of pools and channel structure hinder the Mullen Slough Reach from functioning effectively as rearing habitat and as storm refuge. The channel just north of S. 277th Street has been straightened and is unshaded.

Project Goals

- The goal at the Mullen Slough Site is to create a natural habitat for rearing and storm refuge. Restoration along Mullen Slough will include channel meandering, large woody debris placement, and riparian plantings.

- Proposed Solutions
  - Alternative No. 1 - No Action: No modifications to the existing stream conditions. Habitat conditions would remain marginal.
  - Alternative No. 2 – Implement the following restoration activities:
  - Minimal stream disturbance conveyance improvement is recommended; gently meander from S. 277th Street to the beginning of the tree canopy and maintain a one stage stream configuration.
  - Placement of large woody debris will introduce stream shade and structure. Riparian plantings are needed from S. 277th Street to the beginning of the tree canopy. For the remainder of the project it is estimated that about 20% of the channel and surroundings are lacking in vegetation. Create a 100-foot buffer on each side of the channel. Any reedcanary grass, blackberry, purple loose stribe, and other harmful weeds should be removed prior to planting.

Recommended Plan

The no action alternative will not achieve the project goals and is not a viable option for this site. Alternative No. 2 is recommended to accomplish the project goals.

The conceptual design for the recommended plan is depicted in the attached Mullen Slough Reach Site Plan, Figure No. 4. Located at the north end of this reach is a large pool and beaver dam that needs to be reconfigured to allow fish passage and habitat. This needed work will be investigated further during Advanced Engineering & Design.

The proposed channel has a greater cross sectional area than that of the existing channel to offset any decrease in the channel hydraulic capacity.

One-stage channel configuration with riparian planting scheme can be found in the 1-Stage Channel Detail, Figure No. 12. Plantings include a combination of shrubs, coniferous and deciduous trees to be planted in natural random clusters. Water fluctuation zone plants will further reduce water temperatures, increase dissolved oxygen levels, and bind the soil. Pacific Willow and Red Alder, are to be staked in the water fluctuation zone along channel side slopes at a maximum ninety degree angle. Quantity calculations for all 3 plant types in the water fluctuation zone (2 staking plants and slough sedge) were based upon a 3 row zone with one row of each type with plants 2-feet center to center and rows 1 to 2 feet apart and staggered. Each row, however, should be a random mix of the plant types.

A Woody Debris Pool Detail, Figure No. 14, depicts a typical pool with rootwads keyed into the channel side slopes. Excavating moderate pools for placement of wood will prevent it from decreasing the hydraulic capacity of the channel. At the outlet of each pool, a 18- to 24-inch cedar log should be placed along the channel bottom and buried in the banks. The log will prevent downcutting at the constriction. Gravel should be placed in the pool and riffle areas.

For construction quantities purposes, a woody debris pool with two pieces of debris was placed about every 50 feet. This is consistent with the placement of one piece of large woody debris every two stream widths for streams of about 12.5 feet wide.

It should be noted that there are direct access roads on either side of the Slough by the Highway 516 bridge.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.

The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable and are left blank. Quantities were calculated based on the information obtained HDR's site visit and from mapping. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied.

Conclusions and Recommendations

The Mullen Slough Reach can be cost-effectively restored via the above proposed habitat improvements. As part of Advanced Engineering & Design, we recommend that a detailed site survey , hydrologic/hydraulic and sediment analyses be conducted. Also the

h&h analysis will consider the scour and hydraulic effects of placement of LWD in the stream channel.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: **Schuler Brothers Reach (Former Sites 3 and 4)**

Location
The upstream boundary of the Schuler Brothers Reach begins where Mill Creek crosses from east to the west side of SR 167. It meanders north through the Schuler Brothers' property and crosses S. 277th Street.

North of S. 277th Street, Mill Creek crosses from the east to the west side of the West Valley Highway, meanders north, and crosses back over the West Valley Highway. This final crossing is the downstream boundary of the Schuler Brothers Reach. S. 277th Street divides the reach into two sub-reaches along which distinct habitat improvements are proposed. Refer to Mill Creek and Mullen Slough Site location map, Figure No. 1.

Site Constraints/Problems
High temperatures, poor water quality, and low dissolved oxygen levels have been a detriment to the survival and rearing of fish in Mill Creek and have probably caused the death of fry spawned in Peasley Canyon.

Within the Schuler Brothers Reach, Mill Creek widens to an unshaded pond just before crossing S. 277th Street. A straight shallow stream channel and lack of riparian plantings hinder the portion of the Schuler Brothers Reach south of S. 277th Street from functioning effectively as rearing habitat and storm refuge. North of S. 277th, a shallow stream channel and a lack of riparian plantings are limitations.

Project Goals
The goal at the Schuler Brothers Reach is to create a natural habitat for rearing and storm refuge while increasing the reach's high flow hydraulic capacity.

Habitat improvements would include channelization, plantings in the riparian corridor, and the construction of new dendrites.

Proposed Solutions
- Alternative No. 1 - No Action: No modifications to the existing stream conditions. Habitat conditions would remain marginal.
- Alternative No. 2 – Implement the following restoration activities:
  - Just south of S. 277th Street, a two stage re-channeling is recommended in which a meandering narrow segment would bypass the existing pond.

- For the remainder of the Reach create a two-stage channel to provide additional conveyance during high flows. Existing main channel meandering does not need to be improved.
- Riparian vegetation alongside the existing and proposed channels is needed. Any reedcanary grass, blackberry, purple loose stribe, and other harmful weeds should be removed prior to planting.
- Placement of large woody debris will introduce stream shade and structure, and piercing the water table will introduce ground water.
- Along the entire Schuler Brothers Reach, construction of dendrites would provide additional habitat. Dendrites should be about 4 feet wide at the main channel and meander along the natural slope, narrowing gradually and ending at ground elevation. Dendrites should be created about every 1/4-mile along the main channel.
- Hummocks can be formed with cut material from dendrite construction and re-channeling.

Recommended Plan

The no action alternative will not achieve the project goals and is not a viable option for this site. Alternative No. 2 is recommended to accomplish the project goals.

The conceptual design for the recommended plan is depicted in the attached Schuler Brothers Reach Site Plan, Figure No. 6.

The proposed channel has a greater cross sectional area than that of the existing channel to offset any decrease in the channel hydraulic capacity.

The two-stage channel configuration with riparian planting scheme can be found in the 2-Stage Channel Detail, Figure No. 13. Plantings include a combination of shrubs, coniferous and deciduous trees to be planted in natural random clusters. Water fluctuation zone plants will further reduce water temperatures, increase dissolved oxygen levels, and bind the soil. Pacific Willow and Red Alder, are to be staked in the water fluctuation zone along channel side slopes at a maximum ninety-degree angle. Quantity calculations for all 3 plant types in the water fluctuation zone (2 staking plants and slough sedge) were based upon a 3 row zone with one row of each type with plants 2-feet center to center and rows 1 to 2 feet apart and staggered. Each row, however, should be a random mix of the plant types.

A Woody Debris Pool Detail, Figure No. 14, depicts a typical pool with rootwads keyed into the channel side slopes. Gravel should be placed at tailouts and riffles. Excavating moderate pools for placement of wood will prevent it from decreasing the hydraulic capacity of the channel. At the outlet of each pool, an 18- to 24-inch cedar log should be placed along the channel bottom and buried in the banks. The log will prevent down cutting at the constriction.

For construction quantity purposes, a woody debris pool with two pieces of debris was placed about every 50 feet. This is consistent with the placement of one piece of large woody debris every two stream widths for streams of about 12.5 feet wide.

Dendrites serve as storm refuge and offer additional habitat. Construction of hummocks reduces the amount of excavated material to be hauled off-site and provides varied riparian topography. Refer to the Dendrite and Hummock Detail, Figure No. 15, for typical cross sections.

Cost Items and Quantities

Construction line items and quantities are listed in the attached construction cost estimate table. Quantities were calculated based on the information obtained during HDR's site visit and from mapping. Given the extent of survey, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.

Conclusions and Recommendations

The Schuler Brothers Reach can be cost-effectively restored via the above proposed habitat improvements. Prior to project construction, we recommend that a detailed site survey and hydrologic/hydraulic design analyses be conducted on all project features. Also the h&h analysis will consider the scour and hydraulic effects of placement of LWD in the stream channel.

SITE NO. 14

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: **Merlino Reach**

Location

- The Merlino Reach of Mill Creek links the Wetland 5k Reach and the Schuler Brothers Reach and includes the portion of Mill Creek located east of SR 167 to the south edge of the Schuler property. Refer to Mill Creek and Mullen Slough Site location map, Figure No. 1.

Site Constraints/Problems
Corps personnel to add environmental site constraints.

- Previously a ditch, this reach would benefit from re-channelization. A lack of stream structure and riparian vegetation hinder the Merlino Reach from functioning effectively as rearing habitat and storm refuge.

Project Goals

- The goal at the Merlino Site is to create a natural habitat for rearing and storm refuge.

Proposed Solutions

- Alternative No. 1 - No Action: No modifications to the existing stream conditions. Habitat conditions would remain marginal.
- Alternative No. 2 – Implement the following restoration activities:
  - It is recommended that a one-stage channel be constructed south of 37th Street NW and a two-stage channel north of 37th Street NW. Deepening, widening, and meandering the existing stream would decrease stream temperatures and help to prevent fish stranding during high flows. See site plans for specific locations that were agreed upon by Corps biologists.
  - A planting buffer would be added to newly constructed channel. Any reedcanary grass, blackberry, purple loose stribe, and other harmful weeds should be removed prior to planting.
  - Placement of large woody debris would introduce stream shade and structure. Piercing the water table would introduce ground water. Small woody debris should also be placed in dendrites.
  - Construction of dendrites would provide additional habitat. Dendrites should be about 4 feet wide at the main channel and meander along the natural slope, narrowing gradually and ending at ground elevation. Dendrites should be created about every 1/4-mile along the main channel.

- Hummocks can be formed with cut material from dendrite construction and re-channeling.

Recommended Plan
The no action alternative will not achieve the project goals and is not a viable option for this site. Alternative No. 2 is recommended to accomplish the project goals.

The conceptual design for the recommended plan is depicted in the Merlino-Reach Site Plan, Figure No. 5. The proposed channel has a higher cross sectional area than that of the existing channel to help prevent a decrease in the channel's hydraulic capacity.

One-stage channel configuration with riparian planting scheme can be found in the 1-Stage Channel Detail, Figure No. 12. Plantings include a combination of shrubs, coniferous and deciduous trees to be planted in natural random clusters. Existing riparian vegetation will be incorporated into the overall revegetation scheme. Water fluctuation zone plants will further reduce water temperatures, increase dissolved oxygen levels, and bind the soil. Pacific willow and red alder, are to be staked in the water fluctuation zone along channel side slopes at a maximum ninety-degree angle. Quantity calculations for all 3 plant types in the water fluctuation zone (2 staking plants and slough sedge) were based upon a 3 row zone with one row of each type with plants 2-feet center to center and rows 1 to 2 feet apart and staggered. Each row, however, should be a random mix of the plant types.

A Woody Debris Pool Detail, Figure No. 14, depicts a typical pool with rootwads keyed into the channel side slopes. Excavating moderate pools for placement of wood will prevent it from decreasing the hydraulic capacity of the channel. At the outlet of each pool, an 18- to 24-inch cedar log should be placed along the channel bottom and buried in the banks. The log will prevent down cutting at the constriction.

For construction quantity purposes, a woody debris pool with two pieces of debris was placed about every 50 feet. This is consistent with the placement of one piece of large woody debris every two stream widths for streams of about 12.5 feet wide.

Dendrites serve as storm refuge and offer additional habitat. Construction of hummocks reduces the amount of excavated material to be hauled off-site and provides varied riparian topography. Refer to the Dendrite and Hummock Detail, Figure No. 15, for typical cross sections.

Cost Items and Quantities
Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable and are left blank. Quantities were calculated based on the information obtained HDR's site visit and from mapping. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied.

Conclusions and Recommendations

The Merlino Reach can be cost-effectively restored via the above proposed habitat improvements. Prior to project construction, we recommend that a detailed site survey and hydrologic/hydraulic design analyses be conducted on all project features. Also the h&h analysis will consider the scour and hydraulic effects of placement of LWD in the stream channel.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Wetland 5k Reach

Location
The Wetland 5k Reach includes the reach of Mill Creek just north of the Goedeke reach on the west side of SR 167. It extends from Main Street to the crossing of Mill Creek with SR 167. Within this reach of Mill Creek are the Emerald Downs Mitigation Site and a parcel that DOT is attempting to purchase for wetland mitigation. Refer to Mill Creek and Mullen Slough Site location map, Figure No. 1.

Site Constraints/Problems
Corps personnel to add environmental site constraints.

A straight shallow stream channel and a lack of riparian vegetation hinder the Wetland reach from functioning effectively as rearing habitat and storm refuge.

Project Goals
The goal at the Wetlands 5k reach is to create a natural habitat for rearing and storm refuge.

Proposed Solutions

- Alternative No. 1 - No Action: No modifications to the existing stream conditions. Habitat conditions would remain marginal.
- Alternative No. 2 - Implement the following restoration activities to the portions of the reach excluding the Emerald Downs Mitigation Site, unless otherwise specified:
- Minimal stream disturbance is recommended; gently meander and maintain a one-stage stream configuration.
- A dense plantings buffer is defined in the King County Flood Control Plan. Any reedcanary grass should be removed prior to planting.
- Placement of large woody debris would introduce stream shade and structure. Large woody debris should be place along the entire reach, including within the boundaries of the Emerald Downs Mitigation Site. Small woody debris should also be placed in dendrites.
- Construction of dendrites would provide additional habitat. Dendrites should be about 4 feet wide at the main channel and meander along the natural slope, narrowing gradually and ending at ground elevation. Dendrites should be created about every ¼ mile along the main channel.
- Hummocks can be formed with cut material from dendrite construction and re-channeling.

Recommended Plan
The no action alternative will not achieve the project goals and is not a viable option for this site. Alternative No. 2 is recommended to accomplish the project goals.
The conceptual design for the recommended plan is depicted in the Wetland 5k Reach Site Plan, Figure No. 7.
The proposed channel has a higher cross sectional area than that of the existing channel to help prevent a decrease in the channel's hydraulic capacity. As suggested by Corps biologists, plug existing channel downstream of Main Street and connect to old channel, reintroducing flow at the upstream end of the Emerald Downs Mitigation Site.
One-stage channel configuration with riparian planting scheme can be found in the 1-Stage Channel Detail, Figure No. 12. Plantings include a combination of shrubs, coniferous and deciduous trees to be planted in natural random clusters. Water fluctuation zone plants will further reduce water temperatures, increase dissolved oxygen levels, and bind the soil. Pacific willow and red alder, are to be staked in the water fluctuation zone along channel side slopes at a maximum ninety-degree angle. Quantity calculations for all 3 plant types in the water fluctuation zone (2 staking plants and slough sedge) were based upon a 3 row zone with one row of each type with plants 2-feet center to center and rows 1 to 2 feet apart and staggered. Each row, however, should be a random mix of the plant types.

A Woody Debris Pool Detail, Figure No. 14, depicts a typical pool with rootwads keyed into the channel side slopes. Pools should pierce the ground water table where possible and pool bottoms should be lined with gravel. Excavating moderate pools for placement of wood will prevent it from decreasing the hydraulic capacity of the channel. At the outlet of each pool, an 18- to 24-inch cedar log should be placed along the channel bottom and buried in the banks. The log will prevent down cutting at the constriction.

For construction quantity purposes, a woody debris pool with two pieces of debris was placed about every 50 feet. This is consistent with the placement of one piece of large woody debris every two stream widths for streams of about 12.5 feet wide.

Dendrites serve as storm refuge and offer additional habitat. Construction of hummocks reduces the amount of excavated material to be hauled off-site and provides varied riparian topography. Refer to the Dendrite and Hummock Detail, Figure No. 15, for typical cross sections.

Cost Items and Quantities
Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.
The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable and are left blank. Quantities were calculated based on the information obtained HDR's site visit and from mapping. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied.

Conclusions and Recommendations

The Wetland 5k reach can be cost-effectively restored via the above proposed habitat improvements. . Prior to project construction, we recommend that a detailed site survey and hydrologic/hydraulic design analyses be conducted on all project features. Also the h&h analysis will consider the scour and hydraulic effects of placement of LWD in the stream channel.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: **Goedeke North Reach**

Location
This reach is located at the south end of Mill Creek on the west side of SR 167 just downstream of Peasley Canyon. The site begins just upstream of the box culvert through which Mill Creek flows under Highway 18 and ends at Main Street. Refer to Mill Creek and Mullen Slough Site location map, Figure No. 1.

Site Constraints/Problems
A straight shallow stream channel and a lack of riparian vegetation hinder the Goedeke reach from functioning effectively as rearing habitat and storm refuge. In addition, a disconnected pond at the north end of the site is a likely location for fish stranding.

Project Goals
The goal at the Goedeke reach is to create a natural habitat for rearing and storm refuge.

Proposed Solutions

- Alternative No. 1 - No Action: No modifications to the existing stream conditions. Habitat conditions would remain marginal.
- Alternative No. 2 – Implement the following restoration activities:
  - Deepening, widening, and meandering the existing stream coupled with riparian shade plantings would decrease stream temperatures and help to prevent fish stranding during high flows. The existing stream is 5 to 6 feet wide. An 8- to 10-foot wide channel with a defined low flow section with a terrace for flooding is proposed.
  - Just north of a cottonwood grove is an approximately 800-foot long corridor that is a good candidate for a 200-wide buffer of riparian planting. A planting buffer would also be added to the newly constructed channel. Any reedcanary grass, blackberry, purple loose stribe, and other harmful weeds should be removed prior to planting.
  - Placement of large woody debris would introduce stream shade and structure. Small woody debris should also be placed in dendrites.
  - Construction of dendrites would provide additional habitat. Dendrites should be about 4 feet wide at the main channel and meander along the natural slope, narrowing gradually and ending at ground elevation. Two dendrites should be created along the main channel outside of the Cottonwood grove.
  - Hummocks can be formed with cut material from dendrite construction and re-channeling.

Recommended Plan
The no action alternative will not achieve the project goals and is not a viable option for this site. Alternative No. 2 is recommended to accomplish the project goals.
The conceptual design for the recommended plan is depicted in the Goedeke Reach Site Plan, Figure No. 8.

The proposed channel has a larger cross sectional area than that of the existing channel to offset any decrease in the channel hydraulic capacity.

The two-stage channel configuration with riparian planting scheme can be found in the 2-Stage Channel Detail, Figure No. 13. Plantings include a combination of shrubs, coniferous and deciduous trees to be planted in natural random clusters. Water fluctuation zone plants will further reduce water temperatures, increase dissolved oxygen levels, and bind the soil. Pacific willow and red alder, are to be staked in the water fluctuation zone along channel side slopes at a maximum ninety-degree angle. Quantity calculations for all 3 plant types in the water fluctuation zone (2 staking plants and slough sedge) were based upon a 3 row zone with one row of each type with plants 2-feet center to center and rows 1 to 2 feet apart and staggered. Each row, however, should be a random mix of the plant types.

A Woody Debris Pool Detail, Figure No. 14, depicts a typical pool with rootwads keyed into the channel side slopes. Excavating moderate pools for placement of wood will prevent it from decreasing the hydraulic capacity of the channel.

For construction quantity purposes, a woody debris pool with two pieces of debris was placed about every 24 feet. This is consistent with the placement of one piece of large woody debris every two stream widths for streams of about 6 feet wide.

Dendrites serve as storm refuge and offer additional habitat. Construction of hummocks reduces the amount of excavated material to be hauled off-site and provides varied riparian topography. Refer to the Dendrite and Hummock Detail, Figure No. 15, for typical cross sections.

Cost Items and Quantities
Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.
The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable and are left blank. Quantities were calculated based on the information obtained in HDR's site visit and from mapping. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied.

Conclusions and Recommendations
The Goedeke reach can be cost-effectively restored via the above proposed habitat improvements. . Prior to project construction, we recommend that a detailed site survey

and hydrologic/hydraulic design and sediment yield/transport analyses be conducted on all project features. Also the h&h analysis will consider the scour and hydraulic effects of placement of LWD in the stream channel.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Green River Park

Location
The project site is located within Green River Park, City of Kent, WA, at the end of Hawley Road near the River Mile (RM) 23.7 of the Green River. The site extends approximately 600 feet due east from the river bank.

Site Constraints/Problems
The project site is located in an undeveloped section of Green River Park owned by the City of Kent. The City has completed a master plan for the park to be used for passive recreation. This planned use is compatible with the project design, and with the addition of educational elements, such as interpretive signage, would increase the multi-objective values of the property.

The Green River is not constrained by levees at this site however the banks in the park area are steep (>1:1). The banks are vegetated with trees. The soils are composed of silty loams. Through flood control and channelization, the mainstem of the Green River has reduced ability to provide habitat, refugia and channel diversity.
Flood control management by Howard Hanson Dam targets a maximum discharge of 12,000 cfs at the USGS gage near Auburn (USACE, 1997). The present safe channel capacity downstream of Auburn is approximately 12,000 cfs. The Howard Hanson Dam also provides for a minimum instream flow of 110 cfs during all summer months (USACE, 1997).

Sedimentation at the channel mouth is a potential concern. It is prone to deposition on the inside of the meander bend. Additional sedimentation from the proposed backwater slough may produce confluence bars during low flow conditions. Other channel mouth configurations should be investigated prior to project construction.

To maintain a wetted rearing area at the mouth of the backwater channel, the channel elevation in the mouth will need to match the thalweg of the channel in the mainstem due to low river levels in the summer. Sedimentation will be a problem until the channel thalwegs match. An accurate estimate of the excavation cannot be determined without further survey in the area. This area of the Green River does not have levees, so placing a channel in this area will not increase flood elevations in the park.

Project Goals
The project purposes are to provide a summer rearing habitat at the mouth and establish a backwater winter channel refuge for fish during high/flood flows in the mainstem of the Green River.

Project construction should be limited to the project site and minimize the impact to existing vegetation. Erosion and sedimentation control measures should be considered to prevent the transport of sediment into the Green River. The connection with the mainstem of the Green River should be large enough to avoid blockage by sedimentation and be easily accessible to fish during high flows. Excavated material should be removed from the site. The project design should include large woody debris (LWD) and be planted with enough structure to avoid inner channel erosion and slumping.

Proposed Solutions

- Alternative 1: No Action. No modifications to the existing stream conditions. Habitat conditions would remain unchanged.

- Alternative 2: Backwater Slough. Construct a backwater slough to restore feeding, rearing and refuge from high water events that occur in the mainstem of the Green River.

Recommended Plan

Alternative 2 is the recommended alternative. Alternative 1, the No Action alternative, does not meet the purpose of the project and is not a viable option for this site. Alternative 2 provides for the project purpose to establishing feeding, rearing and refuge for salmonids.

The Alternative 2 alignment should minimize ponding and subsequent stranding of fish when water surface levels recede to normal levels after flood flows.

For project feasibility analysis, the Corps provided water surface elevations for two mainstem discharge rates (200 cfs and 12,000 cfs) at the project location. Water surface elevation for average summer and winter flows were estimated from a linear interpolation of these data. By visual inspection of recent mean monthly flows for the months of November through February recorded at Auburn, an average winter flow of 2000 cfs was assumed. Based on the available hydrologic information, the proposed side channel would be entirely wetted during the average winter flow. Further refinements of the proposed side channel hydraulics will be necessary in subsequent design efforts.

The backwater slough is designed to begin at the bank of the Green River and extend approximately 600 linear feet east into the existing park. The entranceway has a bottom elevation of 27 feet to maintain approximately 2-ft of depth during low summer flows. Approximately 100 feet from the entrance, the channel bottom has been designed to maintain a constant slope upward (2%) for 500 feet where the channel daylights the existing ground surface at a ratio of 3H:1V. A grade control structure could have been added to reduce excavation, but with a steady slope the backwater channel will readily react to fluctuating water levels and naturally flush. The proposed backwater channel will be trapezoidal in shape, have 3H:1V side slopes, and an 8-ft bottom width. It is suggested that a grass seed and mulch mixture be applied to the graded bank, and coir fabric be placed to control erosion and to hold the grass mixture in place until

germination. To provide habitat benefits and bank stability, root wads should be placed in the outlet at the toe of the slope and at an average of two stream widths along the proposed slough. The root wad treatment should also extend into the mainstem of the river to control erosion in and around the confluence until riparian vegetation has a chance to establish itself.

Habitat enhancement consists of woody debris and riparian vegetation. The Green River Park Plan, Profile, and Typical Section references riparian plantings and woody debris drawings. Woody debris should be staggered on alternating sides of the channel at approximately one structure per channel high water wetted width. The riparian planting zone should be 50 feet wide and extend from the channel edge on each side of the backwater slough. An h&h analysis should be done to insure that the site does not divert water from the main channel during low flow conditions and that all project features function effectively

Construction Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. Quantities were calculated based on the information obtained during HDR's site visit and from topographical mapping provided by the Corps. Given the extent of the survey, hydrologic, and hydraulic information, at this time, a 15 percent contingency has been applied to the quantities. An additional 25 percent cost contingency will be added when the USACE prepares the cost estimate unless otherwise specified.

Conclusions and Recommendations

The Green River Park project can meet the project purpose with the recommended backwater slough and habitat improvements. However, the summer rearing area will be difficult to maintain due to low summer flows increasing the chance of sedimentation filling the area in and around the confluence. The following items should be considered before final design:

- Geotechnical analysis of the site soil composition to determine stable slope angles and failure potential.
- Sediment transport analysis at the backwater slough outlet to develop final designs that minimize deposition.
- Detailed field survey.
- Expanded water surface profile analysis detailing high, low, and mean flow conditions.

Figures

Green River Park Plan, Profile, and Typical Section
1-Stage Backwater Planting Scheme Detail
1-Stage Woody Debris Detail

References

US Army Corps of Engineers, Green River Water Surface Profiles, Seattle District

US Army Corps of Engineers, Reconnaissance Report, Green-Duwamish River Ecosystem Restoration General Investigation, Green-Duwamish River, King County, Washington, March, 1997

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Horsehead Bend

Location

Horsehead Bend is named for a sharp meander on the Green River located at River Mile (RM) 26. It is located within the city limits of Kent, WA, east of Central Avenue South and west of the intersection of 94th Place South and Green River Road.

Project Constraints/Problems

The Horsehead Bend project area is described in Perkins (1998). Horsehead Bend is a meander bend that has been locked into place by a right bank levee since 1965. The left bank of the river meander forms or borders a terraced area that is the focus of this study. The banks bordering the terrace are up to 22-ft high and are vertical in some locations due to erosion (Perkins, 1998). The banks are densely vegetated and are composed of cohesive silts and sands the average bank has a band or 6 feet of silt at the top with a middle layer of sand of varying thickness and a bottom layer of 8 feet of silt. The middle section is composed of non-cohesive sands that erode readily. The terrace area is densely vegetated with brush and trees. The terrace area shows evidence of a past river channel with ground elevations 2-feet to 10-feet below the terrace (Perkins, 1998).

Flood control management by Howard Hanson Dam targets a maximum discharge of 12,000 cfs at the USGS gage at Auburn. According to Perkins (1998), during the 1996 flood, the flow was measured to be 13,000 cfs at Auburn and based on aerial photos, the terrace did not overtop. Constructing the proposed backwater channel in this area potentially provides a hydraulic connection to the terrace during high flow events. Therefore, any channel design should consider the low elevation areas to minimize ponding and stranding of fish.

Sedimentation at the side channel mouth is a potential concern. To maintain a wetted rearing area at the mouth of the proposed side channel, the thalweg elevation of the side channel mouth should match the thalweg of the mainstem channel to assure water during low river levels in the summer. Advanced engineering design efforts will be required to determine if modifications are necessary to the main channel to provide summer low flows at the mouth of the proposed side channel. Also an analysis should be made to insure that this site does not take water from the mainstem during low flow periods. Prior to construction different entrance configurations should be made to insure the site mouth does not silt in. Also other shorter deeper configurations should be investigated to see if they will provide the majority of the benefits.

Project Goals
The project goal is to provide a summer rearing area and to establish a refuge for fish during high flows in the mainstem of the Green River. The project would especially benefit Coho, emergent Chinook fry, and fingerling rearing.

Project construction should minimize removal of existing vegetation. Erosion and sedimentation control measures should be considered to prevent the transport of sediment into the Green River. Excavated material should be removed from the site. Improved habitat should include large woody debris (LWD) and riparian plantings to provide enough structure to avoid erosion and to enhance aquatic habitat.

Proposed Solutions

- Alternative 1: No Action. No modifications to the existing stream conditions. Habitat conditions would remain unchanged.

- Alternative 2: Excavate a backwater channel through the terrace, as described in Perkins (1998). This alternative consists of a 1300-foot side channel excavated along the alignment of the pre-1906 channel.

- Alternative 3: Excavate a backwater channel through the terrace, based on the concept described in Perkins (1998), but modified to minimize potential fish stranding. The channel would be approximately 950 linear feet in length and would follow the old river channel and terminate at a depression located on the east side of the terrace.

Recommended Plan
Alternative 3 is the recommended alternative. Alternative 1, the No Action alternative, does not meet the purpose of the project and is not a viable option for this site. Alternatives 2 and 3 both meet the project purpose. Compared to Alternative 2, Alternative 3 reduces excavation costs and the potential for fish stranding.

The Alternative 3 alignment, displayed in the Horsehead Bend Plan, Profile, and Typical Section, should minimize ponding and subsequent stranding of fish when water surface levels recede to normal levels after flood flows.

For project feasibility analysis, the Corps provided water surface elevations for two mainstem discharge rates (200 cfs and 12,000 cfs) at the project location. Water surface elevation for average summer and winter flows were estimated from a linear interpolation of these data. By visual inspection of recent mean monthly flows for the months of November through February recorded near Auburn, an average winter flow of 2000 cfs was assumed. Based on the available hydrologic information, the proposed side channel would be wetted during the average winter flow to an elevation of approximately 29 feet. Advanced engineering design efforts of the proposed backwater channel hydraulics will be necessary.

The initial 100 feet of the backwater channel starting at the confluence has been designed to maintain approximately 2-ft of depth during low summer flows. Approximately 100 feet from the confluence, the channel bottom has been designed to maintain a constant slope upward (1.4%) until the end of the channel. A grade control structure could have been added to reduce excavation, but the backwater channel designed with a steady slope will readily react to fluctuating water levels and naturally flush itself. Deeper shorter channel configurations will be investigated prior to construction.

The proposed backwater side channel sized for construction feasibility will be trapezoidal in shape, have 3:1 side slopes, and an 8-ft bottom width. It is suggested that a grass seed and mulch mixture be applied to the graded bank. A coir fabric should be placed to control erosion and hold the grass mixture in place until germination. To provide habitat benefits and bank stability, root wads should be field placed in clusters to resemble log jams at alternating sides in the proposed channel every two times the channel width at the toe of the slope. The root wad treatment should also extend to the outlet to control bank erosion at the confluence. Coir fabric overlaid with brush mat should be used to further control erosion in and around the confluence until riparian vegetation has a chance to establish itself.

Habitat enhancement consists of woody debris and riparian vegetation. The Horsehead Bend Plan, Profile, and Typical Section references riparian plantings and woody debris drawings. The non-channel planting zone should be southwest 150 feet wide from the channel edge of the channel and the entire area between the proposed channel and the Green River. In most cases this area between the proposed channel and the river has adequate vegetation at this time. In-channel vegetation is specified in the drawing as water fluctuation zone plantings.

Construction Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. Quantities were calculated based on the information obtained during HDR's site visit and from topographical mapping provided by the Corps. Given the extent of the survey, hydrologic, and hydraulic information, at this time, a 15 percent contingency has been applied to the quantities. An additional 25 percent cost contingency will be added when the USACE prepares the cost estimate unless otherwise specified.

Conclusions and Recommendations

The Horsehead Bend project can meet the project purpose with the recommended side channel and habitat improvements. The following items should be considered in the advanced engineering design phase:

- Geotechnical analysis of the site soil composition to determine stable slope angles and failure potential, as recommended in Perkins (1998).
- A detailed field survey.

- Sediment transport analysis at the side channel outlet to develop final designs that minimize deposition.
- Expanded water surface profile analysis detailing high, low, and mean flow conditions.
- Investigate groundwater potential for maintaining summer and winter flows.

Figures
Horsehead Bend Plan, Profile, and Typical Section
1-Stage Backwater Planting Scheme Detail
1-Stage Woody Debris Detail

References
Perkins, S. J., Geomorphic Feasibility Report for Horsehead Bend Side Channel, report to the US Army Corps of Engineers, Seattle District, October, 1998

US Army Corps of Engineers, Green River Water Surface Profiles, Seattle District

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: NE Auburn Creek

Location
NE Auburn Creek is a Green River tributary located north of SE 277th Street in the City of Auburn, WA. The project site begins at the confluence of NE Auburn Creek and the Green River at about River Mile (RM) 25.9. The project site extends upstream through a series of ditches and culverts for approximately 3,300 feet to the culvert crossing SE 277th Street.

Project Constraints/Problems
At the confluence of NE Auburn Creek and the Green River mainstem, a large flap gate currently impedes fish access to the creek. At this location, the Green River is not constrained by levees. A cottonwood dominated riparian canopy exists for about 2000 feet along NE Auburn Creek immediately above the existing flap-gated culvert. Upstream of the cottonwood, the creek can be characterized as a ditch with little or no riparian vegetation other than blackberry thickets along its course.

The project is potentially affected by a proposed constructed wetland, to be located south of S. 277th Street. The potential wetland site is part of the mitigation plan proposed for the construction of Seattle-Tacoma International Airport's third runway. Based on initial information provided by Parametrix, flow from the wetland mitigation site may be directed into NE Auburn Creek south of S. 277th Street. However, the wetland site may not sustain minimum flows in NE Auburn Creek during summer months (P. Fendt, September 1999, Personal Comm.)

Green River discharge is controlled by Howard Hanson Dam (HHD) located at River Mile (RM) 64.5. HHD provides flood control management for the Standard Project Flood (SPF) of 12,000 cfs (approximately the 500-year frequency event) at the United States Geological Society (USGS) gage near Auburn (USACE, 1997). However, the site has experienced a high flow of approximately 13,000 cfs measured to be 13,000 cfs at Auburn during the 1996 flood event (Perkins, 1998). HHD also provides for a minimum instream flow of 110 cfs during all summer months (USACE, 1997). Since the construction of HHD the minimum flow at the USGS site near Auburn is 152 cfs recorded on October 30, 1987.

Summer low flows are uncertain with the stream dry from April to November and will depend on wetland mitigation plans proposed for the construction of Seattle-Tacoma International Airport's third runway. The wetland would drain north into NE Auburn Creek, potentially providing summer rearing flows for salmonids. Conceptual design

plans call for a weir to control the outflow from the wetland site. At this time the proposed hydraulics of the weir are not known. Advance engineering design efforts will be required to determine necessary criteria to provide for summer low flows in the tributary.

Project Goals

The project purpose is to provide juvenile and adult fish access to winter refugia, foraging, and if conditions permit, a summer rearing habitat within NE Auburn Creek. Some Coho spawning will occur.

Project construction should be limited to the tributary channel while minimizing the impact to existing riparian vegetation and cottonwoods through the entire stream reach. Temporary erosion and sedimentation control measures should be integrated to prevent the transport of sediment into the Green River. Excavated material must be removed from the site. The project site should be landscaped to include large woody debris (LWD) and riparian plantings.

Proposed Solutions

- Alternative 1: No Action. No modifications to the existing stream conditions. Current fish barriers and habitat conditions would remain unchanged.

- Alternative 2: Tidegate. Replace the existing flapgate with a self-regulating tidegate (SRT), and rehabilitate the tributary by increasing vegetation and large woody debris (LWD).

- Alternative 3: Bottomless Culvert. Replace the exiting flapgate and culvert with a bottomless culvert and rehabilitate NE Auburn Creek using LWD and riparian vegetation. The creek channel would be routed through the new culvert with a natural channel gradient maintained.

- Alternative 4: Bridge. Eliminate the existing flapgate and culvert, daylight and enhance the tributary by increasing creek diversity. A hollow girder concrete bridge would be installed to maintain access across the channel.

Recommended Plan

Alternative 4 is the recommended alternative. The No Action alternative (Alternative 1) does not meet the purpose of the project and is not a viable option for this site. Alternatives 2, 3, and 4 all meet the project purpose. Alternatives 2 and 3 are less attractive than alternatives 4 because of their use of culverts and in the case of Alternative 2, a tidegate. An adaptation of alternative #2 is to place a flapgate near the existing culvert just north of the 86th Ave S. and S. 277th St. intersection. Alternative 4 removes the existing flap-gated culvert and headwall, and daylights the tributary. A proposed hollow girder concrete bridge would provide access across the tributary. This option allows for the most optimal tributary condition.

For project feasibility analysis, the Corps provided water surface elevations for two mainstem discharge rates (200 cfs and 12,000 cfs) at the project location. Water surface elevation for average summer and winter flows were estimated from a linear interpolation of these data. By visual inspection of recent mean monthly flows for the months of November through February recorded at Auburn, an average winter flow of 2000 cfs was assumed. Based on the available hydrologic information, winter and summer elevations of the confluence of NE Auburn Creek were estimated to be approximately 27 feet and 24 feet respectively. The proposed project should not affect current flow conditions or increase current flood elevations. Detailed analysis of backwater flooding into the tributary will be evaluated during advanced engineering and design.

The proposed channel will have a 2-stage channel shape, with 3H:1V side slopes and an assumed bottom width 4-ft. Coir fabric overlaid with brush mat should be used to control erosion until riparian vegetation has a chance to establish itself. In addition, a geotechnical investigation is recommended to study side slope stability because of the increased slope heights involved in daylighting the tributary.

To provide habitat benefits and bank stability, root wads should be clustered and field place along the toe of the channel slope every two stream widths on average. The root wads will provide low velocity habitat areas. The root wad treatment should also extend to the outlet of the creek to provide stability. The riparian planting zone should extend 50 feet on both sides of the channel. A reduced planting zone may be necessary along the tributary due to private land. Coir fabric overlaid with brush mat should be used to further control erosion in and around the confluence until riparian vegetation has a chance to establish itself. The NE Auburn Creek Plan, Profile, and Typical Section drawings references LWD and riparian plantings.

As a first order approximation to estimate a minimum bridge length, the 100-year flow for NE Auburn Creek was estimated using the rational method. A runoff coefficient of 0.51, the 100-year 24-hour isopluvial equal to 3.94 inches, and an area of about 200 acres were used to estimate the 100-year discharge of approximately 400 cfs. The creek cross section for the proposed channel was then estimated and a top width of 36.5 feet was calculated. Multiplying the top width of the creek by 1.33, a minimum bridge width of 48.5 feet was determined and rounded up to 50 feet. The new bridge structure will be located over the existing flap-gated culvert. Advanced engineering efforts to model the hydrology and hydraulics of the basin should address this issue. Further criteria for the bridge design must include Sensitive Areas Ordinance and Rules and other agencies such as the City of Auburn and the Washington Department of Fish and Wildlife.

Construction Cost Items and Quantities

Construction line costs and quantities are shown in the MCACES portion of the attached engineering appendix. Quantities and costs were estimated from information obtained during HDR's site visit and topographical maps provided by the Corps. A 15 percent contingency has been added to the quantities given the bounds of the study. An additional 25 percent cost contingency will be added when the USACE prepares the cost estimate unless otherwise specified.

Conclusions and Recommendations
The NE Auburn Creek site can be effectively restored with the above channel and habitat improvements. The following items should be considered in the advanced engineering and design phase:

1. A detailed hydrologic and hydraulic analysis including a detailed backwater analysis, is recommended to address tributary design, ensure adequate fish passage depths and velocities, bridge design, and adequate sizing of existing culverts. This study will also address any possible increase in flooding cased by the project and the amount and timing of the flows that will be available for the creek Also the h&h analysis will consider the scour and hydraulic effects of placement of LWD in the stream channel. A sediment yield study should be conducted to determine its future effect on Auburn Creek and the Green River.
2. Consideration of the proposed wetland mitigation plan for the construction of Seattle-Tacoma International Airport's third runway application.
3. Geotechnical studies should be performed to determine appropriate tributary and bridge foundations.
4. Potential water quality concerns rising from local agricultural land use should be addressed.
5. Determine planting zone limitations due to privately held land.
6.

Figures
NE Auburn Creek Plan, Profile and Typical Section
2-Stage Channel Riverine Planting Scheme Detail
2-Stage Woody Debris Drawing

References
Paul Fendt, Parametrix, Inc., personal communication, September 23, 1999

Perkins, S. J., Geomorphic Feasibility Report for Horsehead Bend Side Channel, report to the US Army Corps of Engineers, Seattle District, October, 1998

US Army Corps of Engineers, Reconnaissance Report, Green-Duwamish River Ecosystem Restoration General Investigation, Green-Duwamish River, King County, Washington, March, 1997

US Army Corps of Engineers, Green River Water Surface Profiles, Seattle District

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Meridian Valley Creek

Location
The Meridian Valley Creek project is located in the City of Kent, WA, and includes the reach of Meridian Valley Creek from the concrete box culvert under SE 256th Street, through an approximately 1000-foot long, rectangular, concrete flume near the confluence with Soos Creek.

Project Constraints/Problems
As described in City of Kent (1999), Kent completed major annexations in 1996. To address potential environmental issues associated with the annexations, the City performed three studies to investigate the hydrology, hydraulics, and fisheries of creeks within the Watersheds of Soosette Creek, Lake Meridian, and Meridian Valley Creek. The creeks within these watersheds are tributary to the middle reach of Soos Creek, which drains into the Green River just east of the City of Auburn. The recently approved Capital Improvement Plan (CIP) includes water resource and habitat enhancement projects, including the Meridian Valley Creek project. The Kent Public Works Engineering Department has begun planning for these projects.

Upstream of the Meridian Valley Creek project, the creek flows through Meridian Valley Creek Golf Course, where salmonid habitat is of relatively good quality. A lack of riparian vegetation along the flume and a deposition problem at its downstream end limit its ability to function as a fish passage to upstream habitat. Additional habitat limitations include a lack of both in-stream cover and off-channel refuge. Further, its proximity to SE 256th Street limits improvements such as riparian plantings. Despite its drawbacks, in a 1998 fisheries assessment (Harza, 1988), coho salmon, cutthroat trout, bullhead, sculpin, and lamprey were found along the flume. Gravel deposits are found in the gently sloped lower half of the flume. The upper section may impede fish passage due to low water depths and high velocities.

Entranco (1999) has completed preliminary designs to replace the existing flume with a naturally functioning channel from SE 256th Street to the Soos Creek confluence. These designs were used to develop the preliminary designs presented here.

The primary hydrologic concerns are related to SE 256th Street and the existing wetlands. The low gradient of the wetland area indicates that the lower reach of the restored reach is likely to be depositional. The selected project alternative should not result in increased flooding risk to SE 256th Street due to backwater effects from the confluence with Soos Creek. The selected project should also avoid draining the existing wetland.

Meridian Valley Creek flows were provided in Entranco (1999) and reported in Table 1. These flows were used to size the channel for the selected alternative.

Table 1. Meridian Valley Creek Streamflow (current basin landuse)

Return Period (Years)	Meridian Valley Creek Streamflow (cfs)
2	99
10	172
25	211
100	273

The confluence with Soos Creek should be designed such that sediment deposition is minimized so that conveyance capacity is maintained and wetland function is not reduced.

Project Goals

The project purpose is to replace the flume and provide passage with habitat enhancements from Soos Creek to Meridian Valley Creek upstream of SE 256th Street. An ancillary benefit of the project is that it will provide a hydraulic connection between Soos Creek and the existing wetlands.

Construction disturbance including fill in the wetland area should be limited. Plantings in the wetland area should occur in the disturbed areas only. The newly constructed channel should provide improved fish passage as well as habitat enhancement features such as woody debris.

Proposed Solutions

- Alternative 1: No Action. No modifications to the existing stream conditions. Habitat conditions would remain marginal.

- Alternative 2: Replace the existing flume with a new channel from the box culvert under SE 256th Street to the confluence with Soos Creek through the existing wetlands. The new channel would be constructed following the alignment proposed by Entranco (1999) and would be designed with fish habitat features. The existing flume would be removed.

- Alternative 3: Identical to Alternative 2 but with a modified alignment that follows a milder grade and minimizes volume of excavated material.

Recommended Plan

The No Action alternative (Alternative 1) does not meet the purpose of the project and is not a viable option for this site. Alternatives 2 and 3 both meet the purpose of the project. Alternative 3 is recommended because it minimizes project costs by reducing the excavation quantities, based on visual inspection of Alternatives 2 and 3 profiles (see Meridian Valley Creek Alternative Profiles drawing). By abandoning the flume and

constructing a 1-stage channel from SE 256 Street to Soos Creek, the flume is removed and habitat is enhanced in the new channel.

Habitat enhancement consists of woody debris and riparian vegetation. The Meridian Valley Creek drawing references riparian plantings and woody debris drawings. Woody debris should be staggered on alternating sides of the channel at approximately two stream width intervals. The riparian planting zone in Reach A (refer to Meridian Valley Creek drawing) should be 100 feet wide and extend from the channel edge on each side of the channel. The non-channel planting zone in Reach B, through the existing wetlands, should be 20 feet wide. In-channel vegetation is specified in the drawing as water fluctuation zone plantings.

A 1-stage channel was designed in the wetland region with a bankfull capacity of the 25-year event flow. To minimize disturbance of habitat within the wetland, the bottom width of the proposed channel was minimized. Conveyance in the steeper, upstream region was also designed as a 1-stage trapezoidal channel with a 25-year event capacity. A freeboard of 1-foot was included in both channel designs. Prior to project constructions studies should be made to see if a 25 year bank full design is desirable or would it be better it were the 2 to 5 year event as this would allow more wetland and bank recharge opportunities. Also a 100 year flood flow should be routed through the proposed site to determine its effects **and a sediment transport and geotec study should be conducted on the upstream channel and the new channel. Studies should also determine if grade controls will be necessary on the new channel.**

Channel parameters such as bottom width and roughness were varied in order to achieve reasonable fish passage depths and velocities. The proposed channel characteristics were determined using the flows listed in Table 1 and Manning's Equation. The channel characteristics of Reach A include a bottom width of 10 feet and side slopes of 3H:1V. The channel characteristics of Reach B include a bottom width of 4 feet and side slopes of 3H:1V. A Manning's Coefficient of 0.08 was used for the proposed channel containing woody debris.

The following tables summarize channel parameters of the two channel reaches (channel depths include 1-foot of freeboard).

Table 2. Channel Summary.

	Reach A, S = 0.022 ft/ft		**Reach B, S = 0.0077 ft/ft**	
	2 Year Event	**25 Year Event**	**2 Year Event**	**25 Year Event**
Flow (cfs)	99	211	99	211
Flow Depth (ft)	2.0	2.9	3.2	4.5
Channel Depth (ft)	3.9	3.9	5.5	5.5

Average Velocity (fps)	3.2	4.0	2.2	2.7

Construction Cost Items and Quantities
Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. Quantities were calculated based on the information obtained from mapping. A 15 percent contingency was added to the quantities. An additional 25 percent cost contingency will be added when the USACE prepares the cost estimate unless otherwise specified.

Conclusions and Recommendations
The Meridian Valley Creek site can be cost-effectively restored with the above channel and habitat improvements. The following items should be considered in the advanced engineering and design phase:

1. A more detailed hydrologic and hydraulic analysis is recommended to ensure that appropriate fish passage depths and velocities are achieved. Entranco (1999) contains initial HEC-RAS modeling that may be updated for the final design.
2. The impacts of woody debris and vegetation on channel hydraulics should be analyzed using the updated hydraulic model.
3. Potential sedimentation at the grade break between Reach A and Reach B and at the confluence of the proposed channel and Soos Creek should be analyzed.
4. Further hydraulic analysis may be required to account for stream bank erosion control measures at the confluence of the proposed channel and Soos Creek.
5. Groundwater and/or geotechnical studies should be performed to evaluate the impacts of the new channel on the existing wetland hydrology so that the constructed project does not de-water the wetland.
6. A retaining wall may be required on the uphill side of Reach A. Geotechnical studies may be necessary for the wall design.

Figures
Meridian Valley Creek Plan and Typical Section
Meridian Valley Creek Alternative Profiles
1-Stage Channel Riverine Planting Scheme Detail
1-Stage Woody Debris Detail

References
City of Kent, Letter from City of Kent Public Works Engineering Department to Corps of Engineers, Seattle District with regard to supporting materials to Kent projects in the Green Duwamish Ecosystem Restoration Study, May 12, 1999

Geologic and Geotechnical Services, Lake Meridian Outlet Creek Realignment Feasibility Study, February 15, 1999

Entranco, SE 256th Street Flume Replacement, Concept Report, April 30, 1999

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Lake Meridian Outlet

Location
The existing project is located in the City of Kent, Washington and extends from the outlet of Lake Meridian at Lake Meridian Park to the confluence with Soos Creek. The majority of the current channel occupies a road ditch.

Project Constraints/Problems
As described in Kent (1999), Kent completed major annexations in 1996. To address potential environmental issues associated with the annexations, the City performed three studies to investigate the hydrology, hydraulics, and fisheries of creeks within the Watersheds of Soosette Creek, Lake Meridian, and Meridian Valley Creek. The creeks within these watersheds are tributary to the middle reach of Soos Creek, which drains into the Green River just east of the City of Auburn. The recently approved Capital Improvement Plan (CIP) includes water resource and habitat enhancement projects, including the Lake Meridian Outlet project. The Kent Public Works Engineering Department has begun planning for these projects.

As described in Kent (1999):

> Lake Meridian is one of the largest lakes in King County, covering a 153-acre area. The outflow from the lake is conveyed by way of surface routing over a distance of approximately 7,000 feet to a confluence with Big Soos Creek. The confluence is outside the City Limits along Kent-Black Diamond Road (152nd Ave SE). Approximately half of the lake outlet conveyance consists of a linear ditch that runs adjacent to the eastern shoulder of the road. There are twenty-one culverts within this reach and almost no riparian vegetation or other habitat features. The other (northern) half of the conveyance is a combination of engineered open channel, (relatively) natural stream, in-line detention, and dispersed flow through a wetland.

Streamflow from the outlet of Lake Meridian is an important concern for the project. According to Kent (1999), "flow duration data indicate that there is no flow from the lake approximately 35% of the time, corresponding to the summer months." If flow is not maintained from the lake through the summer months, summer rearing habitat in the proposed alignment may be limited. Pumping and lake outlet control options may be included in the project to provide necessary flows in the summer months. However, winter rearing and high flow refugia functions can be maintained.

Flood flows and frequencies within the existing outlet creek were described in GeoEngineers (1999) as follows:

Table 1. Lake Meridian Outlet Flood Streamflows
And Frequencies (current land use)

Return Period (years)	Streamflow (cfs)
2	7.4
5	9.2
10	10.4
25	11.7
50	12.7
100	13.5

For preliminary design and quantity calculations, the 2-, 5-, and 50-year flows were used to estimate the dimensions of the proposed channel

Project Goals

The project goal is to replace the existing Lake Meridian Outlet alignment with a naturally functioning waterway between Lake Meridian and Soos Creek. At a minimum, the proposed channel should provide salmonid rearing habitat and passage into Lake Meridian.

Channel construction should minimize loss of existing wood, and excavated material should be removed from the site.

Proposed Solutions

- Alternative 1: No Action. No modifications to the existing stream conditions. Habitat conditions would remain marginal

- Alternative 2: Construct Meridian Creek channel and improve outlet, using Alternative 2 Alignment. See Lake Meridian Outlet Plan and Typical Section drawing. Construct a new channel and enhance with riparian vegetation and woody debris.

- Alternative 3: Construct Meridian Creek channel and improve outlet, using Alternative 3 Alignment. See Lake Meridian Outlet Plan and Typical Section drawing. Construct a new channel and enhance with riparian vegetation and woody debris.

- Alternative 4: Construct Meridian Creek channel and improve outlet, using Alternative 4 Alignment. See Lake Meridian Outlet Plan and Typical Section drawing. Construct a new channel and enhance with riparian vegetation and woody debris.

Recommended Plan

Alternative 2 was selected for feasibility evaluation by the United States Army Corps of Engineers (USACE) because the alignment minimized damage to existing vegetation. The No Action alternative does not meet the purpose of the project and is not a viable option for this site. Construction of the proposed realignments will achieve project goals by providing passage to Lake Meridian and rearing habitat for salmonid species. Alternative 3 was dropped because of its potential for fish stranding and high pond temperatures. Alternative 4 was dropped because of higher construction costs due to its length but should be examined later because of its uniform reduced slope.

Depending on the specific needs of the salmonids that will be supported by the project, it may be necessary to augment the natural flow regime at the lake outlet. The current lake outlet is an unregulated open channel that goes dry during the summer months. If necessary, the outlet could be modified by the addition of an outlet control structure. The addition of the control structure would allow for prolonged storage of water with regulated releases to meet in-stream needs during the summer. Establishment of a pump system is another option that may be considered to augment flows.

Habitat enhancement consists of woody debris and riparian vegetation. The Lake Meridian Outlet Plan drawing references riparian plantings and woody debris drawings. Woody debris should be staggered on alternating sides of the channel at random locations averaging two stream width intervals. The riparian planting zone should extend from the bank full condition 100 feet on both sides of the reach. In-channel vegetation is specified in the drawing as water fluctuation zone plantings. Plantings were based on the assumption that flows are ongoing, however, site conditions should be evaluated before planting occurs in the water fluctuation zone.

To design the channel, channel parameters such as bottom width and Manning's Coefficient (n) were varied in order to achieve reasonable fish passage depths and velocities. Using Manning's Equation for normal flow, roughness values of 0.08 were assumed in the channel designs.
The project area includes 2 average slope regimes, Reach A and Reach B. Based on available topography, the slopes for Reach A and Reach B are 0.011 (ft/ft) and 0.056 (ft/ft), respectively. Because a 1-stage, vegetated, trapezoidal channel yielded normal depths considered too shallow (about 0.5 foot), both channels were designed as 2-stage. The main channel of the realignment was designed to convey the 5-year event, while the overbank areas were designed to the 50-year capacity. A freeboard of 1-foot was included in the overbank channel designs. . Prior to project constructions studies should be made to see if a 50 year bank full design is desirable or would it be better if it were I the 2 to 5 year event as this would allow more wetland and bank recharge opportunities. Also an erosion control study is needed in order to located needed erosion control features for this project.

Table 2 summarizes the estimated parameters of the two chosen channel designs. Overbank channel depth includes 1 foot of freeboard.

Table 2. Summary of Channel Variables.

	Reach A, S = 0.011 ft/ft		Reach B, S = 0.056 ft/ft	
	5 Year Event (main channel)	50 Year Event (overbank)	5 Year Event (main channel)	50 Year Event (overbank)
Flow (cfs)	9	13	9	13
Flow Depth (ft)	1	2	1	1
Channel Depth (ft)	1	3	1	2
Average Velocity (fps)	2	1	3	2

The slope of Reach B indicates that it may require grade control structures to reduce channel erosion. If the proposed Reach B channel follows a slope similar to the existing grade, it would form a step-pool morphology (Montgomery and Buffington, 1993). For feasibility purposes, a two-stage channel with woody debris morphology has been assumed. Further analysis may show that a step-pool morphology is necessary for stable channel design.

Stream flow and hydraulics at the confluence of the re-alignment and Soos Creek should be evaluated in subsequent design efforts. Woody debris may need to be installed to prevent stream bank erosion and provide grade control to reduce potential down-cutting upstream of the confluence.

Cost Items and Quantities

Construction line items and quantities shown in the MCACES portion of the attached engineering appendix. The table was developed as a standard to be used for all of the sites. Quantities were calculated based on the information obtained from mapping. A 15 percent contingency was added to the quantities. An additional 25 percent cost contingency will be added when the USACE prepares the cost estimate unless otherwise specified.

Conclusions and Recommendations

The Lake Meridian Outlet project can meet the project purpose with the recommended channel and habitat improvements. The following items should be considered in the advanced engineering and design phase:

1. The uncertainty of summer flows at the Lake outlet may prohibit the feasibility of this project.
2. A more detailed hydrologic and hydraulic analysis is recommended in final design to ensure that appropriate fish passage depths and velocities are achieved.

3. Stream flow and hydraulics at the confluence of the re-alignment and Soos Creek should be evaluated in final design.
4. Wood may need to be installed to prevent stream bank erosion.
5. Potential sediment issues and down-cutting should be addressed.
6. It may be necessary to augment summer flows from the lake using a modified outlet control and/or pumping.

Figures

Lake Meridian Outlet Plan and Typical Section
2-Stage Channel Riverine Planting Scheme Detail
2-Stage Woody Debris Detail

References

City of Kent, Letter from City of Kent Public Works Engineering Department to Corps of Engineers, Seattle District with regard to supporting materials to Kent projects in the Green Duwamish Ecosystem Restoration Study, May 12, 1999

GeoEngineers, Geologic and Geotechnical Services, Lake Meridian Outlet Creek Realignment Feasibility Study, February 15, 1999

Montgomery, D. R., and Buffington, J. M., Channel classification, prediction of channel response, and assessment of channel condition, Report TFW-SH10-93-002 prepared for the SHAMW committee of the Washington State Timber/Fish/Wildlife Agreement, 1993

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Olson Creek

Location
Olson Creek is a tributary to the Green River located partially within the City of Auburn, WA. The proposed project includes the reach from the confluence with the Green River and extends approximately 1500 feet upstream. The majority of this portion of the creek is within the Auburn City limits.

Project Constraints/Problems
Flows during the summer are colder than the Green River and considered high quality. The failure of an upstream culvert and erosion from the area has caused sediment laden pools, reducing the quality of salmonid habitat and the transport capacity in the reach.

Green River discharge is controlled by Howard Hanson Dam (HHD) located at River Mile (RM) 64.5. HHD provides flood control management for the Standard Project Flood (SPF) of 12,000 cfs (approximately the 500-year frequency event) at the United States Geological Society (USGS) gage near Auburn (USACE, 1997). However, the site has experienced a high flow of approximately 13,000 cfs measured at Auburn during the 1996 flood event (Perkins, 1998). HHD also provides for a minimum instream flow of 110 cfs during all summer months (USACE, 1997). Since the construction of HHD the minimum flow at the USGS site near Auburn is 152 cfs recorded on October 30, 1987.

The proposed project will restore approximately 1500 feet of tributary channel as enhanced habitat and should not impact current flow conditions or increase current flood elevations.

Sedimentation within the channel and at the confluence of the Green River is a potential concern. This area may be prone to deposition due to the grade break near the confluence. The sediment budget must be maintained to avoid blocking flows within the reach.

Summer flow conditions in Olson Creek are uncertain. It will be necessary to identify stream conditions to insure improved habitat criteria is meet.

Project Goals
The project purpose is to improve access to the tributary from the Green River, enhance the tributary habitat, restore ecological integrity, and provide summer and winter rearing habitat for salmonid species.

Project construction should be limited to the tributary area and minimize the impact to existing vegetation. Erosion and sedimentation control measures should be considered to

prevent the transport of sediment into the Green River. Excavated material should be removed from the site. The project design should include large woody debris (LWD) and riparian plantings. Invasive plant species should be removed. Close coordination with the City of Kent Parks Department is required before the beginning of construction.

Proposed Solutions

- Alternative 1: No Action. No modifications to the existing stream conditions. Habitat conditions would remain unchanged.

- Alternative 2: 2-Stage Channel. Remove excess gravel load, install woody debris and riparian plantings. Create a 2-stage channel to provide increased depth during low flow conditions.

Recommended Plan

Alternatives 2, the recommended plan, will address project goals by improving current habitat conditions in a timely manner. Alternative 1, the No Action alternative, was considered a viable option for this site. Excessive sediment in the channel appears to be from a one-time event. Additional sources of sediment from inner gorge mass wasting do not appear to be persistent. Considering that the degraded conditions are likely to improve over time if urbanization in the upper basin does not further alter the basin hydrology, financial resources could be allocated to best management practices (BMPs) in the upper basin. However, Alternative 1 improvements would not be immediately realized.

Excessive material from the creek should be removed. It will be necessary to determine these quantities before the beginning of construction. A preliminary assumption to determine the quantity of material to be excavated was based upon a 20 sq. ft. cross section for 1500 feet. A 2-stage channel has been assumed to provide additional stream depth during low flow conditions. The culvert located under Green River Road may not be properly sized. The advanced engineering phase should analyze the culvert and replace it if necessary.

The riparian planting zone should extend 50 feet on both sides of the channel. Approximately 50 percent of the lower 750 feet of riparian area will be planted as shown on the Olson Creek Plan and Profile. The Olson Creek Plan and Profile reference riparian drawings.

The use of clumped root wad structures to provide further stability and habitat benefits should be field placed at alternating sides in the new channel at the toe of the slope every 2-stream widths on average. Root wad structures should be mixed with smaller packing pieces to increase cover from avian predators. Logs spanning the channel could be used to trap more wood and potentially create dam pools.

Construction Cost Items and Quantities

Construction line costs and quantities are shown in the MCACES portion of the engineering appendix. Quantities and costs were estimated from information obtained

during HDR's site visit and topographical maps provided by the Corps. A 15 percent contingency has been added to the quantities given the bounds of the study. An additional 25 percent cost contingency will be added when the USACE prepares the cost estimate unless otherwise specified.

Conclusions and Recommendations

The Olson Creek project can meet the project purpose with the recommended tributary improvements. The following items should be considered in the advanced engineering and design phase:

1. Stream flow conditions should be evaluated to determine low, average, and peak flow to ensure that appropriate tributary enhancement is achieved.
2. Delineate excessive quantities of material to be excavated.
3. Long term maintenance issues.
4. Hydraulic analysis of culvert to determine if it needs to be replaced.
5. H&H studies of the entire water shed to include a sediment analysis and its effects on the proposed project
6. Geotechnical analysis of the canyon stability and its effect on a proposed future project.

Figures

Olson Creek Plan, Profile and Typical Section
2-Stage Riverine Planting Scheme Detail
2-Stage Woody Debris Detail

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Riverside Estates Side Channel

Location
Riverside Estates Side Channel is named after the existing residential development located near 37th Street NE in the City of Auburn, WA. The site is located at River Mile (RM) 28.8, behind Reddington Levee that currently provides flood protection. The proposed project includes the reach from an existing flap-gated culvert in the levee approximately 1500 feet upstream.

Project Constraints/Problems
The Riverside Estates Side Channel is described in Perkins (1998) as the main channel of the Green River from before 1936 until at least 1960. Currently the Green River at this site is locally constrained by levees on both banks to provide for local flood protection. A flap-gated culvert was installed in the levee to allow the old channel to drain after flooding (Perkins, 1998). Perkins (1998) states that Riverside Estates is below the design flood elevation and is designated Zone AH on the Flood Insurance Rate Map (areas of ponding with flood depths of 1 to 3 feet). The old channel has a well-established cottonwood dominated canopy with heavy ground vegetation. An established ditch leading to the existing flap-gated culvert existed in 1998 and Perkins (1998) believes that minor flooding occurs when the abandoned channel floods due to seepage through the levee. Through flood control and channelization, the current side channel has reduced ability to provide habitat, refugia and channel diversity.

The primary concern is to maintain the current level of flood protection while providing for the project purpose. Howard Hanson Dam located at RM 64.5 provides flood control management for the Standard Project Flood (SPF) of 12,000 cfs (approximately the 500-year frequency event) at the United States Geological Society (USGS) gage near Auburn (USACE, 1997). The Howard Hanson Dam also provides for a minimum instream flow of 110 cfs during all summer months (USACE, 1997). The present safe channel capacity downstream of Auburn is approximately 12,000 cfs.

The proposed project will restore approximately 1500 feet of side channel as reclaimed habitat and should not impact current flow conditions or increase current flood elevations.

Groundwater elevations in the side channel are unknown. However, the side channel area is often wet and may be hydraulically connected to the present mainstem of the Green River. A groundwater analysis including piezometers will be done prior to construction.

Project Goals
The project purpose is to re-establish the side channel habitat to provide summer rearing habitat, and winter refugia while maintaining the existing level of flood protection to the local region.

Project construction should be limited to the side channel area and the levee while minimizing the impact to existing vegetation. Erosion and sedimentation control measures should be considered to prevent the transport of sediment into the Green River. Excavated material should be removed from the site. The side channel design should include large woody debris (LWD) and riparian plantings to provide enhanced habitat.

Proposed Solutions

- Alternative 1: No Action. No modifications to the existing stream conditions. Habitat conditions would remain unchanged.

- Alternative 2: Levee Setback. Construct new levee between abandoned side channel and Riverside Estates to allow for reclamation of side channel for habitat enhancement.

- Alternative 3: Side Channel Modification. Create a groundwater collection pond at the head of the side channel to provide for low summer flows. Replace the existing flap-gated culvert with a new self-regulating tidegate (SRT). Connect pond with mainstem of the Green River by cutting a new channel from the pond to the new tidegate. The new channel will be approximately 1500 feet in length and constructed to permit conveyance of approximately 1-2 cfs during low flow conditions.

- Alternative 4: Perkins 1998. This alternative is based upon Perkins' recommendations in her Feasibility Report (Perkins, 1998). Move the lower portion of the levee upstream across the old abandoned channel to provide storm water detention for Riverside Estates during high flow conditions. Move the existing flap-gated culvert upstream to provide drainage of the detention area. Excavate backwater channel connection to promote seasonal backwater flooding.

Recommended Plan
Alternative 3 is the recommended alternative. Alternative 1, the No Action alternative, does not meet the purpose of the project and is not a viable option for this site. Alternatives 2, 3, and 4 meet the project purpose. Alternative 2, the levee setback, was eliminated because of the small amount of space gained by moving the levee. Alternative 3, the side channel modification would provide for project purpose, maintain the current level of flood protection, and reduced construction impacts. Alternative 4, would require a significant construction effort to move the levee, relocate the existing flap-gated culvert, relocate the existing Green River Trail with a minimum of reclaimed habitat. Additionally, Alternative 4 is not popular with Riverside Estates residence.

For project feasibility analysis, the Corps provided water surface elevations for two mainstem discharge rates (200 cfs and 12,000 cfs) at the project location. Water surface elevations for average summer and winter flows were estimated from a linear interpolation of these data. By visual inspection of recent mean monthly flows for the months of November through February recorded at Auburn, an average winter flow of 2000 cfs was assumed. Further refinements of the proposed side channel hydraulics will be necessary in subsequent design efforts.

A groundwater collection pond will be created at the head of the existing side channel. The pond is based upon the Lower Cedar River Flood Control Mitigation site plan with a side slope ratio of 3H:1V. The pond has been designed to be 10 feet in depth based upon discussions with the United States Army Corps of Engineers (USACE). The ground water source has proven to be a clean and sediment free in other applications.

The proposed channel is about 1500 feet in length and maintains a constant slope (0.0029 ft/ft). The proposed channel has been designed to be trapezoidal in shape, have 2H:1V side slopes, a 1-ft bottom width, a water depth of 0.75 feet, and convey approximately 2 cfs. Parameters used to design the channel include a Manning coefficient (n) of 0.045 and a stream length of 1500 feet. Channel dendrites have been added to avoid stranding fish. For erosion and sedimentation control a coir fabric can be used until the bank is stabilized by vegetation. The use of root wad structures to provide further stability and habitat benefits should be field placed at alternating sides in the new channel at the toe of the slope every 10 feet on average. Additional habitat enhancement consists of woody debris, riparian vegetation, and 18 inches of gravel to be placed on the bottom of the channel for Chum Salmon spawning. The riparian planting zone should extend 50 feet on both sides of the channel. Additional channel diversity could be achieved with the addition of step-pools. The Riverside Estates Plan, Profile, and Typical Section reference riparian and woody debris drawings. SRT details have also been included. It will be necessary to further address proposed side channel hydraulics in advanced engineering design efforts.

The new channel will connect to the mainstem of the Green River through the SRT. The proposed SRT is a float-actuated water control value. The SRT allows the side channel to discharge during low flow conditions. During rising flow conditions, the SRT allows for flow into the side channel. At a designated discharge elevation, the SRT will close providing refugia for species while maintaining the existing level of flood protection to the local region. The SRT will reopen once the high flows have receded. An upstream wing wall is recommended to protect the SRT from high flow debris. Further calculations will be necessary to properly set the required SRT elevations to optimize habitat enhancement and refugia.

Construction Cost Items and Quantities

Construction line costs and quantities are shown in the MCACES portion of the attached engineering appendix. Quantities and costs were estimated from information obtained during HDR's site visit and topographical maps provided by the Corps. A 15 percent contingency has been added to the quantities given the bounds of the study. An

additional 25 percent cost contingency will be added when the USACE prepares the cost estimate unless otherwise specified.

Conclusions and Recommendations

The Riverside Estate Side Channel Project can be reclaimed to meet the project purpose with the recommended channel and habitat improvements. The following items should be considered in the advanced engineering design phase:

- A detailed hydrologic and hydraulic analysis is recommended to ensure that appropriate habitat enhancement and refugia are achieved.
- Stream flow and hydraulics at the existing flap-gated culvert should be evaluated to set elevations for the proposed SRT.
- Determine the required elevation for closure of the SRT to maintain existing flooding and detention benefits.
- A groundwater study is recommended to analyze the new channel and groundwater collection pond.
- A geotechnical analysis of the site soil composition is recommended to determine stable slope angles and failure potential.

Figures

Riverside Estates Plan, Profile, and Typical Section
Self Regulating Tidegate Details
1-Stage Riverine Planting Scheme Detail
1-Stage Woody Debris Drawing

References

Perkins, S. J., Geomorphic Feasibility Report for Reddington Levee, report to the US Army Corps of Engineers, Seattle District, October, 1998

US Army Corps of Engineers, Green River Water Surface Profiles, Seattle District

US Army Corps of Engineers, Reconnaissance Report, Green-Duwamish River Ecosystem Restoration General Investigation, Green-Duwamish River, King County, Washington, March, 1997

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Mainstem Maintenance

Location
The location of the proposed project is the reach from Auburn to Tukwila from River Mile 17 to River Mile 32. In this stretch the river is confined by a levee and bank stabilization project and significant development. The project sites are adjacent to urban and industrial development.

Site Constraints/Problems
The combination of the Howard Hanson Dam and the construction of numerous levees and urban developments have combined to reduce the historical transport rates of sediment, channel migration across the Green River floodway, and the inundation of a significant portion of its floodplain. The construction of these levees and revetments, and the controlled flow release of the dam, has contributed to the river's inability to carve (or even flood) some side channels. Also in this portion of the river the majority of the banks have been hardened and trees and other fish friendly structures have been removed to make the river as efficient as possible. This channel reduction has significantly reduced the amount of rearing habitat available to almost all fish species and has made any existing off stream side channels and accessible wetlands into critical habitat. Also historically the alternative that has been used to maintain the stability of these banks and levees systems is rock protection of the entire effected area. Riprap or rock bank protections have very little or known value to resident or anadromos fish.

The fisheries resources of the existing river include chinook and coho salmon (*Oncorhynchus kisutch*) and anadromous and resident cutthroat trout (*O. clarki clarki*) The pre-disturbed Lower Green River supported a much larger population of spawning and juvenile salmon than it presently does, when the Green River scoured the small wall tributaries and side channels on an annual basis before construction of the Howard Hanson Dam. Many side channel areas were cleared of most trees, and now lack wetland connections, which provided deep rearing pools, critical habitat for salmonids. Also lacking in the Lower Green River is the Large Wood that provided a significant amount of habitat prior to it being removed for agricultural practices and urban development. In summary, there is a critical need for more fish habitat in the Lower Green River to improve the survivability of downstream moving juveniles

Project Goals
The goal of the project is to improve the fish habitat in the lower Green River corridor and provide stable bank and levee conditions for the protection of significant

development in this reach. To achieve these goals, the Corps will work with King County and the Local Dike Improvement District over a 10 year period to implement fish friendly, bio-engineered solutions to the maintenance problems on the River.

Proposed Solutions

- Alternative No. 1 – No action to enhance the existing stream system.

- Alternative No. 2 – The recommended plan, will work with King County and the Diking Improvement District over a 10 year period to help implement bio-engineered solutions to bank and levee slope instability projects on the lower Green River. This project would include the implementation of approximately 5 to 7 miles of dike improvements throughout the lower Green River.

- Alternative No. 3 – Place LWD within the lower Green River channel.

Recommended Plan

Alternative No. 1 – No action was rejected since the need for additional good fish habitat in the lower Green River basin is critical to the overall fish habitat ecosystem through the entire green.

Alternative No. 2 – The recommended plan, involves working with the County and the District on enhancing the overall environmental heath of the lower Green River. Part of this plan will include a river model that will help insure that with the placement of bio-engineered structures do not jeopardize the existing flood control in the lower Green River system. The limiting factors analysis shows that this habitat is critical to the fisheries resources of the lower Green River.

Alternative No. 3 – Placing LWD in the lower Green River is possible but additional studies are needed to insure uncompromising flood control capability of the stream. This alternative is acceptable in locations where we will increase the flow capacity of the stream channel by modifying the bank slope angles for increased bank stability. Prior to construction, an h&h analysis of actual existing wood structures would be completed to determine the Manning n of these proposed in river structures. The proposed LWD design, according to design experience of 11 sites-already in place on other river systems, will minimize the loss of large wood from the structures. LWD placement should consider alternative locations, where flow conveyance is not hydraulically effective (i.e., inside sharp bends, downstream of contractions, etc.) and flood control functions, potentially, are minimally effected. Other alternative locations include portions of the bank that are a given height above the channel bottom or freeboard areas. In general, a significant analysis of flood elevations must be completed prior to construction.

Cost Items and Quantities

Construction items and quantities are shown in the MCACES portion of the attached engineering appendix. The table has been developed as a standard to be used for all of the sites. Those line items not applicable are left blank in the table. Quantities were

calculated based on the information obtained by a King County Department of Natural Resources site visit and from mapping. Additional property easement acquisition would be necessary along with the easements already acquired.

Conclusions and Recommendations

We recommend the implementation of a plan that would allow the Corps to work with the County and District on implementation of a comprehensive bio-engineered program for bank stabilization over a 10 year period.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Porter Levee Setback

Location

This site is one mile upstream of the crossing of Highway 18 and the Green River. It is on the right bank of the river near the Meat Market.

Site Constraints/Problems

Much of the historic flood plain for this portion of the Green River has been converted to agriculture. Levees confine the river to its current position limiting the rivers' ability to meander and make new channels. Only limited places allow the river to spill over its banks to re-charge the adjacent flood plain. These alterations in channel morphology have significantly decreased spawning habitat in the mainstream, reduced flood storage capacity and limited nutrient export from the adjacent terrestrial system. This project would follow the purchase and side channel re-connection project -Section 1135, Early Action Project of 1999. Two site considerations need to be addressed:

1. Is the current agriculture land in a program that would discourage the removal of the training levee and replacement of it back on the Green River Valley Road.
2. The first restoration phase of the area was completed in 1999. A portion of the training levee was removed to re-connect the river to an old slough. If the entire training levee is removed there is a chance the river will occupy this former levee and convert off-channel habitat to the mainstream. If this occurs, newer off-channel habitat could be created by the river as the river shifts from the current channel.

Project Goals

The site (mainstream of the river) currently provides excellent spawning habitat for chinook and over-wintering habitat for juveniles, and refuge from high flows for multiple species (in the recently connected slough). The proposed action is to use land already purchased by the county that was former flood plain - protected from the river by an existing training levee. Potentially, 45 acres of flood plain could be restored to being directly effected by the river by removing the training levee. The goal of the project is to allow the river to move or meander across the former flood plain, increasing channel length in a highly productive chinook spawning area. Benefits include creating additional off-channel habitat, improving nutrient export, and increasing base flow and flood storage capacity.

Proposed Solutions
Three alternatives have been considered. They include:

- Alternative One: This is the no-action alternative where the status quo is maintained.

- Alternative Two: This alternative is a compromise option. The existing training levee would be removed, including its rock toe, and re-constructed half way back in the farm field adjacent to the existing road for the entire length of the project. About twenty acres of flood plain would be reconnected. Uneven compaction under the new rock levee, allowing seepage under the new levee is a potential concern. A small (200ft long) levee would be constructed at the upstream portion of the property to protect the adjacent landowners.

- Alternative Three: This is the full restoration option. The existing training levee would be removed including its toe, and placed at the toe of Green River Valley Road. About 1800 linear ft. of new levee would be constructed there. In addition, a small 200-ft levee would be constructed on the up riverside of the property adjacent to the river to prevent flooding to neighboring property. This alternative restores about 45 acres of flood plain; large woody debris could be placed in the flood plain and plantings done along the river.

Recommended Plan
Alternative three meets the goals of the project and provides the greatest amount of restoration for expenditure of resources.

Cost Items and Quantities
Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.

Conclusions and Recommendations
Alternative three is the best way to meet project goals. This alternative provides a feasible opportunity to reconnect a large portion of the flood plain and allow the river to meander - increasing channel length. The site is currently in agriculture but is routinely flooded in the spring. A flood analysis should be done during plans and specifications. Also an upstream and downstream effect on flow and sediment transport characteristics of the Green River will need to be determined prior to construction. This would be included in a complete h&h, geomorphological and geotec study.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Kaetch Side Channel

Location
The location of the existing side channel is on a gravel terrace just upstream of Neely Bridge on the right bank of the river. The proposed channel would enter the Green River at approximately river mile 35. The existing 300ft long channel would originate at an upstream source of flow and enter the Green River approximately 500 ft downstream.

Site Constraints/Problems
The combination of the Howard Hanson Dam and the construction of numerous levees have combined to reduce the historical transport rates of sediment, channel migration across the Green River floodway, and the inundation of a significant portion of its floodplain. The construction of these levees and revetments, and the controlled flow release of the dam, have contributed to the river's inability to carve (or even flood) some side channels. This channel reduction has significantly reduced the amount of rearing habitat available to almost all fish species and has made any existing off channel side channels into critical habitat; this is especially true if the channel can provide good water quality year around.

The fisheries resources of the existing side channel include coho salmon (*Oncorhynchus kisutch*) and anadromous and resident cutthroat trout (*O. clarki clarki*). The pre-disturbed Lower Green River supported a much larger population of spawning and juvenile salmon -due to the annual scouring of the small wall tributaries and side channels before construction of the Howard Hanson Dam. Many side channel areas were cleared of most trees, destroying wetland connections, which provided deep rearing pools and critical habitat for salmonids.

In summary, there is a critical need for more productive side channels within the Green River system. Healthy riparian growth, pool ripple habitat, large woody debris (LWD), backwater pools and other habitat features are essential for juvenile fish.

Project Goals
The primary goal of the project is to reestablish natural ecosysem processes in the side channel riparian corridor to increase salmonid rearing potential. This will involve constructing additional side channel and wetland refuge habitat within the Green River system.

Proposed Solutions

- Alternative No. 1 – No action to enhance the existing channel system.

- Alternative No. 2 – Action includes: construct a year round water source for an existing 300 foot long side channel that would then enter the Green River at the downstream end; plant native vegetation including Sitka spruce, Western red cedar, black cottonwood, bitter cherry, and cascara; enhance existing plants; remove exotic invasive species; protect channel buffer areas and encourage the establishment of a minimum 100-foot wide riparian buffer; restore and create connections to off-channel habitats for salmonids. This alternative would include a upstream pond that would be designed to capture ground water to feed the pond area.

- Alternative No. 3 – Place LWD within the channel.

Recommended Plan

Alternative No. 1 – No action was rejected since the need for additional good to excellent site channels is considered critical in the Green River.

Alternative No. 2 – This is the recommended alternative. Enhance the side channel corridor by establishing a coniferous native plant community within a channel buffer that is fenced off from livestock. A riparian corridor with a buffer width of a minimum100 feet for each bank is recommended. A coniferous tree cover is necessary for shade, cover, and insect production utilized by salmonids, and that provides an eventual in-stream LWD and structural complexity necessary for successful coho and cutthroat spawning and reproduction. The planting of conifers, such as native Sitka spruce and Western red cedar, and a native plant understory, would create shade and structural diversity in the channel riparian corridor and adjacent wetlands. Specifics include: provide plantings and acquire a 100-foot buffer on both sides of the proposed channel, from the existing side channel to its connection with the Green River, 500 feet downstream. The project would include a log and rock weir that would allow fish passage at all elevations and keep a fairly constant pond level.

Alternative No. 3 – Place LWD in the channel. This action may be phased following the stabilization of sediment input and the establishment of a coniferous riparian cover.

Cost Items and Quantities

Construction items and quantities are listed the MCACES portion of the attached engineering appendix. The table has been developed as a standard to be used for all of the sites. Those line items not applicable are left blank in the table. Quantities were calculated based on the information obtained by a King County Department of Natural Resources site visit and from mapping. Property easement acquisition would be necessary.

Conclusions and Recommendations

We recommend the construction of a water source for an existing 300 ft long side channel with adequate plantings and in-stream diversity including LWD, that will address

current shortages of critical habitat in the Green River System. Restoring channel function with native plant riparian communities, including the placement of spruce and cedar, would reduce forest fragmentation within the channel and improve shading and structural diversity. A ground water study including the instillation of pizometers would be done prior to project construction. Also a h&h analysis of how the proposed project and LWD reacts to flood flows needs to be done prior to construction.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Ray Creek

Location

Ray Creek (WRIA 09.0098) is a former side channel now occupied by a wall-based tributary located within the Green River floodplain. It joins the Green River at river mile 34.2, immediately downstream of the Nealy Bridge. The 2.3-mile-long stream originates within a former Green River side channel that formed along the right bank. The majority of Ray Creek is located within the south half of Sections 22 and 23, Township 21, and Range 5 East (vicinity map attached).

Site Constraints/Problems

The hydrologic regime of the Green River has been drastically changed. The combination of the Howard Hanson Dam and the construction of numerous levees have combined to reduce the historical transport rates of sediment, channel migration across the Green River floodway, and the inundation of a significant portion of its floodplain. The construction of these levees and revetments, and the controlled flow release of the dam, has contributed to the river's inability to carve (or even flood) some side channels.

The sediment source for Ray Creek within the Green River Valley floor seems to be primarily caused by livestock access to the stream and erosion of the floodplain by overgrazing. There are some sediment sources from a few small slope failures along the right bank.

The fisheries resources of Ray Creek include coho salmon (*Oncorhynchus kisutch*) and anadromous and resident cutthroat trout (*O. clarki clarki*) [Washington Department of Fisheries 1975]. The pre-disturbed Ray Creek supported a much larger population of spawning and juvenile coho salmon than it presently does, when the Green River scoured the small wall tributaries and side channels on an annual basis before construction of the Howard Hanson Dam. The tributary was cleared of most trees by 1936, and has lacked wetland connections, which provided deep rearing pools, critical habitat for salmonids. The entire stream reach studied lacked any significant coniferous or hardwood tree stream buffer, especially along the left bank.

In summary, Ray Creek is poor in instream large woody debris (LWD), lacks a coniferous riparian buffer, and is readily accessible to livestock that have muddied and eroded much of the streambank. Fish use in the lower reach is greatly limited by the large amount of sediment within the streambed, historical removal of natural instream structures that cause a lack of LWD, lack of cover, and the paucity of connected deep-water habitats most typically associated with large dammed or backwater pools.

Project Goals
The primary goal of the project is to restore and protect a native coniferous plant community within the riparian buffer and allow natural ecosystem processes to be re-established in the stream riparian corridor. Project goals include creating a natural environment to enhance salmonid rearing within the stream, reduce sediment impacts from cattle, and create additional connected refuge wetland habitat.

Proposed Solutions

- Alternative No. 1 – No action to enhance the existing stream system.

- Alternative No. 2 – Enhance the stream corridor throughout the entire length of Ray Creek with native vegetation that would include the planting of Sitka spruce, Western red cedar, black cottonwood, bitter cherry, and cascara. Enhance existing refugia of forest on the right bank, upslope of the stream. Remove exotic plant invasives. Protect stream buffer areas to exclude livestock through fencing, and encourage the establishment of a 200-foot-wide riparian buffer. Restore and create connections to off-channel habitats for salmonids. Remove the excessive finer sediment load within the streambed with vactoring (Vactor Truck).

- Alternative No. 3 – Place LWD within the channel.

Recommended Plan
Alternative No. 1 – No action was rejected since Ray Creek continues to be a source of juvenile refuge for salmonids and is a valuable source of cool spring-fed water.

Alternative No. 2 – Enhance the stream corridor by establishing a coniferous native plant community within a stream buffer that is fenced off from livestock. A riparian corridor with a buffer width of 100 feet for each bank is recommended. A coniferous tree cover is necessary for shade, cover, and insect production utilized by salmonids, and provides an eventual instream LWD and structural complexity necessary for successful coho and cutthroat spawning and reproduction. The planting of conifers, such as native Sitka spruce and Western red cedar, and a native plant understory, would create shade and structural diversity in the stream riparian corridor and adjacent wetlands. During final design structures for steam stability will be evaluated. Fencing off the buffer area is essential to protecting the riparian corridor. Specifics include:

- Plant, fence and acquire a 100-foot buffer on both sides of Ray Creek, from the King County property line (near the outlet) to 1,400 feet upstream.

- For the subsequent 2,300 feet upstream, plant both right and left banks; acquire a 100-foot buffer on both sides, with fencing along the left bank.

- The next 1,600 feet upstream would also be planted and fenced on both right and left banks; 100-foot buffers on both sides would be acquired.

- The wetland perimeter within the upper end of Ray Creek should be planted and fenced, with acquisition of a 100-foot buffer area for both sides of stream.

- Sediment may be vactored by a truck at key locations. Bank stabilization needs to be implemented first.

Alternative No. 3 – Placing LWD in the channel may be phased following the stabilization of sediment input and the establishment of a coniferous riparian cover. Any hydraulic diversity created by LWD might be readily buried with sediment.

Cost Items and Quantities

Construction items and quantities are shown in the MCACES portion of the attached engineering appendix. Those line items not applicable are left blank in the table. Quantities were calculated based on the information obtained by a King County Department of Natural Resources site visit and from mapping.

Conclusions and Recommendations

The stream riparian native plant community restoration, including the placement of spruce and cedar, would reduce forest fragmentation within the stream and stream floodway and improve shading and structural diversity of the channel. Removal of finer-sized sediment accumulations can be achieved by using a vactor method. Fencing and eliminating livestock destruction of the stream bank is also a restoration alternative. As part of the final design, we recommend that a detailed property survey and analysis be conducted for the purpose of establishing the 200-foot stream riparian buffer and purchasing easement property. A complete h&h analysis needs to be done on this creek prior to project construction as well as an analysis of sediment yield and transport characteristics of the creek. Also design input will be used to design a project that minimizes maintenance.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Hamakami Levee Breach

Location
The location of the proposed Levee Breach is in the vicinity of an existing training levee at approximately river mile 36. The proposed site is adjacent to crop lands and a forested wetland that is landward of the training levee. The wetland landward of the existing levee was a former meander that was separated from the Hamakami levee in 1960.

Site Constraints/Problems
The combination of the Howard Hanson Dam and the construction of numerous levees have combined to reduce the historical transport rates of sediment, channel migration across the Green River floodway, and the inundation of a significant portion of its floodplain. The construction of these levees and revetments, and the controlled flow release of the dam, has contributed to the river's inability to carve (or even flood) some side channels. This channel reduction has significantly reduced the amount of rearing habitat available to almost all fish species and has made any existing off stream side channels and accessible wetlands into critical habitat.

The fisheries resources of the existing river include chinook and coho salmon (*Oncorhynchus kisutch*) and anadromous and resident cutthroat trout (*O. clarki clarki*) s. The pre-disturbed Lower Green River supported a much larger population of spawning and juvenile salmon -due to the annual scouring of the small wall tributaries and side channels before construction of the Howard Hanson Dam. Many side channel areas were cleared of most trees, destroying wetland connections, which provided deep rearing pools and critical habitat for salmonids.

In summary, there is a critical need for more access by fish to existing wetlands especially forested wetlands adjacent to the river. Remaining wetlands connected to the river will be used as models for the proposed wetland connections.

Project Goals
The primary goal of the project is to connect an existing forested wetland to the river to be used for fish habitat. This involves creating a natural environment –used as refuge wetland habitat-to enhance salmonid rearing.

Proposed Solutions
- Alternative No. 1 – No action to enhance the existing stream system.

- Alternative No. 2 – Construct two 175ft long channels which would provide access to an existing forested wetland Construct a third channel on the downstream end of

the forested wetland to insure that during low water periods the fish have egress from the forested wetland. Plant the new channels and augment the natural wetland vegetation as necessary.

- Alternative No. 3 – Place LWD within the channel.

Recommended Plan
Alternative No. 1 – No action was rejected since the need for additional good to excellent side channels is considered critical in the Green River.

Alternative No. 2 – The recommended plan. Enhance the forested wetland by connecting it with two inflow channels and one outlet channel. These channels will be designed to minimize maintenance. This plan provides the necessary side channel habitat that will significantly enhance fish usage of this site. The limiting factors analysis shows that this habitat is critical to the fishery resources of the middle Green River.

Alternative No. 3 – Placing LWD in the access channels and wetland may be phased following the stabilization of sediment input and the establishment of a coniferous riparian cover.

Cost Items and Quantities
Construction items and quantities are shown in the MCACES portion of the attached engineering appendix. The table has been developed as a standard to be used for all of the sites. Those line items not applicable are left blank in the table. Quantities were calculated based on the information obtained by a King County Department of Natural Resources site visit and from mapping. Property easement acquisition would be necessary.

Conclusions and Recommendations
We recommend the construction of two 175 ft long land access channels and one 175 ft long drainage channel which would help reduce the need for this critical habitat in the Green River System. Restoring this wetland function by connecting it to the river would help provide critical habitat for salmon refuge and rearing. H&H studies will be conducted to insure this project will cause no additional flooding of land adjacent to and downstream of the levee and to design channels that will require very little maintenance. The levee is only a training levee and is designed to keep the river in its present location, Under present conditions, the floodplain and wetland inland from the levee are flooded regularly due to upstream overtopping of the floodplain. We will do additional studies to insure that the project does not effect the stability of the existing levee.

SITE NO. 29

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Turley Levee Setback

Location
The location of the existing levee is at River Mile 37 about 2 miles upstream of Neeley Bridge. The proposed project would include moving approximatelly 800 feet of levee back approximatelly 500 feet. This would allow a significant amount of area to be open to the power of the river to flood and work on this new area and sculped it into new fish habitat.

Site Constraints/Problems
The combination of the Howard Hanson Dam and the construction of numerous levees have combined to reduce the historical transport rates of sediment, channel migration across the Green River floodway, and the inundation of a significant portion of its floodplain. The construction of these levees and revetments, and the controlled flow release of the dam, has contributed to the river's inability to carve (or even flood) some side channels. This channel reduction has significantly reduced the amount of rearing habitat available to almost all fish species and has made any existing off channel side channels into critical habitat. This is especially true if the channel can provide good water quality year around.

The fisheries resources of the existing side channel include coho salmon (*Oncorhynchus kisutch*) and anadromous and resident cutthroat trout (*O. clarki clarki*) The pre-disturbed Middle Green River a much larger population of spawning and juvenile salmon than it presently does, when the Green River scoured the small wall tributaries and side channels on an annual basis before construction of the Howard Hanson Dam. Many side channel areas were cleared of most trees , and has lacked wetland connections, which provided deep rearing pools, critical habitat for salmonids.

In summary, there is a critical need for more good river and side channel habitat within the green river system with good riparian growth, pool ripple habitat, large woody debris (LWD) and other habitat features that is readily available to juvenile fish.

Project Goals
The primary goal of the project is to make additional area avalible to the river for it to construct additional side channel habitat within the Green River system in order to allow natural ecosystem processes to be re-established in the side channel riparian corridor.

Project goals include creating as natural an environment as possible to enhance salmonid rearing within the area now open to the river and let the river create refuge wetland habitat.

Proposed Solutions

- Alternative No. 1 – No action to enhance the existing channel system.

- Alternative No. 2 – Allow the river to reaquire access of over 1300 feet of additional river edge and allow it to create additional side channel and main channel habitat. This project would require native vegetation that would include the planting of Sitka spruce, western red cedar, black cottonwood, bitter cherry, and cascara. Enhance existing plants. The project would also require the construction of setback levees tp protect the existing farmland.

- Alternative No. 3 – Place LWD within the setback area.

Recommended Plan

Alternative No. 1 – No action was rejected since the need for additional good to excellent site channels is considered critical in the Green River.

Alternative No. 2 – Open up 1300 feet of river edge to the river by removing and setting back an existing levee so the river can be allowed the freedom to construct additional side channels and off channel areas for fish and wildlife habitat. Construct a let back levee to protect the adjacent farmland and residences from the river. In certain locations additional tree cover will be provided for shade, cover, and insect production utilized by salmonids. The tree cover will eventual provide inchannel LWD and structural complexity necessary for potential successful coho and cutthroat spawning and reproduction. The planting of conifers, such as native Sitka spruce and western red cedar, and a native plant understory, would create shade and structural diversity in the channel riparian corridor and adjacent wetlands. Construct an outlet channel on the downstream end of the project.

Alternative No. 3 – Placing LWD in the levee setback area may be phased following the temporary stabilization of the river channel and the establishment of a coniferous riparian cover.

Cost Items and Quantities

Project quantities and costs are in the attached MCASES cost estimate in this appendix.

Conclusions and Recommendations

We recommend the elimination of an existing levee and construction of a new levee about 500 feet back from the river which will open up approximately 12 acres of land that are currently out of the active river flood way. The project would also include adequate plantings and in channel diversity from channel design and LWD to help reduce

the need for this critical habitat in the Green River System. An h&h, geomorphological and geotec analysis on this site would be done prior to construction.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Lones Levee Removal

Location

The project site lies approximately 1,000 feet south of the 17200 block of Southeast Green Valley Road and on the right bank of the Green River at about river mile (RM) 38 in the south half of Section 25, Township 21 North, Range 5 East.

Site Constraints/Problems

The dynamic natural channel-forming processes associated with the historical Green River have been severely impeded by the construction of revetments and levees that have artificially restricted channel widths. These constraints limit channel-migration activities, side-channel formation, and the creation of variable habitat types that are critical for sustaining viable salmonid populations in the Green River. The construction of the Howard Hanson Dam (~RM 62) flood-control facility has compromised much of the Green River's ability to function as a natural river system. The dam has deprived the lower Green River of upland sediment sources that have historically replenished the river system since the retreat of Puget Sound glaciers. Howard Hanson Dam operations now dampen and control peak flow events that once had a profound influence on Green River channel-migration patterns. The Green River is slowly undergoing an incision process, and the river has assumed a uniform, single-thread channel configuration over most of its length. Meander bends and side channels have become stranded and disconnected from the active channel.

The Lones Levee was constructed in 1960 as a training levee to prevent the middle Green River from migrating northward, in a progressive meander bend, into agricultural/ farmland. The agricultural/farmland sits on a terrace located 2 feet above the critical 12,000-cubic-foot-per-second flow rate regulated by the Howard Hanson Dam. The levee was not designed to prevent flooding; floodwaters currently flow around both ends of the levee as well as through the old meander bend. The Lones Levee has slowly developed a dampening influence on channel-migration activity for approximately 0.5 miles downstream of the site, where a straighter channel void of side channels has formed. This reach of the Green River lacks a considerable amount of habitat complexity, channel-migration capability, and floodplain connectivity that are important functional elements of riverine ecosystems.

Project Goals
The basic goal of this project is to restore natural channel-migration processes that are consistent with present-day flow regimes attributable to the Green River. The Lones Levee is situated close to the downstream terminus of the most active channel-migration zone in the middle Green River. This reach of the river, in Metzler and O'Grady Parks, is distinguished by large-amplitude meander bends, braiding (anabranches), cutoffs, and avulsions. By removing the Lones Levee and re-establishing channel-forming processes, the middle Green River will be allowed to reoccupy and reset old meander bends and channel-migration zones. The re-occupation of these areas will create a diversity of complex habitat types suitable for many fish and other species.

Proposed Solutions
Three alternatives have been considered for the Lones Levee project:

- Alternative No. 1 – No action: Under this alternative, the project goals of restoring natural channel-forming and channel-migration processes would not be addressed.

- Alternative No. 2 – Restore the natural channel-forming processes and channel-migration zone to the middle Green River by implementing the following activities:

  - Remove the Lones Levee including its toe rock to match the existing ground elevations.

  - Excavate and construct a setback revetment/levee on the terrace just above the old meander bend to provide private property protection from potential channel migration.

  - Assess levee removal impacts to lower Burns Creek and evaluate the need for realignment of the creek channel.

  - Install Constructed Log Jams (CLJs) and large woody debris (LWD) near the upper end of the levee removal area and in selected sites, where appropriate, within the old meander bend/channel-migration zone.

  - Buy out parcels threatened by loss of the levee and/or setback-revetment protection. Purchase other properties and flood facility easements.

  - Remove the existing access road that crosses the old meander bend.

- Alternative No. 3 – Leave the Lones Levee in place and deepen the high-flow connection to Burns Creek. This will increase the amount of access to the former meander bend by winter flows. Additionally, remove the access road that crosses the old meander bend and excavate a downstream connection at the lower end of the levee to the river.

Recommended Plan
Alternative No. 1, no action, was rejected since it would not restore natural channel-migration processes to the Lones Levee reach of the middle Green River.

Alternative No. 2, to remove the levee, was selected as it provides an ecosystem process-based opportunity to restore natural channel-forming processes and channel-migration zones to the middle Green River. Removing the Lones Levee will not only allow the old meander bend to be reoccupied, but will also beneficially affect channel-migration zones immediately upstream and downstream of the existing levee. A variety of habitat types will be created over time and should provide rearing and spawning areas for a variety of salmonids and other fish species. Besides the emplacement of CLJs and LWD, recruitment of LWD complexes will occur from the reoccupation of the old meander bend. Larger-sized trees that have grown in the meander bend (since the Lones Levee construction) will have the potential to be recruited by the Green River.

The installation of a setback revetment or levee would provide protection to private property and simultaneously encourage ecosystem processes to re-establish. Burns Creek would naturally merge with the reoccupation of the old meander bend and provide refuge habitat and a cool water source to the meander bend.

Alternative No. 3 does not allow the Green River to naturally reoccupy the old meander bend or reactivate historical channel-migration zones. Complex habitat types associated with large rivers would not be able to develop by allowing the levee to remain in place. The main channel of the Green River would still remain in a relatively straight alignment and would not have any more ability to develop or recruit LWD complexes. This reach of the Green River would still remain spawning-limited. Excavated areas on the upstream and downstream ends of the levee would likely remain as only temporary connections and would not provide long-term access or benefits to the old meander bend.

Cost Items and Quantities
Construction line items and quantities shown in the MCACES portion of the attached engineering appendix.

Conclusions and Recommendations
Proceed with planning, design, and construction of Alternative No. 2. Design analyses and considerations should include the following: perform a hydraulic model of the Green River upstream and downstream of the Lones Levee; input channel geometry changes anticipated from the levee removal into the hydraulic model to analyze potential impacts; consider phasing the project to ensure that site locations for CLJs and LWD are optimized for maximum habitat benefits; evaluate realignment and reconnection of the confluence of Burns Creek to the Green River side channel behind the Lones Levee; conduct a detailed geomorphological and h&h study on this site to determine adequacy of the proposed levee alignment and length., and research the need for any floodplain adjustments that may be required by the Federal Emergency Management Agency.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Burns Creek

Location

Burns Creek (WRIA 09.0105) joins the Green River on the right bank at river mile 38, at the upstream end of the Lones Levee. Burns Creek is approximately 2.1 miles long and flows along the north side of Southeast Green Valley Road, roughly parallel to the Green River. The majority of Burns Creek is located within Section 21, Township 21, and Range 5 East.

Site Description

Burns Creek has an average gradient of 0.2 percent. Three main tributaries from the north side of the Green River Valley wall feed the creek. The two downstream tributaries flow through steep ravines that are subject to landslides, while the upstream tributary (the north fork) is a spring-fed, wall-based channel. Burns Creek provides juvenile rearing habitat for coho salmon, chinook salmon, and cutthroat trout and spawning habitat for chum salmon, coho salmon, and cutthroat trout.

Site Constraints/Problems

Two major landslides occurred in 1991 and 1995 in the Bell Ravine, a tributary to Burns Creek behind the Auburn Youth Resource House. These landslides continue to be active and feed sediments into the stream system during heavy rain events, though they are caused by groundwater exiting the ravine wall and not by channel incision. There is little sign that these landslides are "healing," and there is evidence that other sites in the ravine may begin sliding. Sediments from these landslides and from another much smaller slump immediately adjacent to the Auburn Youth Resource House were and continue to be deposited in the mainstem of Burns Creek. Aggradation of the streambed of Burns Creek causes flooding of a basement upstream of the confluence with the Bell Ravine tributary (18022 Green Valley Road) and several driveways downstream and has overtopped Green Valley Road. Landslide-derived sediment from the ravine has infilled the main channel of Burns Creek through the Auburn Youth Resource House property and damaged salmonid spawning and rearing habitat downstream.

Deficiencies in habitat diversity, in-stream woody debris, riparian vegetation, and spawning gravels are most likely limiting the anadromous and resident fish production in Burns Creek. The filling of pools and spawning gravels with sand from the landslides, and the occasional dredging of these sediments to maintain driveways crossing the creek, have damaged or impaired both rearing and spawning habitat for salmonids. Currently, the only gravel-bedded sections of Burns Creek lie immediately downstream of the

confluence with the Bell Ravine tributary, and this reach is probably the most prone to repeated disturbance and deposition due to the upstream landslides. The paucity of spawning substrate and cover is probably limiting the reproductive and juvenile rearing capacity of the stream.

As stated in the Geomorphic Feasibility Report for Burns Creek, prepared by Perkins GeoSciences, mass wasting in Bell Ravine and the consequent deposition of sediments in the valley below is probably a natural and ongoing process, perhaps aggravated by changes in the hydrology of the basin. This process is a problem because houses and roads are now located adjacent to Burns Creek, constricting its tendency to migrate under these conditions and resulting in flood/erosion damage to those properties.

The natural flow regime of the Green River has also been altered by the Howard Hanson Dam upstream. During high-flow events, flood waters from the Green River may have scoured some of the sediments from the lower reaches of Burns Creek and recruited some of the sediment deposited from Bell Ravine when it routinely flooded this area prior to construction of the dam.

Project Goals

The goal of the Ecosystem Restoration Study for Burns Creek is to enhance salmonid habitat in Burns Creek and to reduce property damage associated with flooding and channel aggradation. This should be accomplished by restoring those functions of the stream that distribute sediments and recruit woody debris in a manner beneficial to aquatic species. Inherent in this goal is the establishment of some equilibrium of the processes of channel migration/formation and sediment transport and deposition. This equilibrium should either allow the stream system to respond to the deposition of sediment in a natural manner by migrating and flooding without causing further property damage, or alter the supply and/or transport of sediments in such a way as to allow the current channel configuration to stabilize, or some combination of these two.

Proposed Solutions

- Alternative No. 1 – No Action to the Existing Stream Conditions

  The "no action" option will allow the continuing buildup of fine sediment and gravel in Burns Creek. This, in turn, will result in the continued filling of any pools downstream of the Burns Creek/Bell Ravine confluence and continued decline in the quality and amount of gravel substrate suitable for salmonid spawning. This alternative will also likely result in migration of the channel below the confluence, eventual undermining of the driveway bridges, continued flooding of upstream properties, and possible flood and scour damage to Green Valley Road.

- Alternative No. 2 – Enhance Habitat Diversity of the Stream

  This alternative would improve streamside vegetation, increase in-stream habitat complexity, provide additional riparian cover, and manage fine silt. This can be accomplished by:

  - Native riparian vegetation plantings;
  - Addition of large woody debris (LWD) complexes to the channel;
  - Fencing to prevent livestock access to the creek and riparian areas;
  - Removal of exotic plant species; and
  - Removal of fine sediment.

  The following is a description of the proposed improvements to Burns Creek under this alternative broken down by six reaches and one tributary.

A. Reach 1 – Mouth of Creek to First Bridge at Southeast Green Valley Road (approximately 1,250 feet in length).

   This reach is of low gradient (1.5 to 4 percent) and much of the habitat is run/riffle with and estimated 30 percent pools and pocket water. LWD is sparse; only four LWD pieces occurred in this reach. Placement of several LWD pieces in-stream would help improve habitat complexity by introducing pools, shade, and refuge areas. However, delivery of LWD would be difficult, probably requiring a helicopter. No LWD should be installed in this reach until the sediment deposition problem has been resolved.

   Planting of native conifers (Western red cedar, Douglas fir, and/or Sitka spruce) throughout this reach would provide longer-lasting overhead cover and a long-term source of woody debris to the system.

   As part of a separate project proposing removal of Lones Levee at the confluence with the Green River, the lower half of this reach may be rerouted into a remnant side channel of the Green River.

B. Reach 2 – Bridge at Green Valley Road to first driveway crossing (Pederson, 17610 Southeast Green Valley Road) [approximately 1,250 feet in length].

   This reach is a fairly low-gradient, unconfined channel. Very little large substrate is found in this reach. There is some riparian vegetation that provides overhead cover, but there is a lack of in-stream structure and overhanging bank cover.

   The addition of approximately 15 pieces of LWD would provide overhead and in-stream cover and some structural complexity to this reach of stream. This could be easily and inexpensively accomplished using a crane placed on the adjacent road shoulder. However, no LWD should be installed in this reach until the sediment deposition problem has been resolved.

Planting of native conifers (Western red cedar, Douglas fir, and/or Sitka spruce) throughout this reach would provide longer-lasting overhead cover and a long-term source of woody debris to the system.

C. Reach 3 – First driveway crossing (Pederson,17610) to brown wood house (18022 Southeast Green Valley Road). The Bell Ravine tributary confluence is near the upstream end of this reach (approximately 1,250 feet in length).

Reach 3 runs through residential and developed area. The stream becomes wide and sandy as a result of fine sediment from landslide activities. Riparian vegetation is sparse to absent. Several driveways cross the stream, and it appears that salmonid juveniles are using them as overhead cover.

Planting of native conifers (Western red cedar, Douglas fir, and/or Sitka spruce) throughout this reach would provide longer-lasting overhead cover and a long-term source of woody debris to the system.

The addition of LWD to this reach could be easily and inexpensively accomplished and would provide some structural and habitat complexity. However, this may be impractical due to the presence of driveway bridges, adjacent houses and yards, and the tendency for sediments to deposit in this reach. The addition of LWD would probably promote sediment deposition in this reach and encourage channel migration. These, in turn, would worsen upstream flooding problems and may endanger the adjacent roadway and other structures. No LWD should be installed in this reach until the sediment deposition problem has been resolved.

Dredging or "vactoring" the fine sediments out of this reach might temporarily improve habitat conditions by re-forming pools and cleaning spawning gravels. However, this would be at best a temporary solution under present conditions and should only be considered after the sediment deposition problem has been resolved.

D. Reach 4 – Driveway of 18022 Southeast Green Valley Road to 18717 Green Valley Road (approximately 3,000 feet in length). This reach is upstream of the confluence with the Bell Ravine tributary confluence.

This reach is probably the most degraded section of Burns Creek. The use of the streamside vegetation by livestock is very intense. There is virtually no habitat diversity.

Removing some of the exotic plants and planting native conifers (Western red cedar, Douglas fir, and/or Sitka spruce) and other native trees and shrubs throughout this reach would provide long-lasting overhead cover and a long-term

source of woody debris to the system. This would need to be done in conjunction with fencing of livestock from the riparian area.

The channel could also be restored to a more natural configuration by making it narrower and deeper (by "vactoring" out fine sediments) and adding meanders and complexes of woody debris. Gravels might also be added if they are not present beneath the silt and sand currently filling the original channel. Much of the work on this reach of channel could be easily accomplished from the adjacent road shoulder, but would require the willing cooperation of the property owner(s).

Work performed in this reach would not be subject to sedimentation from Bell Ravine, as would work done downstream of the Bell Ravine confluence.

E. Reach 5 – From 18717 Southeast Green Valley Road to second bridge at Green Valley Road (approximately 1,000 feet in length).

Reach 5 is a moderately confined channel with low to moderate gradients. The riparian zone is dominated by blackberry and other shrubs in the understory and deciduous trees in the overstory. There is a fair amount of LWD in the stream.

Planting of native conifers (Western red cedar, Douglas fir, and/or Sitka spruce) and other native trees and shrubs throughout this reach would provide long-lasting overhead cover and a long-term source of woody debris to the system.

F. Reach 6 – From the second bridge to upstream end (approximately 600 feet in length).

This last reach has an unconfined to moderately confined channel with a fairly low gradient. It lacks habitat diversity and gravel substrate.

Planting of native conifers (Western red cedar, Douglas fir, and/or Sitka spruce) and other native trees and shrubs throughout this reach would provide long-lasting overhead cover and a long-term source of woody debris to the system.

NOTE: Any efforts to improve habitat conditions within Burns Creek should be either phased in conjunction with efforts to control sediment supply and transport through the system or carried out with the assumption that such control will not be possible. In the latter case, improvements to the stream downstream of the confluence with Bell Ravine should be limited to riparian plantings.

- Alternative No. 3 – Erosion/Sediment Source Control

  A. Revegetate Landslide Scars in Bell Ravine

  Speed up the revegetation process of the bare landscape scars within Bell Ravine to help stabilize the slides and slow transport of sediment down to the stream. Willow or dogwood stakes, and/or contour wattling, could be used in moister and flatter lower sections of the slides, and within the slide bowl near the silt beds. The planting effort may be renewed as many times as needed until the plant community becomes re-established.

  B. Groundwater Interceptor Drains

  Deep perforated pipes could be placed parallel to Bell Ravine to intercept groundwater seepage landward of the slope interface and convey it to the stream without mobilizing sediments.

  C. Ravine Slope Stabilization

  An effort could be made to stabilize the slopes with a combination of revegetation, geo-fabric reinforcement, and bio-engineered techniques.

  D. Slope Regrading

  The eroding slopes could be regraded to a more stable configuration.

- Alternative No. 4 – Sediment Transport Control

  A. Sediment Trapping

  A sediment trap could be constructed at the base of Bell Ravine to intercept and store sediment from the eroding slopes, possibly in conjunction with Alternative No. 3 and/or 4B. This may help reduce sediment deposition in the stream but may decrease the supply of spawning gravel. The pond will require frequent maintenance for removal and disposal of sediment and would probably have to be very large to trap sufficient volumes of sediment.

  B. Tightlining Surface Water Discharge

  Flows, either in their entirety or those above a certain discharge, could be tightlined through the sensitive portions of the ravine and discharged into a control point at the bottom of the ravine. This would prevent them from transporting sediments from the slide areas during high-flow events. If specific surface water outlets at the top of the ravine can be identified, these outlets could also be collected into the tightline system. The tightline system could be effective at preventing the transport of sediments from the slide areas to Burns Creek by

bypassing flows around the problem areas. However, it would probably not slow the progress of the slides themselves, since they are caused by groundwater discharge on the ravine walls (Perkins GeoSciences Report, 1999).

- Alternative No. 5 – Buy Out or Alter Properties Affected by Flooding/Deposition

  A. Buy the properties and remove structures along the north side of Green Valley Road that border the stream, with priority given to those that either flood frequently (18022 Green Valley Road) or that are downstream of the Bell Ravine confluence. This alternative would allow the stream to migrate through these areas unhindered (or at least less hindered) by artificial structures and to distribute its sediment load throughout this area. This alternative would also allow the construction of a new channel through these properties that would be further from the roadway.

  B. Remove existing driveway bridges at two or three houses in Reach 3 and replace with one bridge to serve either two or all three residences. This would reduce the impact of artificial structures on the creek and decrease the need for "emergency" dredging. The replacement bridge should be sufficiently wide to accommodate some migration and change to the channel beneath and should be above the 100-year flood elevation.

Analysis of Alternatives and Recommendations

Alternative No. 1, the "no action" alternative, will not achieve either of the project goals. It is likely that landslides in Bell Ravine will continue to contribute large volumes of sediment to the system and that the bed of Burns Creek will continue to aggrade. This, in turn, will cause continued flooding upstream of the confluence, continued siltation of spawning gravels and filling of pools, and will probably result in either damage to the driveway bridges downstream of the confluence or "emergency" dredging by those landowners to prevent that damage. Habitat deficiencies in Burns Creek will persist and probably worsen under the "no action" alternative.

Implementation of portions of Alternative No. 2, enhance habitat diversity of the stream, is the highest priority at this site in terms of cost-benefit returns and enhancing habitat. All planting recommendations should be implemented according to the attached planting plans, as should the fencing recommendation for Reach 4. However, no woody debris should be installed downstream of the Bell Ravine confluence (Reaches 1, 2, and 3) unless and until the sediment source/transport problems are resolved. The addition of woody debris to these reaches would probably encourage sediment deposition, thus aggravating the flooding problems here and upstream. Installation of woody debris and plantings should be carried out in Reach 4 as soon as possible, but only if a fenced buffer can be obtained from the landowner(s).

Alternative No. 3A, revegetate landslide scars in Bell Ravine, should be implemented as soon as possible and possibly repeated yearly, depending upon further evaluation of its

effectiveness. While it is doubtful that this will significantly slow the input of sediment to the stream system, it is inexpensive and worth pursuing on the chance that it will help.

Alternative No. 3B, groundwater interceptor drains, would be very expensive to construct and maintain and of questionable effectiveness, given that the slide faces are already vertical and very high and are not likely to stabilize at their present formation.

Alternative No. 3C, ravine stabilization, may not be practicable due to the extent of the sliding steepness of the slopes. Again, this should be given some further consideration in an analysis of the hydrology and geology of the ravine and surrounding areas.
Alternative No. 3D, slope regrading, would require the removal of an immense volume of earth, along with much existing vegetation and at least two residential structures near the tops of the slopes. This endeavor would be very costly, very intrusive to both the existing natural environment of the area and its residents, and may provoke other erosion problems beyond those currently plaguing the system.

Alternative No. 4A, sediment trapping, may be effective at preventing sediments from Bell Ravine from reaching Burns Creek during less-than-catastrophic events. There is a suitable site for a large sediment trap at the bottom of Bell Ravine, near the confluence with Burns Creek. There is a good discussion of the pros and cons of this alternative in the "Geomorphic Feasibility Report for Burns Creek" prepared by Perkins GeoSciences. In addition to the factors mentioned there, this alternative may be difficult for permitting and regulatory reasons as well.

Alternative No. 4B, tightlining surface water drainage, may be a solution to the transport of excessive sediments from Bell Ravine into Burns Creek. A tightline is a pipe that would pick up flows at the top of Bell Ravine and convey them past the landslide-prone areas. It may reduce the amount of sediment actually transported downstream to Burns Creek, but will probably not stop the landslide activity itself. The success of this approach would depend on a hydrological study of the drainage that concludes a tightline could in fact pick up a large percentage of the flow of the Bell Ravine creek upstream of the slide areas, even during high-flow events. This creek is very steep in gradient, with numerous natural barriers to fish migration, so it is unlikely that any salmonids—resident or anadromous—utilize the ravine reaches.

Alternative No. 5A, buy out or alter properties that restrict the channel's migration or are chronically affected by flooding, may be the most certain solution to the flooding/ property damage problems associated with Burns Creek and may also provide the stream with the natural mechanism for distributing its sediment load. However, this alternative would be expensive, disruptive to local residents, and unlikely to win their necessary cooperation.
Alternative No. 5B, consolidating the driveways in Reach 3 into one stream crossing that is able to withstand flooding and some migration of the stream course, could give the stream some latitude to migrate and distribute sediments, and might also alleviate property damage and/or the need to take drastic measures (for example, dredging) to prevent damage. However, with the adjacent residential structures and yards still present,

it is doubtful that this alone would solve the sediment problem or significantly improve habitat in the system downstream of the properties.

Recommended Plan

Achieving the goals of this project will require the phased implementation of a combination of the above alternatives. Several actions could be undertaken immediately to improve habitat in parts of Burns Creek and alleviate property damage from flooding. Some of these actions, such as fencing and planting in Reach 4, would have substantial and long-reaching benefits to the stream. Others, such as riparian plantings in the lower reaches, would improve the situation but would not solve the most egregious problems affecting those reaches. Long-term solutions to habitat problems in the lower reaches of Burns Creek and to some other flooding problems (for example, threats to the adjacent roadway) will require more study and more involved solutions.

~~The first phase of the recommended plan is the implementation of a combination of~~ Alternative No. 2 and, if possible, some part of Alternative No. 5: Enhance the habitat diversity of the stream as detailed above, and approach landowners along Reach 3 regarding either purchase of their properties or modification/consolidation of their driveway access bridges. In addition, Alternative No. 3A, revegetation of the toes of the landslide scars in Bell Ravine, should be done, perhaps several times if necessary.

This combination of alternatives will probably not significantly reduce the amount of sediment transported out of Bell Ravine. However, it will allow Burns Creek to respond to that sediment input in a more natural manner by allowing it some latitude to migrate and flood, both natural processes of streams. Backwater flooding will probably still occur upstream of the confluence with Bell Ravine, in the vicinity of the residence, unless that residence is moved or removed. Furthermore, this combination of alternatives will allow for substantial improvements to habitat in Burns Creek, especially in Reach 4, the most degraded section of the stream.

In addition to these immediate actions, further study of the hydrology and geology of the Bell Ravine drainage basin should begin as soon as possible in order to assess the feasibility of structural solutions to the sediment transport problem (such as those presented as Alternative Nos. 3 and 4). If these alternatives are found to be viable and practicable, one or more should be implemented. Once this has been accomplished, further improvements to the in-stream habitat of Burns Creek downstream of the Bell Ravine confluence, such as addition of LWD and sediment removal, should be carried out.

Cost Items and Quantities
Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.

Conclusions and Recommendations
The processes of mass wasting, sediment transport, and deposition affecting Bell Ravine and Burns Creek are natural and probably cyclical and have been active since the last ice age (Perkins GeoSciences Report, 1999). Bell Ravine and the floodplain surrounding Burns Creek and the Green River were formed by just such processes. These processes may have been somewhat exacerbated by alteration of the hydrology of the watershed, and study should be devoted to assessing the extent of this relationship. However, the downstream problems associated with these processes of sediment transport and deposition result from constraints placed upon the Burns Creek system that inhibit its ability to respond to the sediment input and deposition. These constraints are the presence of adjacent residential structures, driveways and roads, and the consequent inability of the channel to migrate. Additional geomorphological, geotechnical, and h&h studies will be necessary prior to project construction on this site. These studies will address variations of sediment yield and processes throughout the watershed to put into perspective the landslide source.

Options for dealing with the problems posed by this situation fall into three categories: (1) remove the constraints that prevent a natural response by the system; (2) remove or buy out whatever assets are damaged by the situation as it now stands; or (3) intercede in the system in such a way as to restore some sort of new equilibrium to the system. Each of these approaches has limitations and drawbacks, and a workable solution probably crosses the boundaries of these categories. Removing the constraints to the natural response mechanisms might entail moving Green Valley Road and all of the adjacent residences and structures, which is probably not practical or economically feasible. Removing or buying out those assets that stand to suffer more damage under present circumstances may be slightly more practical in some cases, such as moving or removing individual residences, but equally difficult in others, such as moving a major roadway. The success of interceding in the system would depend upon much study of the system as a whole, upon finding a solution that will indeed solve the problems without creating new ones, and upon that solution being economically and practically feasible.

Remedies to the degraded state of fish habitat in Burns Creek are both intertwined with the above-stated problems and separate. A stream that is allowed to respond naturally to natural disturbance and that has the necessary "tools" to make that response—an intact riparian zone, source of LWD, etc.—will probably, eventually, form complex and productive habitat for fish evolved to live in such systems. Some measures may be taken to improve habitat without necessarily "restoring" the system to its unconstrained state, such as planting conifers in the riparian areas, fencing livestock from the stream, and, perhaps, replenishing the supply of LWD. These measures are relatively inexpensive and easy to execute; however, the beneficial effects of these actions will be limited by the continued deposition of sediment in the channel and the channel's inability to respond naturally to that deposition.

The recommended combination of alternatives stated above is designed to execute those measures that remedy the most egregious and pressing property damage problems (flooding of the Fremouw residence and threats to the driveway bridges in Reach 3 are relatively certain to provide beneficial effects on habitat and sediment and no detrimental effects to surrounding properties [conifer planting, livestock fencing, selective LWD placement, planting of the landslide toes], and leave open the possibility of a more comprehensive solution to the problem [study of the hydrology of the drainage basins and possible structural solutions to the sediment source/transport issues]).

Burns Creek Planting Specifications

Reach 1 – Mouth of Creek to first bridge at Southeast Green Valley Road (approximately 1,250 feet in length).
Install bare-root stock Western red cedar (*Thuja plicata*) in 15-foot intervals along both sides of the creek. Total Quantity: 175 bare-root stock cedar saplings.

Reach 2 – Bridge at Green Valley Road to first driveway crossing (Pederson, 17610 Southeast Green Valley Road) [approximately 1,250 in length].
Install bare-root stock Western red cedar (*Thuja plicata*) in 15-foot intervals along both sides of the creek. Total Quantity: 175 bare-root stock cedar saplings.

Reach 3 – First driveway crossing (Pederson, 17610) to brown wood house (18022 Southeast Green Valley Road) [approximately 1,250 feet in length].
Install bare-root stock Western red cedar (*Thuja plicata*) in 15-foot intervals along both sides of the creek. In addition, native willow (*Salix sp.*) stakes should be installed along the foot of the slump adjacent to the Auburn Youth Resource House on two-foot centers, three deep. Total Quantity: 175 bare-root stock cedar saplings, 100 willow stakes.

Reach 4 – Driveway of 18022 Southeast Green Valley Road to 18717 Green Valley Road (approximately 3,000 feet in length).
Planting specifications for this reach will require more detailed planning in conjunction with fencing and channel reconfiguration and should only be carried out if livestock fencing is installed. See the attached typical planting plan, to be modified as buffer widths are negotiated with landowner(s). The optimal buffer width on the north side of the creek (right bank) is 75 feet.

Reach 5 – From 18717 Southeast Green Valley Road to second bridge at Green Valley Road (approximately 1,000 feet in length).
Install bare-root stock Western red cedar (*Thuja plicata*) in 15-foot intervals along both sides of the creek. Total Quantity: 135 bare-root stock cedar saplings.

Reach 6 – From the second bridge to upstream end (approximately 600 feet in length).
Install bare-root stock Western red cedar (*Thuja plicata*) in 15-foot intervals along both sides of the creek. Total Quantity: 80 bare-root stock cedar saplings.

Bell Ravine Landslide Plantings
Install approximately 300 native willow (*Salix sp.*) stakes in the toes of the two landslide scars in Bell Ravine in any locations where they appear to have a chance of survival. Repeat yearly as necessary and/or potentially useful.

Total bare-root cedar saplings required: 740, plus whatever are required to plant Reach 4 after fencing.

Total native willow stakes required: 300, plus possible yearly supplemental plantings.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Mainstem Green River Large Woody Debris

Location
Approximately 73 sites within the mainstem Green River between the City of Auburn and the City of Tacoma Pipeline withdrawal (river mile [RM] 32 to RM 61).

Site Constraints/Problems
An absence of large wood in the river channel contributes to low channel complexity in the mainstem Green River. Elimination of the supply of naturally recruited large wood through historical and ongoing timber harvest throughout the Green River watershed contributes to the absence of instream wood. Moreover, flow regulation by the Howard Hanson Dam has greatly altered natural flow patterns within the Green River, which in turn alters wood supply through natural landslides and bank erosion caused by flood events, and wood transport. Wood is currently collected in the Howard Hanson Reservoir as routine maintenance, providing a potential supply of wood to be added to the channel downstream of the Tacoma Pipeline intake.

Project Goals
The primary project goal is to restore natural ecosystem processes of large woody debris (LWD) recruitment, transport, and structure in the mainstem Green River. Restoring this ecosystem process will accomplish additional project goals of rehabilitating instream salmon spawning, rearing, and migration habitat while reducing the need for ongoing habitat maintenance. Restoring ecosystem processes will also rehabilitate habitat for non-salmonid aquatic organisms, and non-aquatic organisms that use the Green River for some component of their life history.

Proposed Solutions
Perkins (1999) conducted a detailed analysis of existing LWD in the Green River and made recommendations on LWD enhancement strategies. Recommendations made below draw heavily from that work. The following four alternative approaches to restoring the processes of LWD supply, transport, and structure in the mainstem Green River were considered:

- Alternative No. 1 – No action: no modifications would be made to existing conditions. The mainstem river would remain LWD-limited; the river channel would remain morphologically simple, and degraded salmon habitat would remain unchanged, or even worsen over time.
- Alternative No. 2 – Remove the Howard Hanson Dam to restore natural LWD recruitment and transport in the Green River. Underplant the riparian corridor with

native trees (conifers and cottonwoods) to provide a future source of naturally recruited large wood to the river. Place large wood as unanchored, partly buried debris jams in the mainstem to provide immediate fish habitat structure.

- Alternative No. 3 – Undermine banks along the river downstream of Howard Hanson Dam to create landslides that would provide sources of large wood to the river. Allow existing river hydraulics to transport wood to create logjams where existing channel gradient and morphology allow. Underplant the riparian corridor with native conifers and cottonwoods to provide a future source of naturally recruited large wood to the river. This approach would artificially initiate wood supply through the natural process of landsliding, but continued flow regulation by the Howard Hanson Dam would maintain altered wood transport.

- Alternative No. 4 – Place large wood as unanchored "key members" in the mainstem river to provide the basis for formation of bar apex jams (BAJ) and meander jams (MJ). Typical naturally occurring BAJ and MJ on the Green River are described by Perkins (1999). Add additional wood to the river channel and allow existing river hydraulics to transport wood to create logjams against key members and in other locations where existing channel gradient and morphology allow. Construct "engineered logjams" only in locations where there is an immediate need to protect property or ensure human safety threatened by river migration, as suggested by Perkins (1999). Underplant the riparian corridor with native trees (conifers and cottonwoods) to provide a future source of naturally recruited large wood to the river. This alternative would require ongoing maintenance in the form of periodic additions of wood because natural wood supply and transport processes would not be restored for 80 to 150 years.

Recommended Plan

Alternative No. 1 (no action) was rejected because it does not achieve goals to restore processes of LWD supply and transport in the Green River. This alternative would perpetuate existing low levels of LWD, channel simplicity, and degraded salmonid habitat.

Alternative No. 2 (remove the Howard Hanson Dam to restore natural LWD recruitment and transport) was rejected because current use of the Howard Hanson Dam for flood control in the lower Green-Duwamish River Valley, and for summer storage for the Tacoma water supply system, makes it unlikely that proposals to remove the dam would be successful. Because this alternative provides the best opportunity to restore LWD supply and transport with no need for continued maintenance, and the only opportunity for true ecosystem restoration of these processes, it is recommended that these alternative plans for Green River restoration be evaluated over the long-term.

Alternative No. 3 (create landslides on riverbanks downstream of Howard Hanson Dam to provide sources of wood to the river) was rejected because it is unlikely that landslides would provide enough material to restore wood supplies, especially over time. More analysis would be needed to determine whether the local geology is prone to landsliding.

Potential negative effects of artificially initiated landslides would also need to be evaluated. This alternative warrants further consideration because it provides a supply of wood through the natural process of landsliding, which is an opportunity to accomplish ecosystem process restoration within the constraint of retaining the Howard Hanson Dam.

Alternative No. 4 (add large wood to the mainstem river to encourage formation of logjams) was selected because it provides the best opportunity to accomplish project goals within the constraint of retaining the Howard Hanson Dam. As described above, this alternative will place large wood as unanchored "key members" in the mainstem river to provide the basis for formation of specific logjam types, as described in Perkins (1999). Additional wood would be added to the river channel to be transported by existing river hydraulics to create logjams against key members and in other locations where existing channel gradient and morphology allow. "Engineered logjams" would only be constructed in locations where there is an immediate need to protect property or ensure human safety threatened by river migration.

Although this alternative does not restore natural processes of wood supply and transport, it does supply wood of appropriate sizes, and in locations that will allow for the formation of debris jams similar to those that would have formed under natural conditions. Perkins (1999) identifies suitable wood densities of 0.5 MJ and 4 BAJs per kilometer (km) of the Green River, which yield logjam spacings of 6,500 feet for MJs and 800 feet for BAJs. Perkins (1999) also identifies a wood diameter of 2.8 to 3.6 feet as suitable for key members in unconstrained reaches of the Green River. Unconstrained reaches of river are most suitable for wood placement because high flow velocities and deep water in constrained reaches, such as the Green River Gorge, typically transport wood. Also jams will have least effect on flood elevations in unconstrained reaches. Reaches of the Green River that Perkins (1999) identified as most suitable for wood placement within her study area (Auburn to Palmer) are presented in Appendix A. Potential wood placement sites identified from aerial photographs are also included in the current report; some of these sites are within the Green River Gorge or other confined or partly confined channel reaches. Potential sites between Palmer and the Tacoma Public Utilities Pipeline intake area are included as well. Specifically, LWD placement should consider alternative locations, where flow conveyance is not hydraulically effective (i.e., inside sharp bends, downstream of contractions, etc.) and flood control functions, potentially, are minimally effected. Other alternative locations include portions of the bank that are a given height above the channel bottom or freeboard areas.
In general, a significant analysis of flood elevations must be completed prior to construction.
Also prior to construction, a h&h analysis of actual existing wood structures would be completed to determine the Manning n of these proposed in river structures. The proposed LWD design, according to design experience of 11 sites-already in place on other river systems, will minimize the loss of large wood from the structures.

A total of 51 potential BAJ sites and 22 potential MJ sites were identified, yielding overall logjam densities of 1.13 BAJ/km and 0.49 MJ/km (Table 1 and plans). Potential BAJ sites are at the upstream end of existing gravel bars, and potential MJ sites are on the

outside of meander bends; no sites requiring stabilization by engineered logjams were identified. The sites identified on the plans are preliminary; further analysis may result in the elimination of some sites because of concerns over boater safety, flooding, or potential channel migration that may threaten nearby structures or cause landslides by deflection flow into unstable cliffs.

Table 1. Proposed wood numbers and densities in three potential project reaches of the Green River. BAJ = bar apex jams, MJ = meander jams. Reach locations and wood densities are preliminary and approximate. Appropriate logjam densities for unconfined reaches of the Green River are 0.5 MJ/km and 4 BAJ/km (Perkins 1999).

Reach	Description	Length (km)	BAJ		MJ	
			Number	Density (#/km)	Number	Density (#/km)
1	Auburn to Gorge	20.9	34	1.63	13	0.62
2	Green River Gorge	14.4	13	0.90	0	0
3	Gorge to TPU intake	9.7	4	0.41	9	0.92
Total	Auburn to TPU intake	45.0	51	1.13	22	0.49

Although most of the densities presented in Table 1 are less than those suggested by Perkins (1999) for unconstrained reaches of the Green River, because of the lack of good LWD sites, they provide a good start and allow for future wood additions to achieve better densities.

Alternative No. 4 would require ongoing maintenance in the form of periodic additions of wood because natural wood supply, and transport processes would not be restored as long as Howard Hanson Dam is in place. Future wood additions will be transported by existing flow hydraulics, forming logjams against placed key members, and in other locations where existing channel gradient and morphology allow. Perkins (1999) identified two potential wood-delivery locations: Flaming Geyser State Park, and downstream of existing large logjams such as the MJ at river mile 38.8. Wood collected in the Howard Hanson Reservoir may provide a source of wood for periodic wood additions. Conifer and cottonwood underplantings will provide a future source of naturally recruited LWD. This alternative also allows for potential flow release alterations at Howard Hanson Dam, which may encourage restoration of pre-dam LWD transport processes.

Cost Items and Quantities

Construction line items and quantities are listed in the MCACES portion of the attached engineering appendix.

Each BAJ requires placement of one or two key members, and each MJ requires placement of two or three key members, resulting in a total of about 150 key members. The appropriate size for key members in the Green River is 2.8- to 3.6-foot-diameter log boles with a 3.5- to 4.5-foot-diameter attached rootwad, 35 to 47 feet long (Perkins 1999). Appropriate species include black cottonwood (*Populus trichocarpa*), Western red cedar (*Thuja plicata*), Douglas fir (*Pseudostuga menziesii*), and other native conifers such as western hemlock (*Tsuga heterophylla*) and Sitka spruce (*Picea sitchensis*).

Racked members are smaller pieces of wood, with or without rootwads, of the species listed above and also of native deciduous species such as red alder (*Alnus rubra*) and big-leaf maple (*Acer macrophyllum*). The number of racked members on each logjam varies widely with wood supply and flow velocities. Assuming 3 to 10 racked members for BAJs and 10 to 50 racked members for MJs yields a total of about 800 racked members. This wood may be added over a period of time at the different wood-delivery sites.

Conclusions and Recommendations

Conduct a detailed field reconnaissance of the potential BAJ, MJ, and wood-seeding sites to determine whether they are suitable, especially those located in confined or partly confined river reaches. Evaluate potential for altering flow regulation at Howard Hanson Dam to restore higher flows to transport wood. Proceed with detailed planning and design, including risk assessment for any nearby structures and a monitoring program for adaptive wood placement over time. Coordinate with Mainstem Green River Gravel and Upper Green River Side Channels LWD and Gravel projects, and Tacoma Water restoration efforts. Prior to construction, conduct a detailed geomorphological, geotechnical, and h&h analysis to assess potential impacts of the introduced LWD. Construct several prototype projects on county owned land and observe them over one or two seasons prior to construction of LWD on other sites along the river

References

Perkins, S.J. 1999. Geomorphic feasibility report for large woody debris placement in the middle Green River, WA. Report prepared for Jones and Stokes Associates, Inc., Bellevue, WA.

Appendix A. Recommended debris jam placement methods by river location. From: Perkins, S.J. 1999. Geomorphic feasibility report for large woody debris placement in the middle Green River, WA. Report prepared for Jones and Stokes Associates, Inc., Bellevue, WA.

Reach	River Miles	Physical constraints	Property constraints & opportunities	Place key members to initiate jams[1]	Add floatable LWD for racked members	Construct engineered logjams	Add LWD to side channels
2	31.7-32.0	Unconfined; revetment LB	Undeveloped land; City of Auburn slightly downstream			X	
2	32.0-33.8	Unconfined; some LB revetments	Undeveloped private property downstream half; County Park site upstream half	X	X Probably needed upstream of RM 33 only		
3	33.8-34.1	Mostly confined	3 bridges; RB road				
3	34.1-35.4	Mostly unconfined except near levees	Much public land, private land un-developed or farmed; farm land protected by levees	X	X		
3	35.4-36.1	Confined near levees	Farm buildings and houses behind levees; mostly private land			X (if Kaech/ Horath levee can be set back or removed)	

Reach	River Miles	Physical constraints	Property constraints & opportunities	Place key members to initiate jams	Add floatable LWD for racked members	Construct engineered logjams	Add LWD to side channels
3	36.1-37.8	Unconfined	RB buildings set back at RM 36.4-36.7; private land; 2 County levee easements	X	X		
4	37.8-40.2	Unconfined; very wide meander belt	RB houses RM 38.5-38.7 already threatened by flooding and bank erosion, 2 large parks	X	X		
5	40.2-40.5	Unconfined	County park both sides of river. Backwater flooding could maybe affect private property upstream	X	X		
5	40.5-42.2	Confined	Mostly private land. Numerous buildings near river; a few are floodprone				
6	42.2-	Confined,	LB houses			X?	

Reach	River Miles	Physical constraints	Property constraints & opportunities	Place key members to initiate jams[1]	Add floatable LWD for racked members	Construct engineered logjams	Add LWD to side channels
	43.4	steep, large landslide	protected by bedrock, high terrace. RB publicly owned				
6	43.4-43.9	Confined	State park both sides; roads on high terrace		X Existing islands can serve as key members		
6	43.9-44.9	Moderately confined	State park both sides; roads and buildings on high terraces; roads protected by riprap	X	X		
Palmer	58.4-60.3	Moderately to totally confined; channel very stable	City of Tacoma ownership; buildings and infrastructure on high terrace	X Less frequent spacing in upstream confined section	X		X

[1] Minimum key member spacing of 6,500 feet for MJ and 800 feet for BAJ.

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Green River Gravel Replenishment

Location

This project includes work along a substantial length of the Green River, starting at the City of Tacoma water supply intake at approximately RM (River Mile) 61, and extending downstream to the vicinity of Flaming Geyser State Park, in the vicinity of RM 45.

