MAY CREEK EROSION STABILIZATION DRAFT REPORT

MAY CREEK SEDIMENT TRANSPORT STUDY PHASE 3

Prepared for

King County

Department of Natural Resources and Parks

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1 INTRODUCTION

This report represents Phase 3 of Anchor QEA's scope of services, and identifies conceptual restoration and stabilization actions to be taken at specific locations in a portion of the ravine reach of the May Creek basin (Coal Creek Parkway to 148th Avenue SE). Phase 1 of this effort involved site reconnaissance and the development of three monitoring sites to collect hydrologic and sediment transport data. Phase 2 included analysis of collected data and resulted in the May Creek Sediment Transport Study (Anchor QEA 2009). This report summarizes the monitoring and evaluation effort and describes the geomorphic, hydrologic, and hydraulic conditions in the May Creek reach between 148th Avenue SE and Coal Creek Parkway and the implications of these conditions on sediment transport and bank erosion through the reach.

These reports draw from and expand upon previous studies conducted through this reach and larger segments of the May Creek basin. King County (County) developed the May Creek Basin Action Plan (2001) in order to evaluate basin and reach scale issues in the May Creek Basin. This plan was based on several supporting studies that reflect conditions as reported in the May Creek Existing and Future Conditions Report, released in 1995.

The May Creek drainage basin is located on the southeast side of Lake Washington in King County, Washington (Figure 1). The basin has been increasingly developed in the past several decades, resulting in increased adverse impacts by land use on stream and floodplain processes resulting in geomorphic and ecologic effects. While erosion is an effect of natural channel evolution, urban development has undoubtedly impacted the hydrologic and geomorphic conditions of the system and led to increased erosion and sedimentation issues in various locations within the basin. The results of these impacts can be undesirable for landowners and detrimental to salmonid species that rely on May Creek for essential habitat.

A detailed site reconnaissance was performed in order to evaluate present erosion conditions throughout the reach and identify potential project sites. Based on the results of this reconnaissance, conceptual projects were identified based on criteria developed to reduce erosion and restore instream and riparian habitat. The implementation of these projects will be considered in conjunction with activities proposed in King County. This report has been

prepared as a complementary document to the Conceptual Restoration Plan: May Creek Habitat Restoration Project Geoengineers 2008, a study that identified recommended actions in the valley reach upstream of 148th Avenue SE.

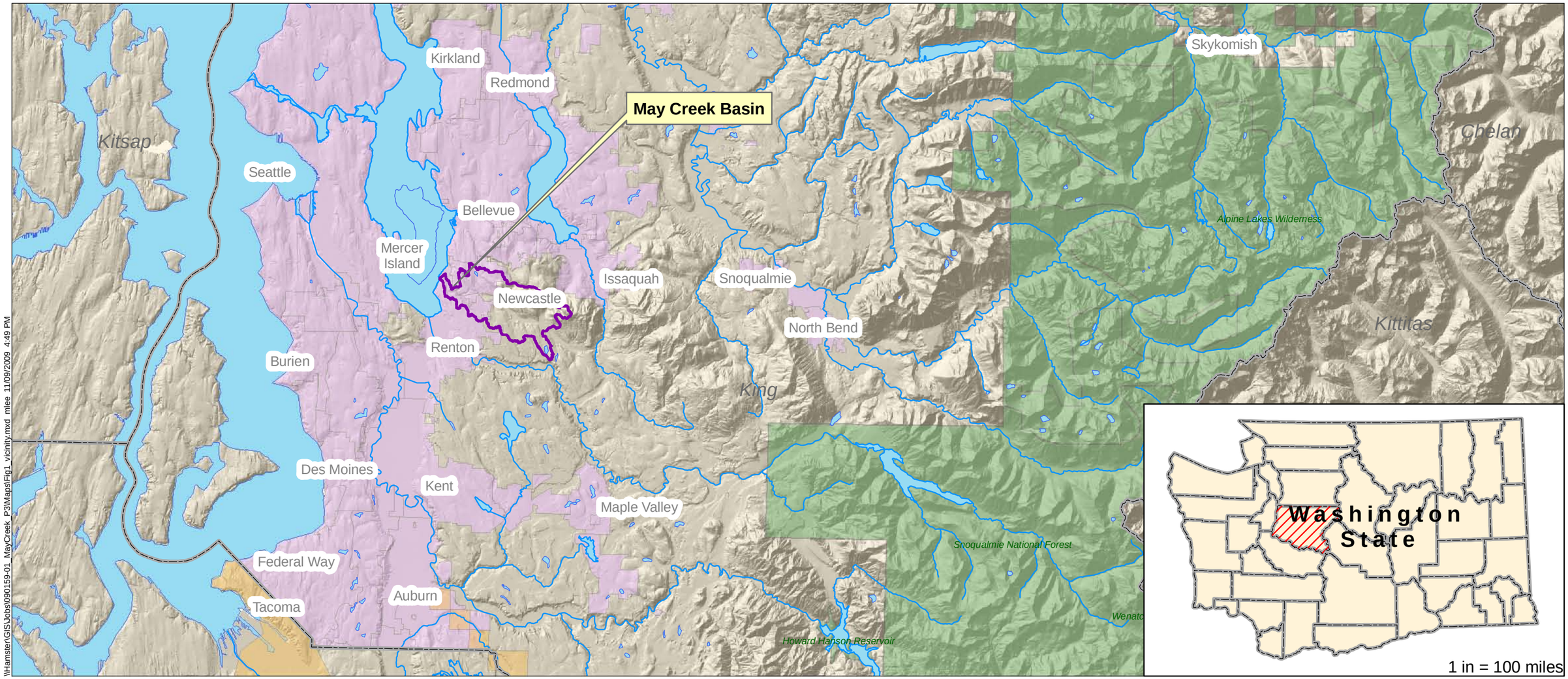


Figure 1
Vicinity Map
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

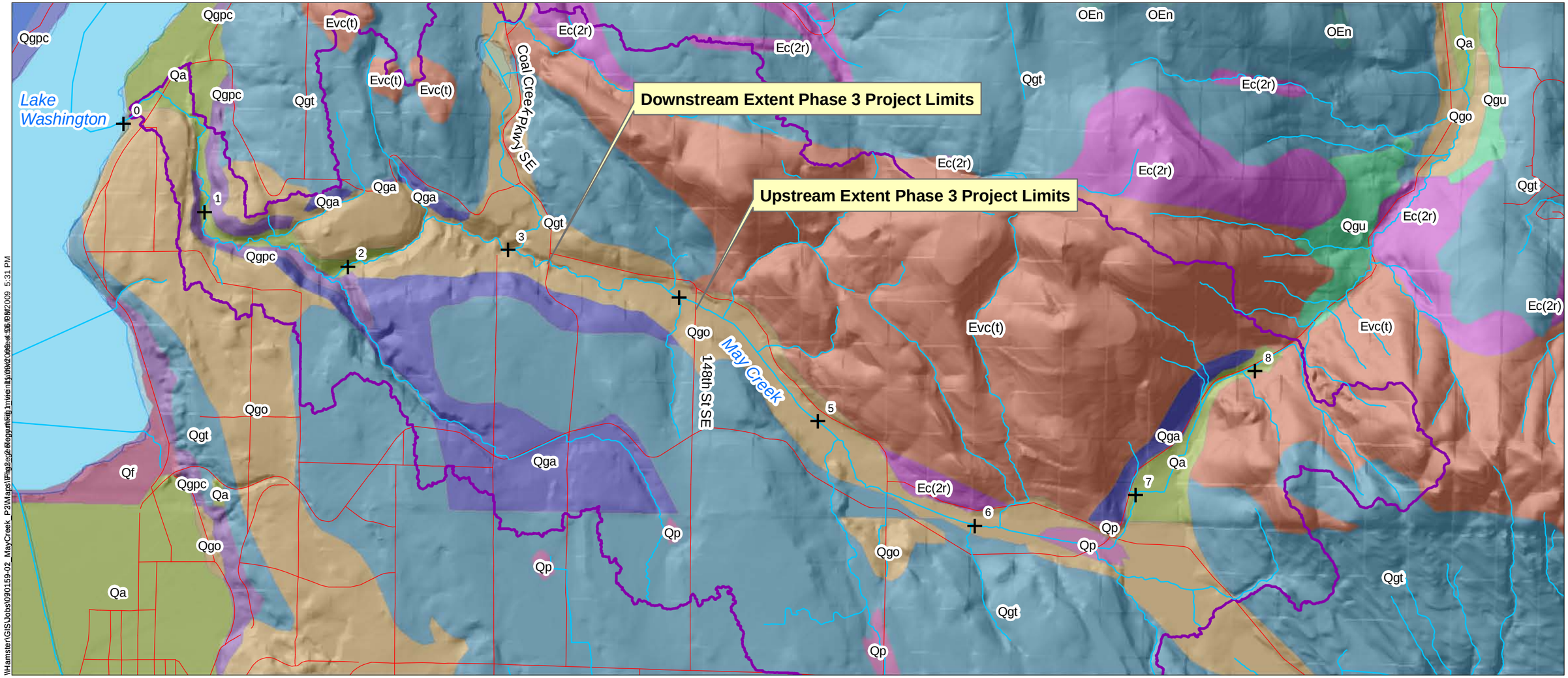
2 GEOLOGIC SETTING

2.1 Regional Setting

The May Creek basin is located in the greater Cedar-Sammamish River basin and outlets into Lake Washington. The basin is composed of high-relief sedimentary and volcanic bedrock on the northeastern side of the valley, and Vashon glacial sediments that have infilled a subsurface trough of bedrock through the remainder of the valley (Figure 2). Following bedrock formation in the Eocene, several periods of glaciation occurred that reached Western Washington. The most prominent of these events for the May Creek basin is the Vashon Stade, which began approximately 16,500 years before present. A majority of the glacial sediments observed at the surface are from the Vashon Stade. Till material deposited by the ice and compacted during glacial occupation underlies the valley bottom and is present at the surface throughout much of the basin. As the ice retreated, large quantities of meltwater flowed through the May Creek valley, widening the valley bottom to what is observed today. As the volume of water lessened and the capacity to flush large volumes of available sediment through the system decreased, the valley bottom was filled with recessional outwash deposits. These deposits are highly erodible and presently account for much of the sediment contribution to the stream. Incision into these glacial sediments since the end of the glacial period led to the creation of steep valley walls via stream erosion and mass wasting. Continued incision and ongoing present-day geomorphic processes have led to the current geography and geomorphic conditions of May Creek.

2.2 Basin-Scale Geomorphology

May Creek originates in the steep topography of the Cascade Foothills and flows out into the wide, shallow May Valley (Figure 2). The stream drops off steeply as it enters the ravine area, eventually flowing into Lake Washington. The longitudinal profile shown in Chart 1 is indicative of incision following the last glaciation which continues to occur into the present day as the headcut advances up the valley through the ravine reach. Within the longitudinal profile, the project reach is located near the transition in grade from low and flat (valley) to high and steep (ravine). This transition may be controlled by a number of geologic features including an unidentified bedrock hardpoint. This grade control along with weirs and other structures downstream of 148th Avenue SE have likely prevented the headcut from



LEGEND

- Approx. River Miles
- Streams
- Roads
- May Creek Basin
- Qf - Artificial Fill
- Qp - Peat Deposits/Peat Bog
- Qa - Alluvium
- Qls - Landslide Deposits
- Qgu - Glacial Drift, Undivided
- Qgt - Glacial Till
- Qgo - Undiff. Glacial Outwash
- Qga - Glacial Advance Outwash
- Qgpc - Continental Glacial Drift
- OEn - Nearshore Sedimentary Rocks
- OEm - Marine Sedimentary Rocks
- Ec(2r) - Continental Sed. Deposits/Rocks
- Evc(t) - Volcaniclastic Deposits/Rocks
- Water

Miles
0 0.25 0.5 0.75 1

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Figure 2
Surficial Geology Map
May Creek Erosion Stabilization Report
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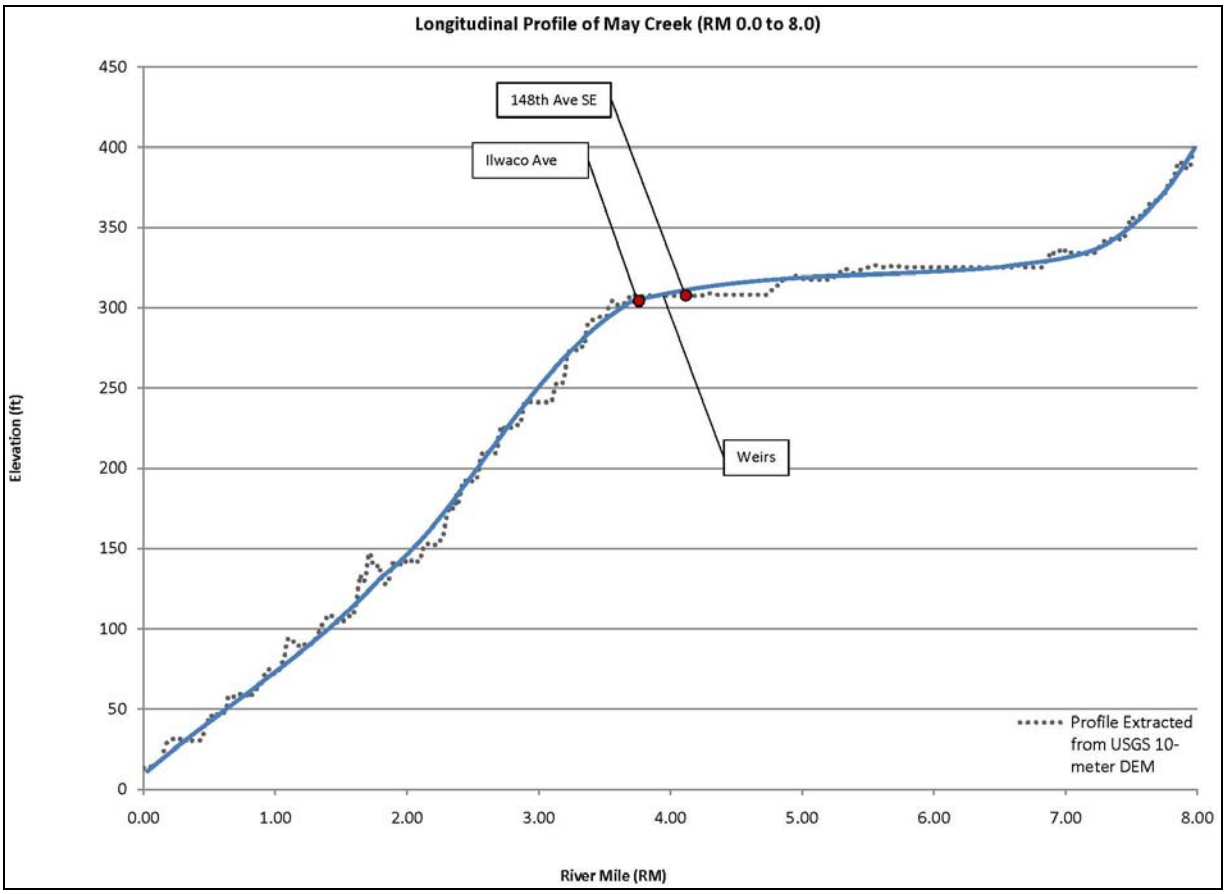
migrating upstream of the ravine. Downstream of 148th Avenue SE, incision continues to be the major source of channel erosion, as well as the dominant geomorphic process affecting channel dynamics within the project reach.

Chart 1

Longitudinal Profile of May Creek from USGS 10-meter DEM



2.3 Reach-Scale Geomorphology

Chart 1 displays the basin scale geomorphic processes within the May Creek valley, however it is important to note that similar micro scale perturbations in the channel grade exist within the project reach that are important to understand when evaluating sites and designing for stabilization or habitat concerns. These micro features are formed by concentrated areas of lag deposits composed of larger clasts than present in the bed load of the creek. These areas have formed boulder runs that slow the effect of incision-related erosion. Boulder runs are sections of the stream where a steep grade is held by larger boulder

materials with a pool on the downstream end. These boulder runs typically unravel from the bottom up as boulders near the downstream end unravel into the pool. In this way, these areas inhibit, but do not halt, the incision process. Therefore, on a micro scale there are a series of small scale headcuts in the reach within the larger basin scale incised area. The overall effect on the channel profile is a stepped configuration with alternating flatter and steeper sections.

2.4 Geomorphic Implications on Stabilization and Habitat Restoration

Channel incision is occurring on a basin scale within the May Valley and micro scale headcuts within the reach raise concerns about future stabilization and habitat restoration within the reach. Our reconnaissance identified numerous human infrastructure placements that have experienced the effects of bed lowering and have become undercut. Additional concrete placement or large rock has been placed to mitigate for these effects. The presence of the log and rock weirs suggests that incision has concerned landowners in the past and these features were placed to mitigate for a perceived undesirable effect. In summary, past management actions have been taken in an attempt to combat the incision process. In some locations these actions have exacerbated conditions requiring additional management actions by property owners.

The stabilization and restoration actions considered in this report are based upon an understanding of the basin and reach scale geomorphic conditions and represent an approach to work with natural processes to achieve the desired objectives. The general approach would be to remove features that confine the channel and implement approaches that do not lock the channel in place. Stabilization approaches that rely on bioengineering and long-term riparian development are prioritized. Establishing a stream corridor that can naturally evolve without impacting private property and infrastructure or creating excessive maintenance requirements is desirable.

3 PROJECT OBJECTIVES AND APPROACH

The overall approach to reduce erosion concerns and restore or enhance habitat is to work within the geomorphic context of the Project reach understanding that existing conditions are a snapshot in time and this system is evolving. This is an important perspective when considering stabilization and restoration actions.

A site assessment was performed to evaluate geomorphic, erosion, and habitat conditions throughout the reach and to identify specific sites within the ravine reach that may or may not be suitable for implementation of a specific project action. Anchor QEA staff walked the length of the reach and documented characteristics of the streambed, banks, and floodplain. Based upon field observations, the following were evaluated or noted:

- Active erosion including bed and bank stability, and the effects of incision
- Instream and riparian habitat conditions
- Additional considerations including floodway impacts, encroachment and the affect of obstructions and other features

The following sections describe the approach greater detail.

3.1 Evaluate Erosion

3.1.1 Bank Stability

A bank stability protocol originally proposed by Henshaw & Booth (2000) for evaluation of urban watersheds in the Northwest was adapted for the purposes of identifying areas of increased erosion during the site assessment. The degree (or class) of bank stability was used as a basis for selecting favorable project sites and for determining the preferred restoration action. For example, a site with a higher degree of instability may require a bank stability treatment structure, while a stable reach does not require any treatment for erosion. Table 1 provides a summary of the physical features that were assessed by Anchor QEA staff in order to classify the banks throughout the Project area. This protocol was adapted to separately describe portions of the bank where the banks are naturally-occurring or where armoring or manmade structures such as bridges influence bank stability.

Table 1

Bank Stability Evaluation Protocol

Class	
IV	**Stable**
	Vegetation (other than grasses) to ordinary high water line No raw or undercut banks (some erosion on outside of meander bends OK with deposition on inside bank) No recently-exposed roots No recent tree falls If bank armoring is present it does not appear to contribute to overall stability, or offers little stability
IV.A	**Stable with Bank Armoring**
	Bank armoring is present and appears to be the primary source of bank stability Bank armoring appears stable and/or was observed in conjunction with the above features
III	**Slightly Unstable**
	Vegetation to ordinary high water line in most places Some scalloping of banks Minor erosion and/or bank undercutting Recently exposed tree roots rare but present If bank armoring is present it does not appear to contribute to overall stability, or offers little stability
III.A	**Slightly Unstable with Bank Armoring**
	Bank armoring is present and appears to be the primary source of bank stability Bank armoring appears to be degrading slightly or is located such that it only partially stabilizes the bank
II	**Moderately Unstable**
	Vegetation to waterline sparse (mainly scoured or stripped by lateral erosion) Bank held mainly by hard points (trees, boulders) and eroded back elsewhere Extensive erosion and bank undercutting Recently exposed tree roots and fine root hairs common If bank armoring is present it does not appear to contribute to overall stability, or offers little stability
II.A	**Moderately Unstable with Bank Armoring**
	Bank armoring is present and appears to be the primary source of bank stability Bank armoring is degrading extensively or is located such that it only stabilizes the bank somewhat
I	**Completely Unstable**
	No vegetation (other than grasses) at ordinary high water line Banks held only by hard points Severe erosion of both banks (straight runs) or outside bank with no deposition on inside bank (bends) Recently exposed tree roots common Tree falls and/or severely undercut trees common If bank armoring is present it does not appear to contribute to overall stability

Note: Adapted from Henshaw and Booth (2000).

Sites with classes less than IV or IV.A showed signs of active erosion and loss of bank materials. Minimizing excessive erosion with treatment actions would include implementing one of the stabilization options described in Appendix A, such as a log cribwall, toe protection, or slope regrading and planting.

3.1.2 Effect of Incision

In the May Creek ravine reach, incision and headcutting is the most prominent geomorphic process and in some locations is the underlying cause of erosional concerns. During site reconnaissance, Anchor QEA staff documented evidence of incision, including undercutting of infrastructure (e.g., walls or bridges) and signs of maintenance such as reinforcement of bridge abutments. Unstable banks with armoring were also an indicator of possible undercutting. Grade-controlling features such as weirs or geologic controls were noted, because these features were likely placed to combat incision. In addition, discussions with landowners living adjacent to the creek provided insight into how the bed elevation and banks have changed over time. These features were observed and documented to understand the effects and rate of incision in the reach in order to design projects that will work with these ongoing geomorphic processes.

3.2 Evaluate Habitat Conditions

3.2.1 Instream Habitat

Historically ESA-listed chinook salmon (*Oncorhynchus tshawytscha)* have been present in significant numbers in May Creek, which has been confirmed by landowners that have been living near the stream for several decades (Duffus 2009). Although they have not been documented, the stream may provide habitat for coho (*O. kisutch*), sockeye (*O. nerka*), and rainbow trout (*O. mykiss*) (King County 2001). The effects of urbanization on the watershed have led to the deterioration of suitable spawning habitat for salmonid species, one of the causes being changes in sediment transport through the channel and degradation of suitable habitat.

Preferred instream habitat for chinook includes ample deep, cold, oxygenated pools and the presence of spawning areas with spawning-sized gravels. The locations of existing pools, portions of the stream lacking in pools, excessive velocities or temperatures, gravel-starved areas, or abrupt changes in water surface elevations that may create passage barriers were noted during the site reconnaissance.

3.2.2 Riparian Habitat

With urbanization and the occupation of invasive species, habitat conditions within the riparian corridor have been degraded. The lack of suitable cover and shading, bank vegetation that traps fine sediment and adds roughness, and lack of nutrients have an adverse effect on instream and upland species. Degraded habitat conditions were observed and noted during site reconnaissance.

3.3 Additional Considerations

In addition to the evaluation of erosion and habitat conditions, other features that may have an effect on geomorphic processes or flooding were documented. The following additional factors were investigated throughout the reach:

- Manmade channel obstructions (including debris)
- Channel constrictions
- Locations of infrastructure
- Encroachment of vegetation or infrastructure

4 SITE ASSESSMENT

Anchor QEA performed a site reconnaissance and assessment for the project reach between 148th Avenue SE and Coal Creek Parkway (approximately RM 2.9 to 4.1) (Figure 3). During this reconnaissance we documented observations as described in Section 3 of this report. For the purposes of this report, the analyzed reach was stationed along the thalweg and broken down into four sub reaches in order to describe observations of present conditions and specific concerns. Reaches were numbered 1 through 4 beginning at the downstream extent of the site near Coal Creek Parkway and moving upstream to Reach 4 near 148th Avenue SE. Each reach has distinct channel and floodplain characteristics such as bank conditions, grade and planform controls, magnitude of human impacts to instream, floodplain, and riparian habitat. The channel grades of the four reaches are summarized in Table 2, and additional observations including descriptions and locations of specific channel and floodplain features are provided in the following paragraphs.

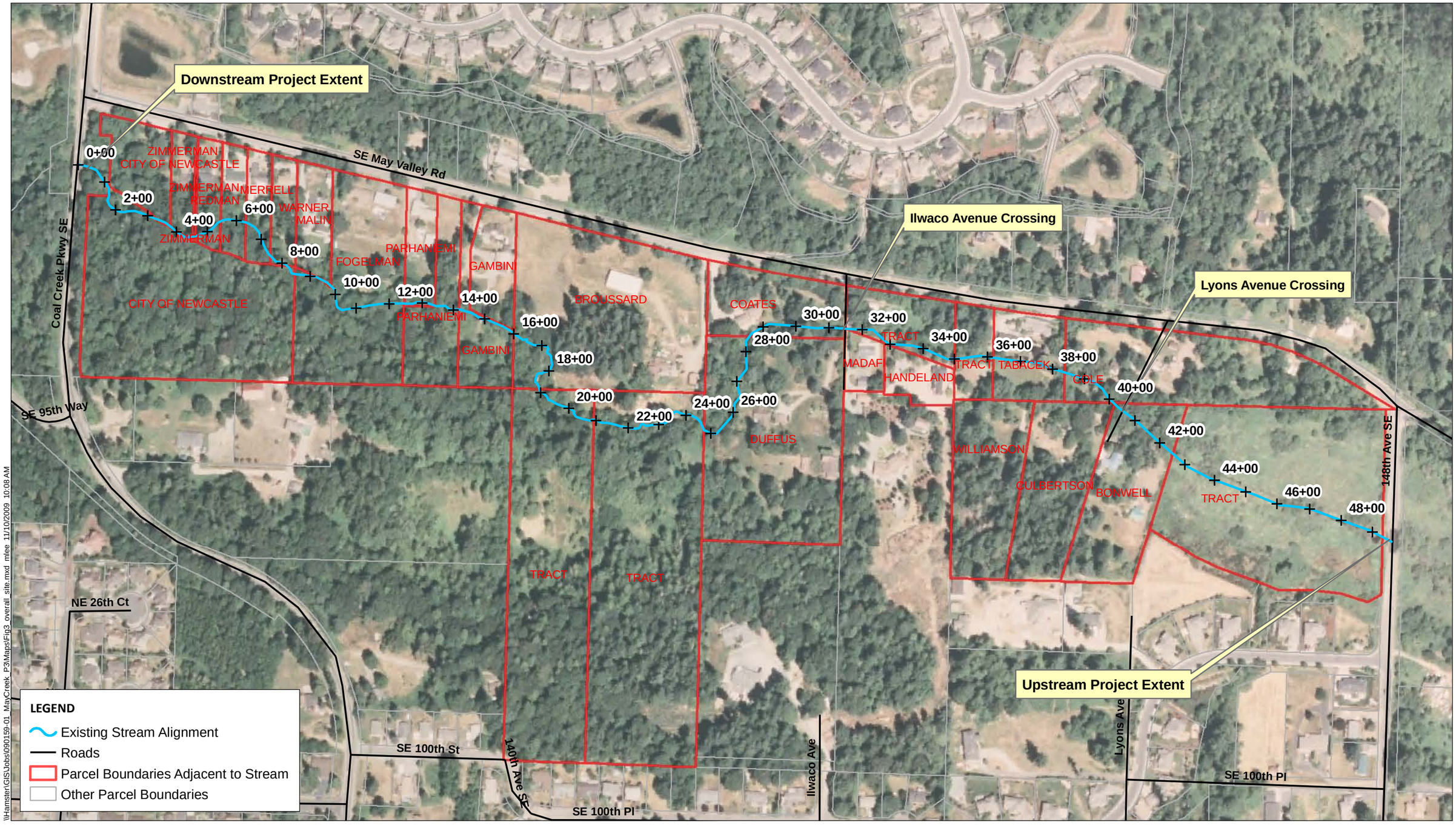
Table 2
Summary of General Reach Properties

Reach	Approximate Station	Approximate Gradient
1	0+00 to 20+00	1.10%
2	20+00 to 31+50	0.89%
3	31+50 to 40+55	0.43%
4	40+50 to 49+00	0.11%

Note: Channel grades estimated from 2009 survey data. Data are not available downstream of approximately Station 14+00. Data upstream of approx. Station 39+50 from were provided by a previous King County survey (date unknown).

4.1 Reach 1

Reach 1 is located from Coal Creek Parkway to the north side of Tract A (Station 0+00 to 20+00). The average grade through this reach is relatively steep when compared to the other reaches evaluated. While Reach 1 was not completely surveyed (in 2009), several grade breaks were observed in the field where boulder runs have created steeper sections and inhibited channel incision. However, the large scale channel incision process



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Notes: For discussion purposes only.
All locations are approximate.

Figure 3
Overall Site Map
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

in the system is apparent through this reach, as creek banks rise approximately 50 feet above the channel near Coal Creek Parkway. The height of the banks progressively decreases moving upstream.

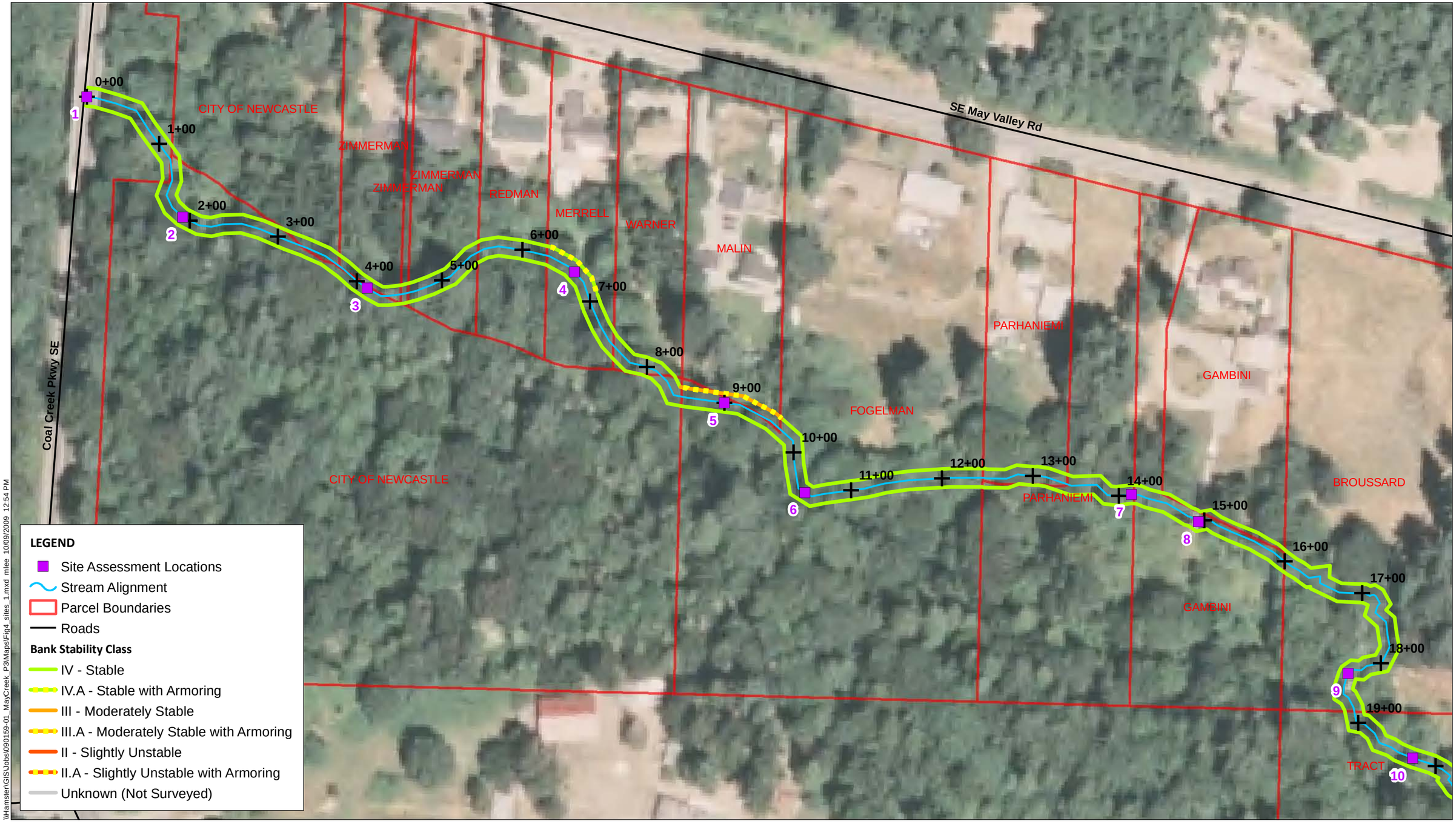
From a sediment transport perspective, Reach 1 is a transport reach where sediments moving into the reach are transported through the system as the channel is relatively narrow with little accessible floodplain. Some localized gravel bars are present near bends contributing to the width of the active channel in these areas. Several outcrops of erosion-resistant fine grained material (clays) are present in Reach 1 that likely influence incision and contribute to grade control where they are located in the bed of the channel. The resistant outcrops are also present along the banks representing a planform control where channel migration is limited by highly resistant bank materials in several locations.

These outcrops are likely subject to some erosion but it is minor in comparison with the sandy glacial outwash deposits that make up the banks and floodplain in other locations. Because the channel is entrenched, minimal evidence of lateral erosion was observed. Evidence of incision was observed, although a majority of the banks were classified as stable (Figure 4). Some undercutting of structures and the presence of features that were implemented to prevent erosion were observed including bank reinforcement in the form of riprap. Additional observations in Reach 1 include an undercut foot bridge and concrete debris in the channel from previous bridge abutments.

Habitat conditions in Reach 1 are better when compared to the other project reaches. Juvenile salmonids were observed in deep pools forced by clay outcrops and pool spacing was more frequent. However, little to no functional large woody debris (LWD) was observed through most of this reach. Spawning gravels were limited in some areas but primarily present through the reach. Vegetation in the riparian corridor is well-developed although it includes a large amount of invasive species, particularly Himalayan blackberry.

4.2 Reach 2

Reach 2 is located from the northwest corner of Tract A to the Ilwaco Avenue Bridge crossing (Station 20+00 to 31+50). The channel is relatively wide and riffle-dominated.



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Notes: For discussion purposes only.
All locations are approximate.

Feet
0 50 100 150 200

Figure 4
Bank Stability Classes and Site Locations, Lower Reach
May Creek Erosion Stabilization Report
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The average grade through this reach is relatively steep and broken up by short, steeper boulder run sections. Reach 2 is the most dynamic reach and appears to function more similarly to a natural (unmanaged) condition compared to the other reaches. The channel is actively incising, leaving the channel relatively entrenched with high banks that likely contain a majority of floodwaters and little accessible floodplain. However, Reach 2 has the greatest amount of active erosion and is the only reach where slightly unstable banks are present (Figure 5). Few resistant outcrops that influence the bed elevation or planform were observed. The most prominent of these outcrops is at approximately Station 25+00 where a resistant bank forces a deep pool.

Few erosion control measures have been implemented through Reach 2. A private retaining wall from approximately Station 28+60 to 29=40 was the only significant infrastructure observed and the channel flows through undeveloped land through the remainder of the reach. Other features noted in Reach 2, such as one large tree in the channel, are naturally-occurring.

Pool presence is lacking in Reach 2 and little gravel is available upstream of approximately Station 29+00. Riparian habitat is variable; non-native species are located along much of the banks and some thicker patches of reed canarygrass are located through this reach.

4.3 Reach 3

Reach 3 is located from the private bridge crossing at Ilwaco Avenue to the Lyons Avenue Bridge crossing (Station 30+00 to 40+50). The grade drops significantly through Reach 3 to about half that of Reach 2 and is controlled by several weirs. Natural boulder runs that were observed downstream were not observed in Reach 3. The channel profile and planform are limited by infrastructure which has led to a lack of sediment supply. The channel is less incised although some evidence of incision was observed near infrastructure. The weirs were likely installed to combat channel incision and maintain the channel grade, although it is clear that undercutting of the Ilwaco and Lyons Avenue Bridges remains a concern. The floodplain is accessible in a majority of Reach 3 and landowners have expressed flooding concerns, citing past flooding on their properties.

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Notes: For discussion purposes only.
All locations are approximate.

Feet
0 50 100 150 200

Figure 5
Bank Stability Classes and Site Locations, Mid-Reach
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

Some evidence of recent erosion was observed in Reach 3, which is likely due to the effect of infrastructure. The banks were classified as stable, although primarily because of the presence of armoring (Figure 5 and 6). Stream stabilization features and other infrastructure of note includes seven rock or log weirs, two private road bridges reinforced with riprap, two private pedestrian foot bridges, concrete debris in the channel, approximately 450 feet of channel lined with vertical stone sidewalls, and approximately 155 linear feet of additional riprap.

Instream habitat conditions in Reach 3 are degraded by infrastructure. Weirs create slow flat-water pools during low flows allowing for warm water and growth of weeds on the channel bottom. Spawning-sized sediment is lacking throughout a majority of the reach, much of this sediment is likely prevented from moving downstream by the weirs. Riparian vegetation is sparse and the lack of shading is a concern, particularly where the channel runs through landscaped yards (i.e., grass lawn banks). Where riparian vegetation exists it is typically not well developed or is overgrown by Himalayan blackberry, morning glory and other invasive plants.

4.4 Reach 4

Reach 4 is located from the Lyons Avenue crossing to the 148th Avenue SE crossing (Station 40+50 to 49+00). Due to access restrictions, the portion of Reach 4 upstream of the Lyons Avenue Bridge to approximately Station 41+50 was not assessed. The remainder of Reach 4 is straight, deep (approximately 3 feet or more at low flows) and narrow with a relatively flat grade as it flows through a wide, shallow floodplain. The floodplain and banks are vegetated with dense reed canarygrass with some other brush and immature trees. Despite the lack of mature vegetation, the banks are stable and channel migration is minimal (Figure 6). The banks are low relative to the water surface and flooding occurs frequently. The floodplain is wet much of the year and water is temporarily stored in the floodplain wetlands. According to anecdotal evidence, a bedrock outcrop exists in the channel near Station 40+00 which likely acts as a grade control to prevent erosion and headcutting upstream of the outcrop. Erosion and stabilization measures such as weirs or riprap was not observed in Reach 4, although the channelization of the creek through the tract area downstream of 148th Avenue SE indicates that the channel has been straightened in the past.

Notes: For discussion purposes only.
All locations are approximate.

