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**REDDINGTON LEVEE SETBACK**

**HABITAT MONITORING PLAN**

**GREEN RIVER, RM 28.2 TO 29.5**

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## Executive Summary

The Reddington Levee Setback Project is part of a larger overall flood risk reduction and river corridor improvement strategy for the lower Green River. This project will set the Reddington Levee back along the left (west) bank of the Green River through a portion of the City of Auburn. The project area is 1.3 miles in length (33 acres) and extends from the southern boundary of Port of Seattle's wetland mitigation project at rivermile (RM) 28.2 (43rd Street Northeast) to RM 29.5 at Brannan Park (26th Street Northeast). The project consists of removal of existing rock armor and levee fill materials, demolition of existing structures, utility construction and relocation, construction of a setback levee and access road, rock barbs, engineered log jams, wetland creation, and site revegetation.

The project will result in increased flood conveyance, a wider riparian corridor with enhanced ecological benefits, improved instream habitat along the channel margin and expanded flood refugia for salmonids during higher flow events. Once the setback levee is constructed and the existing levee is removed, the river channel will be free to migrate laterally within a broader riverine corridor, forming new channel patterns and complex salmon habitat. Excavation of alcoves and a channel inlet and outlet will create riverine wetland. Extensive revegetation will jumpstart establishment of a wider riparian buffer for water quality and habitat protection.

Ecological parameters will be monitored for 10 years. A significant investment in monitoring is warranted because the project is the largest levee setback project constructed by King County on the Lower Green River to date. Long-term monitoring will assure the project meets performance standards (e.g., at least 0.44 acres of wetland creation, 80% survival of installed vegetation, 75% cover of native woody vegetation by Year 10, etc.). Where appropriate, 10-year-long, Before-After experimental design will be used.

The purpose of this monitoring effort is to:

1. Ensure the project satisfies habitat design objectives (Implementation Monitoring),
2. Determine whether levee setback project actions are producing the intended effects on floodplain reconnection, wetland creation, and aquatic habitat conditions (Effectiveness Monitoring), and
3. Improve habitat design, construction, and maintenance practices using monitoring results (Adaptive Management).

General indicators of ecological project performance include salmonid rearing habitat, side channel connectivity, stability of placed wood, native riparian and invasive vegetation cover, and development of wetland characteristics in designated areas. Examples of sampling methods include slow water edge habitat maps at a range of flows, field assessments of large wood stability and function combined with photo points, time lapse photography of side channel connectivity, percent survival estimates for planted vegetation, percent cover estimates for native and invasive vegetation, and wetland delineation.

Monitoring results will be used to measure ecological performance, inform site management, comply with permits, and improve effectiveness of similar projects in the future.

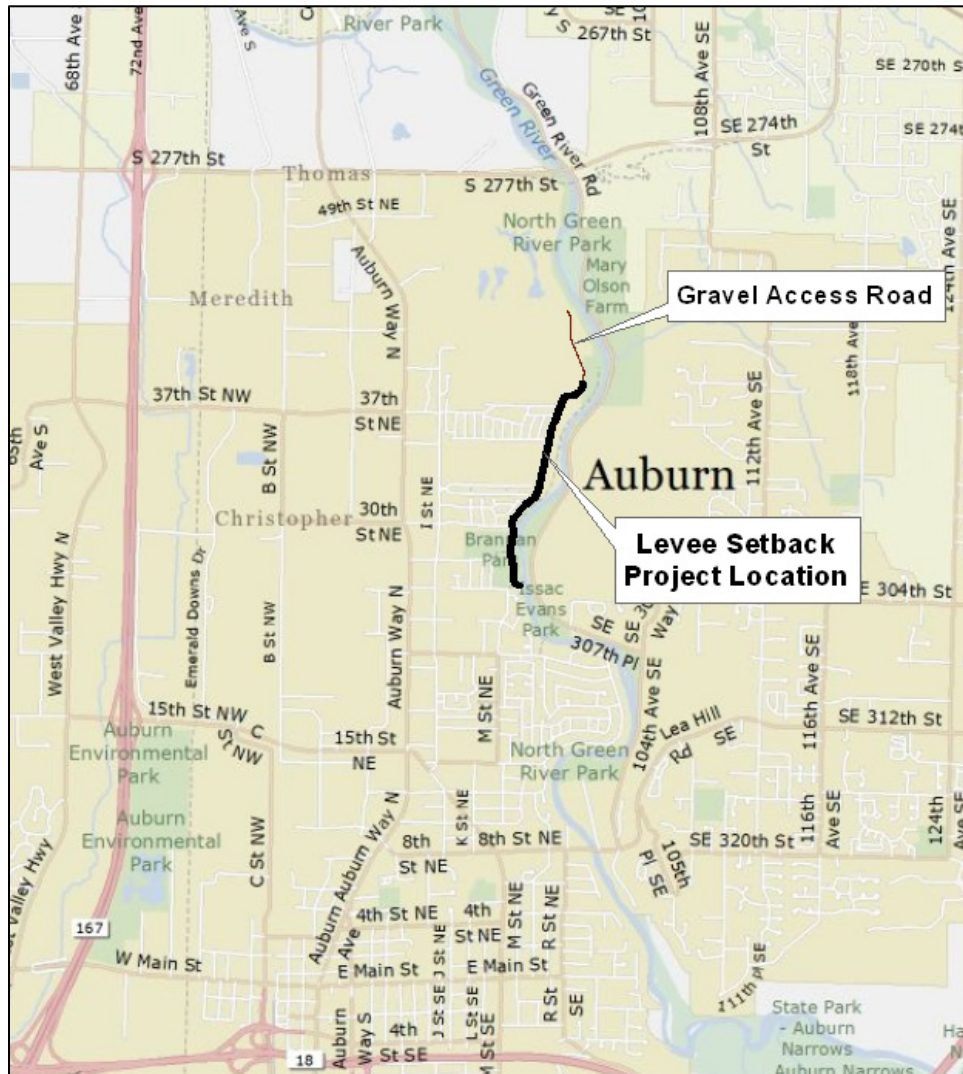
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## Project Summary

### Project Location

The project area extends from the southern boundary of Port of Seattle's wetland mitigation project at rivermile (RM) 28.2 (43rd Street Northeast) to RM 29.5 at Brannan Park (26th Street Northeast). The gravel access road extends from RM 28.2 to RM 28.6 and the levee setback ( 0.9 miles long) extends from the northern end of the River Mobile Estates (RM 28.6) to the southern end of Brannan Park (RM 29.5).



**Figure 1.** Reddington Levee Setback vicinity map.

## Project Justification

King County's 2006 Flood Hazard Management Plan (King County, 2007) proposed system-wide improvements to the county's aging system of levees and revetments, many of which no longer function as originally designed.

The 2006 Flood Plan identified the Reddington/Brannan Park area as follows:

*"The Reddington Levee here follows an old road alignment and cuts off older meander scrolls, one of which has been developed as a trailer park within the mapped floodplain of the Green River. These older meanders are connected to the river with a poorly constructed culvert through the levee, fitted with a small flap-gate. Flooding of the trailer park still occurs, when this system fails to properly close during flood events. Just upstream of these meanders, a newer culvert outfall with a flap-gate and backup closure system have recently been constructed to serve new developments and a future regional stormwater system planned by Auburn. The lower end of the Reddington Levee is constructed at steep slope angles with rip-rap armor, and supports very little vegetation other than blackberries and canary grass. Central portions of this segment are set well back from the riverbank, and pass through a mature deciduous riparian grove of cottonwoods and other trees and shrubs. The Brannan Park portions of this reach include very steep rip-rap armored portions that encroach closely on the channel, together with a minor, vegetated meander bar near the upstream end. The levee borders an Auburn park with ball fields, a sewage pump lift station, and a regional biofiltration swale with a concrete imbedded rip-rap outfall through the levee. Toe structure is questionable in all rip-rap slope portions along the channel edge. Two feet of freeboard is likely present throughout, with landward areas, especially at Brannan Park, located about 6 to 8 feet in elevation below the levee crest."*

The 2006 Flood Plan identified the following project to address the flood risks and habitat restoration opportunities at the Reddington Levee:

*"Remove and reconstruct the Reddington Levee in a setback location adjacent to the mobile home park, along the landward edge of the old side channel area. Reconnect the old side-channel habitat to the main stem. Reduce the flooding of mobile homes due to the existing malfunctioning flap-gate/culvert system, and install a new, robust flood closure system with a backup closure device. Stabilize the channel edge and restore aquatic habitat complexity with large woody debris installations, and revegetate both the new levee slopes and the former levee footprint area with native riparian trees and shrubs."*

The Green River basin is identified under Washington State's water resource planning program as the Green/Duwamish and Central Puget Sound Watershed, or Water Resource Inventory Area (WRIA) 9. The WRIA 9 Salmon Habitat Plan (WRIA 9, 2005) identifies categories of actions for the recovery of endangered salmon in the Green River, along with specific project recommendations. The plan presents policy statements that are pertinent to the Reddington Levee setback project, including the following:

- Policy LG1—In the Lower Green River, every opportunity should be taken to set back levees and revetments to the maximum extent practicable. Habitat rehabilitation within the Lower Green River corridor should be included in all new developments and re-developments that occur within 200 feet of the river.

