Lower East Fork Lewis River

Habitat Restoration Plan

Developed with oversight by the East Fork Lewis Working Group
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The East Fork Lewis Working Group participants that contributed to the development of this aquatic habitat restoration plan include: Phil Burgess, Patrick Lee, John Tyler, and Joel Rupley of Clark County; Denis Smee of Clark County Conservation District; Jeff Wittler of Clark Public Utilities District; Dan Roix of Columbia Land Trust; Shannon Wills and Rudy Salakory of Cowlitz Indian Tribe; Bill Dygert Consultant; Tony Lasher and Nello Picinich of Lower Columbia Fish Enhancement Group; Jeff Breckel and Bernadette Graham Hudson of Lower Columbia Fish Recovery Board; Dean Swanson Landowner; Dick Dyrland Friends of the East Fork and also Fish First; John DiVittorio, Dick Doi, Bill Leistritz, and Jack Kaeding of Fish First; Stephanie Ehinger of National Oceanic and Atmospheric Administration; Dan Guy of National Marine Fisheries Service; Russ Lawrence of Pace Engineers; Jeroen Kok, Brian Potter and Rich Kolb of Vancouver-Clark Parks and Recreation; Tonnie Cummings of Washington Department of Ecology; Donna Bighouse, and Tim Rymer of Washington Department of Fish and Wildlife.

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Prepared by:

Gardner Johnston
Hydrologist
Inter-fluve, Inc
1020 Wasco Street, Suite 1
Hood River, Oregon 97031
www.interfluve.com

Kathryn Arendt
Fish Biologist
Cramer Fish Sciences
600 NW Fariss Road
Gresham, Oregon 97039
www.fishsciences.net

EXECUTIVE SUMMARY

The EF Lewis River has been identified as a critical component for successful recovery of Lower Columbia ESA-listed salmon and steelhead species (LCFRB 2004). The East Fork Working Group (Work Group) was convened to develop a consensus based plan of prioritized actions to recover and restore important salmon and steelhead habitat in the Lower East Fork Lewis River Basin. Development of this Plan was led and coordinated by the Lower Columbia River Fish Recovery Board (LCFRB).

It is the primary objective of the Work Group that this Plan balances the needs of fish and people. Its purpose is to identify the root causes of habitat degradation within the Lower East Fork Lewis Basin and develop goals, objectives, and specific restoration and preservation actions that will, as an aggregate, help recover salmon and steelhead habitat in the EF Lewis River. The specific objectives identified in the Plan include: working to develop strong local support for habitat restoration and preservation; preservation of existing quality habitat, protection and restoration of the channel migration zone, protection and enhancement of in-stream flows, monitoring and enhancing temperature conditions, enhancing in-stream and off-channel habitat, restoring native riparian forests, removing fish passage barriers, improving water quality, assisting with local land use planning, and implementing monitoring programs.

The Working Group identified a suite of restoration and assessment opportunities that accomplish reach-scale objectives and strategies. Project opportunities address the life stage limiting factors that have been identified through previous studies. A project ranking system was used to develop a final list of prioritized actions. This Plan identifies a total of 55 restoration/preservation actions for priority reaches in the Lower East Fork Lewis River Basin. These include 41 instream projects, 2 levee removal projects, 4 riparian restoration projects, 4 fish passage improvement projects, 3 assessment projects, and 1 land preservation project. Thirteen of the highest ranking projects were taken forward to the conceptual design stage; these projects are presented in Table 1.

Table 1. Summary of the highest ranking restoration, preservation, and assessment actions (identified by name and location) forwarded to the conceptual design stage.

Project ID	Project Name	Reach Name	River Mile
EF-A 02	Daybreak Pits avulsion risk assessment	EF Lewis 6A, 6B, 6C, 7, 8A	7.3 - 9.5
EF 28	Side-channel restoration	EF Lewis 8A	9.0 – 9.5
EF 41	Riparian restoration	EF Lewis 5A, 5B	5.7 - 7.3
MS 01	Lower Mason habitat enhancement	Mason Creek 1	0 - 1
EF 10	Side-channel habitat enhancement	EF Lewis 8B	13 - 13.5
MN 02	Manley Creek habitat enhancement (downstream of 259th)	Manley Creek 1B - 1C	0.2 - 0.75
EF 21	Side-channel habitat enhancement	EF Lewis 8A	10.5
EF 42	Levee and drainage ditch removal	EF Lewis 4B	5.1
EF 20	Side-channel and backwater habitat enhancement	EF Lewis 8B	10.7
EF 12	Instream habitat enhancement	EF Lewis 8B	11 - 11.3
EF-A 01	Ridgefield Pits alternatives assessment	EF Lewis 6B; Dyer Cr 1,2	7.3 - 8.3
EF-A 03	Temperature and groundwater assessment	EF Lewis 5A-8B	5.7 - 15
EF 05	Off-channel habitat enhancement	EF Lewis 8B	14

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CHAPTER 1 - INTRODUCTION

Background

The East Fork Lewis River Basin once supported significant populations of fall Chinook salmon, chum salmon, coho salmon, and winter steelhead. These populations have declined dramatically in the watershed, and beginning in 1998, were listed under the Endangered Species Act (ESA) as Threatened. In 2004, the Lower Columbia Fish Recovery Board (LCFRB) developed a Salmon Recovery Plan and Sub-basin Fish and Wildlife Plan (Recovery Plan) (LCFRB 2004). The Recovery Plan included an assessment of conditions in the East Fork Lewis River, identification of factors limiting fish population and recovery, and developed a suite of protection and restoration goals to aid recovery of these critical populations.

The decline of native anadromous fish populations in the Columbia Basin have been attributed to many factors which are commonly referred to as the "four H's:" harvest, hydropower development, hatchery impacts, and habitat loss. While the Recovery Plan addressed many of the factors associated with the "four H's, it did not identify specific restoration actions necessary to restore and protect aquatic habitat. This Habitat Restoration Plan (Plan), being undertaken by the East Fork Lewis River Work Group (Working Group), addresses the specific goals and measures needed to improve aquatic habitat in the Lower East Fork Lewis Basin.

The Plan's approach builds on the previous work of the Recovery Plan by developing reach specific restoration and preservation objectives and constraints, identifying project sites where it is appropriate to conduct restoration/preservation or monitoring projects, and prioritizing the projects based on biological benefits, cost, and other feasibility factors. These prioritized projects will be used as the basis for future grant applications and actions by the LCFRB and other entities in the watershed. A subset of projects deemed suitable for near-term implementation was further developed to the conceptual design stage.

Additional resources consulted during development of the Plan can be found in the attached annotated bibliography (Appendix C).

Geographic focus

The geographic extent of the Plan area begins at the confluence of the EF Lewis and Lewis River at RM 0.0 and extends up the East Fork to RM 15.0. All of the major tributaries that fall within this section are included. To assist in identifying existing conditions and habitat restoration and preservation objectives for a large number of reaches, the reaches have been grouped based on geomorphic similarities and the spatial extent of available information. Tributary reaches were segmented into two categories; the first segment includes reaches that lie within the mainstem EF Lewis River valley floor; the second segment includes tributary reaches that extend beyond the valley floor.

Collaborative process

The partners involved in the development of this plan include a variety of federal, state, tribal and private interests. Some of the partners have jurisdiction for improving habitat, some are responsible for land management activities, some are local landowners, and others represent various local or regional interests. In developing this Plan, the Working Group recognized the need for a comprehensive, collaborative approach to restoration in the Basin that builds upon existing partnerships and encourages new public and private relationships. By working together to develop reach level goals and objectives and then identifying the highest priority actions in the highest priority reaches, the Working Group hopes to ensure that restoration actions meet recovery goals.

The public is a key partner in restoration

This Plan is not a regulatory document. It relies on the willing cooperation of public landowners, private landowners, local interest groups, and the people of the basin. It also requires the support of federal, state, local and tribal governments. It is a goal of this Plan to engage the public as an active partner in implementing and sustaining restoration efforts. This goal will be achieved by building public awareness, understanding and support; and by providing opportunities for participation in all aspects of restoration implementation. The Working Group has guided the planning process, and public feedback has been incorporated into the Plan. No project that occurs on private land will be forwarded to conceptual design or funding without landowner consent. Projects that have support of the landowner will include all landowner concerns (such as erosion and flood control protection and recreation uses) and will be incorporated as explicit design criteria to guide project designs.

Two public meetings were held in March 2009 to introduce the Plan to landowners and to solicit input on aspects of the Plan. Invitations were sent to all landowners owning land adjacent to waterways in the lower East Fork Lewis River Basin. Attendees submitted verbal and written comments. In some cases, the Plan was amended based on comments, and in other cases, comments were addressed through clarification or explanation. The comments and responses are included as Appendix F. This appendix also includes the input received from members of the Lower Columbia Fish Recovery Board Technical Advisory Committee (TAC).

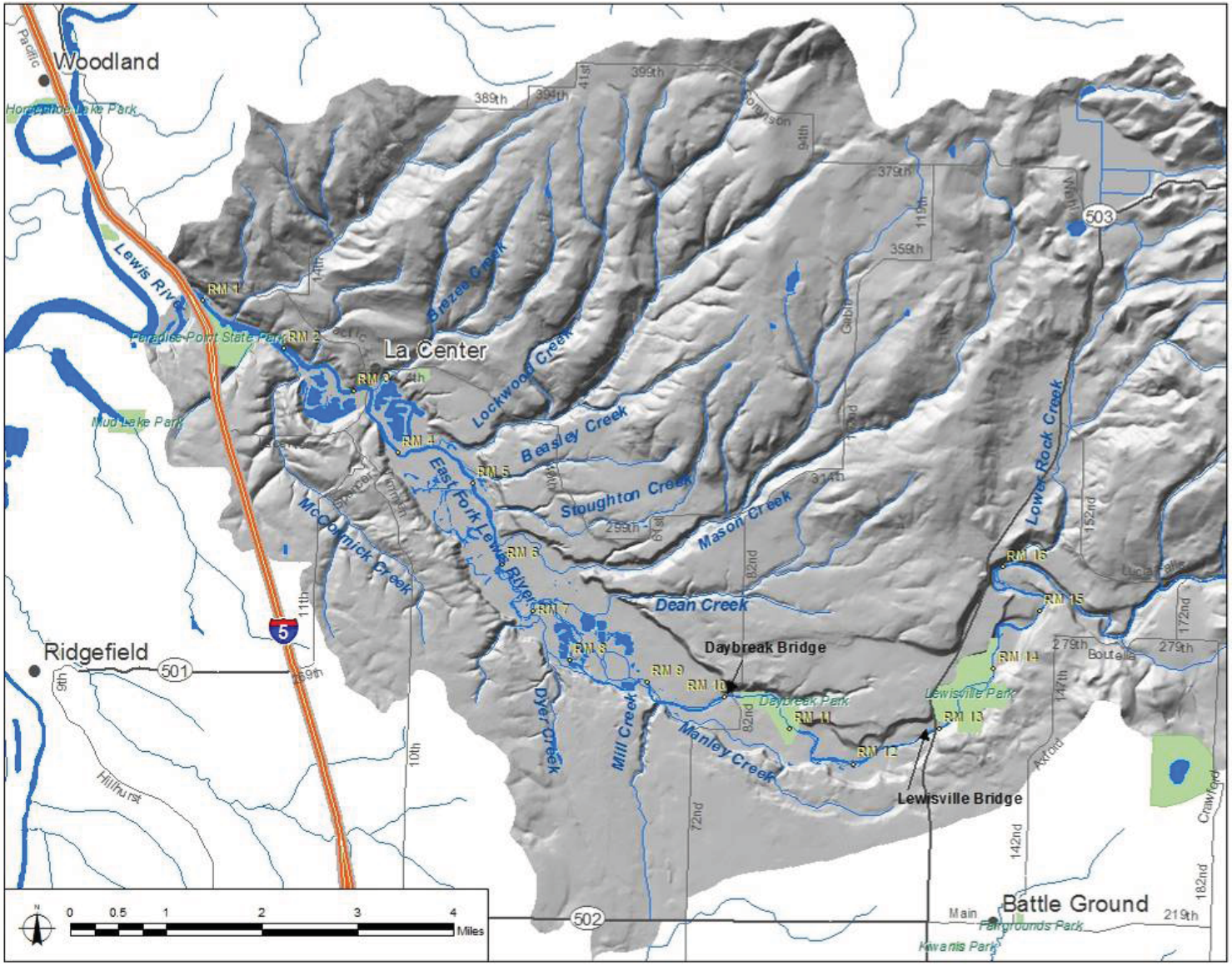


Figure 1. The project area encompasses the Lower East Fork Lewis River Basin (gray hillshade) up to river mile (RM) 15, just upstream of Lewisville Park.

