Final Report

"Fish Friendly" Erosion Control - An Example Hypothetical Program

Prepared for

Oregon Association of Clean Water Agencies

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Table of Contents

Table of Contents (Cont.)

List of Attachments

CHAPTER 1

Introduction

Purpose

The Oregon Association of Clean Water Agencies (ACWA) has worked with a Technical Advisory Committee (TAC) of ACWA members to develop a model "fish friendly" program for erosion control during construction. The program is to be "protective but practical" for addressing fish that are listed as threatened and endangered under the federal Endangered Species Act (ESA). The intent of the model program is to provide:

(1) an "example" program for erosion control during construction that can be designed to meet the Municipal, Residential, Commercial, and Industrial (MRCI) limit for development in the ESA Section 4(d) rule of July 2000 promulgated by the National Marine Fisheries Service (NMFS)[1], and

(2) an ESA effects analysis for use in discussions with NMFS to identify necessary elements of a "protective but practical" program for erosion control during construction that addresses threatened and endangered fish.

This report provides a detailed description and analysis of the model "fish friendly" program for erosion control during construction. To maximize utility of this analysis for ACWA members, the model program describes program elements generically for Oregon's Willamette Valley conditions, using a hypothetical community ("Janetville") with sensitive environmental resources common to the mid Willamette River valley (i.e., ESA-listed fish and their habitats).

Organization of This Report

This report is generally organized according to instructions recommended by NMFS for 4(d) MRCI limit submittals in the *4(d) Rule Implementation Binder for Threatened Salmon and Steelhead on the West Coast* (NMFS 2000). This includes:

- a detailed description of the program and activities to be considered (Chapter 2)
- a description of the specific geographic area to which the program applies, including the environmental baseline of habitat conditions (Chapter 3)

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[1] In July 2000, NMFS adopted a rule under section 4(d) of the ESA that prohibits "take" of salmon and steelhead listed as "threatened", *except* in cases where the take is associated with approved programs or activities (referred to as "limits") as described in the 4(d) rule (65 FR 42422). The MRCI limit in the 4(d) rule addresses erosion control during construction, and requires a "development ordinance or plan [that] includes adequate provisions to prevent erosion and sediment runoff during construction." It is further stated that "development activities should prevent erosion and sediment runoff during and after construction and thus prevent sediment and pollutant discharges. At a minimum, these activities should include detaining flows, stabilizing soils, protecting slopes, stabilizing channels and outlets, protecting drain inlets, maintaining BMPs, and controlling pollutants. This can be accomplished by applying seasonal work limits, phasing land clearing, maintaining undisturbed native top soil and vegetation, etc."

- a description of listed species and their status within the program area (Chapter 4)
- a description and analysis of the effects of the program on listed species and their habitats (Chapter 5)
- conclusions regarding program effectiveness in not impairing properly functioning habitat, or retarding long-term progress toward properly functioning habitat (Chapter 6)

How to Use This Report

Although this submittal is organized based on 4(d) submittal guidelines, **this report is not a 4(d) submittal to NMFS**. ACWA's intent is to use this report only to obtain feedback from NMFS as to whether the "example" program provides for ESA compliance and 4(d) potential, and to identify any outstanding issues where the program may fall short[2].

The "example" program analysis presented in this report is applied to two particular fish species currently listed under the ESA, namely chinook salmon and steelhead (see Chapter 4 for additional details on these species). However, because the two species have life stages with high sensitivity to potential erosion-related effects (particularly fine sediment), the approach and analysis in this report is probably applicable to other fish species as well.

Depending on feedback from NMFS, the approach and analysis presented in this report may provide guidance for specific entities to develop an erosion prevention and control program that is protective of ESA-listed fish, or verify that an existing program is protective. ACWA may also consider using the approach and analysis presented in this report, and feedback from NMFS, to supplement guidance provided in the *Endangered Species Act Assessment Manual* (April 2000) developed jointly by ACWA, the Oregon Water Utilities Council, and the League of Oregon Cities.

The first step for communities concerned about nearby fish populations is to complete a baseline assessment using the ACWA *Endangered Species Act Assessment Manual*[3] (April 2000). Some communities have found that working with Oregon Department of Fish and Wildlife staff or a consulting biologist is useful in completing a baseline assessment.

As described in the ACWA *Endangered Species Act Assessment Manual*, local communities will want to consider the options for ensuring that erosion occurring during construction does not "take"[4] species that are listed as threatened or endangered under the ESA. These options include to:

- modify activities as necessary to avoid a "take",
- apply for and obtain an ESA Section 4(d) limit,
- obtain incidental take authorization under ESA Section 7 consultation if the project has a federal nexus (that is, requires a federal action, such as a permit), or

2 A draft of this report was provided to NMFS staff in mid June 2002. This final report includes some additional information and revisions based on discussion with NMFS staff at a subsequent meeting in late June 2002.

3 An on-line version is posted at www.oracwa.org and CD-ROM copies are available for $10.

4 "Take" is defined as to "harm, harass, kill, injure, or modify essential breeding, feeding, and sheltering behavior." (Per ESA Section 9 (a)(1) take prohibitions)

- obtain an incidental take permit by preparing and receiving approval for a Habitat Conservation Plan under ESA Section 10.

Since the program outlined here is "place-based" in a hypothetical community and uses risk factors to guide decisions about adequate erosion control, the factors may be different by community. Some of the factors that should be reviewed and considered by a community wanting to use the information in this hypothetical example might include:

- population and corresponding building permit activity,
- average annual rainfall,
- soil types and textures,
- lot slope,
- proximity to stream, riparian habitat, or stormwater inlet, and
- threatened and endangered fish species life stage sensitivities, timing, and life stage use.

Some communities may need more stringent factors for their specific location; some communities may need less-stringent factors.

Water quality and fish protection issues are rapidly changing – especially in the Pacific Northwest. The interrelation between the federal Clean Water Act and the ESA regulations and policies continue to evolve and set new challenges. Readers will want to ensure they are using the best, and most up-to-date information on water quality protection, erosion control regulations, fish listings, and fish population restoration plans before moving forward.

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CHAPTER 2

Description of the Program

The program being assessed in this submittal is the *Fish-Friendly Erosion Prevention and Sediment Control Program* (Program) administered by the City of Janetville, Oregon[5]. The purpose of the Program is to provide guidance and requirements for erosion prevention and sediment control (EPSC) plans, measures, and practices for construction projects with land-disturbance of greater than 1,000 square feet in size. This includes EPSC plans and measures for construction projects with land disturbance of more than one acre (43,560 square feet) that are typically the subject of approval by the Oregon Department of Environmental Quality (DEQ)[6]. The Program provides particular emphasis on protection of sensitive environmental resources (e.g., streams, wetlands, riparian areas, habitats), particularly ESA-listed fish species and their habitats.

Janetville's Program is based on the detailed *Example Model Program for Erosion Prevention and Sediment Control During Construction* that is contained in Attachment A of this submittal. As such, Janetville's Program provides specific guidance and requirements for various activities and actions, including:

- required erosion prevention and sediment control (EPSC) permits
- EPSC plans, including design requirements and plan contents
- implementation monitoring and inspection
- effectiveness monitoring
- reporting requirements
- enforcement and penalties

The *Example Model Program for Erosion Prevention and Sediment Control During Construction* (Attachment A) makes extensive reference to use of the *Erosion Prevention and Sediment Control Planning and Design Manual* (the EPSC Manual) prepared by Clean Water Services, Clackamas County Water Environment Services, and City of West Linn (December 2000). Janetville's Program has adopted the EPSC Manual as a key reference for design of EPSC Plans, selection of erosion prevention measures and sediment control practices for construction activities (BMPs), and maintenance and inspections of BMPs. Aspects of the

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5 For purposes of this submittal, Janetville is a hypothetical municipality (pop. 50,000) located in the Willamette Valley. A detailed description of Janetville and its environmental setting is contained in Chapter 3.

6 Erosion and sediment control plans and measures for construction projects with land disturbance of more than one acre (43,560 square feet) are the subject of approval by the Oregon Department of Environmental Quality (DEQ) as required under OAR 340-040 and OAR 340-045 and in accordance with NPDES Storm Water Discharge General Permit #1200-C. Some local governments choose to operate both their local and the state DEQ program for construction activities in their area, and request delegation of the construction permitting activities from DEQ. Under the federal Endangered Species Act (ESA), compliance with a state permit may not be adequate to protect again "take" prohibitions. For the hypothetical program outlined here, the Janetville City Council decided to apply for delegation of the DEQ construction activities permitting program in their community. This program was taken on for the convenience of the local construction contractors. The Council also added additional, more stringent erosion control and sediment prevention measures that they concluded were necessary to ensure endangered fish species were adequately protected.

EPSC Manual are discussed in subsequent sections of this submittal, but the reader is directed to the EPSC Manual itself for more detailed information.

Specific Elements of the Program

Required Permits

Janetville requires that a site owner who is planning a construction project must apply for and obtain a site development permit. Under provisions of the Janetville Program, such a permit for site development that involves land-disturbing activity of 1,000 or more square feet is granted only upon review and approval of an Erosion Prevention and Sediment Control (EPSC) Plan by the City of Janetville. ***There are two important exceptions for site development activities in Janetville for which the Program and its provisions are <u>not</u> applicable.*** These excepted activities include:

- any in-channel work activities or construction of temporary or permanent crossings of watercourses. Development that requires in-channel work activities or construction of watercourse crossings must obtain necessary permits and approvals from other authorizing agencies (such as the U.S. Army Corps of Engineers, Oregon Division of State Lands).
- any emergency activity that is immediately necessary for the protection of life, property or natural resources.

Erosion Prevention And Sediment Control (EPSC) Design and Plans

The objective of EPSC Plans is to provide site-specific information and plans to allow erosion prevention and sediment control measures to be documented, evaluated, approved, implemented, and monitored in a manner that minimizes disturbance of soils and vegetation cover, and protects sensitive environmental resources (such as rivers, streams, riparian habitat, or wetlands).

Contents of the Plan

Janetville's Program requires that EPSC Plans include:

- A map of the site and its location within Janetville. The map must include locations of relevant natural resources features (on and adjacent to the site to be developed) that could contribute to or may be affected by erosion and sedimentation. The natural resources features may include soils, forest or vegetation cover, and sensitive environmental resources (such as rivers, streams, or wetlands).
- A construction sequence for the development site, including clearing and grubbing, rough grading, construction of utilities, infrastructure, and buildings, and final grading and landscaping. Sequencing shall identify the expected date on which clearing will begin, the estimated duration of exposure of cleared areas, and the timing of temporary erosion and sediment measures, and establishment of permanent vegetation with respect to the construction sequence.

- A specific description of all temporary erosion prevention and sediment control measures necessary to meet the objectives of the program throughout all phases of construction, and permanent measures to remain after completion of site development. Depending upon the complexity or size of the project, the drafting of intermediate plans may be required at the close of a particular phase of construction.
- Seeding mixtures and rates, types of sod, method of seedbed preparation, expected seeding dates, type and rate of fertilizer application, and kind and quantity of mulching for both temporary and permanent vegetative stabilization measures.
- Provisions for maintenance of control facilities.

Design Requirements

Janetville's Program has several design provisions and requirements aimed at preventing or minimizing transport of sediment from the site. These include:

1. ***Clearing and Grading***

- Clearing and grading activities in streams, riparian areas, and wetlands shall not be permitted under this Program. Clearing and grading of other undisturbed natural areas, such as forests, shall not be permitted, except when in conformance with all applicable regulations of this Program and other applicable regulations and permits.
- Clearing techniques shall leave in place native vegetation and natural drainage patterns, as described and recommended in the EPSC Manual.
- Clearing, except that necessary to establish sediment control devices, shall not begin until all appropriate sediment control devices have been installed and have been stabilized.

2. ***Erosion Prevention***

- Soil should be stabilized within 14 days of final grading. On high risk sites, or during the wet season, soil stabilization may be required at any time.
- If vegetative erosion control methods, such as seeding, have not become established within 14 days, Janetville may require that the site be reseeded, or that a non-vegetative option be employed.
- On steep slopes (greater than about 10%) or in drainage ways, special techniques that meet the design criteria outlined in EPSC Manual shall be used to ensure stabilization.
- Soil stockpiles must be stabilized or covered at the end of each work day when potential erosion could occur.
- At the close or suspension of construction activity, the soil on the entire site must be stabilized. If vegetation is not sufficiently established, use of a heavy mulch layer, or another method that does not require germination to control erosion is required.
- Techniques shall be employed to prevent the blowing of dust or sediment from the site.

- Techniques that divert upslope overland runoff, if present, to avoid disturbed slopes shall be employed.

3. Sediment Controls

- Sediment controls shall be provided in the form of settling basins (if appropriate) or sediment traps or tanks, and perimeter controls per descriptions and recommendations in the EPSC Manual.
- All on-site stormwater conveyance channels shall be designed according to the criteria outlined in the EPSC Manual.
- Where possible, settling basins shall be designed in a manner that allows adaptation to provide long-term stormwater management.
- Adjacent properties in the potential pathway of erosion and sediment exposure shall be protected by the use of a vegetated buffer strip, in combination with perimeter controls.

4. Construction Site Access

- Temporary, aggregate construction site entrance(s) or access road(s) shall be provided throughout the construction period.
- Other measures may be required at the discretion of Janetville[7] in order to ensure that sediment is not tracked onto public streets by construction vehicles, or washed into storm drains. These measures will be determined during review of the EPSC Plan or from inspections taking into account site and conditions and seasonal timing of construction activities.

Monitoring, Inspection, and Reporting

Janetville's Program includes detailed provisions and requirements for monitoring, inspection, and reporting. Two types of monitoring are included:

(1) ***implementation (compliance) monitoring*** to determine if the provisions of the program are followed; and

(2) ***effectiveness monitoring*** to determine if the implementation of provisions achieved the desired goals and objectives.

Monitoring is performed at two levels—the *project* level and the *program* level—to evaluate impacts of construction actions to sensitive environmental resources in the Janetville area. Project-level monitoring is conducted at the permit-area scale. Program-level monitoring is conducted at the municipality or watershed scales.

Implementation Monitoring at the Project Level

Janetville's Program requires that the permitee designate a competent site steward to make regular inspections of all control measures and BMPs in accordance with the approved EPSC plan or permit. In the absence of significant rainfall events, all control measures and BMPs are required to be inspected at least once per month. During the rainy season, all

[7] Such measures are usually determined based on review of the EPSC Plan or from initial site inspection.

control measures and BMPs are required to be inspected before, during (for storms lasting 24 hours), and after storms.

During implementation monitoring, Janetville's program requires the permitee to obtain and document four kinds of information: (1) types and occurrences of maintenance activities; (2) vegetation establishment; (3) final site restoration (finished grades, log and rock placements, plant composition and density); and (4) a narrative of the project's effect on sensitive environmental resources (e.g., streams, wetlands, riparian areas, habitats). All inspections are documented in writing and submitted to Janetville at the time intervals specified in the approved permit.

The City of Janetville has two full-time EPSC inspectors[8] that make walk-through or onsite inspections as approved work is completed to ensure that the work complies with the EPSC Plan as approved. In order to obtain inspections, the permitee notifies the City of Janetville at least two (2) working days before the required inspection, or close or suspension of construction activity.

Janetville's Program generally includes three types of inspection: initial inspection, monitoring inspections, and final inspection. The initial inspection is conducted before grading permits are released, and hence before any major earthwork is done. The site is inspected to ensure that all appropriate erosion prevention and sediment control measures are in place and in compliance with EPSC Manual guidelines. At this initial stage, measures are usually primarily focused on perimeter controls and construction site entrances.

If there are no deficiencies noted, the inspector issues an "approved" inspection notice to the permittee. If deficiencies are noted, the inspector issues a "not approved" notice to the permittee that informs the permittee of the deficiencies noted and the time frame in which corrections are to be made[9]. The "not approved" notice also serves as a Stop Work warning if deficiencies are not corrected within the time frame. The deficiencies noted include, among others:

- measures are not in place or inadequate to prevent erosion
- measures that are in place require maintenance or reinstallation
- there is evidence of visible and measurable amounts of erodable material in the street or other off-site areas
- gravel construction entrance is substandard or requires maintenance or replacement
- storm drain facilities associated with the site require installation or replacement of sedimentation barriers.

Follow-up inspections are done as necessary to ensure that deficiencies have been corrected. If the permittee fails to make the necessary corrections, a Stop Work order is issued to the permittee and posted at the site location. Additional follow-up inspections are performed until compliance is achieved with a fee charged to the permittee for each follow-up

[8] Based on issuance of about 1,500 site development (building) permits annually.

[9] Time frames are determined based on weather conditions, topography of the site, amount of eroded material, and type of construction. All vehicle tracking associated with construction activities must be cleaned up at the end of each day. Corrections to specific erosion prevention and sediment control measures must usually be done within 48 hours.

inspection. Civil citations and revocation of site development permits are possible actions if the permittee repeatedly fails to make the necessary corrections.

Monitoring inspections are ongoing inspections of permitted sites between the initial and final inspections. The site is inspected on a periodic basis during construction to ensure that all appropriate erosion prevention and sediment control measures are in place and in compliance with EPSC Manual guidelines. During monitoring inspections, various erosion prevention and sediment control measures may be in place depending on the type and size of the construction project. For example, in a phased construction project, each phase may be required to follow inspection requirements independent of other phases.