Site Constraints/Problems

Howard Hanson Dam, constructed in 1961, has blocked passage of bedload sediment from the upper Green River Basin to the channel downstream of the dam. In 1999, Perkins GeoSciences prepared a report entitled "Geomorphic Evaluation of Gravel Placement in the Green River, Washington," which addressed remedial gravel placement below the dam. Information from this report provides most of the background information for the present project proposal. Measurements of the sediment accumulation in Howard Hanson Reservoir suggest that the average annual sediment inflow from the upper basin is 9,000 to 15,000 tons per year. Immediately below the dam, the river has the capacity to transport bedload sediment, but has no upstream sediment supply. As a result, the river has a tendency to scour the channel bed downstream of the dam. The consequences of this process are clear in the channel reach immediately below the dam. Finer particle sizes have been preferentially removed, leaving the existing channel paved with sediment, which is much coarser than the pre-dam streambed.

This effect is clear starting at the dam (RM 64.5), down to the upper end of the Green River Gorge (at approximately RM 58). Because of the inaccessibility of the Gorge, the extent of bed coarsening in this reach is difficult to assess. Observations from other dammed rivers suggest that the sediment depletion extends downstream as a "coarsening front." Perkins (1999) estimated that this front is likely to be moving at a rate of between .39 and .76 miles per year. Given 38 years since closure of the dam, this would place the coarsening front somewhere between the State Route (SR) 169 Bridge and a point well below Flaming Geyser State Park. Currently, there is no clear evidence of bed degradation or coarsening at or below Flaming Geyser. Perkins (1999) suggests that this may in part be due to anomalously high landslide activity in the gorge during the 1990s. If no remedial action is taken, the existing zone of sediment depletion will persist and continue to move downstream, probably as far as the City of Auburn, and possibly farther.

The primary concern with this sediment deficiency is its impact on fisheries habitat. As the bed becomes coarser, areas of gravel that had been suitable spawning sites become cobble-dominated and no longer useful for spawning sites. Of particular note is the

presence of a significant run of (endangered) chinook salmon in the Green River. These fish historically have spawned in the mainstem of the Green River. An area of special concern is the river channel in the vicinity of the Metzler/O'Grady County Park (RM 40). This area is well suited to and heavily used by chinook salmon for spawning. Bed coarsening in this area could render the substrate unsuitable for spawning, thereby decreasing or eliminating use of this area by chinook. Also if gravel supply drops in the Metzler/ O'Grady reach there would be a wholesale change in morphology: channel migration would stop, side channels would no longer be formed and maintained, and the main channel would narrow and deepen.

Project Goal

The goal of this project is to stop further fisheries habitat degradation and to restore areas currently degraded as a result of the bedload blockage at the Howard Hanson Reservoir.

Proposed Solutions

The following six alternative approaches were considered to mitigate for bedload, which has been and is being trapped behind the Howard Hanson Dam:

- Alternative No. 1 – No action: No modifications would be made to existing conditions. Those areas of the Green River that are currently degraded as a result of elimination of bedload sediment supply from the upper watershed would either remain as they are or degrade further. The zone of bed scour and substrate coarsening would expand downstream, degrading additional areas now heavily used by spawning salmon.

- Alternative No. 2 – Remove the Howard Hanson Dam to restore natural sediment recruitment and transport in the Green River. Natural sediment supply from the upper watershed would be reestablished. Bedload sediment would again move through the present reservoir area and supply the channel downstream. The existing zone of sediment depletion would persist for decades and continue to move downstream.

- Alternative No. 3 – Initiate a program of annual gravel placement in the channel reach immediately below the City of Tacoma Water Supply Intake (RM 61). The quantity of gravel placed would be approximately equal to the bedload deposited annually in the Howard Hanson Reservoir (approximately 12,000 tons per year, [Perkins, 1999]). With respect to the downstream system, this alternative would be generally comparable to removal of the dam. Bedload supply would be reestablished, the scoured portion of the channel would begin to aggrade, and the bed texture of the scoured section would become finer. These changes would move progressively downstream from the site of gravel introduction, at approximately the same rate at which the depletion front moved downstream (0.39 to 0.76 miles per year [Perkins, 1999]). The existing zone of sediment depletion would persist for decades and continue to move downstream.

- Alternative No. 4 – Distribute gravel through the zone of existing sediment depletion. This gravel would be intended to make up the deficit resulting from 38 years of

operation of Howard Hanson Dam. The total deficit over this period of time would be 456,000 tons, assuming the average annual bedload discharge at the dam site would have been 12,000 tons per year. This amount could be decreased by 84,000 tons because the deficit between the dam and the Tacoma Water Supply Intake would not be made up. It can be reduced by an additional 100,000 tons to account for the high sediment supply during the 1990s from unusually active landsliding (Perkins, 1999). The net gravel quantity required to make up the sediment deficiency in the project reach is 272,000 tons.

Gravel would be placed between the City of Tacoma Water Supply headwork's (RM 60.4) and Flaming Geyser Bridge (RM 43). No gravel placement is recommended below Flaming Geyser Park because there is no clear indication of gravel deficiency below the Park at this time (Perkins, 1999). Placement of gravel below the area of existing scour would initiate a downstream pulse of excess sediment transport, which could cause channel instability and degrade instream habitat without in any way mitigating for the sediment deficiency upstream. In order to disperse this gravel as evenly as possible, it would be necessary to place the gravel at multiple locations throughout the zone of depletion. Because of the large volume of gravel involved (272,000 tons is approximately 160,000 cubic yards), placement should occur incrementally over a number of years, in order to avoid significantly obstructing the channel at the placement sites.

- Alternative No. 5 – Combine Alternatives Nos. 3 and 4 above to address both the ongoing sediment replenishment of bedload at the dam and gravel replacement in the depleted zone downstream from the dam.

Recommended Plan

Alternative No. 1, no action, was rejected because it does not achieve goals of stopping further degradation of the system, or of enhancing areas already degraded by sediment starvation.

Alternative No. 2, removal of Howard Hanson Dam, was rejected for the present project because of the current function of the dam for flood control in the lower Green-Duwamish River Valley and for summer storage for the Tacoma water supply. This option would also require dealing with discharge of the sediment currently stored in the reservoir. Removal of the dam would restore sediment supply and transport through the project reach, with no need for continued maintenance. It would allow for access by anadromous fish to the upper Green River watershed. This possibility should be considered in long-range planning for the Green River system.

Alternative No. 3, placement of sediment immediately below Howard Hanson Dam, was rejected because it did not prevent degradation of highly productive spawning areas downstream from the Green River Gorge. Although this method would ultimately address sediment starvation issues, it would take decades before the current sediment deficiency would be resolved.

Alternative No. 4, placement of gravel throughout the area of sediment deficiency, was rejected because, although it would address the present sediment deficit, it would do nothing to prevent this circumstance from reoccurring, because there would be no on-going sediment supply from upstream.

Alternative No. 5, initiation of a regular sediment replenishment program, combined with replacement of gravel deficit in the zone of sediment depletion, was selected. This alternative meets all of the specified project goals.

Project Logistics

Sources of Gravel

Gravel for replenishment is potentially available from several sources in the project vicinity. At least five commercial gravel pits are located in general proximity to the Green River in the project area. The locations of several of these pits are shown on the attached plans. These gravel pits are all located in deposits of Quaternary outwash gravels deposited by the rivers during the last glaciation.

Another possible source of gravel for replenishment would be sediment dredged from the delta at the upstream end of the Howard Hanson Reservoir. This is, of course, the sediment that (were it not for the dam) would be carried downstream and maintain a natural sediment supply to the lower river. Utilizing this gravel source could have several benefits to the project. The gravel would presumably be available at no cost (although there would be costs associated with its excavation). Removal of this sediment would reduce the rate in filling of the reservoir.

Gravel Placement Techniques

There are several feasible methods for placement of gravel into the river channel. These various techniques are appropriate at different locations, depending on the conditions at the placement site. To distribute gravel throughout the area of existing deficiency, it will be necessary to use several of these techniques. These various techniques are described below. The various placement locations, along with the suggested placement technique, are shown on the attached plans.

Gravel Placement by Crane

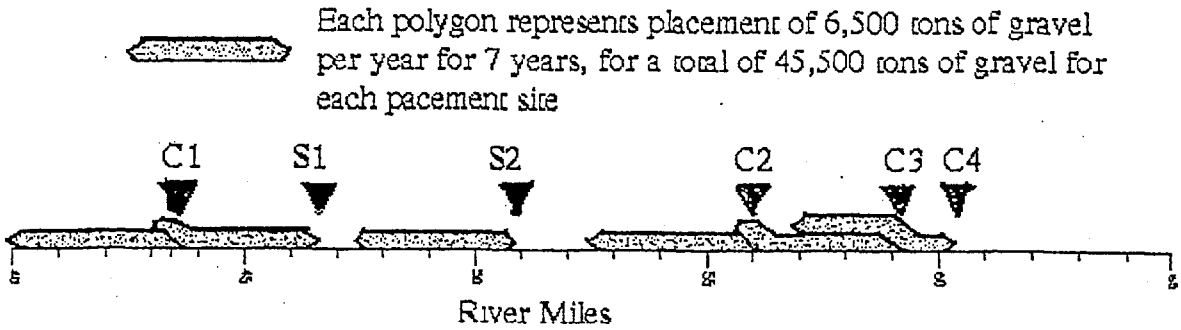
This option is feasible where wheeled construction equipment can work in close proximity (approximately 25 feet) of the riverbank. Either a mobile hydraulic crane or a track-mounted lattice boom crane could be used for this work. Cranes of both types, with appropriate reach and load capacity, are available locally.

Gravel Placement by Skyline

This method would be appropriate in the gorge where it is possible for construction equipment to gain access to the top edge of the gorge. A logging tower could be set up at that point with a cable extending across the ravine to an anchor point on the opposite side. (Vehicular access is not generally necessary to the anchor point.) A bucket, suspended from the skyline, can then be loaded at the tower location and placed at any location below the cable. In some cases, it may be possible and

Figure 1.

Approximate gravel distribution after 7 years, assuming gravel moves at .5 miles per year



Additional Work

A number of tasks should be included in any plan to further develop and refine this project:

- *Field evaluation of placement sites.* The six placement sites proposed for this project were selected based on review of maps and aerial photography. The suitability of these sites needs to be verified by field investigations, if possible, in consultation with appropriate contractors. There appear to be a substantial number of alternative placement sites if any of the proposed sites are not acceptable.

- *Safety planning.* The proposed project involves several public safety issues that will need to be addressed. These include hazards to low-flying aircraft from skyline cables suspended across the gorge, and hazards to boaters and other users traveling down or along the river during project work.

- *Replacement volumes.* The current proposal is to replace all of the bedload sediment trapped by the dam during its operation, and to continue to replace the annual bedload discharge that would be supplied if the dam were not present. Because of the large volume of sediment required by this approach, it would be appropriate to investigate the geomorphic and biological impacts of replacing only a portion of the natural bedload. We also need to focus replacement efforts on reaches that have potential for significant morphological changes that would lead to increased habitat. We need to concentrate on placing gravel upstream of reaches where an increase in spawning areas would occur.

- *Additional gravel replacement Criteria.* Some upstream areas indicate material already available in quantities sufficient for supply to downstream reaches, should the river be capable of carrying it. Hence, existing gravel in the river should be investigated –qualified and quantified- and its effect on downstream spawning determined. This information will contribute to the analysis in determining how

much and where gravel should be placed. Also we need to look at gravel that is now available and look at spawning surveys over the last 38 years to see how it has changed.

- *Determine appropriate texture for gravel placement.* It will be necessary to determine the texture of the gravel appropriate for use in a replenishment project. This should include consideration of the texture of the pre-dam riverbed, of the mobility of the placed gravel under the current flow regime, and of the texture most useful for mainstem spawning. This investigation should also assess the level of fines appropriate for placement in the streambed. This will determine whether use of washed rock is necessary. Based on the fact that the natural sediment load includes both course and fine sediments, and that both are removed in the reservoir, it seems reasonable to suggest that a moderate percentage of fines would be acceptable, and would most closely simulate natural processes.

- *Develop a plan to monitor the effects of the project.* The plan should address how the effects of the project will be monitored, and how the results of that monitoring will be used to refine future project work. Monitoring could include:

  - Establishing or reoccupying cross sections and monitoring changes.
  - Conducting gravel tracing using either magnetically or radio-marked clasts.
  - Obtaining annual, low-level aerial, stereo photography and evaluating changes in the extent and texture of gravel bars, as well as the extent of bedrock and large boulders exposed in the channel.

- *Determine when and how to place gravel.* Contact resource and regulatory agencies and determine the appropriate season for gravel placement. This should include considerations of the life stage and seasonal habits of affected species, anticipated discharge and water quality, and conformity to natural conditions. This process should also address the preferred location for gravel placement: in or out of the low flow channel.

- *Refine volume and velocity estimates by Perkins (1999).* This could include conducting a landslide inventory through the project reach and conducting gravel tracing as mentioned above. A geomorphological study would also be conduced as part of this analysis.

- *Evaluate backwater impacts.* Each placement site should be evaluated to determine the extent to which the gravel placement will cause a backwater condition. The effects of anticipated backwater conditions on channel morphology, stream habitat, and public and private property should be considered.

- *Develop* a *Hec 6 Model.* Develop a Hec 6 computer model and a detailed monitoring plan to help evaluate gravel movement and determine the effects of gravel placement,

on river dynamics over the entire reach through time. Also, utilize this model to determine annual amounts of gravel necessary.
The model will be developed on a reach to reach basis to fully investigate and incorporate variations in sediment transport. This action will address specific circumstances such as Reach 6, which appears to span a grade control and differ significantly in transport potential from surrounding reaches.

Cost Items and Quantities
Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.

Conclusions and Recommendations
A gravel replacement project on the Green River offers the opportunity to both remediate for a significant past impact of Howard Hanson Dam and to prevent that impact from growing in the future. The project can be conducted in a manner that closely replicates natural stream processes. A variety of construction methods are available that could minimize construction disturbance and construction impacts. This project has the potential to significantly protect and enhance the important fisheries resource in the Green River.

SITE NO. 34

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Flaming Geyser Slide

Location
The slide is located on the south side of the Green River at approximately RM 43 just downstream of Flaming Geyser Park. The slide has been very active in the last several years and has been responsible for placing a large amount of fine sediment in the river for a considerable distance downstream of the slide area.

Site Constraints/Problems
The slide has been mentioned as a cause of lack of spawning and spawning success in this area of the river. This disturbance in conjunction with downstream development and construction of the Tacoma Diversion works and Howard Hanson Dam severely limit mainstream and upstream spawning opportunities. Studies are being conducted by both King County and the Muckleshoot Tribe on the cause of the active slide and its effect on the river fishery. Most parties agree that when this slide is very active it has a significant effect on the downstream fishery. Land practices of clearing for agricultural purposes may have caused an increase in water infiltration and increased the potential and severity of the slide. Currently the slide has a face that is several thousand feet long and approximately 300 feet high and in any given year can place thousands of cubic yards of fine material in the Green River.

The major effect of fine sediment in this reach of the river is on Chinook spawning and rearing. The fine sediments choke the spawning gravel and significantly reduce the flow of water and oxygen getting to the salmon eggs. The fine sediment can also have an effect on the fry by effecting their gills.

The source of the instability causing the slide to continue to provide fine material to the river is twofold. First there is a source of groundwater that flows from the slide face. The other source is the river cutting the slide material at the toe of the slide. The combination of both of these sources causes the current instability. Determining which source is most significant will be investigated during the pre construction phase of this project.

Project Goals
The basic goal of this project is to eliminate a large source of fine sediment from this reach of the river. A second goal is to improve the downstream spawning success and juvenile habitat for Salmonids.

Proposed Solutions
Three alternatives have been considered for the Flaming Geyser Slide project:

Alternative No. 1 – No action: Under this alternative, the project goals of eliminating a significant source of fine sediment in the reach downstream of the Flaming Geyser Slide would not be addressed.

Alternative No. 2 – Remove the source of fine sediment by the construction of a channel that would move the river from the toe of the existing slide to eliminate the source of fine sediment.

Alternative No. 3 – Deploy a series of drains upstream of the existing slide face to help eliminate the majority of the water that is causing instability on the slide face.

Recommended Plan
Alternative No. 1, no action, was rejected since it would not eliminate fine sediment in the river downstream of the slide source.

Alternative No. 2, to construct a channel to divert the main channel from the slide toe, is the recommended alternative. It provides action that, based on current investigations, shows the best chance to eliminate the source of fine material to the river downstream of the existing slide. This alternative is shown on the attached drawing.

Alternative No. 3, will not completely eliminate the source of fines to the river and does not address the most significant cause of instability of the slide face. Therefore this alternative was not selected. In preconstruction studies we may find out that some drainage alternatives may be justified as part of alternative 2.

Cost Items and Quantities
~~Construction line items and quantities are listed in the MCACES portion of the attached~~ Engineering Appendix.

Conclusions and Recommendations
Proceed with planning, design, and construction of Alternative No. 2. Conduct a complete h&h, geotechnical and channel analysis prior to construction. Design analyses and considerations should include the following: perform a hydraulic model of the Green River upstream and downstream of the slide area; input channel geometric changes anticipated from this alternative into the hydraulic model to analyze potential impacts; and conduct geotechnical studies on the slide area to insure that the selected alternative will stabilize the slide and not just postpone its taking over the new channel area. Studies need to look at the new channels effects on possible downcutting upstream, in , and downstream of the new proposed channel that would reduce the length of this section of the river be 50%. Other channel alignments need to be investigated. During the feasibility study, geomorphological studies were conducted on this site and more detailed studies are recommended prior to construction. Also, studies will be completed on the actual effect of the slide on downstream spawning. Experts currently believe that this effect is significant, however, studies will provide further confirmation.

Green-Duwamish G.I. Ecosystem Restoration Feasibility Study
Project Description and Write-up

Site Designation: Flaming Geyser Side Channel

Location

The location of the proposed 2100ft long side channel is on a gravel terrace just downstream of an existing wall-based side channel within the Green River floodplain. The channel would originate at the existing wall-based side channel and enter the Green River approximately 1900ft downstream at river mile 44.

Site Constraints/Problems

The combination of the Howard Hanson Dam and the construction of numerous levees have combined to reduce the historical transport rates of sediment, channel migration across the Green River floodway, and the inundation of a significant portion of its floodplain. The construction of these levees and revetments, and the controlled flow release of the dam, has contributed to the river's inability to carve (or even flood) some side channels. This channel reduction has significantly reduced the amount of rearing habitat available to almost all fish species making existing stream side channels critical habitat.

The fisheries resources of the existing side channel include coho salmon (*Oncorhynchus kisutch*) and anadromous and resident cutthroat trout (*O. clarki clarki*). The pre-disturbed Lower Green River supported a much larger population of spawning and juvenile salmon -due to the annual scouring of the small wall tributaries and side channels before construction of the Howard Hanson Dam. Many side channel areas were cleared of most trees, destroying wetland connections, which provided deep rearing pools and critical habitat for salmonids. The existing wall-based channel, upstream of the proposed channel, has many of the attributes that will be modeled for the proposed channel including good riparian growth, pool ripple configuration, and wood content.

In summary, there is a critical need for more productive side channels within the Green River system. Healthy riparian growth, pool ripple habitat, large woody debris (LWD), backwater pools and other habitat features are essential for juvenile fish.

Project Goals

The primary goal of the project is to construct additional side channel habitat within the Green River system in order to allow natural ecosystem processes to be re-established in the side channel riparian corridor. Other project goals include creating a natural environment to enhance salmonid rearing within the side channel and creating refuge wetland habitat.

Proposed Solutions

- Alternative No. 1 – No action to enhance the existing stream system.

- Alternative No. 2 – Construct a 2100ft long side channel which would utilize an existing side channel as a source of flow and then enter the Green River on the downstream end. This channel would require native vegetation that would include the planting of Sitka spruce, Western red cedar, black cottonwood, bitter cherry, and cascara. Enhance existing plants, upstream of the channel. Remove exotic plant invasives. Protect stream buffer areas and encourage the establishment of a 100-foot-wide riparian buffer. Restore and create connections to off-channel habitats for salmonids.

- Alternative No. 3 – Place LWD within the new side channel.

Recommended Plan
Alternative No. 1 – No action was rejected since the need for additional good to excellent site channels is considered critical in the Green River.

Alternative No. 2 – The recommended alternative. Enhance the side channel corridor by establishing a coniferous native plant community within a stream buffer. A riparian corridor with a buffer width of 100 feet for each bank is recommended. A coniferous tree cover is necessary for shade, cover, and insect production utilized by salmonids, and that provides an eventual in-stream LWD and structural complexity necessary for successful coho and cutthroat spawning and reproduction. The planting of conifers, such as native Sitka spruce and Western red cedar, and a native plant understory, would create shade and structural diversity in the stream riparian corridor and adjacent wetlands. Specifics include: provide plantings and acquire a 100-ft buffer on both sides of the proposed channel from the State of Washington, from the existing side channel to its connection with the Green River, 1900ft downstream.

Alternative No. 3 – Place LWD in the channel. This action will follow the stabilization of sediment input and the establishment of a coniferous riparian cover along the proposed new side channel.

Cost Items and Quantities
Construction items and quantities are shown in the MCACES portion of the attached engineering appendix. The table has been developed as a standard to be used for all of the sites. Those line items not applicable are left blank in the table. Quantities were calculated based on the information obtained by a King County Department of Natural Resources site visit and from mapping. Property easement acquisition would be necessary.

Conclusions and Recommendations
We recommend the construction of a 2100ft side channel with adequate plantings and in-stream diversity including LWD, that will address current shortages of critical habitat in the Green River System. The restoration of channel function with native plant riparian communities, including the placement of spruce and cedar, would reduce forest

fragmentation within the channel and improve shading and structural diversity. A complete h&h analysis will be conducted prior to construction.

SITE NO. 36

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Newaukum Creek

Location
Newaukum Creek (WRIA 09.0014) is one of two major tributaries flowing into the middle reach of the Green River and is located in southeast King County, east of Auburn, Washington. The Newaukum Creek watershed is comprised of a 27.4-square-mile drainage area. The mainstem of Newaukum Creek is 14.3 river miles long, and can be divided into three distinct sections: the upper headwater 5-mile section, the middle 6-mile section that meanders through plateau farmland near Enumclaw, Washington, and the lower 3-mile section that descends through a steep-walled ravine from the plateau to the Green River at river mile 40.

Site Constraints/Problems
Salmonid Habitat Conditions. The lower 4 miles of the Newaukum Creek system are poor in instream large woody debris (LWD) content, and the lack of conifers in the riparian buffer in the lower study reach indicates that the riparian zone has been severely altered by logging activities. The active removal of LWD over the past 50 years, coupled with the loss of the coniferous riparian buffer and associated potential recruitment of large trees/key pieces of wood with rootwads, have impacted natural stream-process formation and channel morphology, and ultimately salmonid species composition. There were minimal conifers in the LWD complexes; hardwoods (alder and big-leaf maple) were dominant.

Current LWD amounts within the Newaukum Creek study area below the bridge are low, about five pieces/100 meters of stream. By comparison, although there is considerable variability among watersheds along the Washington-British Columbia Coast, for example, an average of 80 cubic meters of LWD/100 meters is typically found in unlogged tributaries with less than a 2 percent gradient and less than an 8-square-kilometer watershed (Slaney and Zaldokas, 1997). Fish use in the lower reach is greatly limited by the lack of LWD, and large, slow, deep-water habitats most typically associated with large dammed or backwater pools.

The 3-mile section of Newaukum Creek above the Whitney Hill Bridge has more boulder/LWD complexes than below, but the LWD representation is still far below the amount found in a normal unlogged watershed. Likewise, this same section is poor in conifers within the stream buffer (dominated by alder and big-leaf maple).

Wetland Conditions. Historically, the forested wetlands and uplands of the Newaukum Creek subbasin created a complex network of side channels that provided habitat diversity for salmonids and other wildlife species. Logging, then agricultural development that included extensive channeling, ditching, filling, and livestock grazing of wetlands on the plateau, has reduced the water quality of the stream and flow attenuation functions. Riparian wetlands have been cleared and severely altered, including the removal of coniferous native vegetation. Clearing of the riparian buffer, grading, and livestock access to Newaukum Creek, source tributaries, and source wetlands has resulted in bank erosion, siltation, and degraded water quality (King County Basin Reconnaissance 1990). Those impacts have, in turn, severely reduced the amount and diversity of forested wetlands, encouraged the colonization of invasive non-native plants, and changed the processes that affect streambed channel morphology. These impacts have affected both stream and wetland habitat that once provided good rearing habitat for both resident and juvenile anadromous salmonids.

Project Goals

The project goal is to restore process-based ecological functions that include addressing wetland attenuation and wetland native plant diversity on the Enumclaw plateau. This includes reclaiming wetland areas for additional flow attenuation and planting wetlands with native plants to increase functions/values of wetland and stream connections. A secondary goal is to provide additional key LWD pieces within the mid-lower sections of Newaukum Creek channel to promote formation of instream habitat complexity. LWD should form new logjams that will create additional pools, side channels, and juvenile salmonid refuge.

Proposed Solutions

- Alternative No. 1 – No action to enhance the existing stream or plateau wetland systems.

- Alternative No. 2 – Enhance and expand the degraded plateau wetlands adjacent to Newaukum Creek by constructing wetlands and removing invasives and planting with native vegetation, which will provide structural diversity for the wetlands and increase flow attenuation. Enhance and expand the riparian buffer of the plateau section of Newaukum Creek with an expanded 200-foot buffer. Protect stream buffer areas to exclude livestock through fencing. Restore and create connections to off-channel wetland habitats for salmonids.

- Alternative No. 3 – Reconnect the historic (Plemmons Meanders) side channel at 1,300 feet upstream from the mouth of Newaukum Creek. Install wood and boulder debris jams from the mouth, upstream to the Whitney Hill Bridge (approximately one mile).

- Alternative No. 4 – Helicopter LWD into key positions within Newaukum Creek from Whitney Hill Bridge 3 miles upstream.

Recommended Plan

Alternative No. 1 – No action was rejected since Newaukum Creek continues to be a source of spawning and rearing habitat available for salmonids and does not accomplish the goal of restoration.

Alternative No. 2 – Enhancement and expansion of the degraded plateau wetlands and enhancement/expansion of the riparian buffer is recommended as the first phase of an ecosystem-based approach to help attenuate high winter flow discharges from the plateau. Enhancement will be facilitated through planting existing plateau wetlands and the Newaukum Creek riparian 200-foot-wide buffer (plateau area) and fencing off access to livestock. Native vegetation tree cover provides shade, cover, insect production utilized by salmonids, and eventual instream LWD and structural complexity necessary for potential successful salmonid spawning and reproduction. The planting of conifers such as native Sitka spruce and Western red cedar would create shade and structural diversity in stream riparian corridor and adjacent wetlands. Expansion can occur through a combination of reclamation and constructed wetlands. Specific details include:

Reach 1. Starting at 244th Avenue Southeast, first 1,600 feet (upstream) east, acquire 100-foot easements on both sides of stream, planting and fencing both sides. End at 248th Avenue Southeast.

Reach 2. At 248th Avenue Southeast, 4,400 feet (upstream) east along Newaukum Creek, acquire 50- to 100-foot easements where appropriate on both sides, fencing and planting both sides.

Reach 3. North of Southeast 424th Street, 3,300 feet of streambank, acquire 100-foot easements on both sides, fencing and planting both sides. End at 264th Avenue Southeast.

Reach 4. From 264th Avenue Southeast to the east, acquire 200 feet of 100-foot buffer easement on both sides and provide planting and fencing.

Reach 5. Beginning at 200 feet east of 264th Avenue Southeast, acquire 1,560 feet of 100-foot buffer easement on the left bank. Fence and plant buffer area with native vegetation. On the right bank, purchase the north half of property to 268th Avenue Southeast and plant the 100-foot riparian corridor. For the next 1,400 feet upstream, pursue full acquisition of the property and demolish structures. Partial acquisition alternative: Acquire all but the portion of the property that has a structure (approximately 600 feet starting from 268th Avenue Southeast). Acquire a 100-foot buffer easement and fence and plant both sides of the creek to establish the riparian corridor within the 600-foot length in the vicinity of the structure. For the next 2,500 feet upstream, acquire a 100-foot buffer easement on both sides and plant and fence to the intersection of 278th Avenue Southeast and Southeast 416th Street.

Reach 6. From Southeast 416th Street and 278th Avenue Southeast, upstream along 3,100 feet of Newaukum Creek in the headwaters, acquire a 100-foot easement on both sides and provide planting and fencing.

Alternative Nos. 3 and 4 – It is recommended these two alternatives be phased (as Phase 2) after Alternative No. 2 is completed. It is recommended that reconnecting the historic side channel and placing LWD in the lower 4 miles be phased after the implementation of Alternative No. 2. High peak winter flows continue to over-scour and destroy salmon redds in the lower reaches of the system. Because of the hydrologic problems on the plateau due to impacts from development, high flow regimes will affect the survival of Alternative Nos. 3 and 4 on the lower 4 miles of Newaukum Creek. High flows greater than 700 cubic feet per second will continue to transport large amounts of sediment, severely scour the streambed within the middle-lower reaches, and move LWD out of the system.

Cost Items and Quantities

Construction items and quantities are shown in the MCACES portion of the attached engineering appendix. Those line items not applicable are left blank in the table. Quantities were calculated based on the information obtained by a King County Department of Natural Resources site visit and from mapping. Given the extent of survey, geotechnical, and hydraulic information available at this time, a 49 percent contingency has been applied.

Conclusions and Recommendations

The wetland and riparian stream restoration alternative can be cost effectively restored through the above habitat improvements. As part of the final design, we recommend that a detailed property survey analysis be conducted. Prior to construction, a complete h&h, sediment and geotechncial analysis will be completed. Where LWD would be placed in low gradient portions of the creek, a hydraulic analysis should be done to ensure that it will not cause additional flooding. Also prior to, during, and after construction, sediment and high flow sources throughout the basin need to be controlled or the majority of projects benefits will be lost under increasing sediment loads and flows.

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Big Spring Creek

Location
Big Spring Creek (WRIA 09.0119) is located within the Newaukum Creek basin on the northern boundary of the Enumclaw plateau northwest of Enumclaw (vicinity map attached). The 1.2-mile-long stream is a tributary of Newaukum Creek entering at river mile (RM) 6.3. Newaukum Creek is a left-bank tributary of the Green River (RM 40). Big Spring Creek originates within a series of wetlands that are part of its 1,000-acre drainage area. The primary wetland within the Big Spring Creek watershed is the 144-acre King County Newaukum Creek Wetland 51 (King County Wetlands Inventory 1990).

Site Constraints/Problems
The Big Spring Creek subbasin is part of the Enumclaw plateau, a depositional area created by the Osceola Mudflow originating from a past eruption of Mt. Rainier. The poor permeability of the Osceola flow soils, coupled with soil loss, and heavy livestock grazing, has created conditions that favor severe rapid runoff during rain and storm events. These altered hydrologic conditions contribute to excessive streambed scour and to the erosion of streambanks. Many of these wetlands have been filled by agricultural use. Rapid runoff has also been encouraged through past agricultural ditching, where Big Spring Creek has been rerouted into roadside ditches. The road fill has affected wetland hydrologic connectivity and reduced flow attenuation. Poor location of these roads through wetlands has caused an interception of interflow areas, resulting in concentrated point discharges and disruptions to wetland hydrologic functions.

The existing remnant of plateau wetland complexes today are highly disturbed pastures heavily grazed by livestock. Total wetland area has also been reduced in size through agricultural modification that has included filling, ditching, and draining. As previously mentioned, Big Spring Creek has in fact been ditched for much of its course. The clearing of the riparian buffer, grading, and livestock access to Big Spring Creek and source wetlands, has resulted in bank erosion, siltation, and degraded water quality (King County Basin Reconnaissance 1990), which has ultimately affected Newaukum Creek. These impacts have severely reduced the total wetland surface area and attenuation capabilities, wetland connections to the stream, forested wetland diversity and structure, and changed the processes that affect stream-channel morphology. They have also affected both stream and wetland habitat that once provided good rearing habitat for both resident trout and juvenile anadromous salmonids. Big Spring Creek is poor in instream

large woody debris (LWD) and lacks a coniferous riparian buffer. Fish use in the lower reach is greatly limited by the lack of LWD and complex off-channel habitat necessary for juvenile salmon rearing. Instead, the off-channel habitat is dominated by monotypic reedcanary grass ditches that, although groundwater-fed, lack cover and habitat complexity.

A predisturbed Big Spring Creek most likely supported a larger population of coho salmon, steelhead, and cutthroat trout than it presently does, where the upper and middle watershed consisted of a preponderance of forested wetlands and old-growth forest that provided deep rearing pools and critical habitat for salmonids.

The predisturbed conditions of the Big Spring Creek watershed provided habitat complexity through diverse habitats that included forested, scrub-shrub and emergent wetlands, and beaver ponds. Habitat complexity is essential for coho salmon and steelhead, allowing them access into multiple options both spatially and temporally in the system, creating greater stability in the population (Reiser and Bjornn, 1979) and thus maintaining species diversity. The hydrology within the upper Big Spring Creek watershed adjacent to the stream is already there, providing a potential to recapture part of the original wetland system. Reconnecting the wetland system to the stream will restore salmonid off-channel habitat, overwintering refuge, and groundwater-fed areas. Recolonization by beaver and the subsequent creation of beaver ponds may create the most productive coho salmon habitat known in Southeast Alaska, Washington, and Oregon (Nickelson et al., 1991). Salmon are much more adapted to the diverse habitat of connected forested wetlands and off-channel ponds and rearing areas than roadside ditches.

The Muckleshoot Indian tribes find both large sizes and high numbers of coho juveniles in the spring-fed roadside ditches surrounding Big Spring Creek. These interconnected ditches are monotypic zones of reedcanary grass that do not have overstory cover, habitat refuge, or provide diversity of food species. The ditches are productive in spite of having a monotypic cover and food source of tubifex worms because of the influx of cold groundwater, and a high energy input of agricultural fertilizer runoff. However, this productivity is found only in one phase of their life cycle, the juvenile rearing stage.

Project Goals

Restore salmonid habitat complexity and process-based ecological functions by recreating a diverse riparian corridor along Big Spring Creek, addressing wetland attenuation and wetland native plant diversity on the Enumclaw plateau. A more robust and higher surviving population of coho salmon, steelhead, and cutthroat can be encouraged by re-creating Big Spring Creek wetlands and connecting them to the creek, thus creating a greater complexity of habitats for juvenile rearing and refuge. These salmonids are better adapted to these complex habitats, rather than roadside ditches that lack both complexity and cover.

Proposed Solutions

- Alternative No. 1 – No action to enhance the existing stream system.

- Alternative No. 2 – Move Big Spring Creek from the ditched system of 244th Avenue Southeast and Southeast 424th Street, and reroute the stream into a 1,200-foot-constructed, natural-shaped channel through Wetland 51. Separate the system from pollution sources, roads, and dairy. Construct connections between the stream and wetland that will improve off-channel rearing areas. Also provide additional key LWD pieces to promote process formation and instream habitat complexity. LWD should form areas of hydraulic complexity that will create additional pools, side channels, and juvenile salmonid refuge. Move Big Spring Creek from the ditched channel within the pasture south of 244th Avenue Southeast into a 600-foot section of historic original channel. Enhance the buffer by planting conifers and creating off-channel wetland connections to the stream, especially the pastured wetland to the south of Southeast 424th Street. By reconnecting the stream to the adjacent wetlands and removing the stream from a diversion system of ditches, it is anticipated that wetland attenuation will be increased, much like what exists within Wetland 51. Plant conifers to create overhead cover, shade, and food production for salmonids. Fence areas adjacent to the stream to exclude livestock and encourage a riparian buffer.

- Alternative No. 3 – Avoid impacting the large, Class 1 Wetland 51 and move Big Spring Creek from 1,800 feet of roadside ditch into a new channel, set back 30 feet from the road prism of 244th Avenue Southeast and Southeast 424th Street. Place LWD within the channel.

Recommended Plan

Alternative No. 1 was rejected since it will not achieve the project goals. Big Spring Creek continues to be a source of juvenile refuge for salmonids, and provides a valuable source of cool temperature spring water to Newaukum Creek. The current routing of the stream subjects salmonids to pollutants from road runoff, and limits off-channel refuge to within a roadside ditch.

Alternative No. 2 is recommended, which would redirect Big Spring Creek into the natural wetland forested system that it once occupied. This option would create more rearing habitat for coho, steelhead, and cutthroat trout, and would reconnect the stream to Wetland 51, which would act to attenuate winter peak flows in the system. The project would also enhance the wetland functions of the existing reedcanary grass pasture south of Southeast 424th Street. The planting of conifers such as native Sitka spruce and Western red cedar would create shade and structural diversity in the wetland. It is also recommended that the wetlands adjacent to Big Spring Creek be purchased. Specific items include:

- Starting at the outlet of the upper part of the wetland construct 1,200 feet of channel through an existing scrub-shrub/forested wetland. Re-establish wetland connectivity with the channel. Remove invasive plant species and re-establish forested wetland planting. The constructed channel geometry would vary, but would average a 5-foot channel bottom with 3-to-1 side slopes and 3 feet deep. Acquire the affected parcels.

- The next 900 feet will continue the same type of new channel construction through the reedcanary grass wetland. Plant and fence on both sides of the new channel.

- Acquire a 100-foot buffer on both sides of the channel.

- The next 1,600 feet to the confluence with Newaukum Creek would acquire a 100-foot buffer and provide fencing and planting on both sides of the channel.

Beneficial impacts to routing the stream through the wetlands will include restoring the hydrology with an interconnected stream/wetland system. It is thought the size and capacity of the wetlands will dampen any water level fluctuations that would disturb native species. However, native Sitka spruce and Western red cedar do flourish when inundated for short durations of time. An overflow structure could be constructed if high flows prove to be deleterious to the wetland. These high flows can be diverted back to the existing ditched system.

Temporary adverse impacts might occur during construction. There may be a high water table in the forested wetland section, but not in the reedcanary grass wetland. Access roads and staging areas that would cause temporary disturbances will be restored following construction. Blasting may be the least impactful method of re-creating a channel through the forested wetland.

Alternative No. 3 was rejected since it will likewise not provide sufficient buffer to avoid road pollutants, nor will it provide the off-channel refuge for salmonids that can be found within Wetland 51.

Cost Items and Quantities

Construction items and quantities are listed in the attached construction cost estimate table. Those line items not applicable are left blank in the table. Quantities were calculated based on the information obtained by King County Department of Natural Resources site visit and from mapping. Given the extent of survey, geotechnical, and hydraulic information available at this time, a 49 percent contingency has been applied.

Conclusions and Recommendations

The wetland and stream restoration alternative can be achieved through the above habitat improvements. As much as possible, the creek will be placed in its original alignment. As part of the final design, we recommend that a detailed property survey and analysis be conducted. The rerouting of Big Spring Creek through Wetland 51 and the unnamed wetland to the south of Southeast 424th will require a detailed site survey and hydrologic, hydraulic, and soils analysis and property acquisition review. During construction caution should be maintained in the existing wetland areas to insure little or no damage to this critical habitat.

References

Nickelson, Thomas E. et al. 1992. *Seasonal Changes in Habitat Use by Juvenile Coho Salmon (Oncorhynchus kisutch) in Oregon Coastal Systems.* Canadian Journal of Fish and Aquatic Sciences, Volume 49, 1992.

Reiser, D.W., and Bjornn, T.C. 1979. *Habitat Requirements of Anadromous Salmonids.* U.S. Department of Agriculture, Pacific Northwest Forest and Range Experiment Station.

SITE NO. 38

GREEN-DUWAMISH ECOSYSTEM RESTORATION FEASIBILITY STUDY

PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Brunner Slough (Kanasket North)

Location The site is located in unincorporated King County at about river mile 58 up stream of Kanasket and Palmer.

Site Constraints/Problems
In the last one hundred years this portion of the river has become somewhat constricted due to levees and railroad construction. As a result several river meanders, oxbows and side channels have been cut off from the mainstream. Off channel rearing and spawning opportunities have been greatly reduced. Brunner slough is a remnant of a meander bend cut off from the river sometime before 1940. Currently it is a series of high flood channels carved by the river, connected only to the river at high water events. The site is well forested and is adjacent to a gravel pit.

Project Goals
The goal is to provide off-channel winter and summer rearing habitat for a variety of salmon and trout (chinook, coho, chum, steelhead and char). There is some potential for chum spawning in the restored slough.

Alternatives
Three alternatives were evaluated for this project. They include:

- Alternative One: The no-action alternative. This would maintain the status quo, the river would only access the site at high water, and there would be no opportunity for summer rearing.

- Alternative Two: This alternative includes cutting (excavating) a new up-stream connection as well as a down stream connection. These connections would be deep enough to provide fish access throughout the year and be about 20 feet wide.

- Alternative Three: This alternative involves excavation of a 3600 linear foot channel in a currently existing swale. This channel would follow the contour provided by the existing swale. The new channel would be ten feet wide and have a positive slope of 0.1% to allow for drainage. At the upper end of the channel ground water would be daylighted and gravel would be placed to construct a french drain for the ground water to drain through to the channel. An 18inch layer of gravel would be placed on the bottom of the channel throughout its length to encourage chum spawning. At the channel entrance to the Green, the mouth would be 10 ft. wide with 3 on 1 side

slopes. Large tree trunks with root wads would be placed throughout the channel but especially at the mouth to provide cover. Areas of construction will have riparian plantings. The rest of the site is covered in trees so no addition planting would be needed.

Recommended Plan: The first alternative does not provide the benefits desired in the project goals. Alternative two would provide these benefits but there could be some difficulty ensuring that the entire Green River doesn't shift and occupy the newly connected channel; this could result in flooding private property. Alternative three is the most conservative option that could meet the project goals.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix.

Conclusions and Recommendations:

Alternative three is the preferred plan. Day-lighting ground water is the key to this project. A series of piezometers should be installed and monitored over a year to determine ground water elevation and temperature. A geotechnical evaluation of the soils in the area should be done to evaluate if the channel will retain water. In addition, river levels in the area should be observed to make sure that the connection to the Green River is done at the correct elevation. A h&h analysis of the effects of the proposed outlet configuration on Green River flows will be completed prior to construction. The channel can probably maintain good fish habitat with flows in the 2 to 4 cfs range with a good shade canopy. Additional analysis of fish flows need to be done prior to construction and in connection with the above mentioned studies.

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Upper Green River Side Channels, Sites One and Two

Location

Site One is located on the Green River at about river mile (RM) 60, approximately 4.5 miles downstream of the Howard Hanson Dam, in the northeast quarter of Section 13, Township 21 North, Range 7 East (see attached vicinity map). Site Two is located downstream of Site One at about RM 58.5, in the southwest quarter of Section 13, Township 21 North, Range 7 East.

Site Constraints/Problems

The upper Green River is sediment-limited because the Howard Hanson Dam now traps sediment historically supplied by upstream processes, such as landslides and bedload transport. Because natural recruitment of sediment in river reaches located immediately downstream of the dam is insufficient to compensate for lost sediment, the channel has begun to incise, the surface substrate has become imbedded and armored with boulders and cobbles, and there is an absence of gravels of suitable size for spawning salmon. Continued incision of the mainstem channel may isolate side channels if differences in mainstem and side channel bed elevations become pronounced. Therefore, two other Green River ERS projects are proposed that would add gravel and wood to the mainstem of the Green River to counteract this incision trend.

In addition to being sediment-starved, the mainstem Green River and side channels located at both Site One and Site Two lack structural complexity. There is an absence of large wood in the stream channel so that large boulders, which are more abundant at Site Two than Site One, provide the only structure. Moreover, flow regulation by the Howard Hanson Dam has greatly altered natural flow patterns within the Green River, which in turn alters sediment transport. Winter peak flows are smaller and less frequent, and summer and fall base flows are sometimes below levels suitable for spawning salmon.

Project Goals

The project has two primary goals: (1) restore natural ecosystem processes of sediment supply and transport to the side channels (and mainstem) at Sites One and Two, and (2) restore natural ecosystem processes of large woody debris (LWD) recruitment, transport, and structure in the side channels (and mainstem). Restoring these ecosystem processes will accomplish additional project goals of rehabilitating instream salmon spawning, rearing, and migration habitat while reducing the need for ongoing maintenance. Restoring ecosystem processes will also rehabilitate habitat for non-

salmonid aquatic organisms, and non-aquatic organisms that use the Green River for some component of their life history.

Proposed Solutions

The following five alternative approaches to restoring the processes of sediment and LWD supply and transport in the Green River side channels (and mainstem) were considered:

- Alternative No. 1 – No action: No modifications would be made to existing conditions. Side channels and the mainstem river would remain sediment- and LWD-limited. Side channels would continue to provide rearing habitat for juvenile salmon and trout, unless the mainstem incised to an elevation that would prevent water from entering side channels.

- Alternative No. 2 – Undermine banks along the river downstream of Howard Hanson Dam to create landslides that would provide sources of sediment and large wood to the project areas. Allow existing river hydraulics to transport sediment and wood to create spawning beds and logjams where existing river gradient and morphology allow. Underplant the riparian corridor with native conifers to provide a future source of naturally recruited large wood to the river. Alter flow regulation at Howard Hanson Dam to provide suitable flows in side channels during the salmon spawning and incubation seasons (roughly mid-August through March). This approach would artificially initiate sediment and wood supply through the natural process of landsliding, but continued flow regulation by the Howard Hanson Dam would maintain altered sediment and wood transport.

- Alternative No. 3 – Add sediment and wood to the stream channel and allow existing river hydraulics to transport sediment and wood to create spawning beds and logjams where existing river gradient and morphology allow. Underplant the riparian corridor with native conifers to provide a future source of naturally recruited large wood to the river. Alter flow regulation at Howard Hanson Dam to provide suitable flows in side channels during the salmon spawning and incubation seasons (roughly mid-August through March). This alternative would require ongoing maintenance in the form of periodic additions of sediment and wood because natural sediment and wood supply processes would not be restored.

- Alternative No. 4 – Construct pool/riffle habitat sequences within the Site One and Two side channels to increase channel complexity, create salmon spawning habitat, and enhance rearing habitat for juvenile salmonids. Two types of habitat sequences would be constructed: bar apex jams (after Abbe and Montgomery 1996) and lateral jams. Lateral jams would consist of an upstream lateral scour pool associated with a lateral constructed logjam, and a downstream riffle in the pool tail-out. Bar apex jams would consist of a mid-channel constructed logjam with an associated upstream crescentic pool and arcuate bar, and a downstream central bar. Constructed habitat sequences would be incorporated within existing channel morphology, comprising about 10 to 15 percent of the total side channel area. Some initial channel excavation

would be required to bury key members of logjams and create associated pools. Scour around logjams is intended to maintain pools over time. Downstream riffles of lateral jams will also be excavated so that they can be backfilled with a spawning gravel substrate mixture. Logs or boulders will be buried downstream of riffles to provide bed control. Additional components of this alternative include: (1) under-planting the riparian corridor with native conifers to provide a future source of naturally-recruited large wood to the side channels, (2) constructing a large logjam at the head of the Site Two side channel to split high river flows and direct a portion of the flow into the side channel, (3) altering flow regulation at Howard Hanson Dam to provide suitable flows in side channels during the salmon spawning and incubation seasons (roughly mid-August through March), (4) constructing supply bars of spawning-sized gravel at the upstream ends of side channels to provide a source of gravel to be transported to and within side channels by existing river hydraulics, and (5) chronic additions of LWD to be transported to and within side channels by existing river hydraulics until conifer underplantings mature and provide a source of naturally recruited LWD.

- Alternative No. 5 – Transform side channels into salmon spawning channels by removing the native substrate, backfilling with spawning-sized gravels, and installing log weirs for bed control. Underplant the riparian corridor with native conifers to provide a future source of naturally recruited large wood to the side channels. Construct a supply bar of spawning-sized gravel at the upstream ends of side channels to provide a source of gravel to be transported to and within side channels by existing river hydraulics. Alter flow regulation at Howard Hanson Dam to provide suitable flows in side channels during the salmon spawning and incubation seasons (roughly mid-August through March).

Recommended Plan

Alternative No. 1, no action, was rejected because it does not achieve goals to restore processes of sediment and large wood supply and transport in the Green River and its side channels. This alternative would maintain existing salmonid rearing habitat within side channels at Sites One and Two unless continued sediment depravation to the mainstem river results in sufficient incision to isolate side channels, causing them to go dry.

Alternative No. 2, create landslides on river banks downstream of Howard Hanson Dam to provide sources of sediment and wood to the project areas, was rejected because it is unlikely that landslides would provide enough material to restore sediment and wood supplies, especially over time. More analysis would be needed to determine whether the local geology is prone to landsliding, and whether landsliding would provide suitable substrate material to the system. Potential negative effects of artificially initiated landslides would also need to be evaluated. Moreover, although this alternative would provide for the formation of spawning beds and logjams in locations and configurations consistent with existing hydraulic conditions, it would not guarantee formation of these habitats at the Site One and Two side channels. This alternative warrants further consideration because it provides a supply of sediment and wood through the natural

process of landsliding, which is the best opportunity to accomplish ecosystem process restoration within the constraint of retaining the Howard Hanson Dam.

Alternative No. 3, add sediment and wood to the stream channel and allow it to be transported by existing hydraulics, was rejected because it does not provide for immediate salmonid habitat restoration. This alternative would require ongoing maintenance in the form of periodic additions of sediment and wood because natural sediment and wood supply processes would not be restored as long as Howard Hanson Dam was still in place. Although this alternative would provide for the formation of spawning beds and logjams in locations and configurations consistent with existing hydraulic conditions, it would not guarantee formation of these features in the Site One and Two side channels. This alternative should be investigated as a potential future phase of the project that would provide non-site-specific restoration opportunities.

Alternative No. 4, construct pool/riffle habitat sequences within existing side channel morphology, was selected because it provides the best opportunity to accomplish related project goals while considering reach-level natural processes within the constraints of retaining the Howard Hanson Dam and restoring salmonid habitat within Site One and Two side channels. As described above, this alternative will construct pool/riffle habitat sequences within the Site One and Two side channels to increase channel complexity, create salmon spawning habitat, and enhance rearing habitat for juvenile salmonids. Two types of habitat sequences would be constructed, bar apex jams (after Abbe and Montgomery 1996) and lateral jams.

Although this alternative does not restore natural processes of sediment and wood supply and transport at the basin scale, it attempts to restore these processes at the reach scale. Periodic wood and gravel seeding at the heads of side channels is intended to provide wood and sediment supplies that would be transported through side channels by existing flow hydraulics; conifer underplantings will provide a future source of naturally recruited LWD. Constructed habitat sequences are intended to create immediate salmon spawning and rearing habitat while restoration of the processes that naturally create these habitat features is underway. Constructing habitat sequences within the existing side channel morphology reduces risk of failure because the existing morphology is stable under current conditions. This alternative also allows for potential flow release alterations at Howard Hanson Dam.

Alternative No. 5, transform side channels into salmon spawning channels, was rejected because it would not restore ecosystem processes of sediment and wood supply and transport, it would not accomplish secondary project goals of restoring salmonid habitat for life history stages other than spawning, and it is unlikely that suitable spawning habitat would be created. Cobbles and boulders currently present in side channels suggest that a uniform channel of spawning-sized gravels would be unstable during typical winter flows even with log weir bed control, resulting in gravel mobilization, redd scour, and embryo mortality. Uniform channel bedform created by this design will likely limit surface water downwelling, resulting in potentially low subsurface dissolved oxygen concentrations and embryo mortality. Flow regulation at Howard Hanson Dam

would have to be altered to provide suitable flows during salmon spawning and incubation periods, an arrangement that has not yet been agreed upon. Side channels currently provide rearing habitat for juvenile salmonids; flows in side channels were insufficient for salmon spawning during field visits in late October 1999.

This alternative would require ongoing maintenance in the form of periodic installations of gravel to replace gravel transported out of side channels during typical winter flows; analysis of shear stresses in side channels would identify expected maintenance requirements. This alternative does not provide the opportunity to restore ecosystem processes; rather it is a traditional site specific, single species, single life history stage approach to habitat restoration like those that have had limited success in the past.

Cost Items and Quantities

Construction line items and quantities are listed in the MCACES portion of the attached engineering appendix.

Conclusions and Recommendations

Conduct hydraulic analyses to determine shear stresses in side channels to identify mobility of spawning-sized gravels. Conduct hydrologic analyses to determine recurrence interval of flows that will mobilize gravels. Survey elevations of side channels and adjacent mainstem to determine risk of side-channel isolation as a result of the proposed project. The survey will also identify which of the several side channels present at Site One are best-suited for restoration, as well as suitable locations for sediment-supply gravel bars upstream of side channels. Obtain aerial photographs so that constructed habitat sequences can be sited within existing channel features (such as large boulders and wood) without the need for detailed ground survey. Insure close coordination with the Howard Hanson project which will be placing LWD in the mainstem. Construct both projects at the same time to eliminate the threat of downcutting of the channel that has no LWD and leaving the other channel high and dry during low flows. Complete an overall h&h model, geomorphologic analysis of the total project, and a stability analysis of log jams under high flow conditions, prior to construction.

SITE NO. 40

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Gale Creek

Location
Site is a perched culvert on Gale Creek located on Road 5530 at milepost 11.5. The creek is tributary to the Green River and the culvert is approximately 3,100 feet upstream of the confluence with the Green River. The confluence is upstream of the Corps' Howard Hansen Dam on Tacoma Public Utilities property. Refer to site location map, included in the Gale Creek Site Plan, Figure No. 4.

Site Constraints/Problems
The existing pipe arch culvert (12 feet wide and 8 feet high) is perched 2.4 feet and prevents fish passage. The existing stream channel width is approximately 12 to 16 feet wide. Restoring upstream fish passage will open up approximately two miles of spawning and rearing habitat on Gale creek. One mile of Boundary Creek, a tributary to Gale Creek, could also become available for spawning and rearing habitat. Based on site investigations and discussions with Tacoma Public Utility staff, it is believed that the existing culvert is undersized. During high flows, the creek has bypassed the culvert and overtopped the road.

Project Goals
The proposed project would eliminate the perched culvert condition and allow fish passage into the upstream reaches of Gale Creek and Boundary Creek. The hydraulic constriction created by the existing culvert would also be eliminated.

Proposed Solutions
The following three alternatives were considered in selecting the proposed project:

- Alternative No. 1 - No Action: No modifications to the existing perched culvert. Fish passage would remain blocked.

- Alternative No. 2 - Bottomless Culvert: Replace the existing pipe arch culvert with a bottomless culvert. The creek channel would be re-routed through the new culvert with the natural channel gradient maintained. Provide spawning gravel upstream of the site.

- Alternative No. 3 - Bridge: Replace the existing pipe arch culvert with a bridge. The creek channel would be re-routed through the bridge, with the natural channel gradient maintained. Provide spawning gravel upstream of the site.

Recommended Plan

The no action alternative will not achieve the project goals and is not a viable option for this site. However, both Alternative 2 and 3 can achieve the project goals. Bottomless culverts are the cost-effective alternative if the culvert span distance is less than 20 feet. The flow for an approximately 100-year storm for Gale Creek was estimated using an empirical formula developed in a previous hydraulic analysis for the Green River prepared by HDR (Maywood Bridge – Green River Hydraulic Analysis, for Tacoma Public Utilities, June 1998). With an estimated drainage basin area for Gale Creek upstream of the site of 5.4 square miles, the calculated 100-year flow is 742 cfs.

A bottomless arch culvert with a span of 20 feet and rise of 10 feet can convey 742 cfs. However, bottomless culverts are cost effective as compared with a bridge crossing when the culvert span is less than 20 feet.

Assuming a bridge width equal to the creek width at ordinary high water (OHW) times 1.33 and an OHW creek width of 25 feet, the minimum bridge width is equal to 33.25 feet. This was rounded up to the nearest 10-foot interval. Thus, a new bridge with a span of 50 feet, allowing for side slopes, is the proposed alternative to meet the project goals. The conceptual design for this structure is depicted in the Gale Creek Site Plan, Figure No. 4.

During construction, a temporary diversion road will be constructed on the upstream side of Road 5530 to detour traffic. A low flow temporary creek crossing will also be required (refer to Temporary Construction Fly By Drawing, Figure No. 9).

In order to minimize creek channel rerouting, the new bridge structure will be located next to the existing culvert. During the first stages of construction, the existing culvert will be retained for a temporary creek diversion in order to avoid removal costs and in-stream construction. Prior to placing the bridge deck, the culvert will be removed. There will be adequate room to allow creek passage within the new bridge creek span until the bridge construction and channel re-routing is completed.

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable to Gale Creek and are left blank. Major items such as the bridge structure, excavation, fill, and restoration are listed along with a contingency and sales tax. Quantities were calculated based on the information obtained in the previous site investigations along with HDR's site visit. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied to the estimate.

Conclusions and Recommendations

The Gale Creek Site can be effectively restored via construction of a 50-foot span bridge. During Advanced Engineering and Design (AED), a detailed site survey, geotechnical investigation, hydrologic/ hydraulic, and channel stability analysis will be completed. Consideration should be given to dropping the bridge deck by 4 feet and regrading the roadway appropriately since the conveyance area of the proposed bridge is more than adequate, and the dimensions are governed by site rather than hydraulic constraints.

Placing of the new arch culvert in the same alignment as the existing culvert while providing appropriate temporary diversion and care of flow in the creek may also be an AED task.

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Site No. 5 - Boundary Creek – Culvert Replacement

Location
This perched culvert passes Boundary Creek under Road 5530A about 1/3 mile from Road 5530. The culvert lies just upstream of Boundary Creek's confluence with Gale Creek, which is roughly 5000 feet upstream of Gale's confluence with the Green River. Refer to site location map, included in the Boundary Creek Site Plan, Figure No. 5.

Site Constraints/Problems
The existing 6-foot high by 8-foot wide, 32-foot long culvert is perched by about 1 foot. The existing stream channel width is approximately 7 to 10 feet wide. The downstream scour hole was relatively small as was the material in it, suggesting a lower flow than at the other sites. A 48-inch diameter, 40-foot long high water diversion culvert to the west of the 32-foot long culvert is perched by about 3.5 feet. Restoring adequate upstream fish passage will open up approximately one mile of spawning and rearing habitat on Boundary creek.

Project Goals
The proposed project would eliminate the perched culvert condition to allow for fish passage in the upstream reaches of Boundary Creek. Upstream habitat improvements would include placement of spawning gravel.

Recommended Solutions
The following four alternatives were considered in selecting the proposed project:

- Alternative No. 1 - No Action: No modifications to the existing perched culvert. Fish passage would remain blocked.
- Alternative No. 2 - Bottomless Culvert: Install a bottomless arch of larger size in the location of the high water diversion culvert. Place spawning gravel upstream of culvert.
- Alternative No. 3 - Bottomless Culvert: Install a bottomless arch of larger size in the location of the existing 6-foot high by 8-foot wide culvert. Place spawning upstream of culvert.
- Alternative No. 4 - Bridge: Replace culvert with a 45-foot bridge. Place spawning gravel upstream of culvert.

Recommended Plan
The no action alternative will not achieve the project goals and is not a viable option for this site. However, both Alternatives 2 and 3 can cost effectively achieve the project goals. Bottomless culverts are the cost-effective alternative if the culvert span distance is less than 20 feet.

The conceptual design for Alternative No. 2 is recommended and is depicted in the Boundary Creek Site Plan, Figure No. 5. This alternative was preferred to Alternative 3 because it provides for a more direct conveyance to the portion of the creek downstream of the culvert.

The flow for an approximately 100-year storm for Boundary Creek was estimated using an empirical formula developed in a previous hydraulic analysis for the Green River prepared by HDR (Maywood Bridge – Green River Hydraulic Analysis, for Tacoma Public Utilities, June 1998). With an estimated drainage basin area for Boundary Creek upstream of the site of 1.2 square miles, the calculated 100-year flow is 203 cfs.

A bottomless culvert with an additional 2 feet of rise was selected to allow a 2-foot bury depth of the culvert and the footing for scour. Therefore, a 16-foot span and an 8-foot rise was selected as the cost-effective solution. The conceptual design for this structure is depicted in the Boundary Creek Site Plan, Figure No. 5.

Remove the existing 48-inch high water diversion culvert and replace with bottomless arch. During the first stages of construction, the existing 6-foot high by 8-foot wide culvert will be retained for a temporary creek diversion in order to avoid removal costs and in-stream construction. Prior to placing the bottomless arch, the 6-foot high by 8-foot wide culvert will be removed. A low flow temporary creek crossing will be required (refer to Temporary Construction Fly By Drawing, Figure No. 9). Footing will be designed to control local scour and prevent recreating perched culvert conditions.

Place gravel and large woody debris for 100 feet upstream of the existing culvert.

Cost Items and Quantities

Construction line items and quantities shown in the MCACES portion of the attached engineering appendix. The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable to Boundary Creek and are left blank. Major items such as the culvert structure, excavation, fill, and restoration are listed along with a contingency and sales tax. Quantities were calculated based on the information obtained in the previous site investigations along with HDR's site visit. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied to the estimate.

Conclusions and Recommendations

The Boundary Creek Site can be effectively restored via a bottomless arch, large woody debris, and spawning gravel. During Advanced Engineering and Design, we recommend that a detailed site survey, geotechnical investigation, hydrologic/ hydraulic and LWD stability analyses be conducted.

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Site No. 8 - Sweeney Creek – Culvert Replacement

Location
Site includes two perched culverts on Sweeney Creek located on Road 3703 at milepost 21.8. The creek is a south tributary of the Green River and the culverts are approximately 200 feet upstream of the confluence with the Green River. The confluence is upstream of the Corps' Howard Hansen Dam on Tacoma Public Utilities property. Refer to site location map, included in the Sweeney Creek Site Plan, Figure No. 8.

Site Constraints/Problems
The existing 60-inch diameter east culvert is perched 1.3 feet and does not allow fish passage; the 48-inch diameter west culvert is perched 3.54 feet. The existing stream channel width is approximately 10 to 14 feet wide. Presently, there is a 4 to 5 foot drop in the last 12 to 15 feet of the creek at the confluence with the Green River. There are large 1-foot diameter rocks in the confluence area. Correcting fish passage blockage and enhancing upstream habitat will open up several miles of spawning and rearing habitat. The upstream habitat would benefit from adding large woody debris. The site has a history of flooding problems.

Project Goals
The proposed project would eliminate the perched culverts as well as the steep gradient in the last 15 feet of the creek to allow for fish passage into the upstream reach of Sweeney Creek. Upstream habitat improvements will include placement of large woody debris in the creek.

Proposed Solutions:
The following three alternatives were considered in selecting the proposed project:

- Alternative No. 1 - No Action: No modifications to the existing perched culverts and downstream channel. Fish passage would remain blocked.

- Alternative No. 2 - Bottomless Culvert: Replace the existing circular culverts with a bottomless culvert. The creek channel would be re-routed through the new culvert with the natural channel gradient maintained. The downstream channel would be excavated to maintain a constant gradient between the new culvert and the confluence with the Green River. Place large woody debris in the upstream reach to provide habit-forming structures.

- Alternative No. 3 - Bridge: Replace the existing circular culverts with a bridge. The creek channel would be re-routed through the bridge with the natural channel gradient

maintained. The downstream channel would be excavated to maintain a constant gradient between the new bridge and the confluence with the Green River. Place large woody debris in the upstream reach to provide habit-forming structures.

Recommended Plan

The no action alternative will not achieve the project goals and is not a viable option for this site. However, both Alternative Nos. 2 and 3 can achieve the project goals. Bottomless culverts are the cost-effective alternative if the culvert span distance is less than 20 feet.

The approximately 100-year flow for Sweeney Creek was estimated using an empirical formula developed in a previous hydraulic analysis for the Green River prepared by HDR (Maywood Bridge – Green River Hydraulic Analysis, for Tacoma Public Utilities, June 1998). With an estimated drainage basin area for Sweeney Creek upstream of the site of 2.4 square miles, the calculated 100-year flow is estimated at 365 cfs. While a bottomless arch culvert with a 15-foot span and 7.5-foot rise is adequate to convey 365 cfs, a bridge is recommended by the Forest Service and supported by Weyerhaeuser and is therefore the selected alternative. The conceptual design for Alternative No. 3 is recommended and is depicted in the Sweeney Creek Site Plan, Figure No. 8.

Assuming a minimum bridge width equal to the creek width at ordinary high water (OHW) times 1.33 and an OHW creek width of 12.3 feet, the minimum bridge width is 16.4 feet which is rounded to 20-feet. Because the resulting bridge dimensions would drop the thalweg beneath the proposed slope regrade, a 50-foot span is recommended. This increase in hydraulic capacity results in a shallower bridge with a thalweg in the approximate location of a natural regrade. Thus, a new bridge with a span of 50 feet is the proposed alternative to meet the project goals. A low flow temporary creek crossing will also be required (refer to Temporary Construction Fly By Drawing, Figure No. 9).

In order to minimize creek channel rerouting, the new bridge structure will be located over the existing 48-inch culvert. During the first stages of construction, the existing 60-inch culvert will be used for a temporary creek diversion in order to avoid removal costs and in-stream construction, and the 48-inch culvert will be removed. Prior to placing the bridge deck, the 48-inch culvert will be plugged. There will be adequate room to allow creek passage within the new bridge creek span until the bridge construction and channel re-routing is completed.

Drawings of creek modifications appear in the Creek Details, Figure No. 10. Modifications to the creek channel consist of placement of large woody debris for 100 feet upstream of the culvert.

For construction quantity estimating purposes, placement of one piece of large woody debris every two stream widths was assumed. Streams were assumed to be about 12.5 feet wide (survey data is not available).

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable to Sweeney Creek and are left blank. Major items such as the bridge structure, excavation, fill, and restoration are listed along with a contingency and sales tax. Quantities were calculated based on the

information obtained in the previous site investigations along with HDR's site visit. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied to the estimate.

Conclusions and Recommendations

The Sweeney Creek Site can be effectively restored via a 50-foot span bridge. Changes in grade-following removal of current stream blockages -will be considered when designing bridge supports. LWD downstream of the bridge will not be installed for a minimum of 2 years after bridge construction. During Advanced Engineering and Design, a detailed site survey, geotechnical investigation, hydrologic/hydraulic analyses, and LWD security study will be conducted.

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Site No. 7 - Olsen Creek – Culvert Replacement

Location
This perched 72-inch CMP culvert is located on Road 3703 at milepost 23.5. The existing stream channel width is approximately 8 to 12 feet wide. Olsen creek is tributary to the Green River and the culvert is located approximately 250 feet upstream of the confluence with the Green River. The confluence is upstream of the Corps' Howard Hansen Dam on Tacoma Public Utilities property. Refer to site location map, included in the Olsen Creek Site Plan, Figure No. 7.

Site Constraints/Problems
Upstream of the culvert there is no woody debris. There are a few large boulders directly at the culvert mouth. The stream bed is flat and undefined. Culvert is buckling. Quality habitat lies about 800-1000 feet upstream of the culvert.

Project Goals
Ensure fish passages enhance fish habitat with additional stream structure, refine existing habitat and providing a link to further habitat upstream.

Proposed Solutions
The following three alternatives were considered in selecting the proposed project:

- Alternative No. 1 - No Action: Habitat would remain as is
- Alternative No. 2 - Stream Structure: Place large woody debris upstream as well as spawning gravel. Downstream, place four notched logs bank to bank, 30 feet apart.
- Alternative No. 3 - Culvert Replacement: Replace existing culvert with a bottomless arch culvert of larger size and place large woody debris upstream as well as spawning gravel.

Recommended Plan
The no action alternative will not achieve the project goals and is not a viable option for this site. However, Alternative No. 3 can best achieve the project goals as the existing culvert is decayed, buckled, and undersized.
The conceptual design for Alternative No. 3 is recommended and is depicted in the Olsen Creek Site Plan, Figure No. 7.
The flow for an approximately 100-year storm for Olsen Creek was estimated using an empirical formula developed in a previous hydraulic analysis for the Green River prepared by HDR (Maywood Bridge – Green River Hydraulic Analysis, for Tacoma

Public Utilities, June 1998). With an estimated drainage basin area for Olsen Creek upstream of the site of 1.77 square miles, the calculated 100-year flow is 284 cfs.
The span and rise dimensions for a bottomless culvert were computed based on 284 cfs. Assuming an arch configuration with the span distance twice as long as the arch rise, a 12-foot span and 6-foot rise is adequate to convey 284 cfs. A bottomless culvert with an additional 2 feet of rise was selected to allow a 2-foot bury depth of the culvert and the footing for scour. Therefore, a 16-foot span and an 8-foot rise was selected as the cost-effective solution. Footing will be designed to control local scour and the recreation of perched culvert conditions.
During construction, the existing culvert will be retained for a temporary creek diversion and then removed. A low flow temporary creek crossing will be required (refer to Temporary Construction Fly By Drawing, Figure No. 9).
Drawings of creek modifications appear in the Creek Details, Figure No. 10. Modifications to the creek channel consist of placement of large woody debris and spawning gravel for 100 feet upstream of the culvert.
For construction quantity estimating purposes, placement of one piece of large woody debris every two stream widths was assumed. Streams were assumed to be about 12.5 feet wide (survey data is not available).

Cost Items and Quantities
Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable to Olsen Creek and are left blank. Major items such as the culvert structure, excavation, fill, and restoration are listed along with a contingency and sales tax. Quantities were calculated based on the information obtained in the previous site investigations along with HDR's site visit. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied to the estimate.

Conclusions and Recommendations
The Olsen Creek Site can be cost-effectively restored via a bottomless culvert, large woody debris, and spawning gravel. During Advanced Engineering and Design (AED), we recommend that a detailed site survey, geotechnical investigation, and hydrologic/ hydraulic analyses be conducted. Furthermore, LWD security analysis, and scour and riprap grade control-to prevent recreating perched conditions-will be completed in design studies prior to construction. Placing of the new arch culvert in the same alignment as the existing culvert while providing appropriate temporary diversion and care of flow in the creek may also be an AED task.

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Site No. 3 – May Creek – Culvert Replacement

Location
This CMP culvert is perched over May Creek under Road 5530. The creek is tributary to the Green River and the culvert is approximately 3,100 feet upstream of the confluence with the Green River. The confluence is upstream of the Corps' Howard Hansen Dam on Tacoma Public Utilities property. Refer to site location map, included in the May Creek Site Plan, Figure No. 3.

Site Constraints/Problems
The existing 48-inch CMP diameter, 60-foot-long culvert is perched by about 2 feet at the downstream end. The existing stream channel width is approximately 6 to 10 feet wide. There is a history of culvert plugging and roadway flooding at the site. Upstream habitat in the stream will benefit from adding diversity. Rock material downstream of the culvert is 12 to 18 inches in size and well rounded, suggesting higher flows occur at this site.

Project Goals
The proposed project would eliminate the perched culvert condition to allow for fish passage into the upstream reach of May Creek. Upstream habitat enhancement would consist of adding large woody debris, spawning gravel and the planting of a riparian corridor. Coordination with BPA will be required to ensure that the proposed plantings will remain in place as part of BPA's Transmission Line Corridor maintenance program.

Proposed Solutions
The following three alternatives were considered in selecting the proposed project:

- Alternative No. 1 - No Action: No modifications to the existing perched culvert. Fish passage would remain blocked.

- Alternative No. 2 - Bottomless Culvert: Replace the existing 48-inch diameter culvert with a bottomless arch culvert of a larger size. Place large woody debris and spawning gravel upstream of the culvert and plant a riparian corridor under the BPA lines.

- Alternative No. 3 - Bridge: Replace the existing 48-inch diameter culvert with a 45-foot wide bridge. Place large woody debris and spawning gravel upstream of the culvert and plant a riparian corridor under the BPA lines

Recommended Plan

The no action alternative will not achieve the project goals and is not a viable option for this site. However, both Alternatives No. 2 and 3 can achieve the project goals. Bottomless culverts are the more cost-effective solution as compared with a bridge alternative if the culvert span distance is less than 20 feet across.

The conceptual design for Alternative No. 2 is recommended and is depicted in the May Creek Site Plan, Figure No. 3.

The flow for an approximately 100-year storm for May Creek was estimated using an empirical formula developed in a previous hydraulic analysis for the Green River prepared by HDR (Maywood Bridge – Green River Hydraulic Analysis, for Tacoma Public Utilities, June 1998). With an estimated drainage basin area for May Creek of 1.4 square miles, the calculated 100-year flow is 232 cfs.

The span and rise dimensions for a bottomless culvert were computed based on 232 cfs. Assuming an arch configuration with the span distance twice as long as the arch rise, a 12-foot span and 6-foot rise is adequate to convey 232 cfs. A bottomless culvert with an additional 2 feet of rise was selected to allow a 2-foot bury depth of the culvert and the footing for scour. Therefore, a 16-foot span and a 8-foot rise was selected. Footing will be designed to control local scour and the recreation of perched conditions.

During construction, the existing culvert will be retained for a temporary creek diversion and then removed. A low flow temporary creek crossing will be required (refer to Temporary Construction Fly By Drawing, Figure No. 9).

Drawings of typical riparian corridor plantings, BPA corridor plantings, and creek modifications appear in the Creek Details, Figure No. 10. Plantings should occur within the approximately 700 foot wide Bonneville Power Administration (BPA) corridor, 650 feet upstream of the culvert. Plantings include a combination of shrubs, coniferous and deciduous trees to be planted in natural random clusters. Water fluctuation zone plants will further reduce water temperatures, increase dissolved oxygen levels, and bind the soil. Pacific willow and red alder, are to be staked in the water fluctuation zone along channel side slopes at a maximum ninety degree angle. Quantity calculations for all 3 plant types in the water fluctuation zone (2 staking plants and slough sedge) were based upon a 3 row zone with one row of each type with plants 2-feet center to center and rows 1 to 2 feet apart and staggered. Each row, however, should be a random mix of the plant types. Low canopy plantings appropriate within the Bonneville Power Administration (BPA) corridor include shrubs and low height trees such as Scouler Willows.

Modifications to the creek channel consist of placement of large woody debris and spawning gravel for 100 feet upstream of the culvert.

For construction quantity estimate purposes, placement of one piece of large woody debris every two stream widths was assumed. Streams were assumed to be about 12.5 feet wide (survey data is not available).

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable to May Creek and are left blank. Major items such as the culvert structure, excavation, fill, and restoration are listed along

with a contingency and sales tax. Quantities were calculated based on the information obtained in the previous site investigations along with HDR's site visit. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied to the estimate.

Conclusions and Recommendations

The May Creek Site can be cost-effectively restored via a bottomless culvert, plantings, and adding large woody debris and spawning gravel. During Advanced Engineering and Design (AED), we recommend that a detailed site survey, geotechnical investigation, and hydrologic/ hydraulic analyses be conducted. Furthermore, a LWD security analysis, and evaluation of scour and riprap grade control –to prevent recreating perched conditions- will be completed prior to construction. Also, Placing of the new arch culvert in the same alignment as the existing culvert while providing appropriate temporary diversion and care of flow in the creek may also be an AED task. Additionally, if there is an existing access road that crosses the creek upstream of the culvert to be replaced, then the potential for adding more large woody debris and spawning gravel upstream should be examined.

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Site No. 2 - Maywood Creek – Culvert Replacement

Location
Site is a perched culvert on Maywood Creek tributary to the Green River located on Road 5530 at MilePost 19.5 approximately 2,000 feet upstream of the confluence with the Green River. The confluence is upstream of the Corps' Howard Hansen Dam on Tacoma Public Utilities property. Refer to site location map, included in the Maywood Creek Site Plan, Figure No. 2.

Site Constraints/Problems
The existing 48-inch diameter culvert is perched 2.6 feet and prevents upstream fish passage. The existing stream channel width is approximately 5 to 8 feet wide. Correcting fish passage blockage and enhancing upstream habitat will open up approximately one mile of spawning and rearing habitat. The upstream habitat would benefit from plantings in the riparian corridor, especially where the creek passes underneath the BPA Transmission Line Corridor.

Project Goals
The proposed project would eliminate the perched culvert condition and allow for fish passage into the upstream reach of Maywood Creek. Upstream habitat improvements would include plantings in the riparian corridor and placement of large woody debris and spawning gravel in the creek. Coordination with BPA will be required to ensure that the proposed plantings will remain in place as part of BPA's Transmission Line Corridor maintenance program.

Proposed Solutions
The following three alternatives were considered in selecting the proposed project:

- Alternative No. 1 - No Action: No modifications to the existing perched culvert. Fish passage would remain blocked.

- Alternative No. 2 - Bottomless Culvert: Replace the existing 48-inch diameter circular culvert with a bottomless culvert adjacent to the existing culvert. The creek channel would be re-routed through the new culvert with the natural channel gradient maintained. Vegetate the upstream riparian corridor to provide shading and place large woody debris and spawning gravel in the upstream reach to provide habit-forming structures.

- Alternative No. 3 - Bridge: Replace the existing 48-inch diameter circular culvert with a bridge. The creek channel would be re-routed through the bridge with the

natural channel gradient maintained. Vegetate the upstream riparian corridor to provide shading and place large woody debris and spawning gravel in the upstream reach to provide habit-forming structures.

Recommended Plan

The no action alternative will not achieve the project goals and is not a viable option for this site. However, both Alternative 2 and 3 can achieve the project goals. Bottomless culverts are the cost-effective alternative if the culvert span distance is less than 20 feet. The conceptual design for Alternative No. 2 is recommended and is depicted in the Maywood Creek Site Plan, Figure No. 2. The span distance required to convey the calculated flow for an approximately 100-year storm was determined. The 100-year flow for Maywood Creek was roughly calculated using an empirical formula developed in a previous hydraulic analysis for the Green River prepared by HDR (Maywood Bridge – Green River Hydraulic Analysis, for Tacoma Public Utilities, June 1998). With an estimated drainage basin area for Maywood Creek upstream of the site of 1.1 square miles, the calculated 100-year flow is 188 cfs.

The span and rise dimensions for a bottomless culvert were computed based on 188 cfs. Assuming an arch configuration with the span distance twice as long as the arch rise, a 12-foot span and 6-foot rise is adequate to convey 188 cfs. A bottomless culvert with an additional 2 feet of rise was selected to allow a 2-foot bury depth of the culvert and the footing for scour. Therefore, a 16-foot span and a 8-foot rise was selected. Footing will be designed to control local scour and prevent recreation of a perched culvert condition. During construction, an existing logging road will be used to detour traffic. The road bypasses the site to the north and formerly had a bridge crossing at Maywood Creek. Because the bridge was washed out, a temporary creek crossing will need to be provided (refer to Temporary Construction Fly By Drawing, Figure No. 9). The existing culvert will be retained for a temporary creek diversion during construction, and then removed. Drawings of typical riparian corridor plantings, BPA corridor plantings, and creek modifications appear in the Creek Details, Figure No. 10. The 1-mile long reach upstream of the existing culvert is to receive plantings. The first 400 feet of this reach are under BPA powerlines. Plantings include a combination of shrubs and coniferous and deciduous trees to be planted in natural random clusters. Water fluctuation zone plants will further reduce water temperatures, increase dissolved oxygen levels, and bind the soil. Pacific willow and red alder, are to be staked in the water fluctuation zone along channel side slopes at a maximum ninety degree angle. Quantity calculations for all 3 plant types in the water fluctuation zone (2 staking plants and slough sedge) were based upon a 3 row zone with one row of each type with plants 2-feet center to center and rows 1 to 2 feet apart and staggered. Each row, however, should be a random mix of the plants types. Low canopy plantings appropriate within the Bonneville Power Administration (BPA) include shrubs and low height trees such as Scouler Willows.

Modifications to the creek channel consist of placement of large woody debris and spawning gravel for 100 feet upstream of the culvert. For construction quantity estimating purposes, placement of one piece of large woody debris for every two stream widths was assumed. Streams were assumed to be about 12.5 feet wide (survey data is not available).

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable to Maywood Creek and are left blank. Major items such as the culvert structure, excavation, fill, and restoration are listed along with a contingency and sales tax. Quantities were calculated based on the information obtained in the previous site investigations along with HDR's site visit. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied to the estimate.

Conclusions and Recommendations

The Maywood Creek Site can be cost-effectively restored via a bottomless culvert and plantings. During Advanced Engineering and Design (AED), we recommend that a detailed site survey, geotechnical investigation, and hydrologic/hydraulic analyses be conducted. Furthermore, a LWD security analysis, and scour and riprap grade control evaluation–to prevent recreating perched conditions-will be completed prior to construction. Placing of the new arch culvert in the same alignment as the existing culvert while providing appropriate temporary diversion and care of flow in the creek may also be an AED task. Additionally, if there is an existing access road that crosses the creek upstream of the culvert to be replaced, then the potential for adding more large woody debris and spawning gravel upstream should be examined.

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Site No. 6 - Gold Creek – Culvert Replacement

Location
This perched 84-inch, 80-foot long CMP is located under Road 3703 at milepost 24.75 and lies next to a concrete culvert of 54-inch diameter. The existing stream channel width is approximately 10 to 14 feet wide. The creek is tributary to the Green River. The confluence is upstream of the Corps' Howard Hansen Dam on Tacoma Public Utilities property. Refer to site location map, included in the Gold Creek Site Plan, Figure No. 6.

Site Constraints/Problems
Flow was relatively high and slopes were steep. Large woody debris upstream, and 6 to 8-inch cobbles downstream, suggest a large drainage basin, as confirmed by subsequent delineation on topographic maps. A cement lined culvert which conveys little flow lies next to the CMP which conveys most flow at this site. Fish cannot migrate upstream because the CMP is perched by about 8-inches. The stream upstream of the culvert would benefit from adding a diversity of biological structure.

Project Goals:
The proposed project would eliminate the perched culvert condition to allow for fish passage in the upstream reaches of Gold Creek. The habitat upstream of the culvert would be improved with the addition of large woody debris for 100 feet.

Proposed Solutions:
The following three alternatives were considered in selecting the proposed project:

- Alternative No. 1 - No Action: No modifications to the existing perched culvert. Fish passage would remain blocked.

- Alternative No. 2 - Culvert Replacement: Replace 54-inch diameter culvert with a bottomless arch of larger size. The creek channel would be routed through the new culvert with the natural channel gradient maintained. Place large woody debris upstream of culvert.

- Alternative No. 3 – Bridge: Replace culvert with a 45-foot bridge. The creek channel would be routed under the bridge with the natural channel gradient maintained. Place large woody debris upstream of culvert.

Recommended Plan

The no action alternative will not achieve the project goals and is not a viable option for this site. However, both Alternative 2 and 3 can achieve the project goals. Bottomless culverts are the cost-effective alternative if the culvert span distance is less than 20 feet. The span distance required to convey the calculated flow for an approximately 100-year storm was determined. The 100-year flow for Gold Creek was roughly calculated using an empirical formula developed in a previous hydraulic analysis for the Green River prepared by HDR (Maywood Bridge – Green River Hydraulic Analysis, for Tacoma Public Utilities, June 1998). With an estimated drainage basin area for Gold Creek of 2.8 square miles, the calculated 100-year flow is 424 cfs.

The span and rise dimensions for a bottomless culvert were computed based on 424 cfs. Assuming an arch configuration with the span distance twice as long as the arch rise, a 14-foot span and 7-foot rise is adequate to convey 424 cfs. A bottomless culvert with an additional 2 feet of rise was selected to allow a 2-foot bury depth of the culvert and the footing for scour. Therefore, a 18-foot span and a 9-foot rise was selected as the cost-effective solution. The conceptual design for this structure is depicted in the Gold Creek Site Plan, Figure No. 6.

Remove the existing 4.5-foot culvert and replace with bottomless arch. During the first stages of construction, the existing 84-inch culvert will be retained for a temporary creek diversion in order to avoid removal costs and in-stream construction. Prior to placing the bottomless arch, the 84-inch culvert will be removed. A low flow temporary creek crossing will be required (refer to Temporary Construction Fly By Drawing, Figure No. 9). A riprap grade control with a low flow notch would be placed downstream of this new culvert. Footing will be designed to control local scour and prevent recreation of perched culvert conditions.

Drawings of creek modifications appear in the Creek Details, Figure No. 10.

Modifications to the creek channel consist of placement of large woody debris for 100 feet upstream of the culvert.

For construction quantity estimating purposes, placement of one piece of large woody debris every two stream widths was assumed. Streams were assumed to be about 12.5 feet wide (survey data is not available).

Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable to Gold Creek and are left blank. Major items such as the culvert structure, excavation, fill, and restoration are listed along with a contingency and sales tax. Quantities were calculated based on the information obtained in the previous site investigations along with HDR's site visit. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied to the estimate.

Conclusions and Recommendations

The Gold Creek Site can be cost-effectively restored via a bottomless culvert, large woody debris, and spawning gravel. During Advanced Engineering and Design (AED), we recommend that a detailed site survey, geotechnical investigation, and

hydrologic/hydraulic analyses be conducted. Also, prior to construction, a LWD stability analysis, and riprap grade control evaluation –to prevent re-creation of a perched condition –must be completed. Placing of the new arch culvert in the same alignment as the existing culvert while providing appropriate temporary diversion and care of flow in the creek may also be an AED task.

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Sunday Creek

Location
Sunday Creek is located in the Upper Green River Basin approximately 2.5 miles upstream of Lester, WA. The project site begins near the location where the Bonneville Power Administration (BPA) power lines crosses Sunday Creek, approximately 2.75 miles upstream of the Sunday Creek confluence. The project extends upstream for approximately 2.9 miles.

Site Constraints and Problems
The vegetation along the project site has been removed to protect the existing power lines in the area. Existing hydrologic conditions probably resemble other west slope Cascade regimes with a seasonal hydrograph having two peaks as a result of winter rainfall and a second peak from rainfall and snowmelt in the spring (USACE, 1997).

The proposed project will increase current vegetation along approximately 2.9 miles of tributary channel as reclaimed habitat and should not impact current flow conditions or increase current flood elevations.

Riparian vegetation must stay below BPA safety limits. Coordination with BPA will be required to define these limits.

Project Goals
The project purpose is to improve salmonid habitat. This will be accomplished by decreasing stream temperatures by providing shade from the reestablishment of riparian vegetation along the riparian corridor.

Proposed Solutions
- Alternative 1: No Action. No modifications to the existing stream conditions. Habitat conditions would remain unchanged.

- Alternative 2: Replant Corridor. Replant the stretch along Sunday Creek with small riparian type shrubs and plants to increase habitat while avoiding interference with BPA's power lines.

Recommended Plan
Alternative 2 is the recommended alternative. Alternative 1, the No Action alternative, does not meet the purpose of the project and is not a viable option for this site. Alternatives 2, will replant the stretch along Sunday Creek.

The riparian planting zone should extend 100 feet on both sides of the channel. Low canopy plantings appropriate within the Bonneville Power Administration (BPA) include shrubs and low height trees such as Scouler Willows. Coordination with BPA will be required to ensure that the proposed plantings will remain in place as part of BPA's Transmission Line Corridor maintenance program. The Sunday Creek Plan references riparian drawings. The Forest Service requires the use of native plant materials for this site. This will require early acquisition of the material prior to planting and close coordination with the Forest Service. LWD will be placed in the stream in clusters averaging on piece every two bank widths or about 25 feet.

Construction Cost Items and Quantities

Construction line costs and quantities are shown in the MCACES portion of the attached engineering appendix. Quantities and costs were estimated from information obtained during HDR's site visit and topographical maps provided by the Corps. A 15 percent contingency has been added to the quantities given the bounds of the study. An additional 25 percent cost contingency will be added when the USACE prepares the cost estimate unless otherwise specified.

Conclusions and Recommendations

The Sunday Creek project can meet the project purpose with the recommended tributary improvements. The following items should be considered in the advanced engineering and design phase:

1. Stream flow conditions should be evaluated to ensure that appropriate tributary enhancement is achieved.
2. Project coordination with BPA.

Figures

Sunday Creek Plan
BPA Planting Scheme

References

US Army Corps of Engineers, Reconnaissance Report, Green-Duwamish River Ecosystem Restoration General Investigation, Green-Duwamish River, King County, Washington, March, 1997

GREEN-DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
PROJECT DESCRIPTION AND WRITE-UP

Site Designation: Site No. 1 – North East Creek – Culvert Replacement

Location
This site is a perched culvert on North East Creek approximately 225 feet upstream of the confluence with Snow Creek. Refer to site location map, included in the North East Creek Site Plan, Figure No. 1.

Site Constraints/Problems
The existing 48-foot long pipe arch culvert is perched approximately 15 to 17 feet above the downstream pool and precludes upstream fish passage to roughly 2 miles of habitat. The existing stream channel width is approximately 10 to 15 feet wide. The Forest Service has funding for the construction of a bridge to replace the existing culvert at this location. Therefore, the Forest Service favors the bridge alternative.

Project Goals
The proposed project would eliminate the perched culvert condition and open upstream habitat access to Coho, Steelhead, and Cutthroat adults as well as certain juveniles. Upstream habitat improvements would include placement of large woody debris and spawning gravel in the creek.

Proposed Solutions
The following six alternatives were considered in selecting the proposed project:

- Alternative No. 1 - No Action: No modifications to the existing perched culvert. Fish passage would remain blocked.

- Alternative No. 2 - Stream Diversion and Bridge Construction in New Location Divert stream upstream of existing culvert. Replace culvert with a bridge at a location to the west of the existing culvert and meander a bypass channel to the confluence with Snow Creek. Place large woody debris and spawning gravel upstream of the existing culvert.

- Alternative No. 3 - Stream Diversion and Bridge Construction in Location of Culvert: Replace culvert with a bridge and meander a bypass channel to the confluence with Snow Creek. Remove existing culvert and construct bridge in same location. Place large woody debris and spawning gravel upstream of the existing culvert.

- Alternative No. 4 - Stream Regrade and Bridge Construction in Location of Culvert: Replace culvert with a bridge and develop a series of step pools on fill to the

confluence with Snow Creek. Remove existing culvert and construct bridge in same location. Place large woody debris and spawning gravel upstream of the existing culvert.

- Alternative No. 5 - Stream Diversion and Culvert Replacement: Replace the existing culvert with bottomless arch culvert and meander a bypass channel to the confluence with Snow Creek. Place large woody debris and spawning gravel upstream of the existing culvert.

- Alternative No. 6 - Stream Regrade and Culvert Replacement: Replace the existing culvert with bottomless arch culvert and develop a series of step pools on fill to the confluence with Snow Creek Bottomless Culvert. Place large woody debris and spawning gravel upstream of the existing culvert.

Recommended Plan

The no action alternative will not achieve the project goals and, therefore, is not a viable option for this site. Because the Forest Service has funding for a bridge, the bridge alternative was selected, and thus Alternative 2 is recommended.

The conceptual design for Alternative No. 2 is depicted in the North East Creek Site Plan, Figure No. 1.

The flow for an approximately 100-year storm for North East Creek was estimated using an empirical formula developed in a previous hydraulic analysis for the Green River prepared by HDR (Maywood Bridge – Green River Hydraulic Analysis, for Tacoma Public Utilities, June 1998). With an estimated drainage basin area for North East Creek upstream of the site of 1.7 square miles, the calculated 100-year flow is 269 cfs.

A minimum bridge width of 50 feet, as prescribed by the Forest Service, is sufficient to convey a flow of 269 cfs. A low flow temporary creek crossing for vehicle access will be required (refer to Temporary Construction Fly By Drawing, Figure No. 9).

For construction, we propose diverting the stream upstream of the existing culvert and constructing the bridge roughly 50 feet west of the culvert. During the first stages of construction, the existing culvert will be retained for a temporary creek diversion in order to avoid removal costs and in-stream construction. Prior to placing the bridge deck, the existing culvert will be removed. There will be adequate room to allow creek passage within the new bridge creek span until the bridge construction and channel re-routing is completed.

Drawings of creek modifications appear in the Creek Details, Figure No. 10.

Modifications to the existing creek channel consist of placement of large woody debris and spawning gravel for 100 feet upstream of the bridge.

For construction quantity estimating purposes, the placement of one piece of large woody debris for every two stream widths was assumed. Streams were assumed to be about 12.5 feet wide (survey data is not available).

The old stream channel should be filled in as much as possible to insure road stability and that the new channel does not try to reoccupy the old channel. Where the old channel meets the existing creek there may be a small side channel that could provide high flow refuge.

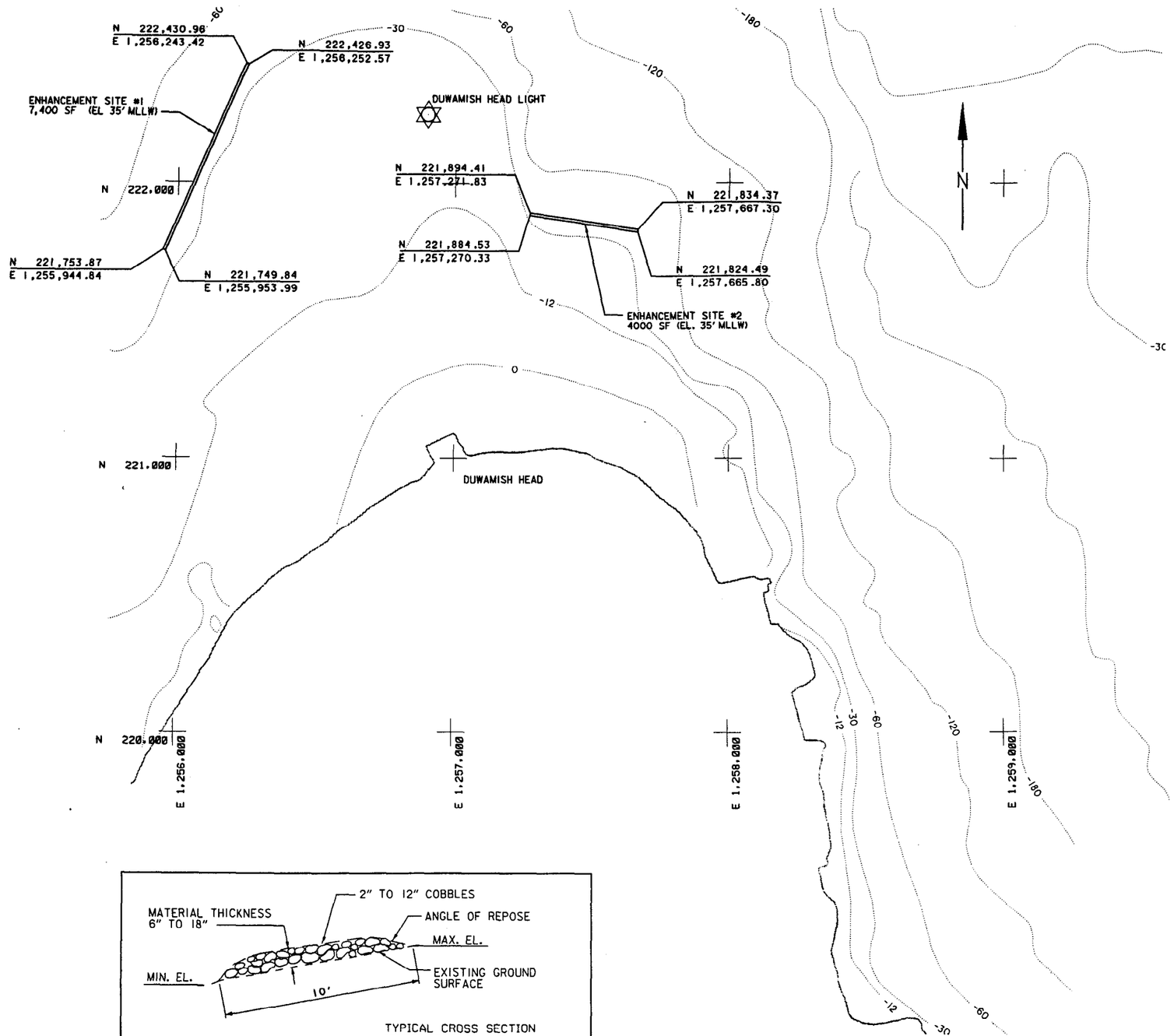
Causes of downstream drop should be determined to incorporate potential invert adjustments into bridge support design criteria.

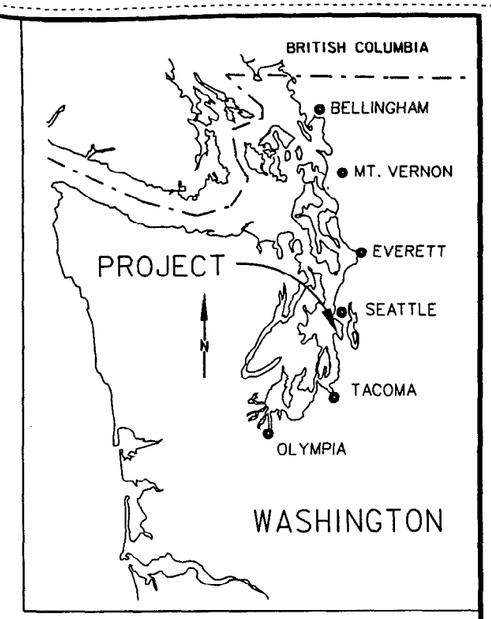
Cost Items and Quantities

Construction line items and quantities are shown in the MCACES portion of the attached engineering appendix. The table was developed as a standard to be used for all of the sites. As such, some of the line items are not applicable to North East Creek and are left blank. Major items such as the bridge structure, excavation, fill, and restoration are listed along with a contingency and sales tax. Quantities were calculated based on the information obtained in the previous site investigations along with HDR's site visit. Given the extent of survey, geotechnical, hydrologic, and hydraulic information available at this time, a 40 percent contingency has been applied to the estimate.

Conclusions and Recommendations

The North East Creek Site can be effectively restored via a 50-foot span bridge, large woody debris, and spawning gravel. During Advanced Engineering and Design, we recommend that a detailed site survey, geotechnical investigation-drilling, LWD stability, and hydrologic/hydraulic analyses be conducted.





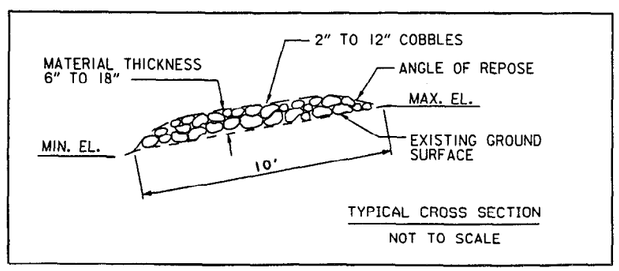
1" = 200' 200' 100' 0 200' 400'

HORIZONTAL CONTROL IS BASED ON NAD 83/91.
VERTICAL DATUM IS MLLW (NOS)

NOTES:

1. CONTRACTOR SHALL NOT PLACE MATERIAL ON EEL GRASS.

2. BOTTOM FILL ELEVATION NOT TO EXCEED 18" IN DEPTH.



Site No. 1

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

GREEN/DUWAMISH RIVER HABITAT RESTORATION

ELLIOT BAY NEARSHORE 1

KING COUNTY — WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
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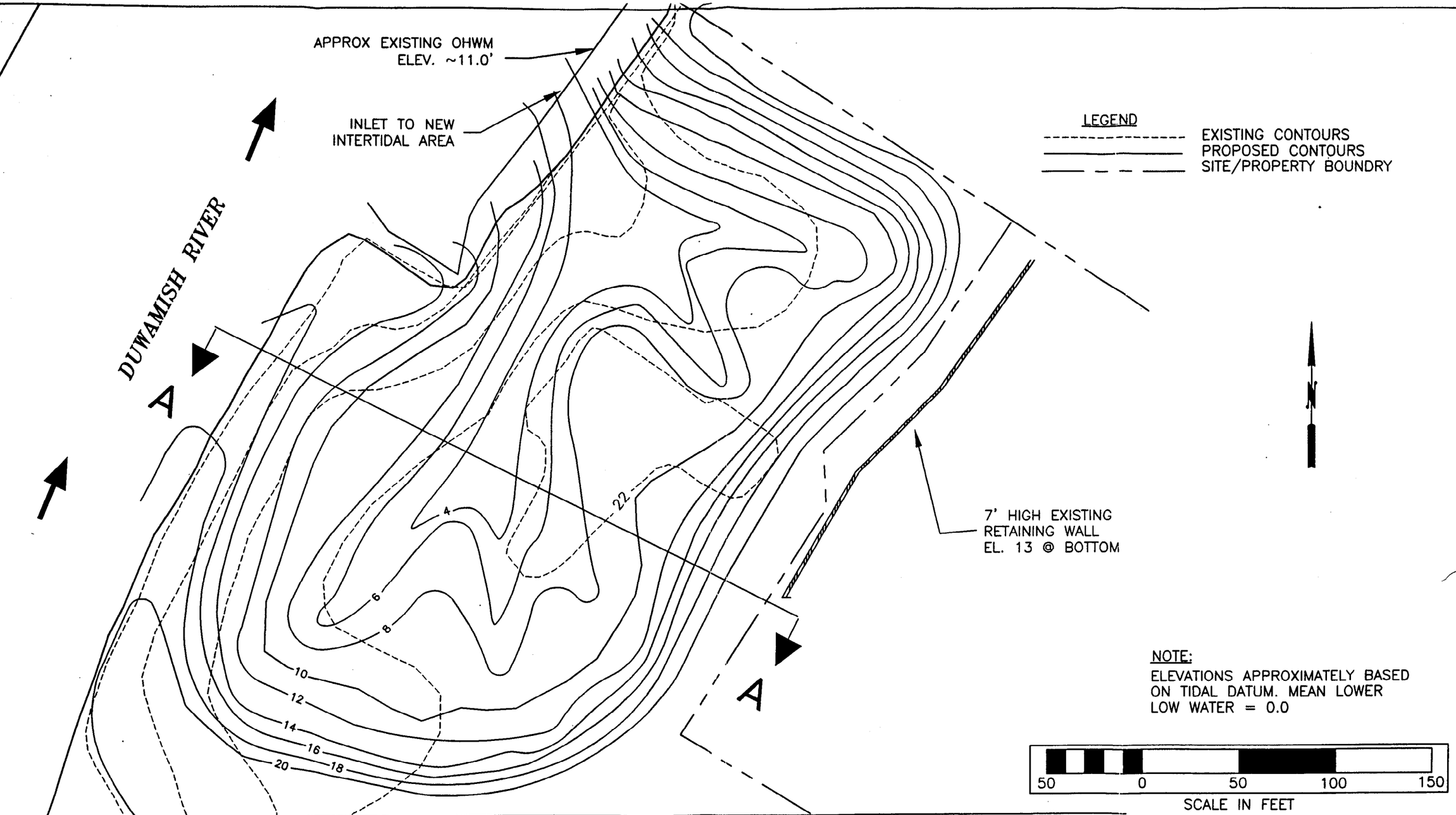

PROJECT NO. 281647	
APPROVED: D. Althouse	DATE: 2/00
PROJECT MANAGER: W. Kirg	DATE: 2/00
ECOLOGIST: J. Hansen	DATE: 2/00
DRAWN: E. Mackington	DATE: 2/00

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY

DUWAMISH SITE 1 2
PROPOSED SITE PLAN

SIZE	DIVISION NO.	FILE NO.	DATE	PLATE
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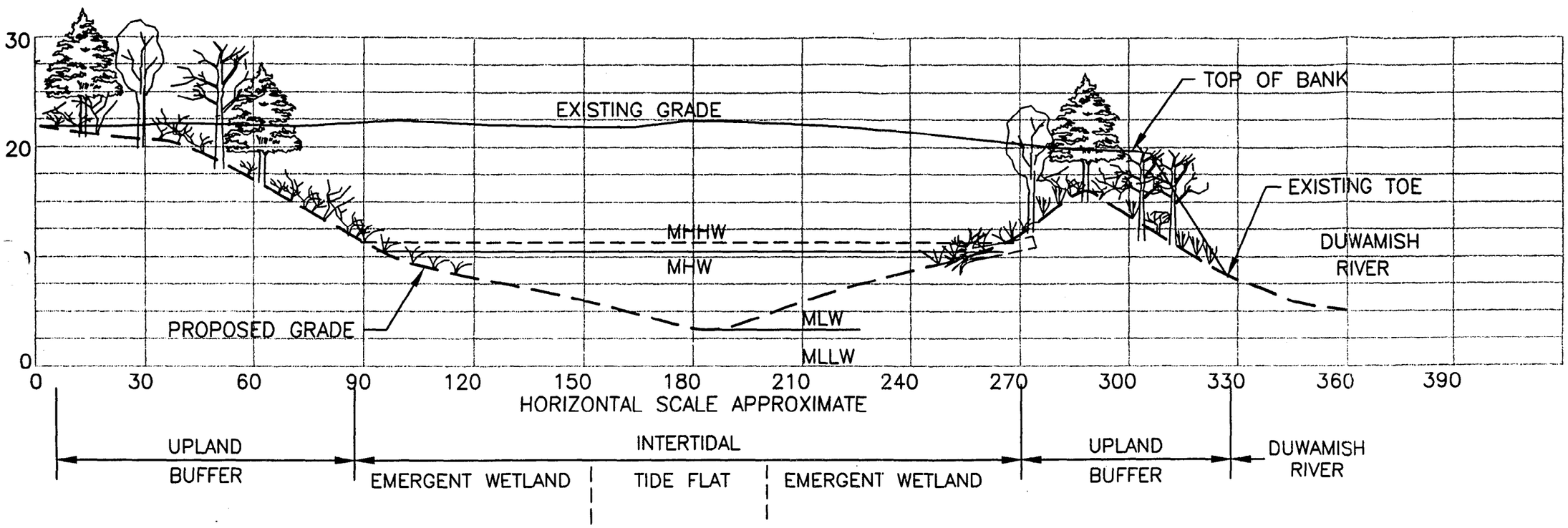
SCAL X		CAD X	SHEET X	

Site No. 2

16



SECTION A-A

PROJECT NO. 281647	
APPROVED: D. Althouser DATE: 2/00	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONNETTE, DIRECTOR SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES
PROJECT MANAGER: W. Karg DATE: 2/00	
ECOLOGIST: J. Hansen DATE: 2/00	
DRAWN: E. MacKinnon DATE: 2/00	

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

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY

DUWAMISH SITE 1
SECTION

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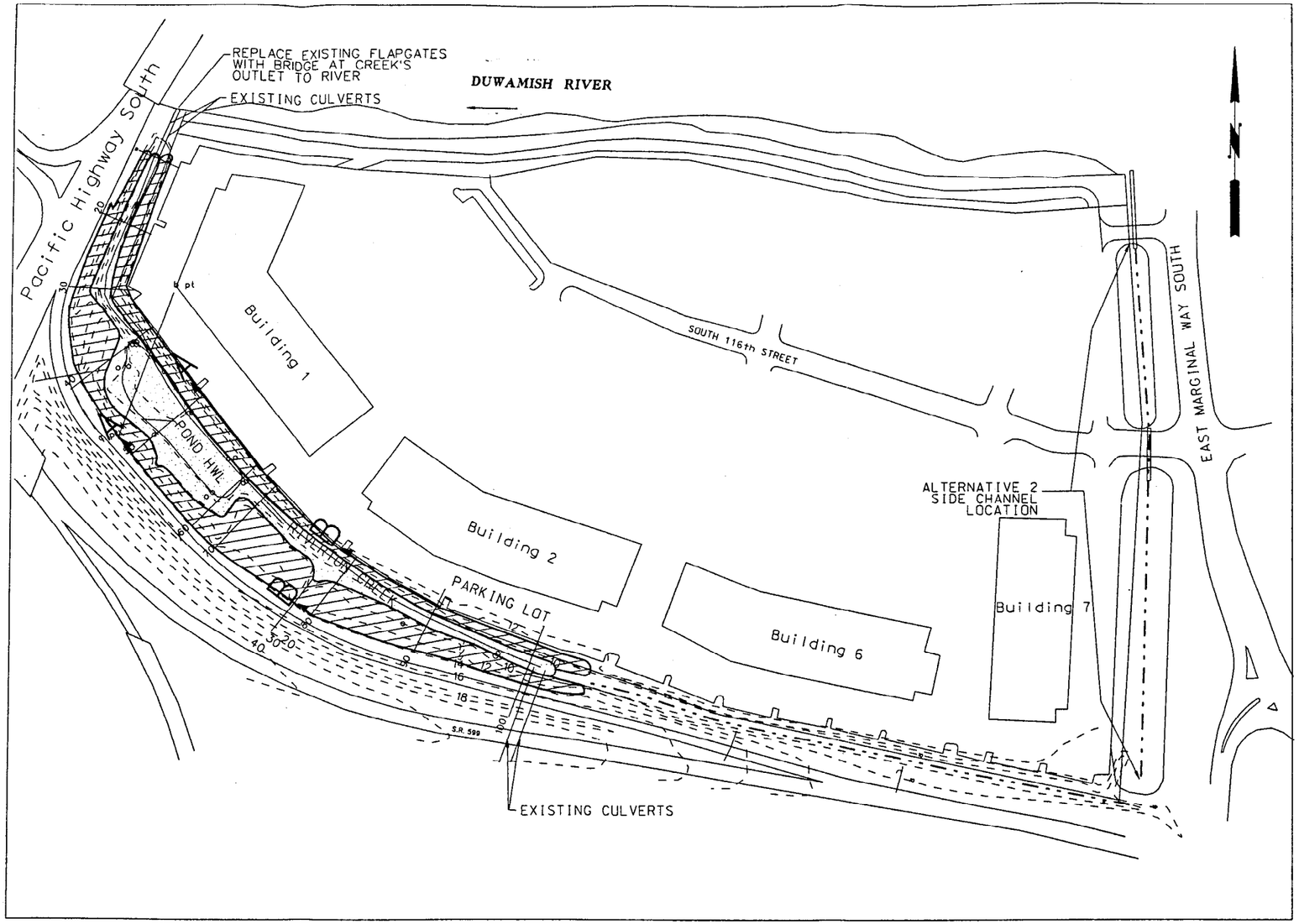
DWGS. X		SPEC. X	SHEET X	

Site No. 2



LEGEND

REMOVE ACCUMULATED SEDIMENT FROM POND AND STREAM CHANNEL AS NECESSARY. PLACE GRAVEL SUBSTRATE AND LARGE WOODY DEBRIS

REMOVE INVASIVE PLANT SPECIES (HIMALAYAN BLACKBERRIES) AND PLANT NATIVE TREES AND SHRUBS.

100 0 100 200 300
SCALE IN FEET

PROJECT NO. 2G1647	
APPROVED: Don Althauser DATE: 2/00	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONNETTE, DIRECTOR SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES
PROJECT MANAGER: Wendy Kara DATE: 2/00	
DESIGNED: J. Hansen, W. Kara DATE: 2/00	
DRAWN: E. MacKinnon DATE: 2/00	

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

GREEN - DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

RIVERTON CREEK
SITE PLAN

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
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DSGN. X		CHK. X	SHEET X	

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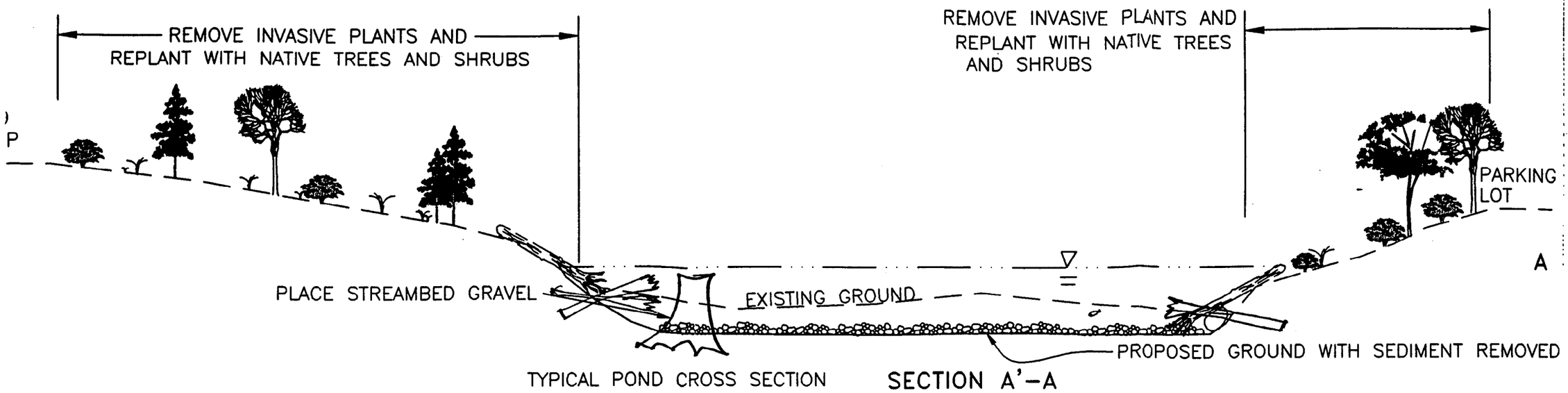
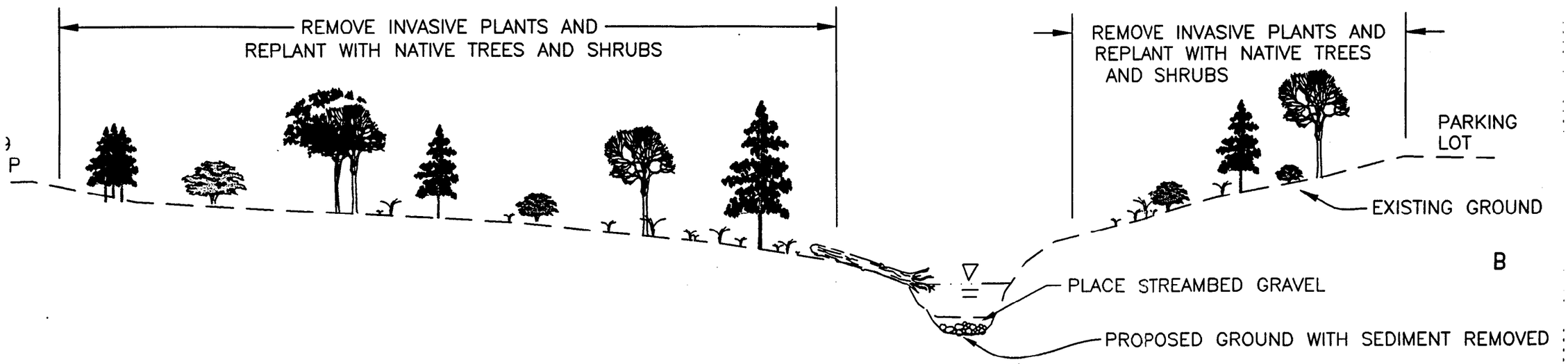


TYPICAL POND CROSS SECTION SECTION A'–A



TYPICAL CHANNEL CROSS SECTION SECTION B'–B

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APPROVED: Don Althauser DATE: 2/00	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONNETTE, DIRECTOR SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES
PROJECT MANAGER: Wendy Kara DATE: 2/00	
DESIGNED: J. Hansen, W. Kara DATE: 2/00	
DRAWN: M. Radella, E. MacKinnon DATE: 2/00	

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

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY

RIVERTON CREEK
CROSS–SECTIONS

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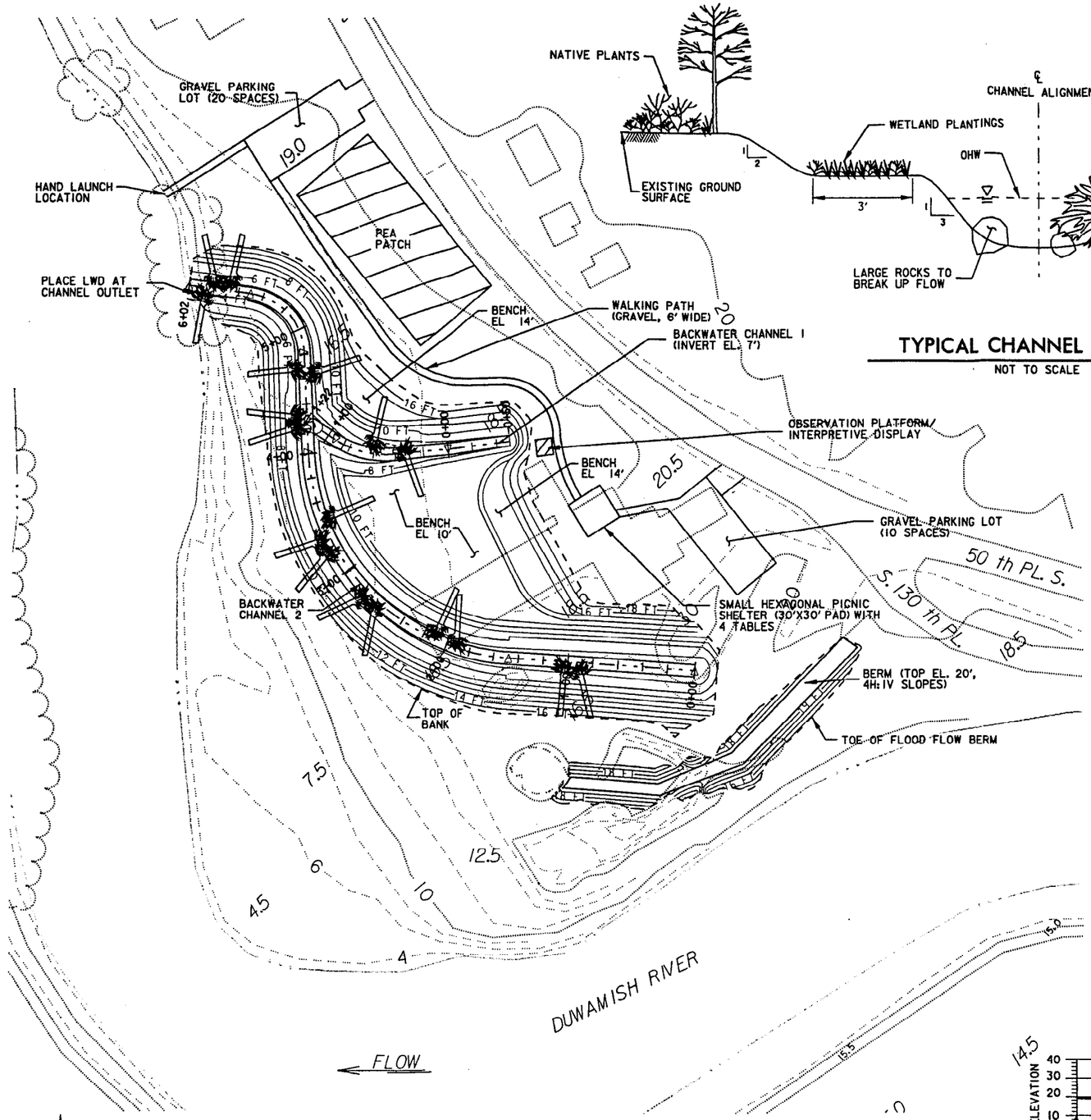

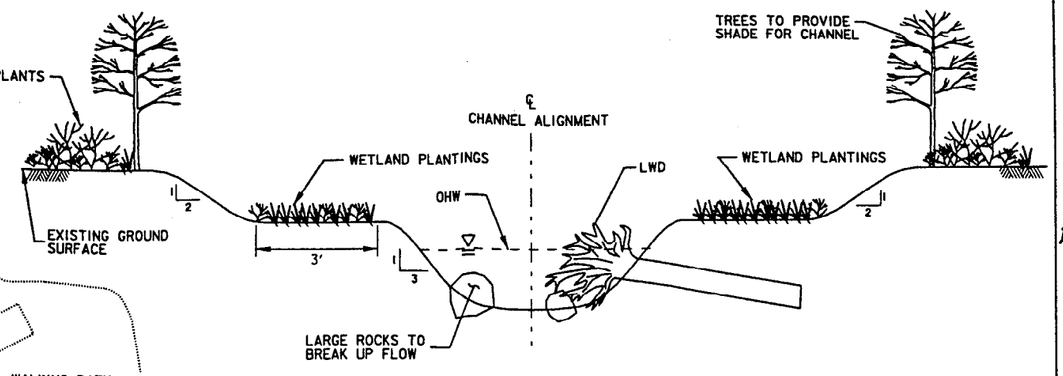

TYPICAL CHANNEL SECTION

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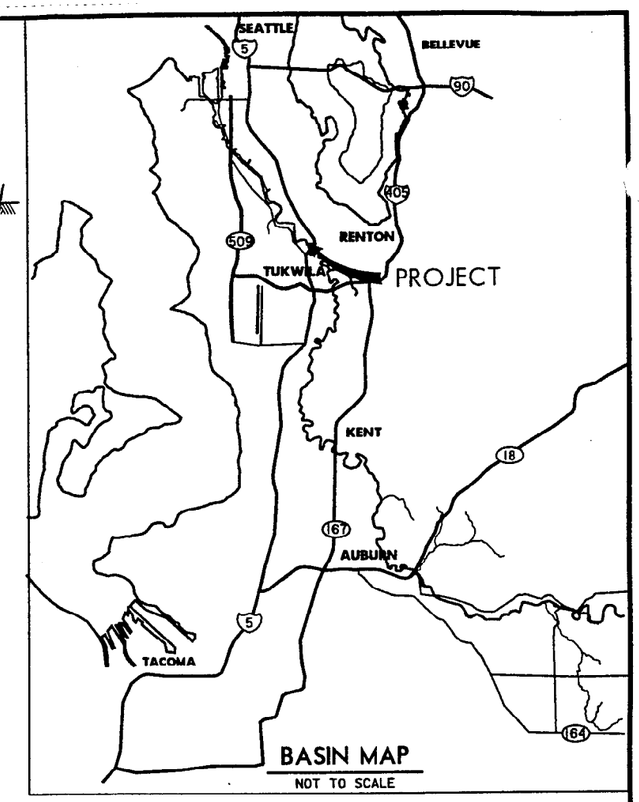


BASIN MAP

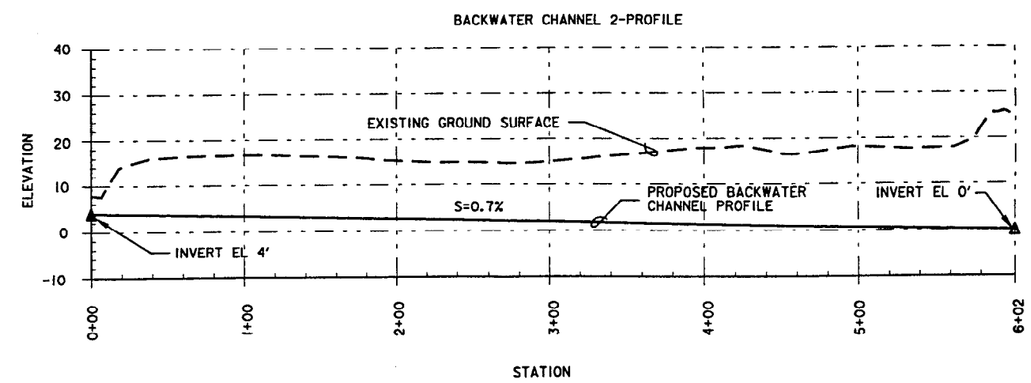
NOT TO SCALE

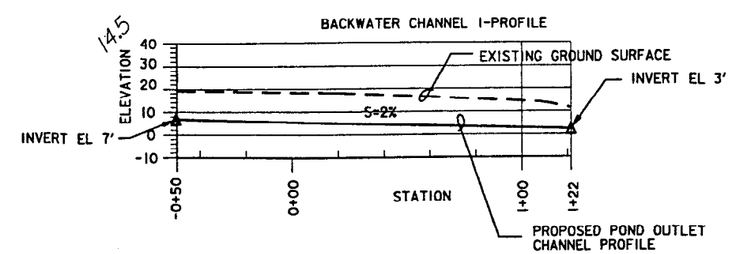
NOTES:

1. PROVIDE WARNING SIGN AT END OF TRAIL. CAPTION TO READ: "CAUTION: WESTWIND WEIR 1.5MI DOWNSTREAM."

PRELIMINARY QUANTITY ESTIMATE:

	QUANTITY
EXCAVATION	21,500 CY
GRAVEL	1,100 CY
ROOTWADS	16 EA
LARGE STONES (12"-18")	20 EA
CONCRETE	25 CY
FILL	650 CY





CODIGA FARM BACKWATER CHANNEL

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1" = 50' 50' 25' 0 50' 100'

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

GREEN/DUWAMISH RIVER HABITAT RESTORATION

CODIGA FARMS BACKWATER CHANNEL

Site No. 4

KING COUNTY WASHINGTON

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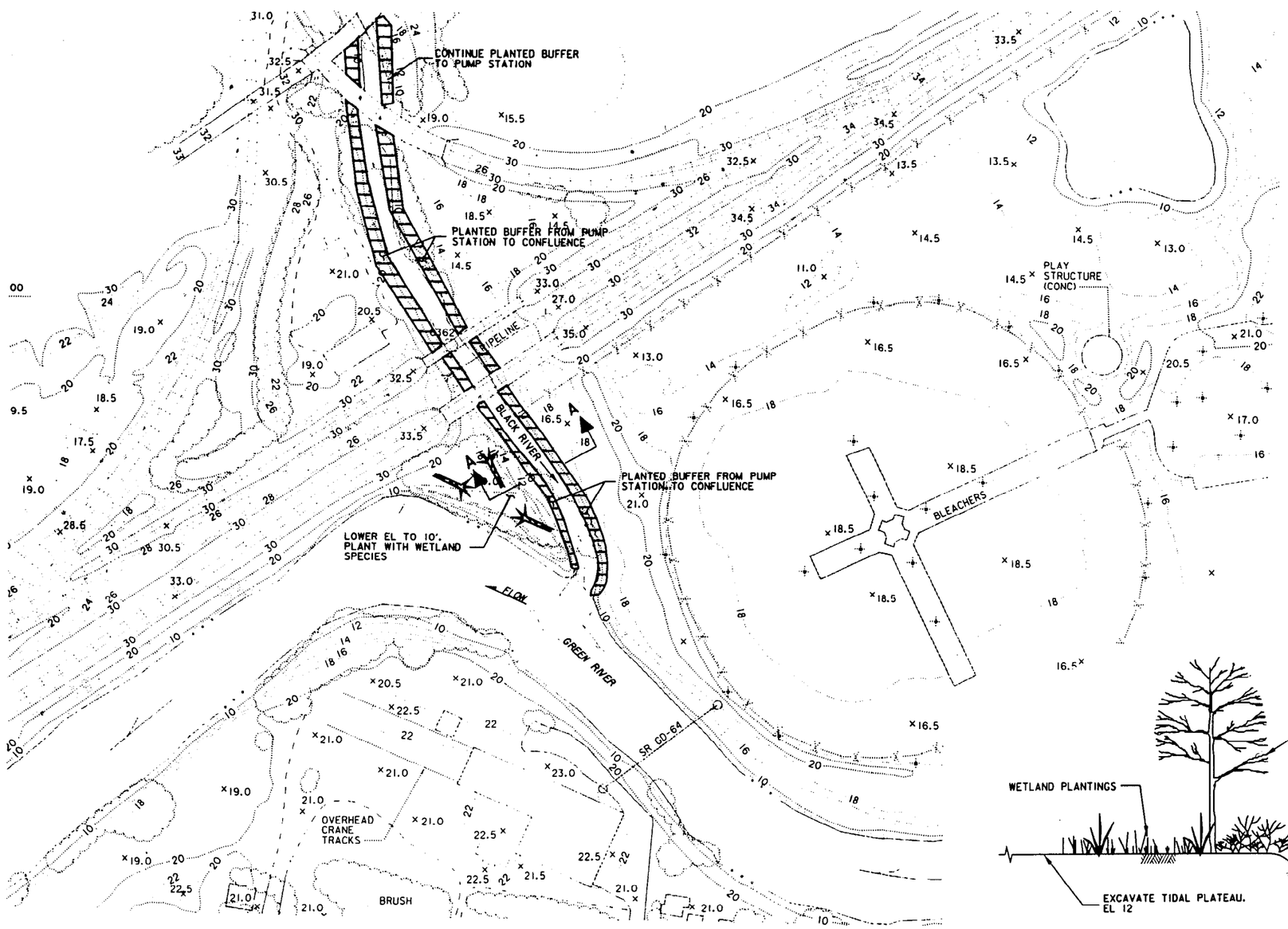

BLACK RIVER ESTUARY-PLAN VIEW

SCALE: 1" = 20'

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

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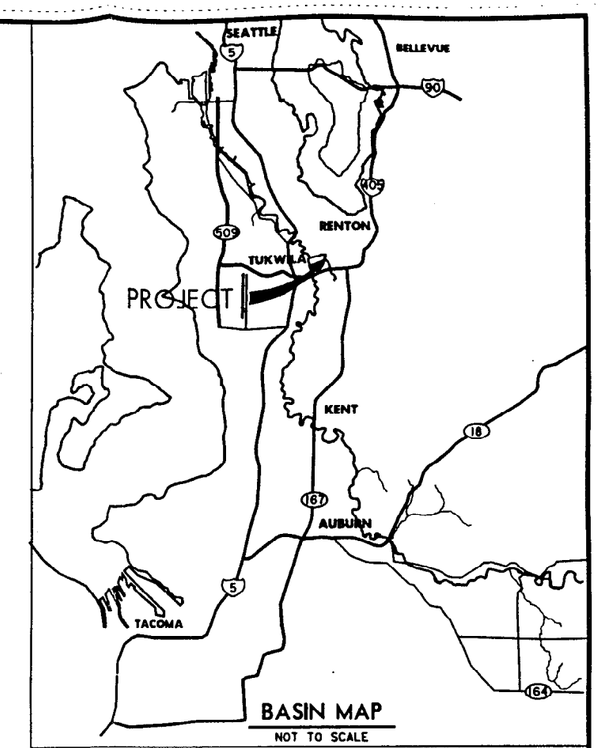
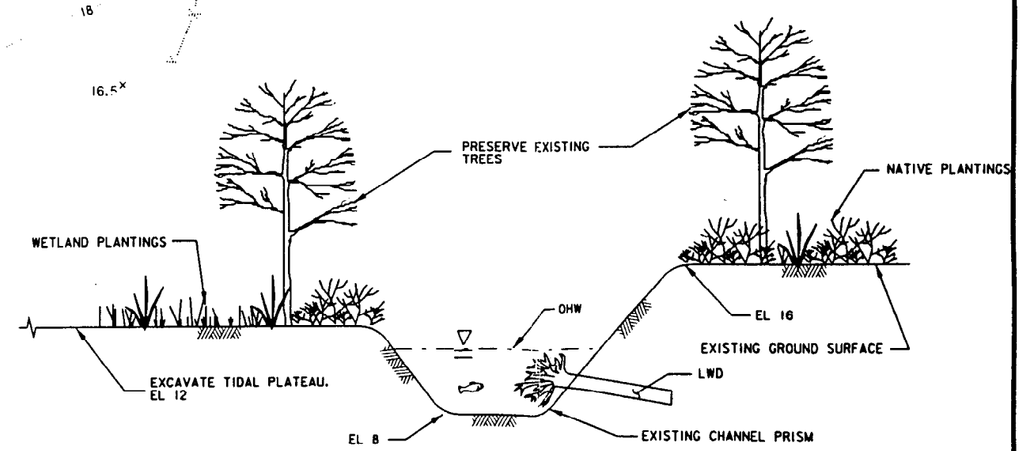


BASIN MAP

NOT TO SCALE



SECTION A-A (TYP)

NOT TO SCALE

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

GREEN/DUWAMISH RIVER HABITAT RESTORATION

BLACK RIVER ESTUARY 5

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
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DSGN. PWN		CHK. DAF	SHEET 5	

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DESIGN

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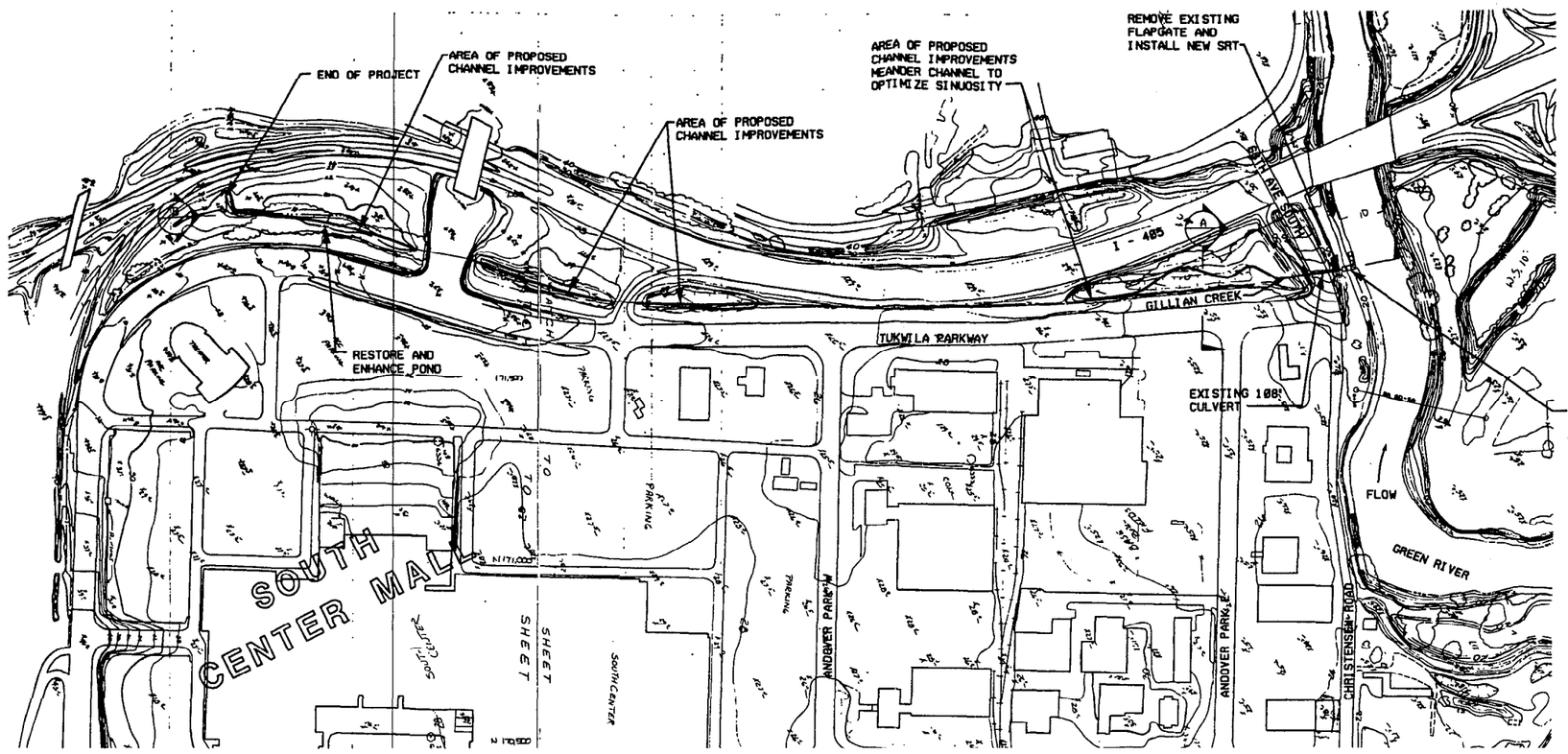
Site No. 5

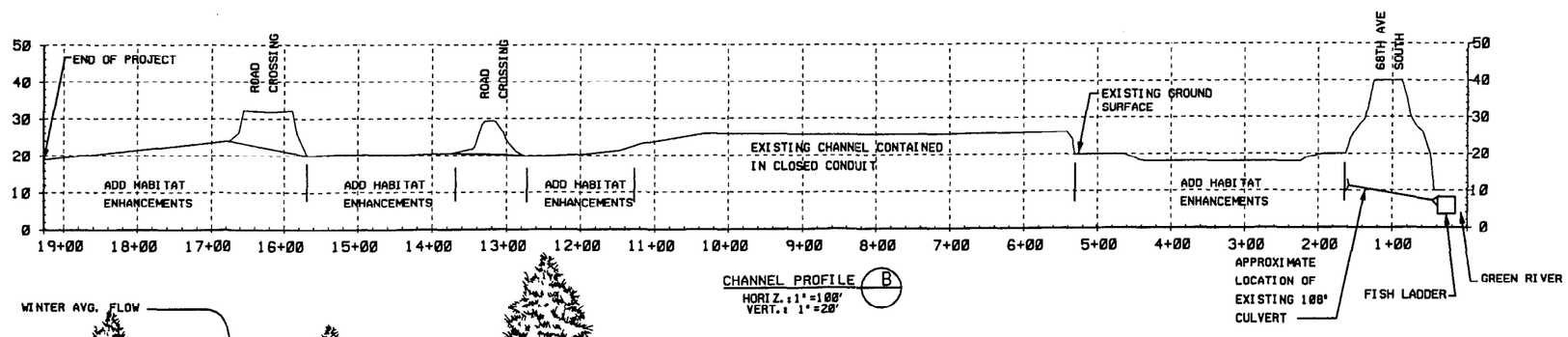
29



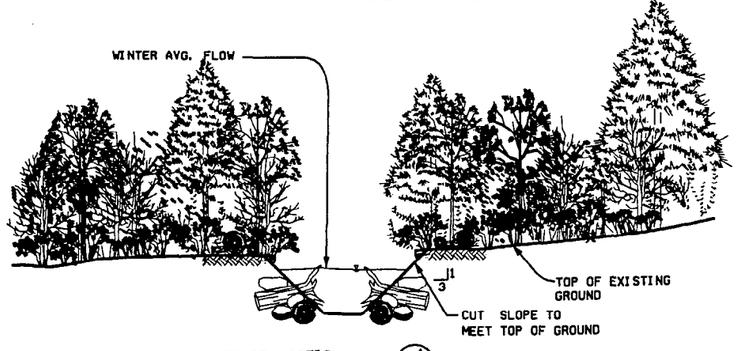
LEGEND

PROPOSED CHANNEL

200' 100' 0 200' 400'



CHANNEL PROFILE (B)
HORIZ.: 1" = 100'
VERT.: 1" = 20'



CROSS SECTION (A)
NOT TO SCALE

NOTES:

1. SEE PLAN AND SECTION DETAILS, 1-STAGE CHANNEL RIVERINE PLANTING SCHEME, FIGURE 6.
2. SEE PLAN AND SECTION DETAILS, FIGURE 14, FOR WOODY DEBRIS DRAWING TYPICAL SECTION . FIELD PLACE ALONG CHANNEL AT ALTERNATING SIDES AN AVERAGE OF 25 FEET.
3. SEE WATERMAN SRT DETAILS.
4. SEE FISHWAY DETAIL.
5. PROJECT FOOT PRINT DOES NOT INCLUDE CONSTRUCTION ACCESS EASEMENTS.
6. FIELD VERIFY ALL CULVERT INVERT ELEVATIONS.

