US Army Corps of Engineers ®
Portland District

Engineering Technical Appendix C

13 January 2014

Attachment 1 TSP Description

US Army Corps of Engineers ®
Portland District

Overview of TSP for Metro-Waterways GI

14 January 2014

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1 Introduction

The Portland District (CENWP) is preparing the Cedar Creek Waterway Restoration Project, Springfield, Oregon, Metro Waterways Study. This is a General Investigation (GI) Feasibility Study report produced in conjunction with the City of Springfield, Oregon, Lane County.

The PDT utilized the new 3x3x3 project management approach which emphasizes using existing data and risk informed decision making techniques (i.e. risk register and supplemented with project synopsis) to address the most important risk elements. This document identifies and outlines feasibility level design decisions made by the Portland District PDT.

1.1 Project Goals

The GI goals are summarized below. They provided focus for the analyses undertaken by the current PDT.

- **Goal #1,** Restore natural habitats along waterways, including main and side channel in-stream habitats, riparian, and wetland habitats and their ecological functions.
- **Goal #2,** Restore access to quality habitat, including removing barriers and improving connectivity, and increasing habitat quantity for species including wet prairie species and juvenile salmonids.
- **Goal #3,** Restore quality places for public use and community development by restoring waterway corridors.

1.2 Project Objectives

This study is intended to guide ecosystem restoration in the Cedar Creek watershed. The alternatives are intended to respond to limiting factors impacting 'species of significance' and their habitats. The restoration alternatives embodied by the TSP and ultimately the National Ecosystem Restoration (NER) plan are intended to provide clear, concise, relevant and sustainable ecological lift benefits under future conditions.

The planning horizon for each project is the 50-year planning horizon. However the final GI's NER plan elements (alternatives) will likely be constructed many years from now (10-20 years for example).

The approach taken by the current PDT was to identify the best measures starting with what had been proposed before and to identify additional opportunities for further maximization of ecosystem function. The PDT proceeded cognizant of the earlier identified deficiencies (e.g. ATR).

TSP alternative feasibility was gauged by how well they could meet the following objectives.

1. Improve overall riparian and aquatic ecological functions.
2. Improve general ecosystem function to Cedar Creek reaches.
3. Restore natural habitats along waterways, including main and side channel aquatic habitats, riparian, and wetland habitats, etc.
4. Protect and restore water resources through reducing erosion, restoring channel complexity, increasing aquatic and riparian vegetation diversity.
5. Protect water quality (minimize sediment buildup and high and temperatures, etc)
6. Minimize adverse impacts to the environment and cultural resources.
7. Maintain existing flood capacity.
8. Not induce flooding from project actions.
9. Do not transfer risks downstream or upstream from project actions.
10. Protect private ownership rights and not adversely impacted.
11. Comply with relevant City, State and Federal regulations. This includes state and Federal floodplain ordinances (i.e. FEMA Special flood hazard areas).
12. Restore quality places for public use and community development by enhancing waterway corridors.
13. Maintain (where feasible) recreation activities and access. (within the constraint of 10% of the overall project cost).

1.3 Technical Analysis Focus

The primary technical (engineering) objectives were to:

1) Provide engineering sufficient to ensure that potential life risk or damage to property issues have been identified/defined and if necessary, qualitatively and quantitatively addressed under the feasibility study.
2) Provide engineering sufficient to support cost determination, reduce the level of uncertainty so that a corresponding reduction in (cost) contingency may be achieved.
3) Provide engineering sufficient to support the needs of the habitat benefit analyses.

1.4 Sources of Technical Information

Existing hydrologic and hydraulic data were available and were used to determine functional design requirements for the TSP alternatives.

The 1999 *Lane County Flood Insurance Study* (FIS) was used as a source for 10, 50 and 100-year peak flows, regulated FEMA floodplain/floodways.

Existing geotechnical and geological reports, water logs and general soil studies were used to identify surface and subsurface characteristics. Historical topographic maps and aerial photographs were used to indicate where fill and cut had taken place, for example for features such as drainage ditches, old log ponds had been subsequently filled in.

Identification of utilities was made during site visits as well as from existing documentation such as the storm water master plans, etc. The PDT was limited by time and costs constraints; however, initial investigations did not identify insurmountable utility issue. However, this will be an area where PED PDT will need to verify and further identify potential utility conflicts.

The previous MCASES cost estimate and supporting summary documents/files were available. The documents were last updated in 2007 and the PDT updated for current year costs (2012) and updated quantities, for the final TSP cost estimate. The data from the previous efforts was used as a starting point as well as source for how previous quantities were estimated and cost out.

Additional alternative details are found in the December 2012 review draft feasibility document. A summary of the flow rates used in the analysis of the various reaches is provided as *Attachment 1* to the H&H portion of the technical appendix.

1.5 Technical Design Criteria:

Design criteria were necessary for sizing potential management measures (e.g. channels, culverts, etc) at each alternative site location.

The hydraulic design event for most channels, cross structures and other hydraulic facilities was the 4% AEP (25-year peak flow). This was pursuant to existing City Springfield Public Works criteria.

The design event for drainage facilities in FEMA designated regulatory floodplains and floodways, applicable for Special Flood Hazard Areas (SHAs), was the 1% chance flood (100-year) event as determined by FEMA and regulated through the National Flood Insurance Program participating community, Lane County.

The existing channels are trapezoidal in shape. For cost estimation and analysis purposes, trapezoidal channels were used. PED will further detail out the optimum configuration. Configurations are given in Appendix C technical appendix.

1.6 Types of Technical Analysis Performed

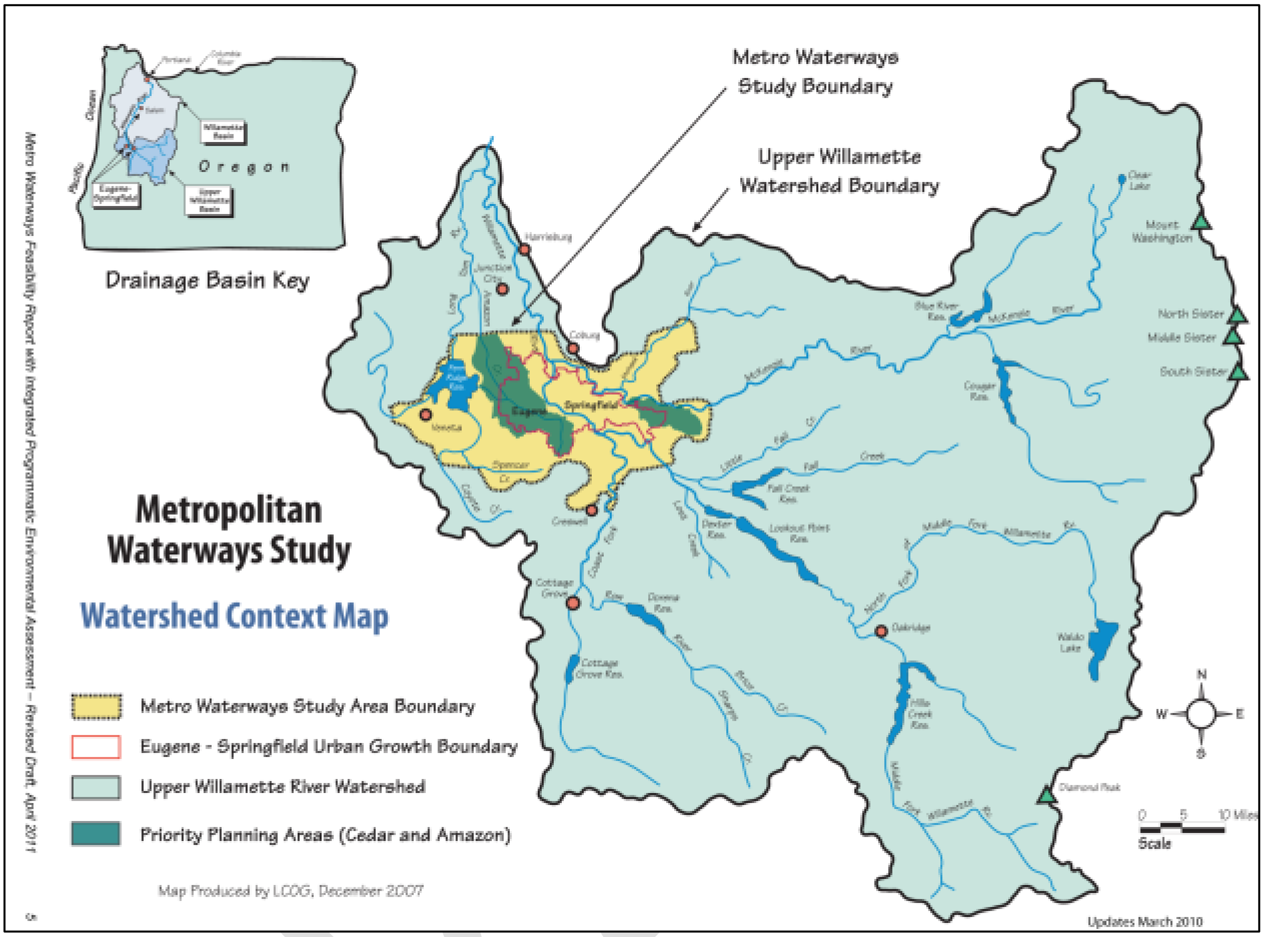
The study team used existing flow and hydraulic modeling data to make qualitative as well as quantitative assessments of technical risks (induced flooding, transferred risk and life risk, etc), to support cost estimating and to support environmental habitat benefit modeling (e.g. HEP/HSI). The PDT did not have sufficient cross sections, invert and structure sizes, etc to perform the normal level of detail analysis. In general approximate methods such as normal depth analysis were used to estimate the approximate sizes of proposed features (channels etc), to verify capacities' and provide justification for feature configurations and to inform cost and cost contingency estimation.

Previously, H&H was not performed to support habitat lift modeling and determination. Normally, hydraulic modeling parameters such as flow depth, velocity and duration frequency are used as inputs into this type of environmental analyses (e.g. HEP/HSI).

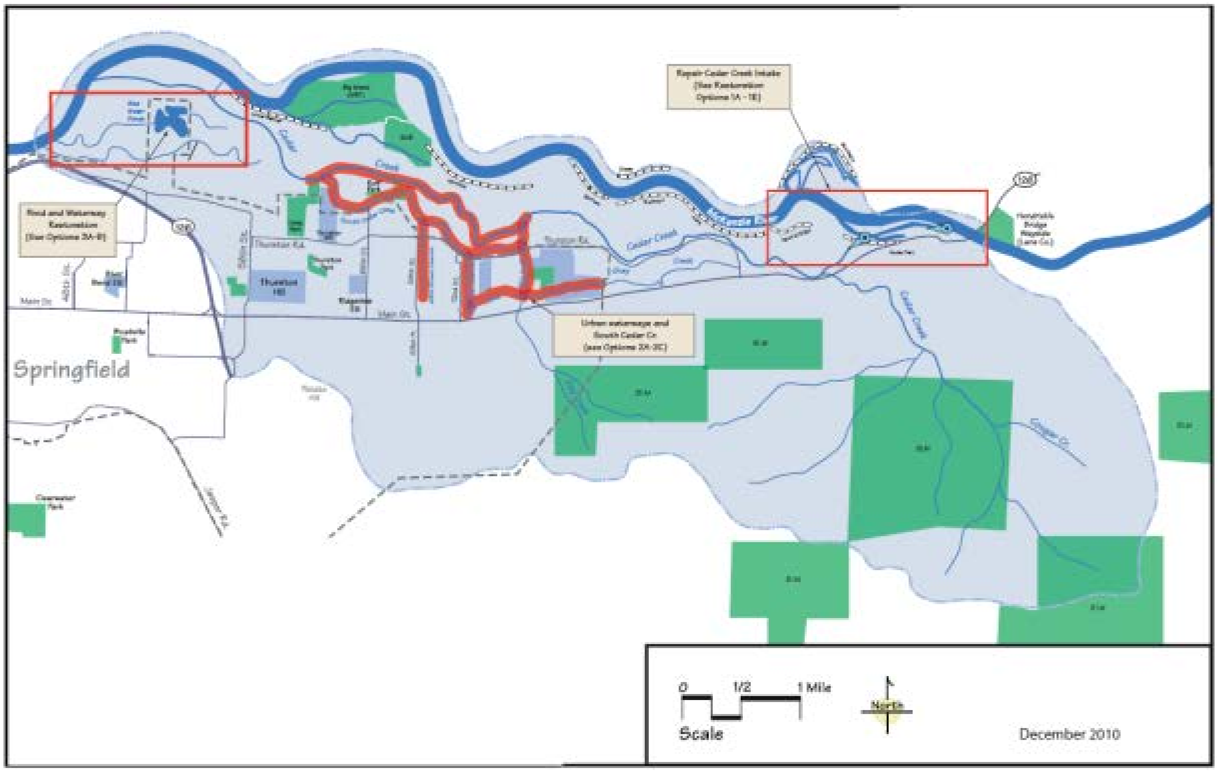
As part of the current update, the PDT coordinated with USACE PCX to validate the previous habitat benefit modeling, The Watersheds Assessment Model (WAM). The study team compared and contrasted Cedar Creek Reach 3. The models provided similar results and PCX gave a conditional use for the WAM model. Therefore, WAM results were used as part of the update efforts and minimal additional H&H input was used. HEC-RAS was used in a limited capacity to support the habitat modeling comparisons. Its value was limited to overall usage by the low resolution of detail outside of Cedar Creek itself.

1.7 Study Location

The study location is shown in the figure below. The TSP is composed of Cedar Creek; the reach/options are 1E, 2B and 3B. See the following figures for graphical summaries of the alternative locations.



Study Area Watershed Map

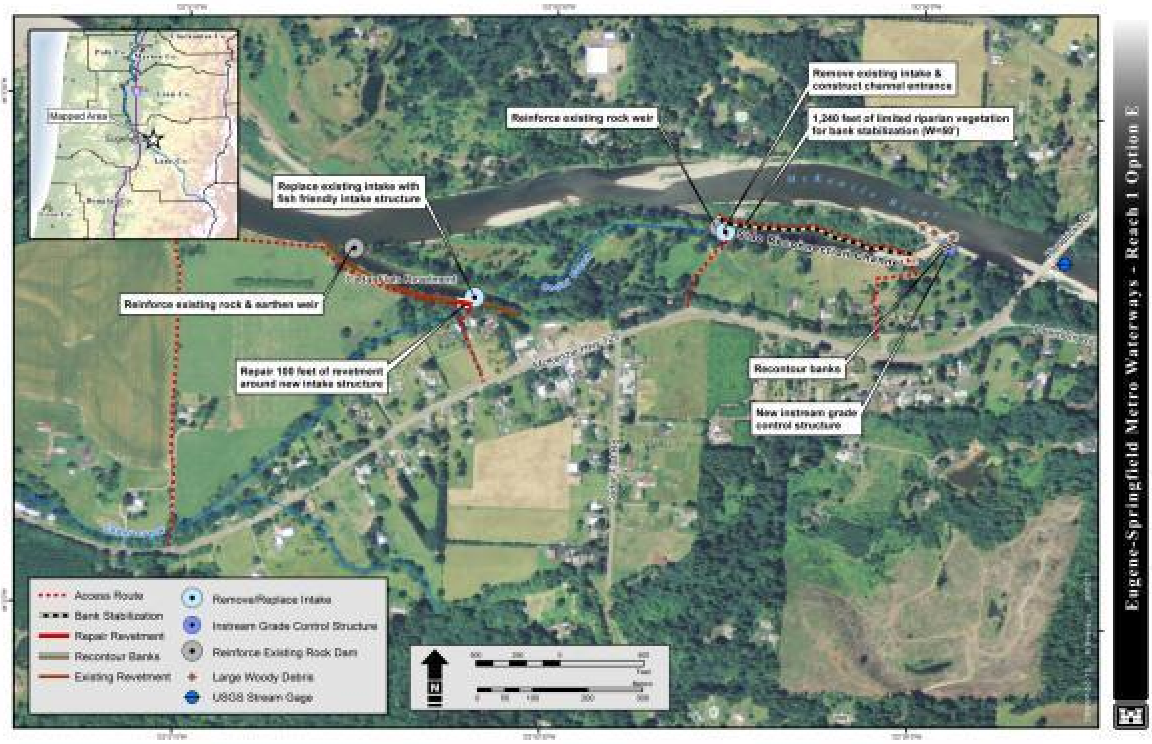


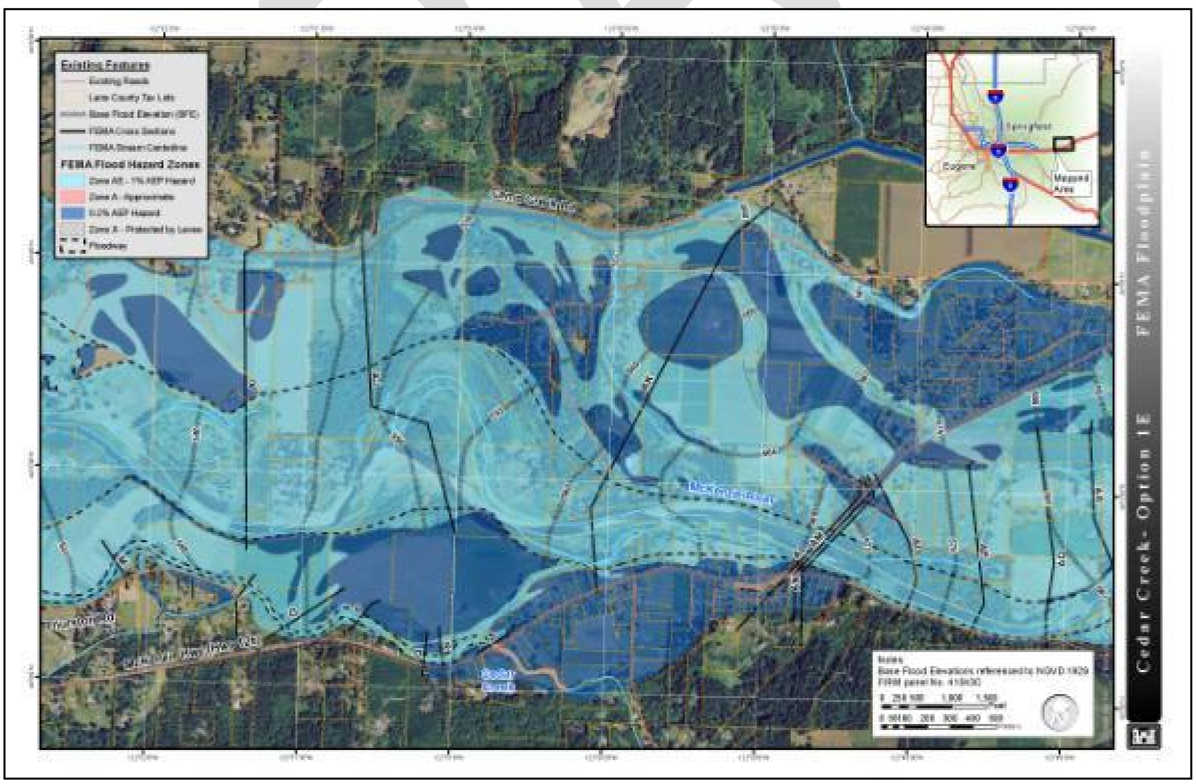
Cedar Creek TSP Sites

2 TSP Alternatives Overview

The following sections summarize reach alternatives composing the tentatively selected plans, the issues and preliminary assessments.

2.1 Cedar Creek Reach 1





2.1.1 Overview

- This alternative impacts the upper reach of Cedar Creek.
- See map for feature details and preliminary sizes.
- Reach 1 Cedar Creek is a part of the McKenzie River 100/500-year floodplains. Reach 1 Cedar Creek runs parallel to the McKenzie River from approximately river mile, RM 22.3 to RM 24,Highway 126, Hendricks Bridge. The reach alternative begins upstream of the existing Cedar Creek intake structure and passes through the Cedar Flat revetment.
- It is anticipated that flows will be diverted from the McKenzie River into Cedar Creek to meet irrigation, groundwater recharge, and fish habitat so that summer time flows range between 10.0 and 15.0 cfs. This action shall be coordinated closely with the Sponsor and regulating agencies.
- A diversion of up to 40 cfs is recommended during periods of the winter to help clean out the channel and create better habitat features (pools and riffles). This segment of Cedar Creek is part of the DCH for Spring Chinook salmon.
- It is understood that a limiting wintertime flow into Cedar Creek is 250 cfs.
- This alternative includes, utilizing an existing McKenzie River side channel to divert flow into Cedar Creek from a point along the river that is more geologically stable (approximately 1,400 feet upstream from the current intake) and to create a fish friendly open water connection between Cedar Creek and the McKenzie River.
- Replace the non-functioning water intake structure constructed in 1964 with a channel bank opening allowing free access between the side connection channel and upstream Cedar Creek.
- Bolster and existing rock berm in the downstream end of the side connection channel with additional riprap.
- Provide tree sappling and shrub vegetation on the south side of the existing gravel bar island, to stabilize the banks and provide added protection against bank erosions observed in the area.
- Remove and replace the existing 4-30-inch pipe culvert, headwall and trash rack on the Cedar Flat revetment with a fish friendly squash/elliptical culvert. The structure will be designed to convey up to 40 cfs. The bottom of the culvert will be natural river rock, etc. The preliminary size of the proposed structure is a 57x38 inch cmpa. A wooden trash rack (composed of interwoven wood piles) which is fish friendly is proposed to reduce the potential of debris accumulation and to reduce O&M.

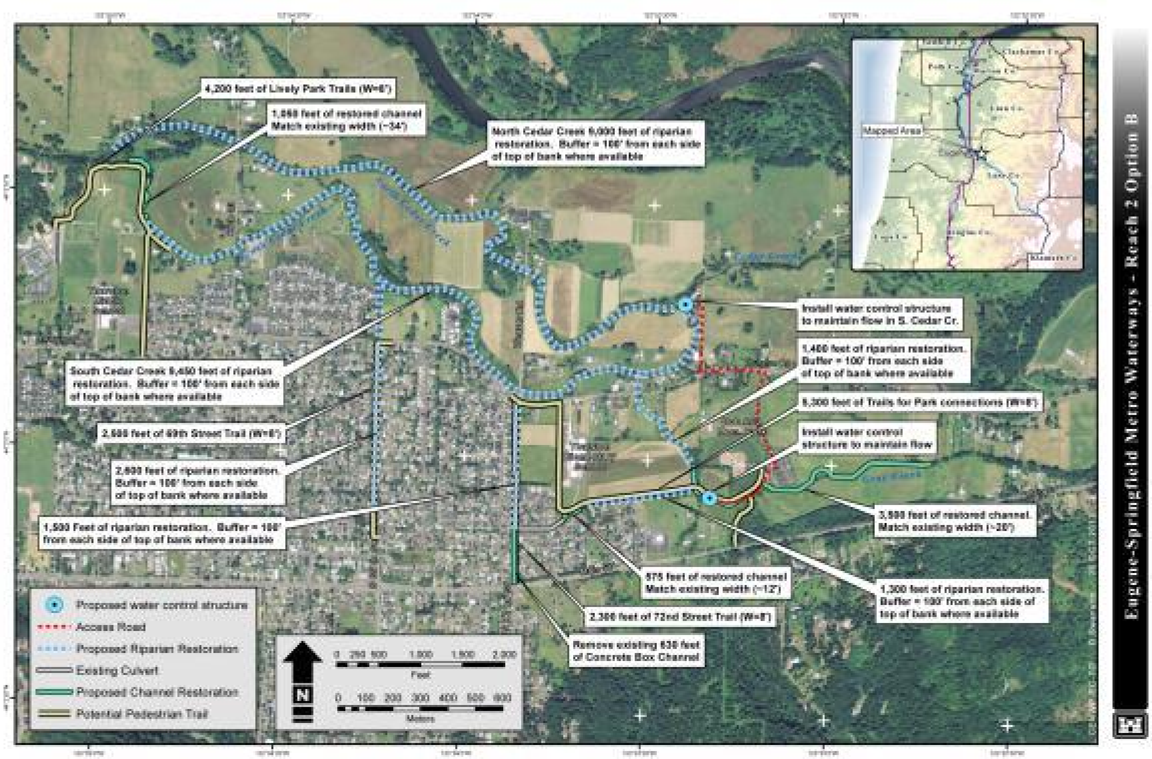
2.1.2 Reach Issues and Constraints

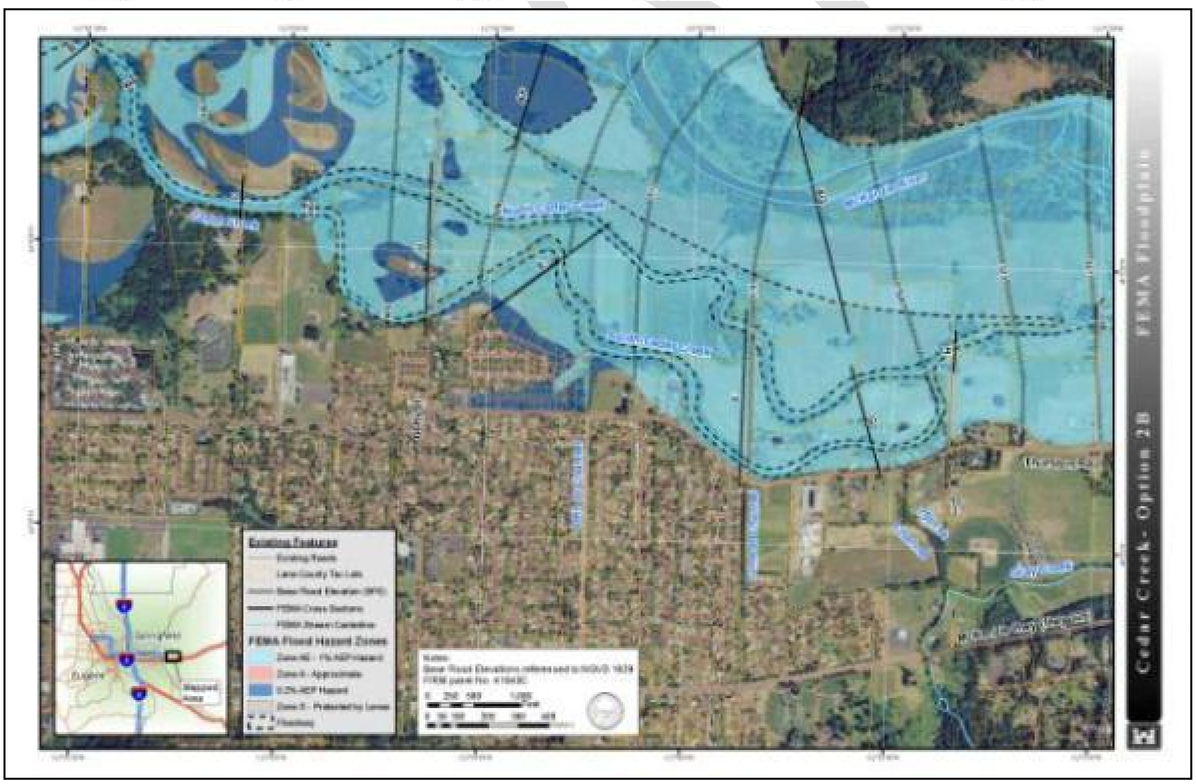
- Do not adversely impact the existing FEMA regulated floodplain.
- Do not cause induced flooding or transfer the risks upstream or downstream.
- Make sure replacement in river connecting structures are fish friendly.
- Need to make sure waters are cool enough especially in areas on Cedar where there are wide open and uncovered.
- May need groundwater analysis for the diversion at Hendricks Bridge.
- Account for ground water losses/seepage in the McKenzie side channel.
- Do not adversely affect the existing revetments.
- Do not adversely impacts to water rights.
- Characterize the headcut issue further and insure it does not become a 'no go' issue.
- Ensure that the diversion of additional flows into the Cedar Creek areas do not cause induced flooding or life risk issues.
- Will the proposed measures promote trapping/take issues for salmonids?