If there are no deficiencies noted, the inspector issues an "approved" inspection notice to the permittee. If deficiencies are noted, the inspector issues a "not approved" notice to the permittee that informs the permittee of the deficiencies noted and the time frame in which corrections are to be made. The deficiencies noted and time frames for corrections are similar to those described above for initial inspections. Follow-up inspections are done as necessary to ensure that deficiencies have been corrected. If the permittee fails to make the necessary corrections, a Stop Work order is issued to the permittee and posted at the site location. Additional follow-up inspections are performed until compliance is achieved with a fee charged to the permittee for each follow-up inspection. Civil citations and revocation of site development permits are possible actions if the permittee repeatedly fails to make the necessary corrections.

A final inspection is done prior to final building inspection and prior to transition to a new owner, if applicable. The final inspection is done to ensure that all appropriate final erosion prevention and sediment control measures are in place and in compliance with EPSC Manual guidelines. At this final stage, measures are usually primarily focused on final soil stabilization and ground cover conditions. The final inspection is done to document any deficiencies relating to EPSC measures and soil stabilization and cover conditions.

If deficiencies are noted, the inspector issues a "not approved" notice to the permittee that informs the permittee of the deficiencies noted and the time frame in which corrections are to be made. The deficiencies noted and time frames for corrections are similar to those described above for initial inspections. Follow-up inspections are done to ensure that deficiencies have been corrected similar to those described above for initial inspections. If there are no deficiencies noted, an "approved" final inspection notice is issued to the permittee who in turn provides the new owner (if applicable) with a copy to establish an understanding of on-going erosion prevention and sediment control responsibilities.

Effectiveness Monitoring at the Project Level

The purpose of effectiveness monitoring is to determine the overall effectiveness of the control measures and BMPs, and the need, if any, for additional control measures and BMPs. The effectiveness monitoring is based on careful inspection by the site steward to ensure that erosion is being controlled and transport of sediment into sensitive areas (e.g., streams, riparian areas, habitats) is being prevented.

Janetville's Program requires that the permitee's effectiveness monitoring provide periodic information of Project site conditions, and conditions of any adjacent sensitive environmental resources (e.g., streams, wetlands, riparian areas, habitats). Typically, permanent photo-monitoring points provide continuity in monitoring efforts and establish reference points against which the effects of construction and EPSC activities can be compared over time. Site vegetation and cover conditions are monitored to evaluate: (1) the type of vegetation that is growing; (2) the density of vegetation and percent ground cover; and (3) any areas of erosion and the type of erosion.

All disturbed areas of the site, areas for material storage, locations where vehicles enter or exit the site, and all the erosion and sediment controls that are identified as part of the EPSC plan are inspected. The inspection focuses on visual evidence of any sediment discharge beyond control measures (e.g., fresh sediment outside of perimeter silt-fence barriers) or from the site (e.g., a turbidity plume in adjacent waterways). If such sediment discharge is evident, the inspection proceeds to identify discharge sources and causes, and direct the prompt implementation of corrective actions. Implementation Monitoring at the Program Level

Janetville's Program includes program-level implementation monitoring to assess whether Program elements are being implemented as required and are effective. Program-level implementation monitoring information, compiled annually, includes summaries of:

- the number of site development permits issued
- the number of site development permits issued that were for land disturbing activity of greater than 1,000 square feet, including those greater than one acre (43,560 square feet) in size
- the number of associated Erosion Prevention and Sediment Control (EPSC) Plans reviewed and approved
- inspections by site type (residential, commercial, industrial)
- the types of erosion prevention and sediment control measures and BMPs that were used among the EPSC Plans reviewed and approved
- the number of permit violations experienced or complaints received, and efforts made to resolve and correct them.

Effectiveness Monitoring at the Program Level

Janetville's Program includes program-level effectiveness monitoring to assess whether protective measures are effective to attain environmentally-protective (including "fish friendly") management objectives. This includes effectiveness monitoring annually for groups of actions (by activity type, time, and subwatershed or watershed) that may affect sensitive environmental resources (e.g., streams, wetlands, riparian areas, habitats). Program-level effectiveness monitoring information includes:

- a summary of information from project inspection reports on any permit violations, failures experienced, or complaints received, and efforts made to correct or resolve them.
- a description of the types of erosion prevention and sediment control measures and BMPs that were used among the EPSC Plans reviewed and approved, and any observations on the effectiveness of the measures/BMPs

- descriptions, locations, and maps of developed, undeveloped, and low density areas, and existing information on sensitive environmental resources (e.g., streams, wetlands, riparian areas, habitats).
- a description of trends in water quality, habitat quality and quantity, and ESA-listed species populations in water courses or subwatersheds in the Janetville area where program and project activities occur (such information is usually summarized from data or reports obtained from the Oregon Department of Environmental Quality, Oregon Department of Fish and Wildlife, and the local Janetville Creek watershed council).
- recommendations for minimizing or reducing effects of the EPSC program on sensitive environmental resources, particularly ESA-listed species and their habitats.

The City of Janetville has been an active participant and supporter of the Janetville Creek watershed council. Since 1998, the City of Janetville has collaborated with the watershed council to conduct an elective water quality monitoring program. The monitoring program consists of monthly measurements of water temperature, dissolved oxygen, pH, and specific conductance using a multi-parameter water quality probe made available by the City of Janetville Wastewater Treatment Plant (WWTP). Sampling is conducted at five sites along Janetville Creek, including a “background” site upstream of the City, and two sites in the Willamette River, above and below the confluence of Janetville Creek.

Recently, due to the implementation of Janetville’s “fish-friendly” program, the elective water quality monitoring program has been expanded to include sampling of turbidity. Turbidity samples are collected in conjunction with the multi-parameter probe sampling and returned to the City of Janetville’s WWTP lab for analysis with a turbidimeter. Turbidity is closely correlated with fine sediment in the water. As such, the elective turbidity monitoring by the City of Janetville provides another useful tool for helping to assess the program’s effectiveness in reducing the presence and trends of turbidity and fine sediments in Janetville Creek over time.

Reporting

As an outcome of monitoring and inspection, the City of Janetville prepares an annual report that provides a program-level summary of Program implementation and effectiveness. The report includes the monitoring information listed above. In addition, the report includes any pertinent recommendations for modifications or improvements in the program and its requirements, such as recommendations for:

- minimizing or reducing effects of the program on sensitive environmental resources.
- additional program protection of sensitive environmental resources
- improving assessment of risks to sensitive environmental resources from developmental activities.

Enforcement

The program includes provisions for the City of Janetville to issue a stop-work order, and suspend or revoke the site development permit in the event that a site development permitee:

- violates the terms of the permit
- implements site development in such a manner as to be materially detrimental to the public welfare, injurious to property or the environment
- places ESA-protected species at risk of being harmed.

The Program also includes specific penalties and fines that can be imposed for such violations, including provisions that require violaters to bear the expense of needed restoration. Additional details on inspections, enforcement of corrective actions if needed, and issuance of stop-work orders are contained in the previous section entitled *Effectiveness Monitoring at the Project Level*.

Specific Activities Regulated by the Program

Specific activities regulated by the Program include construction projects (including clearing, grading, and excavation), primarily of new residential housing and industrial buildings, and occasionally roads, parking areas, and utilities infrastructure. Sizes of individual construction projects are variable, but most are typically 1,000-10,000 square feet in size. Larger project sites are occasionally developed.

Construction projects are typically 4-6 months in duration, but can take more or less time depending on the project. Construction projects can occur any time of the year, but construction activity tends to be greatest during May-October when weather conditions favor operations.

Construction projects occasionally involve in-channel work activities or construction of temporary or permanent crossings of watercourses. However, any development that requires in-channel work activities or construction of watercourse crossings are not covered under Janetville's Program and must obtain necessary permits and approvals from other authorizing agencies (such as the U.S. Army Corps of Engineers, Oregon Division of State Lands).

CHAPTER 3

Geographic Area and Environmental Baseline

Janetville is a hypothetical municipality (population circa 50,000) located in the mid-Willamette Valley above Willamette Falls at the confluence of the Willamette River and the hypothetical Janetville Creek. The Janetville city limits lie mostly within the Janetville Creek watershed, including an area that fronts approximately three miles of the Willamette River. Located in a temperate climate zone, Janetville experiences cool, wet winters and warm, dry summers. Average annual rainfall in the area is approximately 55 inches.

Willamette River in the Janetville Area

Baseline conditions of important fish habitat indicators in the Willamette River near Janetville are summarized in Table 3-1. At present, many of these indicators are not properly functioning or at risk of not properly functioning compared to the levels of function desired to support healthy, self-sustaining populations of listed fish[10].

Streamflow in the Willamette River in the Janetville area reflects the seasonal distribution of precipitation, with about 70 percent of runoff occurring from November through March and less than 10 percent from July through September. The highest streamflows occur during December and January. Streamflow in the Willamette River in the Janetville area is partially managed through controlled releases from upper basin reservoirs.

Willamette River temperatures vary seasonally. Data from the STORET database (spanning 1977-2000) show that river temperatures from December through March vary from 39 to 50 °F (EPA 2002). Temperatures rise to approximately 66 °F from March through June, and increase to a maximum of 76 °F in August. River temperatures measured just upstream of Janetville historically exceed 70 °F. Compared to the mainstem river, water temperatures in shallow, backwater littoral areas of the Willamette River near Janetville likely warm to higher temperatures during summer and early fall. Dissolved oxygen (DO) levels typically remain above 8.0 mg/L in the Willamette River near Janetville. DO levels rarely drop below 7.0 mg/L.

Turbidity is the optical property of water that characterizes light absorption and scattering from suspended particulates or colloids in the water column. Turbidity is typically measured in Nephlometric Turbidity Units (NTU). Suspended particulates can be directly measured as total suspended solids (TSS) in milligrams per liter (mg/L) but are frequently measured indirectly as turbidity.

Data from the STORET database (spanning 1977-2000) show that turbidity values are typically highest during November to February when runoff and river flows are highest, and are lowest during the summer months (EPA 2002). Turbidity values in the Willamette

[10] The indicators and baseline conditions presented in Table 3-1 are based on the concept of Properly Functioning Conditions (PFCs) as presented in *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (NMFS 1996). PFCs are the physical, chemical, and biological factors and criteria needed to sustain healthy salmonid populations and ecosystems.

River in the Janetville area are below 30-40 NTU most of the time, with a median of about 5 NTU. During the flood of February 1996, turbidity peaked at 231 NTU near Janetville.

Janetville Creek Watershed

The Janetville Creek watershed encompasses about 50 square miles on the western side of the Cascade Mountains. Starting in the foothills of the Cascades, Janetville Creek flows northwesterly over about 20 miles to its confluence with the Willamette River. Numerous small tributary streams feed the mainstem of the creek.

The Janetville Creek watershed contains a mix of land uses. Janetville is located in the lower portion of the watershed and consists primarily of urban and suburban areas, with some rural areas that probably will be developed over the next 10-20 years. The upper unincorporated portion of the watershed consists primarily of rural and forested areas. The upper portion of the watershed has a history of extensive timber harvest and experienced a forest fire in the late 1940's that consumed much of the soil's organic matter.

Baseline conditions of important fish habitat indicators in Janetville Creek are summarized in Table 3-2. At present, many of these indicators are not properly functioning or at risk of not properly functioning compared to the levels of function desired to support healthy, self-sustaining populations of listed fish[11].

Conditions at Project Construction Sites in Janetville

The environmental conditions of the local landscape in the Janetville area are diverse. Therefore, construction sites exhibit a range of topographic, soil, and cover conditions so that sites can be more or less susceptible to potential soil erosion depending on specific location. Soil conditions in the Janetville area can range from coarse-textured sands and gravels to fine-textured silts, clays, and loams. Topography in the area ranges from essentially flat (<1% slope) to steep (>12% slope), but most construction sites occur on low to moderate slopes (about 2-6%).

Vegetation cover conditions on undeveloped sites prior to construction also vary. However, nearly all sites have had some degree of predisturbance. Most sites have been used historically for crop land, pasture, or timber harvest. Some sites are being redeveloped from prior urban or suburban uses. As such, the vegetation cover on the sites is primarily tall weeds and short brush, or tall grass with trees but no appreciable brush.

Drainage density is moderate to high within Janetville, so that most construction sites are within 200-400 feet of a stream channel or storm drain inlet. Occasionally, sites are located within 100 feet of a stream channel, including the Willamette River and Janetville Creek. However, the City of Janetville does not issue development permits for construction activity below the "ordinary high water mark"[12] of streams as defined by the State of Oregon Division of State Lands (DSL) or U.S. Army Corps of Engineers (Corps). Such activity

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[11] The indicators and baseline conditions presented in Table 3-2 are based on the concept of Properly Functioning Conditions (PFCs) as presented in NMFS (1996). PFCs are the physical, chemical, and biological factors and criteria needed to sustain healthy salmonid populations and ecosystems.

[12] The water level equaling the "annual flood" or a peak flow that occurs at about a 2-year return interval.

requires Wetland Removal-Fill Permits administered by the DSL and Corps (under Section 404 of the Clean Water Act).

Table 3-1
Baseline Conditions of Important Fish Habitat Indicators in the Mainstem Willamette River (WR) near Janetville.

Factor	Baseline Condition	Notes
Habitat		
Peak Flow	Not Properly Functioning	The Willamette River (WR) basin's storage reservoir/hydropower system has altered the mainstem river's natural flow regime, which has affected water temperature, juvenile survival, and adult migration timing. Urban activities are generally a minor contributor to the mainstem river's altered flow regime.
Baseflow	At Risk	The basin storage reservoir/hydropower system has probably resulted in somewhat higher summer flows.
Channel Characteristics	Not Properly Functioning	Significant dredging, diking, and channelization has occurred in portions of the mainstem Willamette. Banks have been hardened and the river no longer meanders or overflows into low-lying areas. Habitat has been simplified and natural cover has been replaced by docks, piers, and abutments.
Riparian Zone	Not Properly Functioning	Because of the WR's large size, riparian vegetation has a small influence on shade and channel structure. Vegetation does provide localized bank stability and cover habitat benefits.
Water Quality		
Nutrients	At Risk	Some nutrient inputs have occurred in the WR from basin development activities (e.g., agricultural land runoff, irrigation return water, treated wastewater effluent).
Toxic Materials	At Risk	Toxic releases have been identified as an issue in the WR. Stormwater is a potential source of such compounds and could potentially affect rearing and migrating salmonids.
Sediment	At Risk	Fine sediment naturally settles out as the river velocity drops. However, fine sediment has not been identified as a significant concern for salmonids in the WR.
Turbidity	At Risk	Turbidity of the mainstem can be high during peak flow events, but has not been identified as a significant concern for salmonids.
Temperature	At Risk	Temperatures often reach unsuitable levels in the river in midsummer. Urban activities are a relatively minor contributor to the river's thermal input.
Biota		
Biotic Integrity/ Food Chain	At Risk	Biotic integrity of the mainstem Willamette is reduced from historical conditions. Several native species of fish and aquatic insects have been extirpated, and many introduced or nuisance species currently occupy the habitat. Native resident fish productivity is reduced compared to historical numbers, and low-value, tolerant organisms (i.e., *Corophia* spp.) have generally replaced high-value, less tolerant salmonid food organisms.

Table 3-2
Baseline Environmental Conditions of Important Fish Habitat Indicators in Janetville Creek (JC).

Factor	Baseline Condition	Notes
Habitat		
Peak Flow	Not Properly Functioning	Watershed development, particularly impervious surface and floodplain development, have affected the flow regime of Janetville Creek (JC), increasing the magnitude and frequency of flooding. These flow changes have caused stream channel changes, and resulting effects on fish habitat structure and function.
Baseflow	Not Properly Functioning	Summer baseflows are reduced compared to natural conditions, and cause increased summer water temperatures and decreased habitat access to salmonids
Channel characteristics	Not Properly Functioning	Channelization, incision, and bank erosion has occurred in downstream reaches of JC. JC has been narrowed and confined by hardened banks, and the lower section of JC has been covered over and piped. JC no longer meanders or overflows into low-lying areas. Instream habitat has been simplified; no longer complex.
Riparian Zone	Not Properly Functioning	Watershed development and streamside disturbance has reduced riparian vegetation along many sections of JC. Such reduction is a factor contributing to lack of instream cover, increased water temperature, and streambank erosion in JC.
Water Quality		
Nutrients	At Risk	High nutrient concentrations may occur in JC (urban activities contribute to these). However, DO content is suitable, and algal growth is not excessive under most conditions because streamflow is relatively rapid.
Toxic materials	At Risk	High concentrations of certain heavy metals and synthetic organic chemicals have been detected in JC, and are mainly bound to particulates washed into the creek from agricultural and industrial areas.
Sediment	At Risk	Watershed development has increased flooding magnitude and frequency and soil erosion, resulting in increased sediments from stream channel and land erosion. Fines in certain portions of JC are presently at levels that may limit fish food production or embed spawning areas.
Turbidity	At Risk	Turbidity concentrations in JC have not been identified as a significant concern for salmonids. Concentrations are probably higher during peak flow events.
Temperature	At Risk	Temperatures in JC are unsuitable during summer due to reduced base flows and reduced riparian shading conditions that have occurred with watershed and streamside development.
Biota		
Biotic integrity/ Food Chain	At Risk	Biotic integrity of JC is reduced from historical conditions. Several native species of fish and aquatic insects have been extirpated, and many introduced or nuisance species currently occupy the stream's habitat.

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CHAPTER 4

Species Occurrence

Two fish species that are listed under the federal Endangered Species Act (ESA) are known or suspected to occur within the Janetville area, including steelhead *(Oncorhynchus mykiss)* and chinook salmon (*Oncorhynchus tshawytscha*) (Table 4-1). The chinook salmon and steelhead species are part of two different Evolutionarily Significant Units (ESU)[13] as defined by the NMFS. Recovery Plans for these listed ESUs have not yet been developed. Without a Recovery Plan, the most appropriate approach for addressing activities that might adversely affect these ESUs include considerations for protecting critical spawning and rearing habitat areas.