One of the projects listed in the Salmon Habitat Plan is within the Reddington Levee setback project area. It is identified as Project LG-1, and it calls for side channel rehabilitation on the left bank of the Green River at RM 28.8 (the River Mobile Estates). This project is also identified as a priority for habitat restoration in the Green/Duwamish Ecosystem Restoration Project (ERP) Plan.

## Habitat Goals and Objectives

The habitat restoration goal and associated objectives of the Reddington Levee Setback Project are as follows:

### Improve natural river functions to enhance habitat by:

- Setting back levees to allow for more channel movement within the project area,
- Allowing the river to meander, scour and develop more complex instream and riparian habitat, which includes enhanced juvenile salmonid rearing habitat,
- Providing flood refuge for fish by decreasing water velocities within a corridor of newly restored riparian forest in an area that currently is occupied by the existing Reddington Levee,
- Adding large wood to improve habitat complexity and enhance juvenile rearing habitat, and
- Acquiring land that will allow not only the levee setback, but also permanent protection of existing and newly planted vegetation that over time will increase shoreline and channel shading, support the riparian food web, and improve fish and wildlife habitat adjacent to and within the river channel.

## Project Actions

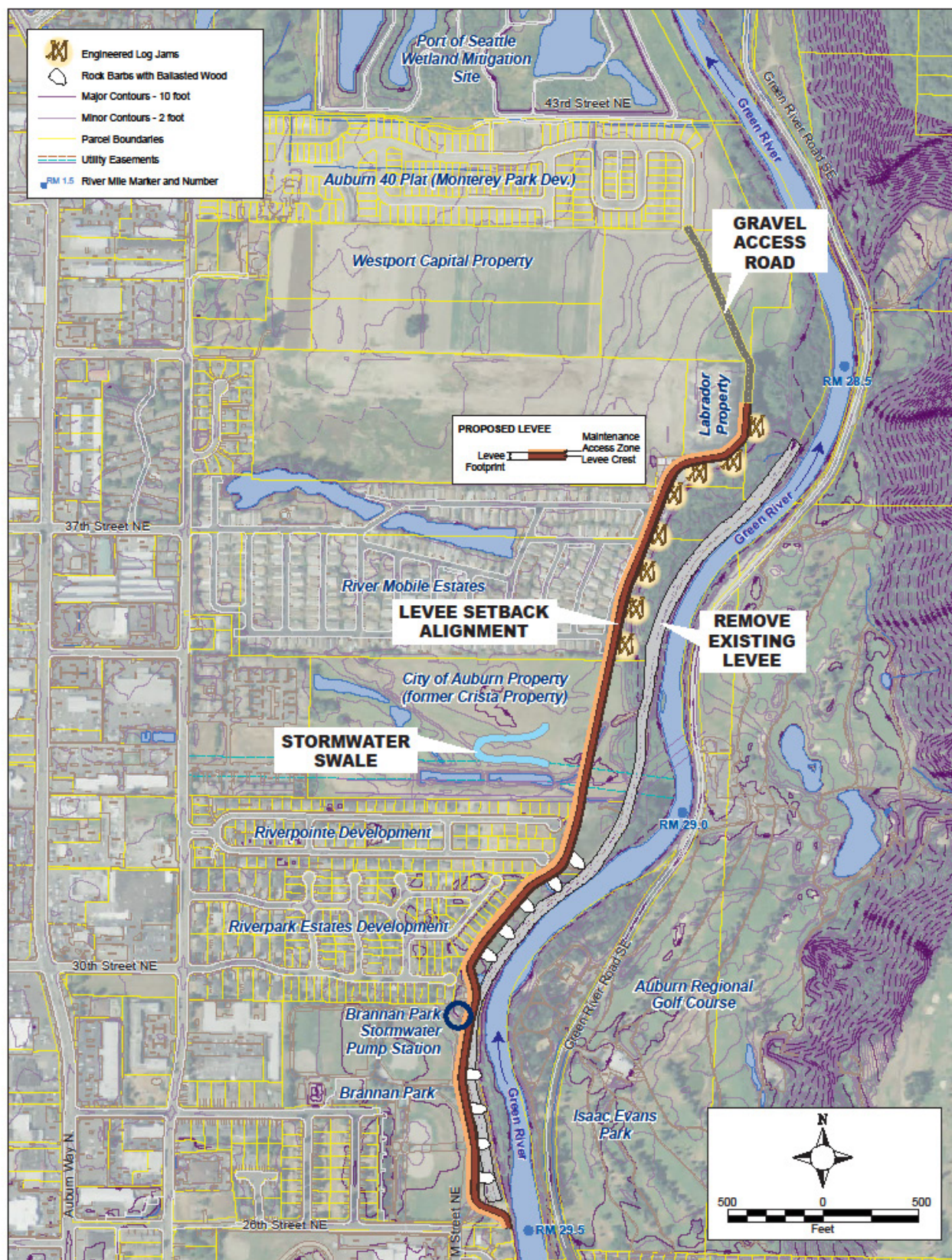
The following actions will be implemented to achieve the above-stated habitat objectives, as well as meet flood risk reduction objectives for the King County Flood Control District (Figure 2):

- Removal of approximately 4,700 linear feet (LF) of existing levee prism and rock revetment (RM 28.6-29.5),
- Construction of approximately 4,800 LF of setback levee (RM 28.6 to 29.5, from the north end of River Mobile Estates south to 26<sup>th</sup> Street NE); a gravel construction and maintenance access road will connect the north end of the levee to R Street,
- Construction of nine buried rock barbs (landward of the existing river channel) that will deflect erosive flows away from the toe of the setback levee and encourage formation of floodplain alcoves and riparian forest,
- Installation of approximately 122 key pieces of large wood between the rock barbs; the log jams in the three excavated alcoves will also include 54 pieces of racking wood and additional slash,
- Reconnection of Wetland E with the active river channel. This wetland was historically part of the active river channel. Levee removal and notching will allow riverine flow-through hydrology to the wetland, thereby restoring natural wetland and riverine conditions,
- Construction of eight ELJs (a total of 112 key pieces and 112 pieces of racking wood) in Wetland E designed to roughen the channel edge and provide salmonid rearing and refuge habitat,
- Excavation of three shallow alcoves between Barbs 6-9 to immediately provide juvenile salmonid rearing and refuge habitat as well as to create at least 0.44 acres of wetland (side channel inlet and outlet excavation may also create some wetland areas),

## Reddington Levee Setback Project Monitoring Plan

- Revegetation and enhancement of approximately 19 acres of riparian and wetland buffer on the left and right banks. The planting includes approximately 4,200 trees, 7,000 shrubs, and 9,000 willow stakes (stake count includes willow lifts in left bank revetments),
- Acquisition and demolition of residential structures to maximize the restored river corridor provided by the levee setback, and
- Utility construction and relocation.





## Reddington Levee Setback

## PROJECT ELEMENTS

Figure 2. Reddington Levee Setback Project elements.



## Performance Standards

Monitoring objectives and performance standards are designed to determine project effectiveness (Table 1).