Feet
0 50 100 150 200

Figure 6
Bank Stability Classes and Site Locations, Upper Reach
May Creek Erosion Stabilization Report
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5 CONCEPTUAL STABILIZATION AND RESTORATION ACTIONS

Addressing instability caused by reach scale channel incision or site-specific bank erosion may be accomplished by undertaking a variety of stabilization or restoration treatment actions within the active channel, along the stream banks, or within the riparian upland adjacent to the creek. These actions could be real estate or property-management related, channel realignment oriented, or site-specific erosion and grade control strategies. Treatment actions considered are further described in Appendix A of this report. These actions include the following:

- Acquisition
- Bridge Removal
- Bridge Replacement
- Weir Removal
- Bank Armoring or Wall Removal
- Instream Debris Removal
- Large Woody Debris Placement
- Planform Modification
- Riparian Habitat Enhancement
- Bank Stabilization Treatments
    - Log Cribwall
    - Toe Stabilization
    - Coir Wrap
    - Slope Grading and Revegetation

6 POTENTIAL PROJECTS

The following sections discuss conceptual site-specific projects for the May Creek ravine reach. Project numbers increase from downstream to upstream; these numbers do not reflect priority or sequence of project implementation.

6.1 Project 1 – Reach 1 Riparian Habitat Enhancement

6.1.1 Location

Project 1 will make improvements in the riparian corridor from Station 0+00 (Coal Creek Parkway crossing) to Station 21+00 over an area of approximately 4.5 acres to achieve an approximately 50-foot riparian buffer on either side of the channel alignment. Property owners in this project extent include the City of Newcastle, Zimmerman, Redman, Merrell, Warner, Malin, Fogelman, Parhaniemi, Gambini, Broussard, and tract space formerly owned by the Langley Development (Figure 7).

6.1.2 Site Description

Both the left and right banks are stable throughout the proposed extent of Project 1, with some localized areas of erosion (see Projects 3 and 4). The streambed has several resistant clay outcrops that have likely slowed the process of incision, however the effects of incision were nonetheless present through the project extent. Reach 1 has developed into a steep-sided ravine since the last glacial period, resulting in high banks that have cut the channel off from the glacial-age floodplain. Hence, the active channel essentially comprises the same area as the valley bottom.

The channel throughout Reach 1 is characterized as a plane bed channel with intermittent pools and riffles among resistant outcrops. Coarse sediment delivery to the reach has been restricted by instream structures (weirs) upstream of the Ilwaco Avenue crossing. Bank erosion downstream of the crossing does contribute sediment to Reach 1 although accumulations of clean gravel are sparse in some areas. Pools forced by resistant outcrops are present within the reach, but the quantity and quality of these features is limited by the spacing and configuration of the outcrops. Little to no functional LWD was observed within the reach and therefore habitat benefits are limited for instream species.

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NOTES:
Conceptual plan for discussion purposes only. All locations and boundary lines shown are approximate.

Feet
0 60 120 180 240

Figure 7
Conceptual Plan View, Projects 1 and 2
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Riparian vegetation in Reach 1 is generally well developed, although habitat conditions are somewhat degraded by invasive species. Numerous mature trees are present throughout the reach that provide a thick canopy cover. Understory brush is moderately dense and composed of a mixture of native plants such as fern and small vine maples, and invasive species, most significantly Himalayan blackberry. Ground cover is variable, with dense patches of reed canarygrass in some locations along the valley floor.

6.1.3 Potential Actions

6.1.3.1 Riparian Habitat Enhancement

Selectively remove invasive plant species through the riparian corridor. The vegetation removal would be followed by replanting with native riparian species. This action would likely be completed using hand labor to minimize disturbance.

6.1.4 Geomorphic Implications

The creek throughout Reach 1 is highly incised and entrenched with limited to no floodplain connectivity. The proposed action will not have significant immediate geomorphic implications. In the long-term a robust riparian corridor will provide greater potential for wood recruitment and promote stability of the banks.

6.1.5 Challenges and Limitations

Site access may be a challenge given multiple landowners will need to be involved, the presence of several closely-spaced private structures, and limited road access to the riparian corridor. Equipment and materials will likely need to be carried by hand into the treatment areas. Additionally, the extent of project actions may be restricted by landowner cooperation and easement procurement.

6.2 Project 2 – Reach 1 Instream Habitat Enhancement

6.2.1 Location

Project 2 will make improvements to instream habitat from Station 00+00 (Coal Creek Parkway crossing) to Station 24+00. Property owners included in the project extent are the City of Newcastle, Zimmerman, Redman, Merrell, Warner, Malin, Fogelman, Parhaniemi, Gambini, Broussard, and tract space formerly owned by the Langely Development (Figure 7).

6.2.2 Site Description

Both the left and right banks are stable throughout the proposed extent of Project 1, with some localized areas of erosion. The streambed has several resistant clay outcrops that have likely slowed the process of incision, however the effects of incision were nonetheless present through the project extent. Reach 1 has developed into a steep-sided ravine since the last glacial period, resulting in high banks that have cut the channel off from the glacial-age floodplain. Hence, the active channel essentially comprises the same area as the valley bottom.

The channel throughout Reach 1 is characterized as a plane bed channel with intermittent pools and riffles among resistant outcrops. Coarse sediment delivery to the reach has been restricted by instream structures (weirs) upstream of the Ilwaco Avenue crossing. Bank erosion downstream of the crossing does contribute sediment to Reach 1 although accumulations of clean gravel are sparse in some areas. Pools forced by resistant outcrops are present within the reach, but the quantity and quality of these features is limited by the spacing and configuration of the outcrops. Little to no functional LWD was observed within the reach and therefore habitat benefits are limited for instream species.

6.2.3 Potential Actions

6.2.3.1 Large Woody Debris Placement

Place LWD at selected locations throughout Reach 1 to create stable hydraulic conditions capable of locally creating deep pools. The location and size of the LWD would be based on natural pool spacing and site-specific hydraulics.

6.2.4 Geomorphic Implications

The placement of additional LWD will increase the occurrence of pool-riffle sequences, enhancing instream habitat for aquatic species. In natural systems pools are often spaced at five to seven times the bankfull channel width. The placement of LWD will create hydraulic refugia during high flows and promote deposition of spawning-sized materials in the lee of the log placement sites.

6.2.5 Challenges and Limitations

The creation of additional pool features will be impacted by access and disturbance issues similar to those for Project 1. The channel in Reach 1 has limited access points and equipment and material may need to be hand carried to some placement locations. The specified LWD may be quite large and require considerable work to transport to some placement sites.

6.3 Project 3 – Bank Stabilization Treatment at Station 6+60

6.3.1 Location

Project 3 will remove existing bank armoring and provide a more naturally appearing bank stabilization treatment that will enhance both instream and riparian habitat conditions near Station 6+60 (Figure 8).

6.3.2 Site Description

The left bank is stable and would not be influenced by the proposed project action. The right bank is presently stable with armoring. While the existing armor material inhibits channel movement, it does not provide natural, habitat-enhancing bank stabilization. Currently, a large gravel and cobble deposit separates the thalweg from the armor along the right bank, however, the channel likely moves throughout the valley bottom during higher flows. Banks are steeply sloped and approximately 20 feet high, therefore there is no floodplain connectivity at this location.

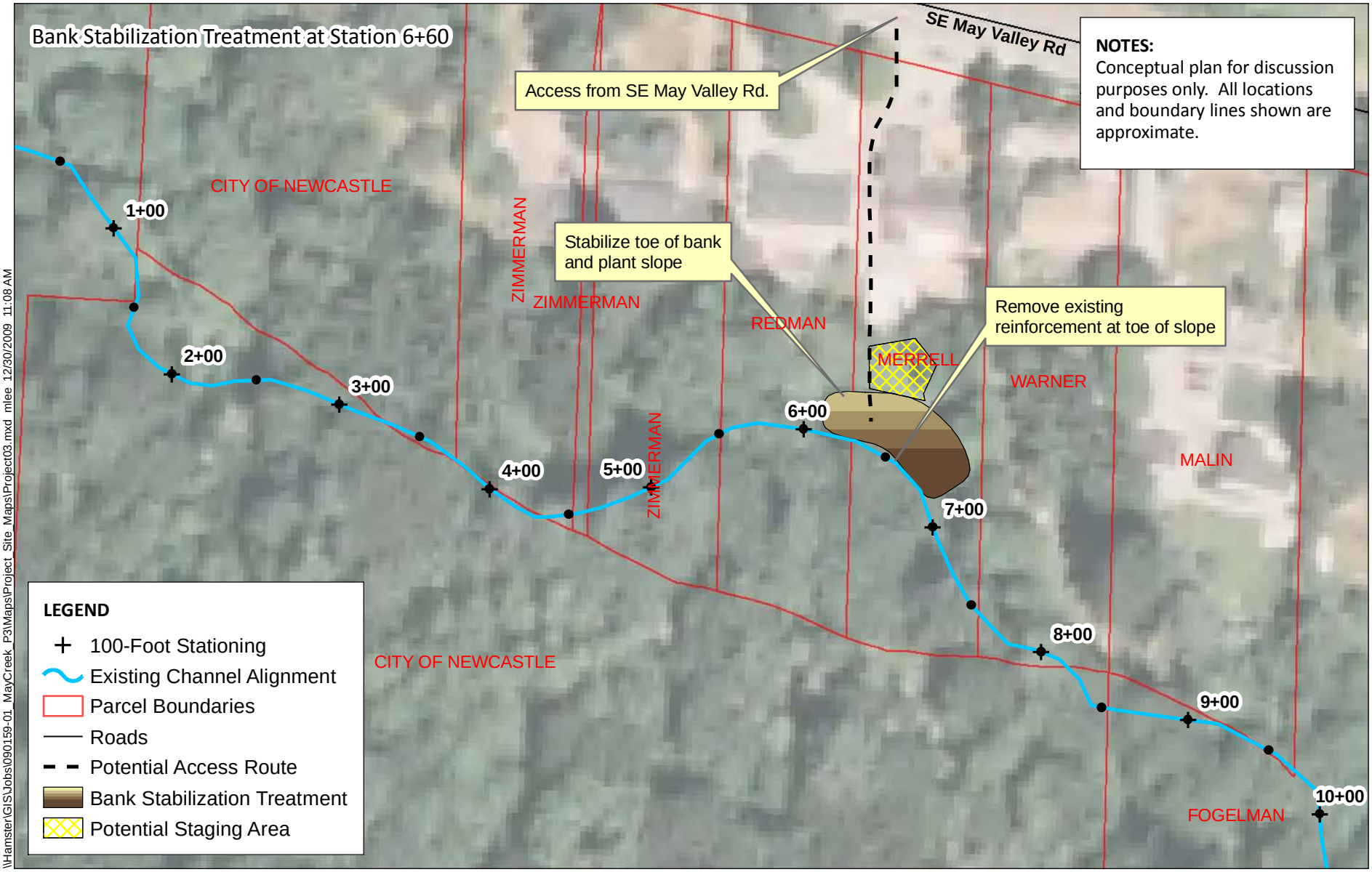

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Figure 8
Conceptual Plan View, Project 3
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

This segment of the channel has a relatively wide active channel and large amount of temporary sediment storage. The position of channel at this site is influenced by the locations of sediment accumulations (gravel bars) that are likely reconfigured during high flow events. Currently, small pools and riffles have formed in the channel bed. Instream habitat conditions are characterized by gravel and cobble substrate, moderate velocities, and moderate to shallow water depths at low flow.

Riparian habitat conditions for the left bank are characterized by several mature, deciduous trees and few coniferous trees, and moderately dense understory composed of immature deciduous trees and bushes, interspersed with non-native species (primarily Himalayan blackberry). The right bank appeared to have been recently modified, based on the lack of trees and the presence of landscaping sheeting or fabric. A majority of the slope is overgrown with morning glory vines. The toe of the slope and the gravel bar are thickly covered with reed canarygrass and morning glory, with a few established native shrubs.

6.3.3 Potential Actions

6.3.3.1 Bank Stabilization Treatment

The right bank will be treated by first removing existing armor material and non-native vegetation, then stabilized using a log cribwall, toe protection and revegetation, or bank sloping and revegetation based on site-specific evaluation.

6.3.4 Geomorphic Implications

There would be limited immediate geomorphic implications related to this project as the stabilization actions would also be placed away from the active channel. However, the proposed stabilization treatment will provide protection to the toe of the bank during high flows when flood flows spill from the main channel and the valley bottom is inundated. Further, should the channel migrate to the toe of the right bank, the structure will provide a naturally stabilized, roughened bank. The proposed design will need to account for future channel incision and channel migration towards existing private structures.

6.3.5 Challenges and Limitations

Site access may be challenging as the access route will be down the steep right bank slope. Future channel migration towards the private residences to the north must be considered during the design phase.

6.4 Project 4 – Bank Stabilization Treatment at Station 9+00

6.4.1 Location

Project 4 will remove existing concrete and stone armoring and provide a bank stabilization treatment near Station 9+00 (Figure 9).

6.4.2 Site Description

The left bank at the project site is stable and would not be influenced by the proposed project actions. The right bank at this project site is moderately stable with armoring. The right bank is low with moderate floodplain connectivity relative to much of Reach 1.

This segment of the stream is characterized as a run located between two sharp bends in the channel forced by resistant outcrops on the upstream and downstream ends of the project area. Instream habitat conditions are characterized by cobble substrate, moderate velocities, and moderate water depths at low flow.

Riparian habitat conditions for the left bank are characterized by mature trees that provide stream cover and shading. The understory is composed of immature trees and native woody plants and shrubs, interspersed with moderate to sparse Himalayan blackberry and other invasive plants. The right bank has few mature trees and thick understory composed of immature deciduous trees, woody native bushes and shrubs. Some invasive growth was identified including Himalayan blackberry vines and thick reed canarygrass along the banks, including a large patch of grass atop the existing armoring.

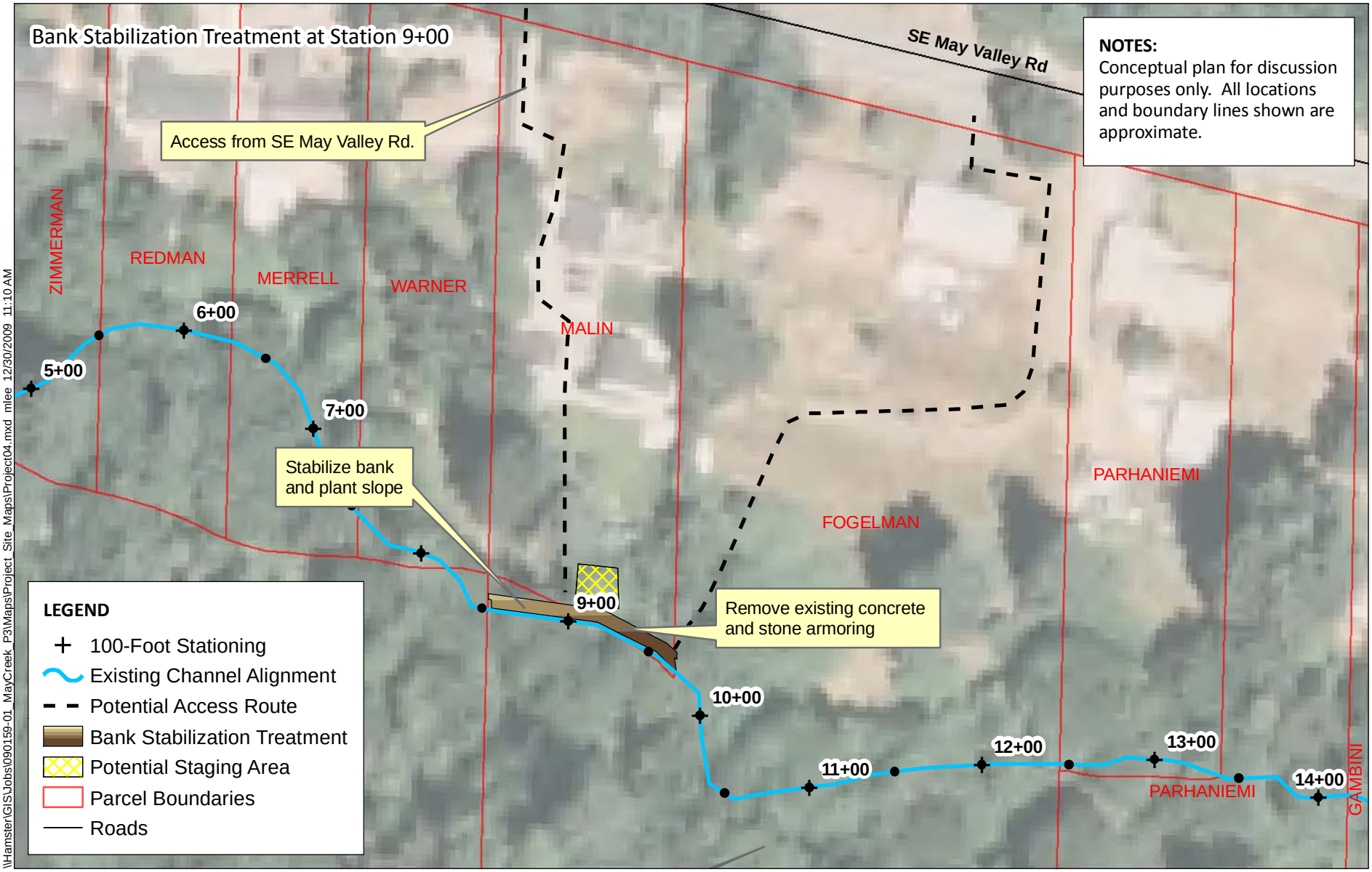

Figure 9
Conceptual Plan View, Project 4
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

6.4.3 Potential Actions

6.4.3.1 Bank Stabilization Treatment

Remove the existing concrete fragments, concrete cylinders, and stone riprap along the right bank. The right bank will be stabilized using either a log cribwall, toe stabilization and revegetation, or bank sloping and revegetation based on site-specific evaluation.

6.4.4 Geomorphic Implications

There will be limited immediate geomorphic implications related to this project. The bank stabilization treatment may be placed near to the location of the existing debris although setting back the structure from the creek would be better suited to account for long-term geomorphic processes. In the long-term the proposed bank stabilization would need to be designed to account for future channel incision and channel migration.

6.4.5 Challenges and Limitations

Large equipment access may be limited by the site access route chosen. Access to the site would be gained from SE May Valley Road through private property, and would be down a steep bank that may require considerable clearing and grading. Disturbed vegetation would require mitigation.

6.5 Project 5 – Concrete Debris Removal at Station 14+10

6.5.1 Location

Project 5 will remove structural remnants (approximately 11 cubic yards (cy); concrete and steel debris) from a decommissioned bridge and provide a bank stabilization treatment near Station 14+10 (Figure 10).

6.5.2 Site Description

The left bank holds a large, embedded concrete abutment. If this abutment is removed the bank would be allowed to support vegetative growth. A separate abutment and associated debris are located in the channel bed. The right bank is presently stable and would not be

influenced by the proposed action. Banks are approximately 10 feet high, preventing access to the floodplain.

At this location the channel is a plane bed run, with a pool locally forced by the channel obstruction (concrete abutment). This abutment appears to act as a lag deposit, accumulating additional oversized material at this location and causing water to back up on the upstream side. Instream habitat conditions are characterized by gravel within the pool and boulders and cobble upstream of the obstruction, low velocities, and relatively high water depths at low flow, particularly adjacent to the obstruction within the pool.

The riparian corridor along the left bank has several mature deciduous trees, and a well-developed understory and groundcover which mainly consists vine maple and sword fern. Stream shading in this location is moderate, however it is primarily contributed by vegetation on the left bank. The right bank consists of poorer riparian habitat conditions and appears to have been cleared and maintained historically. There are few mature trees, some immature deciduous growth and a thick groundcover of grasses and low sprawling Himalayan blackberry vines.

6.5.3 Potential Actions

6.5.3.1 Debris Removal

Remove the existing concrete abutments, concrete fragments, and other debris. Allow the left bank to naturally stabilize over time.

6.5.3.2 Debris Removal and Slope Regrading

Remove the existing concrete and debris and slope back and revegetate the left bank at the location of the removed abutment to mitigate initial erosion potential and stabilize the local area.

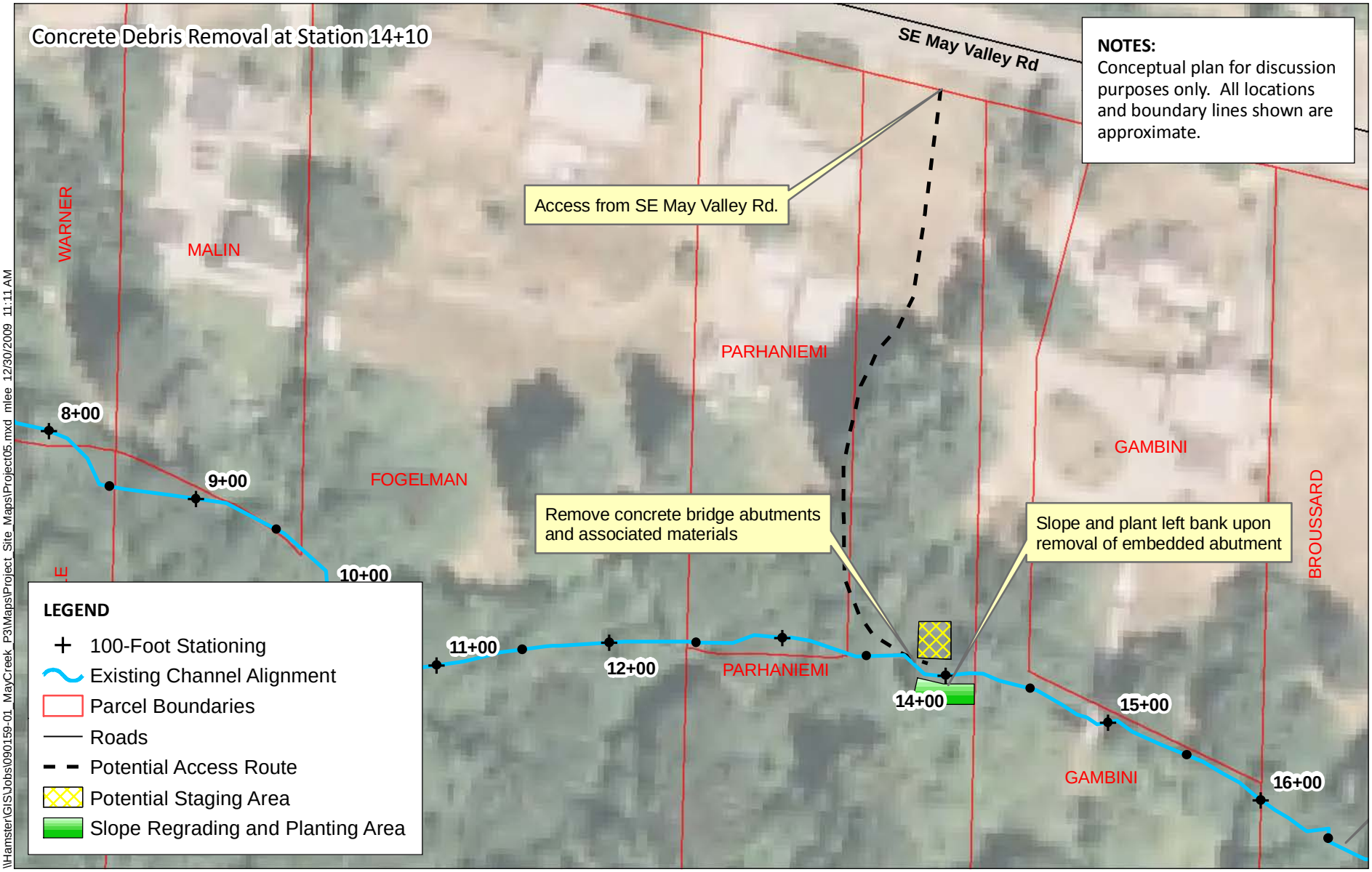

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Figure 10
Conceptual Plan View, Project 5
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

6.5.4 Geomorphic Implications

The implementation of this project will allow the channel to function more naturally in response to flow conveyance and sediment transport. This project is not expected to increase the rate of ongoing incision at the local site, or have an effect on incision upstream or downstream. Ongoing incision will continue to occur without affecting existing public or private infrastructure at this location.

6.5.5 Challenges and Limitations

There is no established access to this site for the heavy equipment that would be required to remove the large abutments. Concrete debris may need to be broken up to be taken offsite. An access route would need to be developed through the forested area from SE May Valley Road through the Parhaniemi property.

6.6 Project 6 – Private Bridge Enhancements at Station 14+90

6.6.1 Location

Project 6 will remove and/or replace an existing private pedestrian bridge (approximately 23 cy; concrete abutments and associated armor materials) and provide local bank stabilization near Station 14+90 (Figure 11).

6.6.2 Site Description

The right bank is currently stable and protected by a relatively large volume of concrete fragments on the upstream and downstream sides of the bridge. The left bank, which is also stable, contains a less extensive amount of armoring that is limited to within a few feet of the existing bridge abutment. Concrete and stone associated with the bridge is located in the channel bed and along the banks, possibly to reduce local scour and incision at the bridge. It appears that high flows are contained within the channel banks and there is no connectivity with the floodplain terrace.

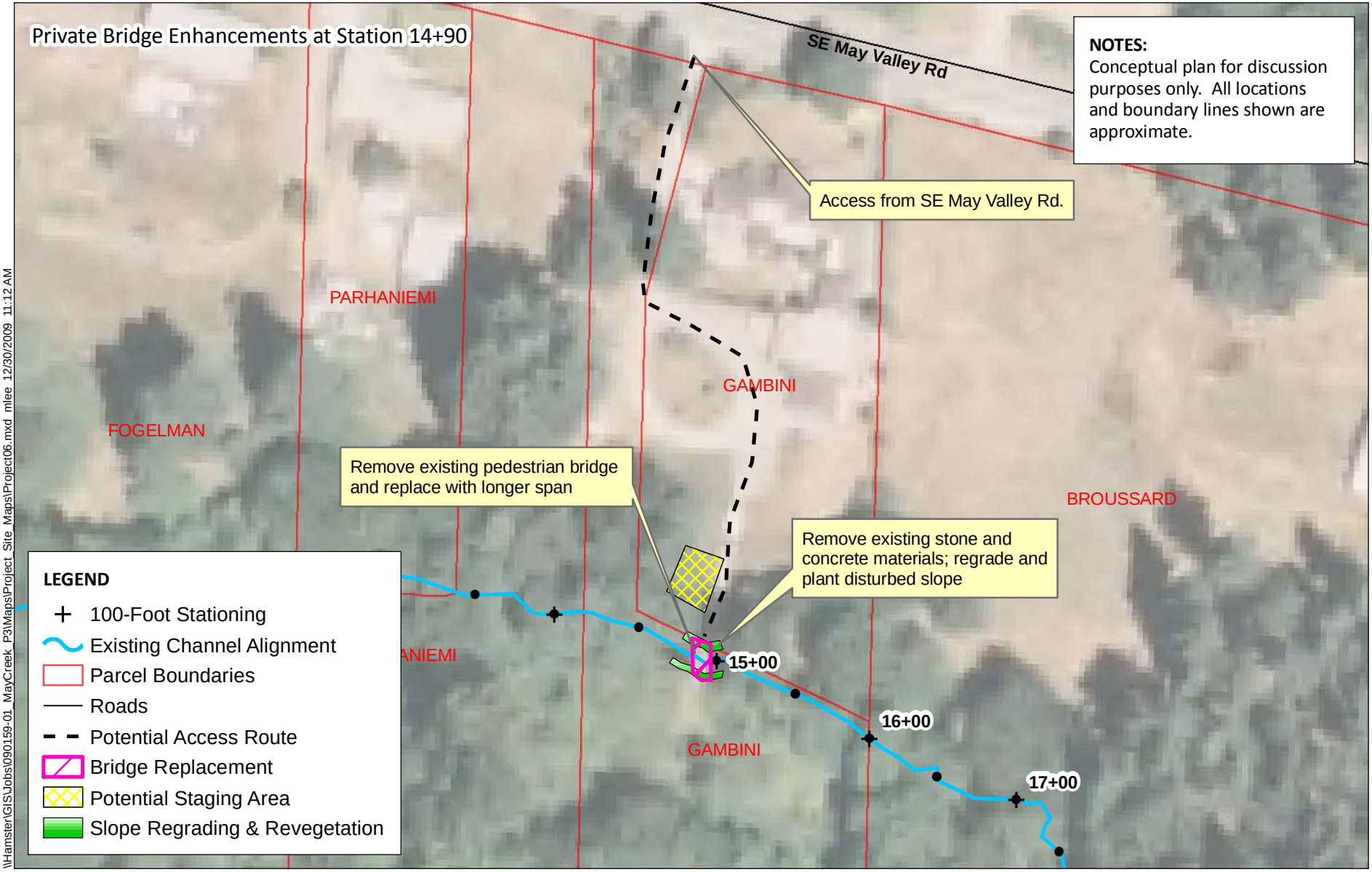

Figure 11
Conceptual Plan View, Project 6
May Creek Erosion Stabilization Report
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This stream segment is characterized as a run within a plane bed section of the stream. Instream habitat conditions around the bridge are characterized by large concrete fragments, boulders and cobble within the bed that protrude above the water surface during low flows, and moderate velocities that may be accelerated beneath the bridge during high flows.

The glacial floodplain terrace connected by the bridge has been historically cleared and remains an open, grassy area. Riparian habitat conditions for both the left and right banks are characterized by a lack of mature trees, and a groundcover of thick grass down to the ordinary high water line (OHWL). Himalayan blackberry vines are sparse along the right bank and thicker along the left bank. Minimal stream shading is provided by the sparse vegetation at this site.

6.6.3 Potential Actions

6.6.3.1 Bridge Removal and Replacement

Remove the existing bridge span, concrete abutments, concrete fragments, and other associated materials. Install a pedestrian bridge with a longer span and abutments on the upland to minimize habitat and flooding impacts. Local slope regrading and planting may be done adjacent to the bridge site.

6.6.3.2 Bridge Removal and Slope Regrading

Remove the existing bridge span, concrete abutments, concrete fragments, and other associated materials. Slope back and revegetate the left and right banks to stabilize the banks and minimize erosion potential.

6.6.3.3 Riparian Habitat Enhancement

Remove invasive and non-native plant species along the riparian corridor. The vegetation removal would be followed by replanting with native riparian species including trees to increase stream shading and further stabilize the stream banks. Riparian planting at this site will be more extensive than the selective removal and supplemental planting described for Project 1.

6.6.4 Geomorphic Implications

The implementation of this project will allow the channel to function more naturally in response to flood conveyance and sediment transport by removing the constriction point caused by the existing structure. By setting the abutments away from the channel, incision will be allowed to occur without affecting public or private infrastructure.

6.6.5 Challenges and Limitations

The landowner has expressed the desire to maintain pedestrian and lawnmower access to the south side of the creek.

6.7 Project 7 – Bank Stabilization Treatment at Station 21+10 to 24+30

6.7.1 Location

Project 7 will stabilize eroding cutbanks with riparian habitat enhancement from Station 21+10 to 22+20 and a bank stabilization treatment from Station 22+20 to 24+30. The property in this project is a designated green space tract formerly owned by the Langley Development (Figure 12).

6.7.2 Site Description

The left bank from approximately Station 21+10 to 22+20 and the right bank from approximately Station 22+20 to 24+30 are slightly unstable. Bank soils are composed of highly erodible glacial outwash. Several exposed tree and plant roots were observed, particularly along the right bank. According to observations over the previous winter season, channel widening in this area has occurred where the right bank experienced severe erosion during high flows. A large gravel deposit along the left of the active channel was likely deposited concurrently, and at least two moderate-sized trees were downed across the channel during this time. The steep banks have incised several feet in the past three decades, cutting off any connectivity with the floodplain that may have existed (Duffus 2009).

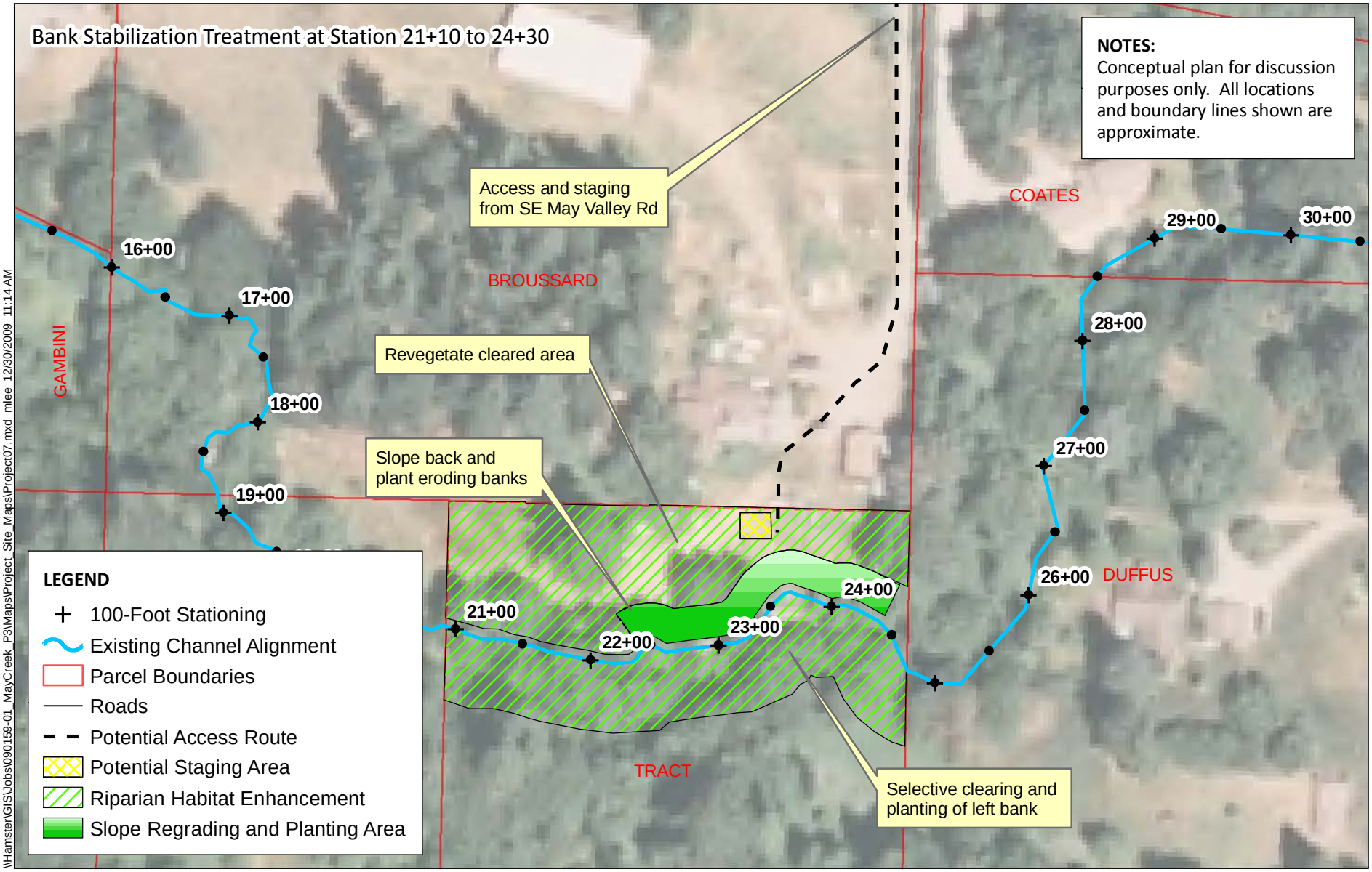

Figure 12
Conceptual Plan View, Project 7
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

This project is located within a relatively dynamic, meandering segment of the creek with pools and riffles forced by downed trees and deposits of sediment, however these features are not stagnant and will likely change during each bed-moving flow. This section of the stream is distinguished from others by ongoing erosion caused by both lateral migration and incision, which contributes sediment load as well as woody debris to the channel. Instream habitat conditions are characterized by clean mobile gravel and cobble substrate, low to moderate velocities, and low to moderate water depths at low flow. Due to the recent tree falls, there is an abundance of low cover from woody debris and growth of vegetation within the active channel, however this wood may be mobile during the next significant high flow.

Riparian habitat conditions for the right bank are characterized by few mature trees and a lack of understory, as the floodplain is mostly a grassy upland terrace (lawn) that provides very little stream shading. The left bank riparian corridor has several mature evergreen and deciduous trees and a moderately well-developed understory of native woody plants, although Himalayan blackberry and reed canarygrass are relatively well-established.

6.7.3 Potential Actions

6.7.3.1 Slope Regrading

Slope back and stabilize the right bank from approximately Station 22+20 to 24+30 with riparian planting along the channel banks.

6.7.3.2 Riparian Habitat Enhancement

Remove invasive and non-native plant species along the riparian corridor. The vegetation removal would be followed by extensive replanting with native riparian species throughout the site, including planting the terrace north of the stream to provide upland habitat and stream shading in place of the open grass area that is currently present.

6.7.4 Geomorphic Implications

The implementation of this project is consistent with large scale geomorphic processes. The channel would be allowed to continue to migrate and incise without affecting public or

private infrastructure. The bank sloping and vegetation will provide natural bank stability and roughness to decrease erosive forces.

6.7.5 Challenges and Limitations

There are some small outbuildings, abandoned cars, and miscellaneous debris that will need to be removed in conjunction with the project. Site access will likely pass through private property from SE May Valley Road.

6.8 Project 8 – Left Bank Stabilization Treatment at Station 25+20 to 28+60

6.8.1 Location

Project 8 will install a bank stabilization treatment from Station 25+00 to 26+50 (Figure 13).

6.8.2 Site Description

The left bank is stable to moderately stable and bounded by a resistant outcrop along the outside of the meander bend downstream of Station 26+50. Approximately 15 feet of armor material was identified along the left bank at the upstream extent that appears to have been in place for several years or decades. The high left bank does not appear to provide floodplain connectivity. The right bank is gently sloped away from the channel and well vegetated on a low, well-connected floodplain, transitioning into point bar at the downstream end of the project area.

This segment of the stream is characterized as a run with a pool forced by a resistant outcrop at the downstream end. Instream habitat conditions are characterized by a clean mobile gravel bed, moderate velocities, and moderate water depths at low flow.

The left bank has a moderate amount of mature trees and several immature trees and native woody plants that create a well-developed understory. However, invasive species including English ivy and Himalayan blackberry are moderately dense within the understory. The right bank has some mature trees and a high density of young deciduous trees in the floodplain with sparse groundcover.