2.1.3 Preliminary Determinations and Recommendations

- Overall there were no indentified issues that would make the proposed management measures at this site, unfeasible moving into PED.
- FEMA and Lane County floodplain ordinances should be followed during PED. It is likely that a CLOMR/LOMR will be required during PED stage.
- The possibility of heightened risk for flooding due to diversion of flows (15-40 cfs) into Cedar Creek is considered minimal because 1) the flow increase is small relative to 100-year event, about 40 cfs compared to 980 cfs (at the upstream most section of Cedar Creek, e.g. Hendricks Bridge). 2) The proposed diversion structures will have headgates providing hydraulic metering control. This configuration will not allow an increase in flows to enter Cedar Creek areas relative to existing conditions.
- It was understood that the 2009 STEP ODFW programmatic application for Cedar Creek allows a minimum of 10 cfs to be withdrawn, May-Oct, plus 5.29 cfs as part of the water right, for a total minimum flow of 15.29 cfs. Based on discussions with LCOG, there very little if any risk of insufficient water (rights), however, because this issue has been evolving, not all of the information has been available. Documentation of this understanding should be performed at latest during Preconstruction Engineering and Design phase of the project, and at the end of Feasibility if possible.
- The headcut located at approximately RM 23.5 was recently evaluated for impact to the proposed diversion intake. It was determined that if the river continues to headcut, there would be adequate elevation drop to continue to provide water during summer flows into the diversion channel below the first headgate. The proposed intake installation below Hendricks Bridge in the bottom of the river should function into the future even with the headcut situation as noted.
- The intention is that the proposed intakes be fish friendly. The exact configurations will be determined at PED. The current PDT did not identify issues impact the feasibility of fish friendly passage.
- Temperature data was gathered during the current PDT efforts. The data shows that introduction of McKenzie flows will likely ameliorate some of the elevated temperatures currently experienced in Cedar Cree. The proposed measures will not worsen WQ/temperature conditions.
- Groundwater analysis may be warranted during PED.
- The proposed measures will necessitate penetration of the Cedar Flat revetment. Local restoration of the impact point will be designed during PED. Estimate for costing purposes was about 50 feet of repair, replace and tie-in to the existing revetment, either side of the penetration.
- The Hart revetment was recommended for some repair/replacement under the current TSP alternative. The amount was about 210 feet of revetment length. Quantities and detail will be further evaluated at PED.

2.2 Cedar Creek Reach 2





2.2.1 Features

- This alternative impacts the middle reach of Cedar Creek.
- See map for feature details and preliminary sizes.
- Reach 2 is characterized as an urban waterway. It impacts the north and south Cedar Creek branches, 69th and 72nd Street Channels, Gray Creek, Gay Creeks.
- This alternative includes flow control structures installed where South and North Cedar Creek split in order to permanently maintain flow in South Cedar Creek and riparian restoration along South Cedar Creek. These improvements shall benefit Spring Chinook salmon habitat DCH. Channel restoration adjacent to middle school; conversion of 69th Street Channel to a low flow channel to improve aquatic habitat; riparian restoration and removal of concrete channel segment on 72nd Street Channel and riparian restoration; day-lighting and channel restoration along Gray Creek to improve aquatic habitat; recreational trail along many of the waterways.

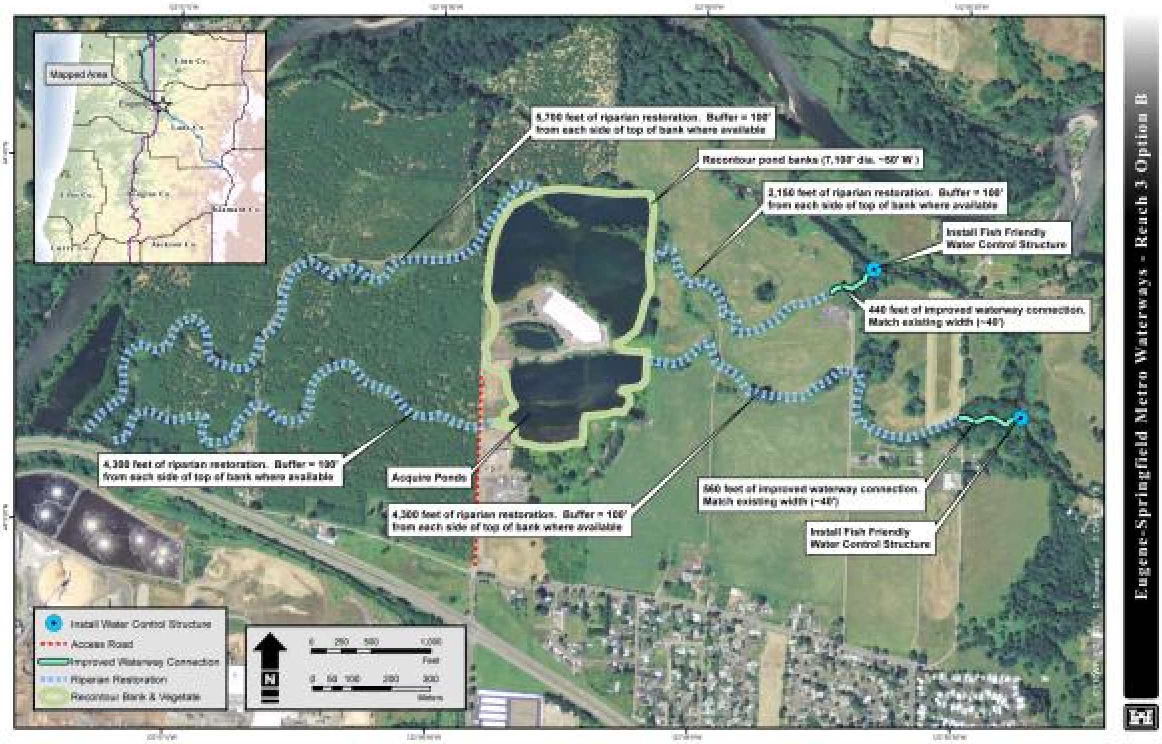
2.2.2 Reach Issues and Constraints

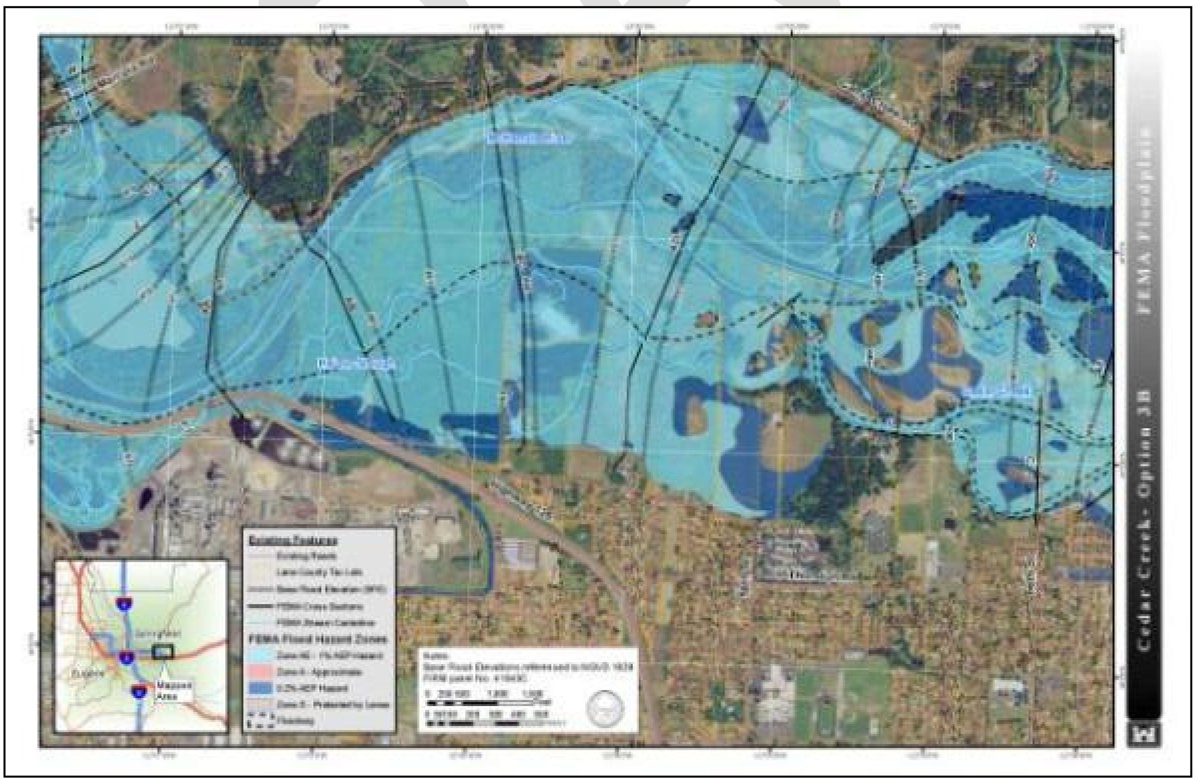
- Do not adversely impact the existing FEMA regulated floodplain.
- Do not cause induced flooding or transfer the risks upstream or downstream.
- There is an existing HEC-RAS model in Cedar Creek. It was used for Cedar Creek Reach 3 PCX habitat model comparison analysis. However, it did not include the sub reaches such as Gray and the street channels. The existing hydrology and hydraulic models were insufficient for accurate flood impact determinations. Qualitative and approximate methods were used in lieu of this data/model gap.

2.2.3 Preliminary Determinations and Recommendations

- Overall there were no indentified issues that would make the proposed management measures at this site, unfeasible moving into PED.
- FEMA and Lane County floodplain ordinances should be followed during PED. It is likely that a CLOMR/LOMR will be required during PED stage.
- The diversion of flow back into the 75th Street Channel was included under the TSP. The potential for flood risk was considered high, as the previous alignment had 75thth Street tie-in to south Cedar Creek, at a right angle and through existing dwellings.
- The 75th Avenue alignment options was reevaluated and it was determined that there is an alignment option near the dwelling that would need additional protection (e.g. increased berm height) but would potentially convey diverted flows around the dwelling into the south fork of Cedar Creek.

2.3 Cedar Creek Reach 3





2.3.1 Features

- This alternative impacts the lower reach of Cedar Creek.
- See map for feature details and preliminary sizes.
- Reach 2 is characterized as urban waterway. It is impacts north and south Cedar Creek branches, 69th and 72nd Street Channels, Gray Creek, Gay Creeks.
- This alternative includes re-contouring banks of ponds to create wetland/riparian habitat; diversion of flow from Cedar Creek to ponds restoring backwater channels for juvenile Chinook salmon and historically present Oregon chub; Western Pond Turtle (SOC) habitat restoration; riparian restoration along 14,000 lf of waterways; recreational access.

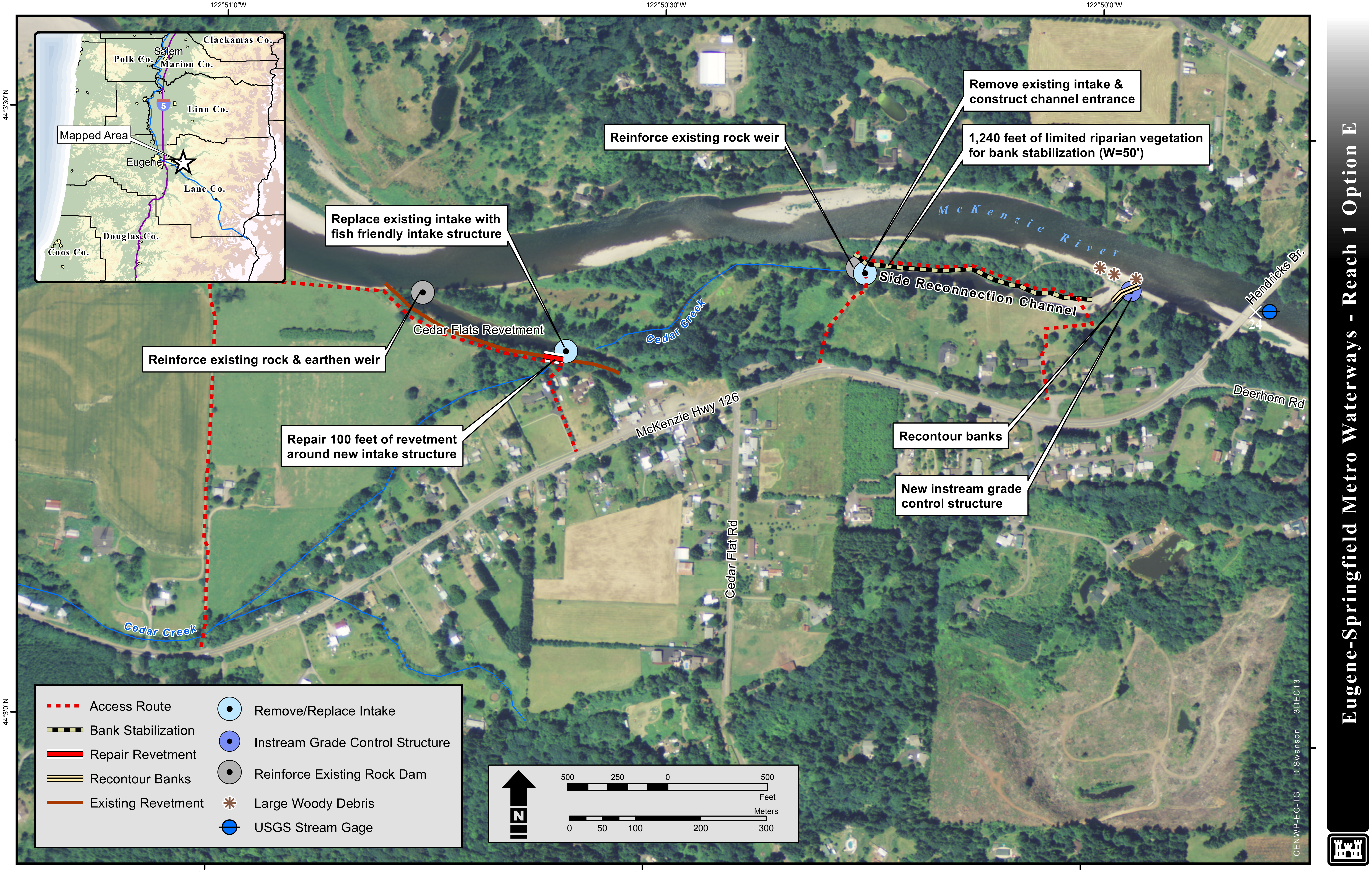
2.3.2 Reach Issues and Constraints

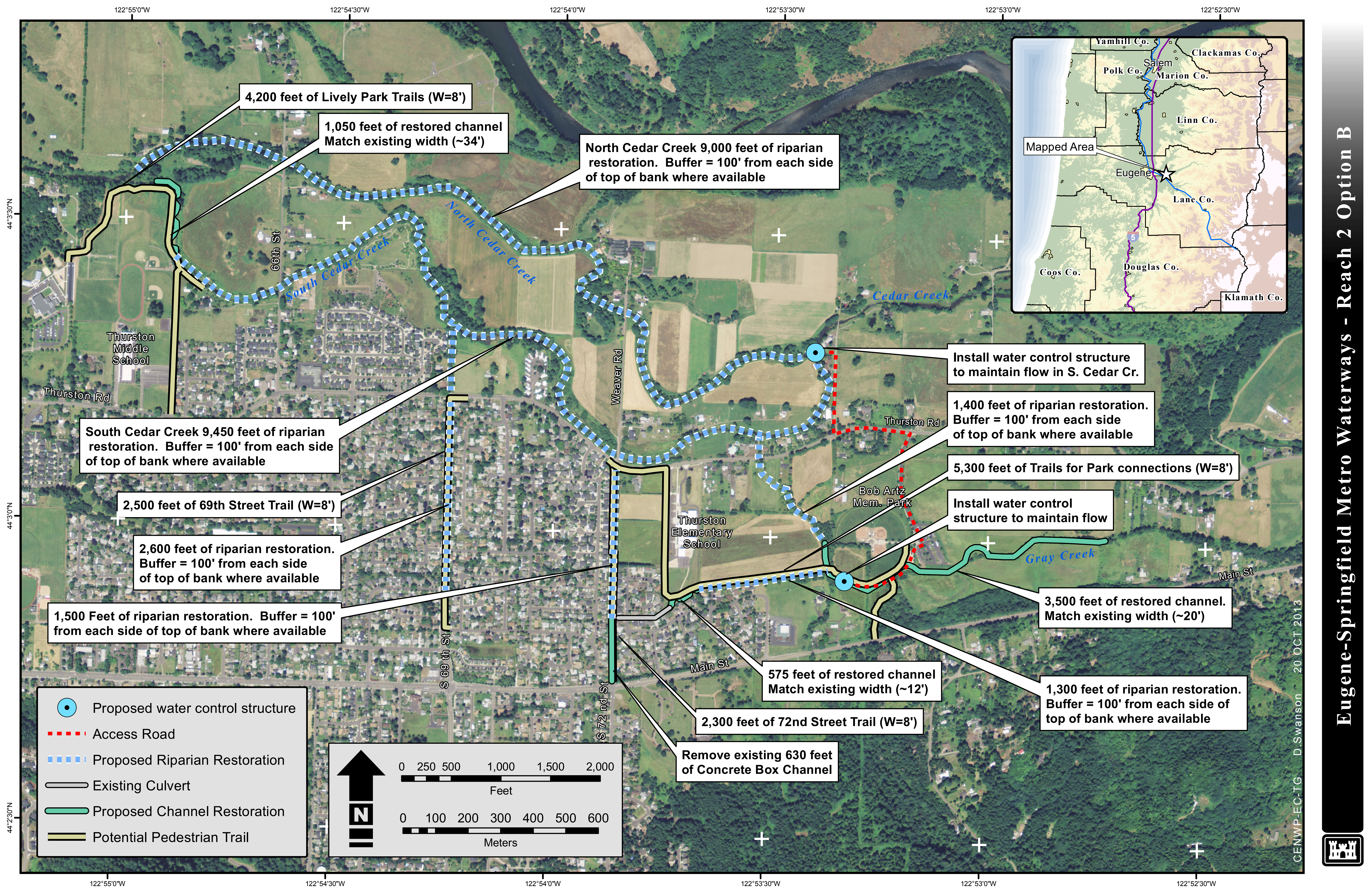
- Potential contamination at the existing ponds may preclude tying in surrounding channels.
- Do not adversely impact the existing FEMA regulated floodplain.
- Do not cause induced flooding or transfer the risks upstream or downstream.
- Do the existing waterways connecting to the ponds have sufficient cross section and overall capacity to provide the diverted flows to the ponds?

2.3.3 Preliminary Determinations and Recommendations

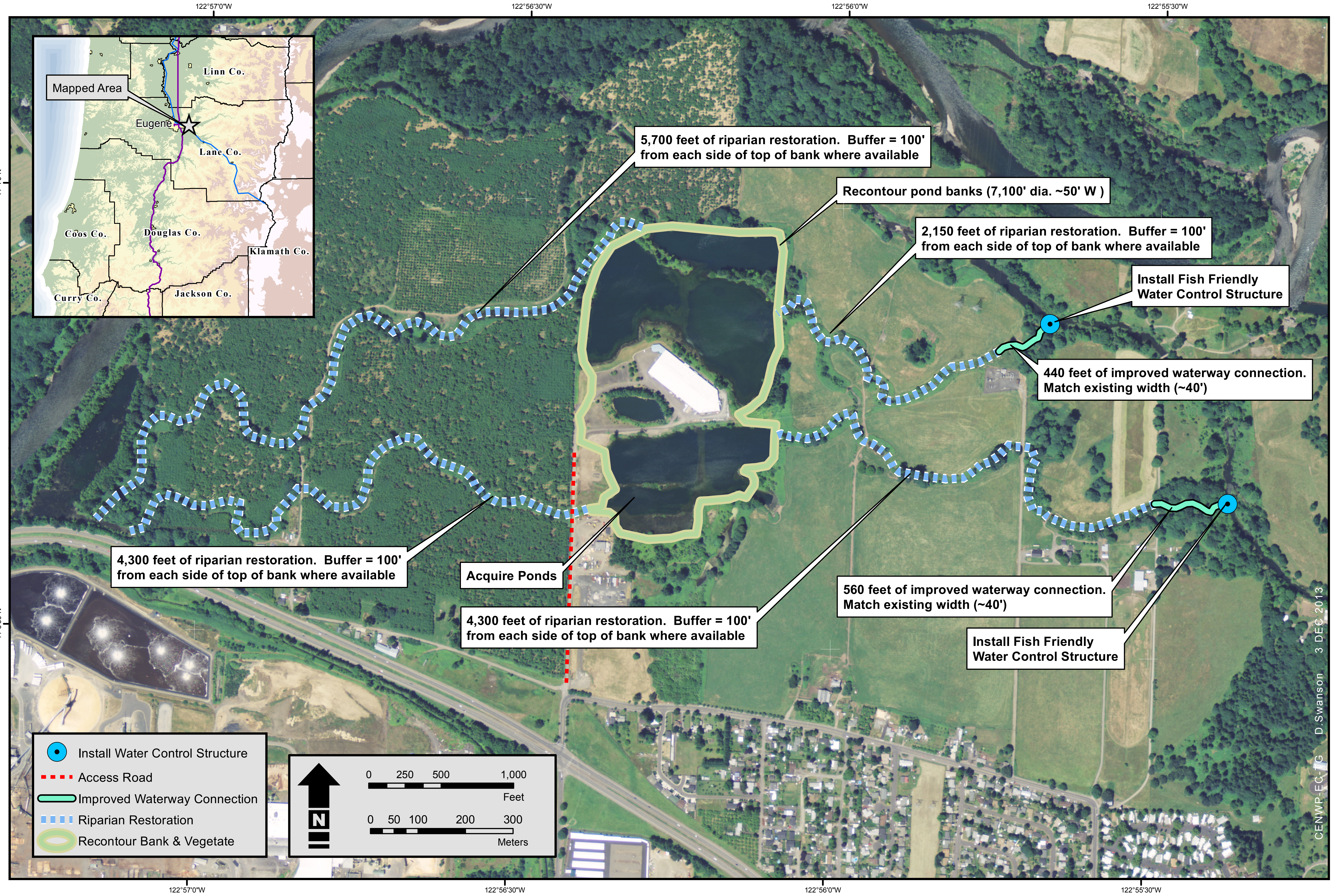
- Potential contamination at the Pond sites may change the preliminary recommendation as shown on the site schematic. This issue is being investigated by the PDT through a forthcoming HTWR report.
- FEMA and Lane County floodplain ordinances should be followed during PED. It is likely that a CLOMR/LOMR will be required during PED stage.
- Based verbal conversations with the Sponsor, it is believed that the sloughs will offer sufficient flow volume conveyance to the intended areas. However, there was no bathymetric data to confirm this. PED PDT will need to re-evaluate the existing condition of the sloughs more thoroughly.

Attachment 2 TSP Reach Plans


Eugene-Springfield Metro Waterways - Reach 1 Option E
Remove existing intake & construct channel entrance
Reinforce existing rock weir
1,240 feet of limited riparian vegetation for bank stabilization (W=50')
Replace existing intake with fish friendly intake structure
Reinforce existing rock & earthen weir
Repair 100 feet of revetment around new intake structure
Recontour banks
New instream grade control structure
McKenzie River
Side Reconnection Channel
Cedar Flats Revetment
Cedar Creek
Cedar Creek
McKenzie Hwy 126
Cedar Flat Rd
Deerhorn Rd
Hendricks Br.
Clackamas Co.
Salem
Polk Co.
Marion Co.
Linn Co.
Mapped Area
Eugene
Lane Co.
Douglas Co.
Coos Co.
5
Access Route
Bank Stabilization
Repair Revetment
Recontour Banks
Existing Revetment
Remove/Replace Intake
Instream Grade Control Structure
Reinforce Existing Rock Dam
Large Woody Debris
USGS Stream Gage
500 250 0 500
Feet
Meters
0 50 100 200 300
N
122°51'0"W
122°50'30"W
122°50'0"W
44°3'30"N
44°3'0"N
CENWP-EC-TG D.Swanson 3DEC13


Eugene-Springfield Metro Waterways - Reach 2 Option B
4,200 feet of Lively Park Trails (W=8')
1,050 feet of restored channel Match existing width (~34')
North Cedar Creek 9,000 feet of riparian restoration. Buffer = 100' from each side of top of bank where available
Install water control structure to maintain flow in S. Cedar Cr.
1,400 feet of riparian restoration. Buffer = 100' from each side of top of bank where available
5,300 feet of Trails for Park connections (W=8')
Install water control structure to maintain flow
3,500 feet of restored channel. Match existing width (~20')
1,300 feet of riparian restoration. Buffer = 100' from each side of top of bank where available
575 feet of restored channel Match existing width (~12')
2,300 feet of 72nd Street Trail (W=8')
Remove existing 630 feet of Concrete Box Channel
South Cedar Creek 9,450 feet of riparian restoration. Buffer = 100' from each side of top of bank where available
2,500 feet of 69th Street Trail (W=8')
2,600 feet of riparian restoration. Buffer = 100' from each side of top of bank where available
1,500 Feet of riparian restoration. Buffer = 100' from each side of top of bank where available
North Cedar Creek
South Cedar Creek
Cedar Creek
Gray Creek
Thurston Middle School
Thurston Elementary School
Bob Artz Mem. Park
Thurston Rd
Main St
Weaver Rd
66th St
S 69 th St
S 72 nd St
Yamhill Co.
Clackamas Co.
Polk Co.
Salem
Marion Co.
Linn Co.
Mapped Area
Eugene
Lane Co.
Coos Co.
Douglas Co.
Klamath Co.
Proposed water control structure
Access Road
Proposed Riparian Restoration
Existing Culvert
Proposed Channel Restoration
Potential Pedestrian Trail
0 250 500 1,000 1,500 2,000
Feet
0 100 200 300 400 500 600
Meters
N
122°55'0"W
122°54'30"W
122°54'0"W
122°53'30"W
122°53'0"W
122°52'30"W
44°3'30"N
44°3'0"N
44°2'30"N
D.Swanson 20 OCT 2013
CENWP-EC-TG

Eugene-Springfield Metro Waterways - Reach 3 Option B



Attachment 3

Technical Issues Overview

Metro-waterways Engineering Technical Appendix

Engineering Technical Issues Overview:

Issues discussed in this Engineering Technical Appendix pertain to the Tentatively Selected Plan (TSP) suite of alternatives (i.e. potential restoration sites and attendant management measures). The TSP is focused on Cedar Creek adjacent to the lower reach of the McKenzie River, in the town of Springfield, OR. It is bounded along its northern edge by the McKenzie River and starts from downstream of Hendricks Bridge, roughly river 8 miles (RM 16-24).