Site No. 6

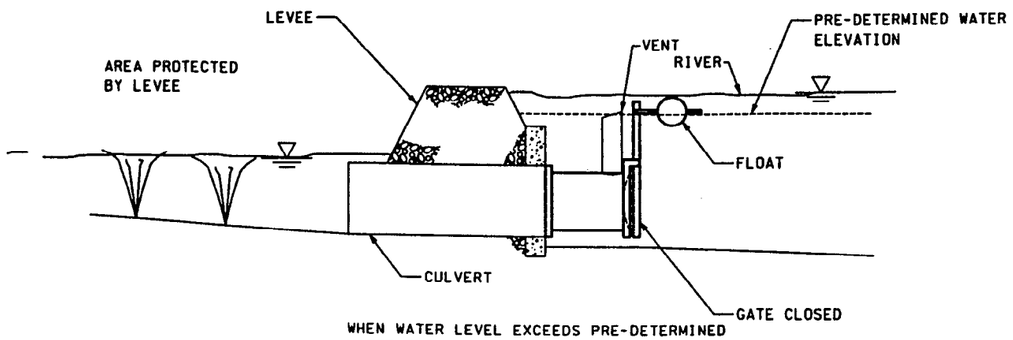
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GILLIAN CREEK
PLAN, PROFILE AND TYPICAL SECTION
GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
DSGN.		CHK.	SHEET	

P:/ENVIRO/FEDERAL/CORP-SEA/PLANNING98/20GREENRESTOR/SITES/GREENRIVER/DGN/GIL



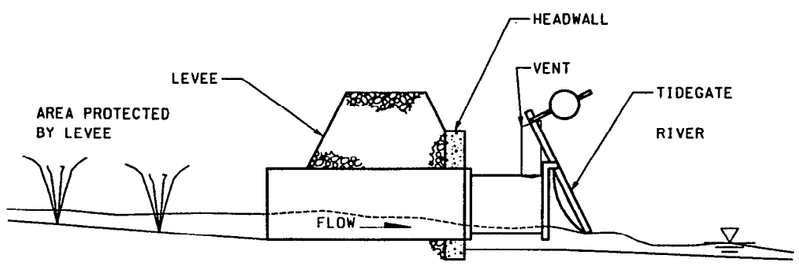
WHEN WATER LEVEL EXCEEDS PRE-DETERMINED WATER ELEVATIONS, GATE LOCKS IN CLOSED POSITION TO PROVIDE EXISTING LEVEL OF FLOOD PROTECTION.

SELF-REGULATING TIDEGATE - CLOSED

NOT TO SCALE

NOTES:

FLOATS LOCATED INSIDE VENTS, BLOCK LOCKING PINS FROM ROTATING AND PREVENT THE GATE FROM OPENING DURING HIGH FLOW CONDITIONS



GATE ACTING AS NORMAL FLAP ALLOWING DRAINAGE

SELF-REGULATING TIDEGATE - OPEN

NOT TO SCALE

Site No. 6

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

SELF REGULATING TIDEGATE

GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION

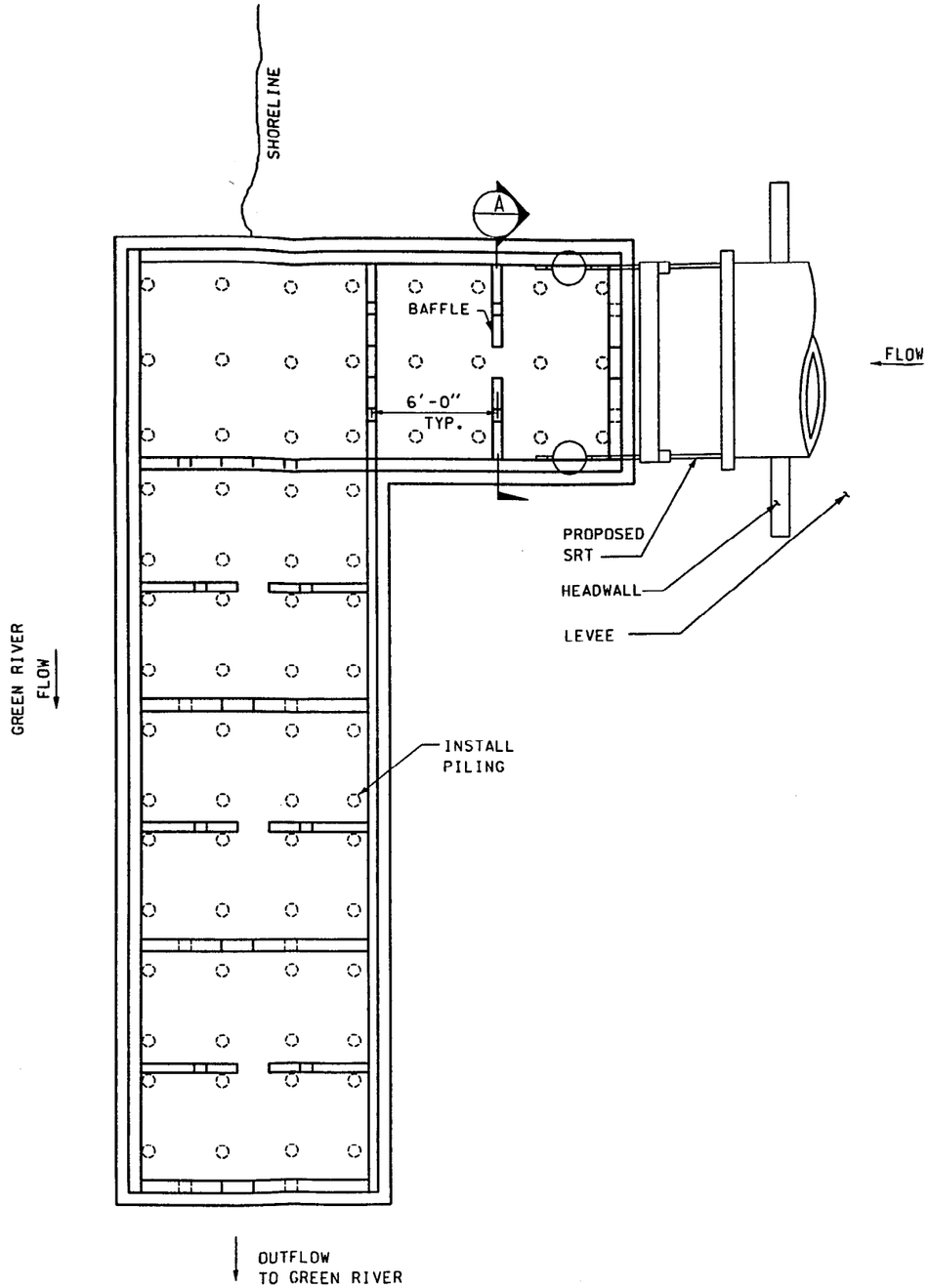
KING COUNTY WASHINGTON

6

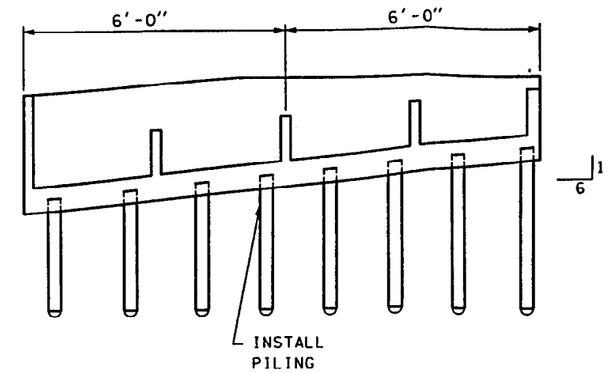
SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
SCAL		CHK.	SHEET	

STORM_SEO.DGN

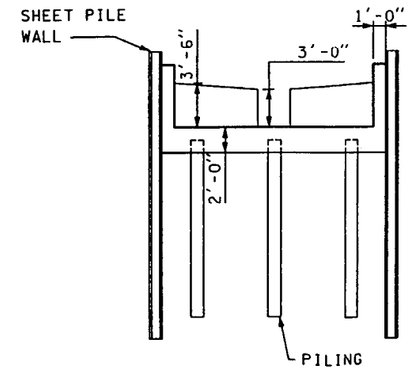
38



PLAN
SCALE: N.T.S.



SECTIONAL ELEVATION
SCALE: N.T.S.



BAFFLE (A)
SCALE: N.T.S.

Site No. 6

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

GILLIAN CREEK
FISHWAY - PLAN AND SECTIONS
GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION

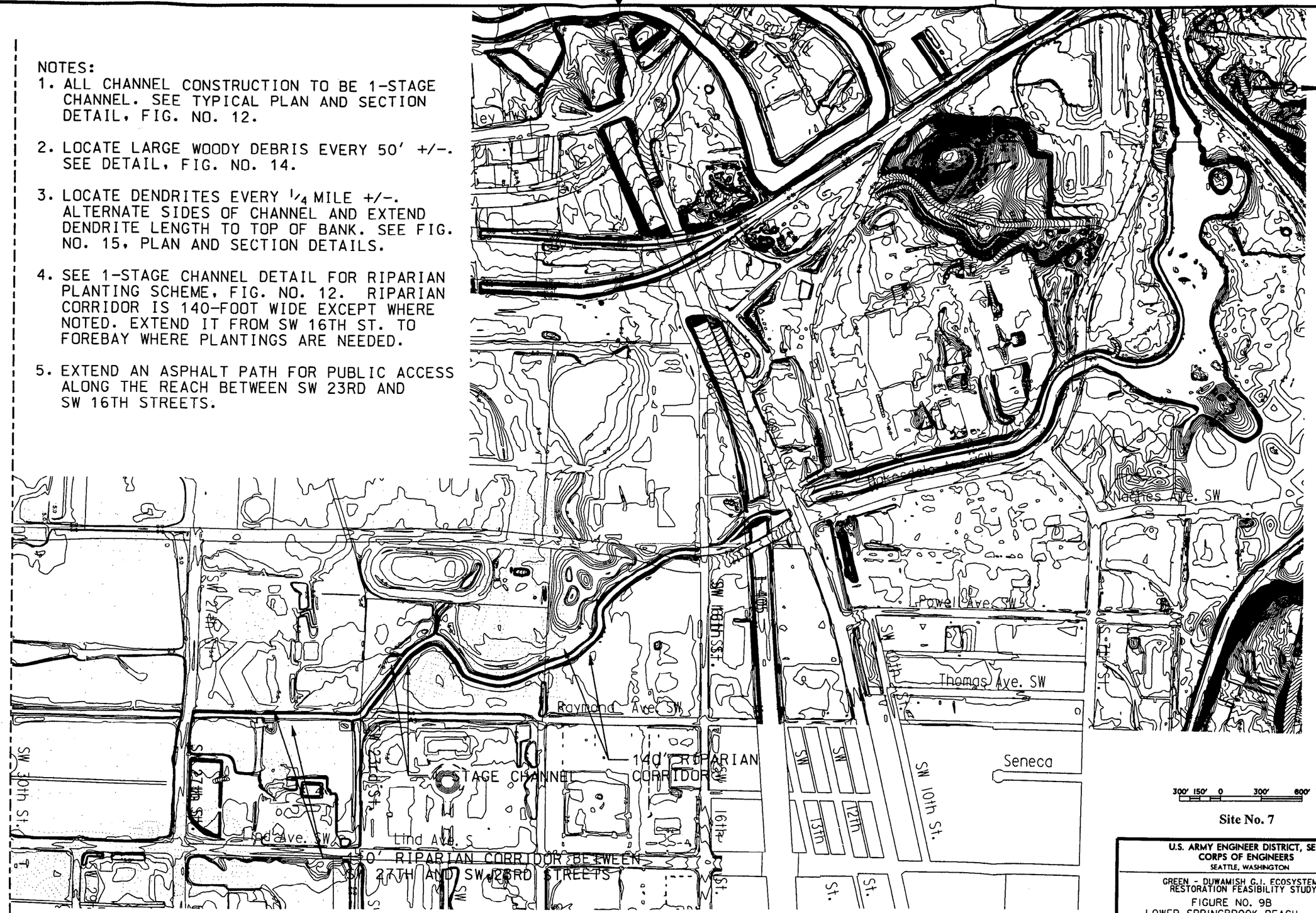
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
DSGN.		CHK.	SHEET	

Filename: P48.200\GLFSH.dgn

NOTES:

1. ALL CHANNEL CONSTRUCTION TO BE 1-STAGE CHANNEL. SEE TYPICAL PLAN AND SECTION DETAIL, FIG. NO. 12.
2. LOCATE LARGE WOODY DEBRIS EVERY 50' +/-. SEE DETAIL, FIG. NO. 14.
3. LOCATE DENDRITES EVERY 1/4 MILE +/-. ALTERNATE SIDES OF CHANNEL AND EXTEND DENDRITE LENGTH TO TOP OF BANK. SEE FIG. NO. 15, PLAN AND SECTION DETAILS.
4. SEE 1-STAGE CHANNEL DETAIL FOR RIPARIAN PLANTING SCHEME, FIG. NO. 12. RIPARIAN CORRIDOR IS 140-FOOT WIDE EXCEPT WHERE NOTED. EXTEND IT FROM SW 16TH ST. TO FOREBAY WHERE PLANTINGS ARE NEEDED.
5. EXTEND AN ASPHALT PATH FOR PUBLIC ACCESS ALONG THE REACH BETWEEN SW 23RD AND SW 16TH STREETS.



PLAN

Site No. 7

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

GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY

FIGURE NO. 9B
LOWER SPRINGBROOK REACH
SITE PLAN-NORTH

KING COUNTY WASHINGTON

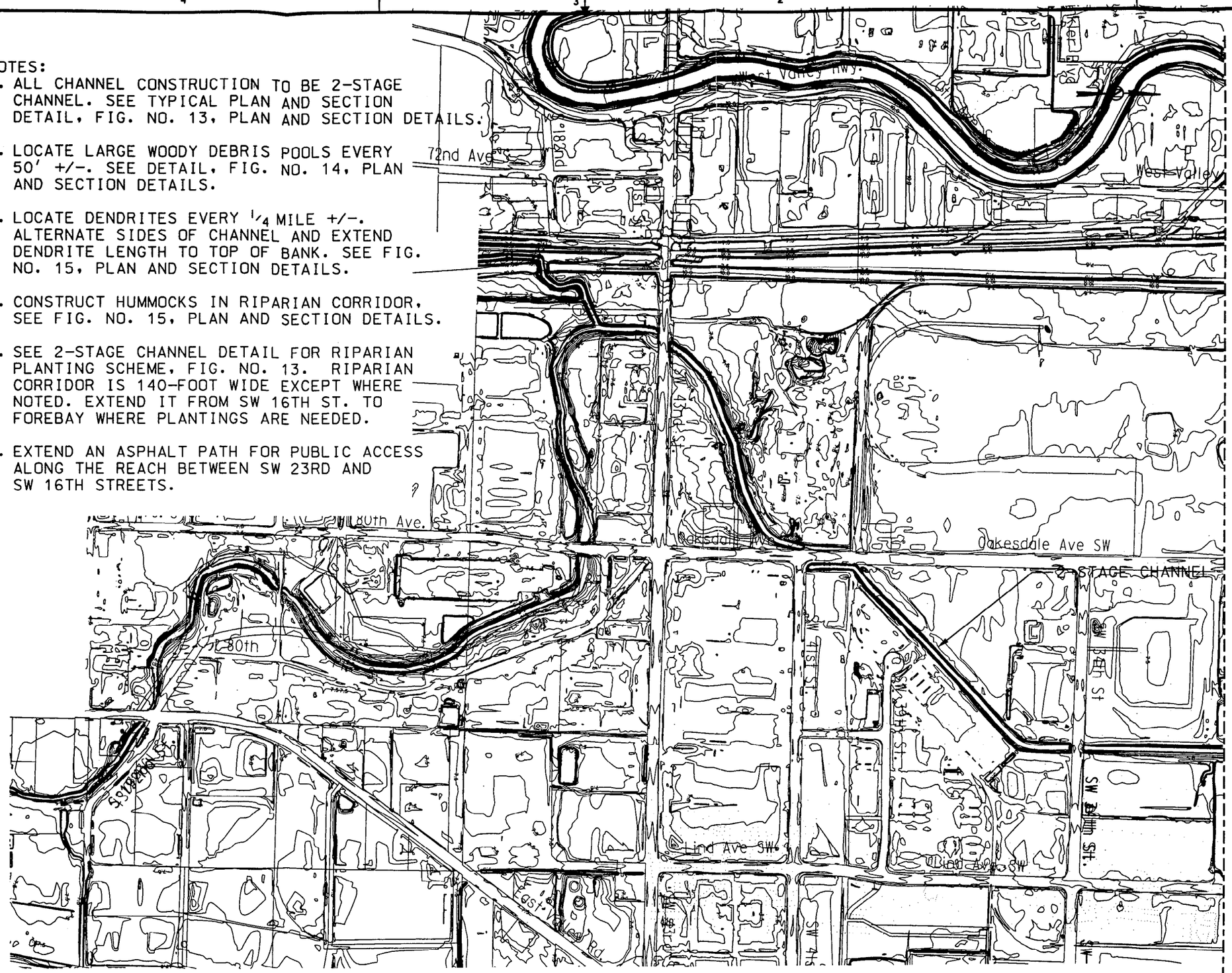
SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: 03-AUG-2000 16:30
DESIGN FILE: HYDRO:08048.050/DRAWINGS/sketch14B.dgn

DATE AND TIME PLOTTED: 03-AUG-2000 16:30 DESIGN FILE: I:\designs\msgd\civil\depinr\sketch14b.dgn

NOTES:

1. ALL CHANNEL CONSTRUCTION TO BE 2-STAGE CHANNEL. SEE TYPICAL PLAN AND SECTION DETAIL, FIG. NO. 13, PLAN AND SECTION DETAILS.
2. LOCATE LARGE WOODY DEBRIS POOLS EVERY 50' +/-. SEE DETAIL, FIG. NO. 14, PLAN AND SECTION DETAILS.
3. LOCATE DENDRITES EVERY 1/4 MILE +/-. ALTERNATE SIDES OF CHANNEL AND EXTEND DENDRITE LENGTH TO TOP OF BANK. SEE FIG. NO. 15, PLAN AND SECTION DETAILS.
4. CONSTRUCT HUMMOCKS IN RIPARIAN CORRIDOR, SEE FIG. NO. 15, PLAN AND SECTION DETAILS.
5. SEE 2-STAGE CHANNEL DETAIL FOR RIPARIAN PLANTING SCHEME, FIG. NO. 13. RIPARIAN CORRIDOR IS 140-FOOT WIDE EXCEPT WHERE NOTED. EXTEND IT FROM SW 16TH ST. TO FOREBAY WHERE PLANTINGS ARE NEEDED.
6. EXTEND AN ASPHALT PATH FOR PUBLIC ACCESS ALONG THE REACH BETWEEN SW 23RD AND SW 16TH STREETS.



PLAN

MATCHLINE SEE FIGURE 9B

300' 150' 0 300' 600'

Site No. 8

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

GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY

FIGURE NO. 9A
LOWER SPRINGBROOK REACH
SITE PLAN-SOUTH

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	980CT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: 03-AUG-2000 16:28
DESIGN FILE: HYDRO:08048.050/DRAWINGS/sketch14.dgn

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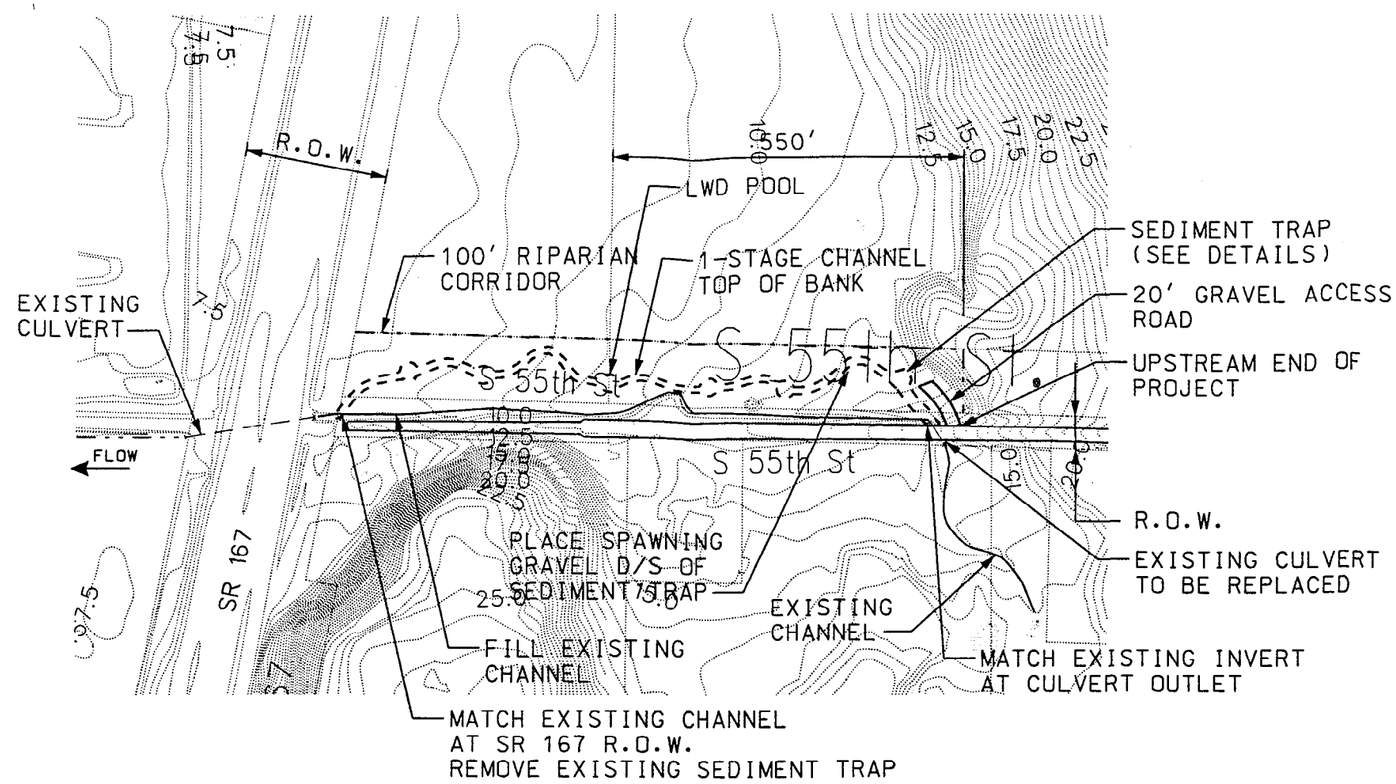
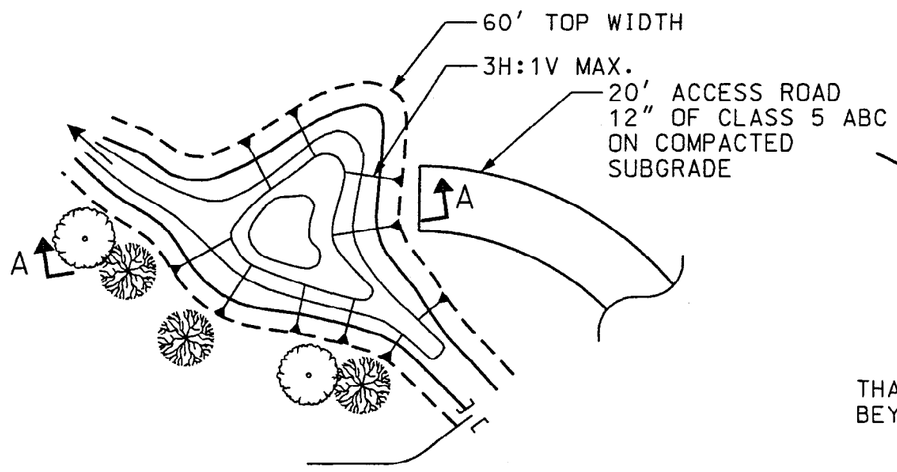


PLAN

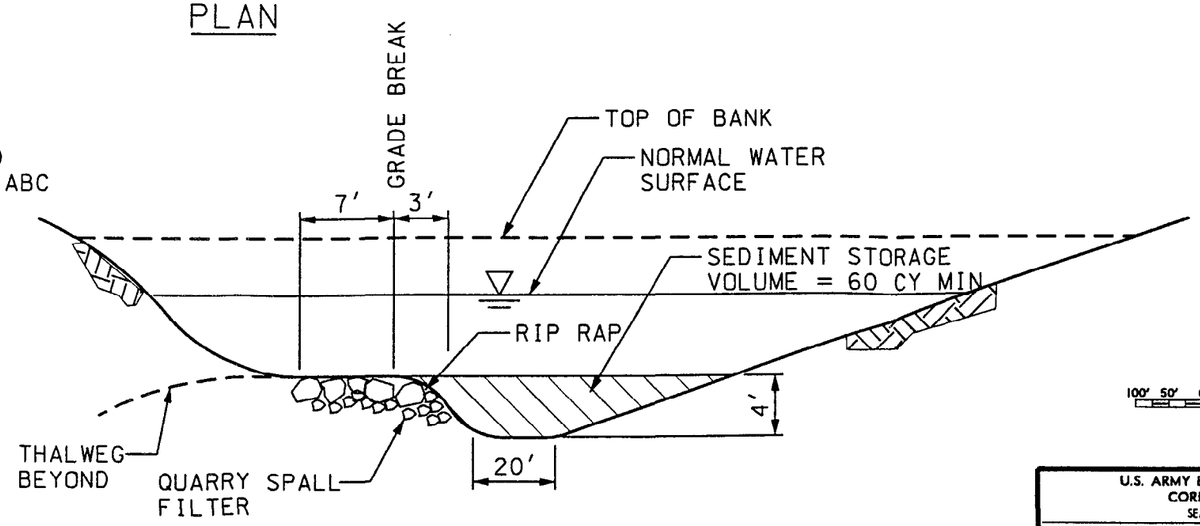
NOTES:

1. ALL CHANNEL CONSTRUCTION TO BE 1-STAGE CHANNEL. SEE TYPICAL PLAN AND SECTION DETAIL, FIG. NO. 12.
2. LOCATE LARGE WOODY DEBRIS POOLS EVERY 10' +/-. SEE DETAIL, FIG. NO. 14.
3. CONSTRUCT HUMMOCKS IN RIPARIAN CORRIDOR, SEE PLAN AND SECTION DETAIL, FIG. NO. 15.
4. SEE 1-STAGE CHANNEL DETAIL FOR RIPARIAN PLANTING SCHEME, PLAN AND SECTION DETAIL, FIG. NO. 12.
5. EXISTING CHANNEL AND DRIVEWAY CULVERTS TO REMAIN.
6. CONTOUR INTERVALS: 0.5 METER.
7. THE WOODED WETLAND SECTIONS OF UPPER SPRINGBROOK WILL BE LEFT IN A NATURAL STATE WITH REVEGETATION CONFINED TO THE DISTURBED PORTION OF THE PROJECT ONLY.



SEDIMENT TRAP DETAIL

NOT TO SCALE



SECTION A-A

NOT TO SCALE

100' 50' 0 100' 200'

Site No. 8

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

GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY

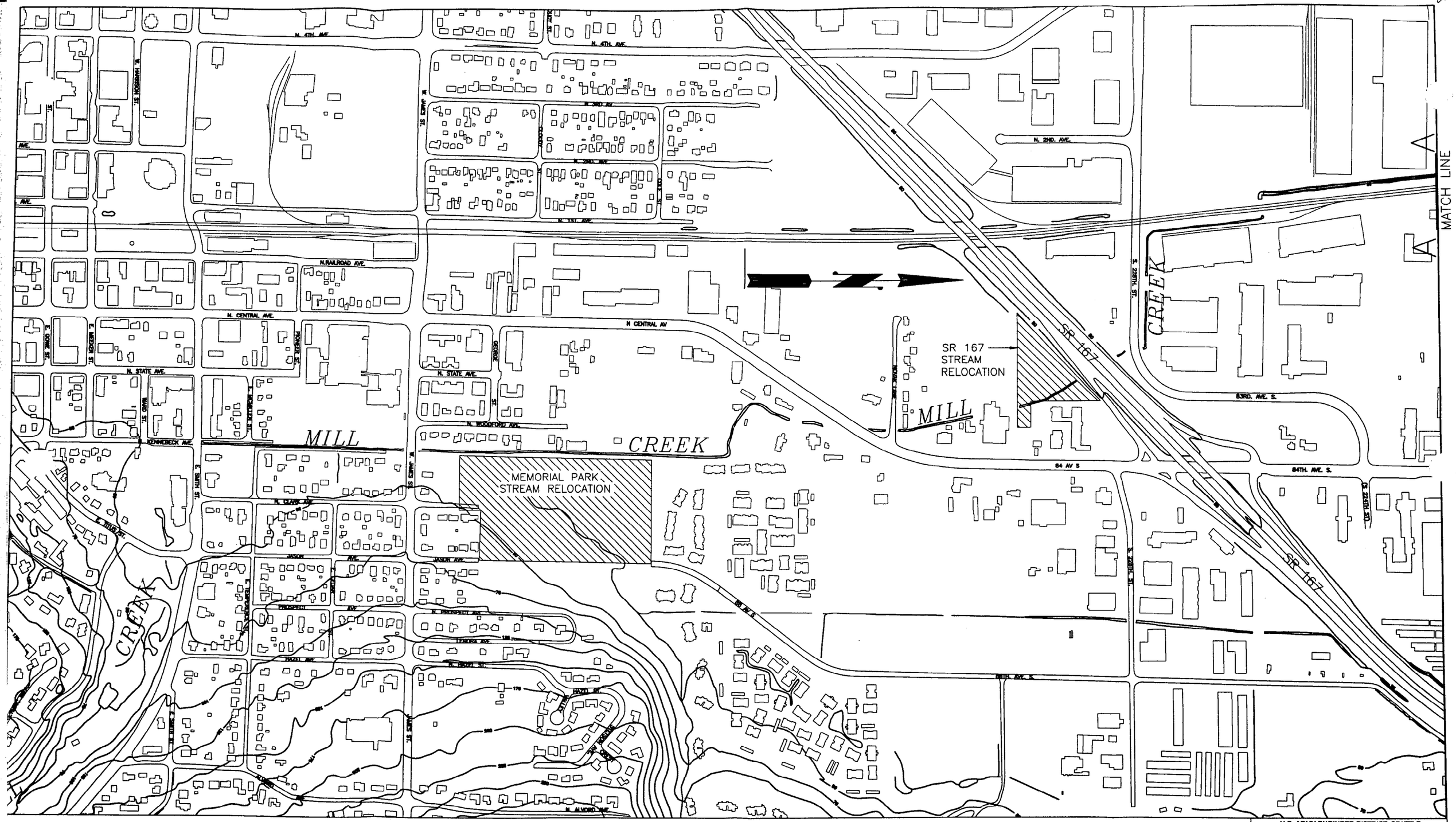
FIGURE NO. 10
UPPER SPRINBROOK REACH
SITE PLAN

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: 04-OCT-2000 14:36
DESIGN FILE: ssP:\ENVIROP48.050\DRAWINGS\SKETCH15.DGN

DATE AND TIME PLOTTED: 04-OCT-2000 14:36 DESIGN FILE: l:\designs\msgdck\v8dep1nr\sketch15.dgn



BASE MAP COURTESY OF CITY OF KENT

250 0 250 500 750
SCALE IN FEET

FOR BUFFER/EASEMENT DETAILS
SEE FIGURE ~~5~~ 4 OF PLAN AND SECTION DETAILS

PROJECT NO. 2H1847	
APPROVED: D. ALTHAUSER	DATE: 2/00
PROJECT MANAGER: W. KARA	DATE: 2/00
DESIGNED: F. KARA	DATE: 2/00
DRAWN: K. RIPLEY	DATE: 2/00

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

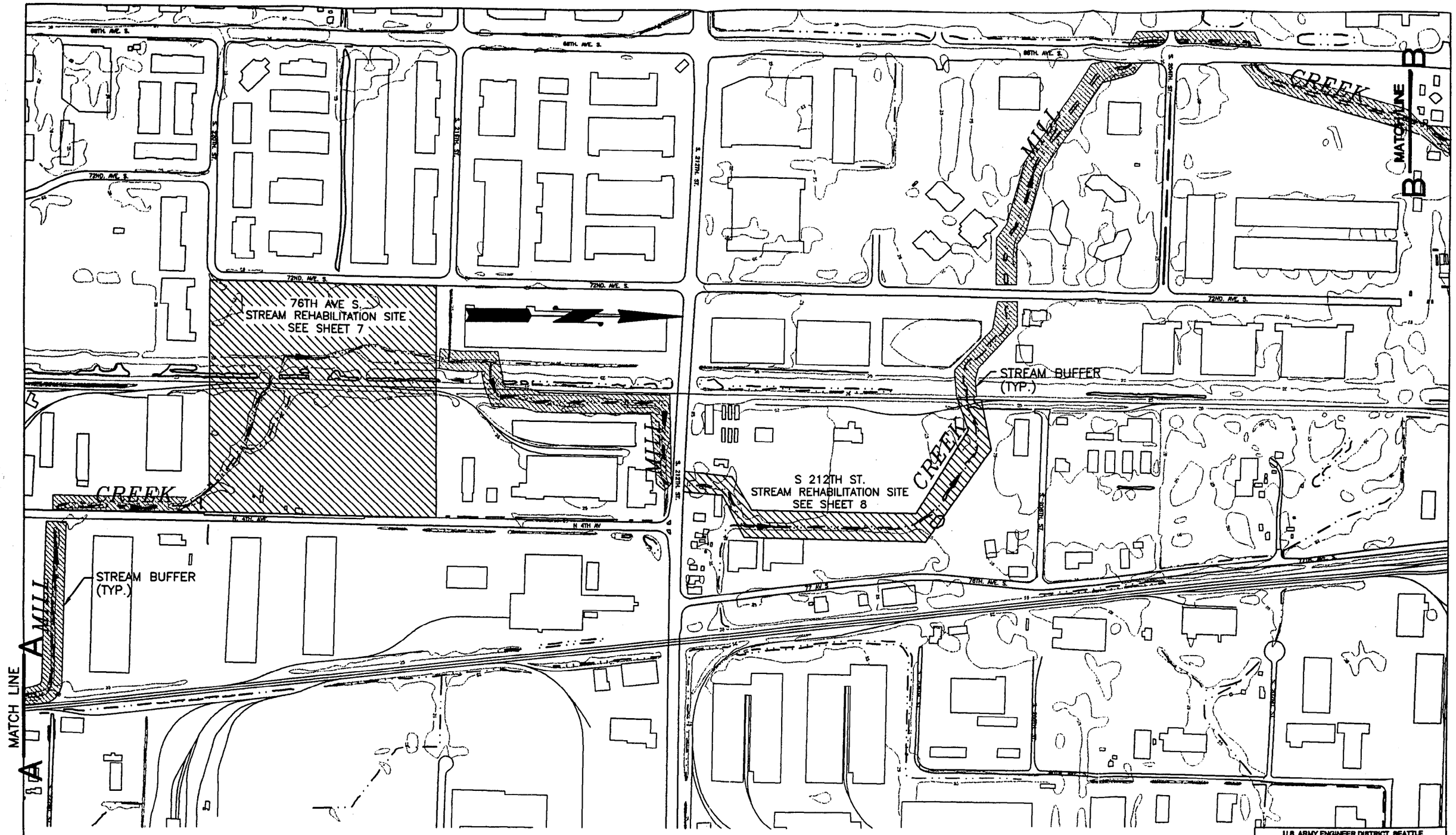
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY
MILL CREEK MEMORIAL PARK SITE
& SR 167 SITE
Site No. 9

SIZE	DRAWING NO.	FILE NO.	DATE 2/00	PLANE
DSGN.		CHK.	SHEET 1 OF 9	

WENDYK/GREEN/MILL/MILLPLN1.DWG XREF:MILLCR.DWG

6



250 0 250 500 750
SCALE IN FEET

FOR BUFFER/EASEMENT DETAILS
SEE SHEET 9

BASE MAP COURTESY OF CITY OF KENT

PROJECT NO. 2H1847	
APPROVED: D. ALTHAUSER	DATE: 2/00
PROJECT MANAGER: W. KARA	DATE: 2/00
DESIGNED: F. KARA	DATE: 2/00
DRAWN: K. BIRLEY	DATE: 2/00

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN - DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY
MILL CREEK 76TH AVE S. SITE
& S. 212TH ST. SITE
SITE PLAN-SHEET 2

2/00
SHEET 2 OF 9

Site No. 9

MATCH LINE

W VALLEY HWY

WEST VALLEY HWY.

TOOD BLVD.

MCDONALD WAY

ANDOVER PARK EAST

WEST VALLEY RD.

72ND AVE S

72ND. AVE. S.

MILL

CREEK

76TH AVE S

80TH. AVE. S.

S. 180TH. ST.

S. 180TH. ST.

S. 180TH. ST.

S. 180TH. ST.

Site No. 9

BASE MAP COURTESY OF CITY OF KENT

250 0 250 500 750

SCALE IN FEET

FOR BUFFER/EASEMENT DETAILS
SEE FIGURE 4 OF PLAN AND SECTION DETAILS

PROJECT NO. 2H1647	
APPROVED: D. ALTHAUSER	DATE: 2/00
PROJECT MANAGER: W. KARA	DATE: 2/00
DESIGNED: F. KARA	DATE: 2/00
DRAWN: K. RIPLEY	DATE: 2/00

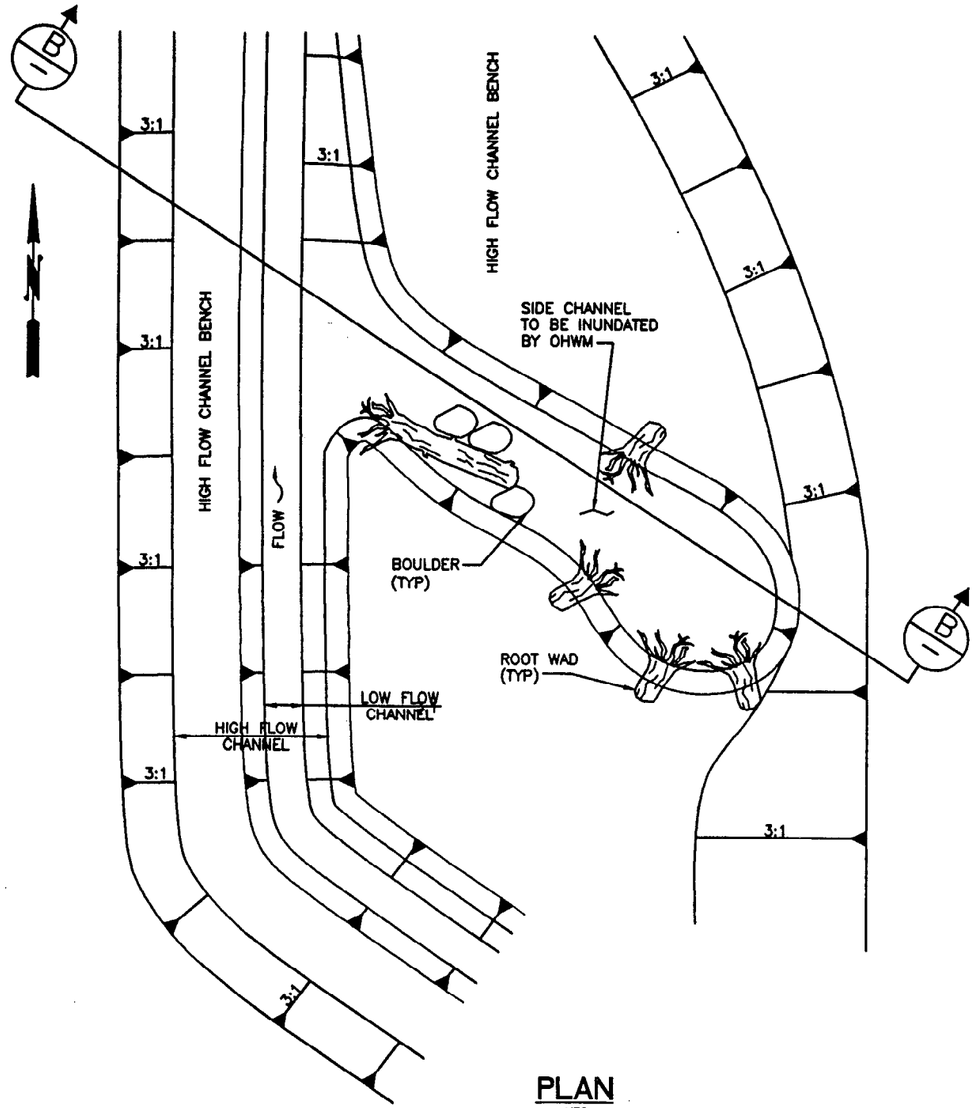
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

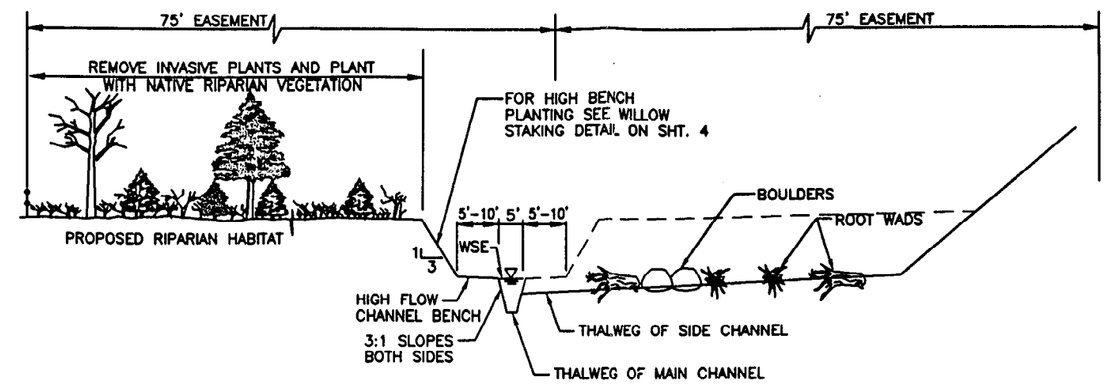
GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY

MILL CREEK
SITE PLAN–SHEET 3

SIZE	SUBMISSION NO.	FILE NO.	DATE	PLATE
X	X	X	2/00	X
DSGN. X		CHK. X	SHEET 3 OF 9	



PLAN
NTS



X-SECTION B-B
NTS

MEMORIAL PARK AND SR 167
STREAM SIDE CHANNEL DETAIL

Site No. 9

PROJECT NO. 2H1847	
APPROVED: D. ALTHAUSER	DATE: 2/00
PROJECT MANAGER: W. KARA	DATE: 2/00
DESIGNED: F. KARA	DATE: 2/00
DRAWN: K. RIPLEY	DATE: 2/00

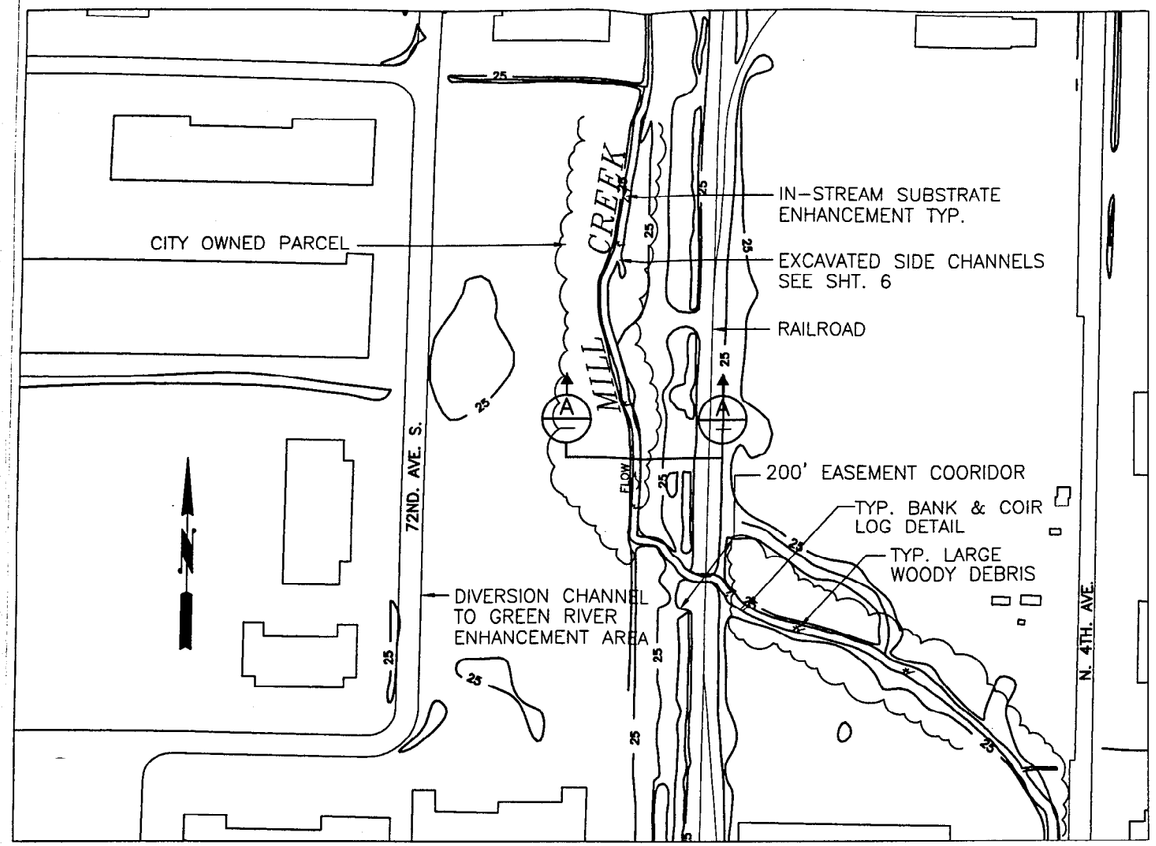
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY
MILL CREEK MEMORIAL PARK
& SR167 STREAM
DETAIL – SHEET 3

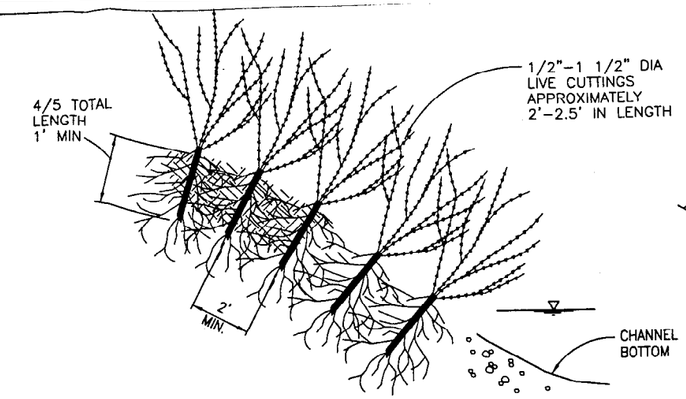
2/00

SHEET 6 OF 9

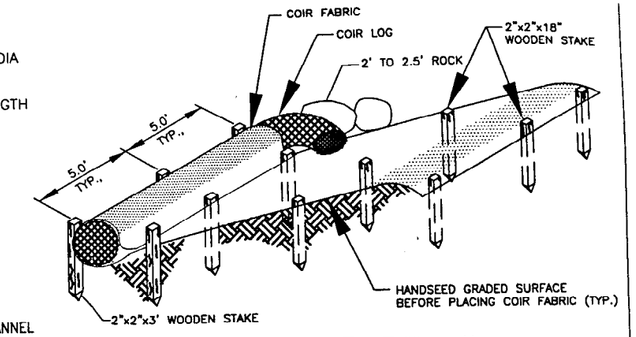


PLAN
NTS

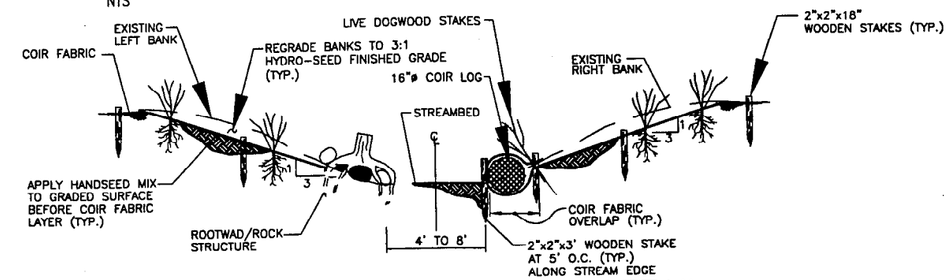
76TH AVE. S. STREAM RESTORATION (BARNIER PROPERTY)



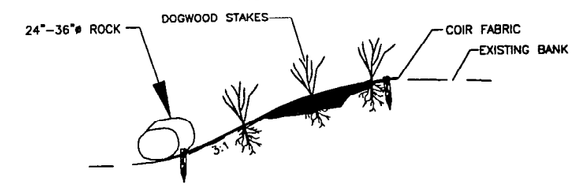
RIPARIAN PLANTINGS TYPICAL, WILLOW STAKES
NTS



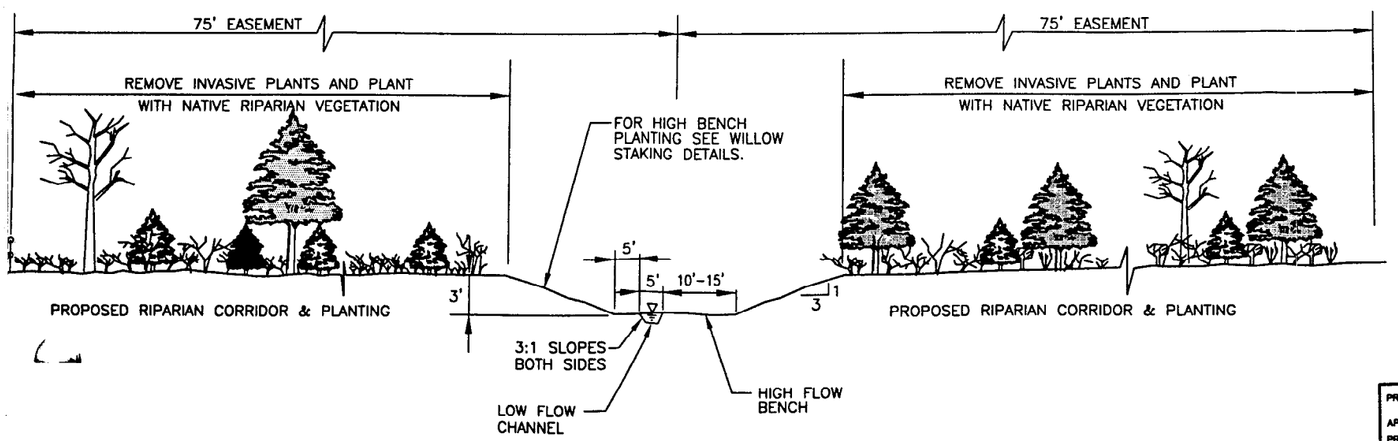
COIR WRAP DETAIL
NTS



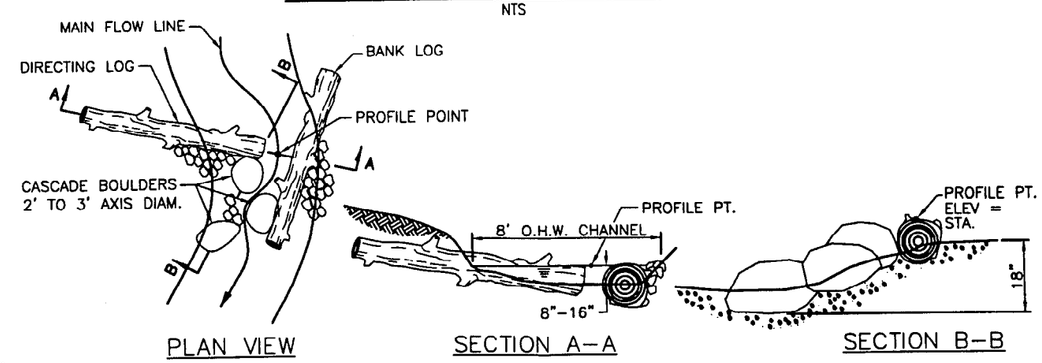
TYPICAL BANK AND COIR LOG DETAIL
NTS



COIR FABRIC BANK DETAIL
NTS



TYPICAL X-SECTION A-A
NTS



TYPICAL LARGE WOODY DEBRIS PLACEMENT
NTS

Site No. 9

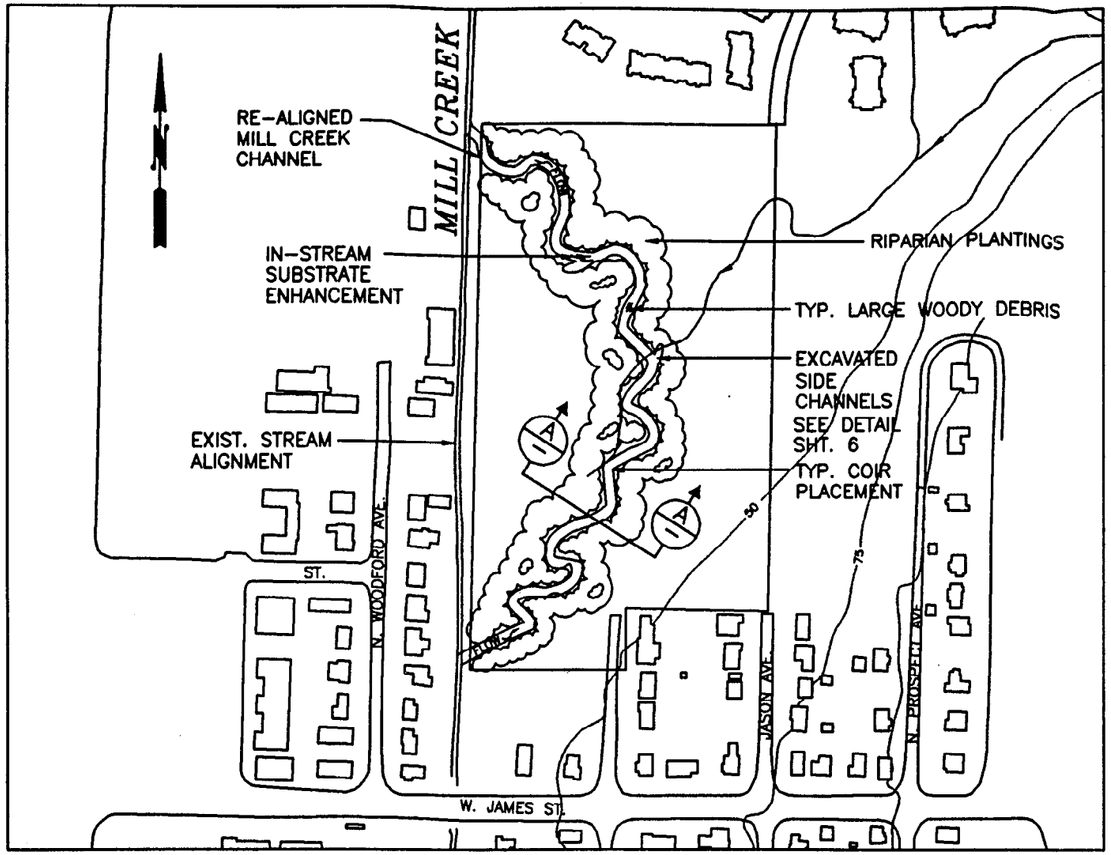
PROJECT NO. 2H1647	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONNETTE, DIRECTOR SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES
APPROVED: D. ALTHAUSER DATE: 2/00	
PROJECT MANAGER: W. KARA DATE: 2/00	
DESIGNED: F. KARA DATE: 2/00	
DRAWN: K. RIPLEY DATE: 2/00	

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

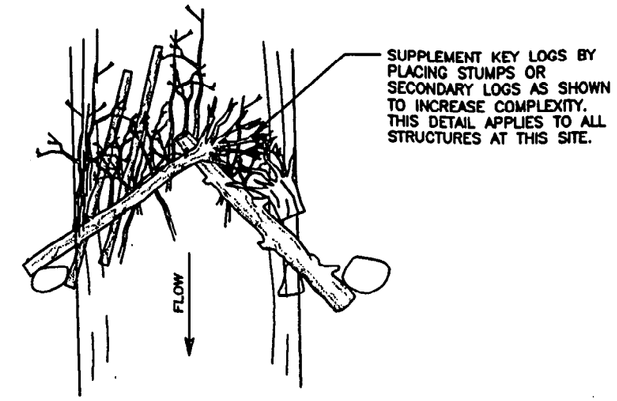
GREEN - DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

MILL CREEK 76TH AVE. SOUTH STREAM DETAIL - SHEET 4

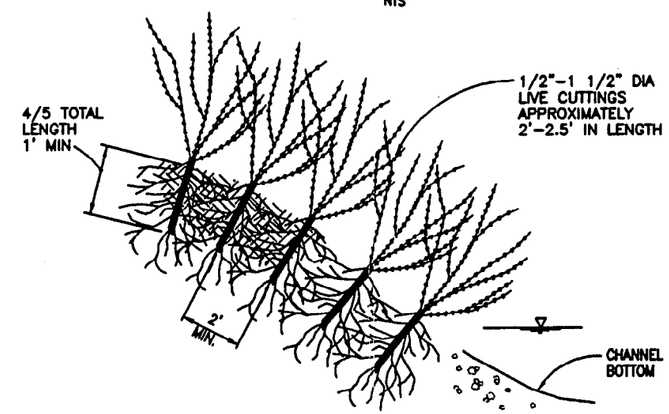
DATE: 2/00
SHEET 7 OF 9



PLAN
NTS

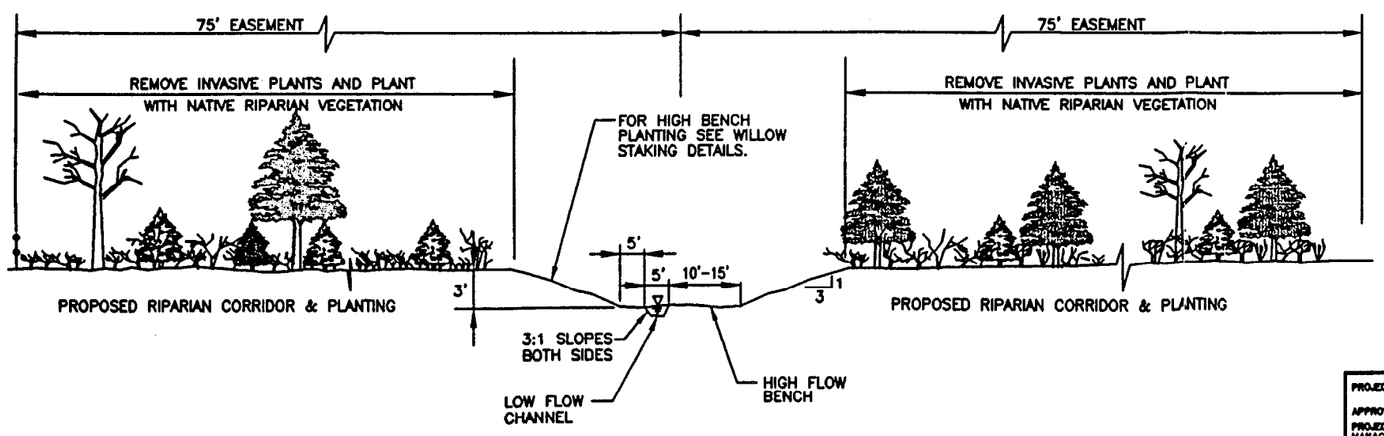


LARGE WOODY DEBRIS DETAIL (TYP.)
NTS

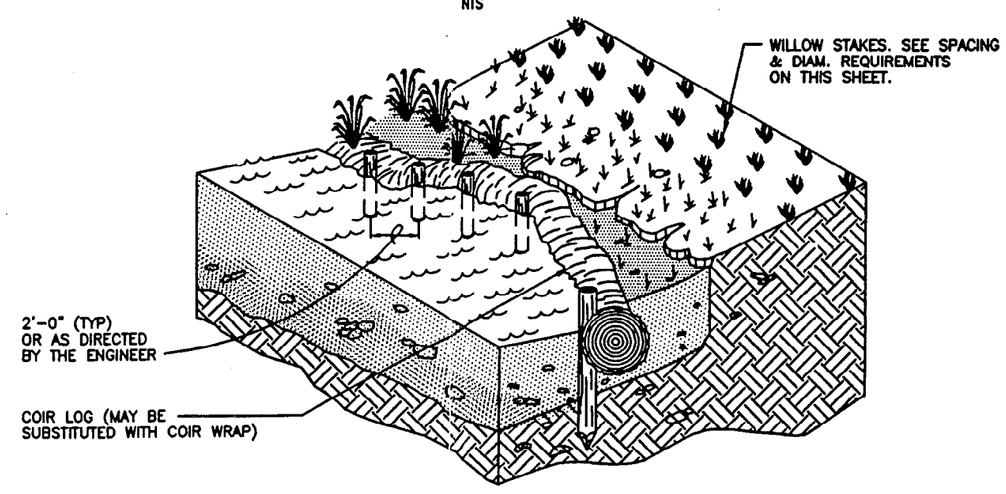


RIPARIAN PLANTINGS TYPICAL, WILLOW STAKES
NTS

MEMORIAL PARK STREAM RESTORATION (LITTLE PROPERTY)



TYPICAL X-SECTION A-A
NTS



TYPICAL COIR PLACEMENT
NTS

PROJECT NO. 2H1847
APPROVED: D. ALTHAUSER DATE: 2/00
PROJECT MANAGER: W. KARA DATE: 2/00
DESIGNED: F. KARA DATE: 2/00
DRAWN: K. BIRLEY DATE: 2/00

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES

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

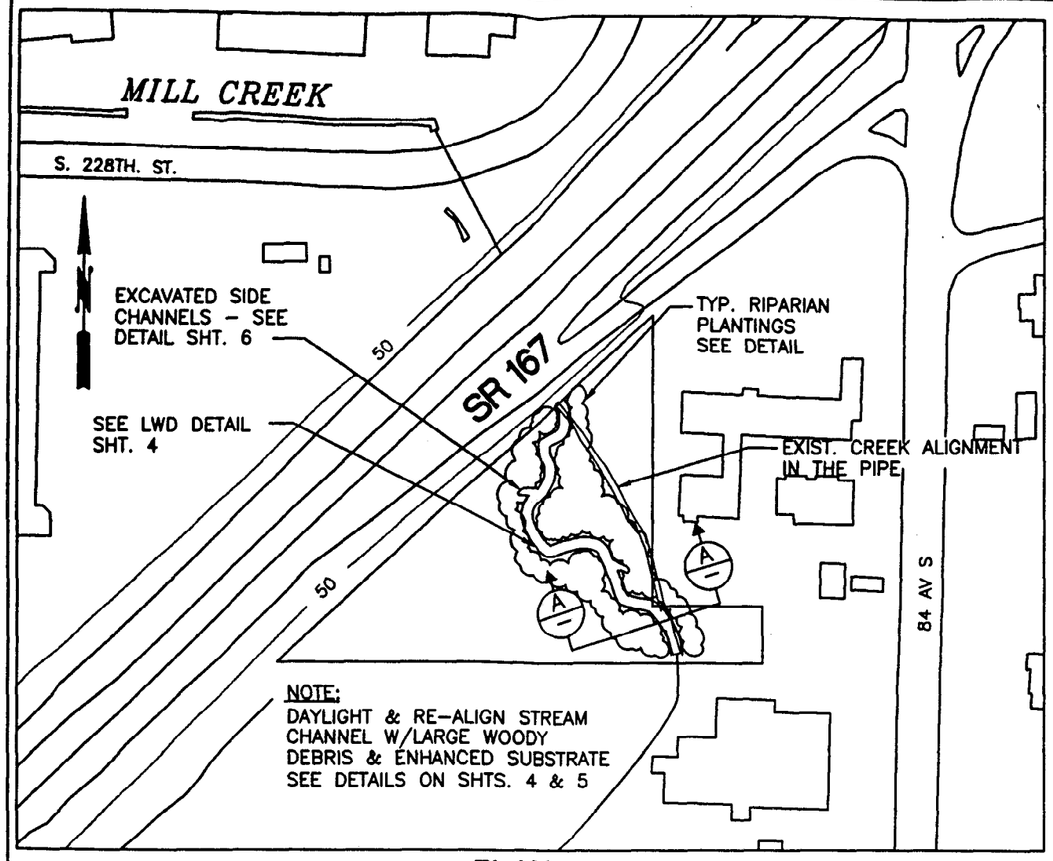
GREEN - DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

MILL CREEK MEMORIAL PARK SITE
DETAIL - SHEET 1

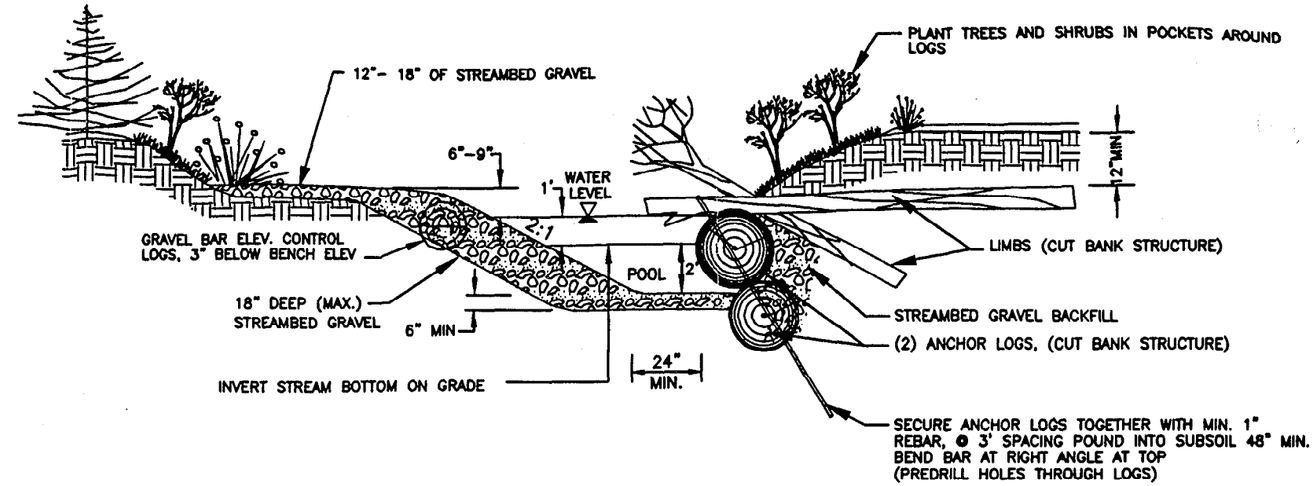
2/00

Site No. 9

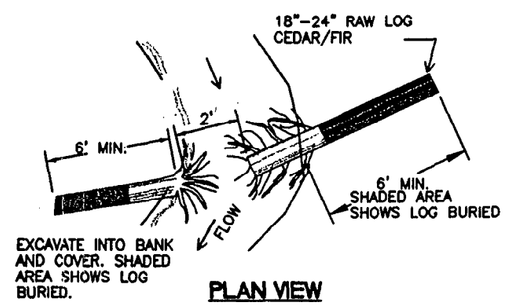
64



PLAN
NTS
SR 167 STREAM RELOCATION

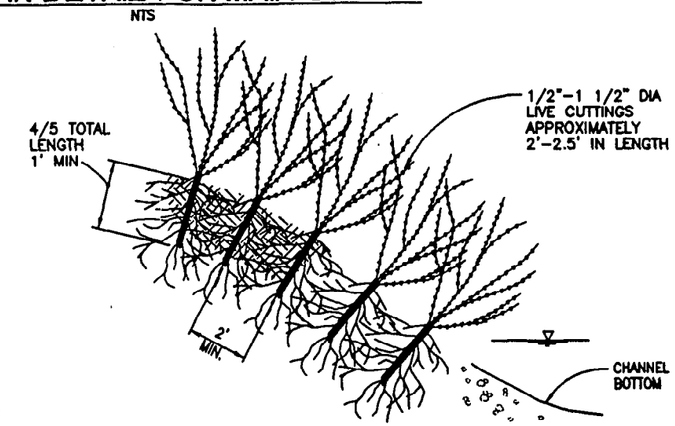


LWD BANK DETAIL FOR MAIN STREAM
NTS

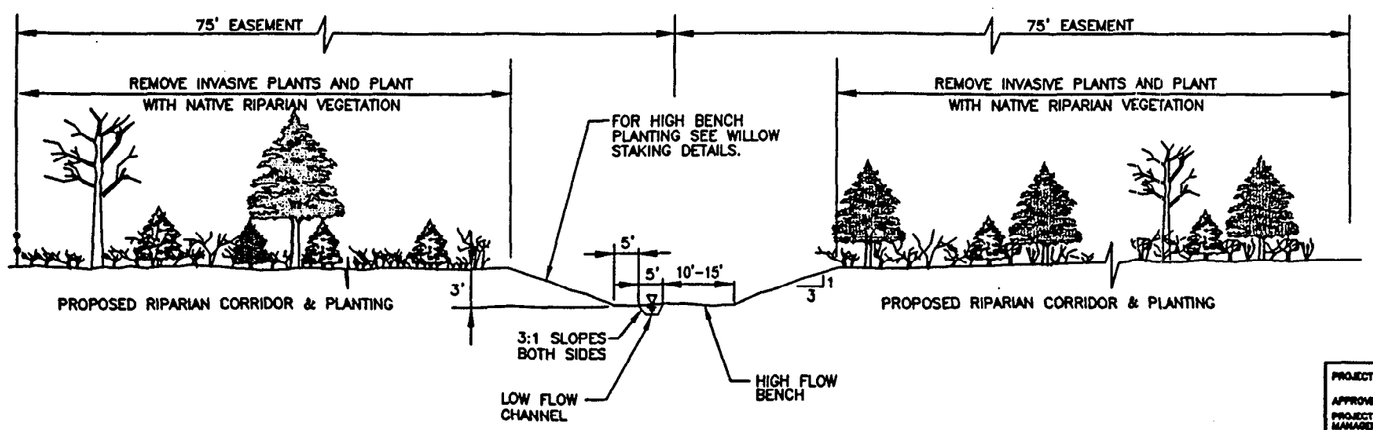


PLAN VIEW

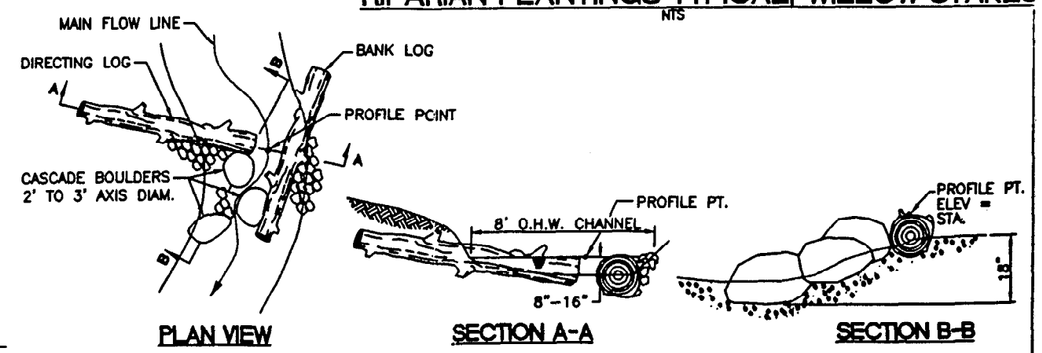
DEFLECTOR LOG WITH STUMP HABITAT
NTS



RIPARIAN PLANTINGS TYPICAL, WILLOW STAKES
NTS



TYPICAL X-SECTION A-A
NTS



PLAN VIEW SECTION A-A SECTION B-B

TYPICAL LARGE WOODY DEBRIS PLACEMENT
NTS

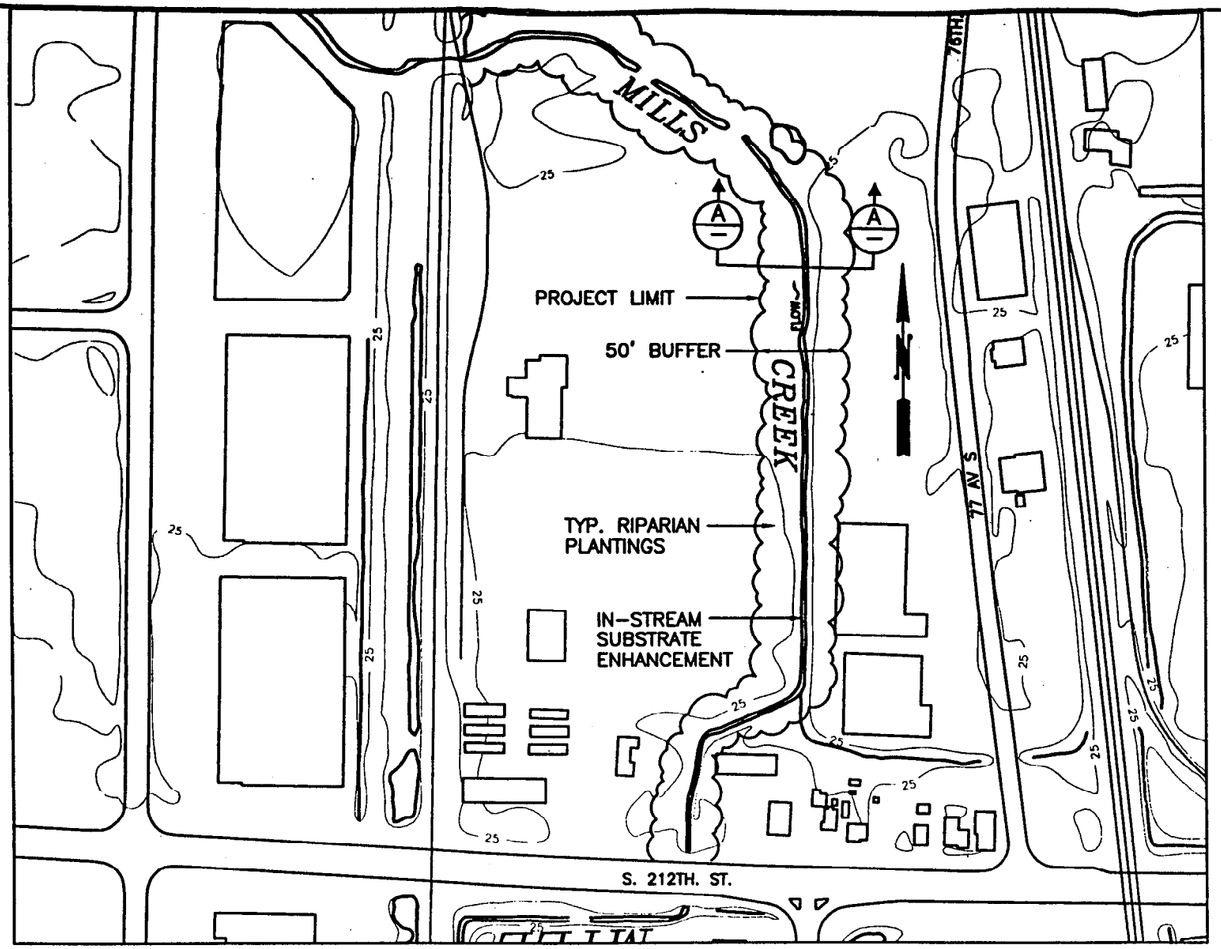
Site No. 9

PROJECT NO. 2H1847	KING COUNTY DEPT OF NATURAL RESOURCES PAM BISSONNETTE, DIRECTOR SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES
APPROVED: D. ALTHAUSER DATE: 2/00	
PROJECT MANAGER: W. KARA DATE: 2/00	
DESIGNED: F. KARA DATE: 2/00	
DRAWN: K. BIPLEY DATE: 2/00	

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

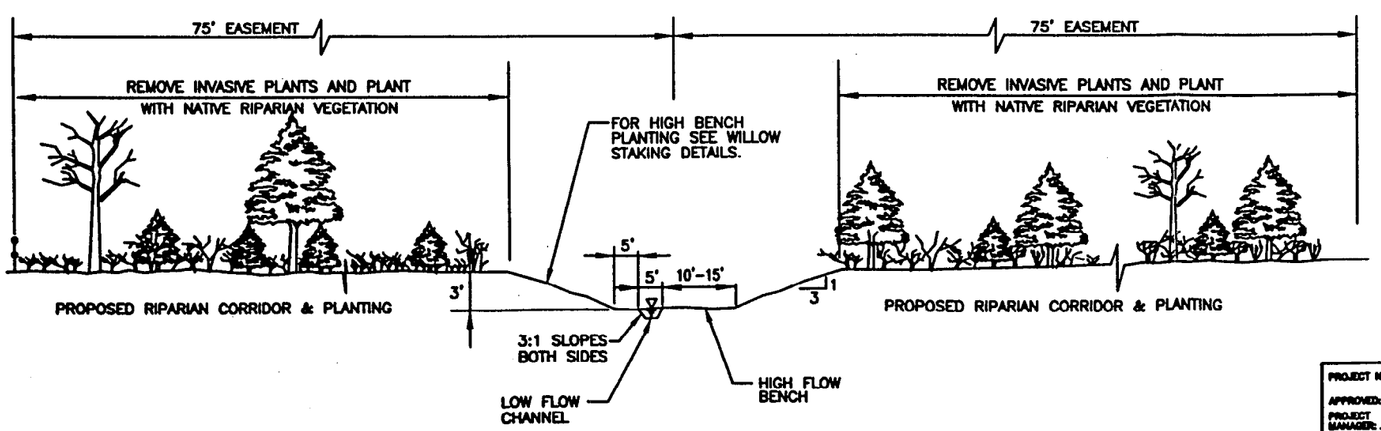
GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY
MILL CREEK SR167 STREAM
DETAIL – SHEET 2

2/00

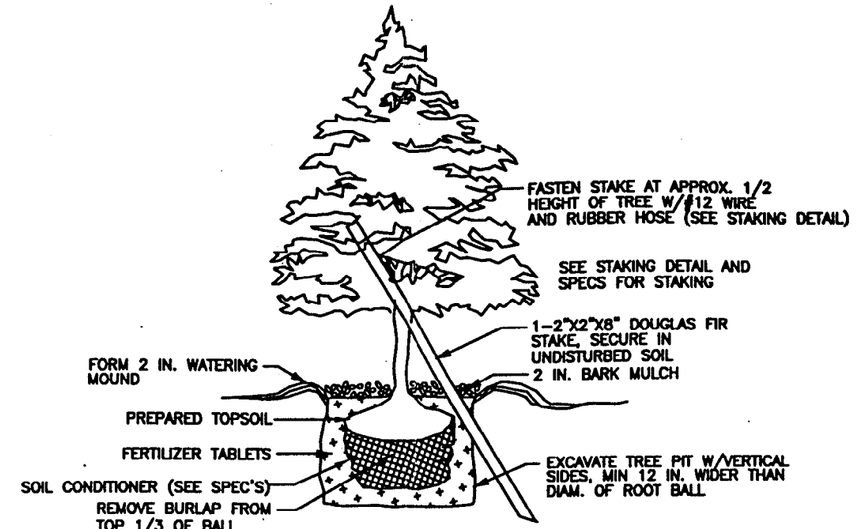


PLAN
NTS

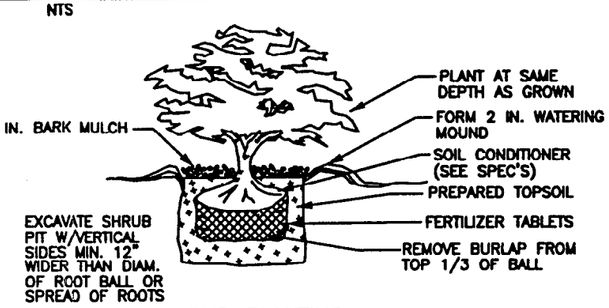
S. 212TH ST. STREAM RESTORATION



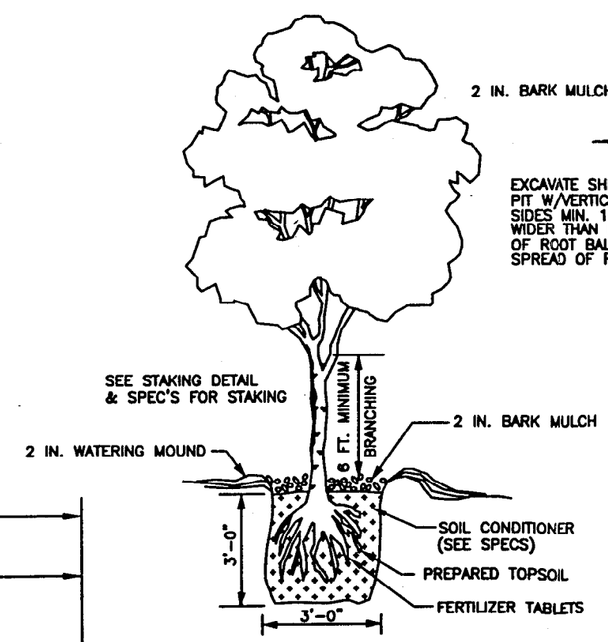
TYPICAL X-SECTION A-A
NTS



EVERGREEN TREE PLANTING
NTS



SHRUB PLANTING
NTS



DECIDUOUS TREE PLANTING
NTS

Site No. 9

TREE PLANTING DETAILS

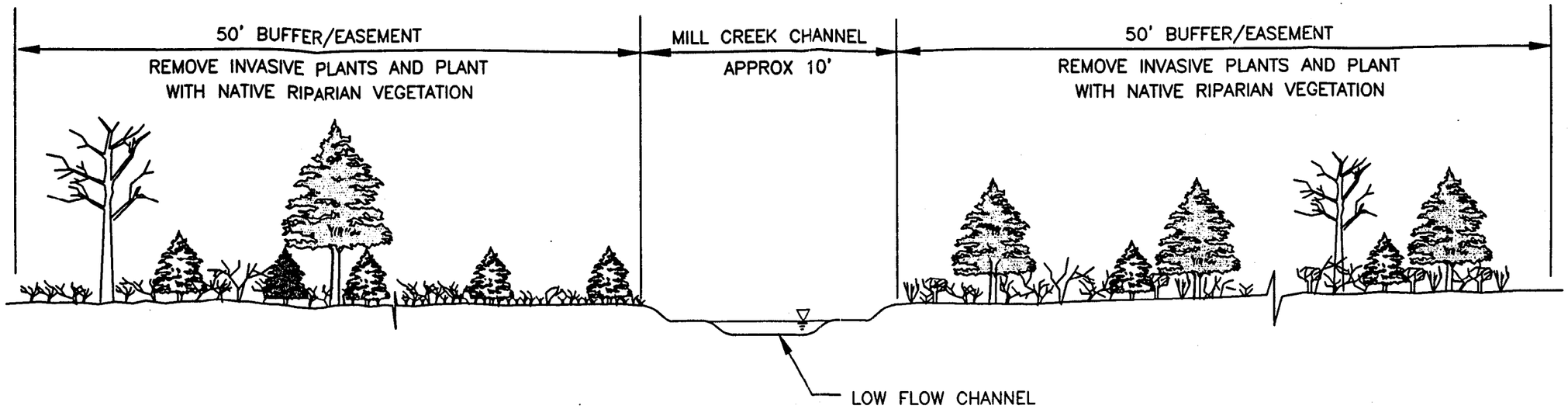
PROJECT NO. 281847
APPROVED: D. ALTHAUSER DATE: 2/00
PROJECT MANAGER: W. KARA DATE: 2/00
DESIGNED: F. KARA DATE: 2/00
DRAWN: K. BIRLEY DATE: 2/00

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

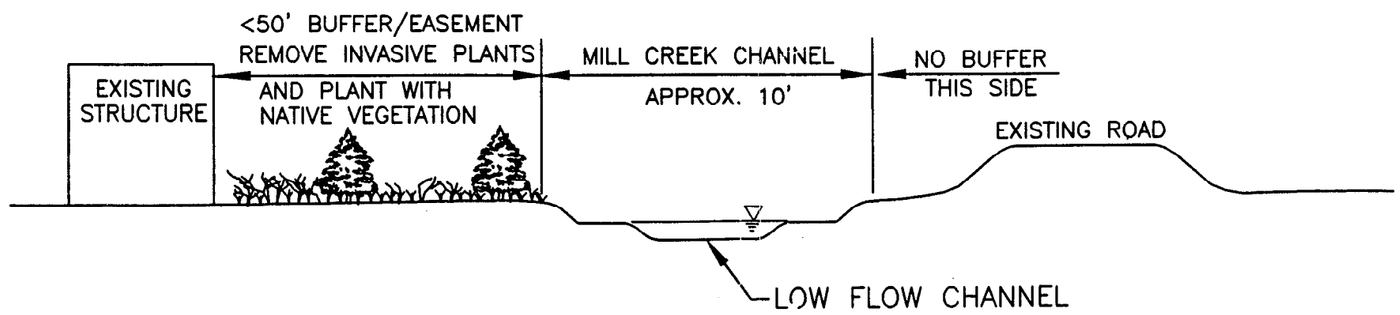
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
MILL CREEK SOUTH 212TH ST.
DETAIL – SHEET 5

2/00



TYPICAL UNCONSTRAINED BUFFER/EASEMENT
N.T.S.



TYPICAL STREAM BUFFER/EASEMENT CONSTRAINED BY EXISTING STRUCTURES
N.T.S.

PROJECT NO. 2H1647	
APPROVED: D. Althauser	DATE: 2/00
PROJECT MANAGER: W. Kara	DATE: 2/00
DESIGNED F. Kara	DATE: 2/00
DRAWN: E. MacKinnon	DATE: 2/00

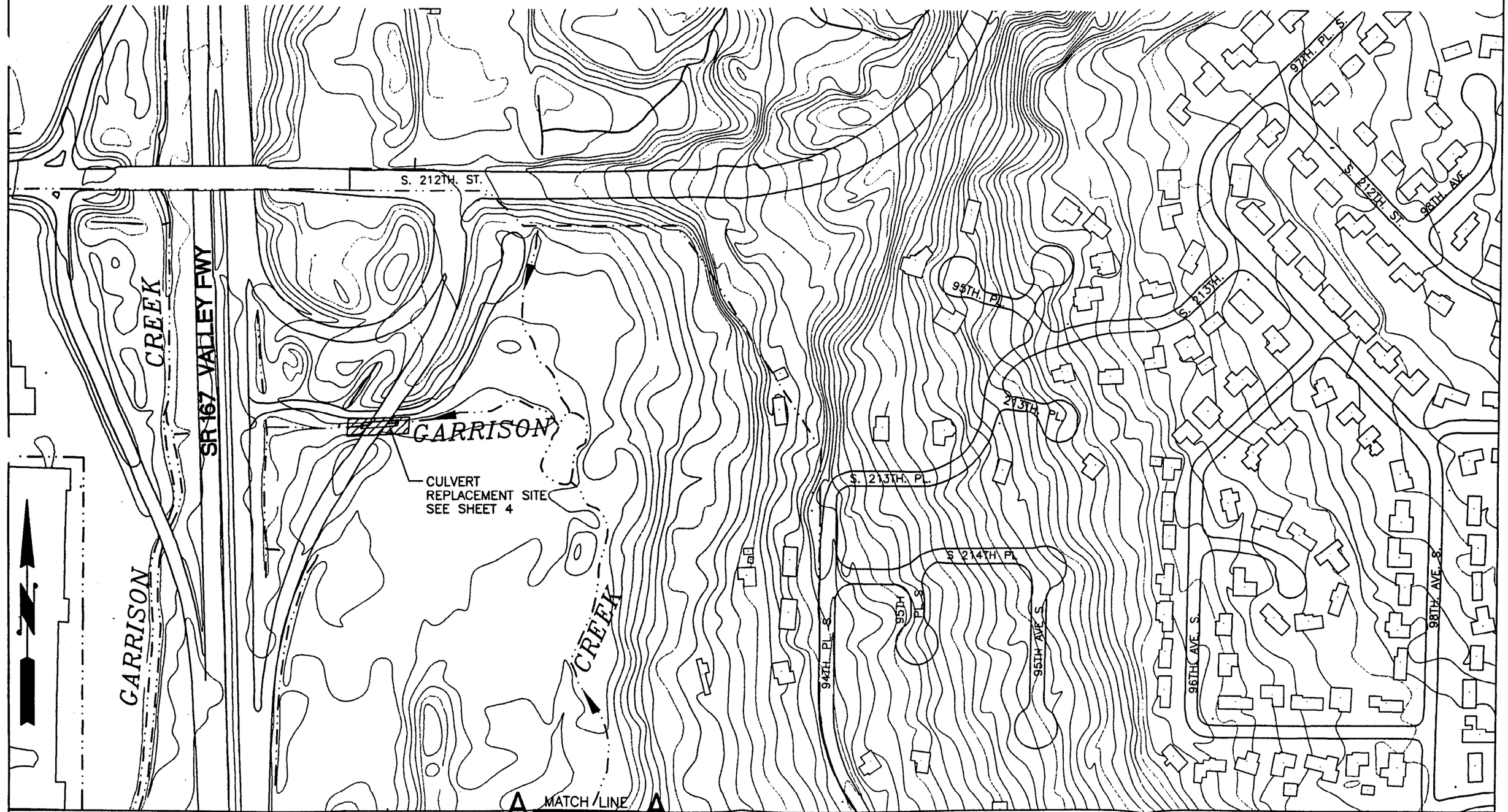
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

MILL CREEK – STREAM BUFFER
DETAIL SHEET 6

SIZE	DIMENSION NO.	FILE NO.	SCALE	PLATE
X	X	X	X	X
DESIGN. X		CHK. X	SHEET 9 of 9	



BASE MAP COURTESY OF CITY OF KENT

100 0 100 200 300
SCALE IN FEET

PROJECT NO. 201647	
APPROVED: D. ALTHAUSER	DATE: 11/98
PROJECT MANAGER: W. KARA	DATE: 11/98
DESIGNED: F. KARA	DATE: 11/98
DRAWN: K. RIPLEY	DATE: 11/98

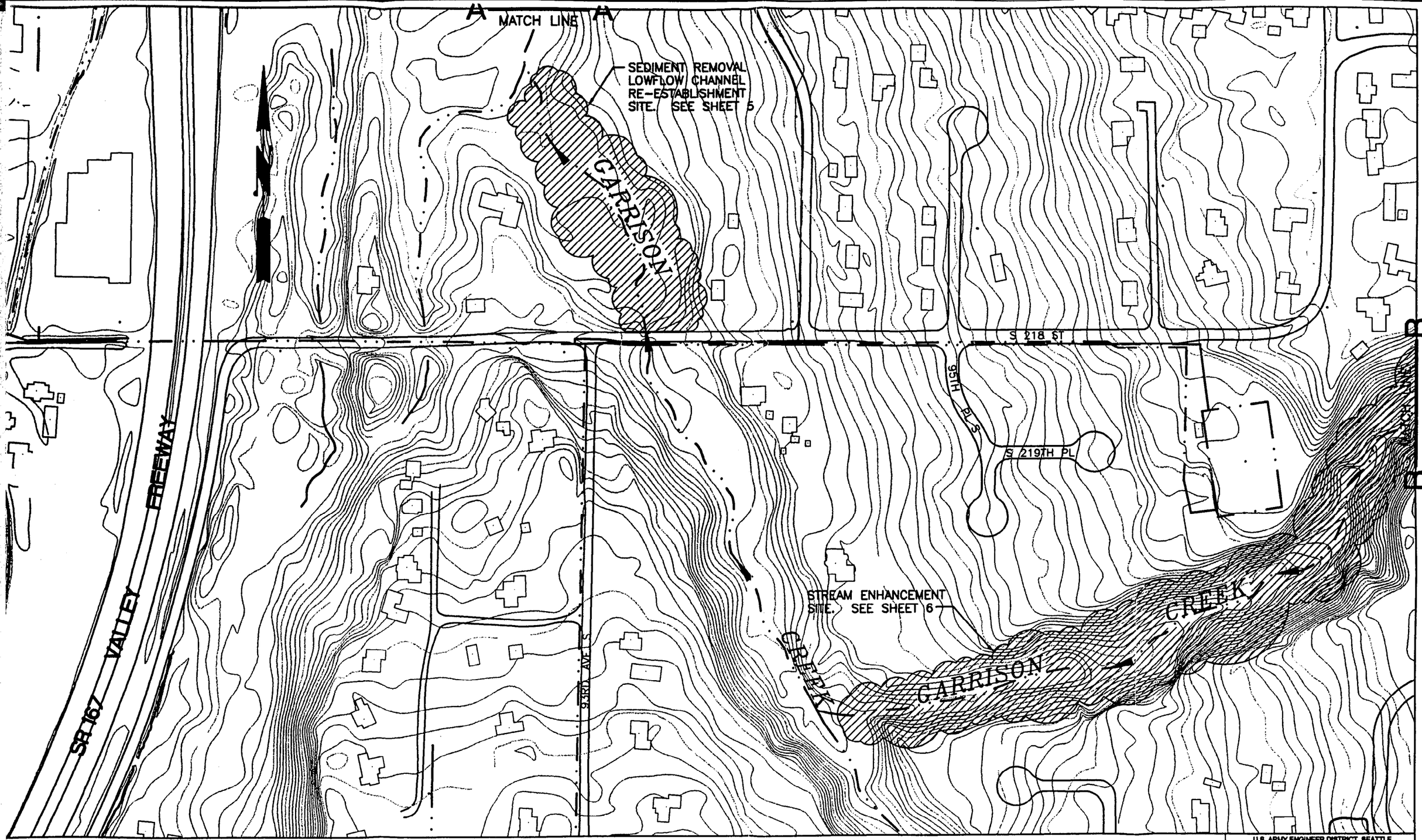
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY
GARRISON CREEK
CULVERT REPLACEMENT SITE
SITE PLAN–SHEET 1

11/98
SHEET 1 OF 7

Site No. 10



BASE MAP COURTESY OF CITY OF KENT

100 0 100 200 300
SCALE IN FEET

PROJECT NO. 921947	
APPROVED: D. ALTHAUSER	DATE: 11/98
PROJECT MANAGER: W. KARA	DATE: 11/98
DESIGNED: F. KARA	DATE: 11/98
DRAWN: K. RIPLEY	DATE: 11/98

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY
GARRISON CREEK – RE-ESTABLISHMENT
& STREAM ENHANCEMENT SITES
SITE PLAN–SHEET 2

11/99
SHEET 2 OF 7

I:\WENDYK\green\mill\NEWDWGS\GARRPLN2.dwg

S. 216TH. ST.

S.E. 216TH. ST.

SLIDE STABILIZATION SITE. SEE SHEET 7

GARRISON CREEK

STREAM ENHANCEMENT SITE. SEE SHEET 6

104TH. PL. S.E.

105TH. PL. S.E.

S.E. 218TH. ST.

105TH. AVE. S.E.

S.E. 219TH.

(PVT.)

(PVT.)

100TH. AVE. S.

S.E.

BASE MAP COURTESY OF CITY OF KENT

100 0 100 200 300

SCALE IN FEET

PROJECT NO. 201847

APPROVED: D. ALTHAUSER DATE: 11/98

PROJECT MANAGER: W. KARA DATE: 11/98

DESIGNED: F. KARA DATE: 11/98

DRAWN: K. RIPLEY DATE: 11/98

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

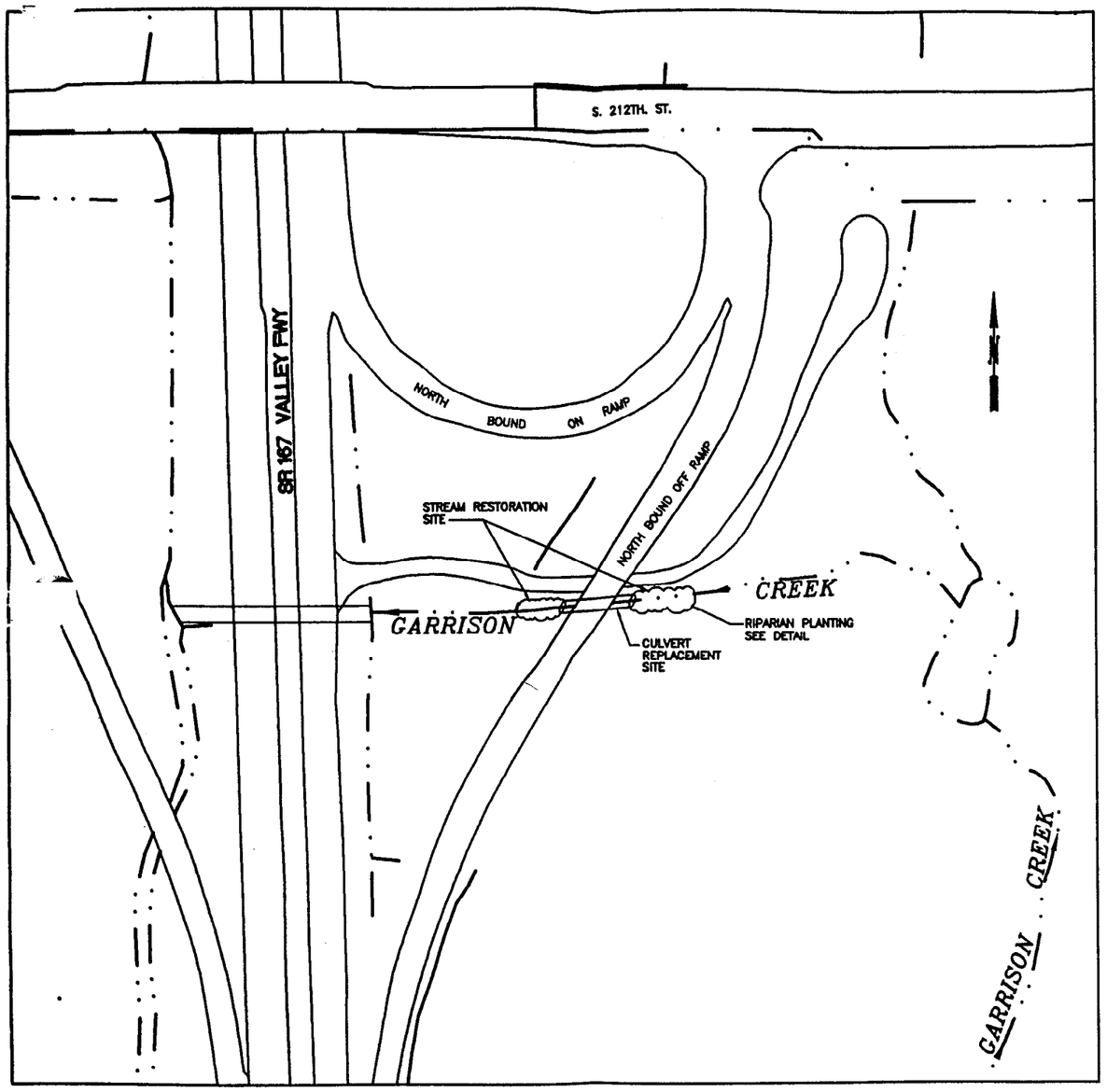
GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY
GARRISON CREEK – STREAM ENHANCEMENT
& SLIDE STABILIZATION SITES
SITE PLAN–SHEET 3

11/99

SHEET 3 OF 7

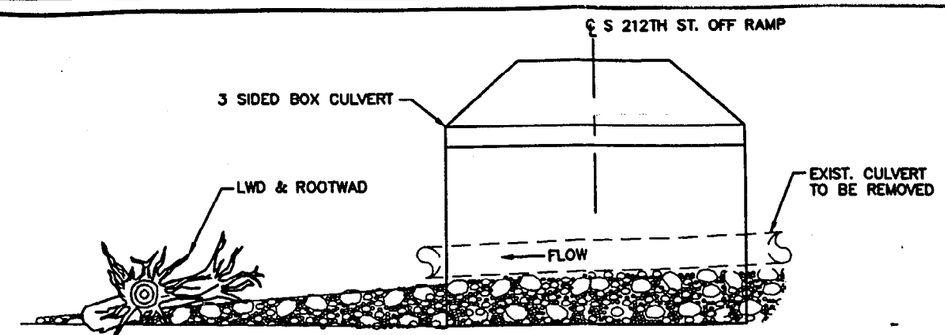
I:\WENDYK\green\mill\NEWDWGS\GARRPLN3.dwg

Site No. 10

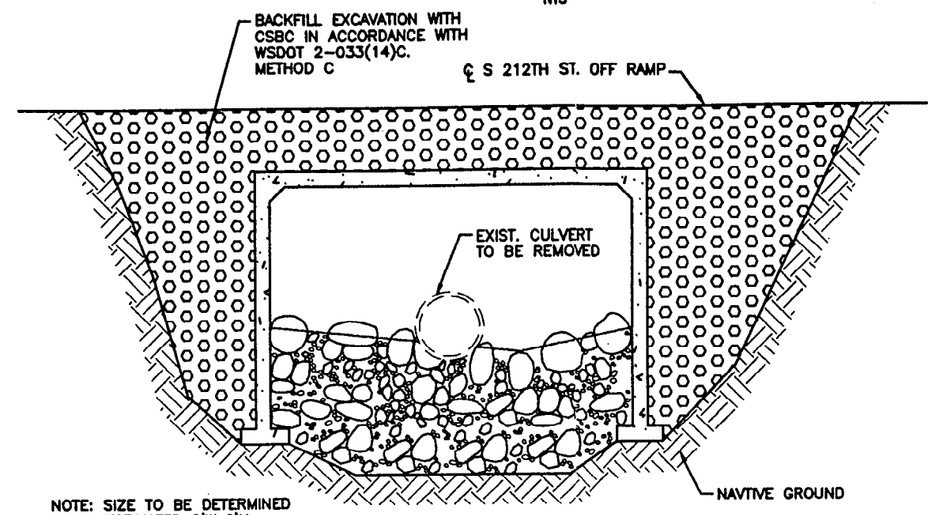


PLAN
NTS

SR 167 CULVERT REPLACEMENT SITE



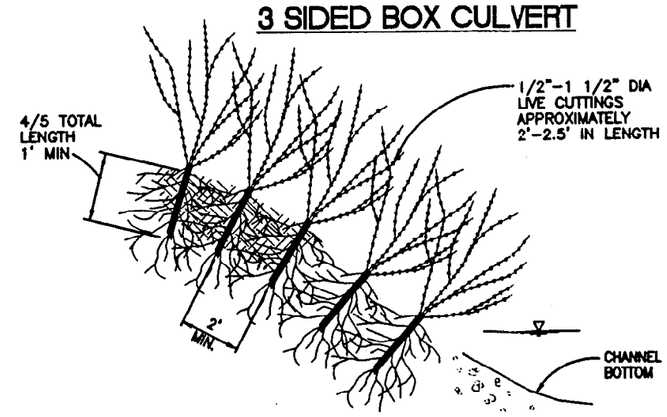
PROFILE
NTS



NOTE: SIZE TO BE DETERMINED
ESTIMATED 8'Wx6'H

X-SECTION
NTS

3 SIDED BOX CULVERT



RIPARIAN PLANTINGS TYPICAL, WILLOW STAKES
NTS

BASE MAP COURTESY OF CITY OF KENT

PROJECT NO. 201647	
APPROVED: D. ALTHAUSER	DATE: 11/99
PROJECT MANAGER: W. KARA	DATE: 11/99
DESIGNED: F. KARA	DATE: 11/99
DRAWN: K. BIRLEY	DATE: 11/99

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

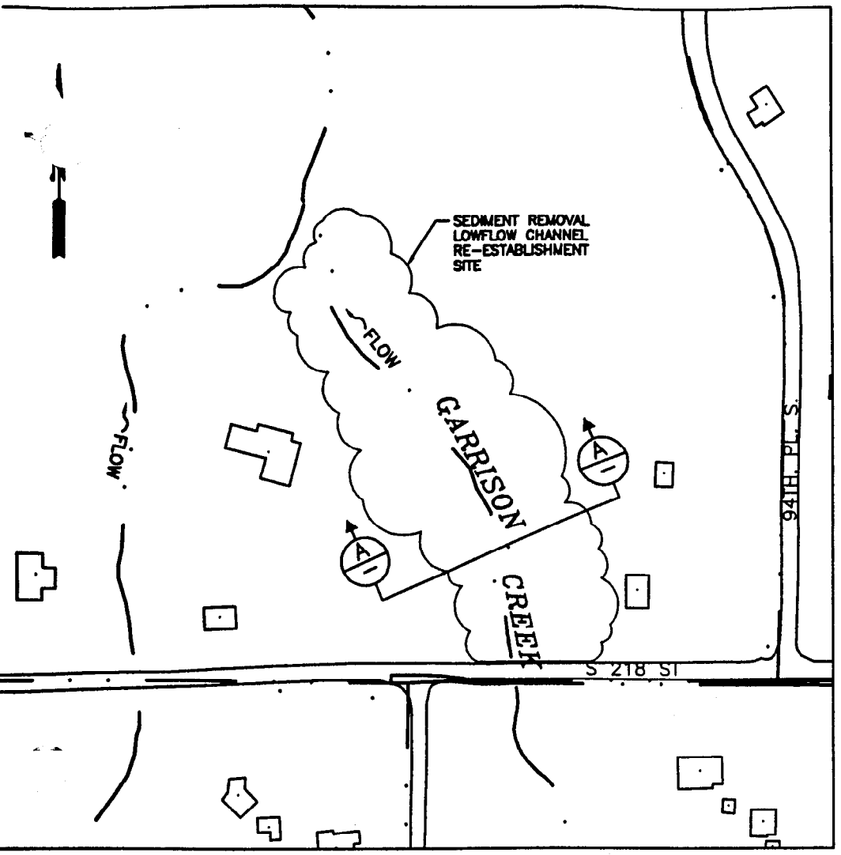
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY
GARRISON CREEK
SR 167 CULVERT REPLACEMENT SITE
DETAIL – SHEET 1

SIZE	SUPERSEDES NO.	FILE NO.	DATE 11/99	PLATE
SCALE		SCALE	SHEET 4 OF 7	

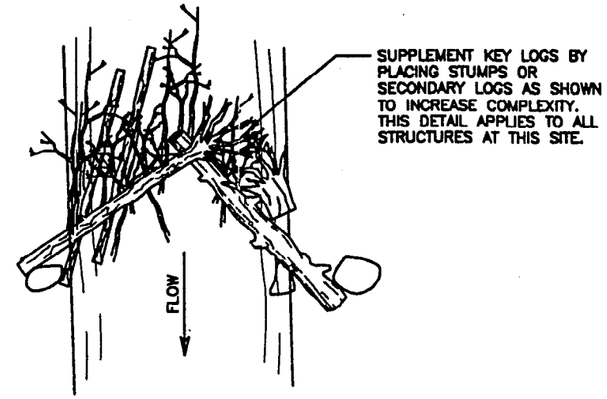
Site No. 10

80

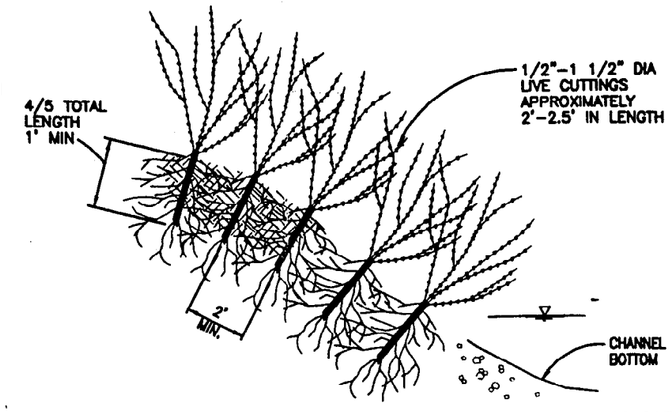


PLAN
NTS

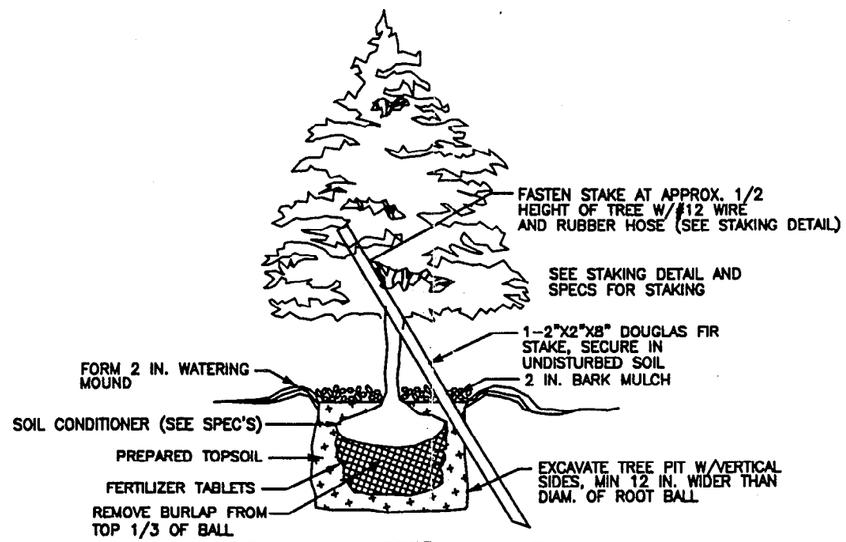
GARRISON CREEK



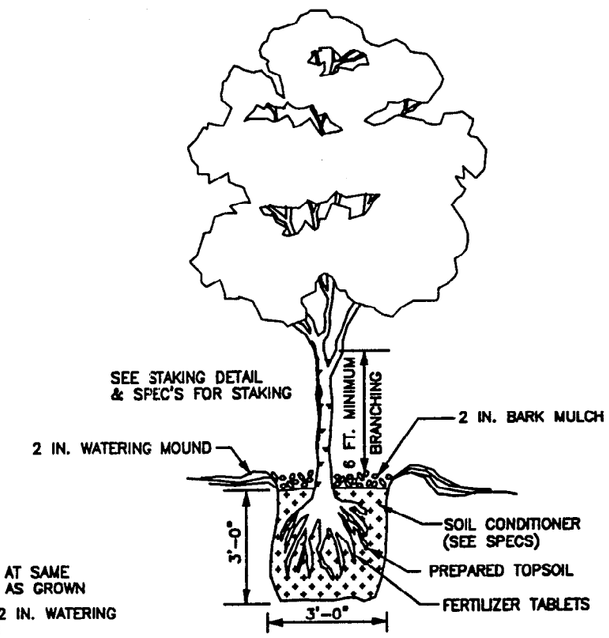
LARGE WOODY DEBRIS DETAIL (TYP.)
NTS



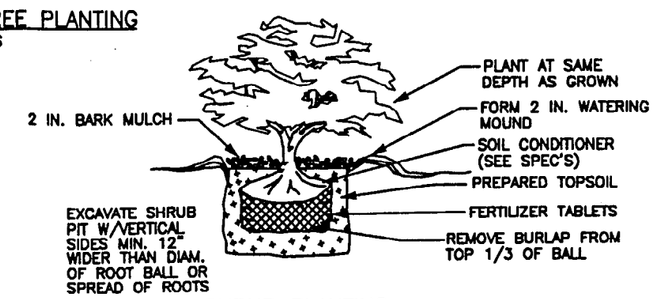
RIPARIAN PLANTINGS TYPICAL, WILLOW STAKES
NTS



EVERGREEN TREE PLANTING
NTS

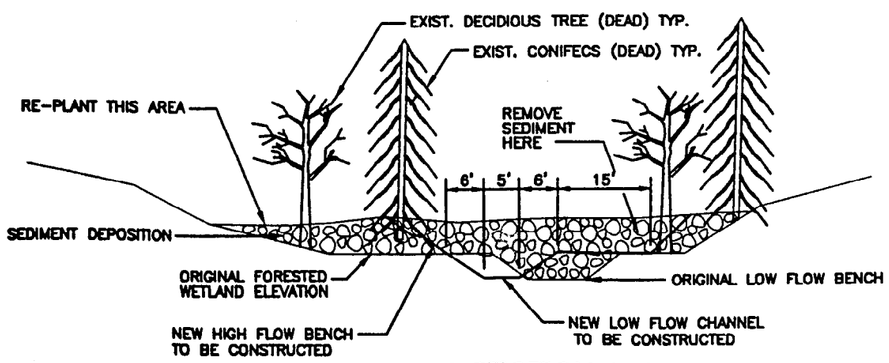


DECIDUOUS TREE PLANTING
NTS



SHRUB PLANTING
NTS

TREE PLANTING DETAILS



TYPICAL X-SECTION A-A
NTS

PROJECT NO. 201847
APPROVED: D. ALTHAUSER DATED 11/98
PROJECT MANAGER: W. KARA DATED 11/98
DESIGNED: F. KARA DATED 11/98
DRAWN: K. BERLEY DATED 11/98

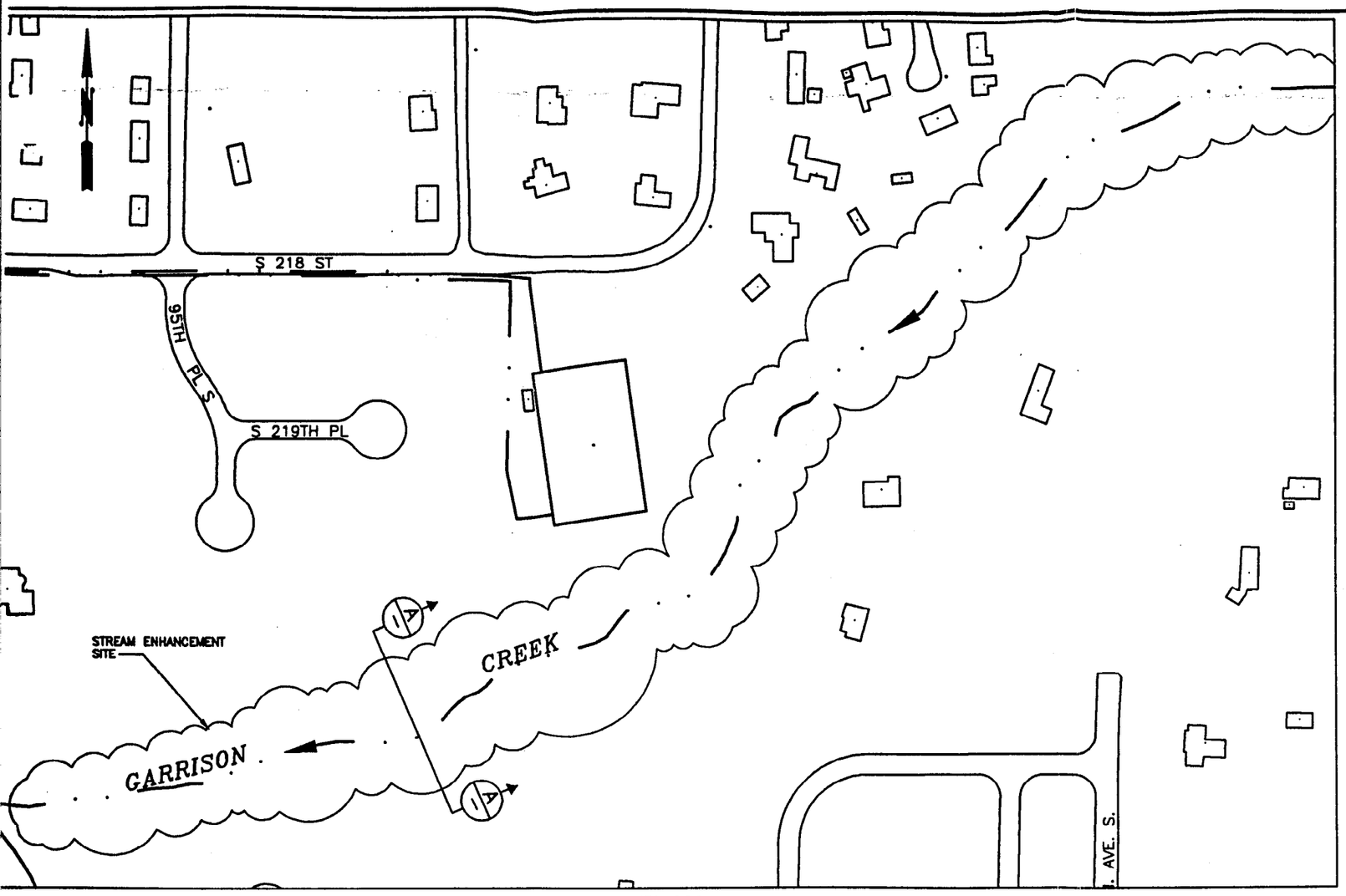
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN - DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
GARRISON CREEK SEDIMENT REMOVAL, LOW FLOW CHANNEL RE-ESTABLISHMENT DETAIL - SHEET 2

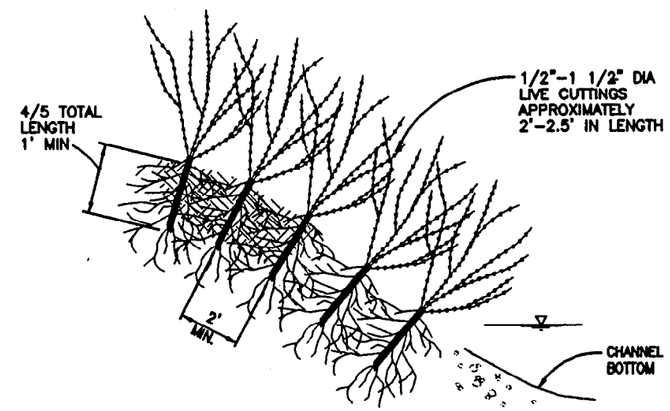
DATE 11/98
SHEET 5 OF 7

Site No. 10

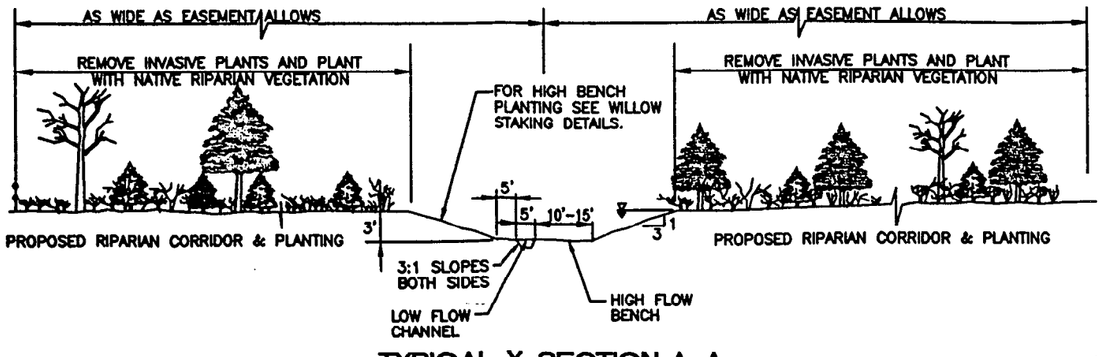


PLAN
NTS

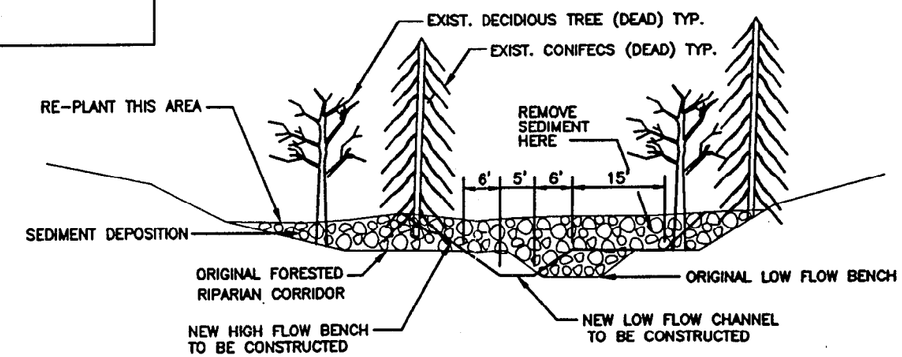
GARRISON CREEK



RIPARIAN PLANTINGS TYPICAL, WILLOW STAKES
NTS



TYPICAL X-SECTION A-A
NTS



TYPICAL X-SECTION A-A
NTS

PROJECT NO. 2021647
APPROVED: D. ALTHAUSER DATE: 11/98
PROJECT MANAGER: W. KARA DATE: 11/98
DESIGNED: F. KARA DATE: 11/98
DRAWN: K. RIPLEY DATE: 11/98

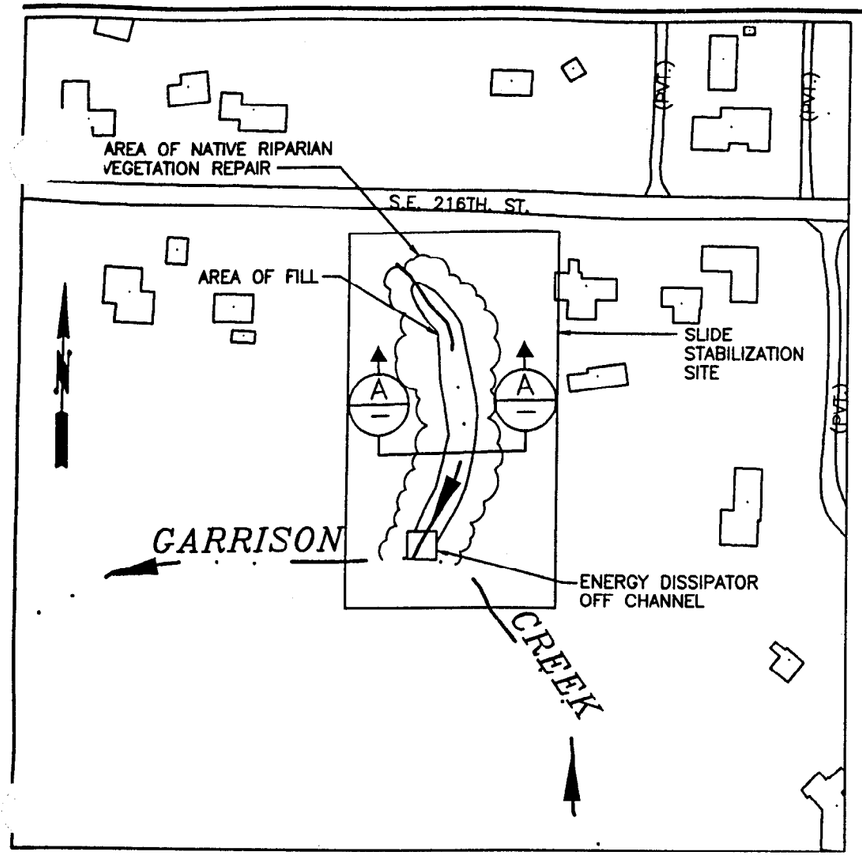
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY
GARRISON CREEK
STREAM ENHANCEMENT SITE
DETAIL – SHEET 3

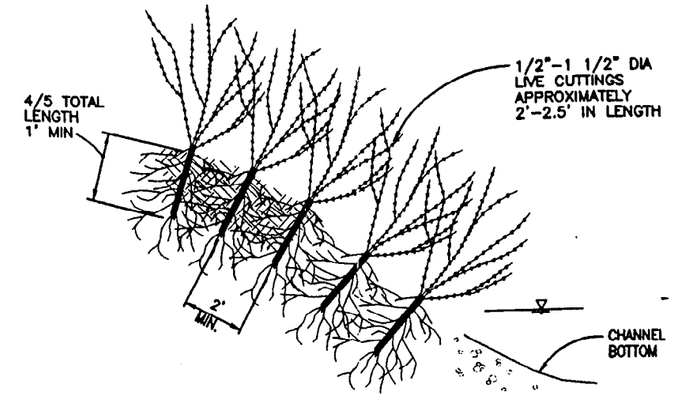
11/98
SHEET 6 OF 7

Site No. 10

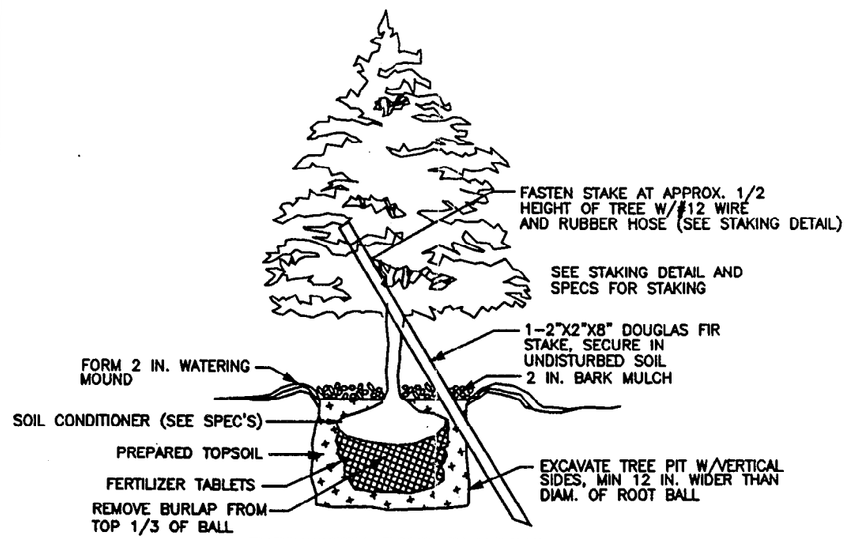


PLAN
NTS

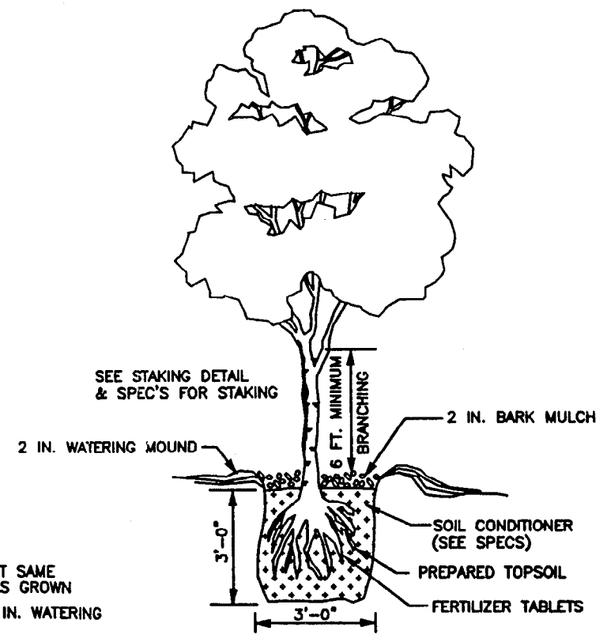
GARRISON CREEK SLIDE STABILIZATION SITE



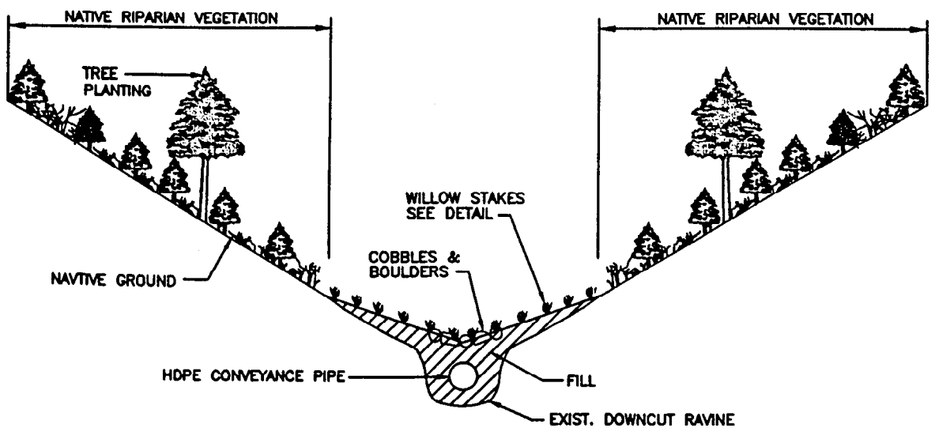
RIPARIAN PLANTINGS TYPICAL, WILLOW STAKES
NTS



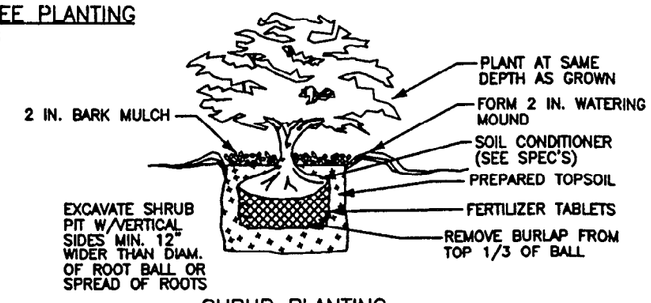
EVERGREEN TREE PLANTING
NTS



DECIDUOUS TREE PLANTING
NTS



TYPICAL RAVINE X-SECTION A-A
NTS



SHRUB PLANTING
NTS

TREE PLANTING DETAILS

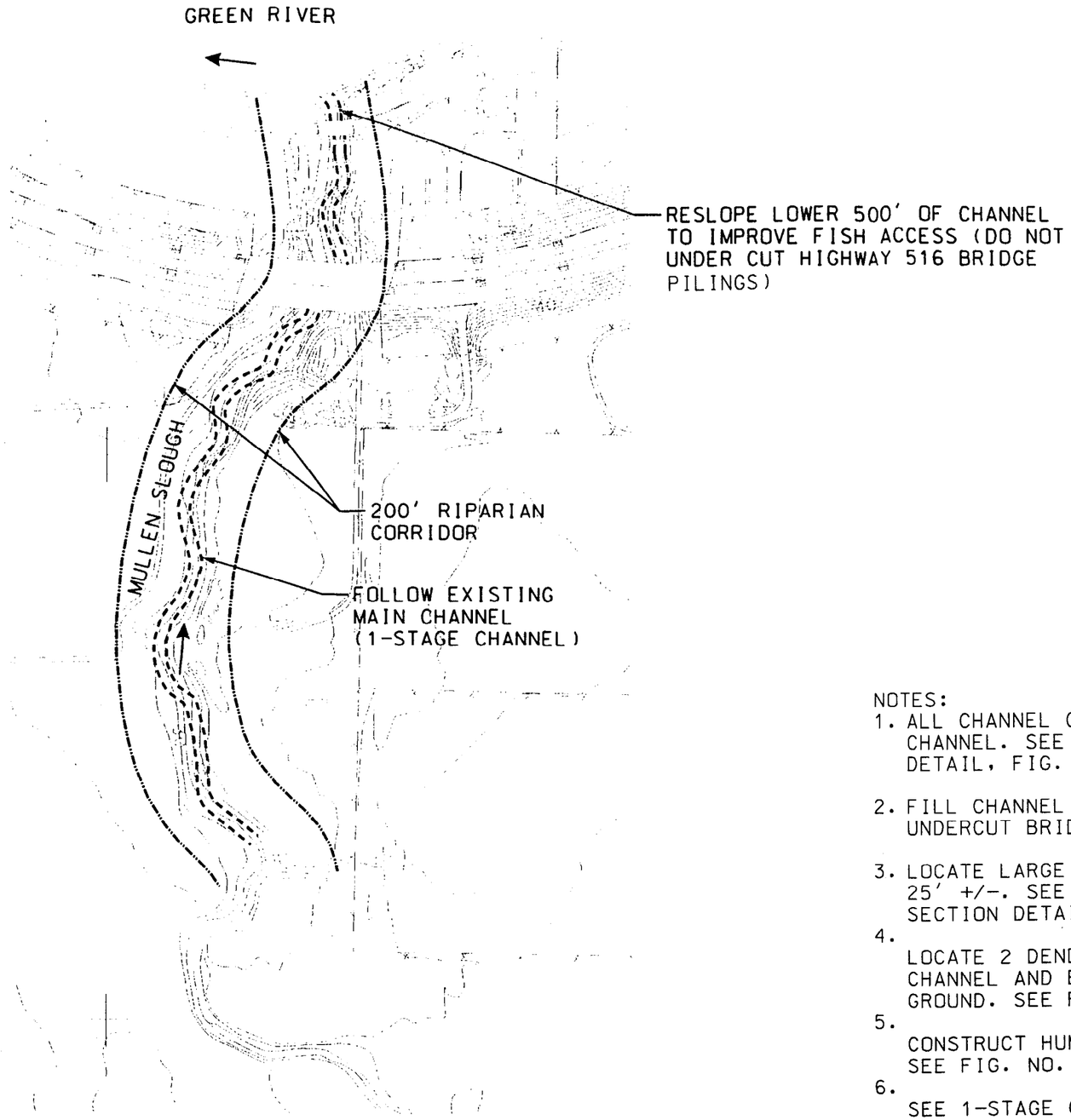
PROJECT NO. 201847	
APPROVED: D. ALTHAUSER DATE: 11/98	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONNETTE, DIRECTOR SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES
PROJECT MANAGER: W. KARA DATE: 11/98	
DESIGNED: T. KARA DATE: 11/98	
DRAWN: K. RIPLEY DATE: 11/98	

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

GREEN - DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
GARRISON CREEK
SLIDE STABILIZATION SITE
DETAIL - SHEET 4

11/98
7 OF 7

Site No. 10



PLAN

NOTES:

1. ALL CHANNEL CONSTRUCTION TO BE 1-STAGE CHANNEL. SEE TYPICAL PLAN AND SECTION DETAIL, FIG. NO. 12.
2. FILL CHANNEL TO ACHIEVE 2% GRADE. DO NOT UNDERCUT BRIDGE PILINGS.
3. LOCATE LARGE WOODY DEBRIS POOLS EVERY 25' +/-. SEE DETAIL, FIG. NO. 14, PLAN AND SECTION DETAILS.
4. LOCATE 2 DENDRITES. ALTERNATE SIDES OF CHANNEL AND EXTEND DENDRITE LENGTHS TO GROUND. SEE FIG. NO. 15, PLAN AND SECTION DETAILS.
5. CONSTRUCT HUMMOCKS IN RIPARIAN CORRIDOR, SEE FIG. NO. 15, PLAN AND SECTION DETAILS.
6. SEE 1-STAGE CHANNEL DETAIL FOR RIPARIAN PLANTING SCHEME, FIG. NO. 13, PLAND AND SECTION DETAILS. SOME PLANTINGS MAY EXIST, FILL IN WHERE NECESSARY.