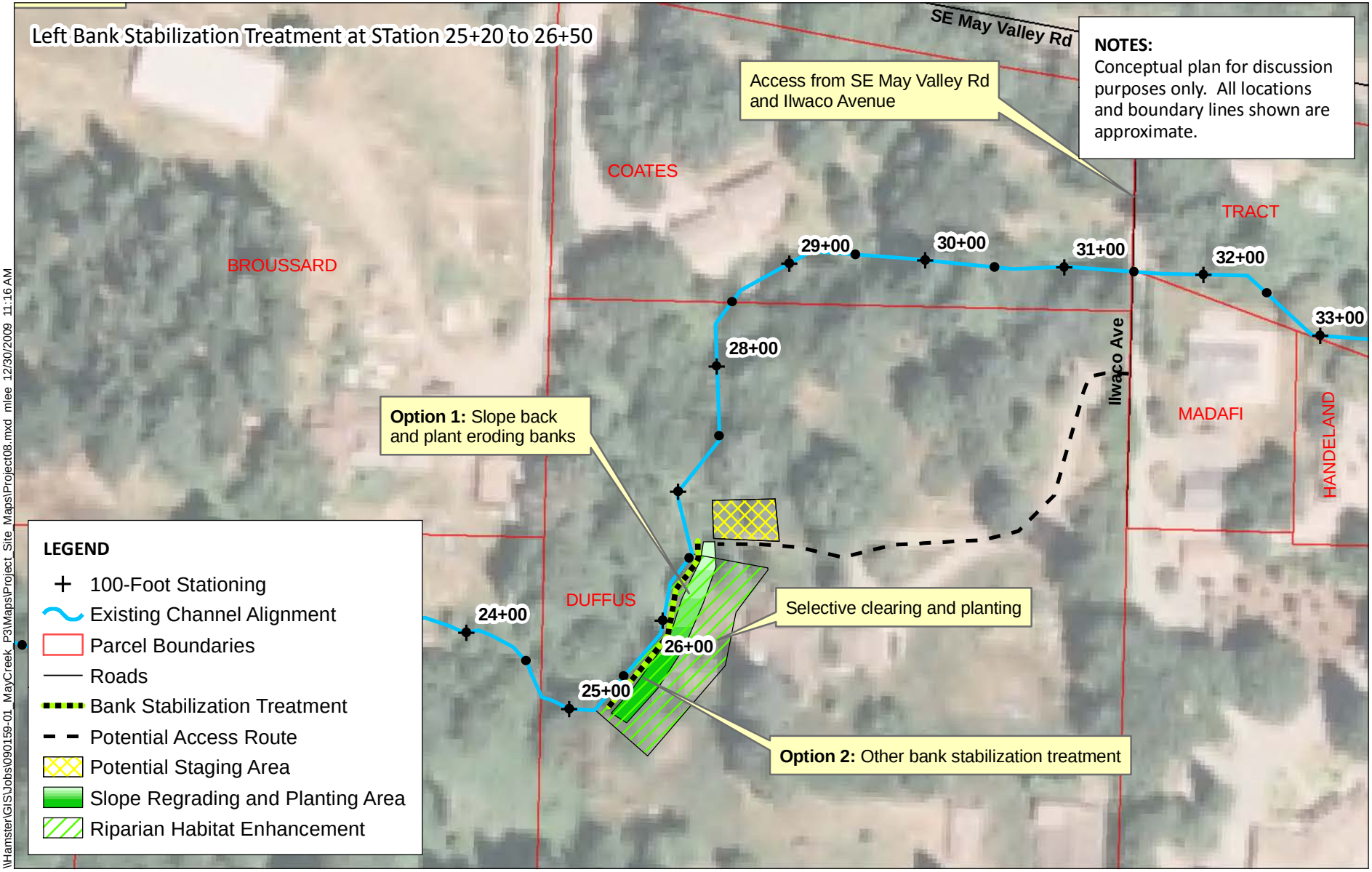

Figure 13
Conceptual Plan View, Project 8
May Creek Erosion Stabilization Report
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6.8.3 Potential Actions

6.8.3.1 Bank Stabilization Treatment

Stabilize the left bank with a bank stabilization treatment, such as sloping and regrading, toe stabilization or a coir wrap, to be determined upon site-specific evaluation. Invasive species would be selectively removed and replaced with native species as a part of the project actions.

6.8.4 Geomorphic Implications

This project will not have a significant influence on geomorphic processes. Lateral erosion towards the left bank would be prevented by the placement of the bank treatment although channel movement through the right bank will remain uninhibited. Design of the stabilization treatment must account for future channel incision.

6.8.5 Challenges and Limitations

Site access would require clearing within private property which may result in significant disturbance to the landowner.

6.9 Project 9 – Channel Realignment at Station 25+00 to 28+60

6.9.1 Location

Project 9 will realign the channel from approximately Station 25+00 to 28+60 (Figure 14).

6.9.2 Site Description

The proposed alignment is located through a forested area with relatively well-developed riparian habitat conditions. The canopy consists of mature deciduous trees with some interspersed coniferous trees. The understory is composed of brush and woody native plants including both native and non-native Himalayan blackberry. Ground cover is sparse in the floodplain. The existing grade in the area of the new alignment is approximately 3 to 9 feet above the existing grade of the stream.

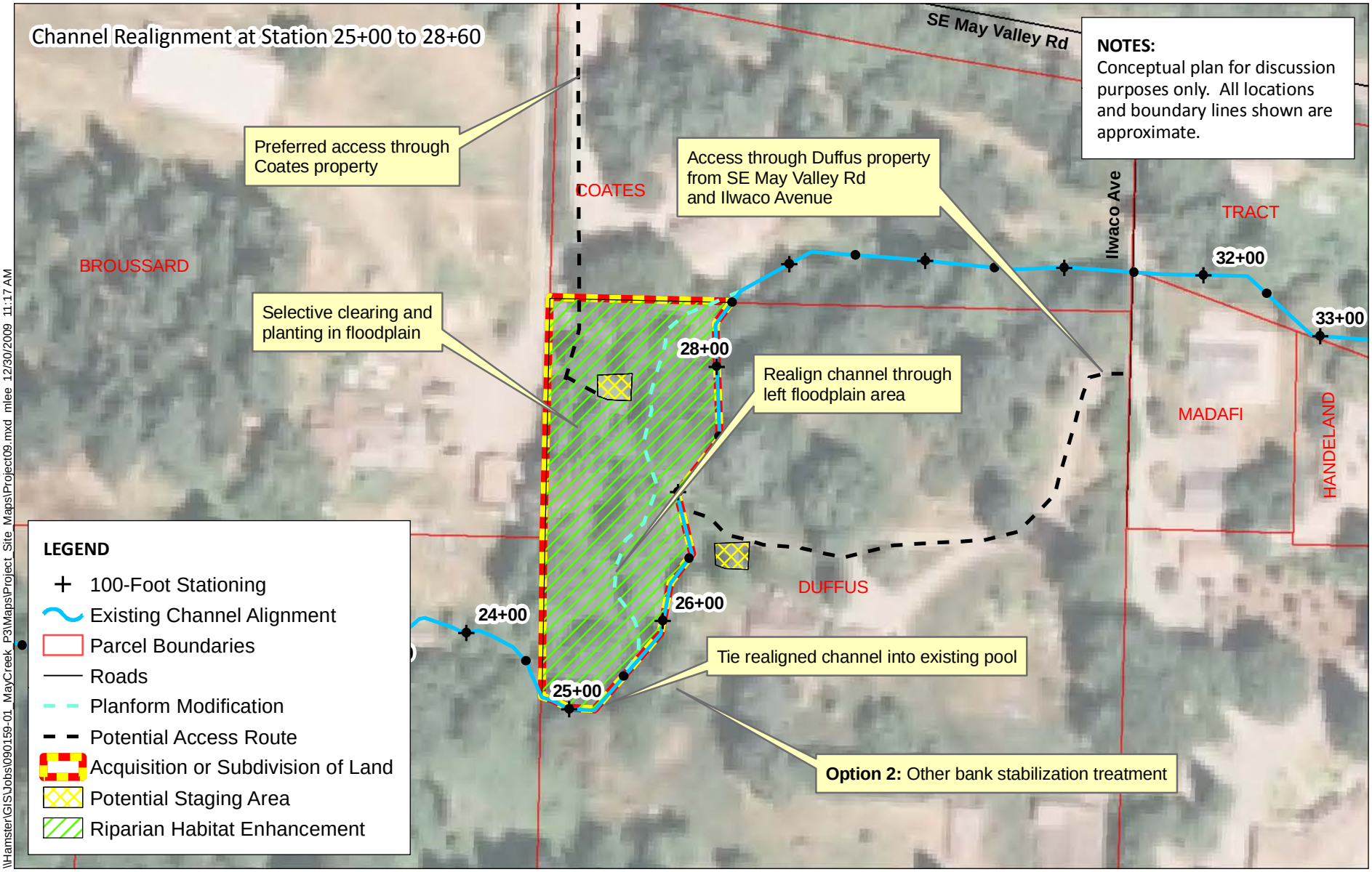

Figure 14
Conceptual Plan View, Project 9
May Creek Erosion Stabilization Report
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6.9.3 Potential Actions

6.9.3.1 Planform Modification

Realign the channel through the right floodplain providing a wider riparian corridor and the potential to develop side channel habitat though the existing channel alignment. Realignment may tie into an additional realignment upstream (see Project 11).

6.9.3.2 Riparian Habitat Enhancement

Selectively remove invasive and non-native plant species along the riparian corridor of the existing and realigned channel (the existing floodplain) and/or throughout the remainder of the floodplain west of the stream within the existing parcel boundary. The vegetation removal would be followed by supplemental planting with native riparian species to increase stream bank and floodplain stability.

6.9.3.3 Acquisition

The portion of the privately-owned parcel west of the existing channel may be subdivided to become designated green space.

6.9.4 Geomorphic Implications

The implementation of this project is consistent with large scale geomorphic processes, as the channel would be allowed to migrate and incise without affecting public or private infrastructure. Development of this project will require coordination with the design of upstream projects.

6.9.5 Challenges and Limitations

This project would require a significant quantity of excavation, either requiring temporary storage and placement or offsite disposal. The stream may also need to be temporarily routed through pipes during construction. The conceptual channel alignment is located through a forested area requiring deep cuts to match stream grade and the potential to impact mature trees. However, if any trees need to be removed they will be incorporated into the stream design as LWD. Power lines from SE May Valley Road to the Duffus property may interfere with realignment of the channel and an alternate utility route may need to be developed.

6.10 Project 10 – Right Cutbank Stabilization Treatment at Station 27+50 to 28+60

6.10.1 Location

Project 10 will apply a bank stabilization treatment from Station 27+50 to 28+60 (Figure 15).

6.10.2 Site Description

The right bank at the project site is a high, slightly unstable cutbank. The left bank is stable with a large gravel point bar to the left of the thalweg that is vegetated with grasses. The left bank is likely high enough that floodplain connectivity is limited, with the gravel bar area providing additional channel conveyance during high flows. The right bank is approximately 10 feet high, inhibiting connectivity with the floodplain.

The channel adjacent to the cutbank is a slow-moving pool along the outside of a meander bend, with some large immobile boulders protruding above the water surface during low flow that have been eroded out of the glacial material that composes the bank. Instream habitat conditions are characterized by a mobile gravel bed with some silt infilling.

Some mature deciduous trees, a thick understory of immature deciduous trees, and other plants overhanging the right bank providing a moderate amount of stream shading. The left bank is a gravel bar that is well vegetated at the OHWL. Invasive species, a majority of which are Himalayan blackberry, are present along both the left and right banks.

6.10.3 Potential Actions

6.10.3.1 Slope Regrading

Slope back and stabilize the right bank with riparian vegetation along the project extent. Invasive species would be selectively removed and replaced with native species as a part of this project action.

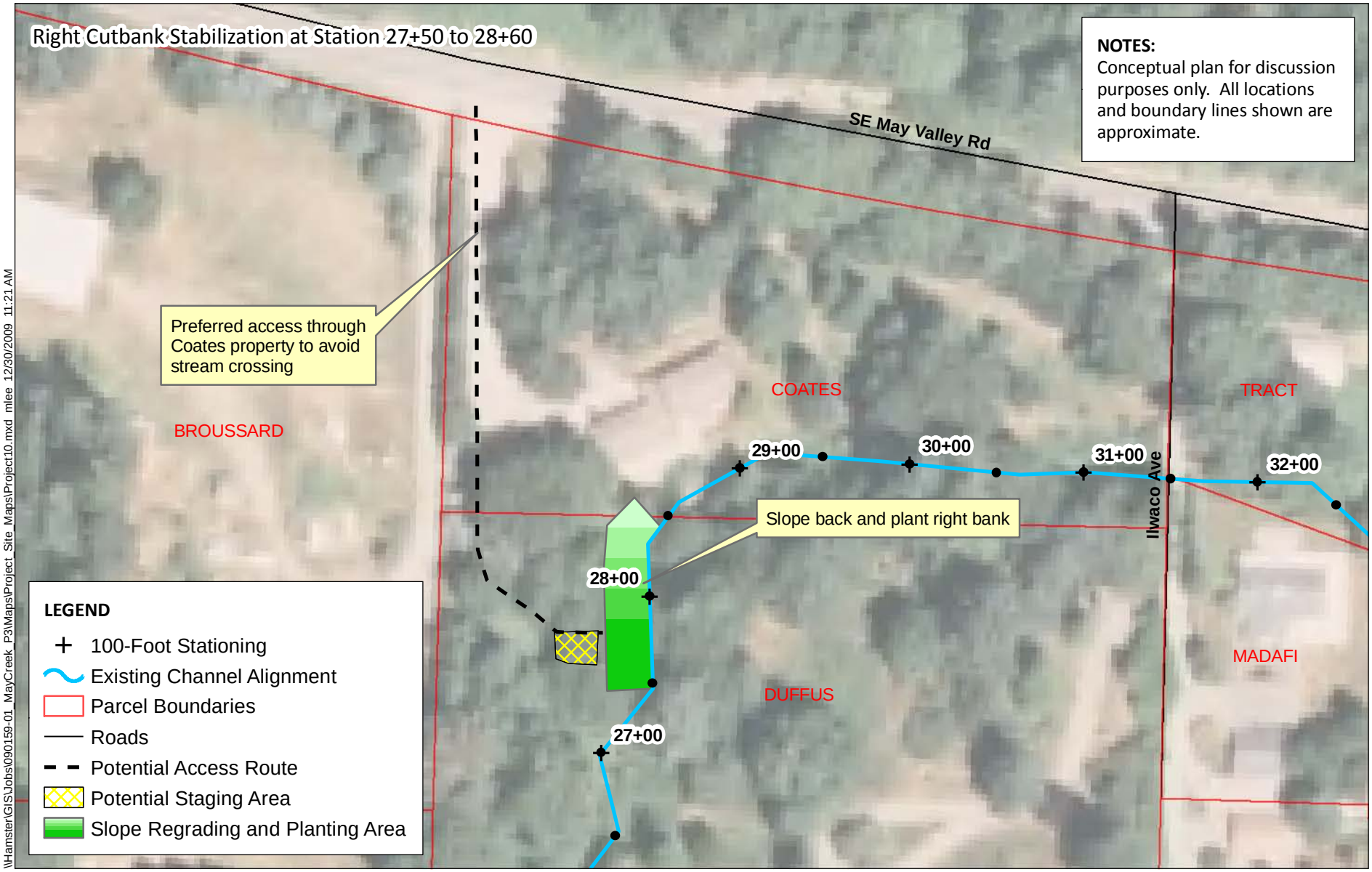

Figure 15
Conceptual Plan View, Project 10
May Creek Erosion Stabilization Report
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6.10.4 Geomorphic Implications

Implementation of this project will improve flood conveyance and reduce hydraulic forces downstream in the short-term. The channel would be allowed to incise without affecting public or private infrastructure. This bank would likely continue to erode in the future and may become a cutbank again. Spawning-sized sediment supplied to the channel downstream by the eroding cutbank would be reduced in the short-term, however the implementation of certain upstream projects may alleviate this concern.

6.10.5 Challenges and Limitations

This project would require a significant quantity of excavation, either requiring temporary storage and placement or offsite disposal. Regrading the area would disturb an existing riparian forested area with relatively well-established vegetative cover. Power lines from SE May Valley Road to the Duffus property may interfere with the bank sloping and an alternate route for the power lines may need to be developed.

6.11 Project 11 – Bank Stabilization Treatment at Station 28+60 to 29+40

6.11.1 Location

Project 11 will remove an existing retaining wall along the right bank (approximately 10 cy; concrete block) and provide a bank stabilization treatment from approximately Station 28+60 to 29+40 (Figure 16).

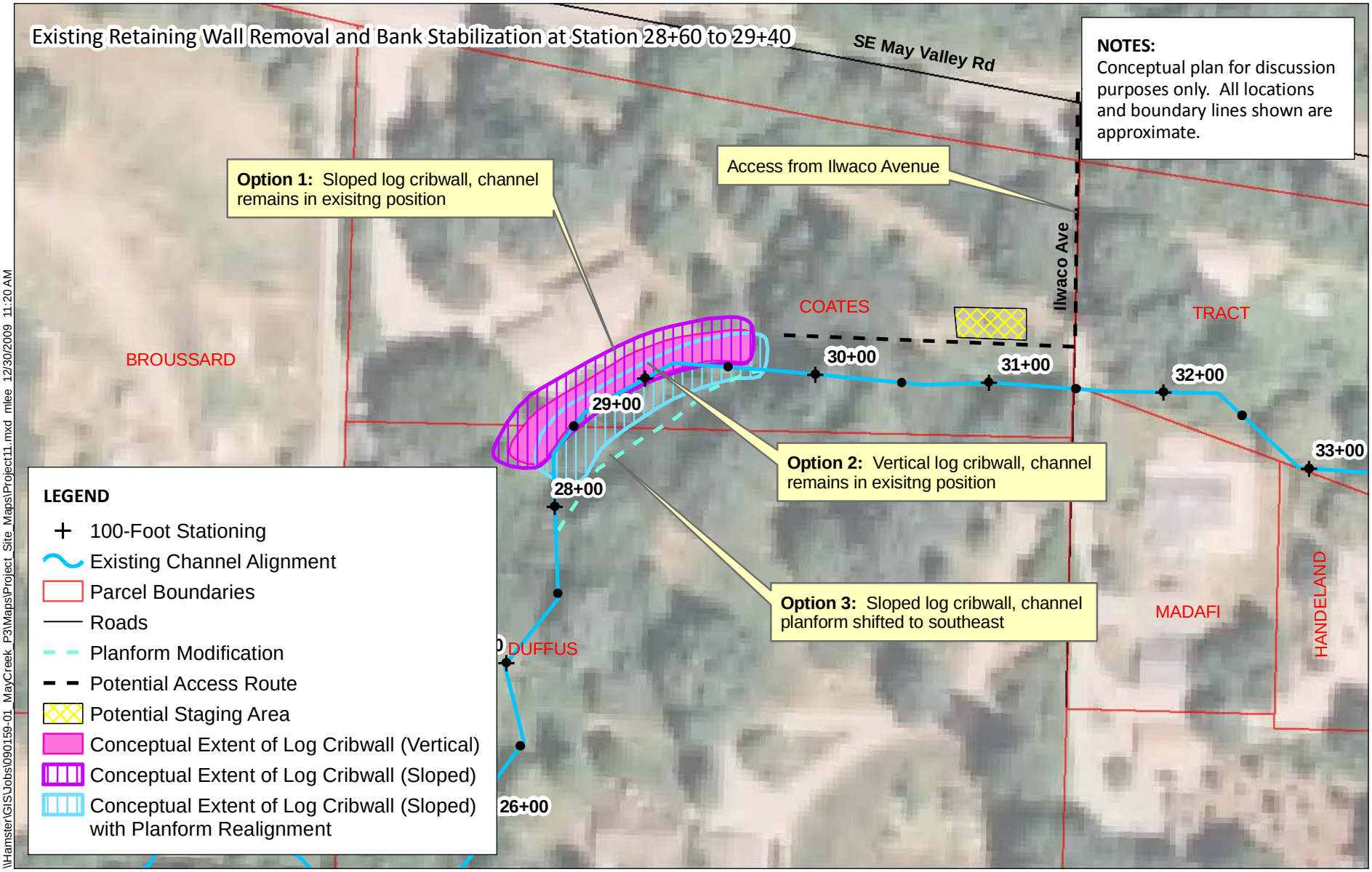

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Figure 16
Conceptual Plan View, Project 11
May Creek Erosion Stabilization Report
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6.11.2 Site Description

The right bank is currently armored with approximately 75 linear feet of concrete block retaining wall that is being severely undercut at the toe. Backfill materials behind the wall are deposited in the channel as the material at the base of the wall is eroded away. The left bank is a gravel bar that is well vegetated below the OHWL. Above the top of the wall, the right bank slopes steeply up to the yard on the Coates property. The landowner has expressed concern that the yard has been progressively slumping towards the stream over the past 5 years he has lived at the residence. The site is directly downstream of a steep boulder run that directs stream power at the wall location. The left bank is likely high enough that floodplain connectivity is limited, with the point bar area providing additional channel conveyance during high flows. The right bank is approximately 10 feet high and has no floodplain connectivity.

The channel adjacent to the wall is a slow-moving pool at low flows. Instream habitat conditions are characterized by a cobble and gravel bed, low to moderate velocities, and deep water at low flow (approximately 3 feet or more). During higher flows velocities and stream power directed at this location are accelerated along the length of the existing wall, likely contributing to the severity of erosion.

Some mature deciduous trees and moderately thick understory of immature deciduous trees and other plants overhanging the left bank and provide some stream shading. The right bank lacks tree cover and only sparse immature (approximately 3 to 4 feet tall) deciduous trees were observed. The slope behind the wall is primarily vegetated with a wide variety of native and non-native shrubs, bushes and vines including Himalayan blackberry and morning glory. Some large patches of reed canarygrass were also observed growing along a gravel accumulation at the upstream end of the wall.

6.11.3 Potential Actions

6.11.3.1 Log Cribwall (Vertical)

A near-vertical log cribwall will be installed in place of the existing block retaining wall to stabilize the steep bank, while minimizing the area required for the footprint of the structure. The cribwall would protect the bank and enhance instream habitat by creating

bank roughness and cover that will provide hydraulic refugia for juvenile salmonids and resident fish. Installing a near-vertical wall would not allow for optimal riparian vegetation to be planted behind and within the structure because of the tight proximity of the logs and protruding rootwads.

6.11.3.2 Log Cribwall (Sloped)

A sloped log cribwall will be installed in place of the existing block retaining wall. The cribwall will protect the bank and enhance instream and riparian habitat. Vegetation will be established at the top of the bank and within the cribwall itself. Building a sloped wall would require the loss of a portion of the Coates' upland property.

6.11.3.3 Planform Modification and Log Cribwall (Sloped)

Realign the channel to the left of its present location towards the south. This would create a wider active channel and a wider footprint in which to build a sloped log cribwall as described above, while minimizing the loss of yard space and maximizing habitat benefit. Realignment of the channel may tie into a downstream realignment as described in Section 6.9.

6.11.4 Geomorphic Implications

The implementation of this project will provide a more naturally stabilized bank that enhances instream habitat conditions and allow for better long-term riparian conditions. The project will need to account for channel incision during the design process and limit channel migration towards the dwelling on the top of the bank. If the channel is realigned it will be capable of handling additional channel incision without threatening adjacent property or infrastructure.

6.11.5 Challenges and Limitations

The close proximity of the Coates' dwelling to the construction area will pose constructability concerns with respect to temporary stabilization of right bank soils, landscaping disturbance, temporary storage of excavated materials, and simple equipment access. Translating the creek to the south and modifying the local channel grade will greatly

ease constructability issues and promote consistency with large scale geomorphic processes. This will likely require some consistency with the implementation of Projects 13 and 14.

6.12 Project 12 – Existing Wall Removal and Natural Channel Development at Station 28+60 to 29+40

6.12.1 Location

Project 12 would encompass acquisition of the Coates property and include removal of an existing rock wall (approximately 10 cy; concrete block) from approximately Station 28+60 to 29+40 (Figure 17).

6.12.2 Site Description

The right bank is currently armored with approximately 75 linear feet of concrete block retaining wall that is being severely undercut at the toe. Backfill materials behind the wall are exposed by the undercutting and deposited in the channel as the material at the base of the wall is eroded away. The left bank is a gravel bar that is well vegetated below the OHWL. Above the top of the wall, the right bank slopes steeply up to the yard on the Coates property. The landowner has expressed concern that the yard has been progressively slumping towards the stream over the past 5 years he has lived at the residence. The site is directly downstream of a steep boulder run that directs stream power at the wall location. The left bank is likely high enough that floodplain connectivity is limited, with the point bar area providing additional channel conveyance during high flows. The right bank is approximately 10 feet high and has no floodplain connectivity.

The channel adjacent to the wall is a slow-moving pool at low flows. Instream habitat conditions are characterized by a cobble and gravel bed, low to moderate velocities, and deep water at low flow (approximately 3 feet or more). During higher flows velocities and stream power directed at this location are accelerated along the length of the existing wall, likely contributing to the severity of erosion.

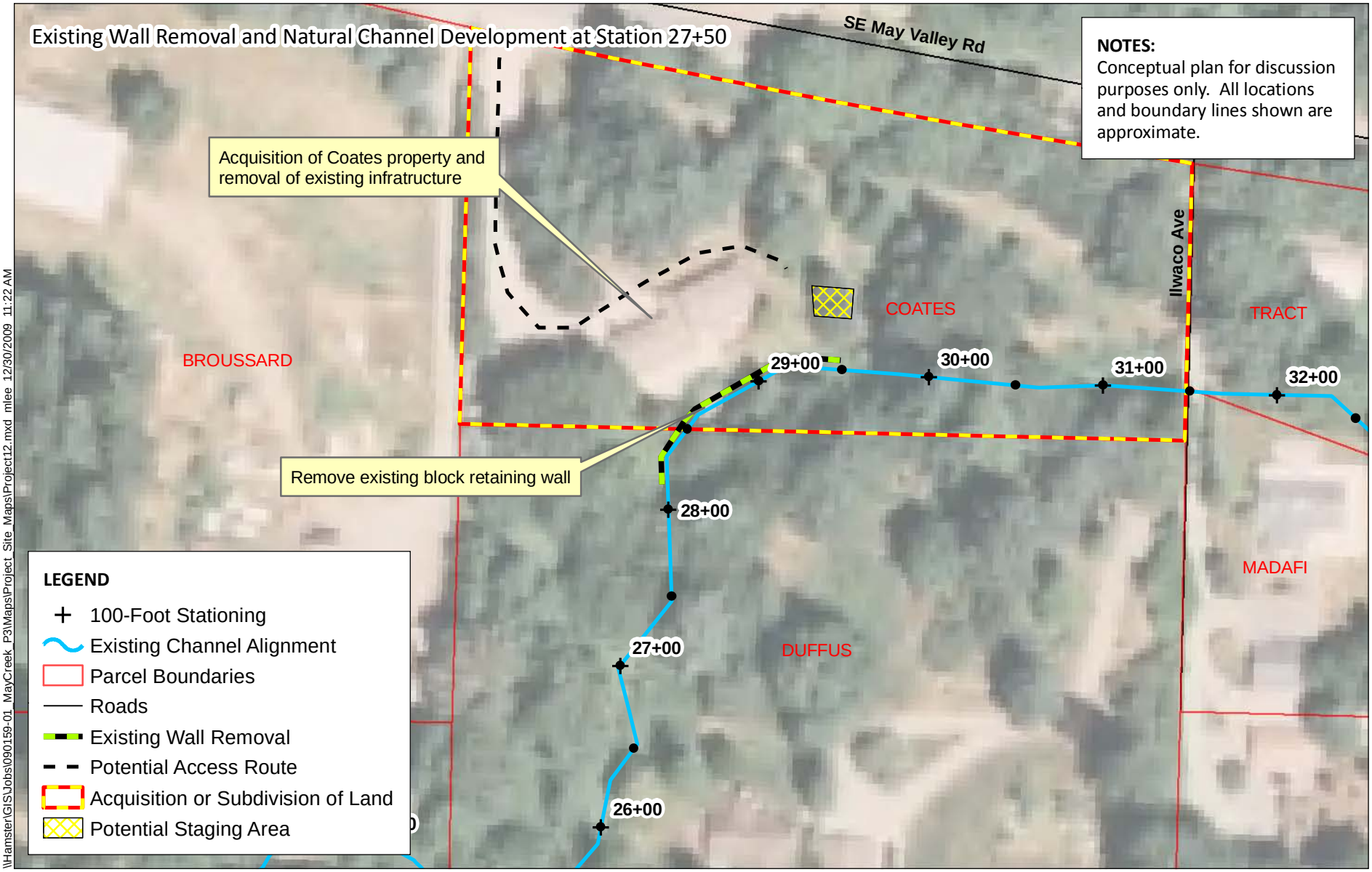

Figure 17
Conceptual Plan View, Project 12
May Creek Erosion Stabilization Report
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Some mature deciduous trees, a moderately thick understory of immature deciduous trees, and other plants overhanging the left bank providing some stream shading. The right bank lacks tree cover and only sparse immature (approximately 3 to 4 feet tall) deciduous trees were observed. The slope behind the wall is primarily vegetated with a wide variety of native and non-native shrubs, bushes and vines including Himalayan blackberry and morning glory. Some large patches of reed canarygrass were also observed growing along a gravel accumulation at the upstream end of the wall.

6.12.3 Potential Actions

6.12.3.1 Acquisition

Acquire the Coates property and remove existing infrastructure including the retaining wall to allow the creek to naturally evolve. This will also include sloping and revegetating the area disturbed by removal of the wall. Additionally the cleared area where the private residence currently resides may be planted with trees and other native vegetation to enhance upland habitat conditions.

6.12.4 Geomorphic Implications

The implementation of this project is consistent with large scale geomorphic processes. The channel would be allowed to migrate and incise without affecting public or private infrastructure.

6.12.5 Challenges and Limitations

The landowner may be unwilling to sell. Recovering purchase costs by reselling the home for offsite relocation may be difficult.

6.13 Project 13 – Left and Right Bank Riparian Habitat Enhancement at Station 29+40 to 31+50

6.13.1 Location

Project 13 will provide long-term stabilization via riparian habitat enhancement from approximately Station 29+40 to 31+50 (Figure 18).

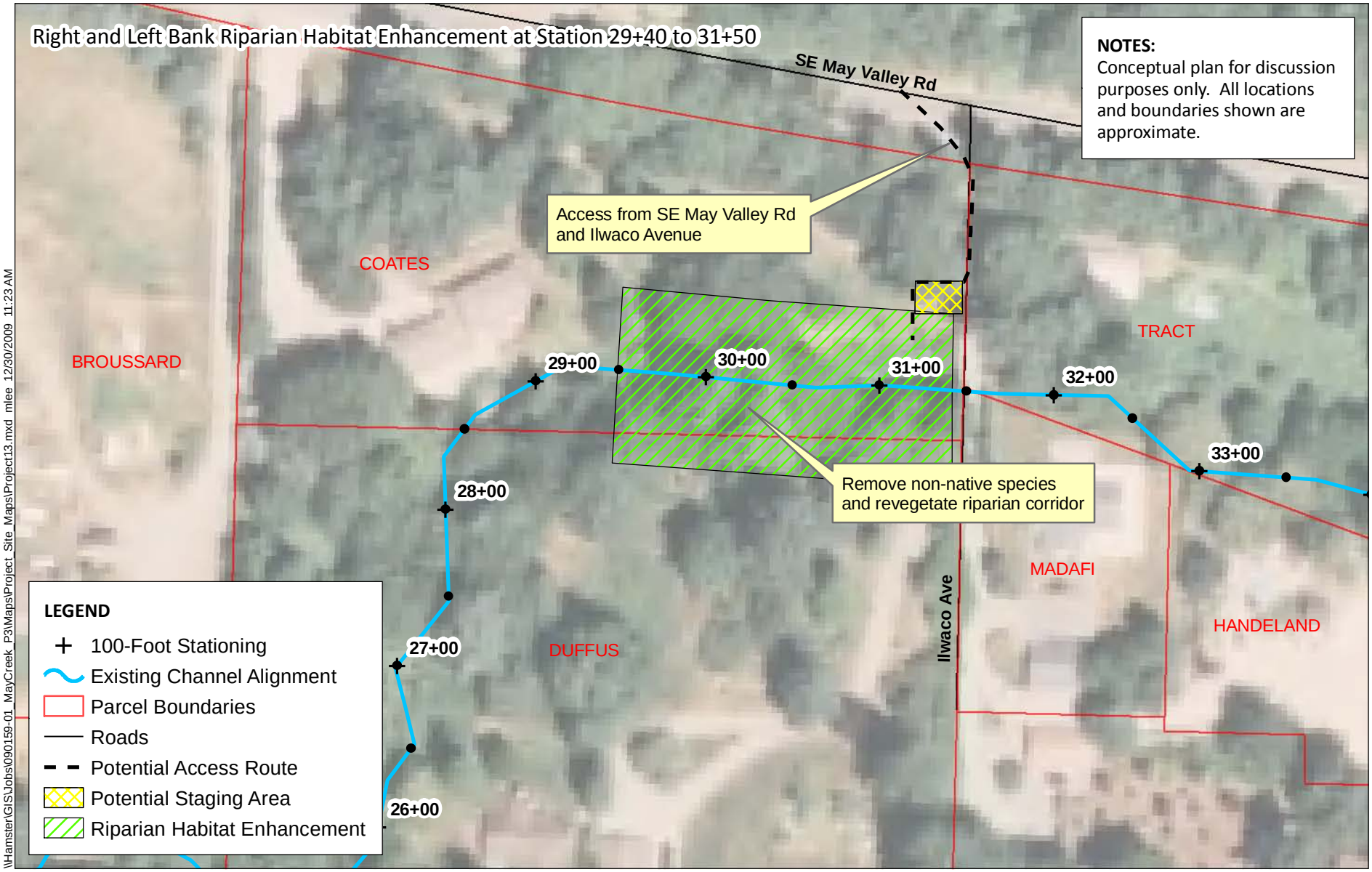

Figure 18
Conceptual Plan View, Project 13
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

6.13.2 Site Description

The right and left banks are currently stable. The steep banks provide limited floodplain connectivity.

The project area has three distinct channel sections. The lower portion of the channel is a narrow, high gradient boulder run. At low flows the boulders are exposed and water flows between the boulders, creating a series of small pools and turbulent, cascading jumps. At higher flows the boulders provide increased bed roughness and flow turbulence relative to adjacent sections of the stream. Upstream of the boulder run, the channel widens and the grade flattens out to a slow-moving pool caused by backwater stacking up behind the boulder section. Upstream of the pool to the Ilwaco Avenue crossing the channel is slightly wider with low to moderate velocities and moderate depths during low flow.

Riparian habitat conditions within the project site are fairly well-developed along the left bank and overgrown with invasive species on the right bank. The right bank lacks sufficient tree cover. Some mature deciduous trees are present in the floodplain that are set back from the channel such that adequate shading is not provided. The right bank is thickly lined with reed canarygrass, Himalayan blackberry vines and a few immature deciduous trees growing along the slope. The left bank is vegetated with several mature deciduous and coniferous trees. A thick understory of immature deciduous trees and woody shrubs has established, although Himalayan blackberry and reed canarygrass are interspersed with native growth.

6.13.3 Potential Actions

6.13.3.1 Riparian Habitat Enhancement

Selectively remove invasive and non-native plant species along the riparian corridor. The vegetation removal would be followed by replanting with native riparian species to stabilize and enhance the upland areas.

6.13.4 Geomorphic Implications

The implementation of this project would not restrict the channel's natural response to flood conveyance and sediment transport. In the long-term a robust riparian corridor will provide greater potential for wood recruitment and promote stability of the banks.

6.13.5 Challenges & Limitations

Clearing and grubbing would likely be done using hand labor primarily along the left bank. This project will need to be considered with respect to upstream and downstream projects.

6.14 Project 14 – Ilwaco Avenue Private Bridge Replacement or Removal

6.14.1 Location

Project 14 will remove or replace an existing bridge and remove an existing log weir near Station 31+50. Approximately 300 to 400 cy of concrete, riprap, and other debris would be removed. The bridge would be replaced and a local bank stabilization treatment applied. Alternately, a new access route may be established from the south via NE 24th Street and 143rd Avenue SE. The existing log weir is located in the channel between the Madafi and tract property (formerly Langley Development designated green space). Ilwaco Avenue is located through the boundary between the Coates, Duffus, Madafi, and tract parcels. The bridge is used for access by these landowners, as well as access to the Handeland and Deleon properties which are located directly east and south of the Madafi residence, respectively (Figures 19 and 20).

6.14.2 Site Description

The Ilwaco Avenue bridge crossing is a private concrete structure with a 6-foot high arch and 15-foot span. The left and right banks through the bridge opening are presently stable with armoring. The channel bed beneath the bridge has been augmented with riprap, cement and rebar to reduce local scour and head cutting at the bridge. A log weir approximately 10 feet upstream of the bridge produces an extensive backwater pool at low flows. At higher flows the bridge opening constricts flows, thereby increasing upstream water levels.