Table 4-1
ESA Listed Fish Species Found in the Vicinity of Janetville in Oregon's Willamette Valley

Species	Scientific Name	Evolutionarily Significant Unit (ESU)	Endangered Species Act (ESA) Listing Status	Listing Decision Date
Steelhead trout	*Oncorhynchus mykiss*	Upper Willamette River	Threatened	March 25, 1999
Chinook salmon	*Oncorhynchus tshawytscha*	Upper Willamette River	Threatened	March 24, 1999

In addition, the Oregon Division of State Lands (DSL) in cooperation with the Oregon Department of Fish and Wildlife (ODFW) has designated specific waterways in these ESUs as Essential Indigenous Anadromous Salmonid Habitat under Oregon Administrative Rules (OAR) 141-102-000. Essential indigenous anadromous salmonid habitat, or essential habitat, refers to the habitat that is necessary to prevent the depletion of indigenous anadromous salmonid species during their life history stages of spawning and rearing. OAR 141-102-000 stipulates policies and standards that must be complied with in these designated areas. However, the Willamette River and Janetville Creek in the Janetville area are not designated as essential habitat. Therefore, compliance with these policies and guidelines is not mandatory.

Chinook Salmon

Presence and Use in the Janetville Area

The Willamette River in the Janetville area is primarily used by spring chinook salmon for upstream and downstream migratory purposes, although some rearing and feeding activity by juveniles likely occurs during their downstream migration. Adult spring chinook

[13] An Evolutionarily Significant Unit (ESU) is the population unit used by NMFS for listings of steelhead and salmon. An ESU is a distinct population that mostly does not breed with other populations and contributes to overall species diversity.

salmon enter the Columbia River during March and April, but do not negotiate Willamette Falls until May or June (PGE 1999). Myers et. al. (1998) state that the migration past the falls generally coincides with a rise in river temperatures above 10^0C. Spawning of spring chinook generally begins in late August and continues into early October, with peak spawning in September. These spring chinook produce ocean-type juveniles that typically enter saltwater either as fry migrants, which migrate at 60-150 days after hatching or as fingerling migrants, which migrate in the late summer or autumn of their first year (Myers et al. 1998).

Spring chinook is the only race of salmon native to the Janetville Creek watershed. Adult spring chinook begin to enter Janetville Creek in mid-May (Figure 4-1). The peak of the migration is from late May to early June. Spring chinook in the Willamette River basin system generally spawn from August through October 15. Spawning and juvenile rearing occurs in the creek's mainstem rather than any of the creek's tributaries.

Most juvenile outmigration occurs either as fry, which migrate at 60-150 days after hatching, or as fingerlings, which migrate in the late summer or autumn of their first year. A few juveniles may remain in freshwater for one year. The spring chinook salmon run is currently a mixture of native and hatchery fish. The proportion of the run that is wild is unknown but has probably decreased because hatchery releases have increased.

Habitat Requirements

Chapman and Bjornn (1969) and Everest and Chapman (1972) report that juvenile chinook are most abundant where substrate particle size is small, velocity is low, and depth is shallow. They also found that fish size is positively correlated with water velocity and depth. Juvenile rearing salmonids typically prefer water with a velocity of 0.16-1.3 feet/second (Reiser and Bjornn 1979). As juveniles grow they begin preferring deeper, faster water.

In the Willamette River near Janetville, nearshore shallow water areas (less than about 20 feet deep) are considered preferred habitat areas for juvenile salmonids, and are utilized predominantly as a migration corridor and for refuge and feeding. Knutsen and Ward (1991) and Ward et al. (1994) observed that outmigrating juvenile salmonids could be found anywhere spatially in the river in the lower Willamette River, but were typically found within 150 feet of the shore and most were collected within 18 feet of the water surface.

Juvenile chinook often prefer and seek natural off channel habitat during their outmigration, such as side channels, off channel ponds or sloughs, alcoves along the river margin, or temporarily flooded riparian areas (BES 1999). Juvenile salmonids are sensitive to rising and falling water levels, moving into off channel habitats as levels rise (such as, during floods) and moving out as levels drop (Bayley 1999). By moving into off channel habitats, the juvenile salmonids are seeking both refuge (particularly from high water velocities and from predators) and sources of food. Bayley (1999) has observed increased growth rates of juvenile chinook while utilizing shallow backwater areas in the upper Willamette River.

In general, adult chinook salmon prefer faster and deeper water than juveniles. Shreck et al. (1994) showed that adult chinook salmon migrated in depths of up to 80 feet in the lower Willamette River. Spawning adult salmonids generally prefer velocities in the range of 1-4 feet per second (fps), depths exceeding about 2 feet, and gravel to cobble-sized substrate material (Bovee 1978, See 1987). However, spawning has not been documented in the lower Willamette

River in the Janetville area, probably because suitable spawning conditions, particularly preferred gravel-cobble substrate is lacking.

Chinook salmon prefer cool water temperature (particularly less than about 65°F) and ample dissolved oxygen concentrations (greater than about 7 milligrams per liter (mg/l)). In general, temperatures between 50 and 57 °F are preferred by young salmonids and avoidance behavior may be seen in juveniles at temperatures above about 65-70°F (Narver 1971). However, temperature acclimation times likely increase the temperature at which avoidance behavior is invoked. Increased water temperatures cause increased metabolic rates, which in turn increases oxygen consumption. In addition, increased water temperatures decrease dissolved oxygen concentrations.

Chinook salmon require high dissolved oxygen concentrations in both intergravel and surface waters. Juvenile salmonids typically prefer water with a dissolved oxygen concentration of 8.0 mg/l (Hermann 1958). The U.S. Environmental Protection Agency (EPA 1987) reports water of 8.0 mg/l dissolved oxygen will have no production impairment on salmonids while concentrations of 6.0 mg/l or below will begin to impair salmonid production. Salmonid juveniles and adults will typically avoid areas with less than 7.0 mg/l dissolved oxygen.

Steelhead Trout

Presence and Use in the Janetville Area

As with spring chinook salmon, steelhead use the Willamette River in the Janetville area primarily for upstream and downstream migratory purposes, although some rearing and feeding activity by juveniles likely occurs during their downstream migration. Both winter and summer steelhead inhabit the Willamette River and Janetville Creek near Janetville; however, summer steelhead are not native to the area. Summer steelhead were introduced into the upper Willamette basin following improvements of fish passage at Willamette Falls and improved water quality.

Both hatchery-reared and wild native winter steelhead trout occur in Janetville Creek, but only the lower mainstem of Janetville Creek is used by steelhead trout for spawning and rearing. The native winter steelhead is a later-spawning stock and generally does not start migrating upstream until February (Figure 4-1). Spawning occurs during April and May with the peak occurring in late April and early May. The native run make up an estimated 30 percent of the production of winter steelhead trout in the watershed. Although spawning and rearing occur in the lower watershed, the upper watershed provides more extensive habitat.

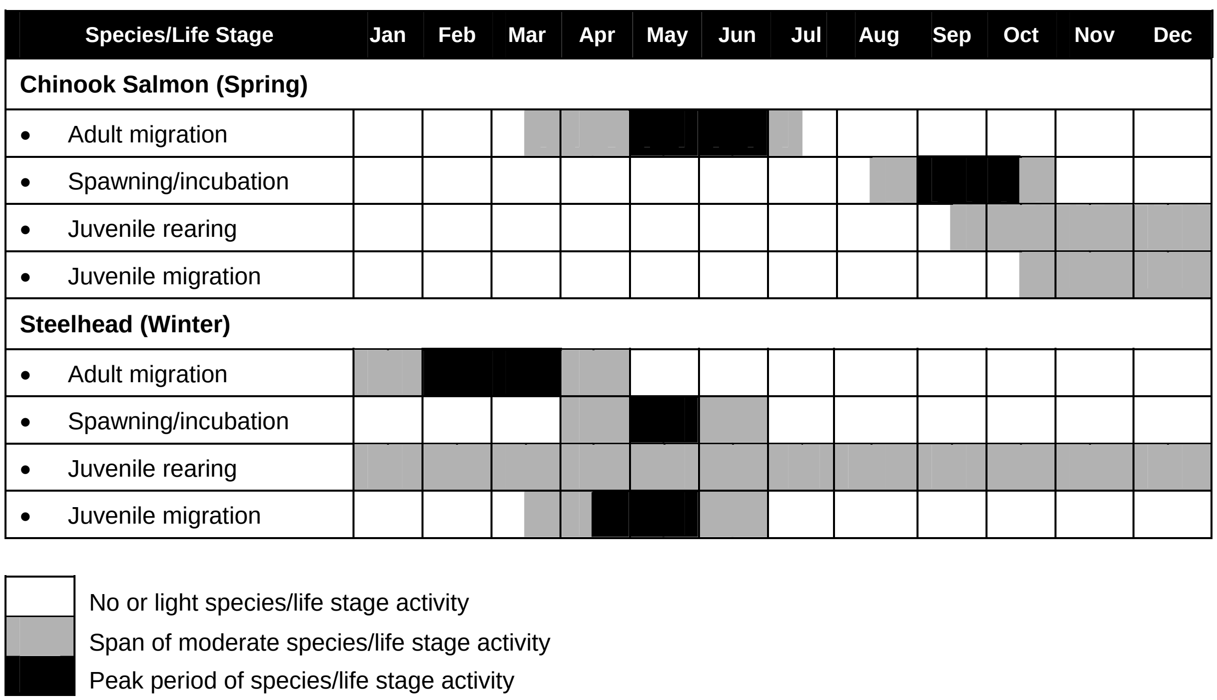
Juveniles rear in the system for 2 to 3 years before migrating to sea. Winter steelhead trout smolts typically outmigrate between April and June.

Habitat Requirements

Most of the habitat requirements as described above for chinook salmon also apply to steelhead. In the Willamette River near Janetville, juvenile steelhead probably can be found anywhere spatially in the river but most often within 100 feet of the shore and within 20 feet of the water surface. Spawning adult steelhead generally prefer velocities in the range of 1-4 feet per second (fps), depths exceeding about 2 feet, and gravel to cobble-sized substrate material (Bovee 1978, See 1987). However, steelhead spawning has not been documented in the lower Willamette River in the Janetville area, probably because suitable spawning conditions, particularly preferred gravel-cobble substrate is lacking.

As with chinook salmon, steelhead prefer cool water temperature (particularly less than about 65°F) and ample dissolved oxygen concentrations (greater than about 7 milligrams per liter (mg/l)). In general, temperatures between 50 and 57 °F are preferred by young salmonids and avoidance behavior may be seen in juveniles at temperatures above about 65-70°F (Narver 1971). Steelhead typically prefer water with a dissolved oxygen concentration of 8.0 mg/l (Hermann 1958). The U.S. Environmental Protection Agency (EPA 1987) reports water of 8.0 mg/l dissolved oxygen will have no production impairment on salmonids while concentrations of 6.0 mg/l or below will begin to impair salmonid production. Salmonid juveniles and adults will typically avoid areas with less than 7.0 mg/l dissolved oxygen.

Figure 4-1
Periods of occurrence of chinook salmon (spring) and steelhead (winter) in the Willamette River and Janetvillle Creek near Janetville.



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CHAPTER 5

Effects of the Proposed Program

This chapter provides an analysis of the effects – including short-term and long-term effects – of the Program on listed species and their habitats. For purposes of this analysis, short term is defined as the period of a typical construction Project, typically about several months. Long term occurs over a substantially longer time period than is typical for a construction Project; that is, on the order of years and over one or more fish life cycles[14]. This analysis of effects is based on currently available information on species and their habitats, and on the Program as currently envisioned (and as described in Chapter 2).

Effects Assessment Method

A risk-based method was developed for systematically analyzing the effects of the Program on listed species and their habitats[15]. This method is not a detailed ecological risk assessment, such as is often used to assess the ecological effects of contaminants (e.g., Cohrssen and Corvello 1989). Rather, a method was developed for use in this effects analysis that encompasses practical concepts of hazard (risk) identification and risk characterization (such as suggested by Canter [1993] for environmental impact assessments).

The risk-based method developed for this analysis is summarized in Figure 5-1 and consists of three parts:

- Baseline *Environmental Sensitivity*, which rates species sensitivity to potential erosion-related effects based on presence of specific species and life stages on or near the site, and the known sensitivity of each life stage to effects from fine sediment and turbidity.
- *Hazard Severity* for erosion and sediment delivery, which rates the site's susceptibility to soil erosion and sediment delivery based on site conditions and the extent of planned construction activities.
- *Risk of Effects* from erosion and sediment delivery, which rates the overall risk of effects to sensitive environmental resources (in this case, fish) from potential erosion and sediment delivery.

Hazard Severity and *Risk of Effects* ratings are first determined for a hypothetical situation under which erosion prevention and sediment control measures are not applied ("unmanaged or untreated conditions"). *Hazard Severity* and *Risk of Effects* ratings are then determined assuming application of the Program and its required and recommended measures ("with EPSC Program"). The specific effects of the Program are determined by

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14 The life cycles of chinook salmon and steelhead are typically 4-6 years.

15 Using this method, Janetville's intent was to analyze effects at the Program level, including by examining example project scenarios representing a range of conditions (as described in subsequent sections of this chapter). Janetville does not require that this method be applied on actual individual projects. However, Janetville encourages use of the method or components of the method (such as the Revised Universal Soil Loss Equation) as an informative tool for EPSC planning, especially for sites and projects that are large, complex, or otherwise involve factors that pose high risk of soil erosion.

comparing the two sets of ratings. As such, the effects of the Program are expected to be positive and relate directly to the effectiveness of the Program to avoid or minimize unmanaged or untreated erosion and sediment delivery.

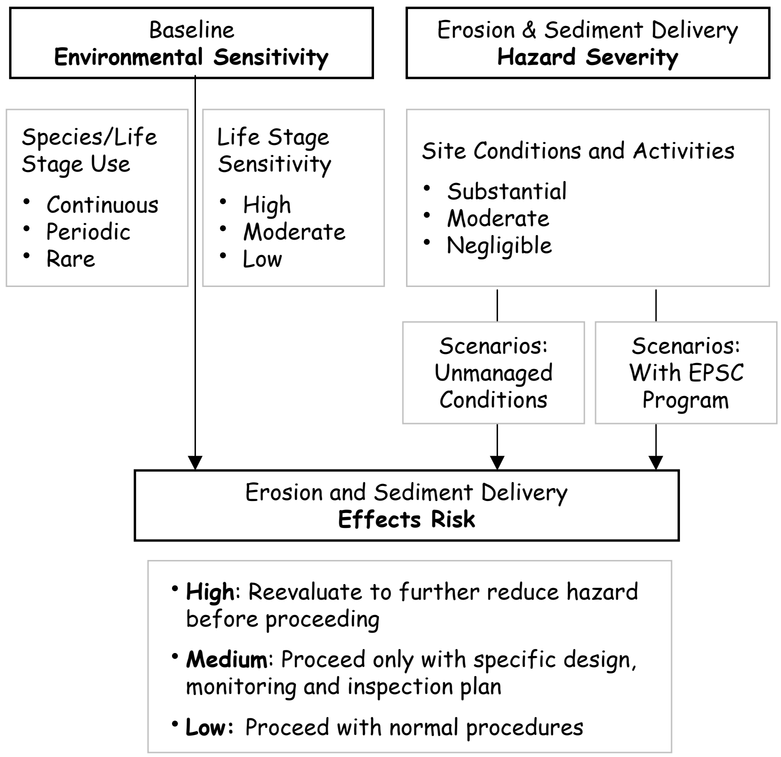

Figure 5-1. Effects analysis framework.

Potential Effects of Construction Activities

When land is disturbed at a construction site, the erosion rate can accelerate substantially. Removal of ground cover increases the site's susceptibility to erosion because vegetation on an undisturbed site protects the soil surface. Also, reduction is soil permeability increases the site's susceptibility to erosion because more water is forced to run across soil surfaces. The rate of erosion on a construction site varies with site conditions, climate, and soil types, but is typically on the order of 100-200 tons of soil per acre, and may be as high as 500 tons of soil per acre (CWS, WES, and City of West Linn 2000).

Even though construction requires that land be disturbed and left bare for periods of time, proper planning and use of erosion prevention measures can reduce associated environmental impacts (CWS, WES, and City of West Linn 2000). Even with proper EPSC measures, increased sediment yields above predevelopment conditions will probably occur during storm events. However, Fifield (2001) reports that as erosion control measures are implemented or once final stabilization is achieved, predevelopment (or lower) sediment yields can be realized.

Specific Effects on Water Quality

The major environmental problem associated with erosion on a construction site is the movement of soil off the site and its impact on water quality. Suspended sediment and turbidity are water quality parameters that reflect the level of sediment delivery to a receiving water body. Suspended sediments and turbidity have known effects on salmonid species (see Attachment B entitled *Sensitivity of Salmonids to Suspended Sediment and Turbidity*[16]). Sediment carried in streamflow can settle into low velocity reaches of stream channels, filling voids in the gravel, affecting spawning and incubating eggs, or decreasing substrate available to aquatic insects that serve as food for juvenile fish. Turbid water generally decreases feeding opportunities for salmonid parr, but may offer refuge from predators to parr and migrating smolts. In general, moderate levels of turbidity that occur occasionally or episodically are not considered especially harmful to salmonids, but high levels can result in the above detrimental effects.

Sediment loading may also increase the amount of nutrients in water. For example, some soils have high levels of one or more nutrients, especially if the soils have high clay content. Sediment loading may also increase the amount of pesticides and heavy metals in water if pesticides and heavy metals are found in soils on the construction site. Over half the trace metals carried in surface waters are attached to sediment particulates (Fifield 2001).