100' 50' 0 100' 200'

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

GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY

FIGURE NO. 3
PRENTICE NURSERY REACH
SITE PLAN

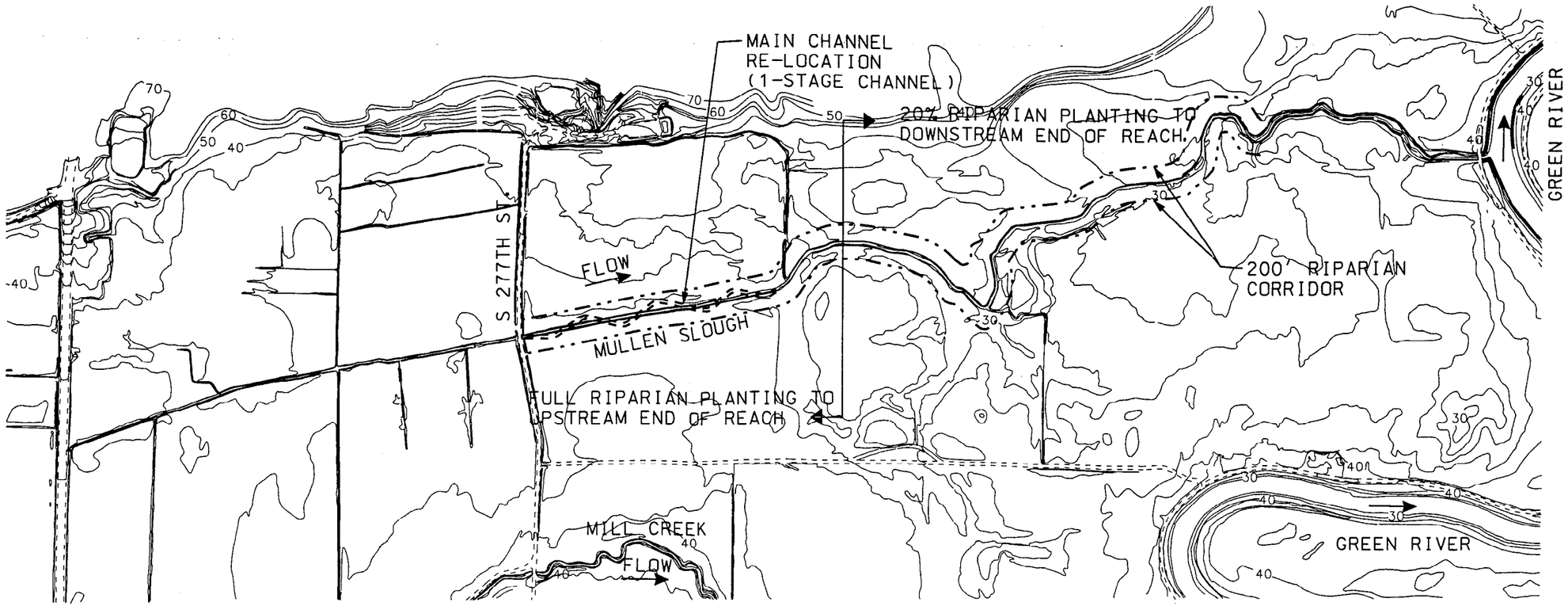
KING COUNTY WASHINGTON

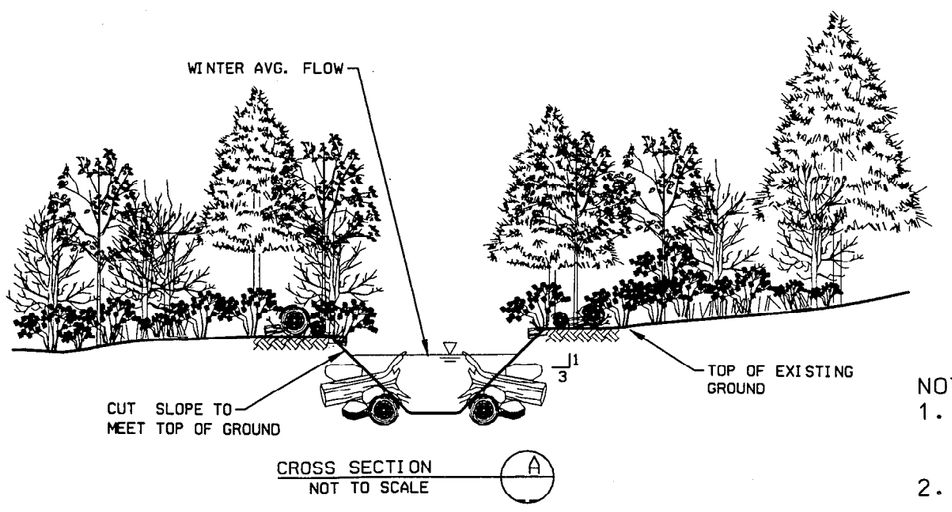
SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: ***DATE**** *TIME
DESIGN FILE: HYDRO:08048.005/DRAWINGS/sketch12.dgn

DATE AND TIME PLOTTED: ***DATE**** *TIME DESIGN F

Site No. 11





CROSS SECTION A
NOT TO SCALE

NOTES:

1. ALL CHANNEL CONSTRUCTION TO BE 1-STAGE CHANNEL. SEE TYPICAL PLAN AND SECTION DETAIL, FIG. NO. 12, PLAN AND SECTION DETAILS.
2. LOCATE LARGE WOODY DEBRIS POOLS EVERY 50' +/-. SEE DETAIL, FIG. NO. 14, PLAN AND SECTION DETAILS.
3. CONSTRUCT HUMMOCKS IN RIPARIAN CORRIDOR, SEE FIG. NO. 15, PLAN AND SECTION DETAILS.
4. SEE 1-STAGE CHANNEL DETAIL FOR RIPARIAN PLANTING SCHEME, FIG. NO. 12, PLAN AND SECTION DETAILS.

300' 150' 0 300' 600'

Site No. 12

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

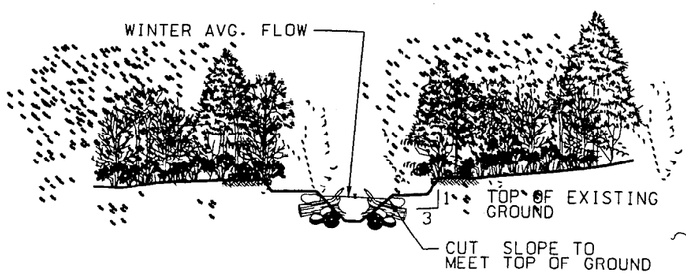
GREEN - DUWAMISH G.I. ECOSYSTEM
RESTORATION FEASIBILITY STUDY
FIGURE NO. 4
MULLEN SLOUGH REACH
SITE PLAN

KING COUNTY WASHINGTON

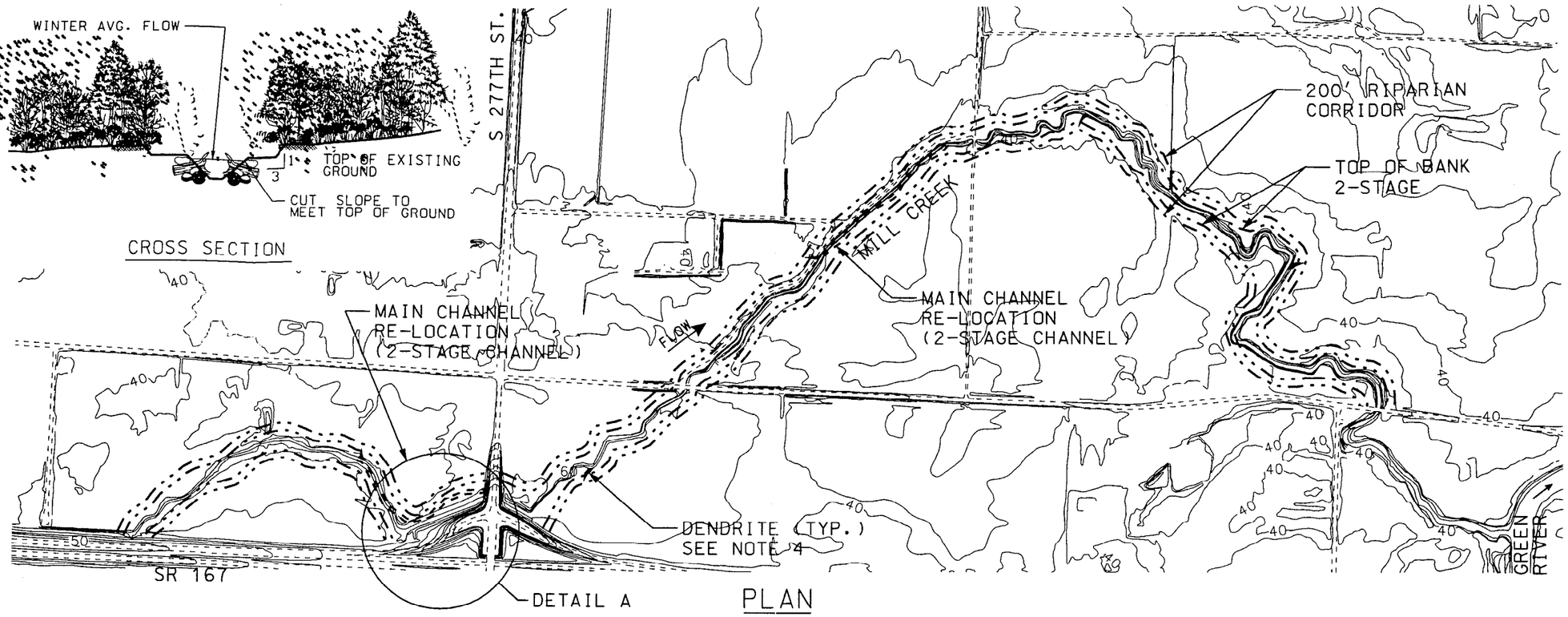
SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: 03-AUG-2000 17:15
DESIGN FILE: $$$P:$ENVIROP48.050$DRAWINGS$SKETCH13.DGN

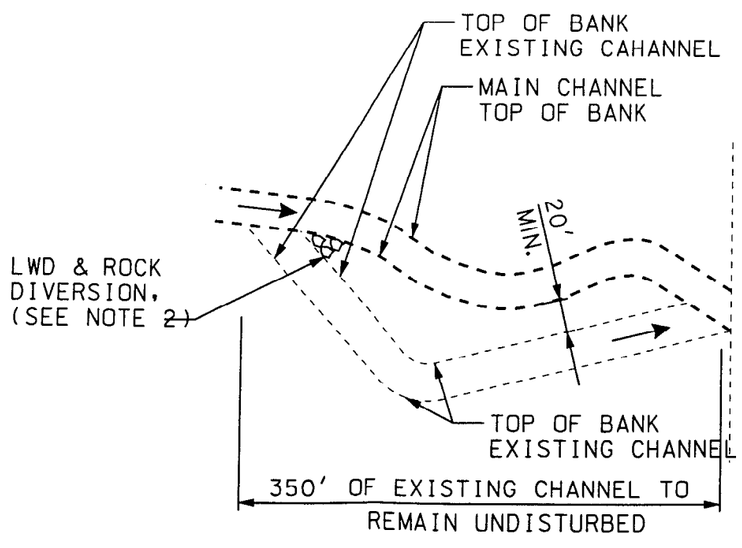
DATE AND TIME PLOTTED: 03-AUG-2000 17:15 DESIGN FILE: P:$designs$nsgdfciv$dept$r$sketch13.dgn



CROSS SECTION



PLAN



DETAIL A
NOT TO SCALE

EXISTING CULVERT UNDER ROADWAY

NOTES:

1. ALL CHANNEL CONSTRUCTION TO BE 2-STAGE CHANNEL. SEE TYPICAL PLAN AND SECTION DETAIL, FIG. NO. 13, PLAN AND SECTION DETAILS.
2. LOCATE LARGE WOODY DEBRIS POOLS EVERY 50' +/-. SEE DETAIL, FIG. NO. 14, PLAN AND SECTION DETAILS.
3. LOCATE DENDRITES EVERY 1/4 MILE +/-. ALTERNATE SIDES OF CHANNEL AND EXTEND DENDRITE LENGTH TO TOP OF BANK. SEE FIG. NO. 15, PLAN AND SECTION DETAILS.
4. CONSTRUCT HUMMOCKS IN RIPARIAN CORRIDOR, SEE FIG. NO. 15, PLAN AND SECTION DETAILS.
5. SEE 2-STAGE CHANNEL DETAIL FOR RIPARIAN PLANTING SCHEME, FIG. NO. 13, PLAN AND SECTION DETAILS.

300' 150' 0 300' 600'

Site No. 13

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

GREEN - DUWAMISH C.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY

FIGURE NO. 6
SCHULER BROTHERS REACH
SITE PLAN

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: 03-AUG-2000 17:36
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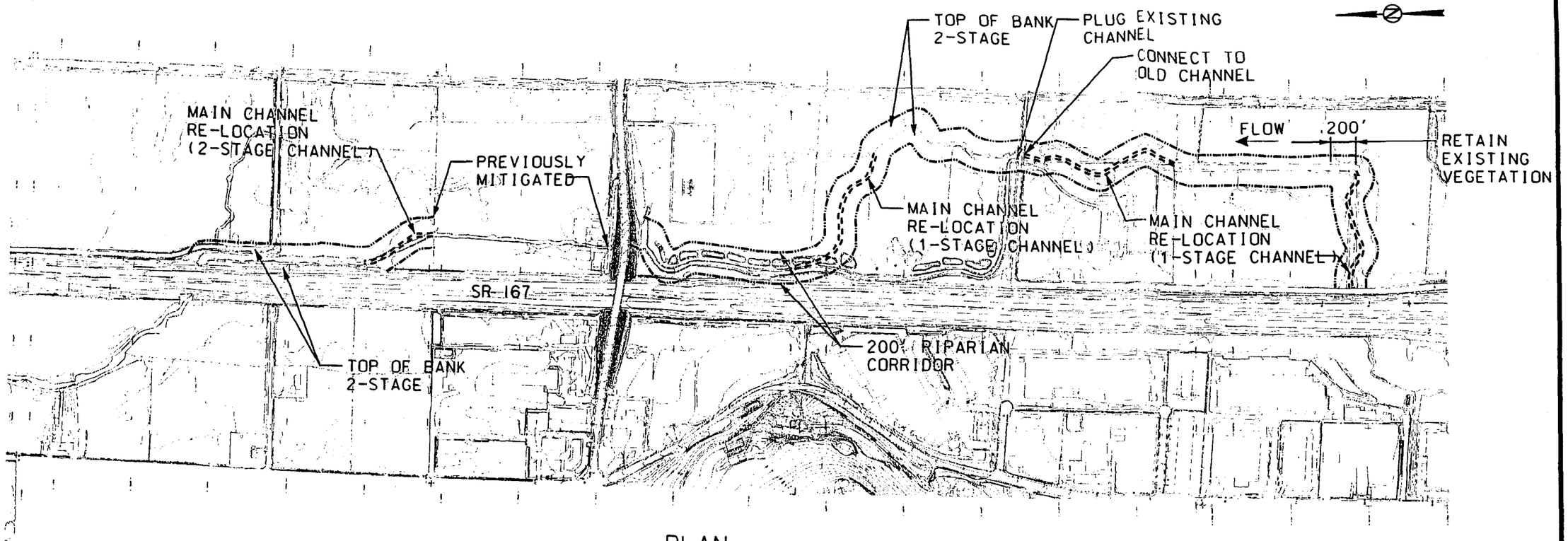


PLAN

NOTES:

1. FOR 2-STAGE CHANNEL CONSTRUCTION SEE TYPICAL PLAN AND SECTION DETAIL. FIG. NO. 13.

2. FOR 1-STAGE CONSTRUCTION SEE TYPICAL PLAN AND SECTION DETAIL. FIG. NO. 13.

3. LOCATE LARGE WOODY DEBRIS POOLS EVERY 50' +/-. SEE DETAIL. FIG. NO. 14.

4. LOCATE DENDRITES EVERY 1/4 MILE +/- . ALTERNATE SIDES OF CHANNEL AND EXTEND DENDRITE TO TOP OF BANK FOR 2-STAGE CHANNEL. EXTEND TO GROUND WHERE CHANNEL IS 1-STAGE.

5. CONSTRUCT HUMMOCKS IN RIPARIAN CORRIDOR. SEE FIG. NO. 15.

6. WHERE CHANNEL IS 2-STAGE. SEE FIG. NO. 13 FOR RIPARIAN PLANTING SCHEME. WHERE CHANNEL IS 1-STAGE. SEE FIG. NO. 12 FOR RIPARIAN PLANTING SCHEME.

7. SOME PLANTINGS MAY EXIST. EXTENT OF RIPARIAN PLANTINGS TO BE DETERMINED.

300' 150' 0 300' 600'

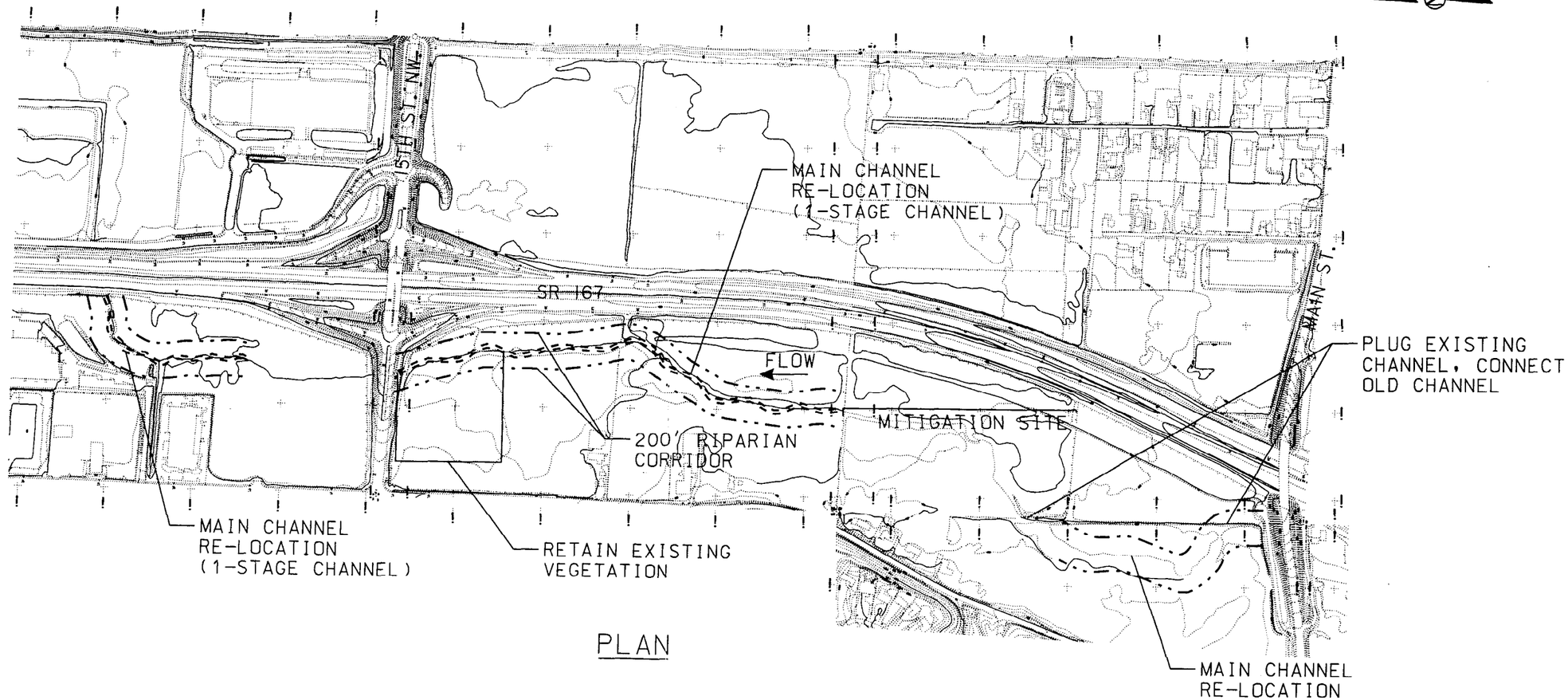
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN - DUWAMISH G.I. ECOSYSTEM
RESTORATION FEASIBILITY STUDY
FIGURE NO. 5
MERLINO REACH
SITE PLAN

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: ***DATE**** *TIME
DESIGN FILE: HYDRO:08048.005/DRAWINGS/sketch8.dgn



PLAN

NOTES:

1. ALL CHANNEL CONSTRUCTION TO BE 1-STAGE CHANNEL. SEE TYPICAL PLAN AND SECTION DETAILS, FIG. NO. 12.
2. LOCATE LARGE WOODY DEBRIS POOLS EVERY 50' +/-. SEE PLAN AND SECTION DETAIL, FIG. NO. 14.
3. LOCATE DENDRITES EVERY 1/4 MILE +/- EXCEPT IN EMERALD DOWNS MITIGATION SITE. ALTERNATE SIDES OF CHANNEL AND EXTEND DENDRITE TO TOP OF BANK. SEE PLAN AND SECTION DETAILS, FIG. NO. 15.
4. CONSTRUCT HUMMOCKS IN RIPARIAN CORRIDOR, SEE PLAN AND SECTION DETAILS, FIG. NO. 15.
5. SEE 1-STAGE CHANNEL DETAIL FOR RIPARIAN PLANTING SCHEME, PLAN AND SECTION DETAILS, FIG. NO. 13.

300' 150' 0 300' 600'

Site No. 15

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

GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY
FIGURE NO. 7
WETLAND 5K REACH
SITE PLAN

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	980CT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: 07-AUG-2000 14:40
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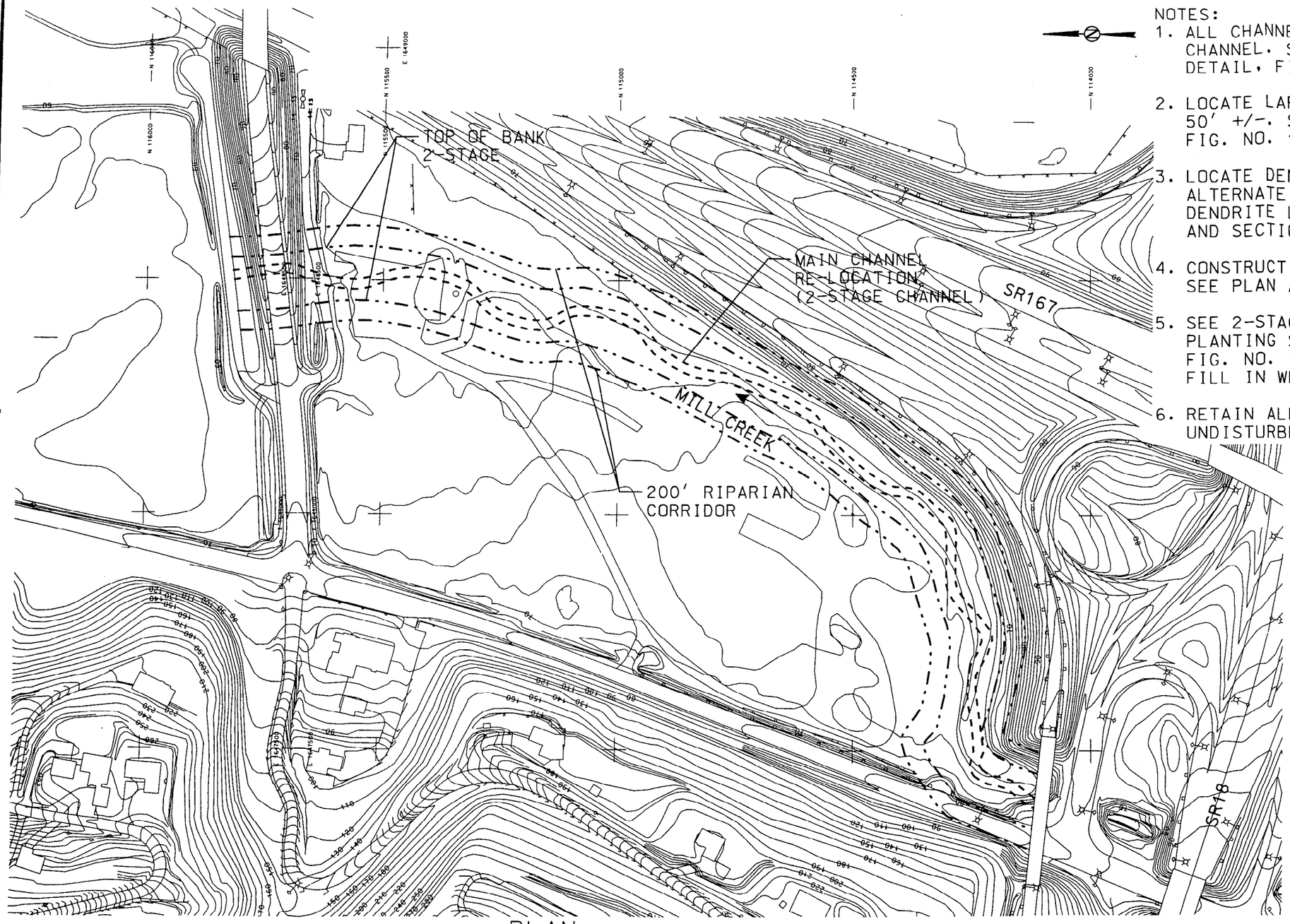

PLAN

NOTES:

1. ALL CHANNEL CONSTRUCTION TO BE 2-STAGE CHANNEL. SEE TYPICAL PLAN AND SECTION DETAIL, FIG. NO. 13.
2. LOCATE LARGE WOODY DEBRIS POOLS EVERY 50' +/-. SEE PLAN AND SECTION DETAILS, FIG. NO. 14.
3. LOCATE DENDRITES EVERY 1/4 MILE +/-. ALTERNATE SIDES OF CHANNEL AND EXTEND DENDRITE LENGTH TO TOP OF BANK. SEE PLAN AND SECTION DETAILS, FIG. NO. 15.
4. CONSTRUCT HUMMOCKS IN RIPARIAN CORRIDOR, SEE PLAN AND SECTION DETAILS, FIG. NO. 15.
5. SEE 2-STAGE CHANNEL DETAIL FOR RIPARIAN PLANTING SCHEME, PLAN AND SECTION DETAILS, FIG. NO. 13. SOME PLANTINGS MAY EXIST, FILL IN WHERE NECESSARY.
6. RETAIN ALL HIGH QUALITY RIPARIAN HABITAT UNDISTURBED.

100' 50' 0 100' 200'

Site No. 16

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

GREEN - DUWAMISH G.I. ECOSYSTEM
RESTORATION FEASIBILITY STUDY

FIGURE NO. 8

GOEDEKE NORTH REACH

SITE PLAN

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: 07-AUG-2000 11:23
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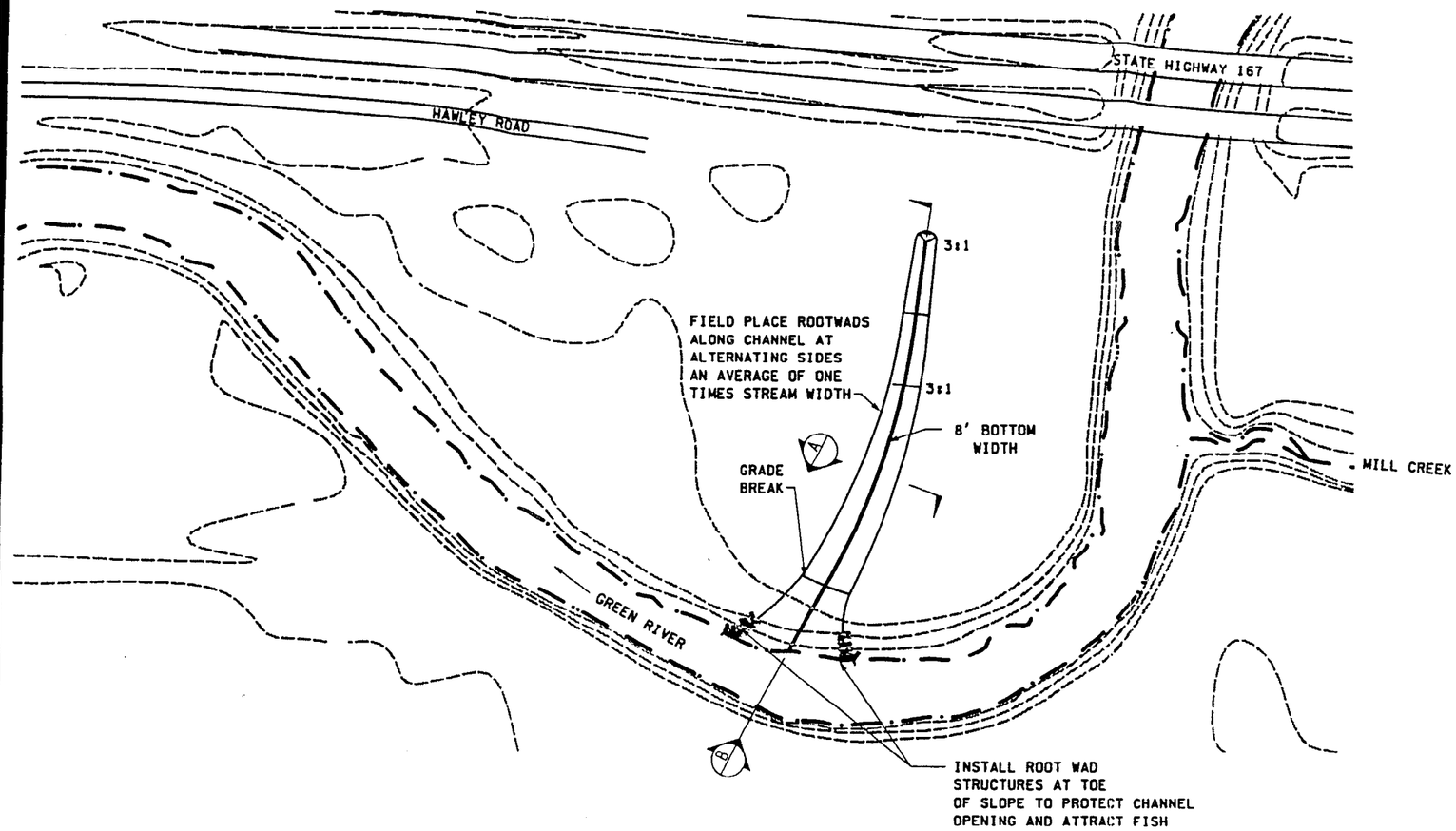


LEGEND

PROPOSED CHANNEL

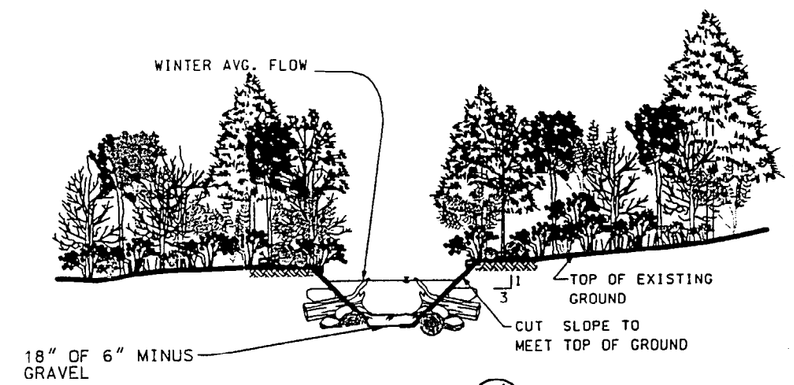
WETLAND OR STREAM BUFFER

100' 50' 0 100' 200'

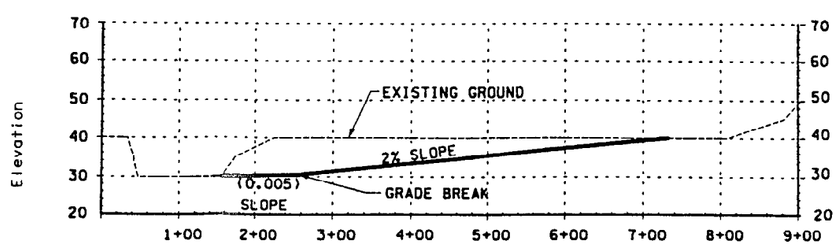
PLAN

NOTES:

1. SEE 1-STAGE CHANNEL BACKWATER CHANNEL PLANTING SCHEME.
2. SEE 1-STAGE WOODY DEBRIS DRAWING FOR TYPICAL SECTION AT BACKWATER CHANNEL MOUTH.
3. PROJECT FOOT PRINT DOES NOT INCLUDE CONSTRUCTION ACCESS EASEMENTS.
4. STREAM BUFFER TO EXTEND 50' FROM EDGES OF CHANNEL.
5. INTENT IS TO CREATE AREA OF COMPLETE OVERHEAD COVER AT NORMAL WINTER FLOWS.



CROSS SECTION A
NOT TO SCALE



CROSS SECTION B
HORIZ.: 1"=100'
VERT.: 1"=20'

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

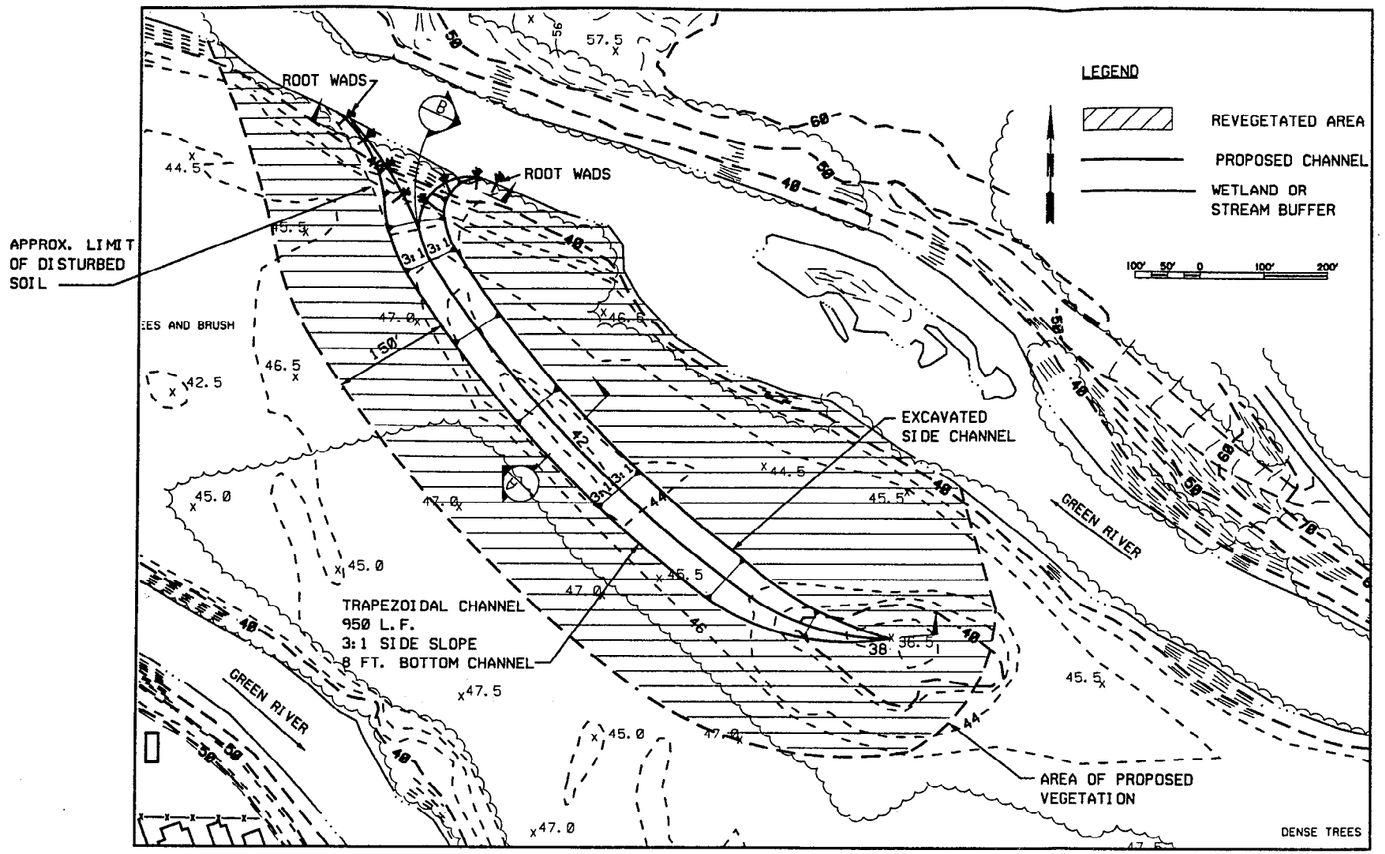
GREEN RIVER PARK
PLAN, PROFILE AND TYPICAL SECTION
GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
DSGN.		CHK.	SHEET	

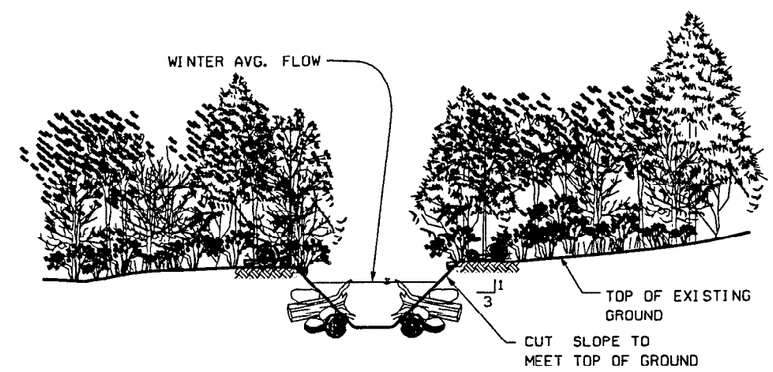
08048.200\GRIVPLAN.DGN

Site No. 17

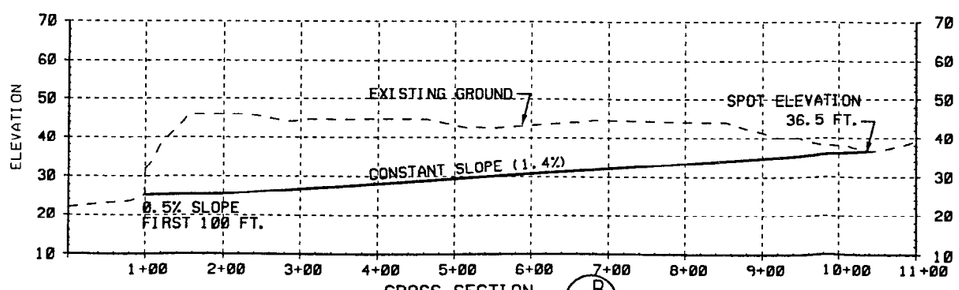


NOTES:

1. SEE FIGURE 8, PLAN AND SECTION DETAILS, FOR 1-STAGE CHANNEL BACKWATER CHANNEL PLANTING SCHEME.
2. SEE FIGURE 14, PLAN AND SECTION DETAILS, FOR 1-STAGE WOODY DEBRIS DRAWING FOR TYPICAL SECTION AT BACKWATER CHANNEL MOUTH. STAGGER. ALTERNATING SIDES, WOOD PLACEMENT ALONG PROPOSED CHANNEL AT 2 TIMES STREAM WIDTHS.
3. PROJECT FOOT PRINT DOES NOT INCLUDE CONSTRUCTION ACCESS EASEMENTS.



CROSS SECTION A
NOT TO SCALE



CROSS SECTION B
HORIZ.: 1"=100'
VERT.: 1"=20'

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

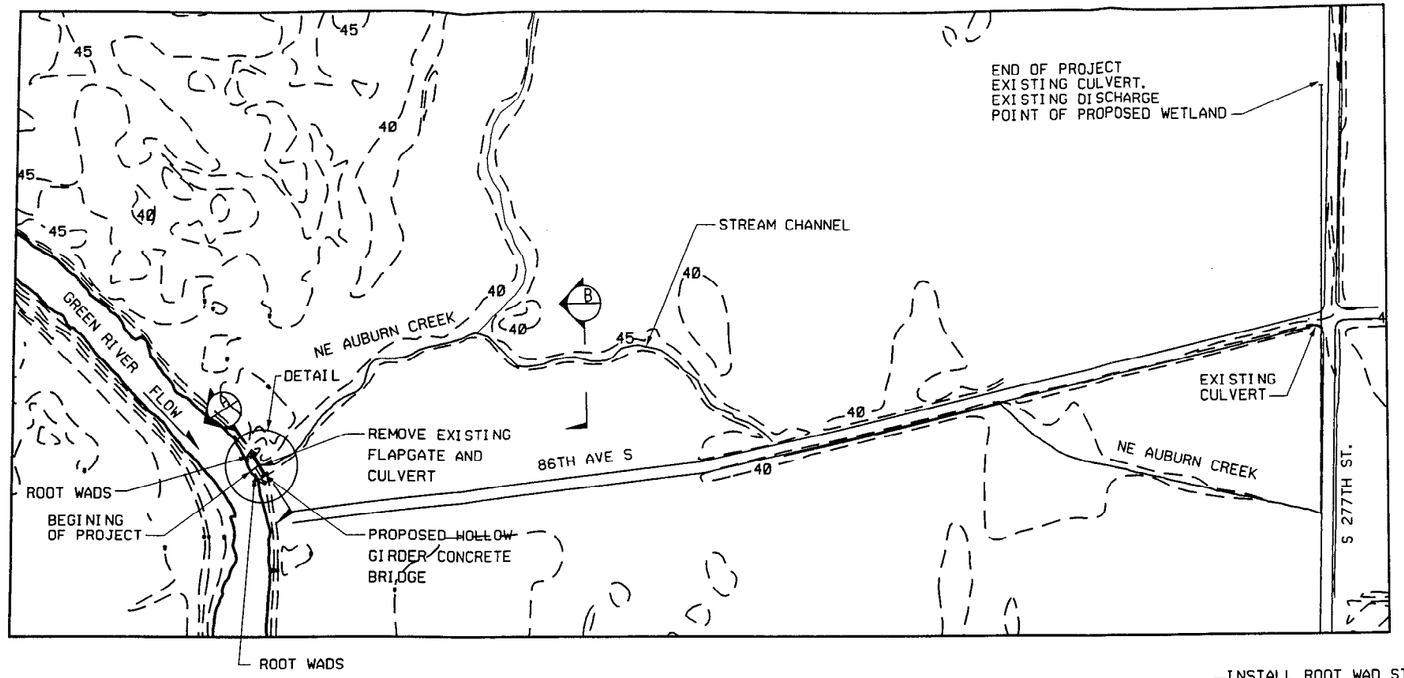
HORSEHEAD BEND
PLAN, PROFILE AND TYPICAL SECTION

GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
DSGN.		CHK.	SHEET	

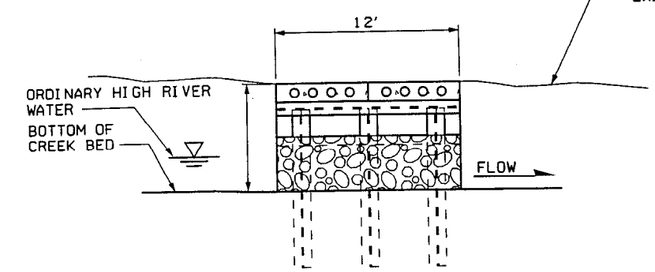
Site No. 18



LEGEND

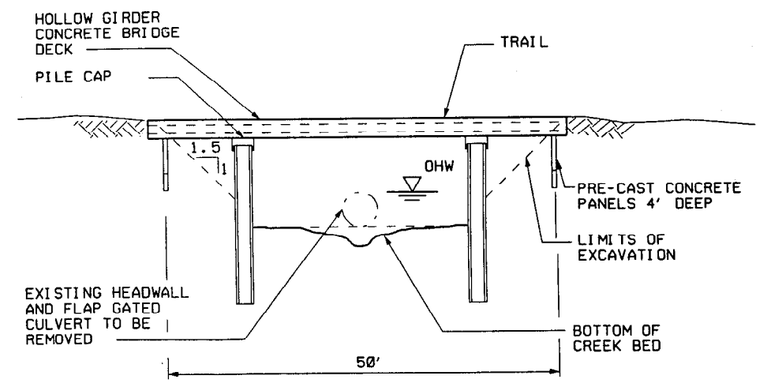
PROPOSED CHANNEL
WETLAND OR STREAM BUFFER

100' 50' 0 100' 200'



BRIDGE CROSS SECTION

NOT TO SCALE

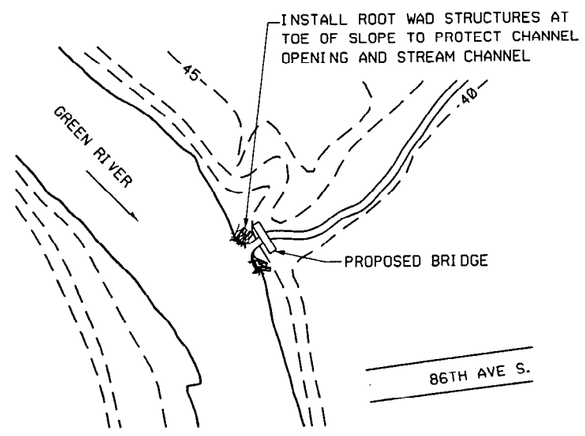


SECTION A

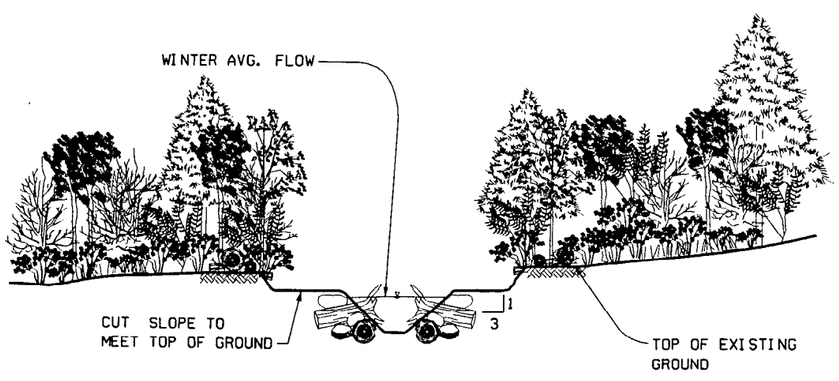
NOT TO SCALE

CROSS SECTION A

NOT TO SCALE



DETAIL



CROSS SECTION B

NOT TO SCALE

NOTES:

1. PROJECT FOOTPRINT DOES NOT INCLUDE CONSTRUCTION ACCESS EASEMENTS.
2. SEE FIGURE 23, PLAN AND SECTION DETAILS, FOR 2-STAGE CHANNEL RIVERINE PLANTING SCHEME. P&SD FIGURE 13.
3. SEE FIGURE 14, PLAN AND SECTION DETAILS, FOR 2-STAGE WOODY DEBRIS DRAWING FOR TYPICAL SECTION - FIELD PLACE ALONG CHANNEL AT ALTERNATING SIDES, AN AVERAGE OF 2 TIMES STREAM WIDTH. P&SD FIGURE 14.

Site No. 19

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

NE AUBURN CREEK
PLAN AND TYPICAL SECTIONS

GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
DSGN.		CHK.	SHEET	

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DATE AND TIME PLOTTED: 16-AUG-2000 12:57

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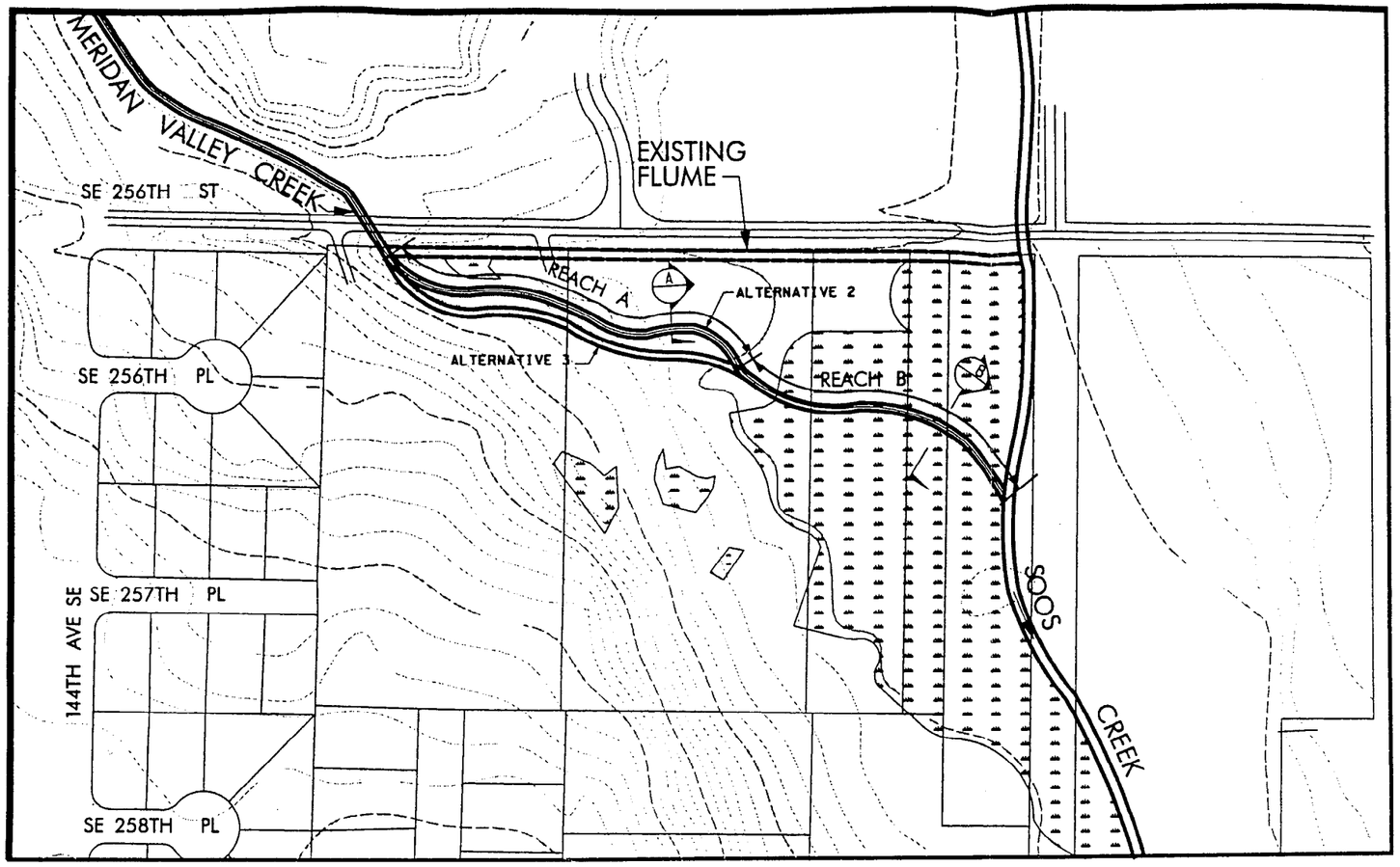
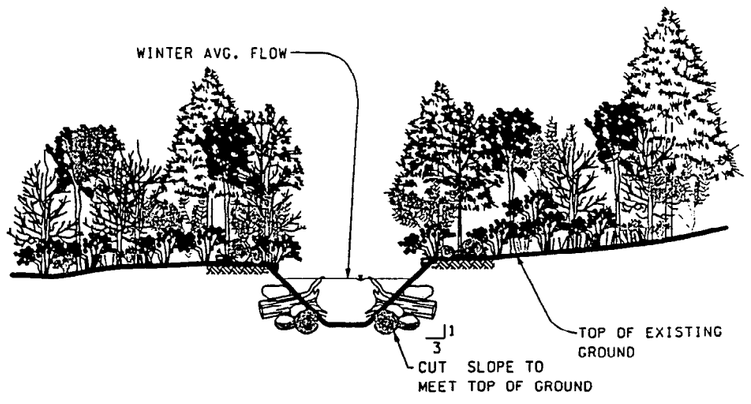




CROSS SECTION A
NOT TO SCALE

	Q25 DEPTH (FT)	Q_2 DEPTH (FT)	CHANNEL DEPTH (FT)	BOTTOM WIDTH (FT)
TYPICAL SECTION A	2.9	2.0	3.9	10
TYPICAL SECTION B	4.5	3.2	5.5	4.0

LEGEND

WETLAND

EXISTING FLUME

WETLAND OR STREAM BUFFER

100' 50' 0 100' 200'
PLAN

NOTES:

1. WETLAND BOUNDARIES SHOWN ARE APPROXIMATE IN SIZE, SHAPE AND LOCATION (FROM B-TWELVE ASSOC.). WETLAND BOUNDARIES HAVE NOT BEEN FIELD VERIFIED AND/OR SURVEYED. DURING CONSTRUCTION NO MATERIAL IS TO BE PLACED IN WETLANDS.

2. THE STREAM ALIGNMENT IS APPROXIMATE, BASED UPON A CONCEPTUAL ALIGNMENT WITHOUT CONSIDERATION OF PROPOSED DEVELOPMENT. THE ALIGNMENT IS SUBJECT TO CHANGE PENDING REVIEW BY STAKEHOLDERS.

3. FLUME TO BE REMOVED.

4. SEE PROFILE DRAWING.

5. SEE 1-STAGE CHANNEL RIVERINE RIPARIAN PLANTING SCHEME DRAWING.

6. SEE 1-STAGE WOODY DEBRIS DRAWING. FIELD PLACE, ALTERNATING SIDES, ALONG PROPOSED CHANNEL AT 2 TIMES STREAM WIDTHS.

7. CHECK FOR UTILITIES PRIOR TO CONSTRUCTION.

Site No. 20

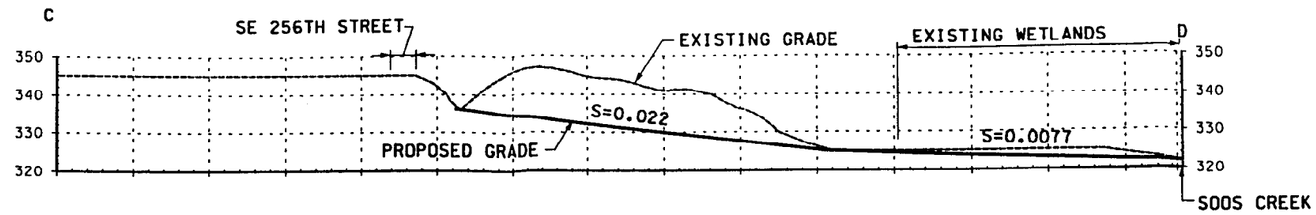
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

MERIDIAN VALLEY CREEK
PLAN & TYPICAL SECTION
GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION

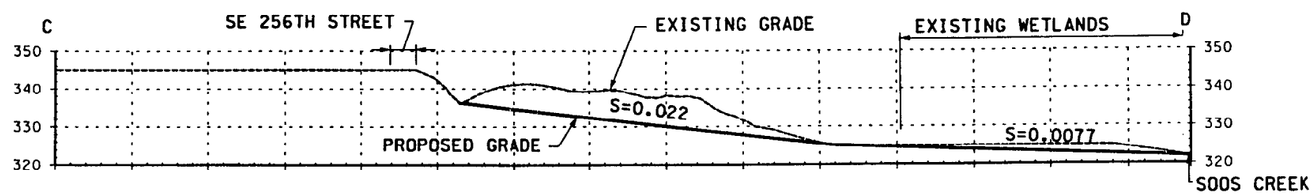
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
DSGN.		CHK.	SHEET	

1 of 2



ALTERNATIVE 2 PROFILE
SCALE: HOR. 1"=100'
VERT. 1"=20'



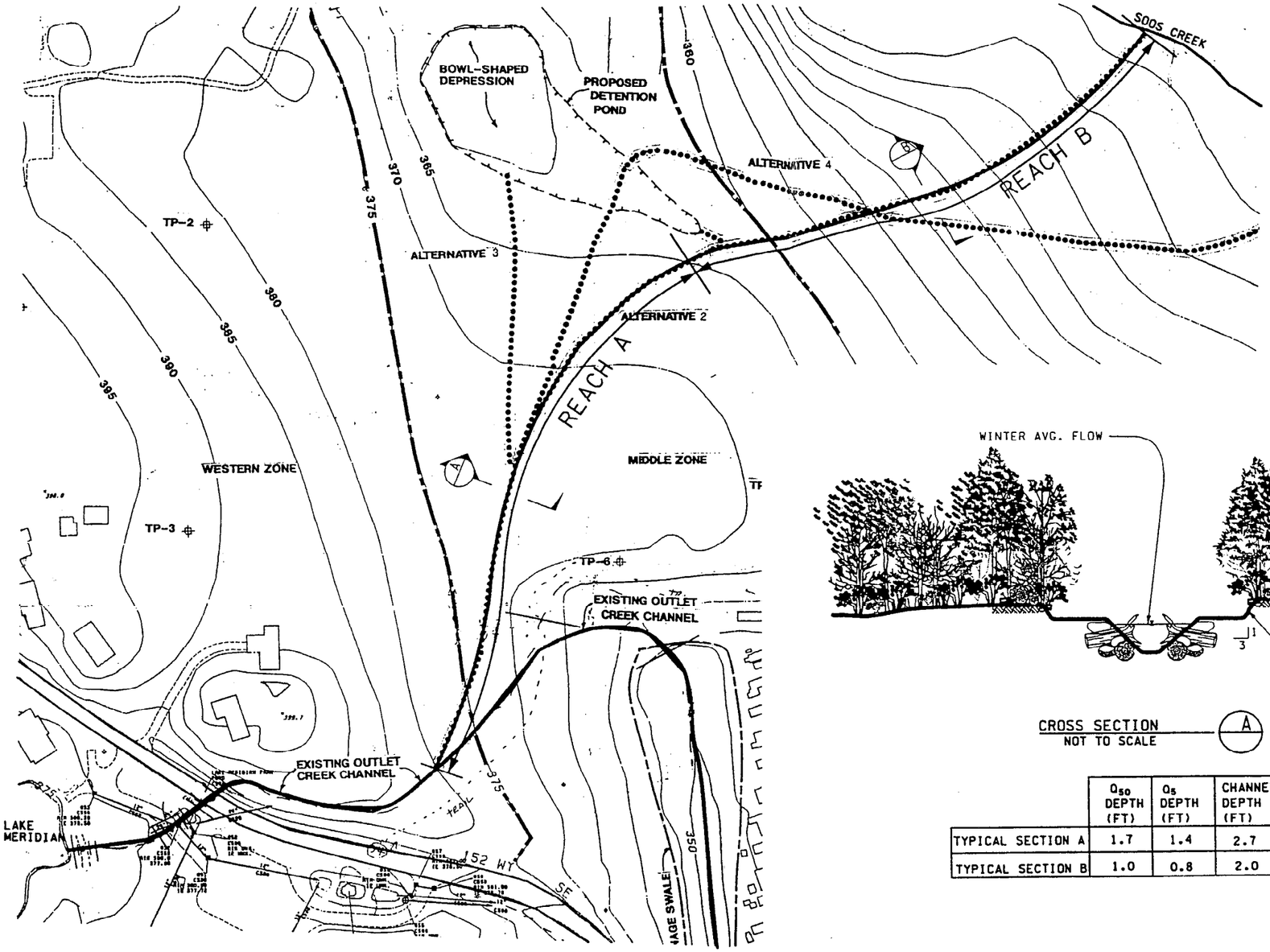
ALTERNATIVE 3 PROFILE
SCALE: HOR. 1"=100'
VERT. 1"=20'

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

MERIDIAN VALLEY CREEK
ALTERNATIVE PROFILES
GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
DSGN.		CHK.	SHEET	

ENVIRO\FEDERAL\(08048.2001)\CORP-SEA\PLANNING3B*GREENRESTOR\SOOSPROF.DGN



LEGEND

PROPOSED CHANNELS

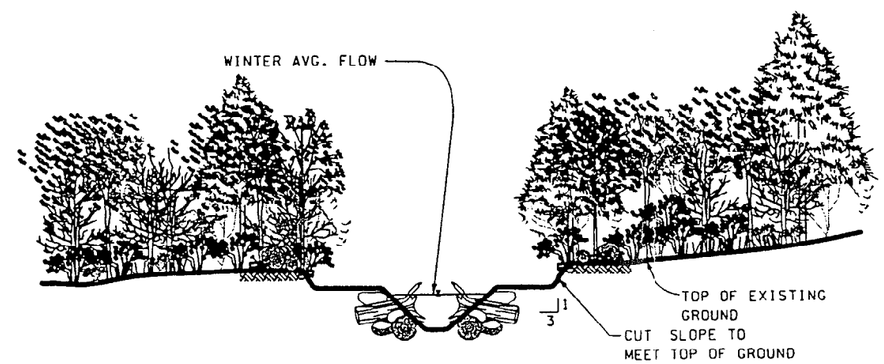
WETLAND OR STREAM BUFFER

100' 50' 0 100' 200'

PLAN

NOTES:

1. SEE 2-STAGE CHANNEL RIVERINE PLANTINGS SCHEME DRAWING, PLAN AND SECTION DETAILS.
2. SEE WOODY DEBRIS DRAWING. STAGGER, ALTERNATING SIDES, ALONG PROPOSED CHANNEL AT 2 TIMES STREAM WIDTH, PLAN AND SECTION DETAILS, FIGURE 14.
3. SOURCE: GEOENGINEERS (1999)



CROSS SECTION A
NOT TO SCALE

	Q_{50} DEPTH (FT)	Q_5 DEPTH (FT)	CHANNEL DEPTH (FT)
TYPICAL SECTION A	1.7	1.4	2.7
TYPICAL SECTION B	1.0	0.8	2.0

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

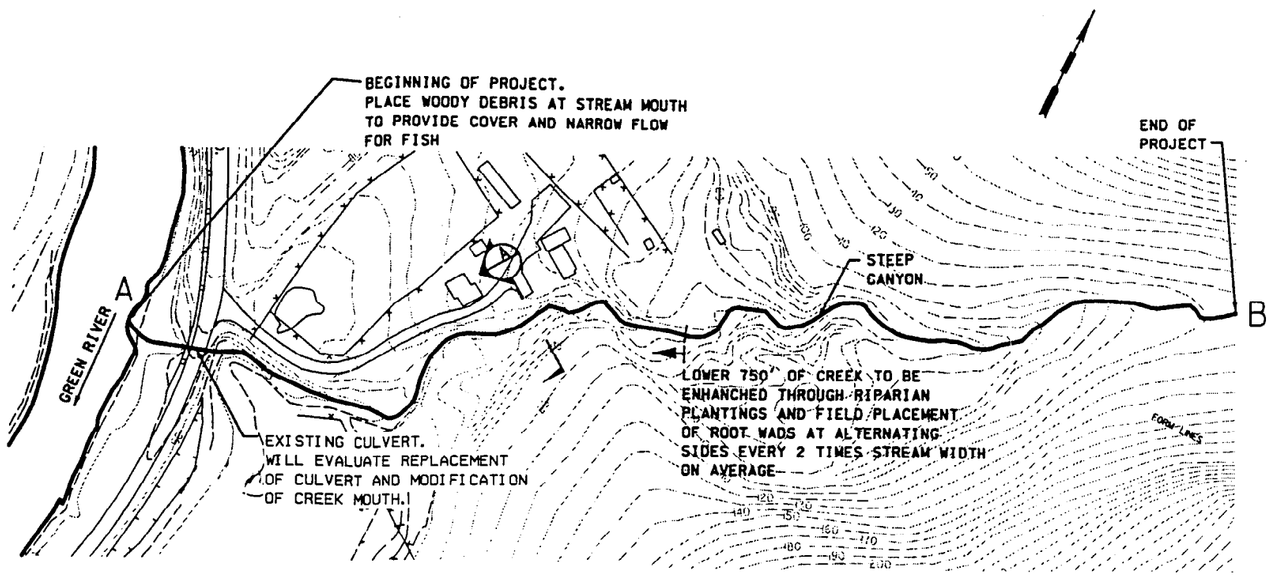
LAKE MERIDIAN OUTLET
PLAN AND TYPICAL SECTION
GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION

KING COUNTY WASHINGTON

SIZE | INVITATION NO. | FILE NO. | DATE | PLATE
DSGN. | CHK. | SHEET

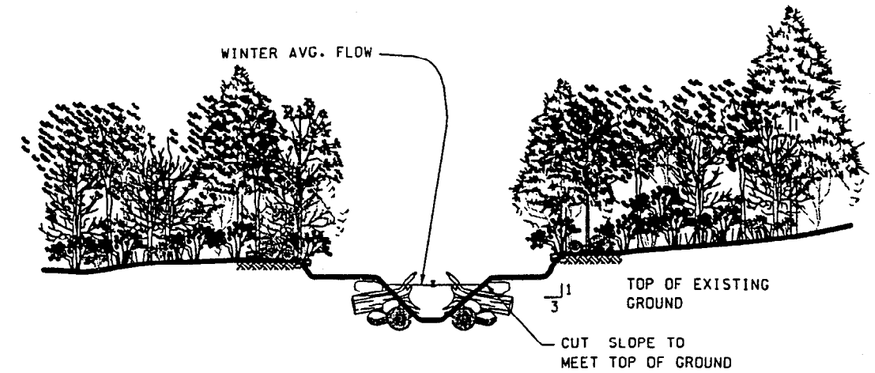
Site No. 21

15

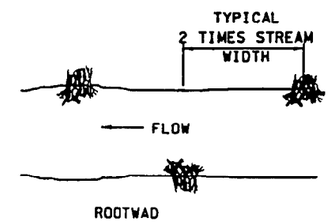


PLAN

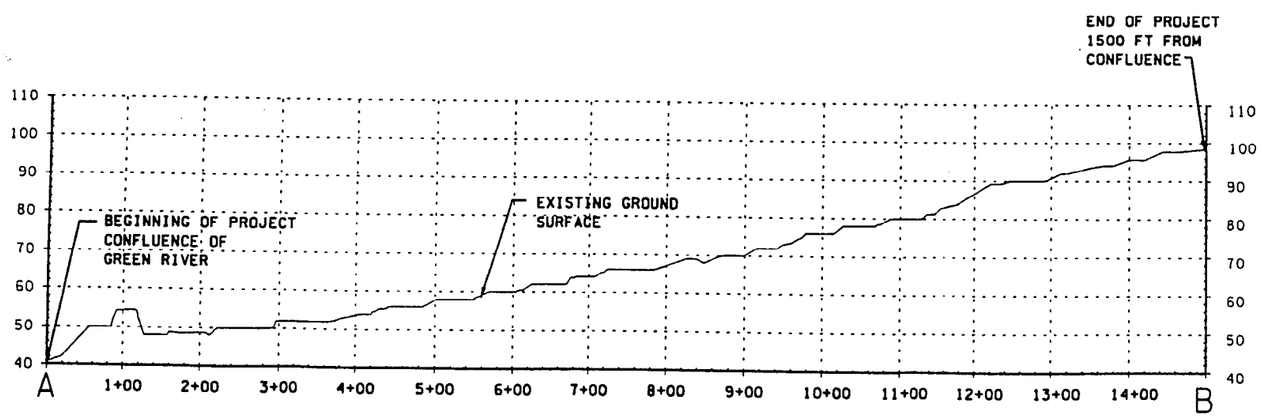
100' 50' 0 100' 200'



CROSS SECTION (A)
NOT TO SCALE



TYPICAL STREAM SEGMENT
NOT TO SCALE



PROFILE
HORIZ.: 1"=100'
VERT.: 1"=20'

NOTES:

1. SEE 2-STAGE CHANNEL RIVERINE PLANTING SCHEME. P&SD FIGURE 13.
2. SEE WOODY DEBRIS DRAWING. P&SD FIGURE 14. FIELD PLACE, ALTERNATING SIDES, ALONG PROPOSED CHANNEL AT 2 X STREAM WIDTH.
3. PROJECT FOOT PRINT DOES NOT INCLUDE CONSTRUCTION ACCESS EASEMENTS.

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

OLSON CREEK
PLAN, PROFILE AND TYPICAL SECTION
GREEN-DUWAMISH C.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION

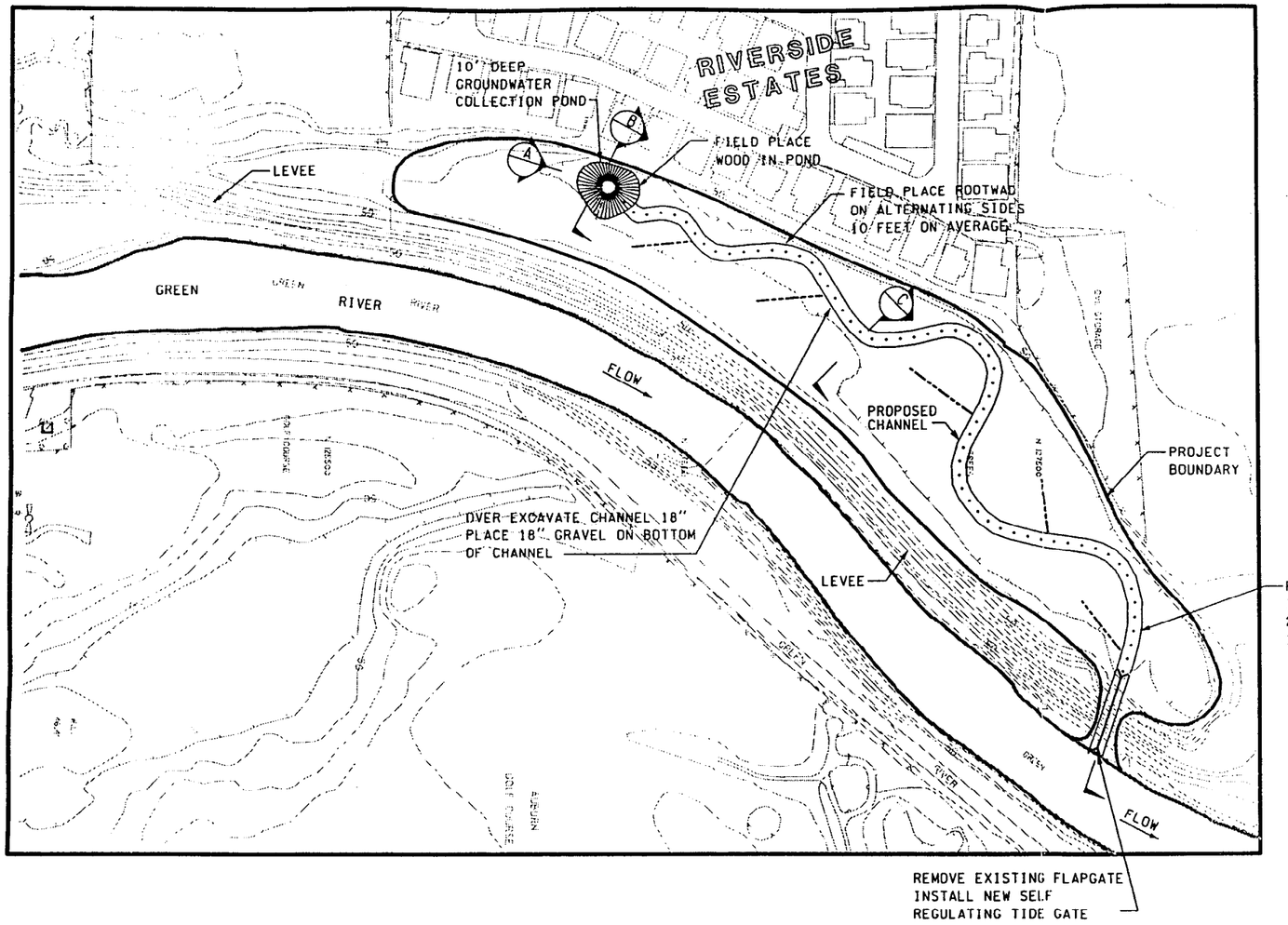
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLAT:
SCAL		CHK.	SHEET	

DESIGN
DATE AND TIME PLOTTED: $DATE$ $TIME$

Site No. 22

157



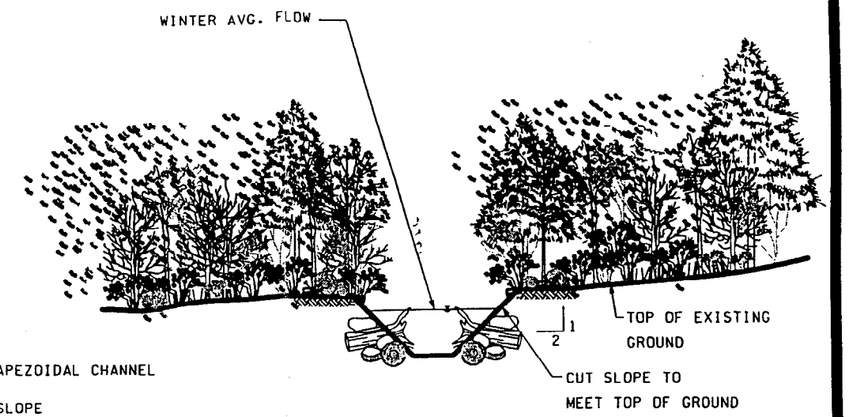
LEGEND

- PROPOSED CHANNEL
- TOP OF CHANNEL
- PROPOSED DENDRITES

100' 50' 0 100' 200'

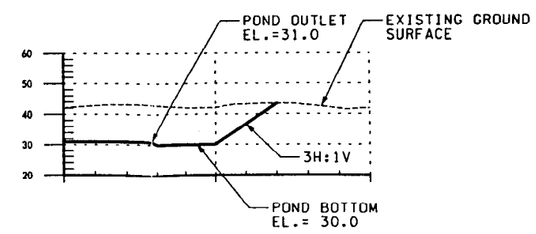
NOTES:

1. SEE 1-STAGE CHANNEL RIPARIAN PLANTING SCHEME, PLAN AND SECTION DETAILS, FIGURE 6.
2. SEE WOODY DEBRIS DRAWING FOR TYPICAL SECTION MOUTH, PLAN AND SECTION DETAILS, FIGURE 14. STAGGER. ALTERNATING SIDES. WOOD PLACEMENT ALONG PROPOSED CHANNEL AT 10 FOOT SPACING.
3. PROJECT FOOT PRINT DOES NOT INCLUDE CONSTRUCTION ACCESS EASEMENTS.

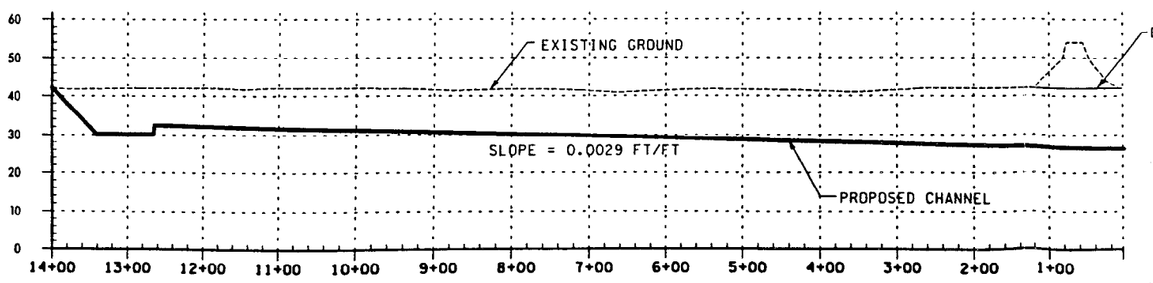


PROPOSED TRAPEZOIDAL CHANNEL
1500' L.F.
2H:1V SIDE SLOPE
1' BOTTOM CHANNEL

CROSS SECTION (C)
NOT TO SCALE



CROSS SECTION (B)
NOT TO SCALE



*NOTE
DIFFERENCE IN CULVERT ELEVATION AND PROPOSED CHANNEL TO BE ADDRESSED

PROFILE CHANNEL ALIGNMENT (A)
HORZ.: 1"=100'
VERT.: 1"=20'

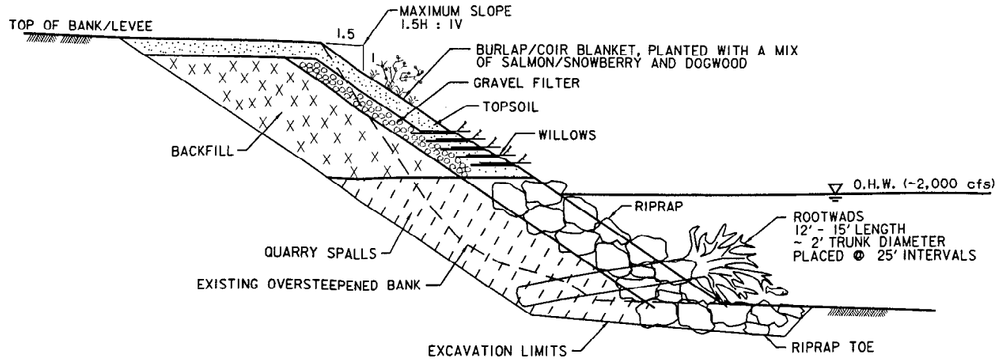
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

RIVERSIDE ESTATES
PLAN, PROFILE AND TYPICAL SECTION
GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
SIGN.		CHK.	SHEET	

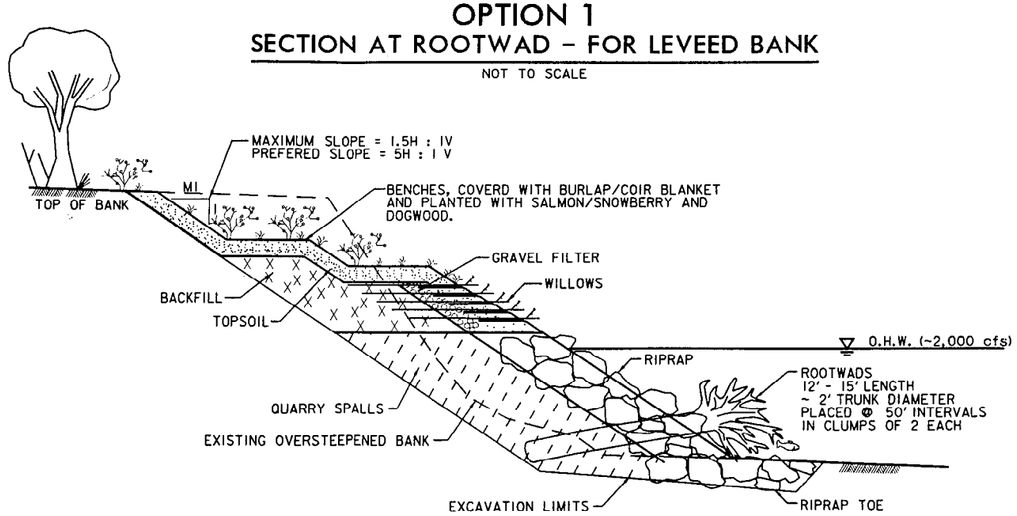
DATE AND TIME PLOTTED: $DATE$ $TIME$ DESIGN FILE: P:\ENVIRO\FEDERAL\CORP-SEA\PLANNING98-GREENRESTOR\SITE

Site No. 23



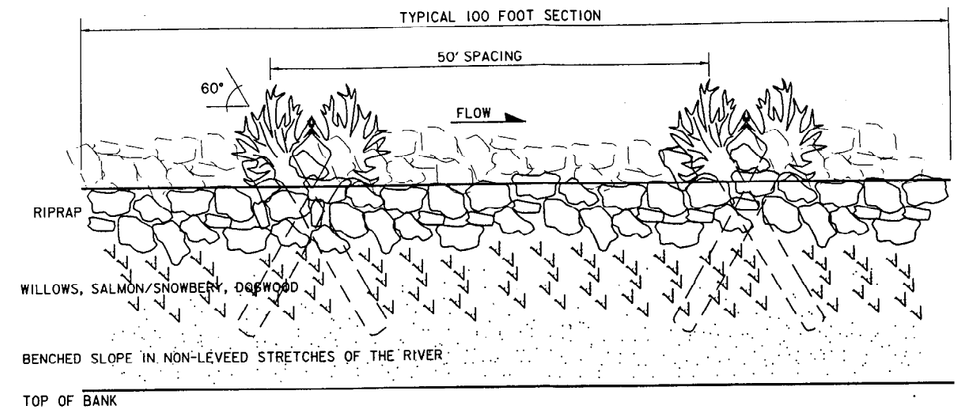
OPTION 1
SECTION AT ROOTWAD - FOR LEVEED BANK

NOT TO SCALE



OPTION 2
SECTION AT ROOTWAD - FOR NON-LEVEED BANK

NOT TO SCALE



OPTION 2 - PLAN VIEW
TYPICAL BANK REHABILITATION

NOT TO SCALE

PROJECT DESCRIPTION ->
STABILIZE EXISTING BANK THAT HAS BECOME OVERSTEEPENED DUE TO UNDERCUTTING BY PLACING LARGE WOODY DEBRIS, RIPRAP, AND PLANTINGS INCLUDING: WILLOW CUTTINGS, SALMONBERRY, SNOWBERRY, AND GRASS.

QUANTITIES ARE GIVEN FOR A 500 FOOT BANK REHABILITATION SITE (10 X 50 FT SECTIONS).
HEIGHT OF BANK IS 15 FEET ABOVE CHANNEL BOTTOM.
INCLUDE 10% QUANTITY CONTIGENCY.

EXCAVATION - 2400 CY

ROOTWAD - 21 EACH, CEDAR, HEMLOCK, SPRUCE, OR FIR ONLY. (EVERY 50' FOR 1000' IN A 5 MILE REACH)

QUARRY SPALLS - 1500 CY

RIPRAP - 1000 CY, CLASS IV

BACKFILL - 1500 CY, USE EXCAVATED MATERIAL.

GRAVEL FILTER - 500 CY

TOPSOIL - 1500 CY (FOR BENCHED SLOPE INCREASE TO 2200 CY)

WILLOW CUTTINGS - 1000 EACH

BURLAP/COIR BLANKET - 2800 SY (FOR BENCHED SLOPE INCREASE TO 4000 SY)

SALMON/SNOWBERRY - 500 EACH (FOR BENCHED SLOPE INCREASE TO 750 EACH)

Site No. 24

REDUCED TO 50% OF FULL SIZE

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

MAINSTEM MAINTENANCE

TYPICAL CROSS SECTIONS

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D				
DSGN. N.C.		CHK. T.C.	SHEET	

This project was designed by the Seattle District U.S. Army Corps of Engineers. The initials or signatures and registration designations of individuals appear within the specifications or on these project documents within the scope of their employment as required by ER 1110-1-8152, Professional Registration.

DATE AND TIME PLOTTED: 09-AUG-2000 16:57
DESIGN FILE: u:\designs\msgd\civ\deptnr\dugreen26sites.dgn

Computer Aided Design + Drafting

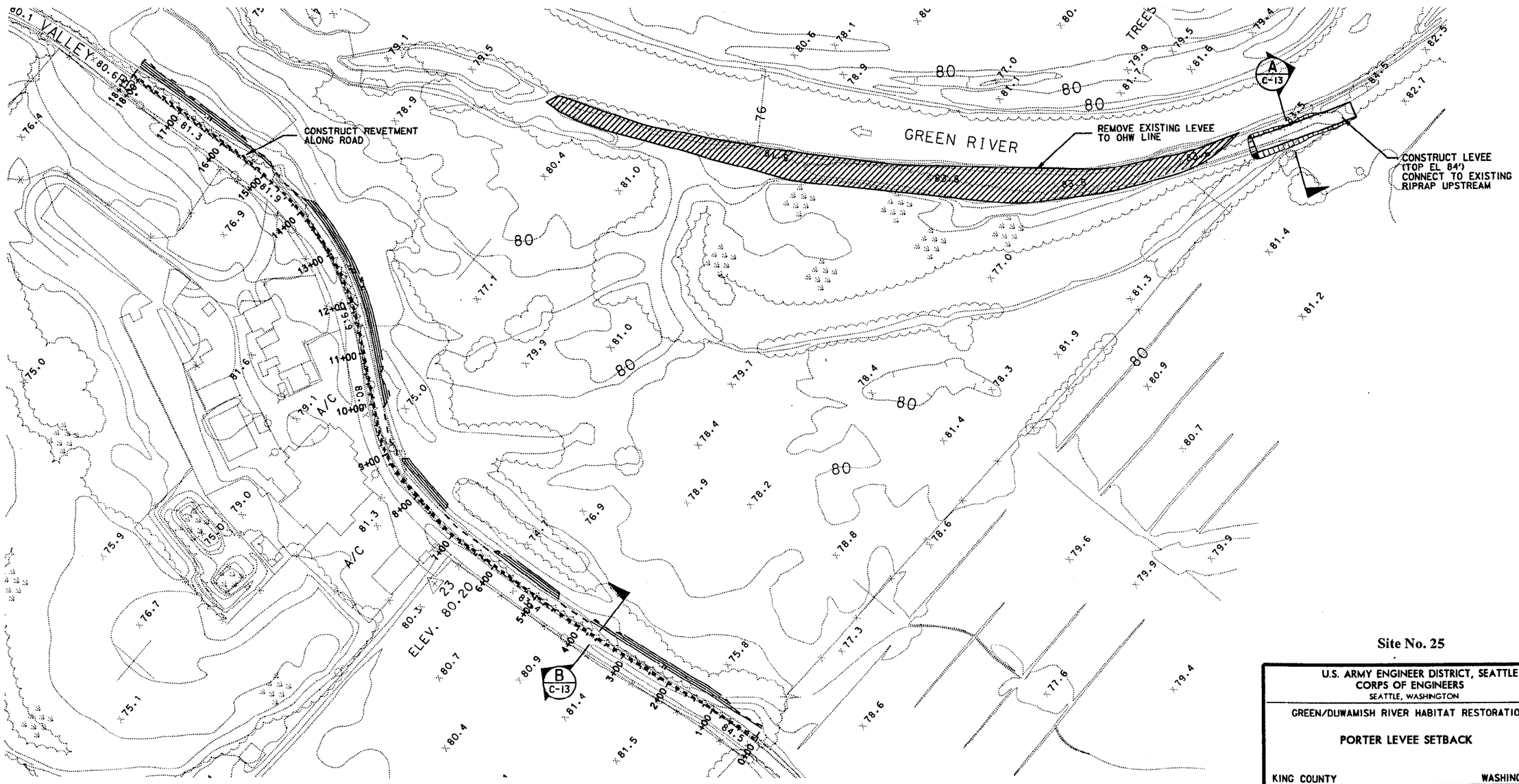
PORTER LEVEE SETBACK-PLAN VIEW

SCALE: 1" = 100'

1" = 100' 100' 50' 0 100' 200'

PRELIMINARY QUANTITY ESTIMATE:

EXCAVATION	12,000 CY
FILL	17,500 CY
RIPRAP	8,000 CY
TOPSOIL	1,000 CY
GRAVEL	1,150 CY



Site No. 25

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

GREEN/DUWAMISH RIVER HABITAT RESTORATION

PORTER LEVEE SETBACK

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	99AUG15	C-11
DSGN.		CHK. DAF	SHEET 12	

DATE AND TIME PLOTTED: 04-OCT-2000 14:33
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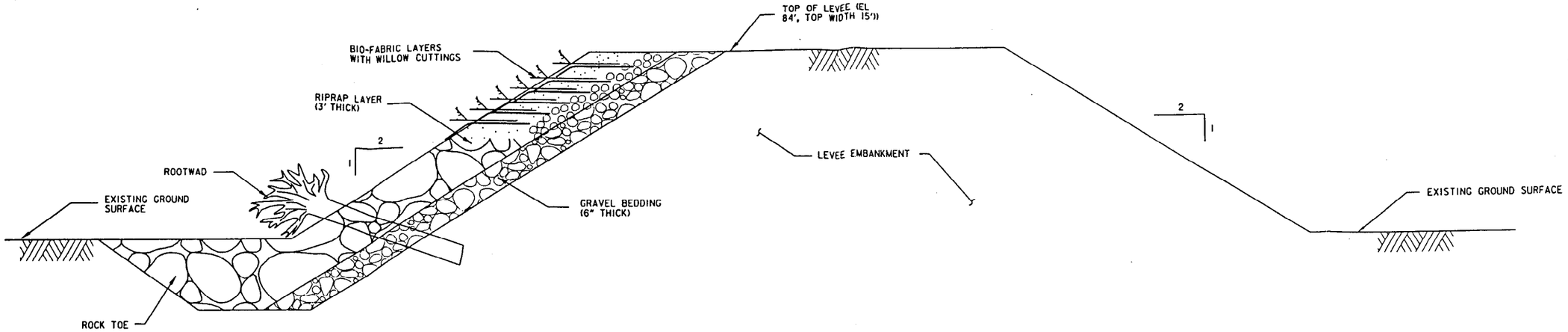
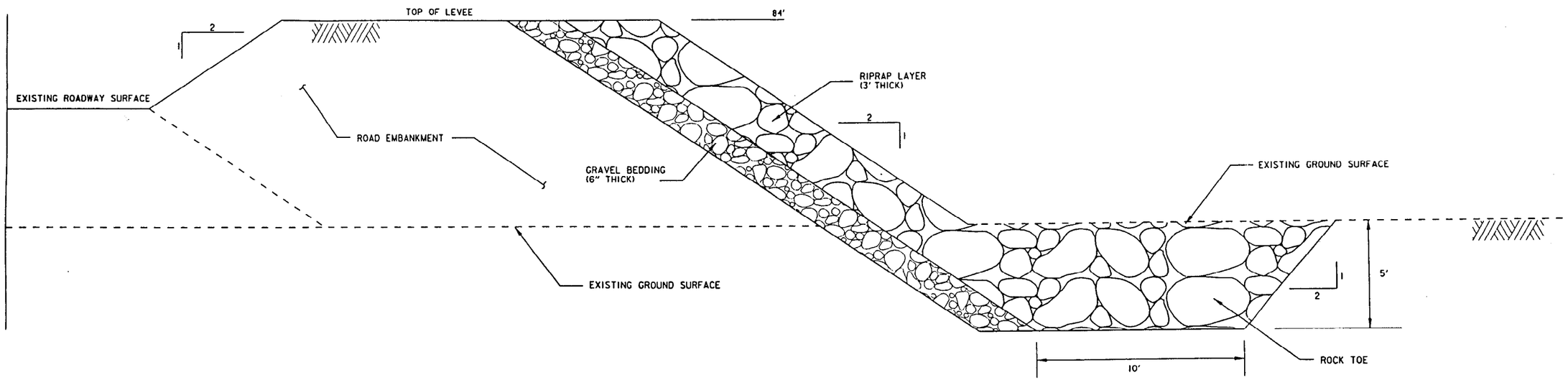


LEVEE SECTION (TYP) A / C-11

NOT TO SCALE



REVETMENT SECTION (TYP) B / C-11

NOT TO SCALE

DATE AND TIME PLOTTED: 03-FEB-2000 10:45
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U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN/DUWAMISH RIVER HABITAT RESTORATION

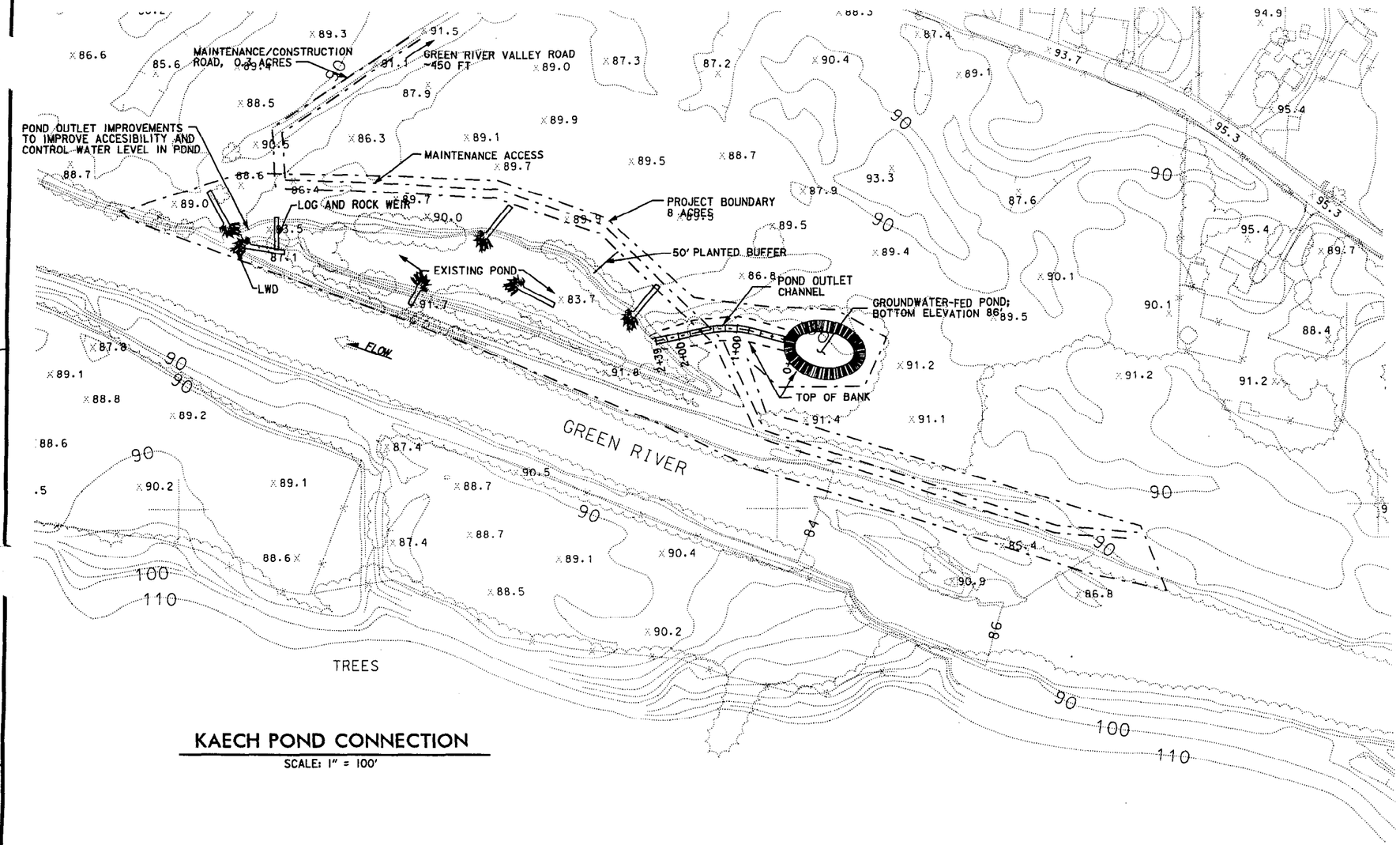
PORTER LEVEE CIVIL DETAILS

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	99AUG15	C-13
DSGN. PWN		CHK. DAF	SHEET 14	

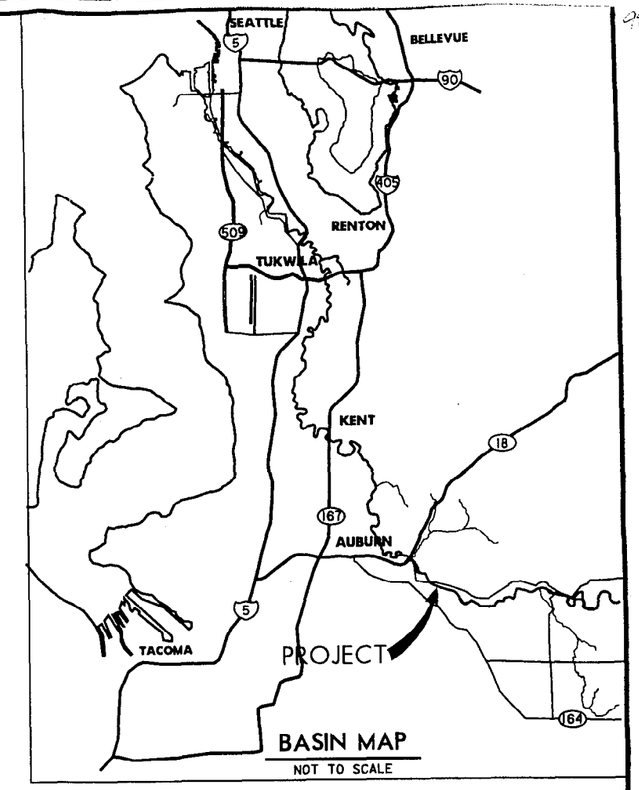
DATE AND TIME PLOTTED: 03-FEB-2000 10:45 DESIGN FILE:

Site No. 25



KAECH POND CONNECTION

SCALE: 1" = 100'



BASIN MAP

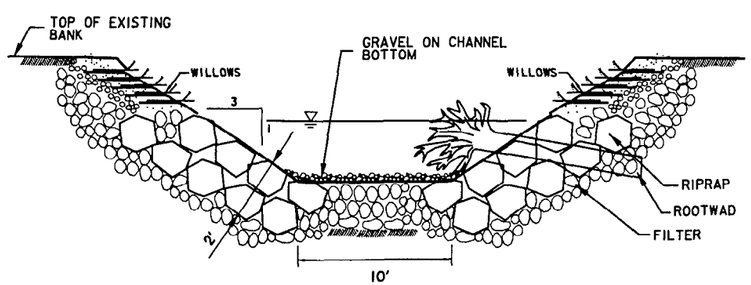
NOT TO SCALE

PRELIMINARY QUANTITY ESTIMATE:

	QUANTITY
EXCAVATION	2,650 CY
FILTER GRAVEL	315 CY
ROOTWADS	8 EA
RIPRAP	340 CY
COIR FABRIC	570 SQ. YRD.
TOPSOIL	90 CY

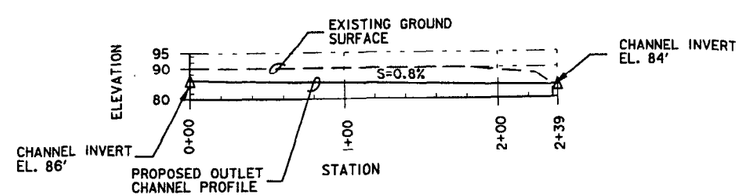
N

NOTES:
1. FOR PLANTING DETAIL, SEE FIGURE 12, PLAN AND SECTION DETAILS.



POND OUTLET CHANNEL CROSS-SECTION

NOT TO SCALE



POND OUTLET CHANNEL-PROFILE

SCALE: 1" = 100'

Site No. 26

1" = 100' 100' 50' 0 100' 200'

DATE AND TIME PLOTTED: 07-AUG-2000 15:02
DESIGN FILE: I:\designs\msgd\civ\msgdcs0a.dgn

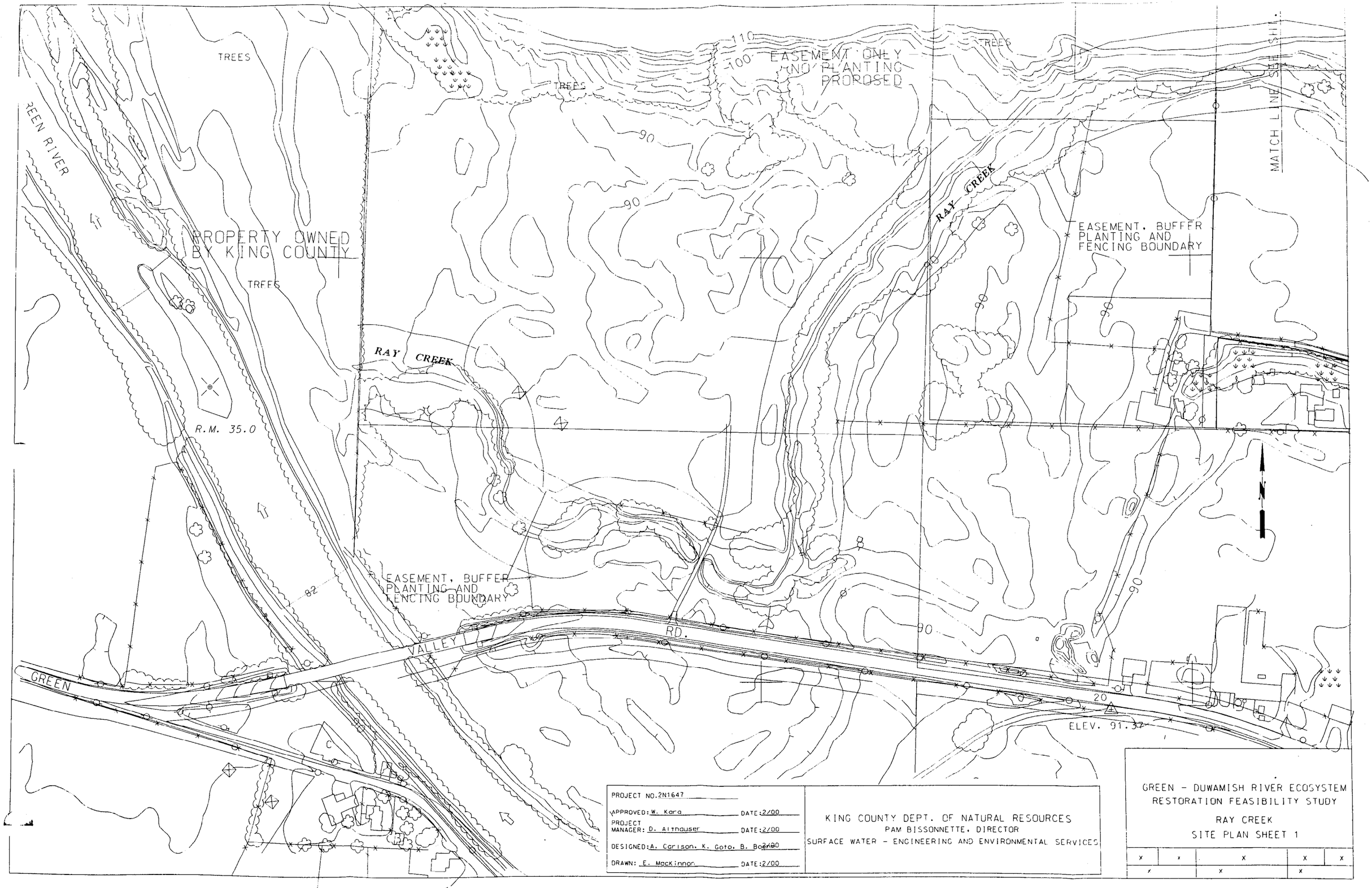
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN/DUWAMISH RIVER HABITAT RESTORATION

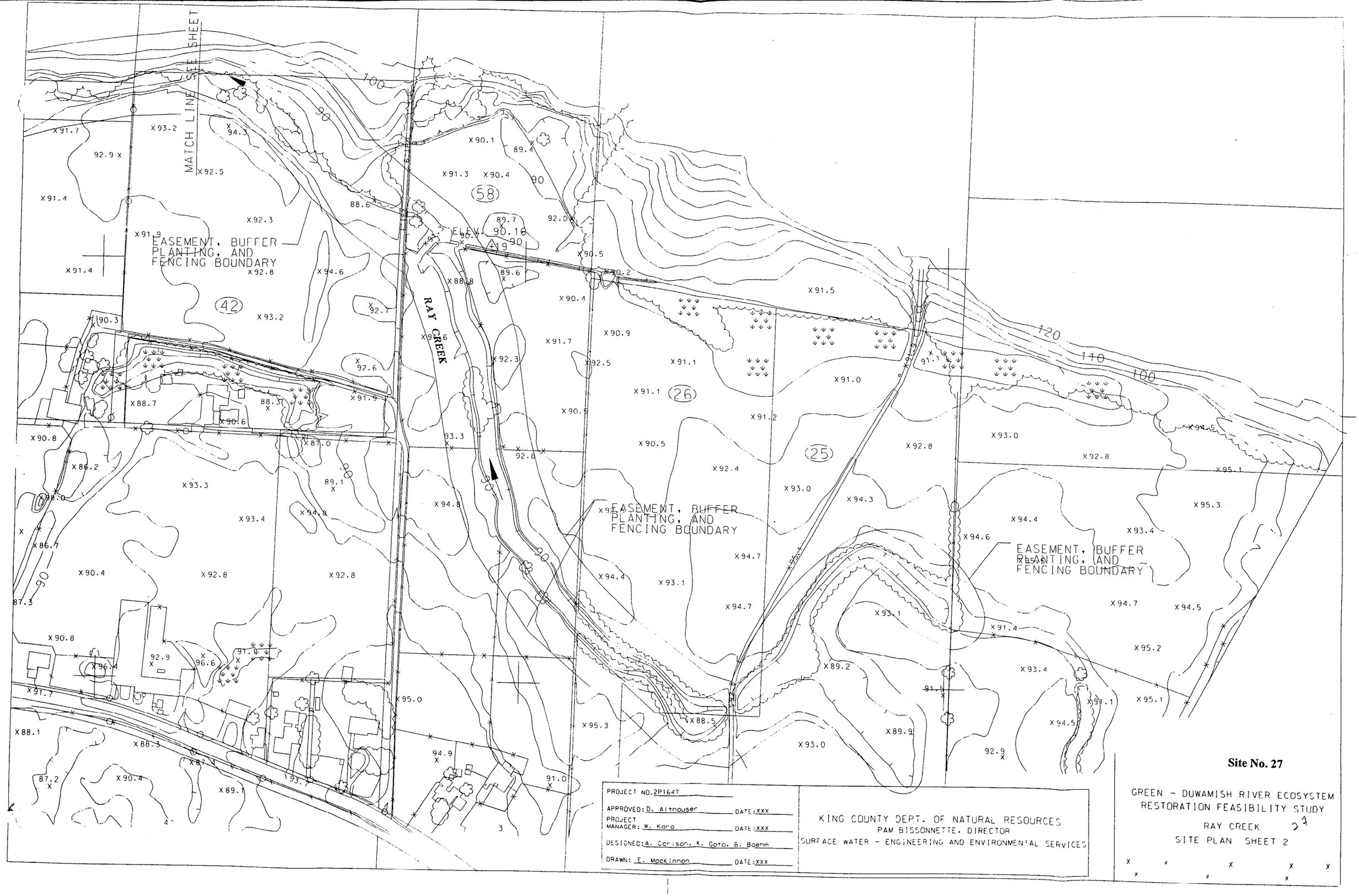
KEACH POND IMPROVEMENTS

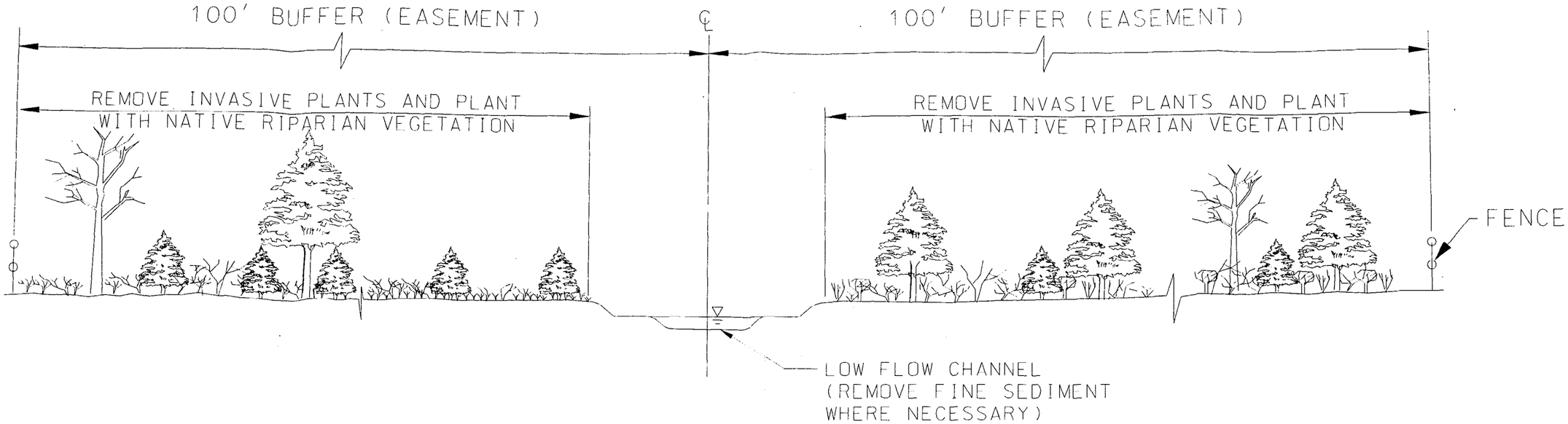
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	99AUG15	C-1
DSGN. PWN		CHK. DAF	SHEET 2	

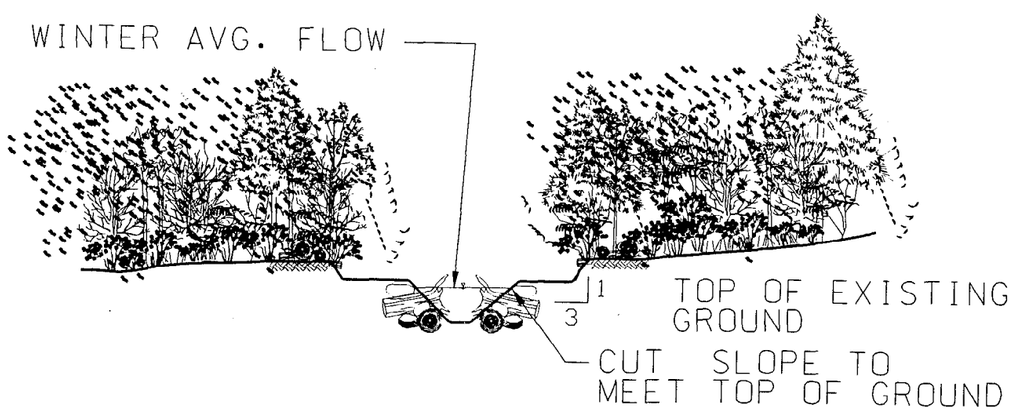

TREES
TREES
TREES
TREES
110
100
EASEMENT ONLY
NO PLANTING
PROPOSED
90
90
90
90
90
90
90
82
20
GREEN RIVER
PROPERTY OWNED
BY KING COUNTY
TREES
RAY CREEK
RAY CREEK
R.M. 35.0
EASEMENT, BUFFER
PLANTING AND
FENCING BOUNDARY
EASEMENT, BUFFER
PLANTING AND
FENCING BOUNDARY
MATCH LINE SHEET
GREEN VALLEY RD.
ELEV. 91.37
N
PROJECT NO. 2N1647
APPROVED: W. Kara DATE: 2/00
PROJECT MANAGER: D. Altnauser DATE: 2/00
DESIGNED: A. Carlson, K. Goto, B. Boehm DATE: 2/00
DRAWN: E. MacKinnon DATE: 2/00
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES
GREEN - DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY
RAY CREEK
SITE PLAN SHEET 1

Site No. 27

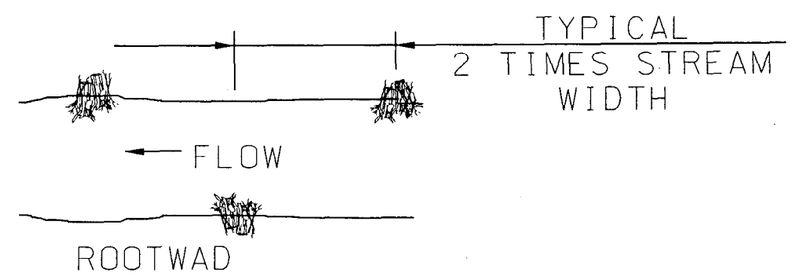

MATCH LINE OF SHEET
EASEMENT, BUFFER PLANTING, AND FENCING BOUNDARY
RAY CREEK
ELEV. 90.16
EASEMENT, BUFFER PLANTING, AND FENCING BOUNDARY
EASEMENT, BUFFER PLANTING, AND FENCING BOUNDARY
PROJECT NO. 2P1647
APPROVED: D. Althauser DATE: XXX
PROJECT MANAGER: W. Kara DATE: XXX
DESIGNED: A. Carlson, K. Goto, B. Boehm
DRAWN: E. MacKinnon DATE: XXX
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES
Site No. 27
GREEN - DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
RAY CREEK
SITE PLAN SHEET 2



TYPICAL SECTION N.T.S.



CROSS SECTION



TYPICAL STREAM SEGMENT

TYPICAL L.W.D. DETAILS N.T.S.

LOCATIONS TO BE DETERMINED

Site No. 27

PROJECT NO. 2P1647	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONNETTE, DIRECTOR SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES
APPROVED: D. Althauser DATE: XXX	
PROJECT MANAGER: W. Karg DATE: XXX	
ECOLOGISTS: K. Goto, A. Carlson, B. Boenm	
DRAWN: E. MacKinnon DATE: XXX	

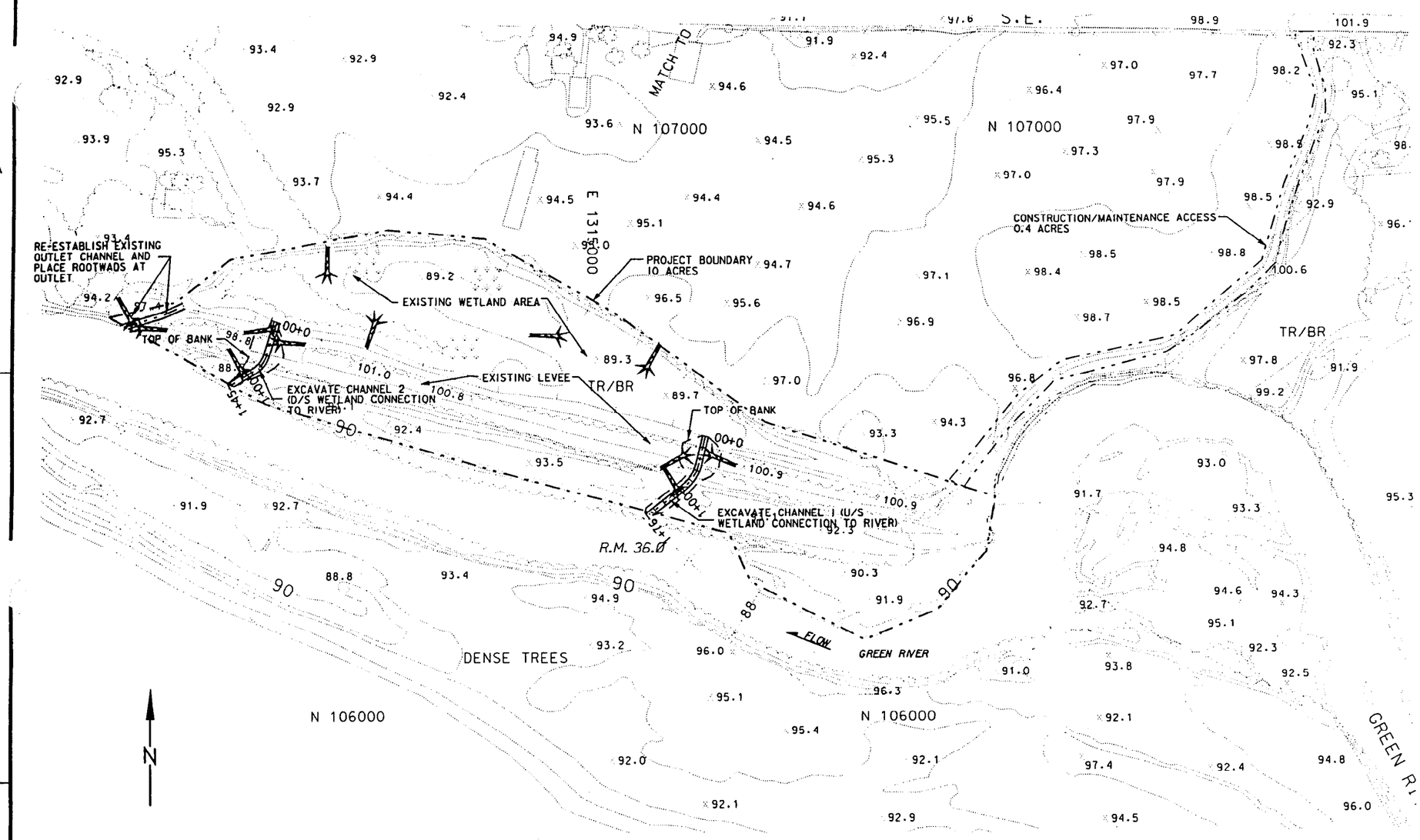
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

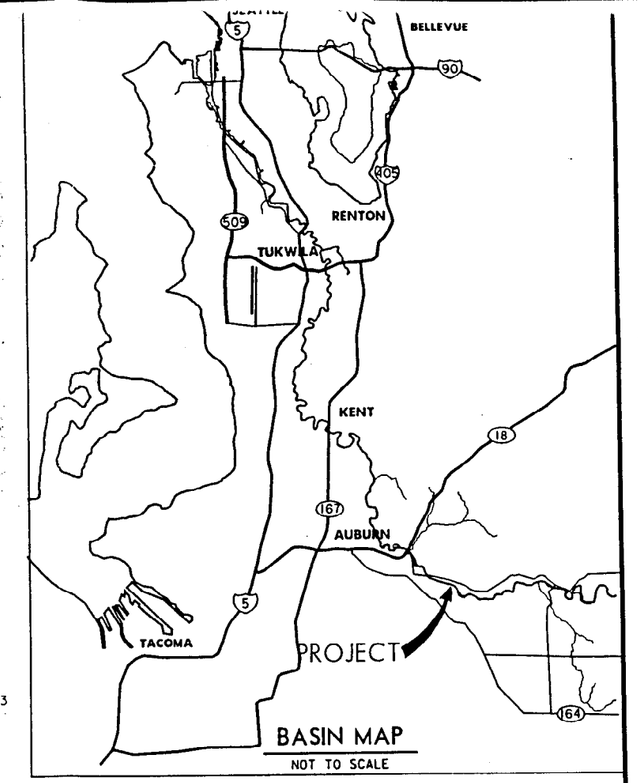
GREEN - DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

RAY CREEK
TYPICAL SECTION

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
X	X	X	X	X
DSGN. Y		CHK. Y	SHEET X	

DESIGN FILE: i:\designs\msgd\civ\deptrier\ray3d.dgn DATE AND TIME PLOTTED: 09-AUG-2000 16:00

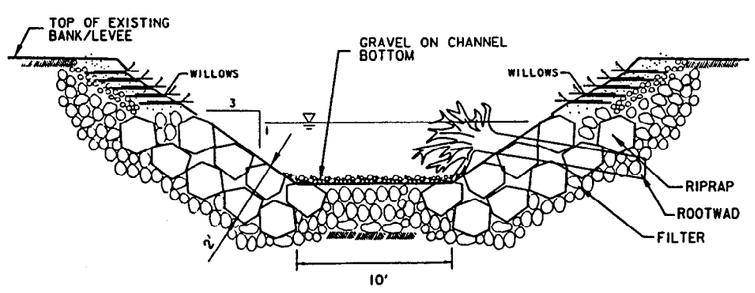




PRELIMINARY QUANTITY ESTIMATE

CHANNEL 1	QUANTITY
EXCAVATION	900 CY
FILTER GRAVEL	190 CY
RIPRAP	275 CY
ROOTWADS	5
WILLOWS	1,240 SF/144 EA.
TOPSOIL	100 CY
COIR FABRIC	3,900 SF

CHANNEL 2	QUANTITY
EXCAVATION	675 CY
FILTER GRAVEL	150 CY
RIPRAP	200 CY
ROOTWADS	5
WILLOWS	885 SF/100 EA.
TOPSOIL	70 CY
COIR FABRIC	3,200 SF



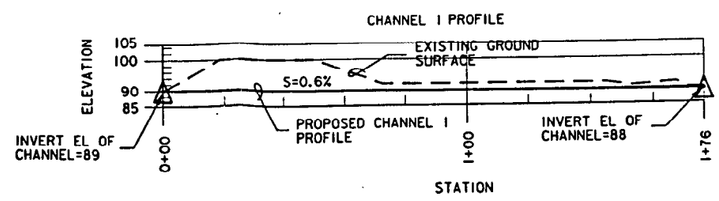
CONNECTION CHANNEL CROSS-SECTION

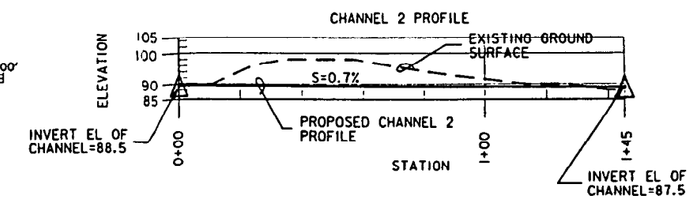
NOT TO SCALE

HAMIKAMI LEVEE BREACH

SCALE: 1" = 100'

1" = 100' 100' 50' 0 100' 200'





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

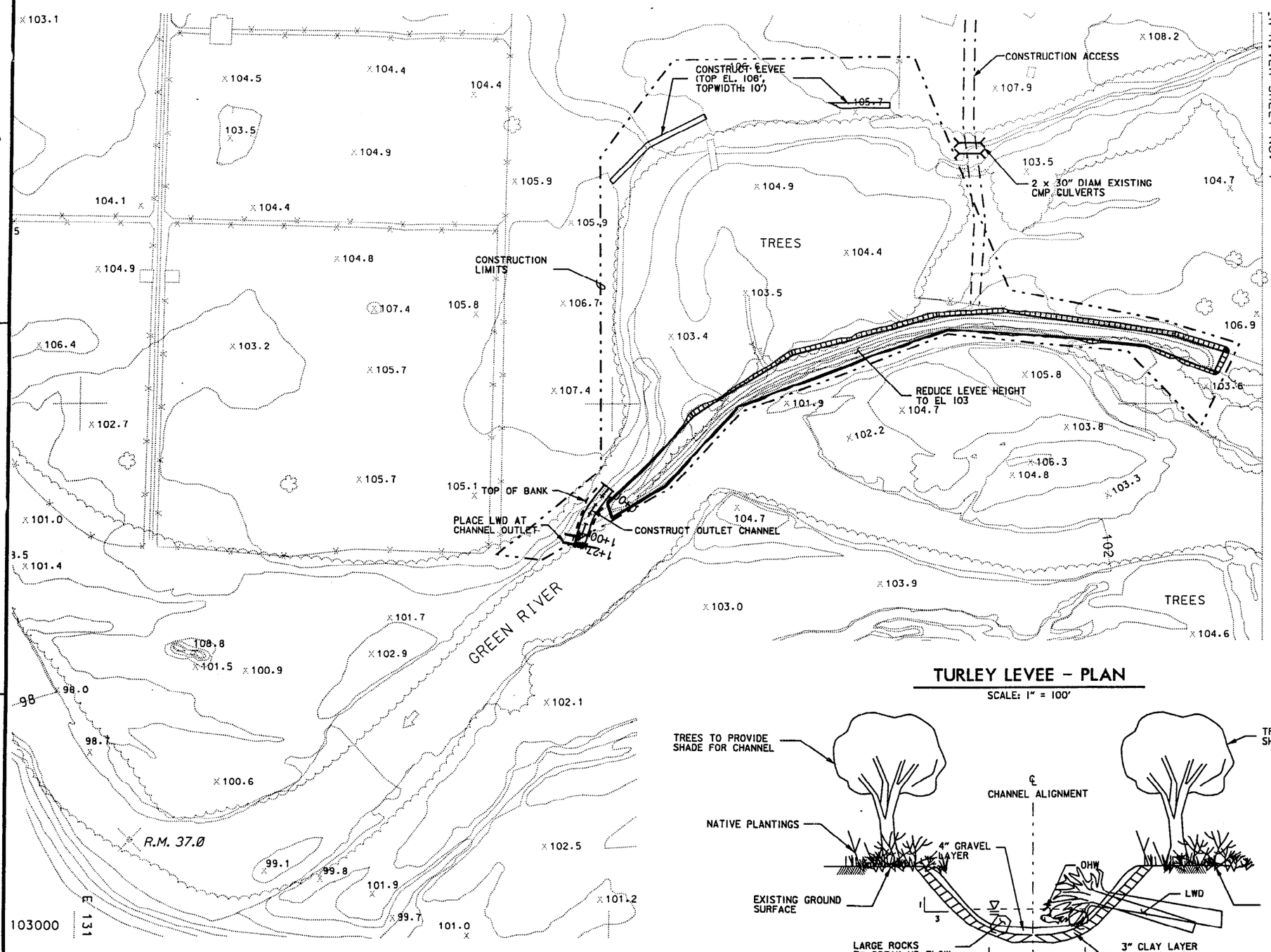
GREEN/DUWAMISH RIVER HABITAT RESTORATION

HAMIKAMI LEVEE BREACH

KING COUNTY WASHINGTON

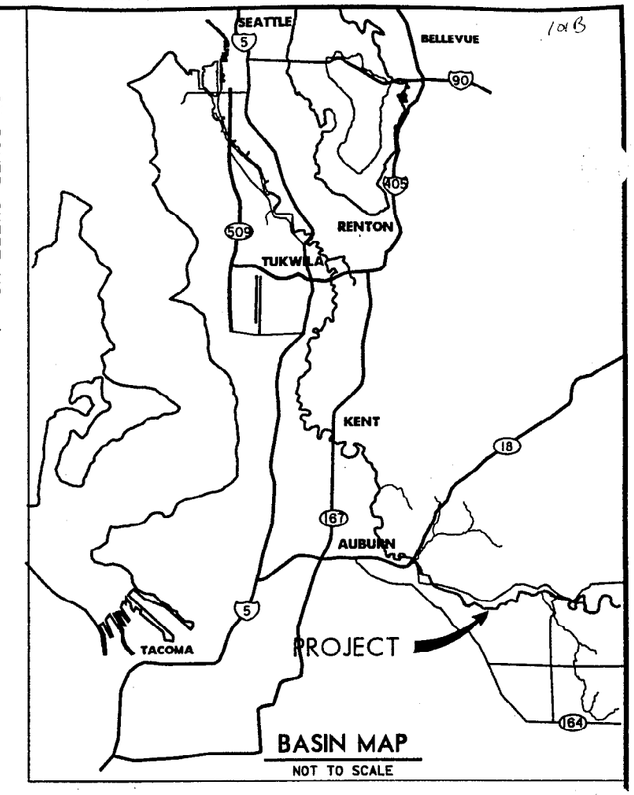
SIZE	NAVIGATION NO.	FILE NO.	DATE	PLATE
D	XX-XX	XX-XX	99AUG15	C-2
DSGN. PWN	DWN. DAF		SHEET 3	

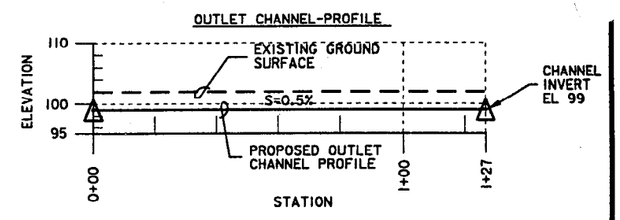
Site No. 28



TURLEY LEVEE – PLAN

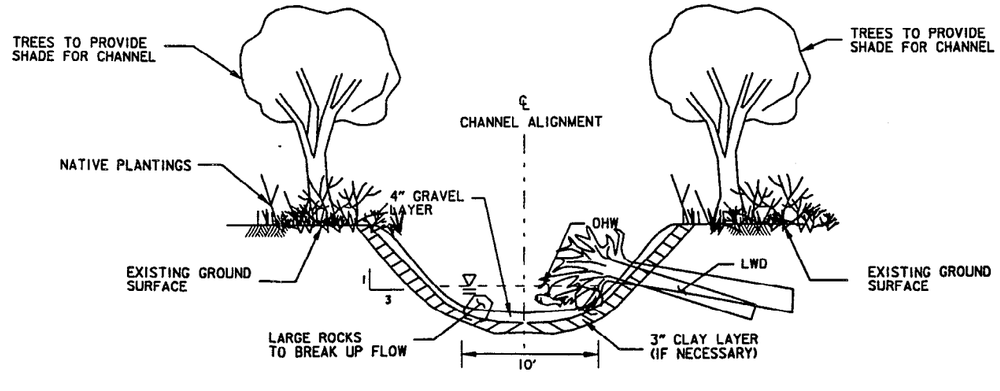
SCALE: 1" = 100'





PRELIMINARY QUANTITY ESTIMATE:

	QUANTITY
FILL:	170 CY
EXCAVATION	5,800 CY
GRAVEL	300 CY
CLAY (IF NECESSARY)	230 CY
LARGE ROCKS (12"-18")	15 EA
ROOTWADS	10 EA



CHANNEL SECTION (TYP)

NOT TO SCALE

N

100' 50' 0 100' 200'

Site No. 29

DATE AND TIME PLOTTED: 04-OCT-2000 14:29
DESIGN FILE: i:\designs\msgd\civ\msgdcs0g.dgn

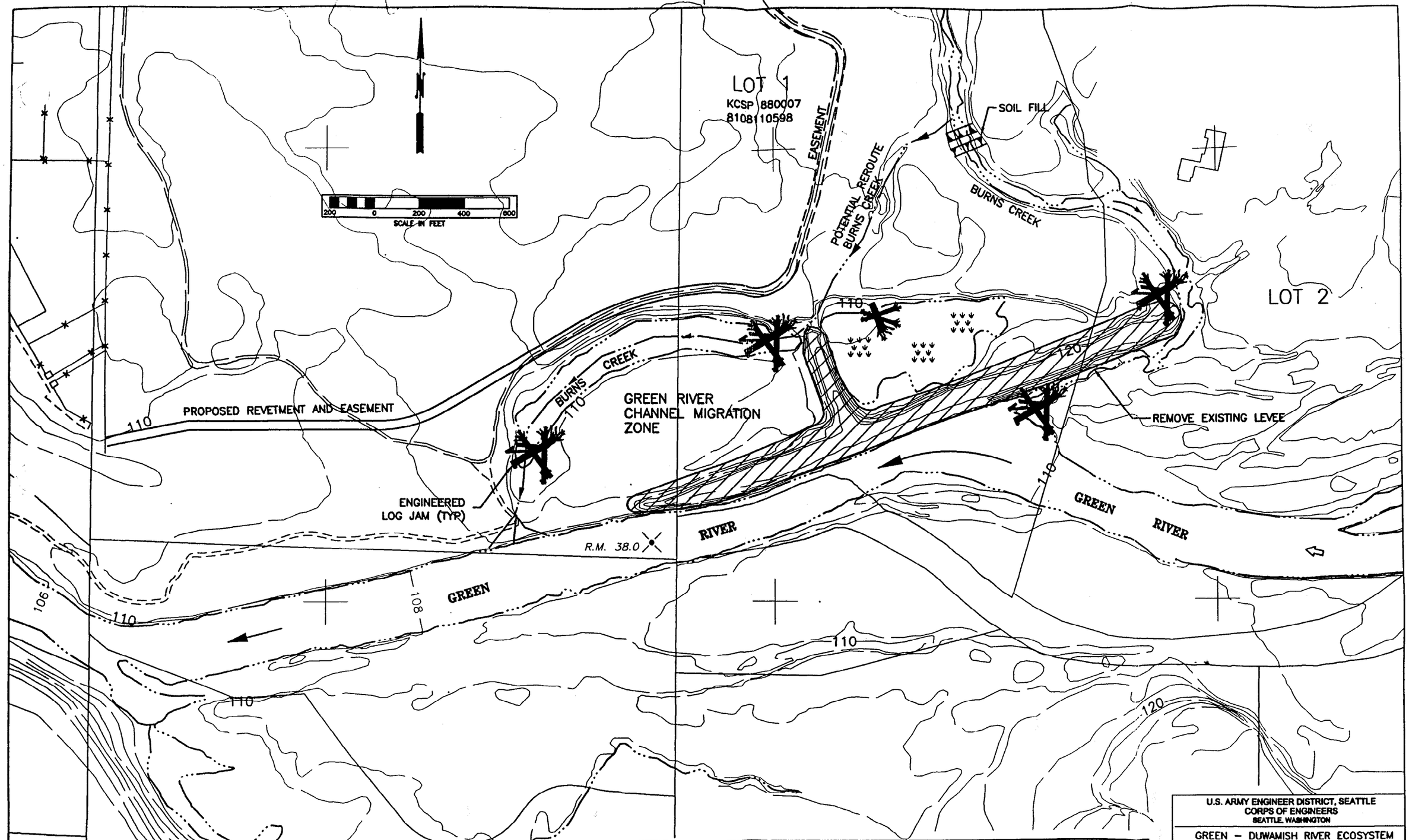
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN/DUWAMISH RIVER HABITAT RESTORATION

TURLEY LEVEE

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	99AUG15	C-7
DSGN. PWN		CHK. DAF	SHEET 8	



PROJECT NO. 2E1847	
APPROVED: D. Althauser	DATE: 10/99
PROJECT MANAGER: D. Althauser	DATE: 10/99
ECOLOGIST A. Stonkus	DATE: 10/99
DRAWN: E. MacGinnon	DATE: 10/99

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

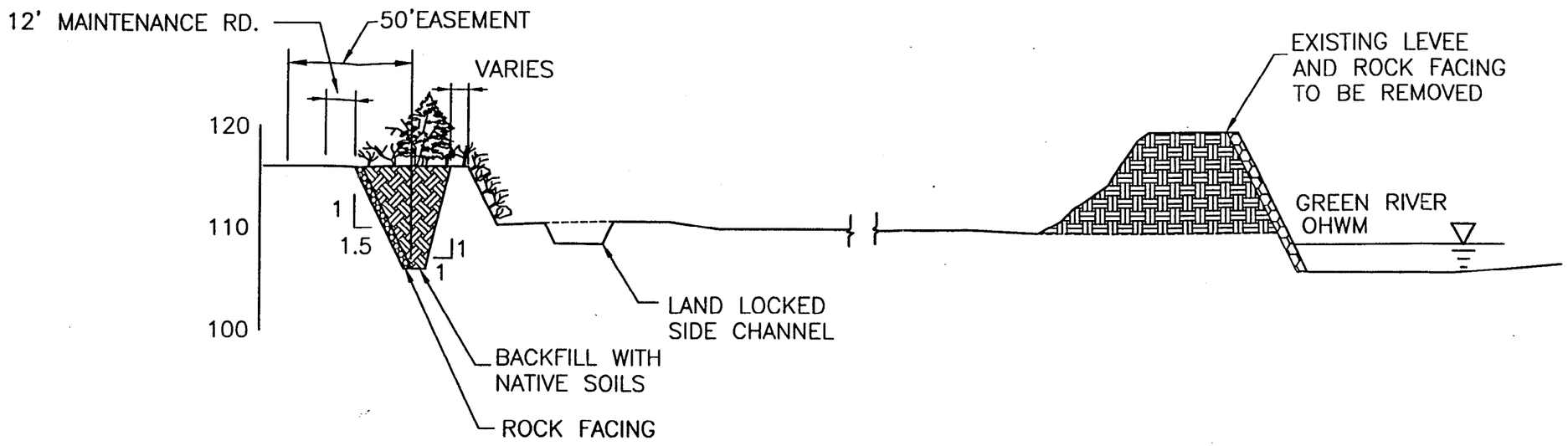
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

LONES LEVEE
SITE PLAN

SIZE	DRAWING NO.	FILE NO.	DATE	PLATE
X	X	X	X	X
SCALE X		CHK. X	SHEET X	

:\WENDYK\green\lones.dwg



LONES LEVEE
TYPICAL SECTION
NOT TO SCALE

PROJECT NO. 2E1647	
APPROVED: D. Althauser P.E.	DATE: 2/00
PROJECT MANAGER: D. Althauser P.E.	DATE: 2/00
ECOLOGIST: A. Stonkus P.E.	DATE: 2/00
DRAWN: E. MacKinnon	DATE: 2/00

KING COUNTY DEPT. OF NATURAL RESOURCES
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SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY

LONES LEVEE
TYPICAL SECTION

SIZE	SUBTUGION NO.	FILE NO.	SCALE:	PLATE
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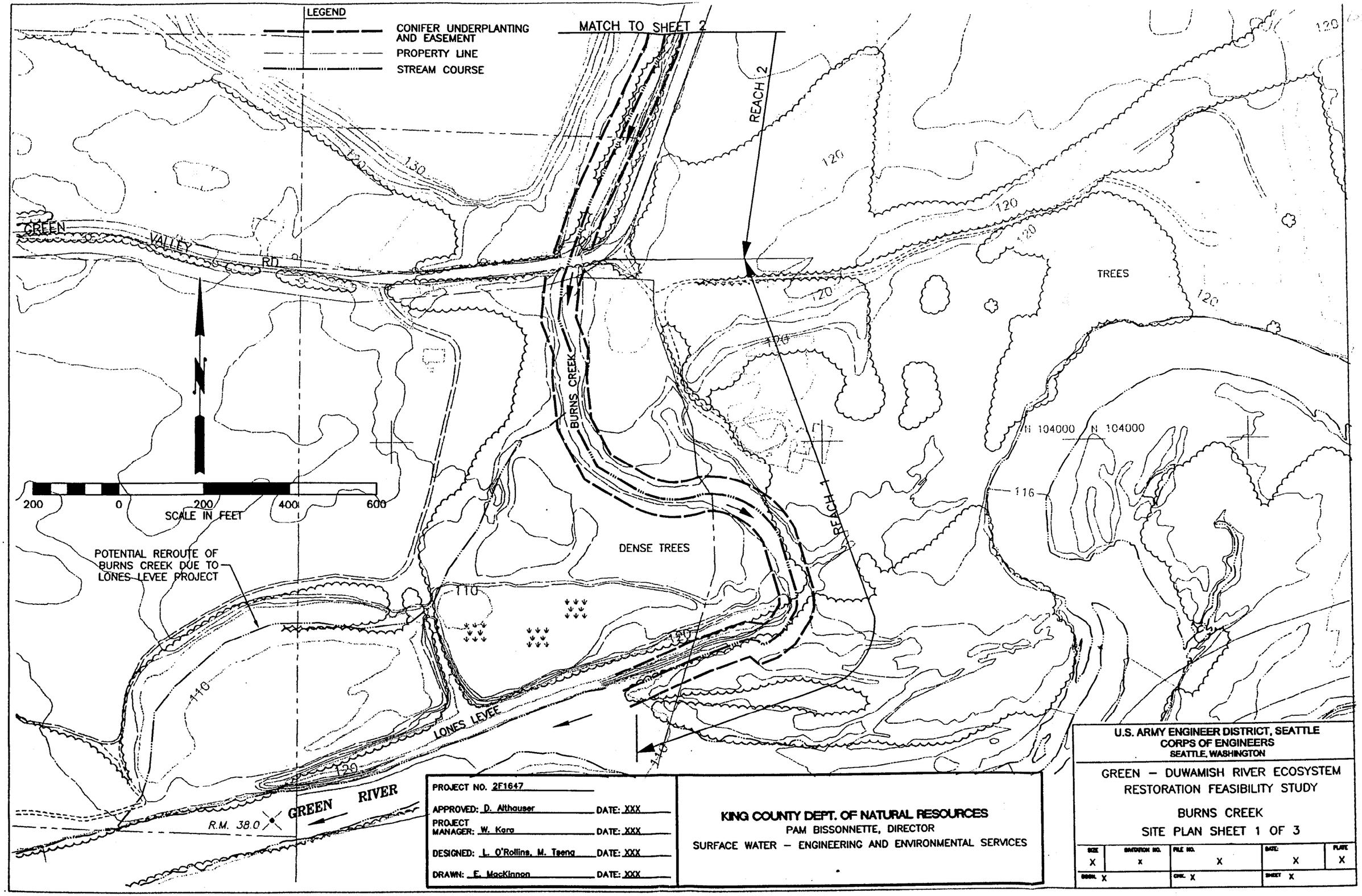
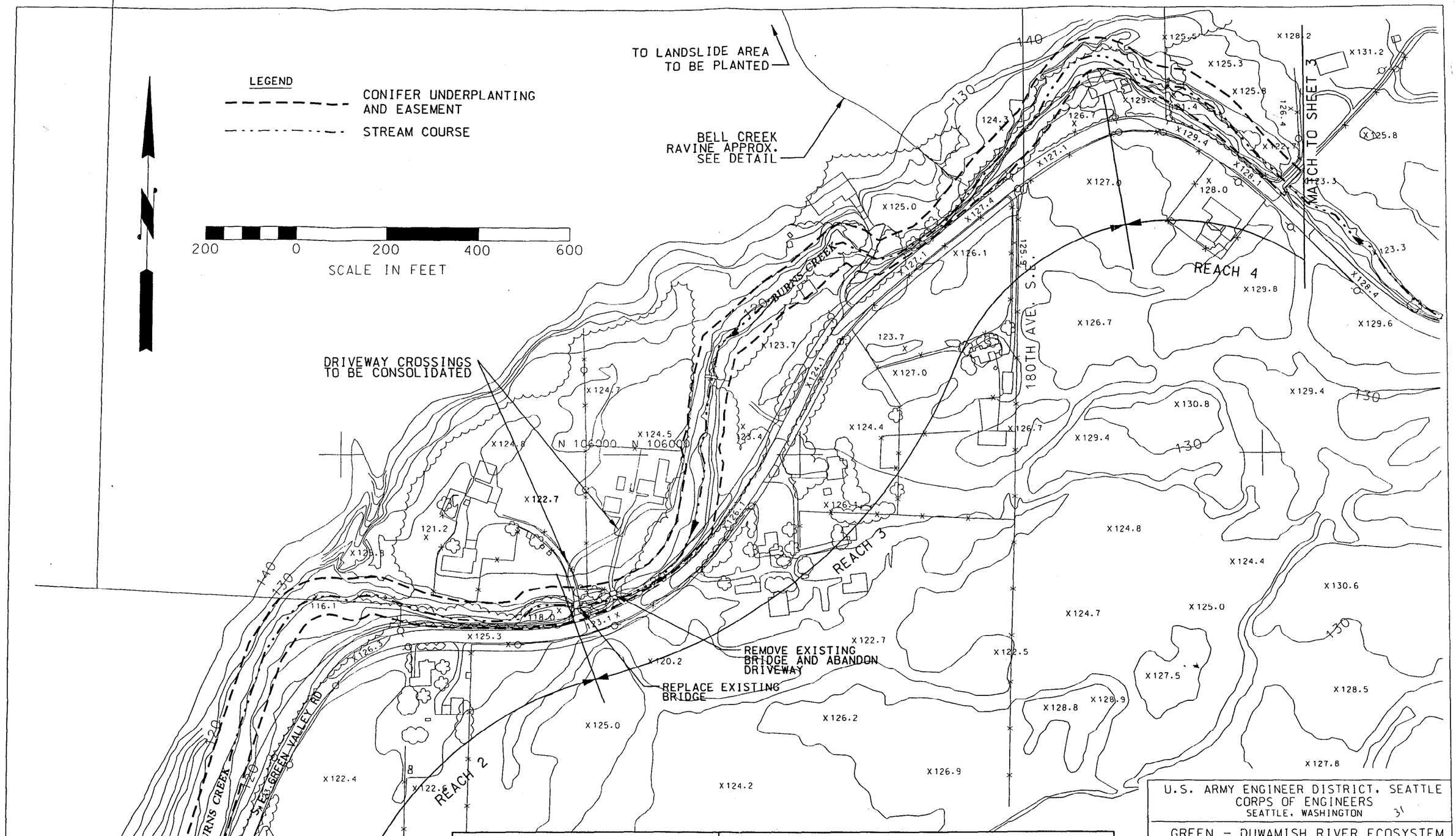
DSGN. X		CHK. X	SHEET X	


LEGEND
CONIFER UNDERPLANTING AND EASEMENT
PROPERTY LINE
STREAM COURSE
MATCH TO SHEET 2
REACH 2
REACH 1
GREEN VALLEY RD
BURNS CREEK
TREES
DENSE TREES
N 104000
N 104000
200 0 200 400 600
SCALE IN FEET
POTENTIAL REROUTE OF BURNS CREEK DUE TO LONES LEVEE PROJECT
LONES LEVEE
GREEN RIVER
R.M. 38.0
120
130
110
116
PROJECT NO. 2F1647
APPROVED: D. Althauser DATE: XXX
PROJECT MANAGER: W. Kera DATE: XXX
DESIGNED: L. O'Rollins, M. Tseng DATE: XXX
DRAWN: E. MacKinnon DATE: XXX
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON
GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
BURNS CREEK
SITE PLAN SHEET 1 OF 3
SIZE X
SIMULATION NO. x
FILE NO. X
DATE: X
PLATE X
DSGN. X
CHK. X
SHEET X



PROJECT NO. 2F1647

APPROVED: D. Althauser DATE: XXX

PROJECT MANAGER: W. Kara DATE: XXX

DESIGNED: L. O'Rollins, M. Tsen DATE: XXX

DRAWN: E. MacKinnon DATE: XXX

KING COUNTY DEPT. OF NATURAL RESOURCES
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U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

31

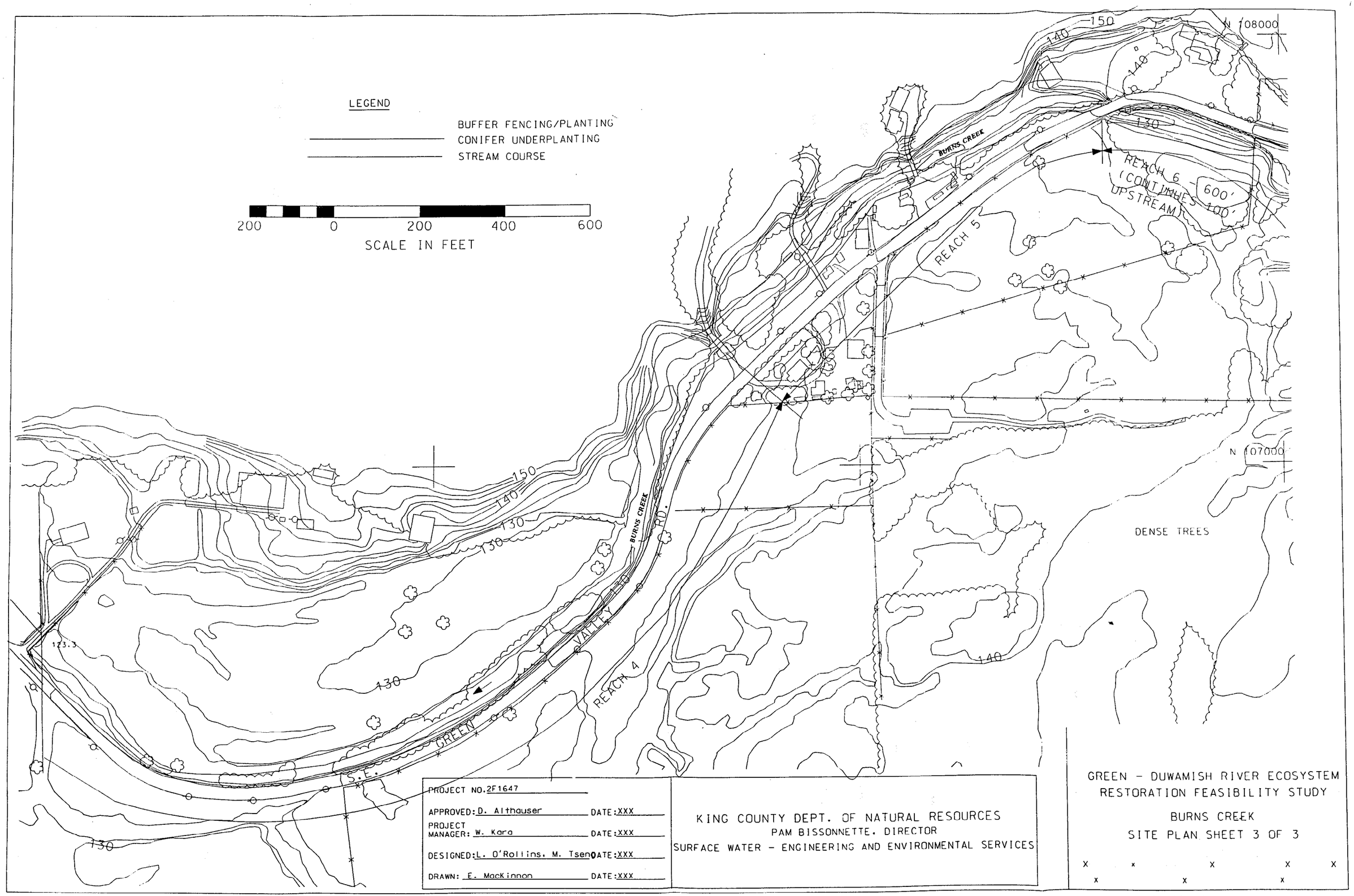
GREEN - DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY

BURNS CREEK **Site No. 31**

SITE PLAN SHEET 2 OF 3

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
X	x	X	X	X
DSGN. X		CHK. X	SHEET X	

DESIGN FILE: t:#designs#msgd#civ#deptnr#burns2.dgn DATE AND TIME PLOTTED: 09-AUG-2000 16:46


LEGEND
BUFFER FENCING/PLANTING
CONIFER UNDERPLANTING
STREAM COURSE
200 0 200 400 600
SCALE IN FEET
N 108000
N 107000
150
140
130
123.3
BURNS CREEK
REACH 6 - (CONTINUES UPSTREAM)
600'
100'
REACH 5
REACH 4
GREEN VALLEY RD. S.E.
DENSE TREES
PROJECT NO. 2F1647
APPROVED: D. Althauser DATE: XXX
PROJECT MANAGER: W. Kara DATE: XXX
DESIGNED: L. O'Rollins, M. Tsen DATE: XXX
DRAWN: E. MacKinnon DATE: XXX
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES
GREEN - DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY
BURNS CREEK
SITE PLAN SHEET 3 OF 3

Site No. 31

KEY

TREES

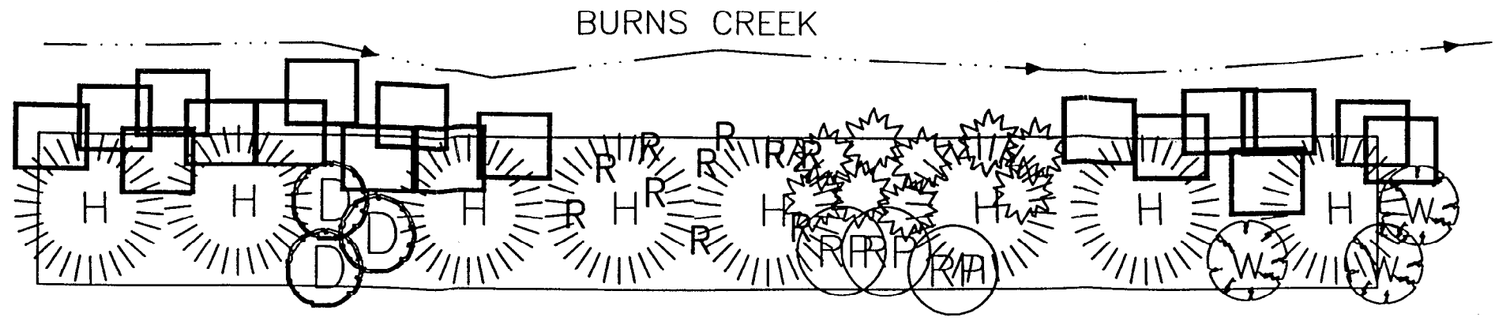
- H — HEMLOCK 4'–5'
- S — SITKA SPRUCE 4'–5'
- C — WESTERN RED CEDAR 4'–5'
- A — OREGON ASH 2'–4'
- W — WESTERN CRABAPPLE 2'–4'
- RP — CASCARA 2'–4'
- D — DOUGLAS HAWTHORN 1'–2'

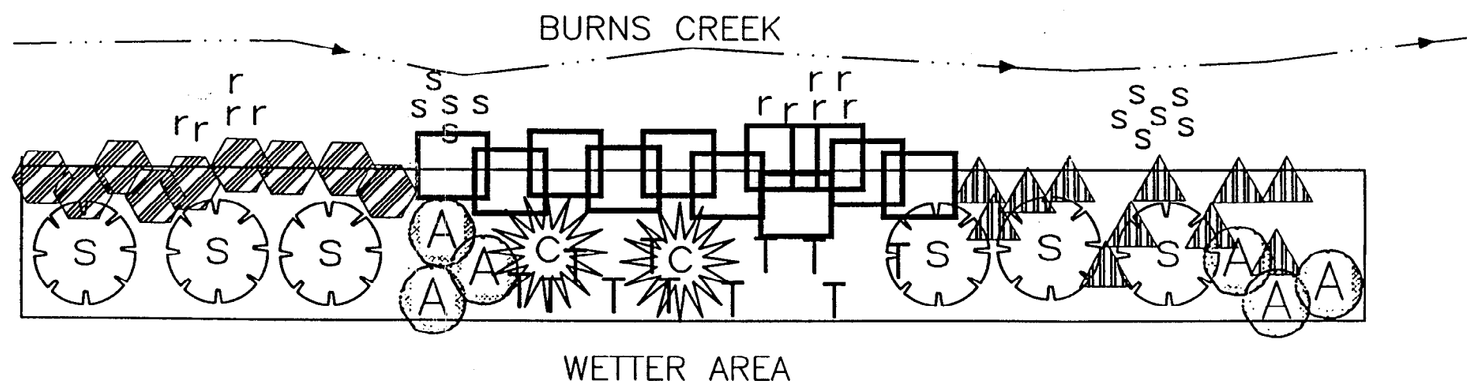
SHRUBS

- PACIFIC WILLOW
- RED OSIER DOGWOOD
- NINEBARK
- T — TWINBERRY
- SALMONBERRY
- R — RED ELDERBERRY

EMERGENTS

- r — RUSHES
- s — SEDGES





PROJECT NO. 2G1647	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONNETTE, DIRECTOR SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES
APPROVED: Don Althouser DATE:	
PROJECT MANAGER: Wendy Karg DATE:	
DESIGNED: Laird O'Rollins; M. Tseng DATE:	
DRAWN: M. Radella, E. MacKinnon DATE:	

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

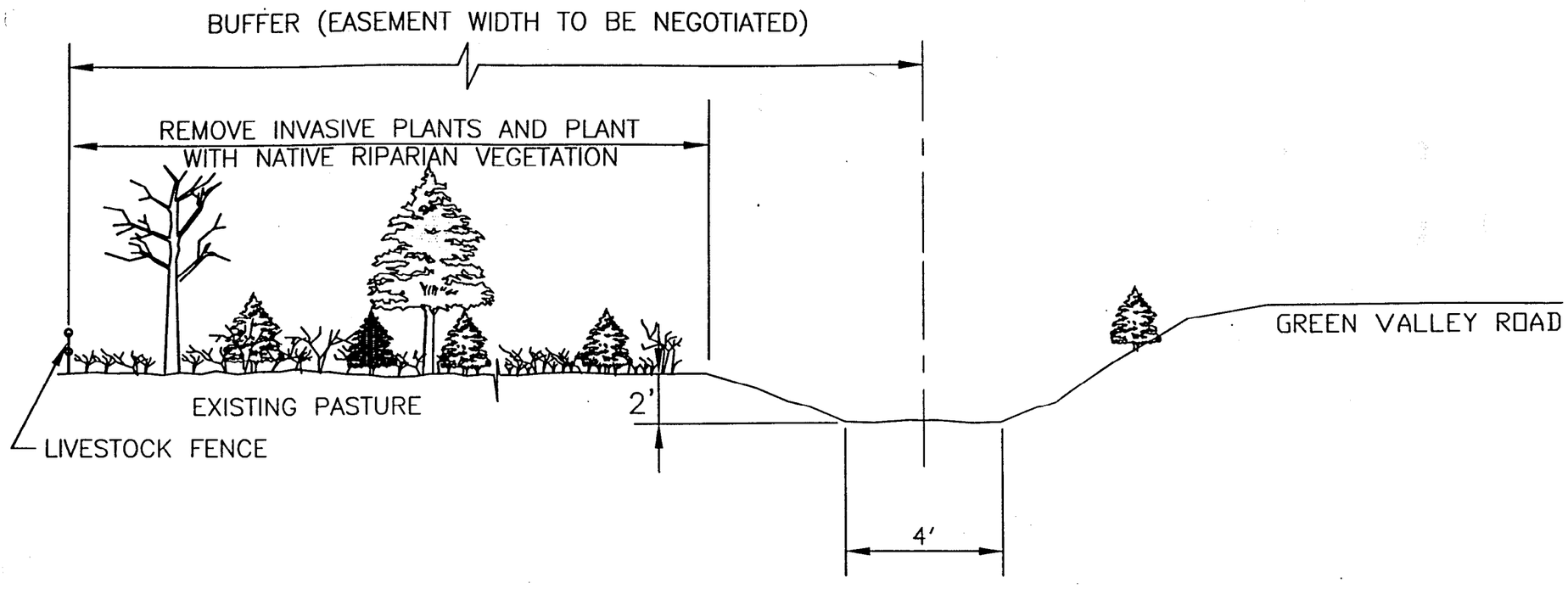
GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

BURNS CREEK

REACH 4 PLANTING PLAN

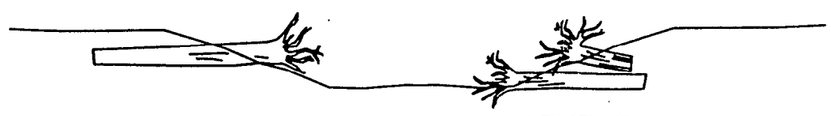
SIZE	DIVISION NO.	FILE NO.	DATE:	PLATE
X	X	X	X	X
DSGN. X		CHK. X	SHEET X	

Site No. 31



TYPICAL SECTION N.T.S.

REACH 4 BURNS CREEK



TYPICAL LWD PLACEMENT

N.T.S. LOCATIONS TO BE DETERMINED

PROJECT NO. 2P1647

APPROVED: D. Althauser DATE: XXX

PROJECT MANAGER: W. Kara DATE: XXX

DESIGNED L. O'Rollins, M. Tseng

DRAWN: E. MacKinnon DATE: XXX

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

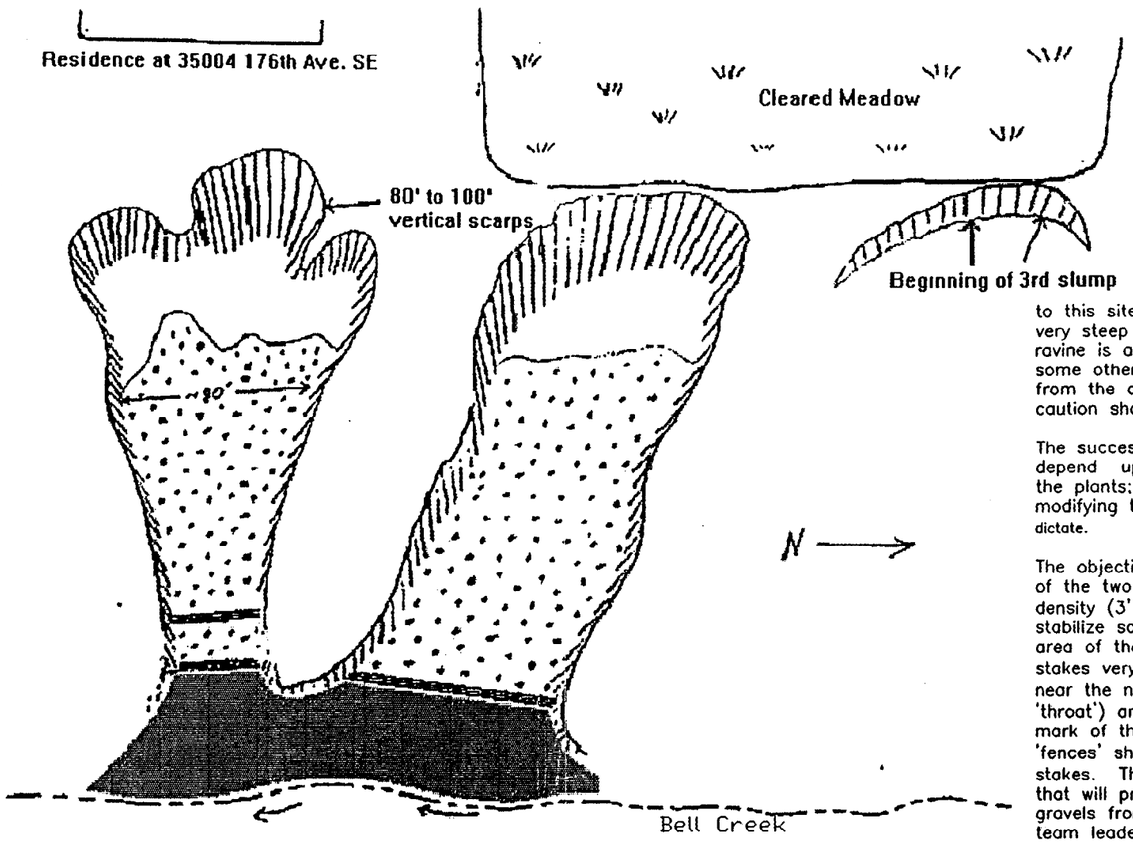
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

BURNS CREEK

REACH 4 TYPICAL SECTION

SIZE	SIMULATION NO.	FILE NO.	DATE:	PLATE
X	X	X	X	X
DSGN. X		CHK. X	SHEET X	



= Native willow stakes on 3' centers

= Native willow stakes on 1' centers

= "Living Fence" constructed of live willow stakes (approx. 6" centers) and available organic debris (see plan notes)

Plan Notes:

This plan is not based on survey data, but rather on the basis of one visual reconnaissance. All figures and distances are approximate. Note also that access to this site is extremely difficult as the terrain is very steep and unstable. The bottom of the ravine is accssable only with the aid of ropes or some other device with which to exit or, perhaps, from the opposite bank of the ravine. Extreme caution should be used in accessing this site.

The successful execution of this planting plan will depend upon the judgement of those installing the plants; they should use their discretion in modifying the plan as field conditions may dictate.

The objective of this plan is to plant the 'floor' of the two scarps with willow stakes in a medium density (3' centers), in the hope that this may stabilize some of these sediments. The riparian area of the stream should be planted with willow stakes very densely (1' centers). At a location near the narrowest part of the scarp (the 'throat') and above the forseeable high-water mark of the stream, a series of live willow 'fences' should be made from very densly planted stakes. The objective here is to form a 'filter' that will prevent at least some sediments and gravels from reaching the stream. The planting team leader should use their judgement in locating the 'fences'. Effectiveness at achieving the filtration objective as well as potential survivability of the stakes and practicality of installation should infuluence site selection. Natural debris found in the vicinity (branches, logs, etc.) may also be used to assemble the 'fence'.

It is imperative that these plantings be at the very least monitored yearly in the spring. Very likely, it will be necessary to replant the scarps and 'fences' yearly for 2-3 years.

PROJECT NO. 2F1647

APPROVED: DON ALTHAUSER, P.E. DATE:

PROJECT MANAGER: WENDY KARA, P.E. DATE:

DESIGNED: LAIRD O'ROLLINS, MIKE TSENG DATE:

DRAWN: LAIRD O'ROLLINS DATE:

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES

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

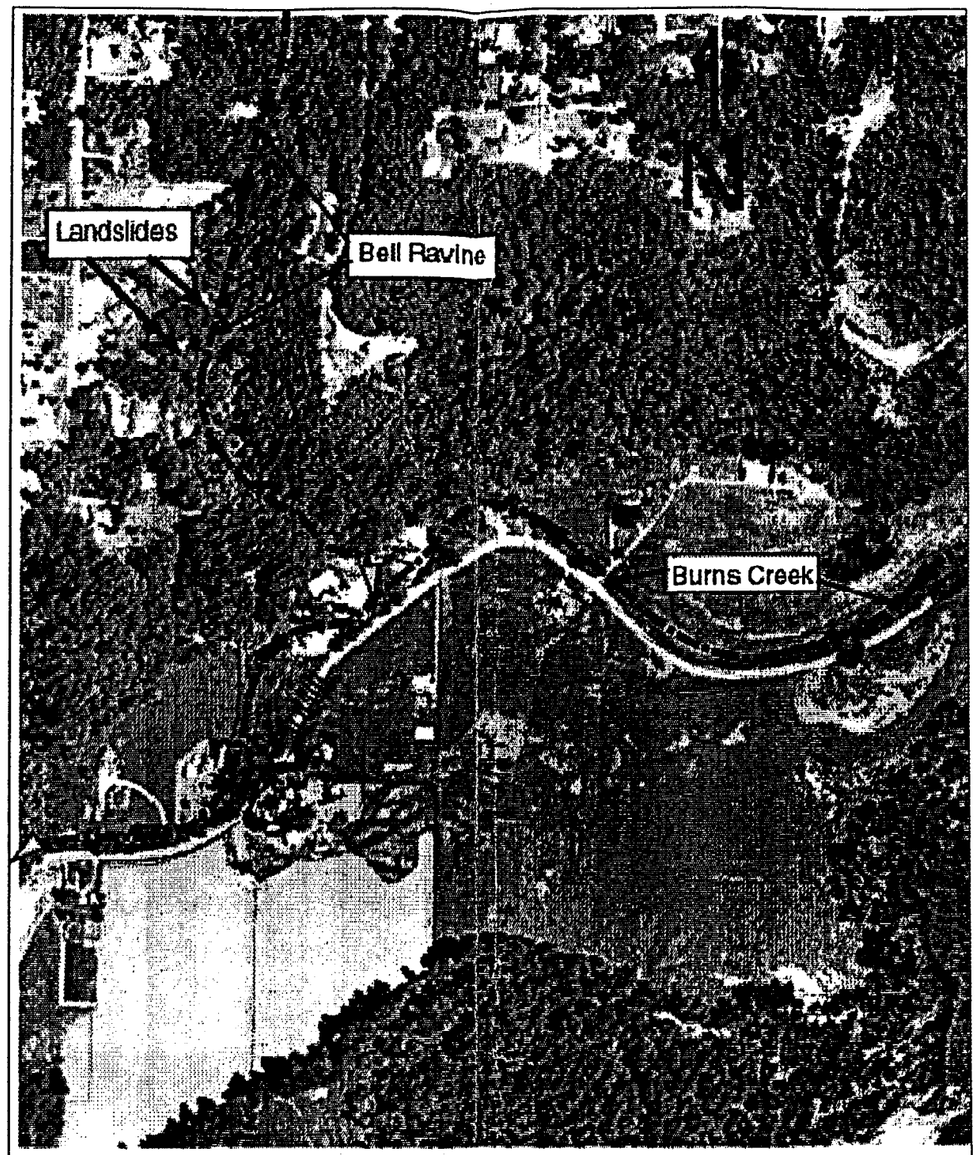
GREEN - DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

BURNS CREEK

LANDSLIDE PLANTING DETAIL

SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
V	>	^	λ	V
DSGN. <		CHK. >	SHEET y	

Site No. 31



Burns Creek 1

PROJECT NO. 2F1647	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONNETTE, DIRECTOR SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES
APPROVED: DON ALTHAUSER, P.E. DATE:	
PROJECT MANAGER: WENDY KARA, P.E. DATE:	
DESIGNED: LAIRD O'ROLLINS, MIKE TSE DATE:	
DRAWN: LAIRD O'ROLLINS DATE:	

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

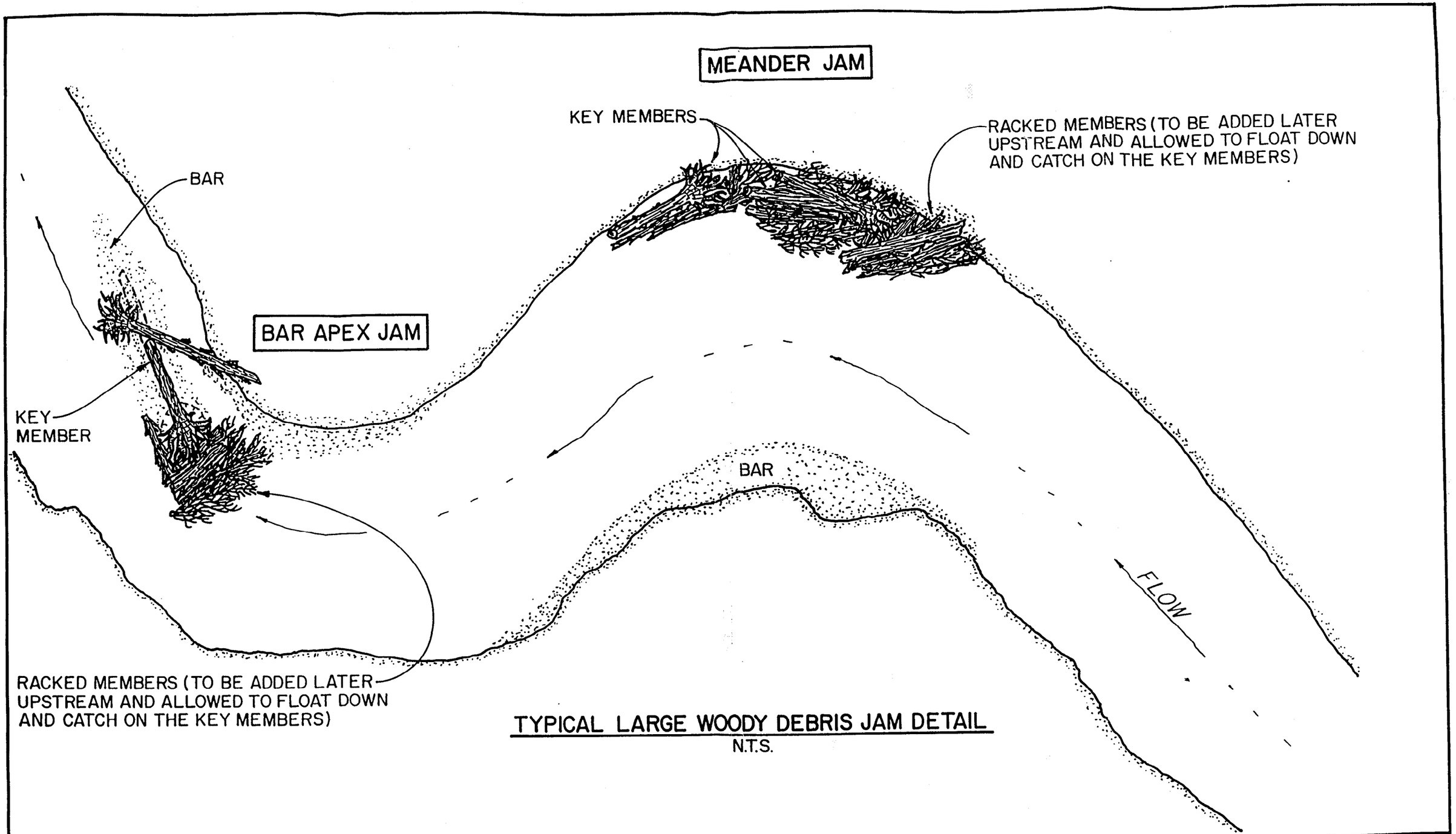
GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY

BURNS CREEK
LANDSLIDE LOCATION DETAIL

SIZE	DIVISION NO.	FILE NO.	DATE	PLATE
V	X	A	A	V
BOOK X		DWG. Y	SHEET Y	

Site No. 31

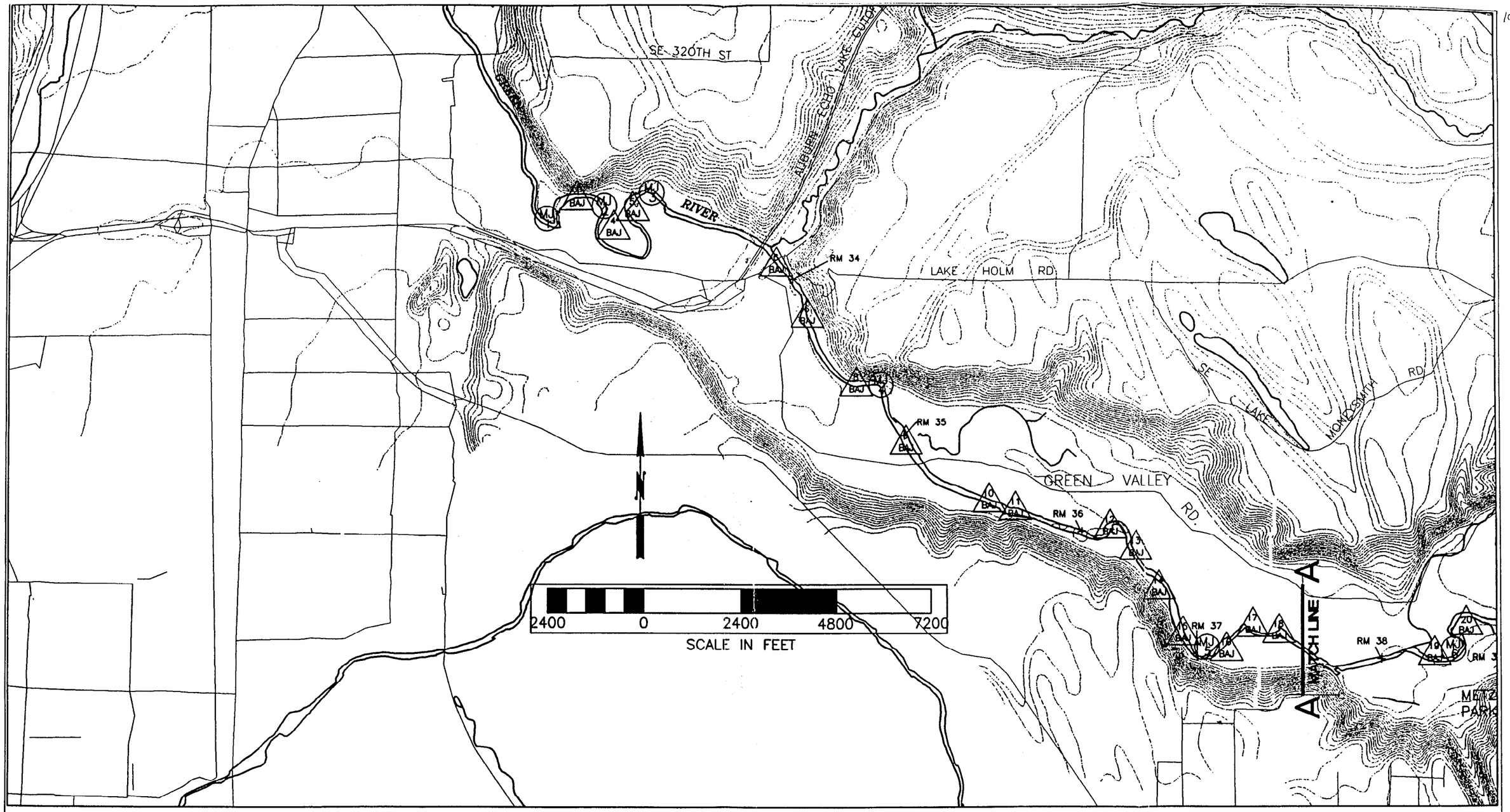
219



TYPICAL LARGE WOODY DEBRIS JAM DETAIL
N.T.S.

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES

U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON
ECOSYSTEM RESTORATION FEASIBILITY STUDY
GREEN RIVER MAINSTEM – L.W.D.
TYPICAL DETAIL



KEY

20 BAJ — Potential Bar Apex Jam (BAJ) Site

MJ 12 — Potential Meander Jam (MJ) Site

PROJECT NO. 2J1647	
APPROVED: D. Althauser	DATE: 2/00
PROJECT MANAGER: W. Kara	DATE: 2/00
ECOLOGIST: Kerry Bauman	DATE: 2/00
DRAWN: E. MacKinnon	DATE: 2/00

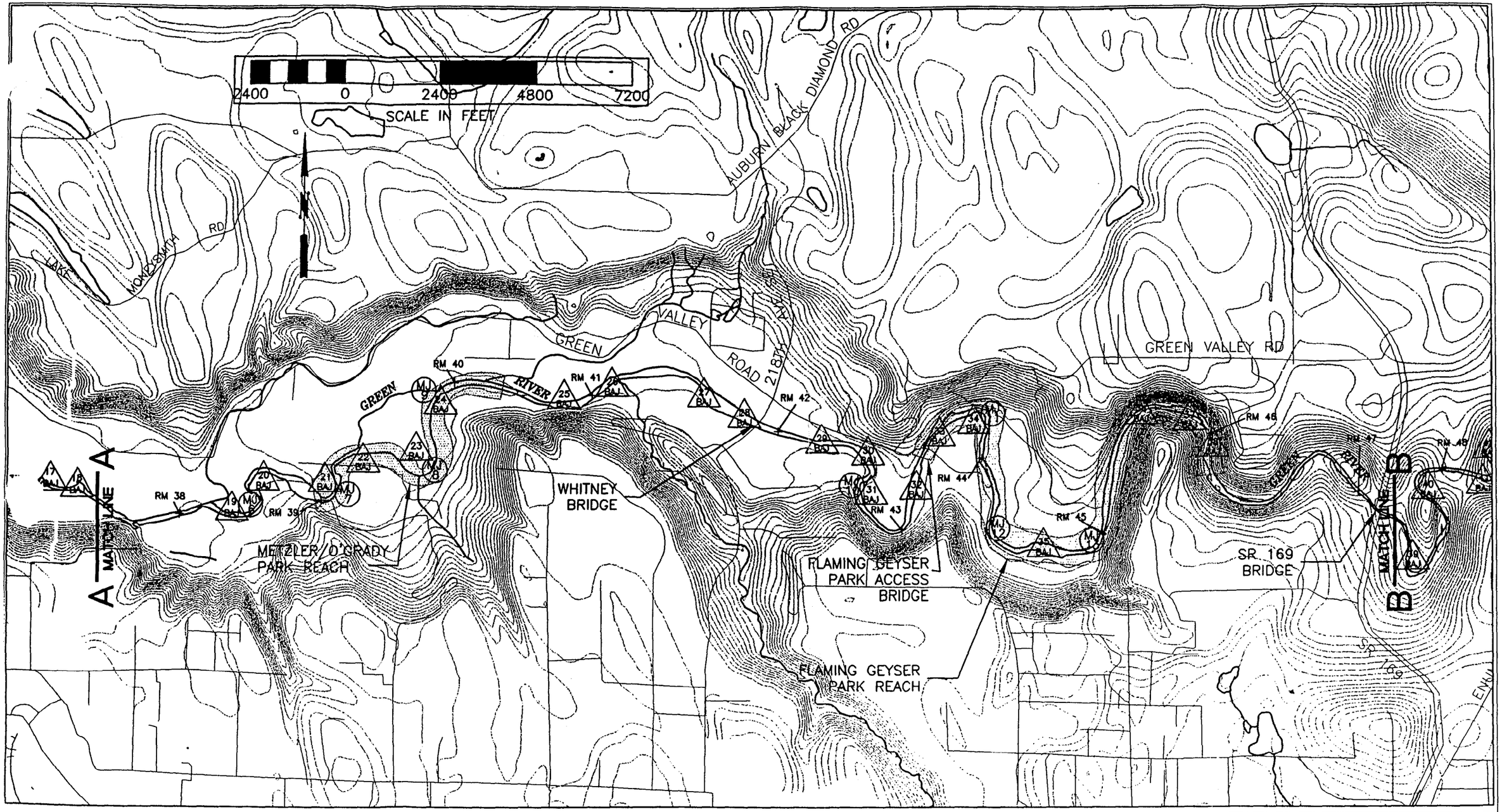
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

MAINSTEM GREEN RIVER
LARGE WOODY DEBRIS

SIZE	DOCUMENTATION NO.	FILE NO.	DATE	PLATE
X	X	X	X	X
DSGN. X		CHK. X	SHEET X	



KEY

20 BAJ — Potential Bar Apex Jam (BAJ) Site

MJ 12 — Potential Meander Jam (MJ) Site

PROJECT NO. 2J1647	
APPROVED: D. Althauser	DATE: 2/00
PROJECT MANAGER: W. Kara	DATE: 2/00
ECOLOGIST: Kerry Bauman	DATE: 2/00
DRAWN: E. MacKinnon	DATE: 2/00

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

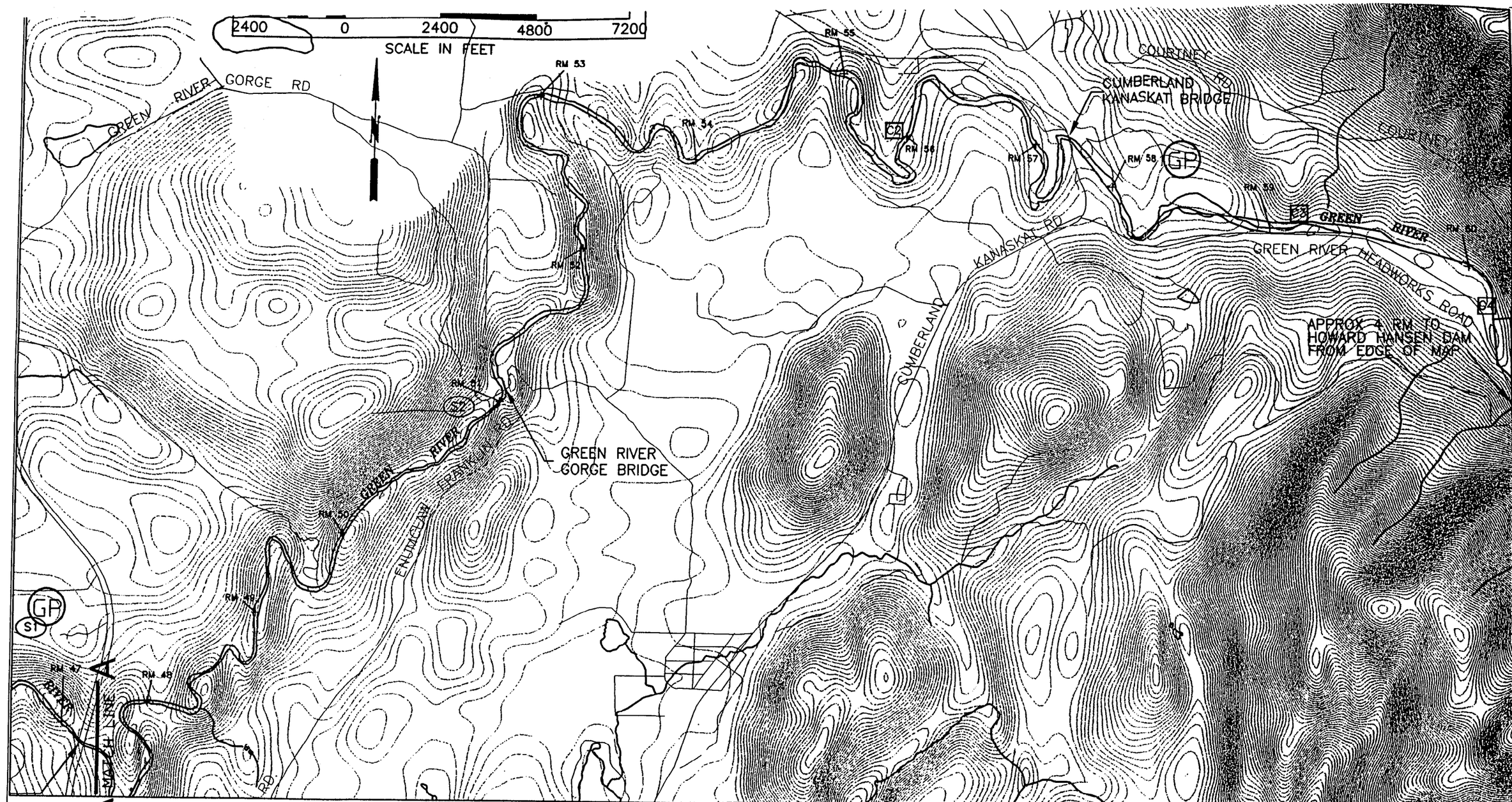
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

MAINSTEM GREEN RIVER
LARGE WOODY DEBRIS

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
X	X	X	X	X
DSGN. X		CHK. X	SHEET X	

230



KEY

(GP) Gravel Pit

[C1] Crane Placement Site

(S1) Skyline Tower Site

PROJECT NO. 2K1647	
APPROVED: D. Althauser	DATE: 2/00
PROJECT MANAGER: W. Karg	DATE: 2/00
GEOLOGIST: John Bethel	DATE: 2/00
DRAWN: E. MacKinnon	DATE: 2/00

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

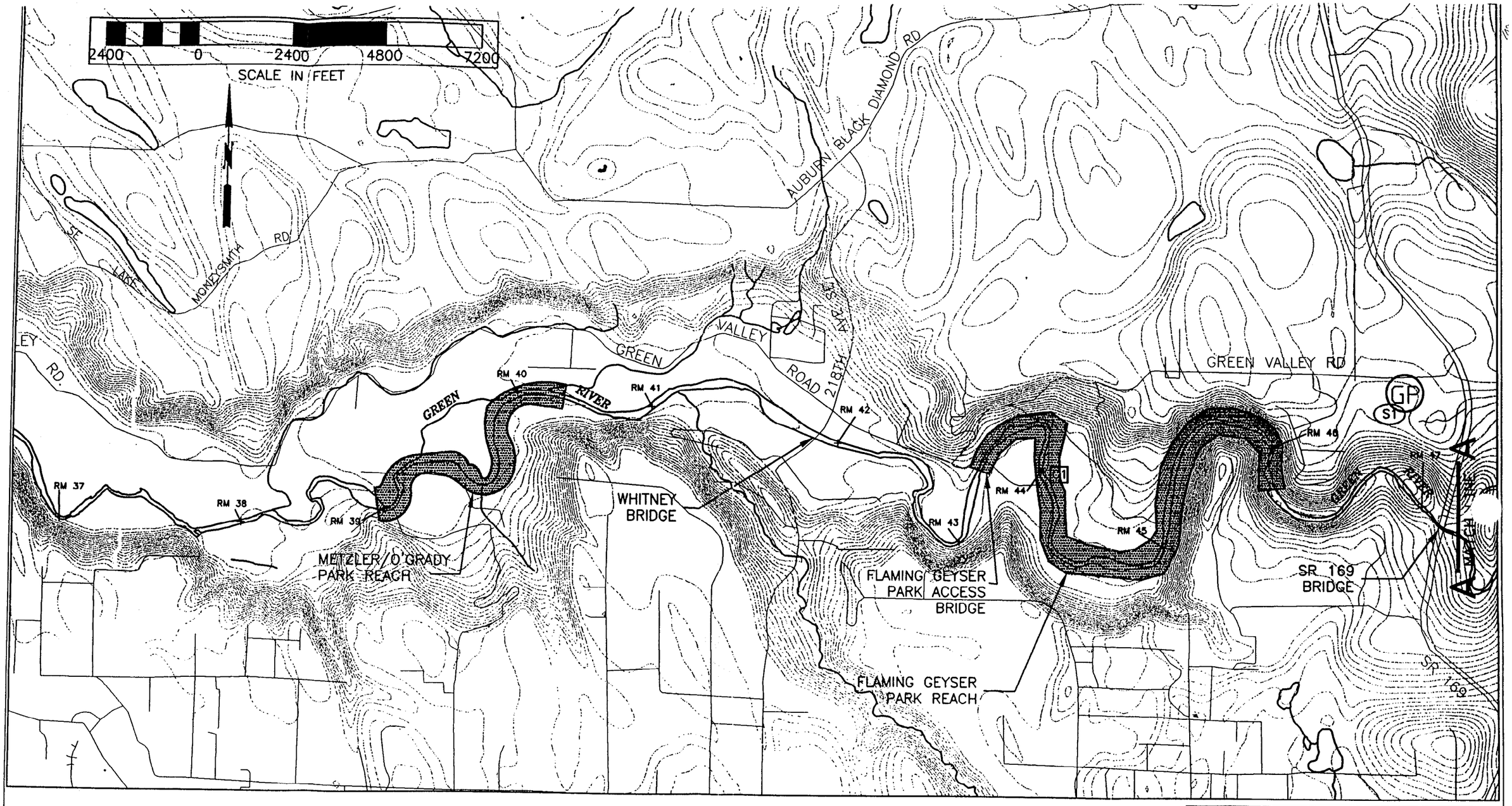
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

GREEN RIVER
GRAVEL REPLENISHMENT

SIZE	SIMTATION NO.	FILE NO.	DATE:	PLATE
X	X	X	X	X
DSGN. X		CHK. X	SHEET 1 OF 2	

Site No. 33



KEY

GP Gravel Pit

C1 Crane Placement Site

S1 Skyline Tower Site

PROJECT NO. 2K1647	
APPROVED: D. Althauser	DATE: 2/00
PROJECT MANAGER: W. Kara	DATE: 2/00
GEOLOGIST: John Bethel	DATE: 2/00
DRAWN: E. MacKinnon	DATE: 2/00

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

U.S. ARMY ENGINEER DISTRICT, SEATTLE
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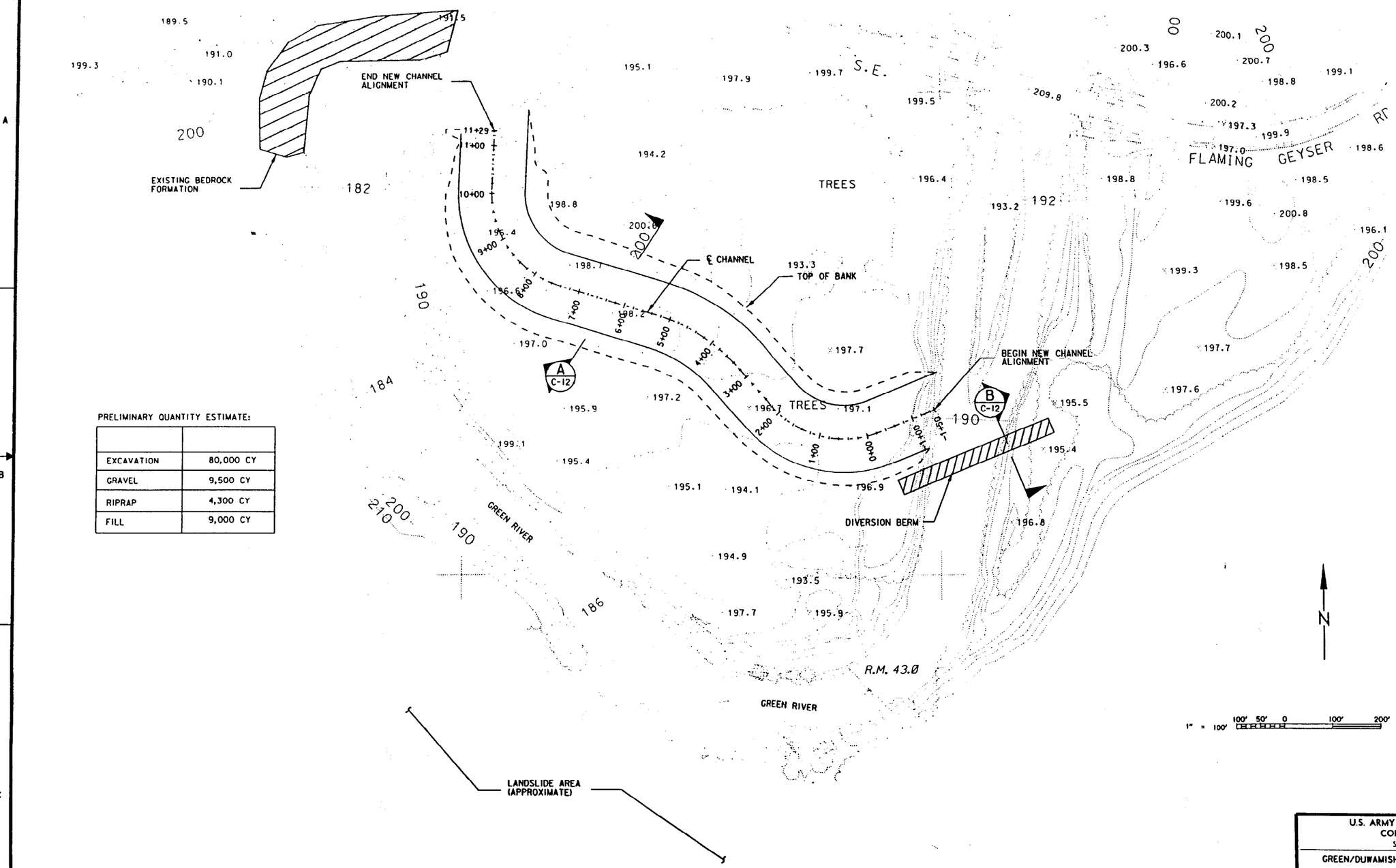
SEATTLE, WASHINGTON

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY

GREEN RIVER
GRAVEL REPLENISHMENT

SIZE	DIVISION NO.	FILE NO.	DATE:	PLATE
X	X	X	X	X
DSGN. X		CHK. X	SHEET 2 OF 2	

Site No. 33



PRELIMINARY QUANTITY ESTIMATE:

EXCAVATION	80,000 CY
GRAVEL	9,500 CY
RIPRAP	4,300 CY
FILL	9,000 CY

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

GREEN/DUWAMISH RIVER HABITAT RESTORATION

FLAMING GEYSER SLIDE

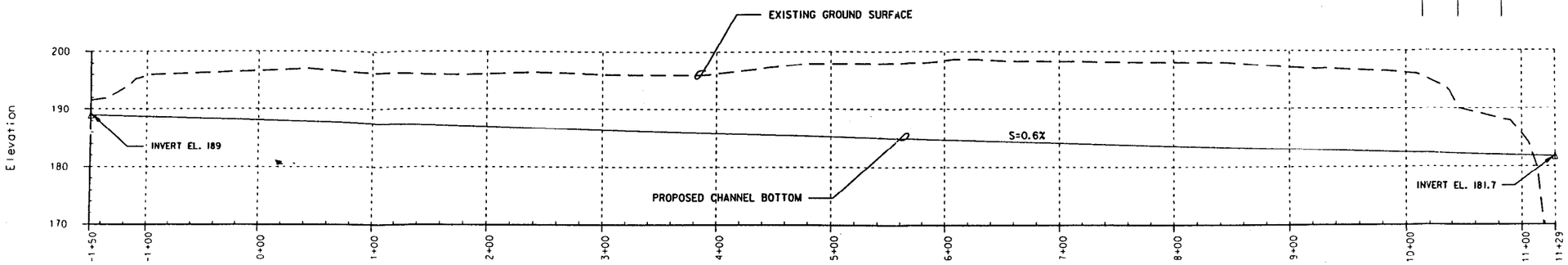
KING COUNTY — WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	99AUG15	C-10
DESIGN: PWN		CHK: DAF	SHEET 11	

DATE AND TIME PLOTTED: 05-JAN-2000 13:22
DESIGN FILE: I:\designs\msgd\civ\MSGDCS0J.dgn

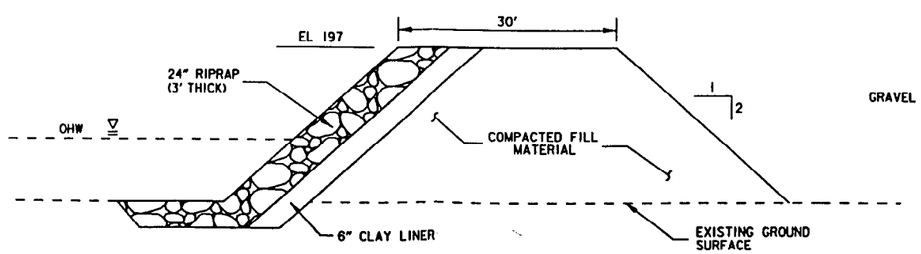
DESIGN FILE: I:\designs\msgd\civ\MSGDCS0J.dgn
DATE AND TIME PLOTTED: 05-JAN-2000 13:22

REVISIONS				
SYMBOL	ZONE	DESCRIPTION	DATE	BY



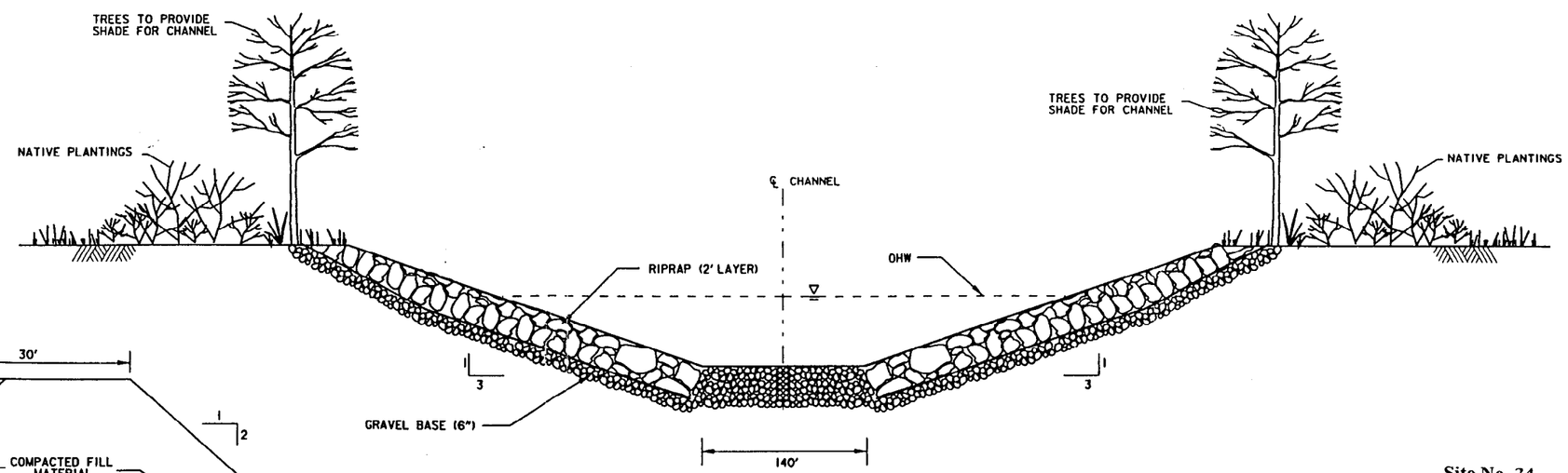
CHANNEL PROFILE

NOT TO SCALE



DIVERSION BERM SECTION (TYP) (B / C-10)

NOT TO SCALE



CHANNEL SECTION (TYP) (A / C-10)

NOT TO SCALE

Site No. 34

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

GREEN/DUWAMISH RIVER HABITAT RESTORATION

FLAMING GEYSER SLIDE CIVIL DETAILS

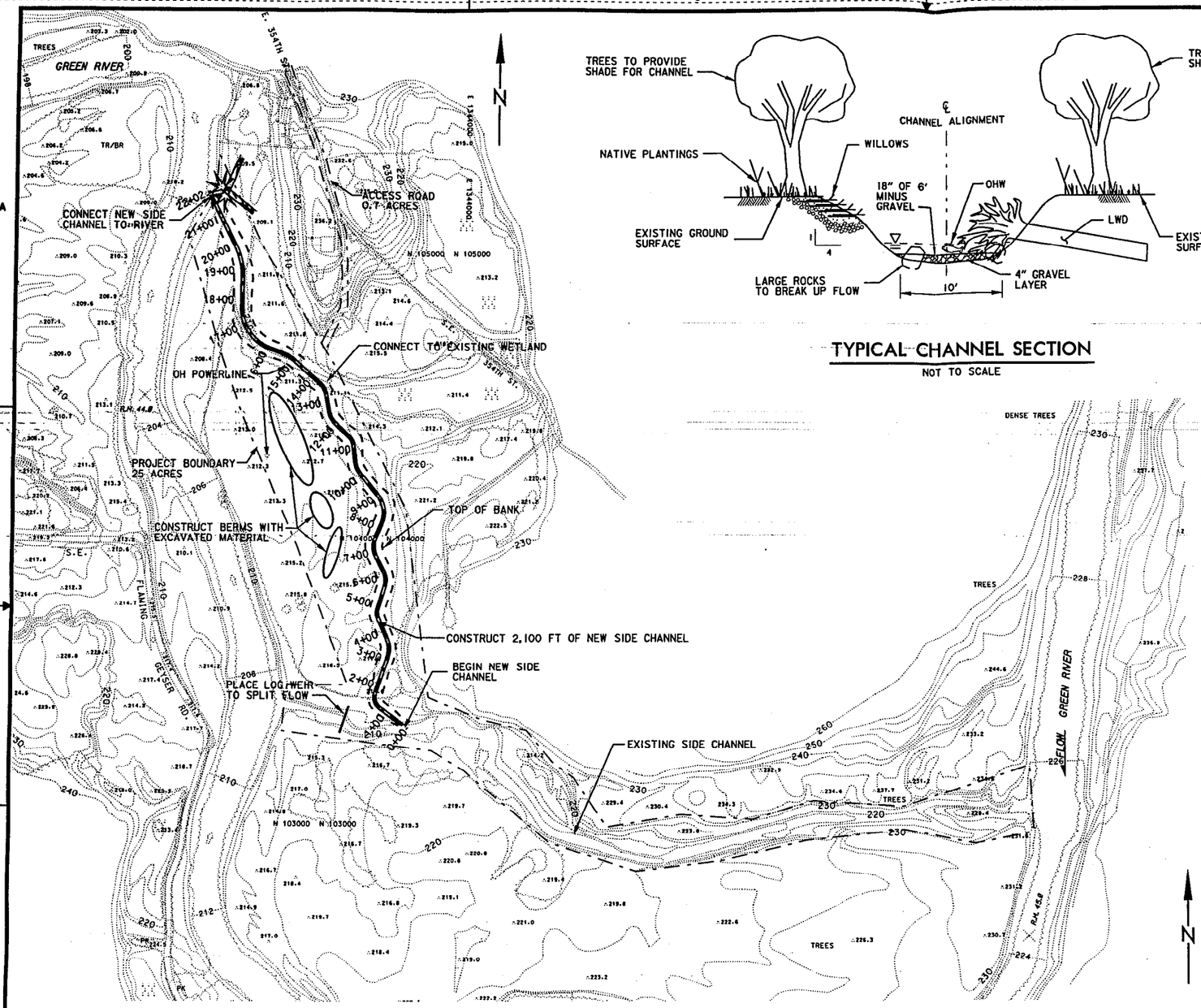
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
D	XX-XX	XX-XX	99AUG15	C-12
DSGN. PWN		DR. DAF	SHEET 13	

DATE AND TIME PLOTTED: 05-JAN-2000 14:51
DESIGN FILE: i:#designs#msgd#civ#msgdcs01.dgn

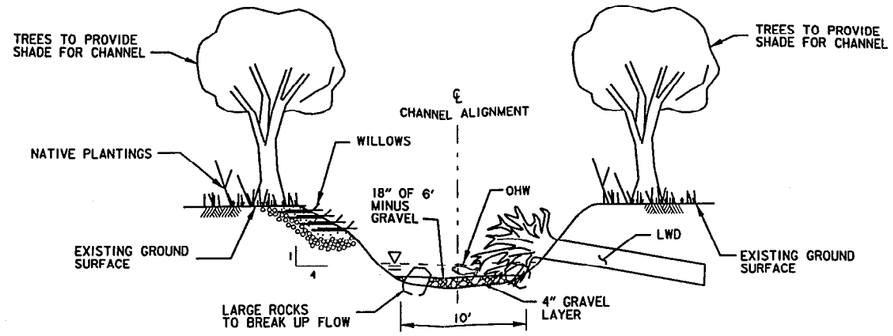
DATE AND TIME PLOTTED: 05-JAN-2000 14:51 DESIGN FILE: i:#designs#msgd#civ#msgdcs01.dgn

244



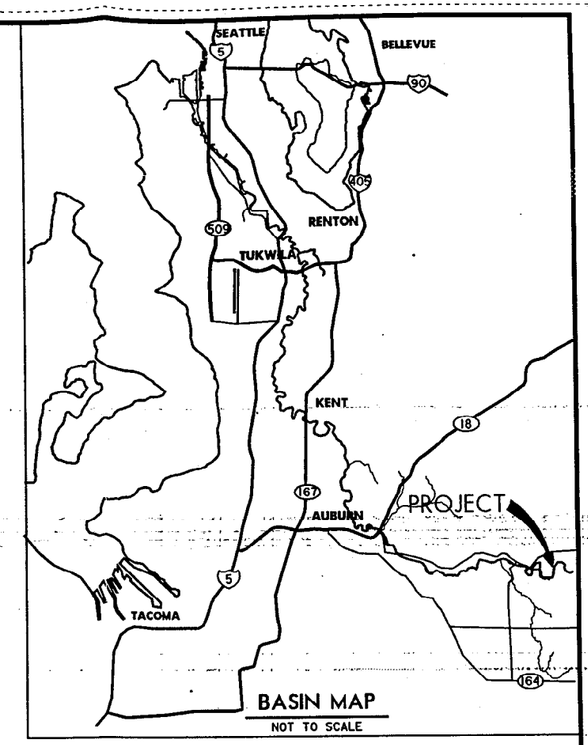
FLAMING GEYSER SIDE CHANNEL CONSTRUCTION

SCALE: 1" = 200'



TYPICAL CHANNEL SECTION

NOT TO SCALE



BASIN MAP

NOT TO SCALE

NOTES:

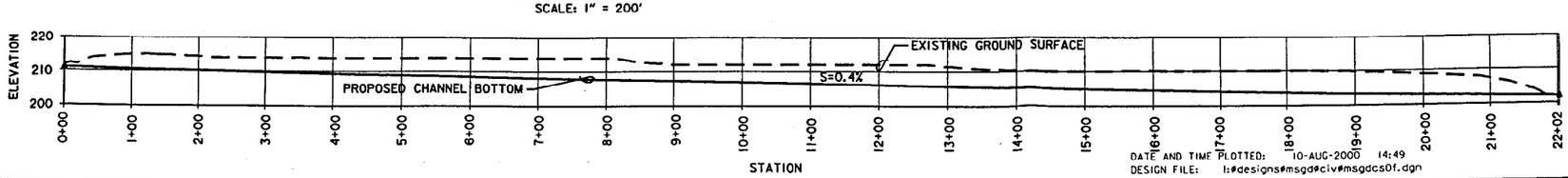
1. CHANNEL TO BE POOL-RIFFLE CONFIGURATION WITH LWD.
2. EXCAVATED MATERIAL TO BE USED ON SITE TO CONSTRUCT ADDITIONAL LANDSCAPE FEATURES.
4. PRIOR TO WATER DIVERSION, NEW CHANNEL WILL REMAIN DRY FOR APPROXIMATELY 2 YEARS TO ALLOW FOR PROPER ESTABLISHMENT OF VEGETATION.

PRELIMINARY QUANTITY ESTIMATE:

	QUANTITY
EXCAVATION	13,870 CY
GRAVEL	1,500 CY
CLAY (IF NECESSARY)	1,125 CY
ROOTWADS	25 EA
LARGE ROCKS (12"-18")	50 EA
COIR FABRIC	2,520 SQ. YRD

1" = 200' 200' 100' 0 200' 400'

Site No. 35



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DESIGN FILE: I:\designs\msgd\civ\msgdcs01.dgn

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

GREEN/DUWAMISH RIVER HABITAT RESTORATION

FLAMING GEYSER SIDE CHANNEL

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	99AUG15	C-6
DSGN. PWN		CHK. DAF	SHEET 7	

DATE AND TIME PLOTTED: 10-AUG-2000 14:49
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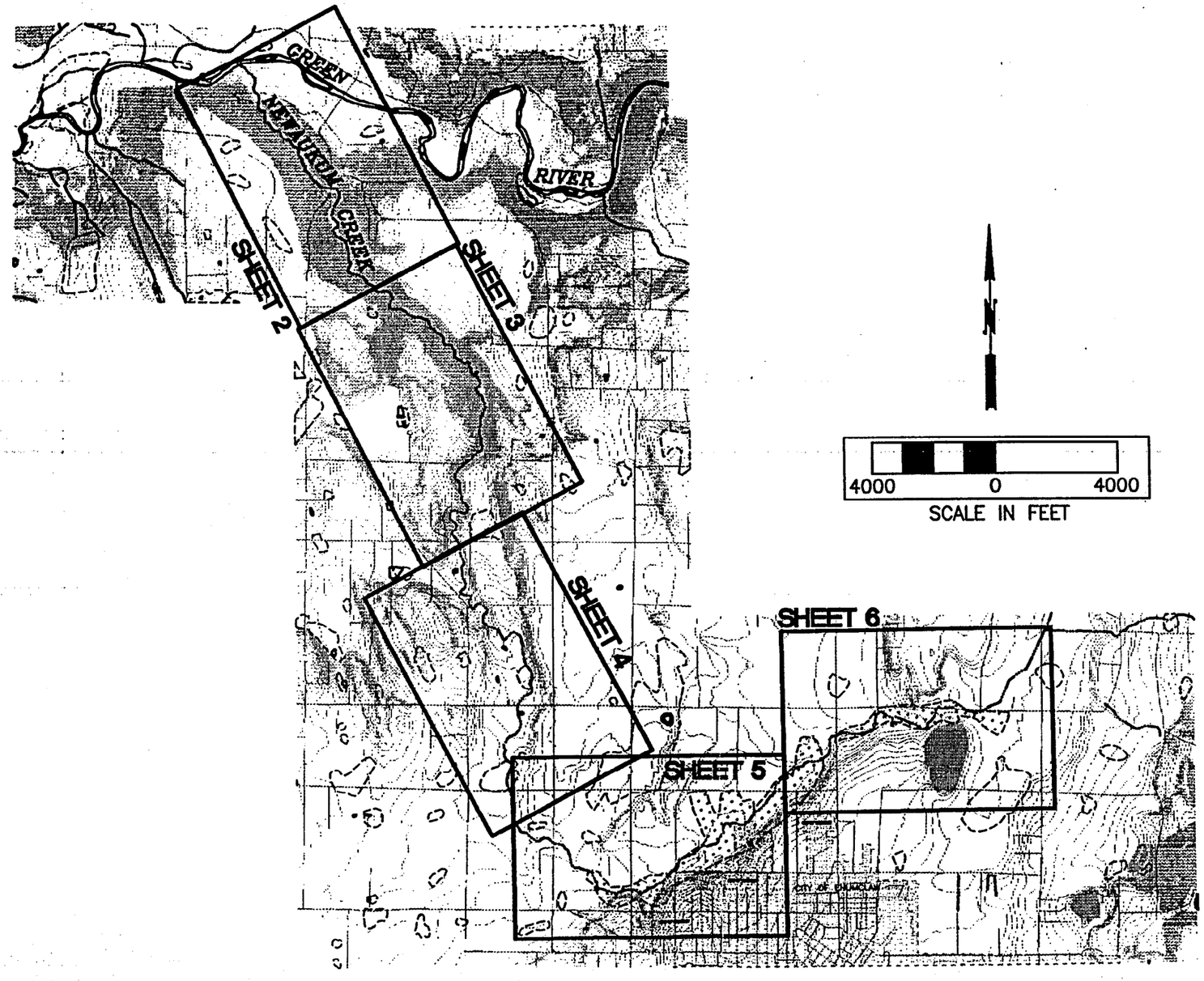


VICINITY LAYOUT PLAN

PROJECT NO. 2M1647	
APPROVED: D. Althauser	DATE: 11/99
PROJECT MANAGER: W. Kara	DATE: 11/99
DESIGNED: Bill Boehm, Karen Goto, Amy Carlson	DATE: 11/99
DRAWN: Traxinger, L.	DATE: 11/99

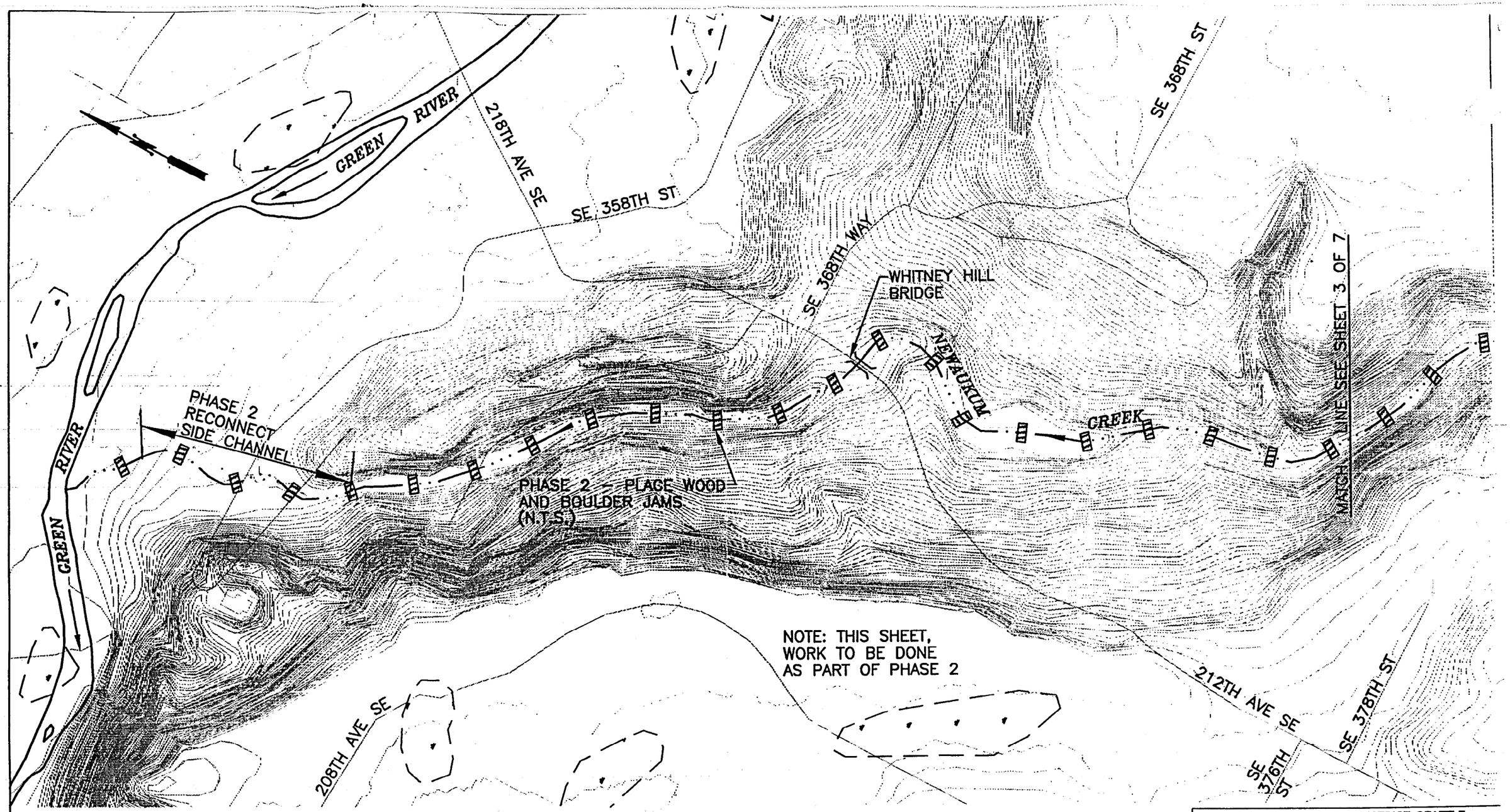
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY

NEWAUKUM CREEK
SITE PLAN SHEET 1 OF 7

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
X	X	X	X	X
DSGN. X		CHK. X	SHEET X	



PROJECT NO. 2M1647

APPROVED: D. Althauser DATE: 11/99

PROJECT MANAGER: W. Kara DATE: 11/99

DESIGNED: Bill Boehm, Karen Goto, Amy Carlson DATE: 11/99

DRAWN: Traxinger, I. DATE: 11/99

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

NEWAUKUM CREEK
SITE PLAN SHEET 2 OF 7

SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
X	X	X	X	X
DSGN. X		CHK. X	SHEET X	

256

Site No. 36

600 0 600 1200 1800

SCALE IN FEET

PROJECT NO. 2M1647

APPROVED: D. Althauser DATE: 11/99

PROJECT MANAGER: W. Kara DATE: 11/99

DESIGNED: Bill Boehm Karen Goto, Amy Carlson DATE: 11/99

DRAWN: Traxinger, L. DATE: 11/99

KING COUNTY DEPT. OF NATURAL RESOURCES

PAM BISSONNETTE, DIRECTOR

SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

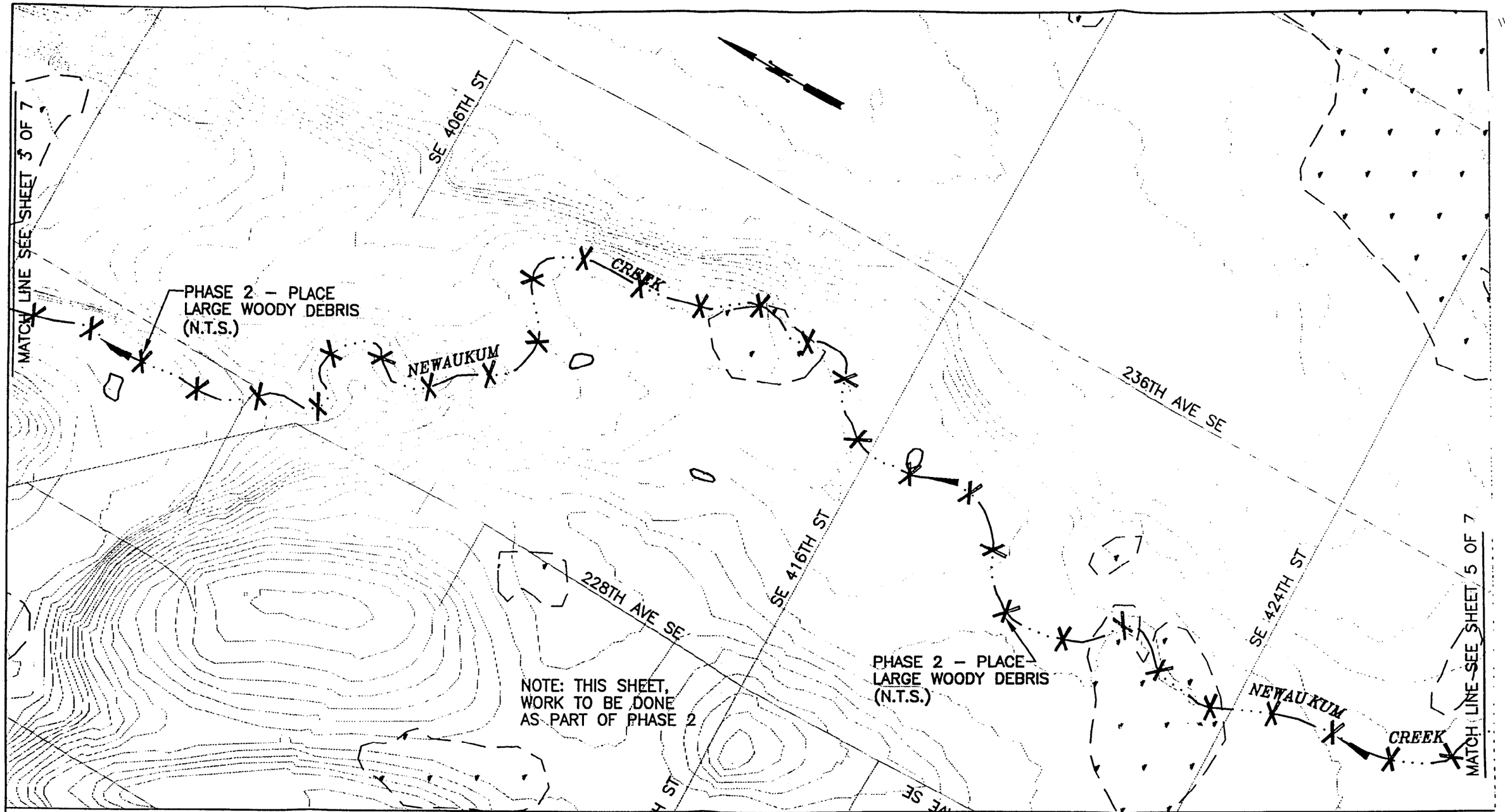
GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

NEWAUKUM CREEK

SITE PLAN SHEET 3 OF 7

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
X	x	X	X	X
DSGN. X		CHK. X	SHEET X	

257



600 0 600 1200 1800

SCALE IN FEET

PROJECT NO. 2M1647

APPROVED: D. Althauser DATE: 11/99

PROJECT MANAGER: W. Kara DATE: 11/99

DESIGNED: Bill Boehm, Karen Goto, Amy Carlson DATE: 11/99

DRAWN: Traxinger, L. DATE: 11/99

KING COUNTY DEPT. OF NATURAL RESOURCES

PAM BISSONNETTE, DIRECTOR

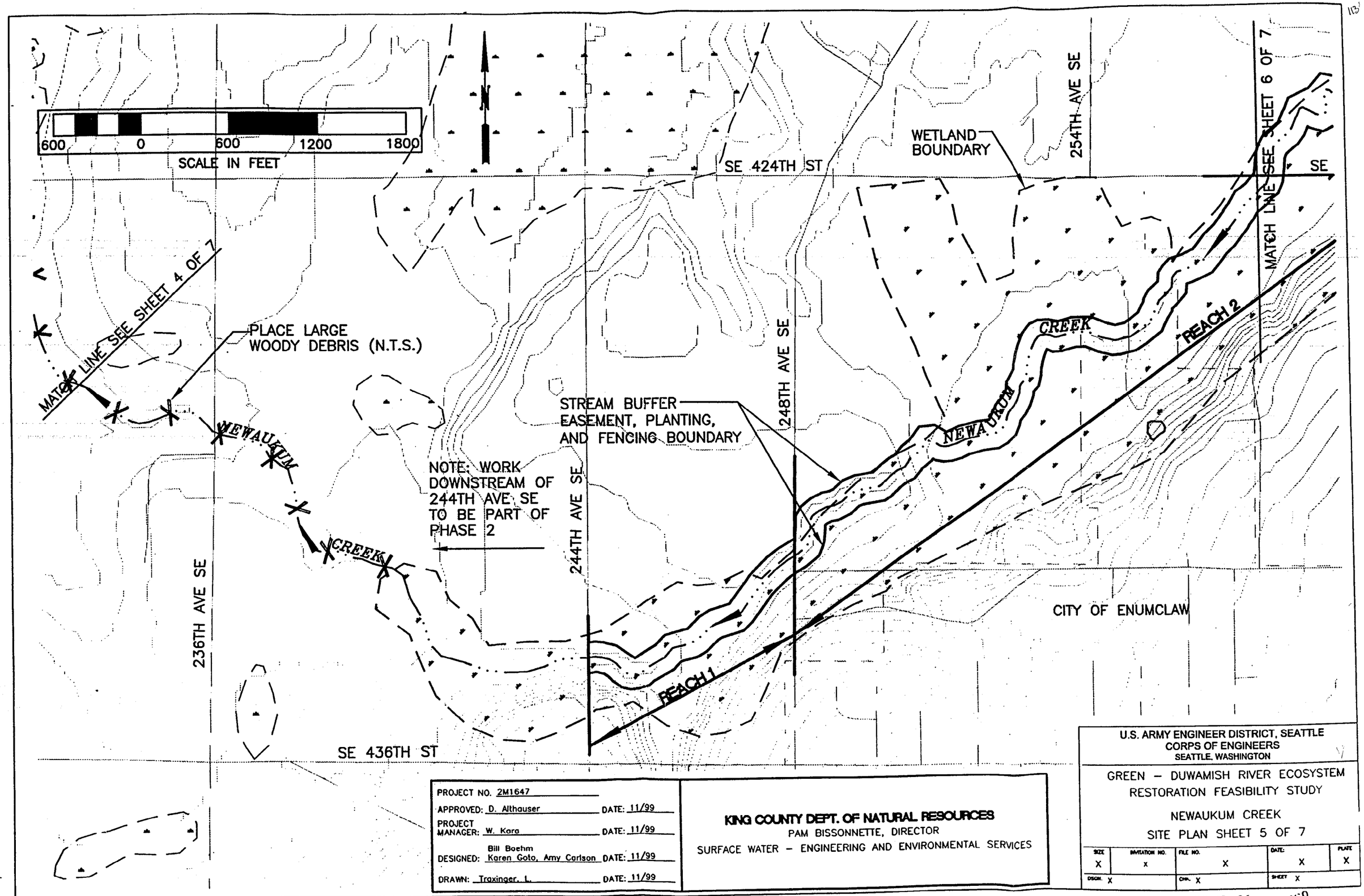
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM
RESTORATION FEASIBILITY STUDY

NEWAUKUM CREEK
SITE PLAN SHEET 4 OF 7

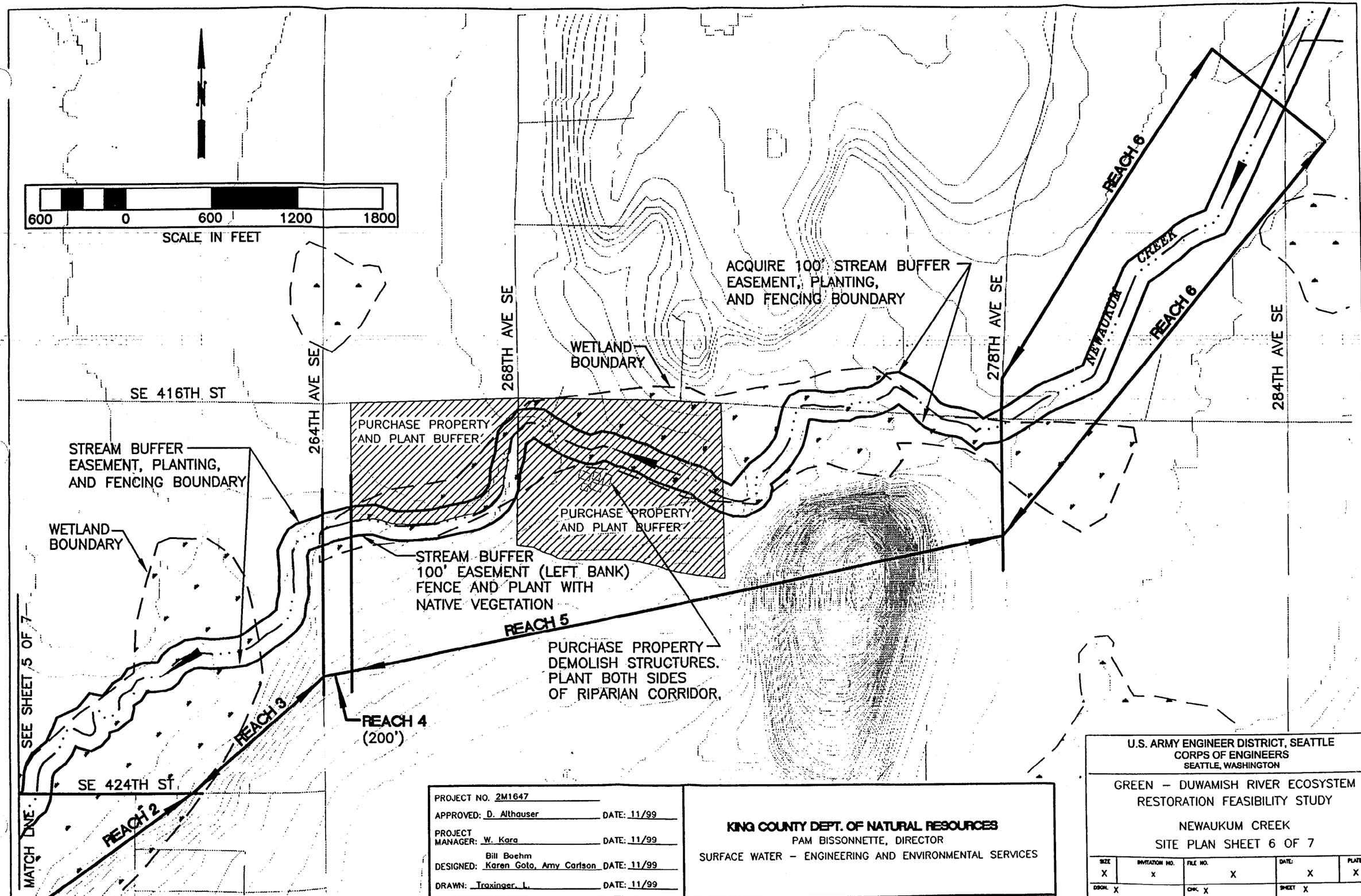
SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
X	x	X	X	X
DSGN. X		CHK. X	SHEET X	



Site No. 36

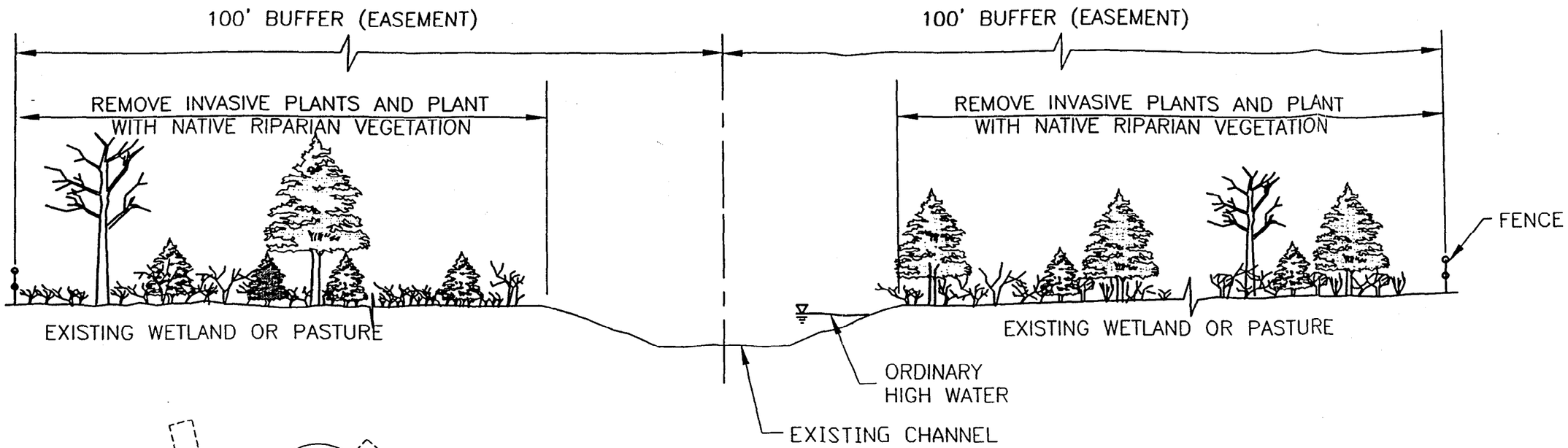
259

I:\WEHNUYK\green\NEWAUKUM\NWPLN2.dwg Fri Dec 03 15:32:08 1999

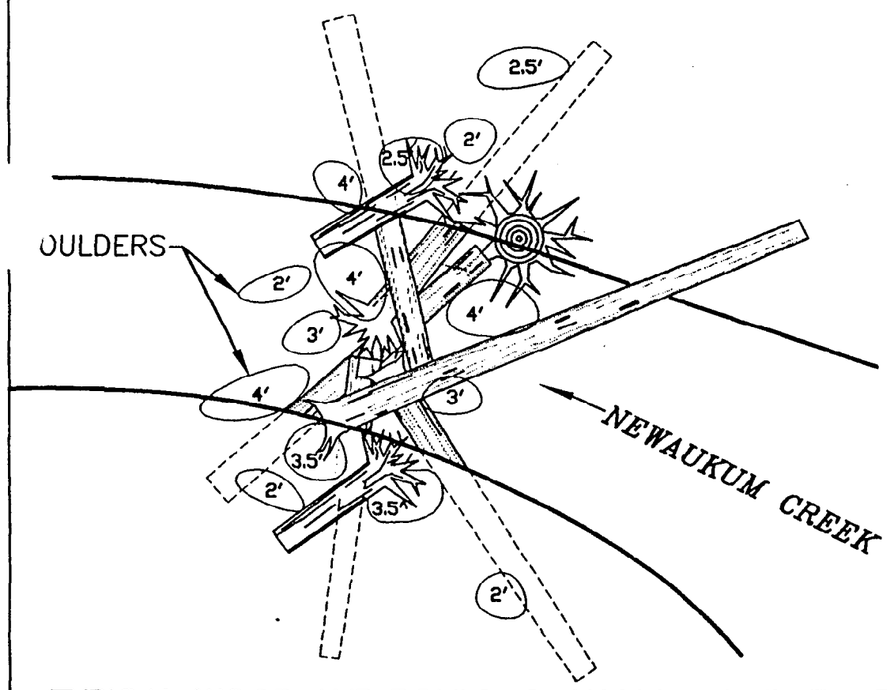


Site No. 36

260



TYPICAL SECTION
N.T.S.



TYPICAL WOOD AND BOULDER JAM PLACEMENT - PHASE 2
LOCATION IN RAVINE TO BE DETERMINED
N.T.S.

PROJECT NO. 2M1647
APPROVED: D. Althauser DATE: XXX
PROJECT MANAGER: W. Kara DATE: XXX
DESIGNED K. GOTO, A. CARLSON, B. BOEHM
DRAWN: TRAXINGER, L. DATE: XXX

KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

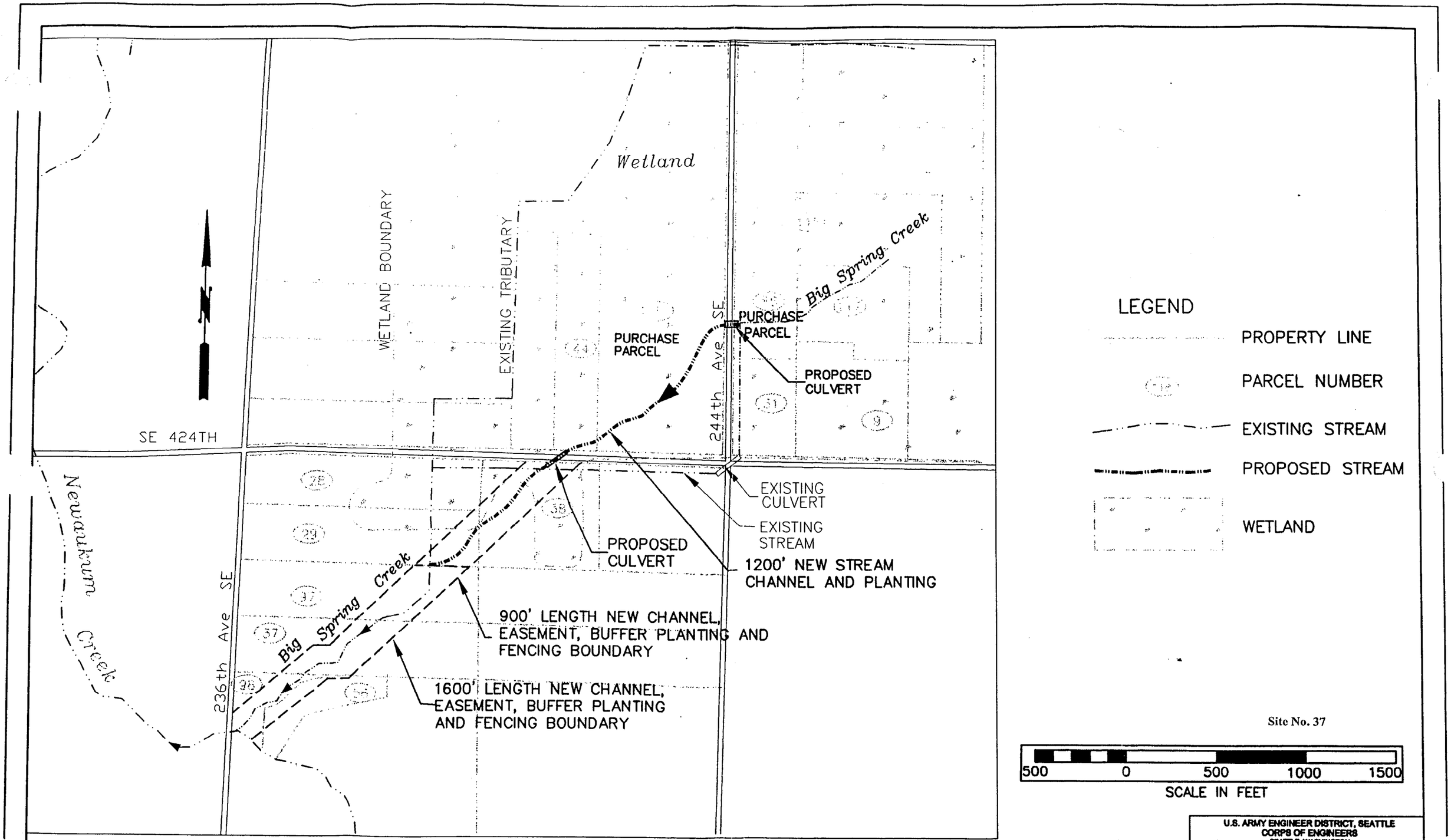
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

NEWAUKUM CREEK
TYPICAL SECTION SHEET 7 OF 7

SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
X	X	X	X	X
DSGN. X		CHK. X	SHEET X	

261



PROJECT NO. 2P1647
APPROVED: D. Althauser DATE: XXX
PROJECT MANAGER: W. Kera DATE: XXX
DESIGNED: K. Golo, A. Carlson, B. Boehm
DRAWN: E. MacKinnon DATE: XXX

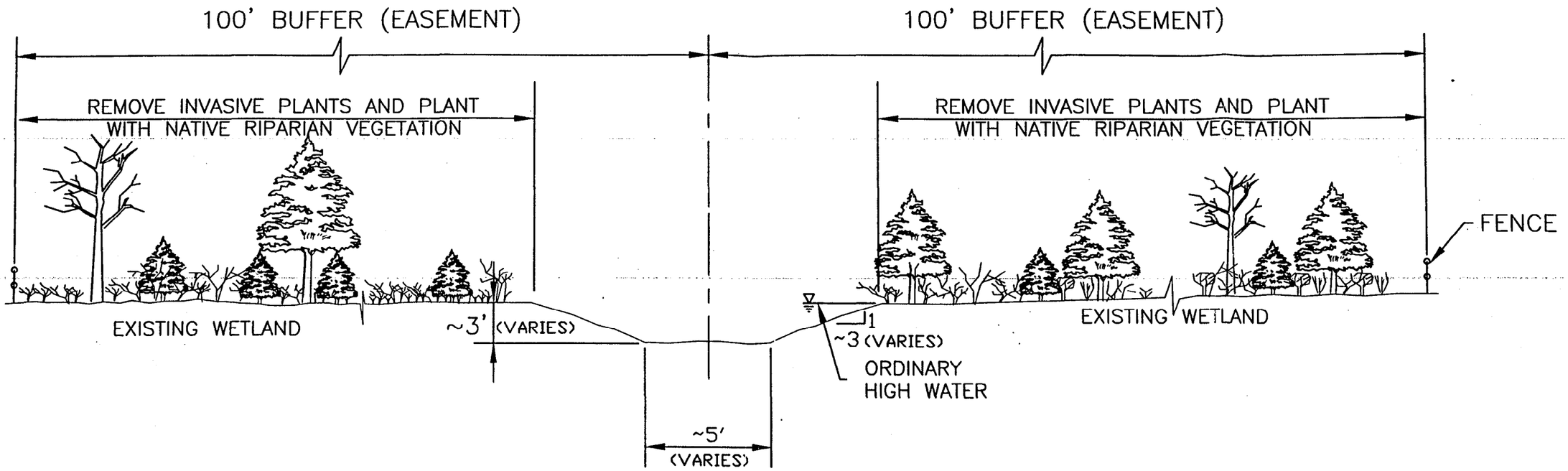
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONNETTE, DIRECTOR
SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES

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

GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

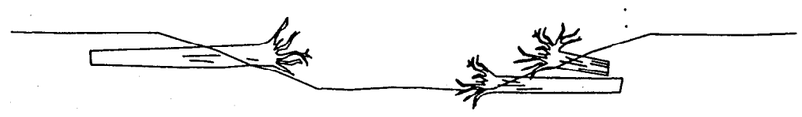
BIG SPRING CREEK
SITE PLAN

X	X	X	X	X
X		X	X	



TYPICAL SECTION N.T.S.

(CHANNEL GEOMETRY VARIES TO INCREASE COMPLEXITY)



TYPICAL LWD PLACEMENT

N.T.S. LOCATIONS TO BE DETERMINED

Site No. 37

PROJECT NO. 2P1647	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONNETTE, DIRECTOR SURFACE WATER – ENGINEERING AND ENVIRONMENTAL SERVICES
APPROVED: D. Althauser DATE: 2/00	
PROJECT MANAGER: W. Karg DATE: 2/00	
DESIGNED K. GOTO, A. CARLSON, B. BOEHM	
DRAWN: E. MacKinnon DATE: 2/00	

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

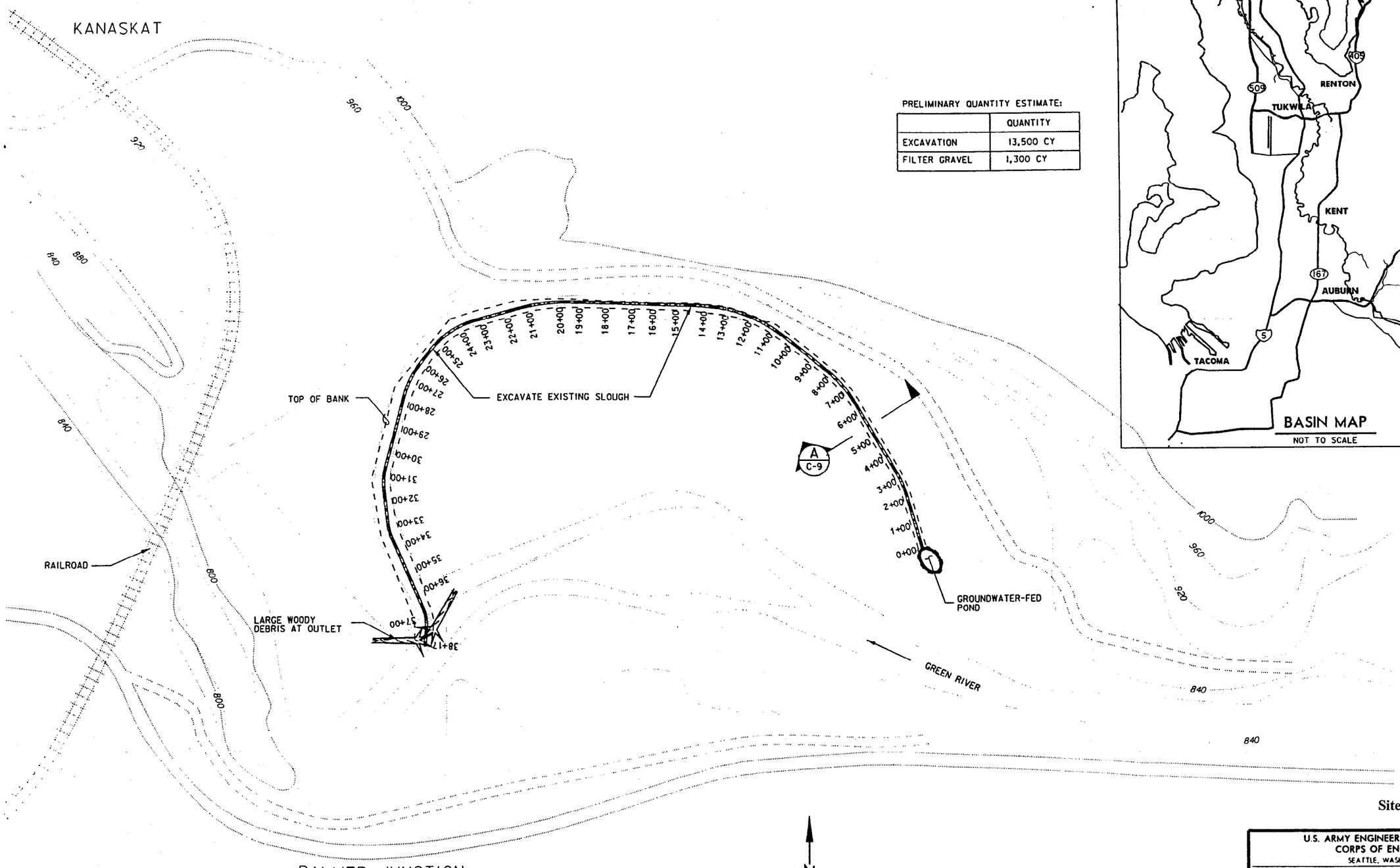
GREEN – DUWAMISH RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY

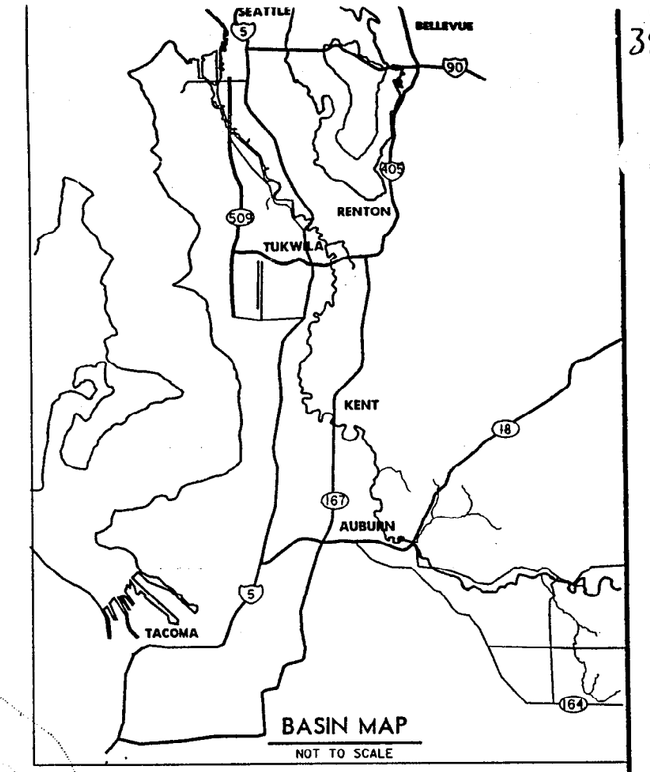
BIG SPRING CREEK
TYPICAL SECTION

SIZE	DRAWING NO.	FILE NO.	DATE:	PLATE
X	X	X	X	X
DSGN. X		CHK. X	SHEET X	

PRELIMINARY QUANTITY ESTIMATE:

	QUANTITY
EXCAVATION	13,500 CY
FILTER GRAVEL	1,300 CY





Site No. 38

BRUNER SLOUGH RESTORATION

SCALE: 1" = 200'

DATE AND TIME PLOTTED: 16-DEC-1999 12:33
DESIGN FILE: i:\des-gns\msgd\civ\msgdcs0n.dgn

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

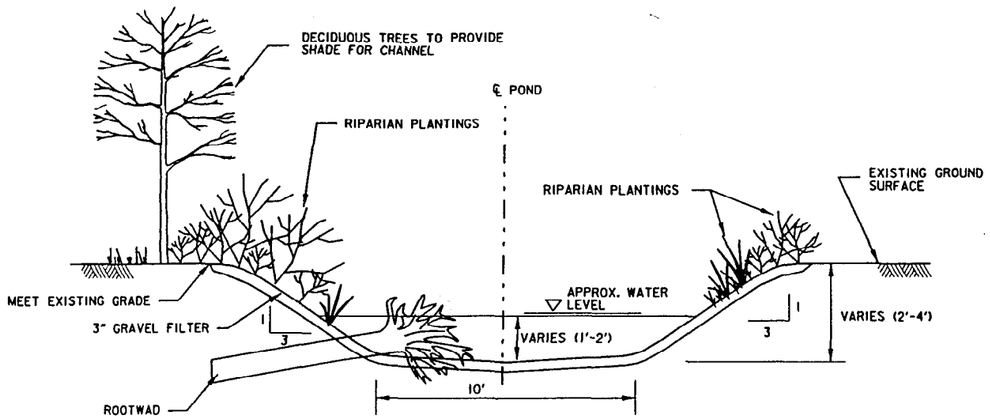
GREEN/DUWAMISH RIVER HABITAT RESTORATION

BRUNER SLOUGH RESTORATION

KING COUNTY WASHINGTON

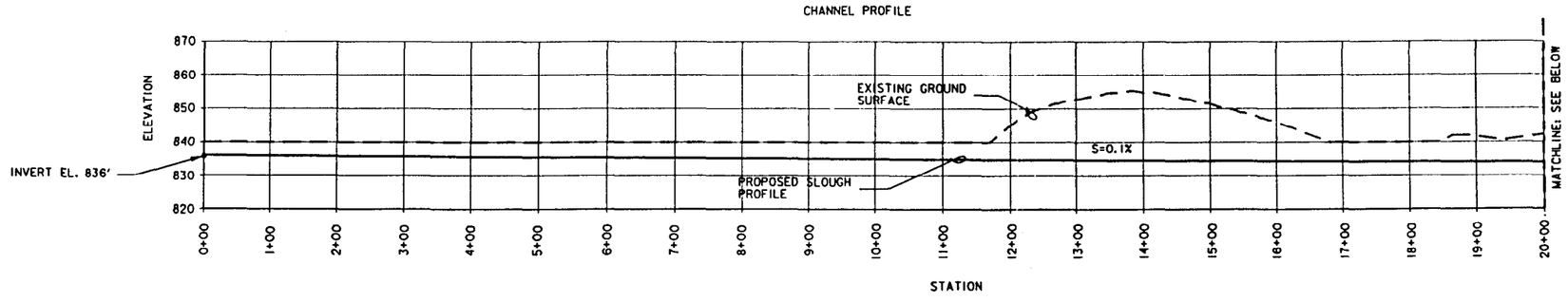
SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	99AUG15	C-8
DSGN. PWN		CHK. DAF	SHEET 9	

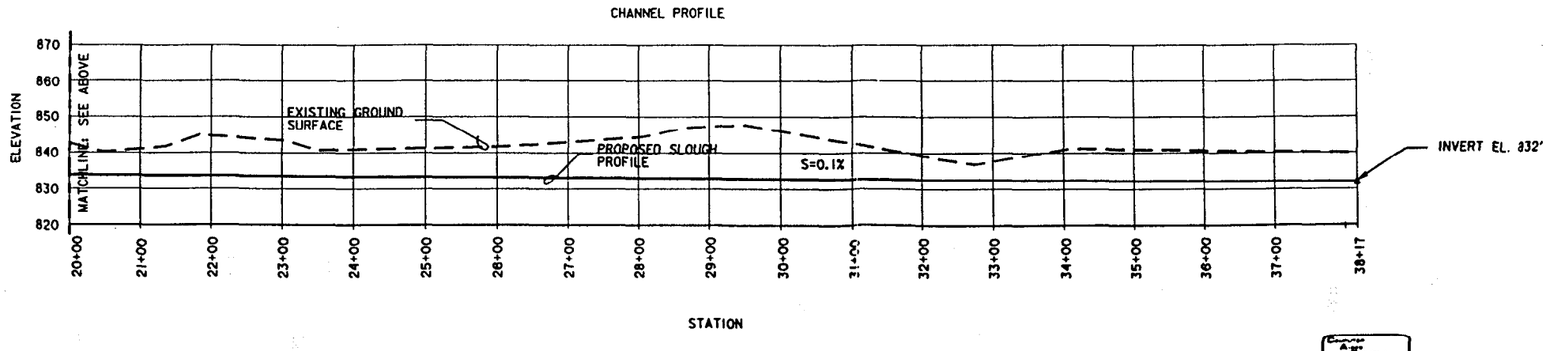
REVISIONS				
SYMBOL	ZONE	DESCRIPTION	DATE	BY



EXCAVATED CHANNEL CROSS-SECTION (A / C-8)

NOT TO SCALE





DATE AND TIME PLOTTED: 05-JAN-2000 11:52
DESIGN FILE: I:\designs\msgd\civil\MSGDCS01.dgn

Site No. 38

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

GREEN/DUWAMISH RIVER HABITAT RESTORATION

BRUNER SLOUGH CIVIL DETAILS

KING COUNTY WASHINGTON

SIZE	VERIFICATION NO.	FILE NO.	DATE	PLATE
D	XX-XX	XX-XX	99AUG15	C-9
DSGN. PWN		CHK. DAF	SHEET 10	

DESIGN FILE: signs\msgd\civil\MSGDCS01.dgn
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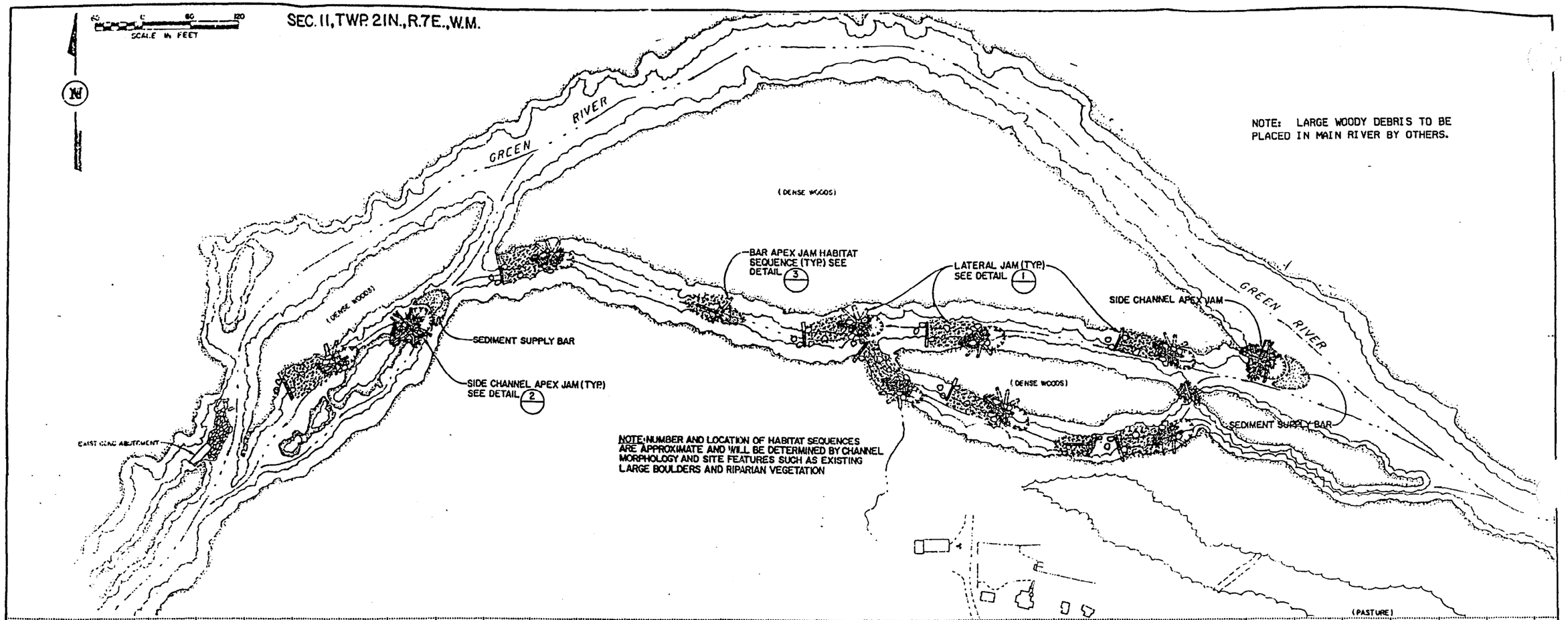


APPROVED: DON ALTHAUSER, P.E. DATE:
PROJECT MANAGER: DON ALTHAUSER, P.E. DATE:
ECOLOGIST: KERRY BAUMAN DATE:
DESIGNED: DON ALTHAUSER, P.E. KERRY BAUMAN DATE:
DRAWN: M.J. MERCIER DATE:

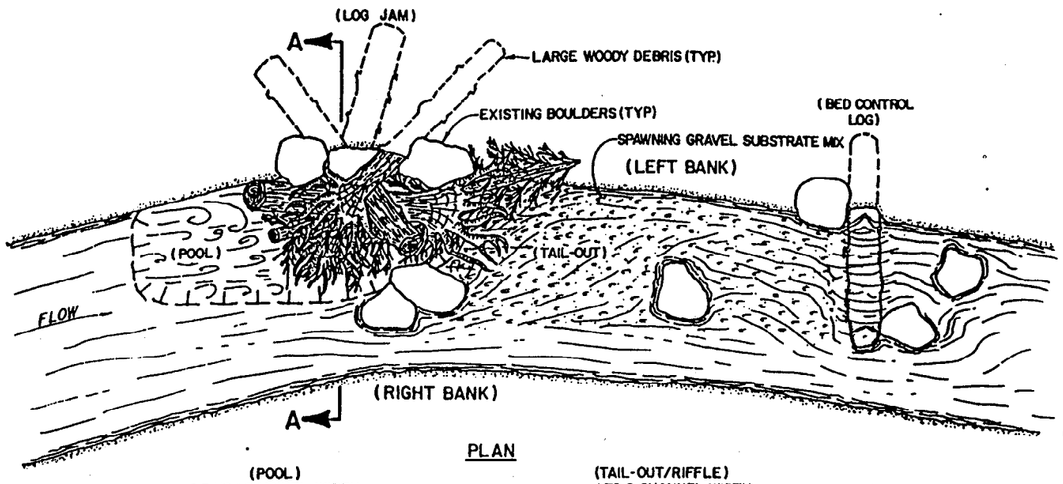
KING COUNTY DEPT. OF NATURAL RESOURCES
PAM BISSONETTE, DIRECTOR
SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES

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

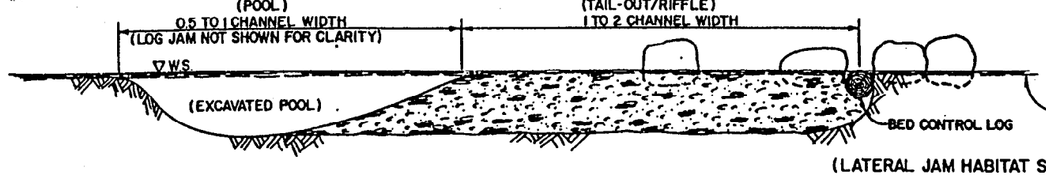
ECOSYSTEM RESTORATION FEASIBILITY STUDY
UPPER GREEN RIVER SIDE-CHANNEL
SITE 1 - RIVER MILE 59.5 (LEFT BANK)
SITE PLAN

SHEET 1 OF 2 SHEETS

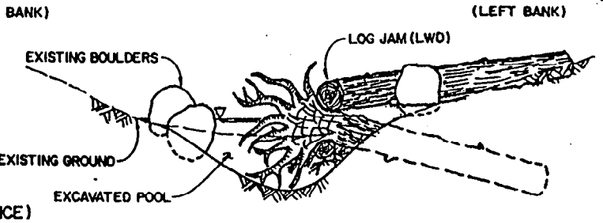
Site No. 39



PLAN



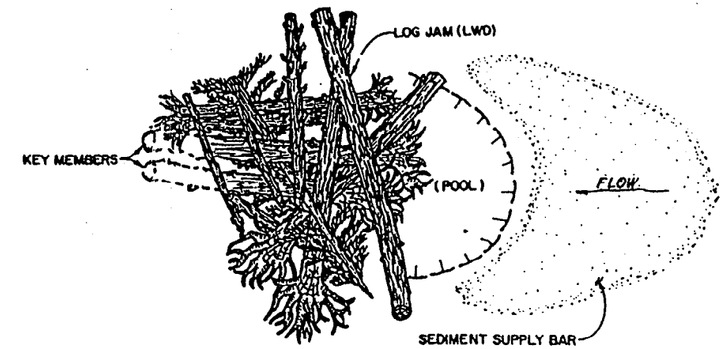
PROFILE



SECTION A-A

(LATERAL JAM HABITAT SEQUENCE)

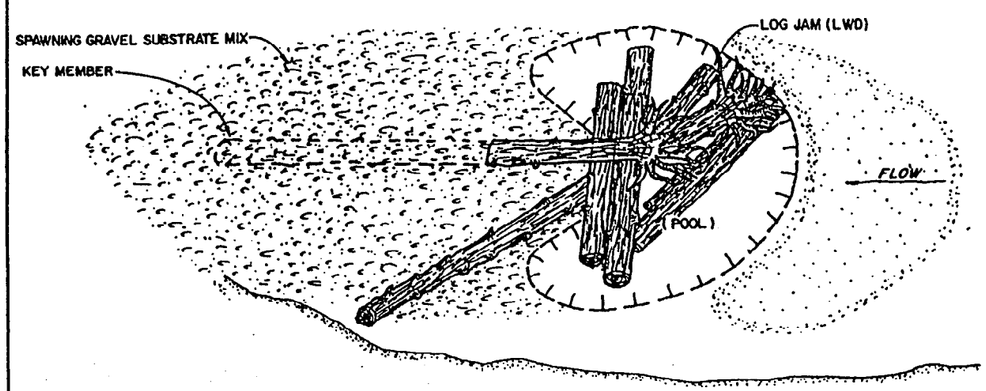
TYPICAL DESIGN DETAILS (1)
N.T.S.



PLAN

(SIDE CHANNEL APEX JAM WITH SEDIMENT SUPPLY BAR)

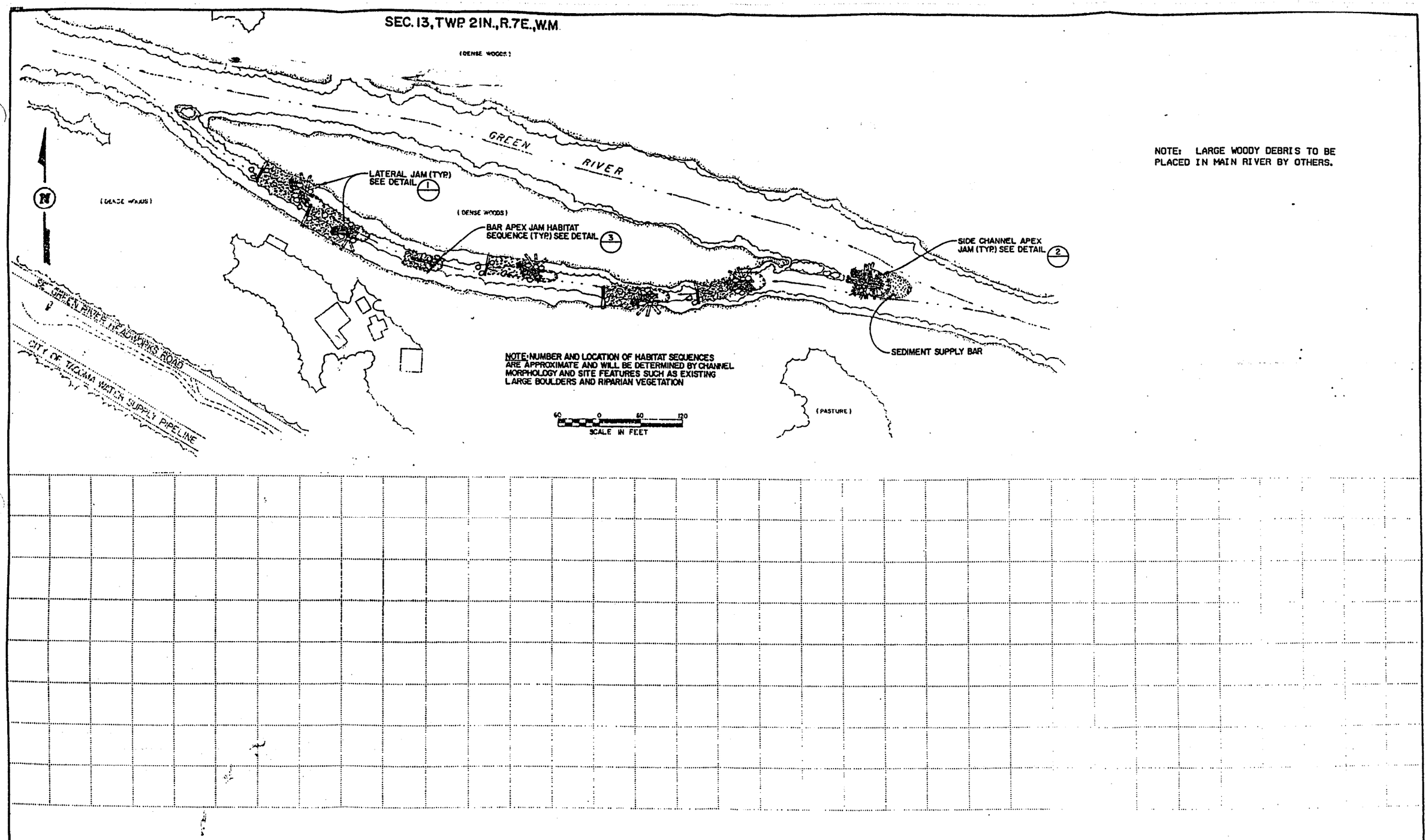
LOG JAM DETAIL (2)
N.T.S.



(BAR APEX JAM HABITAT SEQUENCE)

LOG JAM DETAIL (3)
N.T.S.

	APPROVED: DON ALTHAUSER, P.E. DATE: ____ PROJECT MANAGER: DON ALTHAUSER, P.E. DATE: ____ ECOLOGIST: KERRY BAUMAN DATE: ____ DESIGNED: DON ALTHAUSER, P.E. KERRY BAUMAN DATE: ____ DRAWN: M.J. MERCIER DATE: ____	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONETTE, DIRECTOR SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES	U.S. ARMY ENGINEER DISTRICT, SEATTLE CORPS OF ENGINEERS SEATTLE, WASHINGTON ECOSYSTEM RESTORATION FEASIBILITY STUDY UPPER GREEN RIVER SIDE-CHANNEL SITE 1 - RIVER MILE 59.5 (LEFT BANK) DETAILS	SHEET 2 OF 2 SHEETS



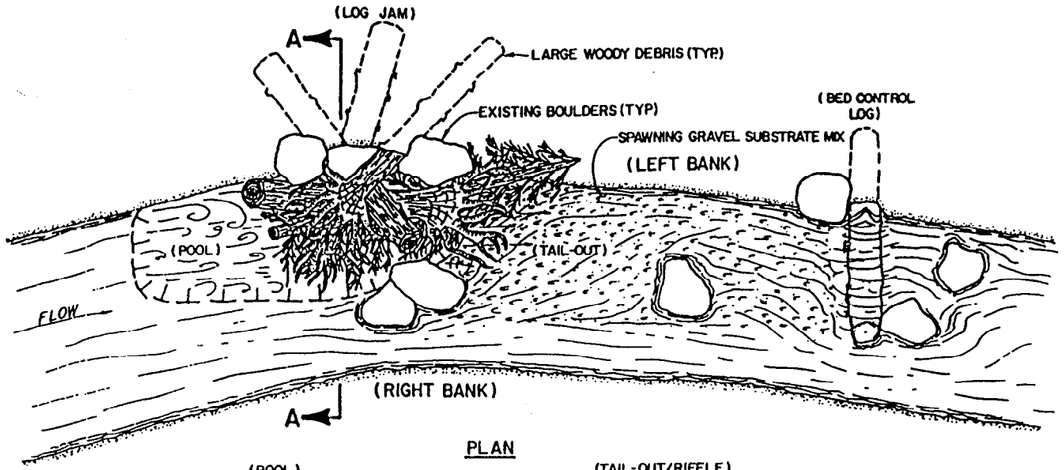
NOTE: LARGE WOODY DEBRIS TO BE PLACED IN MAIN RIVER BY OTHERS.

SURVEYED:				APPROVED: DON ALTHAUSER, P.E. DATE:	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONETTE, DIRECTOR SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES
BASE MAP PLOT:				PROJECT MANAGER: DON ALTHAUSER, P.E. DATE:	
DESIGN PLOT:				ECOLOGIST: KERRY BAUMAN DATE:	
CHECKED:				DESIGNED: DON ALTHAUSER, P.E. KERRY BAUMAN DATE:	
FIELD BOOK:				DRAWN: M.J. MERCIER DATE:	
BY	DATE	REVISION	BY	DATE	

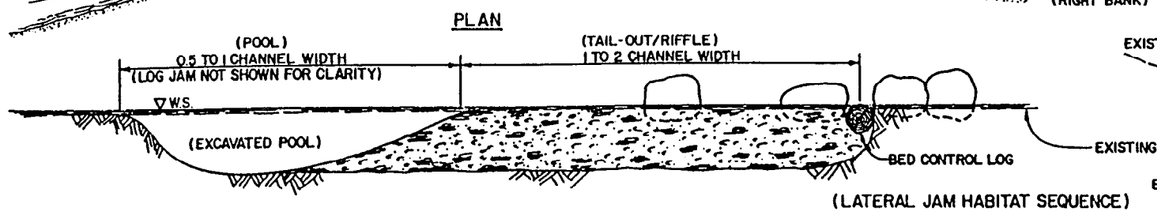
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

ECOSYSTEM RESTORATION FEASIBILITY STUDY
UPPER GREEN RIVER SIDE-CHANNEL
SITE 2 - RIVER MILE 60.0 (LEFT BANK)
SITE PLAN

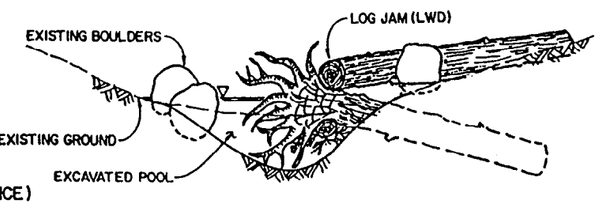
SHEET 1 OF 2 SHEETS



PLAN



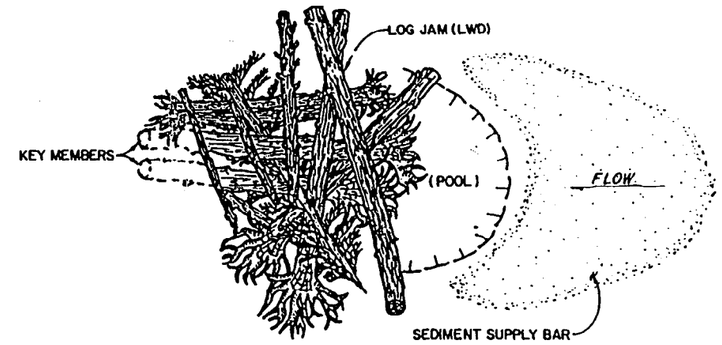
PROFILE



SECTION A-A

(LATERAL JAM HABITAT SEQUENCE)

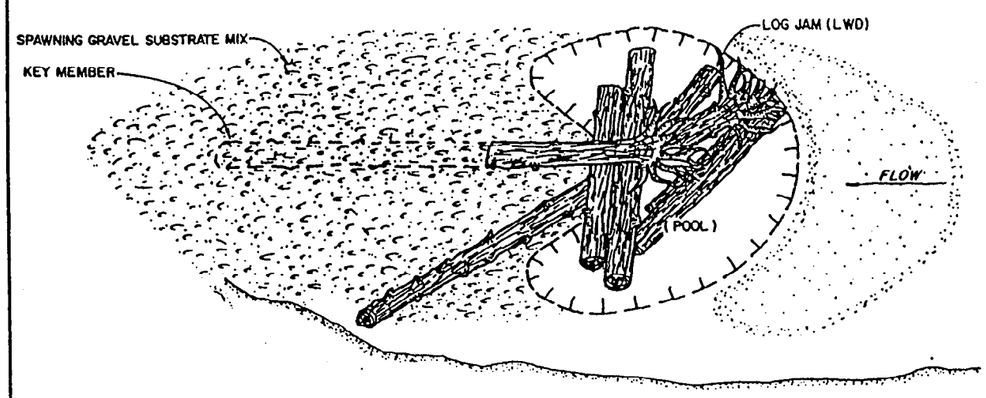
TYPICAL DESIGN DETAILS (1)
N.T.S.



PLAN

(SIDE CHANNEL APEX JAM WITH SEDIMENT SUPPLY BAR)

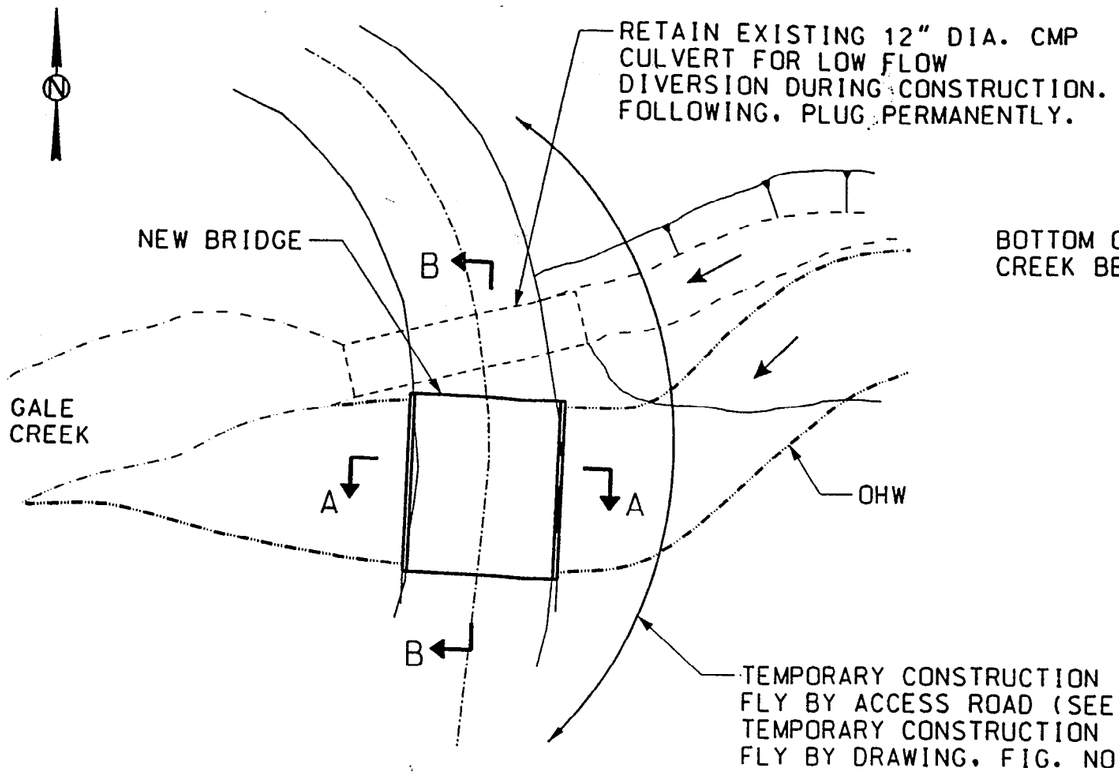
LOG JAM DETAIL (2)
N.T.S.