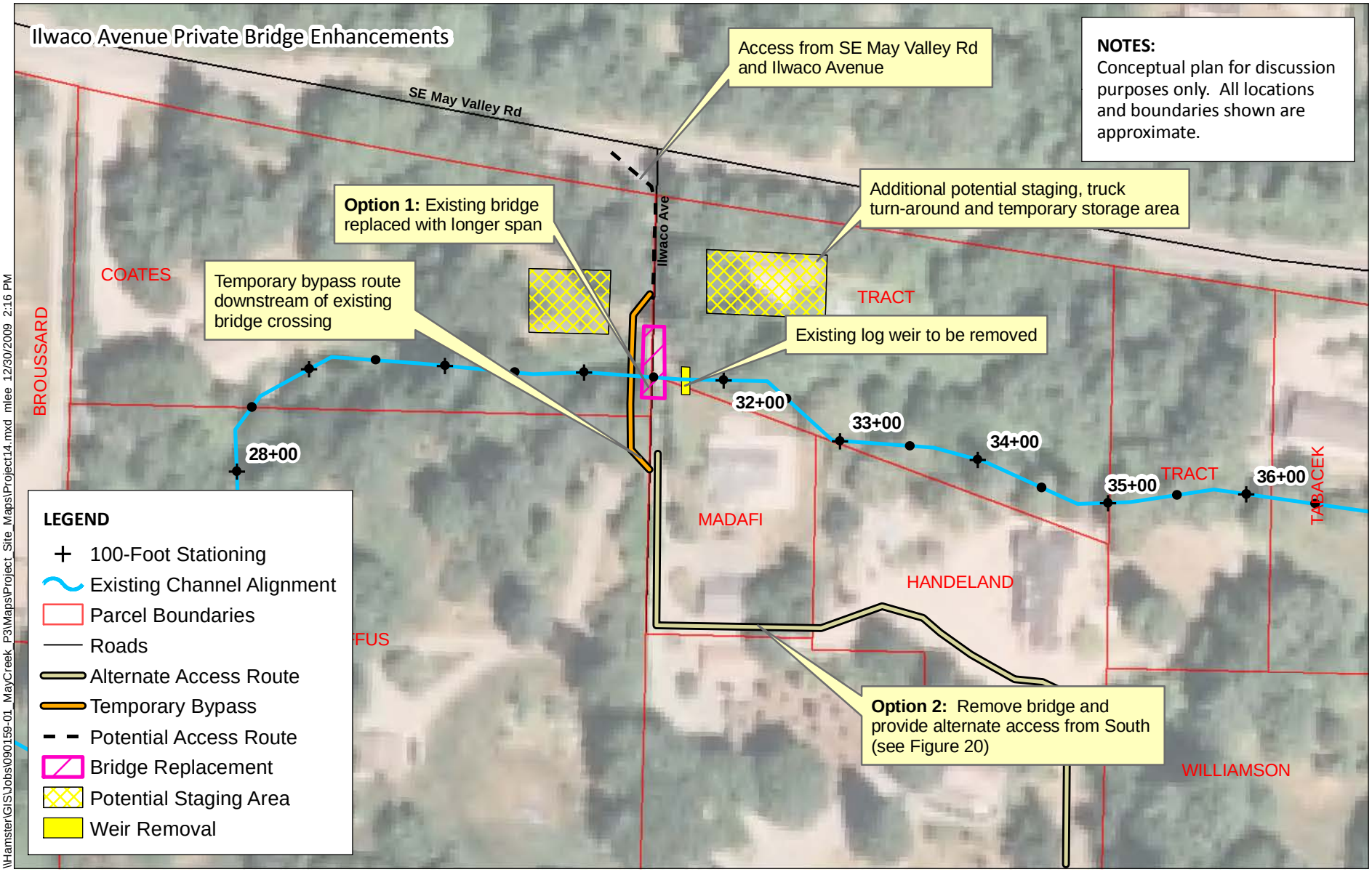

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Figure 19
Conceptual Plan View, Project 14
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

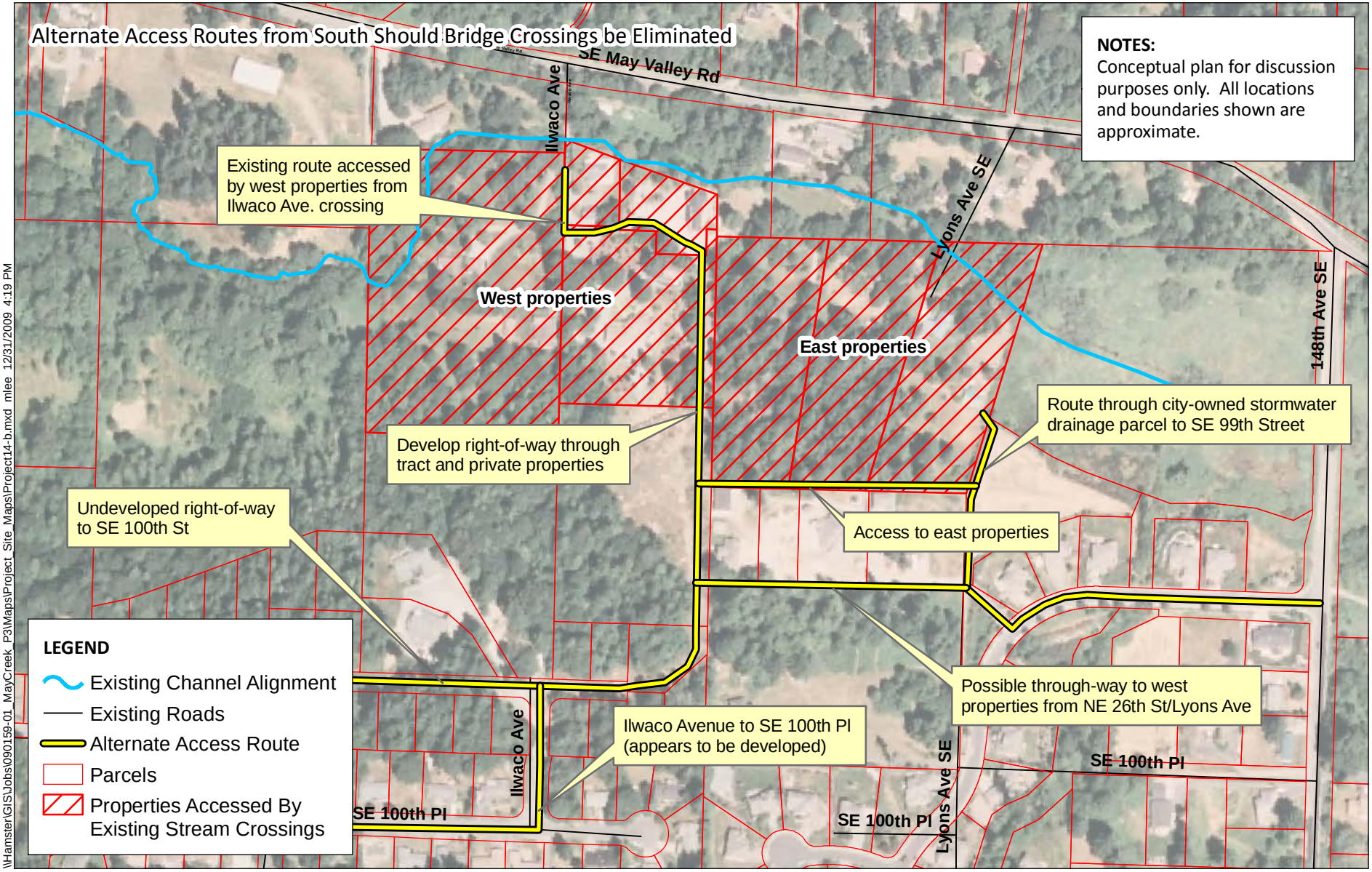

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Figure 20
Conceptual Plan View of Potential Alternate Access Routes
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

This segment of the channel is characterized as a run within a plane bed section of the stream. Instream habitat conditions are characterized by a substrate composed of angular concrete fragments, boulders, and cobble, with moderate velocities and shallow water depths at low flow. Velocities are likely accelerated through the bridge opening during high flows. During low flows, the channel upstream of the bridge is controlled by a log weir that produces an extensive backwater pool and limits transport of spawning-sized gravels. The effect of the weir likely decreases during high flows, although it may continue to contribute to flooding.

Riparian habitat at this site is not well developed. One mature willow is present on the left bank and few mature trees are present on the right bank. The right bank is thickly vegetated with Himalayan blackberry and the left bank is primarily a low-lying landscaped grass. Some stream shading is provided by the tree growth, although the channel is mostly exposed.

6.14.3 Potential Actions

6.14.3.1 Bridge Replacement

Remove the existing bridge, concrete abutments, concrete fragments, and other debris. Install a longer span bridge (approximately 30 feet) with abutments set back from the top of the banks in the upland. Stabilize the disturbed banks by regrading and planting with riparian vegetation.

6.14.3.2 Weir Removal

Remove the existing weir and stabilize the banks locally with riparian vegetation in conjunction with bridge replacement or removal.

6.14.3.3 Bridge Removal and Alternate Access Route

Remove the existing bridge, concrete abutments, concrete fragments and other debris. Stabilize the disturbed banks by regrading and planting with riparian vegetation. Establish an alternate access route from the south. Possibilities for alternate routes include access from the west via an undeveloped right-of-way connecting to SE 100th Place/NE 24th Street or via SE 99th and NE 26th streets from the east. The alternate access may be tied into the

development of alternate access to the Bonwell and Culbertson properties to the east as part of Projects 22 or 23.

6.14.4 Geomorphic Implications

The implementation of this project will allow the channel to function more naturally in response to flood conveyance and sediment transport. Increasing the bridge span will allow the channel to incise without affecting public or private infrastructure. Design of treatment actions must account for future channel incision. Floodwaters would not be backwatered and instream velocities through the bridge opening during floods would be greatly reduced. Increased conveyance through the bridge opening is not expected to adversely affect the channel downstream. Removal and establishment of alternate access will have the added benefit of potential increased floodplain connectivity on the north side of the channel.

6.14.5 Challenges and Limitations

This bridge provides access to multiple properties which would need to be maintained during construction. Bridge replacement may require the installation of a temporary bridge. A replacement bridge would need to be capable of passing residential bridge codes and standards. Creating an alternate access route would likely require establishment of a right-of-way though multiple privately-owned parcels and cooperation of multiple landowners in addition to those that use the existing bridge for access.

6.15 Project 15 – Bank Stabilization Treatment at Station 31+90 to 32+80

6.15.1 Location

Project 15 will remove existing stone armoring (approximately 23 cy) and install a bank stabilization treatment from approximately Station 31+90 to 32+80 (Figure 21).

6.15.2 Site Description

The left and right banks are presently stable. The left bank is currently armored with stone boulders. The banks are relatively low (approximately 3 feet high) and likely have good floodplain connectivity on both sides of the channel.

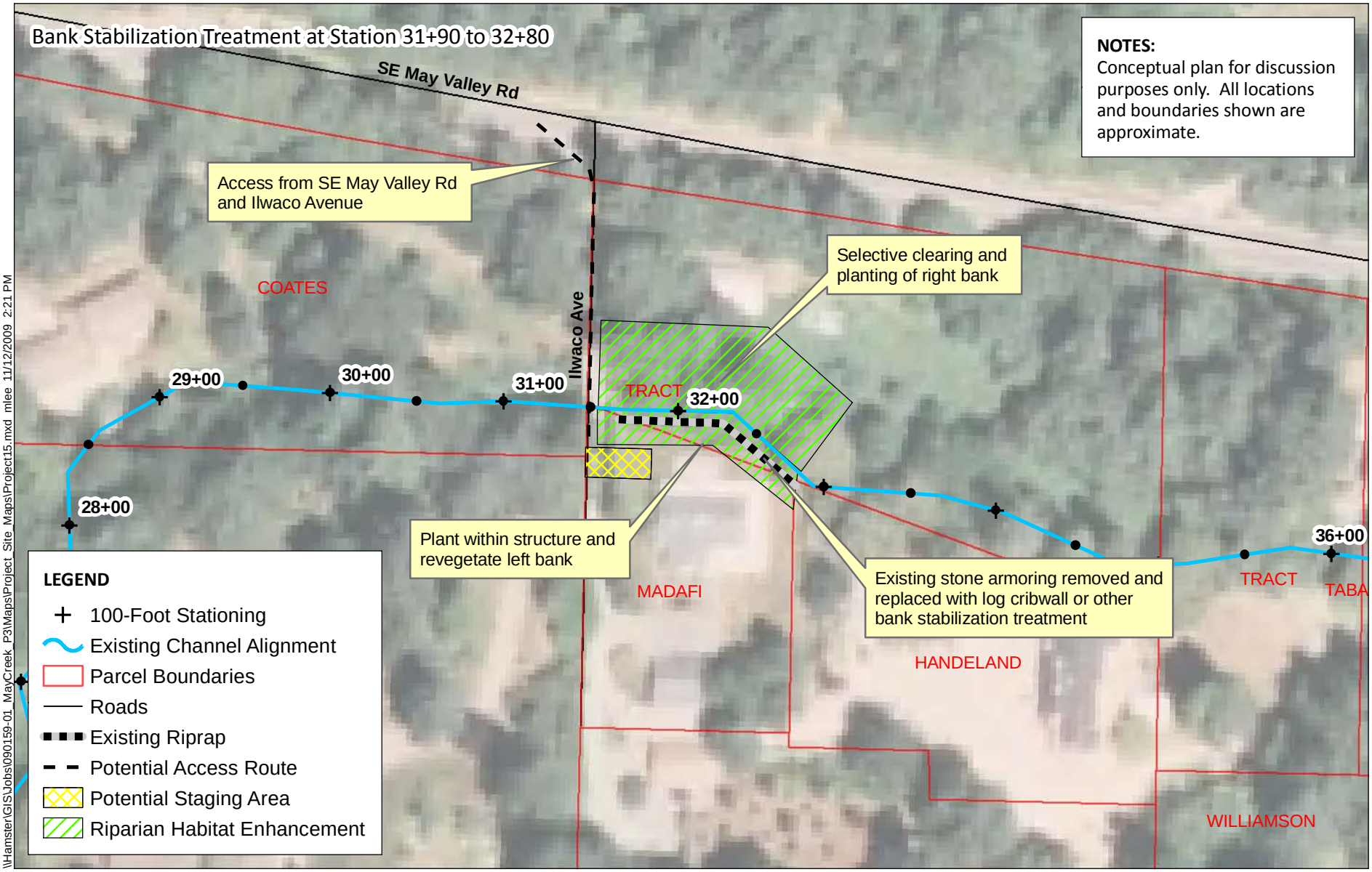

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Figure 21
Conceptual Plan View, Project 15
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

The channel is a slow-moving pool at low flows. The pool is created by a log weir on the downstream end of the armored bank that produces extensive backwater during low flows and limits sediment transport through this section of the channel. The effect of the weir likely decreases during high flows, although it may continue to contribute to flooding. Instream habitat conditions are characterized by embedded gravel with a moderate amount of silt infilling, low velocities, and moderate water depths at low flow. At the upstream end of the site the channel is constricted by a gravel bar along the right bank that forces the thalweg along the base of the armored bank, accelerating velocities through this area.

Riparian habitat is not well developed and can be characterized as a lack of shading and roughness along the left bank, and invasive vegetation along the right bank. Two mature willow trees are located on the left bank and few mature trees on the right bank. The right bank is thickly vegetated with Himalayan blackberry. The gravel bar at the upstream end of the site is vegetated with a large accumulation of reed canarygrass. The left floodplain has no understory and is covered in lawn grass. A moderate amount of stream shading is provided by mature trees along the right bank, while a minor amount is provided by the willow trees on the left bank.

6.15.3 Potential Actions

6.15.3.1 Bank Stabilization Treatment

Remove the existing stone armoring and install a log cribwall to stabilize the left bank. The cribwall will provide bank stabilization and enhance instream habitat by creating roughness and cover. Riparian habitat will be enhanced by planting the cribwall with riparian vegetation.

6.15.3.2 Riparian Habitat Enhancement

Selectively remove invasive plant species and replace with native species throughout the riparian corridor in the tract parcel (right bank). Along the left bank, establish a reasonable riparian buffer width, given the limited space between the existing channel and the existing residence. Based on aerial photographs it appears the maximum width of the riparian buffer along the right bank would range from approximately 20 to 40 feet between the top of bank and the existing structure.

6.15.4 Geomorphic Implications

The implementation of this project will provide a more naturally stabilized bank that enhances habitat conditions and allows for incision to occur while providing protection for private infrastructure. Design of treatment actions must account for future channel incision.

6.15.5 Challenges and Limitations

This project will require landowner cooperation and approval. Access from the north may result in disturbance of existing wetland areas.

6.16 Project 16 – Weir Removal and Bank Stabilization Treatment at Station 33+20 to 35+10

6.16.1 Location

Project 16 will remove an existing weir and associated concrete debris (approximately 13 cy) from Station 33+20 to 34+50, as well as provide a bank stabilization treatment from approximately Station 34+60 to 35+10 (Figure 22).

6.16.2 Site Description

The left and right banks are presently stable. A weir composed of large, immobile concrete debris is located at approximately Station 34+00. Additional pieces of concrete and asphalt debris are scattered throughout this area, primarily along the toe of the left bank. The left bank at the upstream extent of the project is armored with stone. The bank is relatively high and does not appear to overtop during high flows. The right bank is lower and likely has connectivity with the floodplain during high flows.

This segment of the channel is characterized as a plane bed section, with local pools forced by the concrete debris and weir. Instream habitat conditions are characterized by gravel and cobble substrate with silt infilling in backwater areas, low to moderate velocities, and moderate water depths at low flow. The upper portion of the site is somewhat constricted by stone armoring protruding into the channel.

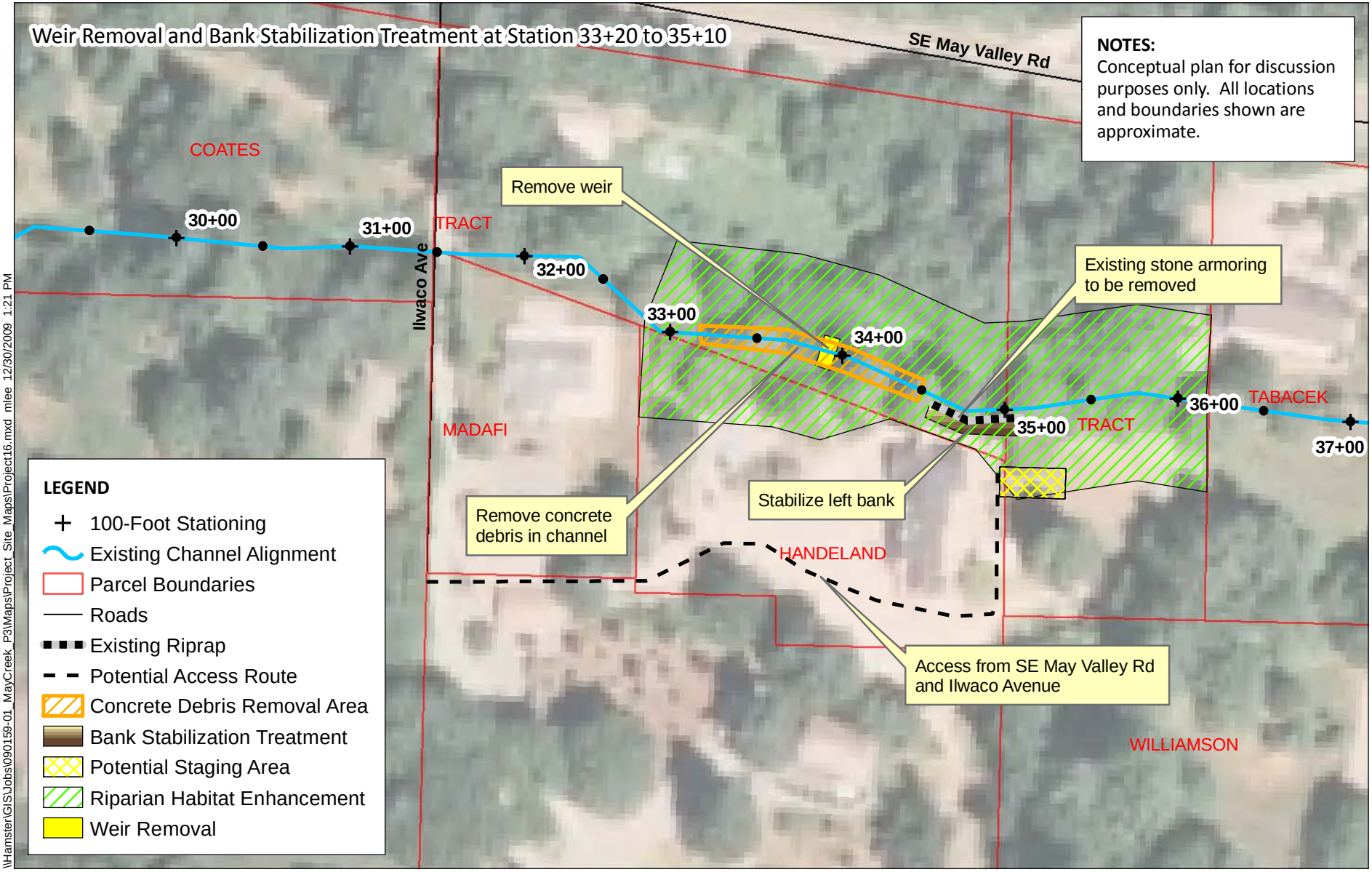

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Figure 22
Conceptual Plan View, Project 16
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

Riparian habitat conditions are characterized by adequate stream shading and lack of a well-developed understory of native vegetation. Several mature trees are present on the left bank, however, there is little understory throughout a majority of the site. The riparian corridor is narrow and transitions into open developed space around the existing residence. The right bank is vegetated with Himalayan blackberry and some interspersed native shrubs. A moderate amount of mature trees provide shading along the right bank.

6.16.3 Potential Actions

6.16.3.1 Debris and Weir Removal

Remove the existing concrete debris in the channel and along the left bank from approximately Station 33+20 to 34+50, including the weir at approximately Station 34+00.

6.16.3.2 Bank Stabilization Treatment

Remove approximately 45 linear feet of existing stone armoring along the left bank from approximately Station 34+60 to 35+10. Install a bank stabilization treatment, such as a coir wrap or toe stabilization, based on site-specific evaluation. The disturbed area of the bank will be planted with native vegetation.

6.16.3.3 Riparian Habitat Enhancement

Selectively remove non-native plant species and replace with native species throughout the riparian corridor in the tract parcel (right bank). Along the left bank, establish a reasonable riparian buffer width given the limited space between the existing channel and the dwelling. Based on aerial photographs it appears the maximum width of the riparian buffer along the right bank would range from approximately 15 and 50 feet between the top of bank and the existing structure. Within the tract parcel on the south side of the channel, establish a 50-foot minimum riparian buffer along the right and left banks, including revegetation of the cleared area.

6.16.4 Geomorphic Implications

The implementation of this project will provide a more naturally stabilized bank that enhances instream and riparian habitat conditions. The channel will be allowed to incise

while protecting existing private infrastructure. Design of treatment actions must account for future channel incision.

6.16.5 Challenges and Limitations

Debris, weir, and stone armoring removal will require landowner cooperation and approval. Site access to the tract space on the right and left banks will require landowner approval. Access from the north may result in disturbance of existing wetland areas.

6.17 Project 17 – Channel Realignment at Station 32+00 to 36+20

6.17.1 Location

Project 17 will realign the channel and provide a bank stabilization treatment from Station 32+00 to 36+20 (Figure 23).

6.17.2 Site Description

A portion of the proposed alignment may be located through an area with known wetlands according to municipal signage on site. Mature deciduous and coniferous trees grow along the edges of the west parcel and throughout the floodplain in the east parcel. The center of the west parcel has become thickly overgrown with Himalayan blackberry following demolition and removal of the buildings that were formerly on the property. The existing grade through the wetland area is 3 to 5 feet above the existing channel grade.

6.17.3 Potential Actions

6.17.3.1 Planform Modification

Realign the channel to the north through the tract parcels providing a wider riparian corridor as well as the potential to develop side channel habitat within the existing channel. Realignment of the main channel through the tract will also reduce flooding and erosion concerns along the private properties on the south side of the existing channel. The realignment may tie into an additional realignment on the left bank (see Project 19).

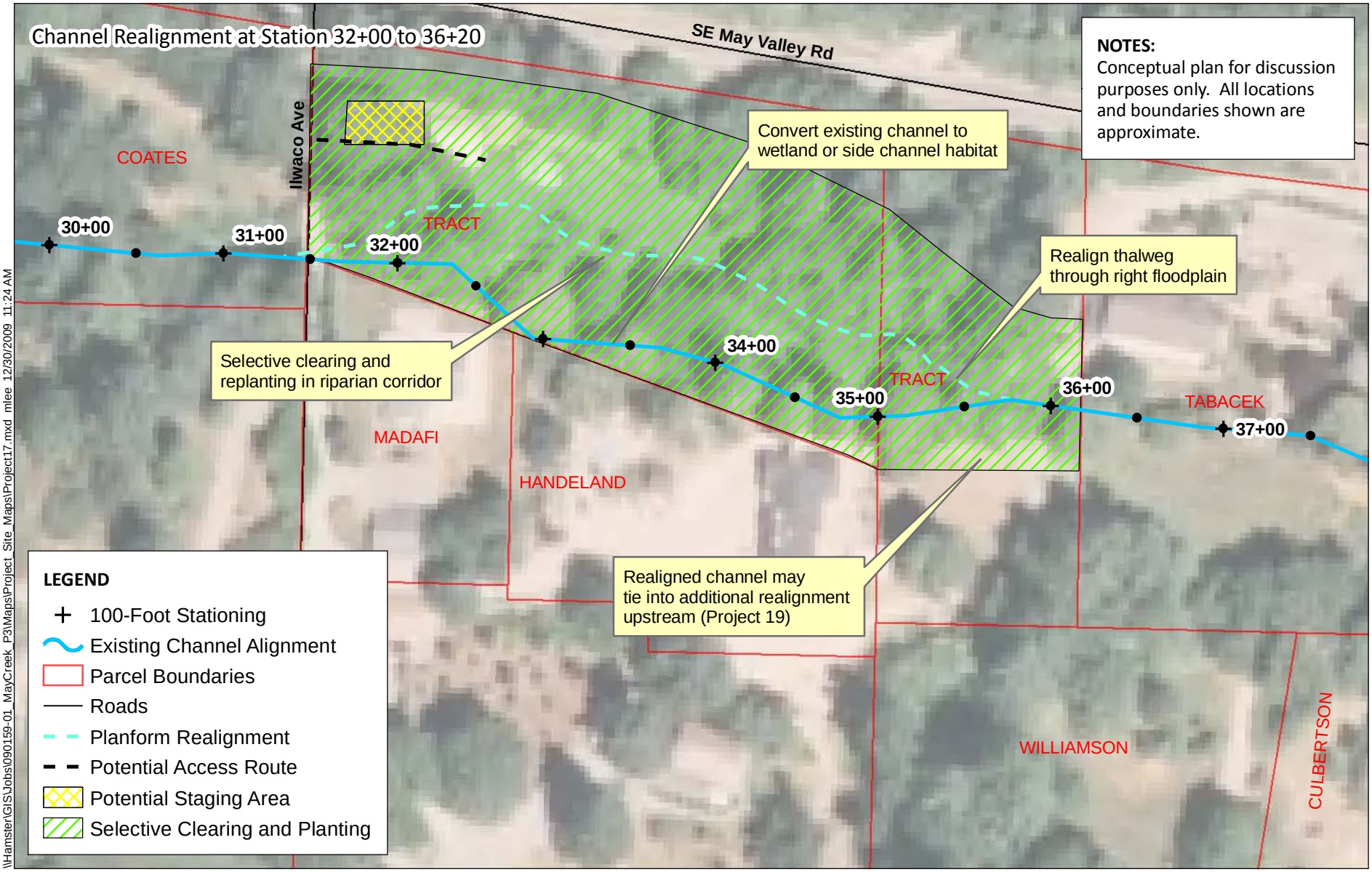

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Figure 23
Conceptual Plan View, Project 17
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

6.17.3.2 Large Woody Debris Placement

Place LWD at selected locations to create stable hydraulic conditions capable of creating deep pools locally. The location and size of the LWD will be based on natural pool spacing and site-specific hydraulics.

6.17.3.3 Riparian Habitat Enhancement

Remove non-native plant species along the riparian corridor of the existing and realigned channel (the existing right floodplain). The vegetation removal will be followed by replanting with native riparian species to provide additional bank and floodplain stability.

6.17.4 Geomorphic Implications

The implementation of this project is consistent with large scale geomorphic processes. The channel would be allowed to migrate and incise without affecting public or private infrastructure. Design of treatment actions must account for future channel incision.

6.17.5 Challenges and Limitations

This project will require a significant quantity of excavation, requiring temporary storage and placement or offsite disposal. The stream may also need to be temporarily routed through pipes during construction. The new channel alignment may be located in part through a wetland area which would require mitigation. Coordination and approval from the property owner (the City of Renton) would be required.

6.18 Project 18 – Channel Improvements at Station 36+20 to 38+40

6.18.1 Location

Project 18 will apply a bank stabilization treatment from Station 36+20 to 38+40 (Figure 24).

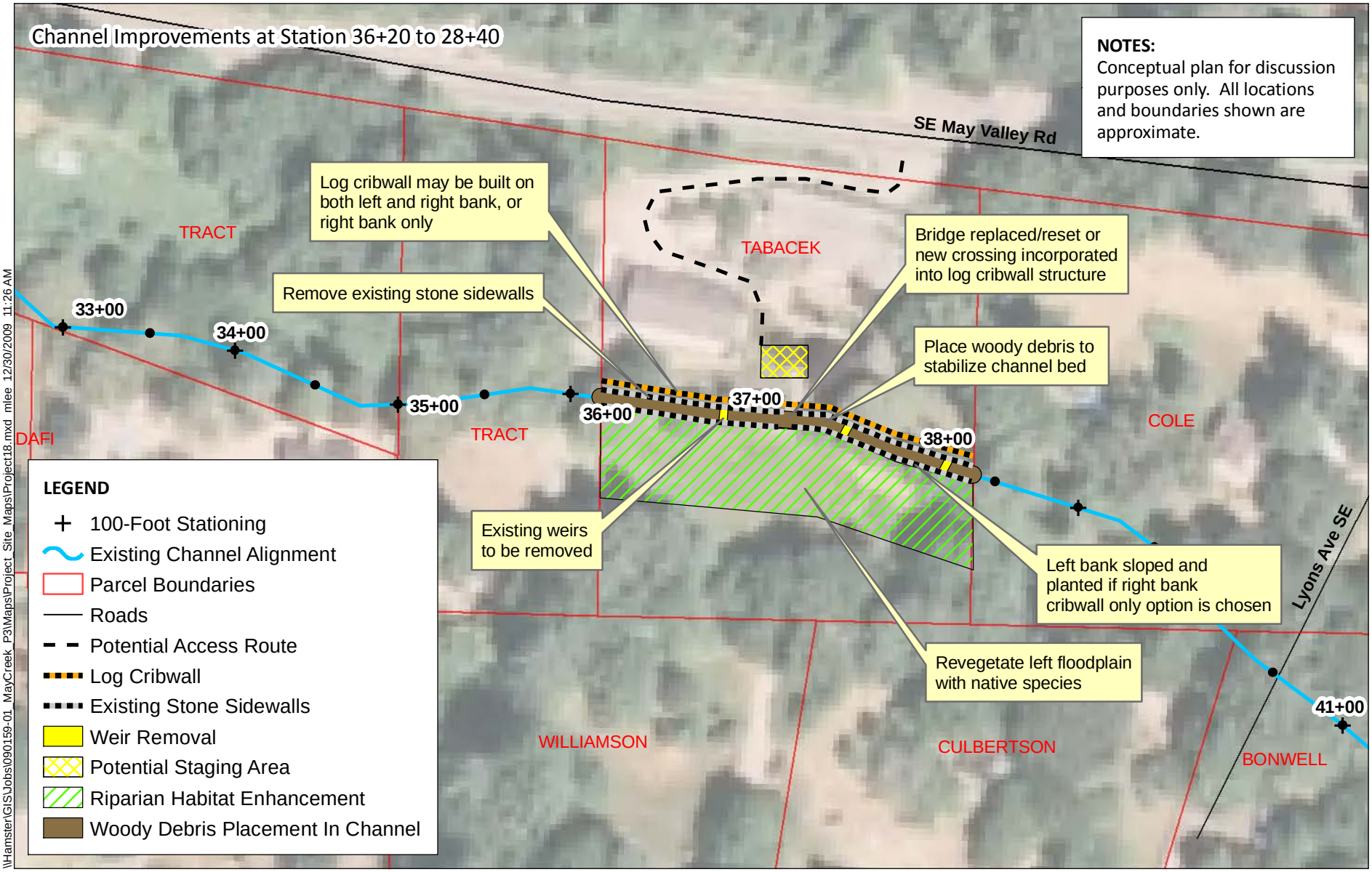

Figure 24
Conceptual Plan View, Project 18
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

6.18.2 Site Description

The left and right banks are presently lined with vertical stone walls. The channel grade is controlled by three rock weirs spaced throughout the property. The weirs create approximately 0.5-foot drops in water surface elevation, and approximately 0.5- to 2-foot drops in bed elevation where plunge pools form on the downstream side of the weir. A wooden pedestrian bridge with a concrete abutment on the south side of the channel is located through the center of the property. The banks are approximately 2.5 feet high and likely provide good floodplain connectivity.

The channel is controlled by the weirs as water plunges over the weirs into pools on the downstream side. The channel has low velocities, and moderate to shallow water depths at low flow. The substrate is sand and gravel with a thick layer of silt infilling as silt is able to be deposited in the low velocities. The backwater created by the weirs allows for warm temperatures and reduced dissolved oxygen concentrations. Several silt-covered weedy plants are growing on the channel bottom and patches of duckweed were observed on the water surface during low flow. In addition, the weirs prevent spawning-sized sediments from being transported downstream. Small accumulations of gravel were observed on the upstream side of the weirs.

Riparian habitat conditions are degraded due to clearing and landscaping of the property. The area is characterized by a lack of mature trees and understory. Some landscaped shrubs are present and the ground is covered in short grass. Stream shading is not provided by the existing vegetation, leaving the channel exposed throughout this section.

6.18.3 Potential Actions

6.18.3.1 Wall Removal, Weir Removal and Log Cribwall Along Both Banks

Remove the existing stone walls and weirs throughout the property. Install log cribwalls along the right and left banks to stabilize the banks and provide habitat benefit. The existing pedestrian bridge may be removed or replaced. The log cribwalls will be planted with native riparian vegetation.

6.18.3.2 Wall Removal, Weir Removal and Log Cribwall Along Right Bank

Remove the existing stone walls and weirs throughout the property. Install a log cribwall along the right bank to stabilize the bank, provide habitat benefit and prevent migration of the channel towards the Tabacek dwelling. The log cribwall will be planted with native riparian vegetation. The left bank will be sloped and planted to mitigate the disturbed area, leaving the left bank unconfined and able to evolve more naturally. The existing pedestrian bridge will be removed.

6.18.3.3 Riparian Habitat Enhancement

Selectively remove non-native plant species within the forested (south) area of the floodplain and along the existing channel banks and supplement with native riparian species to provide additional bank and floodplain stability. In the open area of the left floodplain, establish native riparian vegetation.

6.18.4 Geomorphic Implications

The implementation of this project will allow the channel to function more naturally in response to flood conveyance and sediment transport. The channel will be able to incise without affecting existing infrastructure. Design of treatment actions must account for future channel incision.

6.18.5 Challenges and Limitations

Landowner approval will be necessary to implement this project. Existing infrastructure is relatively close to the present channel alignment in the right floodplain. The landowner may wish to retain access to the left floodplain from the existing pedestrian bridge at approximately Station 37+20.

6.19 Project 19 – Channel Realignment at Station 36+20 to 38+40

6.19.1 Location

Project 19 will modify the channel planform between approximately Station 36+20 to 38+40 (Figure 25).

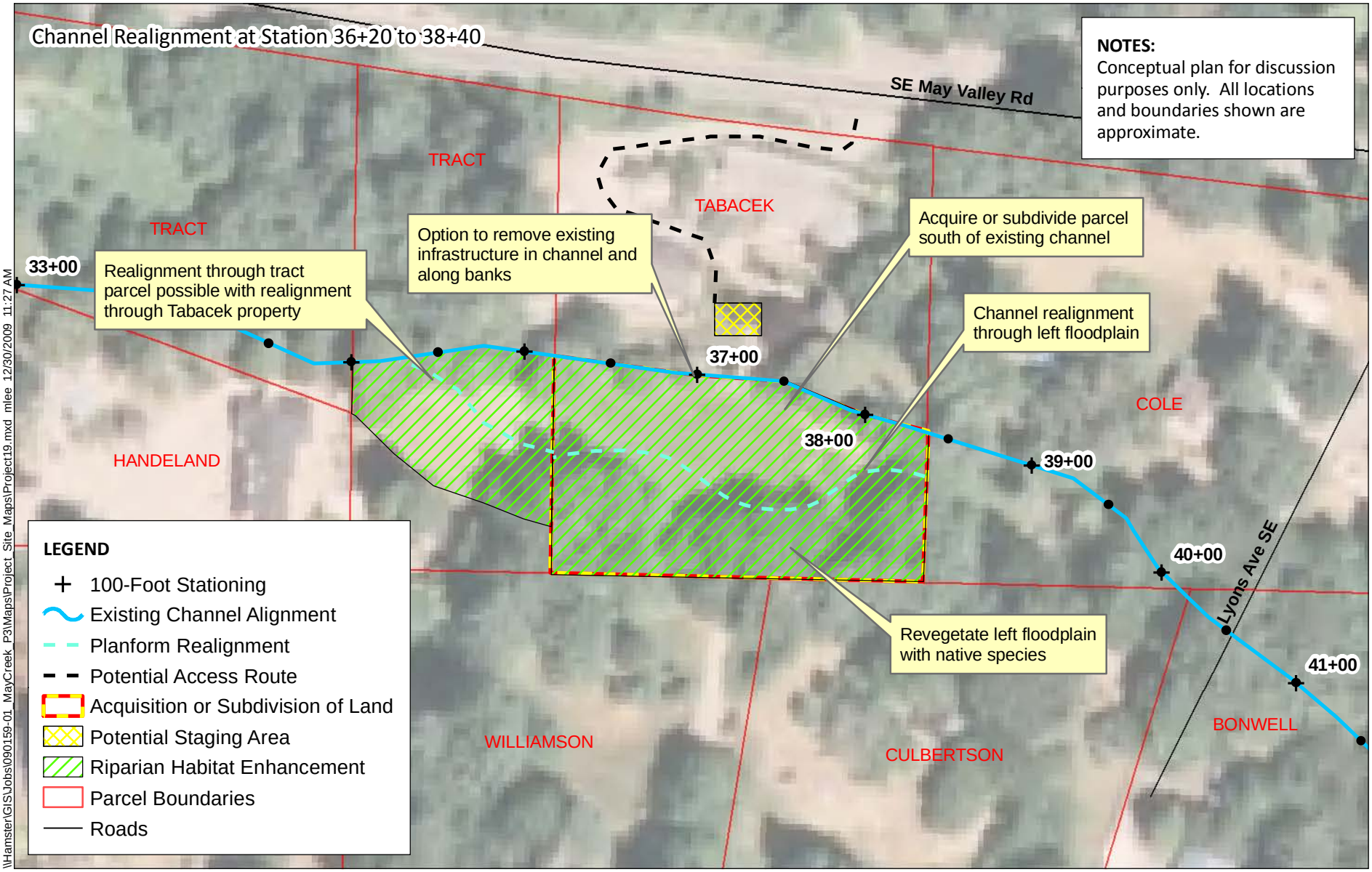

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Figure 25
Conceptual Plan View, Project 19
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

6.19.2 Site Description

The channel realignment will extend through existing yard space south of the existing alignment. The elevation of this area is approximately 3 to 5 feet above the existing channel grade. Within the proposed right floodplain, riparian habitat conditions are degraded due to clearing and landscaping of the property. The area is characterized by a lack of mature trees and understory. Some landscaped shrubs are present and the ground is covered in short grass. Stream shading is not present, leaving the existing channel exposed. Within the proposed left floodplain (the southern end of the parcel), there is more established canopy cover from mature trees.

6.19.3 Potential Actions

6.19.3.1 Planform Modification

Realign the channel to the south through the floodplain. This will provide a wider riparian corridor and allow for establishment of wetland habitat in the floodplain, as well as the potential to develop side channel habitat. This action could be accomplished through landowner cooperation or property procurement through the establishment of a conservation easement. Approval of this project would allow for realignment through the adjacent tract space to the west, further reducing erosion concern and increasing habitat benefit. Realignment may be tied into realignment downstream (Project 17).