For purposes of this analysis, sediment and turbidity are the key inputs used for assessing risk of potential effects to sensitive environmental resources (that is, listed fish and their habitats). Not only do suspended sediments and turbidity have the potential to directly affect fish behavior and habitat quality (see Attachment B entitled *Sensitivity of Salmonids to Suspended Sediment and Turbidity*), but sediment particulates are also the key mechanism for transport of other potential contaminants (such as, nutrients, pesticides, and heavy metals, if present in eroded soils). Therefore, sediments and turbidity are considered to be adequately robust indicators of potential water quality effects for this analysis.

Baseline Environmental Sensitivity

Approach to Deriving Environmental Sensitivity Ratings

Figure 5-2 illustrates how information on the use of the Willamette River and Janetville Creek by listed fish species and their life stages (as presented in Chapter 4 - Species Occurrence) is inserted into a simple decision matrix to classify baseline *Environmental Sensitivity* for the site. The information is inserted into the decision matrix in two ways:

- *Life Stage Sensitivity*: the sensitivity of the life stages present to potential effects from suspended sediment and turbidity[17]. "High" indicates very intolerant and susceptible

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[16] No information was found in the scientific literature on the sensitivity of Oregon chub to suspended sediment and turbidity. In general, chub are probably equally or less sensitive than salmonids to suspended sediment and turbidity.

[17] Judged using information from the scientific literature (see Attachment B entitled *Sensitivity of Salmonids to Suspended Sediment and Turbidity*).

to effects, "low" indicates tolerant to effects, and "moderate" is intermediate between the other categories.

- *Life Stage Use*: the periodicity of use of the life stages in habitats at or near the site or that are otherwise subject to potential erosion and sediment delivery from the site[18]. "Continuous" indicates use by the life stage year-round or throughout the Project period, "periodic" means temporary or short-term use (including seasonal), and "rare" indicates no or very infrequent use.

		Life Stage Sensitivity		
		High	Moderate	Low
Life Stage Use	Continuous	H	H	M
	Periodic	H	M	L
	Rare	M	L	L

Figure 5-2. Baseline environmental sensitivity rating matrix.

The decision matrix provides a systematic means to classify and justify baseline *Environmental Sensitivity* for the site with a simple and useful "high-moderate-low" scale. The resulting *Environmental Sensitivity* rating provides an indicator of the potential risk to listed species by integrating the inherent sensitivity of individual life stages with the probability that the life stage will be present. The simple matrix format shown in Figure 5-2 also allows easy definition of the "high-moderate-low" scale. For example, baseline *Environmental Sensitivity* is "low" where particular life stages are rare and tolerant to sediment and turbidity.

[18] Judged using information from the known timing and periods-of-use of various life stages, and taking into account the planned period of Project construction activities.

Environmental Sensitivity Ratings for the Janetville Area

Table 5-1 presents *Environmental Sensitivity* ratings for the various species and life stages in the Willamette River at Janetville. The results show that sensitivity varies by species, life stage, and watercourse. Chinook and steelhead rearing juveniles are judged to have high sensitivity owing to relatively high susceptibility to fine sediment and turbidity and their periodic presence in the area. All other chinook and steelhead life stages are judged to have moderate sensitivity either because they are more tolerant of fine sediment and turbidity or infrequently use the area. Oregon chub adult and juvenile life stages are judged to have low sensitivity primarily because they rarely, if at all, occupy the area. The Oregon chub spawning/incubation life stage also is unlikely to occupy the area, but is judged to have moderate sensitivity owing to greater susceptibility to fine sediment and turbidity.

Table 5-2 presents *Environmental Sensitivity* ratings for the various species and life stages in Janetville Creek. As in the Willamette River, chinook and steelhead rearing juveniles are judged to have high sensitivity owing to relatively high susceptibility to fine sediment and turbidity and their periodic presence in the area. Unlike the Willamette River, chinook spawning/incubation is judged to have high sensitivity owing to seasonal use of Janetville Creek for spawning. All other chinook and steelhead life stages are judged to have moderate sensitivity either because they are more tolerant of fine sediment and turbidity or infrequently use the area. Oregon chub adult and juvenile life stages are judged to have low sensitivity primarily because they rarely, if at all, occupy the area. The Oregon chub spawning/incubation life stage also is unlikely to occupy the area, but is judged to have moderate sensitivity owing to greater susceptibility to fine sediment and turbidity.

Table 5-1
Sensitivities of key environmental resources in the Willamette River at Janetville.

Species/Life Stage	Life Stage Timing	Life Stage Sensitivity	Life Stage Use	Overall Sensitivity
Chinook (Spring)				
Adult immigration	March-July	Moderate	Periodic	Moderate
Spawning/Incubation	August-October	High	Rare	Moderate
Juvenile rearing	September-December	High	Periodic	High
Juvenile emigration	October-November	Moderate	Periodic	Moderate
Steelhead (Winter)				
Adult immigration	January-April	Moderate	Periodic	Moderate
Spawning/Incubation	April-June	High	Rare	Moderate
Juvenile rearing	Year-round	High	Periodic	High
Juvenile emigration	March-June	Moderate	Periodic	Moderate

Table 5-2
Sensitivities of key environmental resources in Janetville Creek.

Species/Life Stage	Life Stage Timing	Life Stage Sensitivity	Life Stage Use	Overall Sensitivity
Chinook (Spring)				
Adult immigration	March-July	Moderate	Periodic	Moderate
Spawning/Incubation	August-October	High	Periodic	High
Juvenile rearing	September-December	High	Periodic	High
Juvenile emigration	October-November	Moderate	Periodic	Moderate
Steelhead (Winter)				
Adult immigration	January-April	Moderate	Periodic	Moderate
Spawning/Incubation	April-June	High	Rare	Moderate
Juvenile rearing	Year-round	High	Continuous	High
Juvenile emigration	March-June	Moderate	Periodic	Moderate

Erosion and Sediment Delivery Hazard

Approach to Deriving Hazard Severity Ratings

Erosion and sediment delivery *Hazard Severity* provides a rating of the site's susceptibility to soil erosion and sediment delivery based on site conditions and the extent of planned construction activities. *Hazard Severity* is first determined for a hypothetical situation under which erosion prevention and sediment control measures are not applied ("unmanaged or untreated conditions"). *Hazard Severity* is then determined assuming the Program and its required measures are applied ("with EPSC Program"). The specific effects of the Program are determined by comparing the two sets of ratings. As such, the effects of the Program are expected to be positive and relate directly to the effectiveness of the Program to avoid or minimize unmanaged or untreated erosion and sediment delivery.

Significance of Site Condition Factors

Site conditions are significant factors in soil erosion and sediment delivery. For purposes of systematically judging site conditions in Janetville, some key factors and guidelines were developed to help define potential hazard of soil erosion and sediment delivery (Table 5-3). For example, a site with steep slopes and fine-textured soils is considered to pose a substantial potential hazard of soil erosion and sediment delivery compared to a relatively flat site with coarse-textured soils.

Table 5-3
Key factors and guidelines for site risk related to potential hazard of soil erosion and sediment delivery. Janetville Fish-Friendly Erosion Control Program. Values shown are intended for application to fictitious Janetville, Oregon, which may not be applicable to other jurisdictions.

	Relative Hazard of Unmanaged Soil Erosion and Sediment Delivery		
Factor	**Low**	**Moderate**	**High**
Area of disturbance (sq.ft.)[19]	<1000	1,000-10,000	>10,000
Proximity to stream channel, drainage swale or storm drain inlet (ft)[20]	>200	100-200	<100
Slope[21]	<3%	3% to 10%	>10%
Soil type (based on NRCS Hydrologic Soil Group)	Group A	Group B	Group C and D
Soil texture	Coarse texture[22] (mostly coarse sands and gravels)	Moderate texture	Fine texture[23] (mostly silts, clays and fine sands)
Time of year[24]	July – August	May – June; September	October – April
Time period with bare soil surface[25]	<4 days	4-7 days	>7 days

The Revised Universal Soil Loss Equation: A Key Tool

The Revised Universal Soil Loss Equation (RUSLE) was used as the key tool for estimating soil erosion from construction projects in Janetville. RUSLE is a revision of the original Universal Soil Loss Equation (USLE) developed by the U.S. Department of Agriculture for estimating sheet and rill erosion from agricultural fields under specific conditions (Wischmeier and Smith 1978, Renard et al. 1997). The RUSLE equation is the same as for the original USLE (Equation 5-1), but updated to include more flexibility in examining interrelated cover and management variables (i.e., “C-factor” as defined in Equation 5-1).

$$\mathbf{A = R \times K \times LS \times C \times P} \qquad \text{Equation 5-1}$$

[19] The maintenance of vegetation is the most important factor in minimizing erosion during development.

[20] Directly related to the width of buffer zone between development and receiving stream (including storm drain inlets and drainage ditches). Research has shown that sediment flow over land or from vegetated ditches typically extends less than 200 feet from the sediment source, and that 80 percent of sediment volume remains deposited within the first 100 feet from the source (Benoit 1978, Castelle and Johnson 1996, Megahan and Ketcheson 1996). The majority of functional wood is recruited from trees within 100 feet of stream channels (McDade et al. 1990).

[21] Risk of erosion on slopes is related to steepness of slope and slope length. Risk can be lessened by reducing slope length.

[22] High infiltration rate and low runoff potential.

[23] Low infiltration rate and high runoff potential.

[24] Based on percent chance for significant precipitation and soil saturation.

[25] Related to the risk of a precipitation or wind event occurring when bare soil is exposed. Risk varies with time of year.

Where: **A** = Annual soil loss (tons/acre/year)

R = Rainfall and runoff factor based on the number of erosion-index units in an average year's rain. The erosion index is the storm energy in hundreds of foot tons times the 30-minute storm intensity.

K = Soil erodibility factor. The soil loss rate (tons/acre) of a specific soil type and horizon as measured on a standard plot of land.

LS = Topographic factor. A numerical representation of the length and slope steepness.

C = Cover factor. The ratio of soil loss from an area with specified cover to that from the same area but under bare soil conditions.

P = Management practice factor. The ratio of soil loss with a given surface condition to soil loss from the same area but under the effect of various management practices.

Scenarios and Conditions Assessed Using the Revised Universal Soil Loss Equation

Use of RUSLE in this effects analysis is also consistent with use of RUSLE to design and evaluate EPSC plans as recommended in the EPSC Manual (CWS, WES, and the City of West Linn 2000). RUSLE has been adapted for use in evaluating construction site erosion rates (Renard et al. 1997, Balousek et al. 2000, Fifield 2001). For purposes of estimating *Hazard Severity* for construction sites in Janetville, a spreadsheet was developed based on the RUSLE equation as adapted for use in evaluating construction site erosion rates. The spreadsheet was used to estimate erosion rates and sediment yields for each of six construction project scenarios in Janetville (see Chapter 2 for a description of construction projects and activities, and Chapter 3 for a description of site conditions). The six construction project scenarios include:

- Dry season construction; low hazard site
- Dry season construction; moderate hazard site
- Dry season construction; high hazard site
- Wet season construction; low hazard site
- Wet season construction; moderate hazard site
- Wet season construction; high hazard site

Estimated erosion rates and sediment yields for each of the six construction project scenarios are contained on spreadsheets in Attachment C.

As explained in Chapter 3, the six project scenarios provide a full range of potential conditions that occur in Janetville. However, the high hazard site is a conservative, extreme condition because it assumes a combination of all the "high" site conditions (as listed in Table 5-3) that is rarely expected to occur in Janetville. Most of the construction projects in Janetville occupy low and moderate sites. Factors listed in Table 5-3 were basically used as listed in the RUSLE spreadsheet to represent "low", "moderate", and "high" site conditions.

To accurately evaluate the effectiveness of EPSC Program measures in preventing or minimizing soil erosion and sediment delivery, the spreadsheet was used to calculate sediment yield (in tons/year) in four ways:

- *Pre-construction sediment yield* (S_A) from the site before it is disturbed
- *Untreated sediment yield* (S_B) representing the hypothetical yield that could be generated during construction when bare ground exists but with no EPSC treatment measures
- *Treated sediment yield* (S_C) representing the yield estimated during construction with EPSC treatment measures
- *Post-construction sediment yield* (S_D) representing the yield estimated after construction has been completed and final EPSC treatment measures, including cover conditions, are fully established

An important assumption was used in the RUSLE spreadsheet to further describe pre-construction site cover conditions. The rate of erosion is directly proportional to the type and density of cover protecting the soil, particularly vegetation, which absorbs rainfall energy, binds and retains soil particles, increases surface roughness and slows runoff velocity, and enhances soil porosity and infiltration (Fifield 2001). In the RUSLE equation, cover is represented in the C-factor (see Equation 5-1). C-factors developed for various existing vegetative conditions by Wischmeier and Smith (1978) were used to assign a pre-construction C-factor value of 0.7 to the project sites in Janetville for use in RUSLE calculations. A C-factor value of 0.7 approximately represents existing vegetative conditions of project sites in Janetville of 50 to 70 percent ground cover of tall weeds and short brush, or trees but no appreciable brush. C-factor graphs developed by Wischmeier and Smith (1978) are contained in Attachment D.

Several other important assumptions and information sources were used in the RUSLE spreadsheet to further describe EPSC Program treatment measures and their effectiveness. In the RUSLE equation, effectiveness of measures (or BMPs) are represented in the C-factor for non-structural practices installed (i.e., erosion prevention and control) and in the P-factor for structural practices installed (i.e., runoff and sediment control). C-factor and P-factor values for construction site BMPs as reported by Fifield (2001) and Corbett (1990) were used to assign a C-factor and P-factor values for assumed EPSC Program treatment measures used in the RUSLE spreadsheet[26]. Key figures and tables from Fifield (2001) and Corbett (1990) are contained in Attachment D.

In the RUSLE spreadsheet, general categories of treatment measures (or BMPs) were applied in a typical sequencing of their implementation on site[27]. These general categories and their typical sequence include perimeter control (silt-fence barrier), mulching and seeding, sediment basins and swales, temporary vegetation establishment, and permanent vegetation establishment. The assumption is necessarily made that treatment measures are properly

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[26] These C-factor and P-factor values are only guidelines for common construction site BMPs. The actual value may be larger or smaller depending on installation, maintenance, and other site conditions.

[27] The RUSLE analysis is applied at the site scale; sediment yield calculations are not made at the scale of individual BMPs. Therefore, C-factors and P-factors for individual BMPs is not necessary or practical, and C-factors and P-factors for general categories of BMPs are considered sufficient.

selected, designed, installed, and functioning such that the effectiveness assumed in the C-factor and P-factor values would be achieved.

Because treatment measures are sequentially applied and eventually involve a combination of measures, the C-factor and P-factor values in the spreadsheet are adjusted to account for the combined net effectiveness. The combined net effectiveness in the spreadsheets was computed based on a simple weighted average as suggested by Fifield (2001).

Another important factor in the spreadsheet is the Sediment Delivery Ratio (SDR). The SDR is the ratio of sediment delivered at a given location in a drainage system to the soil erosion from the drainage area above that location (Fifield 2001). The SDR is actually not part of the RUSLE equation, but is included as a final factor in the spreadsheet to provide an estimate of potential sediment yield or delivery as suggested by Fifield (2001) and Corbett (1990). The limitation of this method is that SDR is very site-specific, yet is very difficult to accurately measure and, therefore, is rarely done. Many factors influence the value of SDR including:

- size of drainage area
- topography and channel density
- relief and length of watershed slopes
- precipitation and runoff.

For purposes of this analysis, SDR values were estimated using the relationship of SDR and drainage area developed by Corbett (1990) (as contained in Attachment D).

Hazard Severity Ratings for Construction Project Scenarios

Hazard Severity ratings were determined for each of the six construction project scenarios for untreated, treated, and post-construction conditions. First, for each of these conditions (S_B, S_C, S_D), percent change from the pre-construction sediment yield (S_A) was determined (for example, $(S_C-S_A)/S_A$ x 100 for the treated condition). Then, *Hazard Severity* ratings were derived using a scale where:

- "Substantial" indicates potential sediment yield of greater than 10 percent increase over pre-construction sediment yield
- "Moderate" indicates potential sediment yield of 1 to 10 percent increase over pre-construction sediment yield
- "Negligible" indicates potential sediment yield of less than 1 percent increase over pre-construction sediment yield

The specific effectiveness of EPSC Program measures can then be determined by comparing the sets of ratings for the untreated (during construction), treated (during construction), and post-construction conditions (Table 5-4). The comparison indicates the extent to which the EPSC Program measures reduce the potential hazard of soil erosion and sediment delivery. As such, the effects of the Program are expected to be positive and relate directly to the effectiveness of the Program to reduce risk of unmanaged erosion and sediment delivery.

Tables 5-4 presents estimated *Hazard Severity* ratings of erosion and sediment delivery with and without EPSC Program measures under various construction project scenarios in

Janetville. The ratings indicate that implementation of EPSC Program measures reduces potential hazard of erosion and sediment delivery in the short-term (during the construction period) in all scenarios, except for wet season construction on a high hazard site[28]. The ratings further indicate that potential hazard of erosion and sediment delivery is negligible over the long-term (after final EPSC treatment measures, including cover conditions, are fully established) in all scenarios.

Table 5-4
Estimated hazard severity of erosion and sediment delivery to habitat areas with and without EPSC Program measures under various construction project scenarios in Janetville.