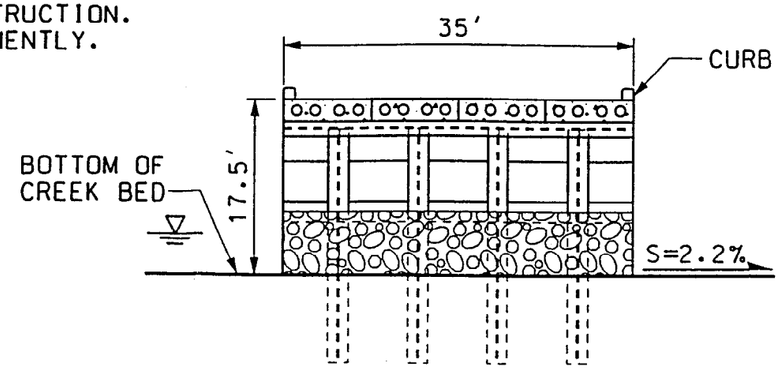
(BAR APEX JAM HABITAT SEQUENCE)

LOG JAM DETAIL (3)
N.T.S.

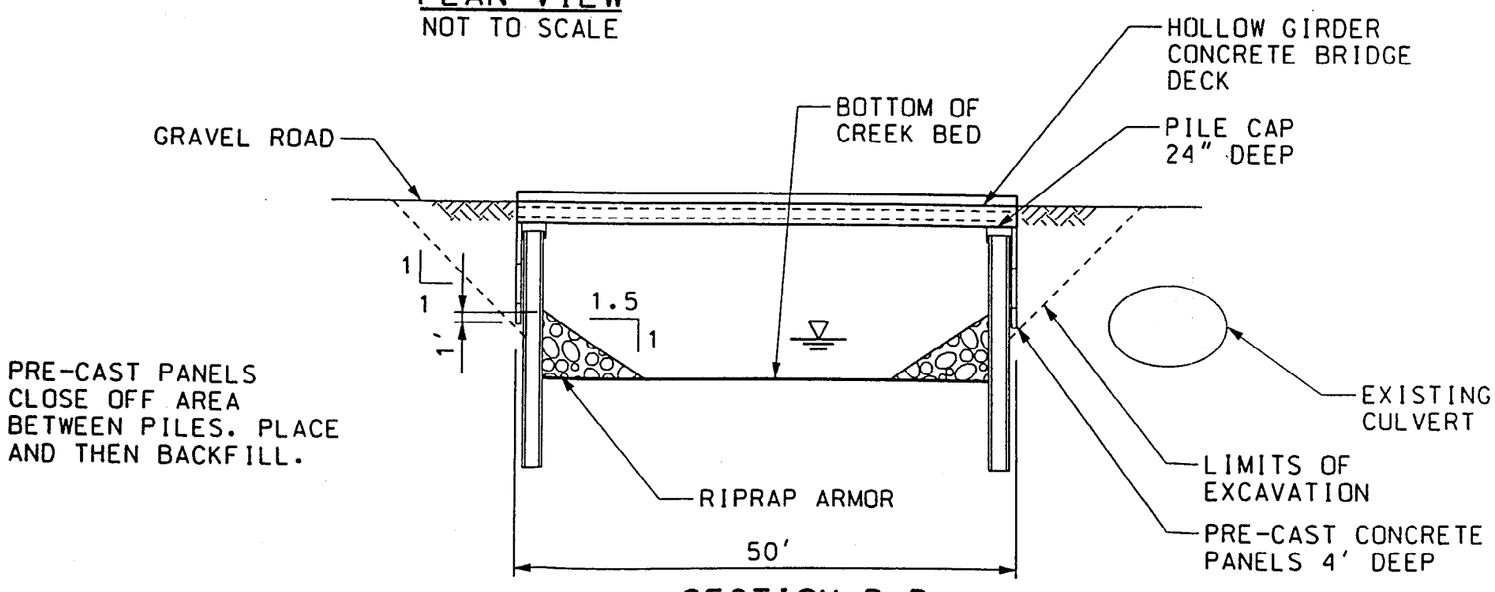
	APPROVED: DON ALTHAUSER, P.E. DATE: ____ PROJECT MANAGER: DON ALTHAUSER, P.E. DATE: ____ ECOLOGIST: KERRY BAUMAN DATE: ____ DESIGNED: DON ALTHAUSER, P.E. KERRY BAUMAN DATE: ____ DRAWN: M.J. MERCIER DATE: ____	KING COUNTY DEPT. OF NATURAL RESOURCES PAM BISSONETTE, DIRECTOR SURFACE WATER - ENGINEERING AND ENVIRONMENTAL SERVICES	U.S. ARMY ENGINEER DISTRICT, SEATTLE CORPS OF ENGINEERS SEATTLE, WASHINGTON ECOSYSTEM RESTORATION FEASIBILITY STUDY UPPER GREEN RIVER SIDE-CHANNEL SITE 2 - RIVER MILE 60.0 (LEFT BANK) DETAILS	SHEET 2 OF 2 SHEETS



PLAN VIEW
NOT TO SCALE



SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

1. SITE LOCATED IN USGS COUGAR MOUNTAIN QUADRANGLE. SEC. 36 TWP. 21 N. R8E ROAD 5530, MILEPOST 11.5.

2. UPSTREAM CREEK CHANNEL RESTORATION: PLACE SPAWNING GRAVEL IN CREEK 1 MILE U/S OF NEW BRIDGE. REFER TO CREEK DETAILS DRAWING, FIG. NO. 10.

Site No. 40

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

GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY
FIGURE NO. 4
CULVERT SITE #4
GALE CREEK

297

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: $$$DATE$$$$ $TIME
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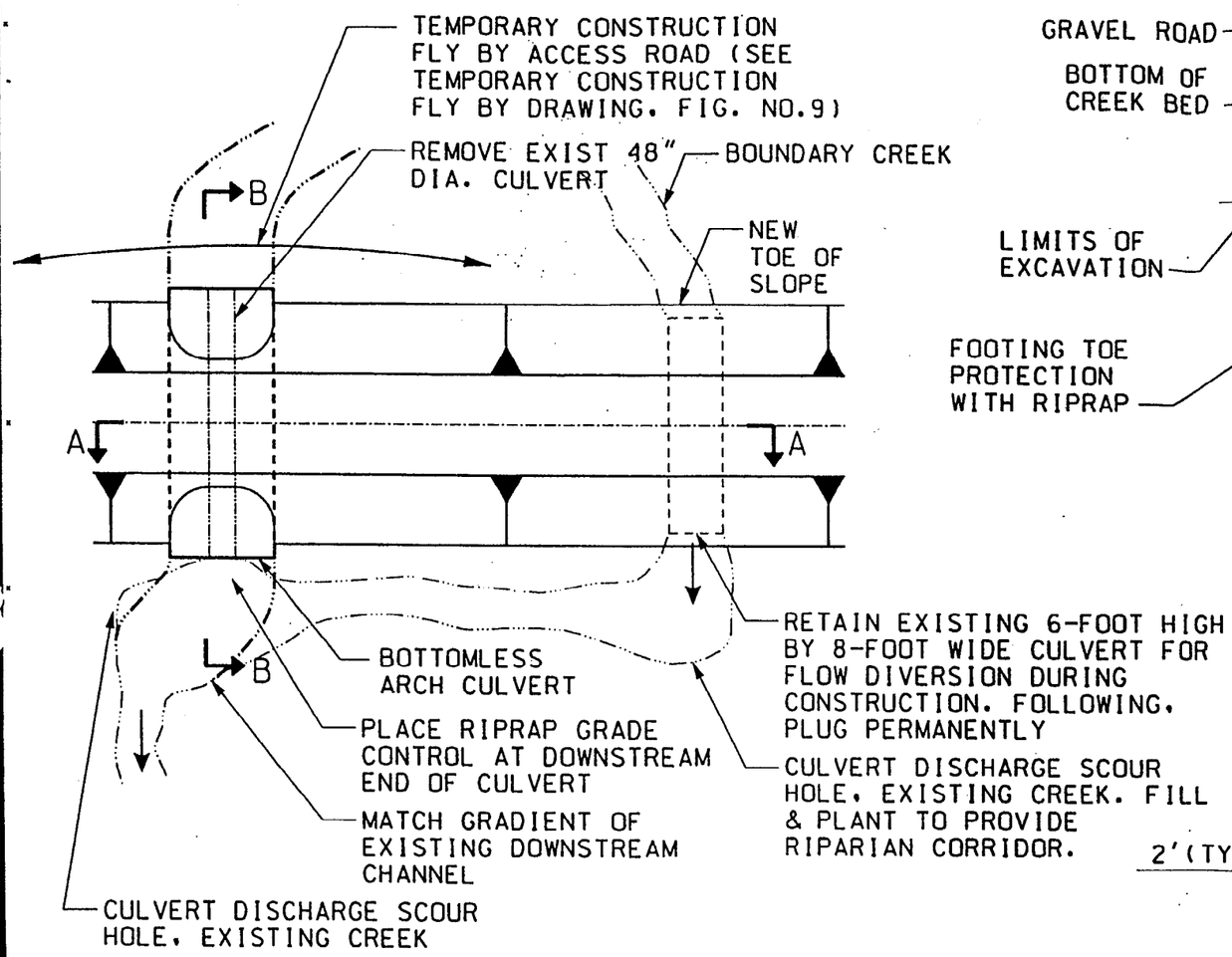
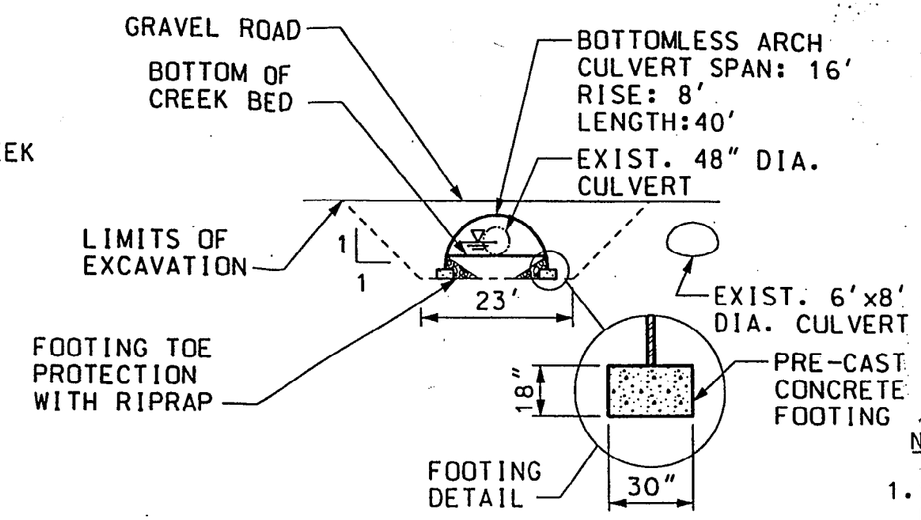
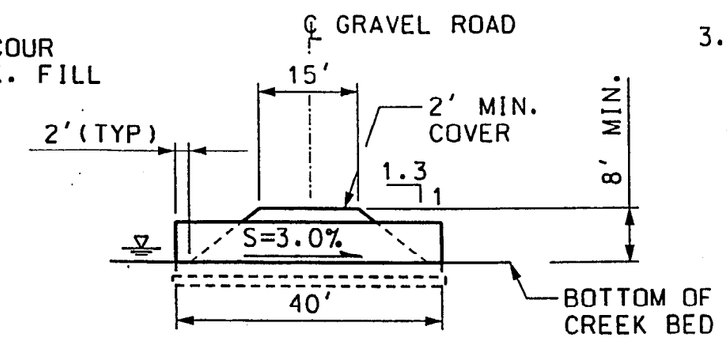


PLAN VIEW
NOT TO SCALE



SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

NOTES

1. SITE LOCATED IN USGS COUGAR MOUNTAIN QUADRANGLE. SEC 36. TWP. 21 N. R8E ROAD 5530A.
2. UPSTREAM CREEK CHANNEL RESTORATION: PLACE SPAWNING GRAVEL IN CREEK 100 FEET U/S OF NEW CULVERT. REFER TO CREEK DETAILS DRAWING. FIG. NO.10.
3. BOTTOMLESS ARCH CULVERT SHOWN. ALTERNATIVELY, BURIED CIRCULAR CULVERTS MAY BE USED IN FINAL DESIGN.

Site No. 41

U.S. ARMY ENGINEER DISTRICT, SEATTLE
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SEATTLE, WASHINGTON

GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY
FIGURE NO.5
CULVERT SITE #5
BOUNDARY CREEK

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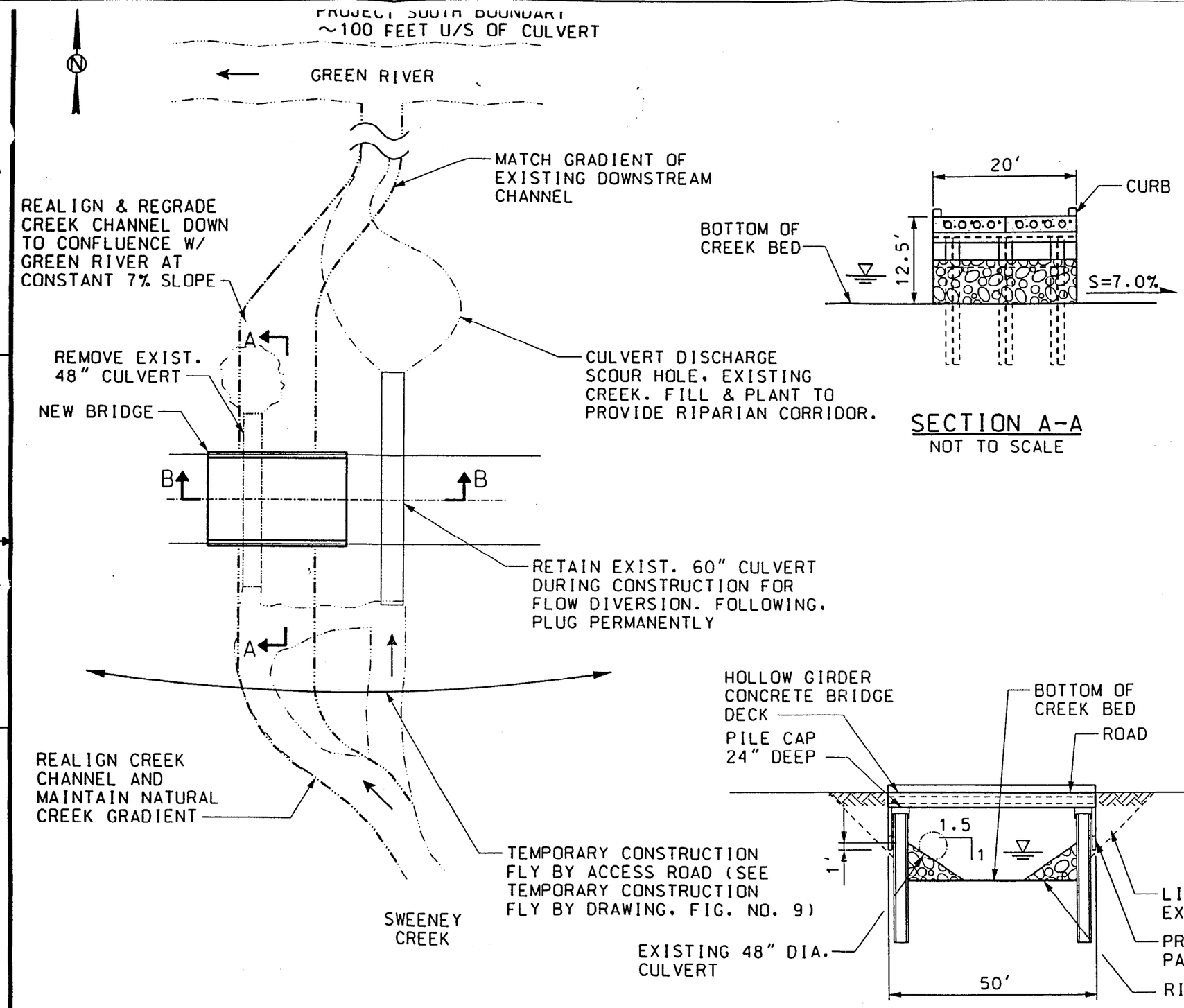
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		DWN.	SHEET X	

DATE AND TIME PLOTTED: ***DATE**** *TIME
DESIGN FILE: ***P:*ENVIROP48.050*DRAWINGS*SKETCH24.DGN



PLAN VIEW
NOT TO SCALE

SECTION A-A
NOT TO SCALE

SECTION B-B
NOT TO SCALE

NOTES

1. SITE LOCATED IN USGS GREENWATER QUADRANGLE. SEC 11, TWP. 20 N. R9E ROAD 3703. MILEPOST 21.8.

2. UPSTREAM CREEK CHANNEL RESTORATION: PLACE LARGE WOODY DEBRIS IN CREEK 100 FEET U/S OF NEW BRIDGE. REFER TO CREEK DETAILS DRAWING. FIG. NO. 10.

U.S. ARMY ENGINEER DISTRICT, SEATTLE
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SEATTLE, WASHINGTON

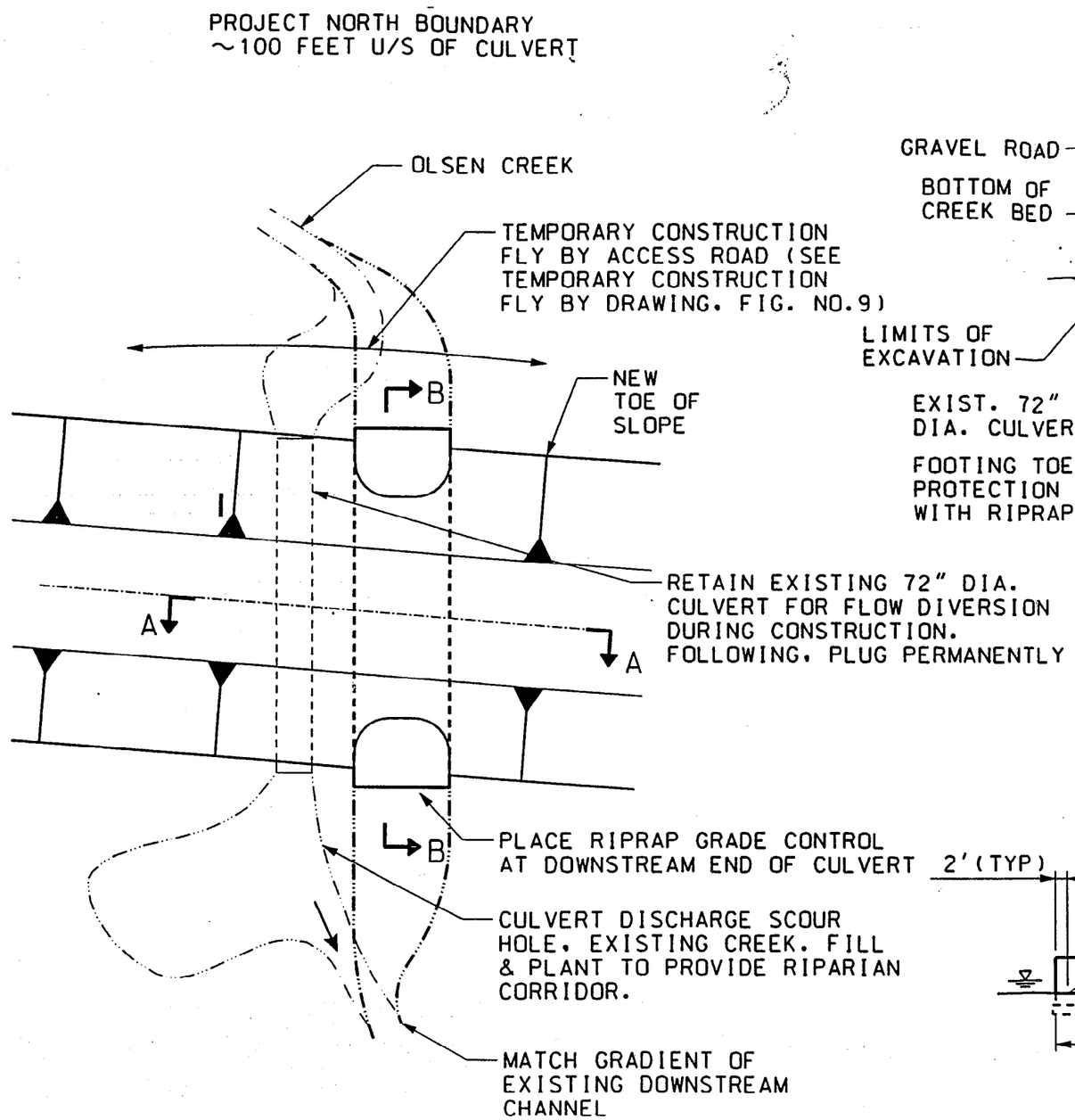
GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY
FIGURE NO. 8
CULVERT SITE #8
SWEENEY CREEK

KING COUNTY WASHINGTON

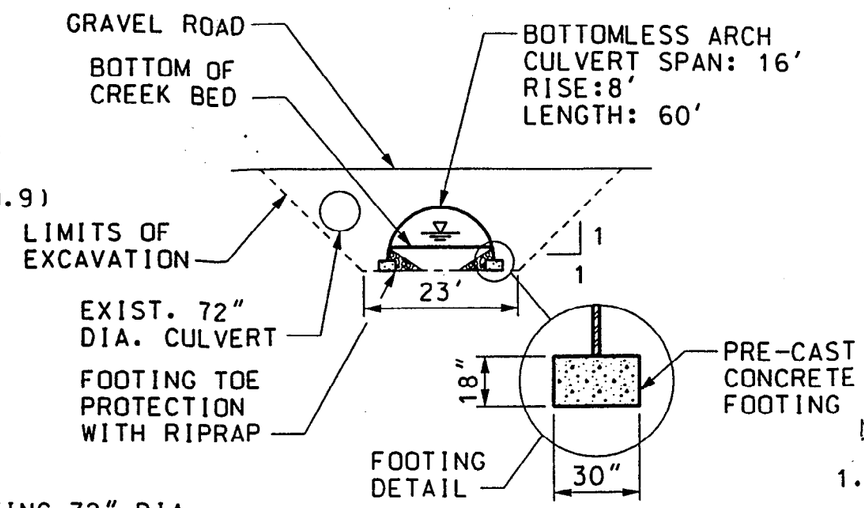
SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
D	XX-XX	XX-XX	980CT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: ###DATE### #TIME
DESIGN FILE: ###P:#ENVIROP48.050#DRAWINGS#SKETCH3.DGN

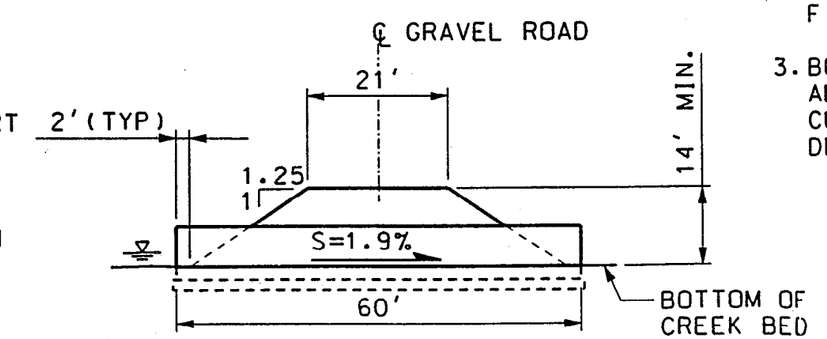
Site No. 42



PLAN VIEW
NOT TO SCALE



SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

NOTES

1. SITE LOCATED IN USGS GREENWATER QUADRANGLE. SEC 8. TWP. 20 N. R9E ROAD 3703 MILEPOST 23.5.

2. UPSTREAM CREEK CHANNEL RESTORATION: PLACE LWD AND SPAWNING GRAVEL IN CREEK 100 FEET U/S OF NEW CULVERT. REFER TO CREEK DETAILS DRAWING. FIG. NO.10.

3. BOTTOMLESS ARCH CULVERT SHOWN. ALTERNATIVELY, BURIED CIRCULAR CULVERTS MAY BE USED IN FINAL DESIGN.

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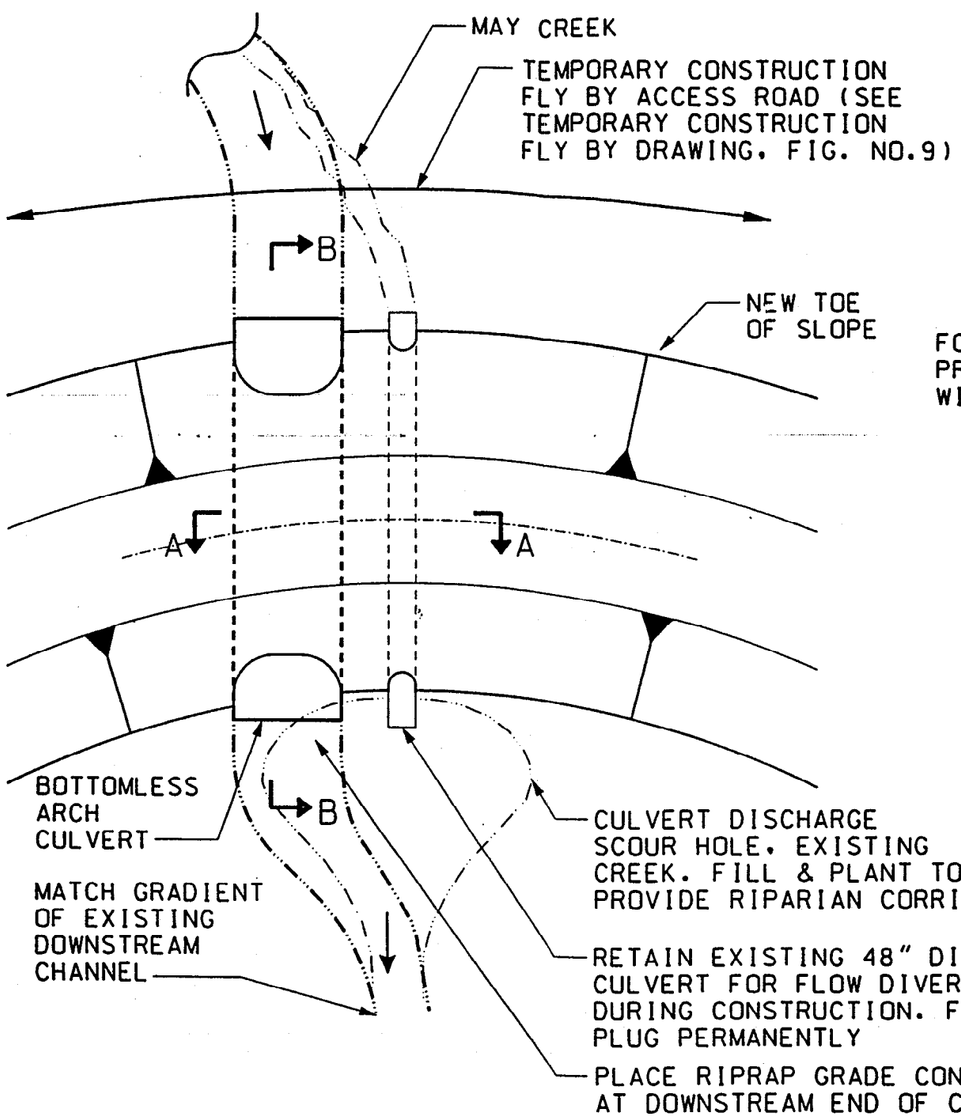
GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY
FIGURE NO.7
CULVERT SITE #7
OLSEN CREEK

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: $$$DATE$$$$ $TIME
DESIGN FILE: $$$P:$ENVIROP48.DSO$DRAWINGS$SKETCH22.DGN



PLAN VIEW
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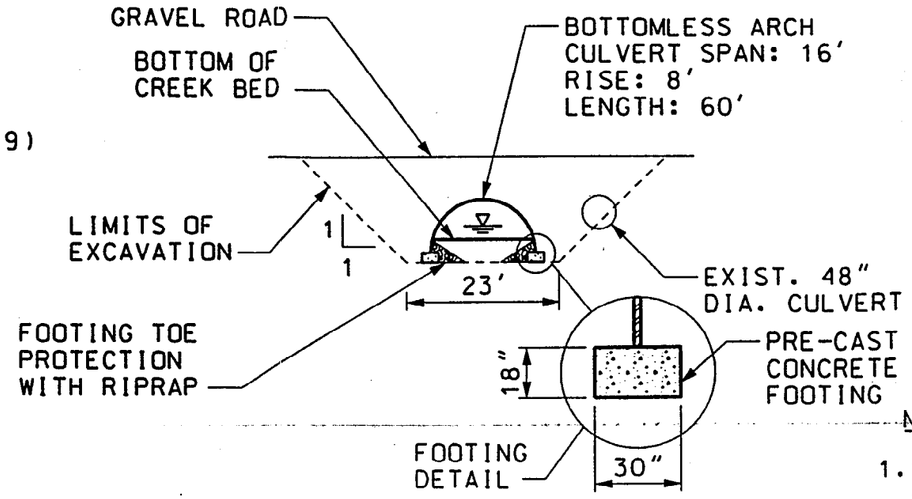
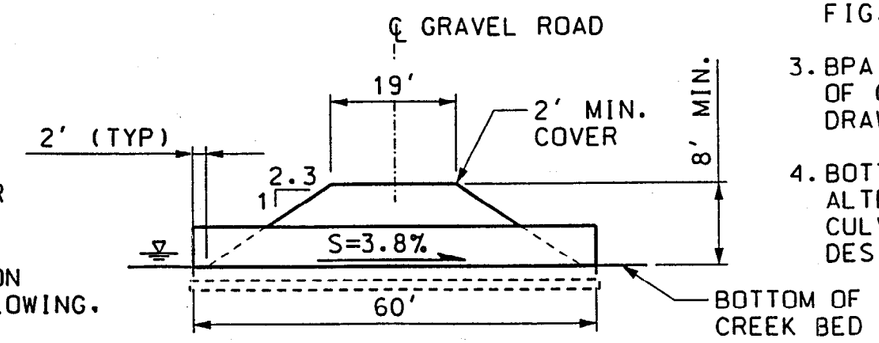


SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

NOTES

1. SITE LOCATED IN USGS GREENWATER QUADRANGLE. SEC 11, TWP. 20 N. R9E ROAD 5530 MILEPOST 18.5.
2. UPSTREAM CREEK CHANNEL RESTORATION PLACE LWD AND SPAWNING GRAVEL IN CREEK 100 FEET U/S OF NEW CULVERT. REFER TO CREEK DETAILS DRAWING, FIG. NO.10.
3. BPA CORRIDOR PLANTINGS 650 FEET U/S OF CULVERT. REFER TO CREEK DETAILS DRAWING.
4. BOTTOMLESS ARCH CULVERT SHOWN. ALTERNATIVELY, BURIED CIRCULAR CULVERTS MAY BE USED IN FINAL DESIGN.

Site No. 44

U.S. ARMY ENGINEER DISTRICT, SEATTLE
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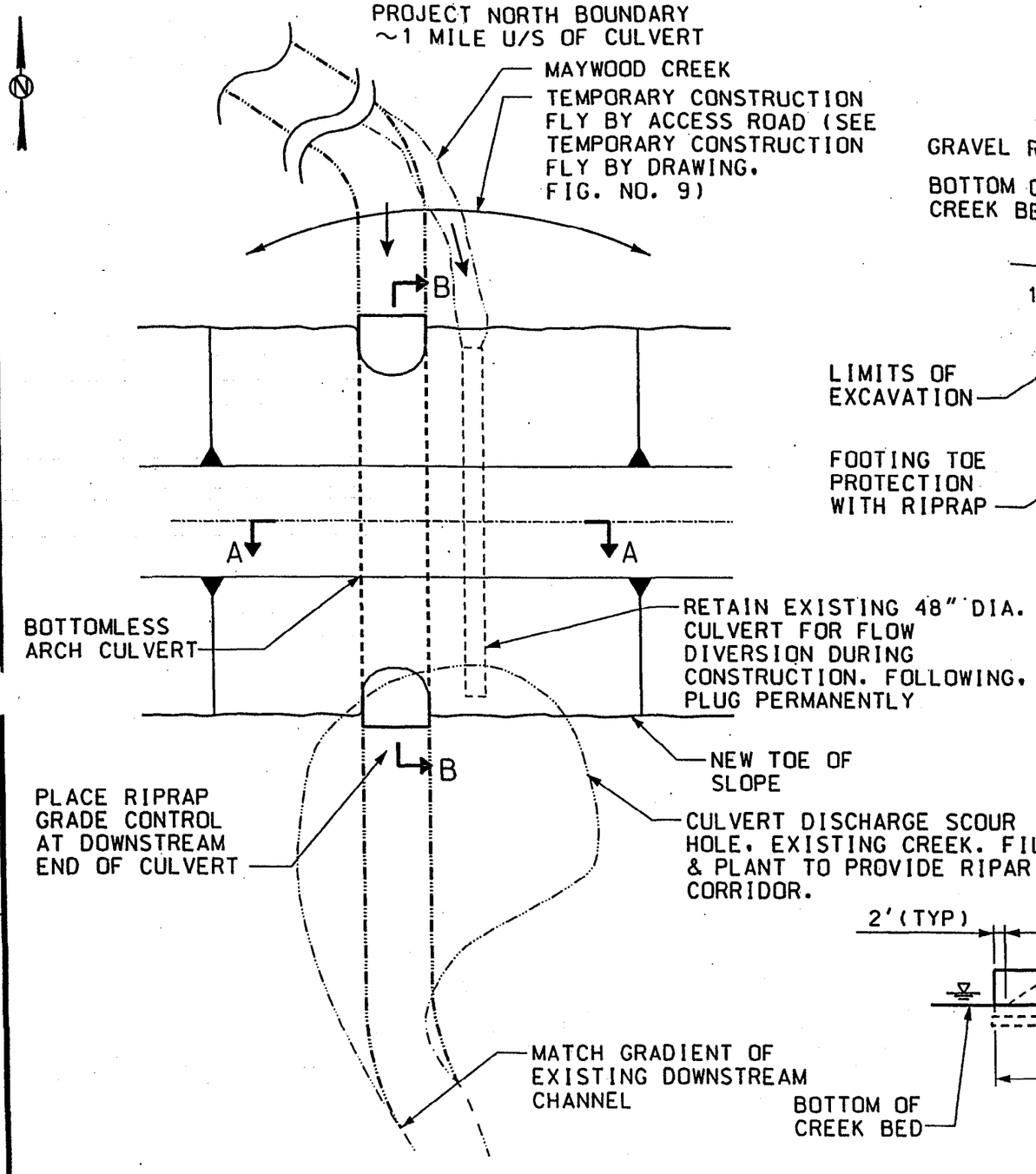
GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY
FIGURE NO.3
CULVERT SITE #3
MAY CREEK

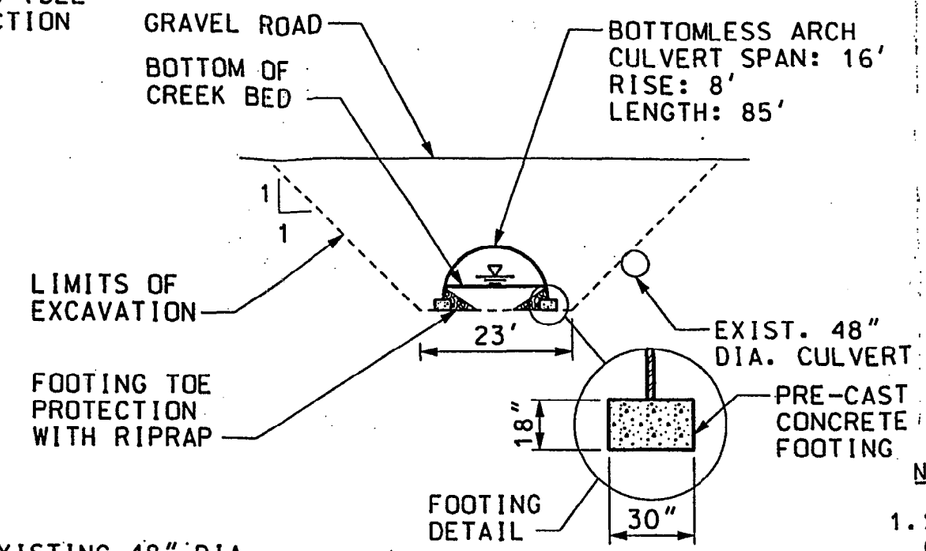
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

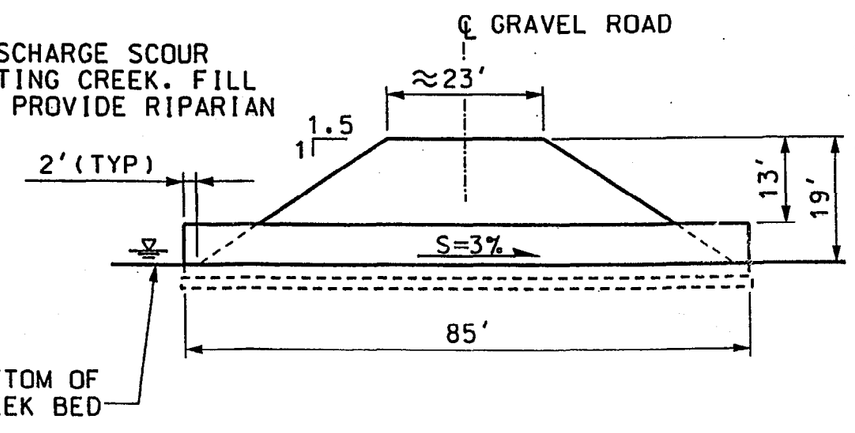
DATE AND TIME PLOTTED: ###DATE#### #TIME
DESIGN FILE: ###P:#ENVIROP48.050#DRAWINGS#SKETCH23.DGN



PLAN VIEW
NOT TO SCALE



SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

NOTES

1. SITE LOCATED IN USGS NAGROM QUADRANGLE. SEC 11, TWP. 20 N. R9E ROAD 5530. MILEPOST 19.5.
2. UPSTREAM CREEK CHANNEL RESTORATION: PLACE LWD AND SPAWNING GRAVEL IN CREEK 1 MILE U/S OF NEW CULVERT. REFER TO CREEK DETAILS DRAWING.
3. BPA CORRIDOR PLANTINGS 400 FEET U/S OF CULVERT. REFER TO CREEK DETAILS DRAWING, FIG. NO. 10.
4. TYPICAL RIPARIAN CORRIDOR PLANTINGS BETWEEN BPA PLANTINGS AND PROJECT NORTH BOUNDARY. REFER TO CREEK DETAILS DRAWING, FIG. NO. 10.
5. BOTTOMLESS ARCH CULVERT SHOWN. ALTERNATIVELY, BURIED CIRCULAR CULVERTS MAY BE USED IN FINAL DESIGN.

Site No. 45

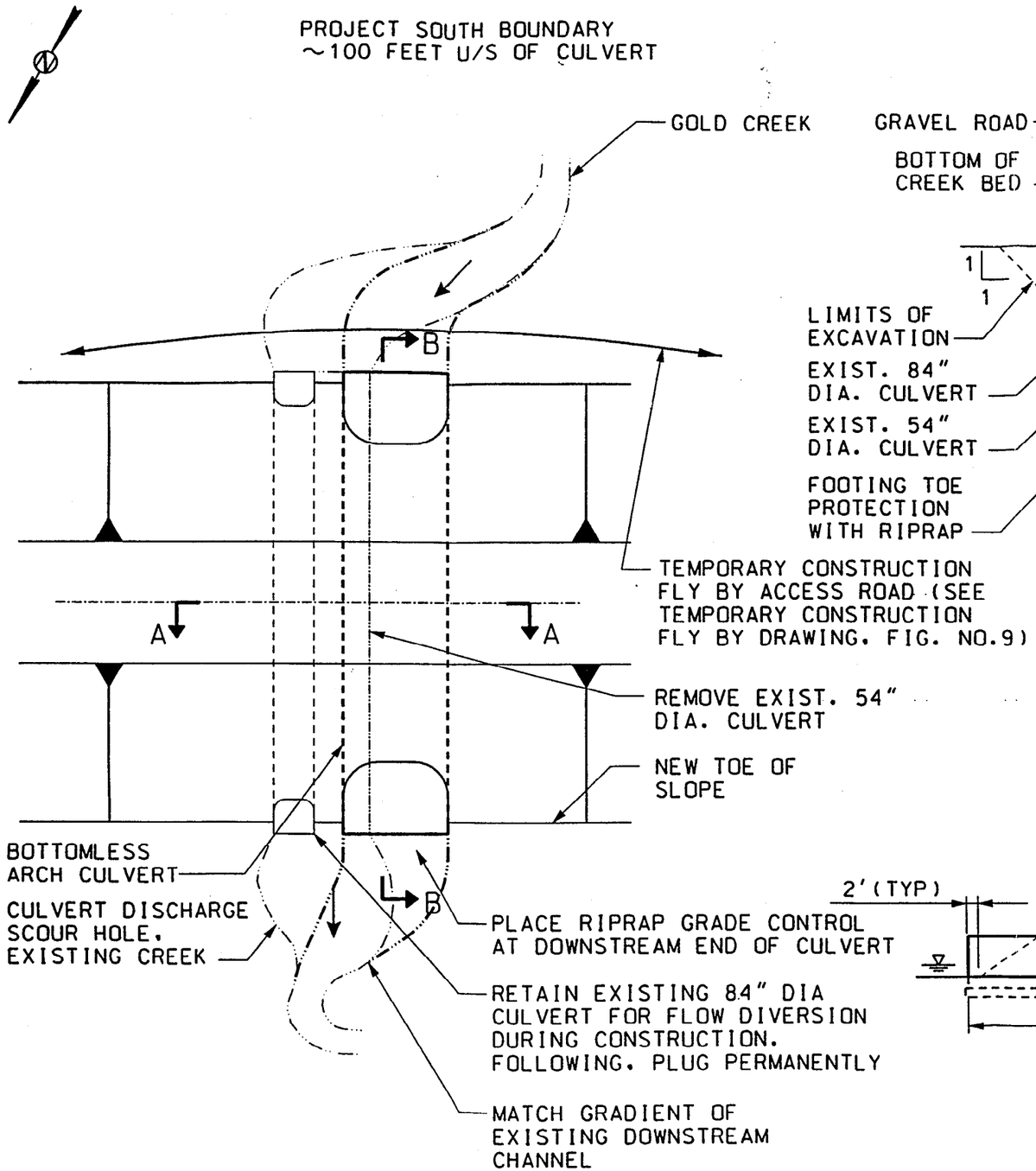
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY
FIGURE NO. 2
CULVERT SITE #2
MAYWOOD CREEK

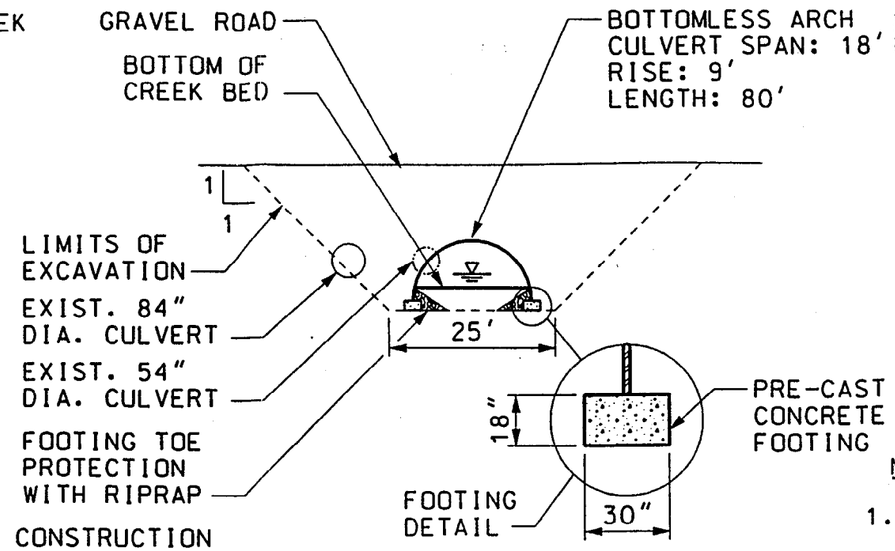
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: ***DATE*** *TIME
DESIGN FILE: ***P:*ENVIROP48.050*DRAWINGS*SKETCH2.DGN



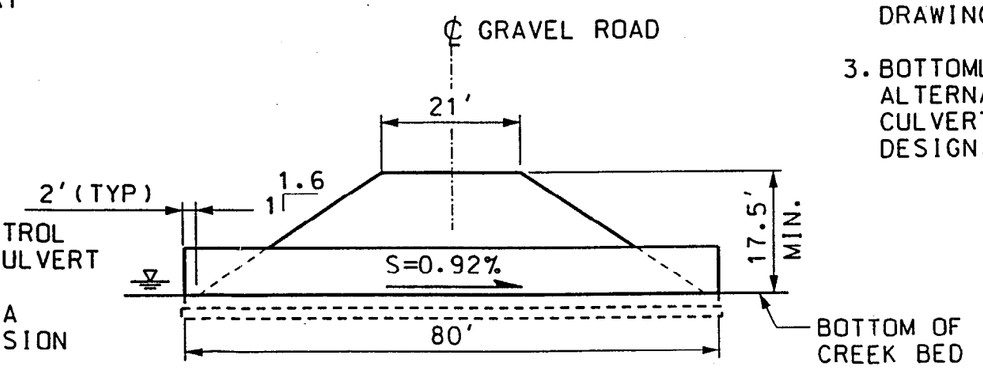
PLAN VIEW
NOT TO SCALE



SECTION A-A
NOT TO SCALE

NOTES

1. SITE LOCATED IN USGS NAGROM QUADRANGLE. SEC 14. TWP. 20 N. R9E ROAD 3703. MILEPOST 24.75.
2. UPSTREAM CREEK CHANNEL RESTORATIO' PLACE LWD IN CREEK 100 FEET U/S O NEW CULVERT. REFER TO CREEK DETAILS DRAWING. FIG. NO.10.
3. BOTTOMLESS ARCH CULVERT SHOWN. ALTERNATIVELY. BURIED CIRCULAR CULVERTS MAY BE USED IN FINAL DESIGN.



SECTION B-B
NOT TO SCALE

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

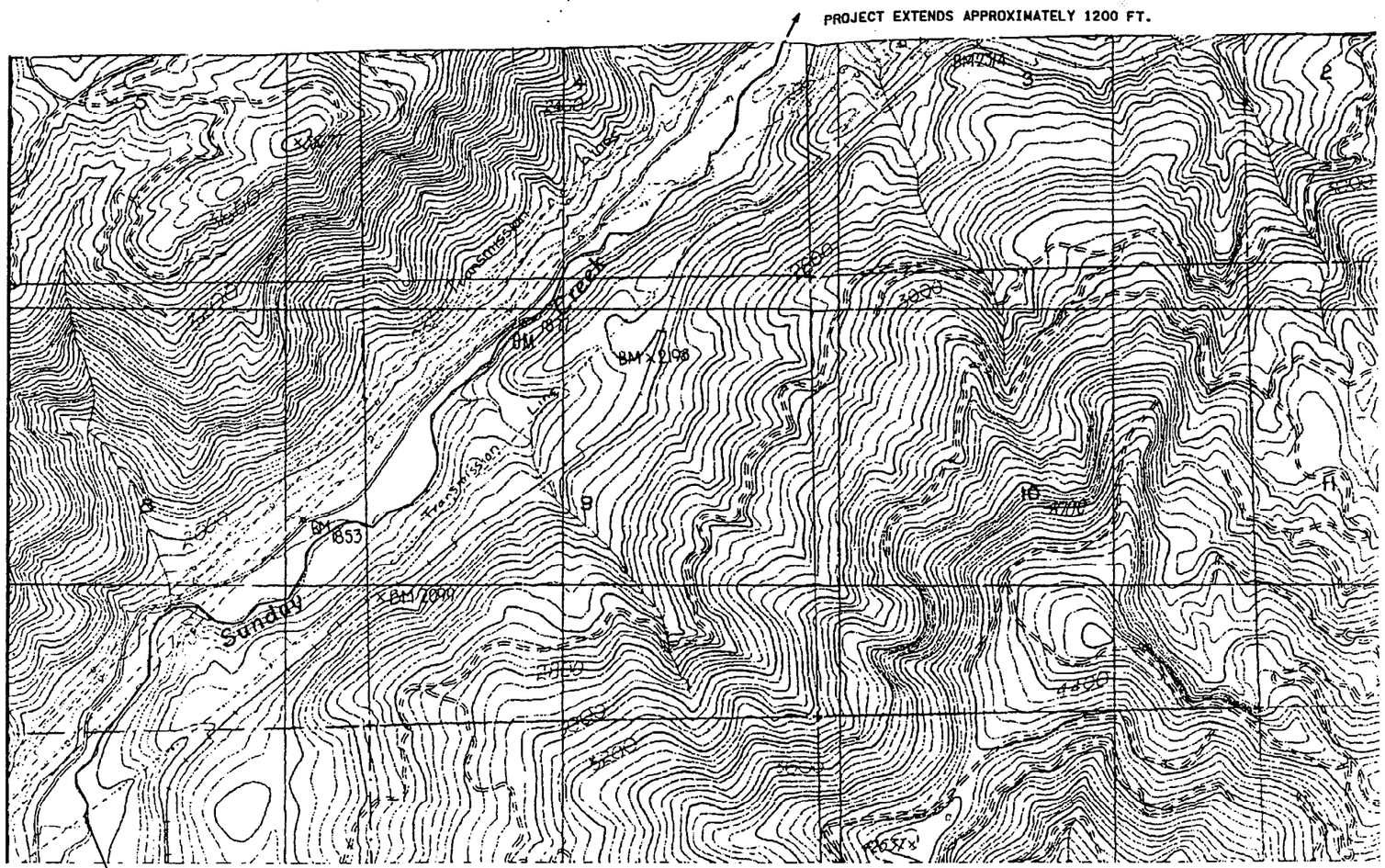
GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY
FIGURE NO.6
CULVERT SITE #6
GOLD CREEK

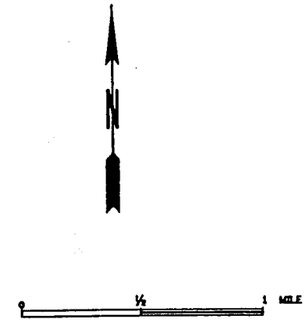
KING COUNTY WASHINGTON

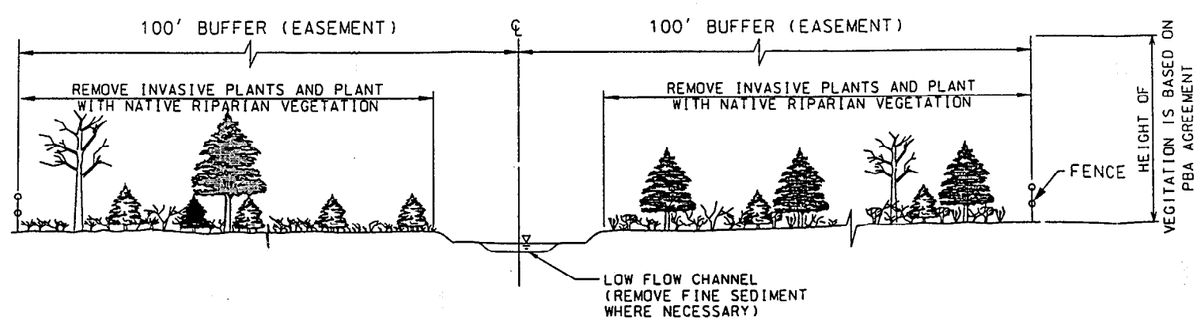
SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: ssDATEssss sTIME
DESIGN FILE: sssP:sENVIROP48.050sDRAWINGSsSKETCH21.DGN

122F







TYPICAL SECTION N.T.S.

NOTES:

1. SEE BPA STAGE CHANNEL RIVERINE PLANTING SCHEME.
2. PROJECT FOOT PRINT DOES NOT INCLUDE CONSTRUCTION ACCESS EASEMENTS.
3. PLANTING AREA EXTENDS 100 FEET ON BOTH SIDES OF CHANNEL.

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

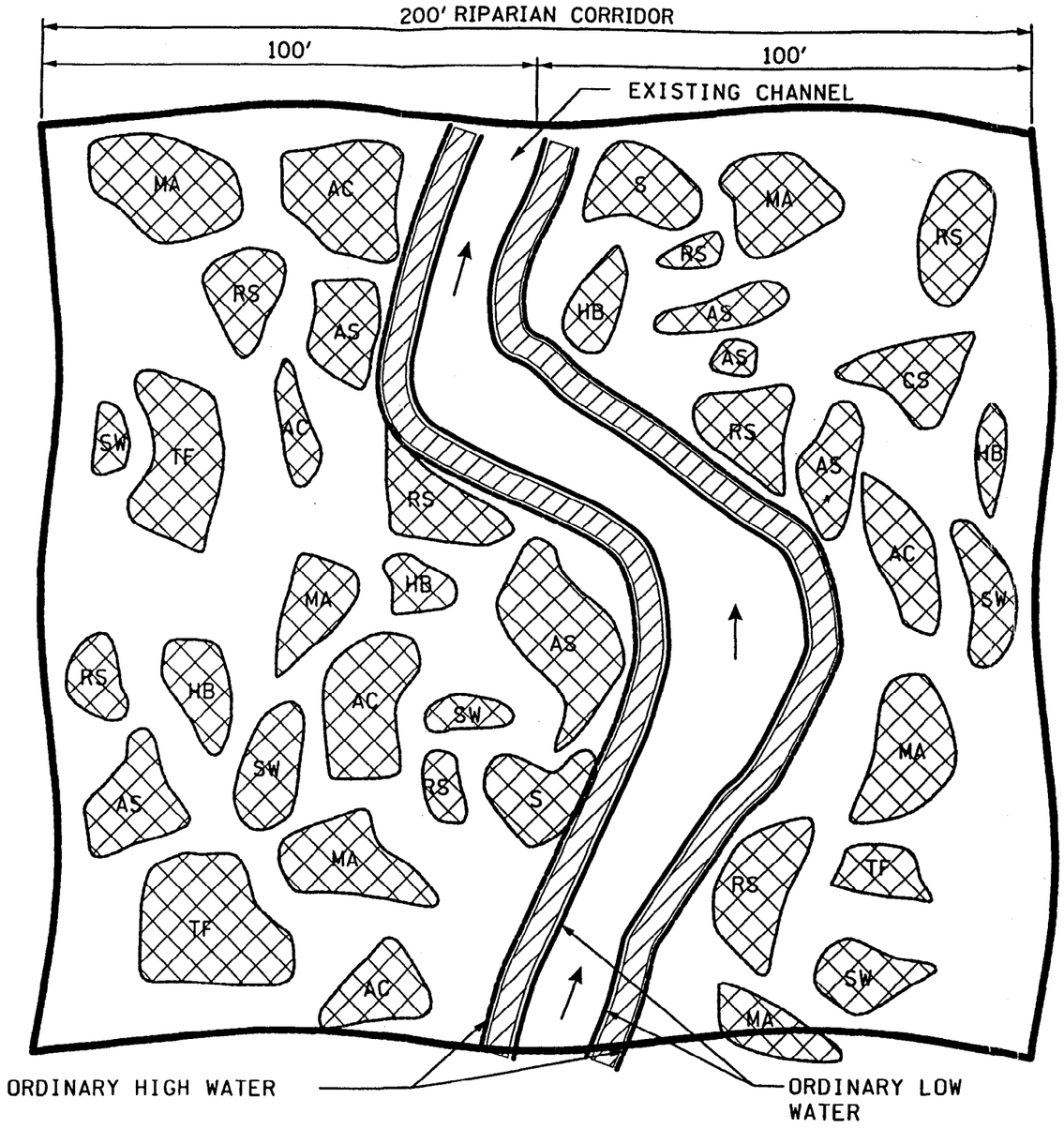
SUNDAY CREEK
PLAN
GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
DESIGN		CHK.	SHEET	

288

Site No. 47

FEDERAL/CORP-SEA/PLANNING98/20GREENRESTOR/SITES/SUNDAYCREEK/DGN/SUNDAY.DGN AND S



TYPICAL PLAN
NOT TO SCALE

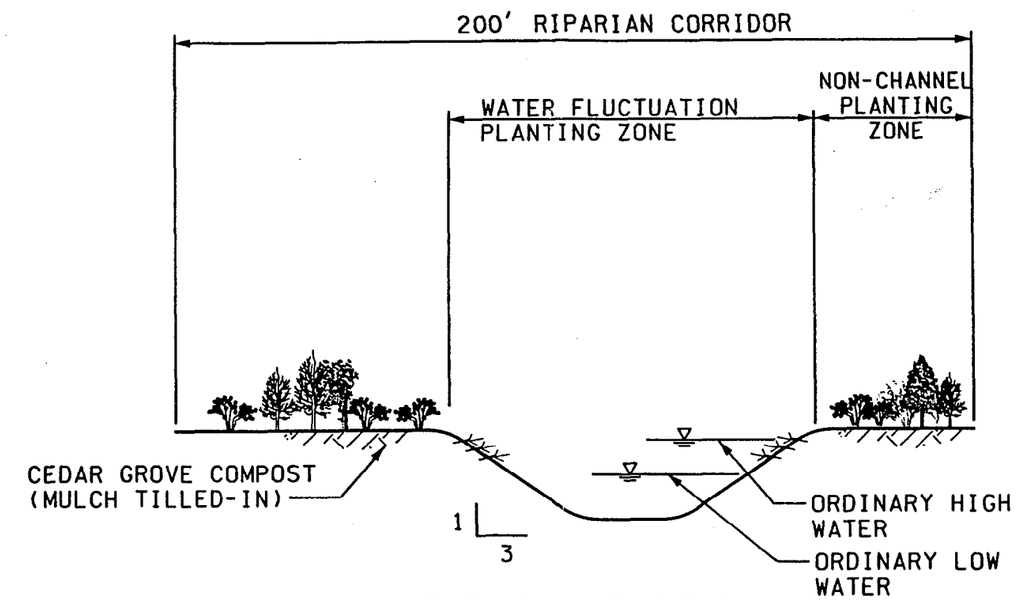
PLANTING LEGEND:

SHRUB/TREE - WATER FLUCTUATION ZONE

SHRUB - UPLAND ZONE

UPLAND PLANTINGS:
- SW - SWORDFERN
- AS - SITKA ALDER
- RS - SALMONBERRY
- TF - TWIN FLOWER
- MA - OREGON GRAPE
- AC - VINE MAPLE
- HB - ALASKAN & EVERGREEN HUCKLEBERRY
- S - SALAL

WATER FLUCTUATION PLANTINGS:
- SS - SITKA WILLOW (LIVE STAKE)
- AS - SITKA ALDER (LIVE STAKE)
- SW - SCOULERS WILOW
- R - RUSHES & SEDGES
- H - HOOKERS



TYPICAL SECTION
NOT TO SCALE

NOTES:
1. THE UPLAND PLANTINGS WILL BE A RANDOM MIX OF LISTED UPLAND SPECIES.

U.S. ARMY ENGINEER DISTRICT, SEATTLE
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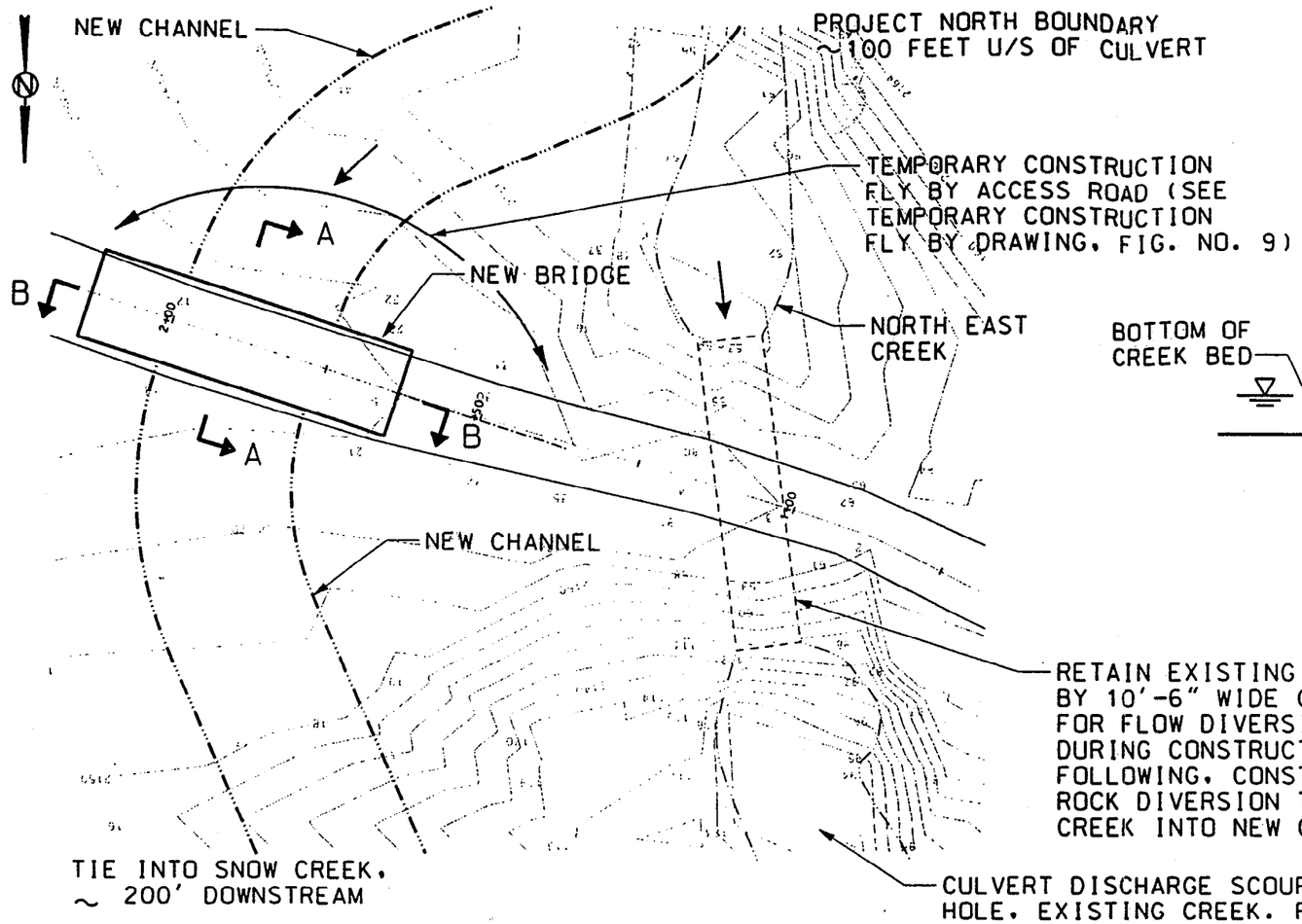
SEATTLE, WASHINGTON

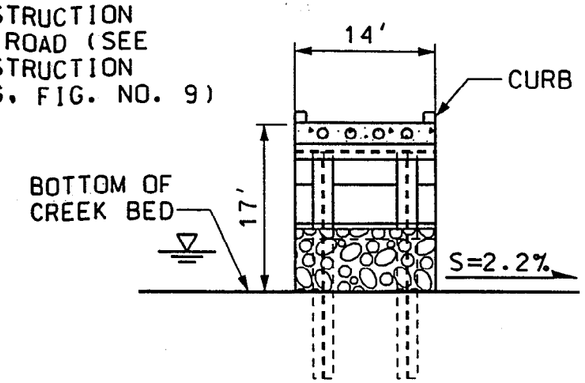
SUNDAY CREEK
BPA PLANTING SCHEME
GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION
KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
DSGN.		CHK.	SHEET	

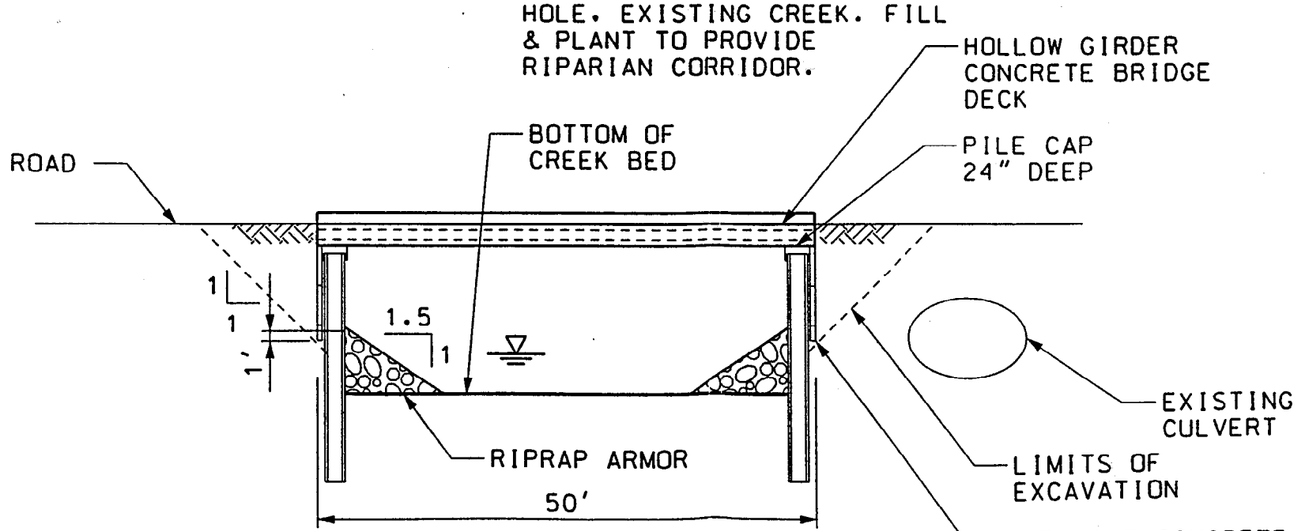
08048.2' greenrestor/sites/sunday/dgn/Sunbpa.dr

Site No. 47





SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

NOTES

1. SITE LOCATED IN USGS LOST LAKE MOUNTAIN QUADRANGLE. SEC. 33 TWP. 21 N. R11E.

2. UPSTREAM CREEK CHANNEL RESTORATION: PLACE LWD AND SPAWNING GRAVEL IN CREEK 100 FEET U/S OF NEW BRIDGE. REFER TO CREEK DETAILS DRAWING, FIG. NO. 10.

Site No. 48

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

COE - GREEN / DUWAMISH UPPER BASIN

FIGURE NO. 1
CULVERT SITE #1
NORTH EAST CREEK

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
D	XX-XX	XX-XX	98NOV	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: ###DATE#### #TIME
DESIGN FILE: ###P:#ENVIROP48.050#DRAWINGS#SKETCH1.DGN

APPENDIX E

ENGINEERING APPENDIX

MCACES COST ESTIMATE

AND

QUANTITY TAKE OFFS

TOTAL PROJECT COST SUMMARY

BASED ON THE FEASIBILITY LEVEL REPORT DATED SEPTEMBER 2000

PROJECT: Green-Duwamish Ecosystem Restoration Study
LOCATION: King County, Washington

DISTRICT: Seattle
POC: Denny Dodge, Chief, Contract Admin/Cost Eng..

ACCOUN NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: Oct 00 / EFFECTIVE PRICING LEVEL: Oct 00 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZED/BUDGET YEAR: / EFFECTIVE PRICING LEVEL: COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED ESTIMATE COST ($K)	CNTG ($K)	FULL ($K)
06	FISH AND WILDLIFE FACILITIES	48,354	8,865	18%	57,219				58,337	11,663	70,000
01	LANDS AND DAMAGES	30,203	7,558	25%	37,761				41,141	8,221	49,362
30	PLANNING, ENGINEERING AND DESIGN	6,490	1,298	20%	7,788				8,489	1,698	10,187
31	CONSTRUCTION MANAGEMENT	10,926	2,185	20%	13,111				16,750	3,349	20,099
	TOTAL PROJECT COSTS	$95,973	$19,906		$115,879				$124,717	$24,931	$149,648

THIS TPCS REFLECTS A PROJECT COST CHANGE OF $0

TOTAL FEDERAL COSTS $97,271

TOTAL NON-FEDERAL COSTS $52,377

THE MAXIMUM PROJECT COST IS $149,648

DISTRICT APPROVED:

Denny Dodge — CHIEF, CONTACT ADMINISTRATION/COST ENGINEERING
Duncan — CHIEF, REAL ESTATE
CHIEF, PLANNING
for D.A. Duncan — CHIEF, ENGINEERING
for Denny Dodge — CHIEF, CONSTRUCTION
for D.A. Duncan — CHIEF, OPERATIONS
David Adams for — CHIEF, PROGRAMS MANAGEMENT
Joel Hilborgh — PROJECT MANAGER
for — DDE (PM)

David Adams for — CHIEF, PROGRAMS MANAGEMENT
for — DIRECTOR OF PPMD
APPROVED DATE: 19 October 2000

CONSTRUCTION COSTS

TOTAL PROJECT COST SUMMARY

BASED ON THE FEASIBILITY LEVEL REPORT DATED SEPTEMBER 2000

PROJECT: Green-Duwamish Ecosystem Restoration Study
LOCATION: King County, Washington

DISTRICT: Seattle
POC: Denny Dodge, Chief, Contract Admin/Cost Eng..

		CURRENT MCACES ESTIMATE PREPARED: Sep 00 / EFFECTIVE PRICING LEVEL: Oct 00				AUTHORIZED/BUDGET YEAR: / EFFECTIVE PRICING LEVEL:			FULLY FUNDED ESTIMATE			
ACCOUN NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	COST ($K)	CNTG ($K)	TOTAL ($K)		COST ($K)	CNTG ($K)	FULL ($K)
06	**FISH AND WILDLIFE FACILITIES**											
06.03	WILDLIFE FACILITIES AND SANCTUARIES											
06.03.05	HABITAT AND FEEDING FACILITIES											
	A Volunteer Revegetation (basinwide)	2,059	382	19%	2,441				Jun 07 26.20%	2,568	513	3,081
	1 Elliot Bay Nearshore	276	52	19%	328				Jun 01 2.40%	280	56	336
	2 Site 1, Duwamish	472	87	18%	559				Jun 04 16.67%	543	109	652
	3 Riverton Side Channel	217	40	18%	257				Jun 04 16.67%	250	50	300
	4 Codiga Farms	915	170	19%	1,085				Jun 01 2.40%	926	185	1,111
	5 Black River Marsh	33	7	21%	40				Jun 06 22.93%	41	8	49
	6 Gilliam Creek	470	87	19%	557				Jun 06 22.93%	571	114	685
	7 Lower Springbrook	2,817	539	19%	3,356				Jun 06 22.93%	3,438	688	4,126
	8 Upper Springbrook	120	23	19%	143				Jun 04 16.67%	139	28	167
	9 Mill Creek East	2,419	449	19%	2,868				Jun 06 22.93%	2,938	588	3,526
	10 Garrison Creek (1)	679	126	19%	805				Jun 04 16.67%	783	156	939
	11 Mullen Slough, Prentice Nursery	264	72	27%	336				Jun 01 2.40%	287	57	344
	12 Mullen Slough Reach	612	114	19%	726				Jun 03 21.87%	738	147	885
	13 Mill Creek Shuler Brothers Reach	1,925	357	19%	2,282				Jun 08 29.50%	2,463	492	2,955
	14 Mill Creek, Merlino Reach	1,891	332	18%	2,223				Jun 06 22.93%	2,278	455	2,733
	15 Mill Creek, Wetland 5K	1,129	174	15%	1,303				Jun 06 22.93%	1,335	267	1,602
	16 Mill Creek, Goedeke Reach	4,871	902	19%	5,773				Jun 07 26.20%	6,072	1,214	7,286
	17 Green River Park	252	47	19%	299				Jun 02 7.87%	269	54	323
	18 Horsehead Bend Side Channel	451	84	19%	535				Jun 02 7.87%	481	96	577
	19 NE Auburn Creek	547	101	18%	648				Jun 02 7.87%	583	116	699
	20 Meridian Valley Creek	246	46	19%	292				Jun 02 7.87%	263	52	315
	21 Lake Meridian Outlet Relocation	625	117	19%	742				Jun 06 22.93%	760	152	912
	22 Olson Creek	80	15	19%	95				Jun 04 16.67%	93	18	111
	23 Riverside Estates Side Channel	376	70	19%	446				Jun 05 19.77%	445	89	534
	24 Mainstem Maintenance	1,258	234	19%	1,492				Jun 10 36.43%	1,697	339	2,036
	25 Porter Levee Setback	727	135	19%	862				Jun 10 36.43%	980	196	1,176
	26 Kaech Levee Pond	199	37	19%	236				Jun 04 16.67%	229	46	275
	27 Ray Creek Trib Corridor	1,674	311	19%	1,985				Jun 10 36.43%	2,257	451	2,708
	28 Hamakami Levee Modification	488	87	18%	575				Jun 04 16.67%	559	112	671
	29 Turley Levee Setback	148	24	16%	172				Jun 06 22.93%	176	35	211
	30 Loans Levee Setback	2,245	334	15%	2,579				Jun 02 7.87%	2,318	464	2,782
	31 Burns Creek Restoration	315	58	18%	373				Jun 01 2.40%	318	64	382
	32 Middle Green River Large Woody Debris	902	167	19%	1,069				Jun 06 22.93%	1,095	219	1,314

BASED ON THE FEASIBILITY LEVEL REPORT DATED SEPTEMBER 2000

PROJECT: Green-Duwamish Ecosystem Restoration Study
LOCATION: King County, Washington

DISTRICT: Seattle
POC: Denny Dodge, Chief, Contract Admin/Cost Eng..

ACCOUN NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: Sep 00 EFFECTIVE PRICING LEVEL: Oct 00 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZED/BUDGET YEAR: EFFECTIVE PRICING LEVEL: COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED ESTIMATE		COST ($K)	CNTG ($K)	FULL ($K)
33	Middle Green River Gravel Replacement	5,067	939	19%	6,006				Jun 03	21.87%	6,100	1,220	7,320
34	Flaming Geyser Landslide	2,836	525	19%	3,361				Jun 10	36.43%	3,821	764	4,585
35	Flaming Geyser Side Channel	502	80	16%	582				Jun 04	16.67%	566	113	679
36	Newaukum Creek	3,247	602	19%	3,849				Jun 06	22.93%	3,943	789	4,732
37	Big Spring Creek	833	154	18%	987				Jun 03	21.87%	1,003	200	1,203
38	Brunner Slough	882	163	18%	1,045				Jun 07	26.20%	1,099	220	1,319
39	Upper Green River Side Channel	506	93	18%	599				Jun 03	21.87%	608	122	730
41	Gale Creek	214	40	19%	254				Jun 02	7.87%	228	46	274
43	Sweeny Creek	108	20	19%	128				Jun 04	16.67%	124	25	149
45	May Creek	187	49	26%	236				Jun 03	16.67%	229	46	275
48	Sunday Creek Riparian Plantings	2,104	389	18%	2,493				Jun 02	7.87%	2,241	448	2,689
49	Northeast Creek	166	31	19%	197				Jun 06	22.93%	202	40	242
	TOTAL CONSTRUCTION COST	$48,354	$8,865	18%	$57,219						$58,337	$11,663	$70,000
01	**LANDS AND DAMAGES**												
A	Volunteer Revegetation (basinwide)	0	0	0%	0				Jun 06	31.00%	0	0	0
1	Elliot Bay Nearshore	13	3	23%	16				Jun 00	0.00%	13	3	16
2	Site 1, Duwamish	951	238	25%	1,189				Jun 03	19.00%	1,179	236	1,415
3	Riverton Side Channel	418	105	25%	523				Jun 03	19.00%	518	104	622
4	Codiga Farms	136	34	25%	170				Jun 00	0.00%	142	28	170
5	Black River Marsh	107	27	25%	134				Jun 06	32.00%	148	29	177
6	Gilliam Creek	59	15	25%	74				Jun 05	32.00%	82	16	98
7	Lower Springbrook	3,259	815	25%	4,074				Jun 05	32.00%	4,482	896	5,378
8	Upper Springbrook	25	6	24%	31				Jun 04	23.00%	32	6	38
9	Mill Creek East	3,464	866	25%	4,330				Jun 05	28.00%	4,618	924	5,542
10	Garrison Creek (1)	500	125	25%	625				Jun 03	19.00%	620	124	744
11	Mullen Slough, Prentice Nursery Reach	67	17	25%	84				Jun 00	0.00%	70	14	84
12	Mullen Slough Reach	763	191	25%	954				Jun 02	13.00%	898	180	1,078
13	Mill Creek Shuler Brothers Reach	809	202	25%	1,011				Jun 08	42.00%	1,197	239	1,436
14	Mill Creek, Merlino Reach	3,852	963	25%	4,815				Jun 05	28.00%	5,136	1,027	6,163
15	Mill Creek, Wetland 5K	793	198	25%	991				Jun 05	28.00%	1,057	211	1,268
16	Mill Creek, Goedeke Reach	652	163	25%	815				Jun 06	32.00%	897	179	1,076
17	Green River Park	115	29	25%	144				Jun 01	10.00%	132	26	158
18	Horsehead Bend Side Channel	148	37	25%	185				Jun 01	10.00%	170	34	204
19	NE Auburn Creek	86	22	26%	108				Jun 01	10.00%	99	20	119

BASED ON THE FEASIBILITY LEVEL REPORT DATED SEPTEMBER 2000

PROJECT: Green-Duwamish Ecosystem Restoration Study
LOCATION: King County, Washington

DISTRICT: Seattle
POC: Denny Dodge, Chief, Contract Admin/Cost Eng..

ACCOUN NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: Sep 00 EFFECTIVE PRICING LEVEL: Oct 00 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZED/BUDGET YEAR: EFFECTIVE PRICING LEVEL: COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED ESTIMATE		COST ($K)	CNTG ($K)	FULL ($K)
20	Meridian Valley Creek	119	30	25%	149				Jun 01	10.00%	137	27	164
21	Lake Meridian Outlet Relocation	136	34	25%	170				Jun 05	28.00%	182	36	218
22	Olson Creek	45	11	24%	56				Jun 03	19.00%	56	11	67
23	Riverside Estates Side Channel	123	31	25%	154				Jun 04	23.00%	158	31	189
24	Mainstem Maintenance	7,066	1,767	25%	8,833				Jun 09	47.00%	10,821	2,164	12,985
25	Porter Levee Setback	247	62	25%	309				Jun 09	47.00%	378	76	454
26	Kaech Levee Pond	76	19	25%	95				Jun 03	19.00%	94	19	113
27	Ray Creek Trib Corridor	382	96	25%	478				Jun 09	47.00%	586	117	703
28	Hamakami Levee Modification	34	9	26%	43				Jun 03	19.00%	43	8	51
29	Turley Levee Setback	113	28	25%	141				Jun 05	28.00%	150	30	180
30	Loans Levee Setback	299	75	25%	374				Jun 01	10.00%	343	68	411
31	Burns Creek Restoration	550	138	25%	688				Jun 00	0.00%	573	115	688
32	Middle Green River Large Woody Debris	582	146	25%	728				Jun 01	10.00%	668	133	801
33	Middle Green River Gravel Replacement	464	116	25%	580				Jun 01	10.00%	532	106	638
34	Flaming Geyser Landslide	138	35	25%	173				Jun 08	42.00%	205	41	246
35	Flaming Geyser Side Channel	270	68	25%	338				Jun 03	19.00%	335	67	402
36	Newaukum Creek	2,792	698	25%	3,490				Jun 05	28.00%	3,723	744	4,467
37	Big Spring Creek	126	32	25%	158				Jun 02	13.00%	149	30	179
38	Brunner Slough	79	20	25%	99				Jun 06	32.00%	109	22	131
39	Upper Green River Side Channel	256	64	25%	320				Jun 02	13.00%	302	60	362
41	Gale Creek	14	4	29%	18				Jun 01	10.00%	17	3	20
43	Sweeny Creek	10	3	30%	13				Jun 03	19.00%	13	2	15
45	May Creek	27	7	26%	34				Jun 02	13.00%	32	6	38
48	Sunday Creek Riparian Plantings	25	6	24%	31				Jun 01	10.00%	28	6	34
49	Northeast Creek	13	3	23%	16				Jun 05	28.00%	17	3	20
	TOTAL LANDS AND DAMAGES	**$30,203**	**$7,558**	**25%**	**$37,761**						**$41,141**	**$8,221**	**$49,362**
30	**PLANNING, ENGINEERING AND DESIGN**	6,490	1,298	20%	7,788				Apr 06	30.80%	8,489	1,698	10,187
31	**CONSTRUCTION MANAGEMENT**	5,193	1,039	20%	6,232				Jun 07	36.20%	7,073	1,415	8,488
	MONITORING	5,733	1,146	20%	6,879				Jun 12	68.80%	9,677	1,934	11,611
	TOTAL PROJECT COSTS	**$95,973**	**$19,906**	**21%**	**$115,879**						**$124,717**	**$24,931**	**$149,648**

Green Duwmish Ecosystem Resto.
45 sites in King County,
Washington

Designed By: HDR, USACE Seattle Dist, Drewery
Estimated By: Contract Admin/Cost Engr. Sec.

Prepared By: Garrott and Pierce

Preparation Date: 08/17/00
Effective Date of Pricing: 10/01/00
Est Construction Time: 1800 Days

Sales Tax: 8.6%

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Construction Narrative

No overtime is anticipated for this project. All construction equipment is locally available. All of the anticipated construction is conventional.

Excavated materials will be disposed of at Seatac Airport 3rd runway or at nearby commercial sites.

The projects will be complete over a ten year period.

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** PROJECT INDIRECT SUMMARY - Detail **

06 Fish and Wildlife Facilities

06.03 Wildlife Facilities & Sanctuary

06.03.73 Habitat

06.03.73.02 Site Work

		QUANTITY UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	INS&BOND	B&O TAX	TOTAL COST	UNIT COST
06.03.73.02_ A	Volunteer Revegetation		1,666,099	136,818	90,146	114,909	40,159	10,241	2,058,372	
06.03.73.02_01	Elliot Bay Nearshore		223,159	18,326	12,074	15,391	5,379	1,372	275,700	
06.03.73.02_02	Site 1, Duwamish		381,682	31,343	20,651	26,324	9,200	2,346	471,547	
06.03.73.02_03	Riverton Side Channel		175,918	14,446	9,518	12,133	4,240	1,081	217,337	
06.03.73.02_04	Codiga Farms		739,988	60,767	40,038	51,036	17,837	4,548	914,214	
06.03.73.02_05	Black River Marsh		26,935	2,212	1,457	1,858	649	166	33,277	
06.03.73.02_06	Gilliam Creek		380,488	31,245	20,587	26,242	9,171	2,339	470,072	
06.03.73.02_07	Lower Springbrook Creek		2,278,975	187,147	123,306	157,178	54,932	14,008	2,815,545	
06.03.73.02_08	Upper Springbrook Creek		97,138	7,977	5,256	6,699	2,341	597	120,008	
06.03.73.02_09	Mill Creek East		1,957,416	160,741	105,908	135,001	47,181	12,031	2,418,277	
06.03.73.02_10	Garrison Creek (1)		549,515	45,126	29,732	37,899	13,245	3,378	678,896	
06.03.73.02_11	Mullen Slough, Prentice Nursery		213,301	17,516	11,541	14,711	5,141	1,311	263,521	
06.03.73.02_12	Mullen Slough Reach		495,577	40,696	26,814	34,179	11,945	3,046	612,258	
06.03.73.02_13	Mill Creek, Schuler Bros. Reach		1,557,524	127,902	84,271	107,421	37,542	9,573	1,924,233	
06.03.73.02_14	Mill Creek, Merlino Reach		1,529,868	125,631	82,775	105,513	36,876	9,403	1,890,066	
06.03.73.02_15	Mill Creek, Wetland 5K Reach		913,809	75,041	49,442	63,024	22,026	5,617	1,128,960	
06.03.73.02_16	Mill Creek, Goedeke Reach		3,941,528	323,674	213,260	271,843	95,006	24,227	4,869,537	
06.03.73.02_17	Green River Park		203,857	16,740	11,030	14,060	4,914	1,253	251,854	
06.03.73.02_18	Horsehead Bend Side Channel		365,239	29,993	19,762	25,190	8,804	2,245	451,232	
06.03.73.02_19	NE Auburn Creek		442,533	36,340	23,944	30,521	10,667	2,720	546,724	
06.03.73.02_20	Meridian Valley Country Club		199,430	16,377	10,790	13,754	4,807	1,226	246,385	
06.03.73.02_21	Lake Meridian Outlet Relocation		506,073	41,558	27,382	34,903	12,198	3,111	625,225	
06.03.73.02_22	Olson Creek		64,731	5,316	3,502	4,464	1,560	398	79,971	
06.03.73.02_23	Riverside Estates Side Channel		304,498	25,005	16,475	21,001	7,340	1,872	376,191	
06.03.73.02_24	Mainstem Maint.(Auburn-Elliot B)		1,018,258	83,618	55,094	70,228	24,544	6,259	1,258,001	
06.03.73.02_25	Porter Levee Setback		588,287	48,309	31,830	40,573	14,180	3,616	726,795	
06.03.73.02_26	Kaech Levee Pond		161,061	13,226	8,714	11,108	3,882	990	198,982	
06.03.73.02_27	Ray Creek Trib Corridor		1,354,215	111,207	73,271	93,399	32,642	8,324	1,673,056	
06.03.73.02_28	Hamakami Levee Modification		394,785	32,419	21,360	27,228	9,516	2,427	487,734	
06.03.73.02_29	Turley Levee Setback		119,398	9,805	6,460	8,235	2,878	734	147,509	
06.03.73.02_30	Loans Levee Setback		1,816,705	149,186	98,295	125,296	43,790	11,166	2,244,437	
06.03.73.02_31	Burns Creek Restoration		254,973	20,938	13,796	17,585	6,146	1,567	315,005	
06.03.73.02_32	Middle Green River LWD		730,123	59,957	39,504	50,356	17,599	4,488	902,027	
06.03.73.02_33	Middle Green Gravel Replacement		4,099,992	336,687	221,834	282,772	98,826	25,201	5,065,310	
06.03.73.02_34	Flaming Geyser Landslide		2,294,779	188,445	124,161	158,268	55,313	14,105	2,835,071	
06.03.73.02_35	Flaming Geyser Side Channel		406,063	33,345	21,970	28,006	9,788	2,496	501,669	
06.03.73.02_36	Newaukum Creek		2,627,660	215,780	142,172	181,227	63,337	16,151	3,246,327	
06.03.73.02_37	Big Spring Creek		673,834	55,334	36,458	46,474	16,242	4,142	832,485	
06.03.73.02_38	Brunner Slough		713,995	58,632	38,631	49,243	17,210	4,389	882,101	
06.03.73.02_39	Upper Green Side Channel Enhance		409,288	33,610	22,145	28,228	9,865	2,516	505,653	
06.03.73.02_41	Gale Creek		172,658	14,178	9,342	11,908	4,162	1,061	213,309	
06.03.73.02_43	Sweeney Creek		86,851	7,132	4,699	5,990	2,093	534	107,299	

		QUANTITY UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	INS&BOND	B&O TAX	TOTAL COST	UNIT COST
06.03.73.02_44	Olsen Creek		84,049	6,902	4,548	5,797	2,026	517	103,837	
06.03.73.02_45	May Creek		151,303	12,425	8,186	10,435	3,647	930	186,926	
06.03.73.02_47	Gold Creek		95,658	7,855	5,176	6,597	2,306	588	118,180	
06.03.73.02_48	Sunday Creek Riparion Plantings		1,702,236	139,786	92,101	117,401	41,030	10,463	2,103,018	
06.03.73.02_49	Northeast Creek		134,307	11,029	7,267	9,263	3,237	826	165,928	
TOTAL	Site Work		39,305,759	3,227,744	2,126,675	2,710,873	947,421	241,592	48,560,064	
TOTAL	Habitat		39,305,759	3,227,744	2,126,675	2,710,873	947,421	241,592	48,560,064	
TOTAL	Wildlife Facilities & Sanctuary		39,305,759	3,227,744	2,126,675	2,710,873	947,421	241,592	48,560,064	
TOTAL	Fish and Wildlife Facilities		39,305,759	3,227,744	2,126,675	2,710,873	947,421	241,592	48,560,064	
TOTAL	Green Duwmish Ecosystem Resto.	1.00 EA	39,305,759	3,227,744	2,126,675	2,710,873	947,421	241,592	48,560,064	48560064

O. 5. Prime Contractor	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST

O. 5. Prime Contractor

0. 5. Prime Contractor			QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
0. 5. 0. Overhead Items - AA													
MIL	<01036 0300 >	Field personnel, general superintendent	72.00	MO	UFLDSUGE1	0.01	12,414	425,518	0	0	0	425,518	5909.97
USR	< >	4x2 pickup truck	72.00	MO	FA-AGENS	1.00	0	427,786	0	0	19,800	447,586	6216.47
MIL	<01036 0580 >	Field personnel, field engineer	72.00	MO	UFLDFENG1	0.01	12,414	349,625	0	0	0	349,625	4855.90
USR	< >	4x4 pickup truck	72.00	MO	FA-AGENS	1.00	0	427,786	0	0	32,400	460,186	6391.47
AF	<01594 1400 >	Toilet, portable chemical, rent per month	300.00	EA	N/A	0.00	0	0	0	23,350	0	23,350	77.83
AF	<01594 0450 >	Office trailer, rent per month, furnished, no hookups, 50' x 10'	72.00	MO	N/A	0.00	0	0	0	21,894	0	21,894	304.08
USR	< >	Power usage	72.00	MO	FA-AGENS	1.00	0	427,786	0	0	7,200	434,986	6041.47
USR	< >	Phone	72.00	MO	FA-AGENS	1.00	0	427,786	0	0	10,800	438,586	6091.47
USR	< >	Water/Sewer	72.00	MO	FA-AGENS	1.00	0	427,786	0	0	5,400	433,186	6016.47
L CIV	< >	Schedule updates	20.00	EA	UFLDCSPE1	0.25	80	2,081	0	597	0	2,679	133.93
CIV	<01533 0200 >	Barricades, 5' high, 3 rail @ 2" x 8", movable	50.00	LF	CODLB6	30.00	5	177	20	1,493	0	1,690	33.80
AF	<01534 0100 >	Fencing, 11 ga, chain link, 6' high	20.00	CLF	ALABCLAB2	0.09	426	14,212	0	8,319	0	22,530	1126.52
AF	<01580 0010 >	Sign, hi-intensity reflectorized, buy	500.00	SF	N/A	0.00	0	0	0	5,490	500	5,990	11.98
AF	<01594 1350 >	Office, storage boxes, 28' x 10', rent per month	30.00	MO	N/A	0.00	0	0	0	3,095	0	3,095	103.17
AF	<01714 0300 >	Cleanup, site debris clean up & removal	25.00	ACR	ULABA5	0.25	230	7,687	447	0	0	8,134	325.36
L MIL	<01036 0640 >	Field personnel, surveyor	3.00	MO	UFLDSRVS1	0.01	517	11,220	0	0	0	11,220	3739.95
USR	< >	4x4 pickup truck	3.00	MO	FA-AGENS	1.00	0	17,824	0	0	1,350	19,174	6391.47
B MIL	< >	Traffic Control	180.00	DAY		0.00	0	86,400	1,800	0	0	88,200	490.00
USR	< >	Straw bales	2000.00	EA		0.00	0	0	0	10,860	0	10,860	5.43
USR	< >	Mechanical Application of Straw	1.00	LS	CLABB64	0.01	400	13,476	4,387	0	0	17,863	17862.66
M HTW	< >	Proj documentation photos, 5" x 7", color, 24 count	160.00	ROL	N/A	0.00	0	0	0	1,390	0	1,390	8.69
	TOTAL	Overhead Items - AA	1.00	EA			26,486	3,067,149	6,655	76,488	77,450	3,227,742	3227741.61

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06. Fish and Wildlife Facilities											
06.03. Wildlife Facilities & Sanctuary											
06.03.73. Habitat											
06.03.73.02. Site Work											
06.03.73.02_ A. Volunteer Revegetation											
06.03.73.02_ A_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	20,000	2,000	1,086	0	23,086	23086.00
06.03.73.02_ A_ 3. Landscaping Yr 1											
B RSM LS < > Western Red Cedar	900.00	EA	ULABM	120.00	23	885	42	3,426	0	4,353	4.84
B RSM LS < > Sitka Spruce	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Hemlock	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Oregon Ash	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Cascara	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Western Crabapple	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Douglas Hawthorne	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Willow, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Red Osier Dogwood, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Ninebark, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Black Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Red Elderberry, 1-2 gal pots	3500.00	EA	ULABM	120.00	88	3,441	164	14,434	0	18,039	5.15
B RSM LS < > Rushes	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Sedges	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Pacific Willow Stakes	15000	EA	ULABM	600.00	75	2,950	140	11,420	0	14,510	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	8,763	1,168	1,269	584	11,785	11784.89
06.03.73.02_ A_ 4. Landscaping Yr 2											
B RSM LS < > Western Red Cedar	900.00	EA	ULABM	120.00	23	885	42	3,426	0	4,353	4.84
B RSM LS < > Sitka Spruce	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Hemlock	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Oregon Ash	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Cascara	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Western Crabapple	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Douglas Hawthorne	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Willow, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Red Osier Dogwood, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Ninebark, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Black Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Red Elderberry, 1-2 gal pots	3500.00	EA	ULABM	120.00	88	3,441	164	14,434	0	18,039	5.15
B RSM LS < > Rushes	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Sedges	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Pacific Willow Stakes	15000	EA	ULABM	600.00	75	2,950	140	11,420	0	14,510	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	8,763	1,168	1,269	584	11,785	11784.89

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_ A_ 5. Landscaping Yr 3											
B RSM LS < > Western Red Cedar	900.00	EA	ULABM	120.00	23	885	42	3,426	0	4,353	4.84
B RSM LS < > Sitka Spruce	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Hemlock	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Oregon Ash	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Cascara	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Western Crabapple	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Douglas Hawthorne	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Willow, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Red Osier Dogwood, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Ninebark, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Black Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Red Elderberry, 1-2 gal pots	3500.00	EA	ULABM	120.00	88	3,441	164	14,434	0	18,039	5.15
B RSM LS < > Rushes	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Sedges	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Pacific Willow Stakes	15000	EA	ULABM	600.00	75	2,950	140	11,420	0	14,510	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	8,763	1,168	1,269	584	11,785	11784.89
06.03.73.02_ A_ 6. Landscaping Yr 4											
B RSM LS < > Western Red Cedar	900.00	EA	ULABM	120.00	23	885	42	3,426	0	4,353	4.84
B RSM LS < > Sitka Spruce	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Hemlock	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Oregon Ash	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Cascara	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Western Crabapple	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Douglas Hawthorne	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Willow, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Red Osier Dogwood, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Ninebark, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Black Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Red Elderberry, 1-2 gal pots	3500.00	EA	ULABM	120.00	88	3,441	164	14,434	0	18,039	5.15
B RSM LS < > Rushes	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Sedges	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Pacific Willow Stakes	15000	EA	ULABM	600.00	75	2,950	140	11,420	0	14,510	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	8,763	1,168	1,269	584	11,785	11784.89
06.03.73.02_ A_ 7. Landscaping Yr 5											
B RSM LS < > Western Red Cedar	900.00	EA	ULABM	120.00	23	885	42	3,426	0	4,353	4.84
B RSM LS < > Sitka Spruce	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Hemlock	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Oregon Ash	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Cascara	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Western Crabapple	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Douglas Hawthorne	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Willow, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Red Osier Dogwood, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Ninebark, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Black Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15

06.03. Wildlife Facilities & Sanctuary		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
B RSM LS <	> Red Elderberry, 1-2 gal pots	3500.00	EA	ULABM	120.00	88	3,441	164	14,434	0	18,039	5.15
B RSM LS <	> Rushes	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS <	> Sedges	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS <	> Pacific Willow Stakes	15000	EA	ULABM	600.00	75	2,950	140	11,420	0	14,510	0.97
B CIV LS <	> Plant Establishment	1.00	YR	N/A	0.00	0	8,763	1,168	1,269	584	11,785	11784.89
06.03.73.02_ A_ 8. Landscaping Yr 6												
B RSM LS <	> Western Red Cedar	900.00	EA	ULABM	120.00	23	885	42	3,426	0	4,353	4.84
B RSM LS <	> Sitka Spruce	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Hemlock	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Oregon Ash	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Cascara	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS <	> Western Crabapple	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS <	> Douglas Hawthorne	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Pacific Willow, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Red Osier Dogwood, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Pacific Ninebark, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS <	> Black Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS <	> Red Elderberry, 1-2 gal pots	3500.00	EA	ULABM	120.00	88	3,441	164	14,434	0	18,039	5.15
B RSM LS <	> Rushes	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS <	> Sedges	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS <	> Pacific Willow Stakes	15000	EA	ULABM	600.00	75	2,950	140	11,420	0	14,510	0.97
B CIV LS <	> Plant Establishment	1.00	YR	N/A	0.00	0	8,763	1,168	1,269	584	11,785	11784.89
06.03.73.02_ A_ 9. Landscaping Yr 7												
B RSM LS <	> Western Red Cedar	900.00	EA	ULABM	120.00	23	885	42	3,426	0	4,353	4.84
B RSM LS <	> Sitka Spruce	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Hemlock	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Oregon Ash	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Cascara	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS <	> Western Crabapple	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS <	> Douglas Hawthorne	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Pacific Willow, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Red Osier Dogwood, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Pacific Ninebark, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS <	> Black Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS <	> Red Elderberry, 1-2 gal pots	3500.00	EA	ULABM	120.00	88	3,441	164	14,434	0	18,039	5.15
B RSM LS <	> Rushes	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS <	> Sedges	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS <	> Pacific Willow Stakes	15000	EA	ULABM	600.00	75	2,950	140	11,420	0	14,510	0.97
B CIV LS <	> Plant Establishment	1.00	YR	N/A	0.00	0	8,763	1,168	1,269	584	11,785	11784.89
06.03.73.02_ A_10. Landscaping Yr 8												
B RSM LS <	> Western Red Cedar	900.00	EA	ULABM	120.00	23	885	42	3,426	0	4,353	4.84
B RSM LS <	> Sitka Spruce	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Hemlock	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Oregon Ash	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS <	> Cascara	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS <	> Western Crabapple	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
B RSM LS < > Douglas Hawthorne	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Willow, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Red Osier Dogwood, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Ninebark, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Black Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Red Elderberry, 1-2 gal pots	3500.00	EA	ULABM	120.00	88	3,441	164	14,434	0	18,039	5.15
B RSM LS < > Rushes	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Sedges	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Pacific Willow Stakes	15000	EA	ULABM	600.00	75	2,950	140	11,420	0	14,510	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	8,763	1,168	1,269	584	11,785	11784.89
06.03.73.02_ A_11. Landscaping Yr 9											
B RSM LS < > Western Red Cedar	900.00	EA	ULABM	120.00	23	885	42	3,426	0	4,353	4.84
B RSM LS < > Sitka Spruce	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Hemlock	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Oregon Ash	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Cascara	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Western Crabapple	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Douglas Hawthorne	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Willow, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Red Osier Dogwood, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Ninebark, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Black Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Red Elderberry, 1-2 gal pots	3500.00	EA	ULABM	120.00	88	3,441	164	14,434	0	18,039	5.15
B RSM LS < > Rushes	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Sedges	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Pacific Willow Stakes	15000	EA	ULABM	600.00	75	2,950	140	11,420	0	14,510	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	8,763	1,168	1,269	584	11,785	11784.89
06.03.73.02_ A_12. Landscaping Yr 10											
B RSM LS < > Western Red Cedar	900.00	EA	ULABM	120.00	23	885	42	3,426	0	4,353	4.84
B RSM LS < > Sitka Spruce	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Hemlock	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Oregon Ash	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Cascara	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Western Crabapple	500.00	EA	ULABM	120.00	13	492	23	1,745	0	2,260	4.52
B RSM LS < > Douglas Hawthorne	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Willow, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Red Osier Dogwood, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Pacific Ninebark, 1-2 gal pots	900.00	EA	ULABM	120.00	23	885	42	3,141	0	4,068	4.52
B RSM LS < > Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Black Twinberry, 1-2 gal pots	5000.00	EA	ULABM	120.00	125	4,916	234	20,620	0	25,770	5.15
B RSM LS < > Red Elderberry, 1-2 gal pots	3500.00	EA	ULABM	120.00	88	3,441	164	14,434	0	18,039	5.15
B RSM LS < > Rushes	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Sedges	15000	EA	ULABM	450.00	101	3,933	188	11,420	0	15,541	1.04
B RSM LS < > Pacific Willow Stakes	15000	EA	ULABM	600.00	75	2,950	140	11,420	0	14,510	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	8,763	1,168	1,269	584	11,785	11784.89

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
TOTAL Volunteer Revegetation					8,185	429,153	28,979	1,202,124	5,842	1,666,099	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_01. Elliot Bay Nearshore											
06.03.73.02_01_ 2. Mob, Demob & Prep Work											
USR AA < > Mob & Demob Floating Plant w/ tug, barge and front end loader	1.00	JOB		0.00	0	5,000	15,000	1,086	0	21,086	21086.00
06.03.73.02_01_ 4. Site Work (USER)											
B RSM AA < > 2"-12" Cobbles, Placed in 6"-18" mounds by FEL from barge	8000.00	CY	UOEHR	90.00	622	22,410	39,168	130,320	0	191,898	23.99
L MIL AA <02232 0245 > Excavate & load, wheeled loader, 3 CY, medium matl	8000.00	CY	CODFB10T	90.00	134	5,062	3,850	0	0	8,912	1.11
B RSM AA < > Material Barge Rental	2.53	WK		0.00	0	0	1,263	0	0	1,263	500.00
TOTAL Elliot Bay Nearshore					756	32,471	59,282	131,406	0	223,159	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_02. Site 1, Duwamish											
06.03.73.02_02_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	6,000	6,000	3,258	3,000	18,258	18258.00
USR AA < > Construction Access Road	7000.00	SF		0.00	0	1,750	3,500	1,520	0	6,770	0.97
06.03.73.02_02_ 4. Site Work											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	2.90	ACR	CODFB7	0.08	232	8,039	3,158	0	0	11,197	3861.01
AF AA <01534 0100 > Fencing, 11 ga, chain link, 6' high	437.00	LF	ALABCLAB2	9.38	93	3,107	0	1,818	0	4,925	11.27
MIL AA <02831 7245 > Fence, CL, 6' high, sgl, 3' W, indl, gates, swing, galv, w/o barb wire	1.00	EA	CLABB80A	3.38	1	30	4	110	0	144	144.09
MIL AA <02831 7260 > Fence, CL, 6' high, dbl, 12'W, indl, gates, swing, galv, w/o barb wire	1.00	EA	CLABB80A	1.38	2	73	11	337	0	421	420.81
USR PV < > Pedestrian Pathway, asphalt	230.00	LF		0.00	0	1,369	822	1,190	0	3,381	14.70
USR CP < > Pedestrian Viewing Platform, wood	225.00	SF		0.00	0	4,019	536	5,819	0	10,373	46.10
06.03.73.02_02_ 6. Channel											
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	1000.00	LF	ALABCLAB2	43.75	46	1,524	0	250	0	1,773	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	42320	CY	CODEB12C	100.00	846	32,806	38,245	0	0	71,051	1.68
L AF AA <02234 0570 > Hauling, hwy haulers, 12 CY, 24 mile round trip @ base wide rate	4232.00	CY	COEIB34B	8.00	529	19,378	18,579	0	0	37,958	8.97
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	38088	CY	COEIB34B	27.00	1,409	51,678	49,545	0	0	101,223	2.66
L AF AA < > Disposal to Hazardous Waste Site (10%)	4232.00	CY	COEIB34B	27.00	157	5,742	5,505	0	0	11,247	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	15000	CY	CODTB10L	46.88	480	18,222	8,220	0	0	26,442	1.76
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	230.00	CY	CODET	35.00	13	488	613	3,962	0	5,062	22.01
06.03.73.02_02_ 8. Habitat Features											
B MIL AA < > LWD	24.00	EA	CODEB12C	6.00	8	310	361	6,516	0	7,188	299.48
B MIL AA < > Snag	6.00	EA	CODEB12C	4.00	3	116	136	326	0	578	96.27
06.03.73.02_02_10. Upland Area/Buffer Plantings											
B RSM LS < > Pacific Ninebark	115.00	EA	ULABM	120.00	3	113	5	401	0	520	4.52
B RSM LS < > Snowberry	230.00	EA	ULABM	120.00	6	226	11	803	0	1,039	4.52
B RSM LS < > Flowering Currant	230.00	EA	ULABM	120.00	6	226	11	803	0	1,039	4.52
B RSM LS < > Salal	345.00	EA	ULABM	120.00	9	339	16	1,423	0	1,778	5.15
B RSM LS < > Oregon Grape	345.00	EA	ULABM	120.00	9	339	16	1,532	0	1,888	5.47
B RSM LS < > Beaked Hazelnut	345.00	EA	ULABM	120.00	9	339	16	1,532	0	1,888	5.47

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
B RSM LS < > Thimbleberry	345.00	EA	ULABM	120.00	9	339	16	1,313	0	1,669	4.84
B RSM LS < > Ocean Spray	345.00	EA	ULABM	120.00	9	339	16	1,313	0	1,669	4.84
B RSM LS < > Nootka Rose	230.00	EA	ULABM	120.00	6	226	11	1,094	0	1,331	5.79
B RSM LS < > Hookers Willow	115.00	EA	ULABM	600.00	1	23	1	88	0	111	0.97
B RSM LS < > Sitka Willow	115.00	EA	ULABM	600.00	1	23	1	88	0	111	0.97
B RSM LS < > Black Cottonwood	115.00	EA	ULABM	120.00	3	113	5	438	0	556	4.84
B RSM LS < > Pacific Crabapple	58.00	EA	ULABM	120.00	1	57	3	221	0	281	4.84
B RSM LS < > Black Hawthorn	86.00	EA	ULABM	120.00	2	85	4	327	0	416	4.84
B RSM LS < > Douglas Fir	115.00	EA	ULABM	120.00	3	113	5	438	0	556	4.84
B RSM LS < > Western White Pine	120.00	EA	ULABM	30.00	12	472	22	457	0	951	7.93
B RSM LS < > Sitka Spruce	120.00	EA	ULABM	30.00	12	472	22	419	0	913	7.61
06.03.73.02_02_12. Intertidal Area Plantings											
B RSM LS < > Deschamipia caespitosa,carex lyngbyie,scirpus validus,aster,p	2875.00	EA	ULABM	450.00	19	754	36	2,736	0	3,526	1.23
06.03.73.02_02_14. Soil Amendments											
B MIL LS < > Hydroseeding	1.20	ACR	COFWI	0.15	14	622	372	1,523	0	2,517	2097.49
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	1265.00	CY	CODFB10S	25.00	76	3,367	1,396	25,603	0	30,365	24.00
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
TOTAL Site 1, Duwamish					4,052	171,164	137,911	69,023	3,584	381,682	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_03. Riverton Side Channel											
06.03.73.02_03_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00
06.03.73.02_03_ 4. Channel											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	1.40	ACR	CODFB7	0.08	112	3,881	1,524	0	0	5,405	3861.01
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	1174.00	CY	CODEB12C	100.00	23	910	1,061	0	0	1,971	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	1174.00	CY	COEIB34B	27.00	43	1,593	1,527	0	0	3,120	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	587.00	CY	CODTB10L	46.88	19	713	322	0	0	1,035	1.76
B MIL AA <02215 1220 > River Gravel Pads, front-end loader, 40 - 60 HP, no compaction	179.00	CY	CODFB10N	30.00	9	340	162	3,888	0	4,390	24.52
06.03.73.02_03_ 5. Water Control Equipment											
L MIL AA <02046 0020 > Remove existing Flapgates	2.00	EA	CODLB6	0.25	24	847	98	0	0	946	472.80
AF AA <02234 4200 > Hauling, w/loading, 12 CY truck, 5 mile haul	12.00	CY	CODEB30	48.00	1	28	33	0	0	61	5.08
L RSM AA <02074 2083 > Concrete Demo	15.00	SF	ALABCLAB1	5.00	3	100	0	0	0	100	6.67
B CIV AA < > Self Regulating Tidegate, 48" Dia	2.00	EA	SIWSL5A	0.25	32	1,296	286	86,880	2,000	90,462	45231.07
06.03.73.02_03_ 8. Habitat Features											
B MIL AA < > LWD	51.00	EA	CODEB12C	6.00	17	659	768	13,847	0	15,274	299.48
B MIL AA < > Boulders	46.00	EA	CODEB12C	8.00	12	446	520	500	0	1,465	31.85
B MIL AA < > Brush (treetops w/ branches)	12.00	EA	CODEB12C	4.00	6	233	271	652	0	1,155	96.27
06.03.73.02_03_10. Non-channel Plantings											
B RSM LS < > Red Osier Dogwood	120.00	EA	ULABM	120.00	3	118	6	419	0	542	4.52
B RSM LS < > Pacific Ninebark	210.00	EA	ULABM	120.00	5	206	10	733	0	949	4.52
B RSM LS < > Elderberry	360.00	EA	ULABM	120.00	9	354	17	1,485	0	1,855	5.15
B RSM LS < > Oregon Grape	360.00	EA	ULABM	120.00	9	354	17	1,599	0	1,970	5.47
B RSM LS < > Beaked Hazelnut	360.00	EA	ULABM	120.00	9	354	17	1,599	0	1,970	5.47
B RSM LS < > Thimbleberry	360.00	EA	ULABM	120.00	9	354	17	1,370	0	1,741	4.84
B RSM LS < > Ocean Spray	360.00	EA	ULABM	120.00	9	354	17	1,370	0	1,741	4.84
B RSM LS < > Wild Rose	360.00	EA	ULABM	120.00	9	354	17	1,713	0	2,084	5.79
B RSM LS < > Willow	230.00	EA	ULABM	600.00	1	45	2	175	0	222	0.97
B RSM LS < > Salmonberry	460.00	EA	ULABM	120.00	12	452	21	1,751	0	2,225	4.84
B RSM LS < > Black Cottonwood	46.00	EA	ULABM	120.00	1	45	2	175	0	222	4.84
B RSM LS < > Pacific Crabapple	23.00	EA	ULABM	120.00	1	23	1	88	0	111	4.84
B RSM LS < > Black Hawthorn	46.00	EA	ULABM	120.00	1	45	2	175	0	222	4.84
B RSM LS < > Douglas Fir	46.00	EA	ULABM	120.00	1	45	2	175	0	222	4.84

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
B RSM LS < > Red Cedar	46.00	EA	ULABM	1200.00	0	5	0	175	0	180	3.91
B RSM LS < > Alder	46.00	EA	ULABM	120.00	1	45	2	161	0	208	4.52
B RSM LS < > Bitter Cherry	46.00	EA	ULABM	120.00	1	45	2	204	0	252	5.47
06.03.73.02_03_14. Soil Amendments											
B MIL LS < > Hydroseeding	1.20	ACR	COFWI	0.15	14	622	372	1,523	0	2,517	2097.49
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	403.00	CY	CODFB10S	25.00	24	1,073	445	8,156	0	9,674	24.00
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
TOTAL Riverton Side Channel					469	27,627	11,231	132,476	4,584	175,918	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_04. Codiga Farms											
06.03.73.02_04_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	5,000	5,000	2,172	1,000	13,172	13172.00
06.03.73.02_04_ 4. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	2.50	ACR	COMCB88	0.53	33	1,294	1,221	0	0	2,515	1005.96
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	200.00	LF	ALABCLAB2	43.75	9	305	0	50	0	355	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	39010	CY	CODEB12C	100.00	780	30,241	35,253	0	0	65,494	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	33450	CY	COEIB34B	16.00	2,091	76,584	73,426	0	0	150,010	4.48
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	5560.00	CY	COEIB34B	40.00	139	5,092	4,882	0	0	9,974	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	5560.00	CY	CODTB10L	46.88	178	6,754	3,047	0	0	9,801	1.76
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	5560.00	CY	CODEB12C	130.00	86	3,315	3,865	0	0	7,181	1.29
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	5560.00	CY	CODTB10L	46.88	178	6,754	3,047	0	0	9,801	1.76
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	5560.00	CY	COFCB10Y	375.00	22	844	334	0	0	1,178	0.21
MIL AA <02220 9010 > Compaction, water, truck, 3000 gal, 6 mile haul	556.00	CY	COKBB45	180.50	6	237	145	121	0	503	0.90
B AF AA < > Clay liner material, delivered	720.00	CY	COEIB34B	15.00	48	1,758	1,686	11,729	0	15,173	21.07
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	720.00	CY	CODTB10L	46.88	23	875	395	0	0	1,269	1.76
RSM AA <02220 5600 > Compaction, riding, 6" lifts, 2 passes, sheepsfoot/wobbly wheel roller	720.00	CY	COFCB10G	300.00	4	137	111	0	0	247	0.34
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	1665.00	CY	CODFB10N	30.00	83	3,160	1,506	36,164	0	40,830	24.52
M RSM AA <02270 0100 > Large rocks, machine placed	220.00	CY	UOEHB12G	7.75	57	2,201	994	7,168	0	10,363	47.10
B MIL AA < > LWD	20.00	EA	CODEB12C	6.00	7	258	301	5,430	0	5,990	299.48
06.03.73.02_04_ 6. Berm											
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	670.00	CY	CODET	75.00	18	663	833	11,540	0	13,036	19.46
B MIL AA < > Hydroseeding	9000.00	SF	COFWI	2500.00	6	239	143	489	0	871	0.10

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_04_ 8. Access Trail/Parking											
CIV AA <02224 1010 > Excavating, bulk, medium matl, 150' push, dozer, open site, 65 HP	300.00	CY	CODTB10L	25.00	18	683	308	0	0	992	3.31
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	300.00	CY	COFCB10Y	375.00	1	46	18	0	0	64	0.21
M MIL PV < > Basecourse for road, 6" thick areas	1800.00	SY	COFGB36B	562.50	26	1,138	934	11,638	0	13,710	7.62
MIL PV <02220 5900 > Compaction of backfill, structural, SP roller, 6" lift	300.00	CY	COFCB10F	117.50	4	173	122	0	0	295	0.98
B MIL PV <02514 0020 > Sidewalks, no base, asphaltic conc, 4" thick	350.00	SY	COFCB37	55.00	38	1,568	297	3,150	0	5,015	14.33
USR CP < > Pedestrian Viewing Platform, wood	225.00	SF		0.00	0	4,019	536	5,819	0	10,373	46.10
L AF CP <01580 0010 > Sign, hi-intensity reflectorized, buy	25.00	SF	N/A	0.00	0	238	60	327	298	922	36.89
06.03.73.02_04_10. PCC Pad											
CIV AA <02228 0312 > Excavate trench, mdm soil, 4'-6' D, 3/4 CY excavator	34.00	CY	CODEB12F	68.13	1	39	17	0	0	56	1.65
MIL AA <02512 2520 > Fine grade, for slab on grade, by hand	900.00	SF	ALABCLAB1	225.00	4	133	0	0	0	133	0.15
MIL PV <02244 0080 > Base course, compacted to 4" deep, crushed 3/4" stone areas	100.00	SY	COFGB36B	562.50	1	63	52	676	0	791	7.91
MIL PV <02514 0350 > PPC pad, no base, 5" T, 3000 PSI, CIP w/ 6x6 mesh, broom fin, conc	900.00	SF	ACMAB24	68.13	40	1,710	0	1,443	0	3,153	3.50
B AF CP <11404 9135 > Picnic table	4.00	EA	ULABA2	0.50	24	959	142	2,586	0	3,687	921.86
USR CP < > Picnic shelter, hexagonal, small	900.00	SF		0.00	0	10,716	2,143	11,638	0	24,497	27.22
06.03.73.02_04_12. Maintenance Road											
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	139.00	CY	CODTB10L	46.88	4	169	76	0	0	245	1.76
M MIL AA < > Basecourse for road, 12" thick areas	417.00	SY	COFGB36B	562.50	6	221	182	1,698	0	2,101	5.04
USR AA < > Geotextile, woven	417.00	SY	CLABB80	540.00	3	109	13	317	0	439	1.05
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	139.00	CY	CODTB10L	46.88	4	169	76	0	0	245	1.76
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	139.00	CY	CODEB12C	130.00	2	83	97	0	0	180	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	139.00	CY	COEIB34B	27.00	5	189	181	0	0	369	2.66

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_04_14. Landscaping											
MIL LS <02241 0805 > Loam or topsoil, furnish & place, imported, 6" deep	170.00	CY	CODFB10S	17.00	15	665	276	3,585	0	4,526	26.63
B RSM LS < > Carex Sp. Plugs	39387	EA	ULABM	450.00	264	10,327	492	29,988	0	40,807	1.04
B RSM LS < > Salmonberry	3300.00	EA	ULABM	120.00	83	3,245	154	12,562	0	15,961	4.84
B RSM LS < > Snowberry	4400.00	EA	ULABM	210.00	63	2,472	118	15,354	0	17,944	4.08
B RSM LS < > Flowering Currant	2200.00	EA	ULABM	120.00	55	2,163	103	7,677	0	9,943	4.52
B RSM LS < > Red Alder	4400.00	EA	CLABB80	120.00	147	6,040	738	16,750	0	23,528	5.35
B RSM LS < > Oregon Grape	2200.00	EA	ULABM	120.00	55	2,163	103	9,771	0	12,037	5.47
B RSM LS < > Salal	2200.00	EA	ULABM	120.00	55	2,163	103	9,073	0	11,339	5.15
B RSM LS < > Black Cottonwood, 10 gal.	396.00	EA	ULABM	6.00	198	7,787	370	9,045	0	17,202	43.44
B RSM LS < > Pacific Crabapple, 8-10 ft.	264.00	EA	ULABM	6.00	132	5,191	247	7,370	0	12,808	48.52
B RSM LS < > Douglas Fir, 8-10 ft.	660.00	EA	ULABM	6.00	330	12,979	617	16,750	0	30,345	45.98
B RSM LS < > Western Red Cedar, 8-10 ft.	528.00	EA	ULABM	6.00	264	10,383	494	15,410	0	26,286	49.78
B RSM LS < > Blue Spruce	1378.00	EA	ULABM	12.00	345	13,549	644	20,983	0	35,176	25.53
B RSM LS < > Hemlock, 8-10 ft.	284.00	EA	ULABM	6.00	142	5,585	265	7,207	0	13,058	45.98
B RSM LS < > Red Alder	1378.00	EA	ULABM	12.00	345	13,549	644	19,234	0	33,427	24.26
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
TOTAL Codiga Farms					6,466	274,324	147,502	316,280	1,882	739,988	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_05. Black River Marsh											
06.03.73.02_05_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	750	2,000	0	0	2,750	2750.00
06.03.73.02_05_ 4. Marsh Creation (lower el. to 10'											
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	200.00	CY	CODEB12C	100.00	4	155	181	0	0	336	1.68
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	200.00	CY	COEIB34B	40.00	5	183	176	0	0	359	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	200.00	CY	CODTB10L	46.88	6	243	110	0	0	353	1.76
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	200.00	CY	CODEB12C	130.00	3	119	139	0	0	258	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	200.00	CY	COEIB34B	12.00	17	611	585	0	0	1,196	5.98
B MIL AA < > LWD	5.00	EA	CODEB12C	6.00	2	65	75	1,629	0	1,769	353.78
06.03.73.02_05_ 6. Access Road Construction/Removal											
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	62.00	CY	CODTB10L	46.88	2	75	34	0	0	109	1.76
M MIL AA < > Basecourse for road, 6" thick areas	187.00	SY	COFGB36B	562.50	3	99	82	1,015	0	1,196	6.40
USR AA < > Geotextile, woven	187.00	SY	CLABB80	540.00	1	49	6	142	0	197	1.05
USR PV < > Construction Access Road Removal	1680.00	SF		0.00	0	200	800	0	0	1,000	0.60
L AF PV < > Hauling, hwy haulers, 12 CY, 6 mi round trip	62.00	CY	COEIB34B	12.00	5	225	216	0	0	441	7.12
06.03.73.02_05_11. Landscaping											
B RSM LS < > Yellowtwig Dogwood Stakes	195.00	EA	ULABM	75.00	8	307	15	148	0	470	2.41
B RSM LS < > Redtwig Dogwood Stakes	195.00	EA	ULABM	75.00	8	307	15	148	0	470	2.41
B RSM LS < > Native Willow Stakes	255.00	EA	ULABM	60.00	13	501	24	0	0	525	2.06
B RSM LS < > Salmonberry	234.00	EA	ULABM	120.00	6	230	11	891	0	1,132	4.84
B RSM LS < > Snowberry	234.00	EA	ULABM	120.00	6	230	11	817	0	1,058	4.52
B RSM LS < > Flowering Currant	312.00	EA	ULABM	120.00	8	307	15	1,089	0	1,410	4.52
B RSM LS < > Black Cottonwood	9.00	EA	ULABM	6.00	5	177	8	206	0	391	43.44
B RSM LS < > Douglas Fir	25.00	EA	ULABM	6.00	13	492	23	634	0	1,149	45.98
B RSM LS < > Western Red Cedar	16.00	EA	ULABM	6.00	8	315	15	467	0	797	49.78
B RSM LS < > Blue Spruce	16.00	EA	ULABM	6.00	8	315	15	426	0	756	47.25
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
TOTAL Black River Marsh					129	12,965	5,139	8,247	584	26,935	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_06. Gilliam Creek											
06.03.73.02_06_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00
06.03.73.02_06_ 4. Channel											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	6.30	ACR	CODFB7	0.08	504	17,465	6,860	0	0	24,324	3861.01
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	3067.00	SY	CLABB80A	300.00	31	1,022	155	2,831	0	4,008	1.31
MIL AA <02266 0120 > Erosion control, revegetation mat, webbed	3067.00	SY	ALABCLAB2	125.00	49	1,635	0	9,493	0	11,128	3.63
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	1500.00	LF	ALABCLAB2	43.75	69	2,285	0	375	0	2,660	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	2477.00	CY	CODEB12C	100.00	50	1,920	2,238	0	0	4,159	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	9711.00	CY	COEIB34B	27.00	359	13,176	12,632	0	0	25,808	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1250.00	CY	CODTB10L	46.88	40	1,519	685	0	0	2,204	1.76
B MIL AA <02215 1220 > River Gravel Pads, front-end loader, 40 - 60 HP, no compaction	150.00	CY	CODFB10N	30.00	8	285	136	3,258	0	3,678	24.52
06.03.73.02_06_ 5. Water Control Equipment											
L MIL AA < > Remove existing Flapgate	1.00	EA	UOEHB13B	0.13	56	1,961	628	0	0	2,589	2588.80
AF AA <02234 4200 > Hauling, w/loading, 12 CY truck, 5 mile haul	12.00	CY	CODEB30	48.00	1	28	33	0	0	61	5.08
L RSM AA <02074 2083 > Concrete Demo	25.00	SF	ALABCLAB1	8.00	3	104	0	0	0	104	4.17
B CIV AA < > Self Regulating Tidegate, 108" Dia	1.00	EA	SIWSL5A	0.02	200	8,100	1,788	81,450	5,000	96,338	96338.36
06.03.73.02_06_ 6. Fishway											
L MIL AA <02228 0374 > Excavate trench, hvy, wet soil, 6'-10' D, 2 CY excavator	10.00	CY	CODEB12C	25.00	1	31	36	0	0	67	6.72
RSM AA <03217 0500 > Reinforcing in place, footings, #4 to #7	7.00	TON	SIWRRODM4	0.26	107	4,270	0	3,882	0	8,152	1164.55
MIL CP <03158 0050 > Forms in place, 2 use, footings, continuous wall, plywood	840.00	SF	ACARC1	55.00	61	2,646	0	1,358	0	4,003	4.77
MIL AA <02366 3600 > Pile, steel, pipe, 50' L 14" dia, 46 lb/LF, conc filled	324.00	VLF	CPIDB19	44.38	58	2,291	1,169	6,495	1,620	11,576	35.73
RSM AA <03326 0150 > Concrete ready mix, regular weight, 3000 psi	18.00	CY	N/A	0.00	0	0	0	1,095	0	1,095	60.82
L MIL AA < > Concrete Pumping	10.00	CY	ACMAC8E	10.00	4	145	89	0	250	484	48.38
RSM AA <02161 0010 > Sheet piling, stl,15' exc,22 PSF,left in place, no wales	6.50	TON	CP1DB40	1.35	38	1,510	649	5,294	0	7,453	1146.63

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_06_ 8. Habitat Features											
B MIL AA < > LWD	50.00	EA	CODEB12C	6.00	17	646	753	13,575	0	14,974	299.48
B MIL AA < > Boulders	210.00	EA	CODEB12C	8.00	53	2,035	2,372	2,281	0	6,688	31.85
B MIL AA < > Footer Logs	100.00	EA	CODEB12C	4.00	50	1,938	2,259	8,145	0	12,342	123.42
06.03.73.02_06_10. Non-channel Plantings											
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	1.80	ACR	COFWI	0.15	21	934	558	2,284	0	3,775	2097.49
B RSM LS < > Red Osier Dogwood	1800.00	EA	ULABM	120.00	45	1,770	84	6,281	0	8,135	4.52
B RSM LS < > Salmonberry	1800.00	EA	ULABM	120.00	45	1,770	84	6,281	0	8,135	4.52
B RSM LS < > Snowberry	1800.00	EA	ULABM	120.00	45	1,770	84	6,281	0	8,135	4.52
B RSM LS < > Flowering Currant	1800.00	EA	ULABM	120.00	45	1,770	84	6,281	0	8,135	4.52
B RSM LS < > Salal	1800.00	EA	ULABM	120.00	45	1,770	84	7,423	0	9,277	5.15
B RSM LS < > Oregon Grape	1800.00	EA	ULABM	120.00	45	1,770	84	7,994	0	9,848	5.47
B RSM LS < > Black Cottonwood	1800.00	EA	ULABM	120.00	45	1,770	84	6,852	0	8,706	4.84
B RSM LS < > Pacific Crabapple	1800.00	EA	ULABM	120.00	45	1,770	84	6,852	0	8,706	4.84
B RSM LS < > Douglas Fir	1800.00	EA	ULABM	120.00	45	1,770	84	6,852	0	8,706	4.84
B RSM LS < > Western Red Cedar	1800.00	EA	ULABM	120.00	45	1,770	84	6,852	0	8,706	4.84
B RSM LS < > Red Alder	1800.00	EA	ULABM	120.00	45	1,770	84	6,852	0	8,706	4.84
06.03.73.02_06_12. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	2300.00	EA	ULABM	600.00	12	452	21	1,751	0	2,225	0.97
B RSM LS < > Scoulers Willow	2300.00	EA	ULABM	600.00	12	452	21	1,751	0	2,225	0.97
B RSM LS < > Pacific Willow	2300.00	EA	ULABM	600.00	12	452	21	1,751	0	2,225	0.97
B RSM LS < > Sedges	2300.00	EA	ULABM	450.00	15	603	29	1,751	0	2,383	1.04
06.03.73.02_06_14. Soil Amendments											
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	230.00	CY	CODFB10S	25.00	14	612	254	4,655	0	5,521	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	85.00	CY	CODFB10U	20.00	6	283	344	1,675	0	2,302	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
TOTAL Gilliam Creek					2,369	99,195	38,347	233,492	9,454	380,488	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_07. Lower Springbrook Creek											
06.03.73.02_07_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	8,000	7,000	3,258	3,000	21,258	21258.00
06.03.73.02_07_ 4. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	87.00	ACR	COMCB88	0.53	1,146	45,032	42,486	0	0	87,518	1005.96
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	2500.00	LF	ALABCLAB2	43.75	114	3,809	0	624	0	4,433	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	10328	CY	CODEB12C	100.00	207	8,006	9,333	0	0	17,340	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip (50Cy to hummocks)	9695.00	CY	COEIB34B	27.00	359	13,154	12,611	0	0	25,765	2.66
L AF AA < > Commercial Disposal Fee	9695.00	CY		0.00	0	0	0	0	29,085	29,085	3.00
06.03.73.02_07_ 6. LWD Pool											
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	61.00	CY	CODFB10N	30.00	3	116	55	1,325	0	1,496	24.52
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	46859	CY	COEIB34B	27.00	1,734	63,578	60,954	0	0	124,532	2.66
B MIL AA < > LWD	736.00	EA	CODEB12C	6.00	245	9,510	11,085	159,859	0	180,454	245.18
B MIL AA < > Cedar Logs	368.00	EA	CODEB12C	4.00	184	7,132	8,314	19,982	0	35,429	96.27
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	46859	CY	CODEB12C	100.00	937	36,325	42,346	0	0	78,672	1.68
L AF AA < > Commercial Disposal Fee	46809	CY		0.00	0	0	0	0	140,427	140,427	3.00
06.03.73.02_07_ 8. Dendrites											
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl (haul to hummock	583.00	CY	CODEB12C	100.00	12	452	527	0	0	979	1.68
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	45.00	CY	CODFB10N	30.00	2	85	41	977	0	1,104	24.52
B MIL AA < > Small Woody Debris	28.00	EA	CODEB12C	10.00	6	217	253	3,041	0	3,511	125.39
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	583.00	CY	COEIB34B	27.00	22	791	758	0	0	1,549	2.66
L AF AA < > Commercial Disposal Fee	583.00	CY		0.00	0	0	0	0	1,749	1,749	3.00
06.03.73.02_07_10. Hummocks											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	633.00	CY	COEIB34B	40.00	16	580	556	0	0	1,135	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	633.00	CY	CODTB10L	46.88	20	769	347	0	0	1,116	1.76

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_07_12. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	11016	EA	ULABM	600.00	55	2,166	103	8,387	0	10,656	0.97
B RSM LS < > Scoulers Willow	11016	EA	ULABM	600.00	55	2,166	103	8,387	0	10,656	0.97
B RSM LS < > Rushes & Sedges	11016	EA	ULABM	450.00	74	2,888	138	8,387	0	11,413	1.04
B RSM LS < > Sitka Willow Stakes	11016	EA	ULABM	600.00	55	2,166	103	8,387	0	10,656	0.97
B RSM LS < > Sitka Alder Stakes	11016	EA	ULABM	600.00	55	2,166	103	8,387	0	10,656	0.97
06.03.73.02_07_14. Upland Area/Buffer Plantings											
B RSM LS < > Snowberry (116,925 ea)	0.35	EA		0.00	0	33,943	3,067	133,237	0	170,248	486421.57
B RSM LS < > Flowering Currant (116,926 ea)	0.35	EA		0.00	0	33,943	3,067	133,237	0	170,248	486421.57
B RSM LS < > Salmonberry (116,925 ea)	0.35	EA		0.00	0	33,943	3,067	133,237	0	170,248	486421.57
B RSM LS < > Red Osier Dogwood (116,925 ea)	0.35	EA		0.00	0	33,943	3,067	133,237	0	170,248	486421.57
B RSM LS < > Salal (116,925 ea)	0.35	EA		0.00	0	33,943	3,067	133,237	0	170,248	486421.57
B RSM LS < > Oregon Grape (116,925 ea)	0.35	EA		0.00	0	33,943	3,067	133,237	0	170,248	486421.57
B RSM LS < > Red Alder (116,925 ea)	0.35	EA		0.00	0	33,943	3,067	133,237	0	170,248	486421.57
B RSM LS < > Black Cottonwood	6327.00	EA	ULABM	120.00	158	6,221	296	24,085	0	30,602	4.84
B RSM LS < > Pacific Crabapple	6327.00	EA	ULABM	120.00	158	6,221	296	24,085	0	30,602	4.84
B RSM LS < > Douglas Fir	6327.00	EA	ULABM	120.00	158	6,221	296	24,085	0	30,602	4.84
B RSM LS < > Western Red Cedar	6327.00	EA	ULABM	120.00	158	6,221	296	24,085	0	30,602	4.84
B RSM LS < > Red Alder	6327.00	EA	ULABM	120.00	158	6,221	296	24,085	0	30,602	4.84
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	21.00	ACR	COFWI	0.15	245	10,892	6,508	26,647	0	44,047	2097.49
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	655.00	CY	CODFB10S	25.00	39	1,743	723	13,257	0	15,723	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	35.00	CY	CODFB10U	20.00	3	116	142	690	0	948	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_07_18. Asphalt Path											
MIL AA <02243 0100 > Base, prepare & roll sub-base, large areas over 2500 SY	4320.00	SY	COFGB32	462.50	37	1,440	1,445	0	0	2,884	0.67
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1440.00	CY	CODTB10L	46.88	46	1,749	789	0	0	2,538	1.76
MIL AA <02244 0100 > Base course, compacted to 6" deep, crushed 3/4" stone, large areas	4320.00	SY	COFGB36B	562.50	61	2,294	1,883	37,204	0	41,381	9.58
USR AA < > Geotextile, woven	4320.00	SY	CLABB80	540.00	32	1,128	138	3,284	0	4,550	1.05
TOTAL Lower Springbrook Creek					6,581	505,106	232,483	1,366,540	174,845	2,278,975	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_08. Upper Springbrook Creek											
06.03.73.02_08_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00
06.03.73.02_08_ 4. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	3.00	ACR	COMCB88	0.53	40	1,553	1,465	0	0	3,018	1005.96
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	2053.00	CY	CODEB12C	100.00	41	1,591	1,855	0	0	3,447	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip (158Cy to hummocks	1619.00	CY	COEIB34B	27.00	60	2,197	2,106	0	0	4,303	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1011.00	CY	CODTB10L	46.88	32	1,228	554	0	0	1,782	1.76
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1011.00	CY	CODEB12C	130.00	16	603	703	0	0	1,306	1.29
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	1011.00	CY	COEIB34B	40.00	25	926	888	0	0	1,814	1.79
06.03.73.02_08_ 6. LWD Pool											
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	1.00	CY	CODFB10N	30.00	0	2	1	22	0	25	24.52
M RSM AA < > Quarry Spalls, random, machine placed for slope protection	4.00	CY	UOEHB12G	7.75	1	40	18	56	0	115	28.64
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	39.00	CY	CODET	35.00	2	83	104	672	0	858	22.01
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	679.00	CY	COEIB34B	27.00	25	921	883	0	0	1,805	2.66
B MIL AA < > LWD	10.00	EA	CODEB12C	6.00	3	129	151	2,172	0	2,452	245.18
B MIL AA < > Cedar Logs	368.00	EA	CODEB12C	4.00	184	7,132	8,314	19,982	0	35,429	96.27
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	679.00	CY	CODEB12C	100.00	14	526	614	0	0	1,140	1.68
06.03.73.02_08_10. Sedimentation Ponds											
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	60.00	CY	CODEB12C	100.00	1	47	54	0	0	101	1.68
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	8.00	CY	CODET	35.00	0	17	21	138	0	176	22.01
M RSM AA < > Quarry Spalls, random, machine placed for slope protection	5.00	CY	UOEHB12G	7.75	1	50	23	71	0	143	28.64
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	60.00	CY	COEIB34B	27.00	2	81	78	0	0	159	2.66