CHAPTER 2 – GOALS AND OBJECTIVES

Vision

The EF Lewis River has been identified as a critical component for successful recovery of Lower Columbia ESA-listed salmon and steelhead (LCFRB 2004). All five populations of salmon and steelhead in the EF Lewis are considered "primary" populations for regional species recovery. The purpose of this Plan is to identify the root causes of habitat degradation within the Basin and develop goals, objectives, and specific restoration and preservation actions that will, as an aggregate, help recover salmon and steelhead habitat in the EF Lewis River.

This Plan builds upon the goals and objectives identified in the Salmon Recovery Plan and Sub-basin Fish and Wildlife Plan (LCFRB 2004), which stated vision is: *of a scientifically credible, socially and culturally acceptable, and economically and politically sustainable plan wherein: Washington lower Columbia salmon, steelhead, and bull trout are recovered to healthy, harvestable levels that will sustain productive sport, commercial, and tribal fisheries through the restoration and protection of the ecosystems upon which they depend and the implementation of supportive hatchery and harvest practices, and; The health of other native fish and wildlife species in the lower Columbia will be enhanced and sustained through the protection of the ecosystems upon which they depend, the control of non-native species, and the restoration of balanced predator/prey relationships (LCFRB 2004).*

Regional recovery plan goals and priorities

All five salmon and trout populations are considered primary to population recovery in the Lower Columbia Basin and are expected to achieve high levels of viability (LCFRB 2004). The current viability status and recovery goal for each of the East Fork populations is presented in Table 2.

The Recovery Plan concluded that contributions to recovery and mitigation in the Lower EF Lewis would come from a variety of actions, programs, and projects. The following list describes the most immediate priorities identified in the Recovery Plan and the 6 Year Habitat Work Schedule. This Plan focuses on four of the nine priorities (highlighted below) which can be specifically addressed by restoration /preservation actions. The remaining priority elements are being addressed via other state and local regulatory compliance means.

1. **Protect intact forests in headwater basins**
2. **Restore lowland floodplain function, riparian function and stream habitat diversity**
3. Manage growth and development to protect watershed processes and habitat conditions
4. Manage forest lands to protect and restore watershed processes
5. **Restore passage at culverts and other barriers**
6. **Address immediate risks with short-term habitat fixes**
7. Align hatchery priorities with conservation objectives
9. Reduce out-of-basin impacts so that the benefits of in-basin actions can be realized.

Table 2. Current viability status of East Fork Lewis populations and the biological objective that is necessary to meet the recovery goal for the Cascade strata and the lower Columbia ESU (source, LCFRB 2004a).

Focal Species	ESA	Hatchery Component[1]	Historical Numbers[2]	Recent Numbers[3]	Current Viability[4]	Recovery Goal
Fall Chinook	Threatened	No	4,000-30,000	100-700	V Low	900
Chum (a)	Threatened	No	120,000-300,000[5]	<100	V Low	not identified
Coho	Threatened	No	5,000-40,000	Unknown	V Low	2,000
Summer Steelhead	Threatened	Yes	1,000-9,000	100	V Low	500
Winter Steelhead	Threatened	Yes	3,000-10,000	100-300	Med	400

(a) Includes combined East Fork and North Fork Lewis populations
1 Significant numbers of hatchery fish are released in the sub-basin.
2 Historical population size inferred from presumed habitat conditions using Ecosystem Diagnosis and Treatment Model and NOAA back-of-envelope calculations..
3 Approximate current annual range in number of naturally-produced fish returning to the subbasin.
4 Prospects for long term persistence based on criteria developed by the NOAA Technical Recovery Team.
5 Historic production for the entire Lewis Basin.

Restoration plan goals and objectives

Central to this Plan are goals, objectives, and specific strategies that guide the development of preservation and restoration opportunities. The underlying intent of these goals is to ensure a holistic approach that addresses the root causes of aquatic habitat impairment. Rehabilitation measures that treat only the symptoms of habitat degradation, while disregarding the causes of impairment, may only provide short term benefits.

Presented below are eleven guiding goals and objectives that came out of Working Group discussions. **Reach specific objectives are presented in Appendix A.** The goals focus on addressing the root causes of habitat degradation to ensure that restoration actions result in long term benefits. The recommended timeline for sequencing and implementing these actions is included in Table 3.

Habitat preservation: Protect existing functioning upland and riparian forests, floodplain, and stream channel habitat and allow no further degradation in order to preserve existing habitat for Chinook, coho, steelhead, chum and other native aquatic species. Protect existing functioning headwater habitat in the tributaries.

Channel migration zone protection and restoration: Protect and restore the Lower East Fork Lewis channel migration zone where feasible to enhance long-term habitat forming processes needed to support multiple species and life-stages. Identify locations where restoration projects and/or acquisition could substantially enhance channel migration functions while considering downstream impacts of migration.

Protect and restore in-stream flows: Identify and correct sources of instream flow impairment. Identify and halt illegal withdrawals. Implement programmatic solutions to

instream flow issues. Supplement flows if necessary to enhance in-stream flows. Focus immediately on critical in-stream flow impairments in the tributaries (i.e. Manley Creek).

Temperature monitoring and enhancement: Take action to reduce elevated summer and fall stream temperatures (to TMDL standard) in order to benefit summer juvenile rearing (coho and steelhead) and prespawning holding and migration (fall Chinook, coho, and chum). Provide support to WDOE in TMDL assessment and help ensure a comprehensive and useful TMDL. Locate and monitor cold water refuge sources (i.e. groundwater). Evaluate innovative approaches for utilizing cold water sources. The Working Group determined that temperature was a critical limiting factor that must be corrected prior to the implementation of certain habitat restoration efforts. In light of temperature impairments, restoration planning should focus on projects that either help to reduce temperature impairment or that provide temperature refugia for fish during warm water periods.

Channel Stability and Sediment: Past gravel mining practices, hydromodifications and riparian degradation have altered channel stability, bank erosion rates, and sediment input and transport in the lower East Fork. Fine sediment deposition can impair spawning and egg incubation. Riparian restoration, placement of LWD, and the use of instream structures will improve sediment transport dynamics and reduce fine sediment input from upstream and local sources.

Habitat enhancement: Conduct habitat enhancement efforts including off-channel / side-channel reconnection and in-stream habitat enhancement using LWD. Preserve and enhance cold water refugia in the channel, floodplain, off-channel and side channel habitats for coho and steelhead rearing and adult migration and holding. Increase habitat complexity and access to thermal refuge areas. Increase abundance and quality of mainstem pool habitat.

Riparian restoration: Restore native riparian forest communities to increase long-term bank stability, shade, and LWD recruitment to benefit multiple species and life-stages. Reforest the lower East Fork Lewis valley bottom (historic floodplain and channel migration zone) from Lewisville Park to the mouth. Expand current efforts and provide annual funding for riparian restoration work. Support invasive species management.

Ridgefield pits restoration and daybreak pits avulsion risk assessment: The Ridgefield Pits avulsion area consists of severely degraded in-stream habitat conditions. Identify and evaluate potential alternatives for recovery of this reach, including active and passive restoration measures. The Daybreak Pits pose a potential avulsion/stream capture scenario that would be extremely detrimental to existing habitat quality and quantity. Assess the potential for stream channel avulsion through the pits and take measures to reduce or eliminate the risks.

Monitoring: Conduct monitoring to accomplish the following objectives: 1) measure progress towards accomplishing this Plan's objectives, 2) evaluate effectiveness of projects to accomplish species recovery goals, and 3) track long-term trends in habitat conditions. Monitoring will provide information that can be used to establish future restoration goals for the basin and will allow for an adaptive management approach to developing treatment strategies. Monitoring activities should occur in conjunction with the regional

monitoring strategy outlined in the Recovery Plan. In general, monitoring activities in the watershed should include:

a. Stream habitat quantity and quality, including the identification of existing and future potential spawning and rearing habitat capacity.
b. Sediment source and transport conditions.
c. Temperature monitoring in the main-stem and off-channel habitats. Establish an extensive temperature monitoring network. Consider an aerial thermal imaging study on the main-stem to identify cool water sources.
d. Invasive plant species monitoring
e. Juvenile and adult fish use patterns, survival, productivity, and abundance

Land use and public land management: Assist local governments and public agencies in developing land use policies and regulations and in managing public lands that will protect, restore and enhance salmon habitat in the Lower East Fork Lewis River.

Passage barriers: Remove barriers to fish passage and migration, such as culverts and dams, to expand access to historic habitat and ensure fish can seasonally migrate to preferred habitat. Specific fish passage barriers are discussed in Appendix B.

Water quality: Improve water quality conditions by restoring runoff processes and reducing fine sediment, farm waste, and storm-water inputs.

Table 3. Scheduling goals for implementation of restoration, preservation, and monitoring actions.

Task	2009	2010	2011	2012	2013	2014	2015
Riparian restoration							
	Have valley floor planted by 2012						
CMZ protection and restoration							
	Work to secure CMZ protection until complete						
Ridgefield and Daybreak Pits Assess							
	Assessment and designs by 2010						
Passage barriers							
	All significant barriers corrected by 2012						
Temperature assessment							
	Assessment and recommendations by 2011						
In-stream flow protection							
	Work to restore in-stream flows until complete						
Habitat preservation and enhancement							
	Enhancement each year based on assessment work						
Monitoring							
	Annually to measure progress and inform enhancement						

Project sequencing and grouping

Whenever feasible, restoration and preservation actions should be combined to maximize fish benefits and gain cost efficiencies. By combining projects and sequencing complimentary projects, impacts to public uses can be reduced, permitting and funding can be streamlined, and disruption to fragile environments minimized. Project sequencing requires cooperation and communication among the various interest groups and ensures that overall strategies and goals are being met.

Consideration of other wildlife and habitat values

The East Fork Lewis River Watershed supports a tremendous number of species of flora and fauna, all of which form relationships that constitute a vital ecosystem. Many of those species have been adversely affected by ecosystem changes. While this Plan focuses on recovery of important salmon and trout habitat, it is critical that preservation and restoration actions integrate other wildlife and habitat values. Projects which negatively impact other important wildlife habitat will not be considered.

CHAPTER 3 – EXISTING CONDITIONS & LIMITING FACTORS

Overview

Existing data and studies were compiled and reviewed. These studies provide baseline information that is used to identify and evaluate appropriate restoration and preservation actions at both the basin and reach scale. An in-office review of technical information included watershed assessment (LCFRB 2005), EDT modeling, and available information on habitat conditions, hydromodifications, passage barriers, riparian conditions, sediment sources, and geomorphology. The majority of the available information can be viewed in the annotated bibliography which accompanies the Plan (Appendix C) as well as the Recovery and Subbasin Plan.

Mainstem and tributary existing conditions are discussed in this section (narrative descriptions and plansheet maps). Additional detailed information of existing conditions on each of the major tributaries is included in Appendix B.