6.19.3.2 Riparian Habitat Enhancement

Selectively remove invasive and non-native plant species within the forested areas of the floodplain and in the existing riparian corridor where applicable and supplement with native riparian species to provide additional bank and floodplain stability. In existing lawn areas, establish native riparian vegetation.

6.19.4 Geomorphic Implications

The implementation of this project will allow the channel to function more naturally in response to flood conveyance and sediment transport. Migration and incision will be allowed to occur without affecting public or private infrastructure.

6.19.5 Challenges and Limitations

This project will require landowner approval, potentially including acquisition of the land on the south side of the existing channel. The new alignment will require considerable excavation and revegetation and temporary disturbance to the landowner. Invasive species will need to be controlled in the disturbed areas to allow native vegetation to be established.

6.20 Project 20 – Bank Stabilization Treatment at Station 38+40 to 40+00

6.20.1 Location

Project 20 will remove an existing rock weir (approximately 1.3 cy), remove or replace a pedestrian bridge (approximately 5.7 cy of debris and concrete), and enhance riparian habitat from Station 38+40 to 40+00 (Figure 26).

6.20.2 Site Description

The right bank is stable to moderately stable and the left bank is stable. The height of the left bank is variable, increasing towards the Lyons Avenue Bridge crossing. The channel likely has some floodplain connectivity near the downstream end of the property but flow is likely contained within the banks at the upstream end of the site. We are aware that flows overtop the bank and cause flooding concerns near the residence.

This segment of the stream is characterized as a slow-moving backwater pool created by the weir on the adjacent property downstream and the weir within the project site. This area has a gravel substrate with silt infilling, low velocities, and moderate depths. The upstream extent of the site, outside of the influence of the weir, is a relatively straight run with a gravel and cobble substrate, moderate velocities, and relatively shallow water depth during low flow.

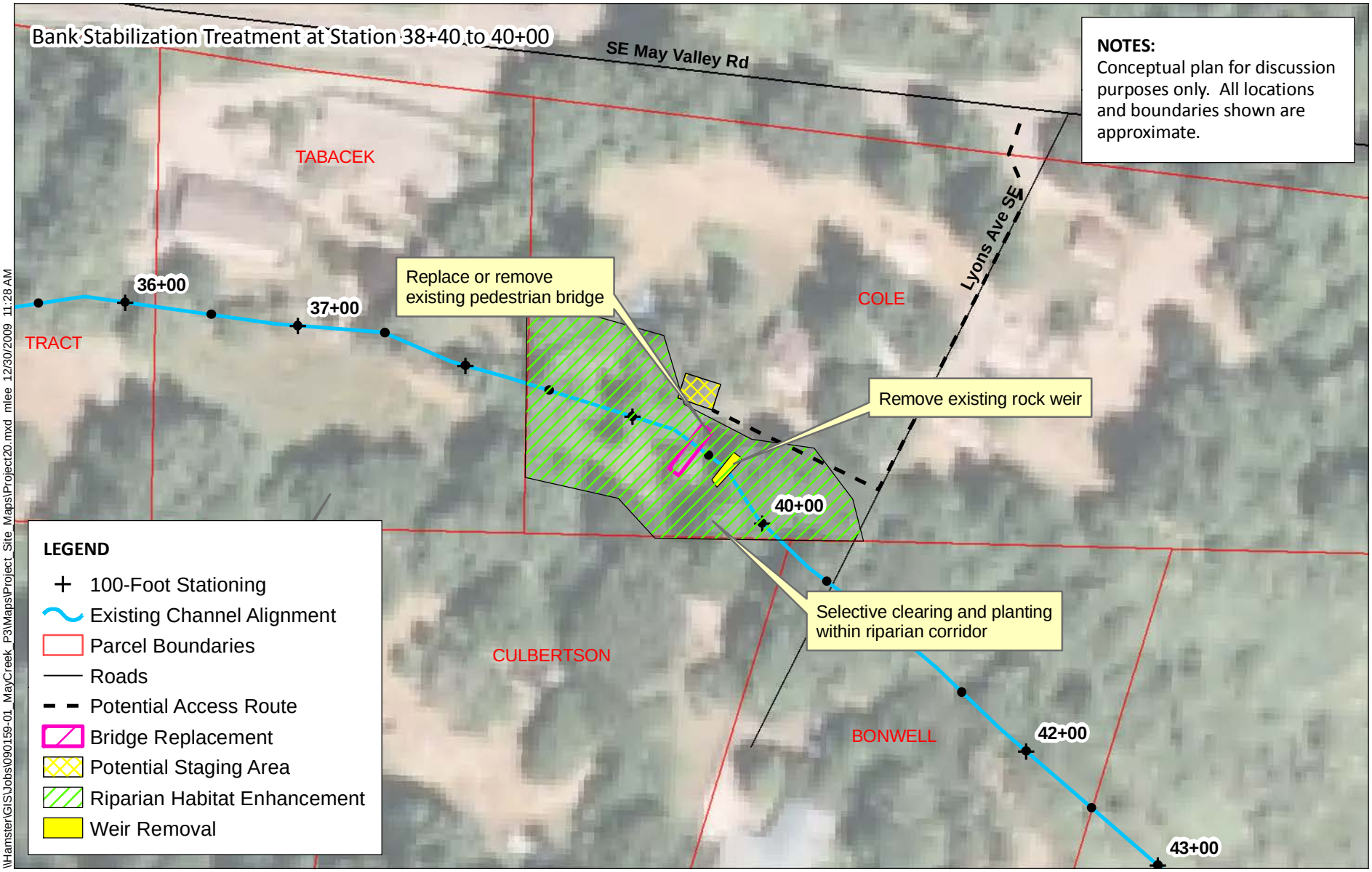

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Figure 26
Conceptual Plan View, Project 20
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

Riparian habitat conditions are characterized by mature trees along the left bank, a moderate amount of invasive understory vegetation, and grassy ground cover. The right bank has a moderate amount of mature trees and sparse understory located solely along the top of the bank. The floodplain is primarily covered in grass lawn with sparse trees and shrubs. Adequate stream shading is provided throughout a majority of the site by the mature trees along both banks.

6.20.3 Potential Actions

6.20.3.1 Weir and Bridge Removal

Remove the existing rock weir, pedestrian bridge and abutments. Slope back the banks disturbed by the bridge removal and plant with native riparian species.

6.20.3.2 Weir Removal and Bridge Replacement

Remove the existing rock weir, pedestrian bridge and abutments. Replace the bridge using a longer span with abutments set back from the banks.

6.20.3.3 Riparian Habitat Enhancement

Selectively remove invasive and non-native plant species within the riparian corridor from approximately Station 38+40 to 40+00. The vegetation removal will be followed by supplemental planting with native riparian species.

6.20.4 Geomorphic Implications

The implementation of this project will allow the channel to function more naturally in response to flood conveyance and sediment transport. The channel will be able to incise without affecting public or private infrastructure. Design of treatment actions must account for future channel incision.

6.20.5 Challenges and Limitations

This project will require landowner approval. The landowner may desire to maintain pedestrian access to the opposite bank.

6.21 Project 21 – Channel Realignment at Station Station 38+40 to 40+00

6.21.1 Location

Project 21 will involve acquisition of the Cole property, removal of existing infrastructure including a pedestrian bridge (approximately 5.7 cy) and rock weir (approximately 1.3 cy), and modification of the channel planform. Implementation of planform realignment through the tract space southeast of the property (Project 24) will be required in conjunction with this project. Establishment of alternate access to the Bonwell and Culbertson properties south of the existing channel alignment, or replacement of the Lyons Avenue Bridge will be required to implement this project (Figure 27).

6.21.2 Site Description

The channel realignment will extend through a wooded area (possible wetlands) on the north end of the parcel, and traverse through a cleared area. A tributary enters May Creek from the north within the wooded area. Existing infrastructure on the property will need to be removed and demolished or relocated. The existing grade along the proposed alignment is approximately 3 to 10 feet above the existing channel grade.

Riparian habitat conditions along the proposed alignment are characterized by a grove of mature trees at the east end of the proposed realignment and well developed understory. Some mature deciduous and coniferous trees and sparse understory plants are present throughout the proposed left floodplain. The remainder of the area is primarily covered in lawn with sparse trees and shrubs. Some canopy cover would be provided by existing mature trees along the proposed right floodplain and banks.

6.21.3 Potential Actions

6.21.3.1 Weir and Bridge Removal

Remove the existing rock weir and pedestrian bridge. Slope back and plant the disturbed banks with native riparian species.

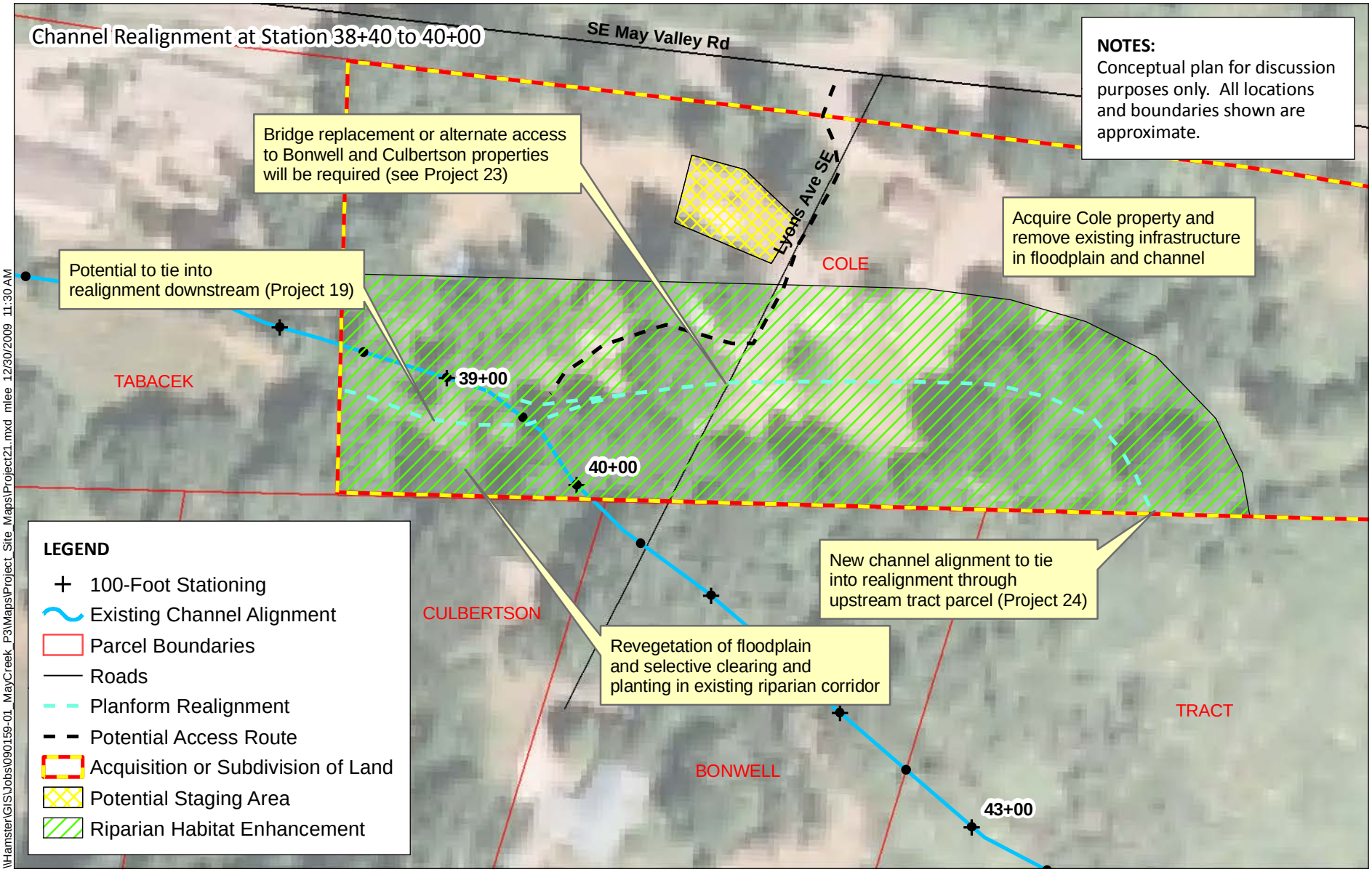

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Figure 27
Conceptual Plan View, Project 21
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

6.21.3.2 Planform Modification

Realign the channel to the north of its present location. The channel will be re-routed around the adjacent property to the south through the east side of the acquired parcel, and tie into the existing channel near the present location of the dwelling. Realignment will provide for a wider riparian corridor and the potential to develop side channel habitat. The realignment may be tied into channel realignment downstream (Project 19). Removal of existing infrastructure in the floodplain will be required (i.e., dwelling and outbuildings).

6.21.3.3 Large Woody Debris Placement

Place LWD at selected locations to create stable hydraulic conditions capable of locally creating deep pools. The location and size of the LWD would be based on natural pool spacing and site-specific hydraulics.

6.21.3.4 Riparian Habitat Enhancement

Selectively remove non-native plant species through the existing riparian corridor and the floodplain and supplement with native riparian species. Revegetate cleared areas (existing lawn) to establish a minimum of 50-foot riparian corridor on both sides of the realigned channel.

6.21.4 Geomorphic Implications

The implementation of this project will allow the channel to function more naturally in response to flood conveyance and sediment transport, and migration and incision will be allowed to occur without affecting public or private infrastructure.

6.21.5 Challenges and Limitations

This project will require acquisition of the Cole property. Agreement by the Bonwell and Culberson property owners may also be required, as access to those properties will be affected. This project will require a significant quantity of excavation, requiring temporary storage and placement or offsite disposal. The new channel alignment is located through a partially forested area requiring deep cuts to match stream grade and the potential to impact mature trees. However, if any trees need to be removed they will be incorporated into the

design of the stream as LWD. Stream flow may need to be temporarily routed through pipes during construction. The tributary to the north may also be temporarily re-routed during construction, and permanent realignment may be required to tie into the new position of the main channel alignment of May Creek. Bedrock may be encountered and blasting may be required for its removal. Underground and overhead utilities from SE May Valley Road may interfere with realignment of the channel, in which case an alternate route for these utilities would need to be developed.

6.22 Project 22 – Lyons Avenue Private Bridge Replacement

6.22.1 Location

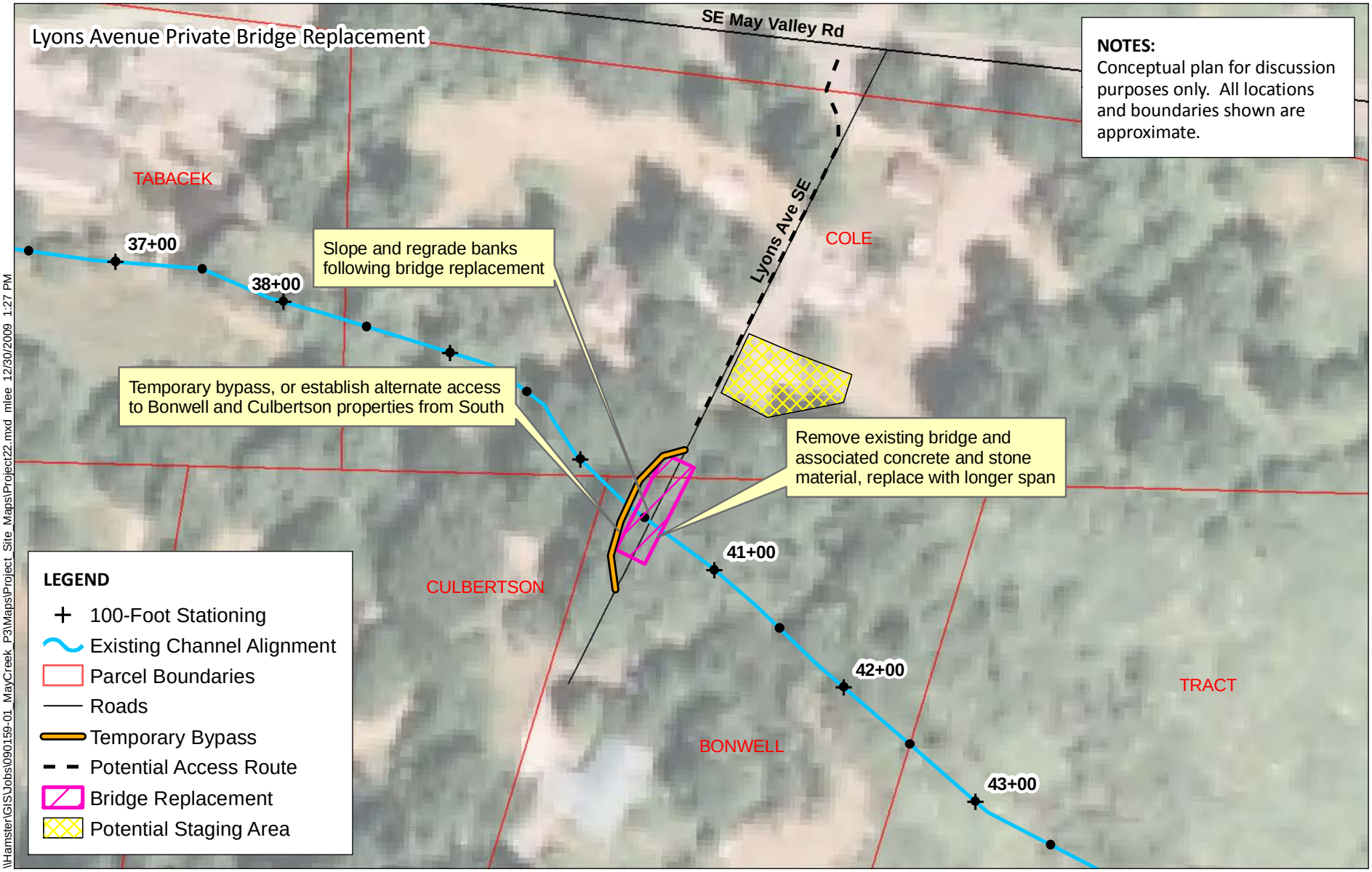
Project 22 will replace an existing private bridge and provide a bank stabilization treatment at approximately Station 40+50. We understand the bridge is used for access to the Bonwell and Culbertson properties (Figure 28). Options for bridge replacement are to be considered with further inspection of existing conditions. These options include complete replacement or modification of the existing bridge.

6.22.2 Site Description

Brief field observations by non-engineering staff concluded that the bridge appears to be in disrepair and has been severely undercut by incision. The banks adjacent to and underneath the bridge appear to be slightly unstable. The banks are somewhat protected by degrading abutments, riprap, and stacked concrete slabs that were likely placed to reinforce the bridge. The bridge deck is approximately 8 feet high above the channel bottom. It appears that the bridge opening may be large enough that significant backwater is not created; however the bridge abutments likely constrict the channel during high flows.

The channel through this area is a plane bed run. Instream habitat conditions are characterized by gravel and cobble substrate, moderate velocities, and moderate to low water depths at low flow. Concrete debris contributed to the channel from the bridge has degraded instream habitat at this location.

Riparian habitat conditions are not applicable to this project.



ANCHOR QEA

Feet
0 40 80 120 160

Figure 28
Conceptual Plan View, Project 22
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

6.22.3 Potential Actions

6.22.3.1 Bridge Replacement

Remove the existing bridge, associated riprap and debris (approximately 40 cy of material), and replace the bridge with a longer span (approximately 60 feet) with abutments set back from the banks. Slope back and stabilize the banks under and surrounding the new bridge with native riparian vegetation.

6.22.4 Geomorphic Implications

The implementation of this project will allow the channel to function more naturally in response to flood conveyance and sediment transport. The channel will be able to incise without affecting public or private infrastructure. Design of treatment actions must account for future channel incision.

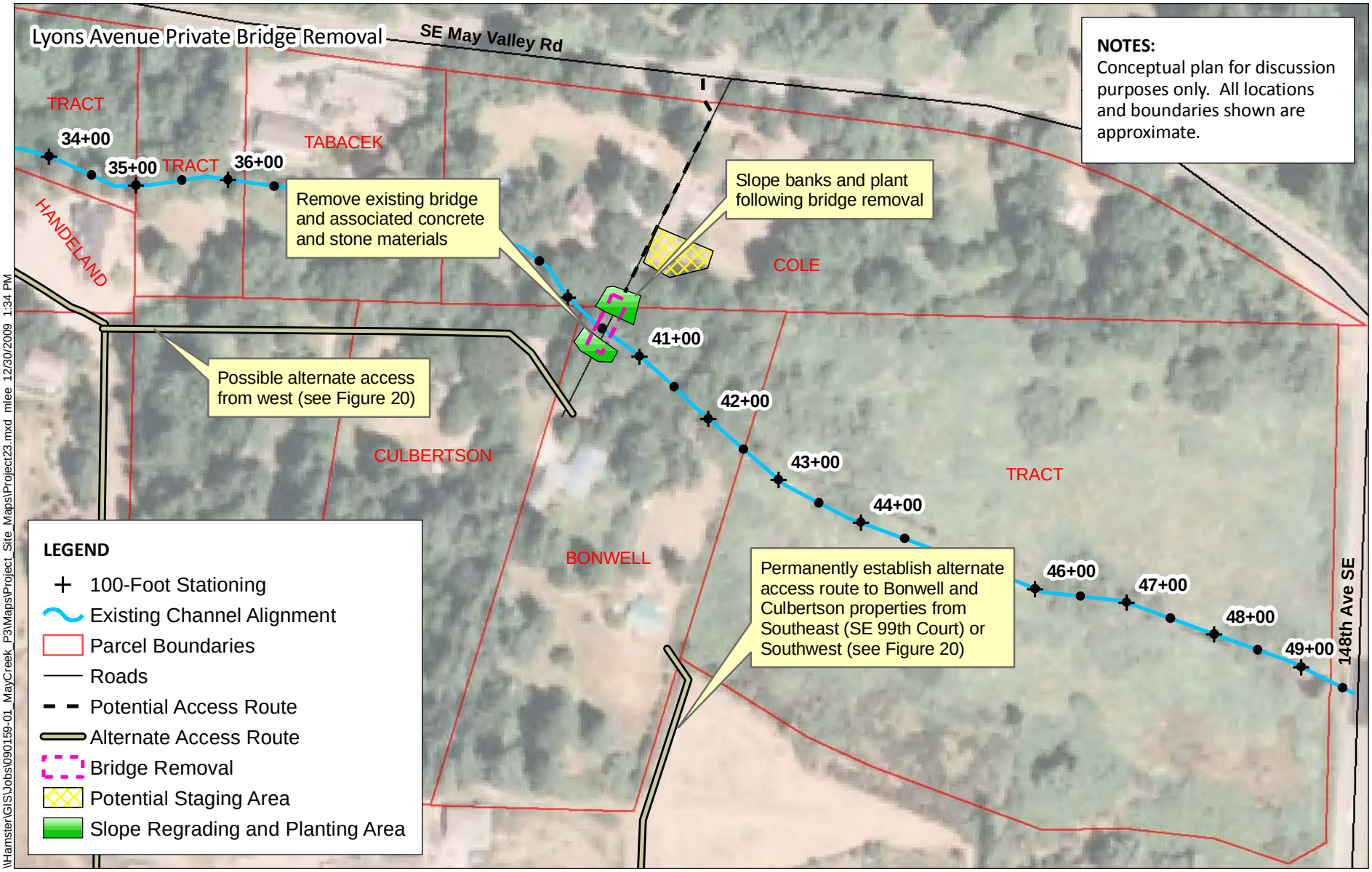
6.22.5 Challenges and Limitations

The bridge provides access to the Bonwell and Culbertson properties from May Valley Road. Approval from these landowners may be required to implement the project. Landowner approval from Cole may also be necessary. Bridge replacement will require the installation of a temporary bypass bridge or temporary establishment of alternate access from south (SE 99th Court). Access to the bridge and the remainder of the Bonwell property has not been granted in the past.

6.23 Project 23 – Lyons Avenue Private Bridge Removal

6.23.1 Location

Project 23 will remove an existing private bridge and provide a bank stabilization treatment at approximately Station 40+50. We understand the bridge is used for access to the Bonwell and Culbertson properties. Options for alternate access from the south side of the creek are to be considered with further inspection of site-specific conditions and real estate limitations. These options include an access route from the east via SE 99th Court or from the west via NE 24th Street (Figure 29). Access from the west may tie into a route established as part of Project 14.



ANCHOR QEA

Feet
0 40 80 120 160

Figure 29
Conceptual Plan View, Project 23
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

Site Description

Brief field observations by non-engineering staff concluded that the bridge appears to be in disrepair and has been severely undercut by incision. The banks adjacent to and underneath the bridge appear to be slightly unstable. The banks are somewhat protected by degrading abutments, riprap, and stacked concrete slabs that were likely placed to reinforce the bridge. The bridge deck is approximately 8 feet high above the channel bottom. It appears that the bridge opening may be large enough that significant backwater is not created; however the bridge abutments likely constrict the channel during high flows.

The channel through this area is a plane bed run. Instream habitat conditions are characterized by gravel and cobble substrate, moderate velocities, and moderate to low water depths at low flow. Concrete debris contributed to the channel from the bridge has degraded instream habitat at this location.

Riparian habitat conditions are not applicable to this project.

6.23.2 Potential Actions

6.23.2.1 Bridge Removal and Alternate Access Route

Remove the existing bridge and associated concrete and other material (approximately 40 cy) and provide access to the Bonwell and Culbertson properties from the south side of the property (SE 99th Court) or from the west as part of Project 14 (see Section 6.4). Slope back and stabilize the disturbed banks with riparian vegetation.

6.23.3 Geomorphic Implications

The implementation of this project will allow the channel to function more naturally in response to flood conveyance and sediment transport, and migration and incision will be allowed to occur without affecting public or private infrastructure.

6.23.4 Challenges and Limitations

The bridge provides access to the Bonwell and Culbertson properties from SE May Valley Road and may require approval from these landowners. Landowner approval from Cole may

also be required if Project 21 is not implemented in conjunction with this project. Access to the bridge and the remainder of the Bonwell property has not been granted in the past.

6.24 Project 24 – Reach 4 Instream and Riparian Enhancement

6.24.1 Location

Project 24 will enhance instream and riparian habitat conditions and realign the channel from approximately Station 42+00 to 49+00. The project is located within a designated green space tract that is owned by the Stonegate Homeowners Association (Figure 30).

6.24.2 Reach Description

The left and right banks are presently stable. The banks and floodplain are heavily vegetated with reed canarygrass, with sparse clusters of shrubs primarily located along the channel margins. The banks are approximately 3 feet high and the area is frequently flooded during the winter months. Water that overtops the bank is temporarily stored in the low floodplain wetlands.

Reach 4 lies within the wide, flat May Valley section, upstream of the transition to the steeper ravine reach (Reaches 1-3). The channel has been straightened in the past, resulting in a narrow, deep channel similar in appearance to an irrigation ditch. Instream habitat conditions are characterized by a sandy substrate, low velocities, and deep water at low flow. Floodplain connectivity is high and flood inundation and temporary storage of floodwaters occurs frequently.

Riparian habitat conditions are severely degraded by thick growth of reed canarygrass throughout the floodplain. There is a lack of mature trees and understory. Some stream shading is provided by the overhanging grasses along the channel margins, otherwise the channel is completely exposed.

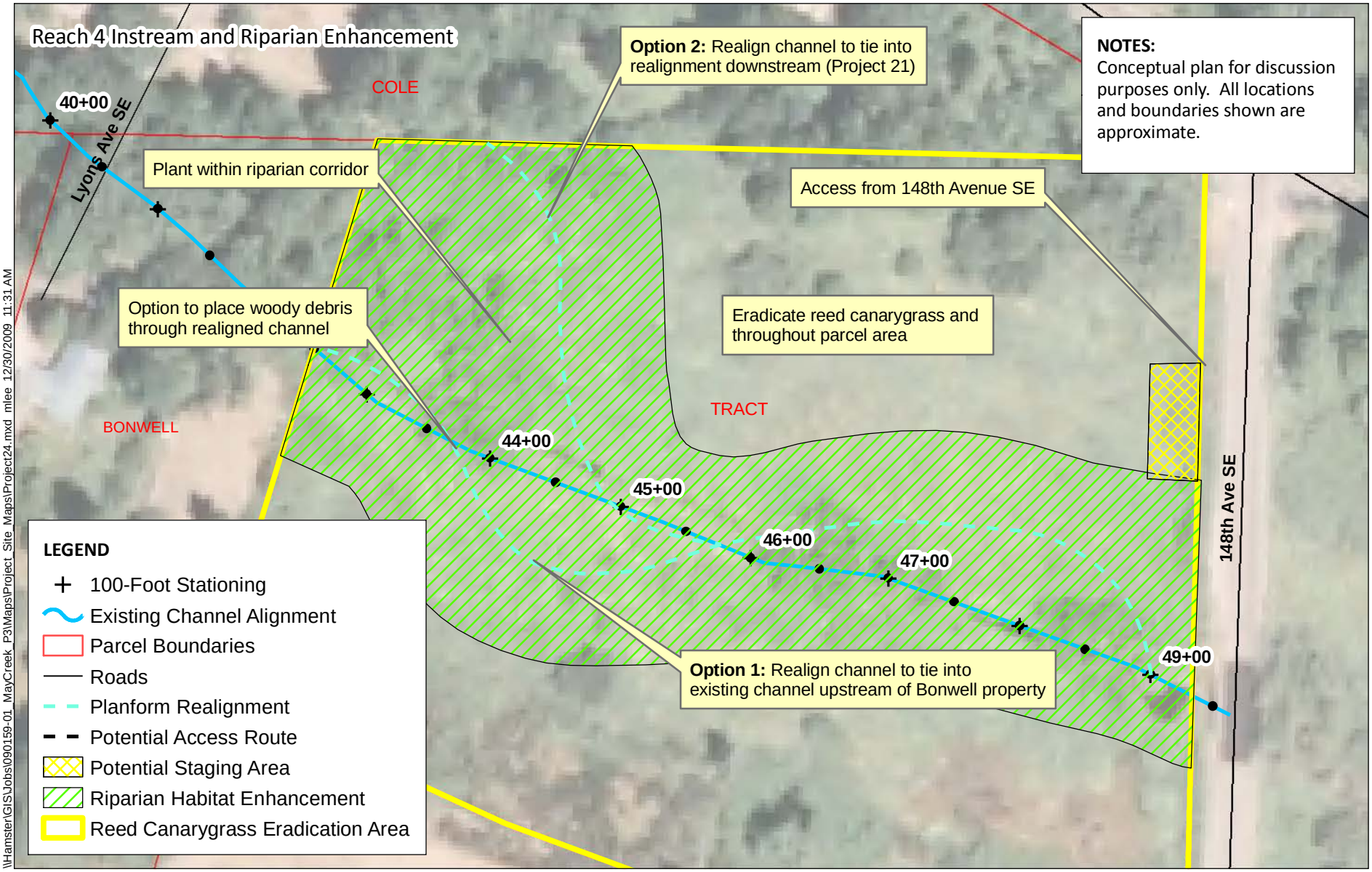


Figure 30
Conceptual Plan View, Project 24
May Creek Erosion Stabilization Report
King County/ May Creek Sediment Transport Study Phase 3

6.24.3 Potential Actions

6.24.3.1 Planform Modification

Realign the channel through the floodplain, creating a naturally-functioning meandering channel with the potential to develop side channel habitat. The channel may be realigned such that it ties into the existing channel just upstream of the Bonwell property, or realigned to the north of the existing channel to tie into Project 21. Instream features such as woody debris placement may be included in the realigned channel, which is described below.

6.24.3.2 Riparian and Floodplain Habitat Enhancement

Eradicate the existing reed canarygrass throughout the tract parcel to minimize re-colonization, and replant the floodplain area with native vegetation. Continue to manage invasive species in the reach over time.

6.24.3.3 Large Woody Debris Placement

Place LWD within the realigned channel to create stable hydraulic conditions capable of locally creating deep pools. The location and size of the LWD would be based on natural pool spacing and site-specific hydraulics.

6.24.4 Geomorphic Implications

Migration and incision within Reach 4 will be allowed to occur without affecting public or private infrastructure.

6.24.5 Challenges and Limitations

The thorough eradication of reed canarygrass will likely be difficult and costly. Cooperation with the owner of the tract parcel will be necessary. The reduction in upstream sources of reed canarygrass seeds and roots will need to be addressed for project success. Realignment through the north floodplain will require a significant quantity of excavation, requiring temporary storage and placement or offsite disposal. Existing wetlands may be impacted by channel realignment and construction activities.

7 PROJECT EVALUATION

Each project was evaluated according to criteria that allow for the relative importance of each project to be assessed. In order to easily and effectively compare projects, each criteria was given a relative scoring from 5 to 1, corresponding to a ranking of high (5), moderate-high (4), moderate (3), moderate-low (2), or low (1). The project evaluations were based on past studies including previous phases of the Sediment Transport Study and Phase 3 site assessment (see Section 3). The following criteria were assessed for each potential project:

1. **Significant impact of Existing Conditions** – What is the relative amount of risk assumed in not taking action at the site? In order to minimize risk, should action be taken immediately or within a longer period of time? Concerns related to erosion and flooding are of particular concern.
2. **Potential Significant Impacts of the Proposed Project** – What are the potential upstream, downstream, and local impacts associated with implementation of the proposed project related to erosion and flooding concerns? What is the relative risk assumed should the project be implemented? For example, a high-risk project would be assigned a low ranking (i.e., 1), because a project the high risk should detract from the overall prioritization value.
3. **Habitat Benefit –** How well does the project meet the goal of restoring or enhancing instream and floodplain (riparian) habitat? Will the project have immediate habitat benefits or will the benefits increase over time?
4. **Consistency with Geomorphic Processes –** Do the proposed actions work with ongoing geomorphic processes on a reach or basin-scale? Does the project allow for natural channel evolution without impacts to public or private infrastructure? How would the site and reach evolve if actions were not implemented?

Additionally, the overall feasibility of each project is generally discussed on a qualitative basis, however, project feasibility was not included in the quantitative assessment and the ranking and prioritization to follow (Sections 8 and 9). Feasibility includes the ease of implementation in regards to likely permitting concerns and impediments, required acquisition of real estate and landowner agreements, and preliminary costs of implementation. Possible permits and regulations that may be required include:

- U.S. Army Corps of Engineers (USACE) Section 404 or Nationwide

- Washington Department of Fish and Wildlife Hydraulic Project Approval (HPA)
- Department of Energy 401 Water Quality Certification (with 404)
- King County Clearing and Grading permit
- State Environmental Policy Act Checklist (SEPA)
- King County Critical Areas Alteration Exception (CAAE)
- King County Boundary or Lot Line Adjustment
- King County Shoreline Regulations Compliance; Shoreline Substantial Development Permit, Shoreline Redesignation, Shoreline Conditional Use Exemption, and Shoreline Variance
- Additional local permits and regulations (i.e., City of Renton)

Typically, a majority of the proposed projects would require (at a minimum) an HPA and SEPA Checklist. More complicated projects may involve federal and additional County permits. When considering conceptual project costs, the immediate cost of project implementation as well as future maintenance that would be required are considered.

7.1 Project 1 – Reach 1 Riparian Habitat Enhancement

7.1.1 Significant Impacts of Existing Conditions

7.1.1.1 Erosion Concerns

Low. Degraded riparian zone vegetation increases bank and upland erosion vulnerability. The stream along the extents of this project is already highly incised and has been for a significant period of time. Additional erosion is only a concern at select locations and over a long time period, therefore any erosion that occurs without project action will be minimal.

7.1.1.2 Flooding Concerns

Low. Flood risk is low along the extents of this project based on the high banks and lack of floodplain connectivity.

7.1.2 Potential Significant Impacts of the Proposed Project

7.1.2.1 Erosion Concerns

High. The enhanced riparian zone vegetation will decrease erosion potential along the extents of this project by increasing the root structure along the creek banks.

7.1.2.2 Flooding Concerns

High. The project will not alter flooding conditions from a conveyance perspective.

7.1.3 Habitat Benefit

Moderate-Low. The existing riparian habitat is relatively well-developed. The proposed project will nonetheless enhance riparian conditions by infilling sparsely vegetated areas and diversifying the tree species. Immediate benefits will be minimal as benefits will increase over time.

7.1.4 Consistency with Geomorphic Processes

Moderate-low. Geomorphic processes will not be significantly affected by project implementation. Over the longer term, riparian vegetation will provide root strength to help hold creek banks in place. In addition, once these trees mature it is likely that some trees and limbs will periodically fall into the creek providing natural LWD recruitment to the creek.

7.1.5 Project Feasibility

Permits required are minimal, as wetlands, flowing water, and instream species will not be affected by project implementation. Procurement of property is not necessary and significant stakeholder concerns are not anticipated. A majority of landowners within the project extent have readily cooperated with restoration actions in the past and the proposed clearing and planting is not expected to disturb the property owners adjacent to the creek. This project is expected to be relatively costly due to the large extent of area to be selectively cleared and replanted, and future monitoring (3-5 years) that would be required to ensure that non-native species remain controlled while native plants become established.

7.2 Project 2 – Reach 1 Instream Habitat Enhancement

7.2.1 Significant Impacts of Existing Conditions

7.2.1.1 Erosion Concerns

Low. Instream erosion and channel down-cutting is naturally occurring along the extents of this project as the channel incises. Instream erosion is presently slowed by natural hard points that force a limited number of pools throughout Reach 1, however this erosion does not typically pose a safety concern.

7.2.1.2 Flooding Concerns

Low. Flood risk is low along the extents of this project. A majority of the private structures are located above assumed flood levels. Channel conveyance is high and free of significant obstructions.

7.2.2 Potential Significant Impacts of the Proposed Project

7.2.2.1 Erosion Concerns

Moderate-High. Local scour at the placement sites is anticipated and desired for instream habitat benefit. Placement of these individual logs will not likely encourage a significant amount of erosion.

7.2.2.2 Flooding Concerns

High. The proposed placements are not likely to adversely alter water surface elevation during floods. Logs will be secured to the creek bed or banks, and the water surface elevation during flood flows will inundate the wood placements.

7.2.3 Habitat Benefit

Moderate-High. The proposed project will enhance habitat by creating holding pools used by salmonids prior to spawning. In addition, placement of LWD will create hydraulic refugia for juvenile salmonids and resident fish during high flows and allow for deposition of spawning-sized sediments in the lee of the placement sites. These placement sites will add additional pool-riffle sequences and cover currently lacking within the system.