**Table 1.** Performance standards.

Category	Indicator	Objective	Performance Standards	Adaptive Management
Project Implementation	As-built condition	Project is constructed according to design specifications.	As built condition satisfies design objectives.	N/A; adjustments to meet design specifications made during construction.
Habitat Benefit	Aquatic habitat	The area of slow-water edge habitat will increase.	Increased area <1.5 ft/sec at average daily discharge during Chinook rearing (~1800 cfs).	Project objective not met.
		The side channel at the RME wetland will provide Chinook rearing habitat.	Flow through the side channel at least 25% of the time during Jan-Jun.	Large wood placement or excavation may be considered.
	Placed wood	Engineered log jams and ballasted logs resist significant lateral displacement.	The key pieces are stable and remain within the project segment.	Reposition/reanchor wood as necessary for public safety or habitat benefit.
	Riparian cover	Installed plants survive.	80% survival <sup>1</sup> at end of Year 1 growing season for all installed trees and shrubs (excluding stakes) in Planting Zones A, C, D, E, F, G, and H.	Additional planting or maintenance needed.
			80% survival <sup>1</sup> in Years 1 through 5 for all installed trees in Planting Zones I, J, K, and L (right bank).	Additional planting or maintenance needed.
		Installed plants, as well as volunteers of desirable native woody species, form a healthy canopy cover.	Cover by installed trees and shrubs, including cover by volunteers of desirable native woody species, in Planting Zones A, C, D, E, G (excluding willow-planted areas), and H: Year 2 at least 15%, Year 3 at least 20%, Year 5 at least 40%, Year 7 at least 60%, and Year 10 at least 75%.	Additional planting or maintenance needed.
			Cover by installed trees and shrubs, including cover by volunteers of desirable native woody species, in Planting Zones F and the wetted area of Zone G: Year 2 at least 15%, Year 3 at least 25%, Year 5 at least 50%, Year 7 at least 70%, and Year 10 at least 80%.	Additional planting or maintenance needed.
			Cover by installed cottonwood stakes, including cover by volunteers of desirable native woody species, in Planting Zone B: Year 2 at least 5%, Year 3 at least 10%, Year 5 at least 25%, Year 7 at least 40%, and Year 10 at least 50%.	Performance standards may need to be altered in the future due to expected channel movement in this area.
			Rock barbs allow a vegetated riparian buffer to form between river and setback levee.	Additional planting may be warranted; reconsider design approach in similar settings.
	Invasive cover	Invasive plant cover is minimized due to native revegetation.	Less than 10% invasive cover in planted areas (0% for KC Class A noxious weeds, bindweed, and knotweed).	Additional maintenance needed.
	Wetlands	Wetland characteristics are evident in excavated areas.	At least 0.44 acres of riverine wetland created.	To be determined depending on conditions.
		Wetland area temporarily impacted by construction is restored.	0.51 acres temporarily impacted in Wetland E restored as Waters of the US (wetland habitat condition or stream side channel).	To be determined depending on conditions.

<sup>1</sup>Only installed plants count towards achieving the Survival Performance Standard; volunteers do not count.

## Monitoring Strategy

This monitoring plan will help evaluate the effectiveness of project elements intended to restore habitat and mitigate for project-related impacts.

## Monitoring Purpose

An understanding of natural floodplain processes and baseline conditions is essential for planning river and floodplain restoration projects and for evaluating effectiveness (Pess et al. 2005; Ward et al. 2001). Because the science of floodplain restoration is still in development, restoration actions should be viewed as experimental manipulations linked to explicit hypotheses (Pess et al. 2005). The purpose of this monitoring plan is to evaluate whether a large-scale levee setback project on the lower Green River effectively meets the stated project goals and objectives and is able to test the monitoring hypotheses.

The purpose of this habitat monitoring effort is to:

1. Ensure the project satisfies habitat design objectives (Implementation Monitoring),
2. Determine whether levee setback project actions are producing the intended habitat effects on floodplain reconnection, wetland creation, and aquatic habitat conditions (Effectiveness Monitoring), and
3. Improve habitat design, construction, and maintenance practices using monitoring results (Adaptive Management).

## Audience

The primary audiences for implementation and effectiveness monitoring results include:

1. King County staff – Results will be shared to inform future project design, construction, and monitoring protocols, as well as project maintenance needs. The reporting format includes presentations, monitoring reports, and access to real-time data.
2. Regulatory agencies – Monitoring results will allow regulatory agencies to determine whether performance standards are being met, as well as inform review of future projects with similar elements. Monitoring reports will be submitted to the US Army Corps of Engineers in Years 1, 2, 3, 4, 5, 7, and 10.
3. Key stakeholders – The results of this study will be shared with project stakeholders including the Muckleshoot Indian Tribe, the Water Resource Inventory Area (WRIA) 9 Forum, and the City of Auburn. The reporting format includes presentations and monitoring reports.
4. Scientific community – This study will add to a growing body of research into the effects of large-scale levee setback projects on channel processes and habitat conditions, as well as the efficacy of levee setbacks for flood risk reduction in managed rivers.

## Monitoring Design

The project reach will be monitored before and after project implementation to measure changes in physical and biological process as well as to assess the ability of the project to meet its stated objectives. A control reach will be used where appropriate to account for variability related to environmental fluctuations (Roni et al. 2005).

## Monitoring Tasks and Objectives

This section explains the specific steps that will be followed to measure performance indicators (Table 2).

**Table 2.** Monitoring objectives, data needs, and outputs.

Category	Indicator	Performance Standard	Task	Monitoring Method	Timing (Years)	Output
Project Implementation	As-built condition	As built condition satisfies design objectives.	1	Manage construction to ensure project satisfies design objectives; Produce record drawings.	Immediately post-construction	Record drawings
Habitat Benefit	Aquatic habitat	Increased area <1.5 ft/sec at average daily discharge during Chinook rearing (~1800 cfs).	2	Map slow water areas on channel margins at flows representing 50th, 75, and 90th percentile flows during Jan-Jun	1, 5, 10	Change in edge habitat area relative to baseline
		Flow through the side channel at least 25% of the time during Jan-Jun.	3	Document side channel flow conditions during Jan-Jun rearing period using time lapse photography.	1, 3, 5, 7, 10	% of days side channel connected to mainstem
	Placed wood	The key pieces are stable and remain within the project segment.	4	Document stability	1, 5, 10; following Phase III floods	Visual assessment of change
	Riparian cover	80% survival at end of Year 1 growing season for all installed trees and shrubs (excluding stakes) in Planting Zones A, C, D, E, F, G, and H.	5	Fixed plots	1	Percent survival of installed plants
		80% survival in Years 1 through 5 for all installed trees in Planting Zones I, J, K, and L (right bank).	6	Plant tallies	1, 2, 3, 4, 5	Percent survival of all installed plants
		Cover by installed trees and shrubs, including cover by volunteers of desirable native woody species, in Planting Zones A, C, D, E, G (excluding willow-planted areas), and H: Year 2 at least 15%, Year 3 at least 20%, Year 5 at least 40%, Year 7 at least 60%, and Year 10 at least 75%.	7	Fixed plots <sup>1</sup>	1, 2, 3, 4, 5, 7, 10	Percent cover of native installed and volunteer woody vegetation (trees and shrubs)
		Cover by installed trees and shrubs, including cover by volunteers of desirable native woody species, in Planting Zones F and the wetted area of Zone G: Year 2 at least 15%, Year 3 at least 25%, Year 5 at least 50%, Year 7 at least 70%, and Year 10 at least 80%.		See Task 7	1, 2, 3, 4, 5, 7, 10	Percent cover of native installed and volunteer woody vegetation (trees and shrubs)
		Cover by installed cottonwood stakes, including cover by volunteers of desirable native woody species, in Planting Zone B: Year 2 at least 5%, Year 3 at least 10%, Year 5 at least 25%, Year 7 at least 40%, and Year 10 at least 50%.		See Task 7	1, 2, 3, 4, 5, 7, 10	Percent cover of native installed and volunteer woody vegetation (trees and shrubs)
		Average vegetated riparian buffer width of 30 feet in Planting Zones G and H.	8	Use ground survey and digital airphotos to measure buffer width at fixed cross-sections	1, 5, 10	Minimum, average, and maximum buffer width.
	Invasive cover	Less than 10% invasive cover in planted areas (0% for KC Class A noxious weeds, bindweed, and knotweed).		See Task 7. Use fixed plots to measure percent cover of invasive plants. Survey entire area for invasive vegetation.	1, 2, 3, 4, 5, 7, 10	Percent cover of invasive plants
	Wetlands	At least 0.44 acres of riverine wetland created.	9	Wetland delineation at Year 5	5	Area of created wetland; Wetland delineation report
		0.51 acres temporarily impacted in Wetland E restored as Waters of the US (wetland habitat condition or stream side channel).		See Task 9. Document soils, vegetation, and hydrology in areas of temporary wetland impact.	5	Wetland delineation report

<sup>1</sup>Make observations of general site and habitat conditions as well as fish and wildlife use of the project site on datasheets.

## Monitoring Schedule

All indicators will be sampled at the project site (Table 3). A control site may be used for edge mapping to account for environmental variability.