EDT and priority stream reaches

To identify the factors which limit fish population in the watershed, the Recovery Plan used the Ecosystem Diagnosis and Treatment (EDT) life cycle model to identify how different species and life stages were affected by habitat conditions in reaches throughout the Lower East Fork Lewis Basin (Lichatowich, *et al* 1995; Lestelle, *et al*. 2004). Reaches were assigned to tiers according to biological objectives, fish distribution, critical life history stages, current habitat conditions, and potential fish population performance.

This Plan uses the same reach tier designations used in the Recovery Plan. Reaches that are high priority for one or more primary populations are identified as Tier 1. Tier 2 reaches are medium priority reaches for one or more primary populations. Tier 4 reaches are low priority for primary populations (Table 4). Detailed information on the life stage limiting factors for each reach and species is located at the end of this section (for mainstem reaches), and in Appendix B (for tributary reaches).

Table 4. Recovery Plan reach tiers in the Lower EF Lewis Basin (source, LCFRB 2004a).

Tier 1	Tier 2	Tier 4
EF Lewis Reach 4A-8B	Dean Cr 3	EF Lewis 1-3, tidal
Brezee Cr 2	Dyer Cr 2, 4	Brezee Cr 1, 3-5, tribs
Dean Cr 1A	Lockwood Cr 1	Beasely Cr
Dyer Cr 1	McCormick Cr 1A,C,I	Dean Cr 2
Jenny Cr	Mill Cr 1 A	Dyer Cr 3,5,dam
Mason Cr Trib 1	Mason Cr 1,3,8	Lockwood Cr 2,3,4, trib
Manley Cr 1 A	Mason Cr RB Trib 1 A	Manly Cr 2, culverts
Manley Cr 1 D	Manley Cr 1 B,C	Mason Cr 2,4-7, tribs/culverts
Manley Cr 1 E		McCormick 1B

Tier 1	Tier 2	Tier 4
Manley Cr 1 F		Mill Cr 1B-D, culvert, fishway
Manley Cr 1 G		Riley Cr 1-5, culvert, tribs
McCormick Cr D-H		Stoughton Cr 1-3, culvert, dam
Mill Cr 1C		Unnamed Tributary 1

*Note: The absence of Tier 3 reaches results from all of the EF Lewis populations being designated as 'primary' populations with respect to regional recovery objectives.

Key limiting factors

The following are the primary aquatic habitat limiting factors identified as part of Recovery Planning which were used to inform the restoration planning process.

- Water Temperature
- Habitat Diversity
- Key Habitat Quantity
- Channel Stability
- Sediment
- Passage Barriers
- Predation
- Oxygen
- Pathogens
- Lack of Nutrients

The above limiting factors, as well as additional limiting factors identified by the Working Group, were discussed in detail with respect to scientific uncertainty, significance to the watershed, and strategies needed to address underlying causes. The primary limiting factors are presented and discussed below.

Elevated stream temperature

Elevated water temperatures during the summer and early fall are of primary concern to recovery efforts in the Lower East Fork Lewis Basin. Juvenile salmon and steelhead use both the mainstem East Fork and its tributaries as critical rearing habitat during the summer months. Stream temperatures in the mainstem commonly exceed the 64°F (18°C) State standard, and occasionally exceed 73.4ºF (23ºC) at locations from Lewisville Park and downstream (Table 5). Temperatures in excess of 22 ºC are considered lethal to rearing salmon and trout. In the Ridgefield gravel pits (RM 8), temperatures may be warming as a result of large water surface areas within the former gravel pits. Temperature monitoring has found water warmer below the Ridgefield Pits compared to above the Ridgefield Pits (Fish First, unpublished data). Stream temperatures are also a concern in McCormick Creek, Manley Creek, Lockwood Creek, and lower Dean Creek. Temperatures in excess of 77 ºF (25ºC) in lower Dean Creek have been recorded near the mouth.

There are a variety of human caused impacts that result in increased water temperatures. These include: 1) removal of trees and other shade-producing vegetation from stream banks, 2) reduction of summertime stream flows, 3) channel modifications and widening that increases the stream surface exposed to solar radiation, 4) loss of floodplain and groundwater (hyporheic) connectivity due to development, channel simplification, and channel incision, and 5) discharges of warm water from point sources, such as residential ponds adjacent to tributary reaches.

There is evidence that isolated areas of cool water are present both within the mainstem and off-channel habitats (Fish First, Inter-Fluve, unpublished data). In healthy alluvial systems where there is regular aquifer recharge, off-channel and side-channel habitat can be cooler than the mainstem river. Isolated pockets of cold water exist in places where the surface water is in contact with groundwater recharge. Side channels have been found to be resistant to warming and cooling through a buffering effect that occurs when water flows from the main channel, or from groundwater, to side channels via intra-gravel seepage (Poole and Berman 2002). The diversity of surface and subsurface flow allows for stratification, storage, insulation, and re-mixing of water of different temperatures, which can moderate daily temperatures during summer months and provide colder water than the mainstem (Pool et al 2002, Melchior et al 2005).

Table 5. Summary of average 7 day maximum temperatures observed in the mainstem East Fork Lewis River from 2001 to 2007 (source, WDOE 2005).

Mainstem Lewis (7DAM)	2001	2002	2003	2004	2005	2006	2007	Agency
Schultz residence					22.7			WDOE for TMDL
Lewisville Park					23.2			WDOE for TMDL
Daybreak Park/Dollar Corner	24.4	23.9	25.9	25.1	23.2	25.4	23.3	WDOE ambient monitoring
Above Ridgefield Pits					23.5			WDOE for TMDL
Below Dean Cr					23.3			WDOE for TMDL
Above Lockwood Cr					30.9			WDOE for TMDL
Mouth					27.2			WDOE for TMDL

Table 6. Summary of average 7 day maximum temperatures observed in the Lower East Fork Lewis River tributaries from 2002 to 2007 (source: WDOE 2005,Clark County unpublished data).

Tributaries (7DAM)	2002	2003	2004	2005	2006	2007	Agency	Location
Brezee Creek	18.8	19	20.5	19.5	19.4	20.5	Clark Cty	At La Center Road
Brezee Creek				19.5			WDOE	At mouth
Jenny Creek		19.6		19.9			Clark Cty	Pacific Highway
McCormick Creek			20.3				Clark Cty	La Center Road
Manly Creek				21.9	25.2		Clark Cty	Lower Daybreak
Manly Creek				21.5	22.8		Clark Cty	Downstream of culvert
Mason Creek			21.7				Clark Cty	JA Moore Road
Mason Creek				17.7			WDOE	Below Heitmann Cr
Mill Creek			16.3				Clark Cty	NE 259th St
Dean Creek				25.3			WDOE	At mouth
Dean Creek				22.6			WDOE	At JA Moore Road
Lockwood				22.1			WDOE	At mouth

Habitat diversity & key habitat quantity

Habitat diversity & key habitat quantity are low in the Lower East Fork Lewis (LCFRB 2004a). Habitat diversity is related to the complexity of available habitat and is influenced by such factors as gradient, channel confinement, riparian function, and the presence of large woody debris. Channel confinement is related to levees and past incision and has resulted in the loss of connectivity to important off-channel and side-channel habitat. Riparian function has been substantially impacted below RM 10 due to residential, agricultural, and mining development (LCFRB 2005). Complex galleries of

willow, alder, ash, cottonwood, and conifers that covered the valley floodplain have been replaced with remnant stands of those species intermixed with abundant Himalayan blackberry, scotch broom, and reed canary grass (LCFRB 2005). The loss of connected floodplains and healthy streamside forests has resulted in a steep decline in large woody debris inputs to the stream channel and floodplain. LWD density and habitat complexity are low throughout the lower river (LCFRB 2005).

Key habitat is defined as the primary habitat type(s) utilized by a species during a particular life stage; thus key habitat is different for each life stage. In the lower mainstem, main channel pool abundance and quality are poor, as is the quantity of available off-channel and side-channel habitat. Critical spawning habitat has been reduced as a result of channel confinement projects and the river's avulsion into the Ridgefield Pits, which eliminated approximately 3,200 lineal feet of riffle habitat (LCFRB 2005). It is estimated that over 50% of the off-channel habitat and wetlands in the historical lower river floodplain are no longer accessible (Wade 2000).

Channel migration zone

The following paragraphs describe the effects of past land-uses on channel migration and floodplain processes and the potential impacts on habitat quantity and quality. It should be recognized that there exists incomplete information regarding specific cause and effect relationships. It is the hope of the Working Group that additional studies and monitoring will advance our understanding of how land use alterations impact instream habitat and other beneficial uses. Over time, this information will continue to help guide the selection of appropriate enhancement strategies.

In the Lower East Fork Lewis, levees, rip-rap, gravel mining, historical dredging, riparian land clearing, reduction in large woody debris, and development have led to channel confinement and loss of river meander processes (LCFRB 2005). Past incision has been documented in several areas (e.g. Norman 1998) and is likely related to historical instream gravel mining (bar scalping), gravel pit avulsions, and historical dredging. In recent years, secondary aggradation has been observed (Fish First, unpublished data) and is likely a result of channel re-adjustment through bank erosion as the modified stream attempts to establish a new equilibrium. This is a common scenario that has been observed on many alluvial streams that have been subjected to river channelization/incision (Knighton 1998).

In an undisturbed free-formed alluvial river system, new channels are constantly being abandoned, re-shaped, and created anew by long-term geomorphic processes and channel migration. They are formed as the river evolves and migrates across its floodplain and channel migration zone, resulting in full or partial abandonment of meander channels, which can be seasonally or perennially inundated. These secondary channels provide critical habitat for juvenile salmonids by providing refuge from temperature and velocity fluctuations, cover from predation, and large areas of preferred edge habitat (Groot and Margolis 1991, Roni et al 2002). Off-channel habitats are often temporary features, which are created or lost depending on the frequency of channel adjustment. When natural processes such as river meandering, input of large wood, and sediment supply are disrupted by human actions, the channel responds through simplification, floodplain disconnection, loss of secondary habitats (i.e. off-channels and side-channels), and persistent instability (Roni et al 2002).

Channel simplification, incision, and lack of channel migration not only result in loss of habitat but also result in a loss of connection between groundwater and surface flow, which can lead to decreased dry season stream flows and increased summertime stream temperatures. At the habitat unit scale, the presence of connected side-channel and off-channel complexes, especially at low flows, increases the amount of surface water and groundwater connectivity. This hyporheic flow is important for moderating stream temperatures, a benefit that is lost as a result of channel simplification. At the valley and reach scale, the interaction between groundwater and surface flow is equally important. In undisturbed alluvial floodplain systems, water stored in the alluvial aquifer, such as the one that exists throughout the valley floor of the East Fork Lewis, slowly contributes cool water to the stream channel during dry periods. This process is disrupted by channel incision that reduces the ability of wet-season flows to adequately access floodplains and recharge the aquifer and that prematurely drains the stored aquifer water. Aquifer storage is further reduced by agricultural drainage ditches excavated into the floodplain. In disrupted systems where alluvial aquifers are not adequately recharged, instead of receiving water from the surrounding aquifer, rivers may "lose" water to the alluvial aquifer more readily as the dry season progresses, thus compounding temperature problems.

In-stream flow

Low flows in the summer and early fall are of concern in the East Fork Lewis Basin, particularly in the tributaries and as it relates to warm summer temperatures. Stream-flow is a driving force with regards to channel form and aquatic habitat connectivity. It provides the energy needed to transport water, sediment, organic material, nutrients, and thermal energy within the stream corridor. Stream-flow influences the water level of nearby groundwater and surface water bodies (such as wetlands, lakes, and ponds) and dictates the frequency, extent, and duration of floodplain inundation. Human-caused reductions in summer flows in the East Fork can lead to warmer water temperatures, reduced oxygen levels, fish stranding, increased competition for food and quality habitat, vulnerability to predation, and increase in disease.