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_08_12. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	660.00	EA	ULABM	600.00	3	130	6	502	0	638	0.97
B RSM LS < > Scoulers Willow	660.00	EA	ULABM	600.00	3	130	6	502	0	638	0.97
B RSM LS < > Rushes & Sedges	660.00	EA	ULABM	450.00	4	173	8	502	0	684	1.04
B RSM LS < > Sitka Willow Stakes	660.00	EA	ULABM	600.00	3	130	6	502	0	638	0.97
B RSM LS < > Sitka Alder Stakes	660.00	EA	ULABM	600.00	3	130	6	502	0	638	0.97
06.03.73.02_08_14. Upland Buffer Zone											
B RSM LS < > Red Osier Dogwood	443.00	EA	ULABM	120.00	11	436	21	1,546	0	2,002	4.52
B RSM LS < > Salmonberry	443.00	EA	ULABM	120.00	11	436	21	1,546	0	2,002	4.52
B RSM LS < > Snowberry	443.00	EA	ULABM	120.00	11	436	21	1,546	0	2,002	4.52
B RSM LS < > Flowering Currant	443.00	EA	ULABM	120.00	11	436	21	1,546	0	2,002	4.52
B RSM LS < > Salal	443.00	EA	ULABM	120.00	11	436	21	1,827	0	2,283	5.15
B RSM LS < > Oregon Grape	443.00	EA	ULABM	120.00	11	436	21	1,967	0	2,424	5.47
B RSM LS < > Red Alder	443.00	EA	ULABM	120.00	11	436	21	1,686	0	2,143	4.84
B RSM LS < > Black Cottonwood	33.00	EA	ULABM	120.00	1	32	2	126	0	160	4.84
B RSM LS < > Pacific Crabapple	33.00	EA	ULABM	120.00	1	32	2	126	0	160	4.84
B RSM LS < > Douglas Fir	33.00	EA	ULABM	120.00	1	32	2	126	0	160	4.84
B RSM LS < > Western Red Cedar	33.00	EA	ULABM	120.00	1	32	2	126	0	160	4.84
B RSM LS < > Red Alder	33.00	EA	ULABM	120.00	1	32	2	126	0	160	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	65.00	CY	CODFB10S	25.00	4	173	72	1,316	0	1,560	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	41.00	CY	CODFB10U	20.00	3	136	166	808	0	1,110	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_08_16. Access Road											
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	70.00	CY	CODTB10L	46.88	2	85	38	0	0	123	1.76
M MIL AA < > Basecourse for road, 6" thick areas	110.00	SY	COFGB36B	562.50	2	58	48	597	0	704	6.40
USR AA < > Geotextile, woven	110.00	SY	CLABB80	540.00	1	29	4	84	0	116	1.05
06.03.73.02_08_8 . Hummocks											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	158.00	CY	COEIB34B	40.00	4	145	139	0	0	283	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	158.00	CY	CODTB10L	46.88	5	192	87	0	0	279	1.76
TOTAL Upper Springbrook Creek					617	32,036	21,260	42,757	1,084	97,138	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_09. Mill Creek East											
06.03.73.02_09_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00
06.03.73.02_09_ 3. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	4.20	ACR	COMCB88	0.53	55	2,174	2,051	0	0	4,225	1005.96
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	127.00	CY	CODTB10L	46.88	4	154	70	0	0	224	1.76
M MIL AA < > Basecourse for road, 6" thick areas	383.00	SY	COFGB36B	562.50	5	203	167	2,080	0	2,450	6.40
USR AA < > Geotextile, woven	383.00	SY	CLABB80	540.00	3	100	12	291	0	403	1.05
B MIL AA < > LWD	74.00	EA	CODEB12C	6.00	25	956	1,115	16,073	0	18,144	245.18
B MIL AA < > Rootwads	74.00	EA	CODEB12C	6.00	25	956	1,115	12,055	0	14,125	190.88
06.03.73.02_09_ 4. Channel											
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	1725.00	CY	CODEB12C	100.00	35	1,337	1,559	0	0	2,896	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip (158Cy to hummocks	575.00	CY	COEIB34B	27.00	21	780	748	0	0	1,528	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1150.00	CY	CODTB10L	46.88	37	1,397	630	0	0	2,027	1.76
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1150.00	CY	CODEB12C	130.00	18	686	799	0	0	1,485	1.29
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	1150.00	CY	COEIB34B	40.00	29	1,053	1,010	0	0	2,063	1.79
L AF AA < > Commercial Disposal Fee	1150.00	CY		0.00	0	0	0	0	3,450	3,450	3.00
06.03.73.02_09_ 6. Riparian Corridor Plantings											
B RSM LS < > Riparian Corridor Plantings	7.10	AC	ULABM	0.02	968	38,078	1,810	157,664	0	197,552	27824.23
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	460.00	CY	CODFB10U	20.00	35	1,530	1,862	9,065	0	12,457	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_09_ 8. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_09_10. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	7.10	ACR	COMCB88	0.53	94	3,675	3,467	0	0	7,142	1005.96
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	511.00	CY	CODTB10L	46.88	16	621	280	0	0	901	1.76
M MIL AA < > Basecourse for road, 6" thick areas	1533.00	SY	COFGB36B	562.50	22	814	668	8,324	0	9,807	6.40
USR AA < > Geotextile, woven	1533.00	SY	CLABB80	540.00	11	400	49	1,165	0	1,615	1.05
B MIL AA < > LWD	41.00	EA	CODEB12C	6.00	14	530	618	8,905	0	10,052	245.18
06.03.73.02_09_12. Channel											
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	2714.00	CY	CODEB12C	100.00	54	2,104	2,453	0	0	4,557	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip (158Cy to hummocks	1805.00	CY	COEIB34B	27.00	67	2,449	2,348	0	0	4,797	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	909.00	CY	CODTB10L	46.88	29	1,104	498	0	0	1,602	1.76
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	909.00	CY	CODEB12C	130.00	14	542	632	0	0	1,174	1.29
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	909.00	CY	COEIB34B	40.00	23	832	798	0	0	1,631	1.79
L AF AA < > Commercial Disposal Fee	1805.00	CY		0.00	0	0	0	0	5,415	5,415	3.00
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	184.00	CY	CODFB10N	30.00	9	349	166	3,996	0	4,512	24.52
B MIL AA < > Boulders	55.00	EA	CODEB12C	8.00	14	533	621	597	0	1,752	31.85
06.03.73.02_09_14. Riparian Corridor Plantings											
B RSM LS < > Riparian Corridor Plantings	4.20	AC	ULABM	0.02	573	22,525	1,071	93,266	0	116,862	27824.23
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	1022.00	CY	CODFB10U	20.00	77	3,400	4,137	20,140	0	27,677	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_09_16. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00
06.03.73.02_09_18. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	10.60	ACR	COMCB88	0.53	140	5,487	5,176	0	0	10,663	1005.96

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	511.00	CY	CODTB10L	46.88	16	621	280	0	0	901	1.76
M MIL AA < > Basecourse for road, 6" thick areas	1533.00	SY	COFGB36B	562.50	22	814	668	8,324	0	9,807	6.40
USR AA < > Geotextile, woven	1533.00	SY	CLABB80	540.00	11	400	49	1,165	0	1,615	1.05
B MIL AA < > LWD	138.00	EA	CODEB12C	6.00	46	1,783	2,079	29,974	0	33,835	245.18
B MIL AA < > Rootwads	92.00	EA	CODEB12C	6.00	31	1,189	1,386	14,987	0	17,561	190.88
06.03.73.02_09_20. Channel											
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	11270	CY	CODEB12C	100.00	225	8,737	10,185	0	0	18,921	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip (158Cy to hummocks	7475.00	CY	COEIB34B	27.00	277	10,142	9,723	0	0	19,866	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	3795.00	CY	CODTB10L	46.88	121	4,610	2,080	0	0	6,690	1.76
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	3795.00	CY	CODEB12C	130.00	58	2,263	2,638	0	0	4,901	1.29
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	3795.00	CY	COEIB34B	40.00	95	3,475	3,332	0	0	6,807	1.79
L AF AA < > Commercial Disposal Fee	3795.00	CY		0.00	0	0	0	0	11,385	11,385	3.00
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	460.00	CY	CODFB10N	30.00	23	873	416	9,991	0	11,280	24.52
B MIL AA < > Boulders	138.00	EA	CODEB12C	8.00	35	1,337	1,559	1,499	0	4,395	31.85
USR AA < > Coir Logs, 12" dia X 30LF	35.00	EA	ULABM	0.50	210	7,069	336	19,005	875	27,285	779.56
06.03.73.02_09_22. Riparian Corridor Plantings											
B RSM LS < > Riparian Corridor Plantings	10.60	AC	ULABM	0.02	1,445	56,849	2,702	235,386	0	294,937	27824.23
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	511.00	CY	CODFB10U	20.00	38	1,700	2,069	10,070	0	13,839	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_09_24. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00
06.03.73.02_09_26. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	7.90	ACR	COMCB88	0.53	104	4,089	3,858	0	0	7,947	1005.96
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	639.00	CY	CODTB10L	46.88	20	776	350	0	0	1,126	1.76

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
M MIL AA < > Basecourse for road, 6" thick areas	1916.00	SY	COFGB36B	562.50	27	1,018	835	10,404	0	12,257	6.40
USR AA < > Geotextile, woven	1916.00	SY	CLABB80	540.00	14	500	61	1,457	0	2,018	1.05
B MIL AA < > LWD	104.00	EA	CODEB12C	6.00	35	1,344	1,566	22,589	0	25,499	245.18
B MIL AA < > Rootwads	69.00	EA	CODEB12C	6.00	23	892	1,039	11,240	0	13,171	190.88
06.03.73.02_09_28. Channel											
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	10218	CY	CODEB12C	100.00	204	7,921	9,234	0	0	17,155	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip (158Cy to hummocks	6383.00	CY	COEIB34B	27.00	236	8,660	8,303	0	0	16,963	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	3795.00	CY	CODTB10L	46.88	121	4,610	2,080	0	0	6,690	1.76
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	3795.00	CY	CODEB12C	130.00	58	2,263	2,638	0	0	4,901	1.29
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	3795.00	CY	COEIB34B	40.00	95	3,475	3,332	0	0	6,807	1.79
L AF AA < > Commercial Disposal Fee	3795.00	CY		0.00	0	0	0	0	11,385	11,385	3.00
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	460.00	CY	CODFB10N	30.00	23	873	416	9,991	0	11,280	24.52
B MIL AA < > Boulders	144.00	EA	CODEB12C	8.00	36	1,395	1,627	1,564	0	4,586	31.85
USR AA < > Coir Logs, 12" dia X 30LF	29.00	EA	ULABM	0.50	174	5,857	278	15,747	725	22,607	779.56
B MIL AA < > Coir Wraps	863.00	LF	CODEY	21.50	201	7,429	4,832	7,498	0	19,759	22.90
06.03.73.02_09_30. Riparian Corridor Plantings											
B RSM LS < > Riparian Corridor Plantings	7.90	AC	ULABM	0.02	1,077	42,368	2,014	175,429	0	219,811	27824.23
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	479.00	CY	CODFB10U	20.00	36	1,594	1,939	9,439	0	12,972	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_09_32. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00
06.03.73.02_09_34. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	8.10	ACR	COMCB88	0.53	107	4,193	3,956	0	0	8,148	1005.96

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_09_38. Riparian Corridor Plantings											
B RSM LS < > Riparian Corridor Plantings	15.50	AC	ULABM	0.02	2,114	83,128	3,951	344,196	0	431,276	27824.23
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	2130.00	CY	CODFB10U	20.00	160	7,086	8,623	41,975	0	57,683	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	14,021	1,168	1,269	1,168	17,627	17627.09
TOTAL Mill Creek East					10,129	442,377	150,294	1,325,504	39,240	1,957,416	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_10. Garrison Creek (1)											
06.03.73.02_10_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,500	4,000	543	500	7,543	7543.00
06.03.73.02_10_ 4. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	1.20	ACR	COMCB88	0.53	16	621	586	0	0	1,207	1005.96
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	319.00	CY	CODTB10L	46.88	10	388	175	0	0	562	1.76
M MIL AA < > Basecourse for road, 6" thick areas	958.00	SY	COFGB36B	562.50	14	509	418	5,202	0	6,128	6.40
USR AA < > Geotextile, woven	958.00	SY	CLABB80	540.00	7	250	31	728	0	1,009	1.05
B MIL AA < > LWD	104.00	EA	CODEB12C	6.00	35	1,344	1,566	22,589	0	25,499	245.18
B MIL AA < > Rootwads	69.00	EA	CODEB12C	6.00	23	892	1,039	11,240	0	13,171	190.88
06.03.73.02_10_ 6. Channel											
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	9660.00	CY	CODEB12C	100.00	193	7,488	8,730	0	0	16,218	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip (158Cy to hummocks	7360.00	CY	COEIB34B	27.00	272	9,986	9,574	0	0	19,560	2.66
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	2300.00	CY	COEIB34B	40.00	58	2,106	2,019	0	0	4,126	1.79
L AF AA < > Commercial Disposal Fee	7360.00	CY		0.00	0	0	0	0	22,080	22,080	3.00
B MIL AA < > Boulders	69.00	EA	CODEB12C	8.00	17	669	779	749	0	2,197	31.85
06.03.73.02_10_ 8. Riparian Corridor Plantings											
B RSM LS < > Riparian Corridor Plantings	4.00	AC	ULABM	0.02	545	21,452	1,020	88,825	0	111,297	27824.23
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	383.00	CY	CODFB10U	20.00	29	1,274	1,550	7,548	0	10,372	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_10_10. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,500	4,000	543	500	7,543	7543.00
06.03.73.02_10_12. Site Work											
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1597.00	CY	CODTB10L	46.88	51	1,940	875	0	0	2,815	1.76
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	3450.00	CY	COEIB34B	40.00	86	3,160	3,029	0	0	6,189	1.79

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	3450.00	CY	CODTB10L	46.88	110	4,191	1,891	0	0	6,082	1.76
USR AA < > Geotextile, woven	4792.00	SY	CLABB80	540.00	35	1,251	153	3,643	0	5,047	1.05
B MIL AA < > LWD	138.00	EA	CODEB12C	6.00	46	1,783	2,079	29,974	0	33,835	245.18
B MIL AA < > Rootwads	115.00	EA	CODEB12C	6.00	38	1,486	1,732	18,734	0	21,951	190.88
06.03.73.02_10_14. Channel											
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	3450.00	CY	CODEB12C	100.00	69	2,674	3,118	0	0	5,792	1.68
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	2300.00	CY	CODTB10L	46.88	74	2,794	1,260	0	0	4,054	1.76
B MIL AA < > Boulders	58.00	EA	CODEB12C	8.00	15	562	655	630	0	1,847	31.85
06.03.73.02_10_16. Riparian Corridor Plantings											
B RSM LS < > Riparian Corridor Plantings	1.20	AC	ULABM	0.02	164	6,436	306	26,647	0	33,389	27824.23
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	460.00	CY	CODFB10U	20.00	35	1,530	1,862	9,065	0	12,457	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_10_18. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,500	4,000	543	500	7,543	7543.00
06.03.73.02_10_20. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	0.23	ACR	COMCB88	0.53	3	119	112	0	0	231	1005.96
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	192.00	CY	CODTB10L	46.88	6	233	105	0	0	338	1.76
M MIL AA < > Basecourse for road, 6" thick areas	575.00	SY	COFGB36B	562.50	8	305	251	3,122	0	3,678	6.40
USR AA < > Geotextile, woven	575.00	SY	CLABB80	540.00	4	150	18	437	0	606	1.05
06.03.73.02_10_23. Ravine											
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	2300.00	CY	CODTB10L	46.88	74	2,794	1,260	0	0	4,054	1.76
M RSM AA < > Quarry Spalls, random, machine placed for slope protection	230.00	CY	UOEHB12G	7.75	59	2,301	1,039	3,247	0	6,587	28.64
B MIL AA < > Boulders	690.00	EA	CODEB12C	8.00	173	6,687	7,795	7,493	0	21,974	31.85
M MIL AA < > Piping, HDPE, 12" dia	345.00	LF	CLABB14	33.75	61	2,115	126	4,496	0	6,737	19.53

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_10_24. Riparian Corridor Plantings											
B RSM LS < > Riparian Corridor Plantings	1.20	AC	ULABM	0.02	164	6,436	306	26,647	0	33,389	27824.23
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	460.00	CY	CODFB10U	20.00	35	1,530	1,862	9,065	0	12,457	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_10_26. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,500	4,000	543	500	7,543	7543.00
06.03.73.02_10_28. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	1.20	ACR	COMCB88	0.53	16	621	586	0	0	1,207	1005.96
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	192.00	CY	CODTB10L	46.88	6	233	105	0	0	338	1.76
M MIL AA < > Basecourse for road, 6" thick areas	575.00	SY	COFGB36B	562.50	8	305	251	3,122	0	3,678	6.40
USR AA < > Geotextile, woven	575.00	SY	CLABB80	540.00	4	150	18	437	0	606	1.05
B MIL AA < > LWD	12.00	EA	CODEB12C	6.00	4	155	181	2,606	0	2,942	245.18
B MIL AA < > Rootwads	12.00	EA	CODEB12C	6.00	4	155	181	1,955	0	2,291	190.88
06.03.73.02_10_30. Riparian Corridor Plantings											
B RSM LS < > Riparian Corridor Plantings	0.23	AC	ULABM	0.02	31	1,234	59	5,107	0	6,400	27824.23
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	383.00	CY	CODFB10U	20.00	29	1,274	1,550	7,548	0	10,372	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	584	292	32	29	937	937.26
06.03.73.02_10_34. Channel											
MIL AA <02140 1600 > Dewatering	5.00	CY	CODLB6	5.79	3	92	11	73	0	175	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	250.00	LF	ALABCLAB2	43.75	11	381	0	62	0	443	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	173.00	CY	CODEB12C	100.00	3	134	156	0	0	290	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	173.00	CY	COEIB34B	27.00	6	235	225	0	0	460	2.66
B MIL AA < > Boulders	17.00	EA	CODEB12C	8.00	4	165	192	185	0	541	31.85
TOTAL Garrison Creek (1)					2,756	137,560	79,093	307,000	25,862	549,515	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_11. Mullen Slough, Prentice Nursery											
06.03.73.02_11_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	5,000	1,086	1,000	10,086	10086.00
06.03.73.02_11_ 4. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	9.30	ACR	COMCB88	0.53	123	4,814	4,542	0	0	9,355	1005.96
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	1913.00	CY	CODEB12C	100.00	38	1,483	1,729	0	0	3,212	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip (158Cy to hummocks	4446.00	CY	COEIB34B	27.00	165	6,032	5,783	0	0	11,816	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1037.00	CY	CODTB10L	46.88	33	1,260	568	0	0	1,828	1.76
USR AA < > Disposal Fee	4446.00	CY		0.00	0	0	0	0	13,338	13,338	3.00
06.03.73.02_11_ 6. LWD Pool											
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	5.00	CY	CODFB10N	30.00	0	9	5	109	0	123	24.52
M RSM AA < > Quarry Spalls, random, machine placed for slope protection	4.00	CY	UOEHB12G	7.75	1	40	18	56	0	115	28.64
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	39.00	CY	CODET	35.00	2	83	104	672	0	858	22.01
B MIL AA < > LWD	56.00	EA	CODEB12C	6.00	19	724	843	12,163	0	13,730	245.18
B MIL AA < > Cedar Logs	28.00	EA	CODEB12C	4.00	14	543	633	1,520	0	2,696	96.27
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	3565.00	CY	CODEB12C	100.00	71	2,764	3,222	0	0	5,985	1.68
06.03.73.02_11_ 8. Dendrites											
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl (haul to hummock	83.00	CY	CODEB12C	100.00	2	64	75	0	0	139	1.68
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	300.00	CY	CODTB10L	46.88	10	364	164	0	0	529	1.76
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	6.00	CY	CODFB10N	30.00	0	11	5	130	0	147	24.52
B MIL AA < > Small Woody Debris	4.00	EA	CODEB12C	10.00	1	31	36	434	0	502	125.39

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_11_12. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	810.00	EA	ULABM	600.00	4	159	8	617	0	784	0.97
B RSM LS < > Scoulers Willow	810.00	EA	ULABM	600.00	4	159	8	617	0	784	0.97
B RSM LS < > Rushes & Sedges	810.00	EA	ULABM	450.00	5	212	10	617	0	839	1.04
B RSM LS < > Sitka Willow Stakes	810.00	EA	ULABM	600.00	4	159	8	617	0	784	0.97
B RSM LS < > Sitka Alder Stakes	810.00	EA	ULABM	600.00	4	159	8	617	0	784	0.97
06.03.73.02_11_14. Upland Buffer Zone											
B RSM LS < > Red Osier Dogwood	3136.00	EA	ULABM	120.00	78	3,083	147	10,943	0	14,173	4.52
B RSM LS < > Salmonberry	3136.00	EA	ULABM	120.00	78	3,083	147	10,943	0	14,173	4.52
B RSM LS < > Snowberry	3136.00	EA	ULABM	120.00	78	3,083	147	10,943	0	14,173	4.52
B RSM LS < > Flowering Currant	3136.00	EA	ULABM	120.00	78	3,083	147	10,943	0	14,173	4.52
B RSM LS < > Salal	3136.00	EA	ULABM	120.00	78	3,083	147	12,933	0	16,163	5.15
B RSM LS < > Oregon Grape	3136.00	EA	ULABM	120.00	78	3,083	147	13,928	0	17,158	5.47
B RSM LS < > Red Alder	3136.00	EA	ULABM	120.00	78	3,083	147	13,928	0	17,158	5.47
B RSM LS < > Black Cottonwood	502.00	EA	ULABM	120.00	13	494	23	1,911	0	2,428	4.84
B RSM LS < > Pacific Crabapple	502.00	EA	ULABM	120.00	13	494	23	3,185	0	3,702	7.37
B RSM LS < > Douglas Fir	502.00	EA	ULABM	120.00	13	494	23	3,185	0	3,702	7.37
B RSM LS < > Western Red Cedar	502.00	EA	ULABM	120.00	13	494	23	3,185	0	3,702	7.37
B RSM LS < > Red Alder	502.00	EA	ULABM	120.00	13	494	23	1,911	0	2,428	4.84
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_11_8 . Hummocks											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	79.00	CY	COEIB34B	40.00	2	72	69	0	0	142	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	79.00	CY	CODTB10L	46.88	3	96	43	0	0	139	1.76
TOTAL Mullen Slough, Prentice Nursery					1,165	54,980	24,714	118,685	14,922	213,301	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_12. Mullen Slough Reach											
06.03.73.02_12_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	5,000	1,086	1,000	10,086	10086.00
06.03.73.02_12_ 4. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	9.00	ACR	COMCB88	0.53	119	4,659	4,395	0	0	9,054	1005.96
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	2800.00	CY	CODEB12C	100.00	56	2,171	2,530	0	0	4,701	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	2502.00	CY	COEIB34B	27.00	93	3,395	3,255	0	0	6,649	2.66
USR AA < > Disposal Fee	2800.00	CY		0.00	0	0	0	0	8,400	8,400	3.00
06.03.73.02_12_ 6. LWD Pool											
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	18.00	CY	CODFB10N	30.00	1	34	16	391	0	441	24.52
M RSM AA < > Quarry Spalls, random, machine placed for slope protection	70.00	CY	UOEHB12G	7.75	18	700	316	988	0	2,005	28.64
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	820.00	CY	CODET	35.00	47	1,739	2,185	14,124	0	18,048	22.01
B MIL AA < > LWD	210.00	EA	CODEB12C	6.00	70	2,713	3,163	45,612	0	51,488	245.18
B MIL AA < > Cedar Logs	28.00	EA	CODEB12C	4.00	14	543	633	1,520	0	2,696	96.27
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	16044	CY	CODEB12C	100.00	321	12,437	14,499	0	0	26,936	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	16044	CY	COEIB34B	27.00	594	21,768	20,870	0	0	42,639	2.66
USR AA < > Disposal Fee	16044	CY		0.00	0	0	0	0	48,132	48,132	3.00
06.03.73.02_12_12. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	6300.00	EA	ULABM	600.00	32	1,239	59	4,797	0	6,094	0.97
B RSM LS < > Scoulers Willow	6300.00	EA	ULABM	600.00	32	1,239	59	4,797	0	6,094	0.97
B RSM LS < > Rushes & Sedges	6300.00	EA	ULABM	450.00	42	1,652	79	4,797	0	6,527	1.04
B RSM LS < > Sitka Willow Stakes	6300.00	EA	ULABM	600.00	32	1,239	59	4,797	0	6,094	0.97
B RSM LS < > Sitka Alder Stakes	6300.00	EA	ULABM	600.00	32	1,239	59	4,797	0	6,094	0.97
06.03.73.02_12_14. Upland Buffer Zone											
B RSM LS < > Red Osier Dogwood	5888.00	EA	ULABM	120.00	147	5,789	275	20,546	0	26,611	4.52
B RSM LS < > Salmonberry	5888.00	EA	ULABM	120.00	147	5,789	275	20,546	0	26,611	4.52
B RSM LS < > Snowberry	5888.00	EA	ULABM	120.00	147	5,789	275	20,546	0	26,611	4.52
B RSM LS < > Flowering Currant	5888.00	EA	ULABM	120.00	147	5,789	275	20,546	0	26,611	4.52
B RSM LS < > Salal	5888.00	EA	ULABM	120.00	147	5,789	275	24,282	0	30,347	5.15
B RSM LS < > Oregon Grape	5888.00	EA	ULABM	210.00	84	3,308	158	26,150	0	29,616	5.03
B RSM LS < > Red Alder	5888.00	EA	ULABM	120.00	147	5,789	275	26,150	0	32,215	5.47
B RSM LS < > Black Cottonwood	440.00	EA	ULABM	120.00	11	433	21	2,792	0	3,245	7.37

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
B RSM LS < > Pacific Crabapple	125.00	EA	ULABM	120.00	3	123	6	793	0	922	7.37
B RSM LS < > Douglas Fir	125.00	EA	ULABM	120.00	3	123	6	793	0	922	7.37
B RSM LS < > Western Red Cedar	125.00	EA	ULABM	120.00	3	123	6	793	0	922	7.37
B RSM LS < > Red Alder	125.00	EA	ULABM	120.00	3	123	6	476	0	605	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	213.00	CY	CODFB10S	25.00	13	567	235	4,311	0	5,113	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	389.00	CY	CODFB10U	20.00	29	1,294	1,575	7,666	0	10,535	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_12_8 . Hummocks											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	298.00	CY	COEIB34B	40.00	7	273	262	0	0	535	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	298.00	CY	CODTB10L	46.88	10	362	163	0	0	525	1.76
TOTAL Mullen Slough Reach					2,598	109,919	61,954	265,588	58,116	495,577	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_13. Mill Creek, Schuler Bros. Reach											
06.03.73.02_13_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	6,000	6,000	3,258	3,000	18,258	18258.00
06.03.73.02_13_ 4. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	15.00	ACR	COMCB88	0.53	198	7,764	7,325	0	0	15,089	1005.96
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	49556	CY	CODEB12C	100.00	991	38,416	44,784	0	0	83,200	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	43567	CY	COEIB34B	27.00	1,612	59,112	56,672	0	0	115,784	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	4407.00	CY	CODTB10L	46.88	141	5,354	2,415	0	0	7,769	1.76
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	4407.00	CY	COEIB34B	40.00	110	4,036	3,869	0	0	7,905	1.79
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	4407.00	CY	CODEB12C	130.00	68	2,628	3,064	0	0	5,692	1.29
USR AA < > Disposal Fee	43567	CY		0.00	0	0	0	0	130,701	130,701	3.00
06.03.73.02_13_ 6. LWD Pool											
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	38.00	CY	CODFB10N	30.00	2	72	34	825	0	932	24.52
B MIL AA < > LWD	458.00	EA	CODEB12C	6.00	153	5,918	6,898	99,478	0	112,294	245.18
B MIL AA < > Cedar Logs	1.00	EA	CODEB12C	4.00	1	19	23	54	0	96	96.27
M RSM AA < > Quarry Spalls, random, machine placed for slope protection	7.00	CY	UOEHB12G	7.75	2	70	32	99	0	200	28.64
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	42720	CY	CODEB12C	100.00	854	33,117	38,606	0	0	71,723	1.68
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	6.00	CY	CODET	35.00	0	13	16	103	0	132	22.01
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	42720	CY	COEIB34B	27.00	1,581	57,962	55,570	0	0	113,533	2.66
USR AA < > Disposal Fee	42720	CY		0.00	0	0	0	0	128,160	128,160	3.00
06.03.73.02_13_ 8. Dendrites											
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl (haul to hummock	462.00	CY	CODEB12C	100.00	9	358	418	0	0	776	1.68
B MIL AA < > LWD	736.00	EA	CODEB12C	6.00	245	9,510	11,085	159,859	0	180,454	245.18
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	462.00	CY	COEIB34B	27.00	17	627	601	0	0	1,228	2.66
USR AA < > Disposal Fee	462.00	CY		0.00	0	0	0	0	1,386	1,386	3.00
B MIL AA < > Small Woody Debris	18.00	EA	CODEB12C	10.00	4	140	163	1,955	0	2,257	125.39

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_13_12. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	6863.00	EA	ULABM	600.00	34	1,350	64	5,225	0	6,639	0.97
B RSM LS < > Scoulers Willow	6863.00	EA	ULABM	600.00	34	1,350	64	5,225	0	6,639	0.97
B RSM LS < > Rushes & Sedges	6863.00	EA	ULABM	450.00	46	1,799	86	5,225	0	7,110	1.04
B RSM LS < > Sitka Willow Stakes	6863.00	EA	ULABM	600.00	34	1,350	64	5,225	0	6,639	0.97
B RSM LS < > Sitka Alder Stakes	6863.00	EA	ULABM	600.00	34	1,350	64	5,225	0	6,639	0.97
06.03.73.02_13_14. Upland Buffer Zone											
B RSM LS < > Red Osier Dogwood	12637	EA	ULABM	120.00	316	12,425	591	44,097	0	57,113	4.52
B RSM LS < > Salmonberry	12637	EA	ULABM	120.00	316	12,425	591	44,097	0	57,113	4.52
B RSM LS < > Snowberry	12637	EA	ULABM	120.00	316	12,425	591	44,097	0	57,113	4.52
B RSM LS < > Flowering Currant	12637	EA	ULABM	120.00	316	12,425	591	44,097	0	57,113	4.52
B RSM LS < > Salal	12637	EA	ULABM	120.00	316	12,425	591	52,115	0	65,131	5.15
B RSM LS < > Oregon Grape	12637	EA	ULABM	120.00	316	12,425	591	56,124	0	69,140	5.47
B RSM LS < > Red Alder	12637	EA	ULABM	120.00	316	12,425	591	56,124	0	69,140	5.47
B RSM LS < > Black Cottonwood	486.00	EA	ULABM	120.00	12	478	23	1,850	0	2,351	4.84
B RSM LS < > Pacific Crabapple	486.00	EA	ULABM	120.00	12	478	23	1,850	0	2,351	4.84
B RSM LS < > Douglas Fir	486.00	EA	ULABM	120.00	12	478	23	1,850	0	2,351	4.84
B RSM LS < > Western Red Cedar	486.00	EA	ULABM	120.00	12	478	23	1,850	0	2,351	4.84
B RSM LS < > Red Alder	486.00	EA	ULABM	120.00	12	478	23	1,850	0	2,351	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	1887.00	CY	CODFB10S	25.00	113	5,022	2,082	38,192	0	45,296	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	424.00	CY	CODFB10U	20.00	32	1,411	1,716	8,356	0	11,483	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	14,021	1,168	1,269	1,168	17,627	17627.09
06.03.73.02_13_8 . Hummocks											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	1582.00	CY	COEIB34B	40.00	40	1,449	1,389	0	0	2,838	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1582.00	CY	CODTB10L	46.88	51	1,922	867	0	0	2,789	1.76
TOTAL Mill Creek, Schuler Bros. Reach					8,727	353,179	249,494	690,434	264,415	1,557,524	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_14. Mill Creek, Merlino Reach											
06.03.73.02_14_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	6,000	6,000	3,258	3,000	18,258	18258.00
06.03.73.02_14_ 4. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	54.00	ACR	COMCB88	0.53	711	27,951	26,371	0	0	54,322	1005.96
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	11548	CY	CODEB12C	100.00	231	8,952	10,436	0	0	19,388	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	11190	CY	COEIB34B	27.00	414	15,183	14,556	0	0	29,739	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	15.00	CY	CODTB10L	46.88	0	18	8	0	0	26	1.76
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	15.00	CY	COEIB34B	40.00	0	14	13	0	0	27	1.79
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	15.00	CY	CODEB12C	130.00	0	9	10	0	0	19	1.29
USR AA < > Disposal Fee	11190	CY		0.00	0	0	0	0	33,570	33,570	3.00
06.03.73.02_14_ 6. LWD Pool											
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	26.00	CY	CODFB10N	30.00	1	49	24	565	0	638	24.52
B MIL AA < > LWD	314.00	EA	CODEB12C	6.00	105	4,057	4,729	68,201	0	76,987	245.18
B MIL AA < > Cedar Logs	157.00	EA	CODEB12C	4.00	79	3,043	3,547	8,525	0	15,115	96.27
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	19991	CY	CODEB12C	100.00	400	15,497	18,066	0	0	33,563	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	19991	CY	COEIB34B	27.00	740	27,124	26,004	0	0	53,128	2.66
USR AA < > Disposal Fee	19991	CY		0.00	0	0	0	0	59,973	59,973	3.00
06.03.73.02_14_ 8. Dendrites											
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl (haul to hummock	250.00	CY	CODEB12C	100.00	5	194	226	0	0	420	1.68
B MIL AA < > LWD	736.00	EA	CODEB12C	6.00	245	9,510	11,085	159,859	0	180,454	245.18
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	19.00	CY	CODFB10N	30.00	1	36	17	413	0	466	24.52
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	250.00	CY	COEIB34B	27.00	9	339	325	0	0	664	2.66
USR AA < > Disposal Fee	250.00	CY		0.00	0	0	0	0	750	750	3.00
B MIL AA < > Small Woody Debris	12.00	EA	CODEB12C	10.00	2	93	108	1,303	0	1,505	125.39

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_14_12. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	4680.00	EA	ULABM	600.00	23	920	44	3,563	0	4,527	0.97
B RSM LS < > Scoulers Willow	4680.00	EA	ULABM	600.00	23	920	44	3,563	0	4,527	0.97
B RSM LS < > Rushes & Sedges	4680.00	EA	ULABM	450.00	31	1,227	59	3,563	0	4,849	1.04
B RSM LS < > Sitka Willow Stakes	4680.00	EA	ULABM	600.00	23	920	44	3,563	0	4,527	0.97
B RSM LS < > Sitka Alder Stakes	4680.00	EA	ULABM	600.00	23	920	44	3,563	0	4,527	0.97
06.03.73.02_14_14. Upland Buffer Zone											
B RSM LS < > Red Osier Dogwood	22751	EA	ULABM	120.00	569	22,370	1,063	79,391	0	102,824	4.52
B RSM LS < > Salmonberry	22751	EA	ULABM	120.00	569	22,370	1,063	79,391	0	102,824	4.52
B RSM LS < > Snowberry	22751	EA	ULABM	120.00	569	22,370	1,063	79,391	0	102,824	4.52
B RSM LS < > Flowering Currant	22751	EA	ULABM	120.00	569	22,370	1,063	79,391	0	102,824	4.52
B RSM LS < > Salal	22751	EA	ULABM	120.00	569	22,370	1,063	93,825	0	117,258	5.15
B RSM LS < > Oregon Grape	22751	EA	ULABM	120.00	569	22,370	1,063	101,043	0	124,476	5.47
B RSM LS < > Red Alder	22751	EA	ULABM	120.00	569	22,370	1,063	101,043	0	124,476	5.47
B RSM LS < > Black Cottonwood	3640.00	EA	ULABM	120.00	91	3,579	170	13,857	0	17,606	4.84
B RSM LS < > Pacific Crabapple	3640.00	EA	ULABM	120.00	91	3,579	170	13,857	0	17,606	4.84
B RSM LS < > Douglas Fir	3640.00	EA	ULABM	120.00	91	3,579	170	13,857	0	17,606	4.84
B RSM LS < > Western Red Cedar	3640.00	EA	ULABM	120.00	91	3,579	170	13,857	0	17,606	4.84
B RSM LS < > Red Alder	3640.00	EA	ULABM	120.00	91	3,579	170	13,857	0	17,606	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	364.00	CY	CODFB10S	25.00	22	969	402	7,367	0	8,738	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	25.00	CY	CODFB10U	20.00	2	83	101	493	0	677	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	14,021	1,168	1,269	1,168	17,627	17627.09
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	15.00	ACR	COFWI	0.15	175	7,780	4,648	19,034	0	31,462	2097.49
06.03.73.02_14_8 . Hummocks											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	343.00	CY	COEIB34B	40.00	9	314	301	0	0	615	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	343.00	CY	CODTB10L	46.88	11	417	188	0	0	605	1.76
TOTAL Mill Creek, Merlino Reach					7,773	322,721	136,969	971,717	98,461	1,529,868	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_15. Mill Creek, Wetland 5K Reach											
06.03.73.02_15_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	12,000	15,000	3,258	3,000	33,258	33258.00
06.03.73.02_15_ 4. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	33.00	ACR	COMCB88	0.53	435	17,081	16,115	0	0	33,197	1005.96
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	6222.00	CY	CODEB12C	100.00	124	4,823	5,623	0	0	10,446	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	5876.00	CY	COEIB34B	27.00	217	7,973	7,644	0	0	15,616	2.66
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	30.00	CY	CODTB10L	46.88	1	36	16	0	0	53	1.76
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	30.00	CY	COEIB34B	40.00	1	27	26	0	0	54	1.79
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	30.00	CY	CODEB12C	130.00	0	18	21	0	0	39	1.29
USR AA < > Disposal Fee	5876.00	CY		0.00	0	0	0	0	17,628	17,628	3.00
06.03.73.02_15_ 6. LWD Pool											
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	21.00	CY	CODFB10N	30.00	1	40	19	456	0	515	24.52
B MIL AA < > LWD	256.00	EA	CODEB12C	6.00	85	3,308	3,856	55,603	0	62,767	245.18
B MIL AA < > Cedar Logs	128.00	EA	CODEB12C	4.00	64	2,481	2,892	6,950	0	12,323	96.27
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	16299	CY	CODEB12C	100.00	326	12,635	14,729	0	0	27,364	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	16299	CY	COEIB34B	27.00	603	22,114	21,202	0	0	43,316	2.66
USR AA < > Disposal Fee	16299	CY		0.00	0	0	0	0	48,897	48,897	3.00
06.03.73.02_15_ 8. Dendrites											
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl (haul to hummock	167.00	CY	CODEB12C	100.00	3	129	151	0	0	280	1.68
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	13.00	CY	CODFB10N	30.00	1	25	12	282	0	319	24.52
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	167.00	CY	COEIB34B	27.00	6	227	217	0	0	444	2.66
USR AA < > Disposal Fee	167.00	CY		0.00	0	0	0	0	501	501	3.00
B MIL AA < > Small Woody Debris	8.00	EA	CODEB12C	10.00	2	62	72	869	0	1,003	125.39

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_15_12. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	2880.00	EA	ULABM	600.00	14	566	27	2,193	0	2,786	0.97
B RSM LS < > Scoulers Willow	2880.00	EA	ULABM	600.00	14	566	27	2,193	0	2,786	0.97
B RSM LS < > Rushes & Sedges	2880.00	EA	ULABM	450.00	19	755	36	2,193	0	2,984	1.04
B RSM LS < > Sitka Willow Stakes	2880.00	EA	ULABM	600.00	14	566	27	2,193	0	2,786	0.97
B RSM LS < > Sitka Alder Stakes	2880.00	EA	ULABM	600.00	14	566	27	2,193	0	2,786	0.97
06.03.73.02_15_14. Upland Buffer Zone											
B RSM LS < > Red Osier Dogwood	14337	EA	ULABM	120.00	358	14,097	670	50,030	0	64,796	4.52
B RSM LS < > Salmonberry	14337	EA	ULABM	120.00	358	14,097	670	50,030	0	64,796	4.52
B RSM LS < > Snowberry	14337	EA	ULABM	120.00	358	14,097	670	50,030	0	64,796	4.52
B RSM LS < > Flowering Currant	14337	EA	ULABM	120.00	358	14,097	670	50,030	0	64,796	4.52
B RSM LS < > Salal	14337	EA	ULABM	120.00	358	14,097	670	59,126	0	73,893	5.15
B RSM LS < > Oregon Grape	14337	EA	ULABM	120.00	358	14,097	670	63,674	0	78,441	5.47
B RSM LS < > Red Alder	14337	EA	ULABM	120.00	358	14,097	670	63,674	0	78,441	5.47
B RSM LS < > Black Cottonwood	2294.00	EA	ULABM	120.00	57	2,256	107	8,733	0	11,096	4.84
B RSM LS < > Pacific Crabapple	2294.00	EA	ULABM	120.00	57	2,256	107	8,733	0	11,096	4.84
B RSM LS < > Douglas Fir	2294.00	EA	ULABM	120.00	57	2,256	107	8,733	0	11,096	4.84
B RSM LS < > Western Red Cedar	2294.00	EA	ULABM	120.00	57	2,256	107	8,733	0	11,096	4.84
B RSM LS < > Red Alder	2294.00	EA	ULABM	120.00	57	2,256	107	8,733	0	11,096	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	230.00	CY	CODFB10S	25.00	14	612	254	4,655	0	5,521	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	16.00	CY	CODFB10U	20.00	1	53	65	315	0	433	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	14,021	1,168	1,269	1,168	17,627	17627.09
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	9.00	ACR	COFWI	0.15	105	4,668	2,789	11,420	0	18,877	2097.49
06.03.73.02_15_8 . Hummocks											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	316.00	CY	COEIB34B	40.00	8	289	277	0	0	567	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	316.00	CY	CODTB10L	46.88	10	384	173	0	0	557	1.76
TOTAL Mill Creek, Wetland 5K Reach					4,929	217,660	97,798	527,156	71,194	913,809	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_16. Mill Creek, Goedeke Reach											
06.03.73.02_16_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	12,000	15,000	3,258	3,000	33,258	33258.00
06.03.73.02_16_ 4. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	49.00	ACR	COMCB88	0.53	646	25,363	23,929	0	0	49,292	1005.96
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	8089.00	CY	CODEB12C	100.00	162	6,271	7,310	0	0	13,581	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	7377.00	CY	COEIB34B	27.00	273	10,009	9,596	0	0	19,605	2.66
USR AA < > Disposal Fee	7377.00	CY		0.00	0	0	0	0	22,131	22,131	3.00
06.03.73.02_16_ 6. LWD Pool											
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	54.00	CY	CODFB10N	30.00	3	102	49	1,173	0	1,324	24.52
B MIL AA < > LWD	652.00	EA	CODEB12C	6.00	217	8,424	9,820	141,614	0	159,859	245.18
B MIL AA < > Cedar Logs	326.00	EA	CODEB12C	4.00	163	6,318	7,365	17,702	0	31,385	96.27
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	41511	CY	CODEB12C	100.00	830	32,179	37,513	0	0	69,693	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	41511	CY	COEIB34B	27.00	1,536	56,322	53,998	0	0	110,320	2.66
USR AA < > Disposal Fee	41511	CY		0.00	0	0	0	0	124,533	124,533	3.00
06.03.73.02_16_ 8. Dendrites											
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl (haul to hummock	292.00	CY	CODEB12C	100.00	6	226	264	0	0	490	1.68
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	23.00	CY	CODFB10N	30.00	1	44	21	500	0	564	24.52
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	292.00	CY	COEIB34B	27.00	11	396	380	0	0	776	2.66
USR AA < > Disposal Fee	292.00	CY		0.00	0	0	0	0	876	876	3.00
B MIL AA < > Small Woody Debris	14.00	EA	CODEB12C	10.00	3	109	127	1,520	0	1,755	125.39
06.03.73.02_16_10. Pond											
M RSM AA < > Quarry Spalls, random, machine placed for slope protection	4.00	CY	UOEHB12G	7.75	1	40	18	56	0	115	28.64
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	12.00	CY	CODET	35.00	1	25	32	207	0	264	22.01
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	10307	CY	CODEB12C	100.00	206	7,990	9,314	0	0	17,304	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	10307	CY	COEIB34B	27.00	381	13,985	13,407	0	0	27,392	2.66

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA < > Disposal Fee	10307	CY		0.00	0	0	0	0	30,921	30,921	3.00
06.03.73.02_16_12. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	4680.00	EA	ULABM	600.00	23	920	44	3,563	0	4,527	0.97
B RSM LS < > Scoulers Willow	4680.00	EA	ULABM	600.00	23	920	44	3,563	0	4,527	0.97
B RSM LS < > Rushes & Sedges	4680.00	EA	ULABM	450.00	31	1,227	59	3,563	0	4,849	1.04
B RSM LS < > Sitka Willow Stakes	4680.00	EA	ULABM	600.00	23	920	44	3,563	0	4,527	0.97
B RSM LS < > Sitka Alder Stakes	4680.00	EA	ULABM	600.00	23	920	44	3,563	0	4,527	0.97
06.03.73.02_16_14. Upland Buffer Zone											
B RSM LS < > Red Osier Dogwood	81925	EA	ULABM	120.00	2,048	80,552	3,829	285,881	0	370,262	4.52
B RSM LS < > Salmonberry	81925	EA	ULABM	120.00	2,048	80,552	3,829	285,881	0	370,262	4.52
B RSM LS < > Snowberry	81925	EA	ULABM	120.00	2,048	80,552	3,829	285,881	0	370,262	4.52
B RSM LS < > Flowering Currant	81925	EA	ULABM	120.00	2,048	80,552	3,829	285,881	0	370,262	4.52
B RSM LS < > Salal	81925	EA	ULABM	120.00	2,048	80,552	3,829	337,859	0	422,241	5.15
B RSM LS < > Oregon Grape	81925	EA	ULABM	120.00	2,048	80,552	3,829	363,849	0	448,230	5.47
B RSM LS < > Red Alder	81925	EA	ULABM	120.00	2,048	80,552	3,829	363,849	0	448,230	5.47
B RSM LS < > Black Cottonwood	13108	EA	ULABM	120.00	328	12,888	613	49,899	0	63,400	4.84
B RSM LS < > Pacific Crabapple	13108	EA	ULABM	120.00	328	12,888	613	49,899	0	63,400	4.84
B RSM LS < > Douglas Fir	13108	EA	ULABM	120.00	328	12,888	613	49,899	0	63,400	4.84
B RSM LS < > Western Red Cedar	13108	EA	ULABM	120.00	328	12,888	613	49,899	0	63,400	4.84
B RSM LS < > Red Alder	13108	EA	ULABM	120.00	328	12,888	613	49,899	0	63,400	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	1311.00	CY	CODFB10S	25.00	79	3,489	1,447	26,534	0	31,470	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	24.00	CY	CODFB10U	20.00	2	80	97	473	0	650	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	14,021	1,168	1,269	1,168	17,627	17627.09
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	15.00	ACR	COFWI	0.15	175	7,780	4,648	19,034	0	31,462	2097.49
06.03.73.02_16_8 . Hummocks											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	712.00	CY	COEIB34B	40.00	18	652	625	0	0	1,277	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	712.00	CY	CODTB10L	46.88	23	865	390	0	0	1,255	1.76
TOTAL Mill Creek, Goedeke Reach					20,884	841,583	226,725	2,690,591	182,629	3,941,528	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_17. Green River Park											
06.03.73.02_17_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00
06.03.73.02_17_ 4. Channel											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	2.70	ACR	CODFB7	0.08	216	7,485	2,940	0	0	10,425	3861.01
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	5213.00	SY	CLABB80A	300.00	52	1,737	263	4,812	0	6,812	1.31
MIL AA <02266 0120 > Erosion control, revegetation mat, webbed	3067.00	SY	ALABCLAB2	125.00	49	1,635	0	9,493	0	11,128	3.63
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	1500.00	LF	ALABCLAB2	43.75	69	2,285	0	375	0	2,660	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	9711.00	CY	CODEB12C	100.00	194	7,528	8,776	0	0	16,304	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	9711.00	CY	COEIB34B	14.00	693	25,410	24,362	0	0	49,772	5.13
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	4850.00	CY	CODTB10L	46.88	155	5,892	2,658	0	0	8,550	1.76
B MIL AA <02215 1220 > River Gravel Channel Liner, front-end loader, 40 - 60 HP, no compaction	110.00	CY	CODFB10N	30.00	6	209	99	2,389	0	2,697	24.52
06.03.73.02_17_ 8. Habitat Features											
B MIL AA < > LWD	60.00	EA	CODEB12C	6.00	20	775	904	16,290	0	17,969	299.48
B MIL AA < > Boulders	250.00	EA	CODEB12C	8.00	63	2,423	2,824	2,715	0	7,962	31.85
B MIL AA < > Footer Logs	130.00	EA	CODEB12C	4.00	65	2,520	2,937	10,589	0	16,045	123.42
06.03.73.02_17_10. Non-channel Plantings											
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	0.50	ACR	COFWI	0.15	6	259	155	634	0	1,049	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	540.00	EA	ULABM	120.00	14	531	25	1,884	0	2,441	4.52
B RSM LS < > Salmonberry	540.00	EA	ULABM	120.00	14	531	25	1,884	0	2,441	4.52
B RSM LS < > Snowberry	540.00	EA	ULABM	120.00	14	531	25	1,884	0	2,441	4.52
B RSM LS < > Flowering Currant	540.00	EA	ULABM	120.00	14	531	25	1,884	0	2,441	4.52
B RSM LS < > Salal	540.00	EA	ULABM	120.00	14	531	25	2,227	0	2,783	5.15
B RSM LS < > Oregon Grape	540.00	EA	ULABM	120.00	14	531	25	2,398	0	2,954	5.47
B RSM LS < > Black Cottonwood	35.00	EA	ULABM	120.00	1	34	2	133	0	169	4.84
B RSM LS < > Pacific Crabapple	35.00	EA	ULABM	120.00	1	34	2	133	0	169	4.84
B RSM LS < > Douglas Fir	35.00	EA	ULABM	120.00	1	34	2	133	0	169	4.84
B RSM LS < > Western Red Cedar	35.00	EA	ULABM	120.00	1	34	2	133	0	169	4.84
B RSM LS < > Red Alder	35.00	EA	ULABM	120.00	1	34	2	133	0	169	4.84

06.03. Wildlife Facilities & Sanctuary

		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
	06.03.73.02_17_12. Water Fluctuation Zone Plantings											
B MIL LS <	> Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	1.80	ACR	COFWI	0.15	21	934	558	2,284	0	3,775	2097.49
B RSM LS <	> Hookers Willow	2346.00	EA	ULABM	600.00	12	461	22	1,786	0	2,269	0.97
B RSM LS <	> Scoulers Willow	2346.00	EA	ULABM	600.00	12	461	22	1,786	0	2,269	0.97
B RSM LS <	> Pacific Willow	2346.00	EA	ULABM	600.00	12	461	22	1,786	0	2,269	0.97
B RSM LS <	> Sedges	2346.00	EA	ULABM	450.00	16	615	29	1,786	0	2,431	1.04
	06.03.73.02_17_14. Soil Amendments											
M MIL LS <02241 0400	> Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	70.00	CY	CODFB10S	25.00	4	186	77	1,417	0	1,680	24.00
MIL LS <02250 1400	> Soil stbtn, w/scarifying & cmpct, delivered & screened, crushed rock	26.00	CY	CODFB10U	20.00	2	86	105	512	0	704	27.08
B CIV LS <	> Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
	TOTAL Green River Park					1,777	75,647	50,603	75,023	2,584	203,857	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_18. Horsehead Bend Side Channel											
06.03.73.02_18_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00
06.03.73.02_18_ 4. Channel											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	11.00	ACR	CODFB7	0.08	880	30,494	11,977	0	0	42,471	3861.01
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	1457.00	SY	CLABB80A	300.00	15	486	73	1,345	0	1,904	1.31
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	2500.00	LF	ALABCLAB2	43.75	114	3,809	0	624	0	4,433	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	15376	CY	CODEB12C	100.00	308	11,919	13,895	0	0	25,815	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	15376	CY	COEIB34B	14.00	1,098	40,233	38,574	0	0	78,807	5.13
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	7700.00	CY	CODTB10L	46.88	246	9,354	4,220	0	0	13,574	1.76
B MIL AA <02215 1220 > River Gravel Channel Liner, front-end loader, 40 - 60 HP, no compaction	180.00	CY	CODFB10N	30.00	9	342	163	3,910	0	4,414	24.52
06.03.73.02_18_ 8. Habitat Features											
B MIL AA < > LWD	70.00	EA	CODEB12C	6.00	23	904	1,054	19,005	0	20,964	299.48
B MIL AA < > Boulders	240.00	EA	CODEB12C	8.00	60	2,326	2,711	2,606	0	7,643	31.85
B MIL AA < > Footer Logs	140.00	EA	CODEB12C	4.00	70	2,713	3,163	11,403	0	17,279	123.42
06.03.73.02_18_10. Non-channel Plantings											
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	3.00	ACR	COFW1	0.15	35	1,556	930	3,807	0	6,292	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	3160.00	EA	ULABM	120.00	79	3,107	148	11,027	0	14,282	4.52
B RSM LS < > Salmonberry	3160.00	EA	ULABM	120.00	79	3,107	148	11,027	0	14,282	4.52
B RSM LS < > Snowberry	3160.00	EA	ULABM	120.00	79	3,107	148	11,027	0	14,282	4.52
B RSM LS < > Flowering Currant	3160.00	EA	ULABM	120.00	79	3,107	148	11,027	0	14,282	4.52
B RSM LS < > Salal	3160.00	EA	ULABM	120.00	79	3,107	148	13,032	0	16,287	5.15
B RSM LS < > Oregon Grape	3160.00	EA	ULABM	120.00	79	3,107	148	14,034	0	17,289	5.47
B RSM LS < > Black Cottonwood	202.00	EA	ULABM	120.00	5	199	9	769	0	977	4.84
B RSM LS < > Pacific Crabapple	202.00	EA	ULABM	120.00	5	199	9	769	0	977	4.84
B RSM LS < > Douglas Fir	202.00	EA	ULABM	120.00	5	199	9	769	0	977	4.84
B RSM LS < > Western Red Cedar	202.00	EA	ULABM	120.00	5	199	9	769	0	977	4.84
B RSM LS < > Red Alder	202.00	EA	ULABM	120.00	5	199	9	769	0	977	4.84
06.03.73.02_18_12. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	3715.00	EA	ULABM	600.00	19	731	35	2,828	0	3,594	0.97
B RSM LS < > Scoulers Willow	3715.00	EA	ULABM	600.00	19	731	35	2,828	0	3,594	0.97
B RSM LS < > Pacific Willow	3715.00	EA	ULABM	450.00	25	974	46	2,828	0	3,849	1.04
B RSM LS < > Sedges	3715.00	EA	ULABM	600.00	19	731	35	2,828	0	3,594	0.97

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_18_14. Soil Amendments											
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	400.00	CY	CODFB10S	25.00	24	1,065	441	8,096	0	9,602	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	40.00	CY	CODFB10U	20.00	3	133	162	788	0	1,083	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
TOTAL Horsehead Bend Side Channel					3,491	139,060	82,138	141,456	2,584	365,239	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_19. NE Auburn Creek											
06.03.73.02_19_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00
06.03.73.02_19_ 4. Bridge											
L MIL BR <02046 0020 > Remove existing Flapgate	1.00	EA	CODLB6	0.13	24	1,009	117	0	0	1,126	1126.12
AF BR <02234 4200 > Hauling, w/loading, 12 CY truck, 5 mile haul	12.00	CY	CODEB30	48.00	1	34	39	0	0	73	6.04
L RSM BR <02074 2083 > Concrete Demo	100.00	SF	ALABCLAB1	10.00	10	397	0	0	0	397	3.97
MIL BR <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	500.00	CY	CODEB12C	100.00	10	462	538	0	0	1,000	2.00
L AF BR < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	500.00	CY	COEIB34B	14.00	36	1,558	1,494	0	0	3,052	6.10
MIL BR <02232 0135 > Excavate & load, hydr excavator, 2 CY, lt matl	500.00	CY	CODEB12C	146.25	7	316	368	0	0	684	1.37
MIL BR <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	500.00	CY	CODTB10L	46.88	16	723	326	0	0	1,050	2.10
L MIL BR <02364 4000 > Piles, conc, square, precast, prestressed, 40' long, 18" thick	200.00	VLF	CPIDB19A	45.00	36	1,661	980	4,377	0	7,018	35.09
B RSM BR < > Pile Cap	6.00	EA		0.00	24	715	536	7,760	0	9,010	1501.74
L AF BR <01580 0010 > Sign, hi-intensity reflectorized, buy	30.00	SF	N/A	0.00	0	286	71	392	357	1,107	36.89
B RSM BR < > Precast Concrete Panels	75.00	SF	ALABCLAB1	0.79	94	3,745	0	3,880	0	7,625	101.66
B MIL BR <03436 0150 > Hollow Girder Deck, 50' X 12' X 26", voided slab(Concrete Tech.) 3000 psi	600.00	SF	SIWSC11	45.00	120	5,696	1,927	27,160	1,786	36,570	60.95
B AF BR < > Steel bearing pads	5.00	SF	SIWSSSWK2	0.50	20	953	0	485	0	1,438	287.69
L MIL BR <05548 0600 > Misc. Fabrication and Fasteners castings	1000.00	LB	SIWSE4	250.00	16	768	48	1,035	0	1,850	1.85
L RSM BR <02270 0100 > Rip-rap, random, machine placed for slope protection	40.00	CY	CODET	35.00	2	101	127	820	0	1,048	26.21
B RSM BR < > Gate, steel	1.00	EA	ALABCLAB1	0.02	42	1,661	0	2,587	0	4,247	4247.27
06.03.73.02_19_ 6. Channel											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	11.00	ACR	CODFB7	0.08	880	30,494	11,977	0	0	42,471	3861.01
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	1457.00	SY	CLABB80A	300.00	15	486	73	1,345	0	1,904	1.31
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	2500.00	LF	ALABCLAB2	43.75	114	3,809	0	624	0	4,433	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	15376	CY	CODEB12C	100.00	308	11,919	13,895	0	0	25,815	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	15376	CY	COEIB34B	14.00	1,098	40,233	38,574	0	0	78,807	5.13

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	7700.00	CY	CODTB10L	46.88	246	9,354	4,220	0	0	13,574	1.76
B MIL AA <02215 1220 > River Gravel Channel Liner, front-end loader, 40 - 60 HP, no compaction	180.00	CY	CODFB10N	30.00	9	342	163	3,910	0	4,414	24.52
06.03.73.02_19_ 8. Habitat Features											
B MIL AA < > LWD	70.00	EA	CODEB12C	6.00	23	904	1,054	19,005	0	20,964	299.48
B MIL AA < > Boulders	240.00	EA	CODEB12C	8.00	60	2,326	2,711	2,606	0	7,643	31.85
B MIL AA < > Footer Logs	140.00	EA	CODEB12C	4.00	70	2,713	3,163	11,403	0	17,279	123.42
06.03.73.02_19_10. Non-channel Plantings											
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	3.00	ACR	COFWI	0.15	35	1,556	930	3,807	0	6,292	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	3160.00	EA	ULABM	120.00	79	3,107	148	11,027	0	14,282	4.52
B RSM LS < > Salmonberry	3160.00	EA	ULABM	120.00	79	3,107	148	11,027	0	14,282	4.52
B RSM LS < > Snowberry	3160.00	EA	ULABM	120.00	79	3,107	148	11,027	0	14,282	4.52
B RSM LS < > Flowering Currant	3160.00	EA	ULABM	120.00	79	3,107	148	11,027	0	14,282	4.52
B RSM LS < > Salal	3160.00	EA	ULABM	120.00	79	3,107	148	13,032	0	16,287	5.15
B RSM LS < > Oregon Grape	3160.00	EA	ULABM	120.00	79	3,107	148	14,034	0	17,289	5.47
B RSM LS < > Black Cottonwood	202.00	EA	ULABM	120.00	5	199	9	769	0	977	4.84
B RSM LS < > Pacific Crabapple	202.00	EA	ULABM	120.00	5	199	9	769	0	977	4.84
B RSM LS < > Douglas Fir	202.00	EA	ULABM	120.00	5	199	9	769	0	977	4.84
B RSM LS < > Western Red Cedar	202.00	EA	ULABM	120.00	5	199	9	769	0	977	4.84
B RSM LS < > Red Alder	202.00	EA	ULABM	120.00	5	199	9	769	0	977	4.84
06.03.73.02_19_12. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	3715.00	EA	ULABM	600.00	19	731	35	2,828	0	3,594	0.97
B RSM LS < > Scoulers Willow	3715.00	EA	ULABM	600.00	19	731	35	2,828	0	3,594	0.97
B RSM LS < > Pacific Willow	3715.00	EA	ULABM	600.00	19	731	35	2,828	0	3,594	0.97
B RSM LS < > Sedges	3715.00	EA	ULABM	450.00	25	974	46	2,828	0	3,849	1.04
06.03.73.02_19_14. Soil Amendments											
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	400.00	CY	CODFB10S	25.00	24	1,065	441	8,096	0	9,602	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	40.00	CY	CODFB10U	20.00	3	133	162	788	0	1,083	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
TOTAL NE Auburn Creek					3,948	159,144	88,709	189,952	4,728	442,533	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_20. Meridian Valley Country Club											
06.03.73.02_20_ 2. Reach A Mobilization											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	1,500	1,086	1,000	5,086	5086.00
06.03.73.02_20_ 4. Reach A Channel											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	1.80	ACR	CODFB7	0.08	144	4,990	1,960	0	0	6,950	3861.01
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	2300.00	LF	ALABCLAB2	43.75	105	3,504	0	574	0	4,079	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	6440.00	CY	CODEB12C	100.00	129	4,992	5,820	0	0	10,812	1.68
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	3220.00	CY	CODTB10L	46.88	103	3,912	1,765	0	0	5,676	1.76
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	3220.00	CY	COEIB34B	40.00	81	2,949	2,827	0	0	5,776	1.79
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	3220.00	CY	COEIB34B	14.00	230	8,425	8,078	0	0	16,503	5.13
B MIL AA <02215 1220 > River Gravel Channel Liner, front-end loader, 40 - 60 HP, no compaction	230.00	CY	CODFB10N	30.00	12	437	208	4,996	0	5,640	24.52
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	3220.00	CY	CODTB10L	46.88	103	3,912	1,765	0	0	5,676	1.76
06.03.73.02_20_ 6. Reach A Habitat Features											
B MIL AA < > LWD	30.00	EA	CODEB12C	6.00	10	388	452	8,145	0	8,984	299.48
B MIL AA < > Boulders	130.00	EA	CODEB12C	8.00	33	1,260	1,469	1,412	0	4,140	31.85
B MIL AA < > Footer Logs	60.00	EA	CODEB12C	4.00	30	1,163	1,356	4,887	0	7,405	123.42
06.03.73.02_20_ 8. Reach A Non-Channel Plantings											
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	0.50	ACR	COFWI	0.15	6	259	155	634	0	1,049	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	540.00	EA	ULABM	120.00	14	531	25	1,884	0	2,441	4.52
B RSM LS < > Salmonberry	540.00	EA	ULABM	120.00	14	531	25	1,884	0	2,441	4.52
B RSM LS < > Snowberry	540.00	EA	ULABM	120.00	14	531	25	1,884	0	2,441	4.52
B RSM LS < > Flowering Currant	540.00	EA	ULABM	120.00	14	531	25	1,884	0	2,441	4.52
B RSM LS < > Salal	540.00	EA	ULABM	120.00	14	531	25	2,227	0	2,783	5.15
B RSM LS < > Oregon Grape	540.00	EA	ULABM	120.00	14	531	25	2,398	0	2,954	5.47
B RSM LS < > Black Cottonwood	35.00	EA	ULABM	120.00	1	34	2	133	0	169	4.84
B RSM LS < > Pacific Crabapple	35.00	EA	ULABM	120.00	1	34	2	133	0	169	4.84
B RSM LS < > Douglas Fir	35.00	EA	ULABM	120.00	1	34	2	133	0	169	4.84
B RSM LS < > Western Red Cedar	35.00	EA	ULABM	120.00	1	34	2	133	0	169	4.84
B RSM LS < > Red Alder	35.00	EA	ULABM	120.00	1	34	2	133	0	169	4.84

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_20_10. Reach A Water Fluct. Zone Plants											
B RSM LS < > Hookers Willow	2760.00	EA	ULABM	600.00	14	543	26	2,101	0	2,670	0.97
B RSM LS < > Scoulers Willow	2760.00	EA	ULABM	600.00	14	543	26	2,101	0	2,670	0.97
B RSM LS < > Pacific Willow	2760.00	EA	ULABM	600.00	14	543	26	2,101	0	2,670	0.97
B RSM LS < > Sedges	2760.00	EA	ULABM	450.00	18	724	35	2,101	0	2,860	1.04
06.03.73.02_20_12. Reach A Soil Amendments											
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	70.00	CY	CODFB10S	25.00	4	186	77	1,417	0	1,680	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	51.00	CY	CODFB10U	20.00	4	170	206	1,005	0	1,381	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_20_13. Reach B Mobilization											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	1,500	1,086	1,000	5,086	5086.00
06.03.73.02_20_18. Reach B Channel											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	1.40	ACR	CODFB7	0.08	112	3,881	1,524	0	0	5,405	3861.01
L RSM AA <02216 2000 > Backfill, sand & gravel, 75 HP dozer	3220.00	CY	CODTB10L	90.00	54	2,037	919	0	0	2,956	0.92
B MIL AA <02215 1220 > River Gravel Channel Liner, front-end loader, 40 - 60 HP, no compaction	180.00	CY	CODFB10N	30.00	9	342	163	3,910	0	4,414	24.52
06.03.73.02_20_20. Reach B Habitat Features											
B MIL AA < > LWD	30.00	EA	CODEB12C	6.00	10	388	452	8,145	0	8,984	299.48
B MIL AA < > Boulders	110.00	EA	CODEB12C	8.00	28	1,066	1,243	1,195	0	3,503	31.85
B MIL AA < > Footer Logs	50.00	EA	CODEB12C	4.00	25	969	1,130	4,073	0	6,171	123.42
06.03.73.02_20_22. Reach B Non-channel Plantings											
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	0.40	ACR	COFWI	0.15	5	207	124	508	0	839	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	450.00	EA	ULABM	120.00	11	442	21	1,570	0	2,034	4.52
B RSM LS < > Salmonberry	450.00	EA	ULABM	120.00	11	442	21	1,570	0	2,034	4.52
B RSM LS < > Snowberry	450.00	EA	ULABM	120.00	11	442	21	1,570	0	2,034	4.52
B RSM LS < > Flowering Currant	450.00	EA	ULABM	120.00	11	442	21	1,570	0	2,034	4.52
B RSM LS < > Salal	450.00	EA	ULABM	120.00	11	442	21	1,856	0	2,319	5.15
B RSM LS < > Oregon Grape	450.00	EA	ULABM	120.00	11	442	21	1,999	0	2,462	5.47
B RSM LS < > Black Cottonwood	30.00	EA	ULABM	120.00	1	29	1	114	0	145	4.84
B RSM LS < > Pacific Crabapple	30.00	EA	ULABM	120.00	1	29	1	114	0	145	4.84
B RSM LS < > Douglas Fir	30.00	EA	ULABM	120.00	1	29	1	114	0	145	4.84
B RSM LS < > Western Red Cedar	30.00	EA	ULABM	120.00	1	29	1	114	0	145	4.84
B RSM LS < > Red Alder	30.00	EA	ULABM	120.00	1	29	1	114	0	145	4.84

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_20_24. Reach B Water Fluct. Zone Plants											
B RSM LS < > Hookers Willow	2130.00	EA	ULABM	600.00	11	419	20	1,622	0	2,060	0.97
B RSM LS < > Scoulers Willow	2130.00	EA	ULABM	600.00	11	419	20	1,622	0	2,060	0.97
B RSM LS < > Pacific Willow	2130.00	EA	ULABM	600.00	11	419	20	1,622	0	2,060	0.97
B RSM LS < > Sedges	2130.00	EA	ULABM	450.00	14	558	27	1,622	0	2,207	1.04
06.03.73.02_20_26. Reach B Soil Amendments											
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	60.00	CY	CODFB10S	25.00	4	160	66	1,214	0	1,440	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	43.00	CY	CODFB10U	20.00	3	143	174	847	0	1,164	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
TOTAL Meridian Valley Country Club					1,530	74,002	36,697	85,563	3,168	199,430	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_21. Lake Meridian Outlet Relocation											
06.03.73.02_21_ 2. Reach A Mobilization											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	1,500	1,086	1,000	5,086	5086.00
06.03.73.02_21_ 4. Reach A Channel											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	1.00	ACR	CODFB7	0.08	80	2,772	1,089	0	0	3,861	3861.01
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	4600.00	CY	CODEB12C	100.00	92	3,566	4,157	0	0	7,723	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	4600.00	CY	COEIB34B	14.00	328	12,036	11,540	0	0	23,576	5.13
B MIL AA <02215 1220 > River Gravel Channel Liner, front-end loader, 40 - 60 HP, no compaction	400.00	CY	CODFB10N	30.00	20	759	362	8,688	0	9,809	24.52
06.03.73.02_21_ 6. Reach A Habitat Features											
B MIL AA < > LWD	80.00	EA	CODEB12C	6.00	27	1,034	1,205	21,720	0	23,959	299.48
B MIL AA < > Boulders	300.00	EA	CODEB12C	8.00	75	2,907	3,389	3,258	0	9,554	31.85
B MIL AA < > Footer Logs	150.00	EA	CODEB12C	4.00	75	2,907	3,389	12,218	0	18,514	123.42
06.03.73.02_21_ 8. Reach A Non-Channel Plantings											
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	2.00	ACR	COFWI	0.15	23	1,037	620	2,538	0	4,195	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	1980.00	EA	ULABM	300.00	20	779	37	6,909	0	7,725	3.90
B RSM LS < > Salmonberry	1980.00	EA	ULABM	300.00	20	779	37	6,909	0	7,725	3.90
B RSM LS < > Snowberry	1980.00	EA	ULABM	300.00	20	779	37	6,909	0	7,725	3.90
B RSM LS < > Flowering Currant	1980.00	EA	ULABM	300.00	20	779	37	6,909	0	7,725	3.90
B RSM LS < > Salal	1980.00	EA	ULABM	300.00	20	779	37	8,166	0	8,981	4.54
B RSM LS < > Oregon Grape	1980.00	EA	ULABM	300.00	20	779	37	8,794	0	9,609	4.85
B RSM LS < > Black Cottonwood	70.00	EA	ULABM	50.00	4	165	8	266	0	440	6.28
B RSM LS < > Pacific Crabapple	70.00	EA	ULABM	50.00	4	165	8	266	0	440	6.28
B RSM LS < > Douglas Fir	70.00	EA	ULABM	50.00	4	165	8	266	0	440	6.28
B RSM LS < > Western Red Cedar	70.00	EA	ULABM	50.00	4	165	8	266	0	440	6.28
B RSM LS < > Red Alder	70.00	EA	ULABM	50.00	4	165	8	266	0	440	6.28
06.03.73.02_21_10. Reach A Water Fluct. Zone Plants											
B RSM LS < > Hookers Willow	4300.00	EA	ULABM	600.00	22	846	40	3,274	0	4,160	0.97
B RSM LS < > Scoulers Willow	4300.00	EA	ULABM	600.00	22	846	40	3,274	0	4,160	0.97
B RSM LS < > Pacific Willow	4300.00	EA	ULABM	600.00	22	846	40	3,274	0	4,160	0.97
B RSM LS < > Sedges	4300.00	EA	ULABM	450.00	29	1,127	54	3,274	0	4,455	1.04

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_21_12. Reach A Soil Amendments											
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	250.00	CY	CODFB10S	25.00	15	665	276	5,060	0	6,001	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	94.00	CY	CODFB10U	20.00	7	313	381	1,852	0	2,546	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_21_13. Reach B Mobilization											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	1,500	1,086	1,000	5,086	5086.00
06.03.73.02_21_18. Reach B Channel											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	11.00	ACR	CODFB7	0.08	880	30,494	11,977	0	0	42,471	3861.01
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	1457.00	SY	CLABB80A	300.00	15	486	73	1,345	0	1,904	1.31
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	2500.00	LF	ALABCLAB2	43.75	114	3,809	0	624	0	4,433	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	15376	CY	CODEB12C	100.00	308	11,919	13,895	0	0	25,815	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	15376	CY	COEIB34B	14.00	1,098	40,233	38,574	0	0	78,807	5.13
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	7700.00	CY	CODTB10L	46.88	246	9,354	4,220	0	0	13,574	1.76
B MIL AA <02215 1220 > River Gravel Channel Liner, front-end loader, 40 - 60 HP, no compaction	180.00	CY	CODFB10N	30.00	9	342	163	3,910	0	4,414	24.52
06.03.73.02_21_20. Reach B Habitat Features											
B MIL AA < > LWD	70.00	EA	ULABM	6.00	35	1,178	56	19,005	0	20,239	289.13
B MIL AA < > Boulders	270.00	EA	ULABM	8.00	101	3,408	162	2,932	0	6,502	24.08
B MIL AA < > Footer Logs	140.00	EA	ULABM	4.00	105	3,534	168	11,403	0	15,105	107.89
06.03.73.02_21_22. Reach B Non-channel Plantings											
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	1.80	ACR	COFWI	0.15	21	934	558	2,284	0	3,775	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	1870.00	EA	ULABM	120.00	47	1,839	87	6,525	0	8,452	4.52
B RSM LS < > Salmonberry	1870.00	EA	ULABM	120.00	47	1,839	87	6,525	0	8,452	4.52
B RSM LS < > Snowberry	1870.00	EA	ULABM	120.00	47	1,839	87	6,525	0	8,452	4.52
B RSM LS < > Flowering Currant	1870.00	EA	ULABM	120.00	47	1,839	87	6,525	0	8,452	4.52
B RSM LS < > 6	1870.00	EA	ULABM	120.00	47	1,839	87	7,712	0	9,638	5.15
B RSM LS < > Oregon Grape	1870.00	EA	ULABM	120.00	47	1,839	87	8,305	0	10,231	5.47
B RSM LS < > Black Cottonwood	120.00	EA	ULABM	120.00	3	118	6	457	0	580	4.84
B RSM LS < > Pacific Crabapple	120.00	EA	ULABM	120.00	3	118	6	457	0	580	4.84
B RSM LS < > Douglas Fir	120.00	EA	CLABB80	120.00	4	165	20	457	0	642	5.35
B RSM LS < > Western Red Cedar	120.00	EA	CLABB80	120.00	4	165	20	457	0	642	5.35
B RSM LS < > Red Alder	120.00	EA	CLABB80	120.00	4	165	20	457	0	642	5.35

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_21_24. Reach B Water Fluct. Zone Plants											
B RSM LS < > Hookers Willow	3440.00	EA	ULABM	600.00	17	676	32	2,619	0	3,328	0.97
B RSM LS < > Scoulers Willow	3440.00	EA	ULABM	600.00	17	676	32	2,619	0	3,328	0.97
B RSM LS < > Pacific Willow	3440.00	EA	ULABM	600.00	17	676	32	2,619	0	3,328	0.97
B RSM LS < > Sedges	3440.00	EA	ULABM	450.00	23	902	43	2,619	0	3,564	1.04
06.03.73.02_21_26. Reach B Soil Amendments											
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	240.00	CY	CODFB10S	25.00	14	639	265	4,857	0	5,761	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	89.00	CY	CODFB10U	20.00	7	296	360	1,754	0	2,410	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
TOTAL Lake Meridian Outlet Relocation					4,376	178,091	102,430	222,383	3,168	506,073	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_22. Olson Creek											
06.03.73.02_22_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00
06.03.73.02_22_ 4. Channel											
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	639.00	CY	CODEB12C	100.00	13	495	577	0	0	1,073	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	639.00	CY	COEIB34B	16.00	40	1,463	1,403	0	0	2,866	4.48
USR AA < > Disposal Fee	639.00	CY		0.00	0	0	0	0	1,917	1,917	3.00
B MIL AA < > LWD	20.00	EA	CODEB12C	6.00	7	258	301	5,430	0	5,990	299.48
B MIL AA < > Boulders	90.00	EA	CODEB12C	8.00	23	872	1,017	977	0	2,866	31.85
B MIL AA < > Footer Logs	40.00	EA	CODEB12C	4.00	20	775	904	3,258	0	4,937	123.42
USR AA < > Coir fabric	1150.00	SY	ULABM	100.00	35	1,161	55	4,496	0	5,713	4.97
06.03.73.02_22_10. Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	690.00	EA	ULABM	600.00	3	136	6	525	0	667	0.97
B RSM LS < > Scoulers Willow	690.00	EA	ULABM	600.00	3	136	6	525	0	667	0.97
B RSM LS < > Pacific Willow	690.00	EA	ULABM	600.00	3	136	6	525	0	667	0.97
B RSM LS < > Sedges	690.00	EA	ULABM	450.00	5	181	9	525	0	715	1.04
06.03.73.02_22_12. Non-channel Plantings											
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	2.10	ACR	COFWI	0.15	25	1,089	651	2,665	0	4,405	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	670.00	EA	ULABM	120.00	17	659	31	2,338	0	3,028	4.52
B RSM LS < > Salmonberry	670.00	EA	ULABM	120.00	17	659	31	2,338	0	3,028	4.52
B RSM LS < > Snowberry	670.00	EA	ULABM	120.00	17	659	31	2,338	0	3,028	4.52
B RSM LS < > Flowering Currant	670.00	EA	ULABM	120.00	17	659	31	2,338	0	3,028	4.52
B RSM LS < > Salal	670.00	EA	ULABM	120.00	17	659	31	2,763	0	3,453	5.15
B RSM LS < > Oregon Grape	670.00	EA	ULABM	120.00	17	659	31	2,976	0	3,666	5.47
B RSM LS < > Black Cottonwood	43.00	EA	ULABM	120.00	1	42	2	164	0	208	4.84
B RSM LS < > Pacific Crabapple	43.00	EA	ULABM	120.00	1	42	2	164	0	208	4.84
B RSM LS < > Douglas Fir	43.00	EA	ULABM	120.00	1	42	2	164	0	208	4.84
B RSM LS < > Western Red Cedar	43.00	EA	ULABM	120.00	1	42	2	164	0	208	4.84
B RSM LS < > Red Alder	43.00	EA	ULABM	120.00	1	42	2	164	0	208	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	90.00	CY	CODFB10S	25.00	5	240	99	1,822	0	2,160	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	32.00	CY	CODFB10U	20.00	2	106	130	631	0	867	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	3,505	292	317	292	4,407	4406.77
TOTAL Olson Creek					290	16,218	7,655	38,149	2,709	64,731	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_23. Riverside Estates Side Channel											
06.03.73.02_23_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00
06.03.73.02_23_ 4. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	5.40	ACR	COMCB88	0.53	71	2,795	2,637	0	0	5,432	1005.96
MIL AA <02140 1600 > Dewatering	50.00	CY	CODLB6	5.79	26	915	106	733	0	1,754	35.09
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	500.00	LF	ALABCLAB2	43.75	23	762	0	125	0	887	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	12665	CY	CODEB12C	100.00	253	9,818	11,445	0	0	21,263	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	12665	CY	COEIB34B	27.00	469	17,184	16,475	0	0	33,659	2.66
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	96.00	CY	CODFB10N	30.00	5	182	87	2,085	0	2,354	24.52
USR AA < > Disposal Fee	12665	CY		0.00	0	0	0	0	37,995	37,995	3.00
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	2300.00	SY	CLABB80A	300.00	23	767	116	2,123	0	3,006	1.31
06.03.73.02_23_ 5. Water Control Equipment											
L MIL AA <02046 0020 > Remove existing Flapgates	1.00	EA	CODLB6	0.25	12	424	49	0	0	473	472.80
AF AA <02234 4200 > Hauling, w/loading, 12 CY truck, 5 mile haul	12.00	CY	CODEB30	48.00	1	28	33	0	0	61	5.08
B CIV AA < > Self Regulating Tidegate, 24" Dia	1.00	EA	SIWSL5A	0.50	8	324	72	20,200	1,000	21,595	21595.13
06.03.73.02_23_ 8. Habitat Features											
B MIL AA < > LWD	90.00	EA	CODEB12C	6.00	30	1,163	1,356	24,435	0	26,953	299.48
B MIL AA < > Boulders	350.00	EA	CODEB12C	8.00	88	3,392	3,954	3,801	0	11,146	31.85
B MIL AA < > Footer Logs	170.00	EA	CODEB12C	4.00	85	3,295	3,841	13,847	0	20,982	123.42
06.03.73.02_23_10. Non-channel Plantings											
B RSM LS < > Black Cottonwood	151.00	EA	ULABM	120.00	4	148	7	575	0	730	4.84
B RSM LS < > Pacific Crabapple	151.00	EA	ULABM	120.00	4	148	7	575	0	730	4.84
B RSM LS < > Douglas Fir	151.00	EA	ULABM	120.00	4	148	7	575	0	730	4.84
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	3.90	ACR	COFWI	0.15	46	2,023	1,209	4,949	0	8,180	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	2360.00	EA	ULABM	120.00	59	2,320	110	8,235	0	10,666	4.52
B RSM LS < > Salmonberry	2360.00	EA	ULABM	120.00	59	2,320	110	8,235	0	10,666	4.52
B RSM LS < > Snowberry	2360.00	EA	ULABM	120.00	59	2,320	110	8,235	0	10,666	4.52
B RSM LS < > Flowering Currant	2360.00	EA	ULABM	120.00	59	2,320	110	8,235	0	10,666	4.52
B RSM LS < > Salal	2360.00	EA	ULABM	120.00	59	2,320	110	9,733	0	12,163	5.15
B RSM LS < > Oregon Grape	2360.00	EA	ULABM	120.00	59	2,320	110	10,481	0	12,912	5.47
B RSM LS < > Western Red Cedar	151.00	EA	ULABM	120.00	4	148	7	575	0	730	4.84
B RSM LS < > Red Alder	151.00	EA	ULABM	120.00	4	148	7	575	0	730	4.84

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	170.00	CY	CODFB10S	25.00	10	452	188	3,441	0	4,081	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	64.00	CY	CODFB10U	20.00	5	213	259	1,261	0	1,733	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_23_16. Water Fluctuation Zone											
B RSM LS < > Hookers Willow	3191.00	EA	ULABM	600.00	16	628	30	2,429	0	3,087	0.97
B RSM LS < > Scoulers Willow	3191.00	EA	ULABM	600.00	16	628	30	2,429	0	3,087	0.97
B RSM LS < > Pacific Willow	3191.00	EA	ULABM	600.00	16	628	30	2,429	0	3,087	0.97
B RSM LS < > Sedges	3191.00	EA	ULABM	450.00	21	837	40	2,429	0	3,306	1.04
TOTAL Riverside Estates Side Channel					1,595	71,131	46,235	145,553	41,579	304,498	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_24. Mainstem Maint.(Auburn-Elliot B)											
06.03.73.02_24_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	6,000	6,000	3,258	3,000	18,258	18258.00
USR AA < > Placeholder	1.00	JOB		0.00	0	0	0	0	1,000,000	1,000,000	1000000.00
TOTAL Mainstem Maint.(Auburn-Elliot B)					0	6,000	6,000	3,258	1,003,000	1,018,258	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_25. Porter Levee Setback											
06.03.73.02_25_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,000	3,000	1,086	500	6,586	6586.00
06.03.73.02_25_ 4. Levee Removal											
L MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	9650.00	CY	CODEB12C	85.00	227	8,802	10,260	0	0	19,062	1.98
L MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	9650.00	CY	COEIB34B	25.00	386	14,140	13,557	0	0	27,697	2.87
06.03.73.02_25_ 6. Revetment + Levee Construction											
B RSM LS < > Willow Stakes	125.00	EA	ULABM	600.00	1	25	1	95	0	121	0.97
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip, soil	10860	CY	COEIB34B	14.00	775	28,416	27,244	0	0	55,661	5.13
USR AA < > Imported fill	10860	CY		0.00	0	0	0	58,970	0	58,970	5.43
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	10860	CY	CODTB10L	46.88	348	13,193	5,951	0	0	19,144	1.76
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	10860	CY	COFCB10Y	375.00	43	1,649	653	0	0	2,301	0.21
MIL AA <02220 9010 > Compaction, water, truck, 3000 gal, 6 mile haul	1086.00	CY	COKBB45	180.50	12	463	284	236	0	982	0.90
B RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	15455	CY	CODET	50.00	618	22,948	28,824	266,196	0	317,967	20.57
USR AA < > Coir fabric	3750.00	SF	ULABM	900.00	12	421	20	1,629	0	2,070	0.55
MIL LS <02241 0805 > Loam or topsoil, furnish & place, imported, 6" deep	1820.00	CY	CODFB10S	17.00	161	7,123	2,954	38,383	0	48,460	26.63
B MIL AA < > Hydroseeding	1.20	ACR	COFWI	0.15	14	533	318	1,303	0	2,154	1795.12
06.03.73.02_25_ 8. Construction Haul Road											
USR AA < > Construction Access Road	24000	SF		0.00	0	1,200	4,800	9,122	0	15,122	0.63
USR AA < > Construction Access Road Removal	24000	SF		0.00	0	1,200	4,800	0	0	6,000	0.25
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	667.00	CY	COEIB34B	12.00	56	2,036	1,952	0	0	3,988	5.98
USR AA < > Disposal Fee	667.00	CY		0.00	0	0	0	0	2,001	2,001	3.00
TOTAL Porter Levee Setback					2,652	104,147	104,618	377,021	2,501	588,287	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_26. Kaech Levee Pond											
06.03.73.02_26_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	1,500	1,086	1,000	5,086	5086.00
06.03.73.02_26_ 4. Pond											
M RSM AA < > Quarry Spalls, random, machine placed for slope protection	4.00	CY	UOEHB12G	7.75	1	40	18	56	0	115	28.64
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	780.00	CY	CODET	35.00	45	1,654	2,078	13,435	0	17,167	22.01
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	4000.00	CY	CODEB12C	100.00	80	3,101	3,615	0	0	6,716	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 40 mi round trip @ base wide rate	4000.00	CY	COEIB34B	6.00	667	24,422	23,414	0	0	47,836	11.96
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	2000.00	CY	CODTB10L	46.88	64	2,430	1,096	0	0	3,526	1.76
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	1400.00	CY	CODFB10N	30.00	70	2,657	1,266	30,408	0	34,332	24.52
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	190.00	CY	CODFB10N	30.00	10	361	172	4,127	0	4,659	24.52
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	1463.00	SY	CLABB80A	300.00	15	488	74	1,350	0	1,912	1.31
MIL AA <02266 0120 > Erosion control, revegetation mat, webbed	1463.00	SY	ALABCLAB2	125.00	23	780	0	4,528	0	5,308	3.63
M MIL AA <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	360.00	CY	CODFB10S	25.00	22	820	340	6,236	0	7,396	20.54
06.03.73.02_26_11. Maintenance Road											
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1180.00	CY	CODTB10L	46.88	38	1,433	647	0	0	2,080	1.76
M MIL AA < > Basecourse for road, 12" thick areas	3539.00	SY	COFGB36B	562.50	50	1,880	1,543	14,413	0	17,835	5.04
USR AA < > Geotextile, woven	3539.00	SY	CLABB80	540.00	26	924	113	2,690	0	3,727	1.05
06.03.73.02_26_6 . Habitat Features											
B MIL AA < > LWD	10.00	EA	CODEB12C	6.00	3	129	151	2,715	0	2,995	299.48
B RSM AA < > Willow Stakes	450.00	EA	ULABM	600.00	2	76	4	293	0	373	0.83
TOTAL Kaech Levee Pond					1,115	42,694	36,030	81,338	1,000	161,061	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_27. Ray Creek Trib Corridor											
06.03.73.02_27_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00
06.03.73.02_27_ 4. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	2.30	ACR	COMCB88	0.53	30	1,191	1,123	0	0	2,314	1005.96
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	200.00	LF	ALABCLAB2	43.75	9	305	0	50	0	355	1.77
AF AA <01534 0100 > Fencing, 11 ga, chain link, 6' high	13800	LF	ALABCLAB2	9.38	2,944	98,112	0	57,399	0	155,512	11.27
06.03.73.02_27_10. Non-channel Plantings											
B RSM LS < > Pacific Ninebark	5796.00	EA	ULABM	120.00	145	5,699	271	20,225	0	26,195	4.52
B RSM LS < > Ladyfern	29980	EA	ULABM	120.00	750	29,478	1,401	133,148	0	164,027	5.47
B RSM LS < > Sword fern	29980	EA	ULABM	120.00	750	29,478	1,401	133,148	0	164,027	5.47
B RSM LS < > Black Cottonwood	1449.00	EA	ULABM	120.00	36	1,425	68	5,516	0	7,008	4.84
B RSM LS < > Pacific Crabapple	725.00	EA	ULABM	120.00	18	713	34	2,760	0	3,507	4.84
B RSM LS < > Douglas Fir	151.00	EA	ULABM	120.00	4	148	7	575	0	730	4.84
B RSM LS < > Oregon Ash	1449.00	EA	ULABM	120.00	36	1,425	68	5,056	0	6,549	4.52
B RSM LS < > Sitka Spruce	7245.00	EA	ULABM	120.00	181	7,124	339	27,580	0	35,042	4.84
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	3.90	ACR	COFWI	0.15	46	2,023	1,209	4,949	0	8,180	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	14490	EA	ULABM	120.00	362	14,247	677	50,564	0	65,488	4.52
B RSM LS < > Salmonberry	21735	EA	ULABM	120.00	543	21,371	1,016	75,845	0	98,232	4.52
B RSM LS < > Snowberry	29980	EA	ULABM	120.00	750	29,478	1,401	104,617	0	135,495	4.52
B RSM LS < > Vine Maple	7245.00	EA	ULABM	120.00	181	7,124	339	25,282	0	32,744	4.52
B RSM LS < > Black Twinberry	8694.00	EA	ULABM	120.00	217	8,548	406	35,854	0	44,809	5.15
B RSM LS < > Oregon Grape	2360.00	EA	ULABM	120.00	59	2,320	110	10,481	0	12,912	5.47
B RSM LS < > Western Red Cedar	7245.00	EA	ULABM	120.00	181	7,124	339	27,580	0	35,042	4.84
B RSM LS < > Grand Fir	1449.00	EA	ULABM	120.00	36	1,425	68	5,516	0	7,008	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	1449.00	CY	CODFB10S	25.00	87	3,856	1,599	29,327	0	34,782	24.00
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	8,763	5,842	1,269	1,168	17,043	17042.87
06.03.73.02_27_16. Water Fluctuation Zone											
B RSM LS < > Hookers Willow Stakes	14490	EA	ULABM	750.00	58	2,279	108	18,387	0	20,774	1.43
B RSM LS < > Pacific Willow Stakes	14490	EA	ULABM	750.00	58	2,279	108	18,387	0	20,774	1.43
06.03.73.02_27_18. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_27_20. Channel											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	1.20	ACR	COMCB88	0.53	16	621	586	0	0	1,207	1005.96
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	200.00	LF	ALABCLAB2	43.75	9	305	0	50	0	355	1.77
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	107.00	CY	CODEB12C	100.00	2	83	97	0	0	180	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip @ base wide rate	107.00	CY	COEIB34B	27.00	4	145	139	0	0	284	2.66
USR AA < > Disposal Fee	107.00	CY		0.00	0	0	0	0	321	321	3.00
B MIL AA < > Coir Wraps	1150.00	LF	CODEY	21.50	267	9,900	6,439	9,991	0	26,331	22.90
06.03.73.02_27_22. Habitat Features											
B MIL AA < > LWD	690.00	EA	CODEB12C	6.00	230	8,915	10,393	187,335	0	206,643	299.48
TOTAL Ray Creek Trib Corridor					8,009	311,902	41,588	995,236	5,489	1,354,215	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_28. Hamakami Levee Modification											
06.03.73.02_28_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00
06.03.73.02_28_ 4. Channel											
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	495.00	CY	CODET	35.00	28	1,050	1,319	8,526	0	10,895	22.01
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	1970.00	CY	CODEB12C	100.00	39	1,527	1,780	0	0	3,307	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 40 mi round trip @ base wide rate	1970.00	CY	COEIB34B	6.00	328	12,028	11,532	0	0	23,559	11.96
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1000.00	CY	CODTB10L	46.88	32	1,215	548	0	0	1,763	1.76
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	720.00	CY	CODFB10N	30.00	36	1,367	651	15,638	0	17,656	24.52
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	210.00	CY	CODFB10N	30.00	11	399	190	4,561	0	5,150	24.52
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	1486.00	SY	CLABB80A	300.00	15	495	75	1,372	0	1,942	1.31
MIL AA <02266 0120 > Erosion control, revegetation mat, webbed	1486.00	SY	ALABCLAB2	125.00	24	792	0	4,599	0	5,392	3.63
M MIL AA <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	430.00	CY	CODFB10S	25.00	26	979	406	7,448	0	8,834	20.54
B MIL LS < > LWD	10.00	EA	CODEB12C	6.00	3	151	176	5,076	0	5,403	540.27
06.03.73.02_28_ 8. Maintenance Road											
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1180.00	CY	CODTB10L	46.88	38	1,433	647	0	0	2,080	1.76
M MIL AA < > Basecourse for road, 12" thick areas	3539.00	SY	COFGB36B	562.50	50	1,880	1,543	14,413	0	17,835	5.04
USR AA < > Geotextile, woven	3539.00	SY	CLABB80	540.00	26	924	113	2,690	0	3,727	1.05
06.03.73.02_28_10. Landscaping											
MIL LS <02241 0805 > Loam or topsoil, furnish & place, imported, 6" deep	430.00	CY	CODFB10S	17.00	38	1,683	698	9,069	0	11,449	26.63
USR LS < > Coir fabric	1486.00	SY	ULABM	100.00	45	1,753	83	6,788	0	8,625	5.80
B RSM LS < > Willow Stakes	475.00	EA	ULABM	600.00	2	93	4	362	0	459	0.97
B RSM LS < > Yellowtwig Dogwood Stakes	702.00	EA	ULABM	600.00	4	138	7	534	0	679	0.97
B RSM LS < > Redtwig Dogwood Stakes	702.00	EA	ULABM	600.00	4	138	7	534	0	679	0.97
B RSM LS < > Native Willow Stakes	1000.00	EA	ULABM	60.00	50	1,966	93	0	0	2,060	2.06
B RSM LS < > Salmonberry	1500.00	EA	ULABM	120.00	38	1,475	70	5,710	0	7,255	4.84
B RSM LS < > Snowberry	1500.00	EA	ULABM	120.00	38	1,475	70	5,234	0	6,779	4.52
B RSM LS < > Flowering Currant	1500.00	EA	ULABM	120.00	38	1,475	70	5,234	0	6,779	4.52
B RSM LS < > Red Alder	1500.00	EA	CLABB80	120.00	50	2,059	252	5,710	0	8,021	5.35
B RSM LS < > Oregon Grape	75.00	EA	ULABM	120.00	2	74	4	333	0	410	5.47

06.03. Wildlife Facilities & Sanctuary

		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
B RSM LS <	> Salal	75.00	EA	ULABM	120.00	2	74	4	309	0	387	5.15
B RSM LS <	> Black Cottonwood, 10 gal.	725.00	EA	ULABM	6.00	363	14,257	678	16,559	0	31,494	43.44
B RSM LS <	> Pacific Crabapple, 8-10 ft.	480.00	EA	ULABM	6.00	240	9,439	449	13,400	0	23,288	48.52
B RSM LS <	> Douglas Fir, 8-10 ft.	1200.00	EA	ULABM	6.00	600	23,598	1,122	30,454	0	55,174	45.98
B RSM LS <	> Western Red Cedar, 8-10 ft.	960.00	EA	ULABM	6.00	480	18,878	897	28,018	0	47,793	49.78
B RSM LS <	> Blue Spruce, 6-8- ft.	960.00	EA	ULABM	6.00	480	18,878	897	20,709	0	40,484	42.17
B RSM LS <	> Hemlock, 8-10 ft.	480.00	EA	ULABM	6.00	240	9,439	449	12,182	0	22,069	45.98
B CIV LS <	> Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
	TOTAL Hamakami Levee Modification					3,367	139,643	27,416	226,642	1,084	394,785	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_29. Turley Levee Setback											
06.03.73.02_29_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	8,000	1,086	500	12,586	12586.00
06.03.73.02_29_ 4. Channel											
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	360.00	CY	CODET	35.00	21	764	959	6,201	0	7,923	22.01
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	4840.00	CY	CODEB12C	100.00	97	3,752	4,374	0	0	8,126	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	3340.00	CY	COEIB34B	16.00	209	7,647	7,332	0	0	14,979	4.48
B AF AA < > Clay liner material, delivered	40.00	CY	COEIB34B	15.00	3	98	94	652	0	843	21.07
USR AA < > Disposal Fee	3340.00	CY		0.00	0	0	0	0	10,020	10,020	3.00
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	1500.00	CY	COEIB34B	40.00	38	1,374	1,317	0	0	2,691	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1500.00	CY	CODTB10L	46.88	48	1,822	822	0	0	2,644	1.76
MIL AA <02220 9010 > Compaction, water, truck, 3000 gal, 6 mile haul	150.00	CY	COKBB45	180.50	2	64	39	33	0	136	0.90
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	1500.00	CY	COFCB10Y	375.00	6	228	90	0	0	318	0.21
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1500.00	CY	CODTB10L	46.88	48	1,822	822	0	0	2,644	1.76
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	140.00	CY	CODFB10N	30.00	7	266	127	3,041	0	3,433	24.52
B RSM AA <02270 0100 > Large Rocks, machine placed	20.00	CY	CODET	20.00	2	74	93	391	0	558	27.92
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	210.00	CY	CODFB10N	30.00	11	399	190	4,561	0	5,150	24.52
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	1486.00	SY	CLABB80A	300.00	15	495	75	1,372	0	1,942	1.31
MIL AA <02266 0120 > Erosion control, revegetation mat, webbed	1486.00	SY	ALABCLAB2	125.00	24	792	0	4,599	0	5,392	3.63
M MIL AA <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	430.00	CY	CODFB10S	25.00	26	979	406	7,448	0	8,834	20.54
B MIL LS < > LWD	10.00	EA	CODEB12C	6.00	3	151	176	5,076	0	5,403	540.27
06.03.73.02_29_ 6. Landscaping											
MIL LS <02241 0805 > Loam or topsoil, furnish & place, imported, 6" deep	165.00	CY	CODFB10S	17.00	15	646	268	3,480	0	4,393	26.63
B RSM LS < > Native Willow Stakes	400.00	EA	ULABM	60.00	20	787	37	0	0	824	2.06
B MIL LS < > Hydroseeding	0.20	ACR	COFWI	0.08	5	207	124	254	0	585	2926.05
B RSM LS < > Salmonberry, 1 gal.	46.00	EA	ULABM	120.00	1	45	2	175	0	222	4.84
B RSM LS < > Snowberry, 1 gal.	46.00	EA	ULABM	120.00	1	45	2	161	0	208	4.52
B RSM LS < > Flowering Currant, 1 gal.	46.00	EA	ULABM	120.00	1	45	2	161	0	208	4.52

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
B RSM LS < > Red Alder, 1 gal.	46.00	EA	CLABB80	120.00	2	63	8	175	0	246	5.35
B RSM LS < > Oregon Grape, 1 gal.	23.00	EA	ULABM	120.00	1	23	1	102	0	126	5.47
B RSM LS < > Salal, 1 gal.	23.00	EA	ULABM	120.00	1	23	1	95	0	119	5.15
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	2,337	117	127	0	2,581	2580.62
06.03.73.02_29_10. Construction Haul Road											
USR AA < > Construction Access Road	14400	SF		0.00	0	720	2,880	5,473	0	9,073	0.63
USR AA < > Construction Access Road Removal	14400	SF		0.00	0	720	2,880	0	0	3,600	0.25
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	400.00	CY	COEIB34B	12.00	33	1,221	1,171	0	0	2,392	5.98
USR AA < > Disposal Fee	400.00	CY		0.00	0	0	0	0	1,200	1,200	3.00
TOTAL Turley Levee Setback					636	30,608	32,409	44,661	11,720	119,398	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_30. Loans Levee Setback											
06.03.73.02_30_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00
06.03.73.02_30_ 4. Site Work											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	5.00	ACR	CODFB7	0.08	400	13,861	5,444	0	0	19,305	3861.01
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	6.50	ACR	COMCB88	0.53	86	3,364	3,174	0	0	6,539	1005.96
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	127.00	CY	CODTB10L	46.88	4	154	70	0	0	224	1.76
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	716.00	CY	CODTB10L	46.88	23	870	392	0	0	1,262	1.76
USR AA < > Geotextile, woven	2147.00	SY	CLABB80	540.00	16	561	68	1,632	0	2,261	1.05
B RSM AA < > Quarry Spalls	358.00	CY	CODTA	75.00	7	277	123	5,054	0	5,453	15.23
M MIL AA < > Basecourse for road, 5" thick areas	2147.00	SY	COFGB36B	562.50	30	1,140	936	9,327	0	11,403	5.31
USR AA < > Geotextile, woven	383.00	SY	CLABB80	540.00	3	100	12	291	0	403	1.05
B MIL AA < > LWD	74.00	EA	CODEB12C	6.00	25	956	1,115	16,073	0	18,144	245.18
B MIL AA < > Rootwads	74.00	EA	CODEB12C	6.00	25	956	1,115	12,055	0	14,125	190.88
B MIL AA < > Hydroseeding	11.50	ACR	COFWI	0.15	134	5,105	3,050	12,489	0	20,644	1795.12
B MIL AA < > Traffic Control	23.00	DAY		0.00	0	11,040	230	0	0	11,270	490.00
06.03.73.02_30_ 6. Levee Removal											
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	72450	CY	CODEB12C	130.00	1,116	43,202	50,367	0	0	93,569	1.29
MIL AA <02232 0150 > Excavate & load, hydr excavator, 2 CY, rock	8050.00	CY	CODEB12C	53.75	299	11,611	13,534	0	0	25,145	3.12
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip, soil	72450	CY	COEIB34B	10.00	7,245	265,399	254,459	0	0	519,858	7.18
06.03.73.02_30_ 8. Revetment Construction											
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	32200	CY	CODEB12C	130.00	496	19,201	22,385	0	0	41,586	1.29
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip, soil	8050.00	CY	COEIB34B	14.00	575	21,064	20,195	0	0	41,259	5.13
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	24150	CY	CODTB10L	46.88	773	29,337	13,234	0	0	42,572	1.76
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	24150	CY	COFCB10Y	375.00	97	3,666	1,451	0	0	5,117	0.21
MIL AA <02220 9010 > Compaction, water, truck, 3000 gal, 6 mile haul	2415.00	CY	COKBB45	180.50	27	1,029	631	525	0	2,185	0.90
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip, rock	8050.00	CY	COEIB34B	11.00	732	26,808	25,703	0	0	52,511	6.52
B RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	8050.00	CY	CODET	75.00	215	7,969	10,009	0	0	17,977	2.23

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	8050.00	CY	CODTB10L	46.88	258	9,779	4,411	0	0	14,191	1.76
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip, soil	43700	CY	COEIB34B	14.00	3,120	114,345	109,630	0	0	223,976	5.13
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip, rock	8050.00	CY	COEIB34B	16.00	503	18,430	17,671	0	0	36,101	4.48
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip, rock	8050.00	CY	COEIB34B	16.00	503	18,430	17,671	0	0	36,101	4.48
B RSM AA <02270 0100 > Rip-rap, toe rock, machine placed	5750.00	CY	CODET	20.00	575	21,343	26,810	124,890	0	173,043	30.09
06.03.73.02_30_10. Channel											
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	9660.00	CY	CODEB12C	130.00	149	5,760	6,716	0	0	12,476	1.29
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip, soil	9660.00	CY	COEIB34B	10.00	966	35,387	33,928	0	0	69,314	7.18
06.03.73.02_30_12. Habitat Features											
B MIL AA < > LWD	345.00	EA	CODEB12C	6.00	115	4,458	5,196	149,868	0	159,522	462.38
06.03.73.02_30_14. Revegetation											
USR LS < > Revetment Revegetation	1.20	AC		0.00	0	1,402	701	5,329	0	7,433	6193.90
USR LS < > Revegetation	9.20	AC		0.00	0	10,750	5,375	40,859	0	56,984	6193.90
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_30_16. Maintenance Road											
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1180.00	CY	CODTB10L	46.88	38	1,433	647	0	0	2,080	1.76
B RSM AA < > Quarry Spalls	2180.00	CY	CODTA	75.00	44	1,684	747	21,307	0	23,738	10.89
B MIL PV < > Basecourse for road, 5" thick areas	6542.00	SY	COFGB36B	690.00	76	3,372	2,768	16,919	0	23,059	3.52
USR AA < > Geotextile, woven	6542.00	SY	CLABB80	540.00	48	1,708	209	4,973	0	6,890	1.05
TOTAL Loans Levee Setback					18,721	725,963	663,760	424,398	2,584	1,816,705	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_31. Burns Creek Restoration											
06.03.73.02_31_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	200.00	LF	ALABCLAB2	43.75	9	305	0	50	0	355	1.77
B CIV AA < > Plant Establishment	1.00	YR	N/A	0.00	0	8,000	1,000	1,086	0	10,086	10086.00
06.03.73.02_31_ 4. Reach 1 Conifer Underplantings											
B RSM LS < > Western Red Cedar	201.00	EA	ULABM	6.00	101	3,953	188	5,866	0	10,007	49.78
06.03.73.02_31_ 6. Reach 2 Conifer Underplantings											
B RSM LS < > Western Red Cedar	201.00	EA	ULABM	6.00	101	3,953	188	5,866	0	10,007	49.78
06.03.73.02_31_11. Reach 3 Plantings											
B RSM LS < > Western Red Cedar	201.00	EA	ULABM	6.00	101	3,953	188	5,866	0	10,007	49.78
B RSM LS < > Native Willow Stakes	115.00	EA	ULABM	60.00	6	226	11	0	0	237	2.06
06.03.73.02_31_13. Fremouw Residence Removal											
L AF AA <02050 0500 > Remove Floodwall	1.00	LS		0.00	0	8,000	20,000	0	5,000	33,000	33000.00
L AF AA <02050 0500 > Building dml, single family, one story house, wood, maximum	1.00	EA	CODEB12C	0.25	8	310	361	0	0	672	671.58
AF AA <02050 0500 > Disposal only, urban bldg w/ salvage value allowed, wood fr	64.00	CY	CODFB3	30.88	12	445	266	0	2,560	3,271	51.10
MIL AA <02049 0610 > Building dml, foundations, conc, reinforced	500.00	CF	CODFB5	84.46	41	1,469	410	0	0	1,880	3.76
B AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip + disposal fee	181.00	CY	COEIB34B	16.00	11	414	397	983	0	1,795	9.91
TOTAL Driveway Consolidation/New Bridg	1.00	AA			0	7,500	3,500	19,000	0	30,000	30000.00
06.03.73.02_31_20. Reach 4											
MIL FE <02834 7060 > Fence, misc metal, barbed wire fence post, std 3-wire fence	1725.00	LF	CLABB80A	37.50	138	5,424	821	3,800	0	10,045	5.82
B RSM LS < > Western Red Cedar	173.00	EA	ULABM	6.00	87	3,402	162	5,049	0	8,613	49.78
B RSM LS < > Sitka Spruce	173.00	EA	ULABM	6.00	87	3,402	162	4,390	0	7,954	45.98
B RSM LS < > Hemlock	173.00	EA	ULABM	6.00	87	3,402	162	4,390	0	7,954	45.98
B RSM LS < > Oregon Ash	173.00	EA	ULABM	6.00	87	3,402	162	5,049	0	8,613	49.78
B RSM LS < > Cascara	58.00	EA	ULABM	6.00	29	1,141	54	1,693	0	2,888	49.78
B RSM LS < > Western Crabapple	58.00	EA	ULABM	6.00	29	1,141	54	1,693	0	2,888	49.78
B RSM LS < > Douglas Hawthorne	58.00	EA	ULABM	6.00	29	1,141	54	1,693	0	2,888	49.78
B RSM LS < > Pacific Willow, 1-2 gal pots	345.00	EA	ULABM	120.00	9	339	16	1,204	0	1,559	4.52
B RSM LS < > Red Osier Dogwood, 1-2 gal pots	575.00	EA	ULABM	120.00	14	565	27	2,006	0	2,599	4.52
B RSM LS < > Pacific Ninebark, 1-2 gal pots	288.00	EA	ULABM	120.00	7	283	13	1,005	0	1,302	4.52
B RSM LS < > Twinberry, 1-2 gal pots	288.00	EA	ULABM	120.00	7	283	13	1,188	0	1,484	5.15
B RSM LS < > Black Twinberry, 1-2 gal pots	575.00	EA	ULABM	120.00	14	565	27	2,371	0	2,964	5.15
B RSM LS < > Red Elderberry, 1-2 gal pots	173.00	EA	ULABM	120.00	4	170	8	713	0	892	5.15
B RSM LS < > Rushes	1725.00	EA	ULABM	450.00	12	452	22	1,313	0	1,787	1.04
B RSM LS < > Sedges	1725.00	EA	ULABM	450.00	12	452	22	1,313	0	1,787	1.04
B RSM LS < > Pacific Willow Stakes	2300.00	EA	ULABM	600.00	12	452	21	1,751	0	2,225	0.97

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
L MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	1150.00	CY	CODEB12C	80.00	29	1,114	1,299	0	0	2,414	2.10
L MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	1150.00	CY	COEIB34B	40.00	29	1,053	1,010	0	0	2,063	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1150.00	CY	CODTB10L	46.88	37	1,397	630	0	0	2,027	1.76
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1150.00	CY	CODEB12C	130.00	18	686	799	0	0	1,485	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	1150.00	CY	COEIB34B	16.00	72	2,633	2,524	0	0	5,157	4.48
USR AA < > Disposal Fee	1150.00	CY		0.00	0	0	0	0	3,450	3,450	3.00
B MIL AA <02215 1220 > River Gravel, front-end loader, 40 - 60 HP, no compaction	489.00	CY	CODFB10N	30.00	24	928	442	10,621	0	11,992	24.52
B MIL AA < > LWD	86.00	EA	CODEB12C	6.00	29	1,111	1,295	23,349	0	25,755	299.48
B MIL AA < > Boulders, >16" dia.	58.00	EA	CODEB12C	8.00	15	562	655	630	0	1,847	31.85
06.03.73.02_31_25. Reach 5											
B RSM LS < > Western Red Cedar	155.00	EA	ULABM	6.00	78	3,048	145	4,524	0	7,717	49.78
06.03.73.02_31_30. Reach 6											
B RSM LS < > Western Red Cedar	92.00	EA	ULABM	6.00	46	1,809	86	2,685	0	4,580	49.78
06.03.73.02_31_35. Bell Ravine Landslide Plantings											
B RSM AA < > Native Willow Stakes (year 1)	345.00	EA	ULABM	50.00	21	697	33	0	0	730	2.12
B RSM AA < > Native Willow Stakes (year 2)	345.00	EA	ULABM	50.00	21	697	33	0	0	730	2.12
B RSM AA < > Native Willow Stakes (year 3)	345.00	EA	ULABM	50.00	21	697	33	0	0	730	2.12
TOTAL Burns Creek Restoration					1,489	82,476	39,295	121,692	11,510	254,973	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_32. Middle Green River LWD											
06.03.73.02_32_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00
06.03.73.02_32_ 4. Site Work											
B MIL AA <02232 0145 > Key Member,2.8'-3.6'dia,35-47LF conifer/black cottonwood w/rootw	173.00	EA	CODEV	0.50	1,038	38,354	57,784	375,756	0	471,895	2727.71
B MIL AA <02232 0145 > Racked Member, size and wood type varies	920.00	EA	CODEV	14.00	197	7,284	10,975	229,798	0	248,057	269.63
TOTAL Middle Green River LWD					1,235	48,639	71,759	607,726	2,000	730,123	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_33. Middle Green Gravel Replacement											
06.03.73.02_33_ 2. Mob, Demob & Prep Work											
USR AA < > Mob/Demob, site c1-c4, crane	1.00	JOB		0.00	0	5,000	15,000	2,715	1,000	23,715	23715.00
USR AA < > Mob/Demob, site s1, skyline	1.00	JOB		0.00	0	7,500	15,000	2,715	1,000	26,215	26215.00
USR AA < > Mob/Demob, site s2, skyline	1.00	JOB		0.00	0	7,500	15,000	2,715	1,000	26,215	26215.00
06.03.73.02_33_ 4. Crane Sites C1-C4											
B AF AA < > Streambed gravel delivered, 6 mi (Quote: Cadman $3.98/ton)	209300	TON	COEIB34B	36.00	5,819	212,984	204,193	909,199	0	1,326,376	6.34
L MIL AA < > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	209300	TON	CODTB10L	475.00	670	25,095	11,323	0	0	36,418	0.17
L MIL AA < > Excavate & load, wheeled loader, 3 CY, medium matl	209300	TON	CODFB10T	450.50	691	26,456	20,135	0	0	46,590	0.22
L MIL AA <02225 0300 > Place by Dragline, 3 CY bucket, gravel bank meas	209300	TON	UOEHB12V	190.00	2,198	85,394	144,647	0	0	230,042	1.10
L MIL AA < > Excavate & load, wheeled loader, 3 CY, medium matl	209300	TON	CODFB10T	95.00	3,307	125,454	95,441	0	0	220,895	1.06
06.03.73.02_33_ 6. Skyline Site S1											
B MIL AA <02234 0340 > Streambed gravel delivered to stockpile, 1 mi cyc/hr)	52325	TON	COEIB34B	70.00	748	27,382	26,251	227,300	0	280,933	5.37
L MIL AA < > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	52325	TON	CODTB10L	475.00	167	6,274	2,831	0	0	9,105	0.17
L MIL AA < > Excavate & load, wheeled loader, 3 CY, medium matl	52325	TON	CODFB10T	450.50	173	6,614	5,034	0	0	11,648	0.22
B MIL AA <02225 0300 > Place by Skyline, 5 CY, gravel bank meas	52325	TON		0.00	0	26,163	10,465	8,524	0	45,151	0.86
L MIL AA < > Excavate & load, wheeled loader, 3 CY, medium matl	52325	TON	CODFB10T	150.00	523	19,863	15,111	0	0	34,974	0.67
06.03.73.02_33_ 8. Skyline Site S2											
B AF AA < > Streambed gravel delivered to stockpile, 6 mi	52325	TON	COEIB34B	36.00	1,455	53,246	51,048	227,300	0	331,594	6.34
L MIL AA < > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	52325	TON	CODTB10L	475.00	167	6,274	2,831	0	0	9,105	0.17
L MIL AA < > Excavate & load, wheeled loader, 3 CY, medium matl	52325	TON	CODFB10T	450.50	173	6,614	5,034	0	0	11,648	0.22
B MIL AA <02225 0300 > Place by Skyline, 5 CY, gravel bank meas	52325	TON		0.00	0	26,163	10,465	8,524	0	45,151	0.86
L MIL AA < > Excavate & load, wheeled loader, 3 CY, medium matl	52325	TON	CODFB10T	150.00	523	19,863	15,111	0	0	34,974	0.67

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_33_10. Crane Sites C3 & C4											
B AF AA < > Streambed gravel delivered to stockpile, 6 mi	151800	TON	COEIB34B	36.00	4,220	154,472	148,096	659,419	0	961,987	6.34
L MIL AA < > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	151800	TON	CODTB10L	475.00	486	18,201	8,212	0	0	26,413	0.17
L MIL AA < > Excavate & load, wheeled loader, 3 CY, medium matl	151800	TON	CODFB10T	450.50	501	19,188	14,603	0	0	33,791	0.22
L MIL AA <02225 0300 > Place by Dragline, 3 CY bucket, gravel bank meas	151800	TON	UOEHB12V	190.00	1,594	61,934	104,909	0	0	166,843	1.10
L MIL AA < > Excavate & load, wheeled loader, 3 CY, medium matl	151800	TON	CODFB10T	95.00	2,398	90,989	69,221	0	0	160,210	1.06
TOTAL Middle Green Gravel Replacement					25,812	1,038,619	1,009,962	2,048,410	3,000	4,099,992	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_34. Flaming Geyser Landslide											
06.03.73.02_34_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00
06.03.73.02_34_ 4. Channel											
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	105105	CY	CODEB12C	100.00	2,102	81,477	94,983	0	0	176,461	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 40 mi round trip @ base wide rate	100605	CY	COEIB34B	6.00	16,771	614,234	588,901	0	0	1,203,135	11.96
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	105105	CY	CODEB12C	130.00	1,619	62,674	73,069	0	0	135,743	1.29
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	105105	CY	CODTB10L	46.88	3,363	127,682	57,598	0	0	185,279	1.76
MIL AA <02232 0245 > Excavate & load, wheeled loader, 3 CY, medium matl	105105	CY	CODFB10T	137.50	1,146	43,524	33,108	0	0	76,632	0.73
B AF AA < > Clay liner material, delivered	110.00	CY	COEIB34B	15.00	7	269	258	1,792	0	2,318	21.07
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	105105	CY	COEIB34B	40.00	2,628	96,255	92,282	0	0	188,537	1.79
MIL AA <02220 9010 > Compaction, water, truck, 3000 gal, 6 mile haul	450.00	CY	COKBB45	180.50	5	192	118	98	0	407	0.90
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	4610.00	CY	COFCB10Y	375.00	18	700	277	0	0	977	0.21
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	4500.00	CY	COEIB34B	40.00	113	4,121	3,951	0	0	8,072	1.79
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	4610.00	CY	CODTB10L	46.88	148	5,600	2,526	0	0	8,127	1.76
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	18475	CY	CODFB10N	30.00	924	35,067	16,711	200,639	0	252,417	13.66
B RSM AA <02270 0100 > Large Rocks, machine placed	20.00	CY	CODET	20.00	2	74	93	391	0	558	27.92
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	210.00	CY	CODFB10N	30.00	11	399	190	4,561	0	5,150	24.52
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	1486.00	SY	CLABB80A	300.00	15	495	75	1,372	0	1,942	1.31
MIL AA <02266 0120 > Erosion control, revegetation mat, webbed	1486.00	SY	ALABCLAB2	125.00	24	792	0	4,599	0	5,392	3.63
M MIL AA <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	430.00	CY	CODFB10S	25.00	26	979	406	7,448	0	8,834	20.54

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_34_ 6. Landscaping											
MIL LS <02241 0805 > Loam or topsoil, furnish & place, imported, 6" deep	295.00	CY	CODFB10S	17.00	26	1,155	479	6,221	0	7,855	26.63
B MIL LS < > Hydroseeding	0.14	ACR	COFWI	0.05	5	210	126	171	0	507	3754.62
06.03.73.02_34_10. Construction Haul Road											
USR AA < > Construction Access Road	14400	SF		0.00	0	720	2,880	5,473	0	9,073	0.63
USR AA < > Construction Access Road Removal	14400	SF		0.00	0	720	2,880	0	0	3,600	0.25
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	400.00	CY	COEIB34B	12.00	33	1,221	1,171	0	0	2,392	5.98
USR AA < > Disposal Fee	400.00	CY		0.00	0	0	0	0	1,200	1,200	3.00
TOTAL Flaming Geyser Landslide					28,984	1,081,560	975,081	234,938	3,200	2,294,779	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_35. Flaming Geyser Side Channel											
06.03.73.02_35_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,000	3,000	1,086	500	6,586	6586.00
06.03.73.02_35_ 4. Channel											
L RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	535.00	CY	CODET	35.00	31	1,135	1,425	9,215	0	11,775	22.01
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	14355	CY	CODEB12C	100.00	287	11,128	12,973	0	0	24,101	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	9855.00	CY	COEIB34B	16.00	616	22,563	21,633	0	0	44,196	4.48
B AF AA < > Clay liner material, delivered	600.00	CY	COEIB34B	15.00	40	1,465	1,405	9,774	0	12,644	21.07
USR AA < > Disposal Fee	9855.00	CY		0.00	0	0	0	0	29,565	29,565	3.00
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	600.00	CY	CODTB10L	46.88	19	729	329	0	0	1,058	1.76
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	1600.00	CY	CODFB10N	30.00	80	3,037	1,447	34,752	0	39,236	24.52
B RSM AA <02270 0100 > Large Rocks, machine placed	250.00	CY	CODET	20.00	25	928	1,166	4,887	0	6,981	27.92
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	210.00	CY	CODFB10N	30.00	11	399	190	4,561	0	5,150	24.52
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	1486.00	SY	CLABB80A	300.00	15	495	75	1,372	0	1,942	1.31
MIL AA <02266 0120 > Erosion control, revegetation mat, webbed	1486.00	SY	ALABCLAB2	125.00	24	792	0	4,599	0	5,392	3.63
M MIL AA <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	430.00	CY	CODFB10S	25.00	26	979	406	7,448	0	8,834	20.54
B MIL LS < > LWD	10.00	EA	CODEB12C	6.00	3	151	176	5,076	0	5,403	540.27
06.03.73.02_35_ 6. Landscaping											
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
MIL LS <02241 0805 > Loam or topsoil, furnish & place, imported, 6" deep	940.00	CY	CODFB10S	17.00	83	3,679	1,525	19,824	0	25,029	26.63
M MIL LS <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	10551	SY	CLABB80A	300.00	106	4,109	621	11,380	0	16,111	1.53
MIL LS <02266 0120 > Erosion control, revegetation mat, webbed	10551	SY	ALABCLAB2	125.00	169	6,573	0	38,157	0	44,730	4.24
B RSM LS < > Willow Stakes	3165.00	EA	ULABM	600.00	16	622	30	2,410	0	3,062	0.97
B MIL LS < > Hydroseeding	0.60	ACR	COFWI	0.10	11	467	279	761	0	1,507	2511.77
B RSM LS < > Yellowtwig Dogwood Stakes	968.00	EA	ULABM	600.00	5	190	9	737	0	936	0.97
B RSM LS < > Redtwig Dogwood Stakes	968.00	EA	ULABM	600.00	5	190	9	737	0	936	0.97
B RSM LS < > Native Willow Stakes	1290.00	EA	ULABM	60.00	65	2,537	121	0	0	2,657	2.06
B RSM LS < > Salmonberry	1278.00	EA	ULABM	120.00	32	1,257	60	4,865	0	6,181	4.84
B RSM LS < > Snowberry	1278.00	EA	ULABM	120.00	32	1,257	60	4,460	0	5,776	4.52
B RSM LS < > Flowering Currant	1278.00	EA	ULABM	120.00	32	1,257	60	4,460	0	5,776	4.52
B RSM LS < > Red Alder	1278.00	EA	CLABB80	120.00	43	1,754	214	4,865	0	6,834	5.35
B RSM LS < > Oregon Grape	564.00	EA	ULABM	120.00	14	555	26	2,505	0	3,086	5.47

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
B RSM LS < > Salal	564.00	EA	ULABM	120.00	14	555	26	2,326	0	2,907	5.15
B RSM LS < > Black Cottonwood, 10 gal.	134.00	EA	ULABM	6.00	67	2,635	125	3,061	0	5,821	43.44
B RSM LS < > Pacific Crabapple, 8-10 ft.	89.00	EA	ULABM	6.00	45	1,750	83	2,485	0	4,318	48.52
B RSM LS < > Douglas Fir, 8-10 ft.	222.00	EA	ULABM	6.00	111	4,366	208	5,634	0	10,207	45.98
B RSM LS < > Western Red Cedar, 8-10 ft.	16.00	EA	ULABM	6.00	8	315	15	467	0	797	49.78
B RSM LS < > Blue Spruce, 6-8- ft.	178.00	EA	ULABM	6.00	89	3,500	166	3,840	0	7,506	42.17
B RSM LS < > Hemlock, 8-10 ft.	99.00	EA	ULABM	6.00	50	1,947	93	2,512	0	4,552	45.98
B MIL LS < > LWD	10.00	EA	CODEB12C	6.00	3	151	176	3,172	0	3,499	349.93
B MIL LS < > LWD	10.00	EA	CODEB12C	6.00	3	151	176	3,172	0	3,499	349.93
06.03.73.02_35_ 8. Maintenance Road											
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1636.00	CY	CODTB10L	46.88	52	1,987	897	0	0	2,884	1.76
M MIL AA < > Basecourse for road, 12" thick areas	3400.00	SY	COFGB36B	562.50	48	1,806	1,482	13,847	0	17,134	5.04
M RSM AA < > Gravel, 5/8" deep, crushed stone areas	3400.00	SY	COFGB36B	575.00	47	1,766	1,450	1,846	0	5,062	1.49
USR AA < > Geotextile, woven	3400.00	SY	CLABB80	540.00	25	888	108	2,585	0	3,581	1.05
TOTAL Flaming Geyser Side Channel					2,349	99,075	52,827	223,512	30,649	406,063	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_36. Newaukum Creek											
06.03.73.02_36_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	1,500	1,086	1,000	5,086	5086.00
06.03.73.02_36_ 4. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	4.60	ACR	COMCB88	0.53	61	2,381	2,246	0	0	4,627	1005.96
MIL FE <02834 7060 > Fence, misc metal, barbed wire fence post, std 3-wire fence	34500	LF	CLABB80A	37.50	2,760	108,478	16,414	76,002	0	200,893	5.82
06.03.73.02_36_ 6. Landscaping											
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
B RSM LS < > Hookers Willow Stakes	37950	EA	ULABM	600.00	190	7,463	355	28,893	0	36,711	0.97
B RSM LS < > Pacific Willow Stakes	37950	EA	ULABM	600.00	190	7,463	355	28,893	0	36,711	0.97
B RSM LS <02957 0600 > Red Osier Dogwood	37950	EA	ULABM	120.00	949	37,314	1,774	132,428	0	171,516	4.52
B RSM LS < > Salmonberry	56925	EA	ULABM	120.00	1,423	55,971	2,661	198,642	0	257,274	4.52
B RSM LS < > Snowberry	75900	EA	ULABM	120.00	1,898	74,628	3,547	264,857	0	343,032	4.52
B RSM LS < > Vine Maple	18975	EA	ULABM	120.00	474	18,657	887	66,214	0	85,758	4.52
B RSM LS < > Black Twinberry	22770	EA	ULABM	120.00	569	22,388	1,064	93,904	0	117,356	5.15
B RSM LS < > Pacific Ninebark	15180	EA	ULABM	120.00	380	14,926	709	52,971	0	68,606	4.52
B RSM LS < > Ladyfern	75900	EA	ULABM	120.00	1,898	74,628	3,547	337,090	0	415,266	5.47
B RSM LS < > Sword fern	75900	EA	ULABM	120.00	1,898	74,628	3,547	337,090	0	415,266	5.47
B RSM LS < > Black Cottonwood	3795.00	EA	ULABM	120.00	95	3,731	177	14,447	0	18,355	4.84
B RSM LS < > Pacific Crabapple	1898.00	EA	ULABM	120.00	47	1,866	89	7,225	0	9,180	4.84
B RSM LS < > Sitka Spruce	18975	EA	ULABM	120.00	474	18,657	887	66,214	0	85,758	4.52
B RSM LS < > Western Red Cedar	18975	EA	ULABM	120.00	474	18,657	887	72,234	0	91,777	4.84
B RSM LS < > Oregon Ash	3795.00	EA	ULABM	120.00	95	3,731	177	13,243	0	17,152	4.52
B RSM LS < > Grand Fir	3795.00	EA	ULABM	120.00	95	3,731	177	14,447	0	18,355	4.84
06.03.73.02_36_ 8. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,500	4,000	543	500	7,543	7543.00
06.03.73.02_36_10. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	6.90	ACR	COMCB88	0.53	91	3,572	3,370	0	0	6,941	1005.96
MIL FE <02834 7060 > Fence, misc metal, barbed wire fence post, std 3-wire fence	34500	LF	CLABB80A	37.50	2,760	108,478	16,414	76,002	0	200,893	5.82
06.03.73.02_36_12. Construction Haul Road											
USR AA < > Construction Access Road	1533.00	SF		0.00	0	77	307	583	0	966	0.63
USR AA < > Construction Access Road Removal	1533.00	SF		0.00	0	77	307	0	0	383	0.25
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	383.00	CY	COEIB34B	12.00	32	1,169	1,121	0	0	2,290	5.98
USR AA < > Disposal Fee	383.00	CY		0.00	0	0	0	0	1,149	1,149	3.00
TOTAL Newaukum Creek					16,851	673,682	67,102	1,883,643	3,233	2,627,660	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_37. Big Spring Creek											
06.03.73.02_37_ 2. Mob/Demob u/s											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00
06.03.73.02_37_ 4. Site Work											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	6.90	ACR	CODFB7	0.08	552	19,128	7,513	0	0	26,641	3861.01
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	664.00	CY	CODTB10L	46.88	21	807	364	0	0	1,170	1.76
M MIL AA < > Basecourse for road, 6" thick areas	1993.00	SY	COFGB36B	562.50	28	1,058	869	10,822	0	12,749	6.40
USR AA < > Geotextile, woven	1993.00	SY	CLABB80	540.00	15	520	64	1,515	0	2,099	1.05
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	332.00	CY	CODEB12C	130.00	5	198	231	0	0	429	1.29
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	332.00	CY	CODTB10L	46.88	11	403	182	0	0	585	1.76
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	332.00	CY	COEIB34B	16.00	21	760	729	0	0	1,489	4.48
USR AA < > Disposal Fee	332.00	CY		0.00	0	0	0	0	996	996	3.00
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	250.00	LF	ALABCLAB2	43.75	11	381	0	62	0	443	1.77
06.03.73.02_37_ 6. Channel											
B AF AA < > Streambed gravel delivered to stockpile, 6 mi	518.00	CY	COEIB34B	20.00	26	949	910	3,375	0	5,234	10.10
B MIL AA < > LWD	98.00	EA	CODEB12C	6.00	33	1,266	1,476	21,286	0	24,028	245.18
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	2185.00	CY	CODEB12C	130.00	34	1,303	1,519	0	0	2,822	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	2185.00	CY	COEIB34B	16.00	137	5,003	4,796	0	0	9,799	4.48
USR AA < > Disposal Fee	2185.00	CY		0.00	0	0	0	0	6,555	6,555	3.00
06.03.73.02_37_ 8. Riparian Corridor Plantings											
B RSM LS < > Western Red Cedar	690.00	EA	ULABM	120.00	17	678	32	2,627	0	3,337	4.84
B RSM LS < > Sitka Spruce	690.00	EA	ULABM	120.00	17	678	32	2,408	0	3,118	4.52
B RSM LS < > Grand Fir	138.00	EA	ULABM	120.00	3	136	6	525	0	667	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	138.00	CY	CODFB10S	25.00	8	367	152	2,793	0	3,313	24.00
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	2,337	584	317	292	3,530	3530.44
06.03.73.02_37_10. Mob/Demob d/s pasture											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_37_12. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	3.50	ACR	COMCB88	0.53	46	1,812	1,709	0	0	3,521	1005.96
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	498.00	CY	CODTB10L	46.88	16	605	273	0	0	878	1.76
M MIL AA < > Basecourse for road, 6" thick areas	1495.00	SY	COFGB36B	562.50	21	794	652	8,118	0	9,564	6.40
USR AA < > Geotextile, woven	1495.00	SY	CLABB80	540.00	11	390	48	1,136	0	1,575	1.05
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	249.00	CY	CODEB12C	130.00	4	148	173	0	0	322	1.29
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	249.00	CY	CODTB10L	46.88	8	302	136	0	0	439	1.76
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	249.00	CY	COEIB34B	16.00	16	570	547	0	0	1,117	4.48
USR AA < > Disposal Fee	249.00	CY		0.00	0	0	0	0	747	747	3.00
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	250.00	LF	ALABCLAB2	43.75	11	381	0	62	0	443	1.77
06.03.73.02_37_14. Channel											
B AF AA < > Streambed gravel delivered to stockpile, 6 mi	403.00	CY	COEIB34B	20.00	20	738	708	2,626	0	4,072	10.10
B MIL AA < > LWD	75.00	EA	CODEB12C	6.00	25	969	1,130	16,290	0	18,389	245.18
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1610.00	CY	CODEB12C	130.00	25	960	1,119	0	0	2,079	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	1610.00	CY	COEIB34B	16.00	101	3,686	3,534	0	0	7,220	4.48
USR AA < > Disposal Fee	1610.00	CY		0.00	0	0	0	0	4,830	4,830	3.00
MIL FE <02834 7060 > Fence, misc metal, barbed wire fence post, std 3-wire fence	2070.00	LF	CLABB80A	37.50	166	6,509	985	4,560	0	12,054	5.82
06.03.73.02_37_16. Riparian Corridor Plantings											
B RSM LS < > Red Osier Dogwood, 1-2 gal pots	2070.00	EA	ULABM	120.00	52	2,035	97	7,223	0	9,355	4.52
B RSM LS < > Salmonberry	3105.00	EA	ULABM	120.00	78	3,053	145	10,835	0	14,033	4.52
B RSM LS < > Snowberry	4140.00	EA	ULABM	120.00	104	4,071	193	14,447	0	18,711	4.52
B RSM LS < > Vine Maple	1035.00	EA	ULABM	120.00	26	1,018	48	3,612	0	4,678	4.52
B RSM LS < > Black Twinberry	11592	EA	ULABM	120.00	290	11,398	542	47,806	0	59,745	5.15
B RSM LS < > Pacific Ninebark	828.00	EA	ULABM	120.00	21	814	39	2,889	0	3,742	4.52
B RSM LS < > Hookers Willow Stakes	2070.00	EA	ULABM	120.00	52	2,035	97	2,627	0	4,759	2.30
B RSM LS < > Pacific Willow Stakes	2070.00	EA	ULABM	600.00	10	407	19	1,576	0	2,002	0.97
B RSM LS < > Ladyfern	4140.00	EA	ULABM	120.00	104	4,071	193	18,387	0	22,651	5.47
B RSM LS < > Sword fern	4140.00	EA	ULABM	120.00	104	4,071	193	18,387	0	22,651	5.47
B RSM LS < > Black Cottonwood	207.00	EA	ULABM	120.00	5	204	10	788	0	1,001	4.84
B RSM LS < > Pacific Crabapple	104.00	EA	ULABM	120.00	3	102	5	396	0	503	4.84
B RSM LS < > Western Red Cedar	1035.00	EA	ULABM	120.00	26	1,018	48	3,940	0	5,006	4.84
B RSM LS < > Sitka Spruce	1035.00	EA	ULABM	120.00	26	1,018	48	3,612	0	4,678	4.52
B RSM LS < > Oregon Ash	207.00	EA	ULABM	120.00	5	204	10	722	0	936	4.52
B RSM LS < > Grand Fir	207.00	EA	ULABM	120.00	5	204	10	788	0	1,001	4.84