The primary engineering goals were to:

1) Provide engineering sufficient to ensure that potential life risk or damage to property issues have been identified/defined and if necessary, qualitatively and quantitatively addressed under the feasibility study.
2) Provide engineering sufficient to support cost determination, reduce the level of uncertainty so that a corresponding reduction in (cost) contingency may be achieved.
3) Provide engineering sufficient to support the needs of the habitat benefit analyses.

The TSP is composed of Cedar Creek reach options 1E, 2B and 3B. See the separate Engineering Technical Appendix sections as well as the main report for further detail on reach and option specifics.

Hydrology and Hydraulics

Cedar Creek is salmonid bearing and the focus aquatic restoration for the fish species. H&H supported efforts to assess and document the habit benefits associated with various alternatives.

The H&H analyses were performed to assess the potential for damage and life loss as well as to support derivation of quantities by providing H&H/engineering basis for sizing the drainage facilities and other restoration features. Quantitative and qualitative hydraulic analyses were performed to assess the potential for induced flooding and life loss, etc. There did not appear to be significant risk from this particular risk item, under the revised NER/TSP. Individual site alternatives were detailed out and options discussed as part of a separate Technical Appendix H&H section.

The design storm used for sizing flow conveyance features such as channels, culverts and other control structures was the 25-year, 4% chance storm. It was found that a significant number of channels already possessed excess capacity over the 25-year storm.

Reach alternatives located in the FEMA designated floodplains (Figure 4) were evaluated and designed to meet existing conveyance capacity (and flood protection) as documented in the most current Flood Insurance Study (i.e. flood tables and flood hazard area maps, etc.). No Cedar Creek reaches were identified as being impacted by the FEMA floodplain designations. Proposed flow changes in Cedar Creek do not impact the McKenzie River or Cedar Creek regulatory floodplains.

In Reach 1, the proposed flows into Cedar Creek from the McKenzie River near Hendricks Bridge (approximately RM 24.5), will be 10-15 cfs during the summertime and up to 40 cfs during the wintertime. Flow changes are seasonal and below the threshold of any FEMA floodplain impacts. The flows are accepted by City and the County as being beneficial to the ecosystem function and do not pose an adverse impact to the downstream properties.

In Reach 2, there are proposed flow diversions into the South Fork Cedar Creek and into the old 75^{th} Street channel which is currently cut off. The flow diversions are small and will not impact the 100-year FEMA regulatory floodplain. Diversions will match existing downstream conveyance capacity.

During the Preconstruction Engineering and Design (PED) phase the PDT may be required to complete no-rise certification to document that the proposed improvements to show that the actions do not negatively impact or affect the regulatory Floodway. Under the current TSP, no Alternatives were identified as requiring a no rise certification.

For environmental modeling purposes, mean monthly flows (e.g. summertime low flows) were used in hydraulic modeling (e.g. normal depth approximation or HEC-RAS). Hydraulic modeling generated flow velocities and depths used as input to HEP models (e.g. PCX validation of WAM benefits modeling). These flows were derived from existing data sources including the City of Springfield Stormwater Facilities Master Plan (prepared October 2008), flow gage records such as the USGS 14164700 CEDAR CREEK AT SPRINGFIELD, OR and USGS 14165500 MCKENZIE RIVER NEAR COBURG, OR.

Surveying, Mapping, and other Geospatial Data Requirements

Limited mapping and geospatial data were available to the PDT for the feasibility study update. However what was used had been provided by the Corps and the Sponsor, LCOG during earlier phases of the project. This included limited topographic mapping (contours), County assessor shape files, adobe publisher maps and schematics etc. The Corps provided LIDAR data collected by Watershed Sciences through a contract to collect high resolution topographic data with Oregon Department of Geology & Mineral Industries (DOGAMI). LiDAR coverage was data was collected between 28 September 2008 and 15 March 2009. Bare earth and highest hit data were delivered in ArcInfo Grid format with a 3 foot cell size.

For quantity takeoffs, GIS (ESRI ArcMap 10) and Google Earth were utilized for measuring purposed alternative measures and to assess current (and past) site conditions. Rough elevation data was taken off of USGS quad maps and/or from the survey information already supplied by the Sponsor. Some utilities were noted where possible, but most data was limited to surface and not subsurface utilities (see Utilities section below).

Geotechnical

Limited geotechnical information is available for all of the alternatives, and subsurface exploration and geotechnical testing and analysis will be required prior to final design. However, most of the proposed alterations involve grading operations, with few structural elements. Proposed structures are limited to generally lightly loaded water control gate structures and revetments; these structures can be incorporated into the existing project design and cost assumptions, even if difficult soil conditions are encountered.

A 1997 Phase 1 Environmental Site Assessment identified areas of concern in Cedar Creek Reach 3B around the Blue Ponds. There may be risk of contaminants on the Ballenger Property at the southwest part of the site. This property has used heavy equipment on site. They have been involved in providing logging equipment and other supplies. They have also performed truck repair and painting on site. The truck repair and painting operations could be a concern. The document suggests that the Ballenger Property poses a low risk to the northern part of the site, but does not address issues related to the southern pond and the southwest slough connection. These sites can also have areas of uncontrolled fill with variable permeability. Individual site alternatives were detailed out and options discussed as part of a separate Technical Appendix Geotechnical section.

Environmental Engineering

The intent of the alternatives is to utilize or reutilize as much naturally occurring materials as possible. Most of the proposed stream realignment improve or re-establish historic stream courses. The existing natural earthen material will be reused as backfill as much as possible to fill in decommissioned ditches, alter stream banks, or to construct berm features. Topsoil will be stripped and stockpiled for reuse as much as possible. Design elements will incorporate and blend in with existing topographic features as much as possible.

Utilities

Limited information is currently available related to utility locations and easements/right-of-ways. Real-estate surveys will need to be completed for each alternative to identify existing utility easements/right-of-ways and ownerships. Most project elements will be confined within and along existing stream channels and banks, where few if any existing utilities are anticipated. Existing utilities may be encountered where new stream alignment are proposed. Existing utilities will need to be relocated or abandoned, if possible. Where utility alignments cannot be altered, the utility line may need to be redesigned to allow for bridging across the new stream channel, or the project may need to be redesigned to accommodate the utility. The risk that the presence of utilities would require significant project redesign is considered low.

Civil Design

The alternatives were selected based on environmental and restoration criteria, with final selection incorporating cost factors. Civil design considerations were used during the initial alternative layout phase. The initial civil layout designs accounted for site topography, hydrology, biologic usages, and historic drainage patterns. Implementation and construction of the selected alternatives will require purchase of private properties. The designs require relocation of some facilities/utilities in some areas, including relocation of some water control gate structures and stream channels. As an example, in

Cedar Creek Reach 2B, a concrete box channel will be removed and restored to a more natural drainage channel. In addition, a buried culvert will be removed and replaced with an open stream channel.

Access Roads

Access roads will be required for all alternatives for staging and construction. No final access road designs or locations have been completed. It is anticipated that temporary access roads will be constructed through stripping of topsoil and placement and compaction of crushed rock fill (6 to 12 inches). Where soft soil conditions are present, thicker base rock and/or the use of geotextiles will be required. Access roads will connect into existing roads; all alternatives are within 1,000 feet of an existing road. Temporary access roads longer than 1,000 feet will be required for most alternatives to access all project site areas. It is anticipated that most or all of the temporary access roads will be removed and re vegetated following construction.

Hazardous and Toxic Materials

Many of the sites (Reach 1 and 2) are in areas of historic low density industrial development; most sites are in open field and stream environments with minimal historic human activity, other than agricultural activities. For these low density areas, the risk of encountering contaminated soils or groundwater is low.

However, Cedar Creek Reach 3B is in areas of historic industrial activity, and the risk of encountering contaminated soil or groundwater increase. A detailed review of potential contaminated sites for the entire project area has not been completed to date. A Phase I was performed by OMNICON in 1992. It found some potential for concern for contaminant impacts around the north blue pond in the vicinity of an existing fiberglass boat building There was some cause for about imported fill around the building and potential concern for a storm water point source emanating from the subject boat building facility. In 1997 a Phase II Environmental Site Assessments (sampling around the subject boat building) was completed by Bergeson-Boese and Associates, investigating these areas of concern. The sampling did not find any detectable VOCs or MRLs.

As described in the Geotech section above, there may be risk of contaminants on the Ballenger Property at the southwest part of the Blue Ponds site. These sites can also have areas of uncontrolled fill with variable permeability.

For this feasibility study the Corps has performed updated searches of relevant databases, historic aerial photograph review, and historic topographic map review indicate there is little potential for the presence of hazardous and toxic materials. Additional information regarding the four orphan sites listed indicates that they are of no risk to the project. No remediation is anticipated for the Blue Water Ponds area.

Structural Requirements

Some structural detail work may be required at PED in Cedar Creek where the existing intake structures (e.g. 4-30-inch pipe intake structure) are proposed to be removed and replaced by a 57x38 inch fish passable culvert (equivalent to a 48-inch pipe culvert for hydraulic capacity). Additionally detailed structural design will be required on 69th Street where it is intended to remove the existing RCBC and days light the channel. Therefore, there has not been structural involvement at this stage. However, it is likely that structures will become involved during the Preconstruction Engineering and Design stage.

Electrical and Mechanical Requirements

There is no significant or overly complex electrical/mechanical issue identified at this time. Therefore, there has not been involvement from this design discipline. However, it is likely that electrical and mechanical design sections will become involved during the Preconstruction Engineering and Design stage.

Cost Estimates

Cost estimates were updated with new quantity take offs and using revised rates appropriate for the new schedules. The current estimate incorporates the latest MII libraries available. Those include the 2010 National Labor Library (Seattle), 2010 English Cost Book for MII, and the 2009 Engineering Pamphlet Region 8 Equipment Ownership and Expense Schedule. No adjustments have been made using cost indices for out years for the work features within the various reaches since it is not known at this time which future year the construction activities will occur. As the designs are finalized, those costs will be adjusted to account for current cost and pricing. More information is provided as a separate cost section in the Engineering Technical Appendix.

Attachment 4 H&H

Attachment 4 H&H

H&H Overview

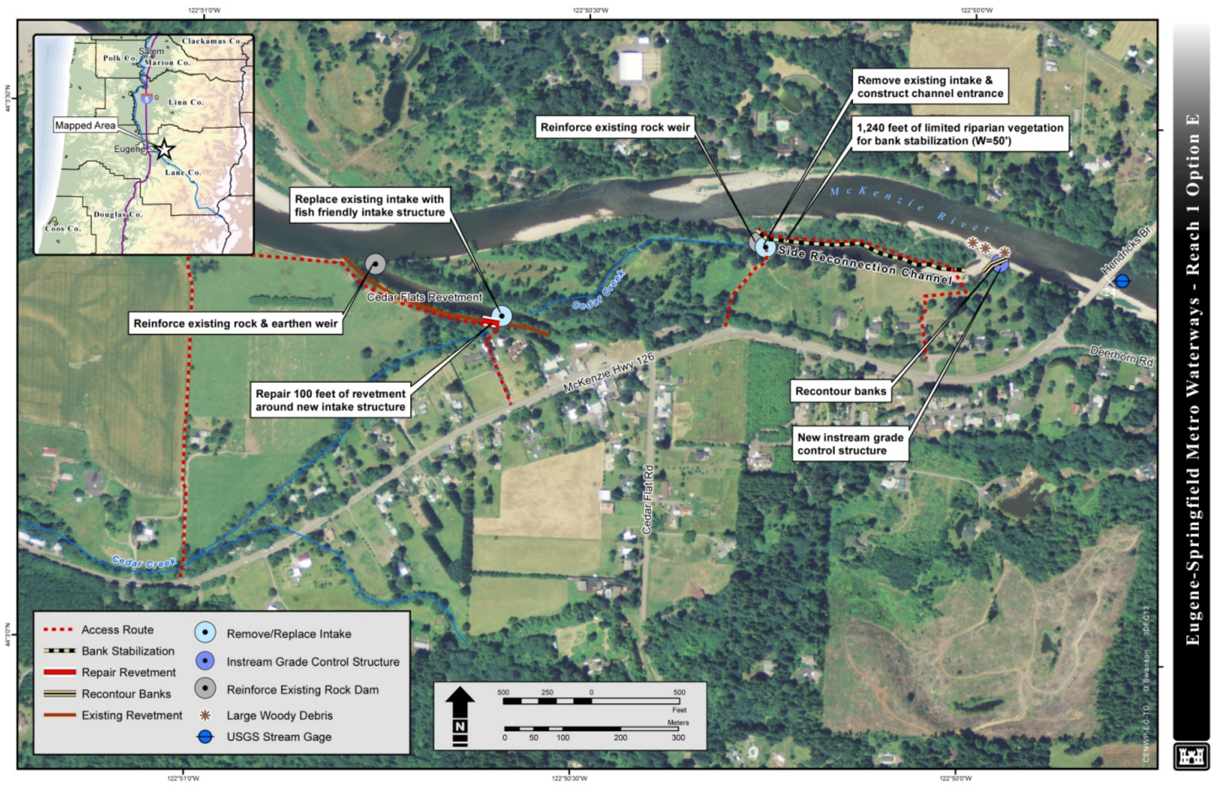
Cedar Creek, Reach 1 Option E: Hydrology and Hydraulics Summary Sheet

Alternative Reach and Option Overview:

Cedar Creek Reach 1 is located at the confluence of Cedar Creek where it connects with the McKenzie River (River mile, RM 24) just downstream from Hendrick's Bridge to RM 22.3 at the west terminus of the Hart revetment, and is outside of the City of Springfield's Urban Growth Boundary (UGB) in rural Lane County. Locating and installing reliable and sustainable new water supply intakes from the McKenzie River to Cedar Creek are the key issue for this reach. This segment of Cedar Creek is part of the DCH for Spring Chinook salmon.

Reach 1E Alternative Measures

R1E management measures include Utilize an existing McKenzie River side channel to divert flow into Cedar Creek from a point along the river that is more geologically stable (approximately 1,400 feet upstream from the current intake) and to create a fish friendly open water connection between Cedar Creek and the McKenzie River. The reconnection to McKenzie River during low flow periods will be accomplished by the removal of an existing headgate and pipe intake installed 1964 and replacing it with an engineered channel opening to facilitate fish ingress/egress and allow intake of summer inflows. Flows will be conveyed in the existing Cedar Creek channel to a slough adjacent to the Cedar Flat Revetment. The existing 4-30-inch diversion intake (installed circa 1914) will be replaced with a fish friendly passage tentatively selected as a 57x38 inch open bottom arch pipe. Flows will be supplied from the McKenzie River into Cedar Creek to improve fish habitat so that summer time flows range between 10.0 and 15.0 cfs. A diversion of up to 40 cfs is recommended by the Sponsor during periods of the winter to help clean out the channel and create better habitat features (pools and riffles). This segment of Cedar Creek is part of the DCH for Spring Chinook salmon. The 1E measures are shown below, the full suite of alternative measures for the TSP is provided as Attachment 5.



Goal of R1E Hydrology and Hydraulic Analyses

The goal of the hydrologic and hydraulic analysis was to determine adverse impacts (if any) associated with the proposed reach measure. 2) Feasibility level configuration of the (3) diversion and in stream connection structures (fish friendlyincluding provision for adequate fish egress/ingress, etc. Support the development of other quantity take offs and revision of the FS TSP cost estimate by providing a technical basis and facility configuration for proposed management measures.

Design Criteria:

The design flows for the Cedar Creek intakes were provided by Lane Council of Government, LCOG. The low range of flows was 10 to 15 cfs. The maximum flow to be passed by the intakes is 40 cfs. A diversion of up to 40 cfs was recommended during wintertime periods to help clean out the channel and create better habitat features (pools and riffles etc.).

Cedar Creek is in the regulatory floodplain. As such the proposed improvements in the regulatory floodplain cannot cause a net rise to the 1% chance flood (100-year) base flood elevation over 1 foot, and a zero rise certificate is required for fill being placed in the regulated floodway, as applicable for Special Flood Hazard Areas (SHAs) as determined by FEMA and regulated through the National Flood Insurance Program participating community, Lane County. A Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR) as required for final construction of the proposed features which alter the regulated floodplain in any way.

R1E Hydrologic and Hydraulic Methods

No new hydrology flows were determined as part of this revised feasibility report analysis. See "Source of Data" section for further information.

The Cedar Creek FEMA FIS 100-year flow is 980 cfs at Highway 126 (just upstream of the Hendricks Bridge intake).

The broad crested weir equation was used to make a preliminary estimate of the intake opening configurations. A weir coefficient of 3.65 was from Brater and King 6th Ed. Tables for the channel opening at the location of the existing 1964 intake.

The FHWA culvert hydraulics program HY-8 Version 7.2 (2009) was utilized for sizing fish passable culverts. It identified flow rates in and out of the culvert as well as expected velocities. Final analysis should be conducted at PED using update topographic information and other revised or new data.

Sources of Data

Existing hydrologic and hydraulic data were available and were used to determine functional design requirements for Alternative 1E, in particular the sizing of the intake structures along the McKenzie River.

The 1999 *Lane County Flood Insurance Study* (FIS) was used as a source for 100-year peak flow for Cedar Creek. Other return period frequencies were not estimated as part of the FIS.

A summary of the flow rates used in the analysis of the various reaches is provided as *Attachment 1* to the H&H portion of the technical appendix. The FIS floodplain boundaries were available and referenced as part of the analysis. *Attachment 2* shows existing condition flood mapping.

Configuration of Drainage Facilities

For cost estimating purposes, the configurations of the proposed in stream structures (e.g. fish friendly culverts) were estimated by a FHWA culvert hydraulics program and for channel openings, at the 1964 inlet point, by simple weir calculation. The weir length required to pass the 40 cfs peak design flow was estimated to be 34 feet with an allowable head of 2 foot driving flows upstream from the McKenzie River into the side connection channel. A low flow of 15 cfs would require a weir length of 16 feet at about 8 inches of head driving flows from the upstream side connection channel into Cedar Creek.

The headcut located at approximately RM 23.5

On November 9, 2012 the Cedar Creek Partnership held a meeting to discuss the McKenzie/Cedar Creek intake issues. This was documented in, "Summary of Discussion and Recommendations Regarding Potential Headgate Relocation". From the document, the Working Group determined that there is approximately 5.5 feet of elevation drop from Hendricks Bridge to the first headgate. It was determined that if river continues to headcut, there would be adequate elevation drop to continue to provide water during summer flows into the diversion channel below the first headgate. Karl Morgenstern (EWEB) and

Jeff Ziller (ODFW) suggested installation of an intake just below Hendricks Bridge in the bottom of the river, similar to what Weyerhaeuser used in its recent relocation of its diversion intake for its mill. This would entail a screened intake and a series of buried pipes that would water either the present side channel that feeds the first headgate, or directly feed the diversion channel immediately below the first headgate. The following figure shows graphically the intakes and elevations. The vertical datum was not defined.

The determination made above significantly lowers the risk of the headcut progressing upstream and negatively impacting the future function of the intakes. However, there is a need for the Preconstruction Engineering and Design (PED) PDT to validate assumptions and quantify design parameters through geomorphic and additional hydraulic analyses.


Proposed Dam - 552.0'
2nd Headgate - 30' Tubes - 551.4'
Headgate #1- 60" Tube - 552.9'
Present Intake - 557.0'
Proposed Intake - 558.6'
Cedar Flat Rd
Lupe Ln
126
McKenzie Hwy
Frontage Rd
Natures Garden St
Deerhorn Rd
Imagery Date: 8/18/2011
1994
© 2012 Google
Google earth
Eye alt 1.54 km

Resolving the dewatering of the diversion channel between the first and second headgates:

This section is taken from the Cedar Creek Partnership report referenced above. The foremost issue is the impact of the oxbow side channel in the immediate vicinity of the entrance of the diversion channel into the 2nd Headgates, an old side channel of the McKenzie exists. At certain flows this side channel acts like a bathtub, capturing water from the diversion channel and dewatering that channel. In the past, a berm has been constructed to reduce flow into the side channel and force water back into the diversion channel. This berm has proven to work to keep the flow into the 2nd Headgates, but has periodically been washed out by winter flows. Jeff Ziller suggested a two part solution to this problem:

1. Construct a permanent dam of heavy rip rap at the upstream end of the oxbow channel, just downstream of the 2nd Headgates. This could act like the previous berm to keep water in the diversion channel.
2. Remove the downstream end of the oxbow side channel and connect it back to the mainstem McKenzie River, converting this oxbow into an active side channel.

These measures are not currently part of Reach 1E suite of alternative measures. In water work (initial construction as well as associated O&M) may be an issue from the permitting perspective. Additionally the design criteria for the proposed arrangements were not defined, and the measures are likely susceptible from damage and washout occurring as a result high flow events (frequency indeterminate at this time). Reevaluation of these potential measures should be done at PED phase.

Long Term Sustainability of Measure Function

The long term concern to the project functioning into the future is the primary concern and most likely would be caused from potential changes to the McKenzie River channel alignment and profile caused by channel forming floods events. The risk from this potential action appear to be high (there is likely to a channel forming event that will change the channel). However, this is the general condition of the reach and stakeholders have performed O&M and built projects as response to the regular occurrences. This does not appear to be an insurmountable as long as the local stakeholders are comfortable with the risk. Indications are that they are.

The potential negative impact to habitat and function appears to be lessened based on the recent assessments by the Cedar Creek Partnership. However, there is a need to perform significant geomorphic and hydraulic analysis to better understand the headcut progression and bound the extent of the problem both now and likely future progression (ultimate impact at the site).

Induced Flood Risks and Other Hazards

The principal concern for 1E flood risk and life/property loss was the potential adverse impact due to flow diversion into Cedar Creek. Upon further inspection and analysis, it has been determined that the risk is low to none.

The existing intake and channel improvements will not adversely impact the FEMA regulated floodplain. The 100-year flow in Cedar Creek at the most upstream uptakes is 980 cfs (1895 cfs at the downstream confluence with McKenzie River) the additional of 40 cfs will not impact base flood elevation nor will it produce induced flooding.

For regular wintertime conditions, when the additional 40 cfs will be routed into Cedar Creek, the risk from flooding above the existing condition is further ameliorated by the inclusion of headgates which would be used to regulate the high flows above what is desirable to the properties along Cedar creek.

Adverse change to the water quality as a result of the 1E alternative measures was assessed to be unlikely. A more comprehensive assessment will likely be completed for Preconstruction Engineering and Design phase of the project.

Groundwater could be a potential issue at this location. A ground water analysis would benefit the understanding of the effect to water levels on the side channel. It is likely that there is need during the Preconstruction Engineering and Design phase of the project to undertake a more comprehensive groundwater analysis.

H&H for Habitat Benefit Analysis

Flow duration, velocity and depth information was not required for Reach 1E analysis. The WAM model results were found to be acceptable by USACE PCX.

However, such information as the flow duration information is generally used as input for habitat benefit, environmental modeling. However the Waterways Assessment Model (WAM) tool for habitat benefits determination did not require flow duration information. Therefore this was not developed for this analysis. It will likely be developed during PED.

Environmentally beneficial measures were considered (e.g. vegetative protection of banks, etc) in lieu of potential traditional practices, e.g. riprap revetment, etc. However, the intent was to use a method that would both meet environmental goals but not compromise on protection as measured against the design event, e.g. the 100 year velocities and other hydraulic forces.

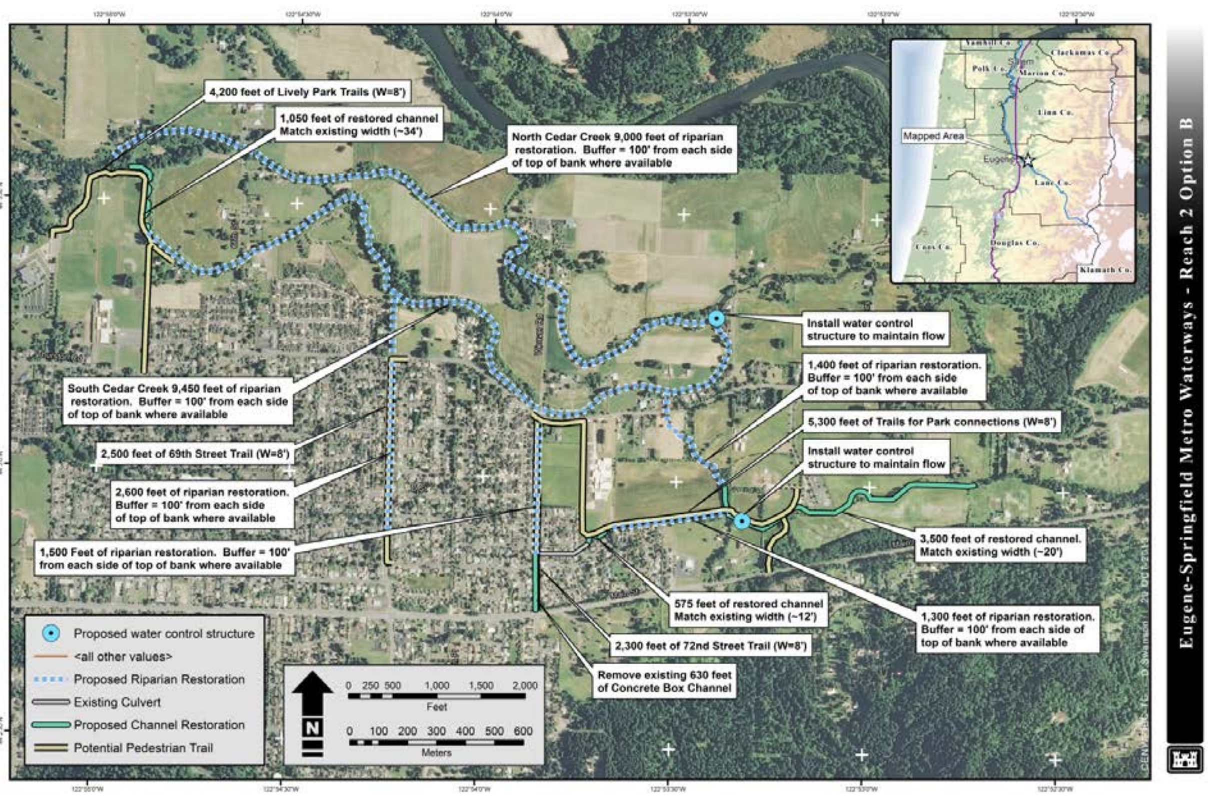
Cedar Creek, Reach 2 Option B: Hydrology and Hydraulics Summary Sheet

Alternative Reach and Option Overview:

Cedar Creek Reach 2 is located in the middle Cedar Creek floodplain. Reach 2 includes North and South Cedar Creeks, Gray Creek, Gay Creek, and the following urban waterway channels: 69th Street Channel, 72nd Street Channel, and the 75th Street Channel. The 69th Street Channel, the 72nd Street Channel, and a short segment of Gray Creek are located within the Springfield city limits in highly developed, urbanized areas where restoration potential is limited due to a relatively narrow riparian corridor. Improving aquatic and riparian habitats and providing public access to restored natural areas are the key issues of this reach. No water quality enhancements are included as part of the TSP.