The WRIA 27/28 Watershed Management Plan, adopted in 2006, sets forth goals, strategies, measures, and actions for managing water resources in the East Fork Lewis. The plan, developed pursuant to the state Watershed Management Act (RCW 90.82), recognizes that stream flows are an important determinant of habitat conditions for fish and other aquatic life in streams, and can be adversely affected by withdrawals for water supply and other human activities. To protect stream flows, the plan:

- Proposed minimum stream flows;
- Recommended that sub-basins be closed to further withdrawals;
- Established water reserves to meet future community needs;
- Developed flow and habitat mitigation measures as conditions for accessing water reserves;
- Called for the curtailment of unauthorized water withdrawals; and
- Identified watershed enhancements needed to improve stream flows over the long-term.

In 2008 the WA Department of Ecology adopted a water management rule (Chapter 173-527 Washington Administrative Code) for the Lewis River Basin that was consistent with the Watershed Plan and formally establishes minimum stream flows, water reservations, and mitigation requirements.

Channel stability & sediment

Bank stability is a concern in both the tributaries and the Lower East Fork. Between RM 7 and RM 10 channel avulsions into gravel mining pits (i.e. Ridgefield Pits and Mile 9 Pit), hydromodifications, and riparian degradation have altered the channel stability and rates of sediment supply in the lower river (LCFRB 2005). Channel avulsions and resulting incision has induced bank failures; and floodplain terraces have been cleared of forest vegetation that provides root strength and large wood recruitment. In some areas, bank retreat exceeds what would be expected if riparian forests were intact. Bank retreat recruits a mix of substrate/sediment depending on location. Some of the material is coarse-grained and contributes spawning-sized gravels, whereas other material is fine-grained and may impair spawning. Bank stability problems in the tributaries include segments of Mason Creek, cattle impacts on Rock Creek, and mass wasting sites in upper Lockwood Creek (Wade 2000, in LCFRB 2005). There are also believed to be many other undocumented bank erosion areas in the tributaries.

Passage barriers

No physical barriers exist on the mainstem of the Lower East Fork Lewis River. However, there are significant passage barriers (both natural and artificial) that exist on the tributaries (Appendix B). Jenny Creek has a natural waterfall barrier at RM 0.13 and Riley Creek has a series of cascades which may limit passage. McCormick, Brezee, Dyer, and Riley Creeks all have reservoirs that act as full or partial barriers. All the tributaries have passage problems at road crossings, where some culverts limit or completely block passage. The WDFW SSHIAP database and Clark County records helped identify and rate passage obstructions in the tributaries (Appendix B). Since Chinook and chum are primarily mainstem river spawners, they are less impacted by the tributary barriers. Coho, and to a lesser extent steelhead, are the species most impacted by the tributary barriers.

Predation

Reduced juvenile mortality due to increases in top predator species is of concern in the Lower East Fork. The ponded, slow water habitat in the avulsed section of the Ridgefield Pits reach provides preferred native and non-native predator habitat. Increased summer water temperature provide habitat for non-native warm water species which were not historically present and which prey on native salmonids. The presence of hatchery steelhead (which are released below Lewisville Park) may also increase predation of smaller native salmonids.

Water quality: pollutants, oxygen, pathogens

The Lower East Fork mainstem was listed on the 1998 WA state 303(d) list of impaired water bodies due to exceedances of temperature and fecal coliform standards (WDOE 1998). Elevated summer water temperatures combined with reduced stream flow can create conditions where dissolved oxygen falls below the preferred range. The primary concern regarding fish pathogens is related to the release of summer steelhead hatchery fish into the basin.

Reach-scale fish use and physical habitat conditions – plan-sheet maps

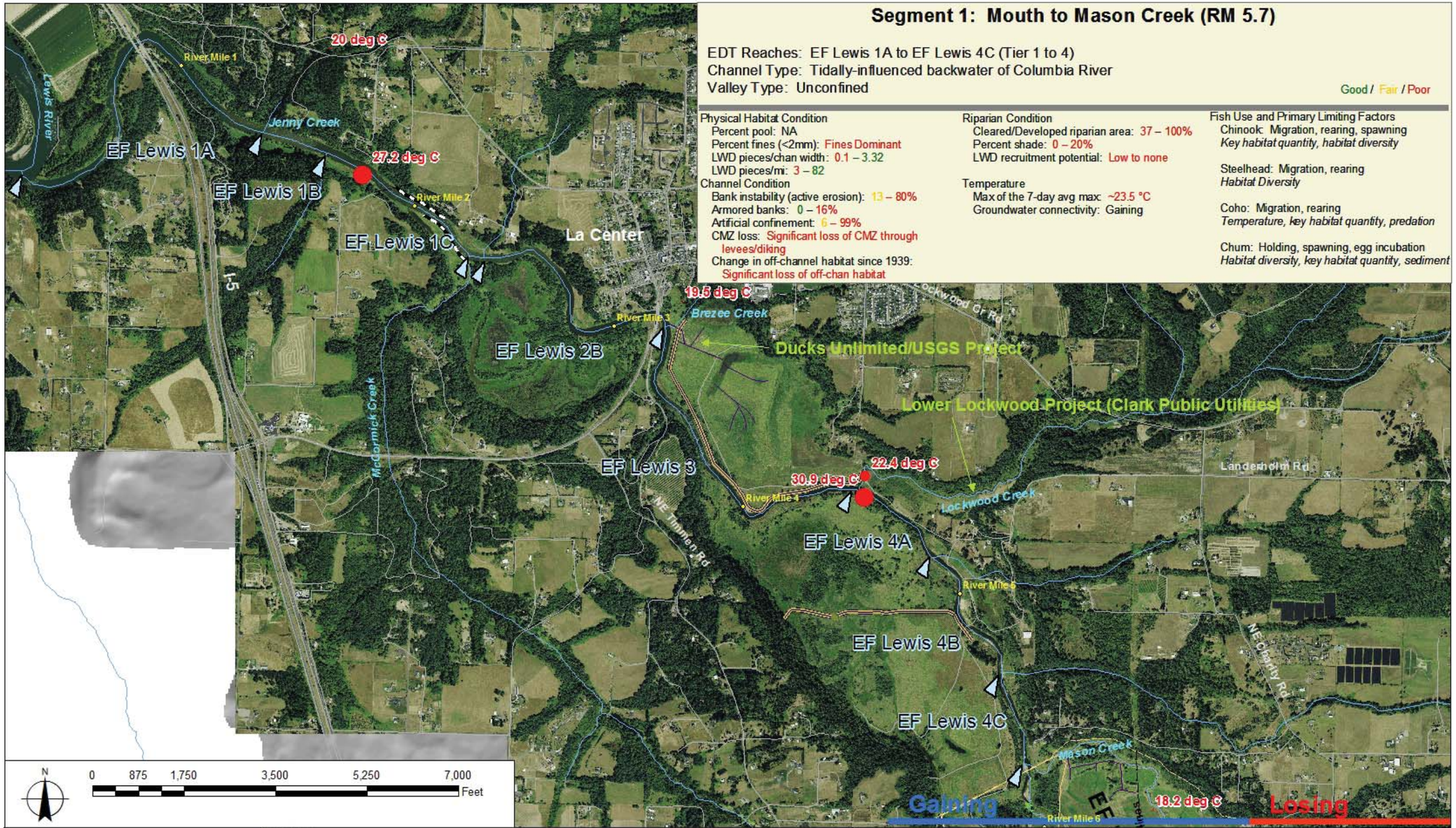
These maps present a summary of the known fish use and physical habitat data that is available for reaches within the Lower East Fork Lewis Basin. Maps are provided for groups of adjacent reaches with similar geomorphic settings. The data summarized on these maps includes results of WDFW spawner surveys (Chinook and steelhead), physical habitat data, stream temperature data, and past or proposed restoration project locations. Tributary reaches were segmented into two categories; the first segment includes reaches that lie within the mainstem East Fork Lewis River valley floor; the second segment includes tributary reaches which extend beyond the valley floor. Information on existing conditions is presented for each of the tributaries in Appendix B**.** Those segments include:

Mainstem East Fork Lewis River Segments:

- Segment 1A-4C: RM 0.0-5.7 (Mouth to Mason Creek).
- Segment 5A-6A: RM 5.7-7.3 (Mason Creek to Ridgefield Pits).
- Segment 6B: RM 7.3-8.0 (Ridgefield Pits Avulsed Reach)
- Segment 6C- 8B: RM 8.0-13 (Ridgefield Pits to Lewisville Bridge)
- Segment 8B: RM 13-15 (Lewisville Bridge to RM 15).

Lower East Fork Lewis River Tributary Segments:

	(valley floor)	(outside valley floor):
• Brezee Creek:	RM 0.0-0.48	RM 0.48 – headwaters
• Beasley Creek:	RM 0.0-0.35	RM 0.35 – headwaters
• Dean Creek:	RM 0.0-0.87	RM 0.87 – headwaters
• Dyer Creek:	RM 0.0-0.53	RM 0.53 – headwaters
• Jenny Creek:	RM 0.0-0.13	RM 0.13 – headwaters
• Lockwood Creek:	RM 0.0-1.39	RM 1.39 – headwaters
• Manley Creek:	RM 0.0-1.52	RM 1.52 – headwaters
• Mill Creek:		RM 0.00 – headwaters
• McCormick Creek:	RM 0.0-0.95	RM 0.95 – headwaters
• Swanson Creek:	RM 0.0-0.60	
• Stoughton Creek:	RM 0.0-0.86	RM 0.86 - headwaters
• Riley Creek:	RM 0.0-headwaters	


Segment 1: Mouth to Mason Creek (RM 5.7)
EDT Reaches: EF Lewis 1A to EF Lewis 4C (Tier 1 to 4)
Channel Type: Tidally-influenced backwater of Columbia River
Valley Type: Unconfined
Good / Fair / Poor
Physical Habitat Condition
Percent pool: NA
Percent fines (<2mm): Fines Dominant
LWD pieces/chan width: 0.1 – 3.32
LWD pieces/mi: 3 – 82
Channel Condition
Bank instability (active erosion): 13 – 80%
Armored banks: 0 – 16%
Artificial confinement: 6 – 99%
CMZ loss: Significant loss of CMZ through levees/diking
Change in off-channel habitat since 1939: Significant loss of off-chan habitat
Riparian Condition
Cleared/Developed riparian area: 37 – 100%
Percent shade: 0 – 20%
LWD recruitment potential: Low to none
Temperature
Max of the 7-day avg max: ~23.5 °C
Groundwater connectivity: Gaining
Fish Use and Primary Limiting Factors
Chinook: Migration, rearing, spawning
Key habitat quantity, habitat diversity
Steelhead: Migration, rearing
Habitat Diversity
Coho: Migration, rearing
Temperature, key habitat quantity, predation
Chum: Holding, spawning, egg incubation
Habitat diversity, key habitat quantity, sediment
20 deg C
River Mile 1
Lewis River
Jenny Creek
EF Lewis 1A
27.2 deg C
EF Lewis 1B
River Mile 2
EF Lewis 1C
La Center
I-5
19.5 deg C
Brezee Creek
River Mile 3
EF Lewis 2B
Ducks Unlimited/USGS Project
Lower Lockwood Project (Clark Public Utilities)
Lockwood Cr Rd
McCormick Creek
EF Lewis 3
22.4 deg C
30.9 deg C
River Mile 4
NE Timmen Rd
Lockwood Creek
Landenholm Rd
EF Lewis 4A
River Mile 5
EF Lewis 4B
NE Chelatchy Rd
EF Lewis 4C
Mason Creek
Gaining
River Mile 6
18.2 deg C
Losing
N
0 875 1,750 3,500 5,250 7,000
Feet
Legend
Roads
Steelhead redd locations ('04-'07)
Chinook redd locations (approx) ('04-'07)
Historic channel migration zone
Current channel migration zone
Reach Break
Levee
Airstrip
Bank Armoring
Ditched
Powerlines
Max of 7 day avg max (deg celsius)
17 - 20
20 - 22
22 - 24
24 - 26
26 - 31
*Temperatures from summer 2005 sampling by WA Dept of Ecology (unpublished data).
*Gaining and Losing designations from August 9, 2005 seepage run study conducted by WA Dept of Ecology (unpublished data).
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Mouth to Mason Creek (River Mile 5.7)
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Segment 2: Mason Creek (RM 5.7) to Ridgefield Pits (RM 7.3)