**Table 3.** Monitoring schedule.

Task	Objectives	Pre-Construction	Post-Construction							
			Baseline	Year 1 2014	Year 2 2015	Year 3 2016	Year 4 2017	Year 5 2018	Year 7 2020	Year 10 2023
1	Record drawings		X							
2	Edge habitat	X		X				X		X
3	Side channel connectivity			X		X		X	X	X
4	Log stability*			X				X		X
5	Plant survival in plots			X	X	X	X	X	X	X
6	Total plant survival (right bank)			X	X	X	X	X		
7	Percent vegetative cover			X	X	X	X	X	X	X
8	Vegetated buffer width			X				X		X
9	Wetland delineation	X						X		

\*Additional sampling following Phase III flood events

## Project Implementation Monitoring Protocols

Upon completion of the project, the design drawings will be updated to become record drawings. The information for these record drawings comes from the Contractor's daily record drawings as well as the Project Representative's field records (daily records, photographs, inspection reports, field directives, and possible change orders) and post-construction site survey. Record drawings represent the best information available as to where improvements and changes from the original design have been made during construction due to unanticipated conditions encountered in the field. The record drawings will show sufficient detail to allow location of these improvements and changes for future monitoring or maintenance.

## Monitoring Protocols for Habitat Benefit Indicators

### General Site Conditions

Surveyors will note general site and habitat conditions on field datasheets. This should include observed fish and wildlife use (direct observation of live or dead animals or indirect observation of prints, scat, etc.), general patterns of vegetation condition, invasive vegetation, illegal use or dumping, deformation or damage (movement of installed wood, bank erosion, etc.), and anything else considered worth noting.

### Aquatic Habitat

The primary focus of aquatic habitat surveys will be to determine how the amount, type, and distribution of low-velocity edge habitat (hydraulic refuge) changes with flow following project implementation. Edge habitats are generally characterized by shallow and low velocity water and fine substrate and have been shown to be important for juvenile salmonids, particularly Chinook (Bjornn 1971; Hillman et al. 1987). This sampling will focus on the channel margins, and habitats will be classified as bar, bank, backwater, or side channel (Beechie et al. 2005).



The margin of the wetted channel will be mapped on foot by GPS (<20cm accuracy). The midstream (waterward) margin of the edge habitat will be located with a flow meter (where water velocity is approximately <0.45m/sec) and the slow-water boundary mapped at multiple points by GPS. Points and water margins will be transferred to a GIS and to permit the area, number, and distribution of low-velocity edges to be quantified for each habitat type.

The surveys will be repeated in exactly the same way at three flow levels (+/- 5%), corresponding to the 50<sup>th</sup>, 75<sup>th</sup>, and 90<sup>th</sup> percentile flows at the Auburn gage (12113000), during the January – June Chinook rearing period. Flow levels are classified according to USGS conventions; daily flows between the 25<sup>th</sup> and 75<sup>th</sup> percentile are considered 'normal', and flows greater than the 75<sup>th</sup> percentile are considered 'above normal'.

- 'Normal' or median: 1440 cfs (1368-1512)
- 'Above normal': 2110 cfs (2005-2216)
- 'High': 3150 cfs (2993-3308)

The side channel adjacent to the River Mobile Estates will be monitored using mounted game cameras, set to take photos one time per day during the January to June rearing period. The cameras will be mounted at the upstream inlet and the downstream inlet to allow for analysis of flow-through conditions.

### Placed Wood

Photopoints will be established to document location and character of installed wood structures. The photopoints will be located with GPS. The physical function of jams and pieces will be noted as: pool scour, bar formation, bank stabilization, flow splitting, meander geometry, and sediment trapping. The ecological functions will be noted as vegetation regeneration, juvenile salmonid cover, juvenile salmonid rearing habitat, and adult holding habitat. Non-ballasted wood (i.e., wood installed as racking wood and wood that recruits in the future) will be described using an alphanumeric code (Montgomery 2008).

### Plant Performance and Invasive Cover

Vegetation monitoring transects and plots will be established in each left bank planting zone to evaluate plant survival, native plant cover, and invasive plant cover. Transects will not cross planting zones, and will be established in Monitoring Year 1. A photo monitoring point will be established at the beginning and end of each transect looking along the transect. The beginning and end of each transect will be permanently established using a stake and recorded using GPS. Some transects in the active floodplain (particularly Planting Zone B) may become inaccessible as channel complexity increases following construction. Reasonable effort will be made to access transects, but if access is unsafe or impossible, these transects may have to be abandoned. A sufficient number of appropriately-sized monitoring plots will be established along each transect to accurately represent the planting areas. The planting plan can be found in Appendix A of this monitoring plan.

### Plant Survival

Plant survival will be measured in the left bank Planting Zones A, C, D, E, F, G, and H at the end of the growing season approximately one year after installation (Year 1). Surveyors will walk along the

transects (tape stretched between the stakes), recording all installed plants within a rectangular band centered on the transect. Surveyors will note the species and whether the plant is alive or dead. Survival does not need to be recorded for stake plantings. Planting Zone B only contains cottonwood stakes, so percent survival will not be estimated in this area.

Installed plants in Planting Zones I, J, K, and L (right bank plantings) will be counted in Years 1, 2, 3, 4, and 5 to estimate survival.

80% survival is the performance measure for installed plants (with the exception of willow and cottonwood stakes). Replanting will occur in the wet season following each monitoring year if this performance standard is not met.

### *Native Vegetation Cover*

Percent cover of installed trees and shrubs, including cover by volunteers of desirable native woody species, will be measured in the monitoring plots along the permanent transects in the left bank Planting Zones A, B, C, D, E, F, G, and H in Years 1, 2, 3, 4, 5, 7, and 10. Monitoring will occur in the end of the growing season each year (between mid-August and mid-September).

Percent cover will not be measured in the right bank Planting Zones I, J, K, and L.

### *Invasive Species*

Percent cover of invasive plant species will be measured in the left bank permanent plots (Planting Zones A, B, C, D, E, F, G, and H) in Years 1, 2, 3, 4, 5, 7, and 10. In addition, general surveys for invasive species will occur during regular monitoring and site inspections. Infestations of invasive species will be noted for removal. If any King County Class A noxious weeds, field bindweed, or knotweed (includes Bohemian, Japanese, giant and Himalayan knotweed) are discovered during monitoring and site inspection, measures will be taken to eradicate them.

### *Regeneration*

Tree and invasive species regeneration will be measured in Planting Zone B at five locations along the transect within 1-m<sup>2</sup> quadrats. The purpose of this is to measure regeneration rates at this site as compared to other project sites within King County. Trees will be classified by species and seedling versus non-seedling. Five 4-m<sup>2</sup> quadrats will be established at the same locations along the transect. Invasive species will be identified and classified as seedling or non-seedling within these quadrats.

### *Wetlands*

A wetland delineation will be conducted five years after project implementation to establish new wetland boundaries and assess the following:

- whether excavation between Barbs 6-9 and at the inlet and outlet of the side channel fostered the development of wetland characteristics,
- whether site evolution affected wetland extents, and
- whether the areas of temporary construction impacts to wetlands were restored to Waters of the US (either wetland habitat condition or stream side channel).

Delineation techniques will be performed in accordance with the U.S. Army Corps of Engineers' Wetland Delineation Manual (U.S. Army Corps of Engineers 1987) as well as the Regional Supplement for the Western Mountains, Valleys, and Coast Region (U.S. Army Corps of Engineers 2010). Wetland flags or stakes will be installed along the wetland boundary and the flag locations will be recorded using GPS.

## **Adaptive Management**

The expected outcomes of this study are:

- Quantitative evaluation of the effectiveness of a large-scale levee setback project on the lower Green River,
- Improved certainty in the outcome of large-scale levee setback projects in mainstem rivers,
- Increased understanding of the effectiveness of levee setback projects as a river system management alternative in managed rivers,
- Empirical understanding of how habitat and watershed processes respond to a suite of project actions, and
- Increased understanding of the appropriateness of specific monitoring methods for evaluating levee setback project effectiveness.

In general, if the evidence confirms the monitoring hypotheses, the actions taken and techniques employed will be viewed as successful and worthy of application in future (similar) projects and monitoring studies. If the hypotheses are not confirmed, or the evidence remains very weak, we will use the accumulated knowledge to explain (or speculate) why the desired outcomes were not achieved. Lessons from both 'successes' and 'failures' are valuable products from this study; these lessons will be summarized in reports and presentations. The results of this study will likely provide valuable lessons and insights that can be applied to similar projects and studies in the future, and to guide adaptive management decisions.

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## **Appendix A. Planting Plan**

\\dnr.kingcounty.gov\cadd\l-rivers\CAD SUPPORT\Reddington Levee\_SB\_L\_PLANT.dwg, L5, 4/16/2013 11:20:00 AM, kkitamura, 1:2

SEC. 32, TWN. 22, R. 5 SW, W.M.

SEC. 5, TWN. 21, R. 5 NW, W.M.

CUT AND TREAT BLACKBERRY  
ALONG EDGE OF FIELD,  
APPROXIMATE WIDTH OF  
TREATMENT ZONE IS 30 FEET.