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	104.00	CY	CODFB10S	25.00	6	277	115	2,105	0	2,496	24.00
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
06.03.73.02_37_18. Mob/Demob d/s confluence											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00
06.03.73.02_37_20. Site Work											
AF AA <02109 8010 > Clear & grub, clear only, light growth, 120 HP dozer, wet conditions	3.50	ACR	COMCB88	0.53	46	1,812	1,709	0	0	3,521	1005.96
B MIL AA < > LWD	173.00	EA	CODEB12C	6.00	58	2,235	2,606	37,576	0	42,417	245.18
MIL FE <02834 7060 > Fence, misc metal, barbed wire fence post, std 3-wire fence	3680.00	LF	CLABB80A	37.50	294	11,571	1,751	8,107	0	21,429	5.82
06.03.73.02_37_24. Riparian Corridor Plantings											
B RSM LS < > Red Osier Dogwood, 1-2 gal pots	3680.00	EA	ULABM	120.00	92	3,618	172	12,842	0	16,632	4.52
B RSM LS < > Salmonberry	5520.00	EA	ULABM	120.00	138	5,427	258	19,262	0	24,948	4.52
B RSM LS < > Snowberry	7360.00	EA	ULABM	120.00	184	7,237	344	25,683	0	33,264	4.52
B RSM LS < > Vine Maple	1840.00	EA	ULABM	120.00	46	1,809	86	6,421	0	8,316	4.52
B RSM LS < > Black Twinberry	2208.00	EA	ULABM	120.00	55	2,171	103	9,106	0	11,380	5.15
B RSM LS < > Pacific Ninebark	1472.00	EA	ULABM	120.00	37	1,447	69	5,137	0	6,653	4.52
B RSM LS < > Hookers Willow Stakes	3680.00	EA	ULABM	600.00	18	724	34	2,802	0	3,560	0.97
B RSM LS < > Pacific Willow Stakes	3680.00	EA	ULABM	600.00	18	724	34	2,802	0	3,560	0.97
B RSM LS < > Ladyfern	7360.00	EA	ULABM	120.00	184	7,237	344	32,688	0	40,268	5.47
B RSM LS < > Sword fern	7360.00	EA	ULABM	120.00	184	7,237	344	32,688	0	40,268	5.47
B RSM LS < > Black Cottonwood	368.00	EA	ULABM	120.00	9	362	17	1,401	0	1,780	4.84
B RSM LS < > Pacific Crabapple	184.00	EA	ULABM	120.00	5	181	9	700	0	890	4.84
B RSM LS < > Western Red Cedar	1840.00	EA	ULABM	120.00	46	1,809	86	7,004	0	8,900	4.84
B RSM LS < > Sitka Spruce	1840.00	EA	ULABM	120.00	46	1,809	86	6,421	0	8,316	4.52
B RSM LS < > Oregon Ash	368.00	EA	ULABM	120.00	9	362	17	1,284	0	1,663	4.52
B RSM LS < > Grand Fir	368.00	EA	ULABM	120.00	9	362	17	1,401	0	1,780	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	368.00	CY	CODFB10S	25.00	22	979	406	7,448	0	8,834	24.00
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
TOTAL Big Spring Creek					3,824	167,469	47,946	442,331	16,089	673,834	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_38. Brunner Slough											
06.03.73.02_38_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,000	3,000	1,086	500	6,586	6586.00
06.03.73.02_38_ 4. Channel											
MIL AA <02232 0145 > Excavate & load, hydr excavator, 2 CY, wet matl	47080	CY	CODEB12C	100.00	942	36,496	42,546	0	0	79,043	1.68
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	47080	CY	COEIB34B	16.00	2,943	107,790	103,345	0	0	211,135	4.48
USR AA < > Disposal Fee	47080	CY		0.00	0	0	0	0	141,240	141,240	3.00
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	47080	CY	CODTB10L	46.88	1,507	57,193	25,800	0	0	82,993	1.76
B MIL LS < > LWD	75.00	EA	CODEB12C	6.00	25	1,132	1,320	23,792	0	26,245	349.93
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	2405.00	CY	CODFB10N	30.00	120	4,565	2,175	52,237	0	58,977	24.52
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	210.00	CY	CODFB10N	30.00	11	399	190	4,561	0	5,150	24.52
M MIL AA <02266 0010 > Erosion control, stapled, jute mesh, 100 SY per roll, 4' wide	1486.00	SY	CLABB80A	300.00	15	495	75	1,372	0	1,942	1.31
MIL AA <02266 0120 > Erosion control, revegetation mat, webbed	1486.00	SY	ALABCLAB2	125.00	24	792	0	4,599	0	5,392	3.63
M MIL AA <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	430.00	CY	CODFB10S	25.00	26	979	406	7,448	0	8,834	20.54
06.03.73.02_38_ 6. Landscaping											
B RSM LS < > Riparian Plantings	13840	EA	ULABM	120.00	346	13,608	647	48,295	0	62,550	4.52
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	5,842	584	634	584	7,645	7645.10
06.03.73.02_38_10. Construction Haul Road											
USR AA < > Construction Access Road	14400	SF		0.00	0	720	2,880	5,473	0	9,073	0.63
USR AA < > Construction Access Road Removal	14400	SF		0.00	0	720	2,880	0	0	3,600	0.25
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	400.00	CY	COEIB34B	12.00	33	1,221	1,171	0	0	2,392	5.98
USR AA < > Disposal Fee	400.00	CY		0.00	0	0	0	0	1,200	1,200	3.00
TOTAL Brunner Slough					5,990	233,953	187,019	149,499	143,524	713,995	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_39. Upper Green Side Channel Enhance											
06.03.73.02_39_ 2. Mob, Demob & Prep Work - site 1											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,000	3,000	1,086	500	6,586	6586.00
06.03.73.02_39_ 4. Site Work											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	2.30	ACR	CODFB7	0.08	184	6,376	2,504	0	0	8,880	3861.01
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	250.00	LF	ALABCLAB2	43.75	11	381	0	62	0	443	1.77
B MIL AA < > Hydroseeding	2.30	ACR	COFWI	0.15	27	1,021	610	2,498	0	4,129	1795.12
USR AA < > Construction Access Road	22080	SF		0.00	0	4,416	12,144	8,393	0	24,953	1.13
USR AA < > Construction Access Road Removal	22080	SF		0.00	0	2,208	8,832	0	0	11,040	0.50
USR AA < > Disposal Fee	819.00	CY		0.00	0	0	0	0	2,457	2,457	3.00
B MIL FE < > Fence repair, std 3 barbed wire	92.00	LF	CLABB80A	60.00	5	181	27	65	0	273	2.97
06.03.73.02_39_ 6. Channel											
B AF AA < > Streambed gravel delivered to stockpile, 6 mi	2070.00	CY	COEIB34B	20.00	104	3,791	3,635	22,480	0	29,907	14.45
B MIL AA < > LWD	97.00	EA	CODEB12C	6.00	32	1,253	1,461	21,068	0	23,783	245.18
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	3450.00	CY	CODEB12C	130.00	53	2,057	2,398	0	0	4,456	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	3450.00	CY	COEIB34B	16.00	216	7,899	7,573	0	0	15,472	4.48
USR AA < > Disposal Fee	3450.00	CY		0.00	0	0	0	0	10,350	10,350	3.00
B MIL AA < > Boulders	104.00	EA	CODEB12C	8.00	26	1,008	1,175	1,129	0	3,312	31.85
06.03.73.02_39_ 8. Maintenance Road											
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1636.00	CY	CODTB10L	46.88	52	1,987	897	0	0	2,884	1.76
M MIL AA < > Basecourse for road, 12" thick areas	4907.00	SY	COFGB36B	562.50	70	2,606	2,139	19,984	0	24,729	5.04
M RSM AA < > Gravel, 5/8" deep, crushed stone areas	4907.00	SY	COFGB36B	575.00	68	2,549	2,092	2,665	0	7,306	1.49
USR AA < > Geotextile, woven	4907.00	SY	CLABB80	540.00	36	1,281	157	3,730	0	5,168	1.05
06.03.73.02_39_10. Revegetation											
USR LS < > Revegetate Stream Buffer	1.20	AC		0.00	0	5,609	1,402	24,363	0	31,374	26145.01
USR LS < > Revegetate Stockpile/Staging Area	2.30	AC		0.00	0	2,687	1,344	10,215	0	14,246	6193.90
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	7,011	584	634	584	8,814	8813.54
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	9.00	CY	CODFB10S	25.00	1	24	10	182	0	216	24.00

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_39_12. Mob, Demob & Prep Work - site 2											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,000	3,000	1,086	500	6,586	6586.00
06.03.73.02_39_14. Site Work											
MIL AA <02109 0152 > Clear & grub, cut & chip medium trees, 10" dia	1.20	ACR	CODFB7	0.08	96	3,327	1,307	0	0	4,633	3861.01
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	250.00	LF	ALABCLAB2	43.75	11	381	0	62	0	443	1.77
B MIL AA < > Hydroseeding	1.20	ACR	COFWI	0.15	14	533	318	1,303	0	2,154	1795.12
USR AA < > Construction Access Road	22080	SF		0.00	0	4,416	12,144	8,393	0	24,953	1.13
USR AA < > Construction Access Road Removal	22080	SF		0.00	0	2,208	8,832	0	0	11,040	0.50
USR AA < > Disposal Fee	819.00	CY		0.00	0	0	0	0	2,457	2,457	3.00
B MIL FE < > Fence repair, std 3 barbed wire	92.00	LF	CLABB80A	60.00	5	181	27	65	0	273	2.97
06.03.73.02_39_16. Channel											
B AF AA < > Streambed gravel delivered to stockpile, 6 mi	1127.00	CY	COEIB34B	20.00	56	2,064	1,979	12,239	0	16,283	14.45
B MIL AA < > LWD	58.00	EA	CODEB12C	6.00	19	749	874	12,598	0	14,221	245.18
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1875.00	CY	CODEB12C	130.00	29	1,118	1,304	0	0	2,422	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	1875.00	CY	COEIB34B	16.00	117	4,293	4,116	0	0	8,409	4.48
USR AA < > Disposal Fee	1875.00	CY		0.00	0	0	0	0	5,625	5,625	3.00
B MIL AA < > Boulders	62.00	EA	CODEB12C	8.00	16	601	700	673	0	1,975	31.85
06.03.73.02_39_18. Maintenance Road											
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1636.00	CY	CODTB10L	46.88	52	1,987	897	0	0	2,884	1.76
M MIL AA < > Basecourse for road, 12" thick areas	4907.00	SY	COFGB36B	562.50	70	2,606	2,139	19,984	0	24,729	5.04
M RSM AA < > Gravel, 5/8" deep, crushed stone areas	4907.00	SY	COFGB36B	575.00	68	2,549	2,092	2,665	0	7,306	1.49
USR AA < > Geotextile, woven	4907.00	SY	CLABB80	540.00	36	1,281	157	3,730	0	5,168	1.05
06.03.73.02_39_20. Revegetation											
USR LS < > Revegetate Stream Buffer	0.30	AC		0.00	0	1,402	351	6,091	0	7,844	26145.01
USR LS < > Revegetate Stockpile/Staging Area	2.30	AC		0.00	0	2,687	1,344	10,215	0	14,246	6193.90
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	3,505	584	634	0	4,724	4724.00
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	5.80	CY	CODFB10S	25.00	0	15	6	117	0	139	24.00
TOTAL Upper Green Side Channel Enhance					1,475	94,250	94,154	198,410	22,473	409,288	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_41. Gale Creek											
06.03.73.02_41_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	3,000	3,000	2,172	2,000	10,172	10172.00
06.03.73.02_41_ 4. Temp. Construction Fly By											
USR AA < > Haul off w/ lowboy	1.00	EA	UTDHA	0.50	12	409	89	0	0	497	497.45
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	2230.00	CY	COEIB34B	14.00	159	5,835	5,594	12,109	0	23,538	10.56
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	2230.00	CY	CODTB10L	46.88	71	2,709	1,222	0	0	3,931	1.76
MIL AA <02220 9010 > Compaction, water, truck, 3000 gal, 6 mile haul	223.00	CY	COKBB45	180.50	2	95	58	48	0	202	0.90
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	2230.00	CY	COFCB10Y	375.00	9	339	134	0	0	473	0.21
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	397.00	CY	CODEB12C	130.00	6	237	276	0	0	513	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	1137.00	CY	COEIB34B	14.00	81	2,975	2,852	0	0	5,827	5.13
USR AA < > Place logs and steel plates for temp creek crossing	1.00	EA	CODEB12C	0.25	8	310	361	272	0	943	943.08
USR AA < > Deliver and offload logs and steel plates for temp creek xing	1.00	EA	ULABN	0.25	16	561	189	272	0	1,022	1021.62
06.03.73.02_41_10. Upstream Channel											
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	100.00	CY	CODEB12C	130.00	2	60	70	0	0	129	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	100.00	CY	COEIB34B	27.00	4	136	130	0	0	266	2.66
06.03.73.02_41_12. Bridge											
MIL BR <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1304.00	CY	CODEB12C	130.00	20	926	1,080	0	0	2,006	1.54
L AF BR < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	1066.00	CY	COEIB34B	14.00	76	3,322	3,185	0	0	6,507	6.10
MIL BR <02366 0232 > Pile, 7 ga steel, 14" constant dia, fluted, end bearing, to 50'	120.00	VLF	CPIDB50	85.00	20	893	272	2,195	0	3,360	28.00
RSM BR <02216 2000 > Backfill, strl, sand & gravel, no cmpct, 75 HP dozer, 50' haul	318.00	CY	CODTB10L	137.50	3	157	71	0	0	228	0.72
MIL BR <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	318.00	CY	COEIB34B	40.00	8	347	333	0	0	679	2.14
MIL BR <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	318.00	CY	CODEB12C	130.00	5	226	263	0	0	489	1.54
MIL BR <02224 7100 > Excavating, bulk, dozer, small area, open site, shaping w/small dozer	318.00	CY	CODTB10L	62.50	8	345	156	0	0	501	1.57
L MIL BR <02364 4000 > Piles, conc, square, precast, prestressed, 40' long, 18" thick	200.00	VLF	CPIDB19A	45.00	36	1,661	980	4,377	1,191	8,209	41.04
B RSM BR < > Pile Cap	8.00	EA		0.00	32	953	715	5,173	0	6,841	855.07

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
L AF BR <01580 0010 > Sign, hi-intensity reflectorized, buy	30.00	SF	N/A	0.00	0	286	71	392	357	1,107	36.89
B RSM BR < > Precast Concrete Panels	700.00	SF	ALABCLAB1	15.00	47	1,852	0	13,580	0	15,432	22.05
B MIL BR <03436 0150 > Hollow Girder Deck 3000 psi	1400.00	SF	SIWSC11	75.00	168	7,975	2,698	54,320	4,168	69,161	49.40
B AF BR < > Steel bearing pads	4.00	SF	SIWSSSWK2	0.50	16	763	0	388	0	1,151	287.69
L MIL BR <05548 0600 > Misc. Fabrication and Fasteners castings	1250.00	LB	SIWSE4	250.00	20	959	60	1,293	0	2,313	1.85
RSM BR <02270 0100 > Rip-rap, random, machine placed for slope protection	80.00	CY	CODET	7.75	21	913	1,146	1,641	0	3,700	46.25
06.03.73.02_41_18. Downstream Channel											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	130.00	CY	COEIB34B	40.00	3	119	114	0	0	233	1.79
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	130.00	CY	CODEB12C	130.00	2	78	90	0	0	168	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	31.00	CY	COEIB34B	27.00	1	42	40	0	0	82	2.66
MIL AA <02239 0012 > Spread & compact, 8" lift, roadway embankment, 300 HP tractor	161.00	CY	CODTB10C	312.50	1	29	49	0	0	78	0.49
06.03.73.02_41_20. Restoration											
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	100.00	CY	CODFB10N	30.00	5	190	90	2,172	0	2,452	24.52
L MIL AA <02239 0200 > Shape shopes machine	600.00	SY	CODEB12C	275.00	4	169	197	0	0	366	0.61
L MIL AA <02239 0200 > Shape creek bed machine	222.00	SY	CODTA	222.00	2	58	26	0	0	84	0.38
TOTAL Gale Creek					867	38,927	25,612	100,403	7,716	172,658	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_43. Sweeney Creek											
06.03.73.02_43_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,000	3,000	1,086	1,000	7,086	7086.00
06.03.73.02_43_ 4. Traffic Diversion											
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	463.00	CY	COEIB34B	14.00	33	1,211	1,162	2,514	0	4,887	10.56
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	463.00	CY	CODTB10L	46.88	15	562	254	0	0	816	1.76
MIL AA <02220 9010 > Compaction, water, truck, 3000 gal, 6 mile haul	46.00	CY	COKBB45	180.50	1	20	12	10	0	42	0.90
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	463.00	CY	COFCB10Y	375.00	2	70	28	0	0	98	0.21
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	463.00	CY	CODEB12C	130.00	7	276	322	0	0	598	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	463.00	CY	COEIB34B	14.00	33	1,211	1,162	0	0	2,373	5.13
USR AA < > Place logs and steel plates for temp creek crossing	1.00	EA	CODEB12C	0.25	8	310	361	272	0	943	943.08
USR AA < > Deliver and offload logs and steel plates for temp creek xing	1.00	EA	ULABN	0.25	16	561	189	272	0	1,022	1021.62
USR AA < > Haul off w/ lowboy	1.00	EA	UTDHA	0.50	12	409	89	0	0	497	497.45
06.03.73.02_43_ 6. Bridge											
MIL BR <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	815.00	CY	CODEB12C	130.00	13	579	675	0	0	1,254	1.54
L AF BR < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	182.00	CY	COEIB34B	14.00	13	567	544	0	0	1,111	6.10
MIL BR <02366 0232 > Pile, 7 ga steel, 14" constant dia, fluted, end bearing, to 50'	90.00	VLF	CPIDB50	85.00	15	670	204	1,646	1,072	3,592	39.91
RSM BR <02216 2000 > Backfill, strl, sand & gravel, no cmpct, 75 HP dozer, 50' haul	609.00	CY	CODTB10L	137.50	7	300	135	0	0	436	0.72
MIL BR <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	487.00	CY	COEIB34B	40.00	12	531	509	0	0	1,040	2.14
MIL BR <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	609.00	CY	CODEB12C	130.00	9	432	504	0	0	937	1.54
MIL BR <02224 7100 > Excavating, bulk, dozer, small area, open site, shaping w/small dozer	609.00	CY	CODTB10L	62.50	15	661	298	0	0	959	1.57
L AF BR < > Hauling, hwy haulers, 12 CY, 6 mi round trip	122.00	CY	COEIB34B	27.00	5	197	189	0	0	386	3.16
MIL BR <02220 7000 > Compaction, struct/trench, walk behind, 6" lifts, 18" wide, vib plate	609.00	CY	COFCB18	25.00	73	2,929	41	0	0	2,970	4.88
MIL BR <02220 7000 > Compaction, struct/trench, walk behind, 6" lifts, 18" wide, vib plate	61.00	CY	COFCB18	25.00	7	293	4	0	0	298	4.88
L MIL BR <02364 4000 > Piles, conc, square, precast, prestressed, 40' long, 18" thick	200.00	VLF	CPIDB19A	45.00	36	1,661	980	4,377	0	7,018	35.09

06.03. Wildlife Facilities & Sanctuary				QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
B RSM BR	<	>	Pile Cap	6.00	EA		0.00	24	715	536	3,880	0	5,130	855.07
L AF BR	<01580 0010	>	Sign, hi-intensity reflectorized, buy	30.00	SF	N/A	0.00	0	286	71	392	357	1,107	36.89
B RSM BR	<	>	Precast Concrete Panels	240.00	SF	ALABCLAB1	15.00	16	635	0	4,656	0	5,291	22.05
B MIL BR	<03436 0150	>	Hollow Girder Deck 3000 psi	600.00	SF	SIWSC11	75.00	72	3,418	1,156	23,280	1,786	29,640	49.40
B AF BR	<	>	Steel bearing pads	3.00	SF	SIWSSSWK2	0.50	12	572	0	291	0	863	287.69
L MIL BR	<05548 0600	>	Misc. Fabrication and Fasteners castings	1000.00	LB	SIWSE4	250.00	16	768	48	1,035	0	1,850	1.85
RSM BR	<02270 0100	>	Rip-rap, random, machine placed for slope protection	40.00	CY	CODET	7.75	10	456	573	820	0	1,850	46.25
06.03.73.02_43_16. Upstream Channel														
MIL AA	<02232 0140	>	Excavate & load, hydr excavator, 2 CY, medium matl	10.00	CY	CODEB12C	130.00	0	6	7	0	0	13	1.29
L AF AA	<	>	Hauling, hwy haulers, 12 CY, 6 mi round trip	10.00	CY	COEIB34B	27.00	0	14	13	0	0	27	2.66
MIL AA	<02239 0200	>	Spread & compact, slope up to 1 in 4, shape enbankment, w/ machine	10.00	SY	COFGB32A	150.00	0	8	5	0	0	13	1.25
06.03.73.02_43_18. Downstream Channel														
MIL AA	<02234 0340	>	Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	14.00	CY	COEIB34B	40.00	0	13	12	0	0	25	1.79
MIL AA	<02232 0140	>	Excavate & load, hydr excavator, 2 CY, medium matl	14.00	CY	CODEB12C	130.00	0	8	10	0	0	18	1.29
MIL AA	<02239 0200	>	Spread & compact, slope up to 1 in 4, shape enbankment, w/ machine	25.00	SY	COFGB32A	150.00	1	19	12	0	0	31	1.25
06.03.73.02_43_20. Restoration														
B MIL AA	<	>	LWD	4.00	EA	CODEB12C	6.00	1	52	60	1,086	0	1,198	299.48
L MIL AA	<02239 0200	>	Shape shopes machine	222.00	SY	CODEB12C	275.00	2	63	73	0	0	136	0.61
06.03.73.02_43_22. BPA/non-BPA Water Fluctuation Zo														
B RSM LS	<	>	Hookers Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS	<	>	Scoulers Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS	<	>	Rushes & Sedges	60.00	EA	ULABM	450.00	0	16	1	46	0	62	1.04
B RSM LS	<	>	Sitka Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS	<	>	Sitka Alder	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B CIV LS	<	>	Plant Establishment	1.00	YR	N/A	0.00	0	584	292	127	0	1,003	1003.22
TOTAL Sweeney Creek								487	23,131	13,533	45,971	4,215	86,851	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_44. Olsen Creek											
06.03.73.02_44_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,000	3,000	1,086	1,000	7,086	7086.00
06.03.73.02_44_ 4. Temp. Construction Fly By											
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	2156.00	CY	COEIB34B	14.00	154	5,641	5,409	11,707	0	22,757	10.56
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	2156.00	CY	CODTB10L	46.88	69	2,619	1,181	0	0	3,801	1.76
MIL AA <02220 9010 > Compaction, water, truck, 3000 gal, 6 mile haul	215.60	CY	COKBB45	180.50	2	92	56	47	0	195	0.90
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	2156.00	CY	COFCB10Y	375.00	9	327	130	0	0	457	0.21
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1725.00	CY	CODEB12C	130.00	27	1,029	1,199	0	0	2,228	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	1725.00	CY	COEIB34B	14.00	123	4,514	4,328	0	0	8,841	5.13
USR AA < > Place logs and steel plates for temp creek crossing	1.00	EA	CODEB12C	0.25	8	310	361	272	0	943	943.08
USR AA < > Deliver and offload logs and steel plates for temp creek xing	1.00	EA	ULABN	0.25	16	561	189	272	0	1,022	1021.62
USR AA < > Haul off w/ lowboy	1.00	EA	UTDHA	0.50	12	409	89	0	0	497	497.45
06.03.73.02_44_12. Culvert Structure											
B MIL AA < > Arch culvert, stl plate, 16' x 8' culv	60.00	LF	CLABB13	5.00	84	2,942	941	13,032	0	16,915	281.92
MIL CP <03158 0050 > Forms in place, 2 use, footings, continuous wall, plywood	360.00	SF	ACARC1	55.00	26	1,134	0	582	0	1,716	4.77
MIL CP <03114 5200 > Accessories, chamfer strip, wood, 3/4" wide	1.20	CLF	ACARCARP1	0.66	2	81	0	42	0	123	102.74
L MIL AA <03372 1950 > Placing conc, pumped, footings, shallow, continuous	24.00	CY	CLABC20	7.00	27	957	281	0	0	1,238	51.60
RSM AA <03326 0200 > Concrete ready mix, regular weight, 3500 psi	24.00	CY	N/A	0.00	0	0	0	1,538	0	1,538	64.07
MIL AA <05548 1100 > Construction castings, heavy sections, >150 lb, misc CI castings	150.00	LB	SIWSE4	525.00	1	46	3	112	0	161	1.08
CIV AA <05075 5050 > Bolt connect sections up	42.00	LF	SIWWE16	7.50	11	445	56	16	0	518	12.34
RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	23.00	CY	CODET	7.75	6	220	277	396	0	893	38.84
CIV AA <02046 3000 > Culvert removal	60.00	LF	CODLB6	11.25	16	565	65	0	0	630	10.51
AF AA < > Haul off culvert	10.00	CY	CODEB30	48.00	1	24	27	0	50	101	10.08
MIL AA <02228 0372 > Excavate trench, mdm soil, 6'-10' D, 2 CY excavator	950.00	CY	CODEB12C	192.00	10	384	447	0	0	831	0.87

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	757.00	CY	COEIB34B	40.00	19	693	665	0	0	1,358	1.79
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	193.00	CY	COEIB34B	14.00	14	505	484	0	0	989	5.13
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	757.00	CY	CODEB12C	130.00	12	451	526	0	0	978	1.29
RSM AA <02216 2000 > Backfill, strl, sand & gravel, no cmpct, 75 HP dozer, 50' haul	757.00	CY	CODTB10L	137.50	8	313	141	0	0	455	0.60
MIL AA <02220 7000 > Compaction, struct/trench, walk behind, 6" lifts, 18" wide, vib plate	757.00	CY	COFCB18	25.00	91	3,058	42	0	0	3,100	4.10
MIL AA <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	24.00	CY	CODFB10U	20.00	2	68	83	405	0	556	23.18
MIL AA <02220 9000 > Compaction, water, truck, 3000 gal, 3 mile haul	75.70	CY	COKBB45	236.00	1	25	15	16	0	56	0.74
06.03.73.02_44_18. Downstream Channel											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	24.00	CY	COEIB34B	40.00	1	22	21	0	0	43	1.79
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	24.00	CY	CODEB12C	130.00	0	14	17	0	0	31	1.29
MIL AA <02239 0200 > Spread & compact, slope up to 1 in 4, shape enbankment, w/ machine	30.00	SY	COFGB32A	150.00	1	23	15	0	0	38	1.25
06.03.73.02_44_20. Restoration											
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	46.00	CY	CODFB10N	30.00	2	87	42	999	0	1,128	24.52
B MIL AA < > LWD	4.00	EA	CODEB12C	6.00	1	52	60	1,086	0	1,198	299.48
L MIL AA <02239 0200 > Shape shopes machine	471.00	SY	CODEB12C	275.00	3	133	155	0	0	288	0.61
L MIL AA <02239 0200 > Shape creek bed machine	111.00	SY	CODTA	222.00	1	29	13	0	0	42	0.38
06.03.73.02_44_22. BPA/non-BPA Water Fluctuation Zo											
B RSM LS < > Hookers Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Scoulers Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Rushes & Sedges	60.00	EA	ULABM	450.00	0	16	1	46	0	62	1.04
B RSM LS < > Sitka Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Sitka Alder	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	584	292	127	0	1,003	1003.22
TOTAL Olsen Creek					761	30,421	20,615	31,963	1,050	84,049	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_45. May Creek											
06.03.73.02_45_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	1,500	2,000	543	500	4,543	4543.00
06.03.73.02_45_ 4. Temp. Construction Fly By											
USR AA < > Haul off w/ lowboy	1.00	EA	UTDHA	0.50	12	409	89	0	0	497	497.45
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	1421.00	CY	COEIB34B	14.00	101	3,718	3,565	7,716	0	14,999	10.56
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1421.00	CY	CODTB10L	46.88	45	1,726	779	0	0	2,505	1.76
MIL AA <02220 9010 > Compaction, water, truck, 3000 gal, 6 mile haul	142.00	CY	COKBB45	180.50	2	61	37	31	0	128	0.90
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	1421.00	CY	COFCB10Y	375.00	6	216	85	0	0	301	0.21
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1137.00	CY	CODEB12C	130.00	18	678	790	0	0	1,468	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	1137.00	CY	COEIB34B	14.00	81	2,975	2,852	0	0	5,827	5.13
USR AA < > Place logs and steel plates for temp creek crossing	1.00	EA	CODEB12C	0.25	8	310	361	272	0	943	943.08
USR AA < > Deliver and offload logs and steel plates for temp creek xing	1.00	EA	ULABN	0.25	16	561	189	272	0	1,022	1021.62
06.03.73.02_45_ 5. Erosion/Sediment Control											
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	250.00	LF	ALABCLAB2	43.75	11	381	0	62	0	443	1.77
CIV AA <02046 3000 > Culvert removal	85.00	LF	CODLB6	11.25	23	800	93	0	0	893	10.51
AF AA < > Haul off culvert	10.00	CY	CODEB30	48.00	1	24	27	0	50	101	10.08
06.03.73.02_45_ 6. Culvert Structure											
B MIL AA < > Arch culvert, stl plate, 16' x 8' culv	60.00	LF	CLABB13	5.00	84	2,942	941	13,032	0	16,915	281.92
MIL CP <03158 0050 > Forms in place, 2 use, footings, continuous wall, plywood	360.00	SF	ACARC1	55.00	26	1,134	0	582	0	1,716	4.77
MIL CP <03114 5200 > Accessories, chamfer strip, wood, 3/4" wide	1.20	CLF	ACARCARP1	0.66	2	81	0	42	0	123	102.74
L MIL AA <03372 1950 > Placing conc, pumped, footings, shallow, continuous	24.00	CY	CLABC20	7.00	27	957	281	0	0	1,238	51.60
RSM AA <03326 0200 > Concrete ready mix, regular weight, 3500 psi	24.00	CY	N/A	0.00	0	0	0	1,538	0	1,538	64.07
MIL AA <05548 1100 > Construction castings, heavy sections, >150 lb, misc CI castings	150.00	LB	SIWSE4	525.00	1	46	3	112	0	161	1.08
CIV AA <05075 5050 > Bolt connect sections up	42.00	LF	SIWWE16	7.50	11	445	56	16	0	518	12.34
RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	23.00	CY	CODET	7.75	6	220	277	396	0	893	38.84

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
CIV AA <02046 3000 > Culvert removal	60.00	LF	CODLB6	11.25	16	565	65	0	0	630	10.51
AF AA < > Haul off culvert	10.00	CY	CODEB30	48.00	1	24	27	0	50	101	10.08
MIL AA <02228 0372 > Excavate trench, mdm soil, 6'-10' D, 2 CY excavator	992.00	CY	CODEB12C	192.00	10	401	467	0	0	868	0.87
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	672.00	CY	COEIB34B	40.00	17	615	590	0	0	1,205	1.79
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	132.00	CY	COEIB34B	14.00	9	345	331	0	0	677	5.13
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	168.00	CY	COEIB34B	27.00	6	228	219	0	0	446	2.66
MIL AA <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	24.00	CY	CODFB10U	20.00	2	68	83	405	0	556	23.18
06.03.73.02_45_ 8. BPA/non-BPA Water Fluctuation Zo											
B RSM LS < > Hookers Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Scoulers Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Rushes & Sedges	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Sitka Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Sitka Alder	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	3,505	584	634	0	4,724	4724.00
06.03.73.02_45_10. Riparian Plantings BPA											
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	1.00	ACR	COFWI	0.15	12	519	310	1,269	0	2,097	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	816.00	EA	ULABM	120.00	20	802	38	2,847	0	3,688	4.52
B RSM LS < > Salmonberry	816.00	EA	ULABM	120.00	20	802	38	2,847	0	3,688	4.52
B RSM LS < > Snowberry	816.00	EA	ULABM	120.00	20	802	38	2,847	0	3,688	4.52
B RSM LS < > Flowering Currant	816.00	EA	ULABM	120.00	20	802	38	2,847	0	3,688	4.52
B RSM LS < > Salal	816.00	EA	ULABM	120.00	20	802	38	3,365	0	4,206	5.15
B RSM LS < > Oregon Grape	816.00	EA	ULABM	120.00	20	802	38	3,624	0	4,465	5.47
B RSM LS < > Red Alder	816.00	EA	ULABM	120.00	20	802	38	3,106	0	3,947	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	130.00	CY	CODFB10S	25.00	8	346	143	2,631	0	3,121	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	24.00	CY	CODFB10U	20.00	2	80	97	473	0	650	27.08
06.03.73.02_45_11. Upstream Channel											
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	46.00	CY	CODFB10N	30.00	2	87	42	999	0	1,128	24.52
06.03.73.02_45_12. Downstream Channel											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	3.00	CY	COEIB34B	40.00	0	3	3	0	0	5	1.79
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	3.00	CY	CODEB12C	130.00	0	2	2	0	0	4	1.29

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
MIL AA <02239 0200 > Spread & compact, slope up to 1 in 4, shape enbankment, w/ machine	10.00	SY	COFGB32A	150.00	0	8	5	0	0	13	1.25
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	1.00	CY	COEIB34B	27.00	0	1	1	0	0	3	2.66
06.03.73.02_45_14. Restoration											
B MIL AA < > LWD	4.00	EA	CODEB12C	6.00	1	52	60	1,086	0	1,198	299.48
L MIL AA <02239 0200 > Shape shopes machine	456.00	SY	CODEB12A	275.00	3	129	87	0	0	216	0.47
L MIL AA <02239 0200 > Shape creek bed machine	110.00	SY	CODTA	222.00	1	29	13	0	0	41	0.38
06.03.73.02_45_16. BPA/non-BPA Water Fluctuation Zo											
B RSM LS < > Hookers Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Scoulers Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Rushes & Sedges	60.00	EA	ULABM	450.00	0	16	1	46	0	62	1.04
B RSM LS < > Sitka Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Sitka Alder	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	3,505	584	634	0	4,724	4724.00
06.03.73.02_45_18. Riparian Plantings BPA											
B MIL LS < > Perenial Ryegrass, White Clover, Creeping Red Fescue (hydroseed)	1.00	ACR	COFWI	0.15	12	519	310	1,269	0	2,097	2097.49
B RSM LS <02957 0600 > Red Osier Dogwood	816.00	EA	ULABM	120.00	20	802	38	2,847	0	3,688	4.52
B RSM LS < > Salmonberry	816.00	EA	ULABM	120.00	20	802	38	2,847	0	3,688	4.52
B RSM LS < > Snowberry	816.00	EA	ULABM	120.00	20	802	38	2,847	0	3,688	4.52
B RSM LS < > Flowering Currant	816.00	EA	ULABM	120.00	20	802	38	2,847	0	3,688	4.52
B RSM LS < > Salal	816.00	EA	ULABM	120.00	20	802	38	3,365	0	4,206	5.15
B RSM LS < > Oregon Grape	816.00	EA	ULABM	120.00	20	802	38	3,624	0	4,465	5.47
B RSM LS < > Western Red Cedar	816.00	EA	ULABM	120.00	20	802	38	3,106	0	3,947	4.84
B RSM LS < > Red Alder	2260.00	EA	ULABM	120.00	57	2,222	106	8,603	0	10,931	4.84
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	130.00	CY	CODFB10S	25.00	8	346	143	2,631	0	3,121	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	24.00	CY	CODFB10U	20.00	2	80	97	473	0	650	27.08
TOTAL May Creek					938	44,217	17,337	89,150	600	151,303	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_47. Gold Creek											
06.03.73.02_47_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,000	3,000	1,086	1,000	7,086	7086.00
06.03.73.02_47_ 4. Temp. Construction Fly By											
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	1935.00	CY	COEIB34B	14.00	138	5,063	4,854	10,507	0	20,425	10.56
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	1935.00	CY	CODTB10L	46.88	62	2,351	1,060	0	0	3,411	1.76
MIL AA <02220 9010 > Compaction, water, truck, 3000 gal, 6 mile haul	193.50	CY	COKBB45	180.50	2	82	51	42	0	175	0.90
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	1935.00	CY	COFCB10Y	375.00	8	294	116	0	0	410	0.21
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1548.00	CY	CODEB12C	130.00	24	923	1,076	0	0	1,999	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	1548.00	CY	COEIB34B	14.00	111	4,050	3,883	0	0	7,934	5.13
USR AA < > Place logs and steel plates for temp creek crossing	1.00	EA	CODEB12C	0.25	8	310	361	272	0	943	943.08
USR AA < > Deliver and offload logs and steel plates for temp creek xing	1.00	EA	ULABN	0.25	16	561	189	272	0	1,022	1021.62
USR AA < > Haul off w/ lowboy	1.00	EA	UTDHA	0.50	12	409	89	0	0	497	497.45
06.03.73.02_47_11. Culvert Structure											
B MIL AA < > Arch culvert, stl plate, 16' x 8' culv	80.00	LF	CLABB13	5.00	112	3,923	1,255	17,376	0	22,554	281.92
MIL CP <03158 0050 > Forms in place, 2 use, footings, continuous wall, plywood	480.00	SF	ACARC1	55.00	35	1,512	0	776	0	2,288	4.77
MIL CP <03114 5200 > Accessories, chamfer strip, wood, 3/4" wide	1.60	CLF	ACARCARP1	0.66	2	109	0	56	0	164	102.74
L MIL AA <03372 1950 > Placing conc, pumped, footings, shallow, continuous	32.00	CY	CLABC20	7.00	37	1,276	375	0	0	1,651	51.60
RSM AA <03326 0200 > Concrete ready mix, regular weight, 3500 psi	32.00	CY	N/A	0.00	0	0	0	2,050	0	2,050	64.07
MIL AA <05548 1100 > Construction castings, heavy sections, >150 lb, misc CI castings	200.00	LB	SIWSE4	525.00	2	61	4	150	0	215	1.08
CIV AA <05075 5050 > Bolt connect sections up	54.00	LF	SIWWE16	7.50	14	573	72	21	0	666	12.34
RSM AA <02270 0100 > Rip-rap, random, machine placed for slope protection	45.00	CY	CODET	7.75	12	431	541	775	0	1,748	38.84
CIV AA <02046 3000 > Culvert removal	80.00	LF	CODLB6	11.25	21	753	87	0	0	841	10.51
AF AA < > Haul off culvert	10.00	CY	CODEB30	48.00	1	24	27	0	50	101	10.08
MIL AA <02228 0372 > Excavate trench, mdm soil, 6'-10' D, 2 CY excavator	1755.00	CY	CODEB12C	192.00	18	709	826	0	0	1,535	0.87
RSM AA <02216 2000 > Backfill, strl, sand & gravel, no cmpct, 75 HP dozer, 50' haul	1188.00	CY	CODTB10L	137.50	13	492	222	0	0	714	0.60

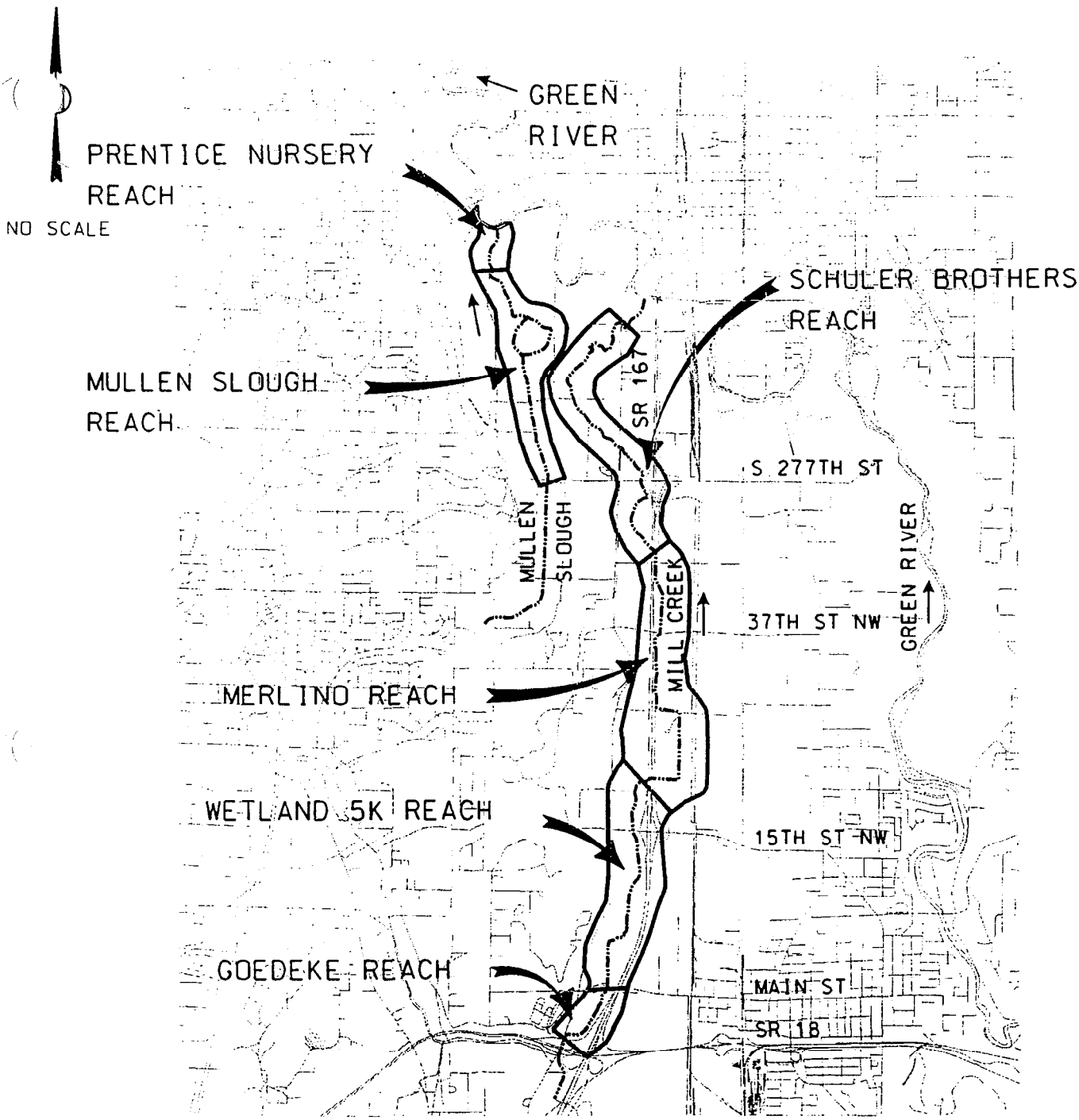
06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	1188.00	CY	COEIB34B	40.00	30	1,088	1,043	0	0	2,131	1.79
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1188.00	CY	CODEB12C	130.00	18	708	826	0	0	1,534	1.29
MIL AA <02224 7100 > Excavating, bulk, dozer, small area, open site, shaping w/small dozer	1188.00	CY	CODTB10L	62.50	29	1,082	488	0	0	1,571	1.32
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	567.00	CY	COEIB34B	14.00	40	1,484	1,422	0	0	2,906	5.13
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	168.00	CY	COEIB34B	27.00	6	228	219	0	0	446	2.66
MIL AA <02220 7000 > Compaction, struct/trench, walk behind, 6" lifts, 18" wide, vib plate	1188.00	CY	COFCB18	25.00	143	4,799	67	0	0	4,865	4.10
MIL AA <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	24.00	CY	CODFB10U	20.00	2	68	83	405	0	556	23.18
06.03.73.02_47_18. Downstream Channel											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	82.00	CY	COEIB34B	40.00	2	75	72	0	0	147	1.79
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	102.00	CY	CODEB12C	130.00	2	61	71	0	0	132	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	20.00	CY	COEIB34B	27.00	1	27	26	0	0	53	2.66
MIL AA <02239 0012 > Spread & compact, 8" lift, roadway embankment, 300 HP tractor	102.00	CY	CODTB10C	312.50	0	19	31	0	0	50	0.49
06.03.73.02_47_20. Restoration											
B MIL AA < > LWD	4.00	EA	CODEB12C	6.00	1	52	60	1,086	0	1,198	299.48
L MIL AA <02239 0200 > Shape shopes machine	493.00	SY	CODEB12C	275.00	4	139	162	0	0	301	0.61
L MIL AA <02239 0200 > Shape creek bed machine	111.00	SY	CODTA	222.00	1	29	13	0	0	42	0.38
06.03.73.02_47_22. BPA/non-BPA Water Fluctuation Zo											
B RSM LS < > Hookers Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Scoulers Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Rushes & Sedges	60.00	EA	ULABM	450.00	0	16	1	46	0	62	1.04
B RSM LS < > Sitka Willow	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B RSM LS < > Sitka Alder	60.00	EA	ULABM	600.00	0	12	1	46	0	58	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	584	292	127	0	1,003	1003.22
TOTAL Gold Creek					927	36,411	22,969	35,228	1,050	95,658	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_48. Sunday Creek Riparion Plantings											
06.03.73.02_48_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	6,000	6,000	3,258	3,000	18,258	18258.00
06.03.73.02_48_ 6. Upland Buffer Zone											
B RSM LS < > Alaskan & Evergreen Huckleberry	31444	EA	ULABM	120.00	786	30,917	1,470	109,725	0	142,112	4.52
B RSM LS < > Salmonberry	31444	EA	ULABM	120.00	786	30,917	1,470	109,725	0	142,112	4.52
B RSM LS < > Sword fern	31444	EA	ULABM	120.00	786	30,917	1,470	109,725	0	142,112	4.52
B RSM LS < > Twin Flower	31444	EA	ULABM	120.00	786	30,917	1,470	129,675	0	162,062	5.15
B RSM LS < > Salal	31444	EA	ULABM	120.00	786	30,917	1,470	129,675	0	162,062	5.15
B RSM LS < > Oregon Grape	31444	EA	ULABM	120.00	786	30,917	1,470	139,650	0	172,037	5.47
B RSM LS < > Sitka Alder	31444	EA	ULABM	120.00	786	30,917	1,470	119,700	0	152,087	4.84
B RSM LS < > Vine Maple	31444	EA	ULABM	120.00	786	30,917	1,470	109,725	0	142,112	4.52
M MIL LS <02241 0400 > Compost, frtn loader, 1.5 CY, spread from pile to (Cedar Grove finish grade	3522.00	CY	CODFB10S	25.00	211	9,373	3,887	71,283	0	84,543	24.00
MIL LS <02250 1400 > Soil stbln, w/scarifying & cmpct, delivered & screened, crushed rock	652.00	CY	CODFB10U	20.00	49	2,169	2,639	12,849	0	17,657	27.08
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	58,422	5,842	6,345	1,168	71,777	71777.27
B MIL LS < > Hydroseeding	120.00	ACR	COFWI	0.15	1,400	62,242	37,186	152,271	0	251,699	2097.49
06.03.73.02_48_4 . Water Fluctuation Zone Plantings											
B RSM LS < > Hookers Willow	10565	EA	ULABM	600.00	53	2,078	99	8,044	0	10,220	0.97
B RSM LS < > Scoulers Willow	10565	EA	ULABM	600.00	53	2,078	99	8,044	0	10,220	0.97
B RSM LS < > Rushes & Sedges	10565	EA	ULABM	450.00	71	2,770	132	8,044	0	10,946	1.04
B RSM LS < > Sitka Willow	10565	EA	ULABM	600.00	53	2,078	99	8,044	0	10,220	0.97
TOTAL Sunday Creek Riparion Plantings					8,178	394,546	67,740	1,235,783	4,168	1,702,236	

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
06.03.73.02_49. Northeast Creek											
06.03.73.02_49_ 2. Mob, Demob & Prep Work											
USR AA < > Mobilization & Demobilization	1.00	JOB		0.00	0	2,500	3,000	1,086	1,000	7,586	7586.00
06.03.73.02_49_ 4. Temp. Construction Fly By											
B AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	550.00	CY	COEIB34B	14.00	39	1,439	1,380	2,987	0	5,805	10.56
MIL AA <02224 7110 > Excavating, bulk, dozer, large area, open site, shaping w/small dozer	550.00	CY	CODTB10L	46.88	18	668	301	0	0	970	1.76
MIL AA <02220 9010 > Compaction, water, truck, 3000 gal, 6 mile haul	10.00	CY	COKBB45	180.50	0	4	3	2	0	9	0.90
RSM AA <02220 5000 > Compaction, riding, vibrating roller, 6" lifts, 2 passes	550.00	CY	COFCB10Y	375.00	2	83	33	0	0	117	0.21
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	440.00	CY	CODEB12C	130.00	7	262	306	0	0	568	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	440.00	CY	COEIB34B	14.00	31	1,151	1,104	0	0	2,255	5.13
USR AA < > Place logs and steel plates for temp creek crossing	1.00	EA	CODEB12C	0.25	8	310	361	272	0	943	943.08
USR AA < > Deliver and offload logs and steel plates for temp creek xing	1.00	EA	ULABN	0.25	16	561	189	272	0	1,022	1021.62
USR AA < > Haul off w/ lowboy	1.00	EA	UTDHA	0.50	12	409	89	0	0	497	497.45
06.03.73.02_49_ 6. Erosion/Sediment Control											
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene	250.00	LF	ALABCLAB2	43.75	11	381	0	62	0	443	1.77
CIV AA <02046 3000 > Culvert removal	48.00	LF	CODLB6	11.25	13	452	52	0	0	504	10.51
AF AA < > Haul off culvert	10.00	CY	CODEB30	48.00	1	24	27	0	50	101	10.08
06.03.73.02_49_ 8. Bridge											
MIL BR <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1996.00	CY	CODEB12C	130.00	31	1,417	1,653	0	0	3,070	1.54
L AF BR < > Hauling, hwy haulers, 12 CY, 24 mi round trip @ base wide rate	686.00	CY	COEIB34B	14.00	49	2,138	2,050	0	0	4,187	6.10
MIL BR <02366 0232 > Pile, 7 ga steel, 14" constant dia, fluted, end bearing, to 50'	90.00	VLF	CPIDB50	85.00	15	670	204	1,646	1,072	3,592	39.91
RSM BR <02216 2000 > Backfill, strl, sand & gravel, no cmpct, 75 HP dozer, 50' haul	1310.00	CY	CODTB10L	137.50	14	646	291	0	0	937	0.72
MIL BR <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	1310.00	CY	COEIB34B	40.00	33	1,429	1,370	0	0	2,798	2.14
MIL BR <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	1310.00	CY	CODEB12C	130.00	20	930	1,085	0	0	2,015	1.54
MIL BR <02224 7100 > Excavating, bulk, dozer, small area, open site, shaping w/small dozer	1310.00	CY	CODTB10L	62.50	31	1,421	641	0	0	2,063	1.57
L MIL BR <02364 4000 > Piles, conc, square, precast, prestressed, 40' long, 18" thick	200.00	VLF	CPIDB19A	45.00	36	1,661	980	4,377	0	7,018	35.09

06.03. Wildlife Facilities & Sanctuary	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
B RSM BR < > Pile Cap	6.00	EA		0.00	24	715	536	3,880	0	5,130	855.07
L AF BR <01580 0010 > Sign, hi-intensity reflectorized, buy	30.00	SF	N/A	0.00	0	286	71	392	357	1,107	36.89
B RSM BR < > Precast Concrete Panels	280.00	SF	ALABCLAB1	15.00	19	741	0	5,432	0	6,173	22.05
B MIL BR <03436 0150 > Hollow Girder Deck 3000 psi	700.00	SF	SIWSC11	75.00	84	3,988	1,349	27,160	2,084	34,580	49.40
B AF BR < > Steel bearing pads	3.00	SF	SIWSSSWK2	0.50	12	572	0	291	0	863	287.69
L MIL BR <05548 0600 > Misc. Fabrication and Fasteners castings	1000.00	LB	SIWSE4	250.00	16	768	48	1,035	0	1,850	1.85
RSM BR <02270 0100 > Rip-rap, random, machine placed for slope protection	178.00	CY	CODET	7.75	46	2,031	2,551	3,651	0	8,232	46.25
06.03.73.02_49_10. BPA/non-BPA Water Fluctuation Zo											
B RSM LS < > Hookers Willow	178.00	EA	ULABM	600.00	1	35	2	136	0	172	0.97
B RSM LS < > Scoulers Willow	178.00	EA	ULABM	600.00	1	35	2	136	0	172	0.97
B RSM LS < > Rushes & Sedges	178.00	EA	ULABM	450.00	1	47	2	136	0	184	1.04
B RSM LS < > Sitka Willow Stakes	178.00	EA	ULABM	600.00	1	35	2	136	0	172	0.97
B RSM LS < > Sitka Alder Stakes	178.00	EA	ULABM	600.00	1	35	2	136	0	172	0.97
B CIV LS < > Plant Establishment	1.00	YR	N/A	0.00	0	584	175	254	0	1,013	1013.27
06.03.73.02_49_12. Upstream Channel											
MIL AA <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	2.00	CY	COEIB34B	40.00	0	2	2	0	0	4	1.79
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	540.00	CY	CODEB12C	130.00	8	322	375	0	0	697	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	1.00	CY	COEIB34B	27.00	0	1	1	0	0	3	2.66
L AF AA <02234 0570 > Hauling, hwy haulers, 12 CY, 24 mile round trip @ base wide rate	540.00	CY	COEIB34B	8.00	68	2,473	2,371	0	0	4,843	8.97
B MIL AA <02215 1220 > 1/4 - 1 inch River Gravel, smooth, front-end loader, 40 - 6 compaction	46.00	CY	CODFB10N	30.00	2	87	42	999	0	1,128	24.52
B MIL AA < > LWD	4.00	EA	CODEB12C	6.00	1	52	60	1,086	0	1,198	299.48
06.03.73.02_49_14. Downstream Channel											
MIL AA <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	4930.00	CY	CODEB12C	130.00	76	2,940	3,427	0	0	6,367	1.29
L AF AA < > Hauling, hwy haulers, 12 CY, 6 mi round trip	4930.00	CY	COEIB34B	27.00	182	6,689	6,413	0	0	13,102	2.66
06.03.73.02_49_16. Restoration											
L MIL AA <02239 0200 > Shape shopes machine	1051.00	SY	CODEB12C	275.00	8	296	345	0	0	642	0.61
TOTAL Northeast Creek					938	41,289	32,894	55,560	4,563	134,307	
TOTAL Fish and Wildlife Facilities					241,198	10266936	5,781,307	20953872	2,303,644	39,305,759	
TOTAL Green Duwmish Ecosystem Resto.	1.00	EA			241,198	10266936	5,781,307	20953872	2,303,644	39,305,759	39305759

PLAN AND SECTION DETAILES



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

GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY

FIRGURE NO. 1
LOCATION MAP - MILL CREEK AND MULLEN SLOUGH SITES

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98NOV	C-X
DSGN.		CHK.	SHEET X	

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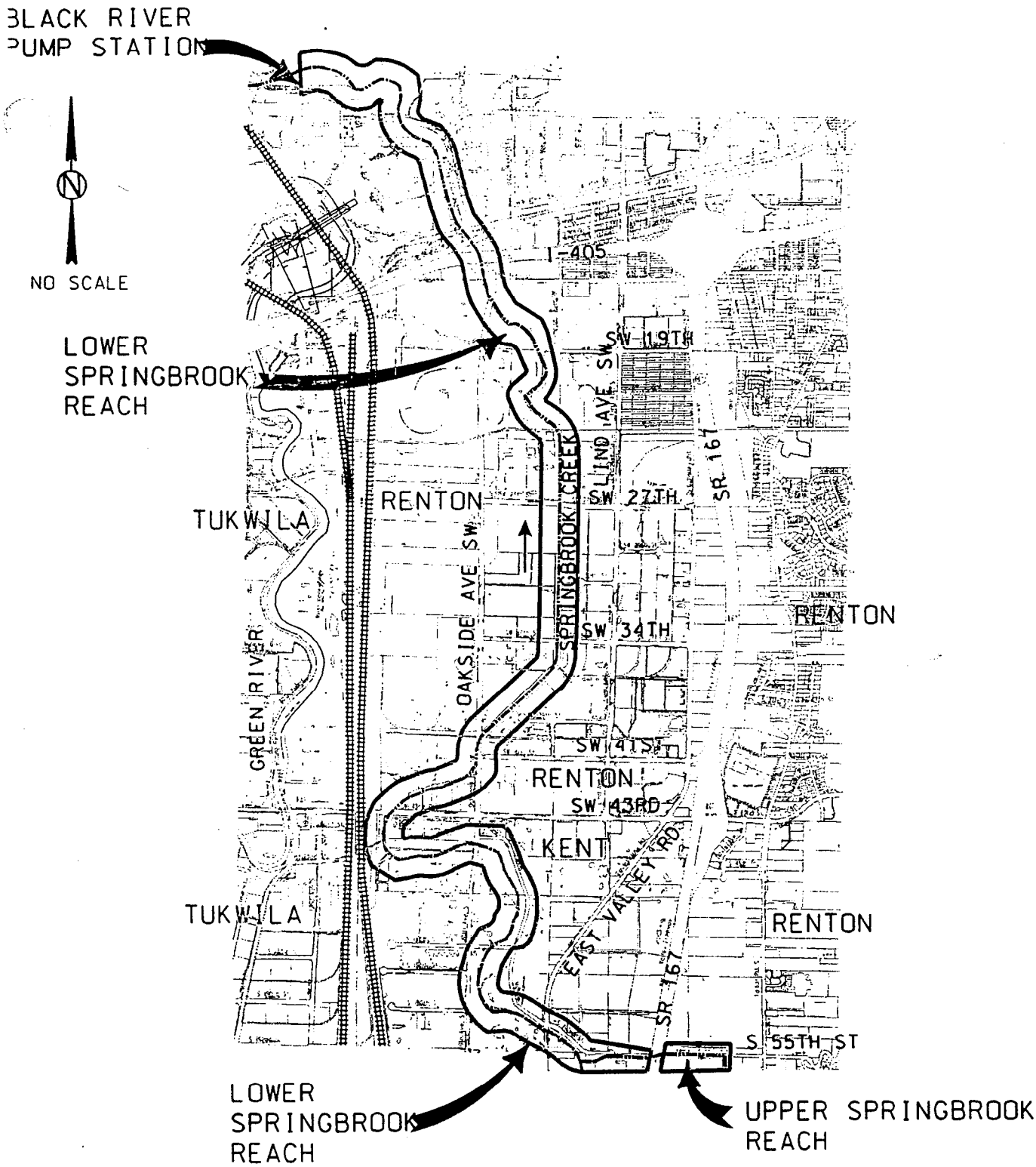

U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN - DUWAMISH G.I. ECOSYSTEM
RESTORATION FEASIBILITY STUDY

FIGURE NO. 2
LOCATION MAP -
SPRINGBROOK CREEK SITES

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98NOV	C-X
DSGN.		CHK.	SHEET X	

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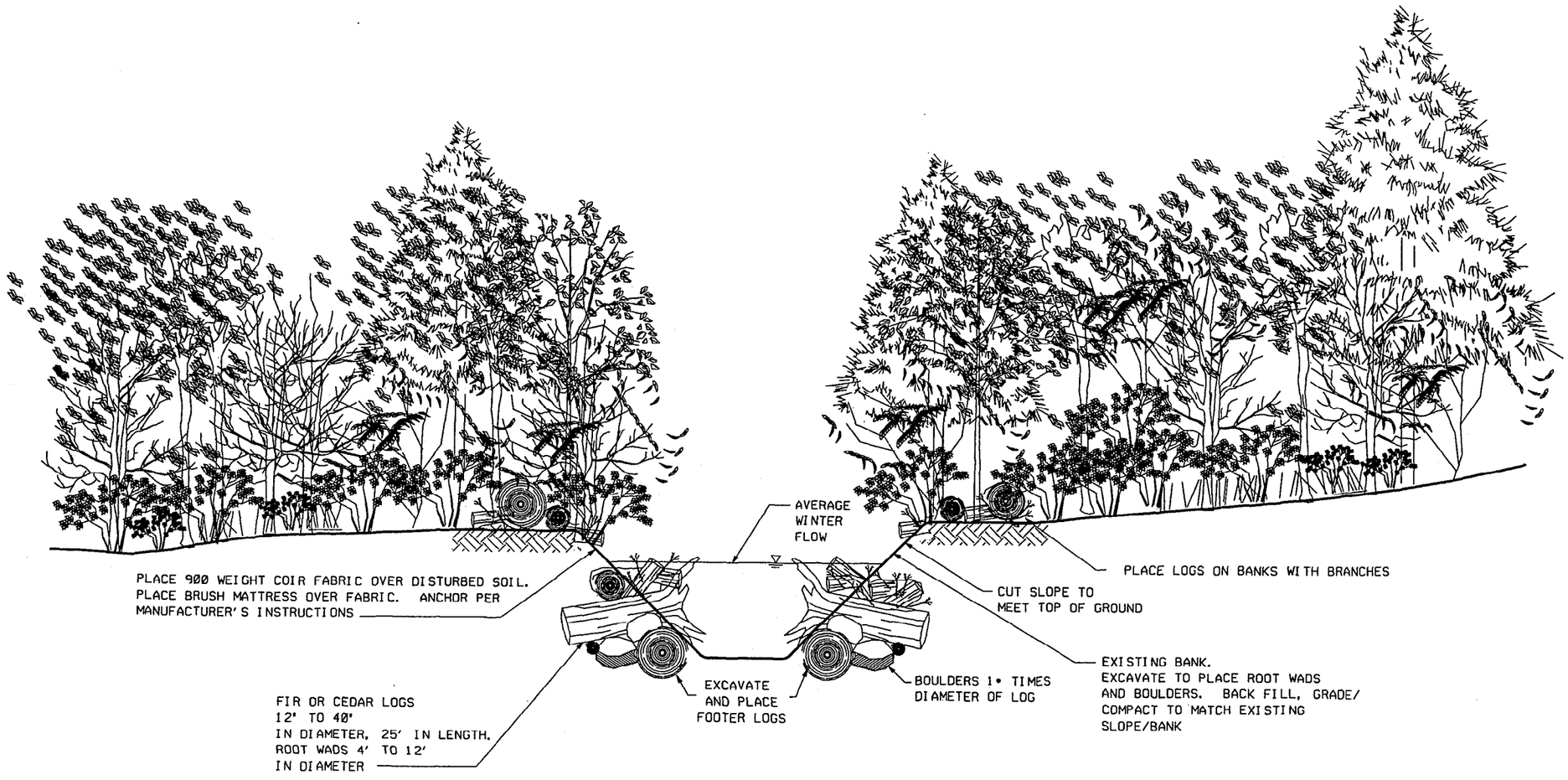


TYPICAL CROSS SECTION

NOT TO SCALE

NOTES:

1. WOOD DEBRIS PLACEMENT SHOULD ALTERNATE BANKS. SPACING TO BE BASED ON SITE CONDITIONS.

2. PLACE SOME LOGS ON BANK WITH BRANCHES.

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

I-STAGE WOODY DEBRIS
GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION

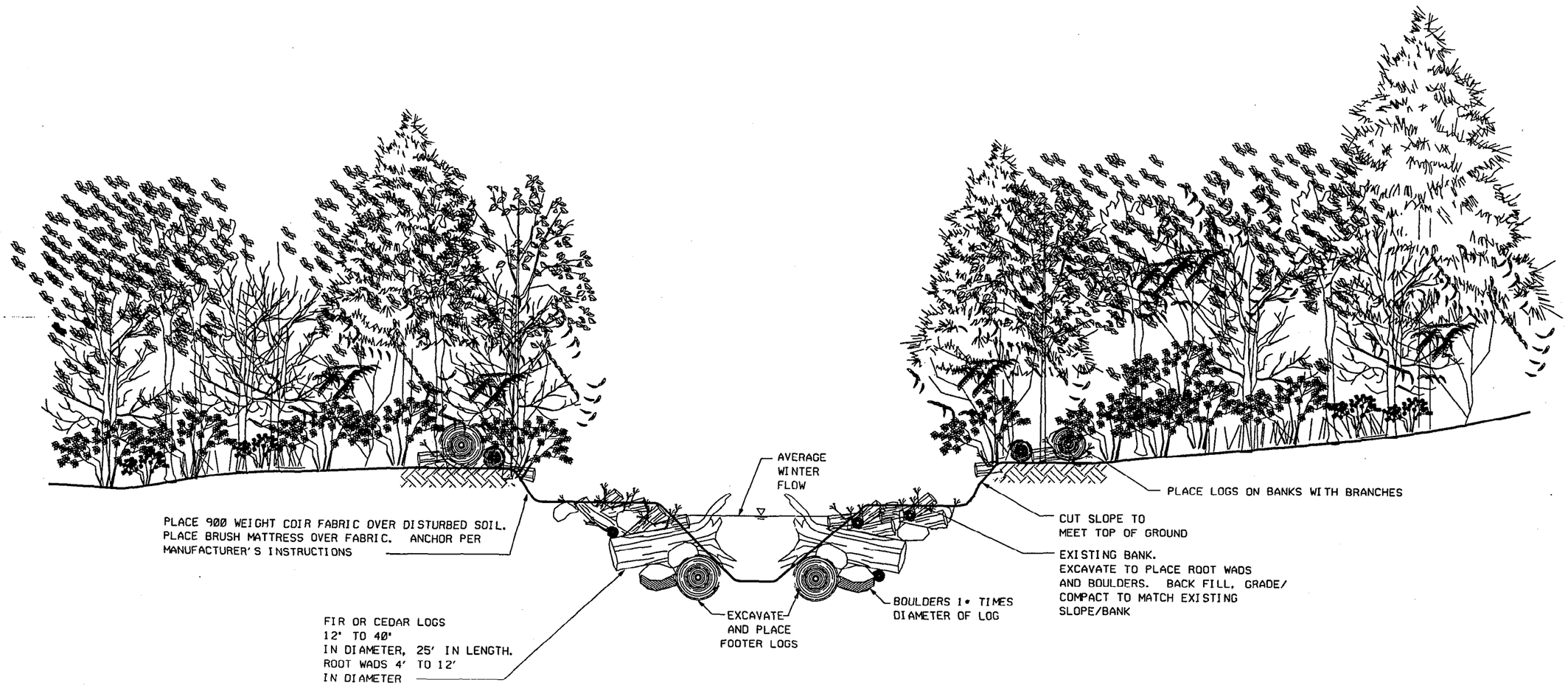
FIGURE 4

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
DSGN.		CHK.	SHEET	

ENVIRO\FEDERAL\CORP-SEA\PLANNING\96\GREENRESTOR\DGN\FIGOD1DEB.dgn

125B



TYPICAL CROSS SECTION

NOT TO SCALE

NOTES:

1. WOOD DEBRIS PLACEMENT SHOULD ALTERNATE BANKS. SPACING TO BE BASED ON SITE CONDITIONS.

2. PLACE SOME LOGS ON BANK WITH BRANCHES.

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

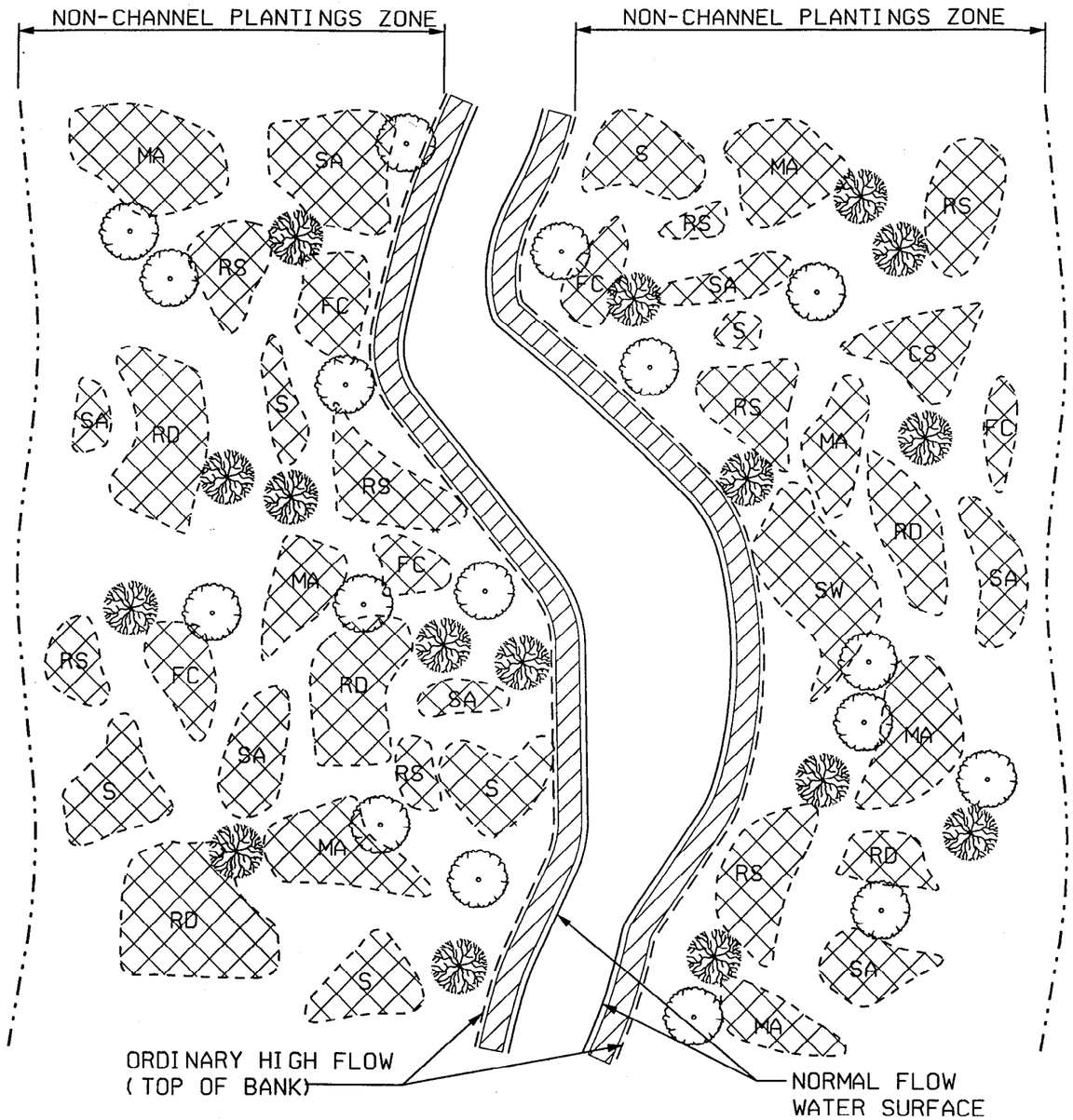
2-STAGE WOODY DEBRIS
GREEN-DUAMISH G.I.
FEASIBILITY STUDY
ECOSYSTEM RESTORATION

FIGURE 5

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
DSGN.		CHK.	SHEET	

ENVIRONFEDERAL#CORP-SEAMPLANNING98\CREEKRESTORWOODCHWOODDEB2.dgn



TYPICAL PLAN

NOT TO SCALE

PLANTING LEGEND:

DECIDUOUS TREE
BLACK COTTONWOOD
RED ALDER
PACIFIC CRABAPPLE

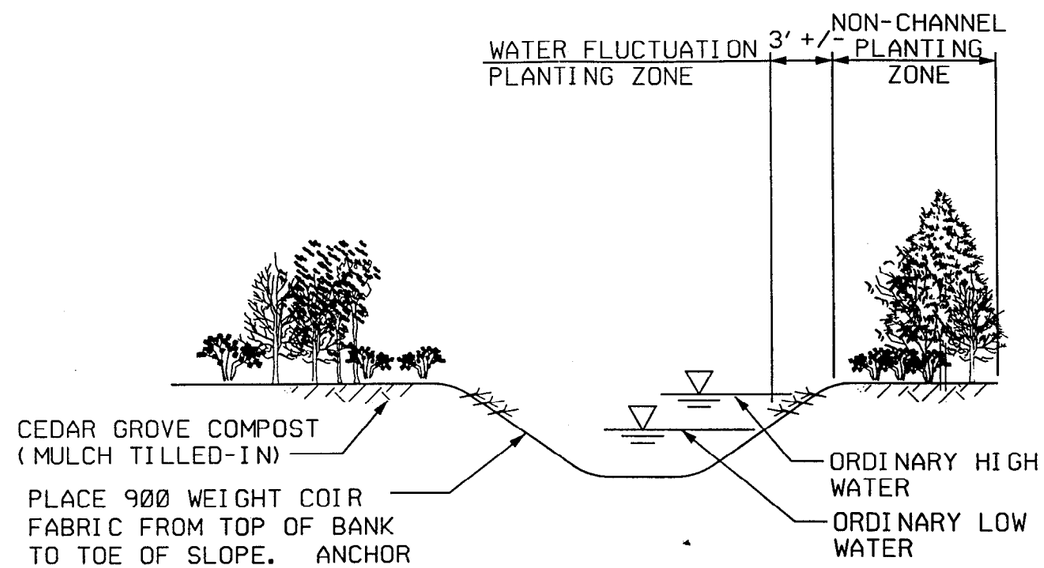
CONIFEROUS TREE
DOUGLAS FIR
WESTERN RED CEDAR

SHRUB/TREE - WATER FLUCTUATION ZONE

SHRUB - UPLAND ZONE

NON-CHANNEL PLANTINGS:
SA - SNOWBERRY
RS - SALMONBERRY
RD - RED OSIER DOGWOOD
MA - OREGON GRAPE
FC - FLOWERING CURRANT
S - SALAL

WATER FLUCTUATION PLANTINGS:
SW - SCOULERS WILOW
R - RUSHES & SEDGES
H - HOOKERS WILLOW
PW- PACIFIC WILLOW



TYPICAL SECTION

NOT TO SCALE

NOTES:
1. THE UPLAND PLANTINGS WILL BE A RANDOM MIX OF LISTED UPLAND SPECIES.

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

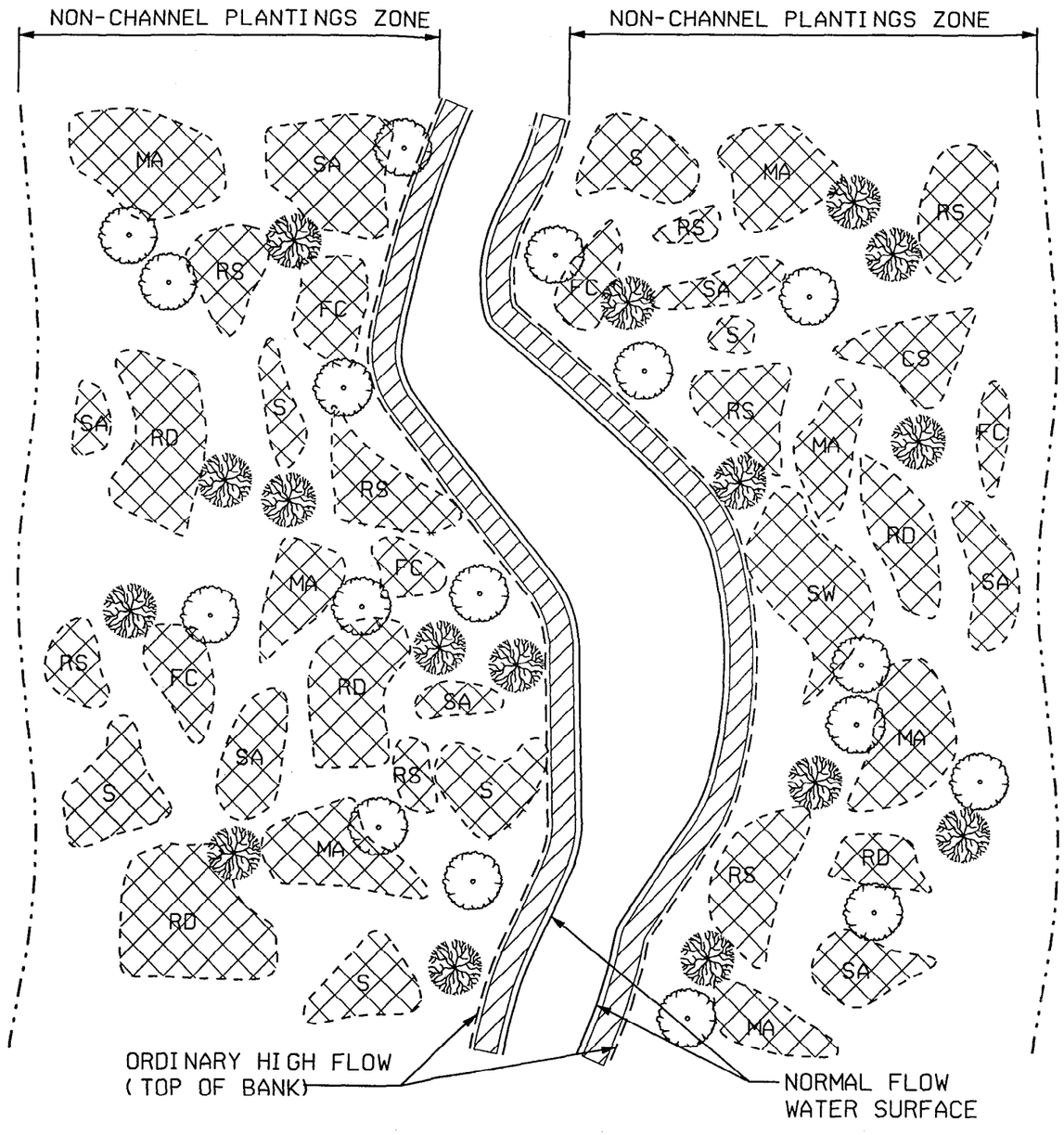
GREEN - DUWAMISH G.I. ECOSYSTEM
RESTORATION FEASIBILITY STUDY

I - STAGE CHANNEL
RIVERINE PLANTING SCHEME

FIGURE 6

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	



TYPICAL PLAN

NOT TO SCALE

PLANTING LEGEND:

DECIDUOUS TREE
BLACK COTTONWOOD
RED ALDER
PACIFIC CRABAPPLE

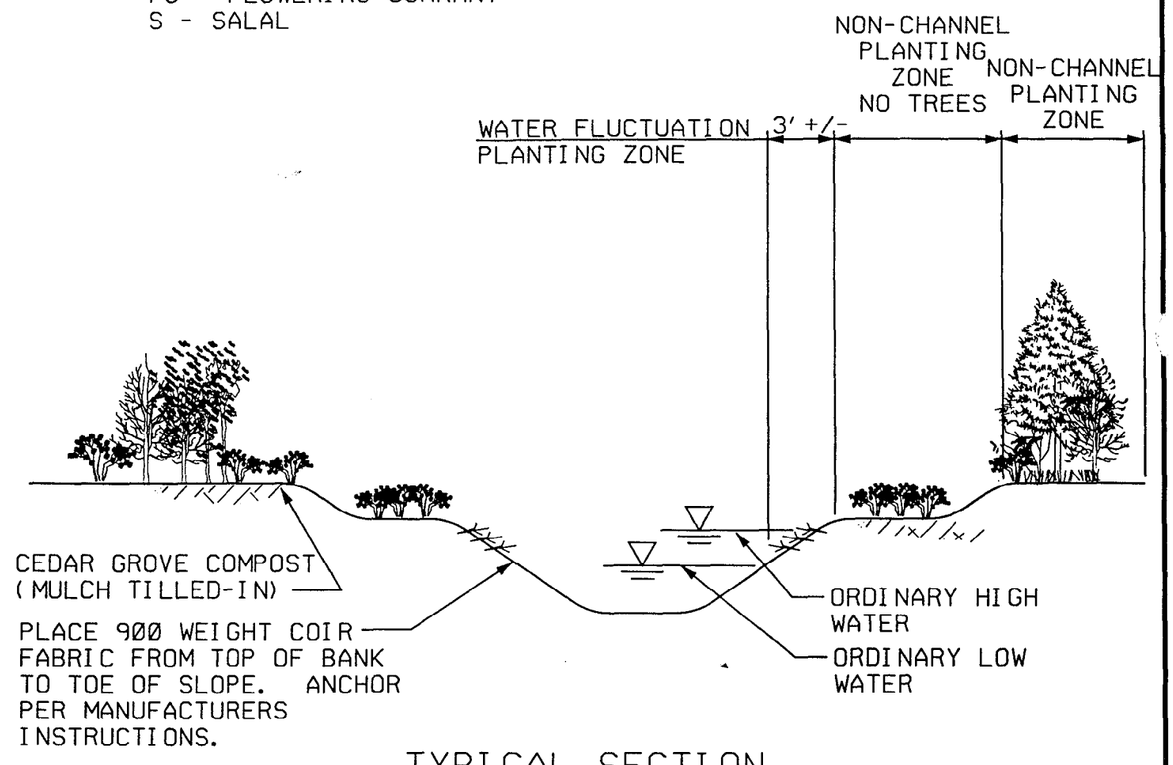
CONIFEROUS TREE
DOUGLAS FIR
WESTERN RED CEDAR

SHRUB/TREE - WATER FLUCTUATION ZONE

SHRUB - UPLAND ZONE

NON-CHANNEL PLANTINGS:
SA - SNOWBERRY
RS - SALMONBERRY
RD - RED OSIER DOGWOOD
MA - OREGON GRAPE
FC - FLOWERING CURRANT
S - SALAL

WATER FLUCTUATION PLANTINGS:
SW - SCOULERS WILOW
R - RUSHES & SEDGES
H - HOOKERS WILLOW
PW- PACIFIC WILLOW



TYPICAL SECTION

NOT TO SCALE

NOTES:
1. THE UPLAND PLANTINGS WILL BE A RANDOM MIX OF LISTED UPLAND SPECIES.

DATE AND TIME PLOTTED: 07-AUG-2000 15:06
DESIGN FILE: $$$P:$ENVIROP48.050$DRAWINGS$GrRivSgl.DGN

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

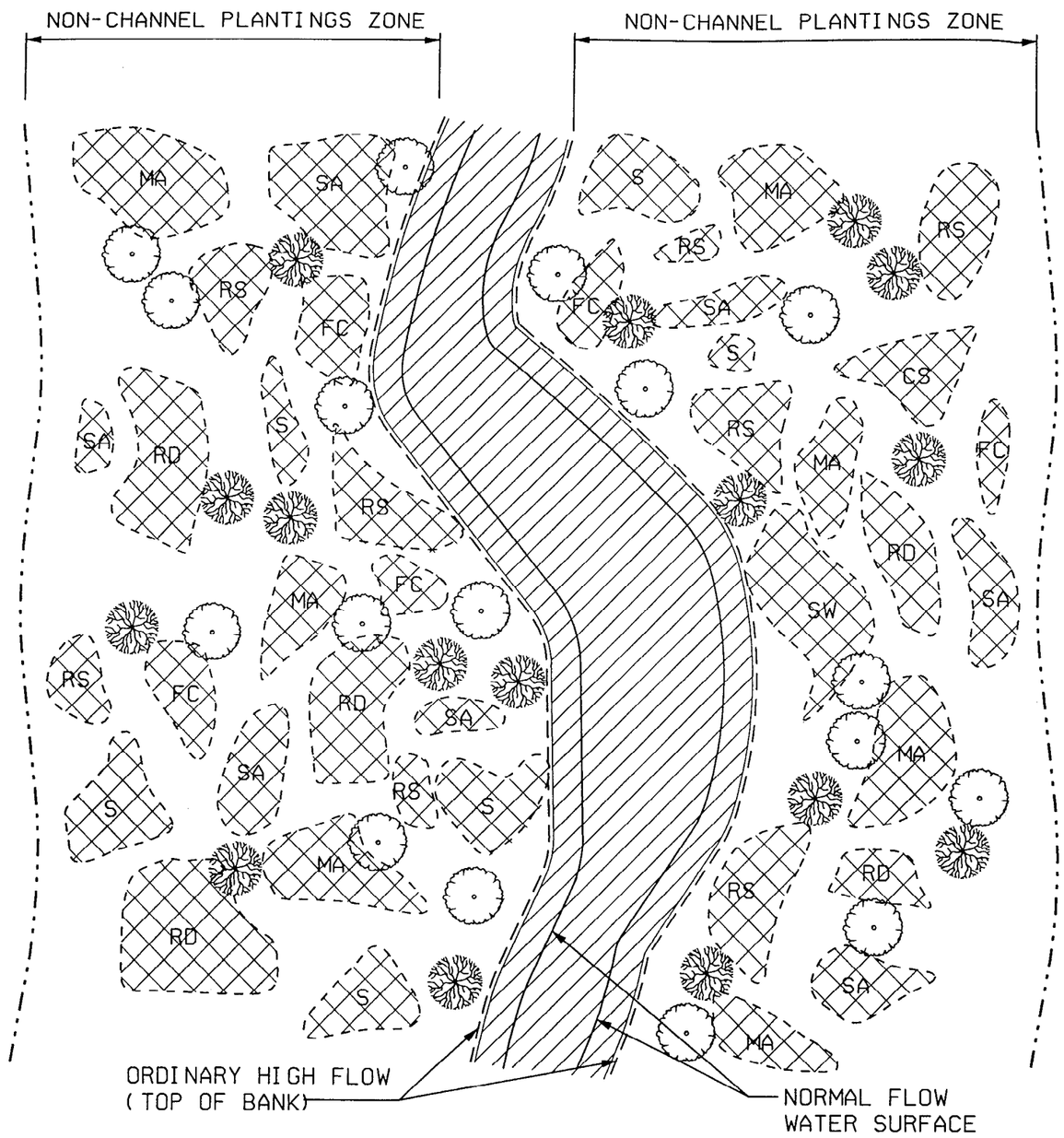
GREEN - DUWAMISH G.I. ECOSYSTEM
RESTORATION FEASIBILITY STUDY

2 - STAGE CHANNEL
RIVERINE PLANTING SCHEME

FIGURE 7

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	



TYPICAL PLAN
NOT TO SCALE

PLANTING LEGEND:

DECIDUOUS TREE
BLACK COTTONWOOD
RED ALDER
PACIFIC CRABAPPLE

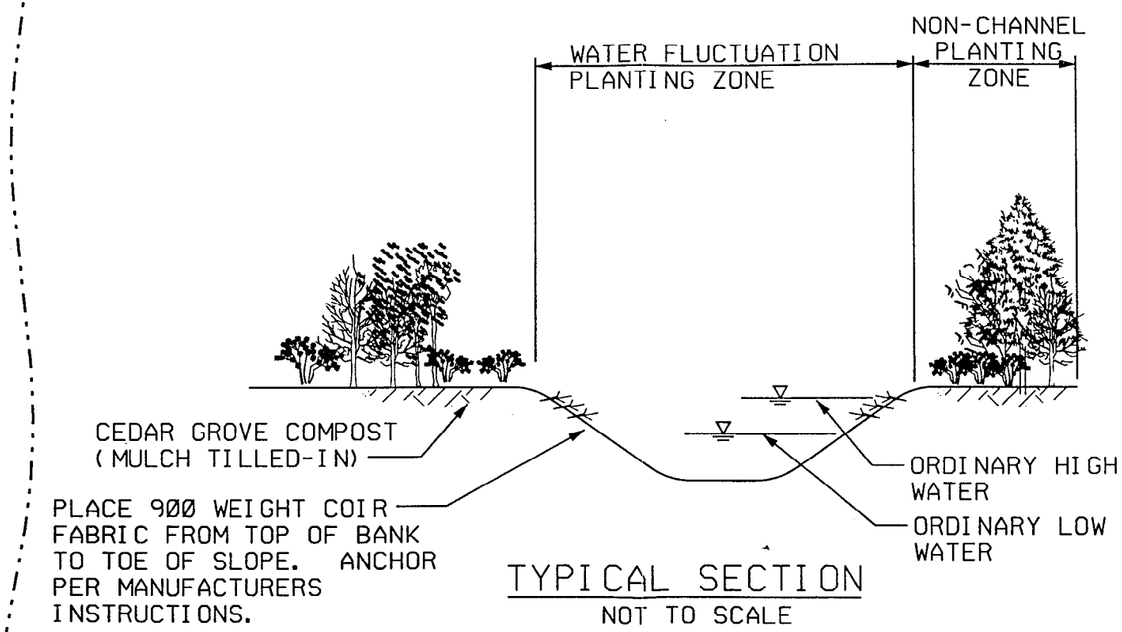
CONIFEROUS TREE
DOUGLAS FIR
WESTERN RED CEDAR

SHRUB/TREE - WATER FLUCTUATION ZONE

SHRUB - UPLAND ZONE

NON-CHANNEL PLANTINGS:
SA - SNOWBERRY
RS - SALMONBERRY
RD - RED OSIER DOGWOOD
MA - OREGON GRAPE
FC - FLOWERING CURRANT
S - SALAL

WATER FLUCTUATION PLANTINGS:
SW - SCOULERS WILOW
R - SEDGES
H - HOOKERS WILLOW
PW- PACIFIC WILLOW



TYPICAL SECTION
NOT TO SCALE

NOTES:
1. THE UPLAND PLANTINGS WILL BE A RANDOM MIX OF LISTED UPLAND SPECIES.

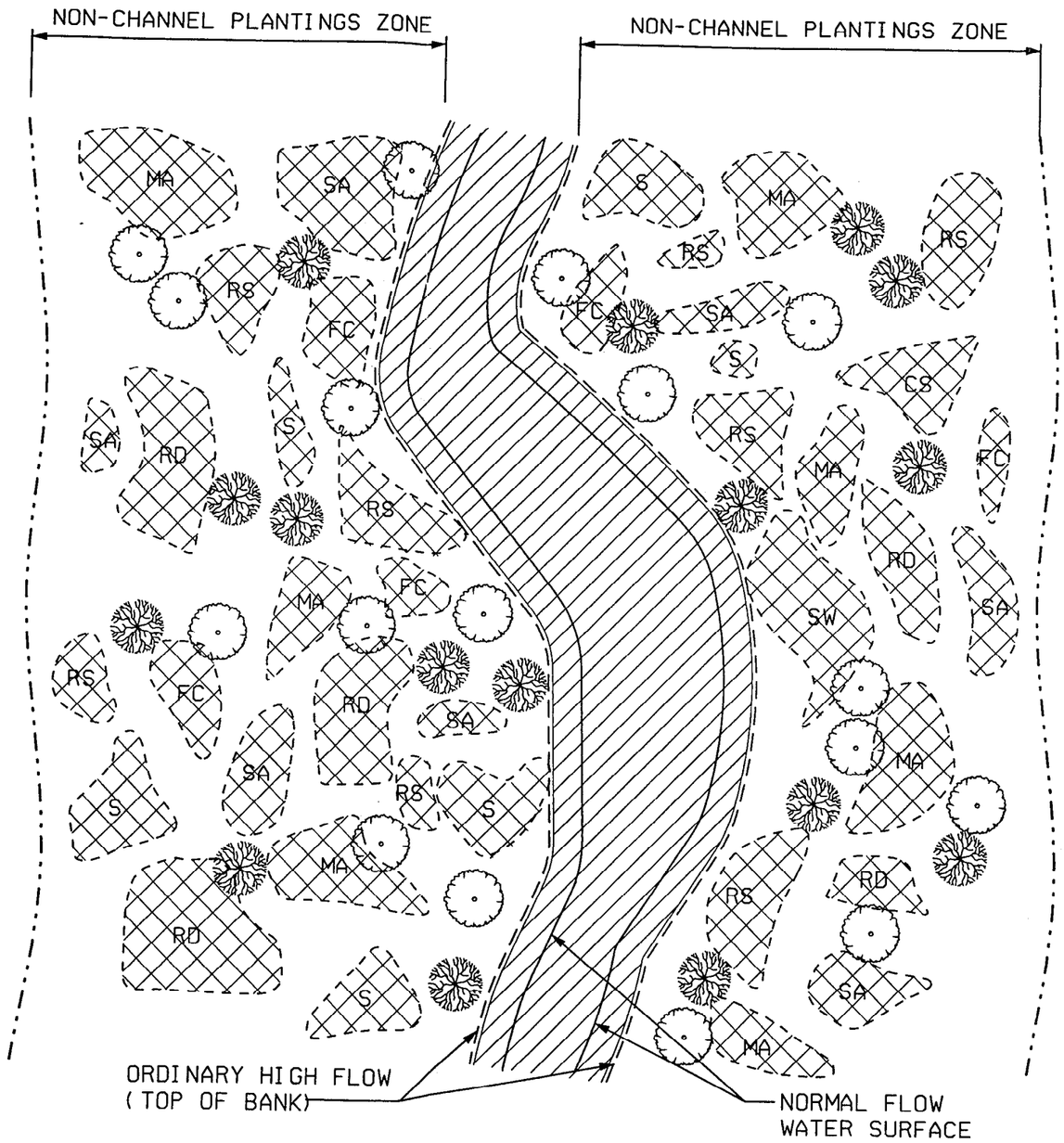
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

GREEN - DUWAMISH G.I. ECOSYSTEM
RESTORATION FEASIBILITY STUDY

I - STAGE CHANNEL
BACK WATER CHANNEL PLANTING
SCHEME
FIGURE 8

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	



TYPICAL PLAN
NOT TO SCALE

PLANTING LEGEND:

DECIDUOUS TREE
BLACK COTTONWOOD
RED ALDER
PACIFIC CRABAPPLE

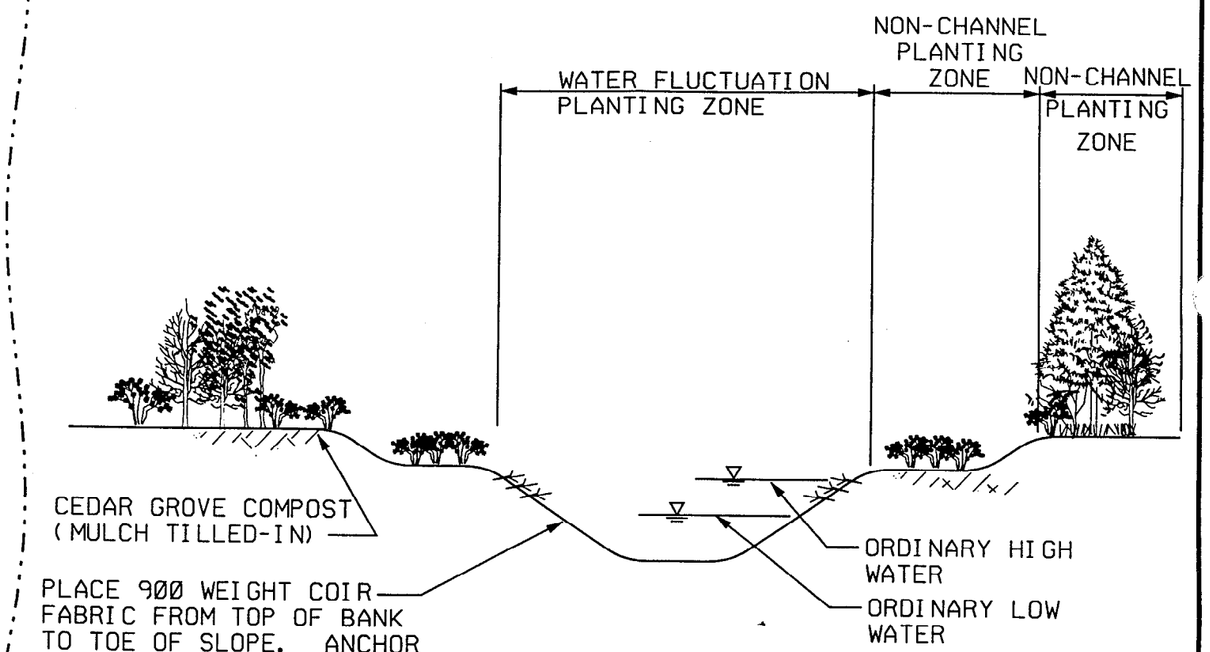
CONIFEROUS TREE
DOUGLAS FIR
WESTERN RED CEDAR

SHRUB/TREE - WATER FLUCTUATION ZONE

SHRUB - UPLAND ZONE

NON-CHANNEL PLANTINGS:
SA - SNOWBERRY
RS - SALMONBERRY
RD - RED OSIER DOGWOOD
MA - OREGON GRAPE
FC - FLOWERING CURRANT
S - SALAL

WATER FLUCTUATION PLANTINGS:
SW - SCOULERS WILOW
R - SEDGES
H - HOOKERS WILLOW
PW- PACIFIC WILLOW



TYPICAL SECTION
NOT TO SCALE

NOTES:
1. THE UPLAND PLANTINGS WILL BE A RANDOM MIX OF LISTED UPLAND SPECIES.

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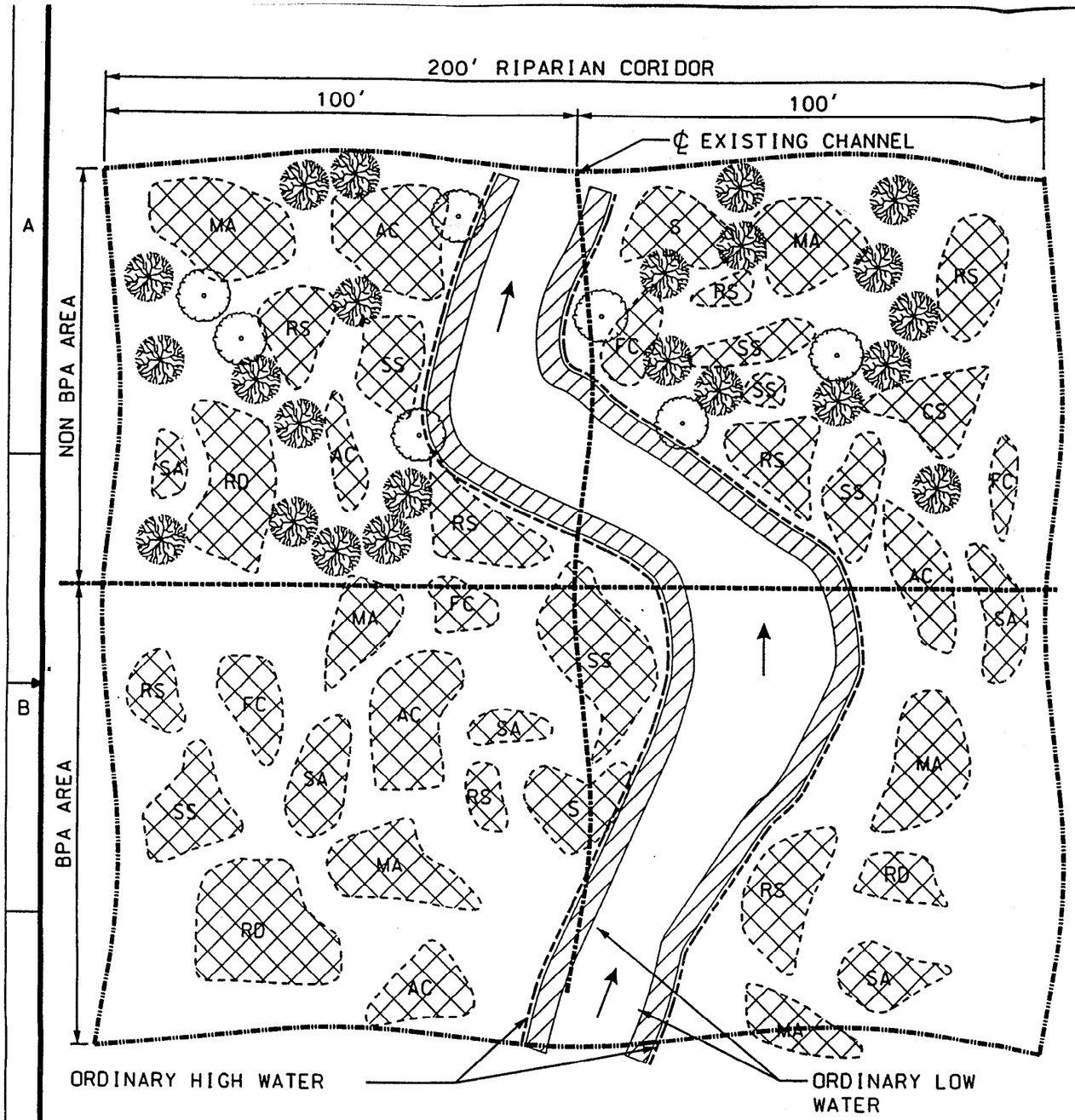
GREEN - DUWAMISH G.I. ECOSYSTEM
RESTORATION FEASIBILITY STUDY

2 - STAGE CHANNEL
BACKWATER CHANNEL PLANTING
SCHEME
FIGURE 9

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGNL		CHK.	SHEET X	



TYPICAL PLAN
NOT TO SCALE

PLANTING LEGEND:

DECIDUOUS TREE
BLACK COTTONWOOD
RED ALDER
CASCARA

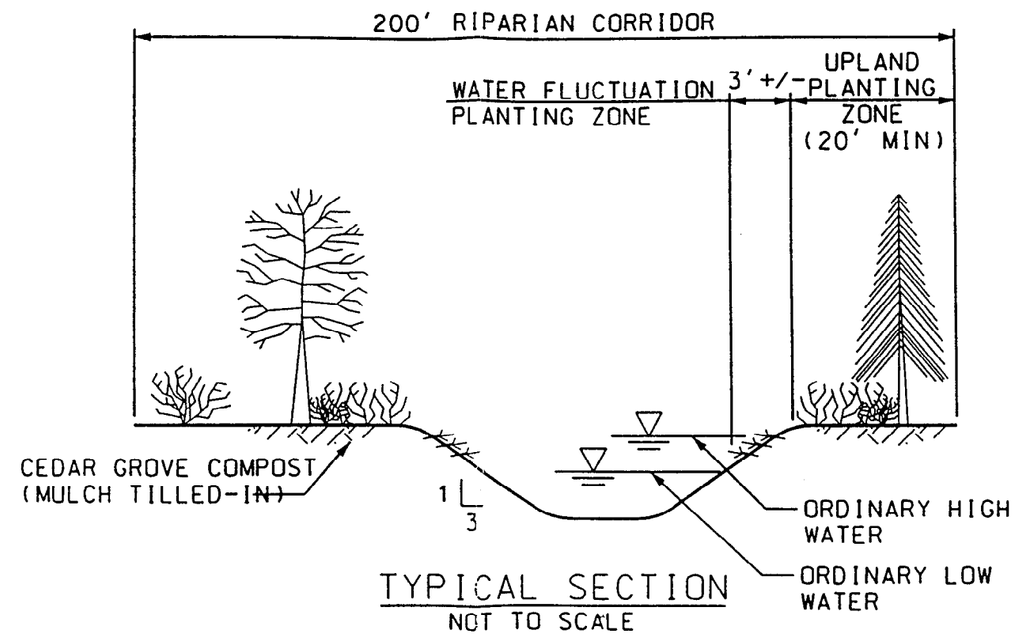
CONIFEROUS TREE
DOUGLAS FIR
WESTERN RED CEDAR
WESTERN HEMLOCK

SHRUB/TREE - WATER FLUCTUATION ZONE

SHRUB - UPLAND ZONE

UPLAND PLANTINGS:
SA - SNOWBERRY
AS - SITKA ALDER
RS - SALMONBERRY
RD - RED HUCKLEBERRY
MA - OREGON GRAPE
AC - VINE MAPLE
FC - SWORD FERN
S - TWIN FLOWER SALAL

WATER FLUCTUATION PLANTINGS:
SS - SITKA WILLOW (LIVE STAKE)
SW - SCOULERS WILOW
R - RUSHES & SEDGES
H - HOOKERS



TYPICAL SECTION
NOT TO SCALE

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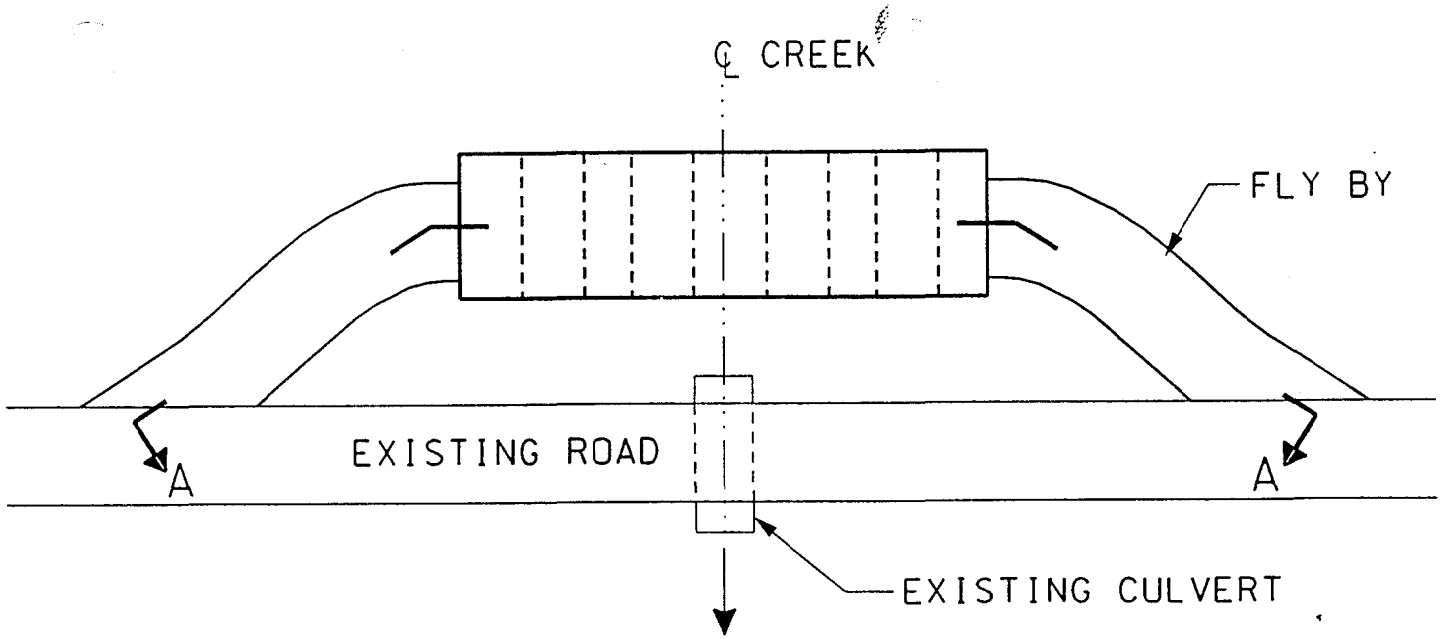
GREEN - DUWAMISH G.I. ECOSYSTEM RESTORATION FEASIBILITY STUDY

FIGURE NO. 10
CREEK DETAILS

KING COUNTY WASHINGTON

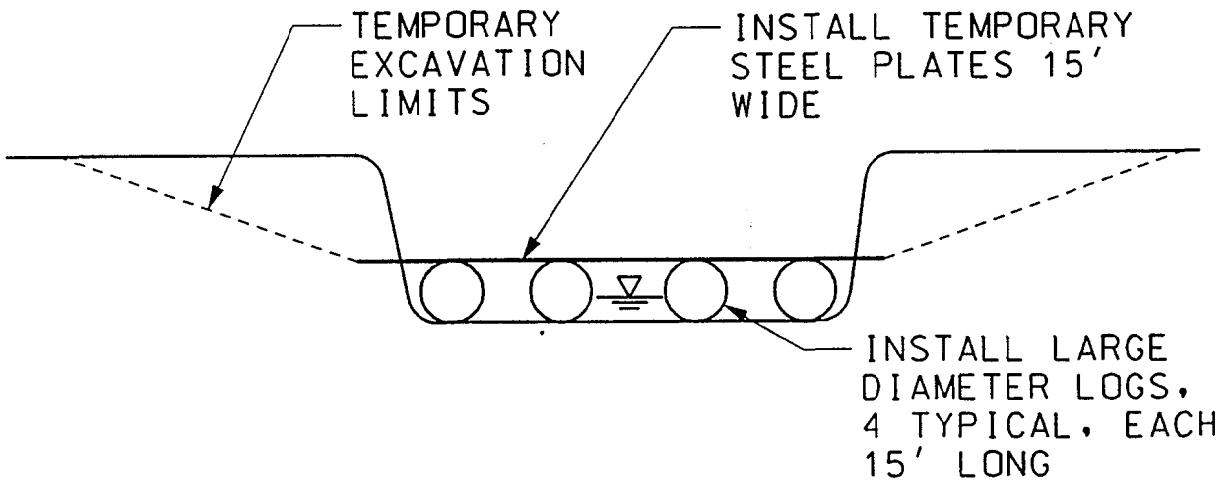
SIZE	INVITATION NO.	FILE NO.	DATE	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: $$$DATE$$$$ $TIME
DESIGN FILE: $$$P:$ENVIROP48.050$DRAWINGS$SKETCH26.DGN



TEMPORARY CONSTRUCTION FLY BY

NOT TO SCALE



LOW FLOW CREEK CROSSING - SECTION A-A

NOT TO SCALE

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FIGURE NO. 11

TEMPORARY CONSTRUCTION FLY BY

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
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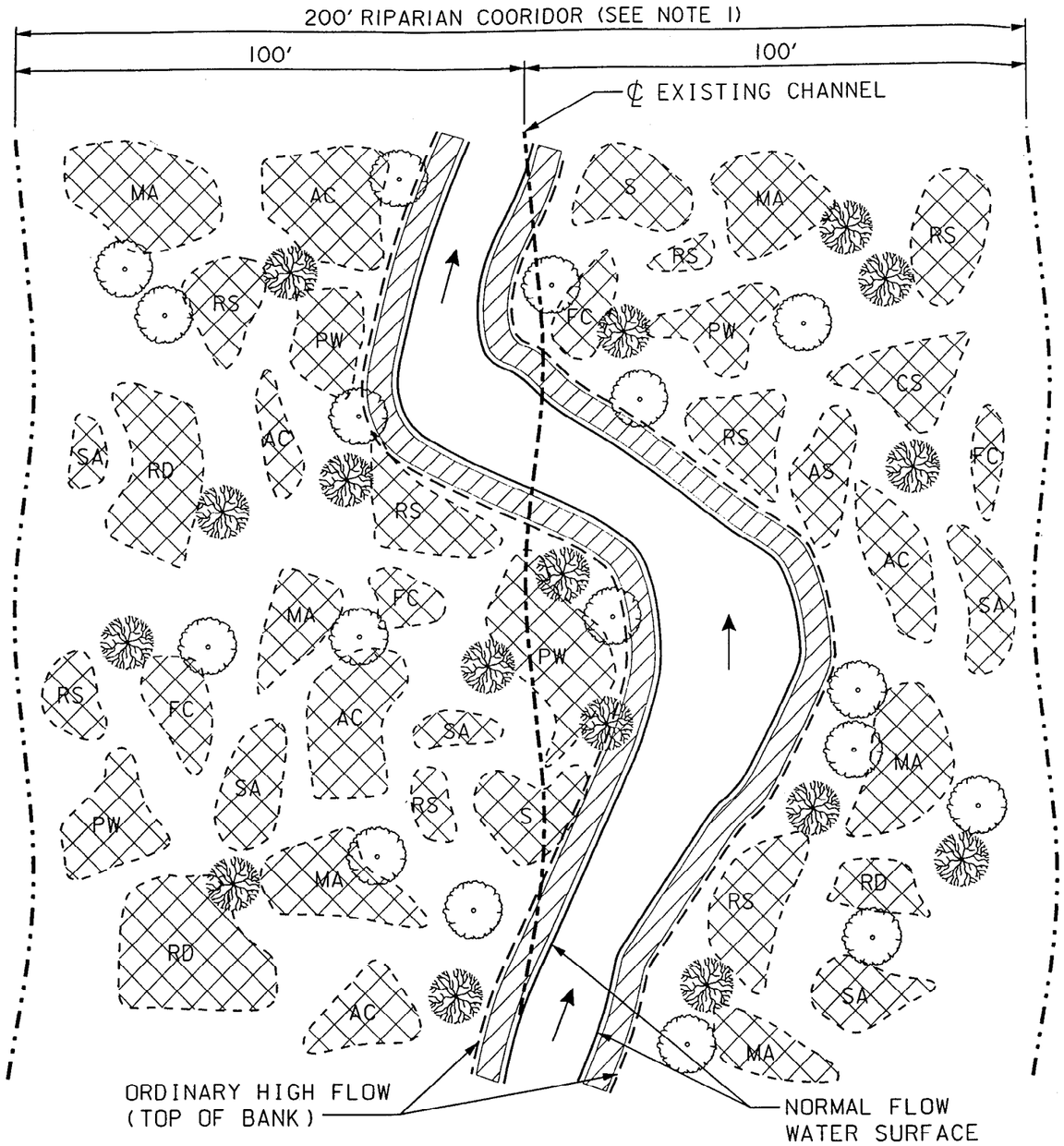
DSGN.		CHK.	SHEET X	



TYPICAL PLAN
NOT TO SCALE

PLANTING LEGEND:

DECIDUOUS TREE
BLACK COTTONWOOD
RED ALDER
PACIFIC CRABAPPLE

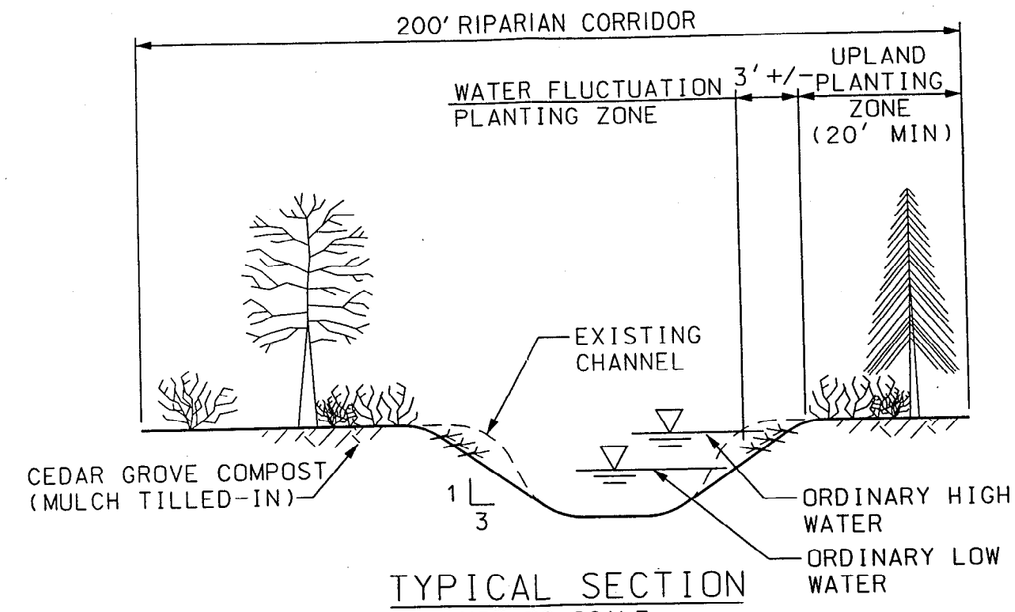
CONIFEROUS TREE
DOUGLAS FIR
WESTERN RED CEDAR
SITKA SPRUCE (WET AREAS)

SHRUB/TREE - WATER FLUCTUATION ZONE

SHRUB - UPLAND ZONE

UPLAND PLANTINGS:
SA - SNOWBERRY
AS - SITKA ALDER
RS - SALMONBERRY
RD - RED OSIER DOGWOOD
MA - OREGON GRAPE
AC - VINE MAPLE
FC - FLOWERING CURRANT
S - SALAL

WATER FLUCTUATION PLANTINGS:
PW - PACIFIC WILLOW
SW - SCOULERS WILOW
R - RUSHES & SEDGES
H - HOOKERS



TYPICAL SECTION
NOT TO SCALE

NOTES:
1. 200' RIRARIAN CORRIDOR DOES NOT APPLY TO THE UPPER & LOWER SPINGBROOK REACHES. CORRIDOR WIDTH FOR THESE REACHES IS NOTED ON RESPECTIVE SITE PLANS.

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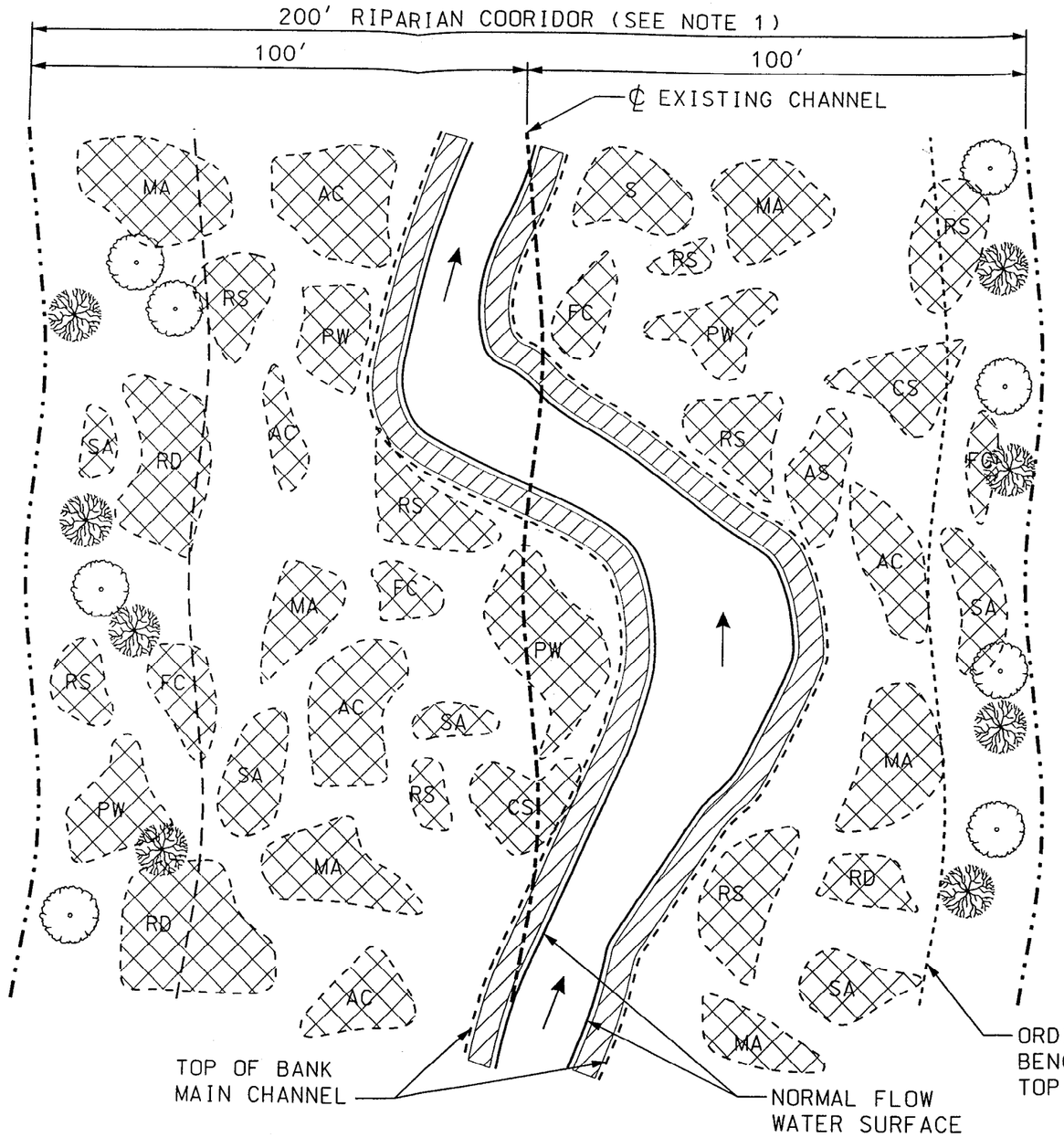
FIGURE NO. 12
1 - STAGE CHANNEL
DETAIL

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: 09-AUG-2000 16:39
DESIGN FILE: $$$P:#ENVIROP48.050#DRAWINGS#SKETCH17.DGN



TYPICAL PLAN
NOT TO SCALE

PLANTING LEGEND:

DECIDUOUS TREE
BLACK COTTONWOOD
RED ALDER
PACIFIC CRABAPPLE

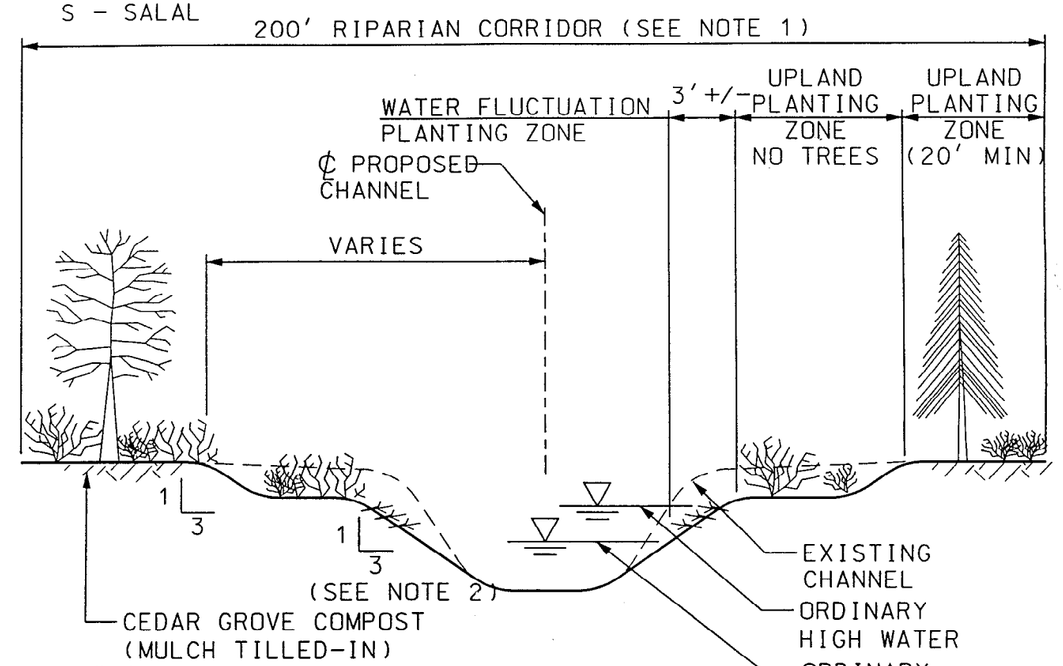
CONIFEROUS TREE
DOUGLAS FIR
WESTERN RED CEDAR
SITKA SPRUCEC (WET AREAS)

SHRUB/TREE - WATER FLUCTUATION ZONE

SHRUB - UPLAND ZONE

UPLAND PLANTINGS:
SA - SNOWBERRY
AS - SITKA ALDER
RS - SALMONBERRY
RD - RED OSIER DOGWOOD
MA - OREGON GRAPE
AC - VINE MAPLE
FC - FLOWERING CURRANT
S - SALAL

WATER FLUCTUATION PLANTINGS:
PW - PACIFIC WILLOWS
SW - SCOULERS WILOW
R - RUSHES & SEDGES
H - HOOKERS



TYPICAL SECTION
NOT TO SCALE

NOTES:
1. 200' RIRARIAN CORRIDOR DOES NOT APPLY TO THE UPPER & LOWER SPINGBROOK REACHES. CORRIDOR WIDTH FOR THESE REACHES IS NOTED ON RESPECTIVE SITE PLANS.

2. SIDE SLOPES ARE 2:1 FOR GOEDEKE REACH.

DATE AND TIME PLOTTED: 09-AUG-2000 16:34
DESIGN FILE: $$$P:#ENVIROP48.050#DRAWINGS#SKETCH18.DGN

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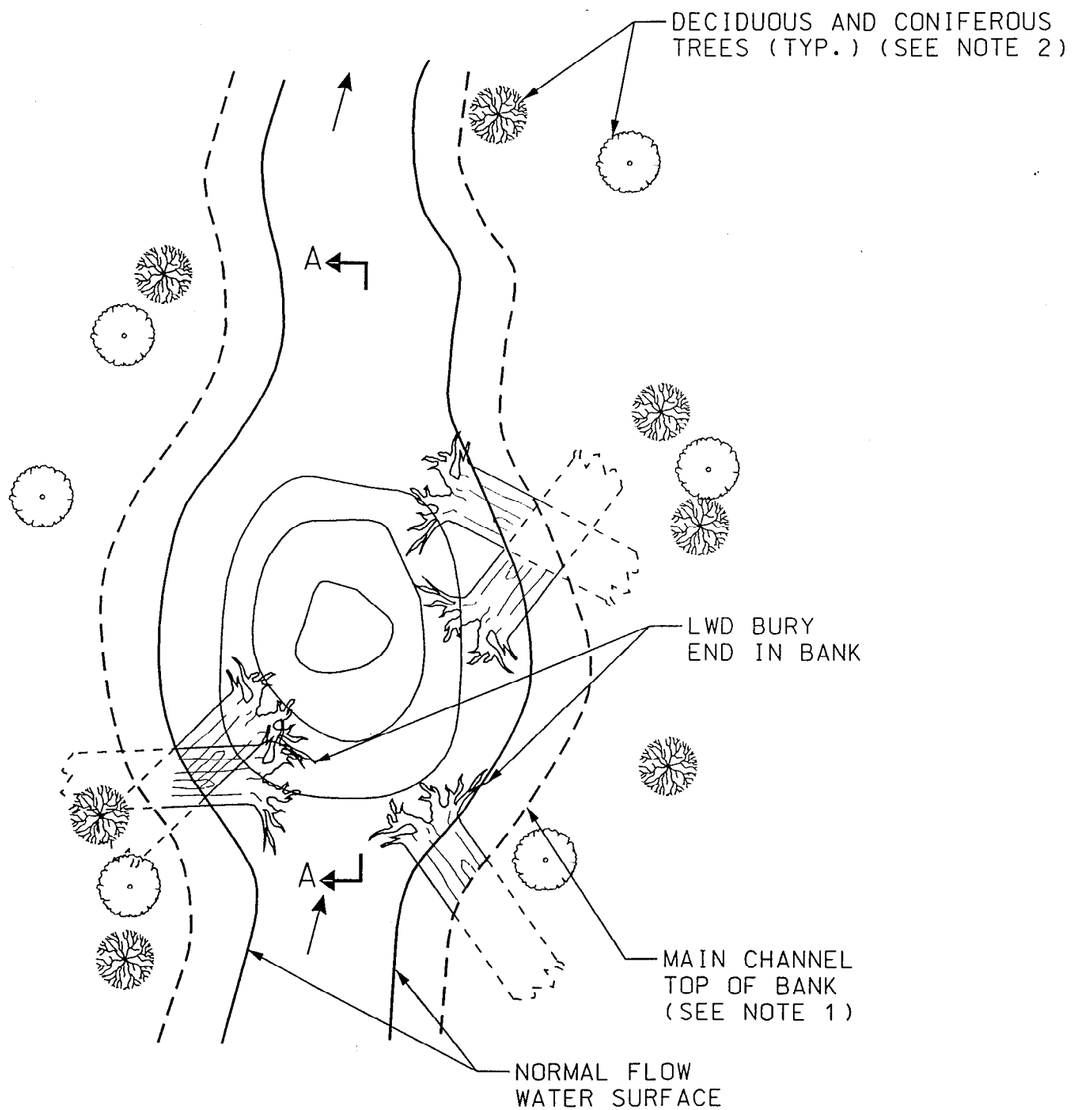
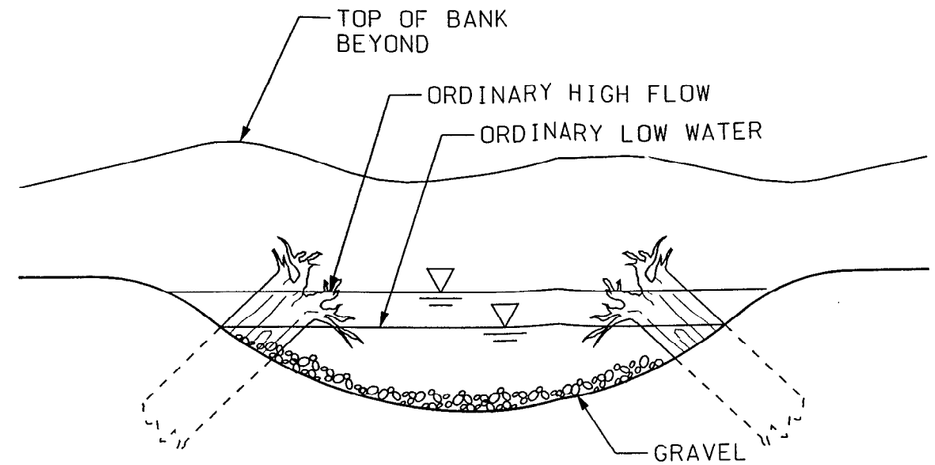
FIGURE NO. 13
2 - STAGE CHANNEL DETAIL

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	



TYPICAL PLAN
NOT TO SCALE



SECTION A-A
NOT TO SCALE

NOTES:

1. TOP OF BANK SHOWN FOR 1-STAGE CHANNEL ORDINARY HIGH WATER SURFACE. FOR 2-STAGE CHANNEL APPLICATION, THIS POINT INDICATES BEGINNING OF UPLAND BENCH SECTION.
2. REFER TO 1-STAGE AND 2-STAGE TYPICAL CHANNEL DETAILS FOR PLANTING SCHEDULE, FIG. NOS. 12 AND 13, RESPECTIVELY.
3. MAINTAIN 3H:1V SIDE SLOPE TO PROJECTED MAIN CHANNEL INVERT ELEVATION. EXCAVATE AT 1:1 TO PIERCE WATER TABLE
4. CEDAR LOGS AT EXIT OF POOL PROTECTS CHANNEL DURING LARGE STORM EVENT.
5. USE LARGE ROOTWADS KEYED INTO BANK.

DATE AND TIME PLOTTED: 09-AUG-2000 16:28
DESIGN FILE: $$$P:$ENVIROP48.050$DRAWINGS$SKETCH19.DGN

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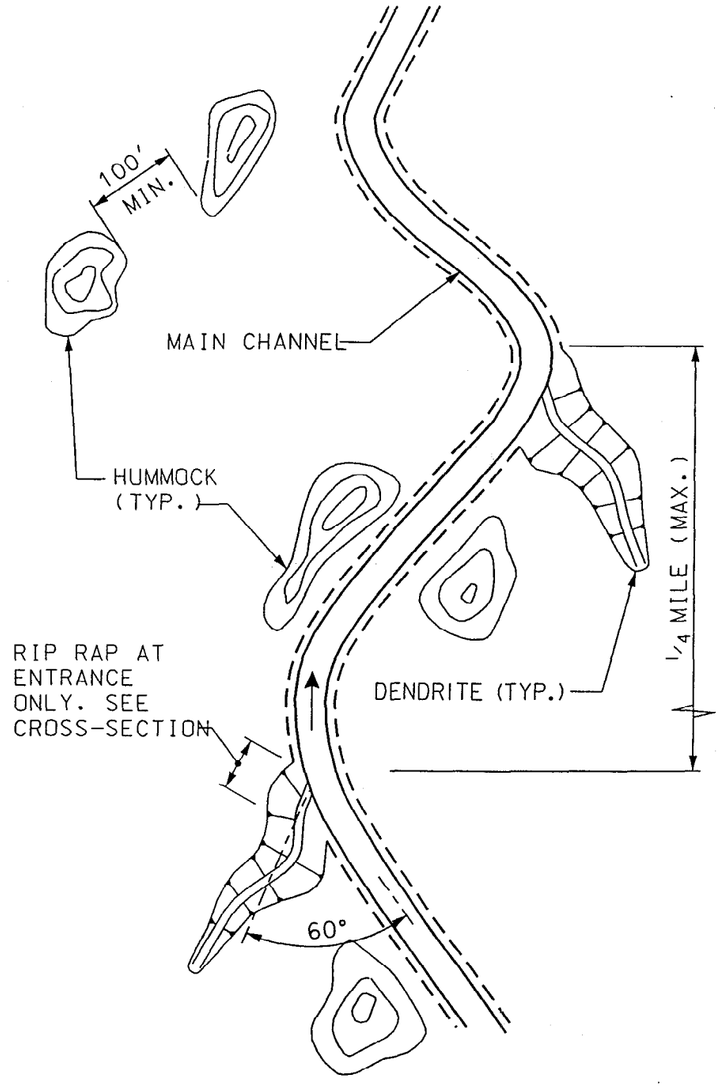
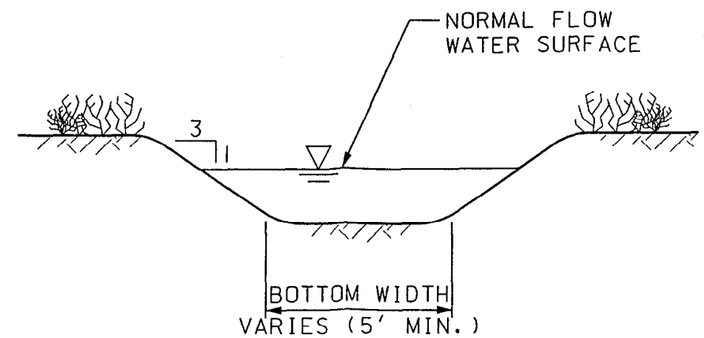
FIGURE NO. 14
LARGE WOODY DEBRIS POOL DETAIL

KING COUNTY WASHINGTON

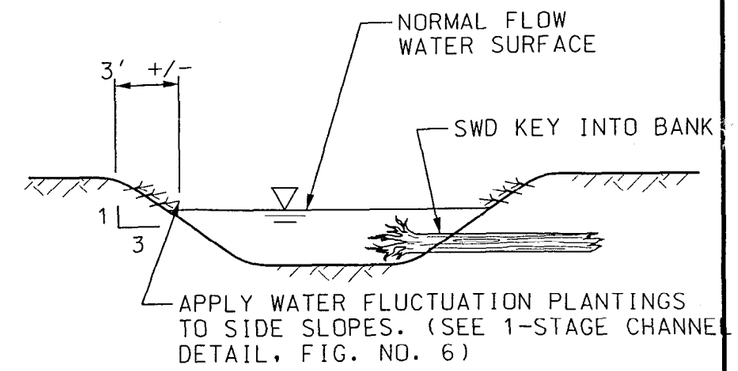
SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	



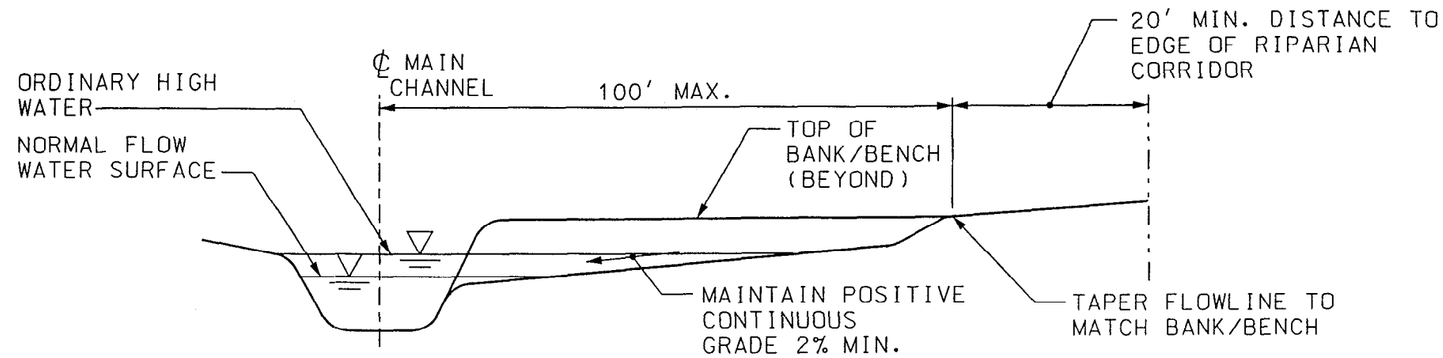
TYPICAL PLAN & LOCATION
NOT TO SCALE



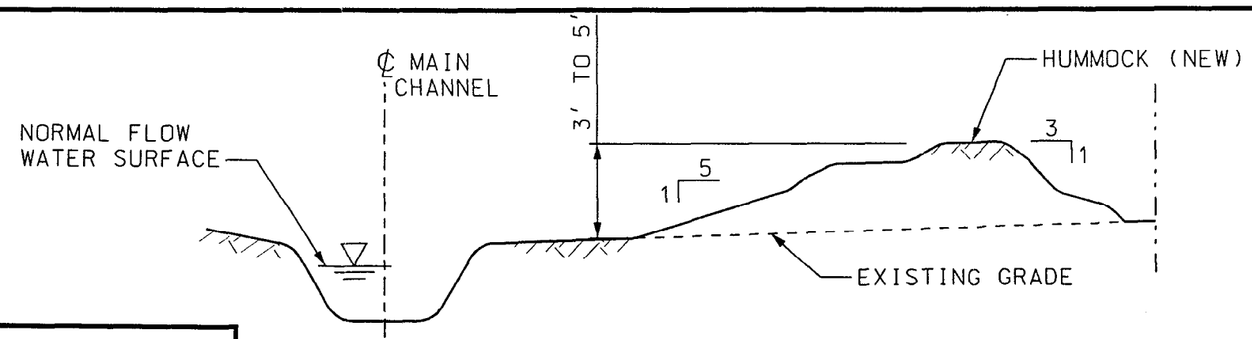
TYPICAL DENDRITE ENTRANCE SECTION
NOT TO SCALE



TYPICAL DENDRITE SECTION
NOT TO SCALE



TYPICAL DENDRITE PROFILE
NOT TO SCALE



TYPICAL HUMMOCK SECTION
NOT TO SCALE

NOTES:
1. CONTINUE STANDARD UPLAND PLANTING ON AND AROUND HUMMOCK, BUT PLANT BUSHES, NOT TREES, ON HUMMOCK.
2. VOLUME OF FILL FOR AVERAGE HUMMOCK APPROXIMATELY 30 CY.
3. ORIENT LONG AXIS OF HUMMOCK PARALLEL WITH MAIN CHANNEL.
4. INCLUDE 2 +/- SMALL WOODY DEBRIS (SWD) PER DENDRITE.

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FIGURE NO. 15
DENDRITE & HUMMOCK DETAIL

KING COUNTY WASHINGTON

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D	XX-XX	XX-XX	98OCT	C-X
DSGN.		CHK.	SHEET X	

DATE AND TIME PLOTTED: 09-AUG-2000 16:12 DESIGN FILE: $$$P:#ENVIROP48.050#DRAWINGS#SKETCH20.dgn