EDT Reaches: EF Lewis 5A to EF Lewis 6A (Tier 1)
Channel Type: Pool-riffle
Valley Type: Unconfined

Good / Fair / Poor

Physical Habitat Condition
- Percent pool: 70%
- Percent fines (<2mm): 7%
- LWD pieces/chan width: 1.12
- LWD pieces/mi: 50

Channel Condition
- Bank instability (active erosion): 34%
- Armored banks: 18%
- Artificial confinement: No levees (18% armored)
- CMZ loss: 64%
- Change in off-channel habitat since 1939: Significant increase

Riparian Condition
- Cleared/Developed riparian area: 45%
- Percent shade: 0 – 20%
- LWD recruitment potential: Low

Temperature
- Max of the 7-day avg max: 23.3 °C
- Groundwater connectivity: Gaining

Fish Use/Potential and Primary Limiting Factors

Chinook: Spawning, fry rearing, migration
Key habitat quantity, habitat diversity, sediment, temperature

Steelhead: Migration, parr rearing
Habitat diversity, sediment, temperature

Coho: Migration, fry and parr rearing
Key habitat quantity, temperature

Chum: Holding, spawning, egg incubation
Habitat diversity, key habitat quantity, sediment

Segment 3: Ridgefield Pits Avulsed Reach (RM 7.3 – 8)

EDT Reaches: EF Lewis 6B (Tier 1)
Channel Type: Pool-riffle
Valley Type: Unconfined

Good / Fair / Poor

Physical Habitat Condition
- Percent pool: 30%
- Percent fines (<2mm): Fines Dominant
- LWD pieces/chan width: 2.77
- LWD pieces/mi: 13 – 37

Channel Condition
- Bank instability (active erosion): 59%
- Armored banks: 0%
- Artificial confinement: 31%
- CMZ loss: Current = 100%; once pits fill = 49%
- Change in off-channel habitat since 1939: +47% (but it is low quality)

Riparian Condition
- Cleared/Developed riparian area: 81%
- Percent shade: 0 – 20%
- LWD recruitment potential: Low

Temperature
- Max of the 7-day avg max: ~23.5 °C
- Groundwater connectivity: Gaining

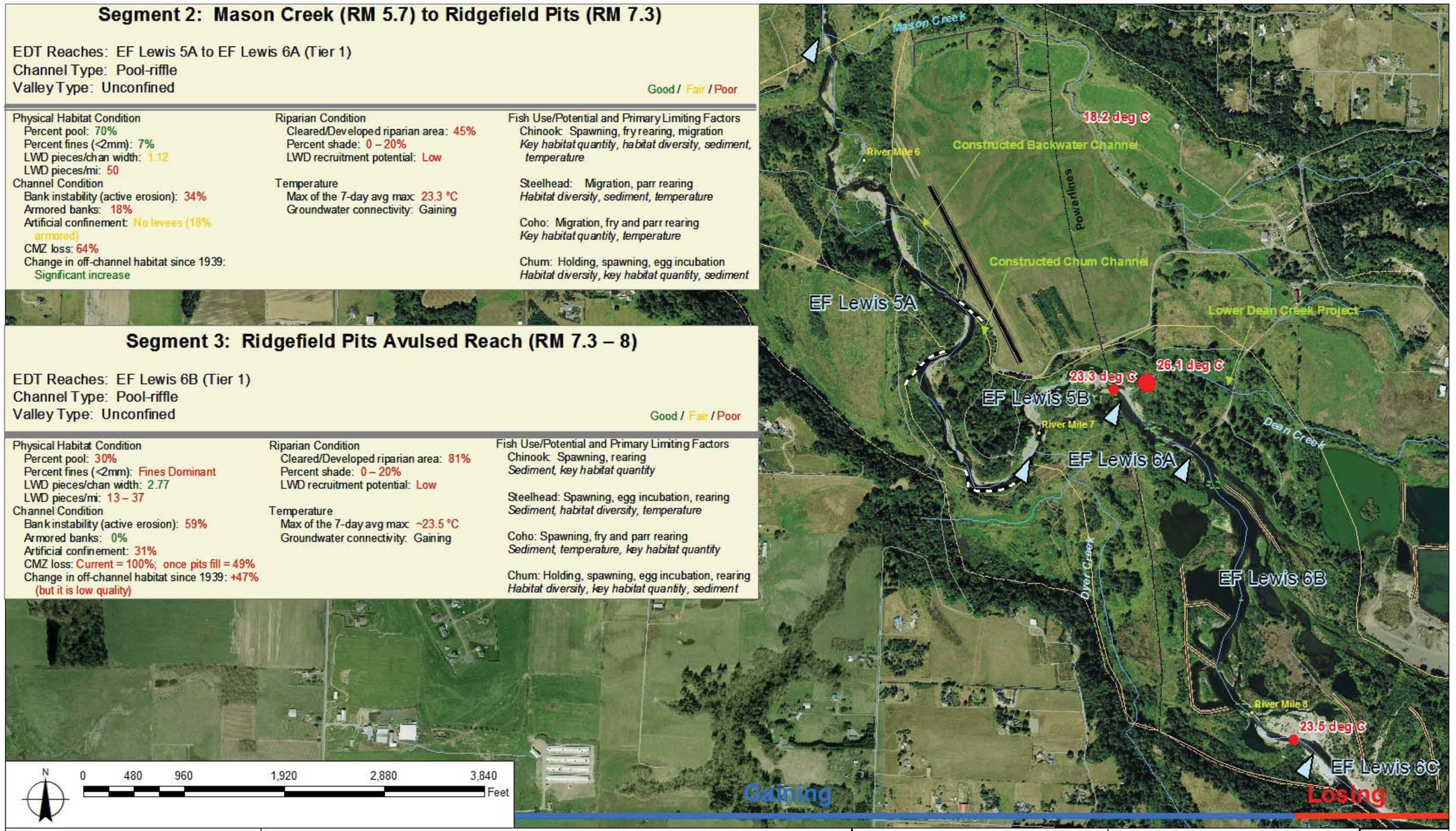
Fish Use/Potential and Primary Limiting Factors

Chinook: Spawning, rearing
Sediment, key habitat quantity

Steelhead: Spawning, egg incubation, rearing
Sediment, habitat diversity, temperature

Coho: Spawning, fry and parr rearing
Sediment, temperature, key habitat quantity

Chum: Holding, spawning, egg incubation, rearing
Habitat diversity, key habitat quantity, sediment



Legend
- Roads
- Steelhead redd locations ('04-'07)
- Chinook redd locations (approx) ('04-'07)
- Historic channel migration zone
- Current channel migration zone
- Reach Break
- Levee
- Airstrip
- Bank Armoring
- Ditched
- Powerlines

Max of 7 day avg max (deg celsius)
- 17 - 20
- 20 - 22
- 22 - 24
- 24 - 26
- 26 - 31

*Temperatures from summer 2005 sampling by WA Dept of Ecology (unpublished data).

*Gaining and Losing designations from August 9, 2005 seepage run study conducted by WA Dept of Ecology (unpublished data).

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Mason Creek (River Mile 5.7) through Ridgefield Pits (RM 8)

SHEET 2 of 6

Segment 4: Ridgefield Pits (RM 8) to Lewisville Bridge (River Mile 13)

EDT Reaches: EF Lewis 6C to EF Lewis 8B (Tier 1)
Channel Type: Pool-riffle
Valley Type: Unconfined

Good / Fair / Poor

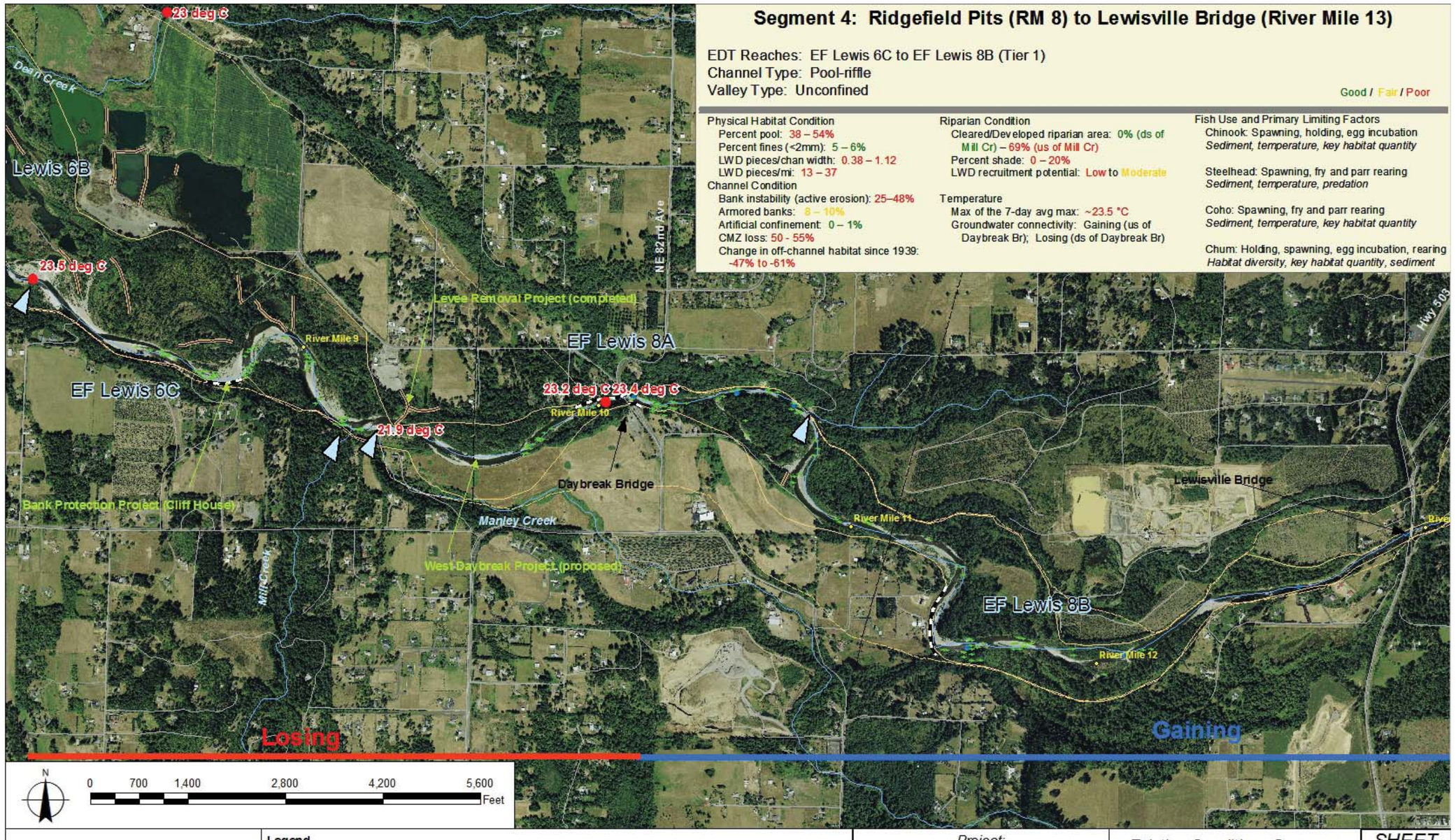
Physical Habitat Condition
- Percent pool: 38 – 54%
- Percent fines (<2mm): 5 – 6%
- LWD pieces/chan width: 0.38 – 1.12
- LWD pieces/mi: 13 – 37