GREEN RIVER

A

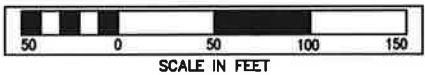
STOCKPILE 200 CY OF  
MULCH IN THESE LOCATION

STOCKPILE 200 CY OF  
MULCH IN THIS LOCATION

STOCKPILE 70 CY OF  
MULCH IN THIS LOCATION

SEC. 6, TWN. 21, R. 5 NE, W.M.

SEC. 31, TWN. 22, R. 5 SE, W.M.



NOTES:

1. ALL TREES AND SHRUBS 2-GALLON OR LARGE BARE-ROOT STOCK UNLESS OTHERWISE NOTED.
2. ALL COTTONWOOD STAKES 2-3 INCHES IN DIAMETER BY 6 FEET LONG WITH LEADERS LEFT ON WHERE POSSIBLE.
3. COTTONWOOD STAKES MAY BE REPLACED WITH POTTED STOCK.

A. Fallow Field			Area (sf)	Spacing
Trees			251,702	12
Species			Percent	Number
Cottonwood (Stakes)			50%	874
Alder			25%	437
Western Red Cedar			13%	218
Douglas Fir			13%	218
Tree Totals			100%	1747
Shrubs			123,556	7
Species			Percent	Number
Red Twig Dogwood			20%	567
Snowberry			50%	1418
Ocean Spray			10%	284
Thimbleberry			10%	284
Baldhip Rose			10%	284
Shrub Totals			100%	2837

CALL 2 WORKING DAYS  
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(UNDERGROUND UTILITY LOCATIONS ARE APPROX.)

MATCHLINE - SEE SHEET L6

NUM.	REVISION	BY	DATE
NUM.	RECORD CHANGES APPROVED	BY	DATE

APPROVED:	TOM BEAN, P.E.	3/2013
PROJECT MANAGER:	ERIK PETERS, P.E.	3/2013
DESIGNED:	ERIK PETERS, P.E.	3/2013
REVIEWED:		
CAD DESIGN:	L. TRAXINGER, K. KITAMURA	3/2013

FUNDING SOURCE No.	
PROJECT No.	1112035
CONTRACT No.	C00817C13



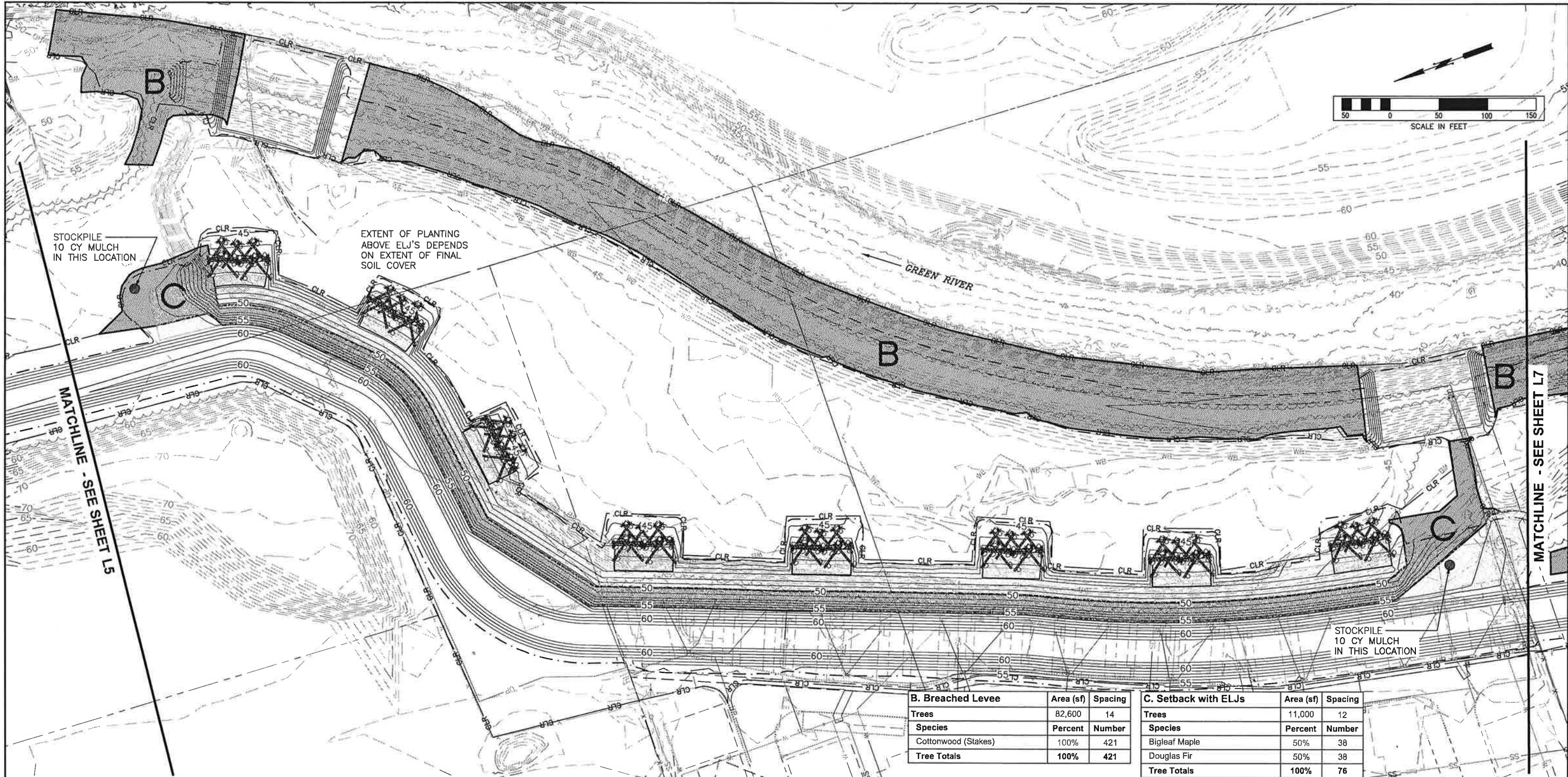
**King County**  
Department of Natural Resources and Parks  
Water and Land Resources Division  
River and Floodplain Management Section  
Christie True, Director

**REDDINGTON LEVEE SETBACK**  
  
**PLANTING PLAN**

SHEET  
L5  
OF  
107  
SHEETS



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B. Breached Levee		
		Area (sf)
Trees	Spacing	82,600
Species	Percent	Number
Cottonwood (Stakes)	100%	421
Tree Totals	100%	421

C. Setback with ELJs		
		Area (sf)
Trees	Spacing	11,000
Species	Percent	Number
Bigleaf Maple	50%	38
Douglas Fir	50%	38
Tree Totals	100%	76

		Area (sf)
	Spacing	29,000
Shrubs	Percent	Number
Dogwood	25%	166
Snowberry	40%	266
Baldhip Rose	10%	67
Black Twinberry	10%	67
Thimbleberry	15%	100
Shrub Totals	100%	666

- NOTES:**
1. ALL TREES AND SHRUBS 2-GALLON OR LARGE BARE-ROOT STOCK UNLESS OTHERWISE NOTED.
  2. ALL COTTONWOOD STAKES 2-3 INCHES IN DIAMETER BY 6 FEET LONG WITH LEADERS LEFT ON WHERE POSSIBLE.
  3. PLANTING AREA "B" MAY BE PLANTED AFTER FIRST SIGNIFICANT HIGH FLOWS.
  4. START PLANTING AREA "C" 6 FEET VERTICAL BELOW TOP OF LEVEE.

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BEFORE YOU DIG  
1-800-424-5555**  
(UNDERGROUND UTILITY LOCATIONS ARE APPROX.)