	Hazard Severity of Erosion and Sediment Delivery		
Scenario	**Untreated**	**With EPSC Program (During Construction)**	**With EPSC Program (After Construction)**
Dry season construction; low hazard site	Moderate	Negligible	Negligible
Dry season construction; moderate hazard site	Substantial	Negligible	Negligible
Dry season construction; high hazard site	Substantial	Moderate	Negligible
Wet season construction; low hazard site	Moderate	Negligible	Negligible
Wet season construction; moderate hazard site	Substantial	Moderate	Negligible
Wet season construction; high hazard site	Substantial	Substantial	Negligible

28 The RUSLE spreadsheet indicates that the EPSC Program measures also substantially reduce sediment yield for wet season construction on a high hazard site. However, even with the substantial reduction in sediment yield, the hazard severity is still rated as *substantial*.

Risk of Erosion and Sediment Delivery Effects on Baseline Environmental Resources

Approach to Deriving Risk of Effects Ratings

Figure 5-3 illustrates how *Environmental Sensitivity* ratings and *Hazard Severity* ratings as previously described are inserted into a simple decision matrix to derive *Risk of Effects* for the six construction project scenarios in Janetville under untreated, treated (with EPSC Program measures), and post-construction conditions. *Risk of Effects* determinations were derived using a scale where:

- "High" indicates that site hazard and/or environmental sensitivity is high enough that, even with EPSC Program measures, construction project planning should be reevaluated to further reduce hazard before proceeding[29].
- "Medium" indicates that site hazard and/or environmental sensitivity is sufficient that construction project planning should proceed only with site-specific design, implementation, monitoring and inspection of EPSC Program measures.
- "Low" indicates that site hazard and/or environmental sensitivity is low enough that construction project planning can proceed with EPSC Program measures or other more standard and routine erosion control practices.

Risk of Effects Ratings for Construction Project Scenarios

Table 5-5 summarizes the *Risk of Effects* ratings for the six construction project scenarios in Janetville by resource sensitivity. A comparison of the *Risk of Effects* ratings indicates the extent to which the EPSC Program measures are sufficient to reduce and minimize effects on sensitive environmental resources (in this case, listed fish species and life stages).

The *Risk of Effects* ratings indicate that, in most cases, the EPSC Program measures are sufficient to reduce and minimize risk to sensitive environmental resources in the short-term (during the construction period) and long-term (after final EPSC treatment measures, including cover conditions, are fully established). However, the following construction project scenarios in Janetville are exceptions:

- Dry or wet season construction on high hazard sites with high resource sensitivity
- Wet season construction on moderate hazard sites with high resource sensitivity
- Wet season construction on high hazard sites with moderate resource sensitivity.

29 Such reevaluation may include redesign of the proposed project to further reduce potential soil erosion (such as by reducing the area and duration of soil disturbance, or avoiding wet weather construction activities), or re-locating the proposed project to a new site or portion of the original site that has lesser risk of potential soil erosion (such as having lesser slopes or greater distance from streams, riparian areas, etc.).

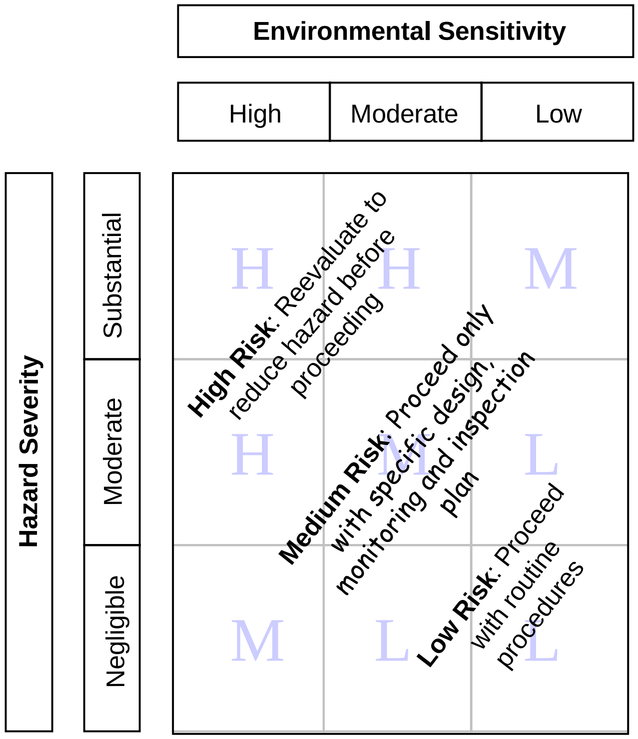

Figure 5-3. Risk of effects assessment matrix.

For these exceptions, the *Risk of Effects* ratings indicate that site hazard and/or environmental sensitivity is high enough that, even with EPSC Program measures, construction project planning should be reevaluated to further reduce hazard before proceeding. Otherwise, EPSC Program measures are effective in reducing and minimizing risk of erosion and sediment effects to sensitive environmental resources.

Table 5-5
Short-term and long-term *Risk of Effects* determinations under various construction project scenarios in Janetville.

Scenario	Risk of Effects Determination by Resource Sensitivity		
	High Resource Sensitivity	**Medium Resource Sensitivity**	**Low Resource Sensitivity**
Short-term (During Construction) Risk of Effects			
Dry season construction; low hazard site	◉	○	○
Dry season construction; moderate hazard site	◉	○	○
Dry season construction; high hazard site	●	◉	○
Wet season construction; low hazard site	◉	○	○
Wet season construction; moderate hazard site	●	◉	○
Wet season construction; high hazard site	●	●	◉
Long-term (After Construction) Risk of Effects			
Dry season construction; low hazard site	◉	○	○
Dry season construction; moderate hazard site	◉	○	○
Dry season construction; high hazard site	◉	○	○
Wet season construction; low hazard site	◉	○	○
Wet season construction; moderate hazard site	◉	○	○
Wet season construction; high hazard site	◉	○	○

● High risk of effects; reevaluate to reduce hazard before proceeding
◉ Medium risk of effects; proceed only with site-specific EPSC Program measures
○ Low risk of effects; proceed with standard erosion control practices

CHAPTER 6

Conclusions

Effects on Listed Fish and Their Habitats

The *Risk of Effects* ratings indicate that, in most cases, the EPSC Program measures are sufficient to reduce and minimize risk to listed fish and their habitats in the short-term (during the construction period) and long-term (after final EPSC treatment measures, including cover conditions, are fully established). However, at sites adjacent to habitats with continuous or periodic use by sensitive life stages, dry or wet season construction on high hazard sites or wet season construction on moderate hazard sites may be exceptions. For these exceptions, the *Risk of Effects* ratings indicate that site hazard and/or environmental sensitivity is high enough that, even with EPSC Program measures, construction project planning should be reevaluated to further reduce hazard before proceeding. Otherwise, EPSC Program measures should effectively prevent construction-related soil erosion and sediment delivery from impairing properly functioning habitat conditions (PFC), appreciably reducing the functioning of already impaired habitat, or retarding the long-term progress of impaired habitat toward PFC.

Actions Taken for Construction Projects in Janetville

The *Risk of Effects* ratings have provided a useful tool for evaluating and reducing risk to listed fish and their habitats from specific construction projects in Janetville, and thereby ensuring that EPSC plans are sufficiently "fish-friendly". As a results of the *Risk of Effects* ratings, several projects proposed on high hazard sites near Janetville Creek, and one large wet-season project proposed on a moderate hazard site adjacent to the Willamette River, were redesigned to reduce hazard severity. For the high hazard sites near Janetville Creek, this included such techniques as reducing the areas of clearing and excavation to minimize soil perviousness, phasing (staging) the construction activities to minimize the duration of bare soil exposure, repositioning building "footprints" to avoid steep slopes, and maximizing retention of existing site vegetation. For the large project adjacent to the Willamette River, the project was redesigned to confine clearing and excavation to the drier months of June-September and to further maximize retention of existing site vegetation. These design revisions effectively reduced *Risk of Effects* ratings for each project. The City of Janetville subsequently issued site development permits for these projects under the "fish-friendly" EPSC Program, including requirements for monitoring, inspection, and reporting (as described in Chapter 2).

The EPSC Program's monitoring, inspection, and reporting requirements have proven to be a valuable tool for reducing uncertainty associated with the Program's effectiveness in protecting listed fish and their habitats. For example, Project-level and Program-level inspection and monitoring information obtained thus far has allowed the City of Janetville to develop a chart of BMP effectiveness that site developers can use for EPSC plans to further reduce and minimize soil erosion and sediment delivery from construction sites

(Attachment E). The monitoring, inspection, and reporting will allow the City of Janetville to make other such refinements to Program requirements if needed over the long-term so that the Program's effectiveness in protecting listed fish and their habitats can be assured.

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Attachment A:
Example Model Program for Erosion and Sediment Control During Construction

Example Model Program for Erosion Prevention and Sediment Control During Construction

Section I. Introduction and Purpose

During the construction process, soil is vulnerable to erosion by wind and water. This eroded soil impairs water resources by reducing water quality, and causing the siltation of aquatic habitat for fish and other desirable species. Eroded soil also necessitates maintenance and repair of sewers, ditches, and stormwater facilities (such as, stormwater detention ponds). In addition, clearing, grubbing, and grading during construction can cause the loss of native vegetation and depletion of soil productivity necessary for terrestrial and aquatic habitat, and to provide a healthy living environment for citizens of (*Municipality)*.

The purpose of this local regulation is to require erosion prevention measures and sediment control practices for construction activities in (*Municipality*) to prevent and restrict the discharge of sediments from the site of these construction activities. As a result, this local regulation will safeguard persons, protect property, prevent damage to the environment and promote the public welfare by guiding, regulating, and controlling erosion prevention measures and sediment control practices for construction activities that move or disturb the topsoil on land in (*Municipality*).

Section II. Definitions

"BMPs" refer to "Best Management Practices" or erosion prevention measures and sediment control practices for construction activities.

"Clearing" is any activity that removes the vegetative surface cover.

"Drainageway" is any channel that conveys surface runoff throughout the site.

"Effectiveness Monitoring" is monitoring to determine if implementation of the erosion prevention measures and sediment control program and practices are achieving the desired objectives.

"Erosion Prevention" means measures that prevent erosion.

"Erosion Prevention and Sediment Control Plan" means a set of plans indicating the specific measures, sequencing, and phasing to be used for preventing erosion and controlling sediment on a development site before, during and after construction.

"Grading" is excavation or fill of material, including the resulting conditions thereof.

"Grubbing" is soil displacement by removing tree stumps, roots, and buried natural material from the soil mantle.

"Implementation Monitoring" is monitoring to see if required or recommended provisions and practices of the erosion prevention measures and sediment control program are properly implemented.

“Perimeter Control” is a barrier that prevents sediment from leaving a site either by filtering sediment-laden runoff, or diverting it to a sediment trap or basin.

“Phasing” means clearing a parcel of land in distinct phases (or staging), with the stabilization of each phase before the clearing of the next.

“Project” is the permitted site development action.

"Program" refers to the erosion prevention and sediment control program and its provisions.

“Sediment Control” means measures that prevent eroded sediment from leaving the site.

“Sequencing” is the scheduled order of individual site development actions.

“Site” is a parcel of land, or a contiguous combination thereof, where grading work is performed as a single unified operation.

“Site Development Permit” is a permit issued by (*Municipality)* for the construction or alteration of ground improvements and structures for the control of erosion and runoff.

"Site Steward" is the designated individual responsible for erosion prevention and sediment control of the site and who has authority to take actions necessary to ensure compliance. For more complex sites, the knowledge and experience of the Site Steward should be comparably higher.

“Stabilization” means the use of practices that prevent exposed soil from eroding.

“Start of Construction” means the first land-disturbing activity associated with a development, including land preparation such as clearing, grubbing, grading, or filling; installation of streets and walkways; excavation for basements, footings, piers or foundations; erection of temporary forms; and installation of accessory buildings such as garages.

“Watercourse” is any body of water, including, but not limited to lakes, ponds, rivers, streams, and wetlands within (*Municipality*).

“Waterway” is a channel that directs surface runoff to a watercourse, or to the public storm drain system.

Section III. Permits

1. No person shall be granted a site development permit for land-disturbing activity that would require the uncovering of 1,000 or more square feet without the approval of an Erosion Prevention and Sediment Control Plan by (*Municipality*).

2. No site development permit is required by this program for the following activities:

   - Any in-channel work activities or construction of temporary or permanent crossings of watercourses. Development that requires in-channel work activities or construction of watercourse crossings shall obtain necessary permits and approvals from (*Approving Agency, such as the U.S. Army Corps of Engineers, Oregon Division of State Lands, or others*).

- Construction activities, including clearing, grading, and excavation, that disturb one acre or more of land. Such construction activities shall obtain necessary permits and approvals from the Oregon Department of Environmental Quality as required under OAR 340-040 and OAR 340-045 and in accordance with NPDES Storm Water Discharge General Permit #1200-C.
- Any emergency activity that is immediately necessary for the protection of life, property or natural resources.

3. Each application shall bear the name(s) and address(es) of the owner or developer of the site, and of any consulting firm retained by the applicant together with the name of the applicant's principal contact at such firm, and shall be accompanied by a filing fee.
4. Each application shall include a statement that any land clearing, construction, or development involving the movement of earth shall be in accordance with the Erosion Prevention and Sediment Control Plan, and that a site steward or erosion prevention contact shall be on site on all days where construction or grading activity takes place.
5. The applicant may be required to file with (*Municipality*) a faithful performance bond or bonds, letter of credit, or other improvement security in an amount deemed sufficient by (*Municipality)* to cover all costs of improvements, landscaping, and maintenance of improvements for such period as specified by (*Municipality*) and engineering and inspection costs to cover the cost of failure or repair of improvements installed on the site.
6. (*Municipality*) will review each application for a site development permit to determine its conformance with the provisions of this local regulation. Within thirty (30) days after receiving an application, (*Municipality*) shall, in writing:
   - approve the permit application; or
   - approve the permit application subject to such reasonable conditions as may be necessary to secure substantially the objectives of this regulation, and issue the permit subject to these conditions; or
   - disapprove or deny the permit application, indicating the deficiencies and the procedure for submitting a revised application and/or submission. (*Municipality*) shall respond in writing within thirty (30) days to resubmitted revised application and/or submission.

Section IV. Erosion Prevention and Sediment Control Plan

Contents of the Plan

The Erosion Prevention and Sediment Control Plan shall include:

- A natural resources map identifying soils, forest cover, and sensitive resources (including wetlands, waterways, lakes) protected under other chapters of this code.

- A sequence of construction of the development site, including clearing, grubbing, rough grading, construction of utilities, infrastructure, and buildings, and final grading and landscaping. Sequencing shall identify the expected date on which clearing will begin, the estimated duration of exposure of cleared areas, and the timing of temporary erosion and sediment measures, and establishment of permanent vegetation.
- All erosion prevention and sediment control measures necessary to meet the objectives of this local regulation throughout all phases of construction and permanently, after completion of development of the site. Depending upon the complexity of the project, the drafting of intermediate plans may be required at the close of a particular phase or stage of construction.
- Seeding mixtures and rates, types of sod, method of seedbed preparation, expected seeding dates, type and rate of lime and fertilizer application, and kind and quantity of mulching for both temporary and permanent vegetative control measures.
- Provisions for maintenance of control facilities.

Modifications to the Plan

- Major amendments of the erosion prevention and sediment control plan shall be submitted to (*Municipality*) and shall be processed and approved, or disapproved, in the same manner as the original plans.
- Field modifications of a minor nature may be authorized by (*Municipality*) by written authorization to the permitee.

Design Requirements

Grading, erosion prevention practices, and sediment control practices shall meet the design criteria set forth in the most recent version of (*Municipality)*, and shall be adequate to prevent transportation of sediment from the site to the satisfaction of (*Municipality*).

1. Clearing and Grading

    - Clearing and grading activities in streams, riparian areas, and wetlands shall not be permitted. Clearing and grading of other undisturbed natural areas, such as forests, shall not be permitted, except when in compliance all other sections of this Code and other applicable regulations and permits.
    - Site development techniques that retain native vegetation and retain natural drainage patterns, as described in (*Erosion Prevention and Sediment Control Manual)*, shall be used to the satisfaction of (*Municipality*).
    - Site development, except that necessary to establish sediment control devices, shall not begin until all appropriate sediment control devices have been installed and have been stabilized.

2. Erosion Prevention

- Soil must be stabilized within 14 days of final grading. On high risk sites or during the wet season, soil stabilization may be required at any time.
- If vegetative erosion control methods, such as seeding, have not become established within 14 days, (*Municipality)* may require that the site be reseeded, or that a non-vegetative option be employed.
- On steep slopes or in drainage ways, special techniques that meet the design criteria outlined in (*Erosion Prevention and Sediment Control Manual)* shall be used to ensure stabilization.
- Soil stockpiles must be stabilized or covered at the end of each work day.
- At the close or suspension of construction activity, the soil on the entire site must be stabilized. If vegetation is not sufficiently established (*insert performance standard here – may differ by region*), use of a heavy mulch layer, or another method that does not require germination to control erosion is required.
- Techniques shall be employed to prevent the blowing of dust or sediment from the site.
- Techniques that divert upland overland runoff, if present, to avoid disturbed slopes shall be employed.

3. Sediment Controls

   - Sediment controls shall be provided in the form of settling basins (if appropriate) or sediment traps or tanks, and perimeter controls as outlined in (*Erosion Prevention and Sediment Control Manual)*.
   - Where possible, settling basins shall be designed in a manner that allows adaptation to provide long term stormwater management.
   - Adjacent properties shall be protected by the use of a vegetated buffer strip, in combination with perimeter controls.

4. Waterways and Watercourses

   - This program does not guide, regulate, or control in-channel work activities or construction of temporary or permanent crossings of watercourses. Development that requires in-channel work activities or construction of watercourse crossings shall obtain necessary permits and approvals from (*Approving Agency, such as the U.S. Army Corps of Engineers, Oregon Division of State Lands, or others*).
   - All on-site stormwater conveyance channels shall be designed according to the criteria outlined in (*Erosion Prevention and Sediment Control Manual)*.
   - Stabilization adequate to prevent erosion must be provided at the outlets of all pipes and paved channels.