Channel Condition
- Bank instability (active erosion): 25–48%
- Armored banks: 8 – 10%
- Artificial confinement: 0 – 1%
- CMZ loss: 50 - 55%
- Change in off-channel habitat since 1939: -47% to -61%

Riparian Condition
- Cleared/Developed riparian area: 0% (ds of Mill Cr) – 69% (us of Mill Cr)
- Percent shade: 0 – 20%
- LWD recruitment potential: Low to Moderate

Temperature
- Max of the 7-day avg max: ~23.5 °C
- Groundwater connectivity: Gaining (us of Daybreak Br); Losing (ds of Daybreak Br)

Fish Use and Primary Limiting Factors
- Chinook: Spawning, holding, egg incubation
  Sediment, temperature, key habitat quantity
- Steelhead: Spawning, fry and parr rearing
  Sediment, temperature, predation
- Coho: Spawning, fry and parr rearing
  Sediment, temperature, key habitat quantity
- Chum: Holding, spawning, egg incubation, rearing
  Habitat diversity, key habitat quantity, sediment



Legend
- Roads
- Steelhead redd locations (04-07)
- Chinook redd locations (approx) (04-07)
- Historic channel migration zone
- Current channel migration zone
- Reach Break
- Levee
- Airstrip
- Bank Armoring
- Ditched
- Powerlines

Max of 7 day avg max (deg celsius)
- 17 - 20
- 20 - 22
- 22 - 24
- 24 - 26
- 26 - 31

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Ridgefield Pits (River Mile 8) to Lewisville Bridge (River Mile 13)

SHEET 3 of 6

Segment 5: Lewisville Bridge (River Mile 13) to River Mile 15

EDT Reach: EF Lewis 8B (Tier 1)
Channel Type: Pool-riffle
Valley Type: Moderately confined

Good / Fair / Poor

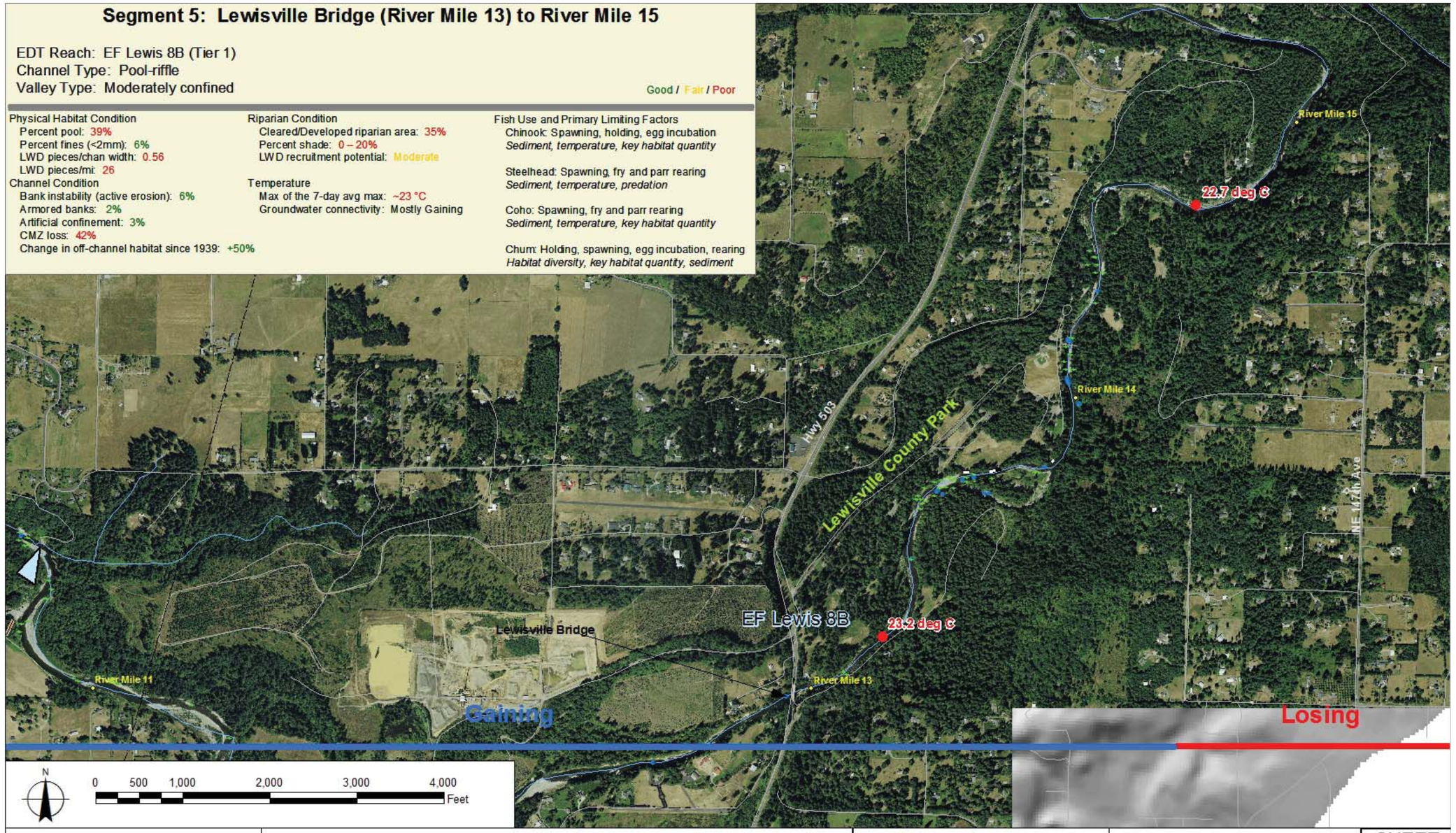
Physical Habitat Condition
- Percent pool: 39%
- Percent fines (<2mm): 6%
- LWD pieces/chan width: 0.56
- LWD pieces/mi: 26

Channel Condition
- Bank instability (active erosion): 6%
- Armored banks: 2%
- Artificial confinement: 3%
- CMZ loss: 42%
- Change in off-channel habitat since 1939: +50%

Riparian Condition
- Cleared/Developed riparian area: 35%
- Percent shade: 0 – 20%
- LWD recruitment potential: Moderate

Temperature
- Max of the 7-day avg max: ~23 °C
- Groundwater connectivity: Mostly Gaining

Fish Use and Primary Limiting Factors
- Chinook: Spawning, holding, egg incubation
  Sediment, temperature, key habitat quantity
- Steelhead: Spawning, fry and parr rearing
  Sediment, temperature, predation
- Coho: Spawning, fry and parr rearing
  Sediment, temperature, key habitat quantity
- Chum: Holding, spawning, egg incubation, rearing
  Habitat diversity, key habitat quantity, sediment



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Legend
- Roads
- Steelhead redd locations (04-07)
- Chinook redd locations (approx) (04-07)
- Levee
- Reach Break
- Airstrip
- Bank Armoring
- Ditched
- Powerlines

Max of 7 day avg max (deg celsius)
- 17 - 20
- 20 - 22
- 22 - 24
- 24 - 26
- 26 - 31

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Existing Conditions Summary

Lewisville Bridge (River Mile 13) to River Mile 15

SHEET
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Segment 6: Tributary Reaches Within Valley Floor

EDT Reaches: McCormick 1A, Brezee Cr 1, Lockwood Cr 1, Beasley Cr 1 & 2, Stoughton Cr 1, Mason 1 & 2, Dean Cr 1A, Dyer Cr 1 &2, Manley Cr 1A – 1G (Tier 1 to 4)

Channel Type: Variable. Mostly pool riffle.

Valley Type: Unconfined

Good / Fair / Poor

Physical Habitat Condition
- Percent pool: <20%
- Percent fines (<2mm): Fines typically dominant
- LWD pieces/chan width: <1.0
- LWD pieces/mi: <70

Channel Condition
- Bank instability (active erosion): up to 100%
- Armored banks: Infrequent
- Artificial confinement: Occasional. Mostly through incision

Riparian Condition
- Cleared/Developed riparian area: Variable
- Percent shade: 0 – 20%
- LWD recruitment potential: Low to none

Temperature
- Max of the 7-day avg max: 18.2 – 26.1 °C

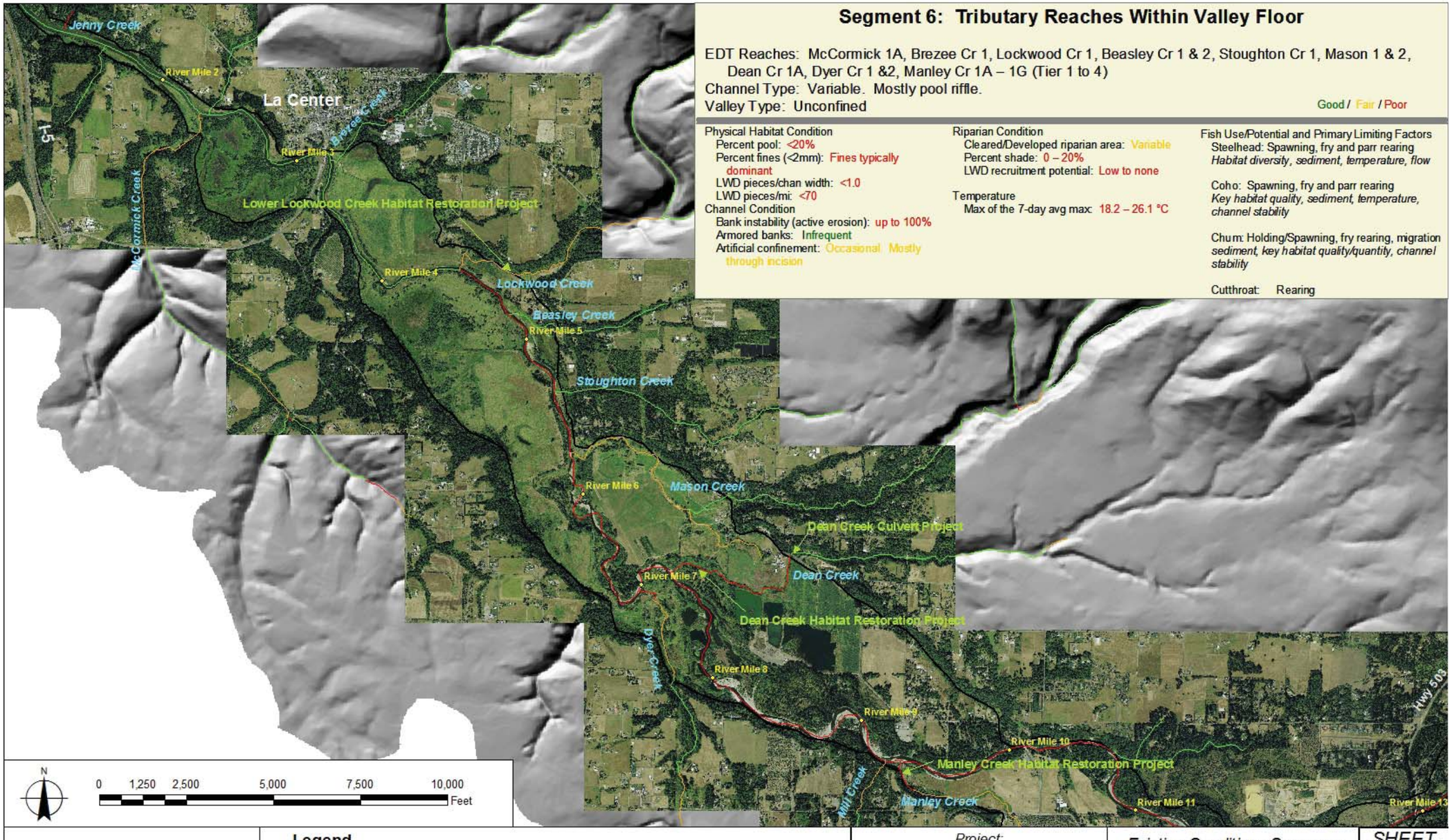
Fish Use/Potential and Primary Limiting Factors