7.2.4 Consistency with Geomorphic Processes

Moderate-High. The wood placements will be consistent with the reach-scale geomorphic processes by forcing pools and promoting pool-riffle sequences found in natural systems. Basin-scale processes will not likely be affected by these placements and continued incision is expected. Through time (on the order of decades), these placements will likely begin to be undercut and possibly fail. However, riparian planting will have matured and may provide a natural means of replenishing the LWD needed in the channel to create habitat complexity.

7.2.5 Feasibility of Implementation

Work will take place in the channel using equipment large enough to move the wood into place and secure it in the channel. Permits involving in-channel work will be required and some temporary disturbance of the channel is anticipated. Acquisition of real estate is not required for this project. Because heavy equipment will be required to place the wood, some disturbance to adjacent property owners could be a concern. The project cost is expected to be moderate. Costs related to site access may be reduced if wood placement is completed concurrently with Project 1. Some future maintenance may be required if a log becomes dislodged and moves into a position where it poses a flooding or erosion problem. However, design recommendations will stress the importance of deep, secure anchoring.

7.3 Project 3 – Bank Stabilization Treatment at Station 6+60

7.3.1 Significant Impacts of Existing Conditions

7.3.1.1 Erosion Concerns

Moderate-Low. Erosion at this location is not presently a concern because a large gravel deposit separates the channel from the right bank. However, this segment of the creek has the potential to migrate through time and the sediment could be mobilized, therefore, it is possible that erosion concerns could be an issue in the future. The debris that will be removed as part of the project is indicative that landowners have been concerned about erosion in the past.

7.3.1.2 Flooding Concerns

Low. The channel banks in this area are well above any anticipated flood levels.

7.3.2 Potential Significant Impacts of the Proposed Project

7.3.2.1 Erosion Concerns

High. This project will not pose erosional concerns. The project will be designed to accommodate future channel migration toward the right valley slope.

7.3.2.2 Flooding Concerns

High. Implementation of this project would not alter flood conditions. The channel conveyance would not be reduced and adverse upstream and downstream impacts are not anticipated.

7.3.3 Habitat Benefit

Moderate. Replacing the existing debris and stone armoring with an alternative bio-engineered bank stabilization treatment will enhance instream habitat conditions once the channel interacts with the treatment and will create a riparian habitat buffer along the toe of the slope. Planting within the treatment area with native vegetation will considerably widen the riparian corridor and provide root strength to the slope.

7.3.4 Consistency with Geomorphic Processes

Moderate-Low. Geomorphic processes will not be significantly affected by this project. The bank stabilization treatment design will need to be designed to accommodate future migration and incision, although it will not be cost effective to design the structure such that it mitigates for long-term incision (on the order of decades).

7.3.5 Feasibility of Implementation

Some work will be required below the OHWL and heavy equipment will be necessary to remove existing materials. In-channel work will require appropriate permits. Property owners along the right bank will be affected by this project, and access though private

property will likely be necessary, therefore some disturbance to landowners is anticipated. The property owner may not desire removal and replacement of the existing bank armoring given the amount of access disturbance anticipated. The project is estimated to cost a moderate amount to complete and maintain including site access, debris removal, a vegetated log cribwall bank stabilization treatment, and a 3 to 5 year monitoring plan to ensure non-native species remain controlled while native plants become established. Plant monitoring may be combined with Project 1 if projects are completed at a similar time. Alternate bank treatments such as toe protection or bank regrading will likely cost less to implement.

7.4 Project 4 – Bank Stabilization Treatment at Station 9+00

7.4.1 Significant Impacts of Existing Conditions

7.4.1.1 Erosion Concerns

Moderate-low. Erosion along the right bank of the project extent is presently mitigated by concrete and stone armoring that is degrading in many places, contributing debris to the channel. If no action is taken these materials will continue to degrade. However, no public or private infrastructure would likely be threatened by erosion of the right bank.

7.4.1.2 Flooding Concerns

Low. Anticipated flooding through this area is far enough away from existing infrastructure that it likely does not cause a concern.

7.4.2 Potential Significant Impacts of the Proposed Project

7.4.2.1 Erosion Concerns

High. This project will not pose erosion concerns. The project will be designed to mitigate existing erosion and accommodate future channel migration toward the right valley slope.

7.4.2.2 Flooding Concerns

High. Implementation of this project would not alter flood conditions. The channel conveyance would not be reduced and adverse upstream and downstream impacts are not anticipated.

7.4.3 Habitat Benefit

Moderate. Replacing the existing debris and riprap with an alternative bio-engineered bank stabilization treatment will enhance instream habitat conditions and create a riparian habitat buffer along the toe of the slope. Planting the treatment area and selective removal of invasive species and replacement with native vegetation will enhance riparian habitat conditions.

7.4.4 Consistency with Geomorphic Processes

Moderate-Low. Geomorphic processes will not be significantly affected by this project. The bank stabilization treatment design will need to be designed to accommodate future migration and incision, although it will not be cost effective to design the structure such that it mitigates for long-term incision (on the order of decades).

7.4.5 Feasibility of Implementation

Some work will be required below the OHWL and heavy equipment will be necessary to remove the existing armor materials. Permits for in-channel work will be required. Property owners along the right bank will be affected by this project. Access though private property will be necessary, although the project appears to be relatively open and the affected bank is far from infrastructure. The cost of the project including site access, debris removal, bank sloping, and revegetation is expected to be relatively minor. The project cost will be significantly increased if an alternate bank stabilization treatment is selected. A monitoring plan may be required for the next 3 to 5 years to ensure non-native species remain controlled while native plants become established, however the area is relatively small and should be easily accessible for monitoring purposes. Plant monitoring may be combined with Project 1 if projects are completed at a similar time.

7.5 Project 5 – Concrete Debris Removal at Station 14+10

7.5.1 Significant Impacts of Existing Conditions

7.5.1.1 Erosion Concerns

Moderate-low. This segment of the creek is straight and little to no erosion was documented during previous phases of work. The concrete debris in the left bank inhibits natural bank

stabilization, and the concrete debris in the center of the channel may induce channel widening around this obstruction. No property damage is anticipated under existing conditions.

7.5.1.2 Flooding Concerns

Low. The banks along the project extent are above the anticipated flood levels and the concrete blocks do not influence water surface elevations to the extent that they increase flooding.

7.5.2 Potential Significant Impacts of the Proposed Project

7.5.2.1 Erosion Concerns

Moderate-High. Implementation of this project would provide long-term bank stability by removing a large obstruction and allowing for more natural bank revegetation. Some temporary erosion impacts are anticipated short-term as the bank stabilizes.

7.5.2.2 Flooding Concerns

High. Implementation of this project would not significantly alter flooding conditions. The channel conveyance would be improved. Potential adverse upstream and downstream erosion impacts are not anticipated.

7.5.3 Habitat Benefit

Moderate. Removing the existing debris and the installation of an alternative bank stabilization treatment will enhance instream habitat along the bank. Planting the right bank with native vegetation will enhance and widen the riparian corridor. An existing pool forced by the channel obstruction will likely be filled in over time, which may detract from existing habitat conditions at this site. A minor amount of temporary habitat disturbance is anticipated from construction but completion of the project will improve overall habitat conditions.

7.5.4 Consistency with Geomorphic Processes

Moderate. Geomorphic processes will not be significantly affected by this project. Removal of the large concrete block in the channel bed will remove an unnatural channel obstruction and allow for more natural sediment transport dynamics.

7.5.5 Feasibility of Implementation

Instream work will be required below the OHWL involving heavy equipment. Necessary permits involving in-channel work will be required. Short-term channel impacts are anticipated as the left bank stabilizes naturally following removal of the embedded concrete abutment. All permits should be easily acquired. The property owner affected has allowed access in the past and has expressed the desire for projects to be completed in the creek. The project costs are expected to be relatively minor to complete and maintain. Site access costs associated with this project may be reduced if done in conjunction with Project 6. Future maintenance is not anticipated. If plant monitoring is required it may be included in the monitoring plan for Project 1 if the projects are completed at similar times.

7.6 Project 6 – Private Bridge Enhancements at Station 14+90

7.6.1 Significant Impacts of Existing Conditions

7.6.1.1 Erosion Concerns

Moderate. The bridge abutments confine the channel and likely limit flood conveyance, thereby inducing increased local velocities. Site observations suggest that there has been some local down-cutting of the creek potentially threatening the bridge piers at the toe of the slope. Concrete debris and large rock have been placed in the bed and along the banks near the bridge, likely to mitigate for erosion concerns.

7.6.1.2 Flooding Concerns

Moderate-Low. While the bridge may constrict flood conveyance, it is unlikely that it significantly increases flooding concerns, because the banks are high and appears to contain most flood events.

7.6.2 Potential Significant Impacts of the Proposed Project

7.6.2.1 Erosion Concerns

Moderate-High. Removing the bridge abutments from the channel will reduce velocities during floods, decreasing the hydraulic energy through the bridge crossing and likely reducing potential erosion concerns. Some local erosion (incision) is expected to occur in the vicinity of the replacement structure; however it appears that this erosion would not be a concern regarding infrastructure or public safety.

7.6.2.2 Flooding Concerns

High. Implementation of this project will remove a channel constriction and likely reduce water surface elevation for a given flood event.

7.6.3 Habitat Benefit

Moderate-low. Replacing the bridge with a longer span and removing existing concrete debris under the bridge will improve instream habitat conditions. Planting the banks adjacent to the replacement bridge with native vegetation will enhance the riparian corridor which is currently degraded at this site.

7.6.4 Consistency with Geomorphic Processes

Moderate-High. Geomorphic processes will no longer be influenced by the constriction and grade control and the creek will be allowed to evolve more naturally. This will result in more natural sediment transport dynamics.

7.6.5 Feasibility of Implementation

Removing the bridge abutments and concrete debris in the channel will be endorsed by the regulatory agencies. Locating the new abutments outside the channel will be preferred. Required permits should be easy to acquire. Acquisition will not be required, and the property owner has allowed access to the creek through the property in the past. Extensive riparian planting may be of concern to the landowner who has stated the grassy area is currently used for recreation. This project is estimated to have a relatively low cost, which includes site access, bridge and debris removal, bridge replacement, bank sloping,

revegetation, and riparian habitat enhancement. Minimal future maintenance is anticipated and plant monitoring may be done in conjunction with Project 1 if the projects are completed at similar times. A bridge maintenance plan may need to be developed depending on applicable regulations for a private structure crossing a creek.

7.7 Project 7 – Bank Stabilization Treatment at Station 21+10 to 24+30

7.7.1 Significant Impacts of Existing Conditions

7.7.1.1 Erosion Concerns

Moderate. Although significant erosion is occurring along the right bank, this erosion does not currently threaten any operational structures.

7.7.1.2 Flooding Concerns

Low. The right bank has a low-lying terrace that was likely connected with the creek during flood events in the past, however incision in the last several decades has lowered the channel several feet below the relative elevation of the terrace.

7.7.2 Potential Significant Impacts of the Proposed Project

7.7.2.1 Erosion Concerns

High. This project will promote stability of the right bank and upstream or downstream erosion concerns will not be influenced.

7.7.2.2 Flooding Concerns

High. Implementation of this project would not significantly affect flooding conditions. The channel conveyance would not be reduced and upstream and downstream impacts are not anticipated.

7.7.3 Habitat Benefit

Moderate-High. Instream habitat conditions will not be affected by this project initially. However, removing derelict buildings and vehicles in the path of channel migration will likely prevent detrimental future instream conditions and potential contamination. Instream

habitat will be enhanced downstream by distributing materials from the bank downstream along the creek margins. Stabilizing the existing cut bank by sloping back the bank and planting native riparian vegetation will enhance the riparian corridor through time. In particular, shading will be provided that is currently lacking. Planting the floodplain terrace will significantly enhance conditions in the riparian corridor which is currently degraded.

7.7.4 Consistency with Geomorphic Processes

Moderate. This project is consistent with ongoing geomorphic processes, and the creek will be allowed to evolve naturally.

7.7.5 Feasibility of Implementation

Sloping the bank and revegetating with native vegetation is consistent with regulatory agency recommendations for eroding banks. Securing permits will likely not be difficult. The project is located on property that is assumed to be designated green space associated with the Langely Development. Derelict structures and vehicles are likely the property of the adjacent property owner. Access from this landowner will be critical to completing the project within the budget used in this evaluation. Costs associated with the project are expected to be moderate. Channel and bank maintenance is not anticipated as the channel will be allowed to evolve naturally, however a monitoring plan may be necessary to evaluate riparian vegetation establishment and non-native species remain eradicated. The project cost may be lowered by reducing the extent of riparian habitat enhancement.

7.8 Project 8 – Left Bank Stabilization at Station 25+20 to 26+50

7.8.1 Significant Impacts of Existing Conditions

7.8.1.1 Erosion Concerns

Moderate-low. The left bank shows signs of progressive migration to the south. There are no infrastructure risks associated with this migration and the erosion rate appears to have decreased during the recent past due to a resistant outcrop at the downstream end.

7.8.1.2 Flooding Concerns

Low. The left bank is high and likely contains flow during flood events. The low right bank and floodplain is through a forested area without any existing infrastructure.

7.8.2 Potential Significant Impacts of the Proposed Project

7.8.2.1 Erosion Concerns

Moderate-High. Implementation of this project will provide increased bank stability in the short-term. The project may also decrease the potential for downstream erosion by reducing the impingement angle of the flow on banks immediately downstream. In the long-term, stability will be increased by the bank stabilization treatment planting the riparian corridor, although erosion is expected to continue occurring at this location.

7.8.2.2 Flooding Concerns

High. Implementation of this project would not adversely alter flooding conditions. The channel conveyance would not be reduced and upstream and downstream impacts are not anticipated.

7.8.3 Habitat Benefit

Moderate. Installation of an alternative bio-engineered bank stabilization treatment will create habitat along the bank. Removal of non-native plants and planting the bank with native vegetation will enhance the riparian corridor.

7.8.4 Consistency with Geomorphic Processes

Moderate-Low. Geomorphic processes will not be significantly affected by this project. The bank stabilization treatment design will need to be designed to accommodate future migration and incision, although it will not be cost effective to design the structure such that it mitigates for for long-term incision (on the order of decades).

7.8.5 Feasibility of Implementation

Installing a bio-engineered bank stabilization treatment is supported by regulatory agencies. Securing permits will not likely be difficult. The landowner has expressed desire for bank stabilization at this location. The project cost is expected to be relatively low, including site access, bank sloping, and revegetation. The project cost will be significantly increased if an alternate bank stabilization treatment is selected. A plant monitoring plan will likely be required to ensure riparian vegetation becomes established.

7.9 Project 9 – Channel Realignment at Station 25+00 to 28+60

7.9.1 Significant Impacts of Existing Conditions

7.9.1.1 Erosion Concerns

Moderate-Low. Bank erosion has been occurring in the existing channel but appears to be causing only minor damage and does not have immediate risk to existing structures.

7.9.1.2 Flooding Concerns

Low. Existing creek banks are high and likely contain stream flow during flood events.

7.9.2 Potential Significant Impacts of the Proposed Project

7.9.2.1 Erosion Concerns

Moderate-High. Implementing this project will smooth out the sharp bend in the creek at approximately Station 28+60, thereby reducing erosive energy during flood events at this location. Maintaining the existing channel as a side channel will further distribute flood flow, thereby further reducing erosive energy and creating additional flow capacity. Some channel migration through the proposed floodplain area is expected. In the long-term (on the order of decades), there is the potential for erosion towards existing infrastructure to the west of the proposed channel.

7.9.2.2 Flooding Concerns

High. Distributing flood flows through multiple channels will reduce water surface elevations, thereby reducing flooding concerns from the existing condition. Some desired

flooding of the floodplain flanking the realigned channel would likely occur, however this flooding is not expected to affect landowners.

7.9.3 Habitat Benefit

High. Excavating a new channel and creating multiple flow paths will significantly increase instream habitat diversity. Reducing erosive energy will allow for more deposition of spawning-sized sediment. Planting the new banks with native vegetation will enhance the riparian corridor. Instream habitat downstream will be enhanced by distributing streambed materials from the channel cut downstream along the creek margins and within the channel realignment area along the left bank of the existing channel. A wide floodplain area will be established, increasing and enhancing upland habitat.

7.9.4 Consistency with Geomorphic Processes

High. Realignment of the channel through the floodplain will allow the channel to evolve naturally without having adverse impacts to surrounding landowners.

7.9.5 Feasibility of Implementation

This project will be a significant construction effort and concerns will be voiced about best management practices (BMPs) and construction impacts. A clear and effective water control plan will need to be developed. Construction designs and permit documents will be a significant effort. Access for construction by heavy equipment will be required through private property which may temporarily disturb landowners. It is unclear whether the landowner will approve this project. Completion of this project is expected to be costly. Costs would likely be increased considerably when acquisition of the existing parcel is considered. The cost should not be significantly affected by variation of the alignment to join planform modification related to Project 11. A plant monitoring plan for riparian vegetation will likely be necessary until riparian plantings have become established. It is not anticipated that other maintenance will be required.

7.10 Project 10 – Right Bank Stabilization Treatment at Station 27+50 to 28+60

7.10.1 Significant Impacts of Existing Conditions

7.10.1.1 Erosion Concerns

Moderate-low. Severe bank erosion has been occurring at this location but is not threatening existing infrastructure.

7.10.1.2 Flooding Concerns

Low. Creek banks are high and likely contain stream flow during flood events.

7.10.2 Potential Significant Impacts of the Proposed Project

7.10.2.1 Erosion Concerns

Moderate-High. Implementation of this project will reduce hydraulic energy, thereby reducing erosive energy at the project site and downstream. The severity of erosion will be decreased in the short-term, although erosion will likely continue to occur. In the long-term the bank may evolve back to its present condition as a high cutbank.

7.10.2.2 Flooding Concerns

High. Implementation of this project would not significantly alter flooding concerns. The channel conveyance would not be reduced and upstream and downstream impacts are not anticipated.

7.10.3 Habitat Benefit

Low. Stabilizing the existing cutbank by sloping back the bank and planting native riparian vegetation will likely require removal of some mature vegetation within the riparian corridor. If excavated materials are placed along the left margin and revegetated, the width of the riparian zone will be increased as vegetation matures. This project will likely result in a short-term loss in riparian habitat conditions with long-term benefits as the replanted areas mature.

7.10.4 Consistency with Geomorphic Processes

Moderate-Low. This project will not appreciably affect geomorphic processes. Some reduction in hydraulic forces may result in deposition of spawning-sized materials at the location, however the supply of streambed materials contributed downstream via erosion of the affected bank will be reduced. This bank would likely continue to erode in the future and may become a cutbank again.

7.10.5 Feasibility of Implementation

Concerns will likely be voiced about the removal of large trees adjacent to the creek. This concern may be mitigated by incorporating trees into the channel as woody debris to provide instream habitat benefits. Project costs are expected to be low to moderate. Channel and bank maintenance is not anticipated.

7.11 Project 11 – Bank Stabilization Treatment at Station 28+60 to 29+40

7.11.1 Significant Impacts of Existing Conditions

7.11.1.1 Erosion Concerns

High. The existing retaining wall is being undercut and is at risk of failure. If the retaining wall fails, significant erosion and property damage may ensue. Bank materials may be eroded away and the dwelling at the top of the bank may become at risk.

7.11.1.2 Flooding Concerns

Low. Creek banks are high and likely contain stream flow during flood events.

7.11.2 Potential Significant Impacts of the Proposed Project

7.11.2.1 Erosion Concerns

Moderate-High. Implementation of this project will address the existing bank instability concerns along the right bank. Currently, the structure extends to the property line and abruptly stops. Design of this project should consider extending the bank stabilization treatment further downstream, as the configuration of the downstream end of the structure

will determine the extent of erosion concerns downstream. Erosion concerns will be reduced if this project is constructed in conjunction with Project 9.

7.11.2.2 Flooding Concerns

High. Implementation of this project would not significantly alter flooding conditions. The channel conveyance would not be reduced and adverse upstream and downstream impacts to flooding are not anticipated.

7.11.3 Habitat Benefit

Moderate-High. Installation of a log cribwall will create roughness in the channel increasing habitat diversity and creating hydraulic refuge along the face of the structure. The rootwads will force pools along the length of the structure creating holding habitat for salmonids and other resident fish. Planting the bank with native vegetation will enhance the riparian corridor. Modifying the planform by translating the channel to the south will provide the most habitat benefit.

7.11.4 Consistency with Geomorphic Processes

Moderate. Construction of a log cribwall will not have a dramatic effect on geomorphic processes. Consistency with geomorphic processes will be attained by translating the channel to the south and regrading the boulder run leading into the structure location.

7.11.5 Feasibility of Implementation

The regulatory community will support the replacement of a rock wall with a bio-engineered stabilization structure. This project will be a significant construction effort and concerns will be voiced about BMPs and mitigating for construction impacts. A clear and effective water control plan will need to be developed. Construction designs and permit documents will be a significant effort. This project will likely require a project agreement with both Coates and Duffus. We feel that a constructability feasibility evaluation will likely indicate that translating the channel to the south as a part of this project will be the most constructible and that other options will raise safety concerns and are much more costly. The expected cost is relatively high considering earthwork and the cost of the vegetated log

cribwall. Future maintenance of the riparian vegetation will be necessary until it becomes established. Maintenance of the cribwall may be necessary following an extreme flood event or similar circumstance, but regular maintenance of the structure is not anticipated.

7.12 Project 12 – Existing Wall Removal and Natural Channel Development at Station 28+60 to 29+40

7.12.1 Significant Impacts of Existing Conditions

7.12.1.1 Erosion Concerns

High. The existing retaining wall is being undercut and is at risk of failure. If the retaining wall fails, significant erosion and property damage may ensue. Bank materials may be eroded away and the dwelling at the top of the bank may become at risk.

7.12.1.2 Flooding Concerns

Low. Creek banks are high and likely contain stream flow during flood events.

7.12.2 Potential Significant Impacts of the Proposed Project

7.12.2.1 Erosion Concerns

High. Implementation of this project will remove hard points in the channel and remove infrastructure currently at risk, greatly reducing erosion concerns.

7.12.2.2 Flooding Concerns

High. Implementation of this project would not significantly alter flooding conditions. The channel conveyance would not be reduced and adverse upstream and downstream impacts to flooding are not anticipated.

7.12.3 Habitat Benefit

High. Removing the existing retaining wall and stabilizing the bank with vegetation enhance habitat along the bank. Removing obstructions to channel migration will allow the channel to evolve naturally and habitat conditions to improve through time.

7.12.4 Consistency with Geomorphic Processes

High. Acquisition of the property will allow for ongoing geomorphic processes to commence without risks to public and private infrastructure.

7.12.5 Feasibility of Implementation

Removing channel obstructions and allowing geomorphic processes to progress naturally is consistent with regulatory agency goals. Permit acquisition effort will be minimal for acquisition without a bank stabilization structure. Acquisition of the Coates property will be required and the landowner may be unwilling to sell. Due primarily to the cost of acquisition this project is expected to have a high cost of implementation. The project cost will be increased if a vegetated log cribwall is included, which will also require additional permitting and design effort. Without the inclusion of a bank stabilization structure, future maintenance is not anticipated.

7.13 Project 13 – Right and Left Bank Riparian Habitat Enhancement at Station 29+40 to 31+50

7.13.1 Significant Impacts of Existing Conditions

7.13.1.1 Erosion Concerns

Low. This segment of the creek is straight and the majority of the site is located away from existing infrastructure with little to no erosion concerns.

7.13.1.2 Flooding Concerns

Low. Creek banks are high and likely contain stream flow during flood events.

7.13.2 Potential Significant Impacts of the Proposed Project

7.13.2.1 Erosion Concerns

High. Long-term riparian establishment will promote greater bank stability.

7.13.2.2 Flooding Concerns

High. Implementation of this project is not expected to alter flooding conditions. The channel conveyance would not be reduced and adverse upstream and downstream impacts are not anticipated.

7.13.3 Habitat Benefit

Moderate. The existing riparian habitat condition is overwhelmed by invasive species and would benefit greatly from the planting of native riparian vegetation. Riparian habitat will be greatly improved through time as vegetation matures.

7.13.4 Consistency with Geomorphic Processes

Moderate-Low. Geomorphic processes will not be significantly affected by this project.

7.13.5 Feasibility of Implementation

Clearing invasive species and planting native vegetation is consistent with regulatory agency goals. Permit acquisition effort will be minimal. Proposed clearing and planting is not expected to disturb the property owners adjacent to the creek and there is clear access from the adjacent road. Project costs are expected to be low to moderate including site access, riparian habitat enhancement and a monitoring plan to ensure non-native species remain controlled while native plants become established.

7.14 Project 14 – Ilwaco Avenue Private Bridge Replacement or Removal

7.14.1 Significant Impacts of Existing Conditions

7.14.1.1 Erosion Concerns

Moderate-High. Down-cutting of the creek bed is evident and the placement of armor material in the channel and along the banks is indicative that prior incision has threatened the bridge abutments. Without countermeasures to address incision, the structural integrity of the bridge may be compromised and could pose a safety concern.

7.14.1.2 Flooding Concerns

High. The bridge constricts the channel and likely reduces channel conveyance at high discharges. This constriction likely presents flooding concerns to upstream properties.

7.14.2 Potential Significant Impacts of the Proposed Project

7.14.2.1 Erosion Concerns

High. Removing the channel constriction will locally reduce instream velocity and downstream erosive energy. This will greatly reduce risks to life and infrastructure.

7.14.2.2 Flooding Concerns

High. Removing the channel construction will reduce water surface elevations during flood events, thereby greatly reducing flood concerns.

7.14.3 Habitat Benefit

Moderate-High. The present bridge configuration likely causes high velocities through the bridge opening during moderate flows and the debris in the channel degrades instream habitat conditions. The weir upstream may create passage concerns during low flows and produces undesirable habitat conditions upstream. Additionally, removal of the weir would allow spawning-sized gravels to be transported downstream of the site. The implementation of this project removes these features and improves instream habitat.

7.14.4 Consistency with Geomorphic Processes

High. Removal of un-natural grade controls allows for geomorphic processes to progress naturally. Removing or replacing the existing bridge with a longer-spanning bridge would allow channel incision to progress without affecting public or private infrastructure. Bridge removal is particularly desirable as the stream floodplain connectivity may be increased on the north side of the channel without adverse impacts.

7.14.5 Feasibility of Implementation

Removing channel constrictions by removing or replacing the existing bridge is consistent with regulatory agency goals. Bridge replacement will be a significant engineering effort and permit documents will need to address best management practices. Establishing an alternate access route as part of bridge removal may be complicated involving several property owners. Permit acquisition is not expected to be difficult, but documentation associated with bridge replacement may be extensive. Multiple properties are accessed using the existing bridge and the private road is located at the boundary line of several parcels. Multiple stakeholder agreements will be necessary. This project is expected to be costly to implement when considering site access, a temporary bypass bridge, bridge removal, debris and weir removal, bridge replacement, bank sloping, and revegetation. A replacement bridge will likely be pile supported away from the active channel such that future maintenance will be minimal to none.

7.15 Project 15 – Bank Stabilization Treatment at Station 31+90 to 32+80

7.15.1 Significant Impacts of Existing Conditions

7.15.1.1 Erosion Concerns

Moderate-Low. Erosion along the left bank is presently mitigated by stable stone armoring. Existing erosion concerns are not evident, however the presence of the armoring is indicative that erosion has occurred at this location in the past.

7.15.1.2 Flooding Concerns

Moderate. Creek banks are low and the floodplain is likely accessed during a wide range of high flows. Flooding is likely exasperated by the presence of the bridge constriction downstream.

7.15.2 Potential Significant Impacts of the Proposed Project

7.15.2.1 Erosion Concerns

Moderate. This project will replace the existing bank stabilization with an approach that provides greater instream habitat benefits. The enhanced riparian vegetation will also decrease erosion potential along the floodplain. However, incision at this location will likely

be increased due to downstream projects, and while this will be mitigated in the short-term, it will not be cost-effective to design a structure that mitigates for long-term incision. Because the existing dwelling is relatively close to the bank, a moderate erosion risk has been assigned to this bank stabilization treatment.

7.15.2.2 Flooding Concerns

High. This project is not anticipated to cause increased flooding concerns. Depending on project limitations, existing flooding may be mitigated somewhat by implementation of this project.

7.15.3 Habitat Benefit

Moderate. Installation of an alternative bio-engineered bank stabilization treatment will increase roughness and create instream and riparian habitat that is currently non-existent along the left bank. Selective removal and planting of the banks will enhance riparian habitat conditions.

7.15.4 Consistency with Geomorphic Processes

Moderate. Geomorphic processes will not be significantly affected by implementation of the project. The bank stability treatment will need to be designed to accommodate future migration and incision.

7.15.5 Feasibility of Implementation

Replacing stone armoring with bio-engineered bank stabilization is consistent with regulatory agency goals. The bank stabilization treatment design will require a moderate engineering effort. Permits will not likely be difficult to secure. The existing armoring is likely providing sufficient bank stability and the landowners may be unwilling to implement this project. The project is expected to have a moderately high cost to complete and maintain. This cost includes site access, wall removal, vegetated log cribwall installation, riparian habitat enhancement, and an associated monitoring plan. The project cost may be lowered by reducing the extent of riparian habitat enhancement. Future maintenance includes a plant monitoring plan to insure native plants become established within the

enhanced riparian corridor including within the cribwall. Regular future maintenance of the structure itself is not anticipated.

7.16 Project 16 – Debris and Weir Removal at Station 33+20 to 35+10

7.16.1 Significant Impacts of Existing Conditions

7.16.1.1 Erosion Concerns

Moderate-Low. The banks within the project area are characterized as stable and erosion concerns are minimal. Erosion along portions of the left bank is presently mitigated by stable armoring. Existing erosion concerns are not evident, however the presence of the armoring is indicative that erosion has occurred at this location in the past.

7.16.1.2 Flooding Concerns

Moderate-low. The right bank is low, and the left bank is a moderate height. Floodwaters may access the floodplain during high flow events, however a majority of flooding is likely concentrated to the right bank where there is no existing infrastructure.

7.16.2 Potential Significant Impacts of the Proposed Project

7.16.2.1 Erosion Concerns

Moderate-High. This project will remove existing concrete debris and a weir. These features do not appear to provide any significant erosion prevention purposes. Stone armoring at the upstream end of the site will be replaced with a bank stabilization treatment.

7.16.2.2 Flooding Concerns

High. Implementation of this project would not significantly alter flooding conditions. The channel conveyance would not be reduced and upstream and downstream impacts are not anticipated.

7.16.3 Habitat Benefit

Moderate. The weir may create passage concerns during low flows and produce undesirable habitat conditions by creating backwater on the upstream side. Removal of the weir would

also allow spawning-sized gravels to be transported downstream of the site. Removing obstructions in the channel caused by the concrete debris will further enhance instream habitat. Riparian conditions will be enhanced by planting sparsely-vegetated areas and diversifying the tree species. Immediate benefits to riparian habitat will be minimal but benefits will increase over time.

7.16.4 Consistency with Geomorphic Processes

Moderate-High. Removal of the concrete debris and rock weir will remove an un-natural grade control, allowing the channel to more naturally incise and respond to sediment transport.

7.16.5 Feasibility of Implementation

This project is consistent with regulatory agency objectives. Permits will not likely be difficult to acquire. The landowner may believe that existing bank armoring is necessary or provides significant value in terms of property protection. The project cost is expected to be moderate, including site access, armoring, weir and concrete debris removal, coir wrap bank stabilization treatment, and riparian habitat enhancement. The project cost may be lowered by reducing the extent of riparian habitat enhancement. The cost will increase if a more complex bank stabilization structure such as a log cribwall is desired. Future maintenance includes a plant monitoring plan may be necessary to insure native plants become established within the riparian corridor and along the coir wrap treatment.

7.17 Project 17 – Channel Realignment at Station 32+00 to 35+10

7.17.1 Significant Impacts of Existing Conditions

7.17.1.1 Erosion Concerns

Low. The banks along the existing channel alignment are stable and erosion concerns are minimal.

7.17.1.2 Flooding Concerns

Moderate. The existing banks are low and the floodplain is likely accessed during a wide range of high flows. Flooding is likely exasperated by the presence of the bridge constriction at Ilwaco Avenue.

7.17.2 Potential Significant Impacts of the Proposed Project

7.17.2.1 Erosion Concerns

High. Implementing this project will move the main channel away from existing private property and into a tract space, greatly reducing erosion risk at these properties. Maintaining the existing channel as a side channel will further distribute flood flow, further reducing erosive energy.

7.17.2.2 Flooding Concerns

High. Although the channel slope would be slightly lowered, the cross sectional area of the channel will be designed such that the proposed channel provides sufficient conveyance capacity during high flows. If the existing channel alignment is converted to side channel habitat, flows will be distributed across the two separate channels. Some flooding through the tract property is anticipated and desired. In the long term, flood impacts through the tract property would be reduced by the presence of established wetland vegetation and soils that will provide temporary storage of floodwaters.

7.17.3 Habitat Benefit

High. Excavating a new channel and creating multiple flow paths will significantly increase instream habitat diversity. Instream habitat downstream will be enhanced by distributing materials from the channel cut downstream along the creek margins. Placement of LWD in the new channel with further enhance instream habitat conditions. Removing invasive species and planting the banks of the proposed channel and floodplain with native vegetation will establish a wide riparian corridor and greatly enhance riparian habitat conditions.

7.17.4 Consistency with Geomorphic Processes

High. Realignment of the channel through the north floodplain will allow the channel to function and evolve naturally without causing adverse impacts to surrounding landowners.

7.17.5 Feasibility of Implementation

This project will be a significant construction effort and concerns will be voiced about BMPs and construction impacts. A clear and effective water control plan will need to be developed. At least a portion of the excavation area has been identified as a wetland. Wetland mitigation may be required. Construction designs and permit documents will likely be a significant effort. This property is owned by the City of Renton and coordination with city representatives will be necessary. This project may not be consistent with City plans that have already been established for this property. The project is expected to have moderately high cost to implement. The cost is not significantly affected by variation in alignment to join realignment associated with Project 19. The project cost may be lowered by reducing the extent of riparian habitat enhancement. Future maintenance includes a plant monitoring plan for riparian vegetation to insure riparian plantings have become established.

7.18 Project 18 – Channel Improvements at Station 36+20 to 38+40

7.18.1 Significant Impacts of Existing Conditions

7.18.1.1 Erosion Concerns

Moderate-Low. Erosion along the banks is presently mitigated by stone block walls along both sides of the channel. Some areas of failure of the rock walls was observed during our site reconnaissance, although these areas were small and distributed along the channel length.

7.18.1.2 Flooding Concerns

Moderate-High. The banks (walls) are low and floodwaters likely access the current yard space during a wide range of high flows. However, structures on the property appear to be above the elevation of the accessible floodplain area.

7.18.2 Potential Significant Impacts of the Proposed Project

7.18.2.1 Erosion Concerns

Moderate-High. This project will replace the existing bank stabilization with an approach that provides greater instream habitat benefits. The enhanced riparian vegetation will also decrease erosion potential of the floodplain. Localized scour forced by the log cribwall is expected and desired for enhanced habitat. Erosion of the left floodplain is anticipated if the right cribwall option is only chosen.

7.18.2.2 Flooding Concerns

High. Flooding concerns will not be affected by this project. Flooding of the low floodplain while likely continue to occur.

7.18.3 Habitat Benefit

Moderate. Removing the existing weirs will allow for more natural channel response to sediment transport. Instream habitat will be further enhanced by creating better oxygen and temperature circulation that is more suitable for fish habitat. Weeds and silt will be flushed from the channel bottom and gravel substrate will be able to accumulate. Installation of a bio-engineered bank stabilization treatment will increase roughness and create edge habitat along the bank. Planting the stabilization structures and the floodplain with native vegetation will greatly enhance the riparian habitat conditions.

7.18.4 Consistency with Geomorphic Processes

Moderate-High. Removal of the rock weirs will remove the un-natural grade controls, allowing the channel to incise naturally over time. The stone sidewalls will be removed and replaced with bank stabilization that will be designed to account for ongoing incision.

7.18.5 Feasibility of Implementation

Replacing the stone walls with bio-engineered bank stabilization is consistent with regulatory agency goals. Design will require a moderate engineering effort. Permits will not likely be difficult to secure. The existing stone walls are likely providing sufficient bank stability and landowner agreement may be difficult to acquire. The project is expected to

have a high cost to implement and maintain, particularly when log cribwalls along both banks are considered. The project cost will be lowered by installing a log cribwall exclusively on the north bank and/or by reducing the extent of riparian habitat enhancement. Future maintenance will likely include a plant monitoring plan.

7.19 Project 19 – Channel Realignment at Station 36+20 to 38+40

7.19.1 Significant Impacts of Existing Conditions

7.19.1.1 Erosion Concerns

Moderate-Low. Erosion along the banks is presently mitigated by stone block walls along both sides of the channel. Some areas of failure of the rock walls were observed during our site reconnaissance, although these areas were small and distributed along the channel length.

7.19.1.2 Flooding Concerns

Moderate-High. The banks (walls) are low and floodwaters likely access the current yard space during a wide range of high flows. However, structures on the property appear to be above the elevation of the accessible floodplain area.

7.19.2 Potential Significant Impacts of the Proposed Project

7.19.2.1 Erosion Concerns

High. While some future channel migration is expected and desired, moving the channel away from existing infrastructure reduces erosion risk.

7.19.2.2 Flooding Concerns

High. This project is not expected to have an adverse effect on flood elevations as the channel grade and floodplain connectivity will not likely be altered. The channel will be realigned away from infrastructure such that flood risk to infrastructure is reduced.

7.19.3 Habitat Benefit

High. Creating multiple flow paths by realigning the channel will significantly increase instream habitat diversity. Planting the proposed banks with native vegetation will enhance riparian habitat conditions. Instream habitat will be enhanced by distributing materials from the channel cut downstream along the creek margins and within the proposed and existing channel areas.

7.19.4 Consistency with Geomorphic Processes

High. Removal of the rock weirs will remove un-natural grade controls. Translating the channel away from infrastructure removes concerns related to incision and channel migration, therefore allowing the channel to evolve naturally over time.

7.19.5 Feasibility of Implementation

This project will be a significant construction effort and concerns will be voiced about BMPs and mitigating for construction impacts. A clear and effective water control plan will need to be developed. Construction designs and permit documents will be a significant effort. Landowner agreement will be necessary and the landowner may not view this project as desirable. This project is expected to have a moderately high cost to implement. The cost is not expected to be significantly affected by variation in joining realignments associated with Projects 17 or 21. The project cost will be increased if property acquisition and existing channel infrastructure removal is included. Future maintenance will likely require a plant monitoring plan.

7.20 Project 20 – Bank Stabilization Treatment at Station 38+40 to 40+00

7.20.1 Significant Impacts of Existing Conditions

7.20.1.1 Erosion Concerns

Moderate. The right bank is moderately stable. Additional erosion would likely not threaten the existing dwelling but may compromise the pedestrian bridge foundations.