5. Construction Site Access

- A temporary, aggregate construction site entrance(s) or access road(s) shall be provided during construction.
- Other measures may be required at the discretion of (*Municipality)* in order to ensure that sediment is not tracked onto public streets by construction vehicles, or washed into storm drains. These measures will be determined during review of the EPSC Plan or from inspections taking into account site and conditions and seasonal timing of construction activities.

Section V. Monitoring, Inspection, and Reporting

Monitoring is needed to improve the quality of construction activities by providing essential feedback to *(Municipality)* on whether erosion prevention measures and sediment control practices for construction activities (BMPs) are being implemented, whether BMPs are effective, whether goals and objectives are being achieved, and to identify the need if any for Program adjustments.

Consequently, *(Municipality)* will develop a mechanism for appropriate monitoring accountability and oversight, conduct monitoring at a level commensurate with the level of on-the-ground activities, and collect feedback on the effects of activities.

The monitoring strategy shall be framed around two aspects of monitoring:

(1) implementation (compliance) monitoring to determine if the provisions of the Program are followed; and

(2) effectiveness monitoring to see if the implementation of provisions achieved the desired goals and objectives.

Monitoring shall be performed at two levels—the Project level and the Program level—to evaluate impacts of construction actions to sensitive environmental resources, such as fish species listed under the Endangered Species Act (ESA). Project-level monitoring shall be conducted at the permit-area scale. Program-level monitoring shall be conducted at the municipality or watershed scales.

(Municipality) shall ensure that schedules and procedures are developed and implemented for monitoring components at both the Project level and the Program level. *(Municipality)* may elect to maximize the utility of monitoring information through coordination with relevant parties and stakeholders, shared objectives, or a joint monitoring network. For example, *(Municipality)* may seek to incorporate NPDES monitoring into this monitoring effort or collaborate with other affected parties on monitoring and reporting.

Project Level Monitoring

It is required that onsite monitoring occur to determine the level of implementation of BMPs, and that effectiveness monitoring be initiated. The value of implementation monitoring is high. The reviews provide the *(Municipality)* as well as the NMFS an avenue through which to discuss site-specific implementation problems and opportunities, to answer questions regarding the intent of BMPs and Program components, and to provide suggestions for better implementation of the Program.

Implementation Monitoring and Inspection

(*Municipality*) or designated agent shall make walk-through or onsite inspections as hereinafter required to be certain that all completed measures are being operated and maintained in the field. If there are no deficiencies noted, the inspector shall issue an "approved" inspection notice to the permittee. If deficiencies are noted, the inspector shall issue a "not approved" notice to the permittee that informs the permittee of the deficiencies noted and the time frame in which corrections are to be made. The "not approved" notice also serves as a Stop Work warning if deficiencies are not corrected within the time frame. Follow-up inspections shall be done as necessary to ensure that deficiencies have been corrected. If the permittee fails to make the necessary corrections, a Stop Work order shall be issued to the permittee.

Plans for grading, stripping, excavating, and filling work bearing the stamp of approval of the (*Municipality*) shall be maintained at the site during the progress of the work. In order to obtain inspections, the permitee shall notify (*Municipality*) at least two (2) working days before the required inspection, or close or suspension of construction activity.

The permitee or his/her agent shall make regular inspections of all control measures and BMPs in accordance with the activity-appropriate inspection schedule outlined on the approved erosion prevention and sediment control plan or permit. In the absence of significant rainfall events, all control measures and BMPs should be inspected at least once per month. During the rainy season, all control measures and BMPs should be monitored before, during (for storms lasting 24 hours), and after storms.

Implementation monitoring should obtain information to describe and document: (1) types and occurrence of maintenance activities; (2) vegetation establishment; (3) final site restoration (finished grades, log and rock placements, planting composition and density; and (4) a narrative of the project's effect on sensitive environmental resources (e.g., streams, wetlands, riparian areas, habitats). All inspections shall be documented in written form and submitted to (*Municipality*) at the time interval specified in the approved permit.

Effectiveness Monitoring

The purpose of effectiveness monitoring will be to determine the overall effectiveness of the control plan, and the need for additional control measures and BMPs. The effectiveness monitoring shall be based on careful inspection to be certain erosion is being controlled and transport of sediment into critical areas is being prevented.

All disturbed areas of the site, areas for material storage, locations where vehicles enter or exit the site, and all the erosion and sediment controls that are identified as part of the plan shall be inspected. The inspection shall focus on visual evidence of any sediment discharge beyond control measures (e.g., fresh sediment outside of perimeter silt-fence barriers) or from the site (e.g., a turbidity plume in adjacent waterways). If such sediment discharge is evident, the inspection shall proceed to identify discharge sources and causes, and promptly implement corrective actions. Additional follow-up inspection of these sources and corrective actions shall continue at least daily until the sources of any such discharges have been halted.

Effectiveness monitoring should provide periodic monitoring point information of Project site conditions, and conditions of any adjacent sensitive environmental resources (e.g., streams, wetlands, riparian areas, and habitats). Permanent photo-monitoring points could be established to enhance continuity in monitoring efforts and to establish reference points against which the effects of construction and EPSC activities can be compared over time. Site vegetation and cover conditions should be monitored to evaluate: (1) the type of vegetation that is growing; (2) the density of vegetation and percent groundcover; and (3) any areas of erosion and the type of erosion. Effectiveness monitoring shall inspect vegetation and structures for the duration of the plan or the time it takes for the site to be finally stabilized and the permanent measures are in place and performing adequately.

Reporting

(Municipality) shall develop a procedure and schedule, and identify responsible parties, for reporting on implementation and effectiveness monitoring. Inspection reports should include information on damages or deficiencies, maintenance or repair activities, monitoring information, and vegetation establishment. Reports should include recommendations concerning the adequacy of P&Ms, additional measures to be taken, operations and maintenance actions, and future monitoring.

Program Level Monitoring

Implementation Monitoring

(Municipality) shall develop and conduct Program-level implementation monitoring to assess whether Program elements are being implemented as required and are effective. Program-level implementation monitoring information shall include summaries of:

- the number of site development permits issued
- the number of site development permits issued that were for land disturbing activity of 1,000 square feet to 1 acre (43,560 square feet) in size.
- the number of associated Erosion Prevention and Sediment Control (EPSC) Plans reviewed and approved
- the types of erosion prevention and sediment control measures and BMPs that were used among the EPSC Plans reviewed and approved
- the number of permit violations experienced or complaints received, and efforts made to resolve and correct them.

(*Municipality*) or its designated agent shall conduct and oversee random spot checks of the EPSC Plans and permit conditions.

(*Municipality*) or its designated agent shall enter the property of the permitee as deemed necessary to make regular inspections to ensure the validity of the reports filed under Section V.

Effectiveness Monitoring

(Municipality) shall develop and conduct Program-level effectiveness monitoring to assess whether protective measures are effective to attain water quality goals and management objectives. This may include effectiveness monitoring annually for groups of actions (by

activity type, time, and subwatershed or watershed) that may affect sensitive environmental resources (e.g., streams, wetlands, riparian areas, and habitats). Program-level effectiveness monitoring information shall include:

- A summary of information from Project inspection reports on any permit violations, failures experienced, or complaints received, and efforts made to correct or resolve them.
- A description of the types of erosion prevention and sediment control measures and BMPs that were used among the EPSC Plans reviewed and approved, and any observations on the effectiveness of the measures/BMPs
- Descriptions, locations, and maps of developed, undeveloped, and low density areas, and existing information on sensitive environmental resources (e.g., streams, wetlands, riparian areas, habitats).
- A description of trends in water quality, habitat quality and quantity, and ESA-listed species populations in watersheds or subwatersheds in which Program and Project activities occur (such information can usually be obtained from the Oregon Department of Environmental Quality, Oregon Department of Fish and Wildlife, local NPDES storm water monitoring programs, or local watershed councils).
- Recommendations for minimizing or reducing effects of the EPSC Program on sensitive environmental resources, particularly ESA-listed species and their habitats. Recommendations should address construction, reconstruction, removal, obliteration and decommissioning as well as an assessment of undeveloped and low density areas in relation to conservation of listed fish.
- Recommendations for additional habitat protection; risks to ESA-listed species from developmental activities; and restoration priorities.

(Municipality) may elect to develop a monitoring strategy including a range of monitoring alternatives commensurate with anticipated construction activity levels, funding, and staffing levels. It may further elect to recruit specialists in fish habitat evaluation, water quality assessment, erosion prevention and sediment control, or sampling design to guide an assessment of construction and management in relation to conservation of listed fish. Sampling and analysis protocols should be scientifically based and repeatable.

Effectiveness monitoring may include any of the following measures:

- Photography: Permanent photo-monitoring plots to enhance continuity in monitoring efforts and establish baseline information against which landscape modifications can be compared.
- Stream Turbidity: Oregon's standard for turbidity is an allowable increase of no more than 10% over background. Stream turbidity can be a problem for salmonids. Migrating salmonids avoid waters with high silt loads and, often, cease migration when such loads are unavoidable (Newcombe and MacDonald 1991, Newcombe and Jensen 1996). Newly emerged fry are more sensitive to turbidity than are older fish. Salmon and steelhead juveniles exhibit reduced growth and emigrate sooner from streams

containing turbidity in the range of 25-50 nephelometric turbidity units (Sigler et al. 1984).

- Erosion control measures and BMPs effectiveness tests: *(Municipality)* may elect to participate in regional efforts to conduct actual pilot test on the effectiveness of specific types of erosion control measures and BMPs.

Reporting

(Municipality) shall provide a Program-level summary of implementation and effectiveness monitoring. Reporting is essential to ensure that BMPs are being implemented, that progress is made toward achieving Program goals and objectives.

A report describing the applicant's success shall be prepared annually and submitted to NMFS. The report shall include the various components of information as listed in the above sections on Implementation Monitoring and Effectiveness Monitoring. In addition, the report shall include any pertinent recommendations for modifications or improvements in the Program and its requirements, such as:

- Recommendations for minimizing or reducing effects of EPSC Program on sensitive environmental resources. Recommendations should address construction, reconstruction, removal, obliteration and decommissioning as well as an assessment of undeveloped and low density areas in relation to sensitive environmental resources.
- Recommendations for additional Program protection of sensitive environmental resources; or better assessment of risks to sensitive environmental resources from developmental activities.

Modifications to the EPSC Program

Provisions for adaptive program modifications shall be based on existing data and data generated from monitoring reports, plans, quality control inspections, and activities. Modification or implementation of BMPs that are deemed more or equally protective of listed fish and fish habitat may be enacted without explicit concurrence of NMFS. Modification or implementation of BMPs that are less protective of listed fish and fish habitat may be enacted only after explicit concurrence of NMFS.

Section VI Enforcement

Stop-Work Order; Revocation of Permit

In the event that any person holding a site development permit pursuant to this ordinance violates the terms of the permit, or implements site development in such a manner as to materially adversely affect the health, welfare, or safety of persons residing or working in the neighborhood or development site so as to be materially detrimental to the public welfare or injurious to property or improvements in the neighborhood or the environment, or place federally protected species at risk of being harmed, (*Municipality*) may issue a stop-work order, and suspend or revoke the site development permit.

Violation and Penalties

No person or entity shall construct, enlarge, alter, repair, or maintain any grading, excavation, or fill, or cause the same to be done, contrary to or in violation of any terms of this ordinance. Any person violating any of the provisions of this ordinance shall be subject to civil penalties in the form of *(Municipality fill in such penalties here)*. Any person or entity that is issued a site development permit is responsible to correctly implement and maintain EPSC provisions and measures as specified in this program or the site development permit, and to prevent sediment from leaving the site and contaminating waterways or adjoining properties. In addition to any other civil penalties authorized by this section, any person or entity that violates any of the provisions of this ordinance shall be required to bear the expense of any necessary corrective or restoration action.

Section VII References

CWS, WES, and City of West Linn. 2000. Erosion Prevention and Sediment Control Planning and Design Manual. Developed in partnership with Clean Water Services (CWS) of Washington County, Water Environment Services (WES) of Clackamas County, and the City of West Linn, Oregon. Revised December 2000.

Newcombe, C. P., and D. D. MacDonald. 1991. Effects of Suspended Sediments on Aquatic Ecosystems. North American Journal of Fisheries Management 11: 72-82.

Newcombe, C. P., and J.O. Jensen. 1996. Channel suspended sediments and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16(4): 693-727.

Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. Effects of Chronic Turbidity on Density and Growth of Steelheads and Coho Salmon. Transactions of the American Fisheries Society 113: 142-150.

Attachment B: Sensitivity of Salmonids to Suspended Sediment and Turbidity

Sensitivity of Salmonids to Suspended Sediment and Turbidity

Suspended sediment (TSS) and turbidity influences on fish reported in the literature range from beneficial to detrimental (Newcombe and MacDonald 1991, Newcombe and Jensen 1996). Elevated TSS conditions have been reported to enhance cover conditions, reduce piscivorous fish/bird predation rates, and improve survival. Elevated TSS conditions have also been reported to cause physiological stress, reduce growth, and adversely affect survival. Of key importance in considering the detrimental effects of TSS on fish are the frequency and the duration of the exposure (not just the TSS concentration).

As observed in many research studies, high turbidity levels, even those well below potentially lethal levels, would stimulate avoidance behavior by salmonids. Behavioral avoidance of turbid waters may be one of the most important effects of suspended sediments (DeVore et al. 1980, Birtwell et al. 1984, Scannell 1988). Salmonids have been observed to move laterally (Servizi and Martens 1992), and downstream to avoid turbid plumes (McLeay et al. 1984, 1987). Avoidance of turbid waters begins between about 25-70 NTU (Sigler et al. 1984, Lloyd 1987, Scannell 1988). Newly emerged fry are more sensitive to turbidity than are older fish. Salmon and steelhead juveniles exhibit reduced growth and emigrate sooner from streams containing turbidity in the range of 25-50 Nephelometric Turbidity Units (Sigler et al. 1984). Juvenile salmonids tend to avoid streams that are chronically turbid, such as glacial streams or those disturbed by human activities, except when the fish need to traverse these streams along migration routes (Lloyd et al. 1987). However, the presence of juvenile salmonids in the Willamette River and Janetville Creek during the spring, when turbidity is naturally high, indicates these areas are not be avoided altogether due to turbidity.

Fish that remain in turbid or elevated TSS waters can experience a reduction in predation from piscivorous fish and birds (Gregory and Levings 1988). In systems with intense predation pressure, this provides a beneficial trade-off (e.g., enhanced survival) to the cost of potential physical effects (e.g., reduced growth). Turbidity levels of about 23 NTU have been found to minimize bird and fish predation risks (Gregory and Levings 1988).

Willamette Valley salmonids have evolved in a system that periodically experiences short-term (days to weeks) or seasonal elevated TSS/turbidity events (winter storms and floods) and are adapted to periodically elevated TSS exposures. Adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjorn and Reiser 1991). However, research indicates that chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Redding et al. 1987, Lloyd 1987, Servizi and Martens 1992). Turbidities in excess of about 25-60 NTU have been reported to decrease visual acuity, leading to reduced feeding rates (Redding et al. 1987, Bjorn and Reiser 1991) and reduced growth (Sigler 1984).

Additional behavioral effects include gill flaring and cough responses. These responses increase at higher suspended sediment concentrations (e.g. 30-60 NTU and 230 mg/L). It is not clear to what extent these behavioral responses affect long-term salmonid health (Berg and Northcote 1985, Servizi and Martens 1992).

Attachment C:
Estimated Erosion Rates and Sediment Yield

Table C-1

Spreadsheet (based on Revised Universal Soil Loss Equation) used to evaluate various scenarios, including comparing unmanaged site conditions with the erosion prevention and sediment control (EPSC) program.

Estimated Erosion Rates Using the Revised Universal Soil Loss Equation

Scenario: ***Dry Season Construction; Low Hazard Risk Site in Janetville***

			Construction Area		
			Pre-Construction	During Construction (Untreated)	After Construction
Drainage Area (ac)		5.00			
Construction Area (ac)		0.02			
Construction Area (sq.ft.)		1000			
Annual Rainfall Factor:	**R**	55			
Soil Erodibility Factor:	**K**	0.20			
Slope (%):	**S**	3.0			
Slope Length (ft):	**L**	200			
Topographic Factor	**LS**	0.3			
Cover Factor:	**C**		0.07	1.00	0.01
Practice Factor:	**P**		1.00	1.00	1.00
Sediment Delivery Ratio:	**SDR**	0.10			

	ESCP Acitivity	Period	Annual Rainfall Factor **R**	Period % R	Soil Erodibility Factor **K**	Slope (%) **S**	During Construction Construction Area: Cover Factor **C**	During Construction Construction Area: Practice Factor **P**	Soil Delivered (tons): Pre-Construction	Soil Delivered (tons): During Construction (Untreated)	Soil Delivered (tons): During Construction (Treated)	Soil Delivered (tons): Post-Construction
		Jan	55	17.5	0.20	3.0	0.07	1.00	0.020	0.020	0.020	0.020
		Feb	55	11.3	0.20	3.0	0.07	1.00	0.013	0.013	0.013	0.013
		Mar	55	10.6	0.20	3.0	0.07	1.00	0.012	0.012	0.012	0.012
		Apr	55	6.0	0.20	3.0	0.07	1.00	0.007	0.007	0.007	0.007
		May	55	4.9	0.20	3.0	0.07	1.00	0.006	0.006	0.006	0.006
C	Perimeter control (silt-fence barrier)	Jun	55	3.0	0.20	3.0	1.00	0.60	0.003	0.004	0.004	0.003
C	Mulching & Seeding	Jul	55	0.9	0.20	3.0	0.20	0.60	0.001	0.001	0.001	0.001
C	Sediment trap/basin	Aug	55	1.9	0.20	3.0	0.20	0.36	0.002	0.002	0.002	0.002
C	Temporary vegetation	Sep	55	3.9	0.20	3.0	0.10	0.36	0.005	0.005	0.005	0.004
C	Established vegetation	Oct	55	8.3	0.20	3.0	0.10	0.36	0.010	0.010	0.010	0.010
		Nov	55	14.2	0.20	3.0	0.07	1.00	0.016	0.016	0.016	0.016
		Dec	55	17.6	0.20	3.0	0.07	1.00	0.020	0.020	0.020	0.020
		Total							**0.116**	**0.117**	**0.116**	**0.115**
		% Change								*1.1*	*0.1*	*-0.4*
		% Effectiveness of ESCP									*65.3*	

Table C-2

Spreadsheet (based on Revised Universal Soil Loss Equation) used to evaluate various scenarios, including comparing unmanaged site conditions with the erosion prevention and sediment control (EPSC) program.