Steelhead: Spawning, fry and parr rearing
Habitat diversity, sediment, temperature, flow

Coho: Spawning, fry and parr rearing
Key habitat quality, sediment, temperature, channel stability

Chum: Holding/Spawning, fry rearing, migration
sediment, key habitat quality/quantity, channel stability

Cutthroat: Rearing



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Legend

Valley Bottom

EDT Reach Tier
- Tier 1
- Tier 2
- Tier 4

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Existing Conditions Summary

Tributary Reaches Within Valley Floor

SHEET 5 of 6

Segment 7: Tributary Reaches Upstream of Valley Floor

EDT Reaches: All other lower basin tributary reaches (Tier 1 to 4)
Channel Type: Varies
Valley Type: Varies

Good / Fair / Poor

Physical Habitat Condition
Variable with many data gaps
Channel Condition
Variable with many data gaps
Barriers
Some data gaps, many partial or full culvert barriers

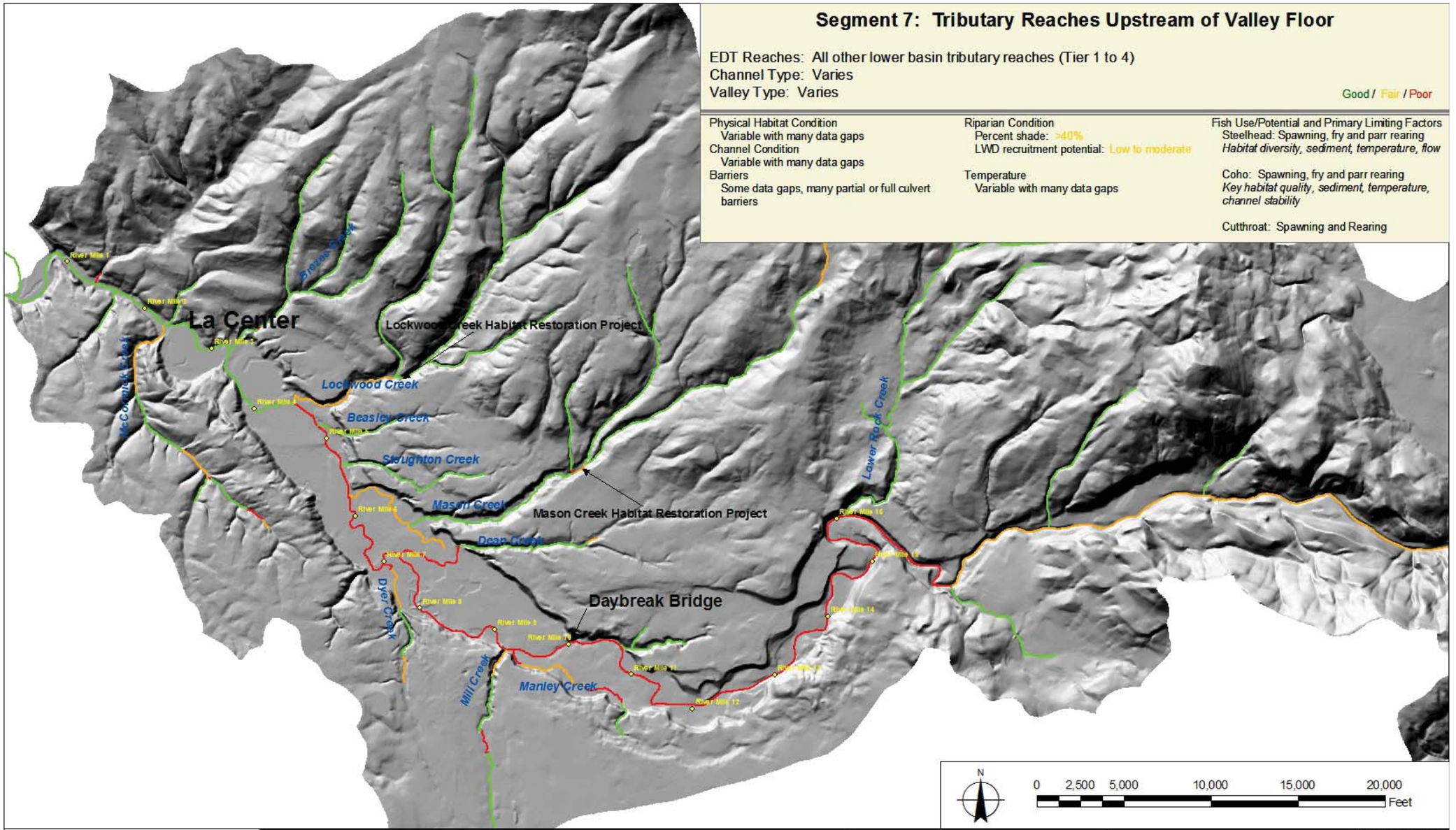
Riparian Condition
Percent shade: ≥40%
LWD recruitment potential: Low to moderate

Temperature
Variable with many data gaps

Fish Use/Potential and Primary Limiting Factors
Steelhead: Spawning, fry and parr rearing
Habitat diversity, sediment, temperature, flow

Coho: Spawning, fry and parr rearing
Key habitat quality, sediment, temperature, channel stability

Cutthroat: Spawning and Rearing



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Legend
EDT Reach Tier
1
2
4

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Existing Conditions Summary

Tributary Reaches Upstream of Valley Floor

SHEET
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CHAPTER 4 – METHODS FOR PROJECT IDENTIFICATION

This section outlines the methodology for identifying and describing potential stream habitat enhancement opportunities in the Lower East Fork Lewis Basin. This effort resulted in a list of preliminary project opportunities and monitoring actions (projects). Projects on the list were subsequently put through a prioritization process (Chapter 5) in order to determine the sub-set of projects to carry forward for conceptual designs.

Project identification relied on office- and field-based approaches and was built off of past studies that identified habitat enhancement opportunities. Project identification focused on project opportunities in high priority reaches and on the primary life-stage limiting factors for the target fish species. Selection of project opportunities was guided by the reach-level strategies and goals developed in coordination with the Working Group.

Office-based identification of project opportunities

The office-based approach began by identifying projects that addressed the primary life-stage limiting factors for a particular reach and the reach-level strategies and goals developed in coordination with the Recovery Plan, Habitat Work Schedule, and Working Group input (Appendix A). Projects which met both the biologic and strategic criteria were added to the list of preliminary project opportunities. Information on project opportunities was compiled from:

1. previous studies
2. information received from EFWG and other community members
3. GIS-based aerial photo interpretation of potential project sites

Field-based identification of project opportunities

One week of field surveys was conducted for this effort. The field surveys were conducted during the first week of September 2008. Personnel conducting field surveys had expertise in fisheries biology and hydrology/geomorphology. Field surveys were first conducted in high priority (Tier 1) mainstem reaches and were followed by surveys of Tier 1 tributary reaches and then lower priority mainstem and tributary reaches as time and access allowed. Foot-based field surveys were conducted on the mainstem East Fork Lewis from Lewisville Park to backwater (approximately Mason Creek confluence). Surveys in tributaries were conducted on foot where access could be obtained. In areas without landowner permission for access, field surveys relied on what could be seen from road-stream crossings or other publicly-accessible points.

Field data collection was limited only to that needed for project conceptual designs and to ensure that projects could be adequately evaluated for the prioritization exercise. Data collection included some or all of the following measures (not all measures were taken at each site):

- Location information (GPS measurement and description)
- Extent of the problem/limiting factor (using range finder, tape measure, visual estimates, or aerial photo/GIS-based measures)

- Geomorphic site conditions, including channel processes and trends, substrate/sediment conditions, and hydrologic characteristics
- Vegetation conditions (including type and extent of invasive species)
- Stream temperature (i.e. spot measurements of temperature gradients between mainstem and off-channel sites)
- Occurrence and location of groundwater/spring inflow sources
- Sediment/substrate characterizations (visual observations)
- Channel conditions (e.g. streambank heights and slopes for conceptual designs using tape measure, hand-level, or clinometer)
- Habitat conditions (e.g. habitat unit types, presence of LWD)
- Access conditions for implementation
- Site photos and field sketches

Project descriptions

Information at each project opportunity area was compiled into the project list. Project information included some or all of the following elements depending on the site and the project type:

- Location information (location description and river mile)
- Species and life-stage use and potential use
- Problem/limiting factor present at site
- Contributing cause of limiting factor
- Recommended approaches to treat limiting factor(s) (with alternative approaches as appropriate)
- Benefit to fish and fish habitat that will be gained from the project alternatives
- Estimate of cost ranges for treatment types
- Logistical issues (constraints) including access and feasibility
- Data gaps / information needs

**preservation opportunities were also identified in areas with healthy, functioning habitat conditions that may be at risk of degradation.*

The project opportunity list was distributed to the Working Group and was discussed and refined at subsequent Working Group meetings.

Preliminary project cost estimates

Preliminary cost estimates were developed for each identified enhancement project in order to assist with project evaluation and prioritization. Construction costs were generated using per-unit values derived from a 25-year database of completed stream habitat restoration projects, and with reference to published heavy construction cost data (i.e. RS Means). All costs were escalated to 2009 values.

Per-unit costs were developed for a range of project type categories. Within each category, high, medium, and low values were established. These represent a range of costs that vary depending on a number of factors including stream size, bank height, machinery access, material source locations, and excavation extents. The project type categories and per-unit values are presented in Table 7. These values served as a guide for estimating construction costs.

A design and contingency multiplier was factored in at 35%. The cost estimates are provided as ranges in order to reflect the uncertainties associated with estimating costs at this preliminary project identification stage. Plus or minus 20% was used to calculate the range.

Cost estimates include the following assumptions:

- All materials and services are purchased outright. Costs may be considerably less than the ranges provided if materials or labor are donated.
- Costs include environmental permitting
- Costs do not include follow-up monitoring
- Costs do not include acquiring conservation easements

*Note: For projects carried forward to the conceptual design phase, more comprehensive cost estimates were developed.

Table 7. Guidelines used to generate project costs.