7.20.1.2 Flooding Concerns

Moderate. According to discussions with residents onsite, the lower level of the dwelling on the property has been flooded several times in the past.

7.20.2 Potential Significant Impacts of the Proposed Project

7.20.2.1 Erosion Concerns

Moderate-High. Implementation of this project would reduce the risk of erosion to the pedestrian bridge abutments. Removal of the weir may induce some incision upstream, however the overall effect is not anticipated to be significant compared to existing conditions.

7.20.2.2 Flooding Concerns

High. Bridge replacement and weir removal will allow for greater conveyance capacity and eliminate backwater caused by the existing features, likely reducing flooding along the project reach. Flooding of the property may continue to be a concern due to backwater caused by instream features downstream, and the low banks near the existing bridge location.

7.20.3 Habitat Benefit

Moderate. This project will remove an existing weir from the channel allowing for reduced backwater that will lead to increased circulation of fresh, cool water and more natural sediment transport response. Riparian habitat conditions will be enhanced by planting native vegetation along the banks and within the riparian corridor. Immediate benefits to riparian habitat will be minimal, however benefits will increase over time as vegetation becomes established.

7.20.4 Consistency with Geomorphic Processes

Moderate. While removing the un-natural grade control will allow for more natural response to sediment transport and flow conveyance, overall geomorphic impacts will be minimal and reach-scale processes will not be significantly affected.

7.20.5 Feasibility of Implementation

This project is consistent with regulatory agency objectives and securing permits will likely not be difficult. Landowner approval will be required. This project is expected to have a low to moderate cost to implement. The project cost may be lowered by reducing the extent of riparian habitat enhancement or bridge removal only without replacement. Future plant monitoring for native plantings along the riparian corridor will be necessary to insure new plants become established.

7.21 Project 21 – Channel Realignment at Station 38+40 to 40+00

7.21.1 Significant Impacts of Existing Conditions

7.21.1.1 Erosion Concerns

Moderate. The right bank of the existing channel is moderately stable. Additional erosion would likely not threaten the existing dwelling but may compromise the foundations of the pedestrian bridge.

7.21.1.2 Flooding Concerns

Moderate. According to discussions with residents onsite, the lower level of the dwelling on the property has been flooded several times in the past.

7.21.2 Potential Significant Impacts of the Proposed Project

7.21.2.1 Erosion Concerns

High. Implementation of this project will move the channel away from existing infrastructure. Acquisition and removal of the existing dwelling will eliminate erosion risk to the property.

7.21.2.2 Flooding Concerns

High. Implementation of this project is not expected to alter flooding conditions upstream or downstream of the project site.

7.21.3 Habitat Benefit

High. Creating multiple flow paths by realigning the channel will significantly increase instream habitat diversity. Planting the proposed banks with native vegetation will enhance riparian habitat conditions. Instream habitat will be enhanced by distributing materials from the channel cut downstream along the creek margins and within the proposed and existing channel areas.

7.21.4 Consistency with Geomorphic Processes

High. Along with the implementation of additional projects downstream, this project will allow the channel to function within the context of ongoing reach-and basin-scale geomorphic processes.

7.21.5 Feasibility of Implementation

This project will be a significant construction effort and concerns will be voiced about BMPs and construction impacts. A clear and effective water control plan will need to be developed. Construction designs and permit documents will likely be a significant effort. Acquisition of the Cole property will be required. Completion of this project is heavily dependent on implementation of the channel realignment associated with Project 24. This project is expected to have a high cost to complete and maintain, primarily due to the cost of property acquisition and earthwork. The project cost may be lowered by reducing the extent of riparian habitat enhancement. Future plant monitoring for native plantings along the riparian corridor will be necessary to insure the new plants become established.

7.22 Project 22 – Lyons Avenue Private Bridge Replacement

7.22.1 Significant Impacts of Existing Conditions

7.22.1.1 Erosion Concerns

Moderate. Incision at the bridge is evident and the bridge abutments at the toe of the slope are at risk. If erosion is allowed to continue the structural integrity of the bridge may be compromised and could pose a safety and flooding concern.

7.22.1.2 Flooding Concerns

Moderate. The bridge does not significantly reduce channel conveyance or present flooding concerns. However, if the bridge were to fail and fall into the creek the debris could produce significant back water effects.

7.22.2 Potential Significant Impacts of the Proposed Project

7.22.2.1 Erosion Concerns

High. Replacing the bridge will remove any constrictions caused by the bridge abutments and reduce risk to the structure.

7.22.2.2 Flooding Concerns

High. Implementation of this project would improve channel conveyance, although overall effects are expected to be minimal. Adverse impacts upstream and downstream are not anticipated.

7.22.3 Habitat Benefit

Moderate. This project will enhance instream habitat by removing debris contributed by the degrading bridge abutments. Instream habitat conditions are not expected to be appreciably affected.

7.22.4 Consistency with Geomorphic Processes

Moderate-High. The bridge would be replaced with a longer-spanning bridge that would eliminate constriction caused by the existing bridge and pier. This will likely result in more natural sediment transport and deposition through this area. The replacement bridge will allow the channel to incise without affecting infrastructure.

7.22.5 Feasibility of Implementation

Replacing bridges that constrict flow with wider spans is consistent with regulatory agency objectives. Permit acquisition will not likely be difficult. Bridge replacement would require a significant engineering effort. At least two landowners use the bridge for access to

properties on the south side of the creek. The private road to access the bridge is located through a property on the north side of the creek. Landowner agreements associated with this project are expected to be difficult to acquire. The project is expected to have a high cost to implement due to costs associated with the infrastructure improvements. The replacement bridge will likely be pile supported away from the active channel such that future maintenance will be minimal to none.

7.23 Project 23 – Lyons Avenue Private Bridge Removal

7.23.1 Significant Impacts of Existing Conditions

7.23.1.1 Erosion Concerns

Moderate. Incision at the bridge is evident and the bridge abutments at the toe of the slope are at risk. If erosion is allowed to continue the structural integrity of the bridge may be compromised and could pose safety and flooding concerns.

7.23.1.2 Flooding Concerns

Moderate. The bridge does not significantly reduce channel conveyance or present flooding concerns. However, if the bridge were to fail and fall into the creek the debris could produce significant back water effects.

7.23.2 Potential Significant Impacts of the Proposed Project

7.23.2.1 Erosion Concerns

High. Removing the bridge will eliminate any risk associated with erosion at this location.

7.23.2.2 Flooding Concerns

High. Implementation of this project would improve channel conveyance, although overall effects are expected to be minimal. Adverse impacts upstream and downstream are not anticipated.

7.23.3 Habitat Benefit

Moderate. This project will enhance instream habitat by removing debris associated with the degrading bridge abutments. Abandonment of the existing access route over the stream will allow for riparian habitat to be established at the location of the existing road, although habitat conditions are not expected to be appreciably affected.

7.23.4 Consistency with Geomorphic Processes

High. Bridge removal would minimize channel confinement, eliminating the un-natural grade control effect of the existing bridge, pier, and associated debris. This project will allow the channel to migrate and incise naturally without adversely affecting public or private infrastructure.

7.23.5 Feasibility of Implementation

Removing bridges is consistent with regulatory agency objectives. Securing permits will likely not be difficult. At least two landowners use the bridge for access to properties on the south side of the creek. An alternative access route for these properties will need to be developed. Landowner agreements may be difficult to secure. This project is expected to have a moderate cost to implement, which includes developing an alternate access route to the Bonwell and Culbertson properties, bank sloping, and revegetation. Future maintenance is not anticipated, however maintenance of an alternate route has not been considered in this assessment.

7.24 Project 24 – Reach 4 Instream and Riparian Enhancement

7.24.1 Significant Impacts of Existing Conditions

7.24.1.1 Erosion Concerns

Low. The banks in Reach 4 are stable and thickly vegetated with reed canarygrass. The stream gradient through the reach is relatively flat and bank erosion is limited.

7.24.1.2 Flooding Concerns

Moderate. This low gradient reach has good floodplain connectivity and is known to inundate portions of 148th Avenue SE during flood events.

7.24.2 Potential Significant Impacts of the Proposed Project

7.24.2.1 Erosion Concerns

High. This project will likely not have an effect on erosion.

7.24.2.2 Flooding Concerns

Moderate-High. This project will not likely have a measurable effect on flood elevations as the channel grade and floodplain connectivity will not likely be altered.

7.24.3 Habitat Benefit

Moderate-High. Realigning the channel and installing LWD will significantly increase instream habitat diversity. In addition, instream habitat will be enhanced by distributing materials from the channel cut downstream along the creek margins and within the proposed and existing channel areas. Eradication of reed canarygrass and planting the proposed banks and floodplain with native vegetation will greatly enhance riparian habitat conditions. Over the long-term, there will be increased benefits to habitat as native vegetation becomes established, providing stabilization of soils and shading.

7.24.4 Consistency with Geomorphic Processes

High. Realignment of the channel will enhance channel function by creating hydraulic diversity that is more characteristic of a natural channel configuration. The channel will be allowed to migrate and incise without affecting public or private infrastructure.

7.24.5 Feasibility of Implementation

Eradication of reed canarygrass is consistent with regulatory agency objectives and permits will be relatively simple to obtain. Landowner agreement should be easy to acquire given the property is designated as green space. Realignment through the floodplain to the north is heavily dependent on implementation of Project 21. This project is expected to have a high cost to complete and maintain, primarily due to the cost of earthwork and maintenance of the enhanced riparian corridor. Project costs will be greatly increased if the project includes complete eradication of reed canarygrass. Eradication of reed canarygrass is a difficult

process and a careful monitoring plan will be necessary to insure it remains under control while native species become established. Eliminating reed canarygrass will likely require several years of maintenance. Regular maintenance of the realigned channel and instream features is not anticipated.

8 PROJECT PRIORITIZATION AND RANKING

The results of the project evaluation were incorporated into a matrix developed to prioritize and rank each conceptual project. The results of the prioritization and ranking process will assist the County in developing a conceptual implementation plan for the May Creek ravine reach. The following sections summarize the prioritization and ranking process. Additional details and complete evaluation information is presented in Appendix B.

8.1 Procedure

A high, moderate-high, moderate, moderate-low, or low rank was assigned a point value between 5 and 1, with 5 being the highest and 1 being the lowest rank, respectively. Each evaluation criterion was normalized to a 10-point maximum for each of the four major criteria (Table 3). Normalization of these criteria has some flexibility, should the County desire to assign a higher priority to one criterion over another based on public input or other available information.

Table 3
Possible Points for Project Evaluation Criteria

Major Evaluation Criteria		Sub-criteria	Total Possible Points
1	Significant Impacts of Existing Conditions	Erosion	5
		Flooding	5
2	Potential Significant Impacts of Proposed Project	Erosion	5
		Flooding	5
3	Habitat Benefit	N/A	10
4	Consistency with Geomorphic Processes	N/A	10

Note: Ten points are possible for each major criterion.

Once the project has been assigned the appropriate point value for each criterion, a weighting coefficient was applied to establish the relative importance of the criteria relative to one another. The sum of the four weighted criteria (the product of the weighting coefficient and total point value for the category) becomes the final Prioritization Value. Because the weighting coefficients add up to a value of 1, the Prioritization Value is out of 10

possible points for each example scenario. Resultant values were also assigned a relative position (Priority Rank) for a more user-friendly summary of the results.

Three separate scenarios were evaluated to assess the prioritization and ranking process as a tool for assessing the relative importance of projects. The purpose of this exercise is to provide the County with an example of how this tool "could" be used. The coefficients used in these examples are arbitrary and do not represent Anchor QEA's opinion of how criteria should be prioritized. The example coefficients assigned to each criterion for the scenarios are summarized in Table 4.

- **Scenario 1:** All categories are equally weighted.
- **Scenario 2:** Criteria 4 is strongly weighted relative to the others.
- **Scenario 3:** All criteria are weighted variably.

Table 4
Example Weighting Coefficients for Evaluation Criteria

Evaluation Criteria		Weighting Coefficient		
		Scenario 1	Scenario 2	Scenario 3
1	Significant Impacts of Existing Conditions	0.25	0.15	0.30
2	Potential Significant Impacts of Proposed Project	0.25	0.15	0.10
3	Habitat Benefit	0.25	0.15	0.20
4	Consistency with Geomorphic Processes	0.25	0.55	0.40

Note: See Appendix B for complete prioritization matrix.

8.2 Results

The projects were prioritized and assigned a Priority Rank within each example scenario. A Priority Rank of 1 signifies the highest priority project. Complete Prioritization Values and Priority Ranking are displayed in Appendix B. Depending on how the criteria were weighted, more or less possible Priority Rank values were achieved. For example, Scenario 1 which had the least amount of variation between the weighting coefficients had 15 possible ranks, while Scenario 3 which was more variable had 19 possible ranks. Assigning a high weighting coefficient to only one criterion produced a spread of 17 values. The results of project prioritization and ranking for the three example scenarios are summarized in Tables 5 through 7 by presenting both the Prioritization Value and the Priority Rank.

It should be noted that this procedure was developed as an example of how the prioritization tool could be used for the purposes of assessing the relative importance of projects to one another based on the established criteria. The prioritization process may be modified by Anchor QEA or the County to better address project objectives, County and public concerns, or other factors.

8.2.1 Scenario 1

When all four criteria were weighted equally, 15 Prioritization Values and associated ranks were possible. Of the 15 ranks, the top five (highest-priority) projects were Projects 12, 14, 17, 19, and 21. The bottom three (lowest-priority) projects identified were Projects 1, 8, and 10.

Table 5
Summary of Example Project Priority Ranking Scenario 1

Project Number	Description	Prioritization Value	Priority Rank
14	Ilwaco Avenue Private Bridge Replacement or Removal	9.25	1
12	Existing Wall Removal and Natural Channel Development at Station 28+60 to 29+40	9.00	2
19	Channel Realignment at Station 36+20 to 38+40	9.00	2
21	Channel Realignment at Station 38+40 to 40+00	9.00	2
17	Channel Realignment at Station 32+00 to 36+20	8.50	3
9	Channel Realignment at Station 25+00 to 28+60	8.00	4
23	Lyons Avenue Private Bridge Removal	8.00	4
22	Lyons Avenue Private Bridge Replacement	7.50	5
11	Bank Stabilization Treatment at Station 28+60 to 29+40	7.25	6
18	Channel Improvements at Station 36+20 to 38+40	7.25	6
24	Reach 4 Instream and Riparian Enhancement	7.25	6
7	Bank Stabilization Treatment at Station 21+10 to 24+30	7.00	7
2	Reach 1 Instream Habitat Enhancement	6.75	8
20	Bank Stabilization Treatment at Station 38+40 to 40+00	6.75	8
6	Private Bridge Enhancements at Station 14+90	6.50	9
13	Right and Left Bank Riparian Habitat Enhancement at Station 29+40 to 31+50	6.50	9
15	Bank Stabilization Treatment at Station 31+90 to 32+80	6.25	10

Project Number	Description	Prioritization Value	Priority Rank
5	Concrete Debris Removal at Station 14+10	6.00	11
16	Weir Removal and Bank Stabilization Treatment at Station 33+20 to 35+10	6.00	11
3	Bank Stabilization Treatment at Station 6+60	5.75	12
4	Bank Stabilization Treatment at Station 9+00	5.75	12
8	Left Bank Stabilization Treatment at Station 25+20 to 26+50	5.50	13
1	Reach 1 Riparian Habitat Enhancement	5.00	14
10	Right Bank Stabilization Treatment at Station 27+50 to 28+60	4.50	15

8.2.2 Scenario 2

Weighting one criterion over the other three was performed in order to evaluate the sensitivity of the prioritization process. When the Scenario 2 weighting coefficients were applied, a spread of 17 Prioritization Values were possible. The top five projects were the same as those for Scenario 1 (Projects 12, 14, 17, 19, and 21). The bottom three projects identified were also the same as those identified using Scenario 1 (Projects 1, 8, and 10).

Table 6

Summary of Example Project Priority Ranking Scenario 2

Project Number	Description	Prioritization Value	Priority Rank
14	Ilwaco Avenue Private Bridge Replacement or Removal	9.55	1
12	Existing Wall Removal and Natural Channel Development at Station 28+60 to 29+40	9.40	2
19	Channel Realignment at Station 36+20 to 38+40	9.40	2
21	Channel Realignment at Station 38+40 to 40+00	9.40	2
17	Channel Realignment at Station 32+00 to 36+20	9.10	3
9	Channel Realignment at Station 25+00 to 28+60	8.80	4
23	Lyons Avenue Private Bridge Removal	8.80	4
22	Lyons Avenue Private Bridge Replacement	7.70	5
18	Channel Improvements at Station 36+20 to 38+40	7.55	6
24	Reach 4 Instream and Riparian Enhancement	7.55	6
2	Reach 1 Instream Habitat Enhancement	7.25	7
6	Private Bridge Enhancements at Station 14+90	7.10	8

Project Number	Description	Prioritization Value	Priority Rank
13	Right and Left Bank Riparian Habitat Enhancement at Station 29+40 to 31+50	7.10	8
11	Bank Stabilization Treatment at Station 28+60 to 29+40	6.75	9
7	Bank Stabilization Treatment at Station 21+10 to 24+30	6.60	10
20	Bank Stabilization Treatment at Station 38+40 to 40+00	6.45	11
15	Bank Stabilization Treatment at Station 31+90 to 32+80	6.15	12
5	Concrete Debris Removal at Station 14+10	6.00	13
16	Weir Removal and Bank Stabilization Treatment at Station 33+20 to 35+10	6.00	13
3	Bank Stabilization Treatment at Station 6+60	5.05	14
4	Bank Stabilization Treatment at Station 9+00	5.05	14
8	Left Bank Stabilization Treatment at Station 25+20 to 26+50	4.90	15
1	Reach 1 Riparian Habitat Enhancement	4.60	16
10	Right Bank Stabilization Treatment at Station 27+50 to 28+60	4.30	17

8.2.3 Scenario 3

In this example scenario, geomorphic implications were the most strongly weighted followed by existing risk, habitat benefits, and potential future risks. When Scenario 3 was applied, 19 values were possible within the ranking system. The highest-priority projects were again the same as those identified by Scenarios 1 and 2 (Projects 12, 14, 17, 19, and 21). The lowest-priority projects were also Projects 1, 8, and 10.

Table 7
Summary of Example Project Priority Ranking Scenario 3

Project Number	Description	Prioritization Value	Priority Rank
14	Ilwaco Avenue Private Bridge Replacement or Removal	9.30	1
12	Existing Wall Removal and Natural Channel Development at Station 28+60 to 29+40	8.80	2
19	Channel Realignment at Station 36+20 to 38+40	8.80	2
21	Channel Realignment at Station 38+40 to 40+00	8.80	2
17	Channel Realignment at Station 32+00 to 36+20	8.20	3
23	Lyons Avenue Private Bridge Removal	8.00	4
9	Channel Realignment at Station 25+00 to 28+60	7.80	5

Project Number	Description	Prioritization Value	Priority Rank
22	Lyons Avenue Private Bridge Replacement	7.20	6
18	Channel Improvements at Station 36+20 to 38+40	7.10	7
24	Reach 4 Instream and Riparian Enhancement	6.90	8
11	Bank Stabilization Treatment at Station 28+60 to 29+40	6.70	9
6	Private Bridge Enhancements at Station 14+90	6.40	10
2	Reach 1 Instream Habitat Enhancement	6.30	11
20	Bank Stabilization Treatment at Station 38+40 to 40+00	6.30	11
7	Bank Stabilization Treatment at Station 21+10 to 24+30	6.20	12
13	Right and Left Bank Riparian Habitat Enhancement at Station 29+40 to 31+50	6.00	13
15	Bank Stabilization Treatment at Station 31+90 to 32+80	5.90	14
5	Concrete Debris Removal at Station 14+10	5.40	15
16	Weir Removal and Bank Stabilization Treatment at Station 33+20 to 35+10	5.40	15
3	Bank Stabilization Treatment at Station 6+60	4.70	16
4	Bank Stabilization Treatment at Station 9+00	4.70	16
8	Left Bank Stabilization Treatment at Station 25+20 to 26+50	4.60	17
1	Reach 1 Riparian Habitat Enhancement	4.00	18
10	Right Bank Stabilization Treatment at Station 27+50 to 28+60	3.80	19

9 RECOMMENDED PROJECT IMPLEMENTATION

(Note: The "Recommended Project Implementation" section is an example product for the Draft Report submittal based on the preliminary prioritization and ranking discussed in Section 8. This section, including all tables and in-text results, will be re-written based on discussions with the County following County and public review of the Draft Report.)

The project ranking presented will likely not be directly applied to the project implementation sequence, due to variable conditions and limitations throughout the area that do not necessarily allow for one conceptual project to be compared and evaluated against another project. In addition, the geomorphic implications of several of the proposed projects will determine the relative order of implementation. However, the relative ranking of projects after considering these factors will be useful in establishing a recommended sequence. Other projects are independent and may be implemented at any time without having a physical effect on other areas of the ravine reach. The implementation of these projects may be sequenced according to prioritization and ranking, or other factors such as those related to feasibility. The following sections summarize the relationships between dependent projects with a recommended sequence of implementation, as well as recommendations for implementing independent projects in the downstream section of the ravine reach. A comprehensive list of dependent and independent projects and reasoning is presented in Appendix C.

9.1 Dependent Projects

The proposed projects from approximately Station 25+00 upstream to the 148th Avenue SE crossing typically have more complex feasibility issues related to reach-scale and basin-scale geomorphic conditions, but are nonetheless crucial to establishing stability in the long-term. A majority of the projects upstream of Station 25+00 are dependent on the implementation of other projects. For example, implementation of Project 14 (Ilwaco Avenue Private Bridge Replacement or Removal) would require mitigation for bank stabilization that may be compromised upstream as a result of the project. Conversely, some projects will become unnecessary should another project be implemented. For example, implementation of Project 17 (Channel Realignment at Station 32+00 to 36+20) would render Projects 15 and 16 unnecessary, as the main channel of May Creek will be relocated away from properties

located adjacent to the existing channel (Appendix C). Table 8 provides a summary of dependent projects in numerical order.

Table 8
Summary of Dependent Projects for Station 25+00 Upstream

Project Number	Description	Potential Dependent Projects
8	Left Bank Stabilization Treatment at Station 25+20 to 26+50	9
9	Channel Realignment at Station 25+00 to 28+60	8, 10
10	Right Bank Stabilization Treatment at Station 27+50 to 28+60	9
11	Bank Stabilization Treatment at Station 28+60 to 29+40	12
12	Existing Wall Removal and Natural Channel Development at Station 28+60 to 29+40	11
14	Ilwaco Avenue Private Bridge Replacement or Removal	15, 17
15	Bank Stabilization Treatment at Station 31+90 to 32+80	16, 17
16	Weir Removal and Bank Stabilization Treatment at Station 33+20 to 36+20	17, 18, 19
17	Channel Realignment at Station 32+00 to 26+20	15, 16, 18, 19
18	Channel Improvements at Station 36+20 to 38+40	19, 20, 21
19	Channel Realignment at Station 36+20 to 38+40	18, 20, 21
20	Bank Stabilization Treatment at Station 38+40 to 40+00	21, 22, 23
21	Channel Realignment at Station 38+40 to 40+00	20, 22, 23, 24
22	Lyons Avenue Private Bridge Replacement	23
23	Lyons Avenue Private Bridge Removal	22
24	Reach 4 Instream and Riparian Enhancement	21

See Appendix C for comprehensive table and explanation of dependencies.

We recommend implementing dependent projects beginning at Station 25+00 and working upstream. Geomorphic implications require sequential implementation through this area. We expect that the creek system will evolve in a manner consistent with basin-scale geomorphic processes after completion of these projects, likely over a period of several years to decades. Based on Scenario 3 prioritization weighting, resultant rankings, and project dependencies summarized in Table 8 above, one potential implementation sequence is provided in Table 9 below.

Table 9

Example Recommended Project Sequence for Station 25+00 Upstream

Project	Description	Scenario 3 Ranking	Relative Order of Implementation
12	Existing Wall Removal and Natural Channel Development at Station 28+60 to 29+40	2	1
14	Ilwaco Avenue Private Bridge Replacement or Removal	1	2
17	Channel Realignment at Station 32+00 to 26+20	3	2
19	Channel Realignment at Station 36+20 to 38+40	2	3
21	Channel Realignment at Station 38+40 to 40+00	2	4
23	Lyons Avenue Private Bridge Removal	4	4
24	Reach 4 Instream and Riparian Enhancement	8	5

9.2 Independent Projects

The remaining projects, typically downstream of Station 25+00, are less complex geomorphically. However, while some of these projects rank lower overall (Tables 5 through 7), they are relatively simple and cost-effective to implement and will generate immediate habitat and/or stabilization benefits. These projects could be completed in a short amount of time (approximately 1 to 5 years) and because they do not have a significant geomorphic effect, the sequencing is not critical. Therefore, the prioritization of these projects may be based on the project ranking system presented in Section 8. An example of project sequencing for independent projects based on the prioritization and ranking method is shown in Table 10.

Table 10

Example Recommended Project Sequence for Independent Projects

Project	Description	Scenario 3 Ranking	Relative Order of Implementation
6	Private Bridge Enhancements at Station 14+90	10	1
2	Reach 1 Instream Habitat Enhancement	11	2
7	Bank Stabilization Treatment at Station 21+10 to 24+30	12	3
13	Right and Left Bank Riparian Habitat Enhancement at Station 29+40 to 31+50	13	4
5	Concrete Debris Removal at Station 14+10	15	5

Project	Description	Scenario 3 Ranking	Relative Order of Implementation
3	Bank Stabilization Treatment at Station 6+60	16	6
4	Bank Stabilization Treatment at Station 9+00	16	7
1	Reach 1 Riparian Habitat Enhancement	18	7

10 REFERENCES

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APPENDIX A
CONCEPTUAL STABILIZATION AND RESTORATION ACTIONS

CONCEPTUAL STABILIZATION AND RESTORATION ACTIONS

Addressing instability caused by reach scale channel incision or site specific bank erosion may be accomplished by undertaking a variety of stabilization or restoration treatment actions within the active channel, along the stream banks, or within the riparian upland adjacent to the creek. These actions could be real estate or property management related, channel realignment oriented, or site specific erosional and grade control strategies. These actions include the following:

- Acquisition
- Bridge Removal
- Bridge Replacement
- Weir Removal
- Bank Armoring or Wall Removal
- Instream Debris Removal
- Large Woody Debris Placement
- Planform Modification
- Riparian Habitat Enhancement
- Bank Stabilization Treatments
    - Log Cribwall
    - Toe Stabilization
    - Coir Wrap
    - Slope Grading and Revegetation

The following paragraphs describe the conceptual treatment actions and alternative methods or variations within each potential action.

Acquisition

Land acquisition may take on several different meanings in the context of this report. Property may be purchased by the County from the current landowner (also known as "fee simple"). Alternately, conservation easements could be agreed upon with landowners, or land may be donated by the landowner as dedicated green space. Property availability acquired through these means would provide more flexibility with potential treatment actions and likely provide a more appropriate riparian habitat buffer through the stream corridor. Land acquisition would allow for actions such as planform modifications where the creek is routed away from critical private infrastructure. Acquisition will also better allow

for existing geomorphic processes to proceed without affecting private properties. Acquisition is the most effective option if the spatial extent is large enough to allow a significant modification to the stream or property is acquired where critical infrastructure concerns exist.

Bridge Removal

Bridge crossings, and their associated abutments (typically concrete), encroach on the channel and act as constriction points that can cause backwater upstream of the bridge. This condition may lead to increased flood elevations and accelerated pressure flow through the bridge opening, increasing velocities. The bridge abutments observed through the ravine area are being undercut as the stream incises and are typically in various states of disrepair. In several locations, additional concrete and other materials have been placed adjacent to the abutments indicating that routine maintenance has occurred to extend the life of the crossing and prevent it from collapsing into the creek. A majority of bridge crossings observed were in poor condition and at risk of collapsing into the creek, creating both risks to safety and habitat. Removal of pedestrian bridges would likely occur only when volunteered by the landowner. Removal of road bridges would occur when a permanent alternative access route to the property can be secured.

Bridge Replacement

In locations where bridges are at risk of failure and site access must be maintained through the existing access corridor, bridge replacement may be an acceptable alternative. Bridges that would be a candidate for replacement include those currently at risk of failure due to channel incision, bridges that cause a constriction point and increase flood elevations, and bridges that are the sole existing access route for adjacent property owners when an alternate access route cannot be established. The existing bridge would be replaced with a longer spanning design that lessens flooding concerns by moving the abutments out of the active channel, thereby minimizing encroachment and channel constriction. Existing armor rock, abutments, and other materials would be removed. The stream crossing under the bridge would be lined with natural streambed materials. Coincident bank stabilization actions would likely be implemented in conjunction with bridge replacement activities.

Weir Removal

Several weirs were identified throughout the study area. These weirs appear to have been installed to control the local channel grade as a part of aesthetic improvements within private landscapes and for recreation. In each case, backwater conditions were identified upstream and a hydraulic drop was identified downstream. While natural pool and riffle features in streams enhance aquatic habitat, the size, spacing, and depth of the pools, or backwater, created by the man-made weirs in May Creek, pose habitat concerns. Extensive sections of backwater upstream of a weir often lead to deposition of sands and gravels on the upstream side, potentially starving the channel downstream of spawning-sized material. The low flow velocities prolong water residence time and allow for increased heating from solar radiation and atmospheric exchange. Consequently, the pool areas warm and reduce habitat suitability for cool water fish species such as salominds and trout. The slower, warmer waters also allow for pond plant species to flourish along the channel bed and on the water surface (i.e., duckweed). Weirs with deep plunge pools and large drops in water surface elevation may also be fish passage barriers for certain species such as chum and chinook.

Weir removal along May Creek would allow for more natural sediment transport through the reach and better allow natural evolution of the stream grade. Hence, a consequence of weir removal will likely be a lowering of the local channel bed elevation. In areas where existing bank stabilization treatments are present, such as stone armoring and rock walls, these treatments may become undercut and fail. Therefore, weir removal must consider the future evolution associated with this action and additional bank stabilization actions will likely be required in conjunction with weir removal.

Bank Armoring or Wall Removal

Bank armoring identified within the project area was composed of boulder-sized armor rock, ranging from approximately 1 foot to 3 feet in diameter, accumulations of stone and concrete blocks or cylinders, pieces of asphalt, tires, and steel drums. Bank armoring along May Creek appears to have been installed primarily by private parties over the past several decades and observations suggest that this practice has continued in recent years to maintain and protect adjacent properties.

Rock walls, stone armoring, and other concrete accumulations can provide local bank stabilization benefits, however, adverse effects are commonplace with these features. Stone,

concrete, and wall-lined banks provide little bank roughness and lead to increased velocities. Increased flow velocities create more hydraulic energy that is available to scour the bed adjacent to the structure and erode the bank directly downstream of the stabilization feature. Therefore, it is common to see eroded banks downstream and failure of bank armoring due to undercutting. These results lead to placement of additional rock and contribution of eroded debris either downstream or within the stream channel to maintain the feature. Armored banks limit the ability of vegetation to establish and grow, thereby, diminishing the ecological conditions. In several locations bank armoring acts as the primary mode of stability for the bank it supports; therefore, slope regrading, planting, and other restoration actions such as bioengineered bank stabilization treatments would be required in conjunction with removal. In other locations the armoring is in disrepair and adds little stability to the bank. In these situations less extensive means of bank stabilization may be possible following removal.

Instream Debris Removal

Concrete and other debris identified included former bridge abutments, concrete cylinders, and concrete-filled culvert pieces. In some areas, moderate to large accumulations of debris are present, while in other areas individual debris elements are scattered about the channel and along the banks. Some of these features affect the function of the channel while others simply represent eyesores within the natural environment. Removal of debris is proposed where the material has adverse impacts to geomorphic or habitat function. However, some removal of miscellaneous debris may be included as part of larger projects if it does not create increased disturbance.

Large Woody Debris Placement

Large woody debris (LWD) placements are logs with rootwads that are installed in the channel bed to create beneficial habitat and desired geomorphic effects. In natural systems riparian trees often fall into a watercourse as the result of erosion, windfall, disease, beaver activity, or natural mortality. This natural source of LWD has often been eliminated by anthropogenic activity along the stream corridor. Despite the intentions of LWD removal it is detrimental to the stream system both ecologically and morphologically.

There are many benefits of LWD in streams, including improved habitat diversity for fish species as the presence of LWD creates scour pools and cover which are critical habitat

features, particularly during low flows. LWD also produces velocity shelters in the lee of the rootwads that act as holding and resting areas. Geomorphic benefits of woody debris include improved bank stability and sediment transport conditions. LWD may be installed to direct flow away from eroding banks and may also provide natural areas for sediment to accumulate in the channel. (Figure A-1)

Planform Modification

Planform modification means realigning or moving the channel within the valley bottom or through the adjacent floodplain. This action would likely be considered when moving the channel would reduce erosion risks and allow for more passive approaches to stabilization that better allow for natural channel evolution and increased habitat benefits. This action would, in most cases, allow for the development of a natural stream corridor and a riparian buffer area between the creek and private infrastructures. (Figure A-2)

Riparian Habitat Enhancement

Riparian habitat enhancement will involve removal of undesirable vegetation and planting of native riparian vegetation on the channel banks and in the floodplain. Ideally, a buffer extending a minimum of 50 feet from the channel (100 feet total) would be established where possible. May Creek is located within private property throughout the ravine reach, causing the buffer to be narrower in some areas due to landowner approval, presence of infrastructure, and other limitations. Riparian planting may also be used with bank stabilization treatments where appropriate.

A well-established riparian corridor provides several habitat and erosion benefits including bank and floodplain roughness, cover, and nutrients for instream species and wildlife. Increased roughness encourages sediment deposition and decreased velocities. Additionally, developed riparian areas are a source of LWD to the stream.

Riparian habitat enhancement may include complete eradication and revegetation in areas overgrown with invasive species, re-establishment of riparian vegetation in cleared areas such as grass lawns, or selective clearing, and supplemental planting within existing riparian zones. While monitoring and maintenance will likely be required for the first few years after planting, monitoring will greatly contribute to the success of the plantings and may be

required for permitting approval. Eradication of large areas of invasive species such as reed canarygrass will likely require a longer and more involved monitoring effort.

Bank Stabilization Treatments

In some locations, bank stabilization structures, slope grading, planting, or a combination of these actions may be the most beneficial alternative to reduce erosion, protect existing infrastructure, and enhance habitat conditions. The bank stabilization treatments described below are consistent with recognized and recommended bio-engineering techniques for stabilizing banks and improving habitat conditions.

Log Cribwall

Log cribwalls are constructed along segments of a stream channel to provide bank stabilization at sites with increased hydraulic energy and scour potential. A log cribwall is a continuous structure installed along the stream bank that is constructed from LWD buried into the adjacent bank. This approach has been widely used as an effective bank stabilization technique and is a preferred alternative over stone armoring in that it can be filled with soil and planted with vegetation. In addition, embedding LWD into the bank with the rootwads exposed in the channel to provides roughness. The added roughness promotes hydraulic refuge areas and sediment deposition in the lee of the structure, while stabilizing the entire length of the bank. Above the ordinary high water level (OHWL), the structure will act as a "planting box" where native vegetation will become established, further reducing erosion and promoting long-term stabilization, as well as improving the riparian corridor. Log cribwalls can be near vertical or constructed on a slope. Each design has unique dimensions to meet the site specific objectives and topographic constraints. (Figure A-3)

Toe Stabilization

Toe stabilization is an approach where the top of the slope is fortified using rock or wood and the remainder of the bank is stabilized using vegetation. This approach can include sloping the banks and/or using a biodegradable fabric (geotextile) to help stabilize the channel banks. This stabilization treatment is most applicable in moderate energy sections of the stream.

If armor rock is used, the rock will be placed to a calculated scour depth and buried a sufficient amount into the bank for stability. LWD can also be used as an alternative to rock; the exposed rootwads create roughness and diversity along the toe of the slope. At least one

layer of logs with rootwads would be buried below the streambed and trenched back into the slope, similar to the base of a log cribwall structure. The logs would likely be further stabilized with stringer logs placed parallel to the bank for reinforcement. With both the rock and wood methods, coir wraps or biodegradable fabric and supplemental plantings would be used to stabilize the disturbed bank (see sections below). (Figure A-4)

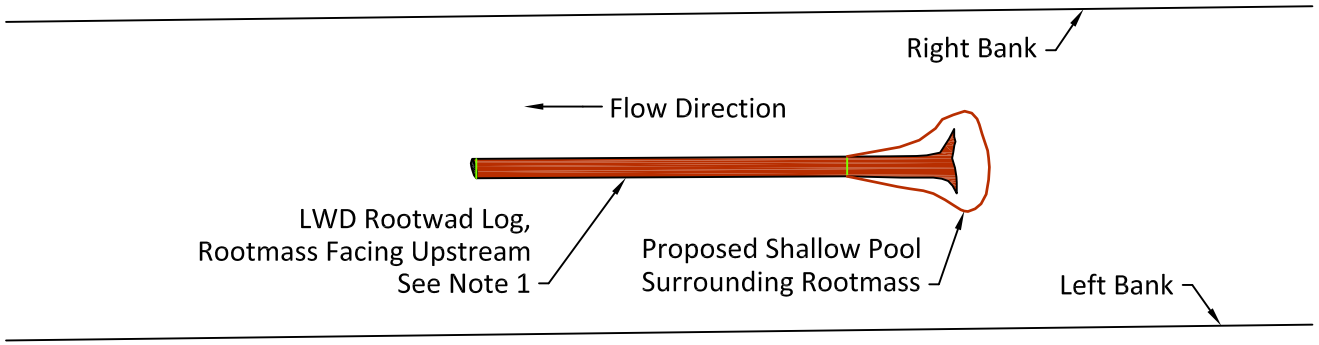
Coir Wrap

Coir wraps (also known as coir logs) are typically used in lower energy environments as a temporary means of stabilization while native plantings become established. The coir wrap is typically used exclusively for low banks with little to no migration potential. In areas where scour or undercutting is anticipated, additional toe stabilization will likely be proposed. The purpose of the coir wrap approach is to create a bank stabilized by native vegetation, which in turn enhances habitat by providing cover and nutrients. Additionally, the coir wrap traps overbank sediments which also provide nutrients to the steambank vegetation.