Estimated Erosion Rates Using the Revised Universal Soil Loss Equation

Scenario: ***Dry Season Construction; Moderate Hazard Risk Site in Janetville***

			Construction Area		
			Pre-Construction	During Construction (Untreated)	After Construction
Drainage Area (ac)		5.00			
Construction Area (ac)		0.23			
Construction Area (sq.ft.)		10000			
Annual Rainfall Factor:	**R**	55			
Soil Erodibility Factor:	**K**	0.35			
Slope (%):	**S**	8.0			
Slope Length (ft):	**L**	200			
Topographic Factor	**LS**	1.2			
Cover Factor:	**C**		0.07	1.00	0.01
Practice Factor:	**P**		1.00	1.00	1.00
Sediment Delivery Ratio:	**SDR**	0.40			

							During Construction Construction Area		Soil Delivered (tons)			
	ESCP Acitivity	Period	Annual Rainfall Factor **R**	Period % R	Soil Erodibility Factor **K**	Slope (%) **S**	Cover Factor **C**	Practice Factor **P**	Pre-Construction	During Construction (Untreated)	During Construction (Treated)	Post-Construction
		Jan	55	17.5	0.35	8.0	0.07	1.00	0.565	0.565	0.565	0.543
		Feb	55	11.3	0.35	8.0	0.07	1.00	0.366	0.366	0.366	0.352
		Mar	55	10.6	0.35	8.0	0.07	1.00	0.344	0.344	0.344	0.331
		Apr	55	6.0	0.35	8.0	0.07	1.00	0.193	0.193	0.193	0.185
		May	55	4.9	0.35	8.0	0.07	1.00	0.158	0.158	0.158	0.152
C	Perimeter control (silt-fence barrier)	Jun	55	3.0	0.35	8.0	1.00	0.60	0.098	0.158	0.132	0.094
C	Mulching & Seeding	Jul	55	0.9	0.35	8.0	0.20	0.60	0.028	0.046	0.029	0.027
C	Sediment trap/basin	Aug	55	1.9	0.35	8.0	0.20	0.36	0.060	0.097	0.060	0.058
C	Temporary vegetation	Sep	55	3.9	0.35	8.0	0.10	0.36	0.126	0.203	0.124	0.121
C	Established vegetation	Oct	55	8.3	0.35	8.0	0.10	0.36	0.268	0.432	0.262	0.258
		Nov	55	14.2	0.35	8.0	0.07	1.00	0.458	0.458	0.458	0.440
		Dec	55	17.6	0.35	8.0	0.07	1.00	0.568	0.568	0.568	0.546
		Total							**3.234**	**3.589**	**3.260**	**3.107**
		% Change								*11.0*	*0.8*	*-3.9*
		% Effectiveness of ESCP									*65.3*	

Table C-3

Spreadsheet (based on Revised Universal Soil Loss Equation) used to evaluate various scenarios, including comparing unmanaged site conditions with the erosion prevention and sediment control (EPSC) program.

Estimated Erosion Rates Using the Revised Universal Soil Loss Equation

Scenario: ***Dry Season Construction; High Hazard Risk Site in Janetville***

			Construction Area		
			Pre-Construction	During Construction (Untreated)	After Construction
Drainage Area (ac)		5.00			
Construction Area (ac)		1.03			
Construction Area (sq.ft.)		45000			
Annual Rainfall Factor:	**R**	55			
Soil Erodibility Factor:	**K**	0.50			
Slope (%):	**S**	15.0			
Slope Length (ft):	**L**	200			
Topographic Factor	**LS**	3			
Cover Factor:	**C**		0.07	1.00	0.01
Practice Factor:	**P**		1.00	1.00	1.00
Sediment Delivery Ratio:	**SDR**	0.80			

							During Construction Construction Area		Soil Delivered (tons)			
	ESCP Acitivity	Period	Annual Rainfall Factor **R**	Period % R	Soil Erodibility Factor **K**	Slope (%) **S**	Cover Factor **C**	Practice Factor **P**	Pre-Construction	During Construction (Untreated)	During Construction (Treated)	Post-Construction
		Jan	55	17.5	0.50	15.0	0.07	1.00	4.038	4.038	4.038	3.323
		Feb	55	11.3	0.50	15.0	0.07	1.00	2.617	2.617	2.617	2.153
		Mar	55	10.6	0.50	15.0	0.07	1.00	2.459	2.459	2.459	2.023
		Apr	55	6.0	0.50	15.0	0.07	1.00	1.376	1.376	1.376	1.132
		May	55	4.9	0.50	15.0	0.07	1.00	1.128	1.128	1.128	0.928
C	Perimeter control (silt-fence barrier)	Jun	55	3.0	0.50	15.0	1.00	0.60	0.699	2.619	1.793	0.575
C	Mulching & Seeding	Jul	55	0.9	0.50	15.0	0.20	0.60	0.203	0.760	0.233	0.167
C	Sediment trap/basin	Aug	55	1.9	0.50	15.0	0.20	0.36	0.429	1.605	0.431	0.353
C	Temporary vegetation	Sep	55	3.9	0.50	15.0	0.10	0.36	0.902	3.380	0.812	0.743
C	Established vegetation	Oct	55	8.3	0.50	15.0	0.10	0.36	1.917	7.182	1.725	1.578
		Nov	55	14.2	0.50	15.0	0.07	1.00	3.271	3.271	3.271	2.692
		Dec	55	17.6	0.50	15.0	0.07	1.00	4.061	4.061	4.061	3.341
		Total							**23.100**	**34.495**	**23.944**	**19.009**
		% Change								*49.3*	*3.7*	*-17.7*
		% Effectiveness of ESCP									*65.3*	

Table C-4
Spreadsheet (based on Revised Universal Soil Loss Equation) used to evaluate various scenarios, including comparing unmanaged site conditions with the erosion prevention and sediment control (EPSC) program.

Estimated Erosion Rates Using the Revised Universal Soil Loss Equation

Scenario: ***Wet Season Construction; Low Hazard Risk Site in Janetville***

			Construction Area		
			Pre-Construction	During Construction (Untreated)	After Construction
Drainage Area (ac)		5.00			
Construction Area (ac)		0.02			
Construction Area (sq.ft.)		1000			
Annual Rainfall Factor:	**R**	55			
Soil Erodibility Factor:	**K**	0.20			
Slope (%):	**S**	3.0			
Slope Length (ft):	**L**	200			
Topographic Factor	**LS**	0.3			
Cover Factor:	**C**		0.07	1.00	0.01
Practice Factor:	**P**		1.00	1.00	1.00
Sediment Delivery Ratio:	**SDR**	0.10			

						During Construction Construction Area		Soil Delivered (tons)			
	ESCP Acitivity	Period	Annual Rainfall Factor **R**	Period % R	Soil Erodibility Factor **K**	Slope (%) **S**	Cover Factor **C**	Practice Factor **P**	Pre-Construction	During Construction (Untreated)	During Construction (Treated)	Post-Construction
C	Perimeter control (silt-fence barrier)	Jan	55	17.5	0.20	3.0	1.00	0.60	0.020	0.021	0.021	0.020
C	Mulching & Seeding	Feb	55	11.3	0.20	3.0	0.20	0.60	0.013	0.014	0.013	0.013
C	Sediment trap/basin	Mar	55	10.6	0.20	3.0	0.20	0.36	0.012	0.013	0.012	0.012
C	Temporary vegetation	Apr	55	6.0	0.20	3.0	0.10	0.36	0.007	0.007	0.007	0.007
C	Established vegetation	May	55	4.9	0.20	3.0	0.10	0.36	0.006	0.006	0.006	0.006
		Jun	55	3.0	0.20	3.0	0.07	1.00	0.003	0.003	0.003	0.003
		Jul	55	0.9	0.20	3.0	0.07	1.00	0.001	0.001	0.001	0.001
		Aug	55	1.9	0.20	3.0	0.07	1.00	0.002	0.002	0.002	0.002
		Sep	55	3.9	0.20	3.0	0.07	1.00	0.005	0.005	0.005	0.004
		Oct	55	8.3	0.20	3.0	0.07	1.00	0.010	0.010	0.010	0.010
		Nov	55	14.2	0.20	3.0	0.07	1.00	0.016	0.016	0.016	0.016
		Dec	55	17.6	0.20	3.0	0.07	1.00	0.020	0.020	0.020	0.020
		Total							**0.116**	**0.119**	**0.116**	**0.115**
		% Change								*3.1*	*0.6*	*-0.4*
		% Effectiveness of ESCP									*69.3*	

Table C-5
Spreadsheet (based on Revised Universal Soil Loss Equation) used to evaluate various scenarios, including comparing unmanaged site conditions with the erosion prevention and sediment control (EPSC) program.

Estimated Erosion Rates Using the Revised Universal Soil Loss Equation

Scenario: ***Wet Season Construction; Moderate Hazard Risk Site in Janetville***

			Construction Area		
			Pre-Construction	During Construction (Untreated)	After Construction
Drainage Area (ac)		5.00			
Construction Area (ac)		0.23			
Construction Area (sq.ft.)		10000			
Annual Rainfall Factor:	**R**	55			
Soil Erodibility Factor:	**K**	0.35			
Slope (%):	**S**	8.0			
Slope Length (ft):	**L**	200			
Topographic Factor	**LS**	1.2			
Cover Factor:	**C**		0.07	1.00	0.01
Practice Factor:	**P**		1.00	1.00	1.00
Sediment Delivery Ratio:	**SDR**	0.40			

							During Construction Construction Area		Soil Delivered (tons)			
	ESCP Acitivity	Period	Annual Rainfall Factor **R**	Period % R	Soil Erodibility Factor **K**	Slope (%) **S**	Cover Factor **C**	Practice Factor **P**	Pre-Construction	During Construction (Untreated)	During Construction (Treated)	Post-Construction
C	Perimeter control (silt-fence barrier)	Jan	55	17.5	0.35	8.0	1.00	0.60	0.565	0.910	0.762	0.543
C	Mulching & Seeding	Feb	55	11.3	0.35	8.0	0.20	0.60	0.366	0.590	0.378	0.352
C	Sediment trap/basin	Mar	55	10.6	0.35	8.0	0.20	0.36	0.344	0.554	0.345	0.331
C	Temporary vegetation	Apr	55	6.0	0.35	8.0	0.10	0.36	0.193	0.310	0.188	0.185
C	Established vegetation	May	55	4.9	0.35	8.0	0.10	0.36	0.158	0.254	0.154	0.152
		Jun	55	3.0	0.35	8.0	0.07	1.00	0.098	0.098	0.098	0.094
		Jul	55	0.9	0.35	8.0	0.07	1.00	0.028	0.028	0.028	0.027
		Aug	55	1.9	0.35	8.0	0.07	1.00	0.060	0.060	0.060	0.058
		Sep	55	3.9	0.35	8.0	0.07	1.00	0.126	0.126	0.126	0.121
		Oct	55	8.3	0.35	8.0	0.07	1.00	0.268	0.268	0.268	0.258
		Nov	55	14.2	0.35	8.0	0.07	1.00	0.458	0.458	0.458	0.440
		Dec	55	17.6	0.35	8.0	0.07	1.00	0.568	0.568	0.568	0.546
		Total							**3.234**	**4.226**	**3.435**	**3.107**
		% Change								*30.7*	*6.2*	*-3.9*
		% Effectiveness of ESCP									*69.3*	

Table C-6

Spreadsheet (based on Revised Universal Soil Loss Equation) used to evaluate various scenarios, including comparing unmanaged site conditions with the erosion prevention and sediment control (EPSC) program.

Estimated Erosion Rates Using the Revised Universal Soil Loss Equation

Scenario: ***Wet Season Construction; High Hazard Risk Site in Janetville***

			Construction Area: Pre-Construction	Construction Area: During Construction (Untreated)	Construction Area: After Construction
Drainage Area (ac)		5.00			
Construction Area (ac)		1.03			
Construction Area (sq.ft.)		45000			
Annual Rainfall Factor:	**R**	55			
Soil Erodibility Factor:	**K**	0.50			
Slope (%):	**S**	15.0			
Slope Length (ft):	**L**	200			
Topographic Factor	**LS**	3			
Cover Factor:	**C**		0.07	1.00	0.01
Practice Factor:	**P**		1.00	1.00	1.00
Sediment Delivery Ratio:	**SDR**	0.80			

	ESCP Acitivity	Period	Annual Rainfall Factor **R**	Period % R	Soil Erodibility Factor **K**	Slope (%) **S**	During Construction Construction Area: Cover Factor **C**	During Construction Construction Area: Practice Factor **P**	Soil Delivered (tons): Pre-Construction	Soil Delivered (tons): During Construction (Untreated)	Soil Delivered (tons): During Construction (Treated)	Soil Delivered (tons): Post-Construction
C	Perimeter control (silt-fence barrier)	Jan	55	17.5	0.50	15.0	1.00	0.60	4.038	15.124	10.356	3.323
C	Mulching & Seeding	Feb	55	11.3	0.50	15.0	0.20	0.60	2.617	9.801	3.003	2.153
C	Sediment trap/basin	Mar	55	10.6	0.50	15.0	0.20	0.36	2.459	9.209	2.473	2.023
C	Temporary vegetation	Apr	55	6.0	0.50	15.0	0.10	0.36	1.376	5.154	1.238	1.132
C	Established vegetation	May	55	4.9	0.50	15.0	0.10	0.36	1.128	4.225	1.015	0.928
		Jun	55	3.0	0.50	15.0	0.07	1.00	0.699	0.699	0.699	0.575
		Jul	55	0.9	0.50	15.0	0.07	1.00	0.203	0.203	0.203	0.167
		Aug	55	1.9	0.50	15.0	0.07	1.00	0.429	0.429	0.429	0.353
		Sep	55	3.9	0.50	15.0	0.07	1.00	0.902	0.902	0.902	0.743
		Oct	55	8.3	0.50	15.0	0.07	1.00	1.917	1.917	1.917	1.578
		Nov	55	14.2	0.50	15.0	0.07	1.00	3.271	3.271	3.271	2.692
		Dec	55	17.6	0.50	15.0	0.07	1.00	4.061	4.061	4.061	3.341
		Total							**23.100**	**54.995**	**29.567**	**19.009**
		% Change								*138.1*	*28.0*	*-17.7*
		% Effectiveness of ESCP									*69.3*	

Attachment D:
Selected Sources of Data and Information Used in Calculations of Erosion Rates and Sediment Yield

Attachment E:
Matrix of BMP Effectiveness

Table E-1
Information related to relative effectiveness of erosion prevention and sediment control BMPs. Janetville Fish-Friendly Erosion Control Program. Ratings shown here are preliminary for discussion purposes only. For example, a rating of high for sediment and turbidity means that the BMP is considered highly effective at preventing, controlling, or reducing sediment and turbidity releases and their potentially detrimental effects.

BMP Application	Sediment & Turbidity	Peak Flow & Runoff Volume	Nutrients and Contaminants	Water Temperature
Erosion Prevention				
Preserve Natural Vegetation *Use of natural vegetation maintains ground cover and natural retention and filtration of runoff*	**High** *Prevents or limits soil disturbance. Preserves natural retention and filtration of runoff.*	**High** *Preserves natural retention and filtration of runoff.*	**High** *Preserves natural retention and filtration of runoff. Reduces need for fertilizer or pesticides.*	**Moderate** *Preserves natural retention and filtration of runoff, as well as shading. The degree of effectiveness is inconclusive, except where directly adjacent to waterway.*
Buffer Zone *Undisturbed area or strip of natural vegetation adjacent to disturbed area*	**High** *Enhanced sediment deposition and limits soil disturbance and erosion. Preserves natural retention and filtration of runoff. Can reduce 40-80% of total suspended solids[30].*	**High** *Slows and reduces runoff by preserving natural retention and infiltration.*	**High** *Preserves natural retention and filtration of runoff. Can reduce nitrogen by 25-65% and phosphorus by 30-70%[1].*	**Moderate** *Preserves natural retention and filtration of runoff, as well as shading. The degree of effectiveness is inconclusive, except where directly adjacent to waterway.*
Temporary/Permanent Seeding *Shields soil from direct impact from rainfall. Reduces erosion potential on hill slopes and traps sediment. Irrigation is necessary if planting in July or August.*	**Moderate** *Effectiveness depends upon the percent coverage of grass on the affected area. Traps sediment and promotes infiltration of smaller storm precipitation. Can be up to 90%[31] efficient after root system is established.*	**Moderate** *Effectiveness depends upon the percent coverage of grass on the affected area. Reduces runoff velocity and promotes infiltration.*	**Moderate** *Effectiveness depends upon the percent coverage of grass on the affected area. Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Moderate** *Increased infiltration of small storm precipitation and shading provides some degree of temperature moderation. The degree of effectiveness is inconclusive.*

30 DEQ (1994). *Non-point Source Pollution Control Guidebook for Local Government*. June 1994.

31 DEQ (2001). *Best Management Practices for Storm Water Discharges Associated With Construction Activities.* August 2001

Table E-1

Information related to relative effectiveness of erosion prevention and sediment control BMPs. Janetville Fish-Friendly Erosion Control Program. Ratings shown here are preliminary for discussion purposes only. For example, a rating of high for sediment and turbidity means that the BMP is considered highly effective at preventing, controlling, or reducing sediment and turbidity releases and their potentially detrimental effects.