Reach 2B Alternative Measures

Flow control structure installed where South and North Cedar Creek split to permanently maintain flow in South Cedar Creek and riparian restoration along South Cedar Creek to benefit Spring Chinook salmon habitat DCH. Channel restoration adjacent to middle school; conversion of 69th Street Channel to a low flow channel to improve aquatic habitat; riparian restoration and removal of concrete channel segment on 72nd Street Channel; diversion of flow back into the 75th Street Channel and riparian restoration; day-lighting and channel restoration along Gray Creek to improve aquatic habitat; recreational trail along many of the waterways. See below for schematic of Reach 2B features.



Goal of R2B Hydrology and Hydraulic Analyses

The goal of the hydrologic and hydraulic analysis was to determine adverse impacts (if any) associated with the proposed reach measures. 2) Support the development of other quantity take offs and revision of the FS TSP cost estimate by providing a technical basis and facility configuration for proposed management measures.

Design Criteria:

The design flows for the Cedar Creek intakes were provided by Lane Council of Government, LCOG. The low range of flows was 10 to 15 cfs. The maximum flow to be passed by the intakes is 40 cfs. A diversion of up to 40 cfs was recommended during wintertime periods to help clean out the channel and create better habitat features (pools and riffles etc.).

For feasibility phase channel sizing purposes it was assumed that the design high annual flow in Cedar creek would be 40 cfs (Reach 1 intake capacity) plus the mean monthly flow (January being the wettest month) as determined from the USGS 14164700 CEDAR CREEK AT SPRINGFIELD, OR flow gage.

The Cedar Creek is in the regulatory floodplain. As such the proposed improvements in the regulatory floodplain cannot cause a net rise to the 1% chance flood (100-year) base flood elevation over 1 foot, and a zero rise certificate is required for fill being placed in the regulated floodway, as applicable for Special Flood Hazard Areas (SHAs) as determined by FEMA and regulated through the National Flood Insurance Program participating community, Lane County. A Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR) as required for final construction of the proposed features which alter the regulated floodplain in any way.

R2B Hydrologic and Hydraulic Methods

No new hydrology flows were determined as part of this revised feasibility report analysis. See “Source of Data” section for further information.

Reach 2 Cedar Creek had limited existing condition flow rate information. The Period of record of flows for USGS 14164700 CEDAR CREEK AT SPRINGFIELD, OR was 2001-2011. There was no existing flow data on Gray Creek.

The diversion ratio between the north and south Cedar Creeks were assumed to be 50-50. Survey during PED may be performed to ascertain the existing split and match it unless there is an (habitat) advantage different one.

Normal depth hydraulic calculations were used to estimate the size of the South Cedar restored channel. A Manning’s n value of 0.045 and laid back side slopes of 4:1 were assumed. The final configuration will likely be adjusted by the PED PDT.

The proposed channel enhancements on Gray Creek (e.g. widening, riparian plantings, etc) were not evaluated hydraulically. The quantities used for cost estimation were estimated based on GIS measurements of the channel length and the top widths. The PED PDT will complete will likely conduct additional survey, collect additional hydrologic data and perform channel hydraulic calculations to verify the capacity of the channels with the proposed improvements in place.

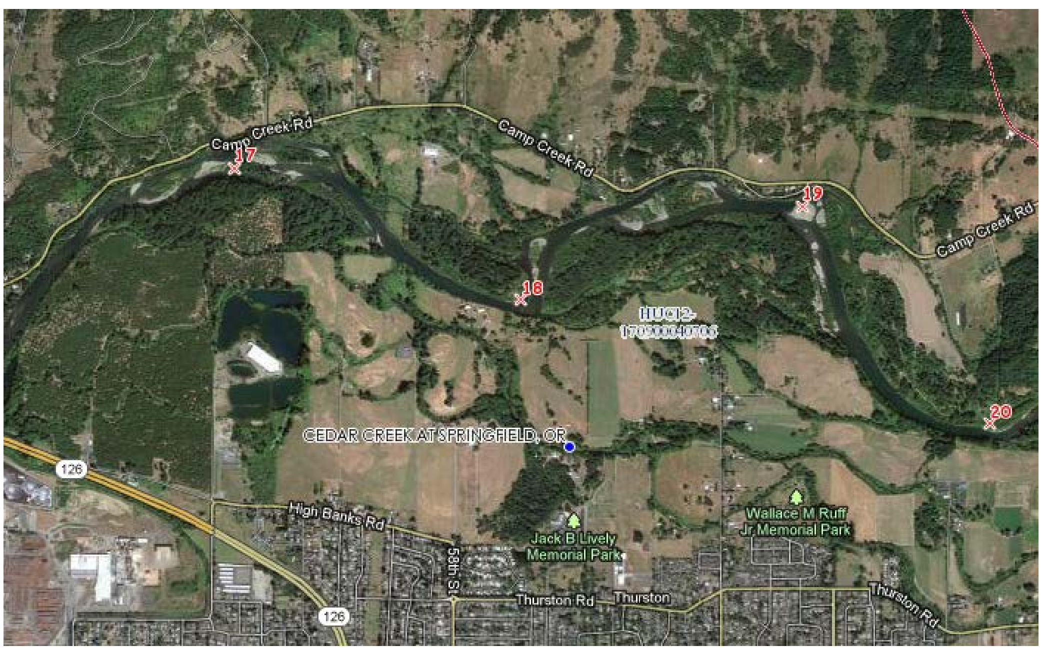
The Grays Creek/75th Street diversion was eliminated as a management measure for Reach 2. This left the only water control structure in Reach 2 being required for the Cedar Creek split. This was estimated by using the broad crested weir equation assuming Weir Breadth of 8 inches; Design Flow, with assumed 50-50 split, 40 cfs + 70 cfs (Jan mean flow) Q = 55 cfs and 1 foot allowable head (high). Final configuration will be determined at PED.

Sources of Data

Existing hydrologic and hydraulic data were available and were used to determine functional design requirements for Alternative 2B, in particular the sizing of Cedar Creek south branch channel.

The 1999 *Lane County Flood Insurance Study* (FIS) was used as a source for 100-year peak flow for Cedar Creek. Other return period frequencies were not estimated as part of the FIS.

USGS 14164700 CEDAR CREEK AT SPRINGFIELD, OR was used to some derive flow data in Cedar Creek. This gage is located coincident with McKenzie River mile 18 and downstream where the Cedar Creek branches recombine. The figure below shows the location of the USGS Cedar Creek at Springfield gage.



The mean monthly flows are shown in the table below.

YEAR	Monthly mean in cfs (Calculation Period: 2001-10-01 -> 2011-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001										16.5	43.1	67.4
2002	60.4	44.5	37.8	47.1	33.2	28.4	28.7	24.5	24.9	27.1	19.3	45.6

2003	53.6	47.7	46.2	58.8	30.3	17	21.7	30.3	28	16.7	17.5	93
2004	84.1	49.4	19.9	23.1	32	22.6	13.2	14.4	10.3	10.1	15.2	34.8
2005	11.6	15	28.6	42.2	47.6	19.4	13.4	9.21	9.58	8.65	19.9	63.2
2006	127	35.3	30.4	30.5	18.5	27	8.49	8.58	7.75	8.47	44	65.5
2007	57.8	45.4	39.7	22.9	14.5	7.39	3.8	8.52	6.91	11.6	27.2	43.3
2008	64.8	45.3	45.8	25	27.8	21.2	7.61	13.2	13.5	13	20.4	38.7
2009	51.7	18.3	33.5	23	28.5	18	7.69	12.5	13.2	12.4	31.8	23.6
2010	55	25.9	35.4	54.5	36.9	64.2	18.9	17.6	14.7	13.2	42.5	105.3
2011	102.3	30.2	55.1	57.7	25.1	24.2	17.9	11.3	9.92			
Mean of monthly Discharge	67	36	37	38	29	25	14	15	14	14	28	58
** No Incomplete data have been used for statistical calculation												

Source: http://waterdata.usgs.gov/or/nwis/nwisman/?site_no=14164700

A summary of the flow rates used in the analysis of the various reaches is also provided as *Attachment 1* to the H&H portion of the technical appendix.

The FIS floodplain boundaries were available and referenced as part of the analysis. *Attachment 2* shows existing condition flood mapping.

For estimating the potential, size of restored South Cedar Creek, the diverted 40 cfs from Reach 1 and the January mean flow were used. Note that the channel restoration for South Cedar Creek comprise laying back the channel banks, addition of small side/finger channels, and restoration of riparian and wetland vegetation on the banks.

The modifications will increase effective conveyance area, assuming vegetation growth is kept to reasonable limits. The PED PDT will define the exact O&M parameters to accomplish this. It is recommended that some form of regular vegetation control is maintained to maximize the ecological lift as well the flood conveyance capacity.

Configuration of Drainage Facilities

For cost estimating purposes, the configurations of the proposed intake were estimated by a simple weir calculation. The downstream connection channel was estimated using normal depth calculations. The following table summarizes the design frequency, flow and the general dimensions of the subject channel.

Channel Geometry Summary						
Channel	**Design T**	**Q (cfs)**	**Z:1**	**Depth (ft)**	**W (ft)**	**Top W (ft)**
South Cedar Creek Restor.	Winter Q	54	4	3.5	6	34

Induced Flood Risks and Other Hazards

The principal concern for flood risk and life/property loss was the potential adverse impact due to flow diversion into (offsite) and within the middle Cedar Creek floodplain (onsite).

The additional flows introduced to Cedar Creek will not impact the regulatory floodplain because the relative magnitude between the diversion flow and the FEMA 100-year flow (40 cfs versus 1,755 and 1,125 cfs at 62nd and Weaver Road, respectively) is small. Additionally gates will be provided at the diversion structures and will regulate higher winter flows entering Cedar Creek.

There was concern that diverting flow into the historic 75th Street channel could cause flooding and increase risk of life and property loss (see Attachment 5 for the schematic of the proposed 2B measures). The proposed alignment of the channel is in close proximity to existing residences and the confluence was proposed to enter at right angles into South Cedar Creek.

It is recommended that there be no diversion from Grays' Creek into South Cedar Creek, via 75th Street channel, as originally proposed in previous versions of the TSP. The future PED PDT may evaluate other options such as buyout of adjacent properties at the confluence point of 75th Street and South Cedar Creek, or an option to routing flows to the south and east, around Thurston Elementary School, etc. The realignment around school was considered but outweighed, by the perceived benefits of maintaining existing flow patterns (reducing transferred risk) and the associated cost reductions in excavation and the elimination of a new diversion structure.

Adverse change to the water quality as a result of the 2B alternative measures was considered but was assessed to be unlikely at this time. A more comprehensive assessment will likely be completed as part of the Preconstruction Engineering and Design phase of the project.

Groundwater was not identified as significant issue at this location. However, ground water analysis would benefit the understanding of the effect to water levels on proposed riparian and wetland enhancements. It is likely the PED PDT will undertake a groundwater analysis.

H&H for Habitat Benefit Analysis

Flow duration, velocity and depth information was not required for Reach 2B analysis. The WAM model results were found to be acceptable by USACE PCX.

However, such information as the flow duration information is generally used as input for habitat benefit, environmental modeling. However the Waterways Assessment Model (WAM) tool for habitat benefits determination did not require flow duration information. Therefore this was not developed for this analysis. It will likely be developed during PED.

Environmentally beneficial measures were considered (e.g. vegetative protection of banks, etc) in lieu of potential traditional practices, e.g. riprap revetment, etc. However, the intent was to use a method that would both meet environmental goals but not compromise on protection as measured against the design event, e.g. the 100 year velocities and other hydraulic forces.

Cedar Creek, Reach 3 Option B: Hydrology and Hydraulics Summary Sheet

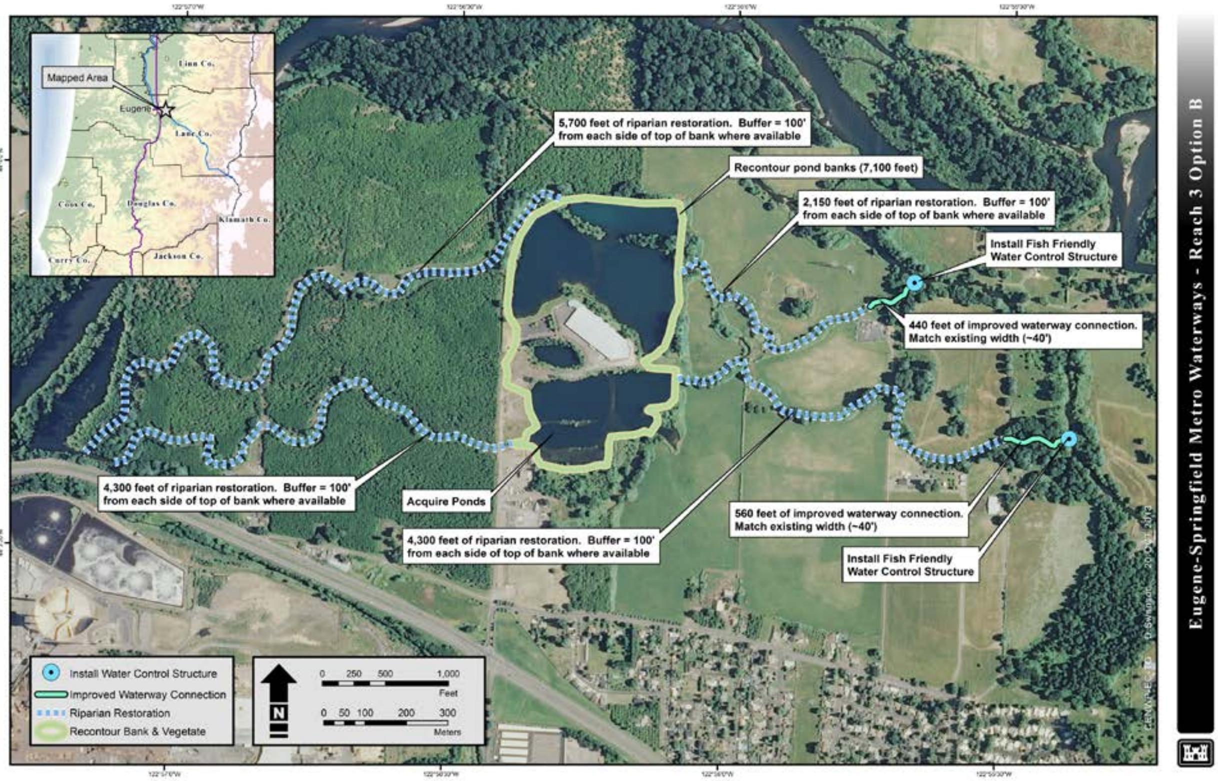
Alternative Reach and Option Overview:

Reach 3 includes the (Keizer Slough) waterways that make up the intake and outflow for Blue Water Ponds. The most southerly, downstream waterway is Keizer Slough. This area is located outside of the Springfield UGB and within rural Lane County. Agriculture is the predominant use in the area with an industrial use located at Blue Water Ponds. Restoring aquatic and riparian habitats are the key issues of this reach.

Blue Water Ponds are located at the western edge of the Planning Area, just north of the intersection of 52nd Street and High Banks Road. There are three distinct ponds of varying size located on private property and they appear to be hydrologically connected (surface as well as groundwater) based on field observations. It is thought that at one time Keizer Slough may have run through this area, but agriculture practices and quarrying activities have modified former surface water connections. The source of the pond waters is believed to predominantly subsurface.

Reach 3B Alternative Measures

Reach 3B management measures include re-contouring banks of ponds to create wetland/riparian habitat; diversion of flow from Cedar Creek to ponds restoring backwater channels for juvenile Chinook salmon and historically present Oregon chub; Western Pond Turtle habitat restoration; riparian restoration along 14,000 linear feet of waterways and some recreational access. The proposed 3B measures are shown below and included as Attachment 5 to this technical appendix.



The majority of the management measures consist of riparian restoration along the Slough. The hydraulic diversions off of Cedar Creek will allow watering of the existing slough channels; however, no channel modification will be made. These “waterway” improvements consist of laying back the slope, vegetation control of invasive plants and riparian plantings on the banks.

Goal of R3B Hydrology and Hydraulic Analyses

The goal of the hydrologic and hydraulic analysis was to determine adverse impacts (if any) associated with the proposed reach measures. 2) Support the development of other quantity take offs and revision of the FS TSP cost estimate by providing a technical basis and facility configuration for proposed management measures.

Design Criteria:

For feasibility purposes, intake sizing was based on the LCOG derived wintertime diversion flow of 40 cfs. Therefore, for feasibility level estimates the water control/intake configuration was assumed to be the same as those on Reach 1(E).

The Cedar Creek is in the regulatory floodplain. As such the proposed improvements in the regulatory floodplain cannot cause a net rise to the 1% chance flood (100-year) base flood elevation over 1 foot, and a zero rise certificate is required for fill being placed in the regulated floodway, as applicable for Special Flood Hazard Areas (SHAs) as determined by FEMA and regulated through the National Flood Insurance Program participating community, Lane County. A Conditional Letter of Map Revision

(CLOMR) and Letter of Map Revision (LOMR) as required for final construction of the proposed features which alter the regulated floodplain in any way.

R3B Hydrologic and Hydraulic Methods

No new hydrology flows were determined as part of this revised feasibility report analysis. See "Source of Data" section for further information.

The broad crested weir equation was used to make a preliminary estimate of the intake diversion structure configuration. The weir coefficient was estimated to be 3.14 (Brater and King 6^{th} Ed., for a 1 foot allowable head and 8-inch wide weir).

Sources of Data

Existing hydrologic and hydraulic data were available and were used to determine functional design requirements for Alternative 3B, in particular the sizing of Cedar Creek south branch channel.

The 1999 *Lane County Flood Insurance Study* (FIS) was used as a source for 100-year peak flow for Cedar Creek. Other return period frequencies were not estimated as part of the FIS.

A summary of the flow rates used in the analysis of the various reaches is also provided as *Attachment 1* to the H&H portion of the technical appendix.

The FIS floodplain boundaries were available and referenced as part of the analysis. *Attachment 2* shows existing condition flood mapping.

Configuration of Drainage Facilities

The weir length required to pass the 40 cfs peak design flow was estimated to be 13 feet with an allowable head of 1 foot. A low flow (15 cfs) section would require a weir length 5 feet.

Induced Flood Risks and Other Hazards

There is no risk from induced flooding in Reach 3. The additional flows introduced to the slough will not impact the regulatory (Cedar Creek) floodplain in any way. The slough areas are devoid of any occupied structure or facility which would increase induced flooding or life loss risk.

Adverse change to the water quality as a result of the 3B alternative measures was considered but was assessed to be unlikely at this time. Water quality will be increased by the additional Cedar Creek inflows. However, a more comprehensive assessment will likely be required as part of permitting during the Preconstruction Engineering and Design phase of the project.

The Blue Water Ponds are currently fed by groundwater and are the result of gravel mining activities in the 1960s. Eugene Sand and Gravel is in the process of filling the south pond. The northern and central ponds are relatively steep banked and have little native cover. Further ground water analysis would likely be necessary during PED.

H&H for Habitat Benefit Analysis

Flow duration, velocity and depth information was not required for Reach 3B analysis. The WAM model results were found to be acceptable by USACE PCX.

A rudimentary HEC-RAS of Cedar Creek was used to inform the PCX evaluation analysis. The resolution/detail of the model was minimal (e.g. it did not include the Cedar Creek stormwater channels, such as 72nd Street, Gray Creek, etc). Additional bathymetric and flow data will be required and effort spent to incorporate it into the model. The potential is there for a useful and comprehensive model of this area, however, the required work effort a current resourcing constraints. However, the model could be resurrected, modified and used during PED and into the future, if resourcing available.

However, such information as the flow duration information is generally used as input for habitat benefit, environmental modeling. However the Waterways Assessment Model (WAM) tool for habitat benefits determination did not require flow duration information. Therefore this was not developed for this analysis. It will likely be developed during PED.

Environmentally beneficial measures were considered (e.g. vegetative protection of banks, etc) in lieu of potential traditional practices, e.g. riprap revetment, etc. However, the intent was to use a method that would both meet environmental goals but not compromise on protection as measured against the design event, e.g. the 100 year velocities and other hydraulic forces.

Attachment 4 H&H

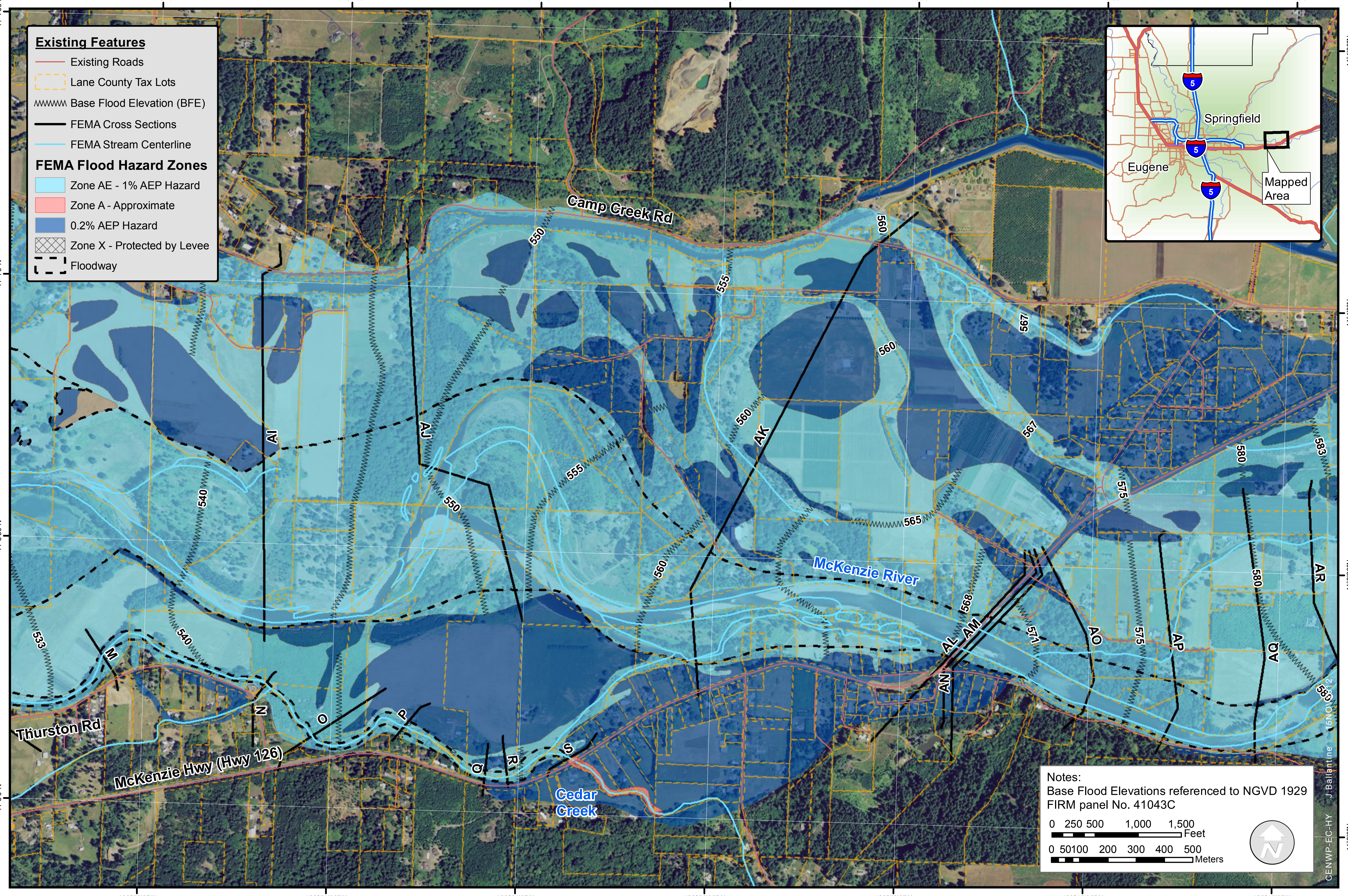
Flows

Alternative	Channel	SW Masterplan Flow (cfs) 2-yr	5-yr	10-yr	25-yr W	25-yr S	50-yr	100-yr	FEMA (cfs) 10-yr	50-yr	100-yr	500-yr	Notes W = Winter; S = Summer
Cedar 1E	McKenzie River	-	-	-	-	-	-	-	33,800.0	54,400.0	60,400.0	88,600.0	The McKenzie River is not part of the Springfield model in any location.
									31,200.0	41,300.0	47,800.0	66,300.0	
	Cedar Creek	-	-	-	-	-	-	-	-	-	980.0	-	Cedar Creek is not part of the Springfield model at this location
Cedar 2B	Cedar Creek	-	-	-	-	-	-	-	-	-	1,755.0	-	Cedar Creek is not part of the Springfield model at this location
									-	-	1,125.0	-	
	North Cedar Creek	-	-	-	-	-	-	-	-	-	-	-	Cedar Creek is not part of the Springfield model at this location
	South Cedar Creek	-	-	-	-	-	-	-	-	-	-	-	Cedar Creek is not part of the Springfield model at this location
	69th Street Channel			See Segments Below									
	A st to C St	28	39	49	58	-	-	66					There are two barrels here; the first is continuous. Values from link 2232
	A St to B St	16	21	26	30	-	-	34					There are two barrels here; the second one has one junction. See figure D4 for geometry. Values from link 1622
	B St to C St	19	26	31	36	-	-	40					There are two barrels here; the second one has one junction. See figure D4 for geometry. Values from link 85
	C St to D St	46	65	79	94	-	-	105					Values from segment Link_152
	Under D St	54	74	88	104	-	-	116					Combines several links that are one culvert. US segments are 73 and 1617; DS segments is 72 and 1616; Total segment is 2-54" culverts with a total flow as listed
	D St to Thurston Rd	52	72	88	104	-	-	116					Values from segment 1_6
	Under Thurston Rd	60	83	101	119	-	-	133					Combines several links that are one culvert. US segments are 3511 and 3761; DS segments is 3657 and Link_48; Total segment is 2-60" culverts with a total flow as listed
	Thurston Rd to Outfall	62	85	104	122	-	-	136					Values from segment Link_155
	72nd Street Channel			See Segments Below									
	Hwy 126 to Culvert	33	40	44	48	-	-	51					Values from segment Link_90r
	Culvert to Outfall	133	172	186	194	-	-	199					Values from segment Link_91r
	75th Street Channel	15	30	50	87	-	-	115					Values from segment Link_221. The model includes the connection from Gray Creek, which would be disconnected with this project.
	Gay Creek			See Segments Below									
	Hwy 126 to Culverts	32	49	63	76	-	-	86					Values from segment Link_6E
	Culvert 1	14	23	30	37	-	-	42					Values from segment 3469
	Culvert 2	18	27	33	39	-	-	44					Values from segment 3470
	Sum Culverts	32	50	63	76	-	-	86					Sum of previous two entries. Two-barrel culvert structure
	Culverts to Gray Creek	32	49	62	76	-	-	86					Values from segment Link_210
	Gray Creek			See Segments Below									
	US end of Model to Gay Creek	40	61	74	90	-	-	103					Values from segment Link_92
	Gay Creek to Culvert	82	115	133	135	-	-	135					Values from segment Link_89
	Culvert 1	87	122	136	139	-	-	141					Values from segment 3071
	Culvert 2	86	122	135	138	-	-	140					Values from segment 38
	Culvert 3	92	130	143	148	-	-	151					Values from segment 1601
	Culvert 4	92	130	143	148	-	-	151					Values from segment 1255
	Culvert to 72nd St Channel	92	130	143	148	-	-	151					Values from segment 40

Alternative	Channel	SW Masterplan Flow (cfs)							FEMA (cfs)				Notes
		2-yr	5-yr	10-yr	25-yr W	25-yr S	50-yr	100-yr	10-yr	50-yr	100-yr	500-yr	W = Winter; S = Summer
Cedar 3B	McKenzie River	-	-	-	-	-	-	-	45,000.0	59,300.0	70,000.0	96,200.0	The McKenzie River is not part of the Springfield model in any location.
									33,800.0	54,400.0	60,400.0	88,600.0	
	Keizer Slough	-	-	-	-	-	-	-	-	-	-	-	Keizer Slough does not appear in the Springfield model.
	Cedar Creek	-	-	-	-	-	-	-	-	-	1,895.0	-	Cedar Creek does not appear in the Springfield model.