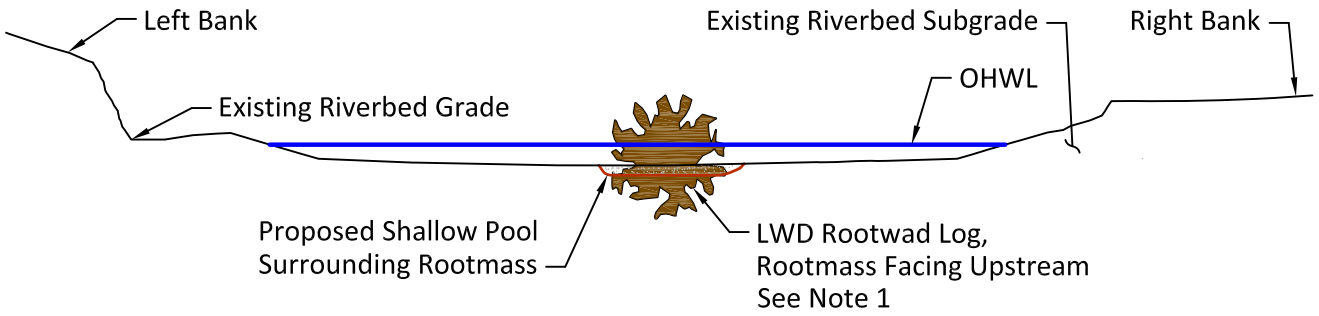
Coir wraps are relatively simple to install and consist of biodegradable coir fabric filled with soil and gravel to form a log shape. A series of the coir logs are placed parallel to the bank and stepped upwards at a stable slope. Cuttings, transplants, and topsoil are placed between each wrap layer. The layers are bound together with additional biodegradable material or anchored with wooden stakes. Over the course of the next several years the fabric will completely degrade and the bank will eventually be stabilized by the root mass of the vegetation. (Figure A-5)

Slope Grading and Revegetation

Stabilizing the banks via slope regrading and vegetation is a potential treatment that can be used in low energy environments where erosion is minor, or where erosion does not threaten public or private infrastructure. This approach is often used in conjunction with other treatments such as log cribwalls or toe stabilization along the upper portions of the banks. The disturbed bank would be revegetated with native riparian species that would provide natural bank stabilization in the long-term. Graded slopes would be treated with biodegradable geotextile or coir fabric that would temporarily stabilize the bank over several years until vegetation becomes established. (Figure A-6)



Typical Large Woody Debris (LWD) Placement
Plan View



Typical Large Woody Debris (LWD) Placement
Section View, Facing Downstream

Notes:
1. LWD Log will be cabled and anchored into riverbed subgrade

B:\Projects\0159_KPFF\090159-01_MayCreek_P3\CAD\Figures\TypicalTreatmentSections2009-10-08.dwg Fig1

Jan 06, 2010 9:26am mlee

SOURCE: N/A
HORIZONTAL DATUM: N/A
VERTICAL DATUM: N/A

NOTES:
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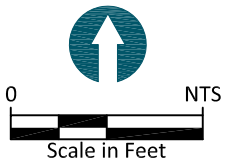
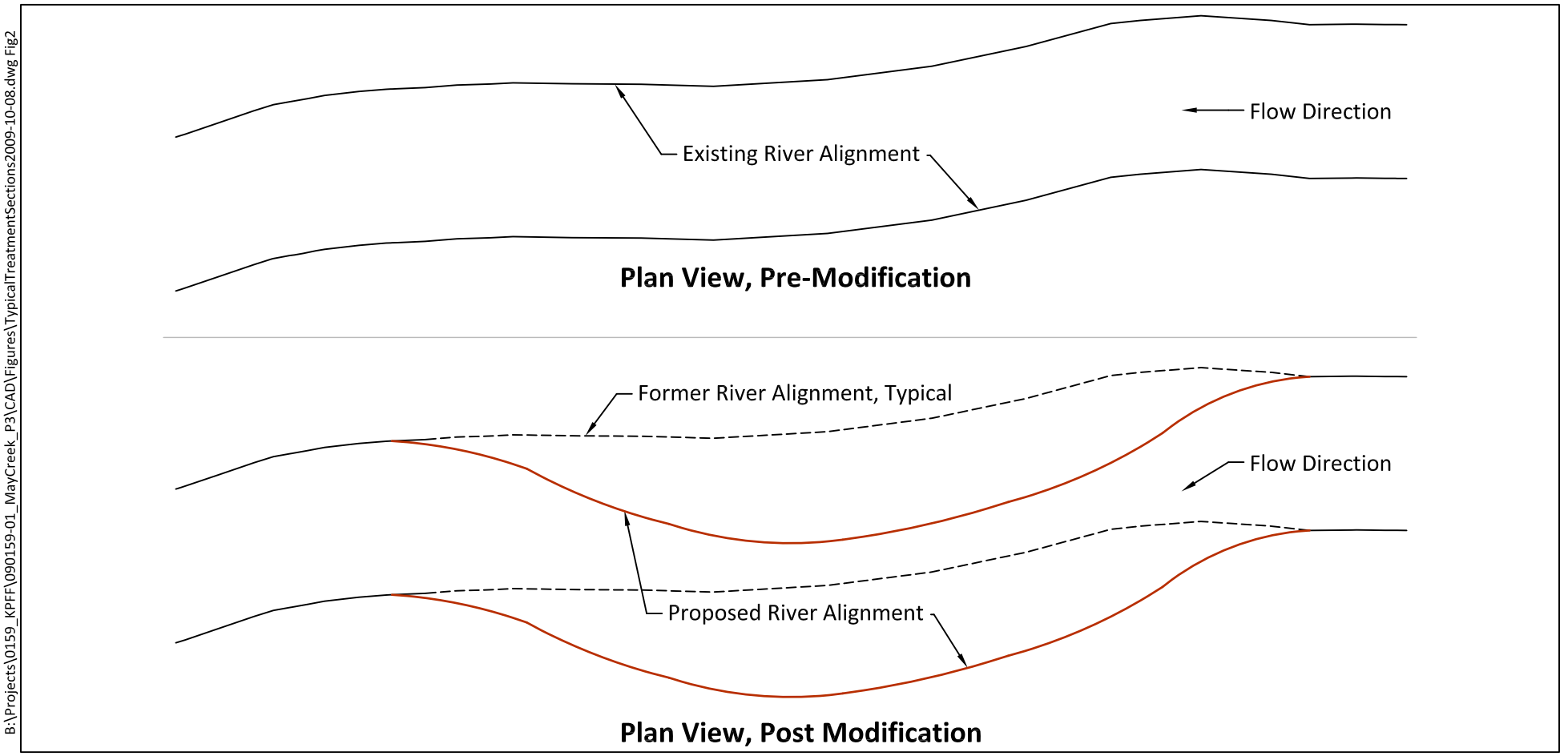
This figure is not intended for construction purposes.



ANCHOR QEA

Figure A-1
Typical Large Woody Debris Placement
May Creek Erosion Stabilization Draft Report
King County/May Creek Sediment Transport Study Phase 3



B:\Projects\0159_KPFF\090159-01_MayCreek_P3\CAD\Figures\TypicalTreatmentSections2009-10-08.dwg Fig2

Jan 06, 2010 9:24am mlee

SOURCE: N/A
HORIZONTAL DATUM: N/A
VERTICAL DATUM: N/A

NOTES:
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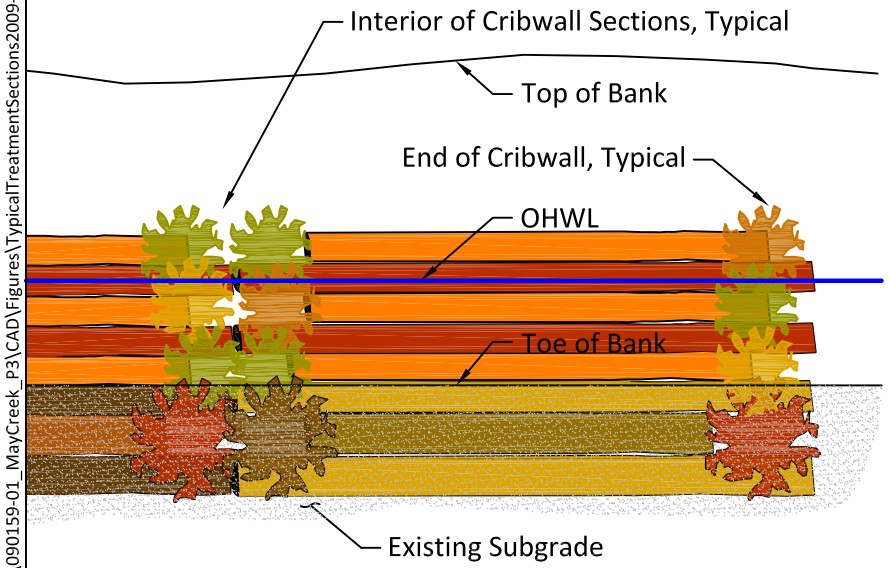
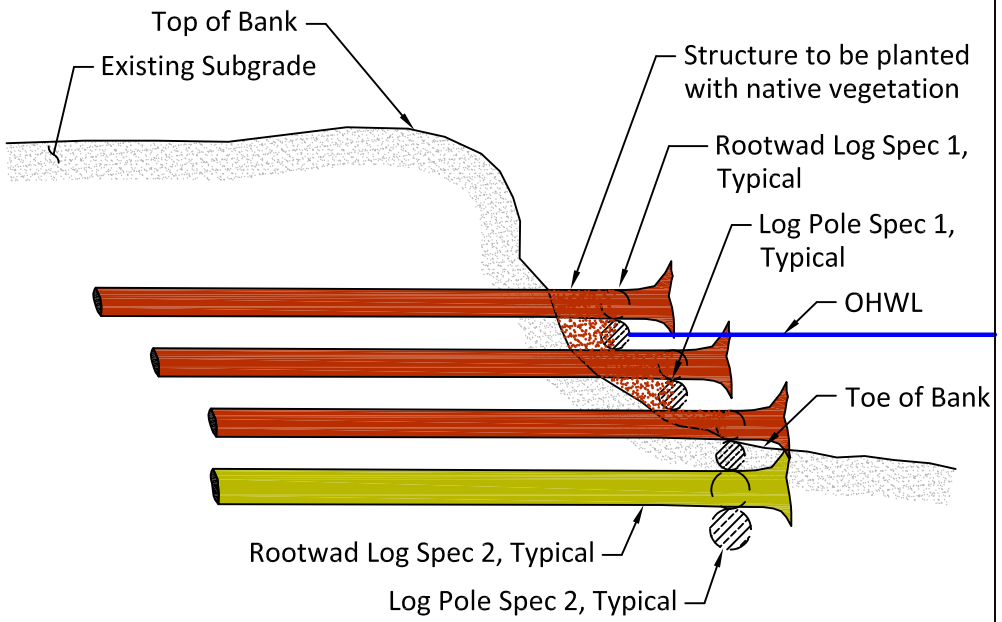
Scale in Feet

Figure A-2
Typical River Planform Modification
May Creek Erosion Stabilization Draft Report
King County/May Creek Sediment Transport Study Phase 3

ANCHOR QEA



Typical Log Cribwall
Section View, Facing Front of Cribwall



Typical Log Cribwall
Section View, Facing Downstream

SOURCE: N/A
HORIZONTAL DATUM: N/A
VERTICAL DATUM: N/A

NOTES:
This figure represents a typical design for conceptual purposes only.
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Scale in Feet

B:\Projects\0159_KPFF\090159-01_MayCreek_P3\CAD\Figures\TypicalTreatmentSections2009-10-08.dwg Fig3
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Figure A-3
Typical Log Cribwall
May Creek Erosion Stabilization Draft Report
King County/May Creek Sediment Transport Study Phase 3

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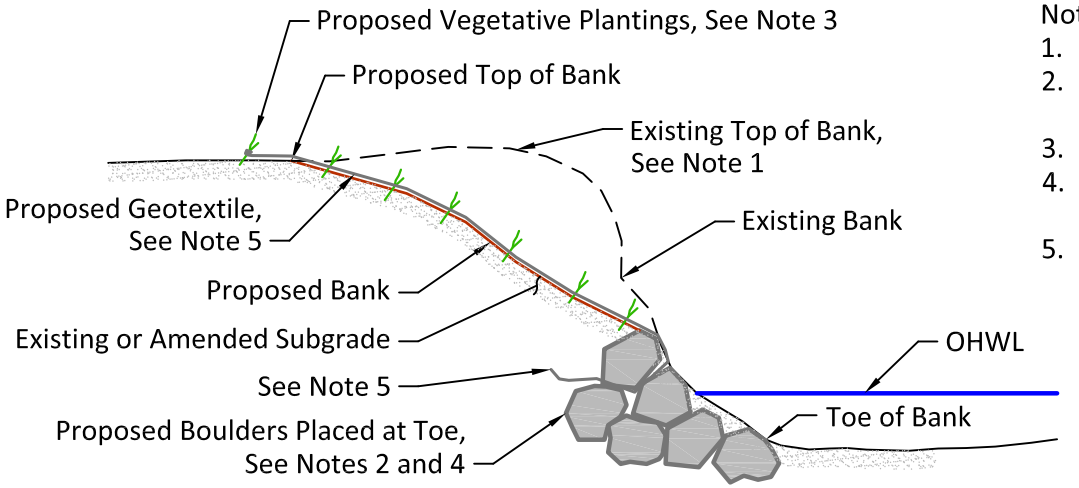

Typical Toe of Slope Stabilization
Section View

Notes:
1. The steep portion of the existing bank is removed.
2. The new bank is stabilized by boulders at the toe of the bank and a geotextile fabric (see also Note 5).
3. The new bank will be vegetated accordingly.
4. Large woody debris (rootwads and logs) may be used in lieu of boulders for the toe stabilization.
5. Geotextile will be placed on disturbed bank. Bottom end of geotextile will be wrapped around boulders at toe of slope.

SOURCE: N/A
HORIZONTAL DATUM: N/A
VERTICAL DATUM: N/A

NOTES:
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This figure is not intended for construction purposes.

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Scale in Feet

Figure A-4
Typical Toe Stabilization
May Creek Erosion Stabilization Draft Report
King County/May Creek Sediment Transport Study Phase 3

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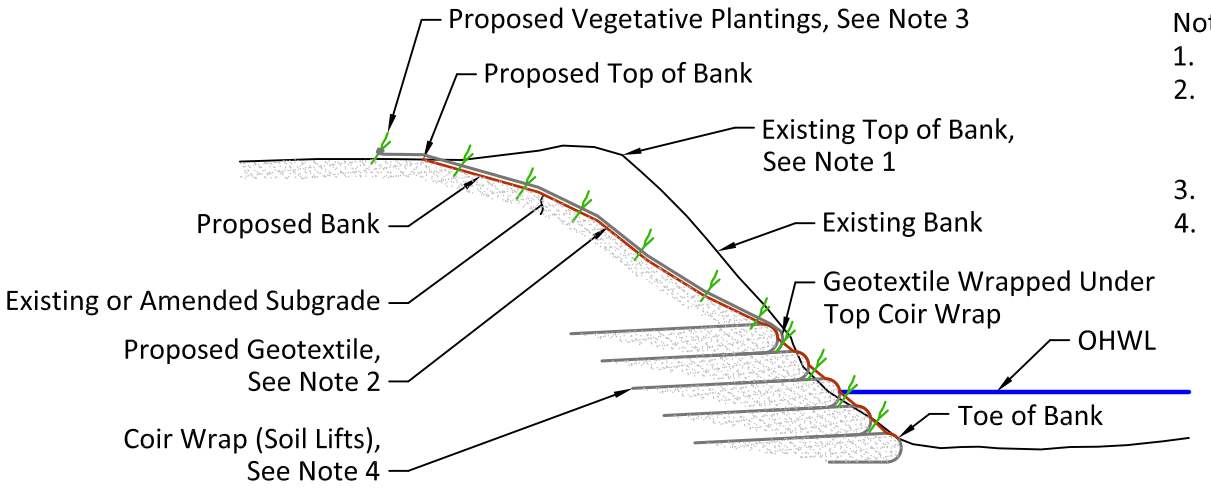
B:\Projects\0159_KPFF\090159-01_MayCreek_P3\CAD\Figures\TypicalTreatmentSections2009-10-08.dwg Fig5



Typical Coir Wrap Bank Stabilization
Section View

Notes:
1. The steep portion of the existing bank is removed.
2. The new bank is stabilized by placement of coir wraps, geotextile, and vegetative plantings. See also Notes 3 and 4.
3. The new bank will be vegetated accordingly.
4. Coir wraps consist of soil wrapped in coir fabric and buried into bank. Successive coir wraps are placed on top of wraps underneath to a designed slope.

Jan 06, 2010 9:15am mlee

SOURCE: N/A
HORIZONTAL DATUM: N/A
VERTICAL DATUM: N/A

NOTES:
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Scale in Feet

Figure A-5
Typical Coir Wrap Bank Stabilization
May Creek Erosion Stabilization Draft Report
King County/May Creek Sediment Transport Study Phase 3

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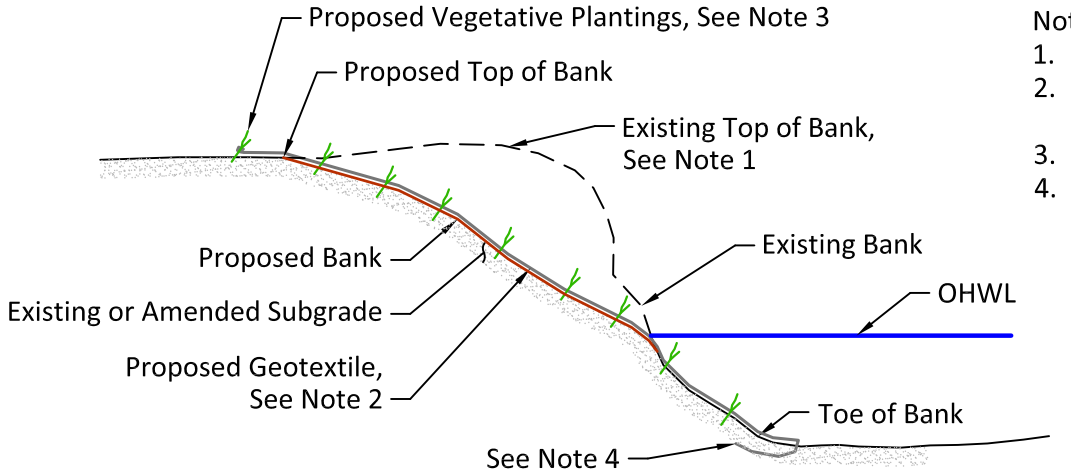

Notes:

1. The steep portion of the existing bank is removed.
2. The new bank is stabilized by placement of geotextile and vegetative plantings. See also Note 3.
3. The new bank will be vegetated accordingly.
4. Bottom end of geotextile will be wrapped around soil at toe of slope and buried into the bank.

Typical Slope Regrading with Geotextile and Revegetation
Section View

SOURCE: N/A
HORIZONTAL DATUM: N/A
VERTICAL DATUM: N/A

NOTES:
This figure represents a typical design for conceptual purposes only.
This figure is not intended for construction purposes.

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Scale in Feet

Figure A-6
Typical Slope Regrading with Geotextile and Revegetation
May Creek Erosion Stabilization Draft Report
King County/May Creek Sediment Transport Study Phase 3

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APPENDIX B
PROJECT PRIORITIZATION AND RANKING TABLES

PROJECT PRIORITIZATION AND RANKING

The results of the project evaluation were applied to a matrix developed to prioritize and rank each conceptual project. The results of prioritization will assist the County in developing a conceptual implementation plan for the May Creek ravine reach.

A high, moderate-high, moderate, moderate-low, or low ranking was assigned a point value between 5 and 1, with 5 being the highest and 1 being the lowest ranking, respectively. Each evaluation criterion was normalized to a 10-point maximum for each of the four major criteria (Table B-1). Normalization of these criteria has some flexibility, should the County desire to assign a higher priority to one criterion over another based on public input or other available information.

Table B-1
Possible Points for Project Evaluation Criteria

Major Evaluation Criteria		Sub-criteria	Total Possible Points
1	Significant Impacts of Existing Conditions	Erosion	5
		Flooding	5
2	Potential Significant Impacts of Proposed Project	Erosion	5
		Flooding	5
3	Habitat Benefit	N/A	10
4	Consistency with Geomorphic Processes	N/A	10

Note: Ten points are possible for each major criterion.

Once the project has been assigned the appropriate point value for each criterion, a weighting coefficient was assigned establish the relative importance of the criteria relative to one another. The sum of the four weighted criteria (the product of the weighting coefficient and total point value for the category) becomes the final Prioritization Value. These values are also assigned a relative position (Priority Rank) for a more user-friendly summary of the results.

Three separate scenarios were developed to assess the prioritization and ranking process as a tool for assessing the relative importance of projects. The purpose of this exercise is to provide the County with an example of how this tool "could" be used. The coefficients used in this example are arbitrary and do not represent Anchor QEA's opinion of how criteria

should be prioritized. The example coefficients assigned to each criterion for the scenarios are summarized in Table 4.

- **Scenario 1:** All criteria are equally weighted.
- **Scenario 2:** Criteria 4 is heavily weighted and all other criteria are equally weighted.
- **Scenario 3:** Criteria are weighted variably.

Table B-2
Example Prioritization of Evaluation Criteria

Evaluation Criteria		Weighting Coefficient		
		Scenario 1	Scenario 2	Scenario 3
1	Significant Impacts of Existing Conditions	0.25	0.15	0.30
2	Potential Significant Impacts of Proposed Project	0.25	0.15	0.10
3	Habitat Benefit	0.25	0.15	0.20
4	Consistency with Geomorphic Processes	0.25	0.55	0.40

The tables on the following pages show the prioritization and ranking of each project using the three scenarios above. The Prioritization Value represents the sum of the points assigned to each criterion out of 10 possible points (p_n) multiplied by the associated weighting coefficient for that criteria (C_n). For example, in Table B-3, Project 1 received a Prioritization Value of 5.00 for Scenario 1. Because the weighting coefficients add up to a value of 1, the Prioritization Value is out of 10 possible points for each example scenario. For each project, this value is calculated by the following equation:

$$\text{Prioritization Value} = (p_2 * C_2) + (p_2 * C_2) + (p_3 * C_3) + (p_4 * C_4)$$

Where:

p_n = point value for criteria *n*
C_n = weighting coefficient for criteria *n* (see Table B-2)

Table B-3
Scenario 1 Prioritization (Criteria Equally Weighted)

Project Information		Rating										Prioritization Value	Priority Rank
		Criteria 1			Criteria 2			Criteria 3		Criteria 4			
		Erosion	Flooding	Point Value (1-10)	Erosion	Flooding	Point Value (1-10)	*Rating*	Point Value (1-10)	*Rating*	Point Value (1-10)		
Number	**Description**	*Rating*	*Rating*		*Rating*	*Rating*							
1	Reach 1 Riparian Habitat Enhancement	1	1	**2**	5	5	**10**	2	**4**	2	**4**	**5.00**	**14**
2	Reach 1 Instream Habitat Enhancement	1	1	**2**	4	5	**9**	4	**8**	4	**8**	**6.75**	**8**
3	Bank Stabilization Treatment at Station 6+60	2	1	**3**	5	5	**10**	3	**6**	2	**4**	**5.75**	**12**
4	Bank Stabilization Treatment at Station 9+00	2	1	**3**	5	5	**10**	3	**6**	2	**4**	**5.75**	**12**
5	Concrete Debris Removal at Station 14+10	2	1	**3**	4	5	**9**	3	**6**	3	**6**	**6.00**	**11**
6	Private Bridge Enhancements at Station 14+90	3	2	**5**	4	5	**9**	2	**4**	4	**8**	**6.50**	**9**
7	Bank Stabilization Treatment at Station 21+10 to 24+30	3	1	**4**	5	5	**10**	4	**8**	3	**6**	**7.00**	**7**
8	Left Bank Stabilization Treatment at Station 25+20 to 26+50	2	1	**3**	4	5	**9**	3	**6**	2	**4**	**5.50**	**13**
9	Channel Realignment at Station 25+00 to 28+60	2	1	**3**	4	5	**9**	5	**10**	5	**10**	**8.00**	**4**
10	Right Bank Stabilization Treatment at Station 27+50 to 28+60	2	1	**3**	4	5	**9**	1	**2**	2	**4**	**4.50**	**15**
11	Bank Stabilization Treatment at Station 28+60 to 29+40	5	1	**6**	4	5	**9**	4	**8**	3	**6**	**7.25**	**6**
12	Existing Wall Removal and Natural Channel Development at Station 28+60 to 29+40	5	1	**6**	5	5	**10**	5	**10**	5	**10**	**9.00**	**2**
13	Right and Left Bank Riparian Habitat Enhancement at Station 29+40 to 31+50	1	1	**2**	5	5	**10**	3	**6**	4	**8**	**6.50**	**9**
14	Ilwaco Avenue Private Bridge Replacement or Removal	4	5	**9**	5	5	**10**	4	**8**	5	**10**	**9.25**	**1**
15	Bank Stabilization Treatment at Station 31+90 to 32+80	2	3	**5**	3	5	**8**	3	**6**	3	**6**	**6.25**	**10**
16	Weir Removal and Bank Stabilization Treatment at Station 33+20 to 35+10	1	2	**3**	4	5	**9**	3	**6**	3	**6**	**6.00**	**11**
17	Channel Realignment at Station 32+00 to 36+20	1	3	**4**	5	5	**10**	5	**10**	5	**10**	**8.50**	**3**
18	Channel Improvements at Station 36+20 to 38+40	2	4	**6**	4	5	**9**	3	**6**	4	**8**	**7.25**	**6**
19	Channel Realignment at Station 36+20 to 38+40	2	4	**6**	5	5	**10**	5	**10**	5	**10**	**9.00**	**2**
20	Bank Stabilization Treatment at Station 38+40 to 40+00	3	3	**6**	4	5	**9**	3	**6**	3	**6**	**6.75**	**8**
21	Channel Realignment at Station 38+40 to 40+00	3	3	**6**	5	5	**10**	5	**10**	5	**10**	**9.00**	**2**
22	Lyons Avenue Private Bridge Replacement	3	3	**6**	5	5	**10**	3	**6**	4	**8**	**7.50**	**5**
23	Lyons Avenue Private Bridge Removal	3	3	**6**	5	5	**10**	3	**6**	5	**10**	**8.00**	**4**
24	Reach 4 Instream and Riparian Enhancement	1	3	**4**	5	4	**9**	4	**8**	4	**8**	**7.25**	**6**

Table B-4
Scenario 2 Prioritization (Criteria 4 Heavily Weighted)

Project Information		Rating										Prioritization Value	Priority Rank
		Criteria 1			Criteria 2			Criteria 3		Criteria 4			
		Erosion	Flooding	Point Value (1-10)	Erosion	Flooding	Point Value (1-10)	*Rating*	Point Value (1-10)	*Rating*	Point Value (1-10)		
Number	**Description**	*Rating*	*Rating*		*Rating*	*Rating*							
1	Reach 1 Riparian Habitat Enhancement	1	1	**2**	5	5	**10**	2	**4**	2	**4**	**4.60**	**16**
2	Reach 1 Instream Habitat Enhancement	1	1	**2**	4	5	**9**	4	**8**	4	**8**	**7.25**	**7**
3	Bank Stabilization Treatment at Station 6+60	2	1	**3**	5	5	**10**	3	**6**	2	**4**	**5.05**	**14**
4	Bank Stabilization Treatment at Station 9+00	2	1	**3**	5	5	**10**	3	**6**	2	**4**	**5.05**	**14**
5	Concrete Debris Removal at Station 14+10	2	1	**3**	4	5	**9**	3	**6**	3	**6**	**6.00**	**13**
6	Private Bridge Enhancements at Station 14+90	3	2	**5**	4	5	**9**	2	**4**	4	**8**	**7.10**	**8**
7	Bank Stabilization Treatment at Station 21+10 to 24+30	3	1	**4**	5	5	**10**	4	**8**	3	**6**	**6.60**	**10**
8	Left Bank Stabilization Treatment at Station 25+20 to 26+50	2	1	**3**	4	5	**9**	3	**6**	2	**4**	**4.90**	**15**
9	Channel Realignment at Station 25+00 to 28+60	2	1	**3**	4	5	**9**	5	**10**	5	**10**	**8.80**	**4**
10	Right Bank Stabilization Treatment at Station 27+50 to 28+60	2	1	**3**	4	5	**9**	1	**2**	2	**4**	**4.30**	**17**
11	Bank Stabilization Treatment at Station 28+60 to 29+40	5	1	**6**	4	5	**9**	4	**8**	3	**6**	**6.75**	**9**
12	Existing Wall Removal and Natural Channel Development at Station 28+60 to 29+40	5	1	**6**	5	5	**10**	5	**10**	5	**10**	**9.40**	**2**
13	Right and Left Bank Riparian Habitat Enhancement at Station 29+40 to 31+50	1	1	**2**	5	5	**10**	3	**6**	4	**8**	**7.10**	**8**
14	Ilwaco Avenue Private Bridge Replacement or Removal	4	5	**9**	5	5	**10**	4	**8**	5	**10**	**9.55**	**1**
15	Bank Stabilization Treatment at Station 31+90 to 32+80	2	3	**5**	3	5	**8**	3	**6**	3	**6**	**6.15**	**12**
16	Weir Removal and Bank Stabilization Treatment at Station 33+20 to 35+10	1	2	**3**	4	5	**9**	3	**6**	3	**6**	**6.00**	**13**
17	Channel Realignment at Station 32+00 to 36+20	1	3	**4**	5	5	**10**	5	**10**	5	**10**	**9.10**	**3**
18	Channel Improvements at Station 36+20 to 38+40	2	4	**6**	4	5	**9**	3	**6**	4	**8**	**7.55**	**6**
19	Channel Realignment at Station 36+20 to 38+40	2	4	**6**	5	5	**10**	5	**10**	5	**10**	**9.40**	**2**
20	Bank Stabilization Treatment at Station 38+40 to 40+00	3	3	**6**	4	5	**9**	3	**6**	3	**6**	**6.45**	**11**
21	Channel Realignment at Station 38+40 to 40+00	3	3	**6**	5	5	**10**	5	**10**	5	**10**	**9.40**	**2**
22	Lyons Avenue Private Bridge Replacement	3	3	**6**	5	5	**10**	3	**6**	4	**8**	**7.70**	**5**
23	Lyons Avenue Private Bridge Removal	3	3	**6**	5	5	**10**	3	**6**	5	**10**	**8.80**	**4**
24	Reach 4 Instream and Riparian Enhancement	1	3	**4**	5	4	**9**	4	**8**	4	**8**	**7.55**	**6**

Table B-5
Scenario 3 Prioritization (Criteria Variably Weighted)

Project Information		Rating										Prioritization Value	Priority Rank
		Criteria 1			Criteria 2			Criteria 3		Criteria 4			
		Erosion	Flooding	Point Value (1-10)	Erosion	Flooding	Point Value (1-10)	*Rating*	Point Value (1-10)	*Rating*	Point Value (1-10)		
Number	**Description**	*Rating*	*Rating*		*Rating*	*Rating*							
1	Reach 1 Riparian Habitat Enhancement	1	1	**2**	5	5	**10**	2	**4**	2	**4**	**4.00**	**18**
2	Reach 1 Instream Habitat Enhancement	1	1	**2**	4	5	**9**	4	**8**	4	**8**	**6.30**	**11**
3	Bank Stabilization Treatment at Station 6+60	2	1	**3**	5	5	**10**	3	**6**	2	**4**	**4.70**	**16**
4	Bank Stabilization Treatment at Station 9+00	2	1	**3**	5	5	**10**	3	**6**	2	**4**	**4.70**	**16**
5	Concrete Debris Removal at Station 14+10	2	1	**3**	4	5	**9**	3	**6**	3	**6**	**5.40**	**15**
6	Private Bridge Enhancements at Station 14+90	3	2	**5**	4	5	**9**	2	**4**	4	**8**	**6.40**	**10**
7	Bank Stabilization Treatment at Station 21+10 to 24+30	3	1	**4**	5	5	**10**	4	**8**	3	**6**	**6.20**	**12**
8	Left Bank Stabilization Treatment at Station 25+20 to 26+50	2	1	**3**	4	5	**9**	3	**6**	2	**4**	**4.60**	**17**
9	Channel Realignment at Station 25+00 to 28+60	2	1	**3**	4	5	**9**	5	**10**	5	**10**	**7.80**	**5**
10	Right Bank Stabilization Treatment at Station 27+50 to 28+60	2	1	**3**	4	5	**9**	1	**2**	2	**4**	**3.80**	**19**
11	Bank Stabilization Treatment at Station 28+60 to 29+40	5	1	**6**	4	5	**9**	4	**8**	3	**6**	**6.70**	**9**
12	Existing Wall Removal and Natural Channel Development at Station 28+60 to 29+40	5	1	**6**	5	5	**10**	5	**10**	5	**10**	**8.80**	**2**
13	Right and Left Bank Riparian Habitat Enhancement at Station 29+40 to 31+50	1	1	**2**	5	5	**10**	3	**6**	4	**8**	**6.00**	**13**
14	Ilwaco Avenue Private Bridge Replacement or Removal	4	5	**9**	5	5	**10**	4	**8**	5	**10**	**9.30**	**1**
15	Bank Stabilization Treatment at Station 31+90 to 32+80	2	3	**5**	3	5	**8**	3	**6**	3	**6**	**5.90**	**14**
16	Weir Removal and Bank Stabilization Treatment at Station 33+20 to 35+10	1	2	**3**	4	5	**9**	3	**6**	3	**6**	**5.40**	**15**
17	Channel Realignment at Station 32+00 to 36+20	1	3	**4**	5	5	**10**	5	**10**	5	**10**	**8.20**	**3**
18	Channel Improvements at Station 36+20 to 38+40	2	4	**6**	4	5	**9**	3	**6**	4	**8**	**7.10**	**7**
19	Channel Realignment at Station 36+20 to 38+40	2	4	**6**	5	5	**10**	5	**10**	5	**10**	**8.80**	**2**
20	Bank Stabilization Treatment at Station 38+40 to 40+00	3	3	**6**	4	5	**9**	3	**6**	3	**6**	**6.30**	**11**
21	Channel Realignment at Station 38+40 to 40+00	3	3	**6**	5	5	**10**	5	**10**	5	**10**	**8.80**	**2**
22	Lyons Avenue Private Bridge Replacement	3	3	**6**	5	5	**10**	3	**6**	4	**8**	**7.20**	**6**
23	Lyons Avenue Private Bridge Removal	3	3	**6**	5	5	**10**	3	**6**	5	**10**	**8.00**	**4**
24	Reach 4 Instream and Riparian Enhancement	1	3	**4**	5	4	**9**	4	**8**	4	**8**	**6.90**	**8**

APPENDIX C
DEPENDENT PROJECTS

DEPENDENT PROJECTS

The following list explains the relationships between all projects with dependencies. For a discussion of the implications of project dependencies to implementation, refer to Section 9.

Chosen Project	Dependent Project	Explanation
Project 8 – Left Bank Stabilization Treatment at Station 25+20 to 26+50	Project 9 is no longer applicable	Choosing this project implies the main channel will remain in its existing condition, therefore realignment of the channel (Project 9) is not possible.
Project 9 – Channel Realignment at Station 25+00 to 28+60	Project 8 is no longer applicable	Main channel will be realigned away from these locations; risk to property eliminated.
	Project 10 is no longer applicable	
Project 10 – Right Bank Stabilization Treatment at Station 27+50 to 28+60	Project 9 is no longer applicable	Choosing this project implies the main channel will remain in its existing condition, therefore realignment of the channel (Project 9) is not possible.
Project 11 – Bank Stabilization Treatment at Station 28+60 to 29+40	Project 12 is no longer applicable	Choosing this project implies acquisition of property (Project 12) is not possible.
Project 12 – Existing Wall Removal and Natural Channel Development at Station 28+60 to 29+40	Project 11 is no longer applicable	Dwelling and residents gone; risk to life and property is eliminated.
Project 14 – Ilwaco Avenue Private Bridge Replacement or Removal	Project 15 is required	Incision effects upstream may be increased, Project 15 will be required to mitigate risk to existing property.
Project 15 – Bank Stabilization Treatment at Station 31+90 to 32+80	Project 16 is required	Incision effects upstream may be increased, Project 16 will be required to mitigate risk to existing property.
	Project 17 is no longer applicable	Choosing this project implies the main channel will remain in its existing condition, therefore realignment of the channel (Project 17) is not possible.
Project 16 – Weir Removal and Bank Stabilization Treatment at Station 33+20 to 36+20	Project 18 is required	Incision effects upstream may be increased, Project 18 or 19 will be required to mitigate risk to existing property.
	Project 19 is required	
	Project 17 is no longer applicable	Choosing this project implies the main channel will remain in its existing condition, therefore realignment of the channel (Project 17) is not possible.
Project 17 – Channel Realignment at Station 32+00 to 36+20	Project 15 is no longer applicable	Main channel will be realigned away from these locations; risk to property eliminated.
	Project 16 is no longer applicable	
	Project 18 is required	Incision effects upstream may be increased, Project

	Project 19 is required	18 or 19 will be required to mitigate risk to existing property.
Project 18 – Channel Improvements at Station 36+20 to 38+40	Project 19 is no longer applicable	Choosing this project implies the main channel will remain in its existing condition, therefore realignment of the channel (Project 19) is not possible.
	Project 20 is required	Incision effects upstream may be increased, Project 20 or 21 will be required to mitigate risk to existing property.
	Project 21 is required	
Project 19 – Channel Realignment at Station 36+20 to 38+40	Project 18 is no longer applicable	Main channel will be realigned away from this location; risk to property eliminated.
	Project 20 is required	Incision effects upstream may be increased, Project 20 or 21 will be required to mitigate risk to existing property.
	Project 21 is required	
Project 20 – Bank Stabilization Treatment at Station 38+40 to 40+00	Project 21 is no longer applicable	Choosing this project implies the main channel will remain in its existing condition, therefore realignment of the channel (Project 21) is not possible.
	Project 22 is required	Incision effects upstream may be increased, Project 22 or 23 will be required to mitigate risk to existing property.
	Project 23 is required	
Project 21 – Channel Realignment at Station 38+40 to 40+00	Project 20 is no longer applicable	Main channel will be realigned away from this location; risk to property eliminated.
	Project 22 is required	Incision effects upstream may be increased, Project 22 or 23 will be required to mitigate risk to existing property.
	Project 23 is required	
	Project 24 is required	Realignment through Reach 4 tract will be required to tie into proposed realignment for Project 21.
Project 22 – Lyons Avenue Private Bridge Replacement	Project 23 is no longer applicable	Access to properties south of creek will be re-established by bridge replacement.
Project 23 – Lyons Avenue Private Bridge Removal	Project 22 is no longer applicable	Alternate access to properties south of creek will be established.
Project 24 – Reach 4 Instream and Riparian Enhancement	Project 21 is required	If the option to realign through the right floodplain is chosen, Project 21 will be required to tie into the downstream end of the realignment.