NUM.	REVISION	BY	DATE
90% DESIGN PERMIT SUBMITTAL JANUARY 2013			
NUM.	RECORD CHANGES APPROVED	BY	DATE

APPROVED: TOM BEAN, P.E.	1/2013
PROJECT MANAGER: ERIK PETERS, P.E.	1/2013
DESIGNED: ERIK PETERS, P.E.	1/2013
REVIEWED:	
CAD DESIGN: L. TRAXINGER, K. KITAMURA	1/2013

FUNDING SOURCE No.	
PROJECT No.	1112035
CONTRACT No.	C00817C13

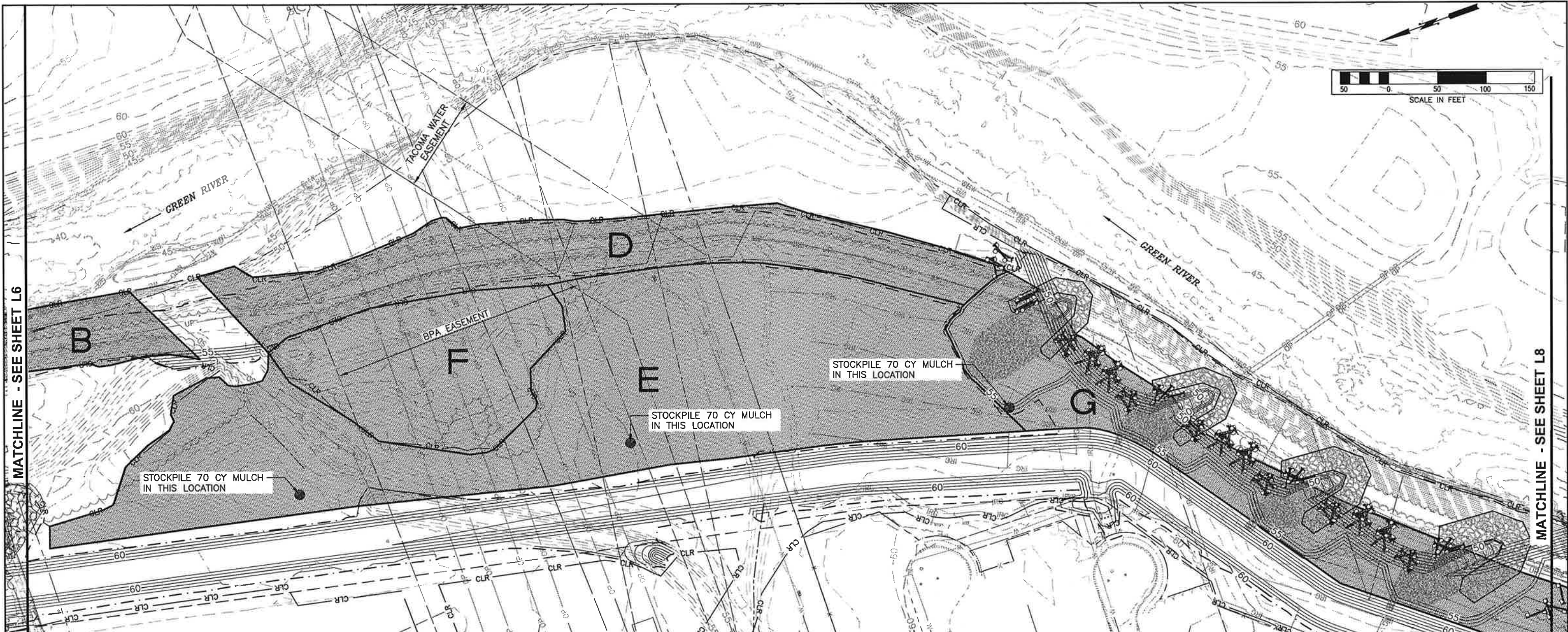
**King County**  
Department of Natural Resources and Parks  
Water and Land Resources Division  
River and Floodplain Management Section  
Christie True, Director

**REDDINGTON LEVEE SETBACK  
AND EXTENSION**  
  
**PLANTING PLAN**

SHEET  
**L6**  
OF  
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SHEETS



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NOTES:

- ALL TREES AND SHRUBS 2-GALLON OR LARGE BARE-ROOT STOCK UNLESS OTHERWISE NOTED.
- WILLOW STAKES 1-2 INCHES DIAMETER BY 6 FEET LONG.
- BLACKBERRY REMOVAL IN AREA "F" SUBJECT TO WETLAND RESTORATION REGULATIONS. PLANT ONLY SHRUBS UNDER POWERLINE ROW.
- START PLANTING AREAS "G" AND "H" 6 FEET VERTICAL BELOW TOP OF LEVEE.
- WILLOW AND OREGON ASH IN PLANTING AREAS "G" AND "H" WILL BE USED PRIMARILY BETWEEN BARBS.
- PLANTING AREA "G" AND "H" TO BE PLANTED AFTER FIRST SIGNIFICANT HIGH FLOWS.
- PLANT ONLY SHRUBS UNDER BPA EASEMENT, NO TREES.

D. Lowered Levee	Area (sf)	Spacing
Trees	29,921	12
Species	Percent	Number
Alder	40%	83
Bigleaf Maple	20%	42
Douglas Fir	20%	42
Cottonwood	20%	42
Tree Totals	100%	209
	Area (sf)	Spacing
Shrubs	47,068	7
Species	Percent	Number
Red Twig Dogwood	40%	432
Snowberry	25%	270
Black Twinberry	15%	162
Thimbleberry	10%	108
Baldhip Rose	10%	108
Shrub Totals	100%	1080

E. Powerline Area	Area (sf)	Spacing
Trees	99,840	12
Species	Percent	Number
Western Red Cedar	20%	139
Alder	30%	208
Cottonwood	30%	208
Bigleaf Maple	10%	69
Douglas Fir	10%	69
Tree Totals	100%	693
	Area (sf)	Spacing
Shrubs	123,556	7
Species	Percent	Number
Red Twig Dogwood	50%	1418
Snowberry	15%	425
Black Twinberry	15%	425
Thimbleberry	10%	284
Cluster Rose	10%	284
Shrub Totals	100%	2836

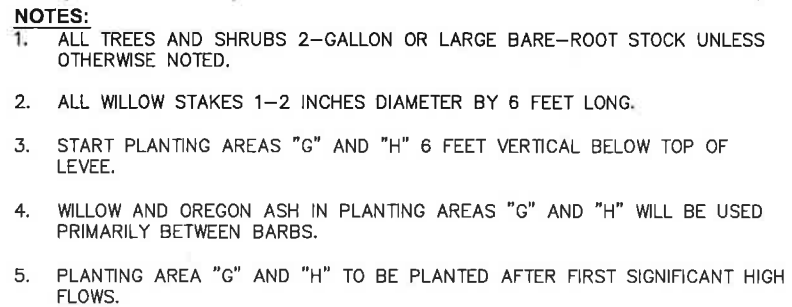
F. Blackberry Wetland	Area (sf)	Spacing
Trees	3,865	12
Species	Percent	Number
Oregon Ash	40%	11
Western Red Cedar	30%	8
Cottonwood	20%	5
Wester Red Cedar	10%	3
Tree Totals	100%	27
	Area (sf)	Spacing
Shrubs	34,967	7
Species	Percent	Number
Red Twig Dogwood	5%	40
Snowberry	15%	120
Black Twinberry	25%	201
Thimbleberry	30%	241
Cluster Rose	25%	201
Shrub Totals	100%	803

G. Downstream Barbs	Area (sf)	Spacing
Trees	71,402	12
Species	Percent	Number
Alder	20%	99
Cottonwood	30%	149
Bigleaf Maple	20%	99
Western Red Cedar	20%	99
Oregon Ash	10%	50
Tree Totals	100%	496
	Area (sf)	Spacing
Shrubs	71,402	7
Species	Percent	Number
Willow Stakes	20%	328
Red Twig Dogwood	20%	328
Snowberry	30%	492
Black Twinberry	10%	164
Thimbleberry	10%	164
Baldhip Rose	10%	164
Shrub Totals	100%	1640

CALL 2 WORKING DAYS  
BEFORE YOU DIG  
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(UNDERGROUND UTILITY LOCATIONS ARE APPROX.)

NUM.	REVISION	BY	DATE	APPROVED: TOM BEAN, P.E.	1/2013	FUNDING SOURCE No.		 King County Department of Natural Resources and Parks Water and Land Resources Division River and Floodplain Management Section Christie True, Director	REDDINGTON LEVEE SETBACK AND EXTENSION  PLANTING PLAN	SHEET L7 OF .. SHEETS
	90% DESIGN PERMIT SUBMITTAL JANUARY 2013			PROJECT MANAGER: ERIK PETERS, P.E.	1/2013	PROJECT No.	1112035			
				DESIGNED: ERIK PETERS, P.E.	1/2013	CONTRACT No.	C00817C13			
NUM.	RECORD CHANGES APPROVED	BY	DATE	REVIEWED:						
				CAD DESIGN: L. TRAXINGER, K. KITAMURA	1/2013					





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SCALE IN FEET

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(UNDERGROUND UTILITY LOCATIONS ARE APPROX.)