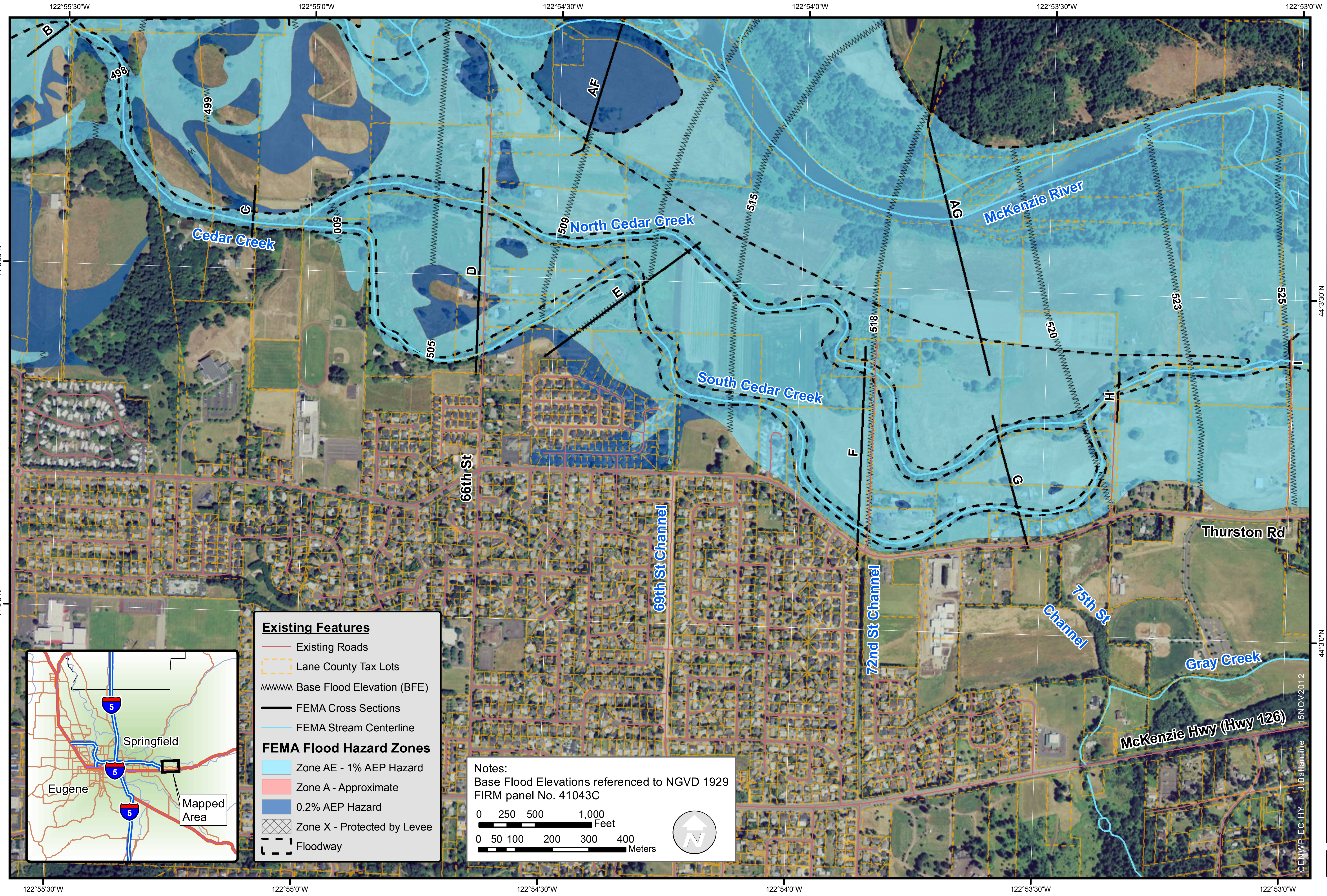
Attachment 4 H&H

Flood Maps

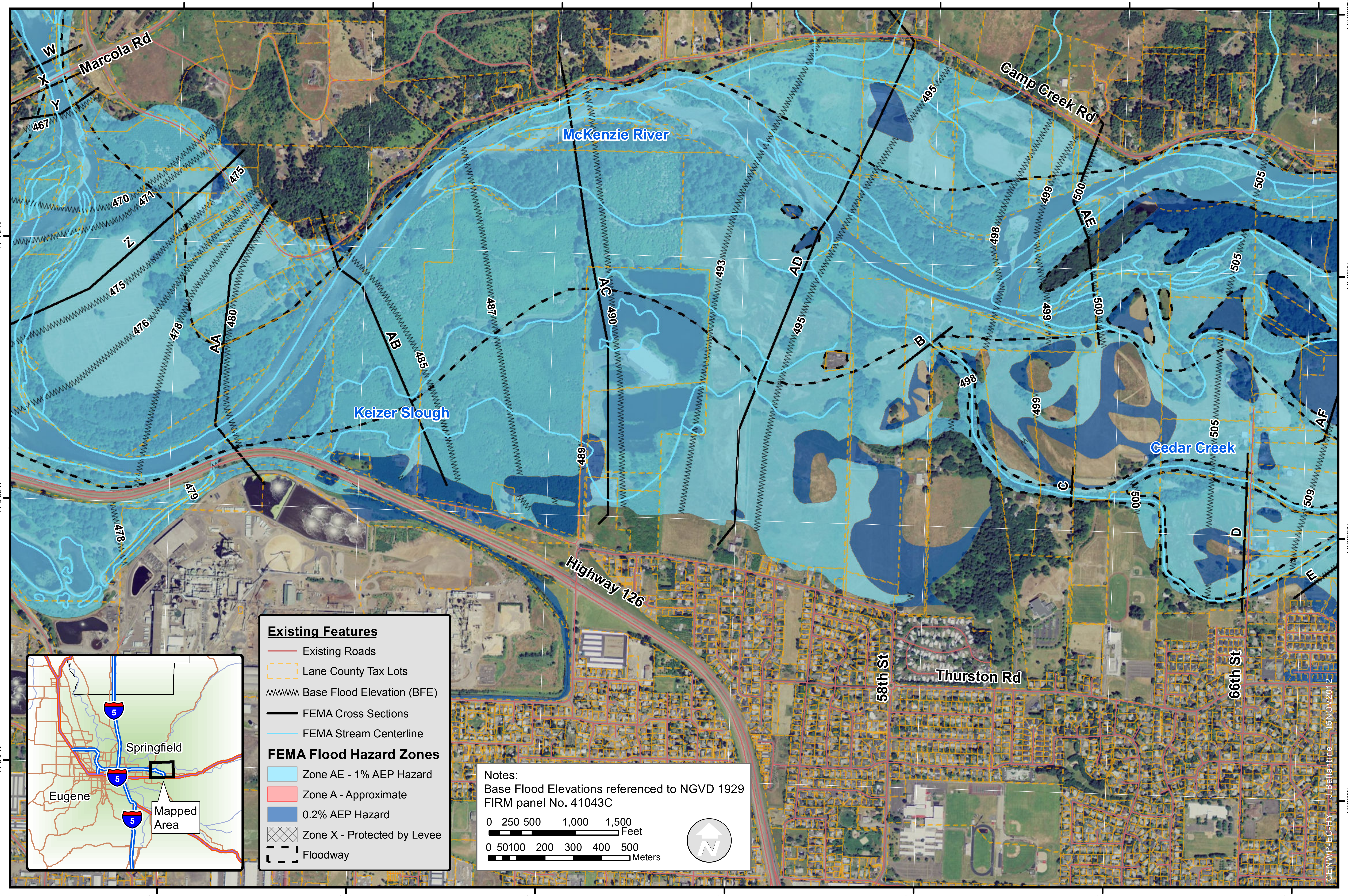


Cedar Creek - Option 1E FEMA Floodplain

Cedar Creek - Option 2B FEMA Floodplain

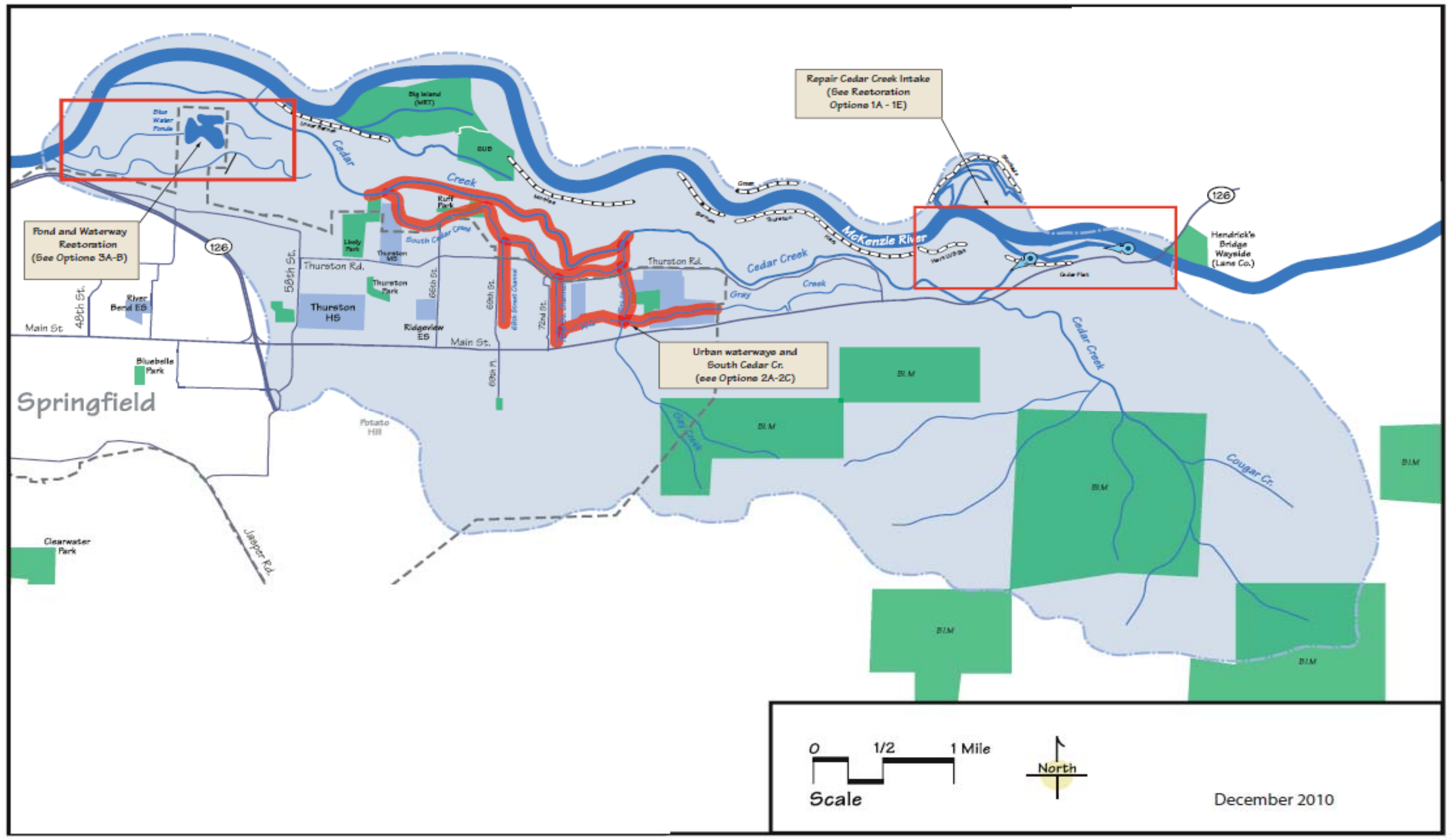


Cedar Creek- Option 3B FEMA Floodplain



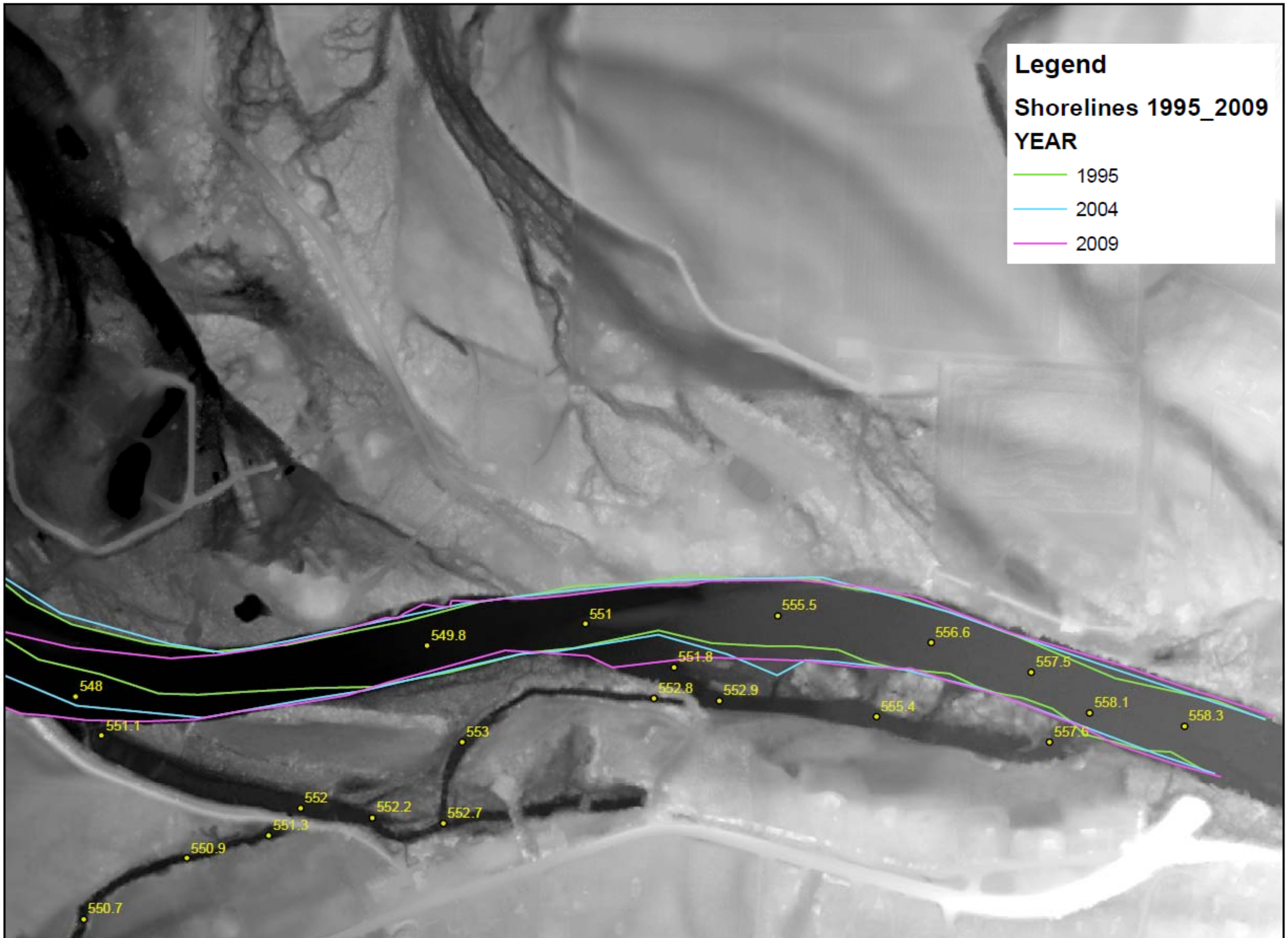
Attachment 4 H&H

Drainage Calculations



Cedar Creek 1E, 2B, 3B

Reach	Waterway	Extent	Description of Restorations
Cedar Creek Planning Area			
1E	Cedar Creek Intake	Cedar Creek intake area and associated revetments along the McKenzie River	Utilize an existing McKenzie River side channel to divert flow into Cedar Creek from a point along the river that is more geologically stable (approximately 1,400 feet upstream from the current intake) and to create a fish friendly open water connection between Cedar Creek and the McKenzie River. Removal of the 1964 headgate and pipe intake and replace with an engineered channel opening to facilitate fish ingress/egress and allow intake of summer inflows. Repair a portion of the Cedar Flat levee in the area where the exisitng (1914) diverison intake will be replaced with a fish friendly passage. Flows will be supplied via the channel openings and the Cedar Flat intake to improve fish habitat so that summer time flows range between 10.0 and 15.0 cfs. A diversion of up to 40 cfs is recommended during periods of the winter to help clean out the channel and create better habitat features (pools and riffles). This segment of Cedar Creek is part of the DCH for Spring Chinook salmon.
2B	Urban Waterways	South Cedar, 69th and 72nd Street Channels, Gray Creek, Gay Creek	Flow control structure installed where South and North Cedar Creek split to permanently maintain flow in South Cedar Creek and riparian restoration along South Cedar Creek to benefit Spring Chinook salmon habitat DCH. Channel restoration adjacent to middle school; conversion of 69th Street Channel to a low flow channel to improve aquatic habitat; riparian restoration and removal of concrete channel segment on 72nd Street Channel; diversion of flow back into the 75th Street Channel and riparian restoration; day-lighting and channel restoration along Gray Creek to improve aquatic habitat; recreational trail along many of the waterways.
3B	Blue Water Ponds	Blue Water Ponds and associated waterways	Re-contouring banks of ponds to create wetland/riparian habitat; diversion of flow from Cedar Creek to ponds restoring backwater channels for juvenile Chinook salmon and historically present Oregon chub (T)*; Western Pond Turtle (SOC)* habitat restoration; riparian restoration along 14,000 lf of waterways; recreational access.



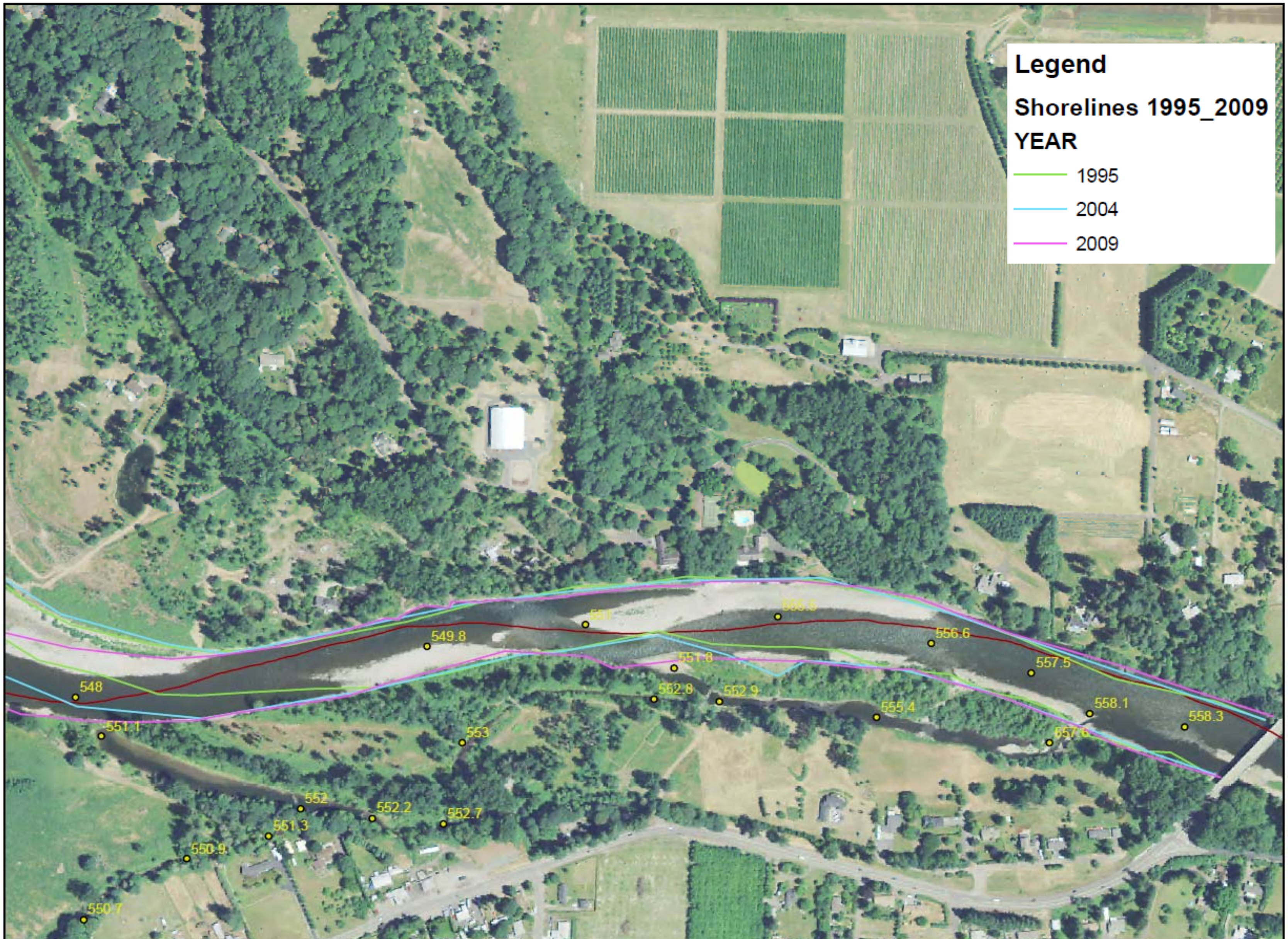
Cedar Creek and McKenzie water elevations and McKenzie shoreline change
Elevations based on LIDAR flown 6/3/2009. Walterville gage was 2780 cfs, 2.80'

N

0 80 160 320 Feet

Base Lidar flown 6/3/2009 DOGAMI

Project: Cedar Ck control gage lidar 4_5_11.mxd
4/5/2011
GIS by Jim Reed



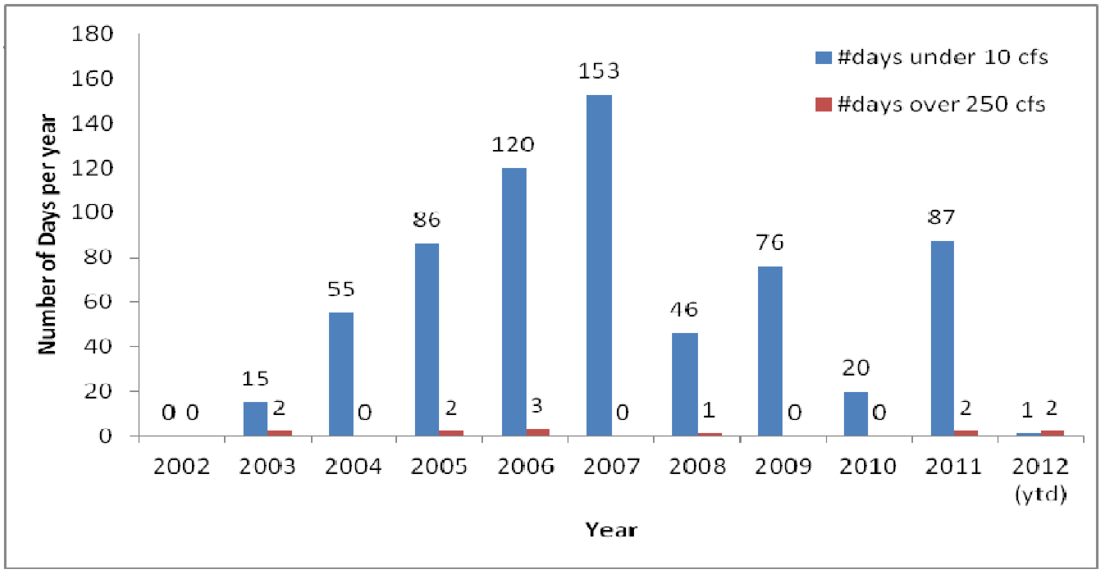
Cedar Creek and McKenzie water elevations and McKenzie shoreline change
Elevations based on LIDAR flown 6/3/2009. Walterville gage was 2780 cfs, 2.80'.