BMP Application	Sediment & Turbidity	Peak Flow & Runoff Volume	Nutrients and Contaminants	Water Temperature
Ground Cover *Application of straw, compost, wood chips, etc.* provides *immediate protection by shielding soil from direct impact from rainfall. This is a temporary measure used until a permanent measure is implemented*	**High** *Traps sediment and conserves moisture. Can be very effective for immediate control. Broken up bales of straw spread by hand perform better than shorter lengths of blown chopped straw.*[32]	**Moderate** *Reduces runoff velocity and promotes infiltration. Will reduce runoff potential from small storms.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Moderate** *Increased infiltration of small storm precipitation provides some degree of temperature moderation. The degree of effectiveness is inconclusive*
Hydraulic Applications *Hydraulic equipment mechanically applies mulch, tackifiers, soil amendments, grass seed, etc. Can be used effectively on steep slopes where access is limited.*	**Moderate** *Traps sediment and promotes infiltration of smaller storm precipitation.*	**Moderate** *Reduces runoff velocity and promotes infiltration. Will reduce runoff potential from small storms.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Moderate** *Increased infiltration of small storm precipitation provides some degree of temperature moderation. The degree of effectiveness is inconclusive.*
Sod *Immediate establishment of permanent turf.*	**High** *Provides high density vegetation that effectively traps sediment.*	**Moderate** *Reduces runoff velocity and promotes infiltration. Must de-compact soil prior to Sod placement to realize infiltration benefit..*	**Moderate** *Very effective at minimizing erosion potential. However, typically requires fertilizer application.*	**Moderate** *Increased infiltration of small storm precipitation provides some degree of temperature moderation. The degree of effectiveness is inconclusive.*
Matting *Manufactured erosion control products such as netting, meshes, blankets, etc. Come in a variety of materials including jute, coconut fiber, straw, synthetics and combinations of materials. Many are biodegradable.*	**High** *Temporary measure that traps sediment and conserves moisture. Can be very effective for immediate control. Must ensure complete contact with soil surface to prevent erosion under the blanket.*	**Moderate** *Reduces runoff velocity and promotes infiltration.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Moderate** *Increased infiltration of small storm precipitation provides some degree of temperature moderation. The degree of effectiveness is inconclusive.*

[32] Wright, F. F. *Keeping Soil in Place When Wet Weather Hits the Construction Site.* Erosion Control Journal, March/April 2002.

Table E-1
Information related to relative effectiveness of erosion prevention and sediment control BMPs. Janetville Fish-Friendly Erosion Control Program. Ratings shown here are preliminary for discussion purposes only. For example, a rating of high for sediment and turbidity means that the BMP is considered highly effective at preventing, controlling, or reducing sediment and turbidity releases and their potentially detrimental effects.

BMP Application	Sediment & Turbidity	Peak Flow & Runoff Volume	Nutrients and Contaminants	Water Temperature
Plastic Sheeting *Impervious material that should only be used when stockpiled material must be kept dry. Has been known to transfer erosion problems downstream.*	**Low** *Effectively protects the material being covered if installed correctly. Is difficult to keep in place in windy conditions. Can cause erosion problem downstream due to addition of new impervious surface.*	**Low** *Increases runoff velocity and runoff volume due to the addition of impervious area.*	**Low** *Reduces the potential of erosion and mobilization of soils for the covered stockpile, but can increase erosion potential and mobilization of nutrients and contaminants downstream of the site.*	**Low** *New impervious surface has high potential to increase the temperature of runoff.*
Dust Control *Control wind transport of soil with the application of water or chemical soil treatments.*	**Low** *Reduces wind induced erosion. However, over-watering can cause surface erosion.*	**Low** *Not applicable*	**Low** *Effective at temporarily reducing the transport of soil from the construction site*	**Low** *Has no impact on water temperature.*
Runoff Control				
Construction Entrance *Stabilized rock pads located at all entrance and exit locations to a construction site.*	**Moderate** *Effective at dislodging soil that is stuck in tire treads and would be deposited on streets. Larger rock causes greater deformation of the tire and is therefore more effective at dislodging the soil.*	**Low** *Does not control peak flows or runoff volume.*	**Moderate** *Reduces the quantity of soil deposited on streets and subsequently washed into storm drain. Therefore, effective at reducing the transport of nutrients and metals bound to the soil particles.*	**Low** *Has no impact on water temperature.*
Tire Wash Facility *Facility to wash tires of vehicles exiting a construction site.*	**Moderate** *Effective at dislodging soil and washing tires to prevent deposition of soil on the street. Wash water must be treated prior to discharge.*	**Low** *Does not control peak flows or runoff volume.*	**Moderate** *Reduces the quantity of soil deposited on streets and subsequently washed into storm drain. Therefore, effective at reducing the transport of nutrients and metals bound to the soil particles.*	**Low** *Has no impact on water temperature.*

Table E-1

Information related to relative effectiveness of erosion prevention and sediment control BMPs. Janetville Fish-Friendly Erosion Control Program. Ratings shown here are preliminary for discussion purposes only. For example, a rating of high for sediment and turbidity means that the BMP is considered highly effective at preventing, controlling, or reducing sediment and turbidity releases and their potentially detrimental effects.

BMP Application	Sediment & Turbidity	Peak Flow & Runoff Volume	Nutrients and Contaminants	Water Temperature
Pipe Slope Drain *Temporary structure installed to convey runoff down a slope without causing erosion. Removed when permanent drainage system is installed.*	**Moderate** *If installed correctly, very effective at conveying runoff down a slope. There is potential for erosion under the pipe if pipe joints are not effectively sealed.*	**Low** *Does not control peak flows or runoff volume.*	**Moderate** *Significantly reduces the potential for erosion on steep slopes and mobilizing soil and nutrients and metals bound to the soil.*	**Low** *Has no impact on water temperature.*
Outlet Protection *Energy dissipation structures used to reduce flow velocity and prevent the scouring of soils.*	**Moderate** *Very effective at preventing scour of soils at pipe and channel outlets. Will help to settle out coarse grain particles, such as sand, but not fine grained particles like silts and clays.*	**Low** *Does not control peak flows or runoff volume.*	**Moderate** *Reduces the scour potential and mobilization of soil by protecting soil at pipe outlets.*	**Low** *Has no impact on water temperature.*
Surface Roughening *Roughening of soil to create depressions that will trap seed and reduce flow velocity.*	**Moderate** *Should be used in conjunction with temporary or permanent seeding. Grooves should run perpendicular, <u>not parallel</u>, to the slope. Can reduce erosion by 10% if grooves are perpendicular or increase erosion by as much as 20% if parallel.*[2]	**Moderate** *Reduces runoff velocity and promotes infiltration. Should be used in conjunction with temporary or permanent seeding.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Moderate** *Increased infiltration of small storm precipitation provides some degree of temperature moderation. The degree of effectiveness is inconclusive.*
Check Dams *Small, pervious dams that are constructed across a swale or ditch to reduce flow velocities, decrease erosion potential and settle out sediment.*	**Moderate** *Effective at reducing the erosion potential as vegetation is becoming established in a bioswale. Effective at settling out coarse grain particles.*	**Moderate** *Reduces runoff velocity and promotes infiltration. Provides some detention storage upstream of check dams.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Moderate** *Increased infiltration of small storm precipitation provides some degree of temperature moderation. The degree of effectiveness is inconclusive.*

Table E-1
Information related to relative effectiveness of erosion prevention and sediment control BMPs. Janetville Fish-Friendly Erosion Control Program. Ratings shown here are preliminary for discussion purposes only. For example, a rating of high for sediment and turbidity means that the BMP is considered highly effective at preventing, controlling, or reducing sediment and turbidity releases and their potentially detrimental effects.

BMP Application	Sediment & Turbidity	Peak Flow & Runoff Volume	Nutrients and Contaminants	Water Temperature
Diversion Dikes/Swales *A ridge of compacted soil or a swale with vegetated or riprap lining. Used to intercept and convey smaller flows. Suitable for sites 5 acres or less. Design for 10-year peak flow.*[2]	**Moderate** *Effective at reducing the erosion potential on steep slopes and at the top and toe of cut slopes. Also effective to use to prevent entry of off-site runoff.*	**Low** *Diverts and conveys flow. Does not control peak flows or runoff volume.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Low** *Effectiveness is not well known or inconclusive.*
Bioswale *Shallow channel lined with grass or native vegetation to reduce runoff and capture sediment. Suitable for sites 10 acres or less.*[2]	**High** *Can remove 83 -92% of total suspended solids*[2].	**Moderate** *Swale acts to detain and reduce runoff volume. Effectiveness is limited depending on magnitude of runoff event. Runoff from smaller events can infiltrate through the swale bottom.*	**Moderate** *Can reduce nitrates by 39 - 89% and phosphorus by 29 - 80%*[2]. *Use of compost and native plants eliminates need for fertilizer or pesticide.*	**Moderate** *Increased infiltration of small storm precipitation provides some degree of temperature moderation. The degree of effectiveness is inconclusive.*
Sediment Control				
Sediment Fence *A temporary sediment trap that is constructed of 30 – 36 inch wide geotextile stretched across and attached to supporting posts. Only effective in overland or sheet flow conditions – should not be placed across streams or other concentrated flows.*[2]	**Moderate** *The following ranges of control can be obtained for TSS:* *Sand: 80% - 99%* *Silt-Loam: 50% - 80%* *Silt-Clay-Loam: 0% - 20%*[2]	**Low** *Does not effectively control peak flows or runoff volume, but has some ability to reduce velocity of sheet flow and promote infiltration.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Low** *Effectiveness not well known or inconclusive*
Bio-filter Bags *Plastic mesh bags filled with wood product waste.*	**Low** *Somewhat effective at filtering sediment if installed correctly. Placing bio-filter bags on the ground surface without proper anchoring provides minimal erosion control.*	**Low** *Does not effectively control peak flows or runoff volume, but has some ability to reduce velocity of sheet flow and promote infiltration.*	**Low** *Can reduce the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Low** *Effectiveness not well known or inconclusive*

Table E-1
Information related to relative effectiveness of erosion prevention and sediment control BMPs. Janetville Fish-Friendly Erosion Control Program. Ratings shown here are preliminary for discussion purposes only. For example, a rating of high for sediment and turbidity means that the BMP is considered highly effective at preventing, controlling, or reducing sediment and turbidity releases and their potentially detrimental effects.

BMP Application	Sediment & Turbidity	Peak Flow & Runoff Volume	Nutrients and Contaminants	Water Temperature
Straw Wattles *Straw, coconut or other material that is wrapped in tubular shaped plastic netting.*	**Moderate** *Effective at filtering sediment if installed correctly. TSS retention capacity averages about 70%.*[2]	**Low** *Does not effectively control peak flows or runoff volume, but has some ability to reduce velocity of sheet flow and promote infiltration.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Low** *Effectiveness not well known or inconclusive*
Sand Bags *Clean sand placed in tightly woven geotextile fabric bag. Size should be 24 x 12 x 6 inches and weigh at least 75 lbs.*[33]	**Low** *Can be effective for emergency situations where concentrated flows are causing erosion.*	**Low** *Can be used to divert or slow the velocity of small flows. Can be used in concrete lined ditches to slow velocity and trap some coarser sediments.*	**Low** *Can be used as a temporary dam to stop the flow of contaminated water.*	**Low** *Effectiveness not well known or inconclusive*
Filter Berm/Continuous Berm *A berm constructed of gravel or crushed rock. A slight variance is the continuous berm that is produced by a continuous berm machine. The machine encapsulates sand, aggregate or soil with geotextile.*	**Moderate** *Effective at filtering sediment. Continuous Berm is rated at up to 95% efficiency in sediment removal.*[2]	**Low** *Does not effectively control peak flows or runoff volume.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Low** *Effectiveness not well known or inconclusive*
Brush Barrier *Low cost temporary sediment barrier on perimeter of site. Constructed of materials available from the clearing and grubbing of the site.*	**Moderate** *Effective as a secondary sediment barrier.*	**Low** *Does not effectively control peak flows or runoff volume.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Low** *Effectiveness not well known or inconclusive*

33 CWS (2000). *Erosion Prevention and Sediment Control Planning and Design Manual.* December 2000

Table E-1
Information related to relative effectiveness of erosion prevention and sediment control BMPs. Janetville Fish-Friendly Erosion Control Program. Ratings shown here are preliminary for discussion purposes only. For example, a rating of high for sediment and turbidity means that the BMP is considered highly effective at preventing, controlling, or reducing sediment and turbidity releases and their potentially detrimental effects.

BMP Application	Sediment & Turbidity	Peak Flow & Runoff Volume	Nutrients and Contaminants	Water Temperature
Compost Berm *A berm constructed of yard debris compost.*	**High** *Very effective at filtering fine grained sediment. Most sediment and colloidal soil particles are negatively charged. Compost is positively charged which tends to attract and hold the soil particles. Much more effective than sediment fence for control of fine grained sediment.*[2]	**Moderate** *Reduces runoff velocity and promotes infiltration. Will reduce runoff potential from small storms.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil. Nutrients can leach out of the compost.*	**Low** *Effectiveness not well known or inconclusive*
Sidewalk Subgrade Gravel Barrier *A gravel barrier placed as the sidewalk subgrade. Generally only used for single family home sites.*	**Moderate** *A low cost method to retain suspended solids on small, flat sites.*	**Low** *Does not effectively control peak flows or runoff volume.*	**Moderate** *Reduces the potential of erosion and potential for mobilizing nutrients and metals that are bound to the soil.*	**Low** *Effectiveness not well known or inconclusive*
Pre-Fabricated Barriers *Fabricated systems that typically consist of a triangular shaped dike made of lightweight material and wrapped with geotextile.*	**Low** *Can be effective at retaining larger suspended particles. However, must be installed exactly as specified by manufacturer.*	**Low** *Does not effectively control peak flows or runoff volume.*	**Low** *Reduces flow velocity and related erosional forces, but only retains larger particles.*	**Low** *Effectiveness not well known or inconclusive*
Inlet Protection *Variety of systems used to prevent coarse sediment from entering the storm drain system. Typically limited to a maximum 1 acre drainage area.*[2]	**Moderate** *Have the least sediment retention of any sediment control option, but can be valuable to retain coarser sediment if properly maintained.*[2]	**Low** *Does not effectively control peak flows or runoff volume.*	**Low** *Retains only larger particles. Typically nutrients and metals are bound to smaller, fine grained particles.*	**Low** *Effectiveness not well known or inconclusive*

Table E-1
Information related to relative effectiveness of erosion prevention and sediment control BMPs. Janetville Fish-Friendly Erosion Control Program. Ratings shown here are preliminary for discussion purposes only. For example, a rating of high for sediment and turbidity means that the BMP is considered highly effective at preventing, controlling, or reducing sediment and turbidity releases and their potentially detrimental effects.

BMP Application	Sediment & Turbidity	Peak Flow & Runoff Volume	Nutrients and Contaminants	Water Temperature
De-Watering (Filtration) *Separation of sediment from water by passing the water through a permeable medium that will trap the sediment particles.*	**Moderate** *Effective for utility work. Some systems have the ability to effectively remove fine grained particles. Must determine soil type prior to selecting dewatering system.*	**Low** *Does not effectively control peak flows or runoff volume.*	**Moderate** *Effective in reducing nutrients and metals bound to sediments in de-watering discharge.*	**Low** *No effect on water temperature.*
Flocculants and Coagulants *Polymers and inorganic chemicals used to speed the settlement of fine grained particles.*	**High** *Mean turbidity reductions can be achieved in the 95.5% to 99.4 % range using a flocculation system.*[2]	**Low** *Does not effectively control peak flows or runoff volume.*	**High** *Very effective in reducing nutrients and metals bound to fine grained sediments.*	**Low** *No effect on water temperature.*
Sediment Trap *A small, temporary ponding area formed by excavation or construction of bermed sides. Limited to drainage areas of 5 acres and smaller.*[4]	**Moderate** *Average 60% removal of TSS.*[2] *Effectiveness is dependent upon native soil type. Not as effective where fine-grained soils exist.*	**Moderate** *Generally used more for ability to capture sediments and pollutants rather than ability to reduce peak runoff flows.*	**Moderate** *Effective in reducing nutrients and metals bound to sediments in incoming runoff.*	**Low** *Effectiveness not well known or inconclusive*
Sediment Basin *Non-natural structure that allows sediment to settle out of runoff. Usually used for drainage areas 5-100 acres in size.*	**Moderate** *Can reduce 55-100% of total suspended solids*[2]*. Effectiveness is dependent upon native soil type. Not as effective where fine-grained soils exist.*	**Moderate** *Generally used more for ability to capture sediments and pollutants rather than ability to reduce peak runoff flows.*	**Moderate** *Effective in reducing nutrients and metals bound to sediments in incoming runoff.*	**Low** *Effectiveness not well known or inconclusive*