**King County**  
Department of Natural Resources and Parks  
Water and Land Resources Division  
**River and Floodplain Management Section**  
*Christie True, Director*

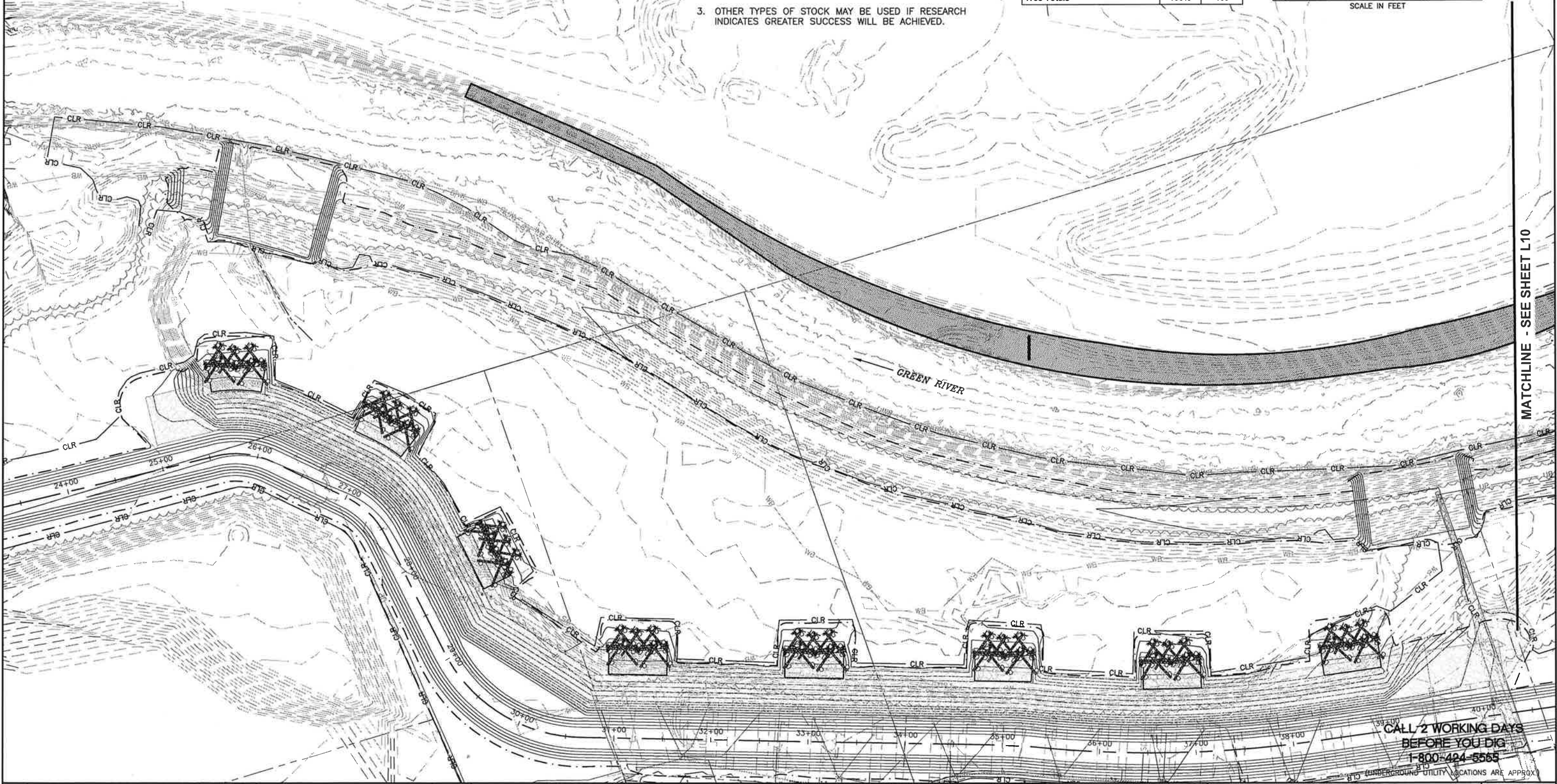
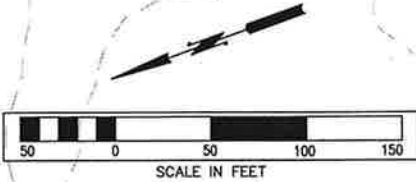
### PLANTING PLAN



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- NOTES:
1. UNLESS OTHERWISE NOTED, PREFERRED PLANT SIZE FOR THE RIGHT BANK SUPPLEMENTAL PLANTING WILL BE FIVE-GALLON STOCK.
  2. TWO GALLON OR LARGE BARE-ROOT STOCK MAY BE SUBSTITUTED IF SUFFICIENT FIVE-GALLON STOCK IS NOT AVAILABLE OR IF AN EXPERIMENTAL DESIGN FOR THE COMPARISON OF TWO- AND FIVE-GALLON PLANT SUCCESS IS DEVELOPED.
  3. OTHER TYPES OF STOCK MAY BE USED IF RESEARCH INDICATES GREATER SUCCESS WILL BE ACHIEVED.

I. Auburn Golf Revetment		
Trees	46,069	10
Species	Percent	Number
Alder	25%	115
Ash	25%	115
Douglas Fir	25%	115
Bigleaf Maple	25%	115
Tree Totals	100%	460



NUM.	REVISION	BY	DATE
	90% DESIGN PERMIT SUBMITTAL JANUARY 2013		
	RECORD CHANGES APPROVED		

APPROVED: TOM BEAN, P.E.	1/2013
PROJECT MANAGER: ERIK PETERS, P.E.	1/2013
DESIGNED: ERIK PETERS, P.E.	1/2013
REVIEWED:	
CAD DESIGN: L. TRAXINGER, K. KITAMURA	1/2013

FUNDING SOURCE No.	
PROJECT No.	1112035
CONTRACT No.	C00817C13



REDDINGTON LEVEE SETBACK AND EXTENSION  
RIGHT BANK SUPPLEMENTAL PLANTING PLAN

SHEET  
L9  
OF  
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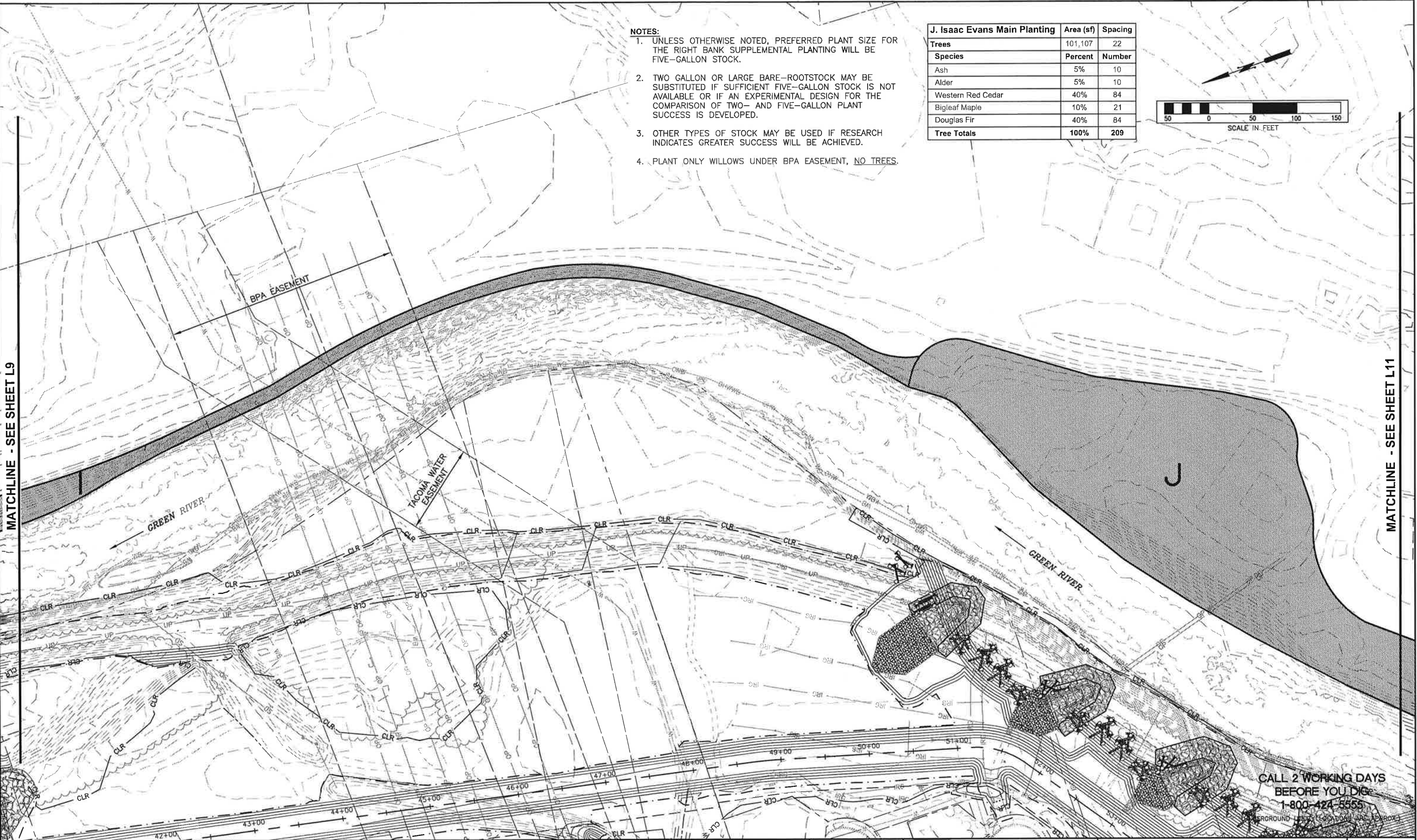
UNDERGROUND UTILITY LOCATIONS ARE APPROX.