This NAIP image was taken 6/29/09
Walterville was 1175 cfs, 1.2'

N

0 80 160 320 Feet

Project: Cedar Ck control gage lidar 4_5_11.mxd
4/5/2011
GIS by Jim Reed



Fr Jeff Ziller 12-12-2013

Cedar Creek Discharge Monitoring Summary
November 9, 2012

To address the conditions outlined in the Salmon and Trout Enhancement Program (STEP) Water Right Exemption, Oregon Department of Fish and Wildlife (ODFW) and the McKenzie Watershed Council (MWC) have established three water level stations on Cedar Creek. The water levels are housed in a stilling well and collect a measurement of pressure within the stilling well every half-hour. When corrected with atmospheric pressure readings, this will provide a record of the water depth at each location. In addition to pressure measurements, the levels also collect water temperature. Each station is associated with cross sectional data collected at various flows.

In addition to these stations, The Eugene Water & Electric Board (EWEB) maintains a United States Geological Survey (USGS) gauging station on mainstem Cedar Creek 0.8 mile upstream from where Cedar Creek enters the McKenzie River. The station records discharge, including occasional overland flow from the McKenzie River into Cedar Creek, and has been operational since October 2001. All discharge information for this site as well as for gauging stations on the McKenzie River can be retrieved from the internet.

(http://waterwatch.usgs.gov/?m=real&r=or).

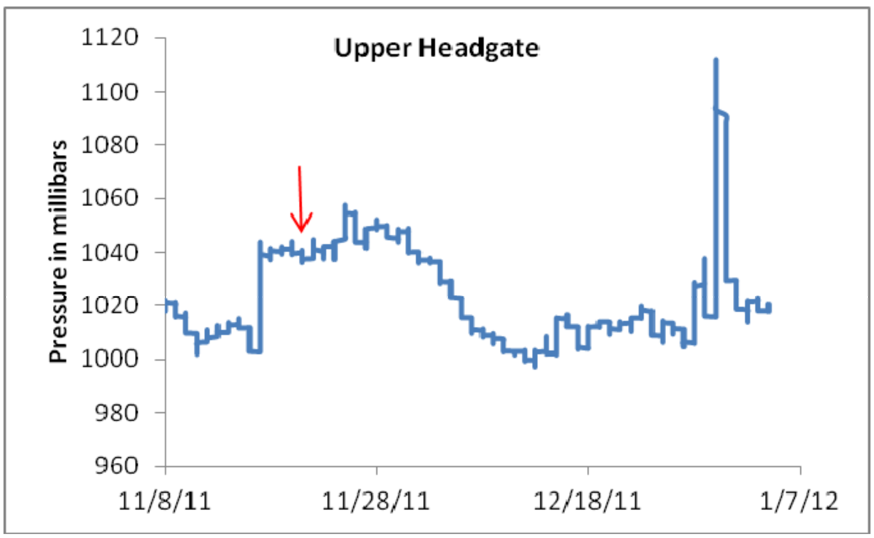
Information obtained from our three stations and the USGS website will be vital in developing a better understanding of year-round flow in Cedar Creek.

Historic data
Objectives of the STEP Water Right include assessing habitat and aquatic life at varying rates of discharge. The minimum in-stream flow for evaluation was 10 cubic feet per second (cfs) and the maximum flow was up to 250 cfs. We evaluated data obtained from the USGS website to determine how often those conditions occurred. Records from 2001 were not included and the 2012 data are included through February 26. The results are below. It is important to note that these data are collected at the EWEB gauge, which is near the downstream connection with the McKenzie River. Flows in the upstream portions were likely quite different.

Water levels

The cross sectional data collected at each water level will enable us to build a relationship between water level (the pressure readings) and discharge in cfs, calculated by multiplying the cross-sectional area by the discharge measured at 1-foot intervals across the width of the stream at the location of the water level. Once this relationship is developed, we will be able to compare discharge at the three water level locations with the EWEB gauge to gain a better understanding of flow within Cedar Creek.

While we have access to several local data sets that will provide the appropriate data for calibrating the water level readings, those data sets are currently in development. The charts displayed below have adjusted scales to show the approximate relationship between flow at the water level locations and the EWEB gauge. However, these charts are only illustrations and *do not represent the actual relationships*; they should be used only for illustrative purposes. Charts are displayed from upstream to downstream. Data from the logger at the four pipes shows some discrepancy in records that will require further analysis.



At the red arrows, flow in cfs calculated from cross sections was 11.39 cfs and 6.8 cfs, respectively.

Updated (through 2013) Gage Data

USGS 14164700 CEDAR CREEK AT SPRINGFIELD, OR

http://waterdata.usgs.gov/or/nwis/nwisman/?site_no=14164700

00060, Discharge, cubic feet per second,												
	Monthly mean in ft3/s (Calculation Period: 2001-10-01 -> 2012-09-30) Calculation period restricted by USGS staff due to special conditions at/near site											
YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001										16.5	43.1	67.4
2002	60.4	44.5	37.8	47.1	33.2	28.4	28.7	24.5	24.9	27.1	19.3	45.6
2003	53.6	47.7	46.2	58.8	30.3	17	21.7	30.3	28	16.7	17.5	93
2004	84.1	49.4	19.9	23.1	32	22.6	13.2	14.4	10.3	10.1	15.2	34.8
2005	11.6	15	28.6	42.2	47.6	19.4	13.4	9.21	9.58	8.65	19.9	63.2
2006	127	35.3	30.4	30.5	18.5	27	8.49	8.58	7.75	8.47	44	65.5
2007	57.8	45.4	39.7	22.9	14.5	7.39	3.8	8.52	6.91	11.6	27.2	43.3
2008	64.8	45.3	45.8	25	27.8	21.2	7.61	13.2	13.5	13	20.4	38.7
2009	51.7	18.3	33.5	23	28.5	18	7.69	12.5	13.2	12.4	31.8	23.6
2010	55	25.9	35.4	54.5	36.9	64.2	18.9	17.6	14.7	13.2	42.5	105.3
2011	102.3	30.2	55.1	57.7	25.1	24.2	17.9	11.3	9.92	9.72	16.5	24.1
2012	104	46.3	106.9	76.1	32.2	24.5	6.68	0.864	0.453			
Mean of monthly Discharge	70	37	44	42	30	25	13	14	**13**	**13**	27	55

USGS 14165500 MCKENZIE RIVER NEAR COBURG, OR

http://waterdata.usgs.gov/or/nwis/nwisman/?site_no=14165500

Mean **Sept flow is 2,416 cfs** and Mean **Oct is 2,475.** Based on USGS (John Risley) works performed for the Sustainable Rivers Project (2010) Oregon November 2010. “Environmental Flow"

From the flow gage:

00060, Discharge, cubic feet per second,												
	Monthly mean in ft3/s (Calculation Period: 1944-10-01 -> 2013-04-30)											
YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1944										1417	2082	2061
1945	6262	11080	7385	8221	8073	3553	2041	1657	1605	1498	6823	11420
1946	11990	7158	9025	5787	5900	4416	2700	1986	1783	2705	8250	12470
1947	6690	7852	6767	8043	3599	3992	2538	1983	1836	5918	9130	6067
1948	12360	9557	7188	7289	7763	5458	2937	2273	2185	2708	5874	11500
1949	3895	10830	7998	7067	10130	4505	2730	2139	2023	2239	3656	5423
1950	8528	12090	12490	8462	7606	7377	3578	2559	2294	6684	12180	11250
1951	13360	11990	7831	7240	6562	3204	2390	2025	1941	5712	6813	11630
1952	6530	11270	7738	8804	7096	5005	3418	2375	2117	1886	1933	3906
1953	18020	15350	7588	6117	8050	6460	3490	2511	2089	2372	8490	14480
1954	10700	11550	6218	7809	4617	4931	3064	2433	2440	2685	3247	4775
1955	6621	5744	6978	9419	7614	7366	3773	2373	2254	3737	10560	20700
1956	14210	6888	9544	9380	9134	6430	3486	2682	2327	3587	4750	9863
1957	4478	8847	13290	7488	5308	3491	2461	2048	1833	2207	2859	12350
1958	11220	13960	6012	7920	5392	4195	2651	1982	1954	1969	7551	6723
1959	10830	7817	6499	6250	5604	3282	2182	1785	2234	3561	3597	3260
1960	4197	8882	10230	9913	9141	4647	2499	2086	1850	2045	9414	7336
1961	6095	17200	11220	6301	7014	3862	2401	1919	1934	2627	6527	11450
1962	7195	5607	8071	9331	7249	4382	2466	2112	1846	3528	6134	8107
1963	3308	10350	5565	8529	8158	3224	2594	1853	1882	1942	7461	5825
1964	11860	6542	6455	6029	5581	5948	2954	2329	2245	2619	5195	24370

1965	18670	10290	4303	4965	4372	3224	2416	2172	2573	3655	2824	3371
1966	11780	4327	7435	5661	4183	2782	2299	1975	1941	2686	4383	7805
1967	9968	7141	4868	4371	4439	3223	2267	1910	2262	3545	4482	6017
1968	6849	9666	5143	3780	3279	2753	2018	2127	2550	3647	9097	12130
1969	9610	5266	5369	5453	6526	4916	3181	2699	2785	3019	3263	6611
1970	13940	9401	4494	3777	4829	2750	2632	2473	2409	2980	7133	8098
1971	14560	8040	8720	7101	7168	5675	3548	3484	3487	3419	8047	12420
1972	13690	11360	16400	7403	7470	5064	3222	3417	3551			
2010												11160
2011	11090	5932	8457	9269	7486	6765	3879	2810		3087	4311	4353
2012	12930	7324	10540	10940	7896	5890	3372	2884	2855	4151	8249	11920
2013	6078	5065	4741	5768								
Mean of monthly Discharge	9920	9170	7890	7220	6570	4630	2840	2300	2240	**3130**	**6140**	9320

** No Incomplete data have been used for statistical calculation

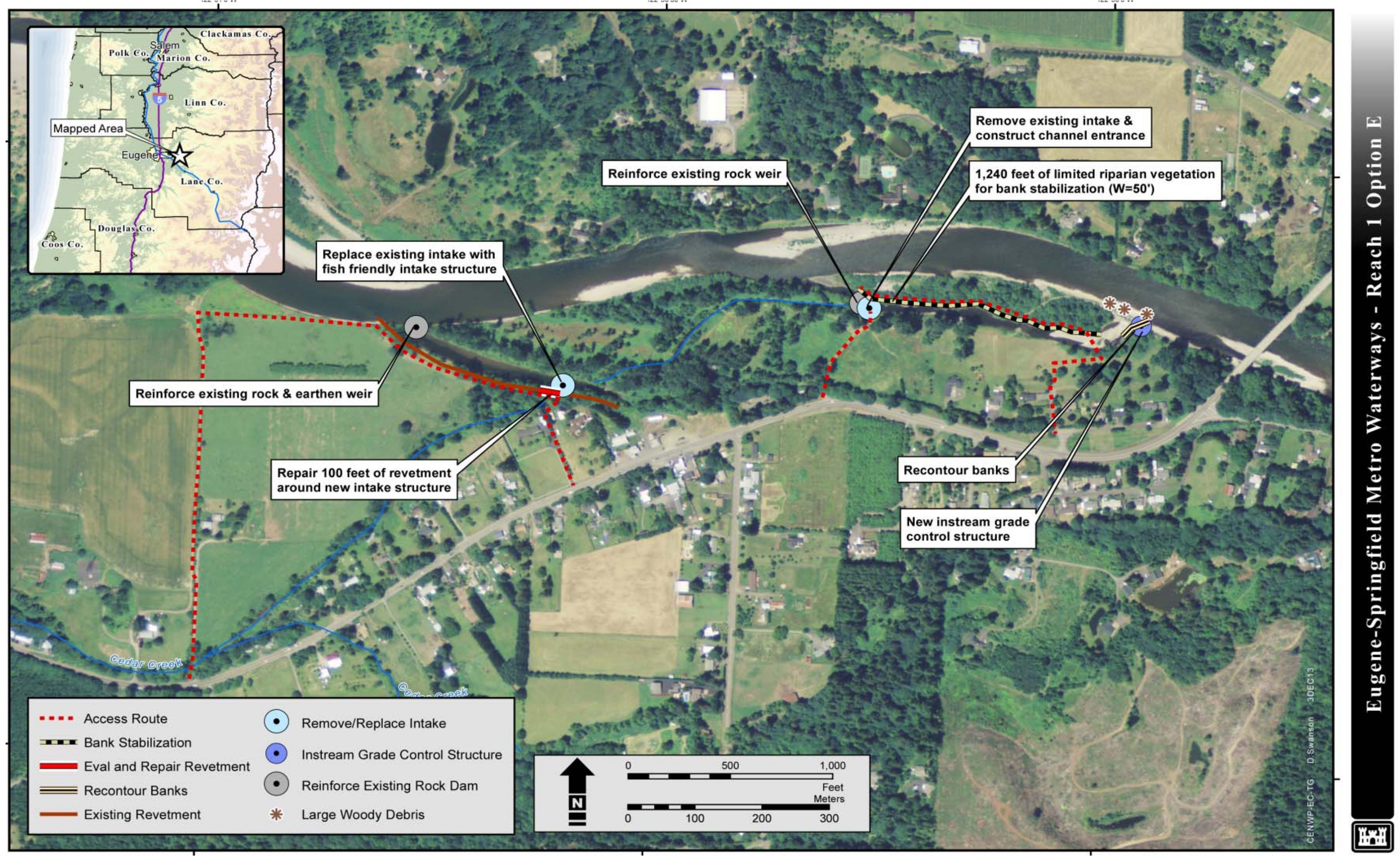
Lower McKenzie River
USGS Gage 14165500

BF	1.5-YR	2-YR	10-YR
25000	34420	39660	65770

Army Corps of Engineers

Cedar Creek Reach 1E Information
Summary

		By:	**KBD**
Project:	**Metro_Waterways FS (Update)**	Date:	**Nov-13**
Subject:	**FS Cedar Creek Reach 1 Option E**		
	Summary		



Determinations:

There is a need to perform significant geomorphic and hydraulic analysis to better assess the headcut progression and bound the extent of the problem both now and likely future progression (ultimate impact at the site).

A ground water analysis is also required in order to better understand the effect to water levels on the side channel. This will be performed at PED.

Assumptions

10-15 cfs for low summer intake flows. 40 cfs for high Intake flow.
Based on STEP 2009 ODFW application for Cedar Creek, Section 2.2.2.2.1 Waterways.
Programmatic allows minimum of 10 cfs to be withdrawn, May-Oct,
+ 5.29 cfs as part of the water right, min. = 15.29 cfs.
Max diversion permitted is up to 250 cfs.
250 cfs winter high flow and 15.3 cfs low flow.
Under Alternative 1E, Intakes should be capable of diveting up to 40 cfs (wintertime flows).
Channel migration occurrs during extreme high water, channel forming events.
Channel migration caused by high McKenzie River high flows can not be fully ameliorated under this project scope.
O&M and post event projects will ensure long term function.

Primary Tentatively Selected Plan features

Modified side channel opening just below Hendricks Br
Recontour the bank to allow flows to more easily enter the side connection channel.
Remove and replace the existing side connection channel intake (1964 intake) w/ a channel opening into Cedar Creek from the side connection channel.
Remove and replace the existing 4-30" pipe intake headgated structure (1914 intake) with a fish passable structure.
Repair ~126 feet of Cedar Flat revetment location, around the new fish passable intake structure.
Bolster the instream rock weir dam on the side connection channel. Place cobble rock on the downstream face of the existing rock weir.
Bolster the instream earth and rock weir dam on the slough downstream of the 4-30" existing intake pipes (1914 intake). Place riprap rock over the existing weir.
Limited 'side bank channel modifications', in form of riparian vegetation to help stabilize the banks. Detailed design will have to evaluate the need for something more robust.
Install riparian vegetation of the right bank on the side connection channel.
Construct XXX' of temporary haul roads for construction purposes and for access.

Quantities

DQC ENGINEERS ESTIMATE*					
Eugene-Springfield Metrowaterways Feasibility Revision					
ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
Jan-00	Grade Control Weir (riprap)	CY	554		
Jan-00	Grade Control Structure and Channel Ex	CY	2311		
Jan-00	Riprap (rock dams)	CY	784		
Jan-00	Side Channel Opening Ex	CY	1704		
Jan-00	Bank Protection Veg	L. FT	1240		
Jan-00	Revetment Repair	L. FT	126		
Jan-00	Remove Existing Revetment	L. FT	100		
Jan-00	Remove Existing Intakes	EA.	2		
Jan-00	New Fish Passage Structure	EA.	1		

*Estimate is DRAFT and subject to change. AC = Acre

Notes:

Side Connection Channel Instream Grade control structure
Ex for installing the grouted riprap grade control structure and
Include both of the existing weir/dam/berm reinforcements
This is the Ex for the removal of the 1964 intake on the side connection channel and constructing the new bank opening
1964 intake on the side connection channel and the 1914 intake located on Cedar Flat Revetment
See Cedar Flat Fish Passage Tab
Why can't we just clean out the existing gravel bar at the entrance of the side channel at Hendrik's Br?
Save on 1 diversion structure.
The short answer is that in water work is often problematic form the permitting standpoint.
Further, the Feasibility measures should bound the high end of possibilities in order that the correct
monies be programmed for the most exspensive eventualites.
So, this measure may be evaluated at PED, but the more conservative measures should be used for
estimating purposes.
How was 40 cfs determined as the Intake high flow? STEP agreement permits up to 250 cfs.

HY-8 Culvert Analysis Report

Table 1 - Summary of Culvert Flows at Crossing: Cedar Flat Culvert

Headwater Elevatio	Total Discharge (c	Cedar Flat Fish Frie Culvert Discharge (	Roadway Discharg (cfs)	Iterations
553.12	10.00	10.00	0.00	1
553.36	15.00	15.00	0.00	1
553.58	20.00	20.00	0.00	1
553.96	25.00	25.00	0.00	1
554.18	30.00	30.00	0.00	1
554.40	35.00	35.00	0.00	1
554.62	40.00	40.00	0.00	1
554.83	45.00	45.00	0.00	1
555.04	50.00	50.00	0.00	1
555.25	55.00	55.00	0.00	1
555.47	60.00	60.00	0.00	1
567.00	172.34	172.34	0.00	Overtopping

Rating Curve Plot for Crossing: Cedar Flat Culvert

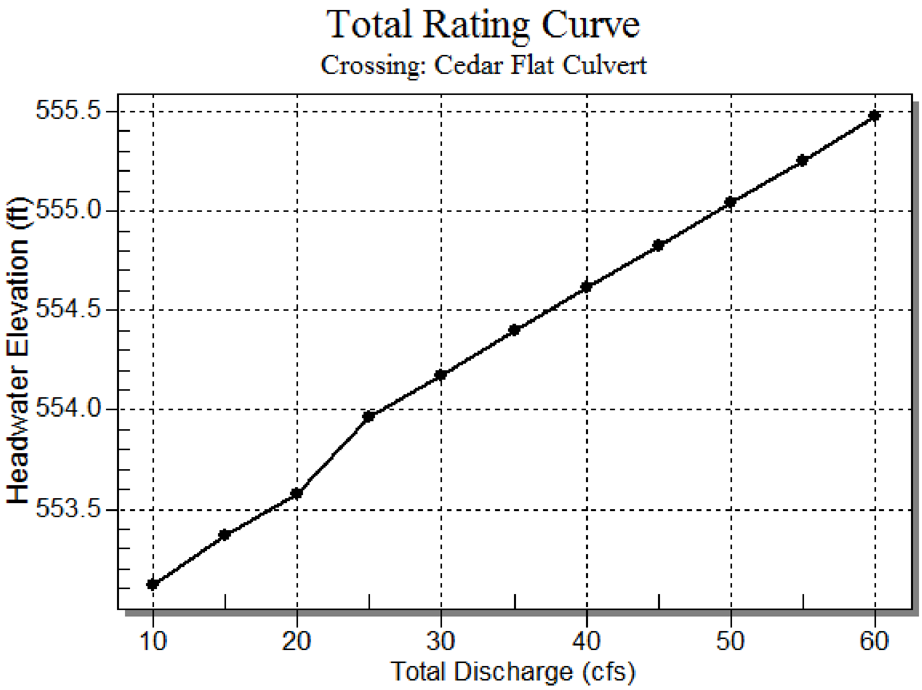
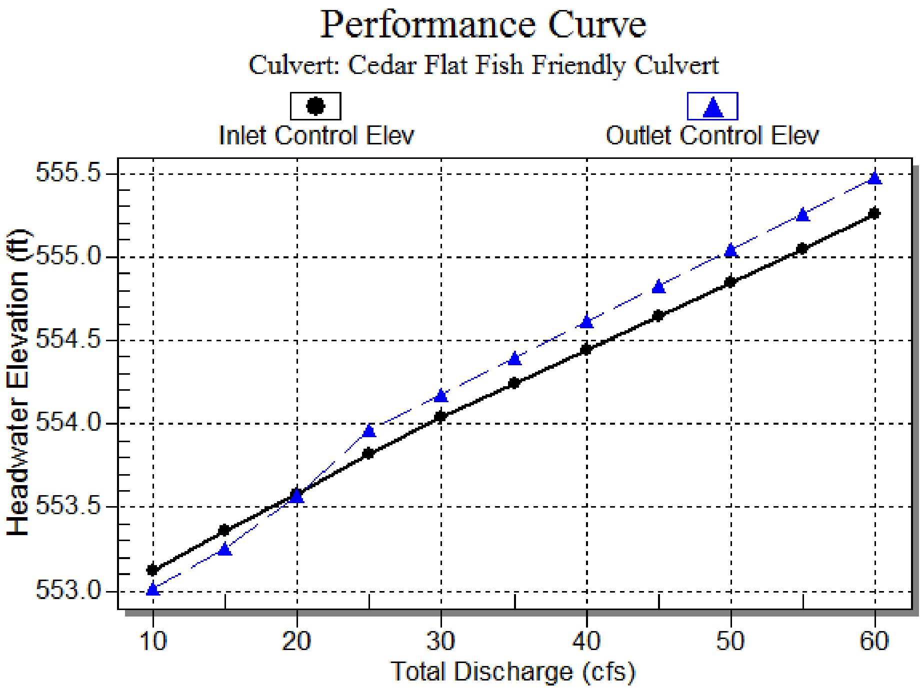


Table 2 - Culvert Summary Table: Cedar Flat Fish Friendly Culvert

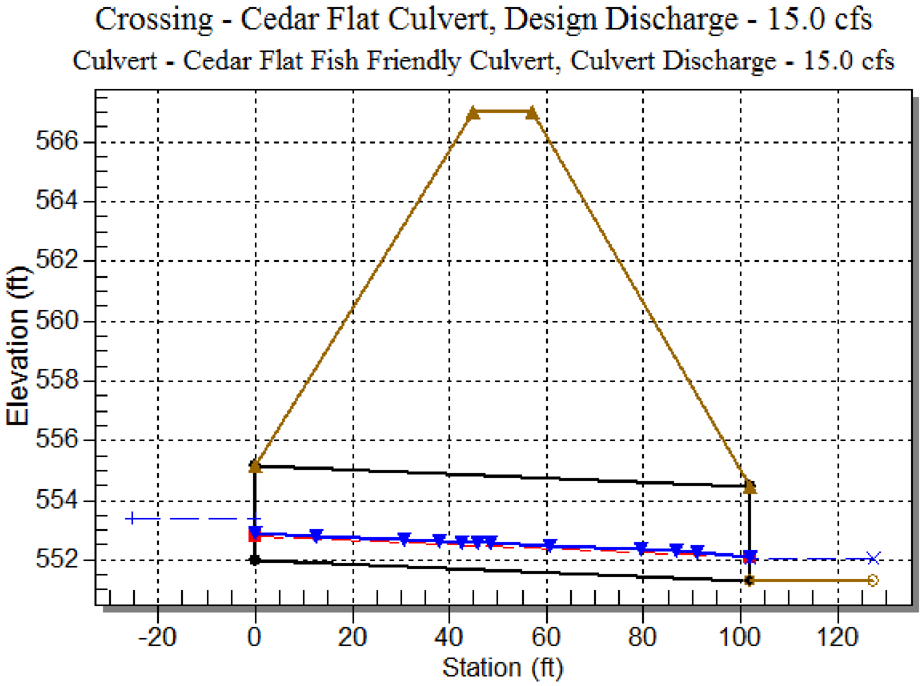
Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10.00	10.00	553.12	1.120	1.018	2-M2	0.720	0.649	0.653	0.585	3.784	0.765
15.00	15.00	553.36	1.365	1.259	2-M2	0.879	0.785	0.800	0.740	4.111	0.883
20.00	20.00	553.58	1.577	1.571	2-M2	1.083	0.920	0.925	0.874	4.470	0.973
25.00	25.00	553.96	1.816	1.960	2-M2	1.306	1.073	1.119	0.993	5.547	1.050
30.00	30.00	554.18	2.037	2.175	2-M2	1.468	1.230	1.241	1.102	5.903	1.115
35.00	35.00	554.40	2.245	2.396	2-M2	1.632	1.349	1.354	1.203	6.242	1.173
40.00	40.00	554.62	2.446	2.616	2-M2	1.798	1.456	1.461	1.297	6.554	1.224
45.00	45.00	554.83	2.643	2.826	2-M2	1.971	1.563	1.564	1.385	6.849	1.272
50.00	50.00	555.04	2.841	3.044	2-M2	2.155	1.658	1.662	1.469	7.136	1.315
55.00	55.00	555.25	3.046	3.252	2-M2	2.371	1.751	1.756	1.550	7.412	1.354
60.00	60.00	555.47	3.259	3.474	2-M2	2.655	1.844	1.846	1.625	7.683	1.393

****
Inlet Elevation (invert): 552.00 ft,   Outlet Elevation (invert): 551.30 ft
Culvert Length: 102.00 ft,   Culvert Slope: 0.0069
****

Culvert Performance Curve Plot: Cedar Flat Fish Friendly Culvert



Water Surface Profile Plot for Culvert: Cedar Flat Fish Friendly Culvert



Site Data - Cedar Flat Fish Friendly Culvert

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 552.00 ft
Outlet Station: 102.00 ft
Outlet Elevation: 551.30 ft
Number of Barrels: 1

Culvert Data Summary - Cedar Flat Fish Friendly Culvert

Barrel Shape: Pipe Arch
Barrel Span: 57.00 in
Barrel Rise: 38.00 in
Barrel Material: Steel or Aluminum
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Inlet Type: Conventional
Inlet Edge Condition: Projecting
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Cedar Flat Culvert)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
10.00	551.88	0.58	0.77	0.04	0.19
15.00	552.04	0.74	0.88	0.05	0.19
20.00	552.17	0.87	0.97	0.05	0.20
25.00	552.29	0.99	1.05	0.06	0.20
30.00	552.40	1.10	1.12	0.07	0.20
35.00	552.50	1.20	1.17	0.08	0.21
40.00	552.60	1.30	1.22	0.08	0.21
45.00	552.68	1.38	1.27	0.09	0.21
50.00	552.77	1.47	1.32	0.09	0.21
55.00	552.85	1.55	1.35	0.10	0.21
60.00	552.93	1.63	1.39	0.10	0.21

Tailwater Channel Data - Cedar Flat Culvert

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 20.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0010
Channel Manning's n: 0.0400
Channel Invert Elevation: 551.30 ft

Roadway Data for Crossing: Cedar Flat Culvert

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 567.00 ft
Roadway Surface: Gravel
Roadway Top Width: 12.00 ft

Army Corps of Engineers

Frontal Weir Calculator
Hydraulic Calculations

		By:	KBD
Project:	**MetroWaterways FS (Update)**	Date:	**Dec-13**
Subject:	**Below Grade Weir Sizing (~600' DS of Hendricks Br) at the entrance to the S**	Checked:	
		Project No.:	

Notes: Provide a below grade control structure to pass maximum STEP allowable flow of 250 cfs.
Use the existing entrance point at the upstream portion of the side connection channel.
Assumed a head of 2' on McKenzie River to allow for flows across the grade control structure and into the side channel
Assumed weir breadth = 5 foot, 250 cfs, Top of Weir, 557' elevation. Assume depth of cutoff wall of approximately 8'.
Assumed NAVD datum, need to verify the elevation at PED. El from headcut fr discussion with Lane County, Nov 2012.