Project Type	Unit	Level of effort	Cost per unit	Definitions
Habitat enhancement (wood additions for habitat) ●includes adding single pieces and accumulations of wood for habitat and channel structure; and minor grading associated with installations	LF	Low	$100	small channel (<15 ft wide), minimal ballasting requirements, easy access
		Avg	$200	medium channel (15-30 ft wide), moderate ballasting requirements, moderate access
		High	$350	large channel (>30 ft wide), high ballasting requirements, difficult access
Mainstem bank structures ●includes meander-bend log jams with boulder and log ballast, grading, revegetation, erosion control	LF	Low	$150	easy access, bank height <3 ft, low ballasting requirements
		Avg	$300	moderate access, bank height 3-8 ft, moderate ballasting requirements, single soil lift or soil lift only in places
		High	$450	difficult access, bank height >8 ft, high ballasting requirements, soil lifts for bank stabilization, de-watering
Side-channel, groundwater channel ●includes excavation, grading, wood additions, planting, access road construction	SF	Low	$10	1-3 ft excavation depth, easy access
		Avg	$18	3-5 ft excavation depth, moderate access
		High	$26	>5 ft excavation depth, difficult access
Passage improvement ●large cost variation depending on site. These values are only used as a very general guide.	EA	Low	$30,000	small channel (<10 ft wide) culvert replacement or diversion structure removal
		Avg	$100,000	medium channel (10-20 ft wide) culvert replacement, small dam removal
		High	$300,000	large channel (>20 ft wide) culvert replacement, bridge construction, dam removal
Channel construction / re-configuration ●Includes excavation, re-grading, habitat enhancements using rock and wood, erosion control, bank stabilization, re-vegetation	LF	Low	$150	small channel (<10 ft wide, <2 ft deep), easy access, minimal soil lifts, on-site source for materials
		Avg	$400	medium channel (10-30 ft wide, 2-4 ft deep), moderate access, material source nearby, intermittent soil lifts
		High	$700	wide channel (>30 wide, >4 ft deep), difficult access, continuous soil lifts, imported gravels
Riparian ●includes clearing invasives, planting, watering, brush control, browse control	SF	Low	$0.50	bare root seedlings, live stakes, 10 ft spacing; minimal need for invasive control, brush control, browse control, or watering
		Avg	$1.50	intermediate between low and high
		High	$2.50	container stock, soil amendments, abundant invasives, high need for brush and browse control, intensive watering needs
Levee removal ●includes excavation and hauling material to a nearby off-site location. Includes erosion control	LF	Low	$50	easy access, on-site disposal, small levee
		Avg	$100	moderate access, nearby disposal, medium levee
		High	$150	difficult access, off-site disposal, large levee

CHAPTER 5 – METHODS FOR PROJECT PRIORITIZATION

Overview

This section outlines the methodology for prioritizing potential stream habitat enhancement opportunities in the Lower East Fork Lewis Basin. This effort takes the list of preliminary project opportunities identified from the in-office and field evaluation efforts and scores them according to how well they meet a number of stream habitat restoration objectives. All projects submitted for scoring meet the following criteria:

- The approach meets the goals and objectives of the Recovery Plan, Habitat Work Schedule, and EFWG,
- The approach is technically appropriate, and
- The project is coordinated with other habitat protection and restoration efforts in the watershed.

Project scoring results help determine appropriate project sequencing in the lower basin and are used to determine which projects are carried forward for conceptual designs.

The prioritization system focuses on evaluating projects according to the potential fish benefits. Fish benefits can be generally defined as the degree to which projects address key life-stage limiting factors for the populations of interest. Each project is assigned fish benefit ratings of High, Medium, or Low as well as a numerical score. This prioritization method is very similar and compatible with the LCFRB Habitat Work Schedule Evaluation Criteria for evaluating "benefits to fish"; and is expected to yield similar results.

In addition to the fish benefit score and H, M, L rating, projects are given a cost/benefit score. Projects also include discussions of special considerations associated with the project. Fish benefit scores, cost/benefit scores, and special considerations are used as tools to determine which projects are carried forward to the conceptual design phase. Final selection of projects to carry forward is determined through discussions with the EFWG.

Benefits to fish

Benefit ratings are high, medium, and low and the maximum benefit score is 200 points. Benefit to fish ratings and scores are the sum of:

- A population/reach rating and score, and
- A benefit rating and score (including protection/access/restoration rating and score).

Population/reach ratings and score: Population/reach ratings and scores reflect the degree to which a project targets priority populations and reaches.

Population/reach rating: A project's Population/Reach Rating is based on the Tier of the targeted reach or reaches. Tier ratings are assigned in the Recovery Plan based on the following rules.

Table 8. Reach tier designation rules (source, LCFRB 2004).

Reaches	Rule
Tier 1	All high priority reaches (based on EDT) for one or more primary populations.
Tier 2	All reaches not included in Tier 1 and which are medium priority reaches for one or more primary population and/or all high priority reaches for one or more contributing populations.
Tier 3	All reaches not included in Tiers 1 and 2 and which are medium priority reaches for contributing populations and/or high priority reaches for stabilizing populations.
Tier 4	Reaches not included in Tiers 1, 2, and 3 and which are medium priority reaches for stabilizing populations and/or low priority reaches for all populations.

If a project targets a Tier 1 reach or Tier 1 reaches, it received a "High" rating. If it targets no Tier 1 reach or reaches, but targets one or more Tier 2 reaches, it received a "Medium" rating. If it targets only Tier 3 or 4 reaches, it received a "Low" rating.

Population/reach score: In addition to its Population/Reach Rating, each project received a Population/ Reach Score. This score reflects that reaches within a given Tier may be utilized by a varying number of populations of varying recovery classifications and that the targeted reach or reaches may be of varying importance to the populations. The score is the cumulative total of the Population Classification (Primary = 3, Contributing = 2, Stabilizing =1) plus the Species Reach Potential (High=3, Medium=2, Low=1) for each population using the targeted reach or reaches. The definitions of population classifications are provided in Table 3. For multiple reach assessments and habitat projects, Population/ Reach Score is the average of the Population/ Reach scores for the individual reaches. The Population Classifications and Species Reach Potential ratings were taken from the Recovery plan. The maximum Population/ Reach Score is 100 points.

Table 9. Salmon and trout population classifications (source, LCFRB 2004a)

Population Classification	Viability Goal	Description	Persistence Probability[1]
Primary (P)	High (H) or High+ (H+)	Low (negligible) risk of extinction (represents a "viable" level)	95-99%
Contributing (C)	Medium (M)	Medium risk of extinction	75-94%
Stabilizing (S)	Low (L)	Stable, but relatively high risk of extinction	40-74%

[1]100-year persistence probabilities (LCFRB 2004)

Benefit ratings and scores (protection/access/restoration – PAR): Benefit ratings and scores reflect whether a project targets priority habitat project needs and the extent to which the project would address those needs. Benefit ratings are High, Medium, and Low and the maximum score is 100 points. The benefit ratings and scores reflect the degree to which the project affects the following elements: 1) habitat protection, 2) Access to blocked habitats, and 3) habitat restoration. The methods for scoring habitat assessments are also described.

**Note: The benefit rating and score differs from the LCFRB TAC scoring methodology in that the TAC scoring also factors in project cost. Because costs can vary dramatically depending on how conceptual project opportunities are configured (e.g. grouping multiple*

activities into one project vs. splitting them out) costs for East Fork Lewis project opportunities are not included in the scoring. Instead, a cost benefit score is calculated separately and is used as an independent consideration for evaluating project benefits.

1. **Protection**
   a. Rating: the protection benefit rating is based on the EDT protection value for the targeted reach or reaches using the flowing scale. EDT reach protection values can be found in the Recovery Plan.

Table 10. Protection benefit rating

EDT Reach Protection Value	Protection Rating
>50%	High
25 to 49%	Medium
<25%	Low

   b. Score: the protection score is the product of the Protection Rating times the number of habitat units. For protection elements, one habitat unit equals 500 feet of stream length on both sides or 1,000 feet of stream length on one side of the stream.

2. **Access**
   a. Rating: The access rating is based on the following two elements:

Habitat quality – Habitat quality is the quality of the habitat that would be made available. It is calculated as the average of upstream Tier reach ratings, where Tier 1 = 4 points, Tier 2 = 3 points, and Tier 4 = 1 point (there are no Tier 3 reaches in the East Fork Lewis Basin; nevertheless, the score values are kept consistent with the LCFRB TAC scoring methods). An average Tier score of 3 or greater is "high", 2 but less than 3 is "medium", and less than 2 is "low".

Passage improvement factor – The passage improvement factor is the degree to which passage will be restored at the barrier. It is calculated as 100% less the current passability percentage of the barrier. A score of 60 to 100% is "high", 30 to 59% is "medium" and <30% is "low".

The overall Access rating is derived using the following matrix.

Table 11. Access rating matrix

		Habitat Quality		
		High	Medium	Low
Passage Improvement	High	High	High	Medium
	Medium	High	Medium	Low
	Low	Medium	Low	Low

b. Score: The access score is the product of the passage improvement percentage (see Passage Improvement Factor above) times the habitat quality factor times the habitat quantity factor. The habitat quality factor and habitat quantity factor are determined from the following table.

Table 12. Habitat quality and habitat quantity factors

Habitat Quantity (miles of accessible upstream habitat that will be restored)	Quantity Factor	Habitat Quality Rating (see description above)	Quality Factor
5+ miles	10	High	10
2 to 4.9 miles	6	Medium	6
1 to 1.9 miles	4	Low/Unknown	2
0.5 to 0.9 miles	2		
<0.5 miles	1		

3. Restoration

a. Rating: The restoration rating is based on the EDT-derived multiple species restoration type ratings (High, Medium, Low) provided in the 6-Year Habitat Work Schedule for the reaches targeted by a project. For each reach, the ratings for the restoration types covered by the project are averaged and rounded up to the next highest rating.

b. Score: The restoration Score is the sum of the benefit score for each restoration type covered by the project. The benefit score of each restoration type is the product of the restoration type rating (High = 3, Medium = 2, Low = 1) times the number of habitat units times an effectiveness factor. A habitat unit equals:

(1) 500 feet on both sides of the stream or 1000 feet on one side of the stream for riparian, floodplain, and hillslope process project types; or
(2) 500 feet of stream length for instream project types.

The effectiveness factor reflects a percentage estimate of the extent to which the project would address the project type within the targeted habitat unit. For example, if the project were deemed to be fully effective in creating instream habitat structure it would receive an effectiveness factor of 100%.

4. Assessment

Assessment projects are important in identifying site-specific restoration opportunities and developing project designs. However, since they do not result in tangible on-the ground benefits the scoring process was amended to allow these projects to be ranked along with on-the-ground projects. The assessment score is based on the restoration score or the protection score, whichever is most applicable to the assessment effort. Since assessments often involve multiple reaches, an average, rather than the sum, of their restoration

or preservation benefits is used. When the restoration score is used, an effectiveness factor of 10 percent is used for all restoration project types being addressed in the assessment. Finally, the average restoration or protection benefit score is weighted to give a higher priority to assessment focusing on comprehensive prescriptions for multiple reaches. This is done by multiplying the average restoration or protection benefit score for an assessment covering 5 or more reaches by a factor of 1.25. An assessment covering 1 or 2 reaches is multiplied by 0.75.

5. **Total benefit ratings and scores (PAR)**
   a. Rating: A project is given an overall PAR rating of High, Medium, or Low based on the rating of the project's predominate type and reach or if the project is felt to address several project types to an equal or similar degree an average of the project type ratings was used.

   b. Score: A project's overall PAR score is the sum of its protection, access, restoration and assessment scores. Protection, access, restoration and assessment scores are normalized so that they carry equal weight. The score range for the PAR component is 0 to 100 points.

Final fish benefit ratings and scores

Rating: A project's overall benefit rating is a combination of the Population/Reach and PAR ratings and is determined using the following matrix.

Score: A project's overall Benefit Score is the sum of its Population/Reach Score and its PAR score. The numerical score is used to rank projects.

Table 13. Overall benefit rating matrix

		Protection/Access/Restoration Rating		
		High	Medium	Low
Population/Reach Rating	High	High	Medium	Low
	Medium	Medium	Medium	Low
	Low	Low	Low	Low

Cost benefit score

Each project is given a cost benefit score. The cost benefit score is calculated separately from the Fish Benefit Score. In this regard, this scoring differs from the LCFRB TAC scoring method, which factors cost benefit into the Fish Benefit Score. The cost benefit score is actually a benefit/cost score. It is calculated by taking the project Fish Benefit Score and dividing it by the estimated project cost. These values are then normalized to a maximum of 100 points.

Special considerations

If a project has special considerations, or constraints or opportunities that may affect the ability to implement the project successfully, these are discussed in the project descriptions (see Chapter 6). Special considerations may reflect landowner issues, sequencing issues, relationships to other projects, and physical, legal, social, or cultural considerations.