MATCHLINE - SEE SHEET L10



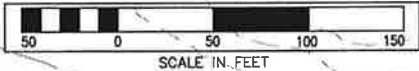
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MATCHLINE - SEE SHEET L9



- NOTES:
1. UNLESS OTHERWISE NOTED, PREFERRED PLANT SIZE FOR THE RIGHT BANK SUPPLEMENTAL PLANTING WILL BE FIVE-GALLON STOCK.
  2. TWO GALLON OR LARGE BARE-ROOTSTOCK MAY BE SUBSTITUTED IF SUFFICIENT FIVE-GALLON STOCK IS NOT AVAILABLE OR IF AN EXPERIMENTAL DESIGN FOR THE COMPARISON OF TWO- AND FIVE-GALLON PLANT SUCCESS IS DEVELOPED.
  3. OTHER TYPES OF STOCK MAY BE USED IF RESEARCH INDICATES GREATER SUCCESS WILL BE ACHIEVED.
  4. PLANT ONLY WILLOWS UNDER BPA EASEMENT, NO TREES.

J. Isaac Evans Main Planting		
Trees	Area (sf)	Spacing
Species	Percent	Number
Ash	5%	10
Alder	5%	10
Western Red Cedar	40%	84
Bigleaf Maple	10%	21
Douglas Fir	40%	84
Tree Totals	100%	209



MATCHLINE - SEE SHEET L11

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NUM.	REVISION	BY	DATE	APPROVED: TOM BEAN, P.E.	1/2013	FUNDING SOURCE No.		 <b>King County</b> Department of Natural Resources and Parks Water and Land Resources Division River and Floodplain Management Section <i>Christie True, Director</i>	<b>REDDINGTON LEVEE SETBACK AND EXTENSION</b>  <b>RIGHT BANK SUPPLEMENTAL PLANTING PLAN</b>	SHEET <b>L10</b> OF .. SHEETS
				PROJECT MANAGER: ERIK PETERS, P.E.	1/2013	PROJECT No. 1112035				
				DESIGNED: ERIK PETERS, P.E.	1/2013	CONTRACT No. C00817C13				
NUM.	RECORD CHANGES APPROVED	BY	DATE	REVIEWED:						
				CAD DESIGN: L. TRAXINGER, K. KITAMURA	1/2013					



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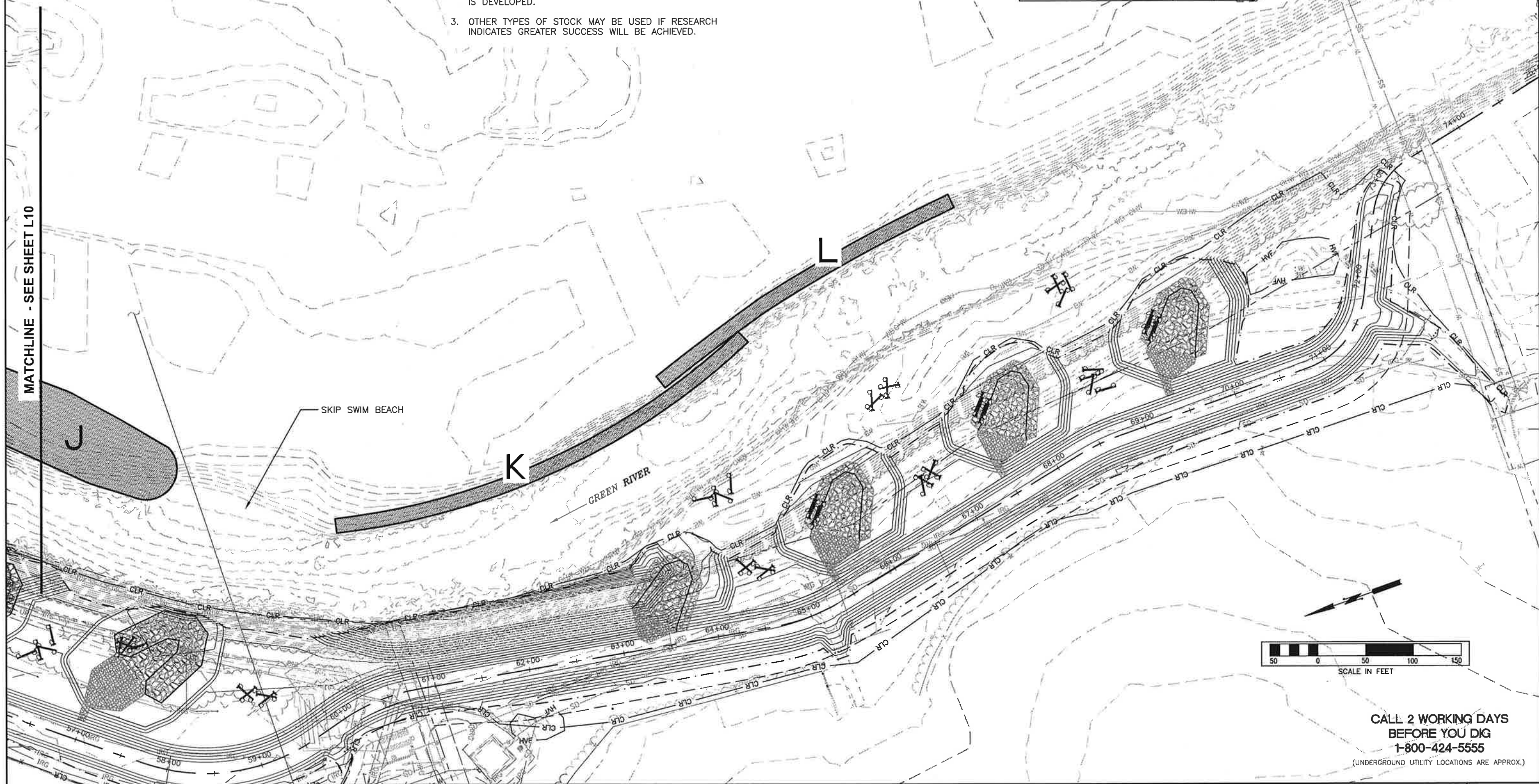
MATCHLINE - SEE SHEET L10

NOTES:

1. UNLESS OTHERWISE NOTED, PREFERRED PLANT SIZE FOR THE RIGHT BANK SUPPLEMENTAL PLANTING WILL BE FIVE-GALLON STOCK.
2. TWO GALLON OR LARGE BARE-ROOT STOCK MAY BE SUBSTITUTED IF SUFFICIENT FIVE-GALLON STOCK IS NOT AVAILABLE OR IF AN EXPERIMENTAL DESIGN FOR THE COMPARISON OF TWO- AND FIVE-GALLON PLANT SUCCESS IS DEVELOPED.
3. OTHER TYPES OF STOCK MAY BE USED IF RESEARCH INDICATES GREATER SUCCESS WILL BE ACHIEVED.

K. Isaac Evans Buffer Planting		
Trees	Area (sf)	Spacing
Species	Percent	Number
Western Red Cedar	60%	17
Douglas Fir	40%	11
Tree Totals	100%	28

L. Isaac Evans Lawn Planting		
Trees	Area (sf)	Spacing
Species	Percent	Number
Western Red Cedar	35%	18
Douglas Fir	35%	18
Bigleaf Maple	30%	15
Tree Totals	100%	51



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NUM.	RECORD CHANGES APPROVED	BY	DATE

APPROVED: TOM BEAN, P.E.	1/2013
PROJECT MANAGER: ERIK PETERS, P.E.	1/2013
DESIGNED: ERIK PETERS, P.E.	1/2013
REVIEWED:	
CAD DESIGN: L. TRAXINGER, K. KITAMURA	1/2013

FUNDING SOURCE No.	
PROJECT No.	1112035
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Department of Natural Resources and Parks  
Water and Land Resources Division  
River and Floodplain Management Section  
Christie True, Director

**REDDINGTON LEVEE SETBACK  
AND EXTENSION**  
  
**RIGHT BANK SUPPLEMENTAL PLANTING PLAN**

SHEET  
**L11**  
OF  
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