Broad Crested Weir Calc:

Q = C*L(H)^1.5
C is the weir coefficient from Brater-King
L is the length of Weir
H is the energy head over weir - assume near zero velocity US.

Calculations

Input

C	2.65
L (ft)	34
H (ft)	2

Riprap Quantities

Length	34	ft
Width	5	ft
Depth	8	ft
% Extra Mass	10	%

Output

Q **254.8413** cfs   Riprap **554.0741** CY

Table 5-3. Values of C in the Formula $Q = CLH^{3/2}$ for Broad-crested Weirs

Measured head in feet, H	Breadth of crest of weir in feet										
	0.50	0.75	1.00	1.50	2.00	2.50	3.00	4.00	5.00	10.00	15.00
0.2	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68
0.4	2.92	2.80	2.72	2.64	2.61	2.60	2.58	2.54	2.50	2.56	2.70
0.6	3.08	2.89	2.75	2.64	2.61	2.60	2.68	2.69	2.70	2.70	2.70
0.8	3.30	3.04	2.85	2.68	2.60	2.60	2.67	2.68	2.68	2.69	2.64
1.0	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63
1.2	3.32	3.20	3.08	2.86	2.70	2.65	2.64	2.67	2.66	2.69	2.64
1.4	3.32	3.26	3.20	2.92	2.77	2.68	2.64	2.65	2.65	2.67	2.64
1.6	3.32	3.29	3.28	3.07	2.89	2.75	2.68	2.66	2.65	2.64	2.63
1.8	3.32	3.32	3.31	3.07	2.88	2.74	2.68	2.66	2.65	2.64	2.63
2.0	3.32	3.31	3.30	3.03	2.85	2.76	2.72	2.68	2.65	2.64	2.63
2.5	3.32	3.32	3.31	3.28	3.07	2.89	2.81	2.72	2.67	2.64	2.63
3.0	3.32	3.32	3.32	3.32	3.20	3.05	2.92	2.73	2.66	2.64	2.63
3.5	3.32	3.32	3.32	3.32	3.32	3.19	2.97	2.76	2.68	2.64	2.63
4.0	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.70	2.64	2.63
4.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.74	2.64	2.63
5.0	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.64	2.63
5.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.64	2.63

Army Corps of Engineers

Frontal Weir Calculator
Hydraulic Calculations

		By:	**KBD**
Project:	**MetroWaterways FS (Update)**	Date:	**Dec-13**
Subject:	**R1 Side Channel Opening Hydraulics**	Checked:	
		Project No.:	

Notes: Size for 40 cfs Cedar Creek Channel winter flows.
Summer flows are ~10-15 cfs
Assume breadth of weir is about 2'
Water is pooled by the downstream rock berm/weir therefore the entrance will act as a inline weir.

Broad Crested Weir Calc:

Q = C*L(H)^1.5

C is the weir coefficient from Brater-King
L is the length of Weir
H is the energy head over weir - assume near zero velocity US.

Calculations

Input			**Quantities**		
C	2.6		Length	16	ft
L (ft)	16		Width	5	ft
H (ft)	0.5		Depth	8	ft
			% Extra Mass	10	

Output

Q	**14.70782**	cfs	Riprap	**260.7407**	CY	(grouted assumed)

Table 5-3. Values of C in the Formula $Q = CLH^{3/2}$ for Broad-crested Weirs

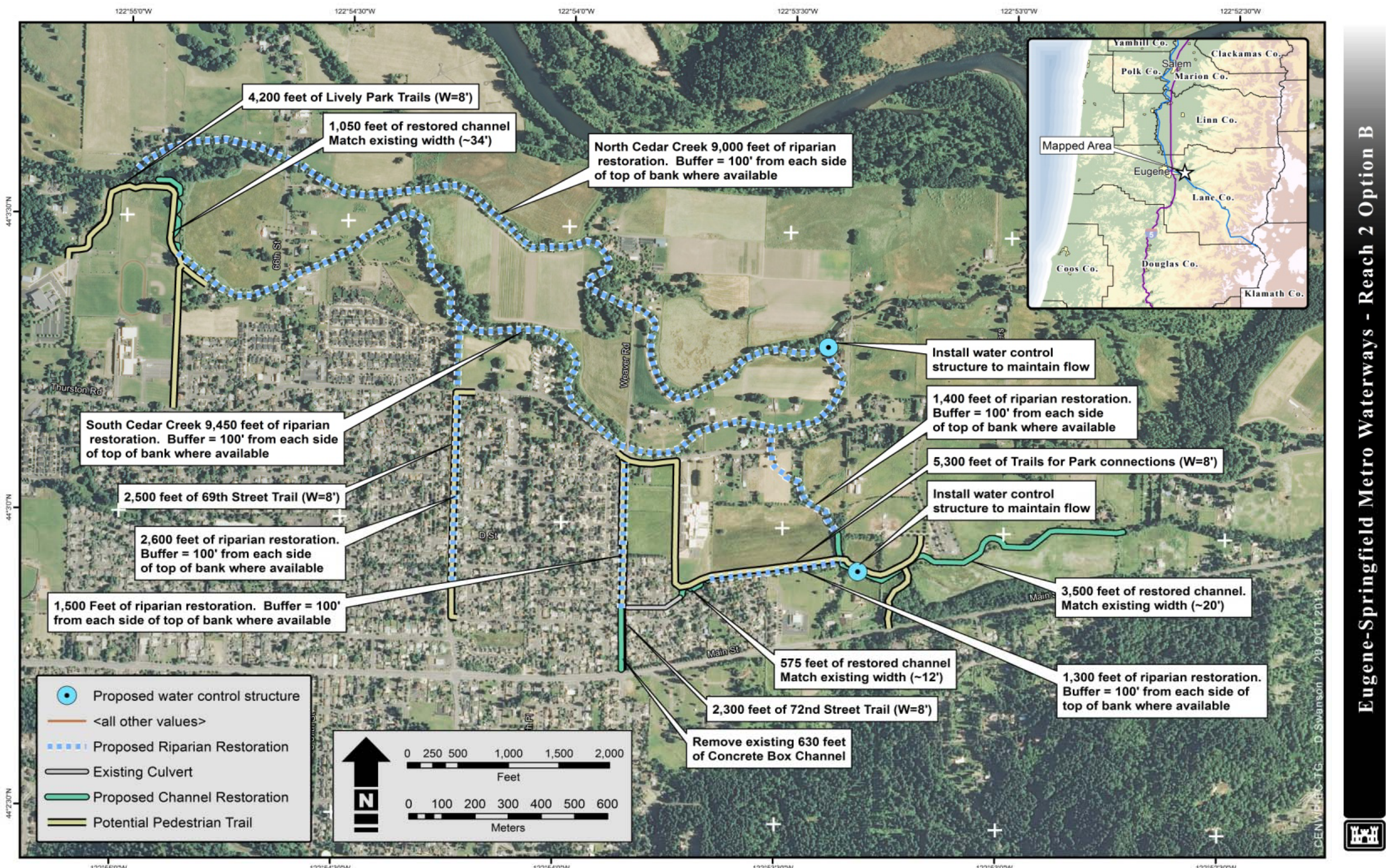
Measured head in feet, H	Breadth of crest of weir in feet										
	0.50	0.75	1.00	1.50	2.00	2.50	3.00	4.00	5.00	10.00	15.00
0.2	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68
0.4	2.92	2.80	2.72	2.64	2.61	2.60	2.58	2.54	2.50	2.56	2.70
0.6	3.08	2.89	2.75	2.64	2.61	2.60	2.68	2.69	2.70	2.70	2.70
0.8	3.30	3.04	2.85	2.68	2.60	2.60	2.67	2.68	2.68	2.69	2.64
1.0	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63
1.2	3.32	3.20	3.08	2.86	2.70	2.65	2.64	2.67	2.66	2.69	2.64
1.4	3.32	3.26	3.20	2.92	2.77	2.68	2.64	2.65	2.65	2.67	2.64
1.6	3.32	3.29	3.28	3.07	2.89	2.75	2.68	2.66	2.65	2.64	2.63
1.8	3.32	3.32	3.31	3.07	2.88	2.74	2.68	2.66	2.65	2.64	2.63
2.0	3.32	3.31	3.30	3.03	2.85	2.76	2.72	2.68	2.65	2.64	2.63
2.5	3.32	3.32	3.31	3.28	3.07	2.89	2.81	2.72	2.67	2.64	2.63
3.0	3.32	3.32	3.32	3.32	3.20	3.05	2.92	2.73	2.66	2.64	2.63
3.5	3.32	3.32	3.32	3.32	3.32	3.19	2.97	2.76	2.68	2.64	2.63
4.0	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.70	2.64	2.63
4.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.74	2.64	2.63
5.0	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.64	2.63
5.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.64	2.63

Army Corps of Engineers

Cedar Creek Reach 2B Information
Summary

By: **KBD**
Date: **Nov-13**

Project: **Metro_Waterways FS (Update)**
Subject: **FS Cedar Creek Reach 2 Option B (*Option 2 B includes trails shown as part of 2C*)**
Summary



A

Channel Geometry Summary						
Channel	**Design T**	**Q (cfs)**	**Z:1**	**Depth (ft)**	**W (ft)**	**Top W (ft)**
72nd St Channel Restore	Winter Q	87	4	4	6	38
South Cedar Creek Restor.	Winter Q	53.5	4	3.5	6	34
Gray Creek Channel Restore	Winter Q	148	4	5	6	46

<u>Determinations:</u>

Terminus of 'revived' 75th Avenue Channel is a concern as water is redirected from Grays Creek into this reach and the terminus with South Cedar Creek runs under Thurson Road, and between residences.

It is proposed to divert flows into the 75th Street Channel. There appears to be space to route the nev flows along the perimter of a residence where the 75th st channel intersects with S Cedar Creek There will also be no sediment traps installed as part of this project (no WQ features in general). Because the only additional flows introduced to Reach 2 are the 40 cfs (max) from the intakes in Reach 1, the risk from induced flooding is minimal.

<u>Totals Summary:</u>

Riparian Restoration	24900	ft
Restored Channel	5745	ft
New Trails	14300	ft
Remove CBC	620	ft

<u>Restored Channel- Ex</u> (Unit cost @$8/yd?)

S Cedar	1050	ft	2722	CY	21776
72nd St	620	ft	2021	CY	16168
Grays Cr	4075	ft	19620	CY	156960

Note: To PDT. Is the excavation quantity too conservatives.
It is assuming full channel depth required by hydraulics. That is not likely realistic, too high.
Dec 2012 submittal provided L/ ft of channel. Based unit cost on Lane County estimate. Is this t

<u>Primary Tentatively Selected Plan features</u>

9,000 feet of riparian restoration along **North Cedar Creek**.
9,450feet of riparian restoration along **South Cedar Creek**.
1 water control structure installed to maintain flow in South Cedar Creek
1 water control structure installed to divert flows from Gray Creek into the abandoned **75th St. channel**.
1,050 feet of restored channel (lay back banks, etc.) on **South Cedar Creek**.
2,600 feet of riparian restoration along **69th Street**.
1,500 feet of riparian restoration along existing **72nd Street** Channel.
620 feet remove existing RCBC along **72nd Street.**
620 feet of restored channel along removed RCBC alignment, **72nd Street.**
1,300 feet of riparian restoration along **Grays Creek.**

3,500 feet of restored channel along **Grays Creek.**
575 feet of restored channel along **Grays Creek, near Thurston Elem. School.**
4,200 feet of Lively Park Trails
2,500 feet of 69th Street Trail
2,300 feet of 72nd Street Trail
5,300 feet of Trail from Artz Park along Grays Creek and potential trail connection to future Willamalena Park.

Assumptions

There is insufficient flow data for Grays Creek and the east end of the South Fork Cedar creek to make hydraulic sizing estimates for the channel restorations (e.g. widenings). This will be done by PED PDT.
The maximum inflow from the upstream diversion/intakes is 40 cfs.
Because the diversions are only 40 cfs max, there is essentially no change to the existing 2 and up to the 100-year flood frequency inundations limits.
Flows patterns in Reach 2, except for the additional of the 40 cfs upstream, are unaltered.
Thereofore, it can be assumed that there is essentially no induced flooding from this Alternative.
WQ features excluded from this Alternative (including sediemtn traps).

Quantities

DQC ENGINEERS ESTIMATE*					
Eugene-Springfield Metrowaterways Feasibility Revision					
ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	Riparian Restoration	L. FT	24900		
2	Restored Channel	L. FT	5745		
3	New Trails	L. FT	14300		
4	Water Control Structure	EA.	2		

Do we want this in CY of Ex?

*Estimate is DRAFT and subject to change. AC = Acre

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Trapezoidal Channel Hydraulic Calculations

Project:	**Metro_Waterways FS (Update)**	By:	**KBD**
Subject:	**2B South Cedar Creek Channel Restoration**	Date:	**Nov-12**
	Layback slopes, add side channels restore riparian and wetland veg.	Checked:	
		Project No.:	

Notes: Eugene-Springfield_Metro_Waterways FS (Update)
Based on conversations with PM-E, Trap channel was deemed appropriate for typical section.

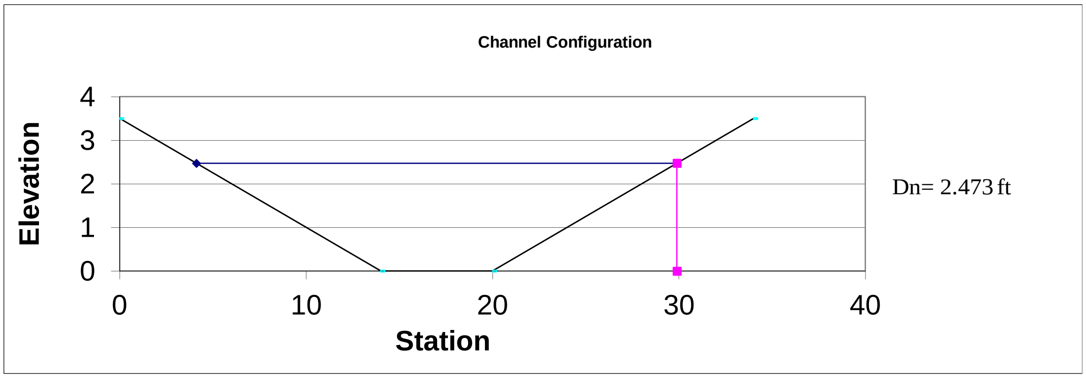
Input

Descriptor = 2B South Cedar Creek Channel Restoration

Design Event (Year) =	Winter Q	Yr	
Flowrate =	53.5	cfs	(40 + 70)/2 , where 70 is mean flow for Jan. high water month, and divided by 2 to accound for the assumed 50-50 split at of flow into the N-S Cedar Creek branches.
Ml (X:1) =	4		
Mr (X:1) =	4		
Bottom Width =	6	ft	
Slope =	0.001	ft/ft	
Manning's n =	0.045		(assumed higher vegetation cover in the channels of Cedar Creek.
Provided Depth =	3.5	ft	Recomended D = Dn + Freeboard = 3.47
Required Freeboard =	1	ft	F = 1 ft min.
Units	1	(1 for US Customary and 2 for SI)	

Output

Normal Depth =	**2.47264993**	**ft**	Critical Depth =	1.062106828	ft
Velocity =	**1.36160413**	**fps**	Critical Veloity =	4.915054704	fps
Hydraulic Top Width =	25.7811995	ft	Shear Stress , Td =	0.154293356	lb/ft^2
Flow Area =	39.2918903	Sq. ft.	Freeboard =	1.027350068	ft
Froude Number =	0.19436722				
Required Channel Depth =	3.47264993	ft			
Channel Top Width =	34	ft			



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Trapezoidal Channel Hydraulic Calculations

Project:	**Metro_Waterways FS (Update)**	By:	**KBD**
Subject:	**2B 72nd St Channel Restoration**	Date:	**Dec-13**
	Layback slopes, add side channels restore riparian and wetland veg.	Checked:	
		Project No.:	

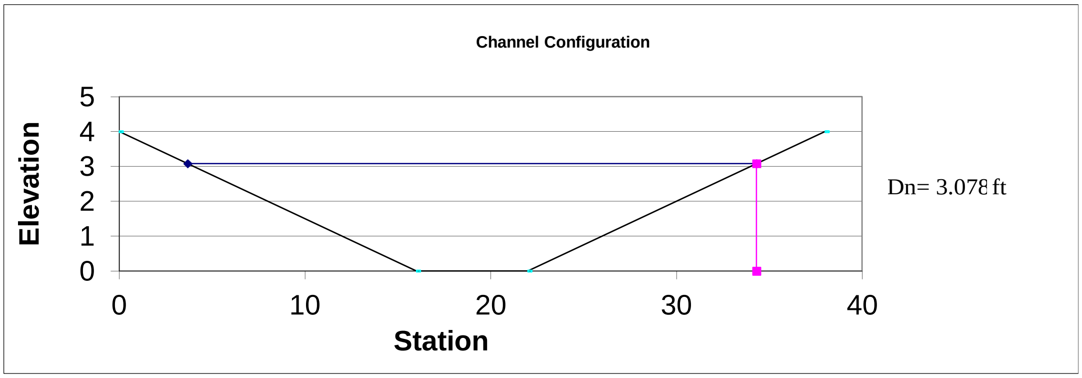
Notes: Eugene-Springfield_Metro_Waterways FS (Update)
Based on conversations with PM-E, Trap channel was deemed appropriate for typical section.

Input

Descriptor =	2B 72nd St Channel Restoration		
Design Event (Year) =	Winter Q	Yr	
Flowrate =	87	cfs	Fr Stormwater Master Plan. Model Link segment 221.
Ml (X:1) =	4		
Mr (X:1) =	4		
Bottom Width =	6	ft	
Slope =	0.001	ft/ft	
Manning's n =	0.045		(assumed higher vegetation cover in the channels of Cedar Creek.
Provided Depth =	4	ft	Recomended D = Dn + Freeboard = 4.08
Required Freeboard =	1	ft	F = 1 ft min.
Units	1	(1 for US Customary and 2 for SI)	

Output

Normal Depth =	**3.07849969**	**ft**	Critical Depth =	1.379164145	ft
Velocity =	**1.54311026**	**fps**	Critical Veloity =	5.477430529	fps
Hydraulic Top Width =	30.6279975	ft	Shear Stress , Td =	0.192098381	lb/ft^2
Flow Area =	56.3796396	Sq. ft.	Freeboard =	0.921500308	ft
Froude Number =	0.20043205				
Required Channel Depth =	4.07849969	ft			
Channel Top Width =	38	ft			



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Frontal Weir Calculator
Hydraulic Calculations

		By:	**KBD**
Project:	**Metro_Waterways FS (Update)**	Date:	**Nov-12**
Subject:	**2B -Flow Split Structure**	Checked:	
	Assume a weir	Project No.:	

Notes: ***Approximate*** Concrete Intake dimmensions = 22'x22'x10' Height = 10'
Weir Breadth = 8"
Design Flow. Assume 50-50 split, 40 cfs + 70 cfs (Jan mean flow)
Q = 55 cfs
1' allowable head

Broad Crested Weir Calc:

Q = C*L(H)^1.5

C is the weir coefficient from Brater-King
L is the length of Weir
H is the energy head over weir - assume near zero velocity US.

Calculations

Input

	High Q
C	3.14
L (ft)	18
H (ft)	1

Output

Q (high) **56.52** cfs

Table 5-3. Values of C in the Formula $Q = CLH^{3/2}$ for Broad-crested Weirs

Measured head in feet, H	Breadth of crest of weir in feet										
	0.50	0.75	1.00	1.50	2.00	2.50	3.00	4.00	5.00	10.00	15.00
0.2	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68
0.4	2.92	2.80	2.72	2.64	2.61	2.60	2.58	2.54	2.50	2.56	2.70
0.6	3.08	2.89	2.75	2.64	2.61	2.60	2.68	2.69	2.70	2.70	2.70
0.8	3.30	3.04	2.85	2.68	2.60	2.60	2.67	2.68	2.68	2.69	2.64
1.0	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63
1.2	3.32	3.20	3.08	2.86	2.70	2.65	2.64	2.67	2.66	2.69	2.64
1.4	3.32	3.26	3.20	2.92	2.77	2.68	2.64	2.65	2.65	2.67	2.64
1.6	3.32	3.29	3.28	3.07	2.89	2.75	2.68	2.66	2.65	2.64	2.63
1.8	3.32	3.32	3.31	3.07	2.88	2.74	2.68	2.66	2.65	2.64	2.63
2.0	3.32	3.31	3.30	3.03	2.85	2.76	2.72	2.68	2.65	2.64	2.63
2.5	3.32	3.32	3.31	3.28	3.07	2.89	2.81	2.72	2.67	2.64	2.63
3.0	3.32	3.32	3.32	3.32	3.20	3.05	2.92	2.73	2.66	2.64	2.63
3.5	3.32	3.32	3.32	3.32	3.32	3.19	2.97	2.76	2.68	2.64	2.63
4.0	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.70	2.64	2.63
4.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.74	2.64	2.63

Army Corps of Engineers

Trapezoidal Channel Hydraulic Calculations

		By:	KBD
Project:	**Metro_Waterways FS (Update)**	Date:	**Nov-12**
Subject:	**2B Gray Creek Channel Restoration - To 75th Ave Channel**	Checked:	
	Layback slopes, add side channels restore riparian and wetland veg.	Project No.:	

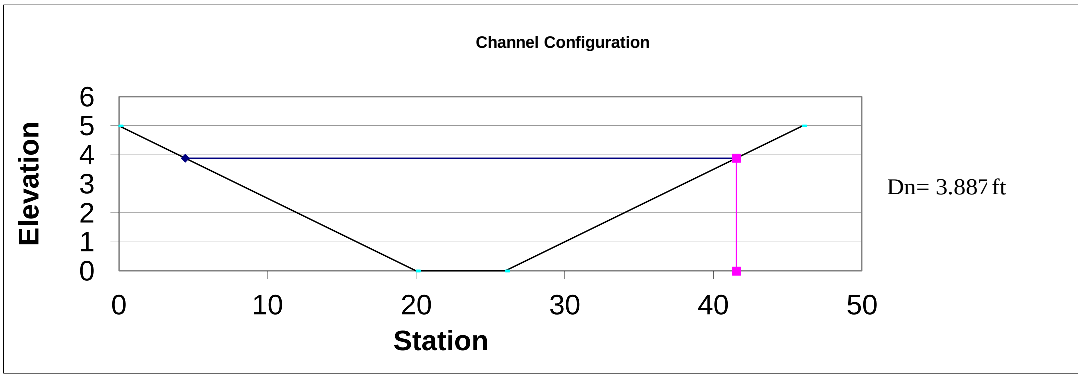
Notes: Eugene-Springfield_Metro_Waterways FS (Update)
Based on conversations with PM-E, Trap channel was deemed appropriate for typical section.

Input

Descriptor =	2B Gray Creek Channel Restoration - To 75th Ave Channel		
Design Event (Year) =	Winter Q	Yr	
Flowrate =	148	cfs	Fr Stormwater Master Plan. Model Link segment 40.
Ml (X:1) =	4		
Mr (X:1) =	4		
Bottom Width =	6	ft	
Slope =	0.001	ft/ft	
Manning's n =	0.045		(assumed higher vegetation cover in the channels of Cedar Creek.
Provided Depth =	5	ft	Recomended D = Dn + Freeboard = 4.89
Required Freeboard =	1	ft	F = 1 ft min.
Units	1	(1 for US Customary and 2 for SI)	

Output

Normal Depth =	**3.88704622**	**ft**	Critical Depth =	1.815990091	ft
Velocity =	**1.76697871**	**fps**	Critical Veloity =	6.144336974	fps
Hydraulic Top Width =	37.0963698	ft	Shear Stress , Td =	0.242551684	lb/ft^2
Flow Area =	83.7587906	Sq. ft.	Freeboard =	1.11295378	ft
Froude Number =	0.2072306				
Required Channel Depth =	4.88704622	ft			
Channel Top Width =	46	ft			



Attachment 5

Civil and Geotechnical Technical

Cedar Creek, Reach 1 Option E: Geotechnical Summary Sheet

Alternative Reach and Option Overview:

Reach 1E is primarily designed to improve water flow and fish passage into Cedar Creek along an approximately 3,000 foot long channel which connects the McKenzie River to Cedar Creek, located immediately west of Hendricks Bridge. Proposed alterations include improving inflow from Mckenzie River by placement of woody debris and possibly construction of a channel bottom weir; removal of a culvert and replacing the culvert with an open channel; and replacement of an existing intake water control structure with a fish friendly intake structure. Other modifications would include improving up to a few hundred feet of revetment and berm structures to protect the intake structure and maintain flows; and regrading and vegetating approximately 1,000 feet of channel bank for erosion control.

Regional and site geology:

The site lies in an area mapped as Holocene alluvium consisting of unconsolidated gravel, sand, silt, and clay deposited in active stream channels and on adjoining flood plans (USGS map I-2569, 2000; and interpolated from McClaughry et al., 2010). Much of the subject channel lies in a channel bar area, likely consisting of interbedded sands and gravels. The highly permeable nature of these deposits is one of the reasons for the need of modifying this channel, to hydrologically separate it from the McKenzie River. It is anticipated that soils in the project area will consist of 1 to 5 feet of silty and sandy topsoil, underlain by interbedded sands and gravel; this needs to be verified through site exploration.

Subsurface Explorations:

No subsurface explorations have been completed to date for the project. It is anticipated that explorations will consist of track-hoe excavated test pits to depths of approximately 15 feet, along the modified channel alignment, and in the area of the reconstructed water control intake structure. It is anticipated that 5 to 10 test pits will be required. Depending on the design of the water control structure, 1 or 2 borings, to depths of 20 to 30 feet, may also be required. Permeability tests should be completed in the test pits along the channel alignment to determine the hydraulic conductivity of the sediment. This information will be required to design the channel modifications. Explorations should be logged by an Oregon Registered Geologists, with soil samples collected for laboratory testing; including gradation, moisture, density, and Atterburg Limits (approximately 2 samples per test pit).

Selection of Preliminary Design Parameters:

It is anticipated that excavations will extend through several feet of loose to medium dense/stiff silty or sandy soils; underlain by interbedded sand and gravel of moderate geotechnical strengths. Soil parameters for design will be determined at the time of subsurface exploration and laboratory testing.

Geophysical Investigations:

No geophysical investigations are required or proposed.

Groundwater Studies:

No groundwater modeling is proposed for this project. It is anticipated that groundwater will be encountered at depths of 0 to 5 feet of the ground surface, during non-flood conditions, depending on location. Due to the permeable nature of the sandy and gravelly alluvium at the site, excavations below the groundwater table will require dewatering measures. Prior to design of the channel modifications, intended to control groundwater flow, permeability tests and groundwater modeling will be required.

Recommended Instrumentation:

No instrumentation is required for geotechnical purposes. However, staff gauges on the intake structure and along the channel, and installation of 2 or more piezometers would be useful for river level and groundwater monitoring purposes.

Earthquake Studies:

No site specific seismic study has been completed to date for the site, or is recommended. The historical earthquake record for the Willamette Valley basin is dominated by small to moderate earthquakes and an appreciable lack of significantly large earthquakes. However, abundant evidence indicates that a series of earthquakes related to the Cascadia Subduction Zone have occurred along the coastline of the Pacific Northwest. These earthquakes were likely of magnitude (M) 8.0 to 9.0, and are believed to have had a recurrence interval of 240 to 600 years, with the more frequent recurrence intervals occurring along the southern Oregon coast. It is not anticipated that future earthquakes will substantially impact the project.

Preliminary Foundation Design and Slope Stability Analysis:

There are currently no structural foundation designs available for the proposed water control structure, and there are no current grading plans for the proposed channel or bank slopes. Based on the limited information available, it is recommended that bank side cuts be designed to provide a stable, self supporting condition, at approximately 2 horizontal to 1 vertical maximum slopes. Final stable slope designs will depend on soil strengths, groundwater conditions, and channel flows. Temporary excavated cuts should be no steeper than 1 horizontal to 1 vertical (1H:1V), and flatter if water seepage is encountered. Groundwater seepage in non-cohesive silts and sands can cause flowing soil conditions; this may require temporary dewatering efforts for some cuts below the groundwater table.

Excavatability Analysis:

All grading activities will be accomplished with standard excavation equipment (track-hoes and dozers). It is anticipated that excavatability will be good. However, shallow groundwater could cause excavation difficulties, unless dewatering measures are implemented.

Anticipated Construction Techniques, Limitations, and Problems:

It is anticipated that construction will be completed primarily using standard excavation equipment. If very soft or loose soils conditions are encountered, subgrade improvement may be required to provide equipment access. Shallow groundwater will require pumping of excavations, and possibly providing flatter slopes to improve stability.

Potential Borrow Sites and Disposal Sites:

It is anticipated that all fill material used at the site will be imported onto the site from local quarries or gravel pits. Riprap, crushed rock, and sand and gravel used for construction will be imported from local quarry pits, within approximately 5 to 8 miles of the site. Excavated materials not used for on-site fills will be transported to approved disposal sites, within approximately 5 miles of the site.

Sources of Concrete Materials:

Concrete material for the water control structures will be obtained from local batch plants, within approximately 5 to 10 miles of the site, and truck onto the site. No material investigations have been completed to date.

Potential Concrete and Fill Sources:

No potential sources of concrete or earthen material has been identified to date. However, the project site lies just east of the Eugene/Springfield metropolitan area which has a number of commercial concrete batch plants. Also, there are a number of sand and gravel pits and rock quarries in the surrounding area that can supply earthen fill materials.

Geotechnical Impacts to Project:

Soil conditions at the site are anticipated to be silty to sandy soils to depths of approximately 1 to 5 feet; underlain by interbedded sands and gravels. Groundwater is anticipated to be 0 to 5 feet below the ground surface, depending on location and time of the year. Soils are anticipated to range from loose to medium dense. These variable soil conditions can be incorporated into the final grading design through varying slope grades. If soft to loose soils are encountered in the foundation area for the water control structures, specialized foundations may be required or overexcavation of soft soils and replacement with structural fill will be required.

Geotechnical Investigation Summary:

Subsurface exploration and soil testing shall be completed during the Preconstruction Engineering and Design phase of the project, as described above (C-4.1.2).

Laboratory Testing Summary:

No laboratory testing has been completed to date. A laboratory testing program will be completed in conjunction with the subsurface exploration during the Preconstruction Engineering and Design phase of the project.

Cedar Creek, Reach 2 Option B: Geotechnical Summary Sheet

Alternative Reach and Option Overview:

Reach 2B consists of approximately 5.5 miles of existing and proposed sloughs and channels that trend through the town of Thurston, Oregon. Proposed alterations are limited primarily to restoring aquatic and riparian habitat within existing channel limits through control of exotic vegetation along channel banks, planting riparian vegetation, and widen and restore channels. Vegetation control and replanting will require only limited geotechnical considerations. However, there will be one fish friendly water control structure constructed at the confluence of Cedar Creek and the north/south Cedar Creek channels, and approximately 4,000 to 4,500 feet of channel modifications, which will require more extensive geotechnical exploration and design.

Regional and site geology:

Much of the northern half of the project site lies in an area mapped as Holocene alluvium consisting of unconsolidated gravel, sand, silt, and clay deposited in active stream channels and on adjoining flood plans (McClaughry, et al., 2010). The central part of the site has been mapped as Holocene to upper Pleistocene older alluvium consisting of unconsolidated gravel, sand, silty and clay that formed on low terraces, on high river benches or abandoned stream channels. The southernmost part of the site generally consists of Quaternary terrace and fan deposits, of deeply dissected, unconsolidated to semi-consolidated, gravel, sand, silty and clay that form along upper alluvial terraces. Based on a preliminary review of water well logs, the site appears to be underlain by 3 to 14 feet of clayey to silty soils, underlain by clayey gravel to sandy gravel. It is not clear how still the upper clayey to silty soils are, or if they contain organic matter.

Subsurface Explorations:

No subsurface explorations have been completed to date for the project. It is anticipated that explorations will consist of track-hoe excavated test pits to depths of approximately 15 feet along the modified channel alignments, with one test pit excavated every 400 feet (10 to 12 test pits total). In addition, two test pits or borings, will be required in the area of the water control structure. Two borings, finished with the installation of piezometers, are also recommended in areas between North and South Cedar Creeks. The piezometers should be approximately 20 feet deep. Explorations should be logged by an Oregon Registered Geologists, with soil samples collected for laboratory testing; including gradation, moisture, density, and Atterburg Limits; assume two samples per test pit.

Selection of Preliminary Design Parameters:

It is anticipated that channels bottoms and side slopes will expose generally fine-grained clayey and silt soils, with moderate to weak geotechnical strengths. Soil parameters for design will be determined at the time of subsurface exploration and laboratory testing.

Geophysical Investigations:

No geophysical investigations are required or proposed.

Groundwater Studies:

No groundwater modeling is proposed for this project. It is anticipated that groundwater will be encountered at depths of 1 to 15 feet of the ground surface, during non-flood conditions, depending on location. It is not anticipated that groundwater conditions will be substantially impacted as the result of this project.

Recommended Instrumentation:

A minimum of two standpipe piezometers are recommended, with screening depths of 10 to 20 feet below existing grades.

Earthquake Studies:

No site specific seismic study has been completed to date for the site, or is recommended. The historical earthquake record for the Willamette Valley basin is dominated by small to moderate earthquakes and an appreciable lack of significantly large earthquakes. However, abundant evidence indicates that a series of earthquakes related to the Cascadia Subduction Zone have occurred along the coastline of the Pacific Northwest. These earthquakes were likely of magnitude (M) 8.0 to 9.0, and are believed to have had a recurrence interval of 240 to 600 years, with the more frequent recurrence intervals occurring along the southern Oregon coast. It is not anticipated that future earthquakes will substantially impact the project.

Preliminary Foundation Design and Slope Stability Analysis:

There are currently no structural foundation designs available for the proposed water control structure. As discussed above (C-4.1.3), overexcavation down to firm sand and gravel may be required in areas to receive structures, depending on subsurface conditions and foundation designs. Temporary excavated cuts should be no steeper than 1 horizontal to 1 vertical (1H:1V), and flatter if water seepage is encountered. Permanent cuts should be no steeper than 2H:1V. Excavations deeper than approximately 5 feet may require dewatering, if water seepage is encountered. Limited slope stability analysis will be required to determine stable slope bank configurations.

Excavatability Analysis:

All grading activities will be accomplished with standard excavation equipment (track-hoes and dozers). It is anticipated that excavatability will be good. There an approximately 600 foot long concrete box channel that will be removed, and the channel restored, at the south end of 72nd Street. Removal of this concrete box will require rock breakers and/or cranes to remove debris. Excavation and removal of the concrete box may be challenging, depending on site access constraints.

Anticipated Construction Techniques, Limitations, and Problems:

It is anticipated that construction will be completed primarily using standard excavation equipment, and possible crane. If very soft soils conditions are encountered, subgrade improvement may be required to provide equipment access. Shallow groundwater will require pumping of excavations, and possibly providing flatter slopes to improve stability. Soft soils under foundations may require specialized foundation design or overexcavation and replacement with structural fill.

Potential Borrow Sites and Disposal Sites:

It is anticipated that the use of fills will be minimal, with the exception of foundation backfill for the water control structure, and crushed rock for temporary access roads. Crushed rock backfill will be imported from local quarry pits, within approximately 5 to 8 miles of the site. Excavated materials not used for on-site fills will be transported to approved disposal sites, within approximately 5 miles of the site.

Sources of Concrete Materials:

Concrete material for the water control structure will be obtained from local batch plants, within approximately 5 to 10 miles of the site, and truck onto the site. No material investigations have been completed to date.

Potential Concrete and Fill Sources:

No potential sources of concrete or earthen material has been identified to date. However, the project site lies just east of the Eugene/Springfield metropolitan area which has a number of commercial concrete batch plants. Also, there are a number of sand and gravel pits and rock quarries in the surrounding area that can supply earthen fill materials.

Geotechnical Impacts to Project:

Soil conditions at the site are anticipated to be fine-grained clayey and silty soils to depths of approximately 3 to 14 feet; underlain by clayey and sandy gravel. Groundwater is anticipated to be 5 to 15 feet below the ground surface, depending on location and time of the year. Soils are anticipated to range from soft to stiff to medium dense. These variable soil conditions can be incorporated into the final grading design through varying slope grades. If soft soils are encountered in the foundation area for the water control structure, specialized foundations may be required or overexcavation of soft soils and replacement with structural fill will be required.

Geotechnical Investigation Summary:

Subsurface exploration and soil testing shall be completed during the Preconstruction Engineering and Design phase of the project, as described above (C-4.1.2).

Laboratory Testing Summary:

No laboratory testing has been completed to date. A laboratory testing program will be completed in conjunction with the subsurface exploration during the Preconstruction Engineering and Design phase of the project.

Cedar Creek, Reach 3 Option B: Geotechnical Summary Sheet

Alternative Reach and Option Overview:

Reach 3B consists of approximately 114 acres of floodplain, slough and pond area. Proposed alterations include riparian restoration, control exotic vegetation, pond reclamation, improvements to waterway connections, and installation of water control structures. There are three existing ponds originally formed by sand and gravel mining activities that require reclamation and/or improvements of side slopes to enhance riparian and emergent wetland vegetation. The sand and gravel pit is an actively permitted operation (Current Permittee is Green & White Rock Products, Permit ID #20-0008). The permit allows for mining of 41 acres. It is somewhat unclear how much of the original 41 acres has not yet been mined, but, records indicate that 32.5 acres of the site were reclaimed in 1998 (including the northern two ponds), and 20.8 acres of the site remain disturbed and un-reclaimed (this area includes the southern pond). The permit was originally opened in 1972, and a reclamation plan approved in 1978.

Fish friendly water control structures will be constructed adjacent to Cedar Creek, on the east side of the reach, to divert a portion of flow from Cedar Creek to the pond areas. Improvements to waterway connections adjacent to the water control structures will be limited to slight deepening of the channel to depths no greater than about 8 to 10 feet. Reach alterations are primarily limited to grading and vegetation activities, with the exception of the water control structures which will likely consist of concrete structures with gate features. Re-contouring of the pond edges will be limited to flatting of slide slope; no filling in of the ponds are anticipated.

Regional and site geology:

Most of the site lies in an area mapped as Holocene alluvium consisting of unconsolidated gravel, sand, silt, and clay deposited in active stream channels and on adjoining flood plans (McClaughry, et al., 2010). Based on a preliminary review of water well logs, the site appears to be underlain by 6 to 8 feet of clayey to silty soils, underlain by sandy gravel with some boulders. It is not clear how still the upper clayey to silty soils are, or if they contain organic matter.

Subsurface Explorations:

No subsurface explorations have been completed to date for the project. It is anticipated that explorations will consist of track-hoe excavated test pits to depths of approximately 15 feet, along the margins of the ponds, along the proposed improved waterway connections, and proposed water control structures. It is anticipated that test pits around the pond and along the sloughs will be excavated at every 400 feet (20 to 25 test pits total). Explorations should be logged by an Oregon Registered Geologists, with soil samples collected for laboratory testing; including gradation, moisture, density, and Atterburg Limits (approximately 2 samples per test pit). Infiltration tests should be conducted in at least 4 of the excavated test pits to determine infiltration and permeability parameters. A minimum of two borings should also be drilled and logged, with piezometers installed following exploration. The piezometers should be approximately 20 feet deep, with one constructed east and one west of the ponds. Depending on the design of the water control structures, one or two geotechnical borings (approximately 20 feet) may be required in the area of these structures to document subsurface conditions and complete testing of foundation soils.

Selection of Preliminary Design Parameters:

It is anticipated that the proposed channel and bank grading will be excavated in generally fine-grained clayey and silt soils, with moderate to weak geotechnical strengths. For excavations that extend below approximately 8 feet depth, sandy gravels may be encountered, which would have greater shear strengths. Depending on the design of the water control structures, and strengths of the overlying clayey and silty soils, overexcavation down to the stronger sand and gravel may be required. Soil parameters for design will be determined at the time of subsurface exploration and laboratory testing.

Geophysical Investigations:

No geophysical investigations are required or proposed.

Groundwater Studies:

No groundwater modeling is proposed for this project. It is anticipated that groundwater will be encountered at depths of 1 to 15 feet of the ground surface, during non-flood conditions, depending on location. It is not anticipated that groundwater conditions will be substantially impacted as the result of this project.

Recommended Instrumentation:

A minimum of two standpipe piezometers are recommended, with screening depths of 10 to 20 feet below existing grades.

Earthquake Studies:

No site specific seismic study has been completed to date for the site, or is recommended. The historical earthquake record for the Willamette Valley basin is dominated by small to moderate earthquakes and an appreciable lack of significantly large earthquakes. However, abundant evidence indicates that a series of earthquakes related to the Cascadia Subduction Zone have occurred along the coastline of the Pacific Northwest. These earthquakes were likely of magnitude (M) 8.0 to 9.0, and are believed to have had a recurrence interval of 240 to 600 years, with the more frequent recurrence intervals occurring along the southern Oregon coast. It is not anticipated that future earthquakes will substantially impact the project.

Preliminary Foundation Design and Slope Stability Analysis:

There are currently no structural foundation designs available for the proposed water control structures, and there are not currently grading plans for the proposed channel or bank slopes. Based on the limited information available, it is recommended that bank side cuts be designed to provide a stable, self supporting condition, at approximately 2 horizontal to 1 vertical maximum slopes. Final stable slope designs will depend on soil strengths, groundwater conditions, and channel flows. Groundwater seepage in non-cohesive silts and sands can cause flowing soil conditions; this may require temporary dewatering efforts for some cuts below the groundwater table. As discussed above (C-4.1.3), overexcavation down to firm sand and gravel may be required in areas to receive structures, depending on subsurface conditions and foundation designs. Limited slope stability analysis will be required to determine stable slope bank configurations.

Excavatability Analysis:

All grading activities will be accomplished with standard excavation equipment (track-hoes and dozers). It is anticipated that excavatability will be good.

Anticipated Construction Techniques, Limitations, and Problems:

It is anticipated that construction will be completed primarily using standard excavation equipment. If very soft soils conditions are encountered, subgrade improvement may be required to provide equipment access. Shallow groundwater will require pumping of excavations, and possibly providing flatter slopes to improve stability. Soft soils under foundations may require specialized foundation design or overexcavation and replacement with structural fill.

Potential Borrow Sites and Disposal Sites:

It is anticipated that all fills used at the site will be obtained through excavation of the existing channel and pond banks, with the exception of any riprap for erosion control, and crushed rock for foundation support and access roads. Any riprap and crushed rock will be imported from local quarry pits, within approximately 5 miles of the site. Excavated materials not used for on-site fills will be transported to apperoved disposal sites, within approximately 5 miles of the site.

Sources of Concrete Materials:

Concrete material for the water control structures will be obtained from local batch plants, within approximately 5 miles of the site, and truck onto the site. No material investigations have been completed to date.

Potential Concrete and Fill Sources:

No potential sources of concrete or earthen material has been identified to date. However, the project site lies just east of the Eugene/Springfield metropolitan area which has a number of commercial concrete batch plants. Also, there are a number of sand and gravel pits and rock quarries in the surrounding area that can supply earthen fill materials.

Geotechnical Impacts to Project:

Soil conditions at the site are anticipated to be fine-grained clayey and silty soils to depths of approximately 6 to 8 feet; underlain by sandy gravel. Groundwater is anticipated to be 1 to 15 feet below the ground surface, depending on location and time of the year. Soils are anticipated to range from soft to stiff to medium dense. These variable soil conditions can be incorporated into the final grading design through varying slope grades. If soft soils are encountered in the foundation area for the water control structures, specialized foundations may be required or overexcavation of soft soils and replacement with structural fill will be required.

Geotechnical Investigation Summary:

Subsurface exploration and soil testing shall be completed during the Preconstruction Engineering and Design phase of the project, as described above (C-4.1.2).

Laboratory Testing Summary:

No laboratory testing has been completed to date. A laboratory testing program will be completed in conjunction with the subsurface exploration during the Preconstruction Engineering and Design phase of the project.

Attachment 6 Costs

2013Dec10

Springfield Metro Waterways Parametric Estimate for Feasibility

Springfield, Lane County Oregon

1. Project Description: This project will involve many features of a general ecosystem restoration. The area of focus will be Cedar Creek watershed system that receives it headwaters from the McKenzie River.

2. Basis of Design: EC 1110-2-1150 Engineering and Design for Civil Works Projects

3. Construction Schedule: Currently the projected time of construction for this work is from 2016 through 2039.

a. Construction Windows. Normal In-Water Work Windows will apply.

c. Acquisition Plan. It is anticipated that the majority of this work will be Small Business Set-Aside. There are a number of construction firms within the immediate area and within the Northwest Region that are capable of performing work of this type.

4. Subcontracting Plan. It is anticipated that most of this work will be broken into smaller contract segments and awarded as funding for design and construction is available. This may limit the requirements for subcontracting plans based on the total dollar value of the contract awards.

5. Project Construction.

a. Site Access. Right of Entry Agreements, Easements, and access road will be required to reach the various features of work along the numerous reaches of stream and river channels.

b. Borrow Areas. Borrow is assumed to be locally available with some re-use of excavated materials for berms, backfill, etc.

c. Construction Methodology. Standard construction techniques are assumed to be employed in the field for excavating, field fabrication, and erection of various features.

d. Unusual Conditions (Soil, Water, Weather). Seasonal high ground water. Dewatering techniques of various methods will be used during in-water work periods.

e. Unique Construction Techniques. N/A

f. Equipment/Labor Availability and Distance Traveled. These elements are covered in the overall project assumptions included in Appendix C of the Report.

6. Environmental Concerns. It is anticipated that all contract work will be performed with well maintained equipment. Spill kits are anticipated to be onsite during construction efforts. Fueling and maintenance are expected to be performed away from all water sources in designated areas.

7. Contingencies by Feature or Sub-Feature. Some quantities used in this estimate are based on distances scaled from aerial maps from GIS input. In addition, features of this estimate were based on quantities and unit prices, historical data, or cost models depending on the level of design information available. Additionally, some reliance was placed on information provided by the LCOG due to site familiarity, and similar related work in the local areas. Lacking design details, best engineering practices were used in assumptions. For a baseline value used for pricing contingencies within this estimate is set at 25%.

8. Effective Dates for Labor, Equipment, Material Pricing. The latest MII cost libraries have been incorporated into this construction estimate. Costs from similar project features were used to supplement the pricing of non-standard costs from the 2012 English Cost Book. Equipment pricing used is from 2011 EP 1110-1-8 Region 8 Equipment and Operating Expense Schedule. Labor rates are from the 2012 Seattle National Labor Library.

9. Functional Costs: Functional costs associated with this work were provided by the Task and Project Managers as follows:

a. 01 Account - Lands and Damages: Since this represents an LCA cost and has been provided by Real Estate.

b. 30 Account - Planning, Engineering and Design:

(1) Plans and Specifications: This account covers preparing plans and specifications, District review, ATR review, contract advertisement and award activities.

(2) Engineering During Construction: This item consists of Planning and Engineering Division support to Construction Division during construction and participation in the prefinal and final inspections of the contract.

c. 31 Account - Construction Management: This account covers construction management of the proposed contract work and pending design requirements, S&A will be assumed at a rate of 8.5% of the cost of construction..

Estimated Costs for Operations & Maintenance Needs

The estimated O&M needs and costs were based on the extensive experience the local sponsors have with aquatic, wetland, and riparian habitat restoration projects, and associated recreation facilities. Local sponsors have over 20 years experience with operating and maintaining habitat restoration type projects, including previous partnerships with the Army Corps of Engineers. Examples of restoration projects built and being maintained include: Checker Mallow, Dragon Fly Bend, Amazon Creek Enhancement Project, Delta Ponds, and most recently the Springfield Mill Race.

Cedar Creek Planning Area

One of the key *guiding principles* that was followed during the development of the restoration proposals was *"design projects for self sustainability, to ensure long-term viability (avoid creating high-maintenance systems)"*. As such, the proposed restoration projects will generally require a relatively low level of maintenance once they have established. However, some level of ongoing operations and maintenance will be required on all waterways proposed for restoration. Anticipated operations and maintenance requirements will be as follows:

Urban Waterways

Operations and maintenance along the waterways that lie within or immediately adjacent to the urban growth boundary will be the primary responsibility of the City of Springfield who currently has responsibility for most of those waterways. That includes South Cedar Creek, the 69th, 72nd, and 75th Street Channels, Gray Creek, and Gay Creek. Typical operation and maintenance tasks will include:

- Water control structure upkeep at the South and North Cedar Creek divergence;
- Vegetation management in riparian areas to control exotic species, provide habitat, and maintain channel flood conveyance function;
- Cleaning and debris removal;
- Bank repair as needed; and
- Routine trail maintenance.

Calculating Annual Operation and Maintenance Costs

Annual O&M costs were calculated for all reach options considered for the Cedar Creek planning area using figures provided by local sponsors based on their experience operating and maintaining similar projects or habitats in the region. The following assumptions were used to calculate annual O&M costs:

- Riparian O&M: $750/acre/year
- Soft Surfaced Trail O&M: $5,000/mile/year
- Pump O&M: $10,000/year (Cedar 1A)
- Headgate O&M: $6,000/year (Cedar 1A-E)

The following table displays the O&M needs and costs by each reach option.

Cedar Creek Planning Area
Estimated Operations & Maintenance Costs by Reach Option

Reach	Waterway	Reach Options	Local Sponsor	Estimated Project Size	O&M Assumption	O&M (yearly estimate)
1	Cedar Intake	Alt. A	Springfield/SUB/ Lane County/ EWEB	3,500 lineal feet of revetment repair 13 ac	Pump O&M Headgate O&M	$16,000
		Alt. B	Springfield/SUB/ Lane County/ EWEB	2,600 lineal feet of new channel; 3,500 lineal feet of revetment repair 11 ac	Headgate O&M	$6,000
		Alt. C	Springfield/SUB/ Lane County/ EWEB	3,500 lineal feet of revetment repair 20 ac	Headgate O&M 5 ac. Riparian	$9,750
		Alt. D	Springfield/SUB/ Lane County/ EWEB	3,500 lineal feet of revetment repair 14 ac	Headgate O&M	$6,000
		Alt. E	Springfield/SUB/ Lane County/ EWEB	1,600 lineal feet of McKenzie River side channel; 3,500 lineal feet of revetment repair 14 ac	Headgate O&M 4 ac. Riparian	$9,000
2	Urban Waterway	Alt. A	Springfield/SUB/ EWEB	10,800 lineal feet of waterways 69 ac	18.5 ac. Riparian	$13,875
		Alt. B	Springfield/SUB/ EWEB	13,700 lineal feet of waterways 82 ac	23.6 ac. Riparian	$17,700
		Alt. C	Springfield/SUB/ EWEB	13,700 lineal feet of waterways 85 ac	23.6 ac Riparian 21,500 lf soft surf trail	$38,060
3	Blue Water Ponds, Keizer Slough	Alt. A	Springfield	14,200 lineal feet of waterways; 48 acres of pond	24 ac. Riparian	$18,000
		Alt. B	Springfield	14,200 lineal feet of waterways; 114 acres of pond	28 ac. Riparian	$21,000